U. S. ARMY CORPS OF ENGINEERS

ECONOMICS SECTION

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

ECONOMICS SECTION

JULY 1971 PRICE LEVELS (P. 56)

43

Prepared by
U. S. Army Engineer District, New Orleans, New Orleans, Louisiana

Revised August 1971

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P. O. BOX 60267
NEW ORLEANS, LOUISIANA 70160

LMNED-PP

30 August 1971

SUBJECT: New Orleans to Venice, Louisiana, Design Memorandum No. 1, General Design, Reach B1 - Tropical Bend to Fort Jackson

Division Engineer, Lower Mississippi Valley
ATTN: LMVED-TD

1. Forwarded herewith for review and approval in accordance with the provisions of ER 1110-2-1150 dated 19 June 1970 is the subject design memorandum.

2. Preparation of the five-point environmental statement is in process and is scheduled for submission in February 1972.

3. Approval of this design memorandum is recommended.

1 Incl (16 cys)
GDM No. 1 fwd sep

RICHARD L. HUNT
Colonel, CE
District Engineer

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

STATUS OF DESIGN MEMORANDUMS

Design Memo No.	Title	Status
1	New Orleans to Venice, La., Design Memorandum No. 1 - General Design Reach B1 - Tropical Bend to Fort Jackson	Approved Aug 67 Revised Aug 71
1	New Orleans to Venice, La., Design Memorandum No. 1 - General Design, Reach B1 - Tropical Bend to Fort Jackson, Supplement No. 1, Alteration of Method of Constructing Stream Closures	Approved Dec 68
2	New Orleans to Venice, La., Design Memorandum No. 2, Detail Design, Reach B1 - Tropical Bend to Fort Jackson, Empire Floodgate	Approved Mar 71
1	New Orleans to Venice, La., Design Memorandum No. 1 - General Design, Supplement No. 3, Reach C - Phoenix to Bohemia	Scheduled Sept 71
1	New Orleans to Venice, La., Design Memorandum No. 1 - General Design, Supplement No. 2 - East Bank Barrier Levee Plan	Scheduled Aug 71
1	New Orleans to Venice, La., Design Memorandum No. 1 - General Design, Supplement No. 4, Reach B2 - Fort Jackson to Venice	Scheduled Nov 71
1	New Orleans to Venice, La., Design Memorandum No. 1 - General Design, Supplement No. 5, Reach A - City Price to Tropical Bend	Scheduled Mar 72

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

TABLE OF CONTENTS (cont'd)

TABLE OF CONTENTS (cont'd)

TABLE OF CONTENTS (cont'd)

TABLES

TABLE OF CONTENTS (cont'd)

PLATES

TABLE OF CONTENTS (cont'd)

PLATES (cont'd)

TABLE OF CONTENTS (cont'd)

PLATES (cont'd)

TABLE OF CONTENTS (cont'd)

TABLES (cont'd)

APPENDIXES

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

PERTINENT DATA

Location of project		Mississippi River Delta section of coastal Louisiana, Plaquemines Parish
Datum plane		mean sea level
Hydrologic data		
Temperature:	Monthly means	
	Maximum	83° Fahrenheit
	Minimum	57° Fahrenheit
	Average annual	70° Fahrenheit
Annual precipitation:	Maximum	85.73 inches
	Minimum	31.04 inches
	Average annual	60.8 inches
Hydraulic design criteria--tidal		
Design hurricane		
Frequency		1 in 100 years
Central pressure index		28.02 inches of mercury
Maximum 5-min. average wind		91 m.p.h.
Levees		
Method of construction		Hydraulic lifts & shape-ups
Levee length (approximate)		12.0 miles
Elevation		15.0 feet mean sea level
Crown width		8 feet
Estimated first cost		
Levees and floodwalls		$20,397,600
Engineering and design		2,429,400
Supervision and administration		1,533,000
Relocations		823,000
Lands and damages		617,000
Total		$25,800,000

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

PROJECT AUTHORIZATION

1. Authority.

a. Public Law. Public Law 874-87th Congress, 2d Session, approved 23 October 1962, authorized the "Mississippi River Delta at and below New Orleans, Louisiana" (renamed "New Orleans to Venice, Louisiana," after authorization) project substantially in accordance with the recommendations of the Chief of Engineers in House Document No. 550, 87th Congress, 2d Session.

b. House Document. The report of the Chief of Engineers, dated 30 July 1962, printed in House Document No. 550, 87th Congress, 2d Session, submitted for transmittal to Congress the report of the Board of Engineers for Rivers and Harbors, accompanied by the reports of the District and Division Engineers. The Chief of Engineers in his report concurred in the recommendations of the Board of Engineers for Rivers and Harbors which are as follows:

"...Accordingly, the Board recommends improvements along the Mississippi River below New Orleans, Louisiana, for prevention of hurricane tidal damages by increasing the heights of the existing back levees and modifying the existing drainage facilities where necessary in four separate reaches consisting of:

"Reach A on the west bank for about 15 miles between City Price and Empire;

"Reach B on the west bank for about 21 miles between Empire and Venice and with such modifications of the main levee as may be required;

"Reach C on the east bank for about 16 miles between Phoenix and Bohemia; and

"Reach E on the east bank for about 8 miles between Violet and Verret;

"generally in accordance with the plans of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable,...."

c. <u>Modification of Mississippi River levees</u>.

(1) The Board of Engineers for Rivers and Harbors in its report recommended "...such modifications of the main river levee as may be required..." for the purpose of hurricane protection. The President of the Mississippi River Commission, in presenting the project to Congress for initial construction, testified in part as follows: "The plan also provides for modification of the main river levee of the project 'Mississippi River and Tributaries,' as may be found necessary to accomplish the purpose of the hurricane protection project. The improvements will provide protection against tides of 100-year frequency, but will not provide complete protection from tidal flooding." (See Hearings on PWA for 1964, Part 2, page 1712, in the House, and Part 1, page 935, in the Senate.) Based on the foregoing, it is considered that authority exists to modify the main line river levees or construct an alternate thereto to accomplish the purpose of the hurricane protection project.

(2) LMVED by letter dated 2 October 1969 subject, "New Orleans to Venice, Project Review," authorized preparation of a review report to determine the needed work for hurricane protection. As part of this study, a survey-scope report comparing alternate plans for protecting the west bank of Plaquemines Parish from hurricane flooding from Breton Sound was submitted to LMVED-TD on 24 March 1970. Two plans were submitted. One plan consisted of raising the river levee on the west bank to a grade high enough to prevent overtopping by tidal surges from the east. An alternate plan consisting of a barrier levee on the east bank of the river from Bohemia to mile 10 AHP and minor enlargement of the west bank river levee from Fort Jackson to Venice would serve the same purpose and was found to be more feasible and economical. Based on the results of the study presented in the report, OCE by 2d Ind dated 2 July 1970 (LMNED-PP basic, 24 March 1970) authorized preparation of a general design memorandum based on the east bank barrier levee plan.

d. <u>Deletion of Reach E</u>. Shortly after authorization, local interest dissatisfaction with the plan of improvement authorized for Reach E became manifest. This dissatisfaction culminated on 8 May 1964 with the adoption by the Committee on Public Works, House of Representatives, of a resolution directing that a restudy of hurricane protection for St. Bernard Parish be made. This restudy was initiated with a public hearing in December 1965. Based on the restudy, the District Engineer on 29 November 1966 recommended an enlargement of the Chalmette Area Plan of the "Lake Pontchartrain, La. and Vicinity" project as a departure from the project document plan within the discretionary authority of the Chief of Engineers. This recommendation was approved by the Chief of Engineers on 31 January 1967. The enlarged Chalmette Area

Plan represents all of the area in St. Bernard Parish for which hurricane protection can be economically justified at this time, and totally encompasses the Reach E protected area. The referenced resolution was closed out by a negative report recommending deauthorization of Reach E; hence, no further consideration need be afforded that reach herein.

e. Division of Reach B. On 5 February 1964, the Plaquemines Parish Commission Council, hereinafter referred to as the Commission Council, representing local interests, requested the division of Reach B into two units--one between Empire and Fort Jackson and the other between Fort Jackson and Venice. The Commission Council further requested that the upper reach (designated Reach B1) thus created be planned and constructed as a separate unit. Investigation having established that the proposal was engineeringly possible and would result in an economically justified unit, the District Engineer, by letter LMNGP-P dated 25 February 1964 subject, "New Orleans to Venice, La., Hurricane Protection (Mississippi River Delta at and below New Orleans, La.)," recommended its adoption. This recommendation was approved by the Chief of Engineers in 2d Indorsement dated 25 March 1964 subject to the proviso that a closure levee at Fort Jackson, required to complete the independently constructed Reach B1 loop, be paid for by the Commission Council.

2. Purpose.

a. The purpose of this general design memorandum as it pertains to Reach B1 is as follows:

(1) Change the levee alignment between Buras and Fort Jackson from the 40-arpent line alignment to an alignment generally along the existing back levee, delete the upper and lower closure levees, and delete the Buras floodgate.

(2) Present the detail design of the levee and floodwalls in sufficient detail to provide an adequate basis for preparing plans and specifications without additional design memorandums.

b. The purpose of this general design memorandum as it pertains to the total project is as follows:

(1) Present up-to-date cost estimates for all reaches of the project including the east bank barrier levee plan.

(2) Present an economic reanalysis of the project based on two independent improvements: (a) enlargement of the non-Federal back levees to provide protection from tidal surges overtopping the back levees, and (b) a barrier levee on the east bank of the river from Bohemia to mile 10 AHP and minor enlargement of the west bank river levee from Fort Jackson to Venice to provide protection from tidal surges from the east overtopping the river levee.

3. Local cooperation. Conditions of local cooperation specified in the report of the Board of Engineers for Rivers and Harbors and concurred in in the report of the Chief of Engineers are as follows:

"...that prior to construction local interests give assurances satisfactory to the Secretary of the Army that they will, without cost to the United States:

"a. Provide all lands, easements, and rights-of-way, including borrow areas and spoil disposal areas necessary for the construction of the project;

"b. Accomplish all necessary alterations and relocations to roads, pipelines, cables, wharves, and other facilities required by the construction of the project;

"c. Bear 30 percent of the first cost, a sum presently estimated at $3,216,000, to consist of items listed in subparagraph a. and b. above and a cash contribution, presently estimated at $1,844,000, to be paid either in a lump sum prior to initiation of construction or in installments prior to start of pertinent work items, in accordance with construction schedules as required by the Chief of Engineers, or, as a substitute for any part of the cash contribution, accomplish in accordance with approved construction schedules items of work of equivalent value as determined by the Chief of Engineers, the final apportionment of costs to be made after actual costs and values have been determined;

"d. Hold and save the United States free from damages due to the construction works;

"e. Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army;

"f. Prevent encroachment on ponding areas unless substitute storage capacity or equivalent pumping is provided promptly; and

"g. At least annually, notify those affected that the project will not provide complete protection from tidal flooding and that further local actions must be taken during hurricane emergencies."

4. Background information.

a. Previous design memorandum. A general design memorandum for Reach B1 was submitted to the Division Engineer on 31 March 1967 and was approved by ENGCW-EZ 2d Ind dated 8 August 1967 (LMNED-PP basic 31 March 1967) subject to comments. The plan of improvement presented therein provided for a conventional hydraulic clay fill levee from Tropical Bend to Fort Jackson, floodgates in the waterways at Empire and Buras, floodwalls at the Bayou Grand Liard and Sunrise pumping stations, an access canal marshward of the project levees between Empire and Buras, return levees at the upper and lower terminus of the reach, overhead roller gates to close the gap in the upper return levee at Louisiana Highway 23 and Missouri Pacific Railroad, and three gravity drainage structures. Certain modifications to the project document plan were included in the above plan as extra cost items to the Commission Council, the project sponsor. These included the upper and lower return levees and feature contiguous thereto and the incremental cost of construction of the levee along the 40-arpent line from Buras to Fort Jackson over the authorized cost for enlargement of the existing back levee.

b. Approved changes to plan subsequent to approval of the GDM (1967).

(1) Alteration of method of construction, stream closures. The method of closing streams or bayous presented in the GDM (1967) was by an embankment constructed entirely of hydraulic clay fill. A supplement dated 30 October 1968 to the GDM was forwarded to LMVD recommending that streams be closed by a shell core with hydraulic clay fill placed on top. This recommendation was approved by LMVED-TD 1st Ind dated 2 December 1968 (NOD basic 30 October 1968) subject to comments.

(2) Alteration in type of levee material. The design presented in the GDM (1967) was based on an all-clay levee. A letter-type report dated 31 December 1969 was forwarded to LMVD recommending that a sand-core levee be adopted as a substitute for an all-clay levee between the Empire floodgate and Buras and that the levee alignment be revised to utilize the existing flood side borrow pit as the base excavation for the sand-core. This recommendation was approved by LMVED-G 1st Ind dated 2 February 1970 (NOD basic 31 December 1969) subject to comments.

c. Additional changes to GDM (1967) plan presented herein are as follows:

(1) Deletion of betterments. As discussed in previous paragraphs, the Commission Council initially requested that the authorized levee alignment between Buras and Fort Jackson be shifted marshward

about 1 mile to follow the 40-arpent line and that closure levees be provided at the upper and lower terminus of Reach B1. These items were considered to be betterments in the interest of the Commission Council. Accordingly, all additional costs to the authorized project for these items were charged to the Commission Council. Subsequent to the devastation of Hurricane Camille, the Commission Council by its letter of 17 April 1970 requested that, because of the excessive increase in the estimated cost of the project, available funds, and comparative benefits derived from the betterments, the project be constructed without betterments, i.e., delete the return levees and 40-arpent line alignment. This change returned the alignment to the project document line and eliminated betterment costs.

(2) Deletion of Buras floodgate. The plan presented in the GDM (1967) provided for the levee to be constructed several hundred feet marshward of the existing levee between Empire and Buras. The plan provided for access into the Buras area for waterborne traffic by a floodgate in the waterway serving Buras. Room for expanding the existing harbor facilities was available along the canal paralleling the existing back levee and located on the flood side of said levee. Adoption of the sand-core levee between Empire and Buras and revision of the levee alignment restricted expansion of the harbor facilities to the two small canals serving Buras. The Commission Council by letter of 10 April 1969 requested this office to eliminate the floodgate since the Commission Council planned to build a new mooring area outside of the new protection levee thereby permitting unlimited future expansion of the boat harbor. The Commission Council was informed that any savings accruing from deletion of the floodgate would be on a cost-sharing basis; that is, local interests would realize 30 percent of the savings.

INVESTIGATIONS

5. Investigations made in connection with the project document. Studies and investigations made in connection with the project document (H.D. No. 550, 87th Congress, 2d Session) consisted of: research of information which was available from previous reports and existing projects in the area, extensive research in history and records of hurricane damages and characteristics of hurricanes, extensive tidal hydraulics investigations, an economic survey, field topographic and hydrographic surveys of reconnaissance scope, and design and cost studies. A public hearing was held in New Orleans, Louisiana, on 13 March 1956 to determine the views of local interests. Federal and state agencies were consulted. The District Engineer made a personal reconnaissance of the area.

6. Investigations made subsequent to project authorization. Studies and investigations made subsequent to project authorization include:

a. Aerial and topographic surveys of the project area;

b. Soils investigations including general type and undisturbed borings and associated laboratory evaluations;

c. Tidal hydraulic studies required for establishing design grades for protective works based on revised hurricane parameters furnished by the U. S. Weather Bureau (now the National Weather Service) subsequent to project authorization;

d. Detailed design studies for construction of levees, channels, and structures;

e. Determination of real estate requirements and costs;

f. Cost estimates for levees, structures, and relocations; and

g. Economic studies for evaluating justification for recommended works.

h. Environmental studies required by the National Environmental Policy Act of 1969.

7. Planned future investigations. Additional soil borings and tests will be made prior to each levee lift subsequent to the first. Design analyses, utilizing information obtained from the additional borings, will be made and preparation of plans and specifications for each lift will be based on these analyses. Also a bearing pile test will be conducted to determine the pile lengths for construction of the T-wall at the Bayou Grand Liard pumping station. Because of the small number of piles at the Sunrise pumping station, no pile test will be conducted.

LOCAL COOPERATION

8. Local cooperation requirements. The items of local cooperation specified in the project document are listed in paragraph 3. Essentially local interests are required to furnish all lands, easements, and rights-of-way; accomplish all necessary alterations and relocations; bear 30 percent of the first cost, inclusive of lands, damages, and relocations, and a cash contribution or equivalent work; hold and save the United States free from damages due to the construction works; maintain and operate all works after completion; prevent any encroachment on ponding areas unless equivalent storage or pumping capacity is provided; and at least annually notify those affected that the project will not provide complete protection from tidal flooding.

9. Status of local cooperation. Assurances were requested from the Commission Council on 7 January 1963. The act of assurance and supporting resolution adopted by the Commission Council on 6 March 1964 covering Reaches A, B, and C were accepted for and on behalf of the United States on 14 April 1965. Supplemental assurances covering the East Bank Barrier levee plan will be requested upon approval of the general design memorandum for the East Bank Barrier levee plan. The principal officers of the Commission Council responsible for the fulfillment of the conditions of local cooperation required by the authorizing act are as follows:

Plaquemines Parish Commission Council
Pointe a la Hache, Louisiana
Mr. Chalin O. Perez, President
Mr. Clarence Kimball, Vice President & Comm. Finance
Mrs. Edna Lafrance, Secretary

10. Views of local interests. The Commission Council represents local interests and is in agreement with the plan to raise the back levees. The Commission Council has indicated that it generally favors the East Bank Barrier levee plan; however, formal indorsement is being withheld pending finalizing the details of the plan.

11. Estimated cost to local interests.

a. The total non-Federal cost for constructing the project, broken down by reach, is shown below. Details of the estimate are shown in appendix C.

	Lands & damages	Relocations	Cash contribution	Total
	$	$	$	$
Reach A	455,000	1,045,000	5,250,000	6,750,000
Reach B1	617,000	823,000	6,300,000	7,740,000
Reach B2	266,000	334,000	5,430,000	6,030,000
Reach C	306,000	1,359,000	1,755,000	3,420,000
Barrier levee	727,000	215,000	2,928,000	3,870,000
Total	2,371,000	3,776,000	21,663,000	27,810,000

b. Work accomplished by local interests other than the normal requirements.

(1) Reach B1. In order to expedite completion of a new highway under construction by the Commission Council, which will ultimately serve as an evacuation route for the occupants of Plaquemines Parish, the Council had prepared a set of plans and specifications for a reach of levee between stations 340+20 and 377+50. These plans and specifications were reviewed and

approved by the District Engineer. Local interests will receive credit for this work, subject to a review of the construction to insure its adequacy for accomplishing the project purpose, as part of their cash contribution.

(2) Reach C. The Commission Council requested that, as a means of expediting construction on Reach C, it be permitted to proceed with construction of this reach on a modified alignment, subject to its receiving a credit applicable to the required local interest contribution on the overall project. It having been determined that the modified alignment would serve project purposes equally as well as the project document alignment, this arrangement was approved and the credit process explained to the Commission Council by LMNGP-P letter dated 15 December 1964. The arrangement was agreed to by the Commission Council on 22 April 1965 (see appendix F). Subsequently, the Commission Council had prepared, by the Louisiana Department of Highways, a set of plans for initiating construction of the levee. The plans were coordinated with the District Engineer. Work for constructing the levee embankment to an interim grade of 14 feet m.s.l.[1] was completed in September 1968. Completion of the levee to an interim grade of 14 feet prevented major flood damages within Reach C which would have otherwise occurred during Hurricane Camille in August 1969.

LOCATION OF PROJECT AND TRIBUTARY AREA

12. Location of project. Project areas are located in the Mississippi River delta region of coastal Louisiana. They include lands on both banks of the Mississippi River from the vicinity of Phoenix to Venice, Louisiana. These lands are located on alluvium and presently are provided a marginal degree of protection from gulf tides by existing non-Federal back levees; they remain vulnerable, however, to the ravages of major tropical storms and hurricanes. A general plan, index map, and vicinity map are shown on plate 1.

13. Tributary area.

a. General. The project area comprises approximately 14,900 acres of land which includes 4,300 acres in Reach A, 3,800 acres in Reach B1, 2,300 acres in Reach B2, and 4,500 acres in Reach C. Interior drainage in Reaches A, B1, and B2 is accommodated by a system of canals and pumping facilities. In Reach C, runoff is disposed of by gravity through gated culverts in the back levee. Principal towns in the project area include Buras-Triumph (population 4,100 - 1970 census) and Port Sulphur (population 3,000 - 1970 census) on the west bank and Pointe a la Hache on the east bank (population 600 - 1970 census).

---

[1]Unless otherwise specified, all elevations herein are in feet and refer to mean sea level.

b. Transportation facilities. Transportation facilities serving the area include the Missouri Pacific Railroad, Louisiana Highway 23, Louisiana Highway 39, Freeport Sulphur Company Canal, and the Federal navigation projects "Barataria Bay Waterway, La.," and "Waterway from Empire, La., to the Gulf of Mexico."

c. Economic activity. Economic activity in the parish is quite varied. Economic activities in Plaquemines Parish include extensive oil and gas production--both onshore and offshore--sulphur production, facilities for commercial and sport fishing, and agricultural production. The parish ranks first in petroleum production, first in production of sulphur, second in the production of natural gas, and third in production of gas liquids. Statistics furnished by the Commission Council indicated that the value of oil and gas from production facilities serviced in and from Plaquemines Parish exceeds $1.3 billion annually. Approximately 40 percent of the offshore production of oil and gas is serviced from Plaquemines Parish. In the 1970-71 fiscal year, the State of Louisiana collected severance taxes from Plaquemines Parish in the amount of $50,580,000--primarily levied against the production of petroleum, natural gas, and sulphur. Fish and wildlife resources in the general area are also of significant value to the state and local economies. Principal fisheries include shrimp, menhaden, oysters, and salt-water finfishes. Two large menhaden plants at Empire process the catches of that species taken from the gulf waters. The total value of commercial fishery landings in the parish exceeds $4.0 million annually; most of this total was handled through the project area. Agricultural production in the parish varies from $500,000 to $1.0 million annually. About 40 percent of this total originates in the project area from the production of citrus, truck crops, and beef cattle.

PROJECT PLAN

14. Project works covered in this general design memorandum. Project works covered in this memorandum are Reaches A, B1, B2, C, and the East Bank Barrier levee plan. Detailed coverage to general design memorandum scope is restricted to Reach B1; the remaining works are covered to the extent of establishing up-to-date cost estimates, benefits, and benefit-cost ratios based on current criteria. All subsequent references to the project and project works are to Reach B1, unless otherwise specified.

15. Project works. The plan of protection, indicated on plate 1, provides for constructing a hurricane protection levee with appurtenant features from Tropical Bend to Fort Jackson. The levee system will be approximately 12.0 miles in length and will have a net grade of elevation 15.0. Land access into the protected area is provided by Louisiana Highway 23 and the Missouri Pacific Railroad. Access into the protected area for waterborne traffic will be provided by the Empire floodgate located in the

Empire to Gulf Waterway near Empire, La. The floodgate will have a width of 84 feet and a sill elevation of -14.0. Floodwalls will be provided at Bayou Grand Liard and Sunrise pumping stations. The pumping station discharge pipes will be modified to accommodate the floodwall. The pumping stations will continue to provide for the drainage of the protected area which is now behind back levees. Modifications will be made to 9 pipelines and 11 facilities in the Buras area will require relocating. An access channel will be provided marshward of the project levees between Empire and Buras. Inasmuch as the floodgate at Empire will be closed during hurricanes only, the existing back levee system within the hurricane protection levees at Empire is required to protect the area against overflow by normal high tides and abnormal tides associated with other than hurricane conditions. Hence, this levee must be maintained at elevation 8 as a part of the project. The levee is currently above this elevation, therefore no construction will be required.

DEPARTURES FROM PROJECT DOCUMENT PLAN

16. General. The project document plan (H.D. 550, 87th Congress, 2d Session) recommended enlargement of the existing back levee system and modifying the existing drainage facilities where necessary in four reaches. The project document plan has been revised as follows:

a. Division of Reach B. At the request of the Commission Council, Reach B has been divided at Fort Jackson to form two independent reaches--Reach B1 and Reach B2. In order for Reach B1 to stand independently of Reaches A and B2, closure levees would be required from the existing back levee to the Mississippi River levee. Authority to divide Reach B was granted by the Chief of Engineers on 25 March 1964 subject to the proviso that local interests bear the costs for constructing the closure levees. Local interests have since withdrawn their request for the independent construction of Reach B1 thereby eliminating the need for the closure levees (reference paragraph 4c). The division of Reach B into two reaches will remain in effect.

b. Revision of levee grades. The net levee grades were revised upward in accordance with the results of tidal hydraulic studies utilizing the latest hurricane parameters developed by the National Weather Service based on information developed subsequent to project authorization.

c. Modification of levee alignment. Levees at Empire. Detailed studies indicate that enlargement of the existing back levee to the project grade in the Empire area is impracticable by reason of the congested nature of improvement in the area. Floodwall construction is excessive in cost and undesirable. Either type of construction involves extreme disruption of existing facilities and high severance costs. A more economical plan was, accordingly, developed. This plan provides for the levee location gulfward of the existing levee at Empire with a floodgate closure in the Empire to Gulf Waterway as shown on plate 1. Cost comparison between the project document plan and the authorized plan is presented on table C-3 in appendix C.

HYDROLOGY AND HYDRAULICS

17. General. Detailed results of the hydrology and hydraulic analysis for Reach B1 are presented in appendix A in three sections. Section I presents the climatology and hydrology of the area. Section II presents detailed descriptions and analyses of tidal hydraulic procedures used in the tidal hydraulic design. Included in the descriptions and analyses are the essential data, assumptions, and criteria used for studies reported herein which provide the bases for determining design wind-tide level, wave runup, overtopping, and frequency of the design hurricane. Section III furnishes information concerning the interior drainage of the project area.

a. Hurricanes of record. Since 1856, about 20 hurricanes have caused flooding in or near the project area. However, reliable hurricane surge heights are available only since 1915. Some of the most severe hurricanes which were critical to the area and caused high stages occurred in September 1915, September 1956 (Flossy), September 1965 (Betsy), and August 1969 (Camille). Some observed stages experienced at or near the project area as a result of these hurricanes were: 1915, 12 feet at Pointe a la Hache and 7.6 feet at Buras; 1956 (Flossy), 13 feet at Ostrica Lock and 8 feet at Grand Isle; 1965 (Betsy), 14.8 feet at Bohemia, 14.4 feet at West Pointe a la Hache, 12.6 feet at Ostrica Lock, and 9.7 feet at Empire; 1969 (Camille), 15.1 feet at Ostrica Lock and 12.6 feet at Buras.

b. Frequencies. Stages critical to the project area are generated by hurricanes that approach from a southerly direction. Records indicate that approximately two-thirds of all hurricanes that strike the Louisiana coast approach from the south while one-third approach from the east. The average azimuth of tracks from the south is 180° while the tracks from the east have an average azimuth of 117°. Therefore, in the computation of stage-frequencies, 67 percent or two-thirds of the observed hurricanes are used to reflect probabilities for the back protective levee of Reach B1. Normally, observed hurricane stages in a project area are beneficial in determining frequencies. However, due to a scarcity of observed stages along the back levee of the project area, the frequency for Grand Isle was utilized to assist in determining the probability of occurrences for the project area. Probability of occurrences reflects prior approved and accepted methods for stage-frequencies for Reach B1.

c. Design hurricane. A hurricane that would produce a 100-year stage was selected as the design hurricane. A hurricane of lesser intensity would require a lower levee grade and would expose the protected areas to hazards of life and property that would be disastrous in the event a hurricane with the intensity and destructive capability of the design hurricane or a greater hurricane occurred. The design hurricane for the project area has a central pressure index of 28.02 inches, a maximum windspeed of 91 m.p.h. at a radius of 30 nautical miles. The forward speed of the hurricane is 11 knots.

d. Design hurricane wave characteristics. The data used to determine design hurricane wave characteristics for the project area are as follows: fetch length, 5 miles; windspeed, 77 m.p.h.; stillwater level, 12.0; average depth of fetch, 6.7 feet; and depth at toe of structure, 8.0 feet. From the data above, it was determined that the design wave height for levee design is 3.2 feet while the design wave height for floodwall design is 5.3 feet. The project is designed to prevent overtopping by waves up to the deepwater significant wave or the highest one-third waves of a wave train.

e. Design elevation of protective structures. Using the data in paragraph 17d above, the design runup on the levee was determined to be 3.0 feet while the design runup on the floodwall would be 6.5 feet to 7.7 feet. Final design elevations for the protective structures are 15.0 for the levees and from 18.5 to 20.0 for the floodwalls. The design height of the floodwalls is dependent on the levee configuration on the floodwall side of the structure.

f. Interior drainage. The completion of the plan of improvement will not materially affect the interior drainage of the project area. This drainage will be furnished by the existing canals and pumping stations and the floodgate which will be constructed at Empire, La. To meet the requirements of navigation, the floodgate will provide an 84-foot width at the sill elevation of -14. This opening is more than adequate to dispose of runoff from intense storms occurring over the drainage area of the structure with the floodgate open.

GEOLOGY

18. Physiography. The project area is located within the Central Gulf Coastal Plain. Specifically, the area is located on the modern subdelta which projects gulfward from the deltaic plain of the Mississippi River. It is a region of extremely low relief. Dominant physiographic features are the natural levees of the Mississippi River and abandoned distributaries, and the marshlands and inland bodies of water that lie between the natural

levee ridges. Elevations range from a maximum of +5 along the crests of the natural levees to a minimum approaching mean sea level in the marshlands between the natural levee ridges. The numerous inland bodies of water vary in depth from 1 to 10 feet. The Mississippi River channel varies in depth from 70 to 190 feet below sea level.

19. General geology. Only the geologic history since the end of the Pleistocene epoch is significant for this project. At that time, with sea level about 450 feet below its present level, the Mississippi River began to aggrade the final entrenchment which it had cut to the west of the project area during the last glacial period. Initial alluvial sedimentation was confined to the central portion of the alluvial valley. Concomitantly, downwarping of the Pleistocene prairie surface and some faulting occurred resulting in a gulfward dip of the prairie surface averaging about 3 feet per mile and increasing southward towards the coastline. The continued rise in sea level resulted in the reworking and redepositing of minor amounts of fluvial sediments in the project area. When sea level reached within tens of feet of its present level, the first marine and fluvial marine sediments of any significance were carried into the project area. About 4,800 to 5,000 years ago, as sea level approached its present stand, the Mississippi River began to migrate laterally back and forth across the deltaic plain. Deltaic marine sediments were first carried into the project area about 3,500 years ago when the Mississippi occupied the Teche course near the western margin of the valley. The first major advance of sediments into the project area occurred approximately 2,800 years ago when the Mississippi River shifted eastward and began to develop the La Loutre-St. Bernard Delta. About 1,500 years ago, the Mississippi River shifted westward to the Lafourche course and for a period of several hundred years, the project area was subjected to only minor amounts of sedimentation and deltaic deterioration and subsidence became important. When the river again shifted eastward about 1,200 years ago and began to occupy the present Plaquemine course, sedimentation again became the predominant process in the project area. With the construction of levees along the Mississippi River, floodwaters have been eliminated from the area and at present no sediments are being introduced into the project area. Subsidence and erosion have become the dominant factors, particularly in the marshlands and inland bodies of water and, unless sediment-laden water is introduced into the area, the land mass along the edges of the project area will continue to decrease.

20. Subsidence and erosion. Progressive subsidence and downwarping have been occurring in the project area since the end of the Pleistocene epoch. The surface of the Pleistocene has been downwarped towards the south and west to a maximum of about 500 feet at the edge of the continental shelf, which is about 30-40 miles south of Buras, La. At present, the rate of subsidence within the project area varies from about 0.5 to 1.0

foot per century at the northern limit of the area and along the natural levees of the Mississippi River and abandoned distributaries, to about 5 feet or more per century along the seaward-facing extremities of the area, gulfward of the project alignment. In addition, as a result of subsidence and wave erosion, the seaward-facing edges of the shoreline and the shorelines of the canals, ponds, lakes, and bays within the marshlands are retreating.

21. Investigations performed. General-type borings to a maximum depth of about 80 feet and 5-inch undisturbed borings to a maximum depth of about 240 feet were made for this project. In addition, the logs of borings made in conjunction with other projects as well as geologic information were available for the interpretation of the subsurface and foundation conditions of the area.

22. Foundation conditions. The subsurface, as shown on plates 30 through 36, consists of Recent deposits varying in thickness from approximately 165 feet at the upstream end of the project (station 0+00) to approximately 210 feet between stations 300+00 and 480+00. The Recent deposits are underlain by Pleistocene materials. Generally, the Recent consists of a surface layer of marsh deposits, varying in thickness from 3 feet at station 0+00 to 20 feet at station 441+00. The marsh deposits consist generally of very soft to soft clays with peat and organic matter. The surface layer of medium clay between station 0+00 and station 4+00 and the alternating layers of medium clays and silts between stations 510+00 and 557+00 represent areas of manmade levee fill which have been placed on top of the soft marsh deposits. Between station limits 0+00 to 92+20, 417+50 to 532+40, 551+90 to 610+50, and 615+30 to 635+72, the marsh deposits are underlain by interdistriburary deposits consisting primarily of very soft to soft clays with lenses and layers of silts and silty sands. The interdistributary deposits vary in thickness from 65 feet in the vicinity of station 45+00 to 76 feet in the vicinity of station 510+00. The marsh deposits are underlain by intradelta deposits from station 109+60 to station 398+50. The intradelta sediments consist primarily of soft to medium clays with alternating lenses and layers of silt, sand, and silty sand, and vary in thickness from 60 feet at station 232+00 to 70 feet at station 156+00. The lateral continuity of the complexly interfingered materials of the interdistributary and intradelta deposits is interrupted by four abandoned distributaries which are distinguishable beneath the marsh deposits in the project area and which are located between the following station limits: 92+20 and 109+60, 398+50 and 417+50, 532+40 and 551+90, and 610+50 and 615+30. Deposits filling these abandoned distributaries are predominantly silts, silty sands, sands, and sands and layers of soft to medium clay. The thickness of deposits contained in the abandoned distributary located between stations 92+20 and 109+60 is approximately 65 feet. The ultimate depth of the other

three abandoned distributaries cannot be determined from project borings. However, deep borings in each respective distributary were projected from along the Mississippi River where these same abandoned distributaries underlie the existing Mississippi River levees, and indicate that the thickness of these deposits is at least 100 feet. The interdistributary, intradelta, and abandoned distributary deposits are underlain along the entire reach by medium to stiff prodelta clays. The thickness of these homogeneous clays varies from approximately 85 feet at station 0+00 to approximately 124 feet at station 635+70. The approximate thicknesses of all deposits underlying the marsh are extrapolated from deep borings along the banks and levees of the Mississippi River and a few isolated borings in the marsh area southwest of the project, except at the locations of the following borings which penetrate the prodelta deposits 1-DU-1, 2-DU-1 through 4-BSU, 3-DU, 10-BU, 1-SBU, and 4-DU. The prodelta deposits are underlain along the entire reach by nearshore sands which contain shell and shell fragments. The nearshore deposits vary in thickness from approximately 4 feet at station 635+70 to approximately 25 feet at station 320+00. The entire sequence of Recent deposits throughout the project area is underlain by stiff to very stiff Pleistocene clays at elevations varying between -165 at station 0+00 and -210 between stations 300+00 and 480+00.

23. Mineral resources. Extensive oil and gas production are found in the vicinity of the project area. However, exploration and production of these natural resources will not be adversely affected by the project, nor will the project be adversely affected by this exploration and production.

24. Conclusions. The subsurface investigations and analyses of all existing and new data indicate that conditions for construction of the proposed earth levees, floodwalls, and floodgates along the established alignment are favorable. No unusual or critical areas were detected in the borings, considering the geological environments represented and the nature of the deposits. As with most deltaic areas, one of the primary problems to be anticipated is that of settlement beneath the structures. Secondary is the availability of construction materials. The subsurface materials below the marsh most susceptible to settlement are the interdistributary deposits which contain relatively thick wedges of soft clays with high water content. Settlement will be less pronounced along areas of intradelta and abandoned distributary deposits which contain considerable amounts of silt, silty sand, and sand. Since the levees will be constructed primarily of hydraulic fill with sand and shell core, building materials should present no problems. Hydraulic fill can be pumped from areas immediately adjacent to the proposed alignment; sand can be secured from the Mississippi River nearby; and shell, aggregate, and riprap can be barged and hauled in as required. Suitable materials for topping out the levees can be obtained from the existing earthfill levee.

SOILS

25. General. This section covers the soils and foundation investigation and design for the hurricane protection system for Reach B1 except for the Empire floodgate which was submitted as DDM No. 2, dated October 1970.

26. Field investigation. A total of 112 general-type and 17 undisturbed borings was made in conjunction with the project. Eight general-type borings were made by the Louisiana Department of Highways to locate a source of sand for borrow in the Mississippi River. Twenty-seven general-type and two 3-inch diameter undisturbed borings were made by the Louisiana Department of Public Works along the authorized levee alignment at the request of the Commission Council. Seventy-seven 1 7/8" I.D. core barrel and fifteen 5" diameter undisturbed borings were taken by the Corps of Engineers. Plates 37 through 42 present borings along the authorized project alignment. Plates 43 and 44 present borings along the 40-arpent line, plates 45 and 46 along the Empire lateral levees, plate 47 along the Buras lateral levees, and plate 48 at the Tropical Bend and Fort Jackson closure levees. Plates 49 and 50 present borings taken in the Mississippi River to locate a sand borrow area. The bottom elevations of the general-type and undisturbed borings range from -40 to -50 and -77 to -242, respectively. Undisturbed boring logs appear on plates 51 through 69.

27. Laboratory tests. Visual classifications were made on all samples obtained from the soil borings, and water content determinations were made on all cohesive samples. Unconfined compression (UC), unconsolidated undrained (Q), consolidated undrained (R), consolidated drained (S), and consolidation (C) tests were performed on selected samples from the undisturbed borings. Unconfined compression tests were made on selected samples from the general-type borings. Indices tests were performed on all samples tested for shear and/or consolidation. Results of shear and consolidation tests appear on plates 51 through 88.

28. Foundation conditions. A generalized soil profile delineating the subsurface conditions along the project alignment is shown on plates 30 through 36. The profile shows that the subsurface consists of Recent deposits of very soft to medium clay soils with peat, silt, and sand layers. The upper 10 to 20 feet of marsh deposits generally consist of very soft organic clays, clays, and peat. Between stations 0+00 and 399+00 the marsh deposit is underlain by interdistributary deposits of approximately 8 to 20 feet of layers of silt, silty sand, and sand. Below these layers is fat clay with layers of silt, silty sand, and sand. Between stations 417+00 and 635+72 the marsh deposits are underlain by predominantly fat clay with intermittent thin layers of silt, sandy silt, and sand. Four abandoned distributaries are located

below the marsh deposits between the following stations: 92+20 - 109+60, 398+50 - 417+50, 532+40 -551+90, and 610+50 - 615+30. These abandoned distributaries are composed of alternate layers of clay, silt, silty sand, and sand. The dominant feature in the design of all the levee sections is the very soft foundation condition between elevation 0 and elevation -12.

29. Type of protection. In general, the protection will consist of a levee. Between stations 0+00 and 98+81 the protection will consist of a conventional hydraulic clay fill levee. From station 104+81 to station 635+72 the protection will consist of a hydraulic clay fill levee with a core composed of sand. A floodgate will be located where the Empire Waterway crosses the project alignment between stations 98+71 and 104+91. Cantilever I-type and T-type walls will be used in the vicinity of the Sunrise (station 232+31 to station 242+41) and Grand Liard (station 532+76 to station 539+81) pumping stations to avoid relocations or major modifications to these facilities.

30. Stability.

a. Levees and dikes. In the interim between the publication of the GDM dated March 1967 and this GDM dated August 1971, plans and specifications were prepared for the first lift construction on two reaches of the project from stations 0+00 to 98+55.3 and stations 104+70 to 340+20. An additional set of plans and specifications were prepared by an A-E for the Commission Council and approved by the District Engineer for a reach of levee from station 340+20 to station 377+50. Plans and specifications for the remaining section between stations 377+50 and 635+72 will be prepared after approval of this general design memorandum. Stability plates 89 through 116 are divided to reflect the above segments as follows:

Stations	Segments
0+00 to 98+81	Tropical Bend to Empire
104+81 to 337+72	Empire to Buras
337+72 to 635+72	Buras to Fort Jackson

(Q) shear stability analyses were performed for these segments using four different shear strength criteria as shown on plates 87 and 88. Using sections and (Q) shear strengths representative of the existing conditions along the alignment, the slopes and minimum berm distances for the levee and dike sections were determined by the method of planes. Levee sections were designed so that the minimum factor of safety of the levee with respect to shear failure in the levee and foundation was 1.3 and 1.5 for failure into the adjacent borrow pit. The retaining and ponding dike sections were designed for a minimum factor of safety of 1.2 for failure into the sand core trench and interior dike borrow, respectively, and a minimum factor of safety of 1.3 for failure into the ponding area and borrow area, respectively. The critical surfaces and stability analyses calculations governing design are shown on plates 89 through 118. Borings 1-DU-1 and 2-DU-1 which were taken for design of the second lift showed no gain of shear strength. However, the second lift sections from 0+00 to 46+00 are somewhat larger than the first lift sections (see plates 89 to 93) because the spoil from the first lift is serving as a flood side berm for the retaining dike. Since there was no spoil from 46+00 to 98+71 the second lift section is the same as the first lift section.

b. Floodwalls. A combination of "I" and inverted "T"-type floodwalls will be used at Sunrise and Bayou Grand Liard pumping stations. At the Sunrise pumping station a T-wall of approximately 60 feet will be required. The I-type wall will be used along the remainder of the existing back levee and as a tie-in into the final levee sections as shown on plate 25. I-wall along the existing back levee at the Bayou Grand Liard pumping station was not feasible because a minimum crown elevation of 10.0 would be required to prevent excessive deflection. A stability analysis was performed with the levee crown elevation at 10.0 and the I-wall in place. In order to maintain the required factor of safety, large stability berms would be necessary in both the land side and flood side drainage pits resulting in either relocation or major modifications to the pumping station. For this reason, a 459-foot T-wall with the levee degraded to elevation +6.0 will be used along the existing back levee with I-type wall joining the T-wall to the final levee section as shown on plate 26. The results of tidal hydraulic analyses indicate that the walls will be subjected to the pressures and forces imparted by a broken wave. In the stability analyses, the wave effect was applied as a line force acting at the centroid of the wave pressure diagram. The water pressure diagram resulting from the wave action was considered effective only to the top of the impervious clay at the top of the levee.

(1) Cantilever I-wall. The stability and required penetration of the steel sheet piling below the fill surface was determined by the method of planes. The long-term (S) shear strengths (c=0) governed the design. Prior to the preparation of plans and specifications for the I-type floodwall tying the final levee section to the I-wall in the existing back levee at Sunrise and the T-wall at Grand Liard, additional borings and analyses will be performed. A factor of safety of 1.25 was applied to the friction angle as follows: ϕ_d (developed friction angle) $= \tan^{-1} \dfrac{(\tan \phi_A)}{F.S.}$.

This developed angle was used to determine K_A and K_P lateral earth pressure coefficients as follows: $K_A = \tan^2 (45° - \dfrac{\phi_d}{2})$ and $K_P = \dfrac{1}{K_A}$.

Using the resulting shear strengths and net horizontal static water, the earth pressure diagrams were determined for movement toward each side of the sheet pile. Using these pressure diagrams and the wave force, the summation of horizontal forces was equated to zero for various tip penetrations. The tip penetrations required for stability were determined as those where the summation of moments approached zero. See plate 119.

(2) Inverted T-wall.

(a) Steel sheet pile cutoff. A steel sheet pile cutoff will be used beneath the T-walls to provide protection against seepage. The recommended tip elevations of the cutoff below the T-walls are shown on plates 25 and 26. No sheet pile analysis was performed for the Sunrise pumping station since the unbalanced waterload is negligible. The analysis for the Bayou Grand Liard pumping station is shown on plate 120 and was analyzed under the following design assumptions:

1. Conventional (Q) shear stability analyses utilizing a F.S. of 1.5 applied to the soil strength parameters were performed at 1-foot intervals.

2. Net driving force = $D_p+R_A+R_B+R_P-D_A$.

3. The driving force above the base of the structure and the horizontal hydrostatic load were carried by the structure.

4. If the net driving force is positive there is available horizontal soil resistance in excess of the unbalanced waterload and therefore the bearing piles are not required to carry any additional lateral load acting on the sheet pile cutoff.

(b) Bearing pile foundation.

1. The T-walls will be supported by piling, battered as required, to provide stability against the unbalanced lateral waterloads. The inverted T-type floodwalls will be used in lieu of the I-type for reasons mentioned above. In compression, a factor of safety of 1.75 was applied to the shear strength and a lateral earth pressure coefficient of K_o=1.0 was used for determining the normal pressure on the pile surface. In tension, a factor of safety of 2.0 was applied to the shear strengths and a coefficient of K_o=0.7 was used. One design was performed for both the (Q) and (S) cases for the Bayou Grand Liard pumping station and is applicable to the Sunrise pumping station since it was considered more conservative. The (Q) case governed. Pile design loads vs. tip elevations and subgrade moduli vs.

tip elevations are shown on plate 120. Settlement of the piles due to consolidation will not be a problem since the major loads are caused by hurricane waterheads of insufficient duration for consolidation of the foundation clays to ensue.

2. During construction, one 12" square concrete pile will be driven at the Bayou Grand Liard pumping station as shown on plate 26. The pile will be tested in compression to twice the design load (35 tons). If the pile fails before this load is reached the spacing will be adjusted accordingly. Since spacings of greater than 10 feet on the tension piles are not desirable, the tension piles will be working well below the design load, and no pile test will be performed in tension. Because of the small number of piles at the Sunrise pumping station, there will be no test piles at this site. In the interest of avoiding a tension pile test and having only one form for casting concrete piles, tension piles will be the same length as compression piles and spaced a maximum of 10 feet on centers, thus reducing the design load to well below the theoretical allowable tension load.

3. The test site will be located in the vicinity of boring 39-BUC. The elevation of the tip of the pile will be -58 and will be tested to 70 tons in compression.

31. Settlement. Based on foundation conditions and consolidation test data from the undisturbed borings, estimates of settlement beneath the levees along the project alignment were made. Available laboratory test data indicated that, from the surface down to the depth where the stress induced by the weight of the recommended levee is negligible, the soils are normally consolidated. The organic clays and peat in the upper 10 to 20 feet of the subsurface are very compressible and consolidate much faster than the fat inorganic clays underlying them. For this reason, more settlement occurs in the areas of highly organic soil. By removing the organic soils under the project levee from station 104+81 to station 635+72 and replacing them with a sand core, the amount of settlement at the levee centerline is greatly reduced. From station 104+81 to station 417+50 the settlement at the levee centerline will be less than the settlement at the edge of the sand core because the sand core is seated on the silt and sand layers underlying the marsh deposits in this reach. From station 417+50 to station 635+72 the settlement at the centerline and the settlement at the edge of the sand core will be approximately equal. Estimates of the ultimate settlements of the foundation for the levee in various project reaches are shown below:

Reach	Station	Construction method	Elev.	Crown Width	Settlement Center-line	Settlement Edge sand core
			ft.	ft.	ft.	ft.
Tropical Bend to Empire	Sta 0+00 to Sta. 37+00	Conventional hydraulic fill	15.0	8.0	4.5	-
Tropical Bend to Empire	Sta. 37+00 to Sta. 98+81	Conventional hydraulic fill	15.0	8.0	5.0	-
Empire to Buras	Sta. 104+81 to Sta. 417+50	Sand core hydraulic fill	15.0	8.0	3.4	5.0
Buras to Fort Jackson	Sta. 417+50 to Sta. 635+72	Sand core hydraulic fill	15.0	8.0	5.6	5.6

32. Erosion protection. Due to the short duration of hurricane flood stages and the resistant nature of the clayey soils, no erosion protection is considered necessary on the levee slopes along most of the levee alignment other than sodding. However, foreshore protection will be placed along the bank of Adams Bay from station 57+50 to the Empire floodgate, along the bank of the Empire to Gulf Waterway from station 62+00 to the Empire floodgate, and on the land side and flood side of the canal closures between stations 46+50 and 87+00 to protect the levee from damages which could occur from waves generated by other than hurricane winds. Design sections for the foreshore protection are shown on plate 22. At the Sunrise and Bayou Grand Liard pumping stations the erosion protection will consist of 18 inches of riprap over a 6-inch thick shell bedding as shown on plates 25 and 26, respectively. Erosion protection at the Empire floodgate will consist of 2 feet of riprap on a minimum 1-foot blanket of clamshell as shown on plates 28 and 29.

33. Settlement observations. Settlement observations will be made on all walls after completion of construction and yearly thereafter until settlement is essentially complete. The sheet pile in the tie-in levees will not be capped for a period of time after they have been driven because of predicted large settlements. Settlement observations will be made and a field settlement curve will be used to determine when all detrimental settlement has occurred. Before- and after-construction profiles and sections will be obtained for each construction stage for the levees and berms and yearly thereafter until settlement is essentially complete.

Observations will be made on all protective features periodically thereafter. Settlement of the walls along the existing levee will not be a problem since the major loads are caused by hurricane waterheads of insufficient duration for consolidation to occur.

DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS

34. Levees. The alignment of the protective levee system for Reach B1 is shown on plate 1. The detailed alignment and profile of the levee and features contiguous thereto are shown on plates 2 through 9. The levee will begin at Tropical Bend (sta. 0+00) at a point approximately 125 feet to the right of the existing non-Federal back levee. From this point the levee will extend southward and skirt the shore of Adams Bay to station 98+81 opposite Empire, where it will cross the Empire to the Gulf of Mexico, La., Waterway and will then extend eastward and generally parallel to the existing back levee to Fort Jackson, the end of Reach B1 (sta. 635+72). From station 0+00 to station 98+81 the levee will consist of a conventional hydraulic clay fill levee. From station 104+81 to station 625+72 the levee will consist of a hydraulic clay fill levee with a core composed of sand. The levee will have a net grade of 15.0. Typical levee design sections are shown on plates 13 through 15, 17, and 19 through 21. Design sections for the shell dikes and canal closures are shown on plates 16 and 18, respectively. The total length of the levee system is approximately 12 miles. Minor changes in the levee centerline location will be permitted in the field where such action will result in a more favorable alignment.

35. Channels.

a. Access channel. An access channel with a minimum width of 100 feet at elevation 9 feet below mean low gulf (m.l.g.) datum will be provided to maintain access between Empire and Buras as shown on plates 3 through 5. The channel will be obtained incident to levee construction (borrow) and no additional costs are anticipated.

b. Temporary bypass channel. A temporary bypass channel was dredged during construction of the first lift levee (0+00 to 98.55.3) at the location shown on plate 2 and to the section shown on plate 19 to provide navigation in and out of Empire during the construction of the floodgate. Spoil material from the excavation of the bypass channel was used in the first lift section of the adjacent levee. The channel excavation in the borrow areas was not included as an item in the cost estimates. The bypass channel ties into the Doullut Canal which will be left open until completion of the floodgate. Applicable stream closure sections for closure of Doullut Canal are shown on plates 13 and 19.

36. Structures.

a. Floodwalls at pumping stations. Sunrise and Bayou Grand Liard pumping stations are located on the protected side of the existing levee, with discharge pipes passing through the levee just below the road surface on the levee crown and terminating in the outfall canals. The new levees will not cross the outfall canals but will tie into the existing levees 200 feet to 300 feet to each side of the pipe crossings. At the Sunrise pumping station, the existing levee and tie levees will be raised to elevation 12.0 with an 8-foot crown and a floodwall will be built into the levee to elevation 20.0 to prevent wave overtopping. Floodwalls at the Sunrise pumping station will be I-type floodwalls except for a 60-foot stretch of inverted T-type floodwall which will be built in the vicinity of the discharge pipes. At the Bayou Grand Liard pumping station, stability of the existing levee section requires that the levee be degraded to elevation 6.0. The tie levee at the Bayou Grand Liard pumping station will have an 8-foot crown at elevation 10.0. Floodwall at the Bayou Grand Liard pumping station will extend to elevation 18.5 and will be inverted T-type floodwall on the existing levee and I-type floodwall on the tie levees. Where the discharge pipes pass through the floodwall, provision for settlement or deflection of the wall or any small movements of the pipes will be provided by the method shown on plate 27. Details of the floodwalls are shown on plates 25, 26, and 27.

b. Floodgate.

(1) A navigation floodgate is required in the new levee in the Empire to Gulf Waterway near Empire, La. Since the gate will be operated infrequently, investigation of alternatives to the conventional sector-gated navigation structure was indicated. Based on these investigations, a design was developed for which the construction cost is estimated to be on the order of three-fourths of that for a conventional structure of the same size. The structure in the Empire to Gulf Waterway will have a clear horizontal opening of 84 feet (approximate authorized width of the Empire to Gulf Waterway) and a sill elevation of -14, which elevation is approximately 4 feet below the authorized depth of the waterway and will provide for any future increase in depth which may reasonably be expected to be authorized in the foreseeable future. The structure will be of reinforced concrete construction with a bottom hinged gate which, in the open position, will be stored in a recess in the base slab. The gate hoisting mechanisms which will be mounted on the walls of the structure will consist of the die lock chain wildcat, driven by an electric motor with an integral brake and a totally enclosed gear train. The wildcat and driven gears will be installed on a common bearing mounted shaft. A diesel engine-driven generator will be provided at the gate for operation of hoist motors and lighting.

(2) The structure will be constructed within an earthen strutted steel sheet pile cofferdam located within the waterway. Consideration was given to building the structure in an adjacent excavation rather than in the waterway but comparative costs were unfavorable to such construction.

(3) Since the floodgate, once closed, cannot be opened until hurricane tides have receded and the stage on the landside is equal to or higher than the stage on the gulfside, closure will be delayed until overall weather conditions are so severe that the arrival of water craft fleeing the scene of a hurricane is unlikely. However, closure of the floodgate will not be delayed after hurricane tides have produced an elevation of 5.0 on the landside of the structure. Assuming that a 100-year, 24-hour rainfall accompanies the design hurricane and that some wave and spray overtopping will occur, the stage between the main hurricane protection levee and the existing back levee at Empire would reach an elevation of approximately 6.3. The existing levee is not lower than elevation 8 and it is proposed to require maintenance of this grade as a part of the Federal project.

(4) For the case of a rising hurricane tide and closure of the gate at elevation 5, the maximum average velocity through the floodgate would be 4.7 f.p.s. (feet per second). This velocity will not provide undue difficulties in closing the gate. After passage of the hurricane, the flood side stage generally will recede at a rate slower than that at which it rose. In this case, ample time should be available to open the gate before large head differentials develop. After the gate is opened, the stages on the protected side will recede at about the same rate as the flood side stages. Generally, therefore, the development of velocities critical to the structure or to the channel protection adjacent to the structure is not expected.

(5) Erosion protection will be provided in the channel adjacent to the structure. The protection will consist of 2 feet of riprap and on a 1-foot thick shell filter blanket.

(6) A plan view of the floodgate is shown on plate 28 and sections are shown on plate 29.

37. <u>Method of construction</u>.

a. <u>Levees</u>.

(1) The levees will be built by stage-construction methods over a period of several years. The levees from station 0+00 to station 98+81 will be constructed of hydraulic clay material in five stages. The hydraulic clay fill obtained from the marsh borrow area will be pumped in three lifts with approximately 2-year intervals

between successive lifts. Approximately 2 years after completion of the third lift the levee will be shaped up by dragline. One year after completion of the first shape-up the levee will be shaped up by dragline to the final section with some overbuild to compensate for future settlement. The first lift in this reach is now in place and plans and specifications for the second lift are being prepared.

(2) From station 104+81 to station 635+72 a sand core hydraulic clay fill levee will be constructed in two stages. A trench for the sand core will be excavated to the dimensions and elevations shown on plates 14 and 15. The material excavated between stations 104+81 and 535+50 will be utilized in the construction of the hydraulic clay fill retaining dikes shown on plates 14 and 15. From stations 538+00 to 635+72 the material excavated from the core trench will be wasted in the designated spoil area. At the stream crossings, shell retaining dikes will be constructed to the sections shown on plate 16. Sand will then be pumped from the sand borrow area in the Mississippi River (plate 23) into the excavated trench to an elevation that will provide sufficient material for shape-up of the sand core as shown on plates 14 and 15. Between stations 538+00 and 635+72 the retaining dikes will be constructed on top of the sandfill from borrow within the ponding area as shown on plate 15. Hydraulic clay fill from the marsh borrow area will then be pumped between the retaining dikes or between the existing back levee and flood side retaining dike to cover the sand core. After the hydraulic clay fill has dried sufficiently (approximately 2 years from time of placement), undisturbed borings and shear tests will be made to evaluate the design of the final levee section. An additional contract will then be initiated for shape-up of the hydraulic clay fill into the net section plus some overbuild to compensate for additional settlement. It is estimated that ultimately, due to settlement, a clay cover over the sand core, including a wave berm, of at least 10 feet will be provided on the flood side slope of the levee. This will afford adequate protection against erosion and potential hazardous seepage. Construction of the first lift levee between station 104+70 and station 377+50 is now in progress.

b. Levees and floodwalls.

(1) At the Sunrise pumping station between stations 236+90 and 237+50 the existing back levee will be degraded to the necessary elevation and the T-wall constructed. The levee will be reconstructed to elevation 12.0 using semicompacted methods. The fill will be placed well in advance of the installation of the steel sheet piling to reduce settlement of the wall.

(2) At the Bayou Grand Liard pumping station the existing back levee between approximate levee stations 534+27 and 538+56 will be degraded to elevation 6 and the wall will then be constructed. Because of the stability into the land side and flood side pits, the levee will not be rebuilt, but maintained at this elevation.

(3) At both pumping stations the tie-in levee will be constructed as soon as possible after the first lift. Sheet piling will be driven, but not capped until a field settlement curve predicts no further detrimental settlement.

OTHER PLANS CONSIDERED

38. Recommended construction plan. In general, the recommended construction plan consists of a conventional hydraulic clay fill levee from station 0+00 to station 98+81 and a hydraulic clay levee with a sand core from station 104+81 to station 635+72.

39. Alternative construction plans for levee. The method of constructing the levee presented in the GDM (1967) was by hydraulic clay fill. Subsequent to approval of the GDM (1967) and initiation of the 1st lift of levee from Tropical Bend to the Empire Floodgate, a letter-type report dated 31 December 1969 was submitted to LMVD recommending that the levee between the Empire Floodgate and Buras be constructed with a sand core. This revised method of constructing the levee was approved by LMVED-G 1st Indorsement dated 2 February 1970 (reference paragraph 3b(2) of this GDM). In addition to the recommended method of constructing the levee with a sand core from Buras to Fort Jackson two alternative plans were considered including straddle enlargement of the existing levee by barging material from the Pointe a la Hache Relief Outlet, stockpiling, and then hauling by truck to the levee (alternate A), and by a hydraulic clay fill levee using the existing levee initially as a retaining dike and finally as topping material (alternate B). Sufficient design analyses were accomplished to determine that the most economical and practicable method of constructing the levee is by hydraulic clay fill with a sand core. A cost comparison between the recommended plan and the alternate plans for the levee between Buras and Fort Jackson is as follows:

Plans	Cost
Hydraulic clay fill levee with sand core (recommended)	$ 8,180,000
Straddle enlargement of existing levee (alternate A)	8,226,000
Hydraulic clay fill levee (alternate B)	14,053,000

ACCESS ROADS

40. General. The work areas may be reached via Louisiana State Highway 23 and local and field roads. A permanent access road is necessary for maintenance and operation of the floodgate and will be constructed at the location shown on plate 28.

STRUCTURAL DESIGN

41. Criteria for structural design. The structural design of the floodwalls complies with standard engineering practice and criteria set forth in Engineering Manuals for Civil Works construction published by the Office, Chief of Engineers, subject to modifications indicated by engineering judgment and experience to meet local conditions. Wave forces were computed from guidelines outlined in Technical Report No. 4, third edition, 1966, "Shore Protection Planning and Design," published by the U. S. Army Coastal Engineering Research Center with the exception that breaking waves were not considered to act on the total structures. (See WES Research Report H-68-2, "Shock Pressures Caused by Waves Breaking Against Coastal Structures," dated September 1968.)

a. Basic data.

Stillwater elevation flood side	12.0
Assumed water elevation land side of floodwall	-4.0
Wave characteristics (see table A-5, appendix A)	
Wave pressures (see figures E-1 through E-4)	
Unit weight of water	62.5 pcf
Unit weight of reinforced concrete	150 pcf

b. Allowable working stresses. The allowable working stresses for concrete and structural steel are in accordance with those recommended in "Working Stresses for Structural Design," EM 1110-1-2101 dated 1 November 1963, and amendment 1 dated 14 April 1965. The basic minimum 28-day compression strength for concrete will be 3,000 p.s.i., except for prestressed concrete piling where the minimum will be 5,000 p.s.i. Prestressed concrete piles will be 12-inch by 12-inch square and will meet the requirements of the Joint AASHO and PCI Committee Standard Specifications for "Square Concrete Prestressed Piles." Steel for steel sheet piling will meet the requirements of ASTM A-328-69, "Standard Specifications for Steel Sheet Piling." For convenient reference, pertinent allowable stresses are tabulated below:

Reinforced concrete (except for concrete piles)

f'c	3,000 psi
f_c	1,150 psi
v_c	60 psi
f_s	20,000 psi
Minimum area steel	0.0025 bd sq.in.
Shrinkage and temperature steel area	0.0020 bt sq.in.

Structural steel

Basic working stress (ASTM A-36)	18,000 psi
Basic working stress (steel sheet piling)	19,250 psi

c. I-type floodwall. I-type floodwall will be constructed from wall line stations 0+00 to 5+39 and from 5+99 to 11+78 at Sunrise pumping station and from wall line stations 0+00 to 2+21 and from 6+80 to 8+80 at Bayou Grand Liard pumping station (see plates 25 and 26). The I-wall will consist of sheet piling driven into the final levee sections as shown on plate 27. The upper portion of the sheet piling will be capped with concrete. The sheet piling will be driven to the required depth with 1 foot of the sheet piling extending above the levee crown. The concrete portion of the floodwall will extend from 2 feet below the levee crown to the design elevation at the top of the floodwall. Wave load computations for the two I-type walls are shown in figures E-1, E-2, and E-4, appendix E. In the design of the I-wall, two loading cases were considered:

Case I - Static water to the SWL, elevation 12.0, 1.5 factor of safety in the soil, no wave force.

Case II - Static water to SWL, elevation 12.0, 1.25 factor of safety in the soil, wave load from non-breaking wave.

Since Case II proved to be the most critical, only the computations for this case are presented. (See figures E-12 and E-13, appendix E.)

d. T-type floodwall. T-type floodwall will be constructed from wall line stations 5+39 to 5+99 at Sunrise pumping station and from wall line stations 2+21 to 6+80 at Bayou Grand Liard pumping station (see plates 25 and 26). The reinforced concrete T-wall section will be supported by battered prestressed concrete piles driven into the levee section as shown on plate 27. The sheet pile cutoff wall below the T-wall base is assumed to be self-supporting and therefore does not cause or resist any load on the T-wall. Wave load computation for the two T-type walls is shown in figures E-1 through E-3, appendix E. The design calculations for the T-type wall at Bayou Grand Liard pumping station are shown in figures E-5 through E-11, appendix E (computations for T-type wall at Sunrise pumping station are similar and therefore are not presented). The T-type walls were designed assuming the following load conditions:

Case I - Static water to SWL, elevation 12.0, no wave force, impervious sheet pile cutoff.

Case II - Static water to SWL, elevation 12.0, no wave force, pervious sheet pile cutoff.

Case III - Static water to SWL, elevation 12.0, wave load from non-breaking wave, impervious sheet pile cutoff. 33 1/3 percent increase in allowable stresses.

Case IV - Static water to SWL, elevation 12.0, wave load from non-breaking wave, pervious sheet pile cutoff. 33 1/3 percent increase in allowable stresses.

In all cases, a crack between concrete and adjacent soil was assumed all around the base of the T-wall.

e. Protective measures against corrosion. All steel sheet piling in contact with the new levee fill will be coated with 20 mils of coal tar epoxy. The coal tar epoxy coating will extend from a minimum of 2 feet below existing ground to 3 inches into the concrete cap. Sheet piling will be electrically bonded together with a No. 6 reinforcing bar welded to the piles near the top. Flexible jumpers will be provided at each expansion joint.

SOURCES OF CONSTRUCTION MATERIALS

42. Sources of construction materials. Sand and gravel are available within 150 miles of the project. Clamshells are available within 80 miles of the project. The nearest sources of rock are in Texas, Alabama, and Arkansas.

a. Rock material. Rock is available from several locations in Texas, Oklahoma, Arkansas, Missouri, and Kentucky. The following is a list of the rock sources suitable for use as riprap:

Source	Type	Unit Wt.
Big Rock Stone & Material Co. Little Rock, Ark. Quarry at Little Rock	Nepheline Syenite	163#/c.f.
West Lake Quarry & Metal Co. Box 206, Bridgeton, Mo. Quarry at Selma, Mo.	Crystalline Limestone	167#/c.f.
Three Rivers Rock Co. Box 218, Smithland, Ky. Quarry at Smithland	Crystalline Limestone	170#/c.f.
Reed Crushed Stone Co. Box 35, Gilbertsville, Ky. Quarry at Gilbertsville	Crystalline Limestone	169#/c.f.
Trinity Concrete Products Co. 1700 Republic Bk. Bldg., Dallas, Tex.		
Quarry at Chico, Tex.	Limestone	167#/c.f.
Quarry at Knippa, Tex.	Igneous Basalt	195#/c.f.
Quarry at Stringtown, Okla.	Argillaceous limestone	161#/c.f.

b. Concrete aggregate. The following is a list of sources from which concrete aggregate, suitable for construction connected with this project, can be produced. The test data for these sources are included in volumes III and IV of WES TM 6-370, "Concrete Aggregates." The locations and index numbers of these sources are as follows:

Para 42b

Plant	Vol.	Lat.	Long.	Index No.	Used at
Dixie Sand and Gravel T4S, R12E, Sec. 16 Washington Ph., La.	IV	30	89	9	Siphons in NOD
Gifford Hill 1 mi. south of Tangipahoa, La.	III	30	90	-	-
Jahncke Service,Inc. Mitchell Pit at Fluker, La.	III	30	90	6	Freshwater Lock
La.Ind. at Franklinton (Price Pit)	-	30	89	9	Floodwall, Lake Pont. & Vic.
Morse-Ory at Amite	-	30	90	-	-
Anderson Gravel Co. at Amite	-	30	90	-	-
Lambert Gravel Co. Bayou Sara at Baines, La.	III	30	91	1 (suppl 2)	(Tested for) Old River Bridge
Holloway Sand & Gravel Thompsons Creek at St.Francisville	III	30	91	2 (suppl 2)	St. Francisville Casting Yard
River Materials Miss. River mile 249 AHP	III	30	91	9	"
Trinity Sand & Gravel Kinder, La.	III	30	92	2 (suppl 3)	(Tested for) Calcasieu S.W. Barrier & Freshwater Lock
Trinity Concrete Prod. Longville, La.	III	30	93	2 (suppl)	"

Test data in WES TM 6-360 are applicable to the above sources of concrete aggregate. All of the above sources were investigated and approved as concrete, sand, and/or gravel sources subject to complete test analysis by WES. The gradation of coarse aggregate shown in CE-1401.01, "Standard Guide Specifications for Concrete," August 1963, is not available from pits within an economic distance of the project. Therefore, the gradation shown below, in one size, will be specified:

Sieve size U. S. Standard square mesh	Percent by weight passing individual sieve
1 1/2 in.	100
1 in.	90-97
1/2 in.	40-60
No. 4	0-6

The above gradation was approved for Wax Lake East pumping station, Wax Lake West pumping station, Calcasieu Saltwater Barrier, Freshwater Bayou lock, and hurricane protection, Lake Pontchartrain and Vicinity.

COORDINATION WITH OTHER AGENCIES

43. U. S. Department of the Interior, Fish and Wildlife Service.

a. Review and recommendations. Extensive coordination with the U. S. Fish and Wildlife Service was accomplished during and subsequent to authorization of the project. By letter dated 15 March 1971, the Regional Director, U. S. Fish and Wildlife Service, Atlanta, Georgia, was informed of the current levee alignment for Reach B1 and requested to furnish views and comments. By letter dated 30 April 1971, the Regional Director stated "...Our comments concerning the fish and wildlife aspects of the proposed Reach B1 levee were adequately considered in previous reports from this office. We do note, however, that location of the proposed Buras to Fort Jackson levee to coincide with the existing back levee will encompass considerably less marsh habitat than the original plan. Construction of the levee in this location will therefore be less damaging to fish and wildlife resources...." In the Regional Director's previous report dated 29 November 1965 he stated "...The Bureau therefore recommends that, in order to minimize adverse project effects on fish and wildlife resources, your final plans for hydraulic dredging provide the following spoil-control measures:

"1. Adequate spoil dikes with effective spillway.

"2. Careful handling to prevent refluxing...."

Copies of the above reports from the Regional Director are included in appendix D.

b. Proposed action. Adequate spoil dikes with effective spillways will be provided during hydraulic construction of the levees to clarify the effluent from the hydraulic dredge to acceptable limits. The effluent will be initially clarified within the levee retaining dikes, will then pass through spillways in the retaining dikes into ponding areas, and then pass through spillways into the adjacent marshlands.

44. U. S. Department of the Interior, Federal Water Pollution Control Administration (now Environmental Protection Agency, Water Quality Office).

a. Review and recommendations. The Regional Director, South Central Region, was informed of the project by letter dated 10 January 1967 and requested to furnish views and comments. The Regional Director in his letter of response dated 13 April 1967 requested that consideration be given to the following:

(1) Spoil bank control to prevent water pollution from turbid conditions.

(2) Minimizing the accidental spillage of petroleum products or other harmful materials and maintenance of sanitary facilities to adequately treat domestic wastes.

b. Proposed action. Provisions relative to water quality degradation during construction, control of accidental spillages, and maintenance of adequate sanitary facilities by construction contractors will be incorporated into the construction plans and specifications.

45. Louisiana Wild Life and Fisheries Commission. The Director was informed by letter dated 2 April 1971 of the current alignment for Reach B1 and requested to furnish views and comments. By letter dated 21 July 1971 the Commission stated "...We wish to concur with the comments of the Bureau of Sport Fisheries and Wildlife in their letter of April 30, 1971, to you...." A copy of the above correspondence from the Commission is inclosed in appendix D.

46. State of Louisiana, Department of Public Works. The Department was informed of the authorized improvements and of the design memorandum studies. Numerous meetings were held with officials of the Department during the studies and the Department has indicated its concurrence in the plan of improvement.

REAL ESTATE REQUIREMENTS

47. General. All rights-of-way will be acquired by local interests and furnished without cost to the United States. There will be no acquisition by the United States.

RELOCATIONS

48. General. The authorizing act specifies that local interests, prior to initiation of construction, give assurances satisfactory to the Secretary of the Army that they will, without cost to the United States, "...accomplish all necessary alterations and relocations to roads, pipelines, cables, wharves, and other utilities required by the construction of the project;...." All relocations for this project are the responsibility of local interests and consist of the following:

a. Pipelines. Relocation of the following pipelines is required by construction of the project:

Location (B/L station at C/L of levee)	Type	Size
161+74	Gas pipeline	4"
188+55	Gas pipeline	8"
198+13	Crude oil pipeline	20"
222+13	Crude oil pipeline	12"
261+49	Crude oil pipeline	12"
261+55	Butane pipeline	6"
261+61	Gasoline pipeline	6"
261+67	Fuel oil pipeline	4"
315+98	Gas pipeline	6"

All of the above relocations are shown on plates 4 and 5. Design sections are shown on plate 24.

b. Pumping station modifications. The discharge pipes of the Sunrise and Bayou Grand Liard pumping stations will require modification to accommodate construction of the floodwalls at the stations.

c. Facilities in the Buras harbor area. Facilities in the Buras harbor area which required relocation because of the project are as follows: one wholesale seafood outlet, three loading and unloading docking facilities for shrimp boats, one boat-launching facility, one boat pier, and one boat shed.

ENVIRONMENTAL QUALITY

49. Environmental quality.

a. General. The engineering treatment required for preserving and maintaining the environmental quality of the project has been considered during preparation of this design memorandum. Specifically, levee erosion protection, corrosion mitigation, and the disposition of dredge waste water are discussed in paragraphs

32, 41e, and 43b, respectively. Further, as indicated in paragraphs 43 through 46, extensive coordination has been accomplished with the appropriate agencies relative to effects of the project on fish and wildlife resources and water quality during and subsequent to construction.

b. Enhancement. With the exception of deviating from the existing levee at Empire, the project works alter the existing terrain only to the extent of raising and strengthening the existing non-Federal levees generally along the same alignment. All borrow material for the sand core will be obtained from sand deposits in the Mississippi River. Borrow material for the clay overlay will be obtained from the marsh area adjacent to the levee. Additional beautification measures beyond those which are normally associated with levee construction, i.e., grading and sodding, are not considered necessary.

ESTIMATE OF COST

50. General.

a. Reach B1. The estimated first cost for constructing Reach B1, based on July 1971 price levels, is $25,800,000, of which $18,060,000 is Federal cost and $7,740,000 is non-Federal cost. A summary of first cost is given in table 1. The detailed estimate of first cost is shown on table C-1, appendix C.

b. Reaches A, B2, C, and East Bank Barrier levee plan. Cost estimates for Reach C and the East Bank Barrier levee plan are of general design memorandum scope. Cost estimates for Reaches A and B2 are of survey report accuracy. The estimated costs for constructing the above reaches are as follows:

	Federal $	Non-Federal $	Total $
Reach A	15,750,000	6,750,000	22,500,000
Reach B2	14,070,000	6,030,000	20,100,000
Reach C	7,980,000	3,420,000	11,400,000
Barrier levee plan	9,030,000	3,870,000	12,900,000
Total	46,830,000	20,070,000	66,900,000

Details of the above costs are shown in tables C-4, C-6, C-8, and C-10, appendix C.

TABLE 1

SUMMARY OF FIRST COST
REACH B1

	Item	Federal	Non-Federal	Total
		$	$	$
01	Lands and damages	-	616,600	616,600
02	Relocations and modifications	-	701,000	701,000
11	Levees and floodwalls	20,397,600	-	20,397,600
30	Engineering & design	2,429,400	73,500	2,502,900
31	Supervision & administration	1,533,000	48,900	1,581,900
	Subtotal	24,360,000	1,440,000	25,800,000
	Cash contribution[1]	-6,300,000	+6,300,000	-
	Total	18,060,000	7,740,000	25,800,000

[1]See table C-2, appendix C, for apportionment of cost between Federal and non-Federal interests.

51. Comparison of cost estimates. The current cost estimate of $25,800,000 for Reach B1 is an increase of $12,524,000 over corresponding costs shown in the PB-3 (effective 1 July 1971). Prices in the PB-3 are based on cost estimates in the general design memorandum which this report revises, escalated to 1971 price levels. Comparisons of cost estimates shown in the project document, in the PB-3, and in this revision are shown in table 2.

a. Reasons for difference, levees and floodwalls. The feature, levees and floodwalls, (comparing PB-3 and design memorandum estimates) is further detailed in table 3. Reasons for the differences, in the amount of $9,460,600 overall increase, are:

(1) Levee embankment, first lift. Costs increased $6,807,175.

(a) Tests on soil borings obtained subsequent to original submission of the DM indicated a lower shear strength of the foundation material than previously determined. Revised design resulted in generally larger final levee configurations. Shrinkage, settlement, and lateral spread were increased, based on recent experience in this project area and on analyses of other projects with comparable foundation conditions which also increased the quantities of material.

TABLE 2

COMPARISON OF COST ESTIMATES
REACH B1

	Project document	PB-3	Revised GDM	Difference--GDM vs. PB-3
11 Levees & floodwalls	$1,358,000	$10,937,000	$20,397,600	+$ 9,460,600
30 Engineering & design	95,200	730,000	2,429,400	+ 1,699,400
31 Supervision & administration	108,800	766,000	1,533,000	+ 767,000
SUBTOTALS	$1,562,000	$12,433,000	$24,360,000	+$11,927,000
Lands & damages	$ 235,000	$ 208,000	$ 617,000	+ 409,000
Relocations	88,000	635,000	823,000	+ 188,000
SUBTOTALS	$ 323,000	$ 843,000	$ 1,440,000	+$ 597,000
TOTALS	$1,885,000	$13,276,000	$25,800,000	+$12,524,000

TABLE 3

COMPARISON OF COST ESTIMATES, LEVEES AND FLOODWALLS

	PB-3				Revised GDM				Difference
	Quantity	Unit	Unit price	Total	Quantity	Unit	Unit price	Total	
Levee embankment, first lift	4,991,306	cu.yd.	$ 0.79	$ 3,935,000	9,113,457	cu.yd.	$ 1.18	$10,742,175	+$6,807,175
Levee embankment, second lift	1,596,514	cu.yd.	0.79	1,253,000	400,000	cu.yd.	1.16	465,000	- 788,000
Levee embankment, third lift	-	-	-	-	300,000	cu.yd.	1.18	355,000	+ 355,000
Levee embankment, first shape-up	675,266	cu.yd.	0.55	371,400	2,067,300	cu.yd.	0.56	1,154,000	+ 782,600
Levee embankment, second shape-up	315,652	cu.yd.	0.55	173,600	140,000	cu.yd.	0.79	111,000	- 62,600
Retaining dikes	1,675,398	cu.yd.	0.55	921,500	-	-	-	-	- 921,500
Excavation, sand-core and channels	-	-	-	-	2,361,196	cu.yd.	0.30	720,180	+ 720,180
Shell dikes and canal closures	-	-	-	-	200,650	cu.yd.	4.58	918,360	+ 918,360
Clearing	-	-	-	-		lump sum		147,260	+ 147,260
Fertilizing and seeding	354.4	acre	100.00	35,400	389	acre	150.00	58,350	+ 22,950
Foreshore protection	-	-	-	-		lump sum		513,700	+ 513,700
Floodwalls at Sunrise Pumping Plant &		lump sum		200,000		lump sum		250,000	+ 50,000
Bayou Grand Liard Pumping Plant		lump sum		156,000		lump sum		308,100	+ 152,000
Empire Floodgate structure		lump sum		1,585,000		lump sum		2,312,000	+ 727,000
Buras Floodgate structure		lump sum		1,134,200	-	-	-	-	- 1,134,200
Subtotals				$ 9,765,200				$18,055,125	+$8,289,925
Contingencies		@ 12%		1,171,800		@ 20%		2,342,475	+ 1,170,675
TOTALS				$10,937,000				$20,397,600	+$9,460,600

(b) Higher unit prices result from wasting the upper 10 feet of unsuitable material from the clay borrow pits. Waste thus produced must be clarified within diked spoil areas to avoid damage to adjacent oyster and marine environment. Effluent from hydraulic clay embankment must also be clarified in ponding areas before releasing liquids into the marine environment. Ponding areas are generally located between the levee and the clay borrow pit, thus increasing lengths of pump lines from hydraulic dredges. The foregoing operate to increase unit prices for embankment, most of which is attributable to environmental considerations not a part of the original DM.

(c) Deletion of the Buras Floodgate results in additional levee embankment across the Fasterling Canal in lieu of the structure.

(2) Levee embankment, second lift. Costs decreased $788,000. The sand-core method of construction provides for immediate covering of sand by a clay blanket; therefore, no second lifts are required for most of Reach B1. In effect, the first and second lifts are incorporated into one which are called first lifts in this DM. Only the all-clay levee from station 0+00 to station 98+81 will require multiple lifts.

(3) Levee embankment, third lift. Costs increased $355,000. A third lift on the levee, station 0+00 to station 98+81, is a requirement not anticipated in the original DM which results from the revised shear strengths, shrinkage, settlement, and lateral spread discussed under paragraph 51a(1)(a).

(4) Levee embankment, first shape-up. Costs increased $782,600. A significantly larger volume of material is to be shaped primarily because of the larger final levee configuration. Additionally, for that part of the levee from approximately station 162+00 to station 317+00 and from approximately station 339+00 to the end of Reach B1, the material presently within the existing back levee will be incorporated into the first shape-up, a consideration not part of the original DM.

(5) Levee embankment, second shapeup. Costs decreased $62,600. Only that segment of levee, station 0+00 to station 98+81, will require a second shape-up, whereas in the original DM the entire length of Reach B1 required a second shape-up.

(6) Retaining dikes. Costs decreased $921,500. The cost of retaining dikes in the original DM is carried as a separate line item. However, this estimate has included these as a part of the levee embankment since they are within berms in the final configuration.

(7) Excavation for sand-core. Costs increased $720,180. The original DM estimate was based upon an all-clay levee whereas this revision includes the sand-core method of construction. The design provides for the foundation to be excavated down to acceptable material, which was not a requirement for the all-clay levee.

(8) Shell dikes and canal closures. Costs increased $918,360. The original DM estimate did not include shell as a part of the canal closure embankment. Lower shear strengths discussed under paragraph 51a(1)(a) were such that shell was required at canal closures when used in conjunction with an otherwise all-clay levee. Supplement No. 1 provided for this change in method of construction. Canal closures have been constructed using shell between stations 0+00 and 98+81 except for the Doullut Canal. There is no requirement for shell closures for the remainder of the levee since the sand-core will serve satisfactorily at these locations. It is necessary, however, to use shell dikes to retain hydraulically-placed sand and clay at deep channels and canals thus preventing undesirable shoaling and pollution.

(9) Clearing. Cost increased $147,260. Clearing is included as a separate item in the revised DM, whereas no separate item was included in the original submission.

(10) Fertilizing and seeding. Costs increased $22,950. Revised fertilizing and seeding standard specifications, along with an increase in surface area of the levees, resulted in a small increase.

(11) Foreshore protection. Costs increased $513,700. Need for foreshore protection along the portion of levee adjacent to the Empire, La., to the Gulf of Mexico Waterway has become evident since initial submission of the DM based on field observations. Extensive use by large watercraft presents a potential erosion hazard to the levee which must be prevented. A channel has been developed, more or less through usage, across Bay Adams, through the Doullut Canal, thence into the Empire harbor area. In the original DM this channel was not known to exist. This revision provides for rerouting the channel parallel and adjacent to the unprotected side of the levee, which route will be used for navigation during construction of the Empire Floodgate structure. It is necessary to protect the levee from erosion along this channel.

(12) Floodwalls at Sunrise and Bayou Grand Liard pumping plants. Costs increased $202,000. At Sunrise pumping plant, added earth work, added slope protection requirements, and increased length of floodwalls resulted in an increase of $50,000. At Bayou Grand Liard pumping plant, added earthwork, added slope protection, added test piling, and a change to T-wall rather than I-wall construction all operated to increase costs by $152,000.

(13) Empire Floodgate structure. Costs increased $727,000. Because of the excavation plan, the quantities of fill required for the cofferdam were increased by approximately 14,400 c.y. to 36,000 c.y. consisting of 15,500 c.y. of shell and 20,500 c.y. of clay fill. It was also necessary to use a shell core in the stream closures. This shell is not included in the material discussed in paragraph 50a(8) above. The structure will be backfilled with shell instead of using random fill, as originally planned, because of foundation strength requirements and a lack of suitable borrow at the structure site. The size of operating machinery was increased in order to operate under greater design conditions than originally considered. Quantities for riprap have been increased by 6,500 tons from the amount included within the PB-3 estimate.

(14) Buras Floodgate structure. Costs decreased $1,134,200. The Buras Floodgate structure has been deleted from the project plan at the request of local interests and the levee is continuous across the former floodgate site. Costs for the levee are included in appropriate items for levee embankment.

(15) Contingency. Costs increased $1,170,675. Because of substantial increases in overall construction costs, contingencies have increased proportionately. In addition, a larger contingency rate has been used (from 12% to 20%) due to uncertain foundation conditions.

b. Reasons for difference, engineering and design. Referring to table 5, costs increased $1,699,400, proportionate to increased construction costs. In addition, the rate of E&D on construction was increased (from 10% to 12%±) due to ecological problems, extensive negotiations with local interests concerning alignments and construction methods, and the requirement to revise this DM.

c. Reason for difference, supervision and administration. Costs increased $767,000 proportionate to increased construction costs.

d. Reasons for difference, lands and damages. Costs increased $409,000 because of additional ponding and spoil areas not contemplated in the original DM and severance costs for the Buras harbor due to deletion of the Buras Floodgate structure.

e. Reasons for difference, relocations. Costs increased $188,000. This reflects an increase of $245,000 for relocation of facilities in the Buras harbor resulting for deletion of the floodgate, an increase of $4,000 for pumping plant modifications, and a decrease of $61,000 for pipeline relocations.

SCHEDULES FOR DESIGN AND CONSTRUCTION

52. Schedules for design and construction. The sequence of contracts and the schedules for design and construction are shown below:

Contracts	Design: Start	Design: Complete	Construction: Advertise	Construction: Award	Construction: Complete	Estimated Construction Cost Includes Contingencies and S&I
Levee,1st lift (sta. 0+00 to 98+55.3)	1966	10 Apr 68	6 May 68	25 Jun 68	4 May 69	$ 779,500 (rounded)
Levee,1st lift (sta. 104+70 to 340+20)	Feb 70	8 May 70	26 May 70	29 Jun 70	Oct 71	4,744,800 (rounded)
Levee,1st lift (sta. 340+20 to 377+50)[1]	May 70	Sept 70	Oct 70	12 Nov 70	Dec 71	760,000 (rounded)
Levee,2d lift (sta. 0+00 to 98+55.3)	Jul 71	Mar 72	Apr 72	May 72	Jun 73	658,800
Empire Floodgate	May 71	Feb 72	Apr 72	May 72	May 74	2,774,000
Levee,1st lift (sta. 377+50 to 534+90)	Oct 71	Jun 72	Jul 72	Aug 72	Dec 73	4,108,000
Levee,1st lift (sta. 538+00 to 635+72.3)	Feb 72	Oct 72	Nov 72	Dec 72	Dec 73	3,078,500
Levee, Final Section(sta. 104+91 to 232+31, 242+41 to 377+50)	Oct 73	Jul 74	Aug 74	Sept 74	May 75	670,000
Levee,3d lift (sta. 0+00 to 98+55.3)	Jun 75	Mar 76	Apr 76	May 76	Mar 77	520,800

[1]Contracted by Plaquemines Parish

Contracts	Design: Start	Design: Complete	Construction: Advertise	Construction: Award	Construction: Complete	Estimated Construction Cost Includes Contingencies and S&I
Levee,Final Section(sta. 377+50 to 532+76, 539+71 to 635+72.3)	Dec 75	Sept 76	Oct 76	Nov 76	Jun 77	$ 851,600
Test Pile, Bayou Grand Liard	Feb 77	May 77	Jun 77	Jul 77	Sept 77	12,000
Floodwall, Pumping stations	Aug 77	Apr 78	May 78	Jun 78	Feb 79	658,600
Levee,1st Shape-up (sta. 0+00 to 98+55.3)	Mar 79	Dec 79	Jan 80	Feb 80	Jul 80	22,300
Levee, Final Section(sta. 0+00 to 98+55.3)	Jul 80	Apr 81	May 81	Jun 81	Jun 82	758,700

53. Funds. To maintain the schedule as shown above for Reach B1, funds will be required by fiscal years as follows:

Total estimated cost through FY 1971	$ 5,917,000
Funds required FY 1972	1,507,000
1973	5,410,000
1974	6,510,000
1975	770,000
1976	390,000
1977	1,550,000
1978	266,000
1979	805,000
1980	155,000
1981	275,000
1982	805,000
Total	$24,360,000[1]

[1]Funds required include all Federal funds appropriated and non-Federal cash contributed.

OPERATION AND MAINTENANCE

54. Federal. Federal operation and maintenance costs are not involved in the project.

55. Non-Federal. As specified in the authorizing act, local interests are to maintain and operate the completed works in accordance with regulations prescribed by the Secretary of the Army and good maintenance practices. The estimated total annual cost of operation, maintenance, and replacements for the project is $60,500, broken down as follows:

Maintenance	
Levees	$21,000
Operation and maintenance	
Floodgate--Empire	27,000
Replacement of component parts	
Floodgate--Empire	12,500
Total	$60,500

ECONOMICS

56. Benefits.

a. General. Economic analyses have been made for all reaches of the project. The analyses are based on two independent improvements: (1) enlargement of the back levees to provide protection from tidal surges overtopping the back levees; and (2) a barrier levee on the east bank of the river from Bohemia to mile 10 and minor enlargement of the river levee from Fort Jackson to Venice to provide protection from tidal surges overtopping the river levees from the east. In these analyses, the barrier levee plan was considered incrementally to the back levees. The economic analyses are inclosed as appendix B.

b. Reach B1. The plan of improvement would provide a high degree of protection (100 years) to approximately 3,800 acres of land which, except for about 400 acres of marshland, is presently located within a levee system affording a marginal degree of protection from hurricane tides. Benefits which would accrue from enlargement of the back levees would be in the form of flood damages prevented on existing and future development. Benefits which would accrue from the East Bank Barrier levee plan would be in the form of flood damages prevented on existing and future development and land enhancement.

c. Reaches A, B2, and C. The benefits which would accrue from enlargement of the back levees in Reaches A and B2 would be in the form of flood damages prevented on existing and future development, and in Reach C the above plus land enhancement. Benefits which would accrue from the East Bank Barrier levee plan in Reaches A and B2 would be in the form of flood damages prevented on existing and future development and land enhancement. The acreages protected are 4,300, 2,300, and 4,500 for Reaches A, B2, and C, respectively.

(1) The average annual benefits which will accrue to the project areas from enlargement of the existing non-Federal back levees are as follows:

Average annual benefits - authorized back levees

	Existing development	Future development	Land enhancement	Total
	$	$	$	$
Reach A	614,000	655,000	0	1,269,000
Reach B1	2,182,000	1,711,000	0	3,893,000
Reach B2	663,000	262,000	0	925,000
Reach C	440,000	174,000	221,000	835,000

(2) The average annual benefits which will accrue to the project areas from the East Bank Barrier levee plan are $3,309,000 for existing development, $2,426,000 for future development, and $2,634,000 for land enhancement, a total of $8,369,000.

57. Annual charges.

a. Reach B1. The total annual charges for constructing Reach B1 along the back levee are $941,500, of which $614,900 is Federal cost and $326,600 is non-Federal cost. Details of the annual charges are shown on table 4.

b. Reaches A, B2, C, and Barrier levee plan. The annual charges for Reaches A, B2, and C, and the Barrier levee plan are shown below. Details of the annual charges are shown on table 5.

Annual charges

	Federal	Non-Federal	Total
	$	$	$
Reach A	508,700	271,800	780,500
Reach B2	454,400	212,000	666,400
Reach C	250,700	154,700	405,400
Barrier levee plan	291,600	180,600	472,200

TABLE 4

ESTIMATE OF ANNUAL CHARGES FOR REACH B1

Summary of project costs	Federal $	Non-Federal $	Total $
Construction	24,360,000	-	24,360,000
Lands, damages, relocations	-	1,440,000	1,440,000
	24,360,000	1,440,000	25,800,000
Less cash contribution	-6,300,000	6,300,000	-
First cost	18,060,000	7,740,000	25,800,000
Interest during construction (8 yrs. @ 2 7/8%)	2,077,000	890,000	2,967,000
Total project investment	20,137,000	8,630,000	28,767,000
Annual economic costs			
Interest (2 7/8%)	578,900	248,000	826,900
Amortization (100 yrs.)	36,000	15,500	51,500
Maintenance and operation	-	48,000	48,000
Replacements	-	12,500	12,500
Economic loss on lands	-	2,600	2,600
Total annual economic costs	614,900	326,600	941,500

TABLE 5

ESTIMATE OF ANNUAL CHARGES FOR REACHES A, B2, AND C

REACH A

Summary of project costs	Federal $	Non-Federal $	Total $
Construction	21,000,000	-	21,000,000
Lands, damages, relocations	-	1,500,000	1,500,000
	21,000,000	1,500,000	22,500,000
Less cash contribution	-5,250,000	5,250,000	-
First cost	15,750,000	6,750,000	22,500,000
Interest during construction (4 yrs. @ 2 7/8%)	906,000	388,000	1,294,000
Total project investment	16,656,000	7,138,000	23,794,000
Annual economic costs			
Interest (2 7/8%)	478,900	205,200	684,100
Amortization (100 yrs.)	29,800	12,800	42,600
Maintenance & operation	-	37,000	37,000
Replacements	-	7,800	7,800
Economic loss on lands	-	9,000	9,000
Total annual economic costs	508,700	271,800	780,500

REACH B2

Summary of project costs	Federal	Non-Federal	Total
Construction	19,500,000	-	19,500,000
Lands, damages, relocations	-	600,000	600,000
	19,500,000	600,000	20,100,000
Less cash contribution	-5,430,000	5,430,000	-
First cost	14,070,000	6,030,000	20,100,000
Interest during construction (4 yrs.)	809,000	347,000	1,156,000
Total project investment	14,879,000	6,377,000	21,256,000

TABLE 5 (cont'd)

REACH B2 (cont'd)

Annual economic costs	Federal	Non-Federal	Total
	$	$	$
Interest (2 7/8%)	427,800	183,300	611,100
Amortization (100 yrs.)	26,600	11,400	38,000
Maintenance & operation	-	14,000	14,000
Replacements	-	-	-
Economic loss on lands	-	3,300	3,300
Total annual economic costs	454,400	212,000	666,400

REACH C

Summary of project costs	Federal	Non-Federal	Total
Construction	9,735,000	-	9,735,000
Lands, damages, relocations	-	1,665,000	1,665,000
	9,735,000	1,665,000	11,400,000
Less cash contribution	-1,755,000	1,755,000	-
First cost	7,980,000	3,420,000	11,400,000
Interest during construction (2 yrs.)	229,000	98,000	328,000
Total project investment	8,209,000	3,518,000	11,728,000

Annual economic costs	Federal	Non-Federal	Total
Interest (2 7/8%)	236,000	101,100	337,100
Amortization (100 yrs.)	14,700	6,300	21,000
Maintenance & operation	-	17,000	17,000
Replacements	-	23,500	23,500
Economic loss on lands	-	6,800	6,800
Total annual economic costs	250,700	154,700	405,400

TABLE 5 (cont'd)

EAST BANK BARRIER LEVEE PLAN

Summary of project costs	Federal	Non-Federal	Total
	$	$	$
Construction	11,958,000	-	11,958,000
Lands, damages, relocations	-	942,000	942,000
	11,958,000	942,000	12,900,000
Less cash contribution	-2,928,000	2,928,000	-
First cost	9,030,000	3,870,000	12,900,000
Interest during construction (4 yrs.)	519,000	223,000	742,000
Total project investment	9,549,000	4,093,000	13,642,000
Annual economic costs			
Interest (2 7/8%)	274,500	117,700	392,200
Amortization (100 yrs.)	17,100	7,300	24,400
Maintenance & operation	-	25,200	25,200
Replacements	-	8,200	8,200
Economic loss on lands	-	22,200	22,200
Total annual economic costs	291,600	180,600	472,200

58. Economic justification.

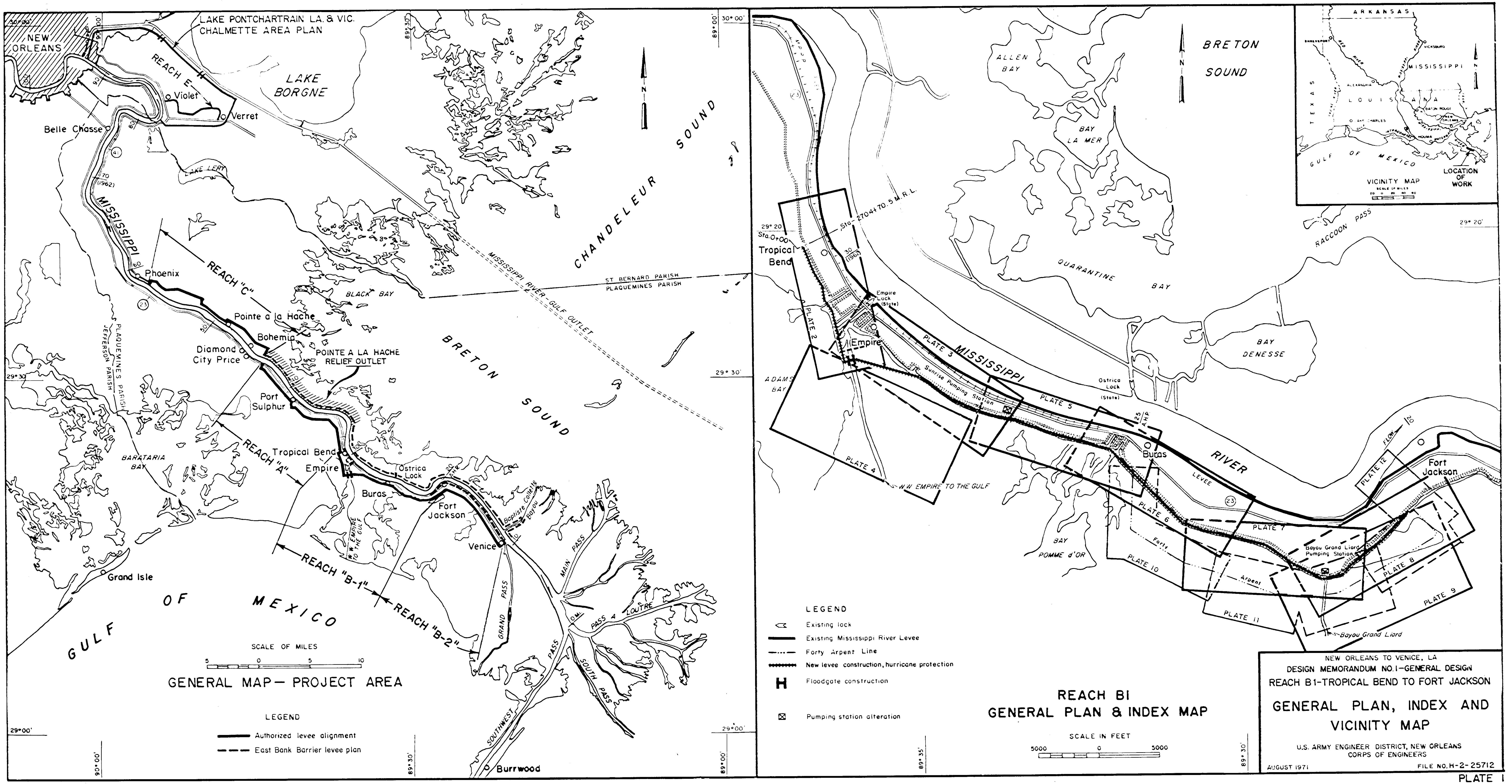
a. Reach B1. The average annual benefits of $3,893,000 and average annual charges of $941,500 result in a favorable benefit-cost ratio of 4.1 to 1.

b. Reaches A, B2, C, and East Bank Barrier levee plan. The average benefits and annual economic costs for Reaches A, B2, C, and East Bank Barrier levee are as follows:

Reach	Annual benefits	Annual charges	Benefit-cost ratio
	$	$	
A	1,269,000	780,500	1.6
B2	925,000	666,400	1.4
C	835,000	405,400	2.1
Barrier levee plan	8,369,000	472,200	17.7

RECOMMENDATIONS

59. Recommendations. The plan of improvement presented herein for Reach B1 consists of a levee with appurtenant features from Tropical Bend to Fort Jackson, a distance of approximately 12 miles. The levee will consist of a conventional hydraulic clay fill embankment from Tropical Bend to Empire and a hydraulic clay fill embankment with a sand core from Empire to Fort Jackson. The plan also provides for a floodgate in the Empire to Gulf Waterway near Empire, floodwalls at the Bayou Grand Liard and Sunrise pumping stations, a navigation canal between Empire and Buras, and modification to pipelines and facilities as necessary. The plan is considered to be the best means of accomplishing the project objectives and is recommended for approval.



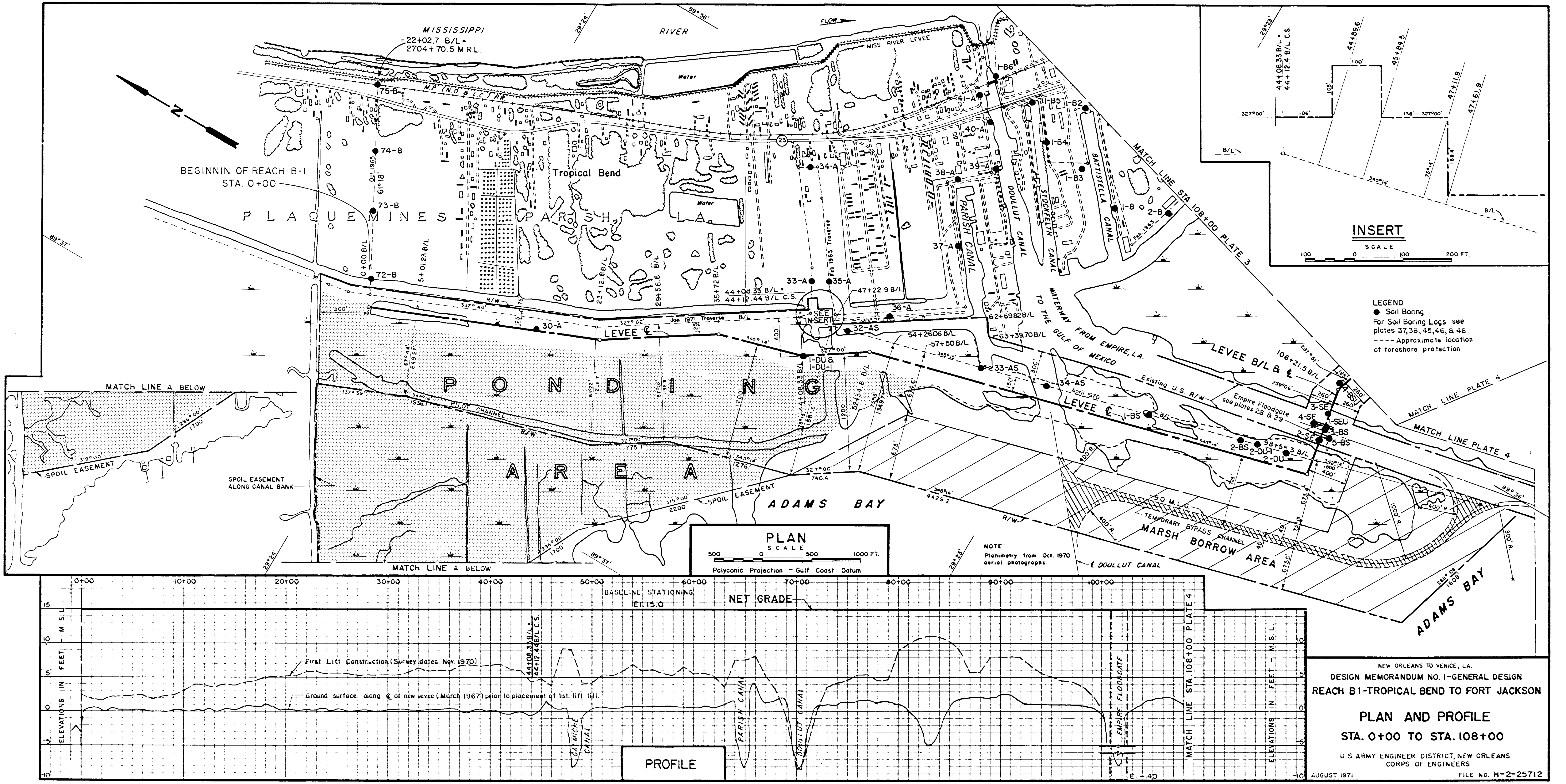
NEW ORLEANS TO VENICE, LA
DESIGN MEMORANDUM NO. 1—GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

GENERAL PLAN, INDEX AND VICINITY MAP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

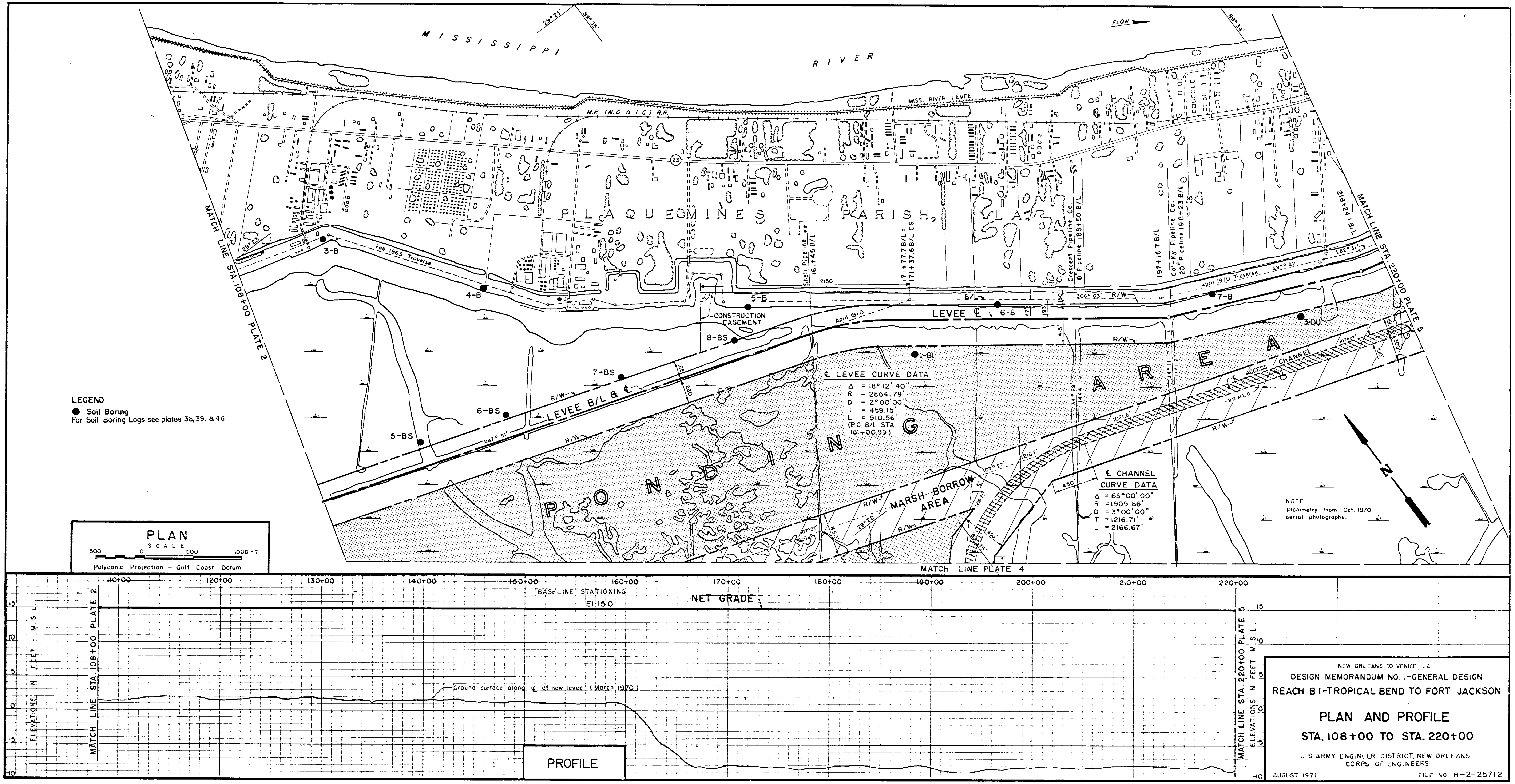
AUGUST 1971 FILE NO. H-2-25712

PLATE 1



MISSISSIPPI
RIVER
FLOW
MISS RIVER LEVEE
Water
-22+02.7 B/L =
2704+70.5 M.R.L.
BEGINNIN OF REACH B-I
STA. 0+00
PLAQUEMINES PARISH, LA.
Tropical Bend
PONDING AREA
PILOT CHANNEL
LEVEE ℄
SPOIL EASEMENT
SPOIL EASEMENT ALONG CANAL BANK
MATCH LINE A BELOW
ADAMS BAY
PARISH CANAL
DOULLUT CANAL
STOCKFELTH CANAL
BATTISTELLA CANAL
WATERWAY FROM EMPIRE, LA. TO THE GULF OF MEXICO
LEVEE B/L & ℄
Existing U.S. R/W
Empire Floodgate see plates 28 & 29
MARSH BORROW AREA
TEMPORARY BYPASS CHANNEL
℄ DOULLUT CANAL
MATCH LINE STA. 108+00 PLATE 3
MATCH LINE PLATE 4
SEE INSERT
INSERT
SCALE
100 0 100 200 FT.
LEGEND
● Soil Boring
For Soil Boring Logs see plates 37, 38, 45, 46, & 48.
---- Approximate location of foreshore protection
PLAN
SCALE
500 0 500 1000 FT.
Polyconic Projection - Gulf Coast Datum
NOTE:
Planimetry from Oct. 1970 aerial photographs.
BASELINE STATIONING
NET GRADE
El. 15.0
First Lift Construction (Survey dated Nov. 1970)
Ground surface along ℄ of new levee (March 1967) prior to placement of 1st lift fill.
ELEVATIONS IN FEET - M.S.L.
GALMICHE CANAL
PARISH CANAL
DOULLUT CANAL
EMPIRE FLOODGATE
MATCH LINE STA. 108+00 PLATE 4
PROFILE
El. -14.0
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON
PLAN AND PROFILE
STA. 0+00 TO STA. 108+00
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971
FILE NO. H-2-25712

PLATE 2



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

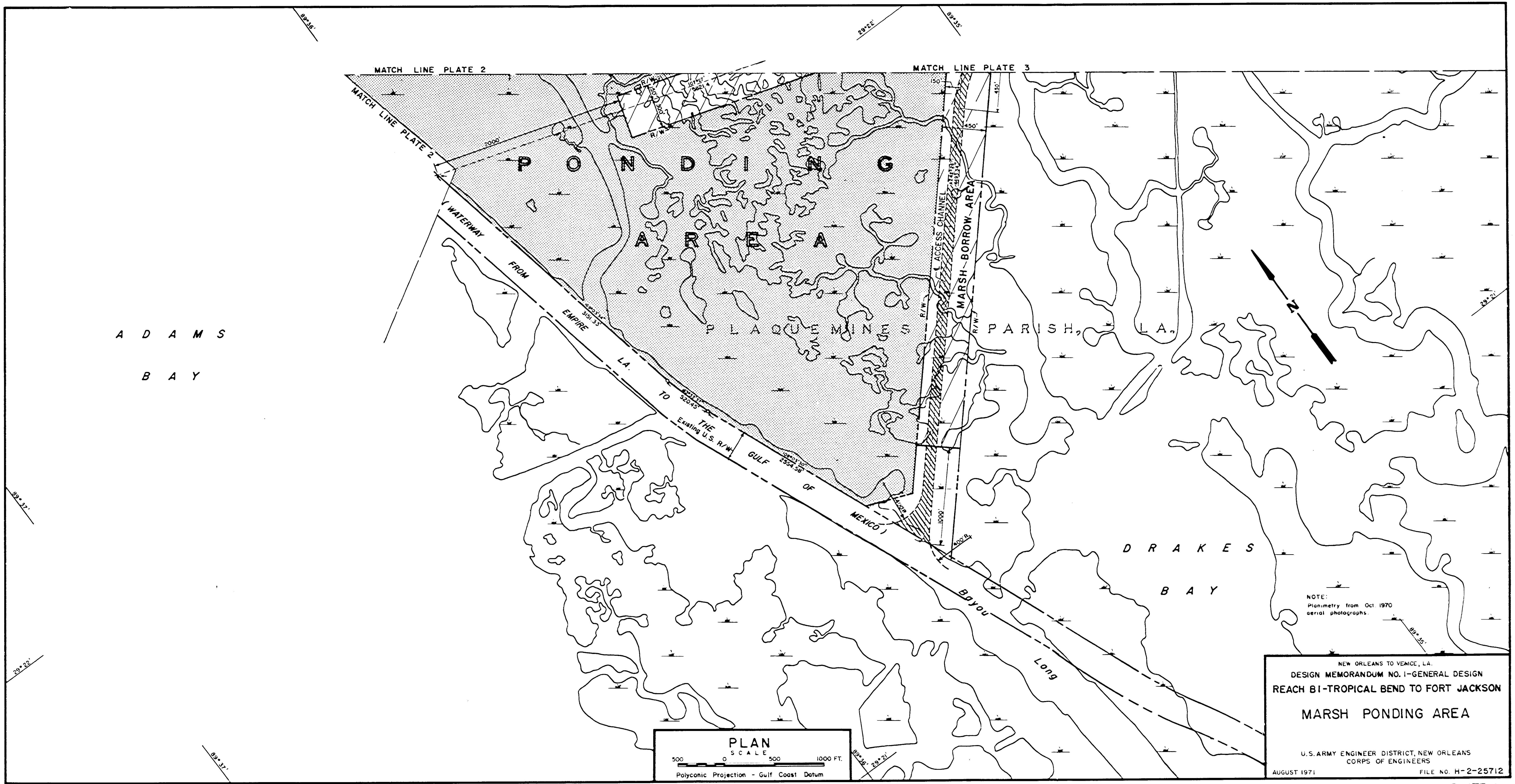
PLAN AND PROFILE

STA. 108+00 TO STA. 220+00

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE 3



PLAN

SCALE 500 0 500 1000 FT.

Polyconic Projection - Gulf Coast Datum

NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

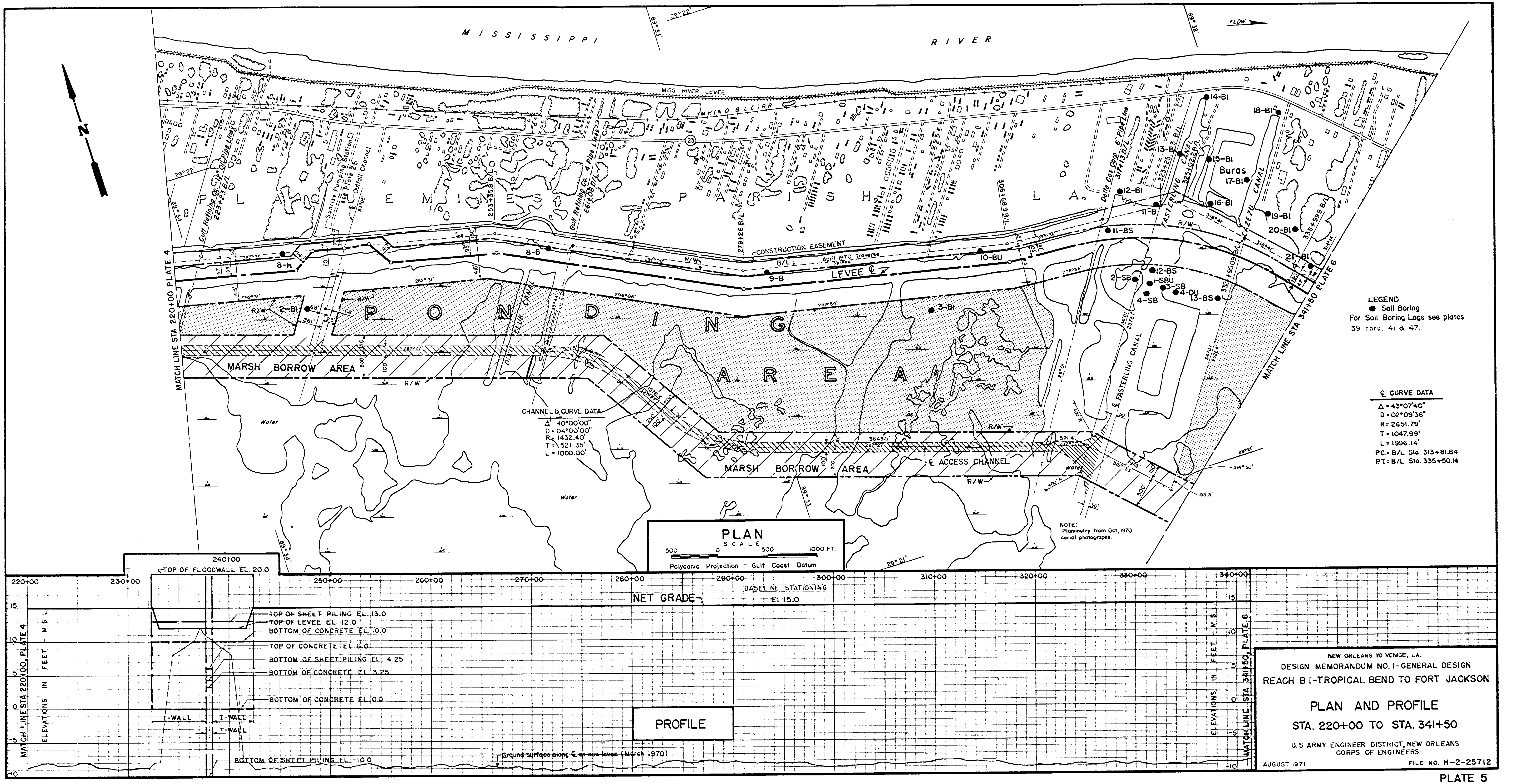
REACH B1-TROPICAL BEND TO FORT JACKSON

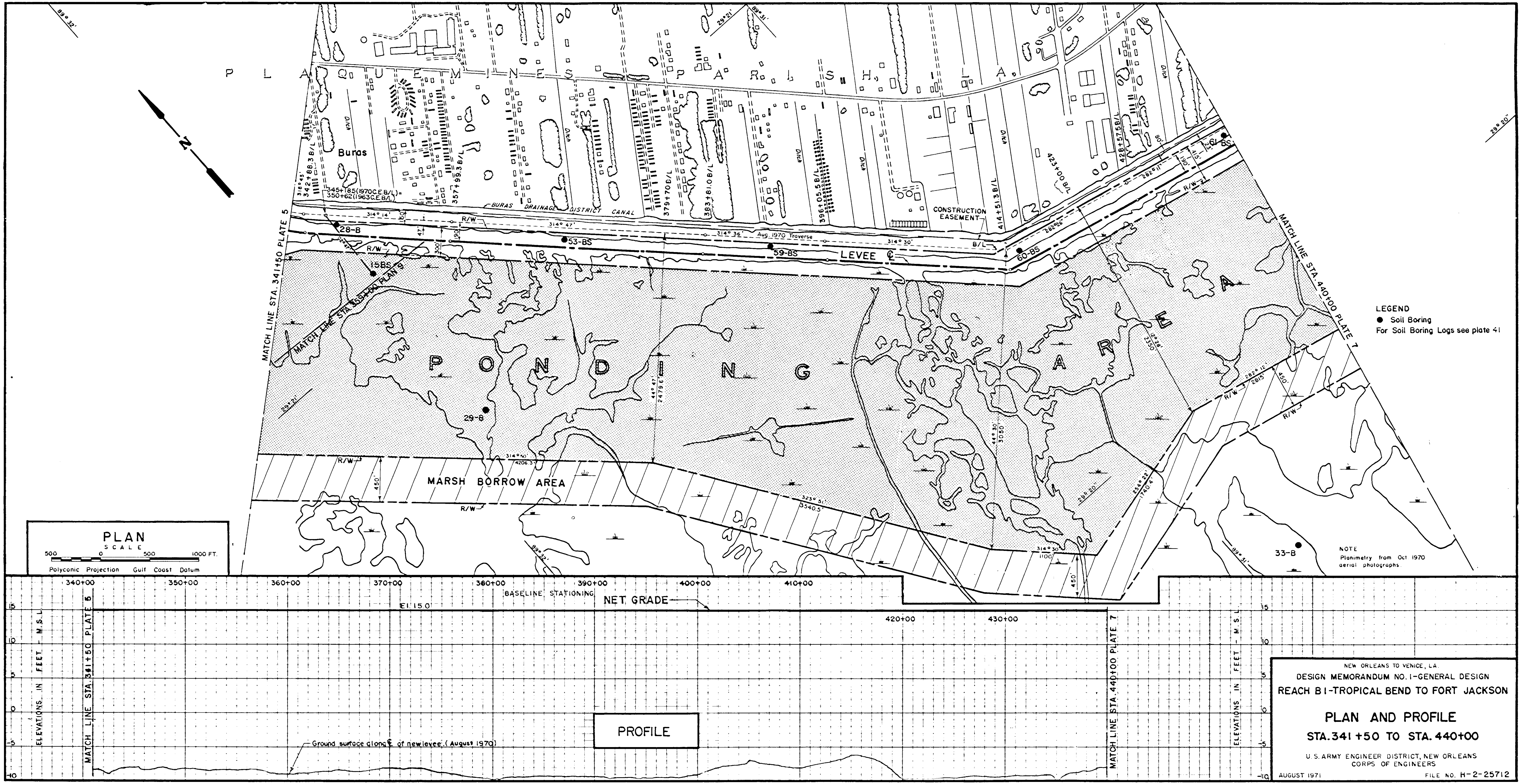
MARSH PONDING AREA

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE 4


MISSISSIPPI RIVER
FLOW
N
MISS RIVER LEVEE
PLAQUEMINES PARISH LA.
CONSTRUCTION EASEMENT
LEVEE ℄
PONDING AREA
MARSH BORROW AREA
℄ ACCESS CHANNEL
℄ FASTERLING CANAL
FASTERLING CANAL
Buras
MATCH LINE STA 220+00 PLATE 4
MATCH LINE STA 341+50 PLATE 6
LEGEND
Soil Boring
For Soil Boring Logs see plates 39 thru. 41 & 47.
℄ CURVE DATA
Δ = 43°07'40"
D = 02°09'38"
R = 2651.79'
T = 1047.99'
L = 1996.14'
P.C. = B/L Sta. 313+81.84
P.T. = B/L Sta. 335+50.14
CHANNEL & CURVE DATA
Δ 40°00'00"
D = 04°00'00"
R = 1432.40'
T = 1521.35'
L = 1000.00'
NOTE: Planimetry from Oct, 1970 aerial photographs
PLAN
SCALE
500 0 500 1000 FT.
Polyconic Projection - Gulf Coast Datum
TOP OF FLOODWALL EL. 20.0
NET GRADE
BASELINE STATIONING
EL. 15.0
TOP OF SHEET PILING EL. 13.0
TOP OF LEVEE EL. 12.0
BOTTOM OF CONCRETE EL. 10.0
TOP OF CONCRETE EL. 6.0
BOTTOM OF SHEET PILING EL. 4.25
BOTTOM OF CONCRETE EL. 3.25
BOTTOM OF CONCRETE EL. 0.0
I-WALL
T-WALL
BOTTOM OF SHEET PILING EL. -10.0
Ground surface along ℄ of new levee (March 1970)
PROFILE
ELEVATIONS IN FEET - M.S.L.
MATCH LINE STA 220+00, PLATE 4
MATCH LINE STA 341+50, PLATE 6
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B 1-TROPICAL BEND TO FORT JACKSON
PLAN AND PROFILE
STA. 220+00 TO STA. 341+50
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971
FILE NO. H-2-25712



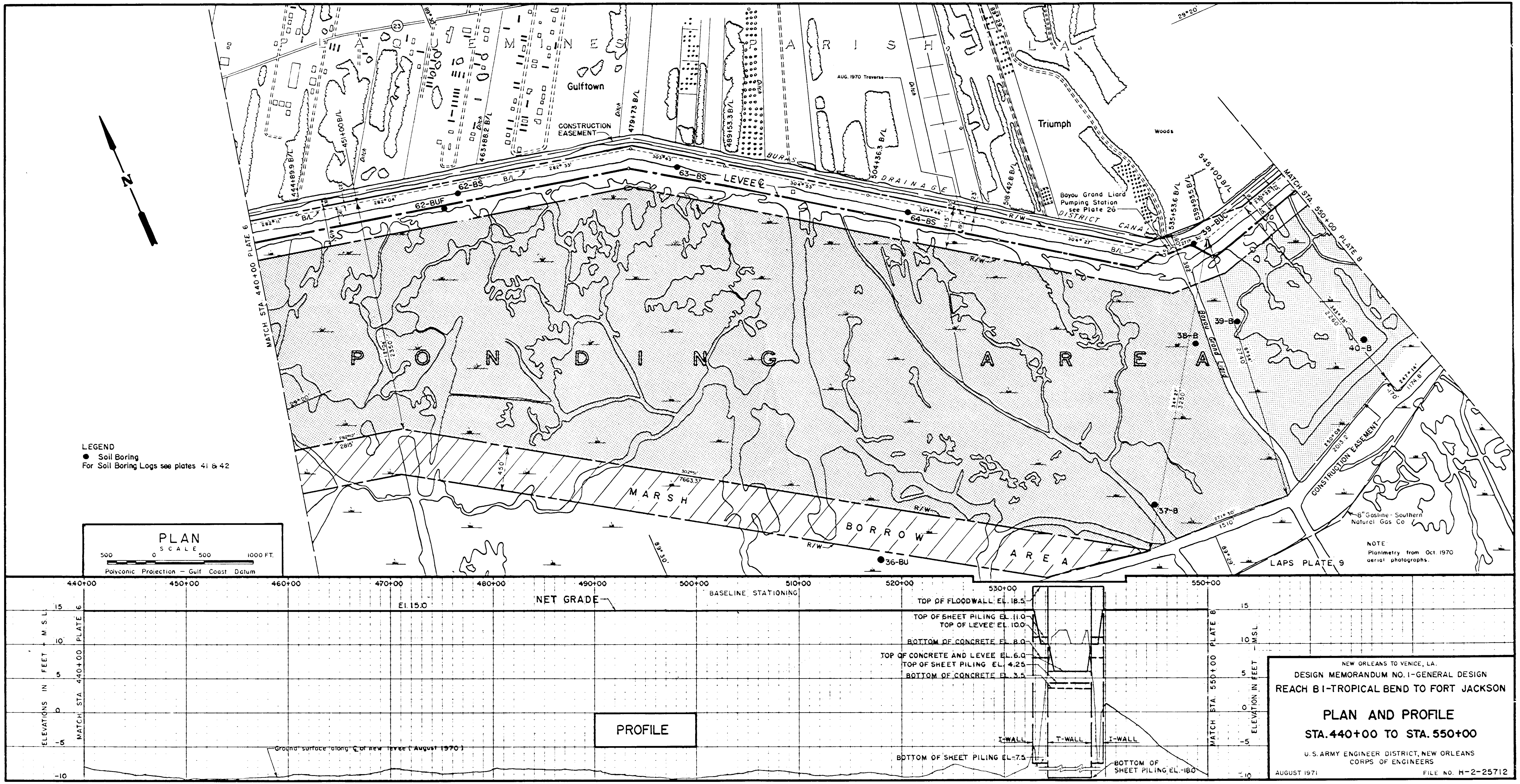
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

PLAN AND PROFILE

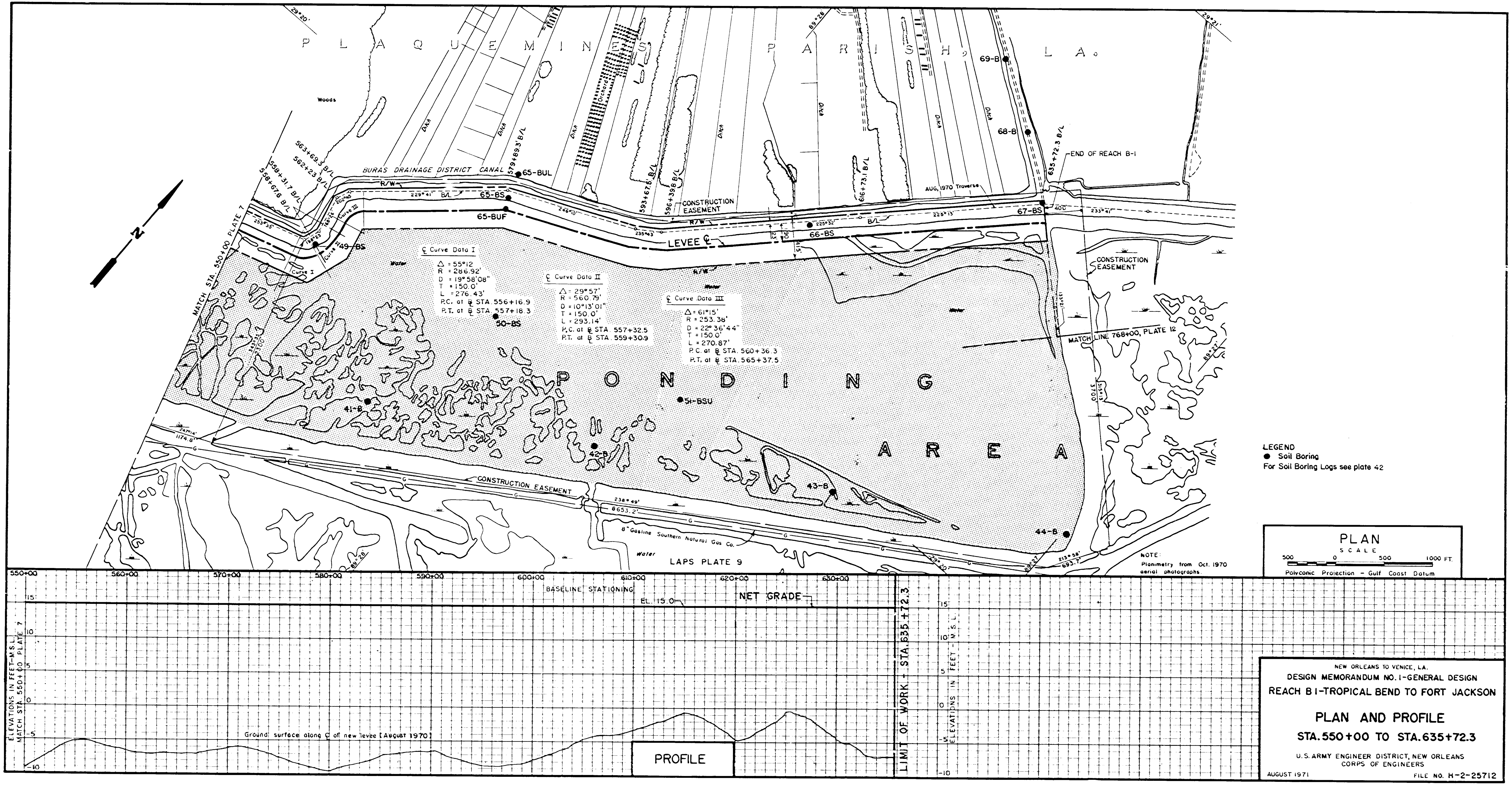
STA. 341+50 TO STA. 440+00

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



PLAQUEMINES PARISH, LA.
Gulftown
Triumph
Woods
CONSTRUCTION EASEMENT
BURAS DRAINAGE DISTRICT CANAL
AUG. 1970 Traverse
Bayou Grand Liard Pumping Station see Plate 26
62-BS
62-BUF
63-BS
64-BS
LEVEE ℄
39-BUC
38-B
39-B
40-B
37-B
36-BU
PONDING AREA
MARSH BORROW AREA
MATCH STA. 440+00 PLATE 6
MATCH STA. 550+00 PLATE 8
LEGEND
● Soil Boring
For Soil Boring Logs see plates 41 & 42
PLAN
SCALE
500 0 500 1000 FT.
Polyconic Projection – Gulf Coast Datum
8" Gasline - Southern Natural Gas Co
NOTE:
Planimetry from Oct. 1970 aerial photographs.
LAPS PLATE 9
BASELINE STATIONING
NET GRADE
El. 15.0
TOP OF FLOODWALL EL. 18.5
TOP OF SHEET PILING EL. 11.0
TOP OF LEVEE EL. 10.0
BOTTOM OF CONCRETE EL. 8.0
TOP OF CONCRETE AND LEVEE EL. 6.0
TOP OF SHEET PILING EL. 4.25
BOTTOM OF CONCRETE EL. 3.5
I-WALL
T-WALL
I-WALL
BOTTOM OF SHEET PILING EL. -7.5
BOTTOM OF SHEET PILING EL. -18.0
PROFILE
Ground surface along ℄ of new levee (August 1970)
ELEVATIONS IN FEET – M.S.L.
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON
PLAN AND PROFILE
STA. 440+00 TO STA. 550+00
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971
FILE NO. H-2-25712



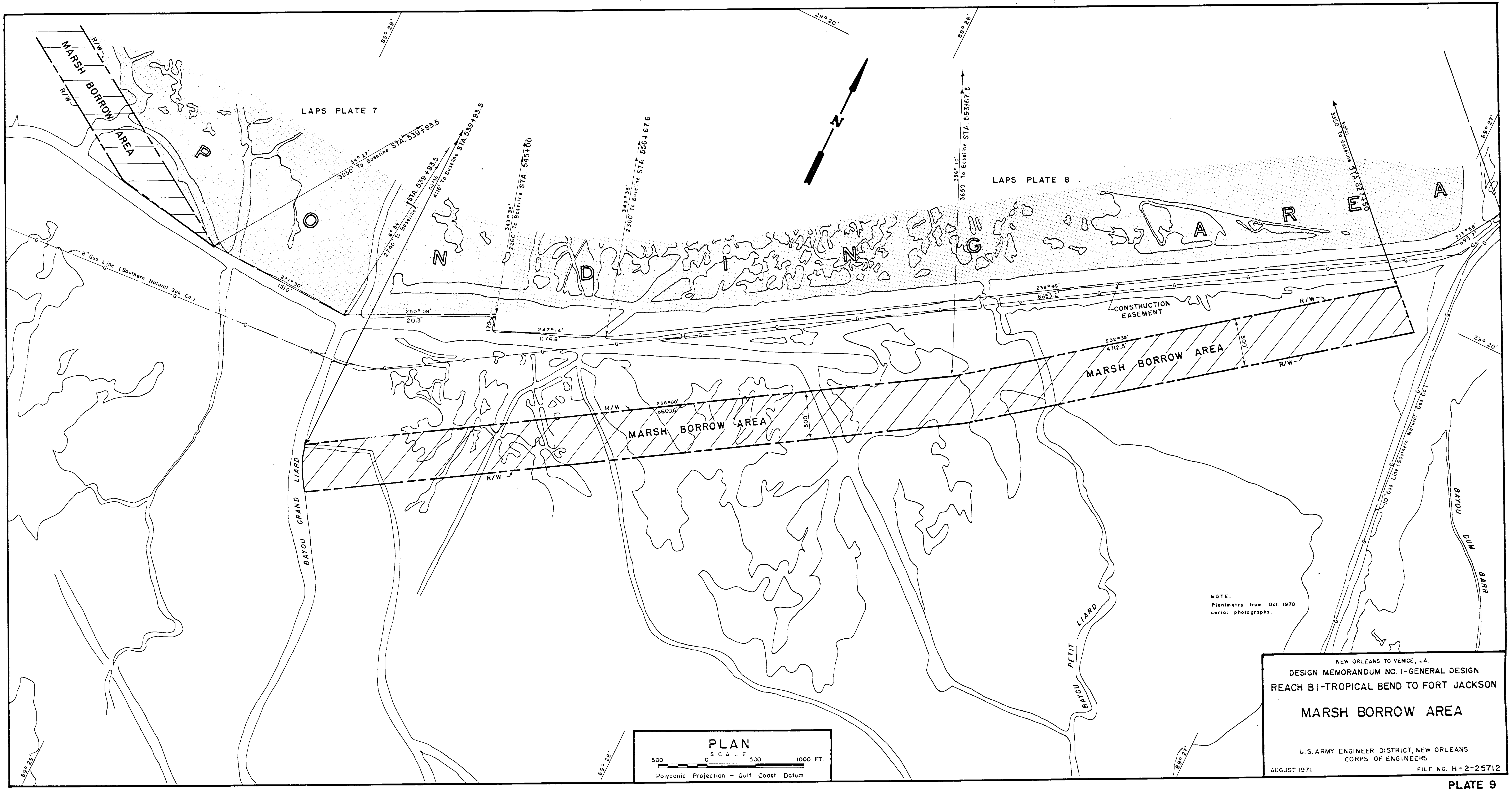
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

PLAN AND PROFILE
STA. 550+00 TO STA. 635+72.3

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE 8



NEW ORLEANS TO VENICE, LA.

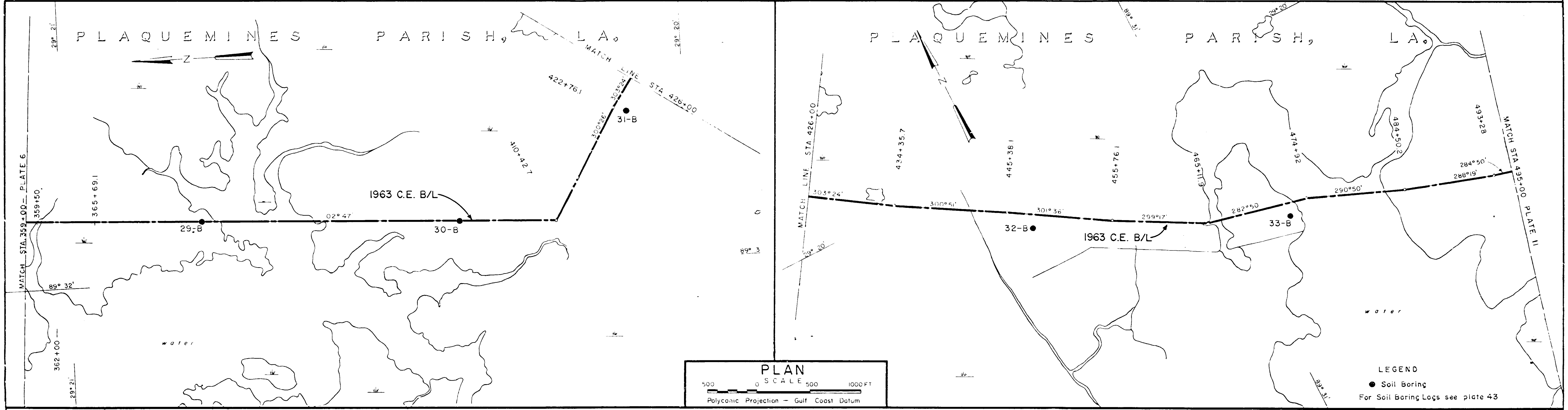
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

REACH B1-TROPICAL BEND TO FORT JACKSON

MARSH BORROW AREA

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

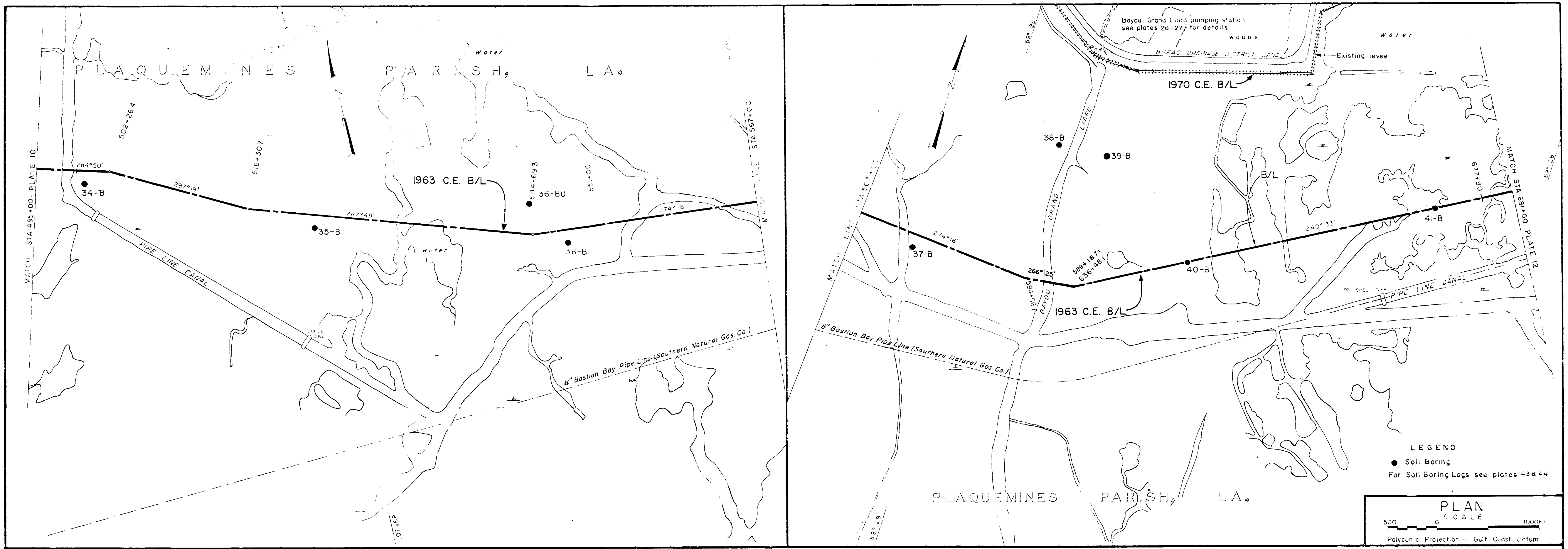


NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOCATIONS ALONG FORTY ARPENT ALIGNMENT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

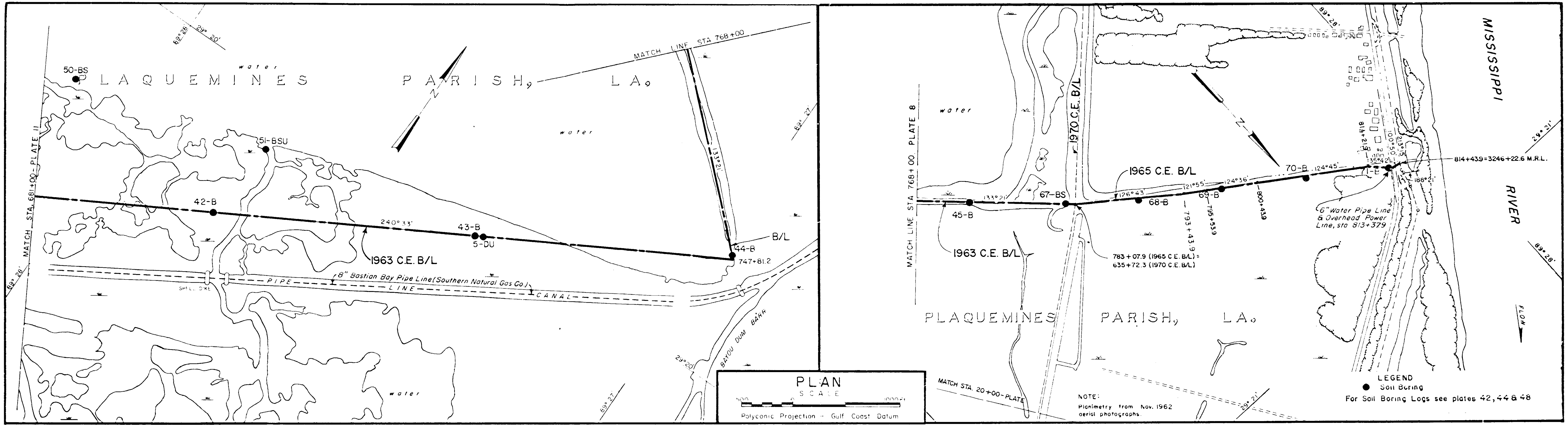


NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOCATIONS ALONG FORTY ARPENT ALIGNMENT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

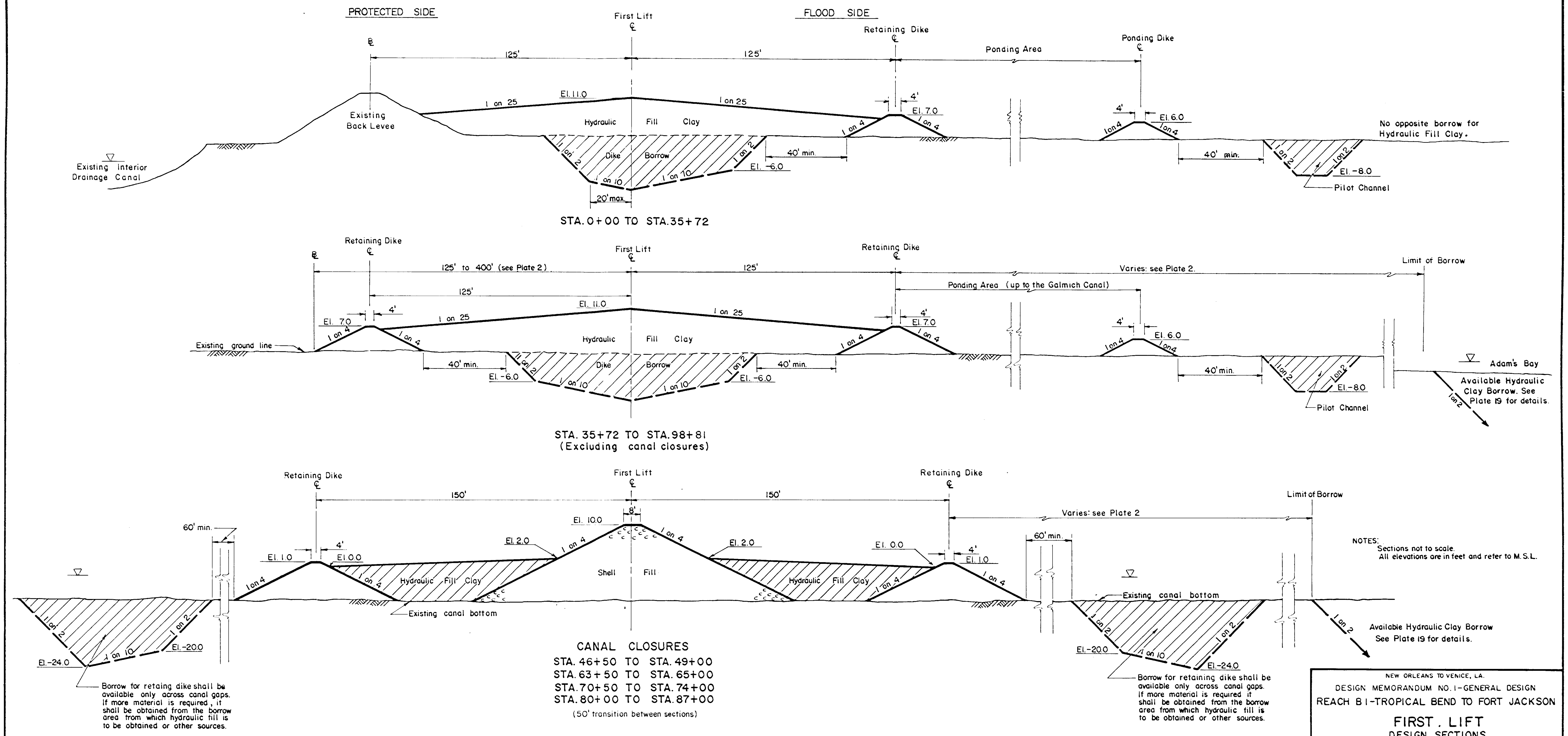


NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

SOIL BORING LOCATIONS ALONG FORTY ARPENT ALIGNMENT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

REACH B1-TROPICAL BEND TO FORT JACKSON

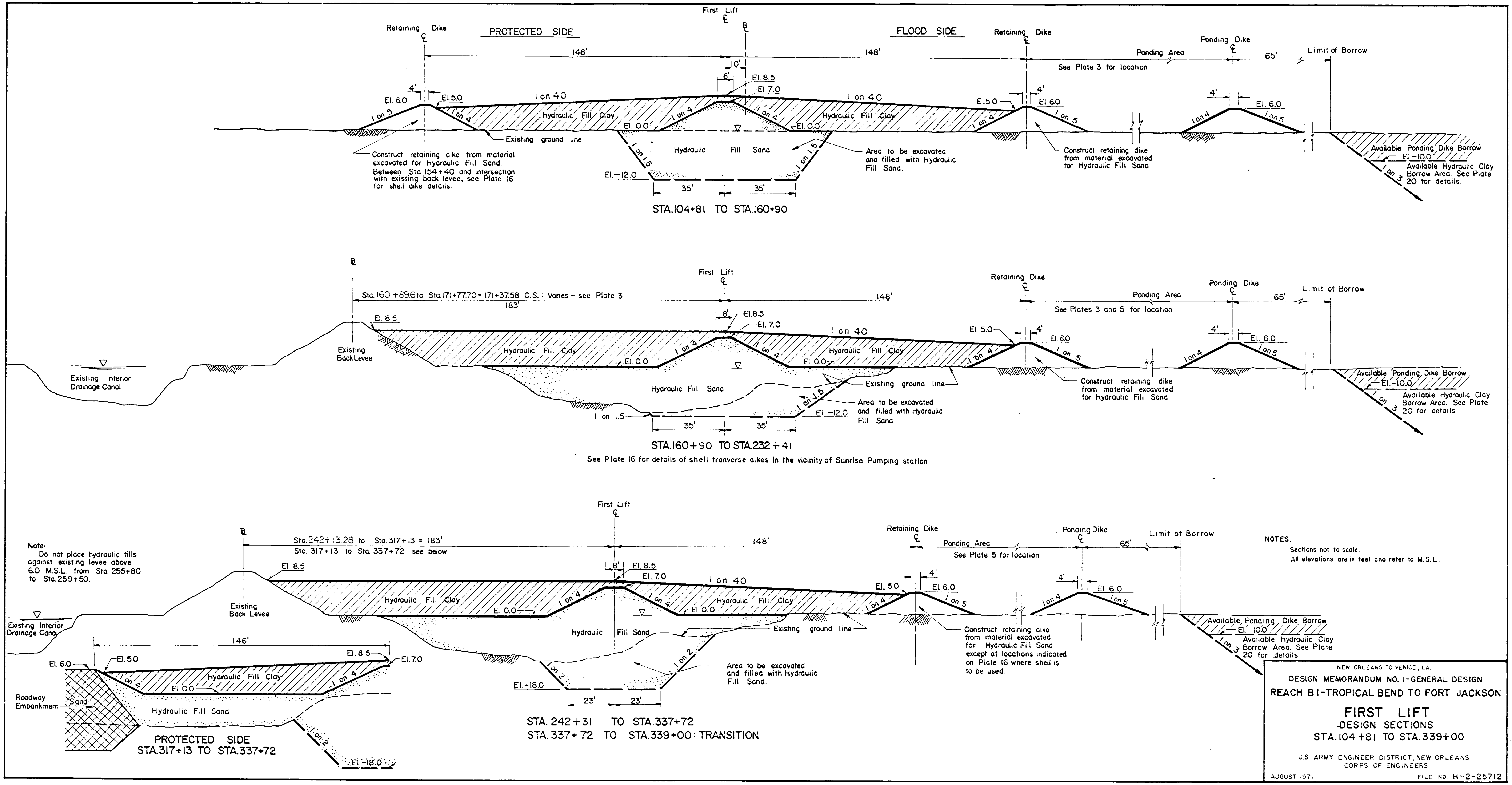
FIRST. LIFT

DESIGN SECTIONS

STA. 0+00 TO STA. 98+81

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



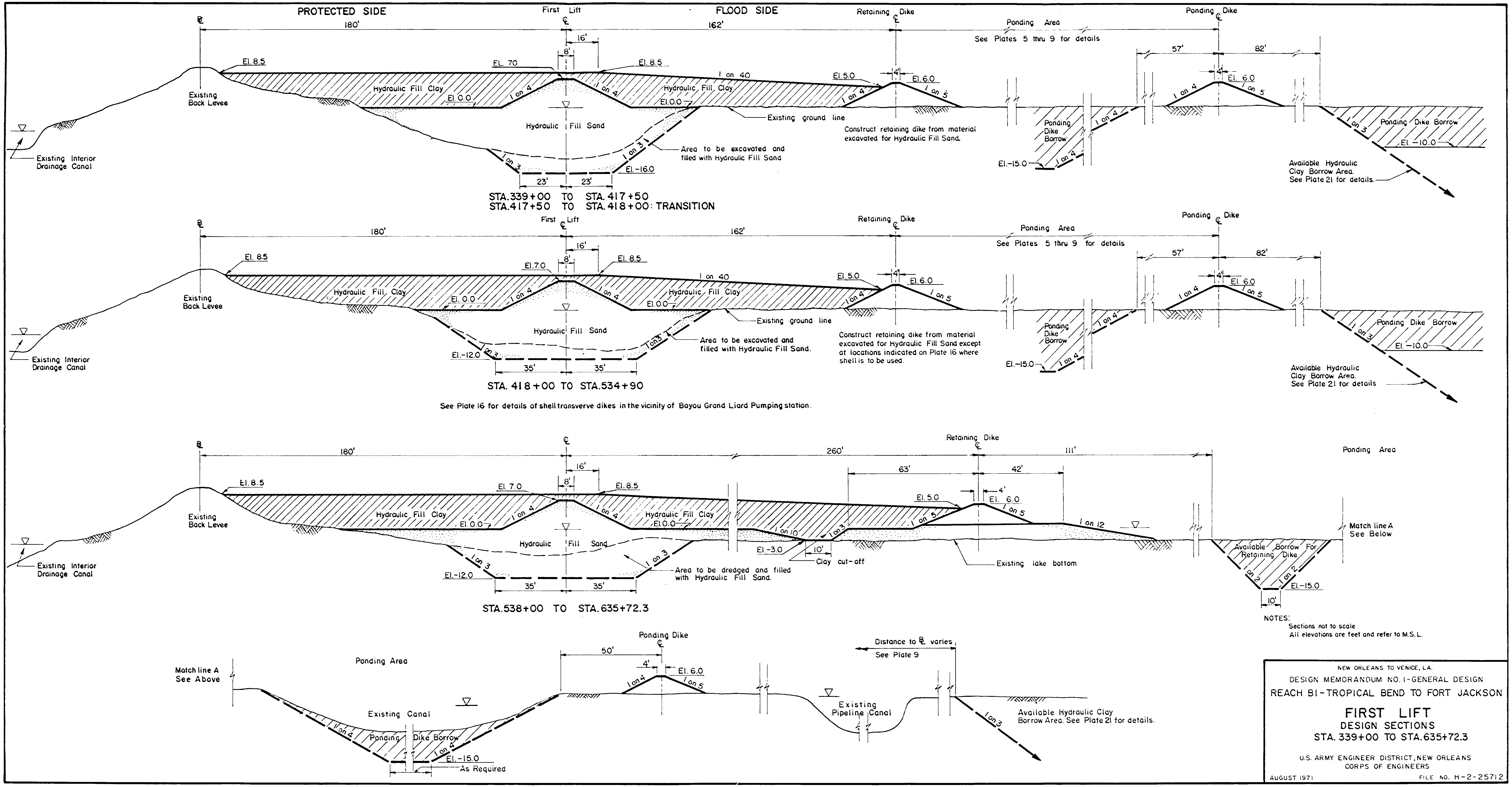
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

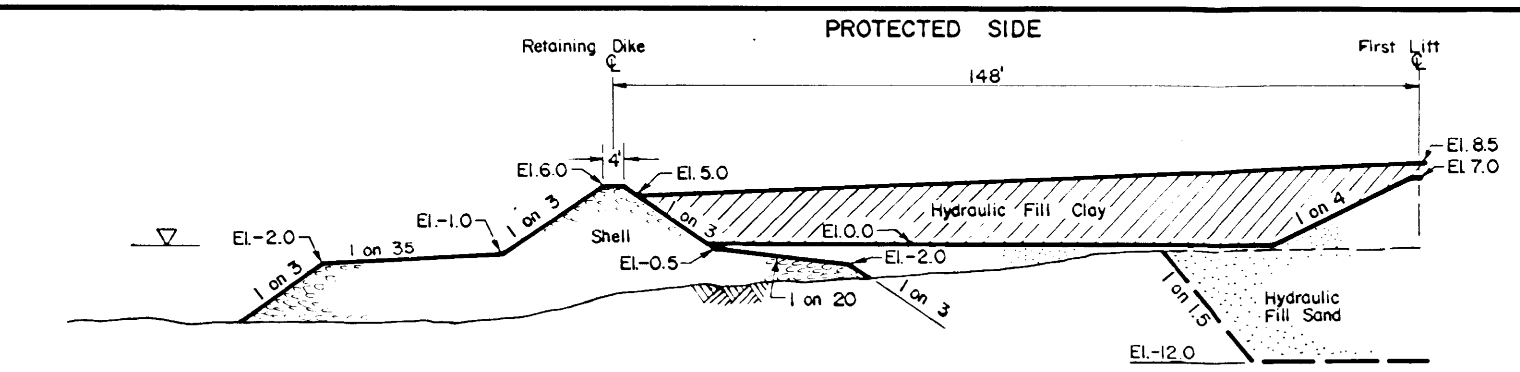
FIRST LIFT
DESIGN SECTIONS
STA. 104+81 TO STA. 339+00

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

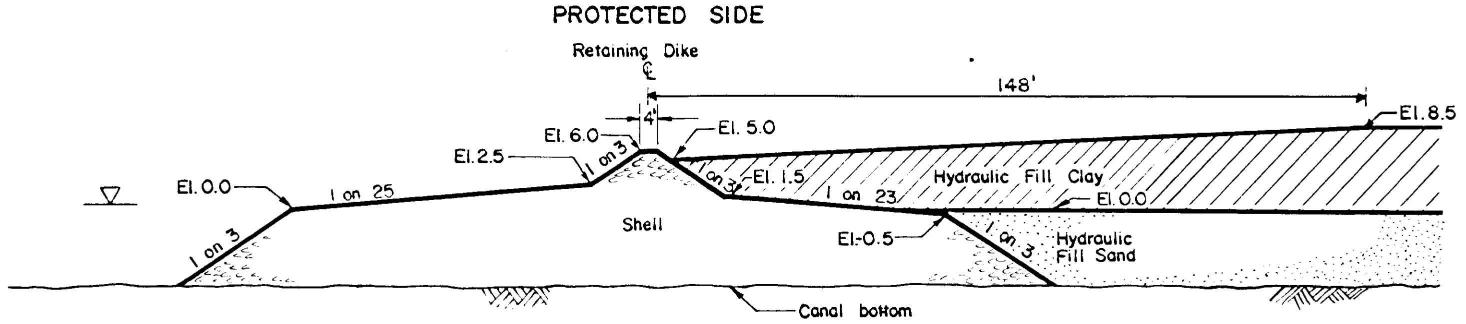
AUGUST 1971 FILE NO H-2-25712

PLATE 14

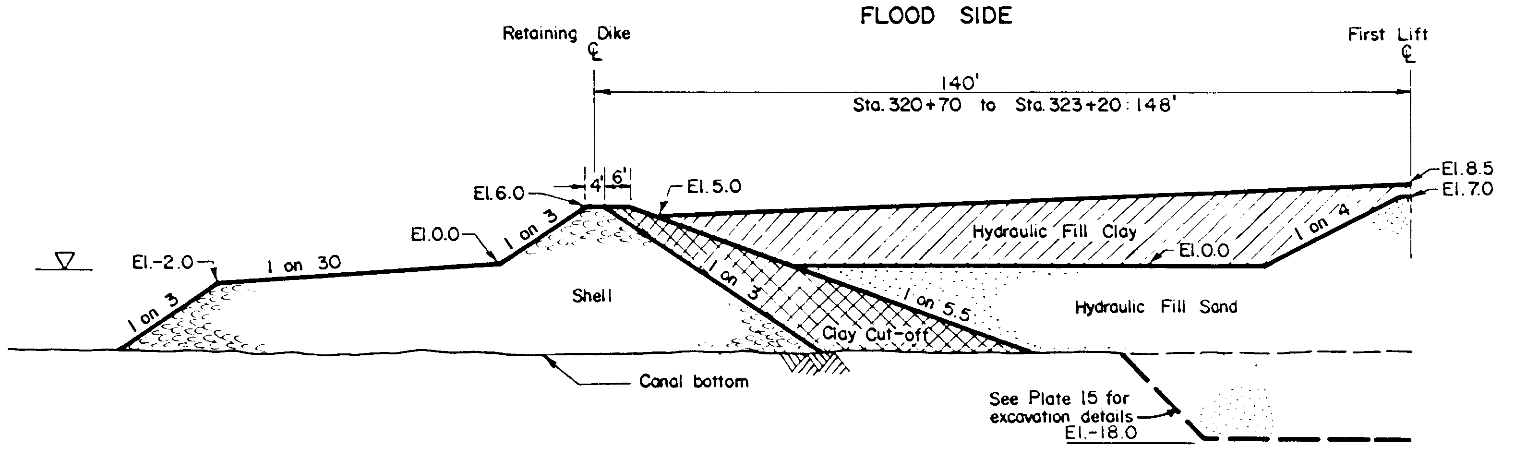

PROTECTED SIDE
First Lift
FLOOD SIDE
Retaining Dike
Ponding Dike
180'
162'
16'
8'
4'
57'
82'
Ponding Area
See Plates 5 thru 9 for details
El. 8.5
EL. 70
El. 8.5
1 on 40
El. 5.0
El. 6.0
1 on 4
1 on 5
Existing Back Levee
Hydraulic Fill Clay
El. 0.0
Hydraulic Fill Sand
Existing ground line
Construct retaining dike from material excavated for Hydraulic Fill Sand.
Area to be excavated and filled with Hydraulic Fill Sand
1 on 3
El. -16.0
23'
23'
Existing Interior Drainage Canal
Ponding Dike Borrow
El. -15.0
El. -10.0
Available Hydraulic Clay Borrow Area. See Plate 21 for details.
STA. 339+00 TO STA. 417+50
STA. 417+50 TO STA. 418+00: TRANSITION
El. 7.0
El. -12.0
35'
35'
Area to be excavated and filled with Hydraulic Fill Sand.
Construct retaining dike from material excavated for Hydraulic Fill Sand except at locations indicated on Plate 16 where shell is to be used.
STA. 418+00 TO STA. 534+90
See Plate 16 for details of shell transverve dikes in the vicinity of Bayou Grand Liard Pumping station.
260'
111'
63'
42'
1 on 10
1 on 12
El. -3.0
10'
Clay cut-off
Existing lake bottom
Area to be dredged and filled with Hydraulic Fill Sand.
Available Borrow For Retaining Dike
1 on 2
El. -15.0
Match line A See Below
STA. 538+00 TO STA. 635+72.3
NOTES:
Sections not to scale.
All elevations are feet and refer to M.S.L.
Match line A See Above
50'
Existing Canal
As Required
Distance to ℄ varies
See Plate 9
Existing Pipeline Canal
Available Hydraulic Clay Borrow Area. See Plate 21 for details.
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON
FIRST LIFT
DESIGN SECTIONS
STA. 339+00 TO STA. 635+72.3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971
FILE NO. H-2-25712



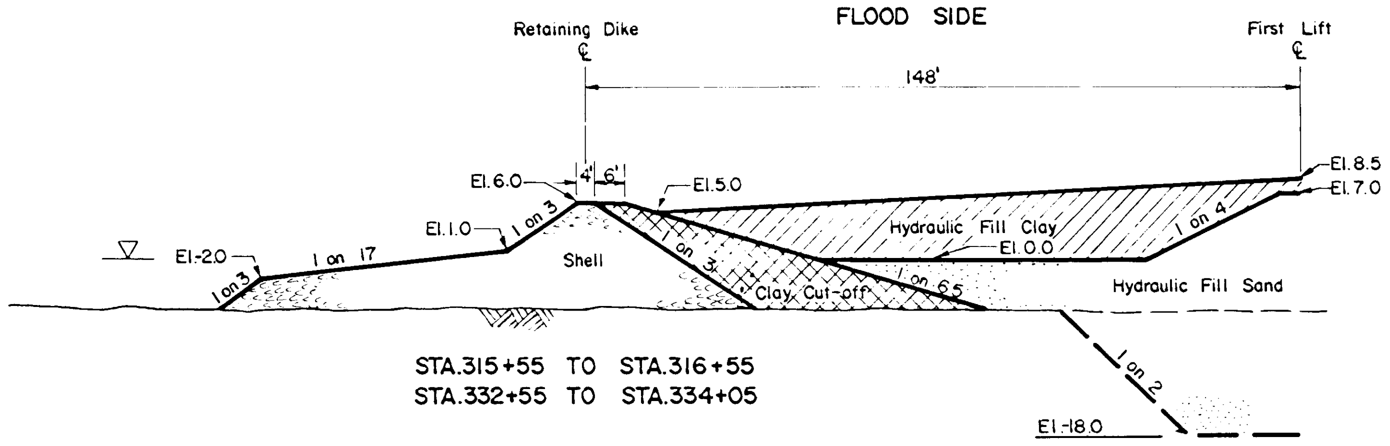
STA.154+40 TO STA.159+76
STA. 159+76 TO STA. 160+06-TRANSITION



STA. 160+06 TO INTERSECTION WITH BACK LEVEE

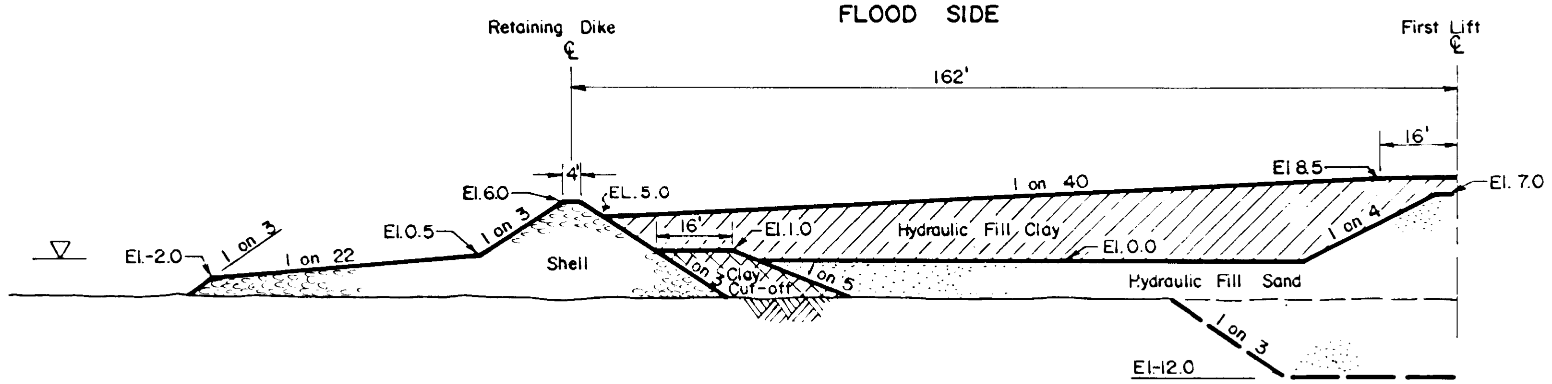


STA.234+04.72 (TRANSVERSE DIKE)
STA.240+73.28 (TRANSVERSE DIKE)
STA.320+70 TO STA.323+20

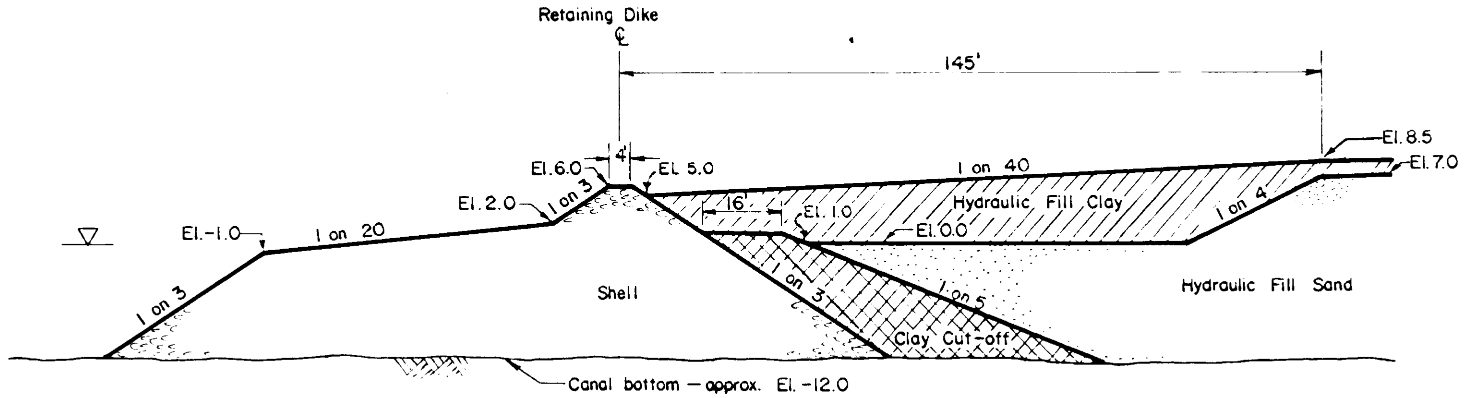


STA.315+55 TO STA.316+55
STA.332+55 TO STA.334+05

NOTES:
Sections not to scale.
All elevations are in feet and refer to M.S.L.



STA. 496+50 TO STA.500+50



STA.534+90 (TRANSVERSE DIKE)
STA.538+00 (TRANSVERSE DIKE)
STA.635+72 (TRANSVERSE DIKE)

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SHELL DIKES FOR FIRST LIFT

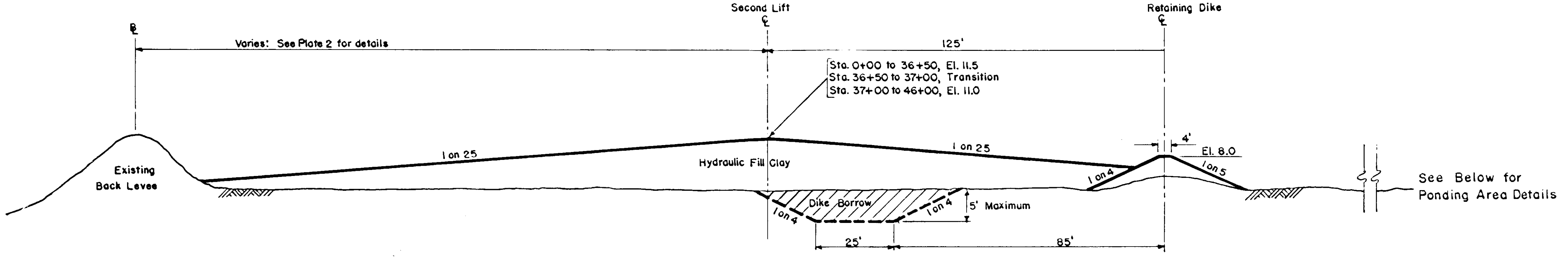
DESIGN SECTIONS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

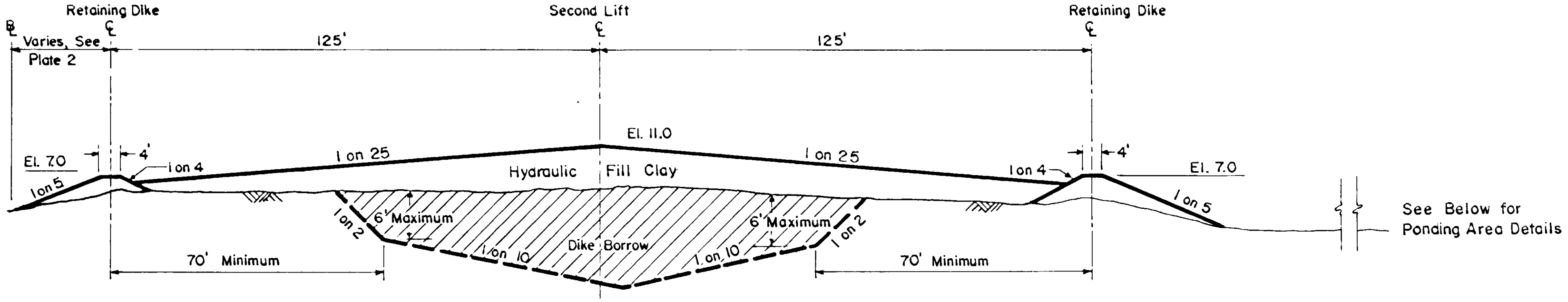
AUGUST 1971 FILE NO. H-2-25712

PROTECTED SIDE

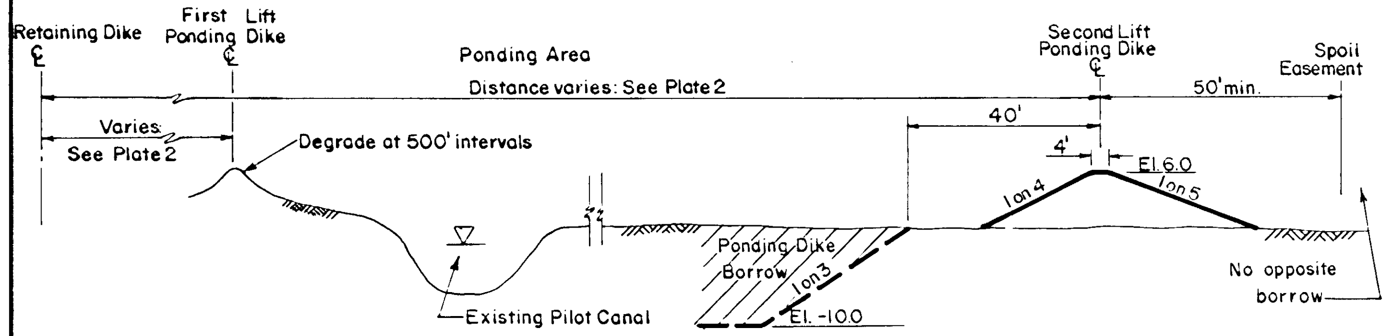
FLOOD SIDE



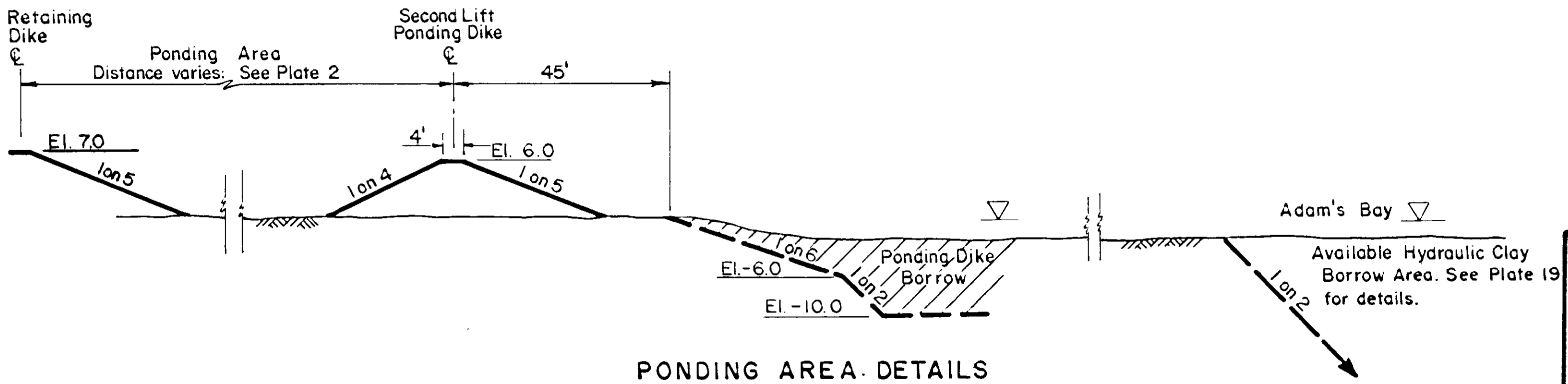
STA. 0+00 TO STA. 46+00



STA. 49+50 TO STA. 63+00
STA. 65+50 TO STA. 70+00
STA. 73+50 TO STA. 79+50
STA. 87+50 TO STA. 98+81
(50' transition between canal closures)



PONDING AREA DETAILS
STA. 0+00 TO STA. 50+25



PONDING AREA DETAILS
STA. 50+25 TO STA. 57+50

NOTES:
Sections not to scale.
All elevations are in feet and refer to M.S.L.

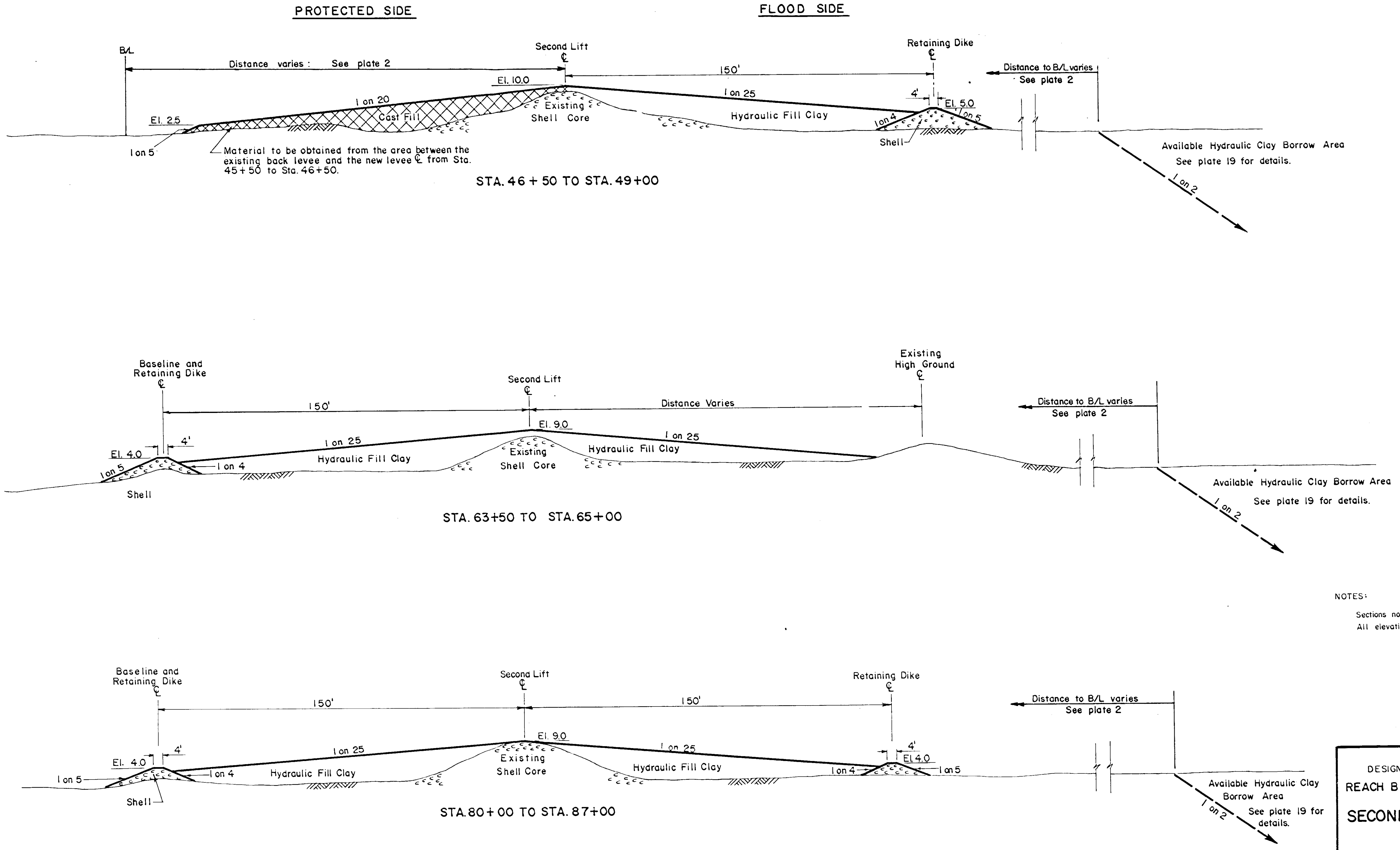
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SECOND LIFT
DESIGN SECTIONS
STA. 00+00 TO STA. 98+81

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE 17



NOTES:

Sections not to scale.
All elevations are in feet and refer to M.S.L.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

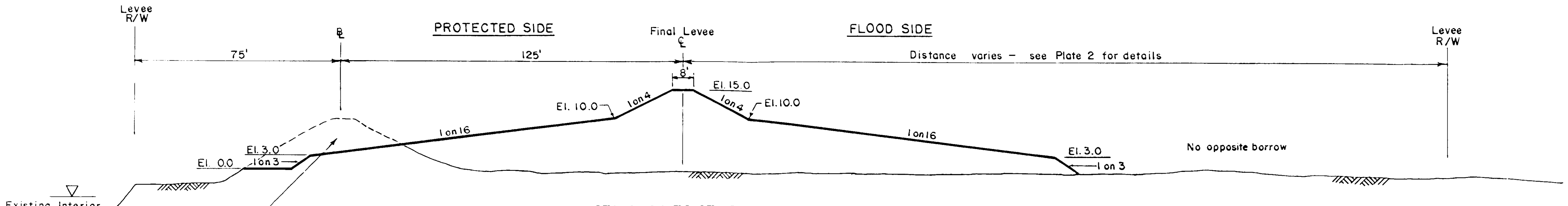
SECOND LIFT - CANAL CLOSURE

DESIGN SECTIONS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

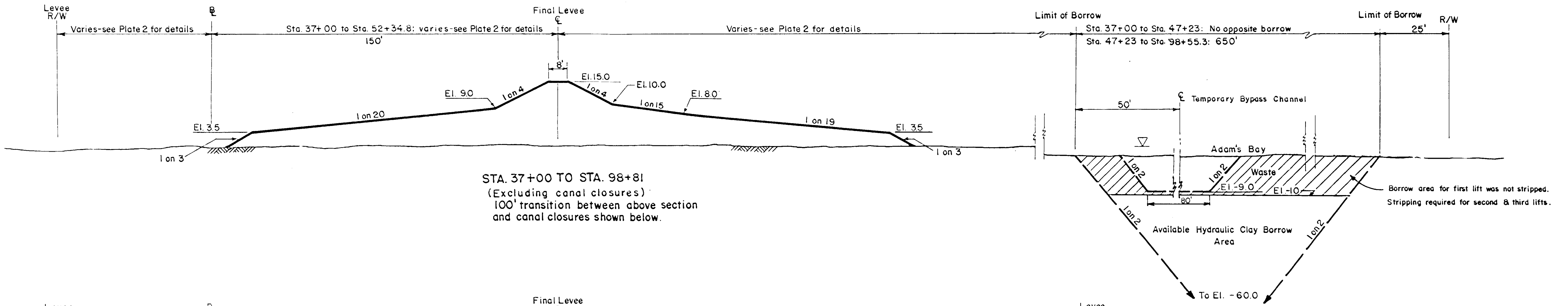
AUGUST 1971 FILE NO. H-2-25712

PLATE 18

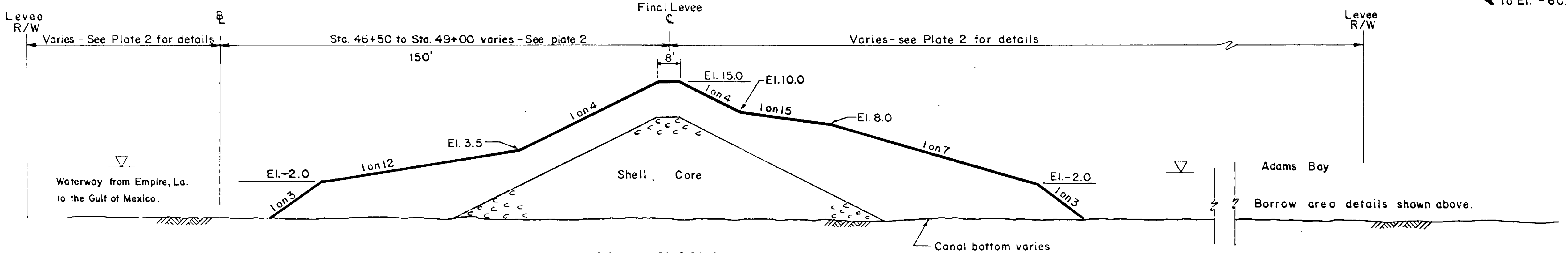


STA. 0+00 TO STA. 35+72

STA. 35+72 TO STA. 37+00: TRANSITION



STA. 37+00 TO STA. 98+81
(Excluding canal closures)
100' transition between above section
and canal closures shown below.



CANAL CLOSURES

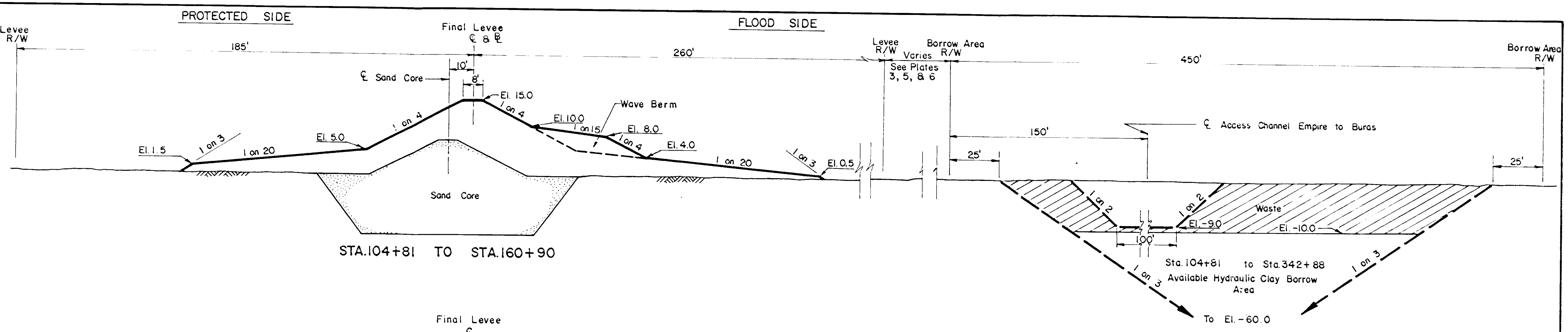
STA. 46+50 TO STA. 49+00
STA. 63+50 TO STA. 65+00
STA. 70+50 TO STA. 74+00
STA. 80+00 TO STA. 87+00

NOTES:
- Sections not to scale.
- All elevations are in feet and refer to M.S.L.
- See plate 22 for foreshore and slope protection.

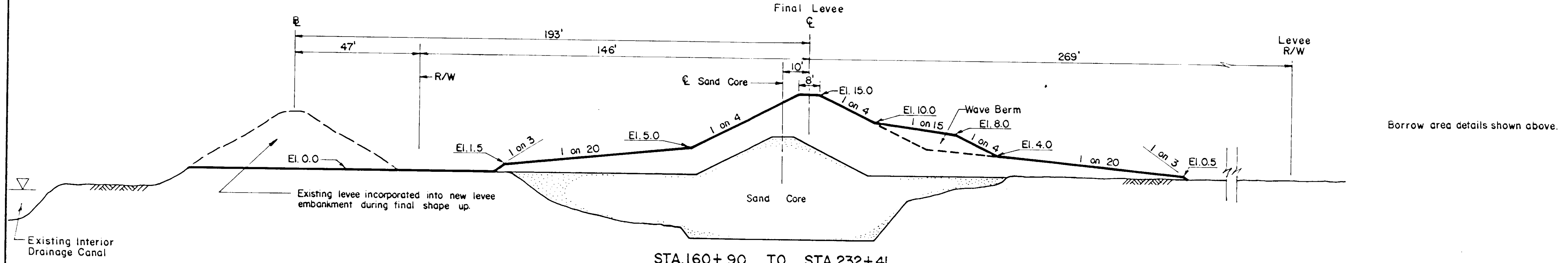
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

FINAL LEVEE
DESIGN SECTIONS
STA. 0+00 TO STA. 98+81

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712

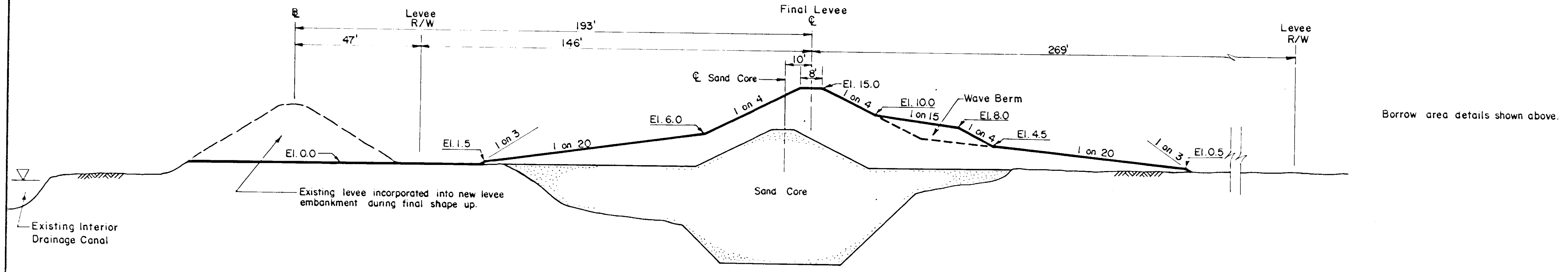


STA.104+81 TO STA.160+90



STA.160+90 TO STA.232+41

STA. 232+31 TO STA.242+41: FLOODWALL AT SUNRISE PUMPING STATION — See Plate 25 for details.



STA.242+31 TO STA.337+72

STA.337+72 TO STA.342+88 : TRANSITION

NOTES:

Sections not to scale.
All elevations are in feet and refer to M.S.L.

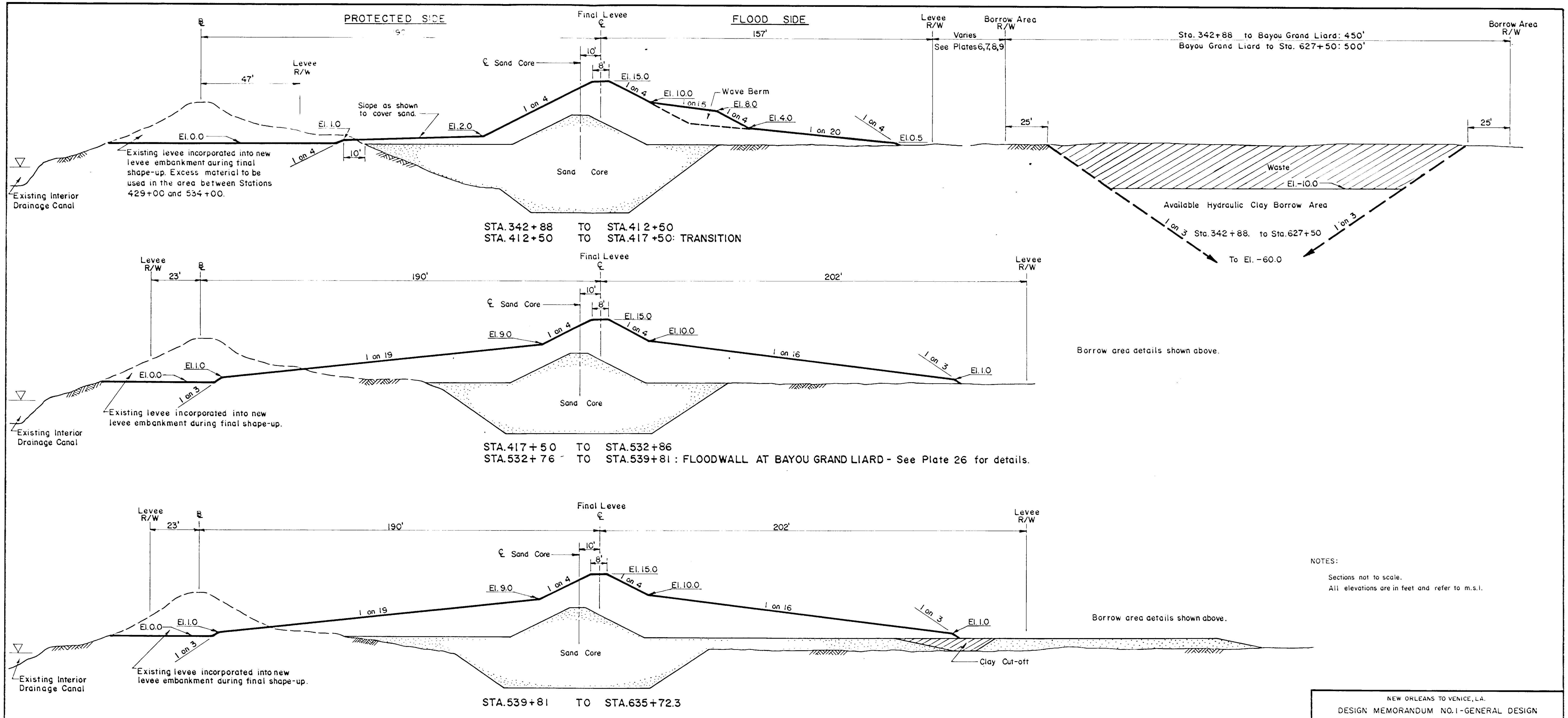
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

FINAL LEVEE
DESIGN SECTIONS
STA.104+81 TO STA.342+88

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE 20



NOTES:

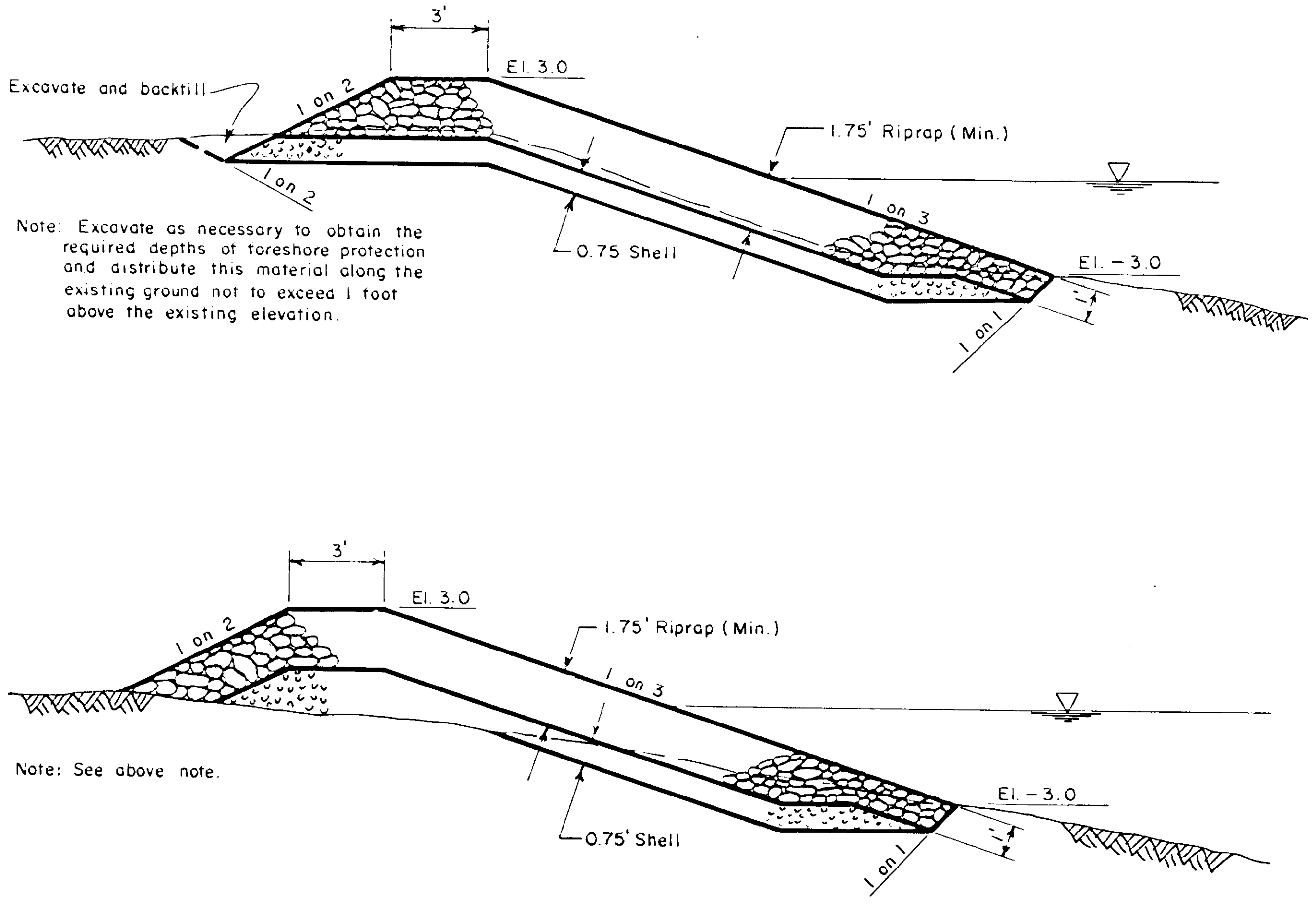
Sections not to scale.
All elevations are in feet and refer to m.s.l.

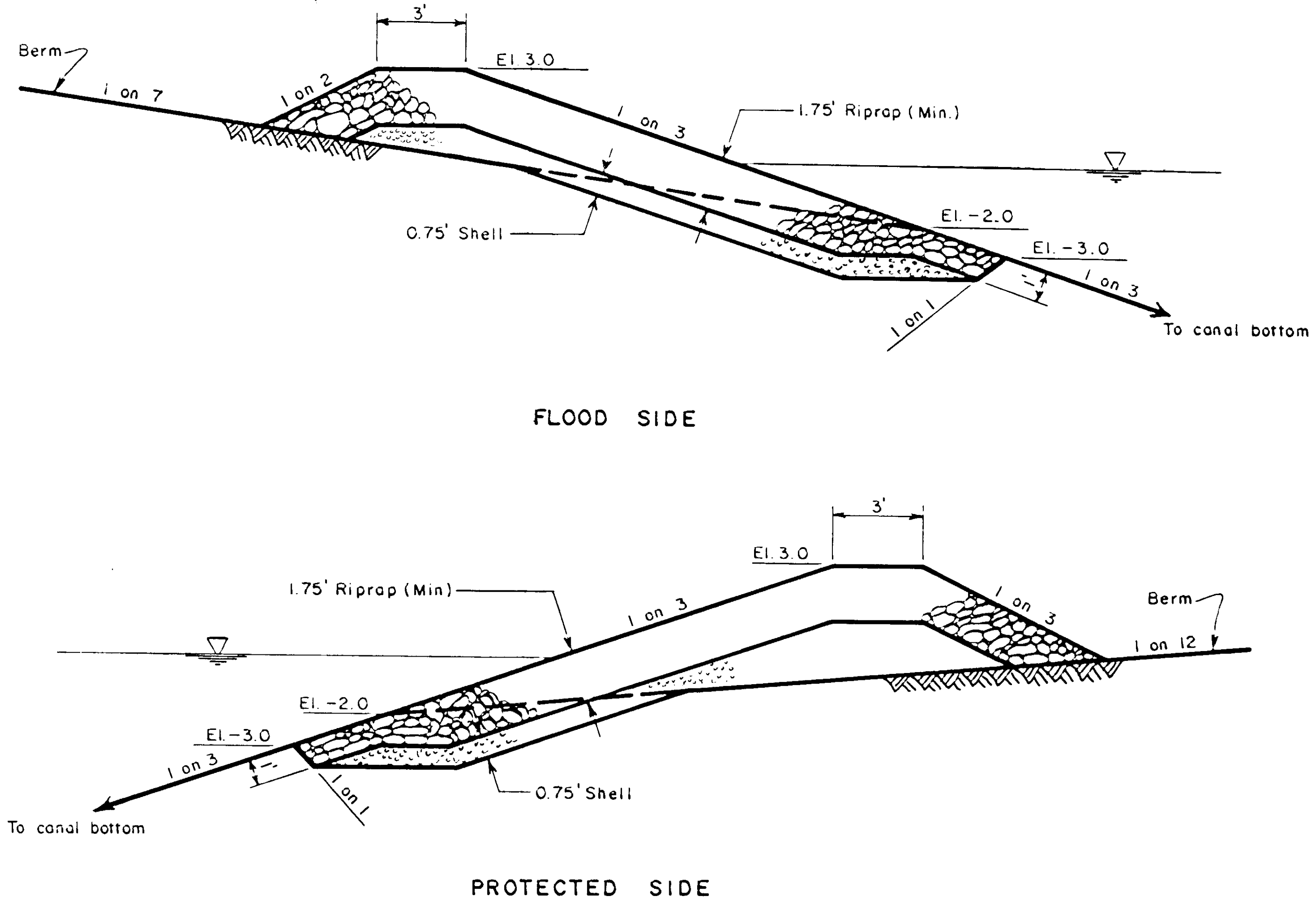
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

FINAL LEVEE
DESIGN SECTIONS
STA. 342+88. TO STA. 635+72.3

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971
FILE NO. H-2-25712





SLOPE PROTECTION - CANAL CLOSURES

NOTES:
Sections not to scale.
All elevations are in feet and refer to M.S.L.

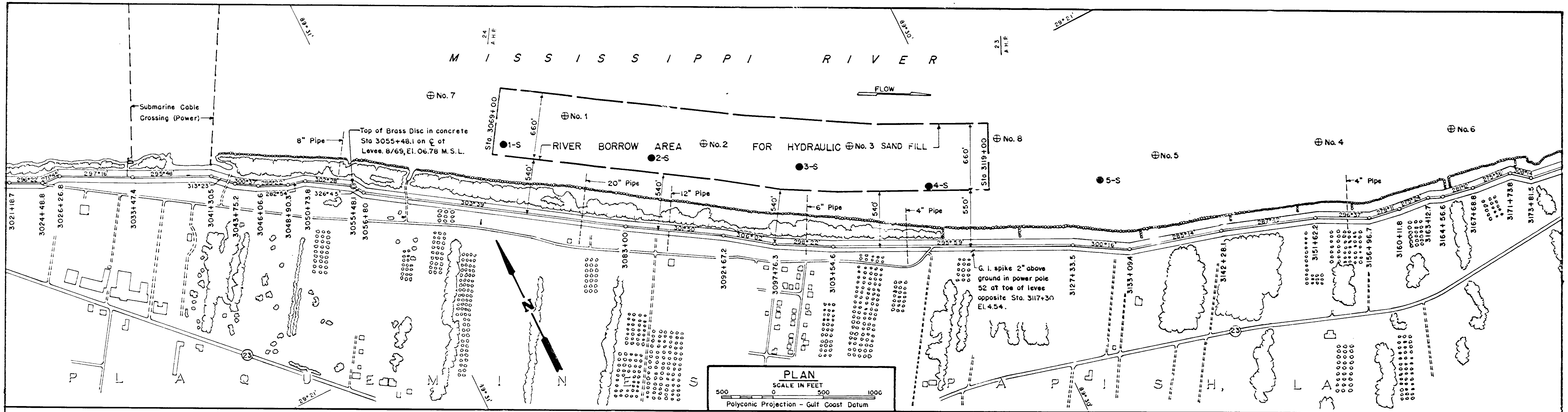
FORESHORE PROTECTION

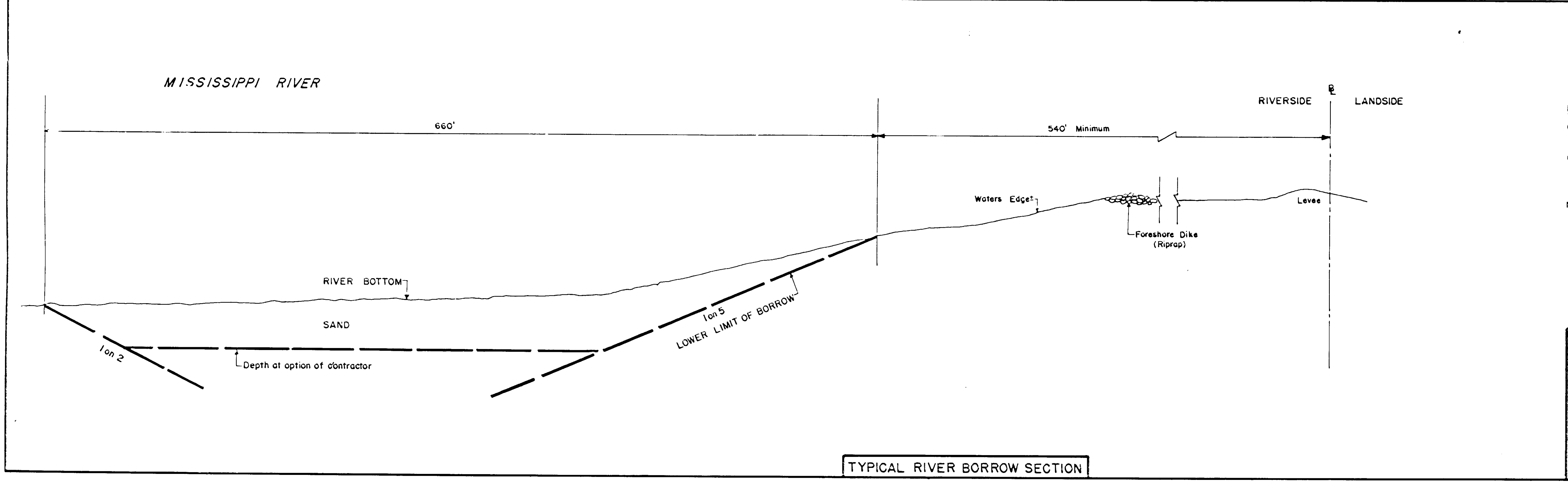
NOTES:
Foreshore Protection to be placed along the bank of Adams Bay between Stations 57+50± and Empire Floodgate.
Foreshore Protection to be placed along the bank of Empire Waterway between Stations 62+00± and Empire Floodgate.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

FORESHORE PROTECTION
DESIGN SECTIONS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712





TYPICAL RIVER BORROW SECTION

LEGEND

⊕ Soil borings taken by State of Louisiana, Department of Highways, 1970

● Soil borings taken by U.S. Corps of Engineers

For Soil Boring Logs see plates 49 & 50.

NOTES:

Sections not to scale.

All elevations are in feet and refer to M.S.L.

NEW ORLEANS TO VENICE, LA.

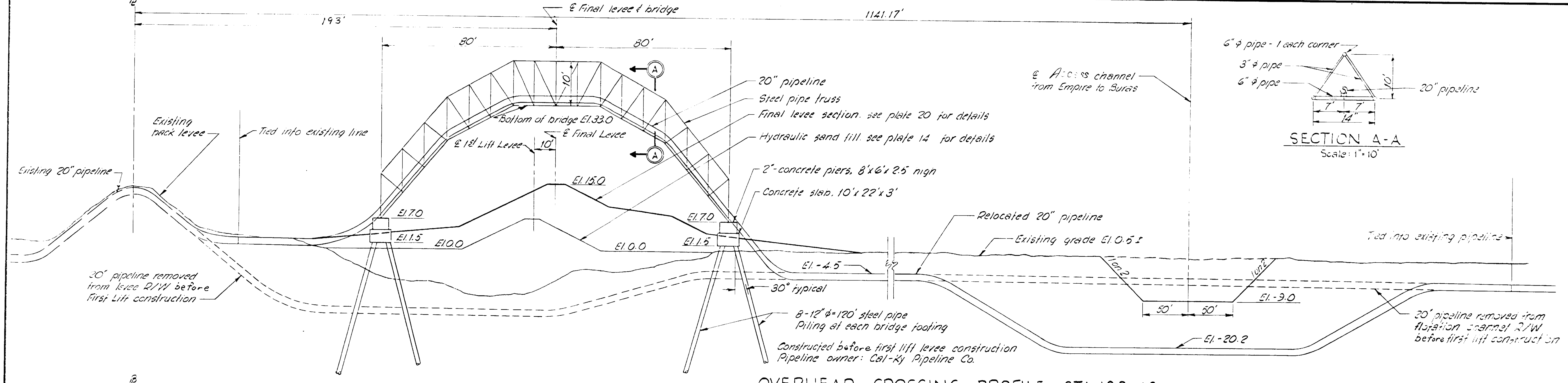
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOCATIONS
RIVER BORROW BORINGS
MILE 22 TO MILE 24 A.H.P.

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

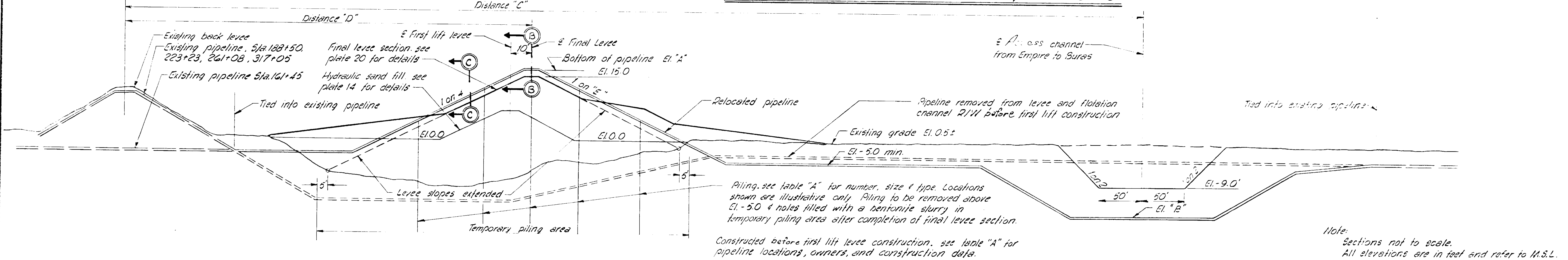
AUGUST 1971 FILE NO. H-2-25712



OVERHEAD CROSSING PROFILE, STA.198+13

SECTION A-A

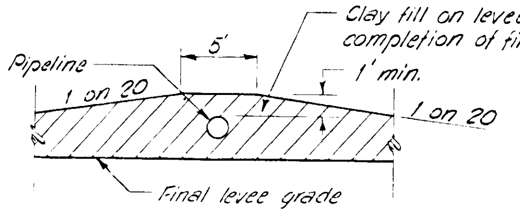
Scale: 1"=10'



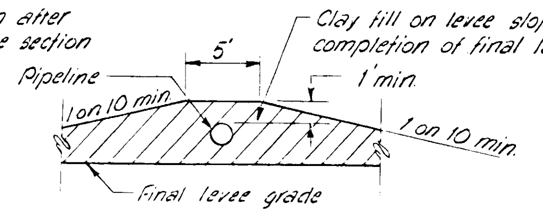
SURFACE CROSSING PROFILE

TABLE A											
PIPELINES				PILING			ELEVATION		DISTANCE	SLOPE	
℄ Station	Owner	No.	Size	No.	Size	Type	A	B	C	D	E
161+74	Shell Pipeline Corp.	1	4"	10	10"	Treated timber	16.5	-16.0	2334.2'	316.4'	4
188+55	Crescent Pipeline Co.	1	8"	6	14"	Prestressed concrete	16.0	-10.0	1444.0'	193'	8
222+13	Gulf Refining Co.	1	12"	4	12"	Treated timber	16.0	-16.0	966.82'	193'	4
261+58	Gulf Refining Co.	4	[1]	16	12"	"	16.0	-18.0	1115.54'	193'	4
315+98	Delta Gas, Inc	1	6"	5	12"	"	17.0	-17.0	2366.5'	193'	4

[1] 1-12", 2-6", 1-4"



SECTION B-B



SECTION C-C

Note:
Sections not to scale.
All elevations are in feet and refer to M.S.L.

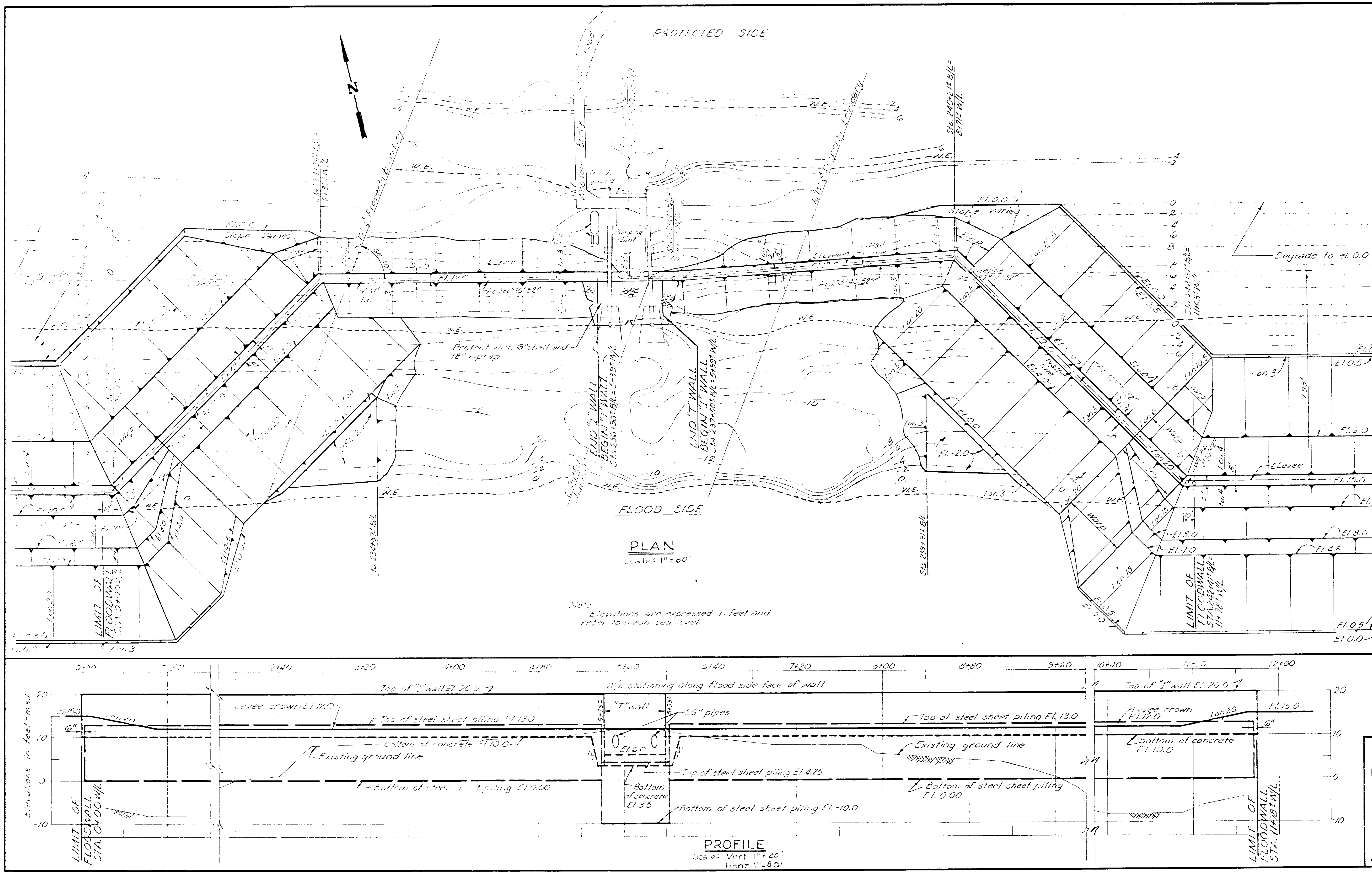
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

PIPELINE RELOCATION

DETAILS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

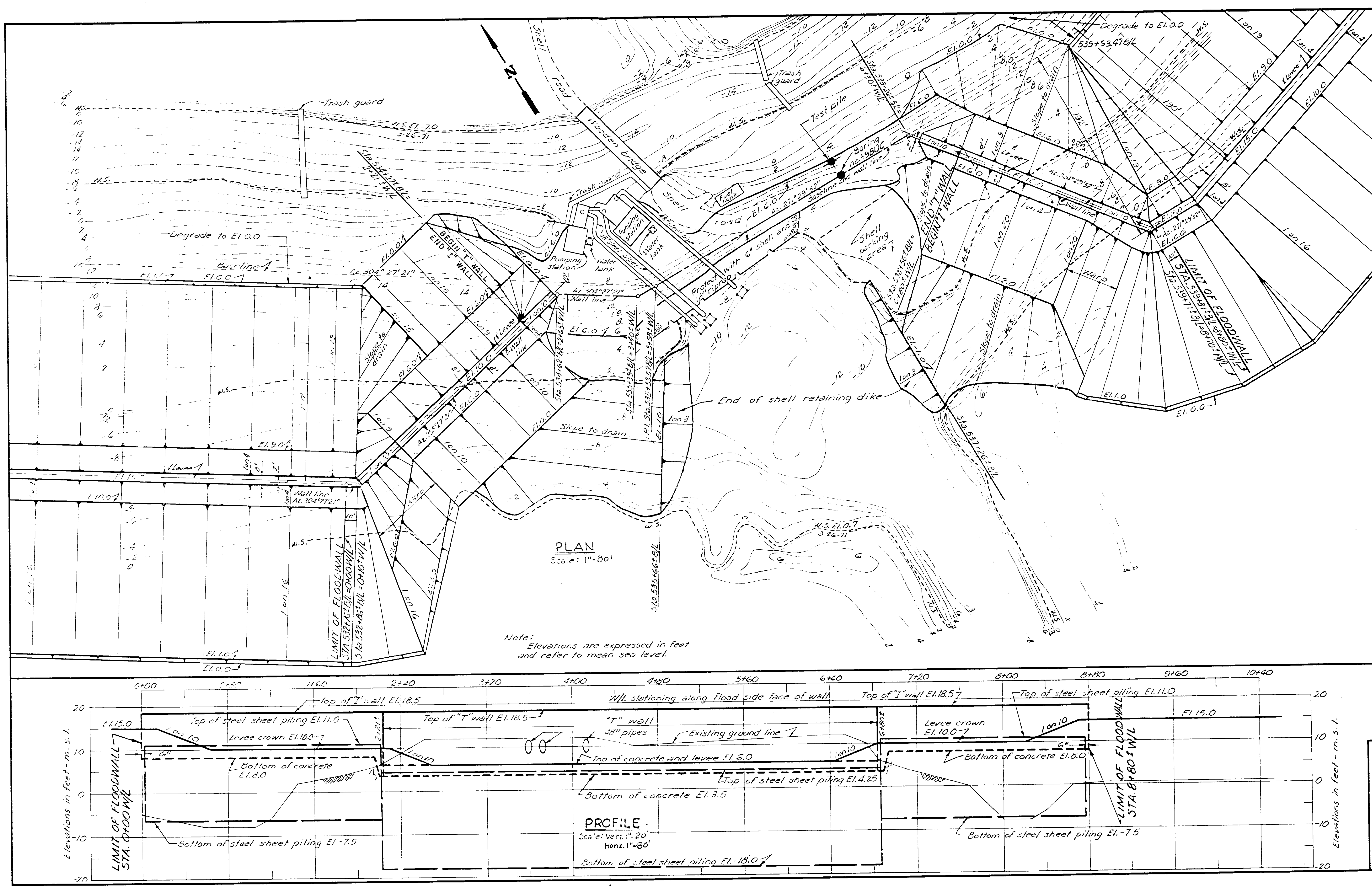
REACH B1-TROPICAL BEND TO FORT JACKSON

SUNRISE PUMPING STATION

PLAN AND PROFILE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

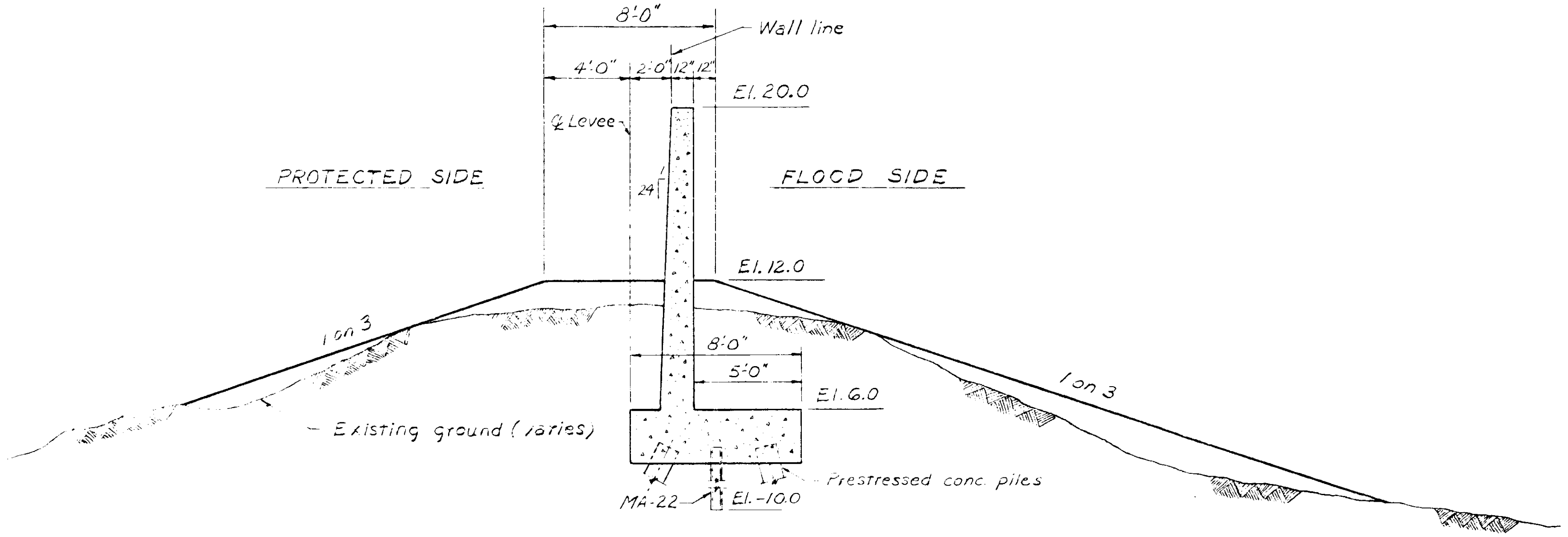
REACH B1-TROPICAL BEND TO FORT JACKSON

BAYOU GRAND LIARD PUMPING STATION

PLAN AND PROFILE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

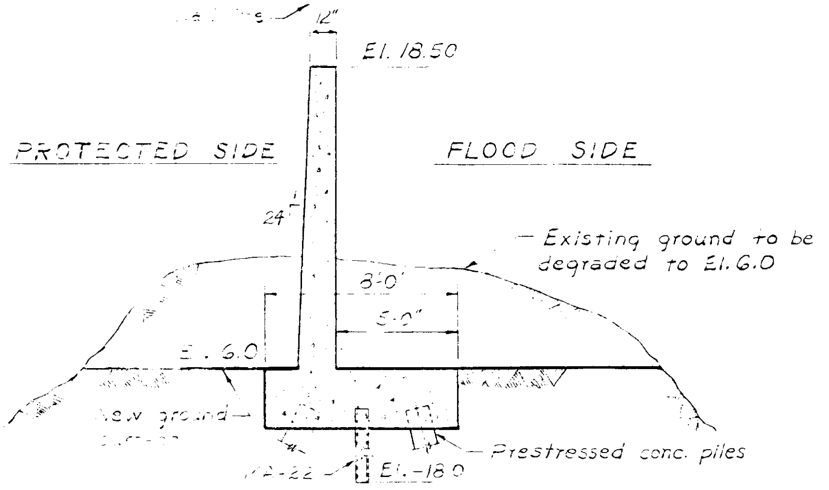
FILE NO. H-2-25712



SUNRISE PUMPING STATION

TYPICAL T-WALL SECTION

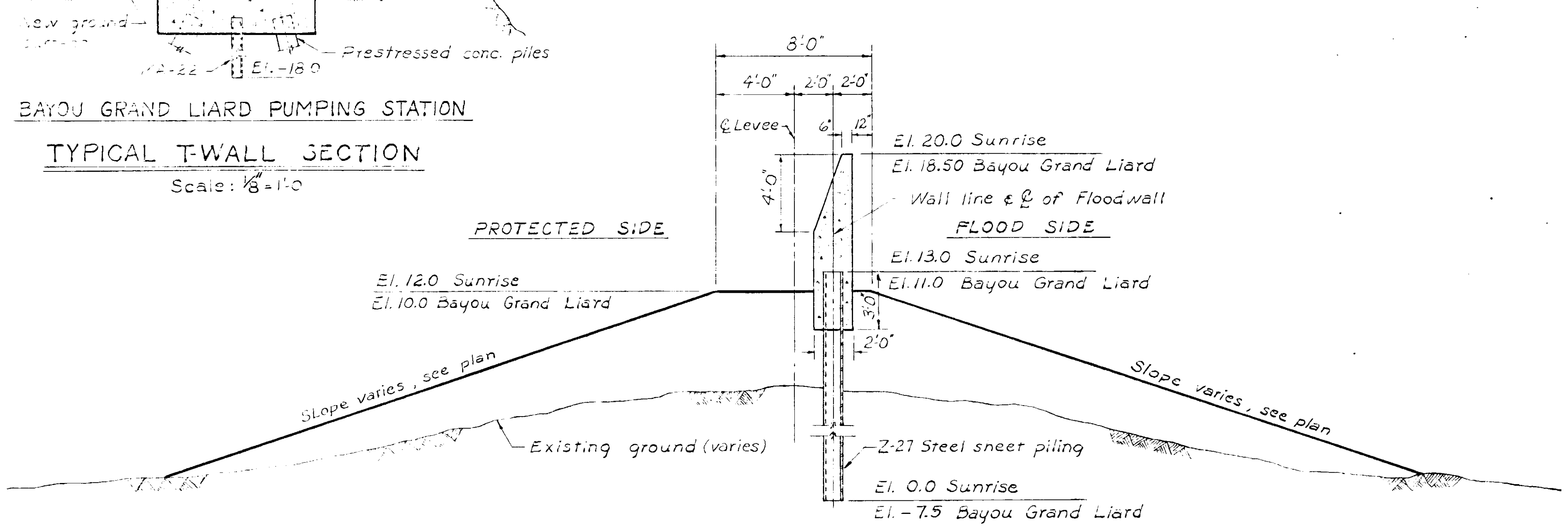
Scale: 1/8"=1'-0"



BAYOU GRAND LIARD PUMPING STATION

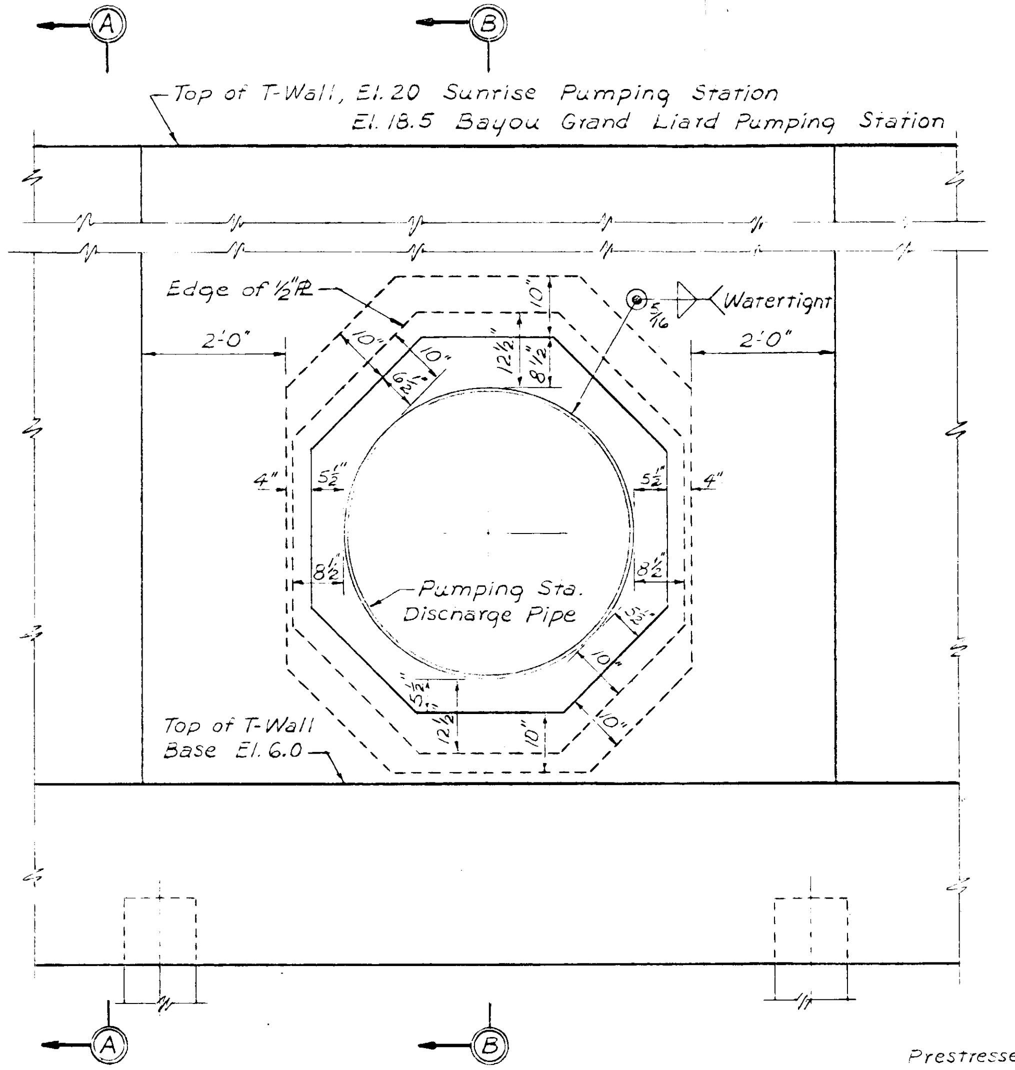
TYPICAL T-WALL SECTION

Scale: 1/8"=1'-0"



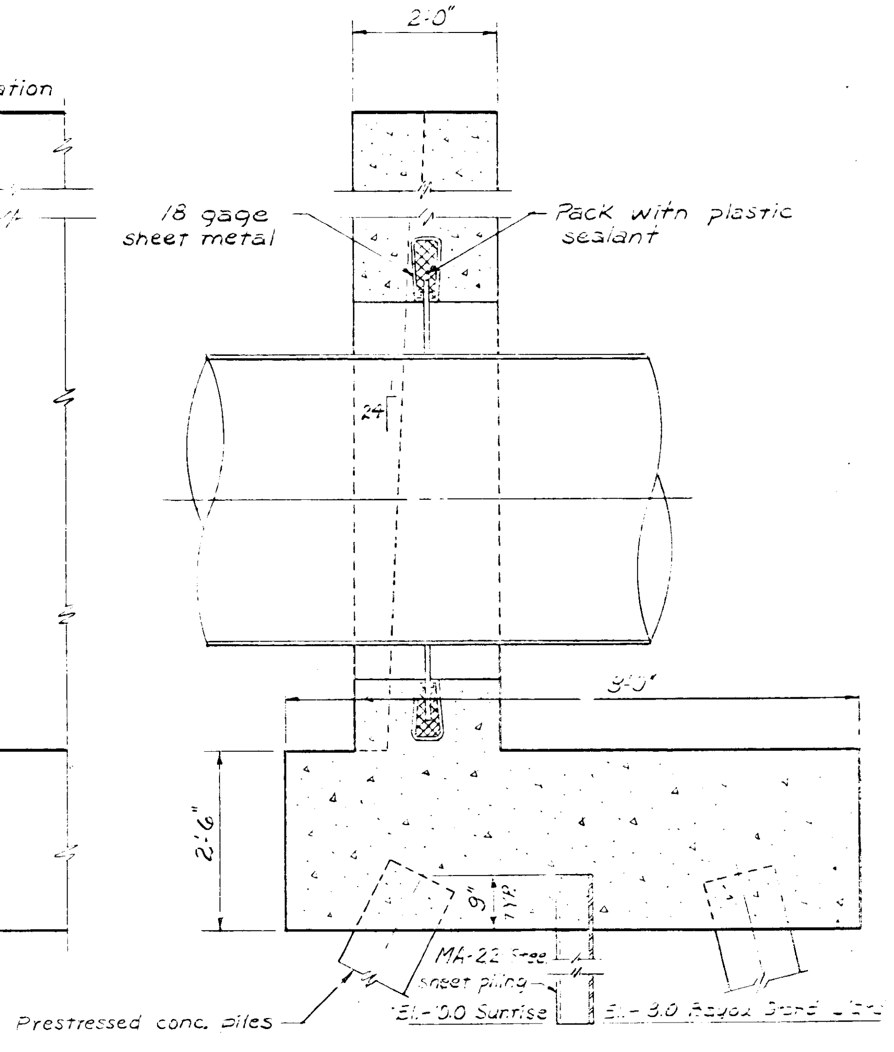
TYPICAL I-WALL SECTION

Scale: 1/8"=1'-0"



PROTECTED SIDE ELEVATION

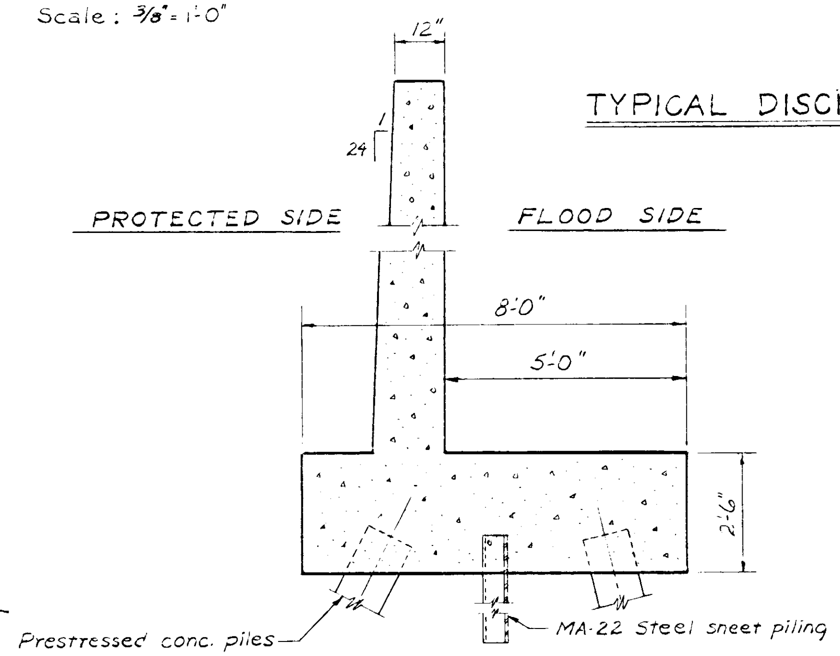
Scale: 3/8"=1'-0"



SECTION B-B

Scale: 3/8"=1'-0"

TYPICAL DISCHARGE PIPE MODIFICATION



SECTION A-A

Scale: 1/4"=1'-0"

NOTE:
Elevations are expressed in feet and refer to mean sea level.

NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

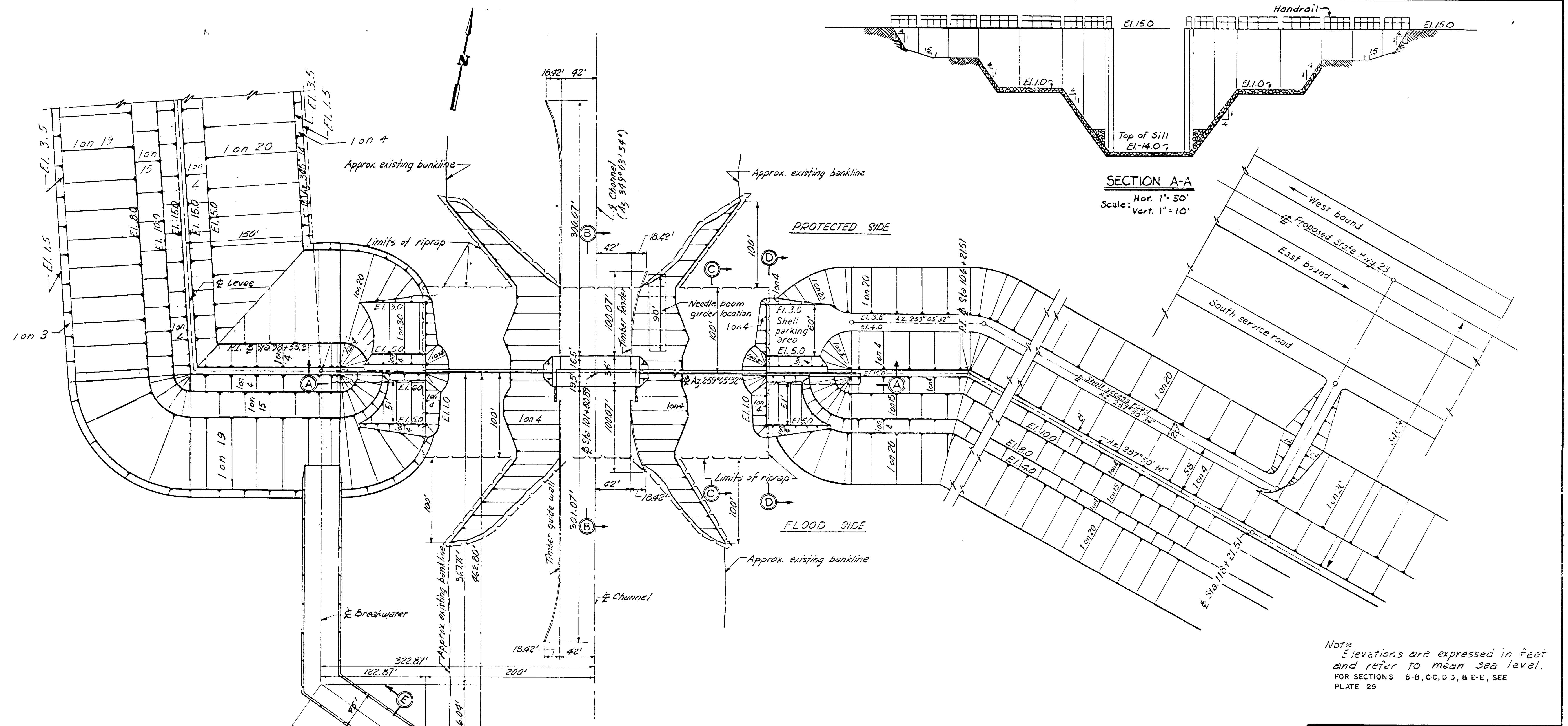
REACH B1-TROPICAL BEND TO FORT JACKSON

SUNRISE AND BAYOU GRAND LIARD PUMPING STATION

FLOODWALL DETAILS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

FILE NO. H-2-25712

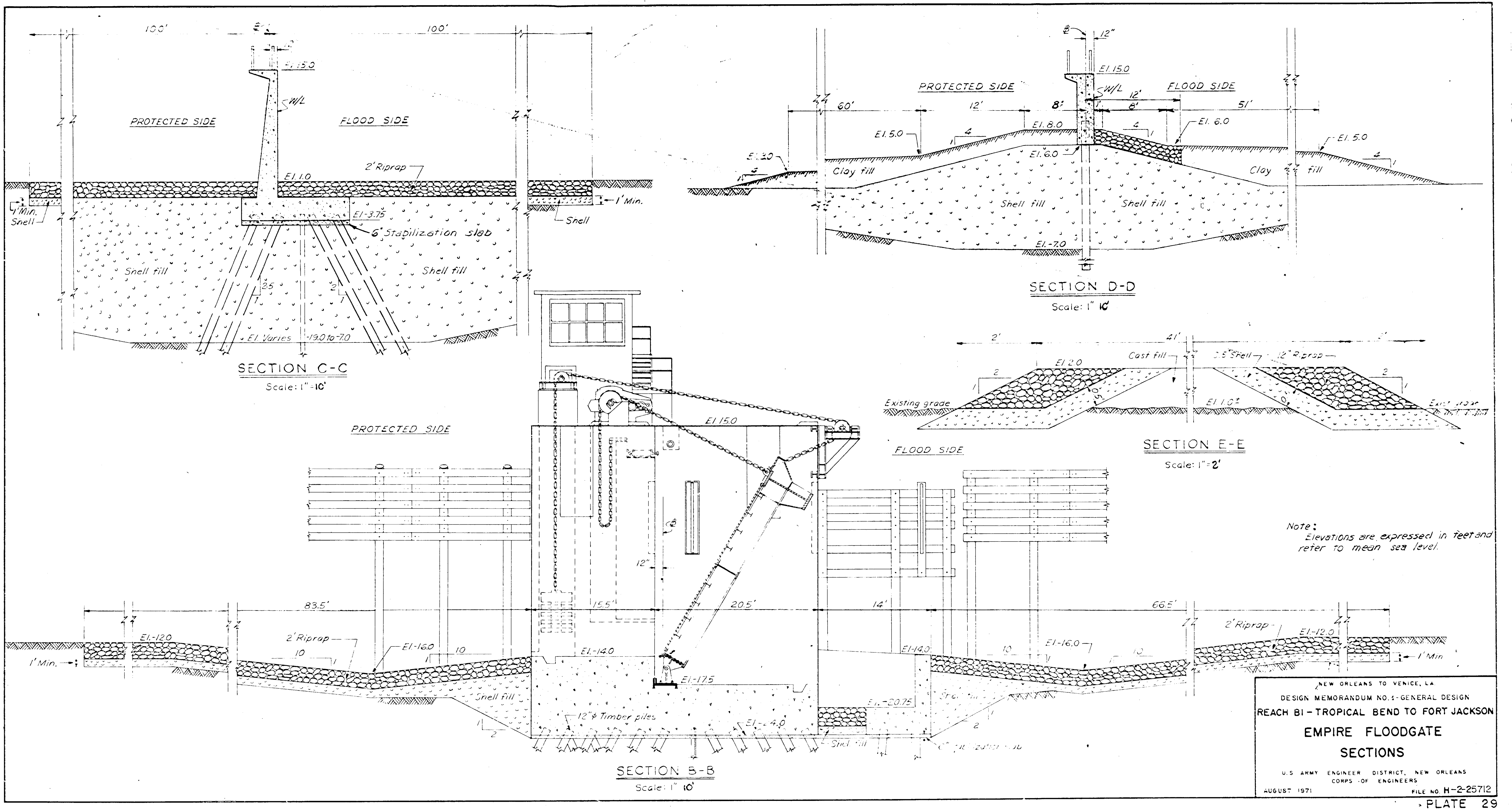


NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

EMPIRE FLOODGATE

SITE PLAN

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712



NEW ORLEANS TO VENICE, LA

DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN

REACH B1 - TROPICAL BEND TO FORT JACKSON

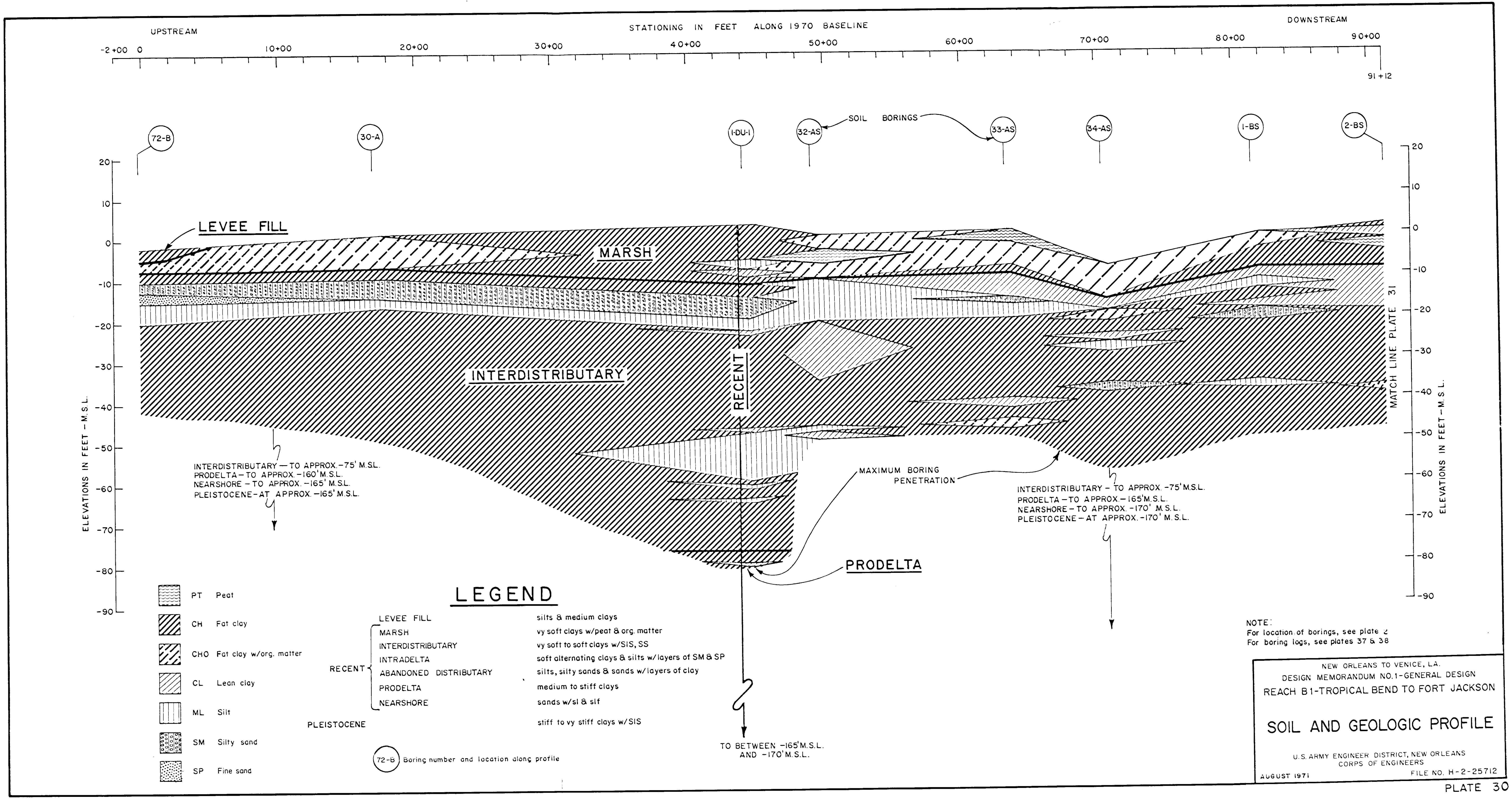
EMPIRE FLOODGATE

SECTIONS

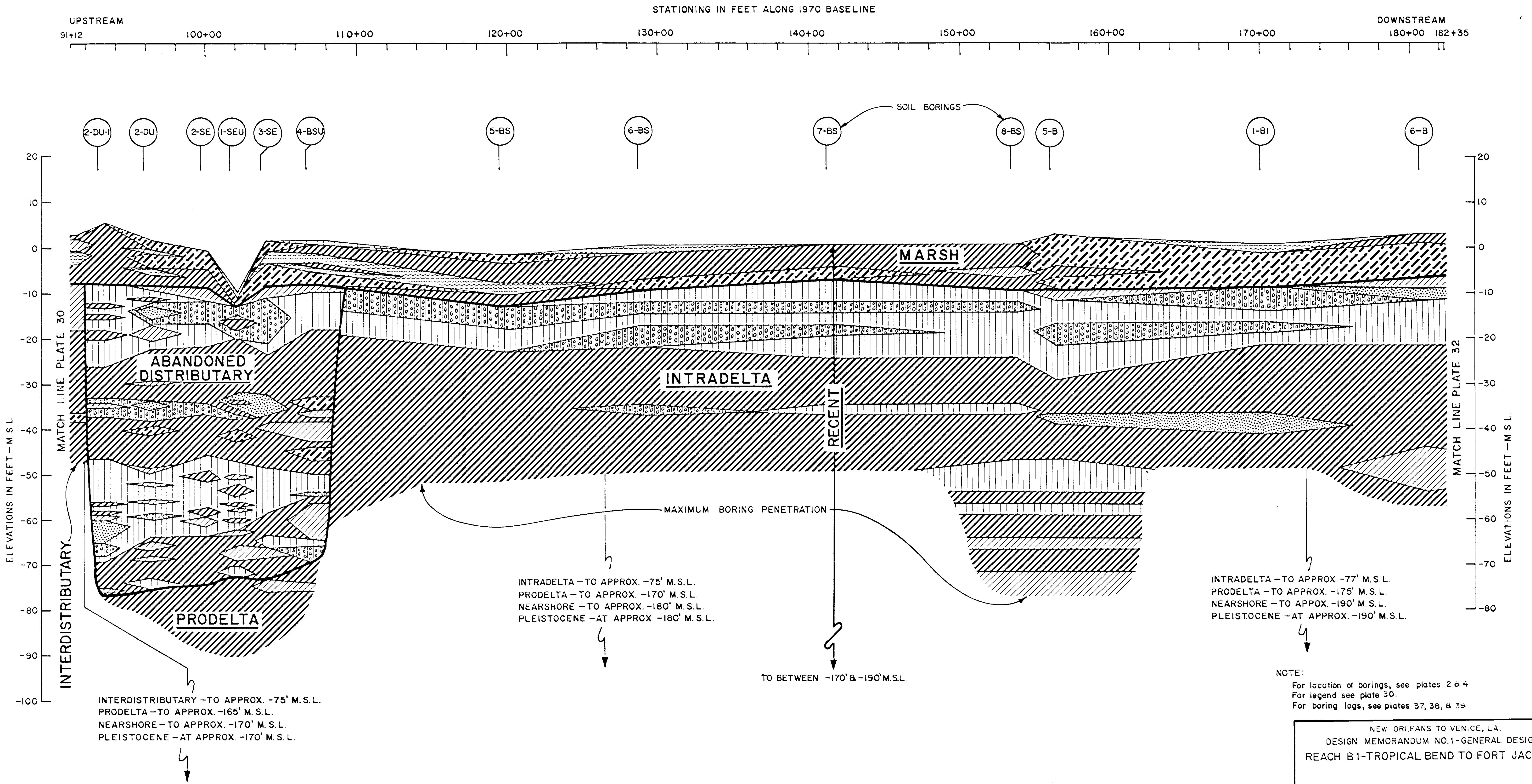
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE 29



UPSTREAM
STATIONING IN FEET ALONG 1970 BASELINE
DOWNSTREAM
-2+00
0
10+00
20+00
30+00
40+00
50+00
60+00
70+00
80+00
90+00
91+12
SOIL BORINGS
72-B
30-A
1-DU-1
32-AS
33-AS
34-AS
1-BS
2-BS
LEVEE FILL
MARSH
INTERDISTRIBUTARY
RECENT
MATCH LINE PLATE 31
ELEVATIONS IN FEET - M.S.L.
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
INTERDISTRIBUTARY — TO APPROX. -75' M.S.L.
PRODELTA - TO APPROX. -160' M.S.L.
NEARSHORE - TO APPROX. -165' M.S.L.
PLEISTOCENE - AT APPROX. -165' M.S.L.
MAXIMUM BORING PENETRATION
INTERDISTRIBUTARY - TO APPROX. -75' M.S.L.
PRODELTA - TO APPROX - 165' M.S.L.
NEARSHORE - TO APPROX. -170' M.S.L.
PLEISTOCENE - AT APPROX. -170' M.S.L.
PRODELTA
LEGEND
PT Peat
CH Fat clay
CHO Fat clay w/org. matter
CL Lean clay
ML Silt
SM Silty sand
SP Fine sand
LEVEE FILL silts & medium clays
RECENT
MARSH vy soft clays w/peat & org. matter
INTERDISTRIBUTARY vy soft to soft clays w/SIS, SS
INTRADELTA soft alternating clays & silts w/layers of SM & SP
ABANDONED DISTRIBUTARY silts, silty sands & sands w/layers of clay
PRODELTA medium to stiff clays
NEARSHORE sands w/sl & slf
PLEISTOCENE stiff to vy stiff clays w/SIS
72-B Boring number and location along profile
TO BETWEEN -165' M.S.L. AND -170' M.S.L.
NOTE:
For location of borings, see plate 2
For boring logs, see plates 37 & 38
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON
SOIL AND GEOLOGIC PROFILE
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971
FILE NO. H-2-25712



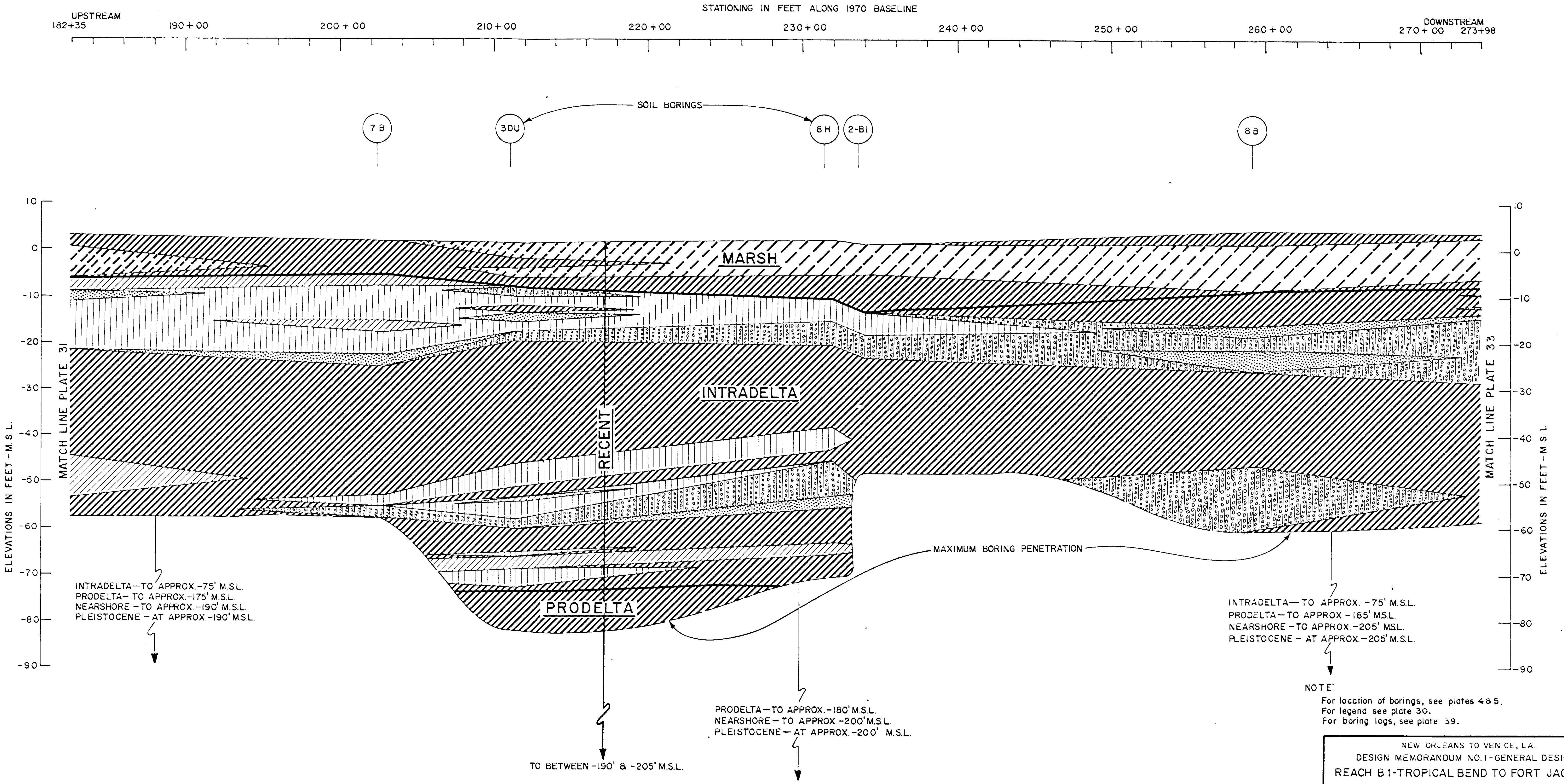
NOTE:
For location of borings, see plates 2 & 4
For legend see plate 30.
For boring logs, see plates 37, 38, & 39

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

SOIL AND GEOLOGIC PROFILE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



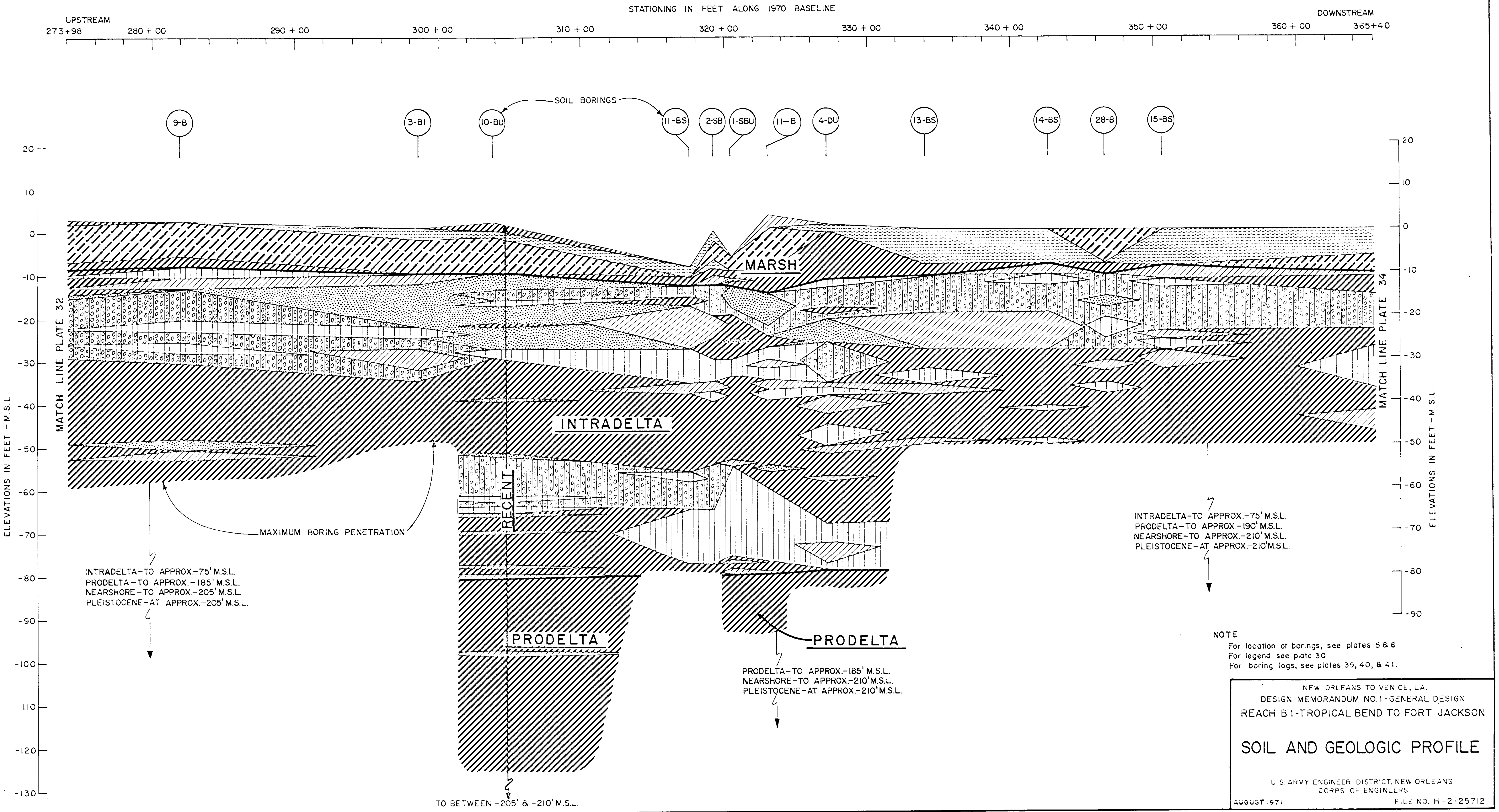
NOTE:
For location of borings, see plates 4 & 5.
For legend see plate 30.
For boring logs, see plate 39.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL AND GEOLOGIC PROFILE

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



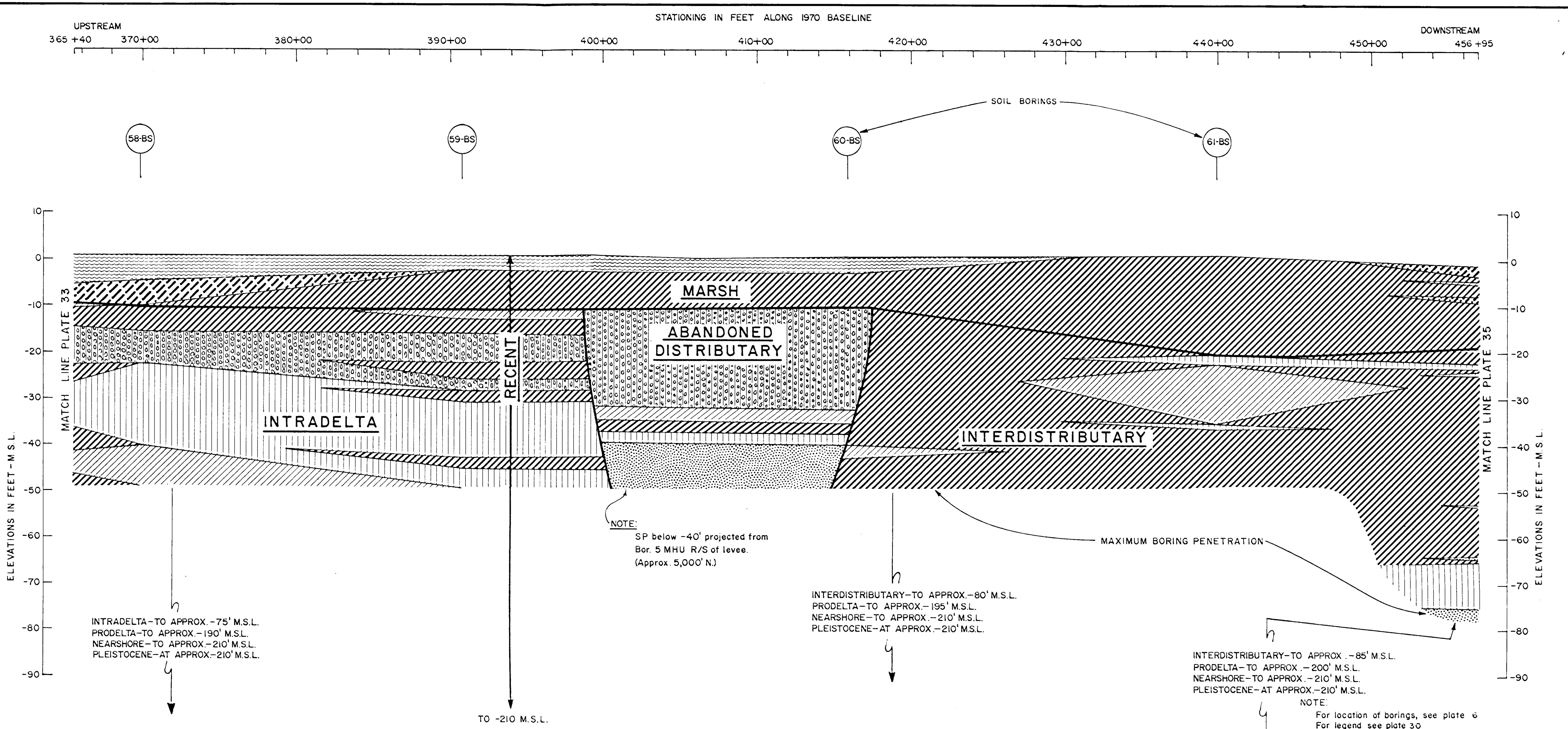
NOTE:
For location of borings, see plates 5 & 6
For legend see plate 30
For boring logs, see plates 39, 40, & 41.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL AND GEOLOGIC PROFILE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

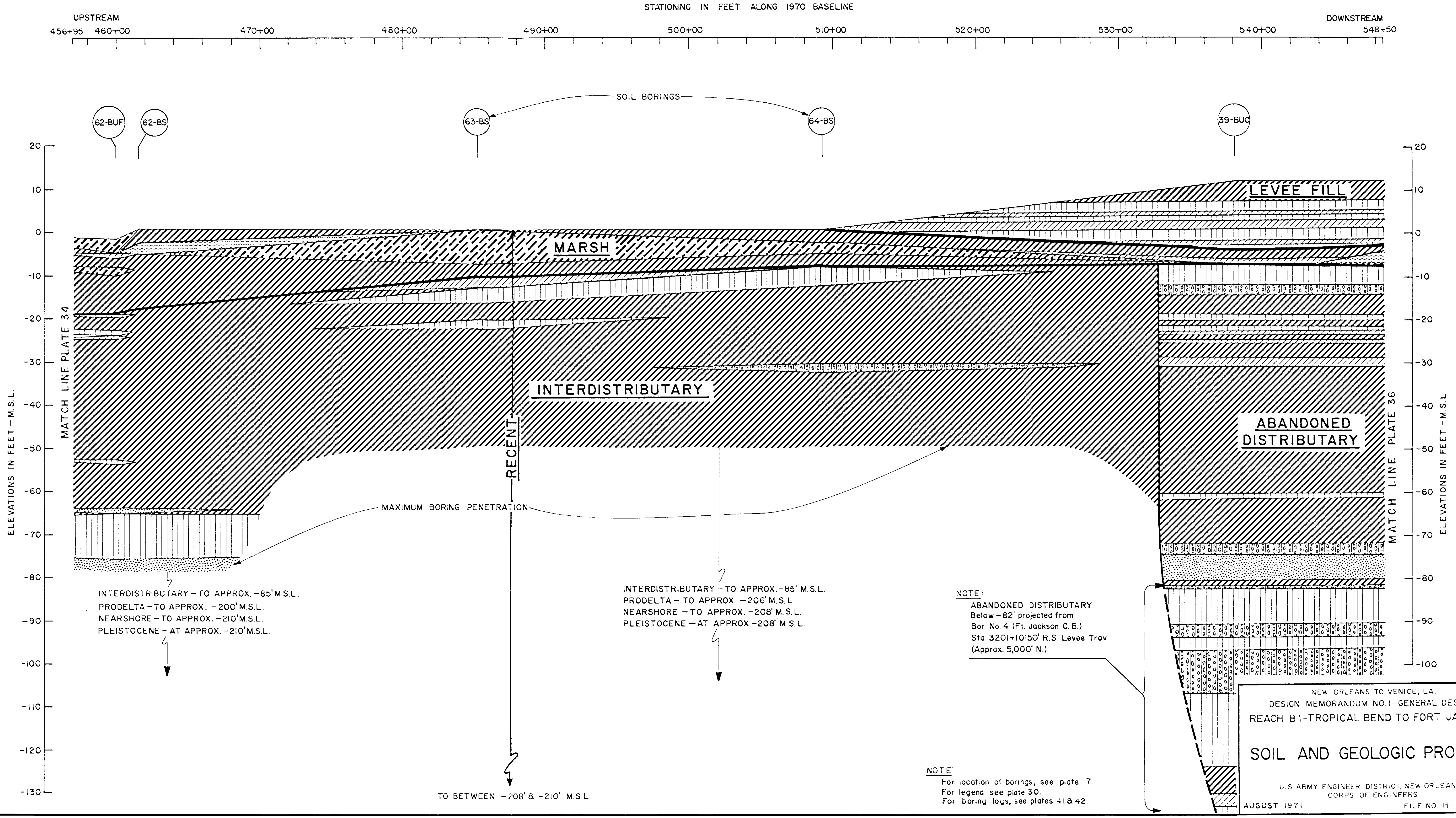


NOTE:
For location of borings, see plate 6
For legend see plate 30
For boring logs, see plate 41

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL AND GEOLOGIC PROFILE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712

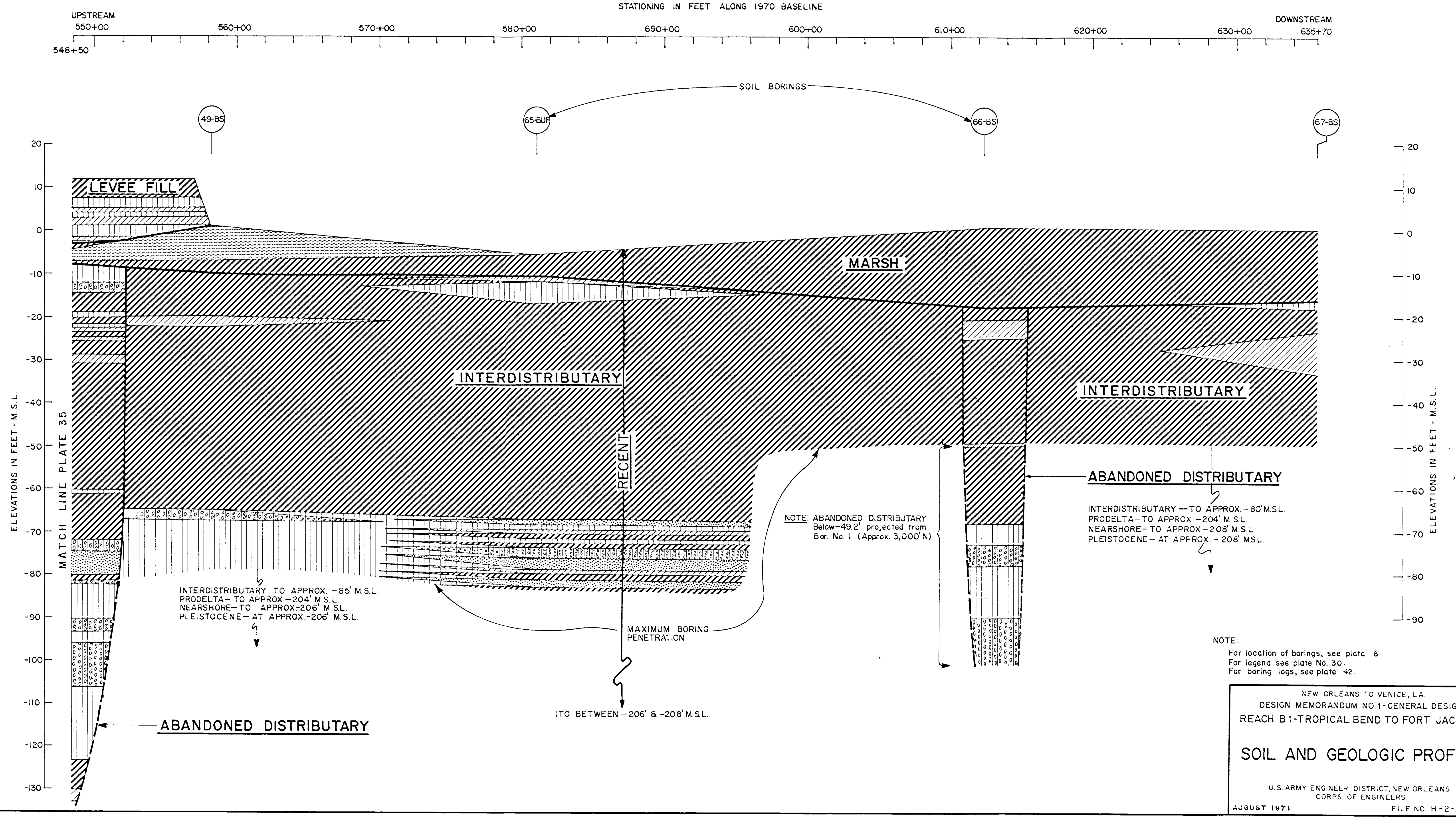


NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 – GENERAL DESIGN
REACH B1 – TROPICAL BEND TO FORT JACKSON

SOIL AND GEOLOGIC PROFILE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



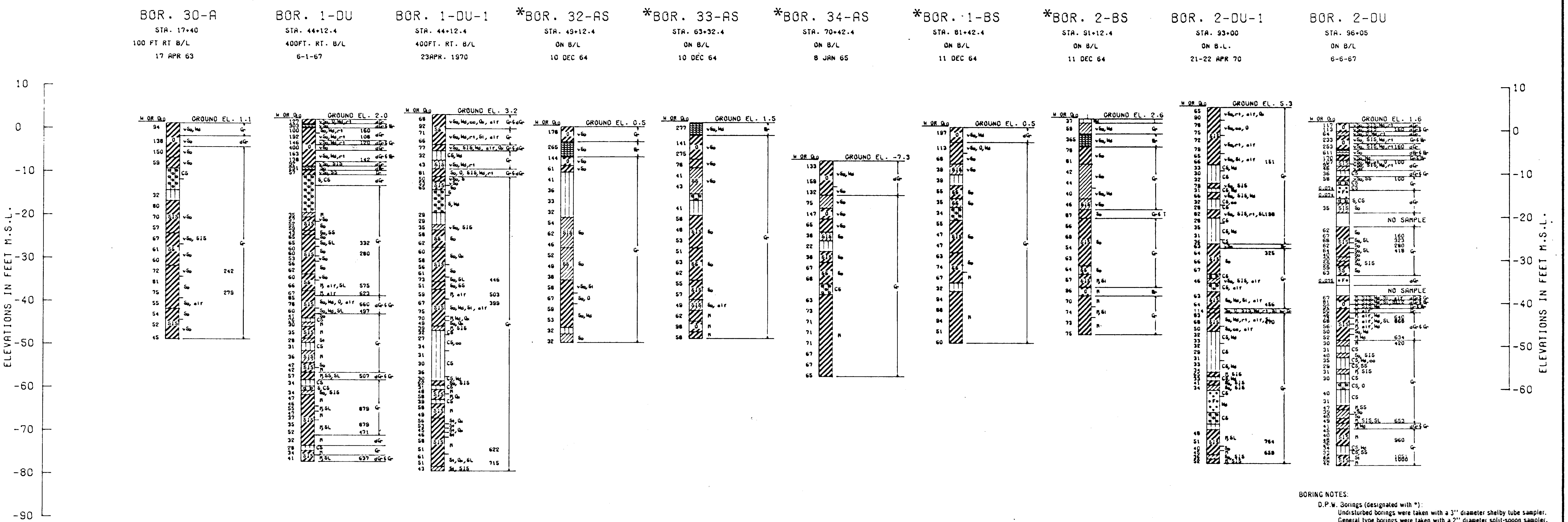
NOTE:
For location of borings, see plate 8.
For legend see plate No. 30.
For boring logs, see plate 42.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL AND GEOLOGIC PROFILE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



BORING NOTES:

D.P.W. Borings (designated with *):
Undisturbed borings were taken with a 3" diameter shelby tube sampler.
General type borings were taken with a 2" diameter split-spoon sampler.

C.E. Borings:
Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.
General type borings were taken with a 1 7/8" I.D. core barrel sampler.

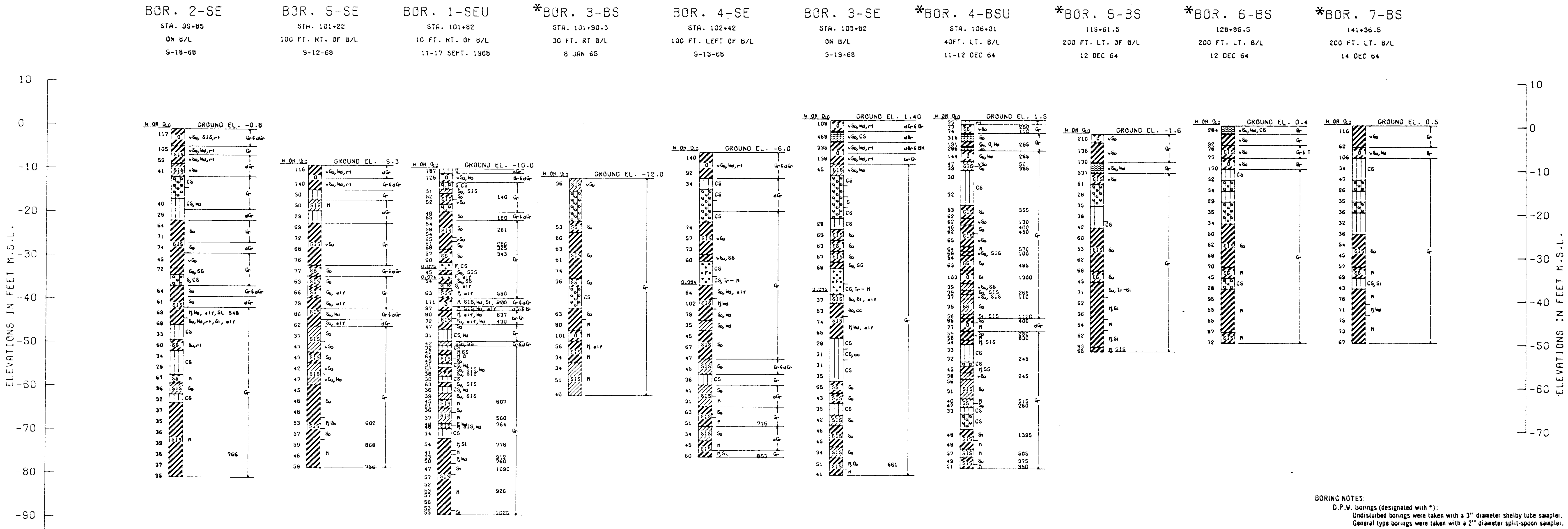
See plate A for soil boring legend.
For location of borings see plates 2.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



BORING NOTES:

D.P.W. Borings (designated with *):
Undisturbed borings were taken with a 3" diameter shelby tube sampler.
General type borings were taken with a 2" diameter split-spoon sampler.

C.E. Borings:
Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.
General type borings were taken with a 1 7/8" I.D. core barrel sampler.

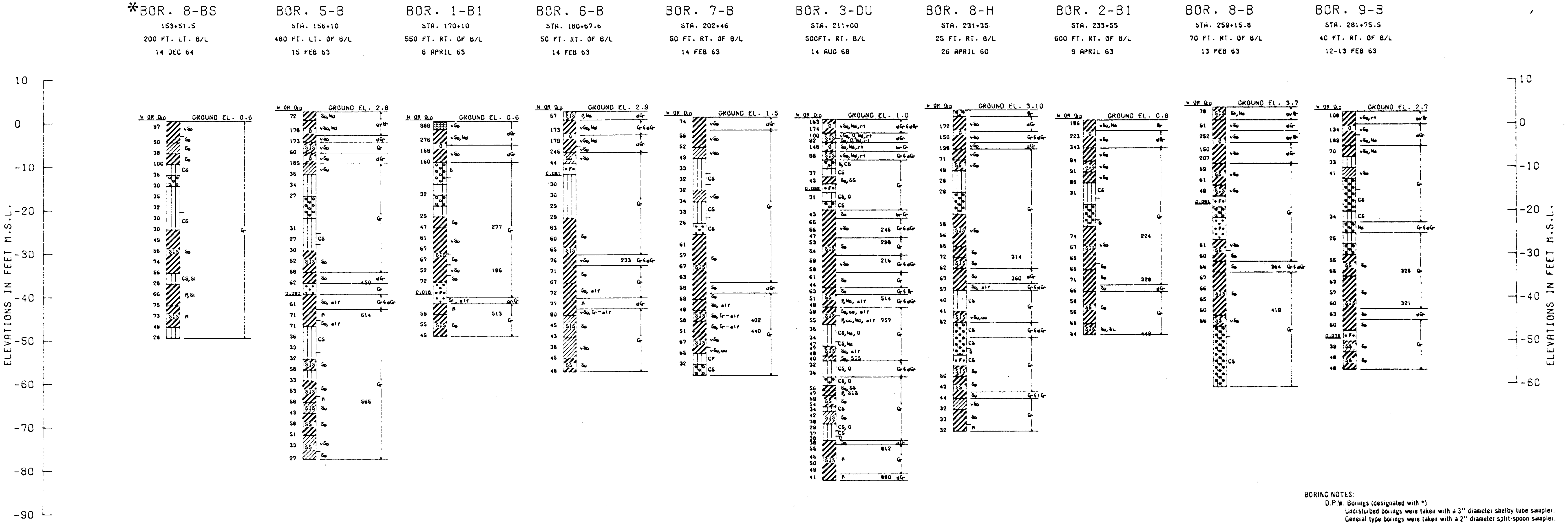
See plate A for soil boring legend.
For location of borings see plates 2 & 4.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



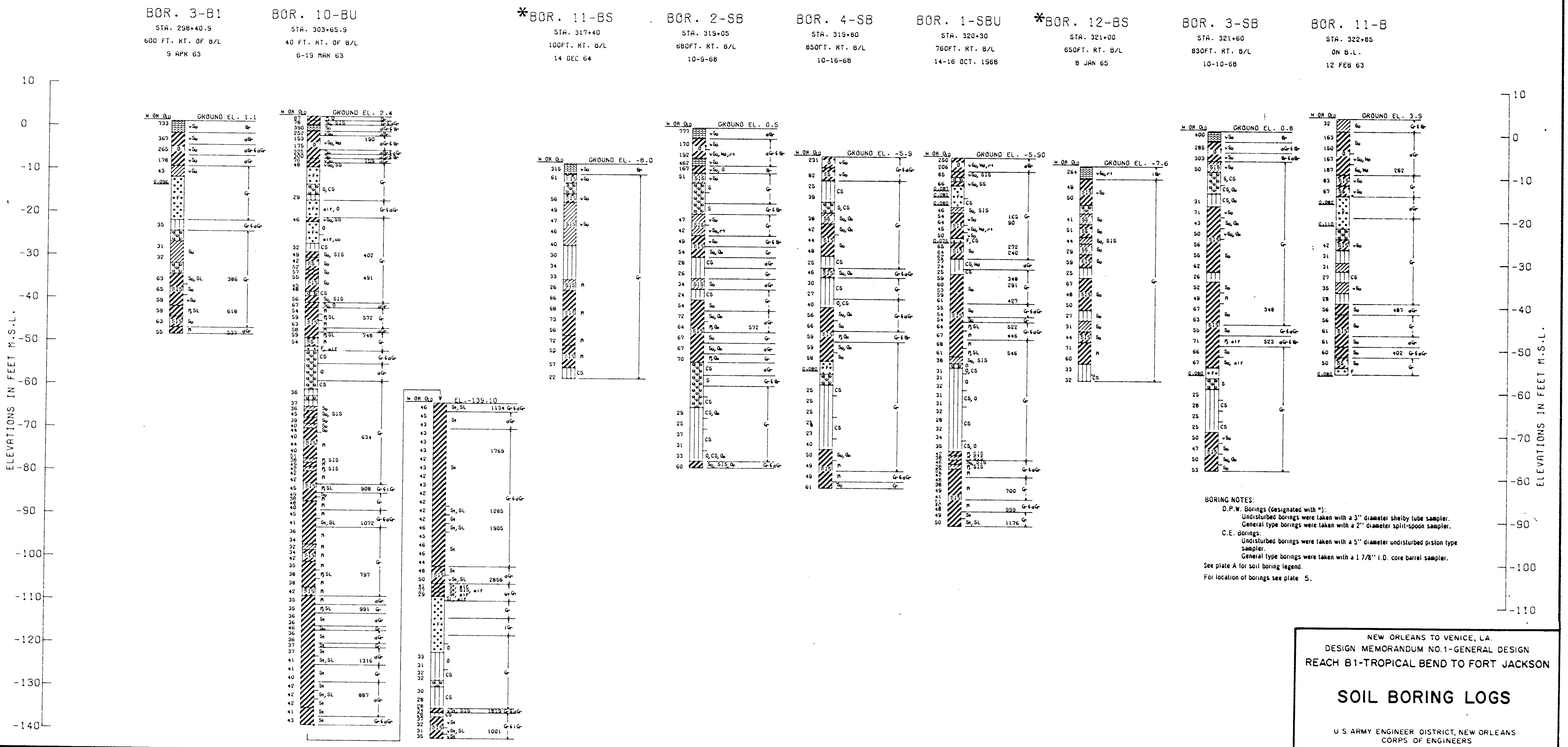
BORING NOTES:
D.P.W. Borings (designated with *):
Undisturbed borings were taken with a 3" diameter shelby tube sampler.
General type borings were taken with a 2" diameter split-spoon sampler.
C.E. Borings:
Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.
General type borings were taken with a 1 7/8" I.D. core barrel sampler.
See plate A for soil boring legend.
For location of borings see plates 4 & 5.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



BORING NOTES:

D.P.W. Borings (designated with *):
Undisturbed borings were taken with a 3" diameter shelby tube sampler.
General type borings were taken with a 2" diameter split-spoon sampler.

C.E. Borings:
Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.
General type borings were taken with a 1 7/8" I.D. core barrel sampler.

See plate A for soil boring legend.

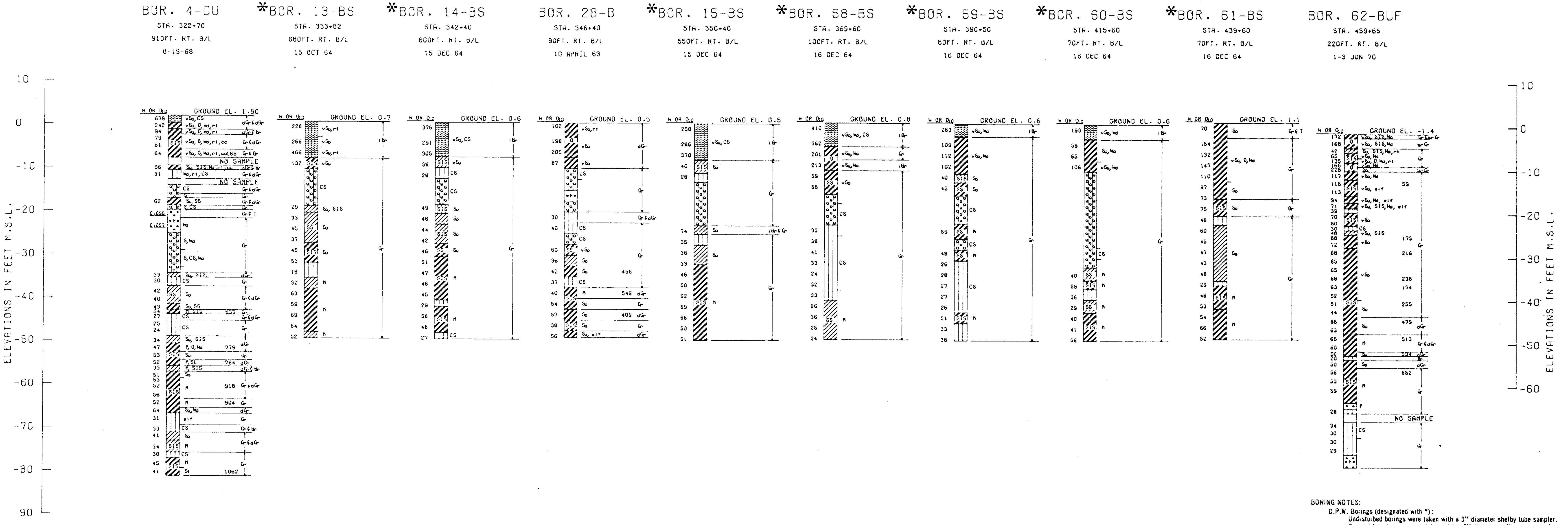
For location of borings see plate 5.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



BORING NOTES:

D.P.W. Borings (designated with *):

Undisturbed borings were taken with a 3" diameter shelby tube sampler.

General type borings were taken with a 2" diameter split-spoon sampler.

C.E. Borings:

Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.

General type borings were taken with a 1 7/8" I.D. core barrel sampler.

See plate A for soil boring legend.

For location of borings see plates 5, 6, & 7

NEW ORLEANS TO VENICE, LA.

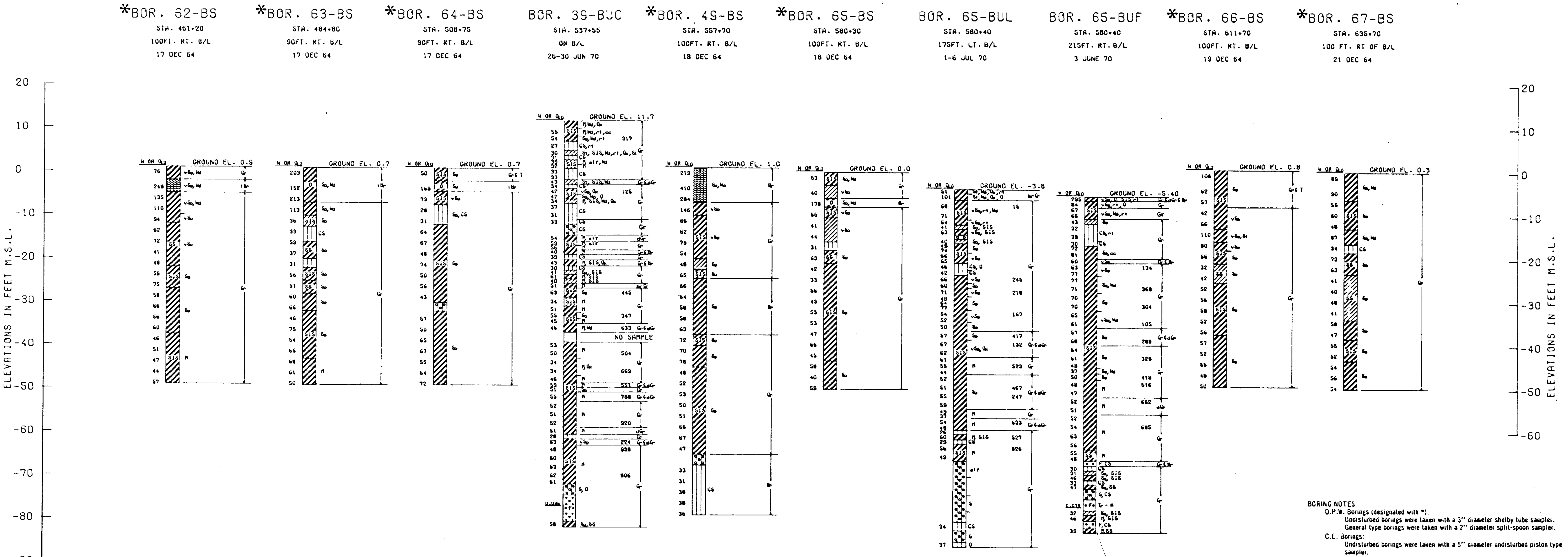
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN

REACH B1 - TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



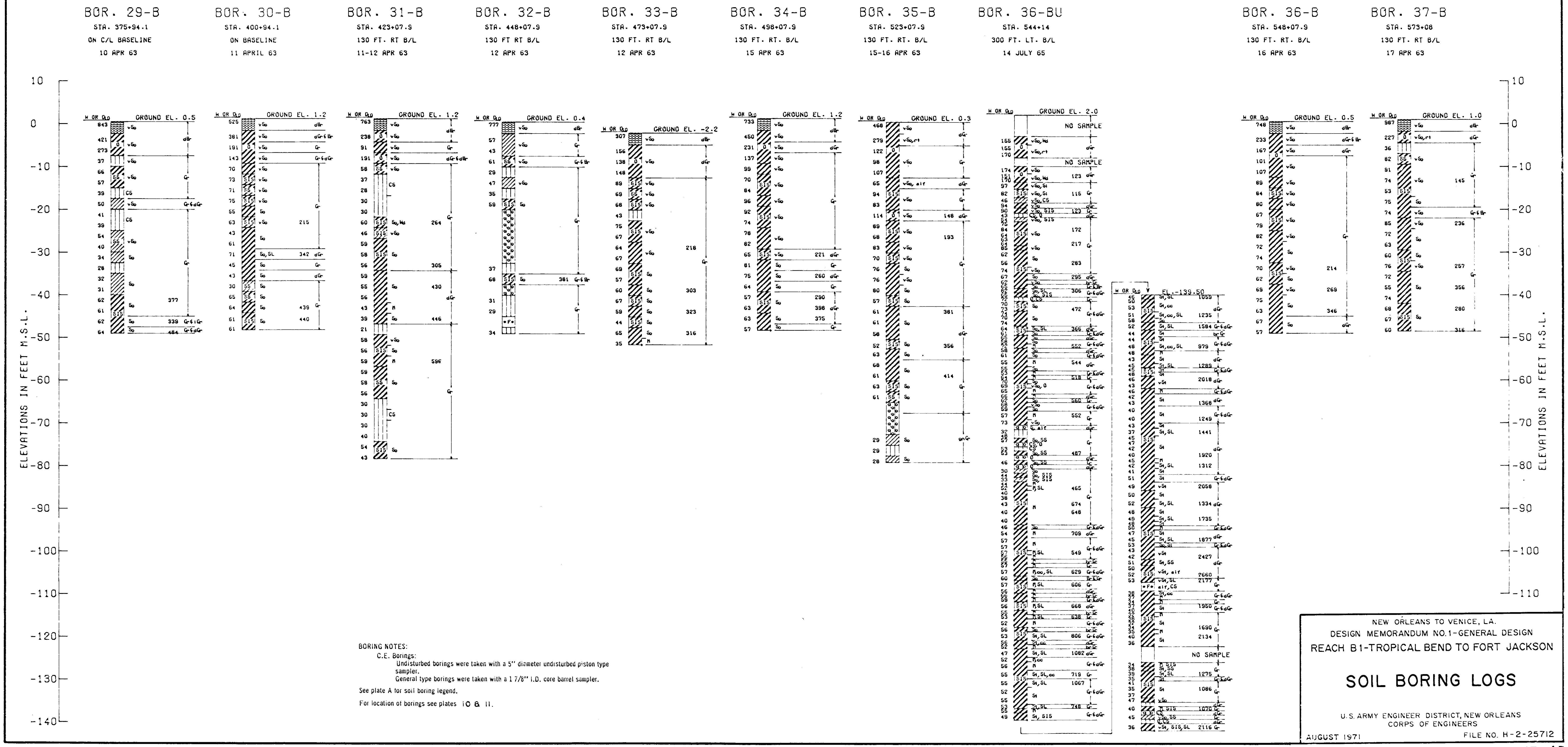
BORING NOTES:
D.P.W. Borings (designated with *):
Undisturbed borings were taken with a 3" diameter shelby tube sampler.
General type borings were taken with a 2" diameter split-spoon sampler.
C.E. Borings:
Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.
General type borings were taken with a 1 7/8" I.D. core barrel sampler.
See plate A for soil boring legend.
For location of borings see plates 7 & 8.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



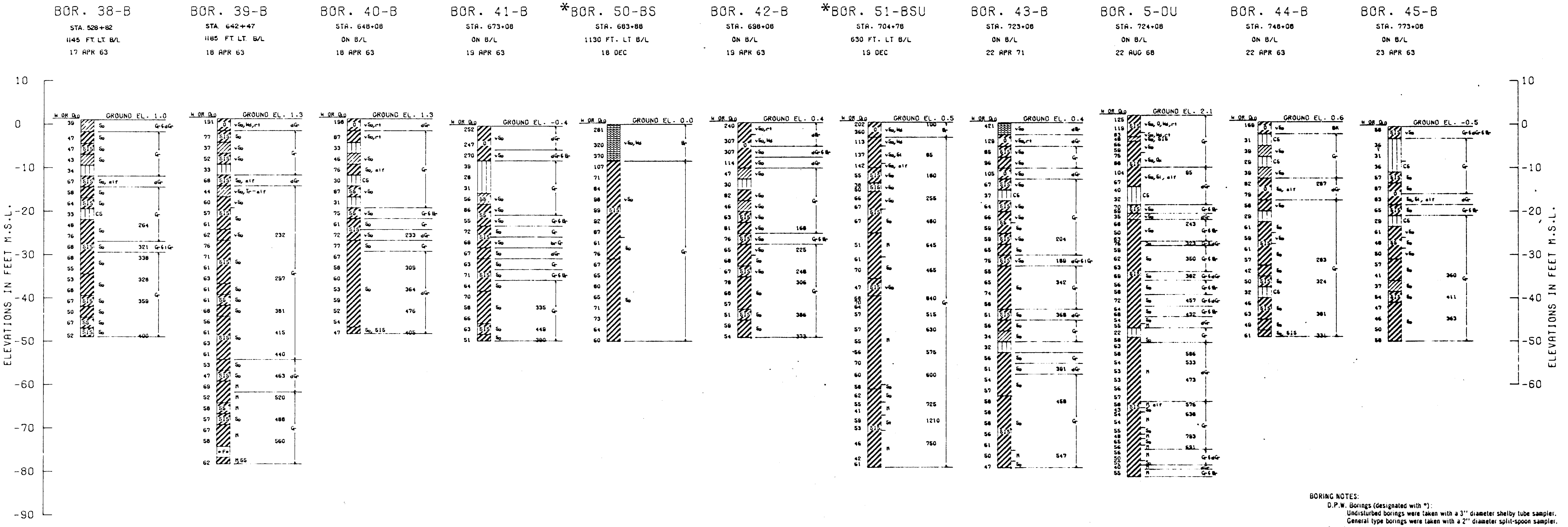
BORING NOTES:
C.E. Borings:
Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.
General type borings were taken with a 1 7/8" I.D. core barrel sampler.
See plate A for soil boring legend.
For location of borings see plates 10 & 11.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



BORING NOTES:

D.P.W. Borings (designated with *):

Undisturbed borings were taken with a 3" diameter shelby tube sampler.

General type borings were taken with a 2" diameter split-spoon sampler.

C.E. Borings:

Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.

General type borings were taken with a 1 7/8" I.D. core barrel sampler.

See plate A for soil boring legend.

For location of borings see plates 11 & 12.

NEW ORLEANS TO VENICE, LA.

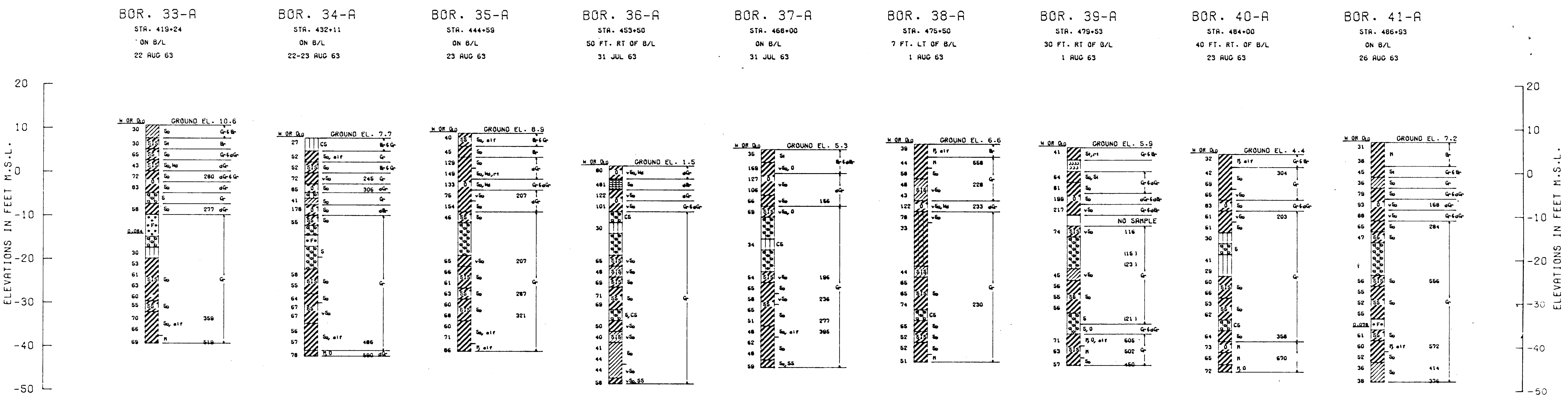
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



NOTES:

Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.

General type borings were taken with a 1 7/8" I.D. core barrel sampler.

See plate A for soil boring legend.

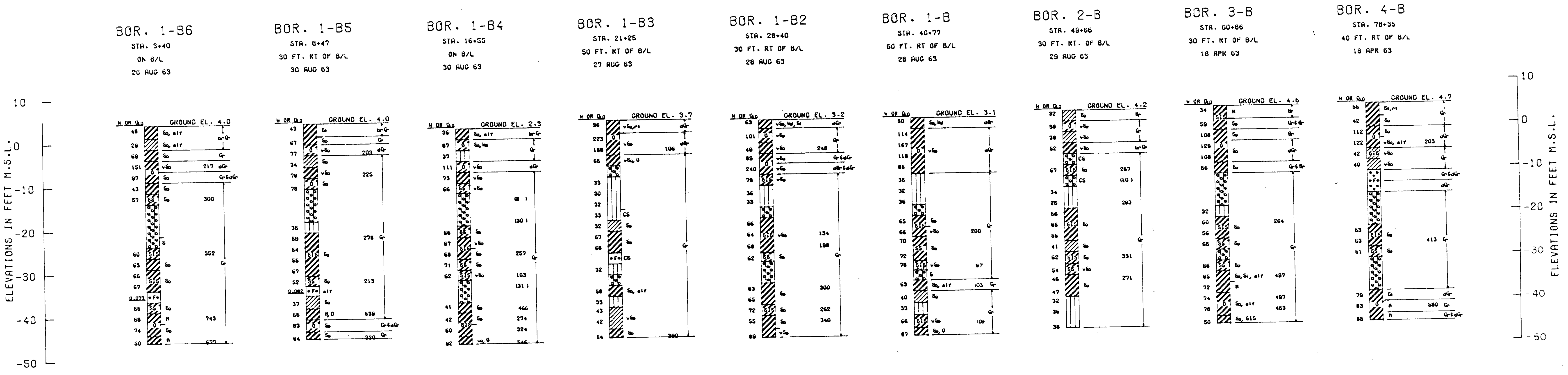
For location of borings see plate 2.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



NOTES:

Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.

General type borings were taken with a 1 7/8" I.D. core barrel sampler

See plate A for soil boring legend.

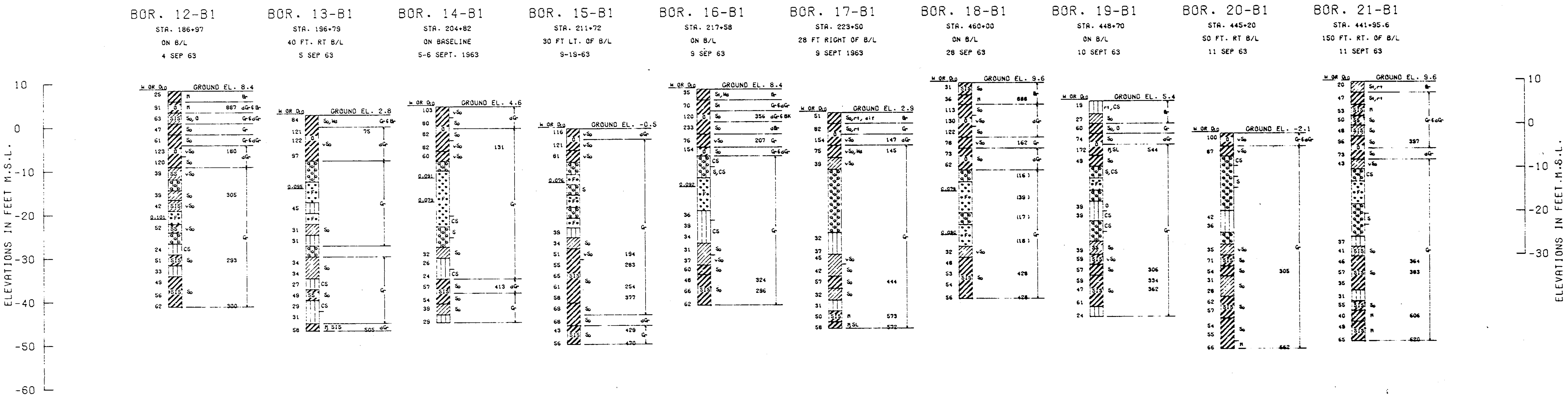
For location of borings see plates 2 & 4.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



BORING NOTES:

C.E. Borings:

Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.

General type borings were taken with a 1 7/8" I.D. core barrel sampler.

See plate A for soil boring legend.

For location of borings see plate 5

NEW ORLEANS TO VENICE, LA.

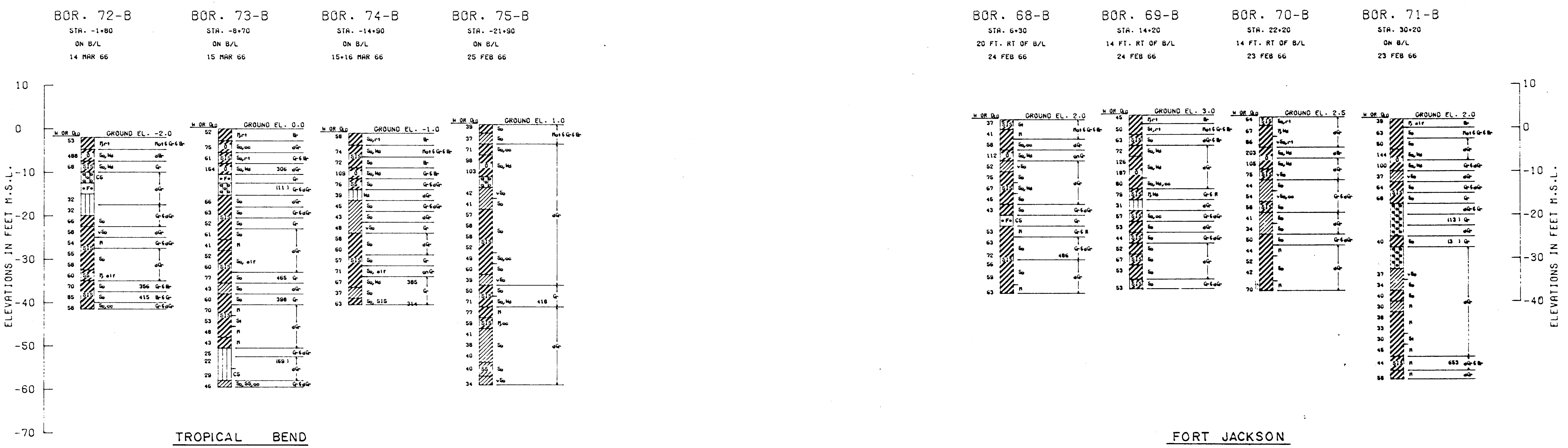
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN

REACH B1 - TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



BORING NOTES:

C.E. Borings:

Undisturbed borings were taken with a 5" diameter undisturbed piston type sampler.

General type borings were taken with a 1 7/8" I.D. core barrel sampler.

See plate A for soil boring legend.

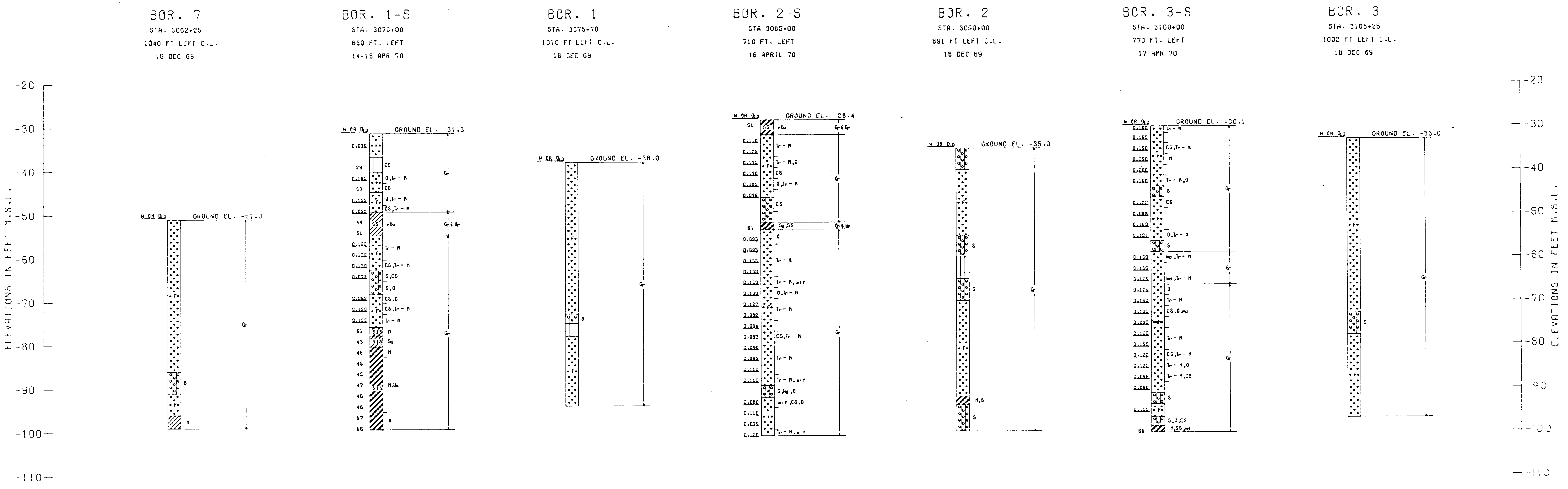
For location of borings see plates 2 & 12.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



NOTE:

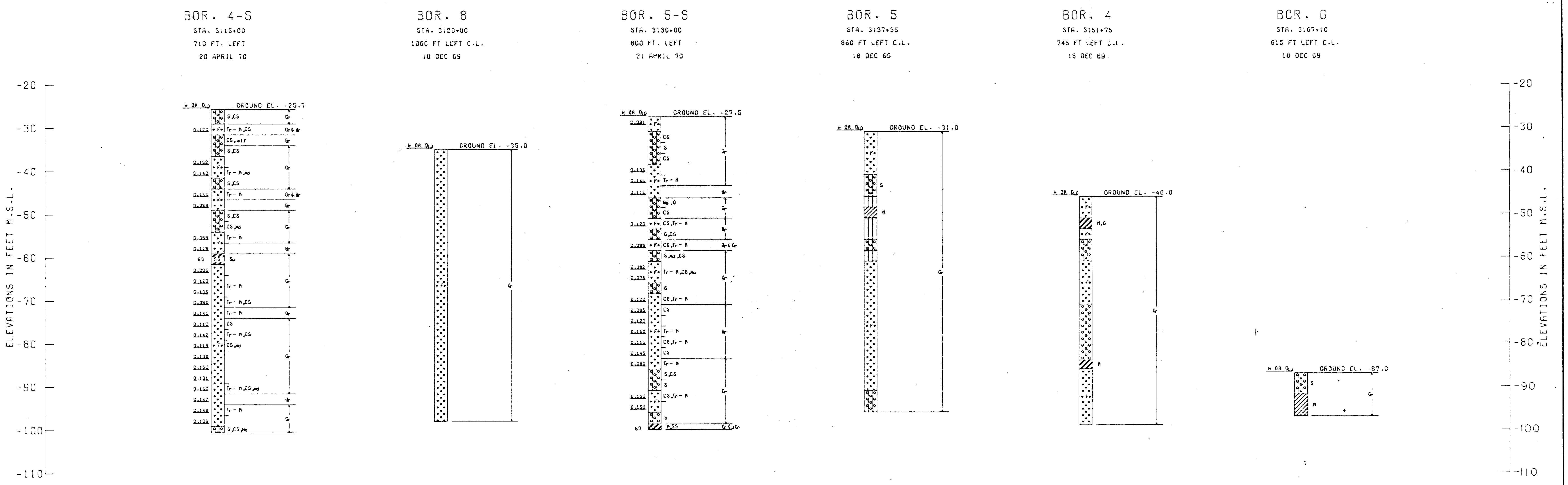
BORINGS 1-S THROUGH 3-S WERE MADE WITH A 1-7/8 IN. I.D. CORE BARREL SAMPLER BY THE CORPS OF ENGINEERS.
BORINGS 1 THROUGH 3 AND BORING 7 WERE MADE BY THE STATE OF LOUISIANA, DEPARTMENT OF HIGHWAYS, CLASSIFIED ACCORDING TO A.A.S.H.O. DESIGNATION M145 SPECIFICATIONS, AND CONVERTED TO THE UNIFIED SOIL CLASSIFICATION BY THE CORPS OF ENGINEERS.
FOR SOIL BORING LEGEND SEE PLATE A.
FOR LOCATIONS OF BORINGS SEE PLATE 23.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SOIL BORING LOGS
RIVER BORROW BORINGS
MILE 22 TO MILE 24AHP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



NOTE:

BORINGS 4-S AND 5-S WERE MADE WITH A 1-7/8 IN. I.D. CORE BARREL SAMPLER BY THE CORPS OF ENGINEERS.

BORINGS 4 THROUGH 6 AND BORING 8 WERE MADE BY THE STATE OF LOUISIANA, DEPARTMENT OF HIGHWAYS, CLASSIFIED ACCORDING TO A.A.S.H.O. DESIGNATION M145 SPECIFICATIONS, AND CONVERTED TO THE UNIFIED SOIL CLASSIFICATION BY THE CORPS OF ENGINEERS.

FOR SOIL BORING LEGEND SEE PLATE A.
FOR LOCATION OF BORINGS SEE PLATE 23.

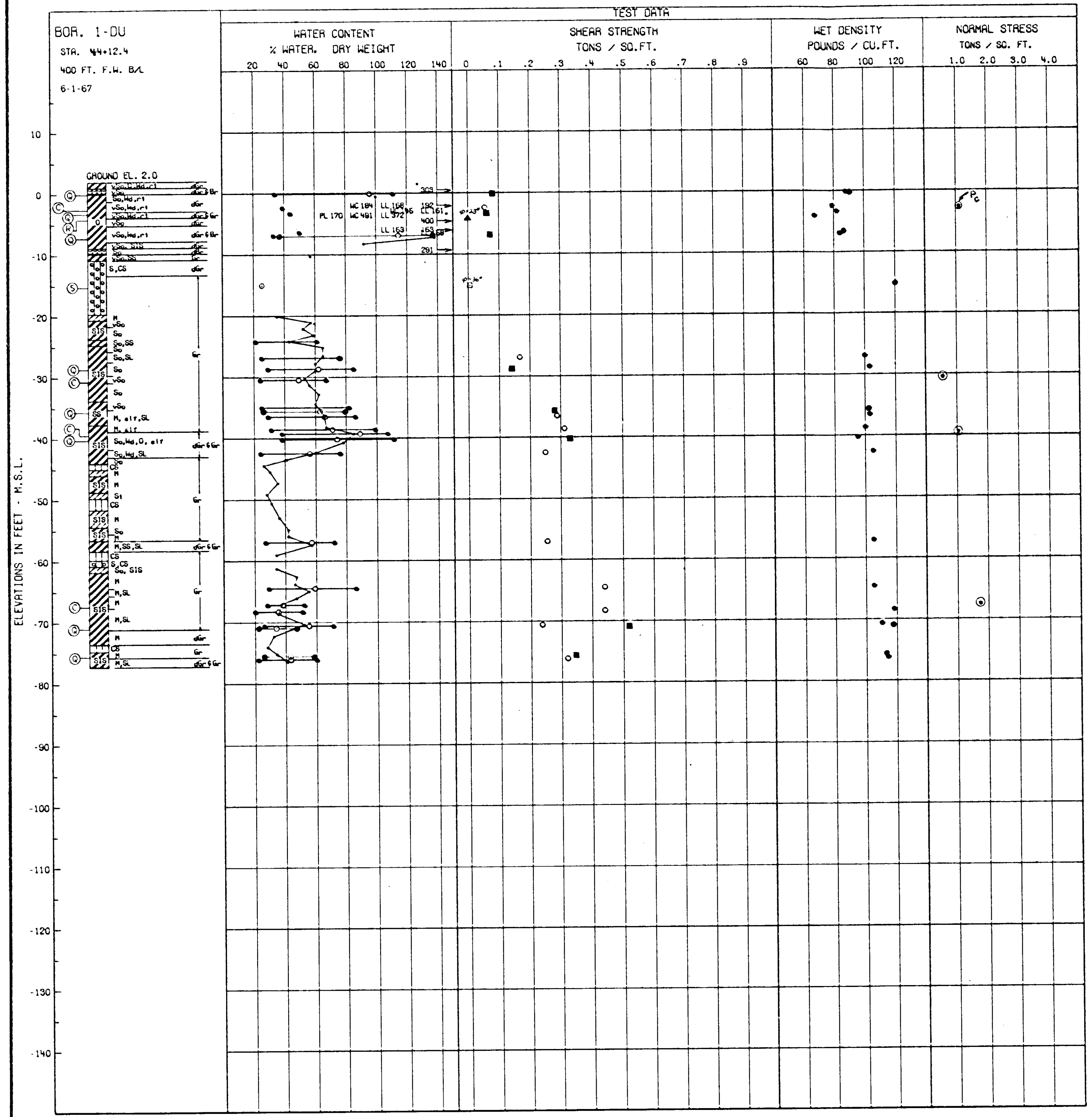
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

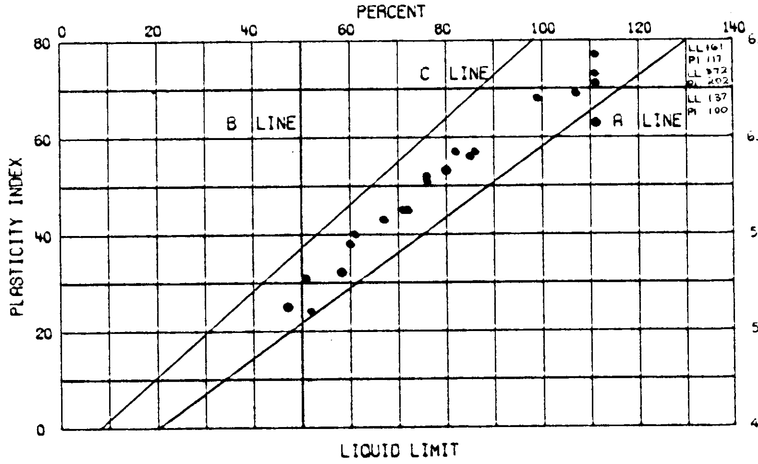
SOIL BORING LOGS

RIVER BORROW BORINGS
MILE 22 TO MILE 24 AHP

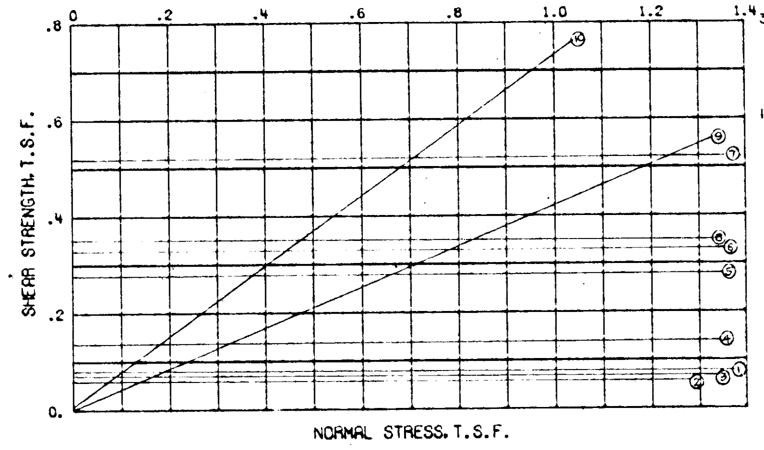
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



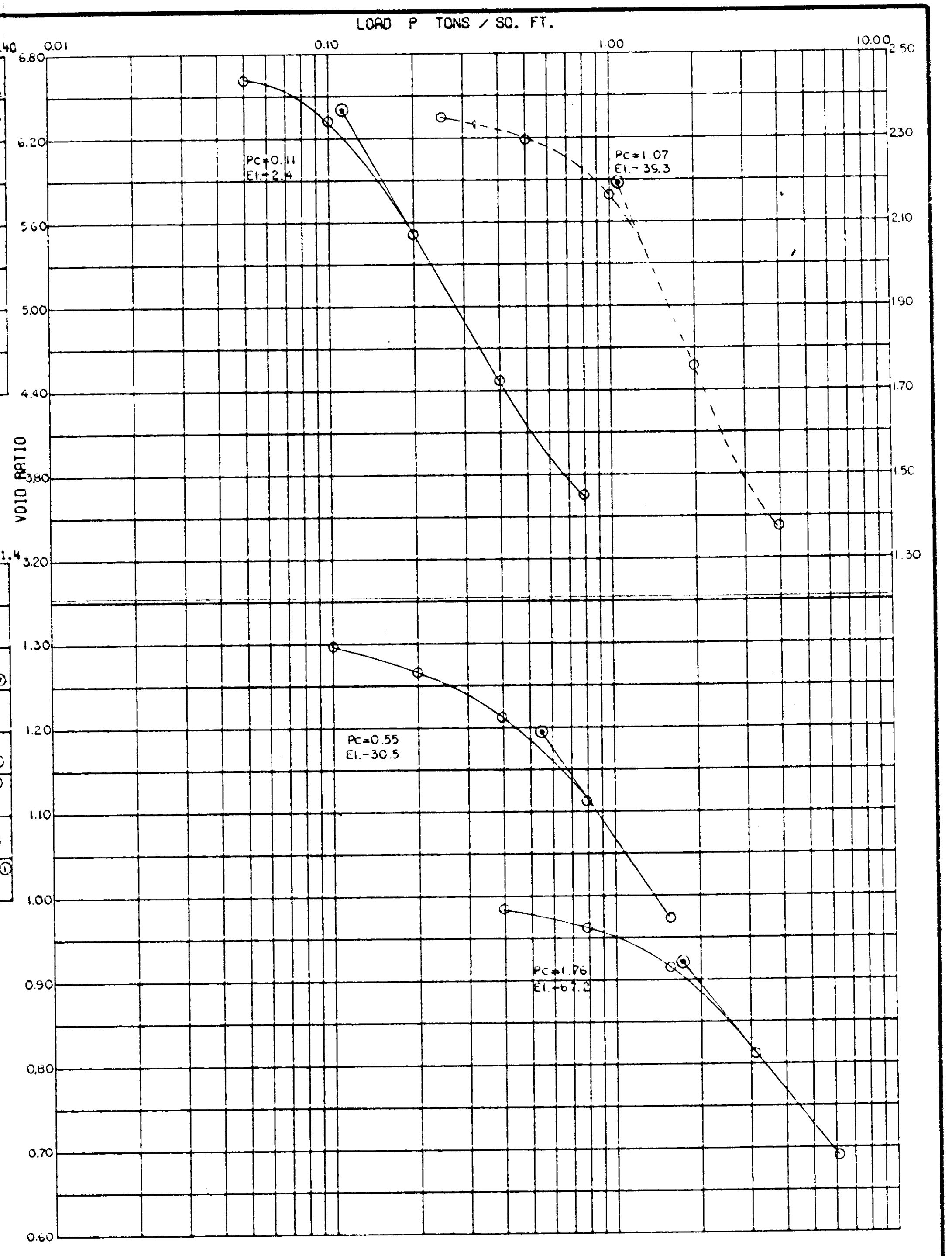


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
1-DU	1	-0.1	Q	0°	0.08	CH
	2	-3.3	Q	0°	0.06	CH
	3	-7.2	Q	0°	0.07	CH
	4	-28.7	Q	0°	0.14	CH
	5	-35.8	Q	0°	0.28	CH
	6	-40.2	Q	0°	0.33	CH
	7	-71.0	Q	0°	0.52	CH
	8	-75.7	Q	0°	0.35	CH
	9	-4.0	R	23°	0.00	PT
	10	-15.2	S	36°	0.05	SM



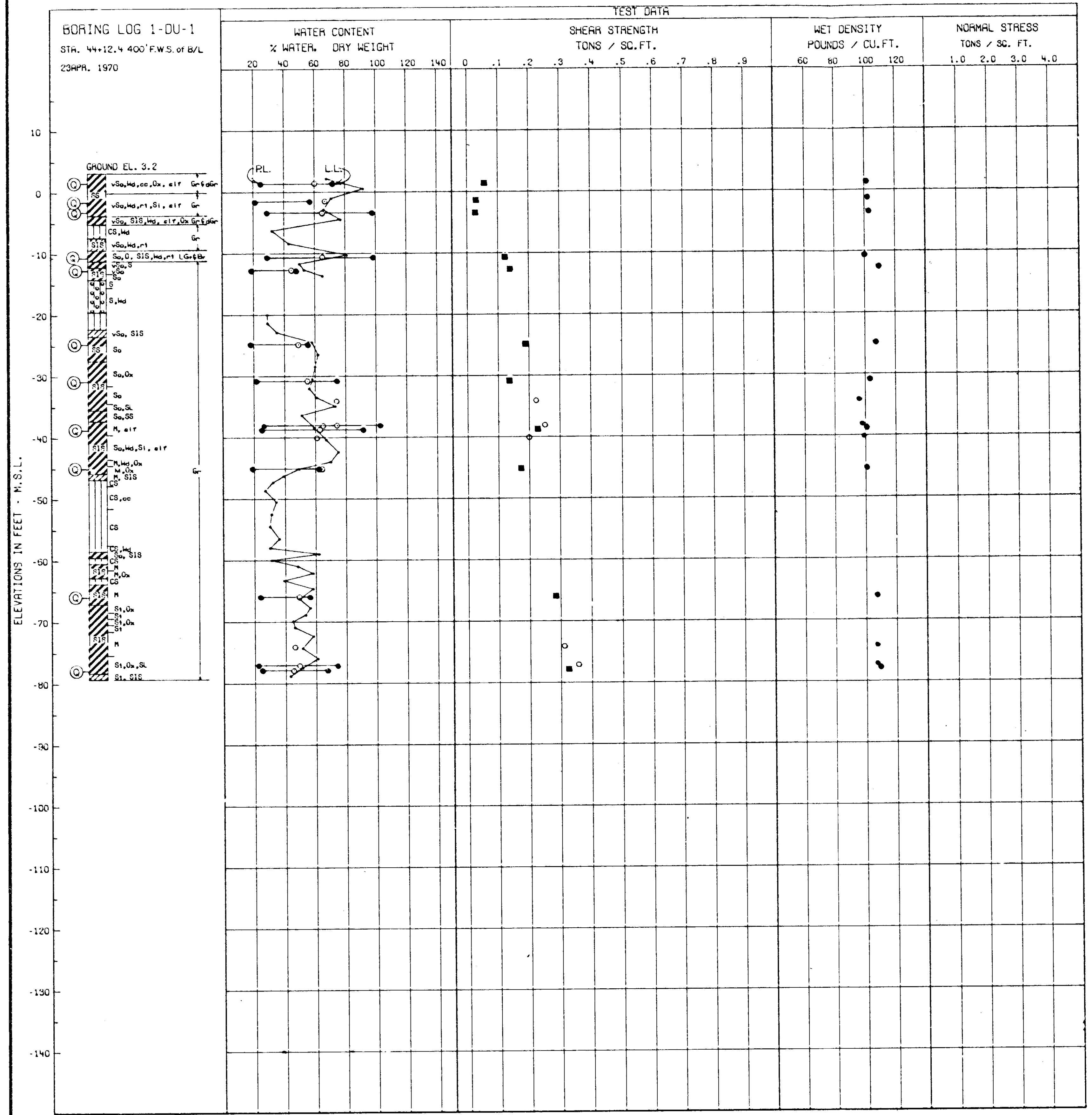
CONSOLIDATION DATA

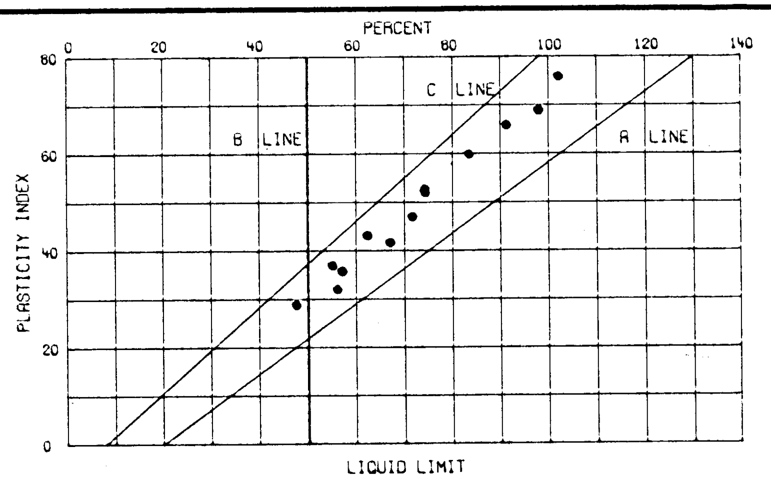
○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST
BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER
FOR SOIL BORING LEGEND SEE PLATE A
FOR LOCATION OF BORING SEE PLATE 2.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

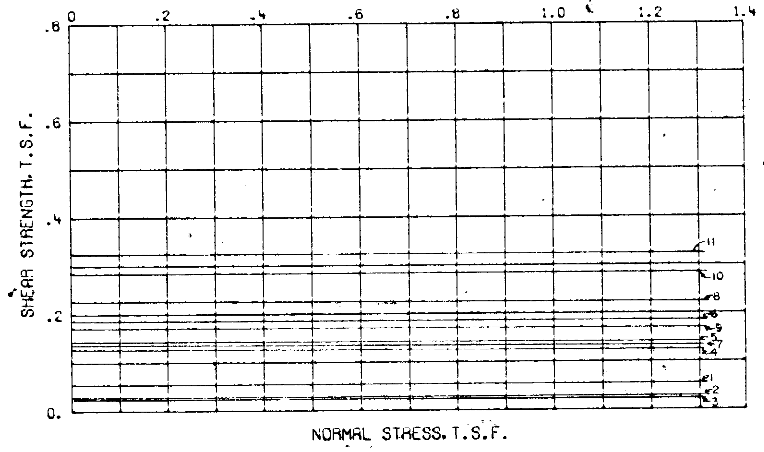
UNDISTURBED BORING I-DU DATA

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712





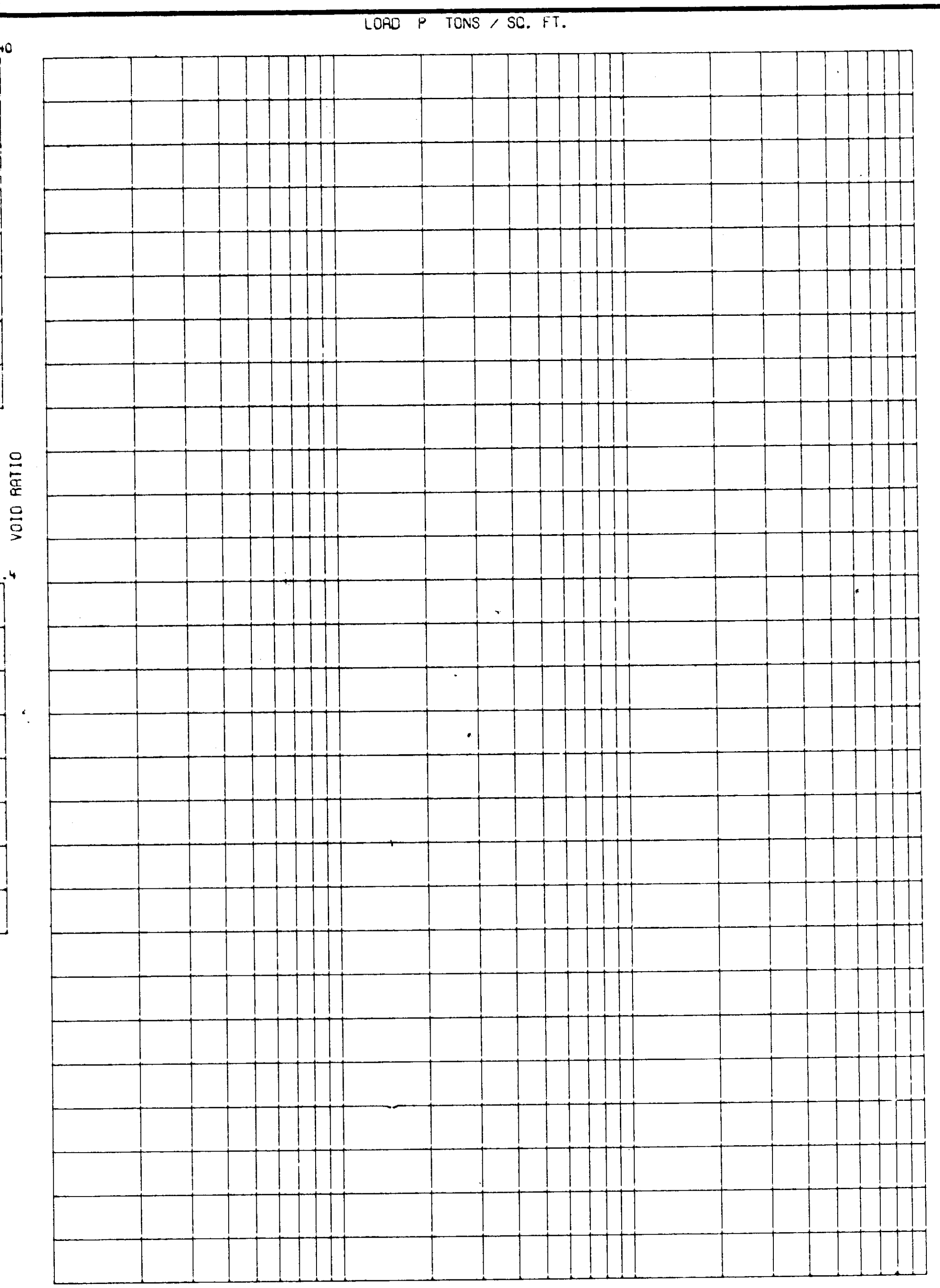
PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
1-DU-1	1	+1.6	Q	0°	.058	CH
	2	-1.5		0°	.030	CH
	3	-3.3		0°	.028	CH
	4	-10.7		0°	.125	CH-O
	5	-12.8		0°	.140	CH
	6	-24.9		0°	.188	CH
	7	-30.8		0°	.135	CH
	8	-38.8		0°	.223	CH
	9	-45.0		0°	.170	CH
	10	-65.9		0°	.283	CH
	11	-77.9		0°	.323	CH

NOTE:
This boring was inadvertently taken at same location as 1-DU, therefore this boring may not be representative of actual conditions.



CONSOLIDATION DATA

○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
- (S) CONSOLIDATED - DRAINED SHEAR TEST

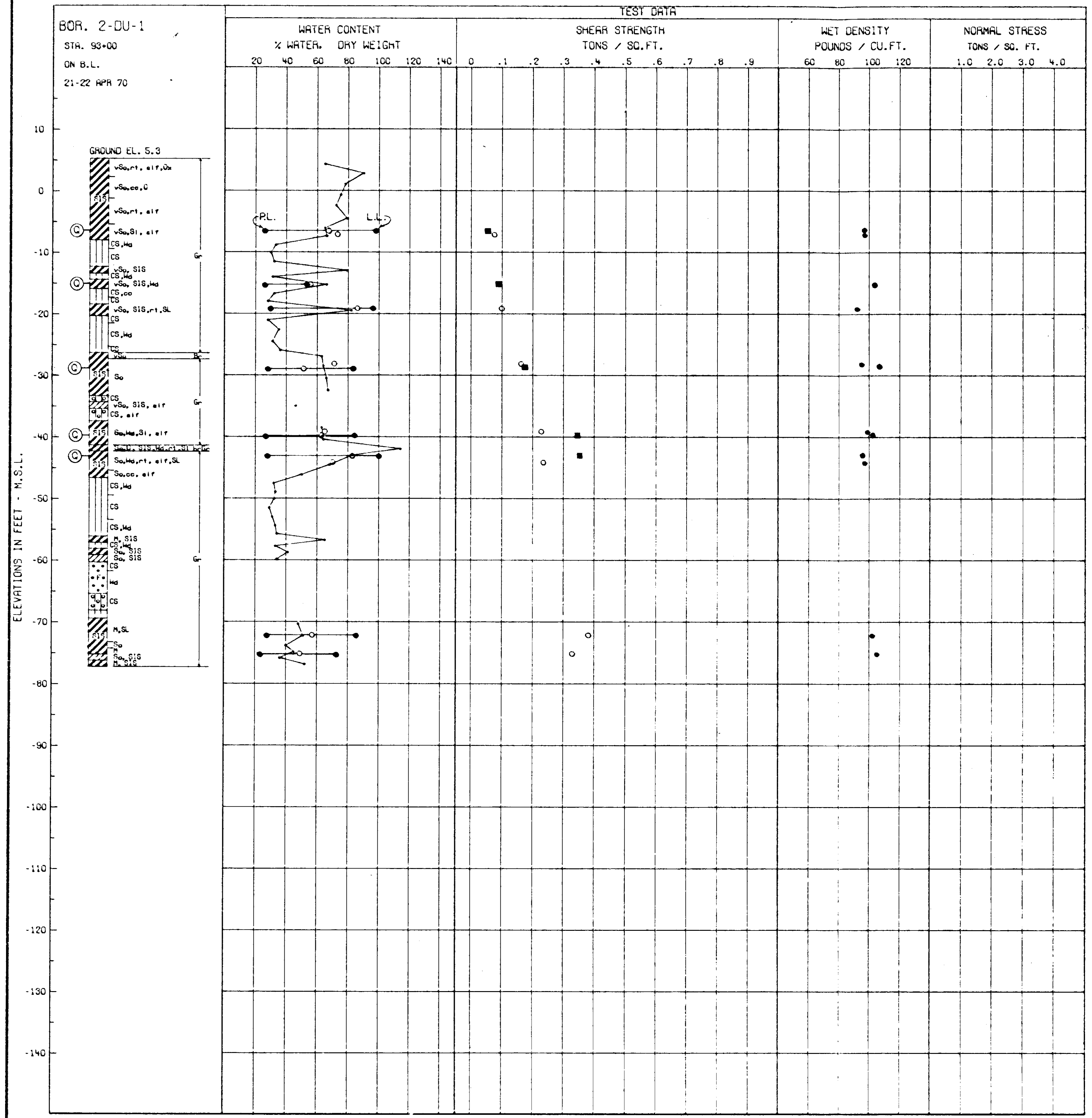
BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER
FOR SOIL BORING LEGEND SEE PLATE A
FOR LOCATION OF BORING SEE PLATE 2.

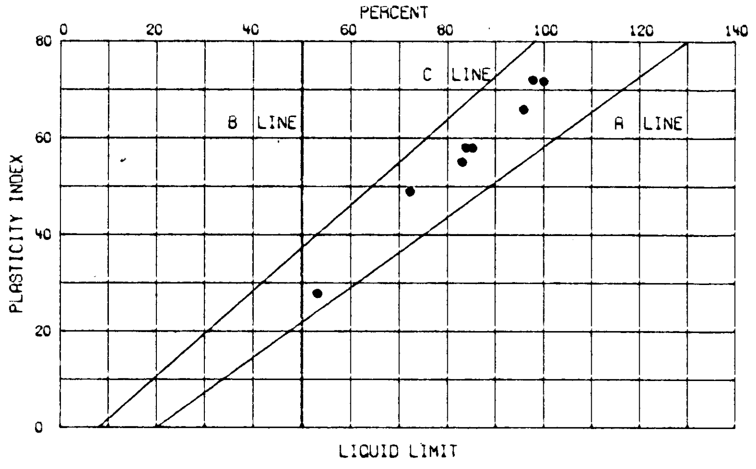
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 1-DU-1 DATA

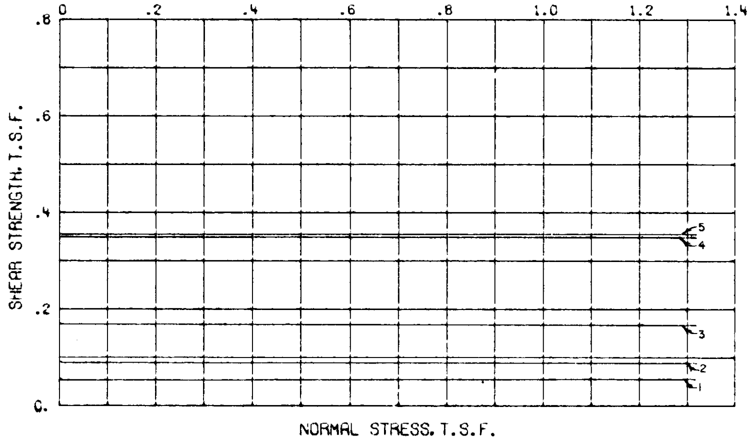
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



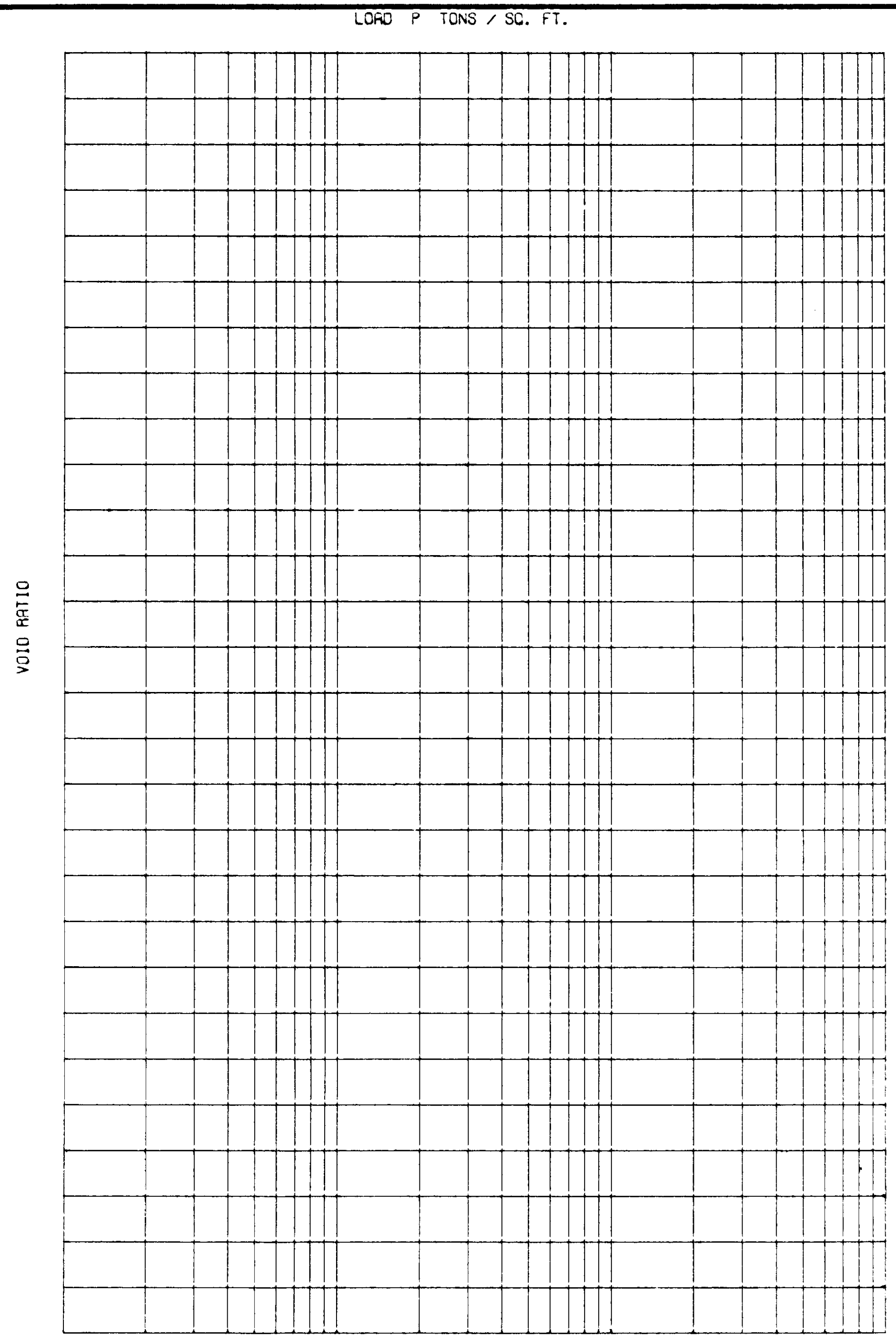


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
2-DU-1	1	-6.3		0°	.053	CH
	2	-15.0		0°	.090	CH
	3	-28.7	Q	0°	.170	CH
	4	-39.9		0°	.350	CH
	5	-43.0		0°	.353	CH



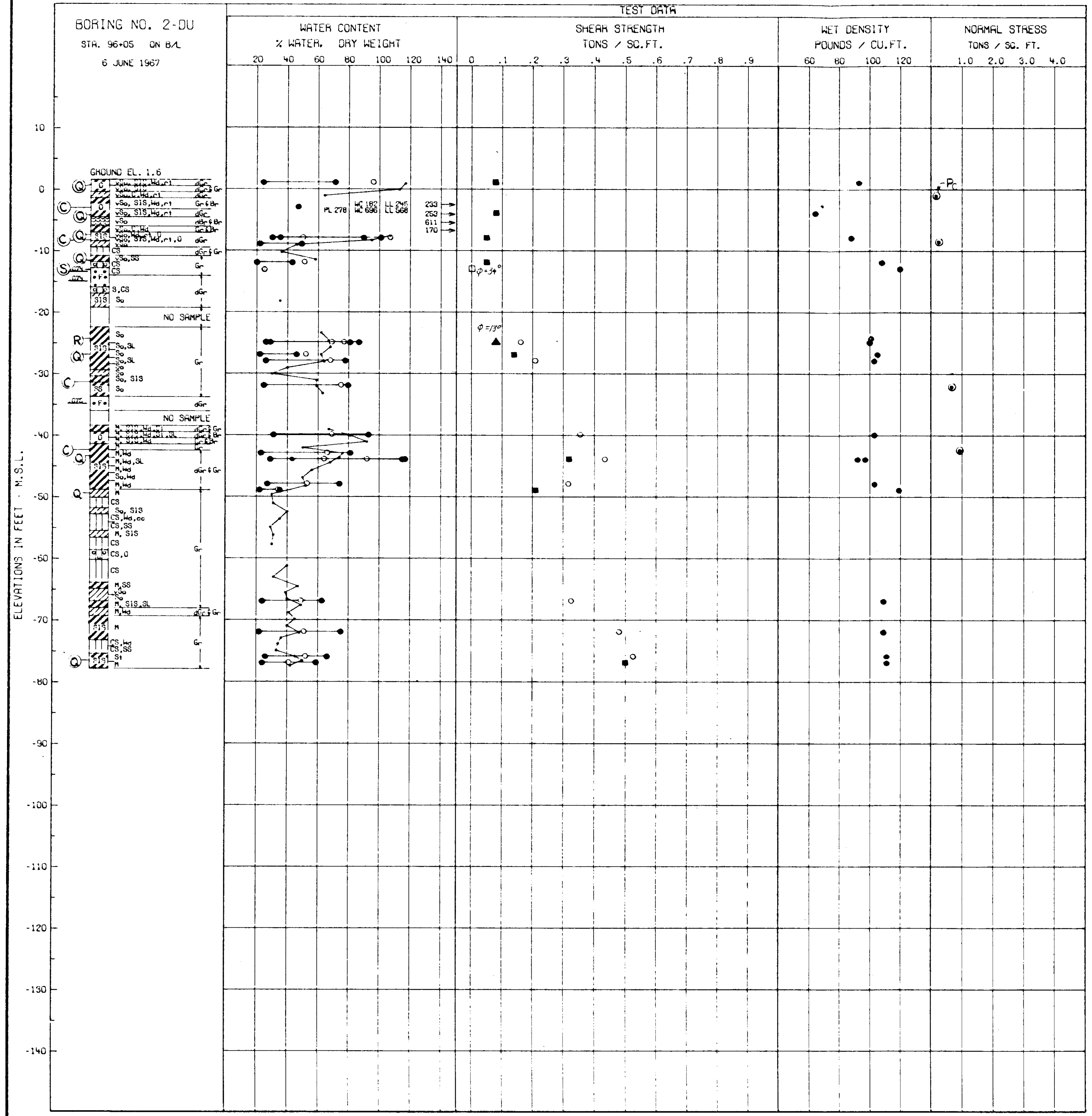
CONSOLIDATION DATA

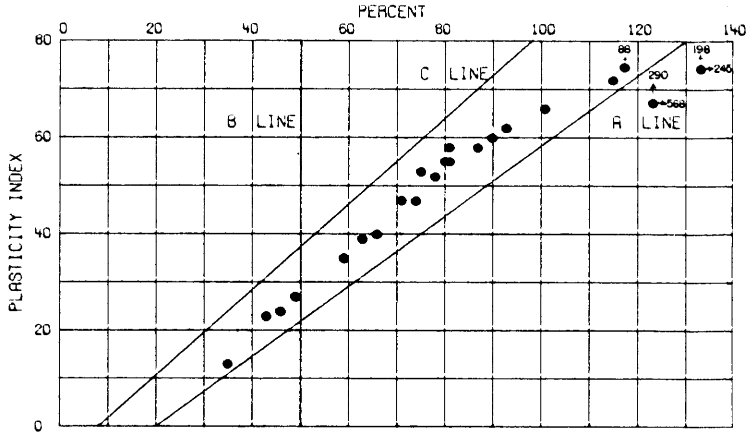
O - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
- (S) CONSOLIDATED - DRAINED SHEAR TEST
BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER
FOR SOIL BORING LEGEND SEE PLATE A
FOR LOCATION OF BORING SEE PLATE 2

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

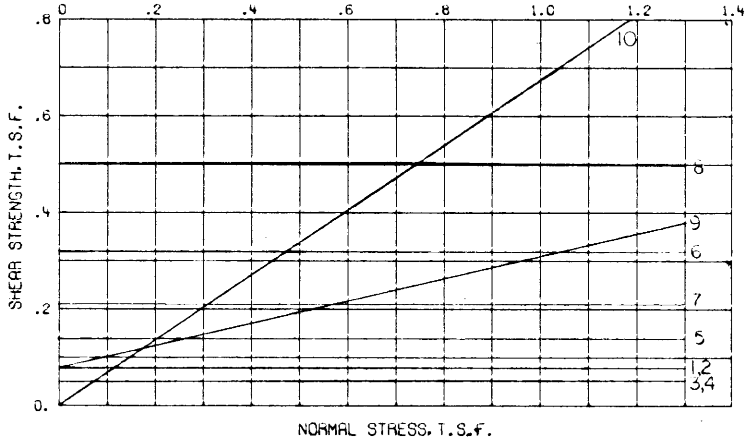
UNDISTURBED BORING 2-DU-1 DATA

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712



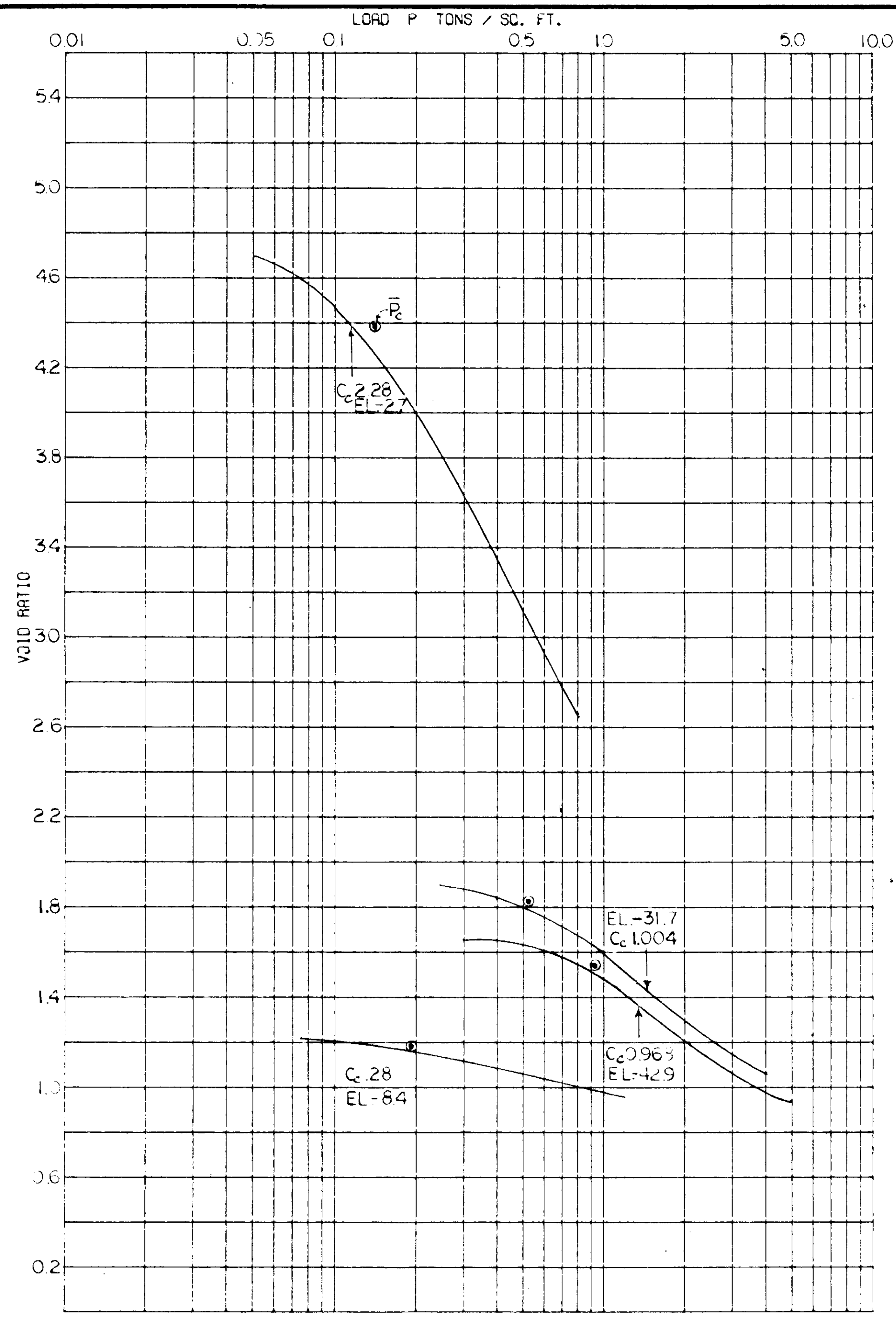


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
2-DU	1	0.8	Q	0	0.08	CH
	2	-4.1		0	0.08	CH
	3	-7.5		0	0.05	CH
	4	-11.5		0	0.05	CH
	5	-27.2		0	0.14	CH
	6	-43.5		0	0.32	CH
	7	-49.2		0	0.21	CL
	8	-76.5		0	0.50	CH
	9	-24.6	R	13°	0.08	CH
	10	-12.9	S	34°	0	SM



CONSOLIDATION DATA

○ - (UC) UNCONFINED COMPRESSION TEST
■ - (C) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

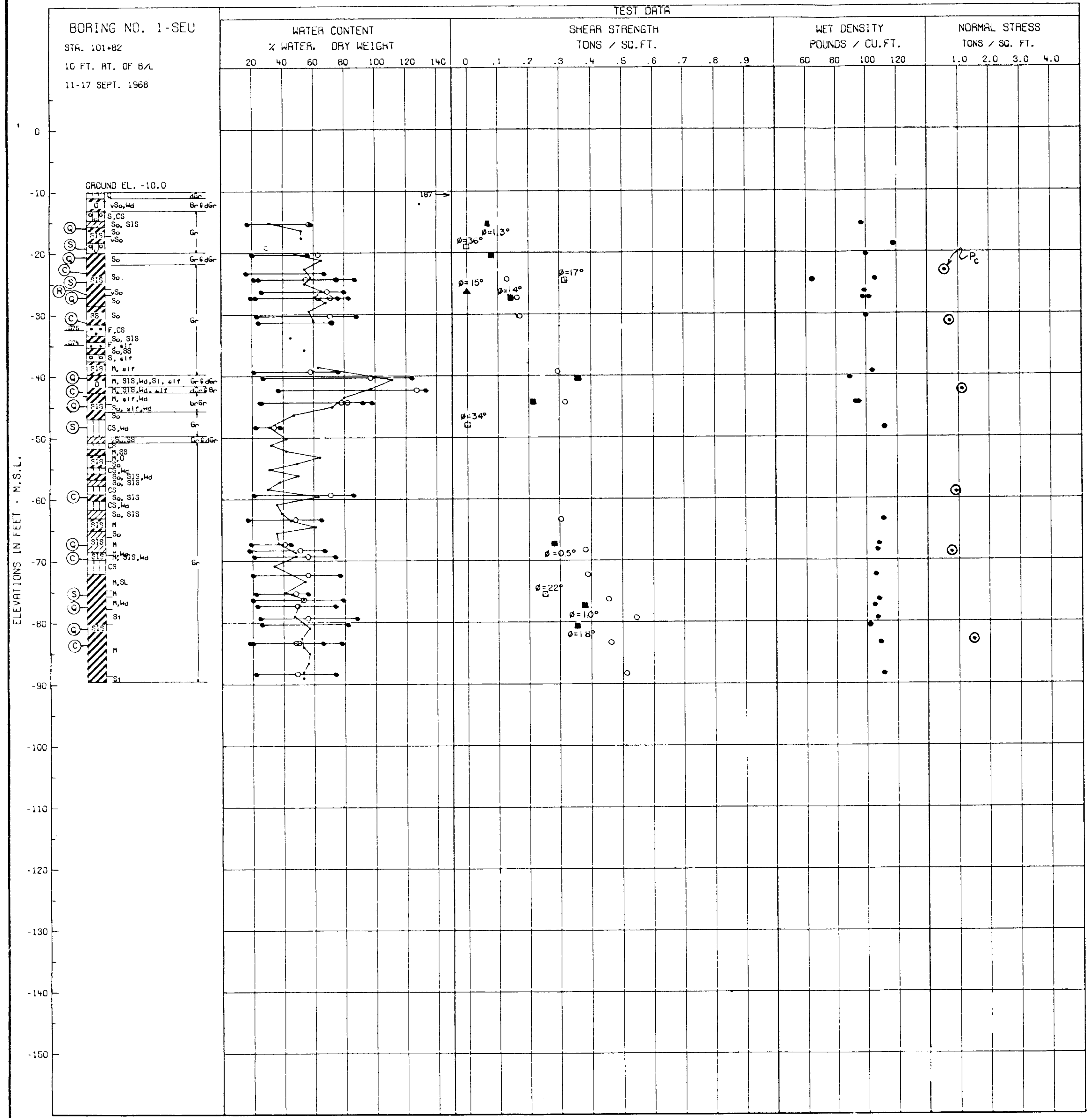
FOR LOCATION OF BORING SEE PLATE 2

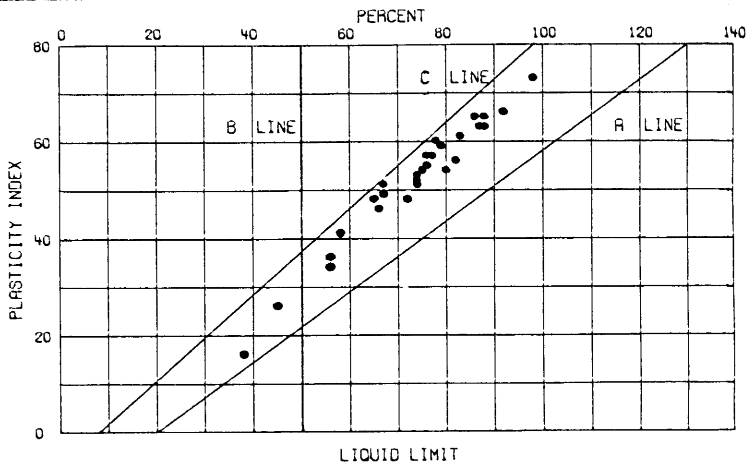
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 2-DU DATA

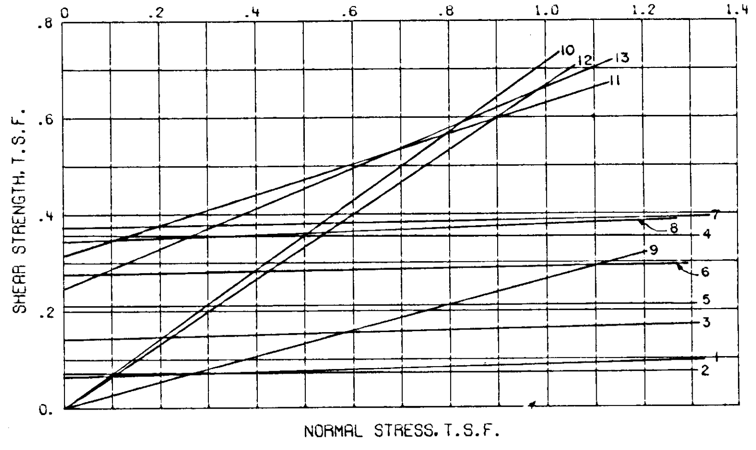
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



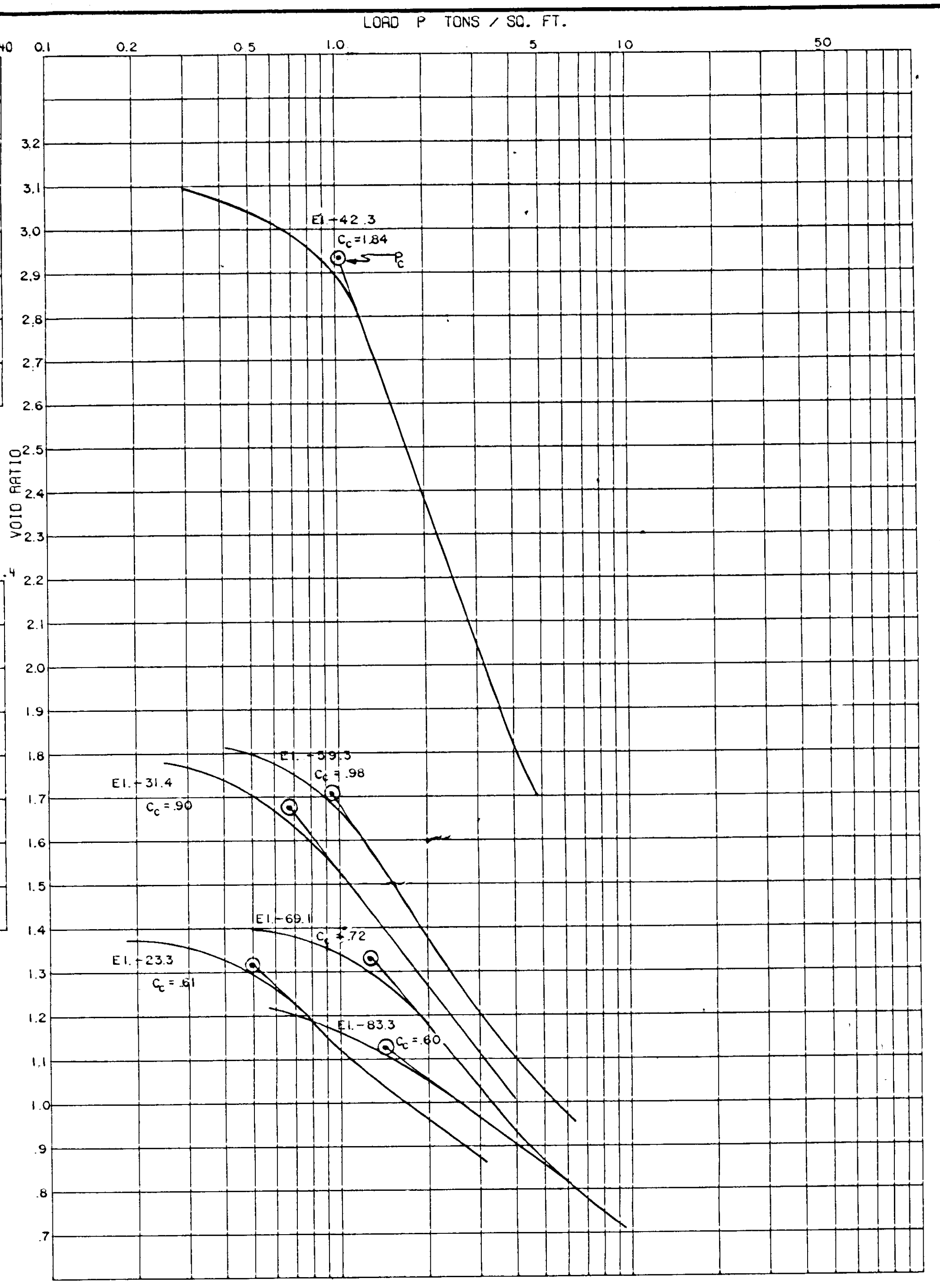


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
1-SEU	1	- 15.8	Q	1.3°	0.07	CH
	2	- 20.9		0°	0.08	CH
	3	- 27.1		1.4°	0.14	CH
	4	- 40.1		0°	0.36	CH
	5	- 44.9		0°	0.22	CH
	6	- 67.3		0.5°	0.28	CH
	7	- 77.0		1.0°	0.38	CH
	8	- 80.9		1.8°	0.35	CH
	9	- 26.4	R	15°	0	CH
	10	- 19.2	S	36°	0	SM
	11	- 24.8		17°	0.32	CH
	12	- 48.9		34°	0	ML
	13	- 75.2		22°	0.25	CH



CONSOLIDATION DATA

○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

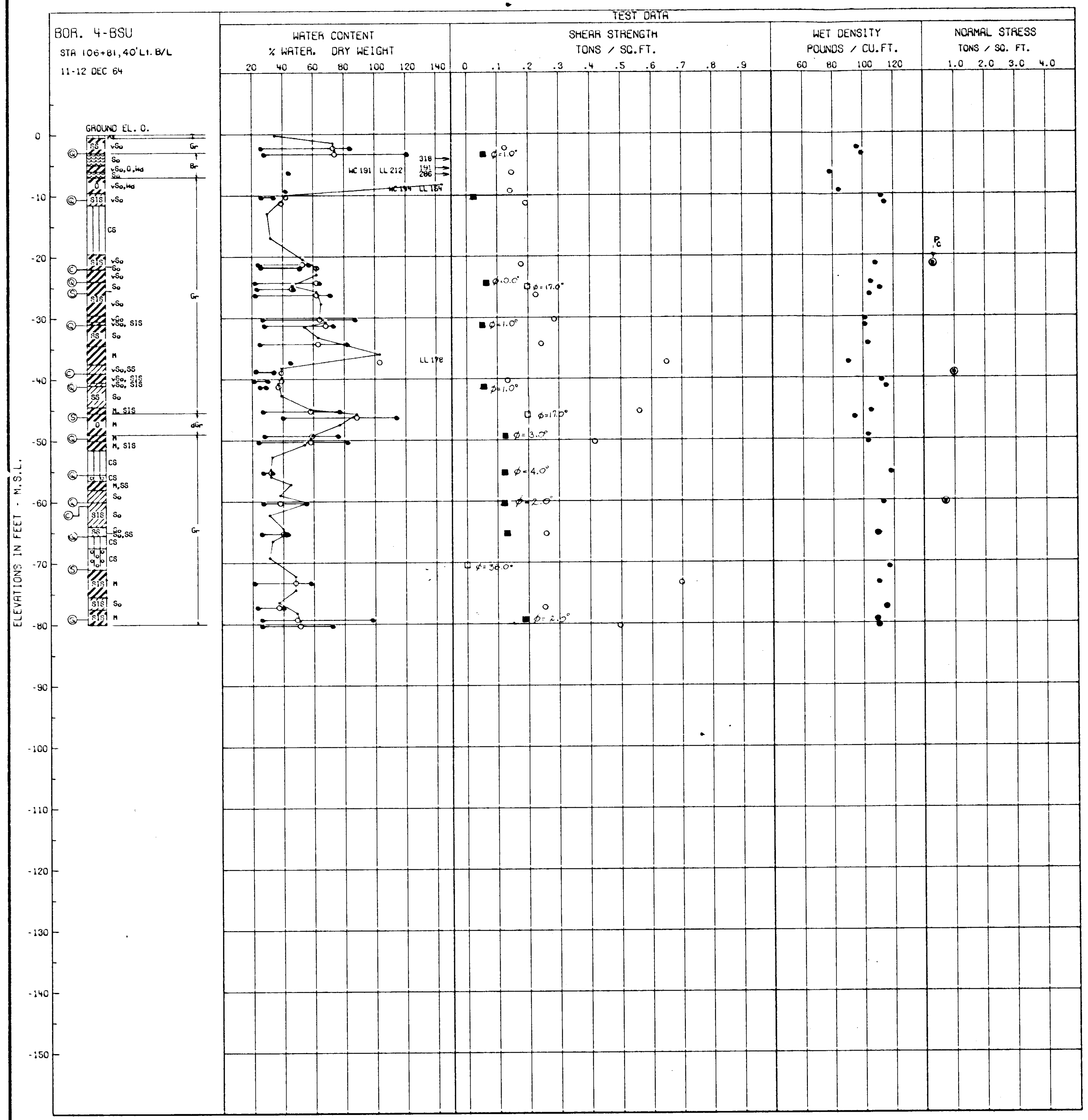
FOR LOCATION OF BORING SEE PLATE 2

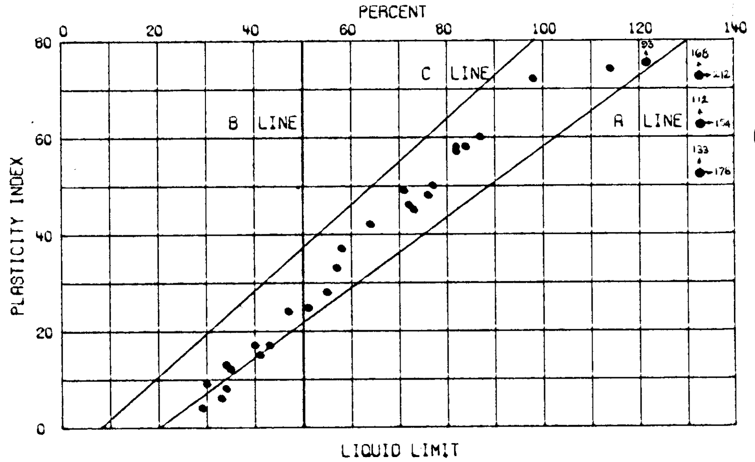
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING
1-SEU DATA

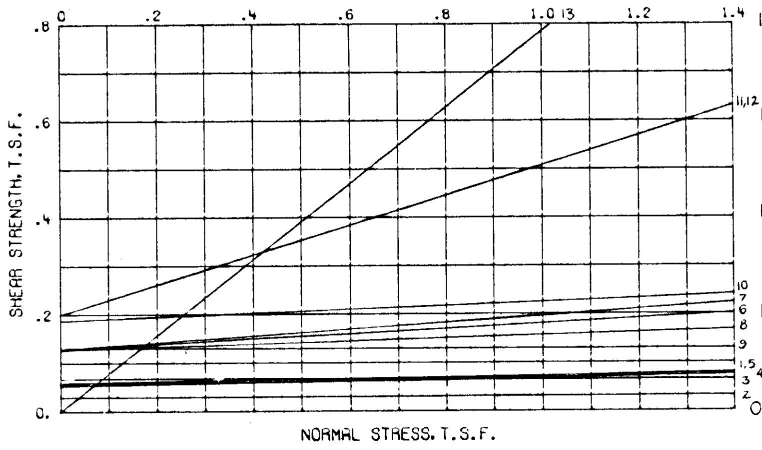
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



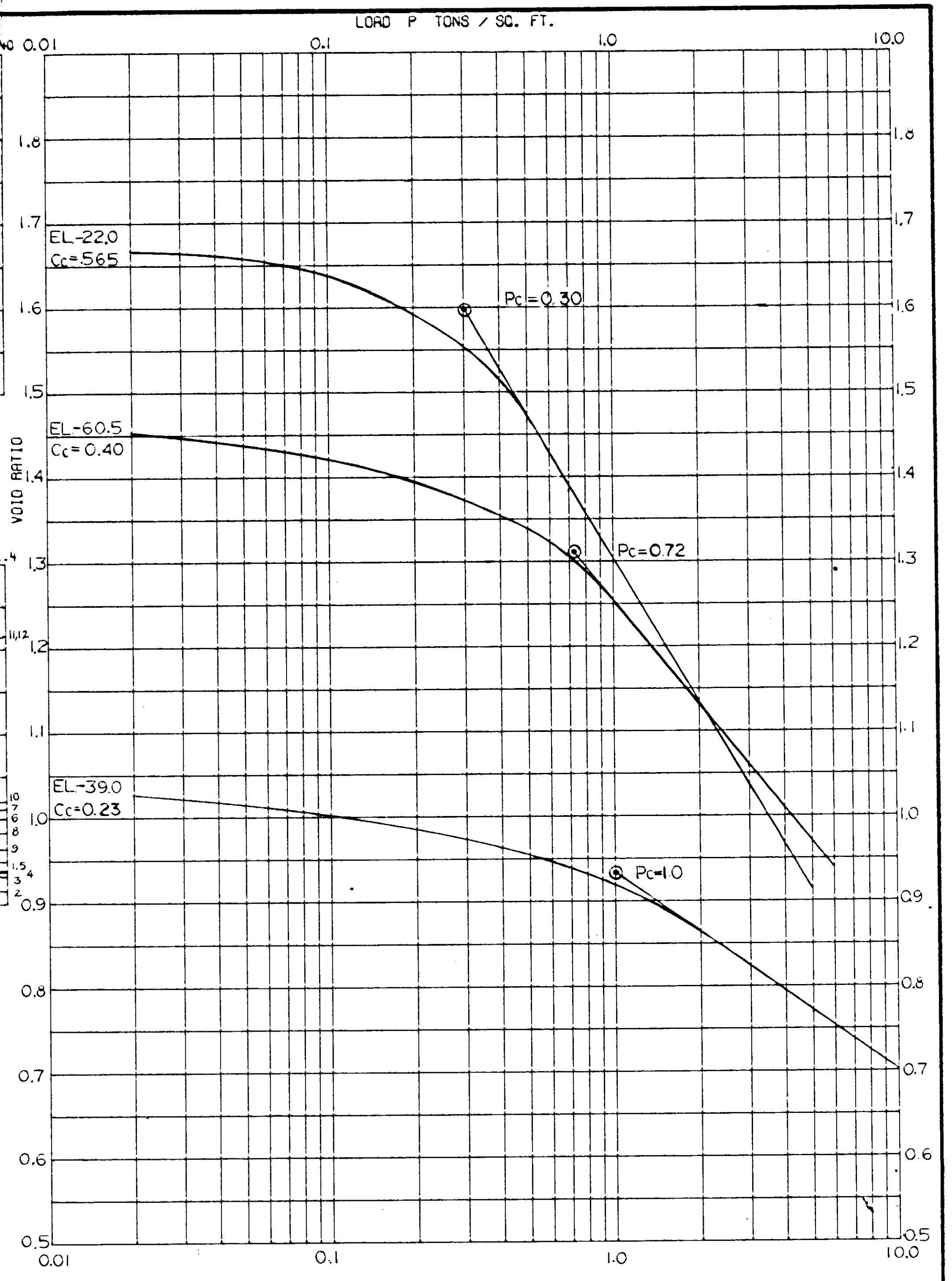


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	EL.	TYPE	STRENGTH Φ	C - TSF	CLASS
4-BSU	1	-3.0	Q	1.0	0.055	CH
	2	-10.5	Q	0.0	0.025	CL
	3	-24.0	Q	0.0	0.065	CH
	4	-31.0	Q	1.0	0.050	CH
	5	-41.0	Q	1.0	0.055	CL
	6	-49.5	Q	3.0	0.125	CH
	7	-55.5	Q	4.0	0.122	ML
	8	-60.0	Q	2.0	0.122	CL
	9	-65.5	Q	0.0	0.130	CL
	10	-79.0	Q	2.0	0.187	CL
	11	-25.5	S	17.0	0.200	CH
	12	-46.0	S	17.0	0.200	CH-OH
	13	-71.0	S	38.0	0.0	SM



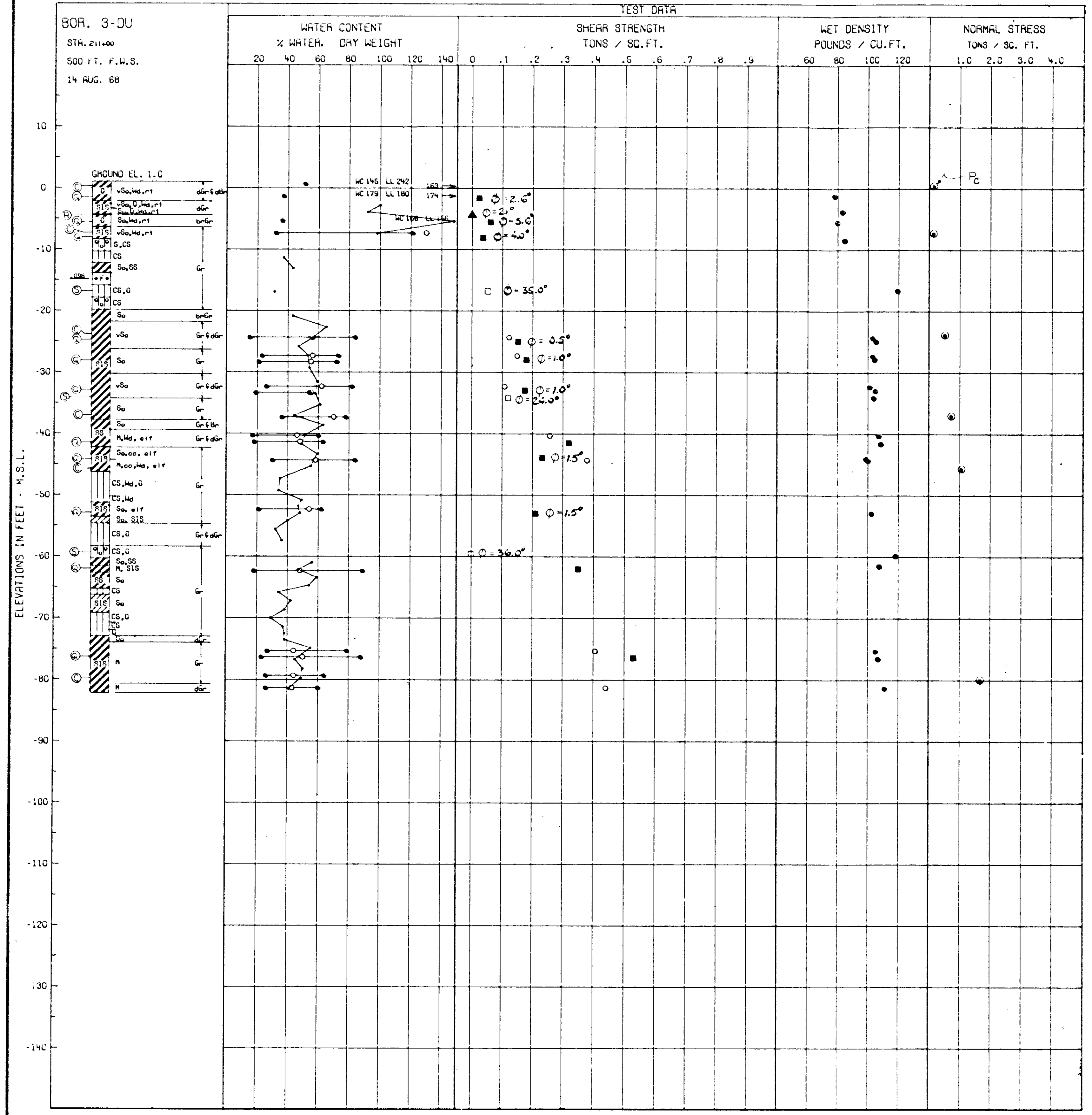
CONSOLIDATION DATA

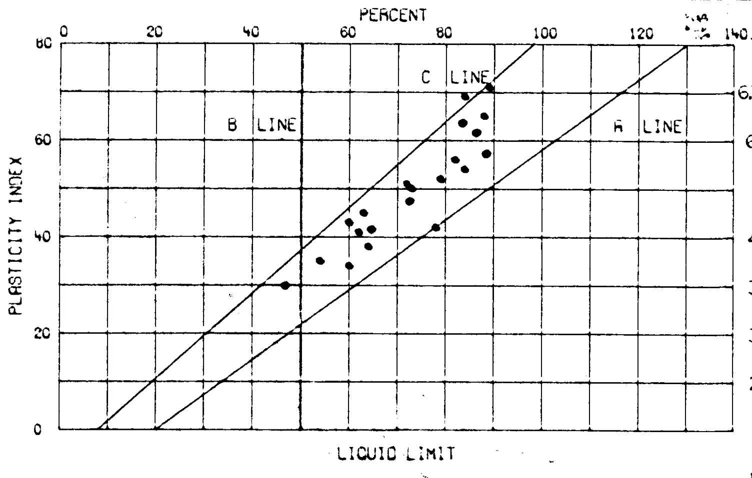
○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST
BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER
FOR SOIL BORING LEGEND SEE PLATE A
FOR LOCATION OF BORING SEE PLATE 2

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

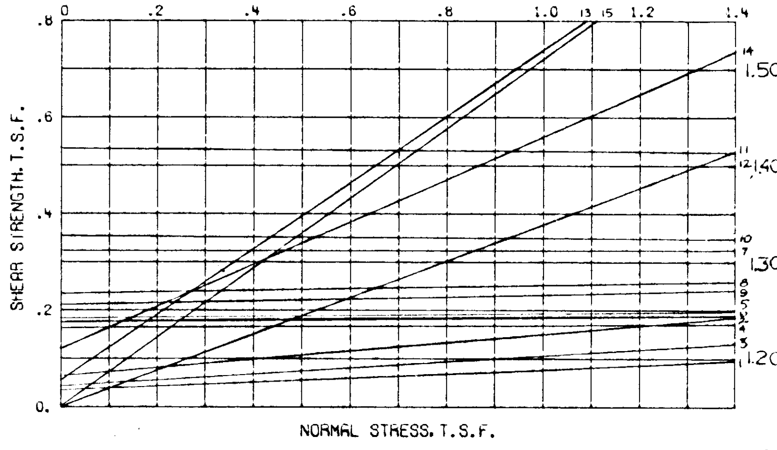
UNDISTURBED BORING 4-BSU DATA

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712



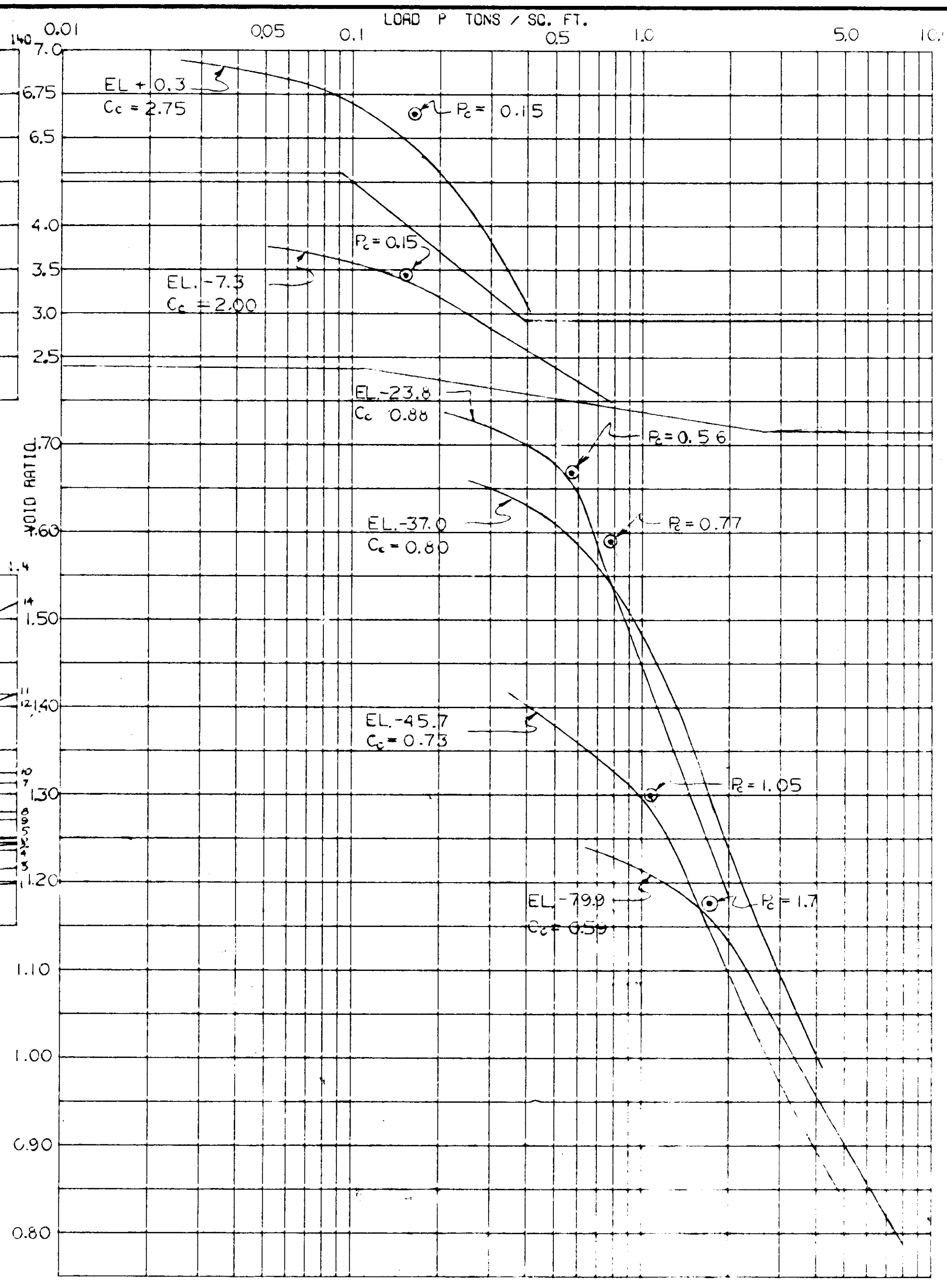


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
3-DU	1	-1.5	G	2.6	0.036	CHO
	2	-5.6		5.6	0.06	CHO
	3	-8.0		4.0	0.04	CH
	4	-24.8		0.5	0.16	CH
	5	-28.1		1.0	0.18	CH
	6	-33.0		1.0	0.17	CH
	7	-41.5		0	0.32	CH
	8	-44.1		1.5	0.23	CH
	9	-52.9		1.5	0.21	CH
	10	-61.9		0	0.35	CH
	11	-76.4		0	0.53	CH
	12	-4.7	R	21.0	0	CH
	13	-16.8	S	35.0	0.05	ML
	14	-34.1	S	24.0	0.12	CH
	15	-59.4	S	36.0	0	ML



CONSOLIDATION DATA

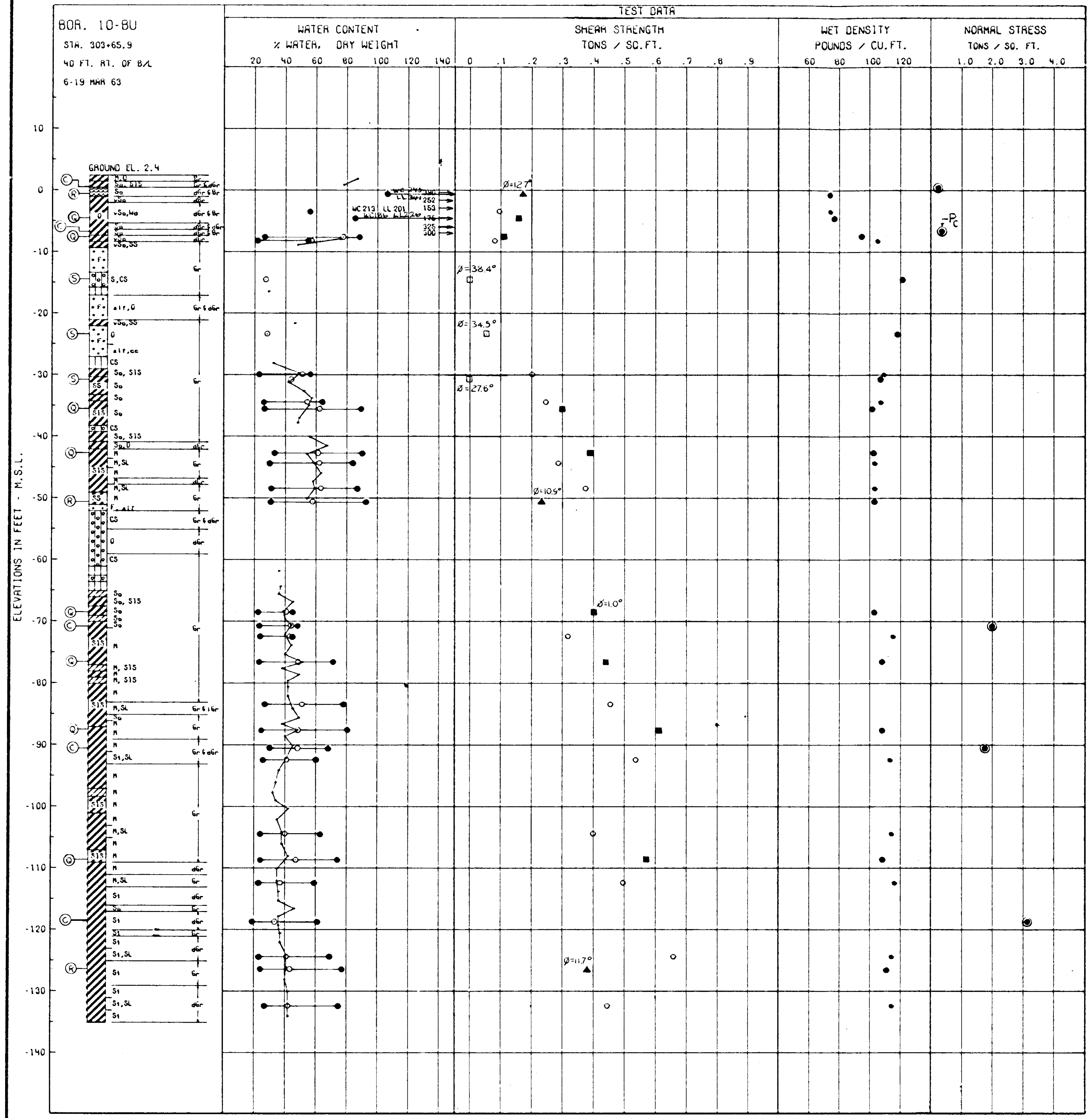
○ - (UC) UNCONFINED COMPRESSION TEST
■ - (C) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST
BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER
FOR SOIL BORING LEGEND SEE PLATE A
FOR LOCATION OF BORING SEE PLATE 4

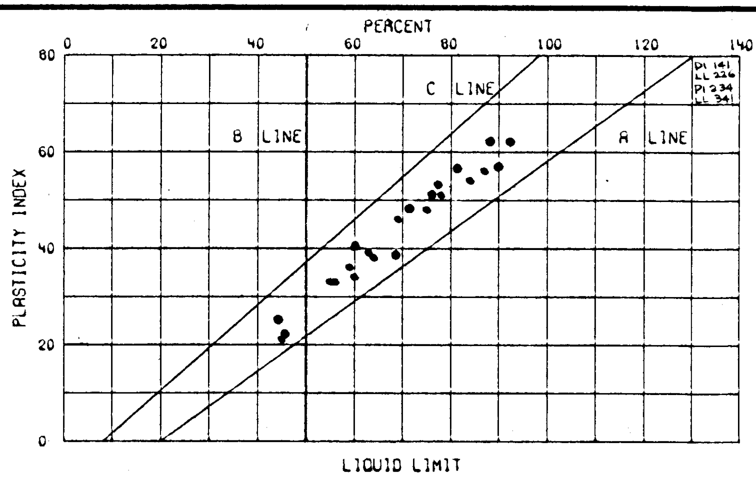
NEW ORLEANS TO VENICE, LA
DESIGN MEMORANDUM NO 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 3-DU DATA

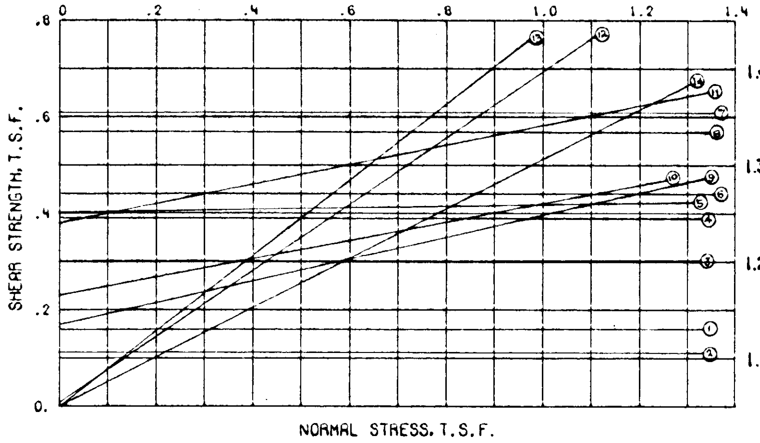
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



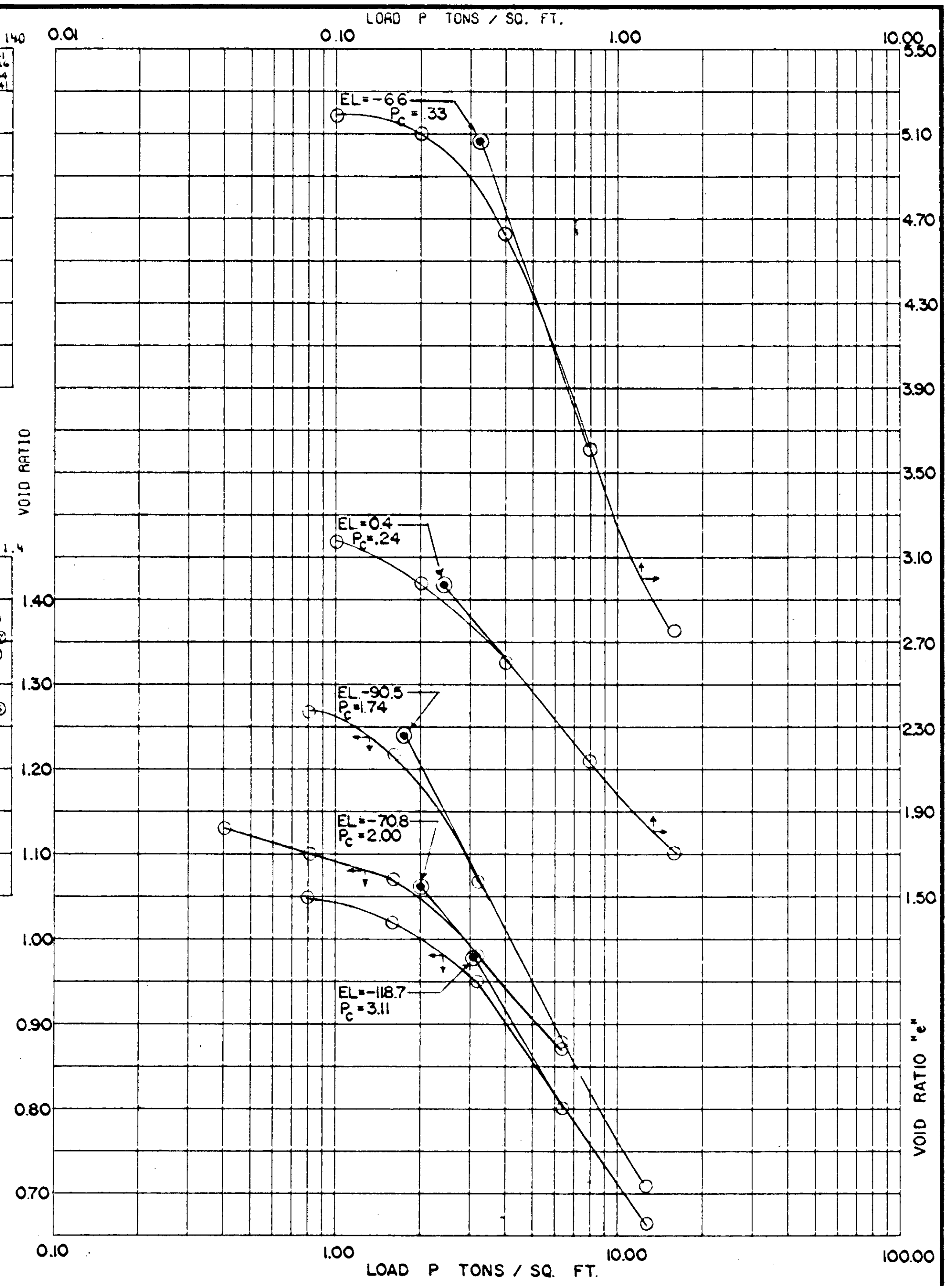


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
10-BU	1	-4.6'	Q	0°	0.16	CH
	2	-7.6'	Q	0°	0.11	CH
	3	-35.6'	Q	0°	0.30	CH
	4	-42.6'	Q	0°	0.39	CH
	5	-68.6'	Q	1.0°	0.40	CH
	6	-76.6'	Q	0°	0.44	CH
	7	-87.6'	Q	0°	0.61	CH
	8	-108.6'	Q	0°	0.57	CH
	9	-0.6'	R	12.7°	0.17	OH
	10	-50.6'	R	10.9°	0.23	CH
	11	-126.7'	R	11.7°	0.38	CH
	12	-23.3'	S	34.5°	0.06	SM
	13	-14.4'	S	38.4°	0.00	SM
	14	-30.8'	S	27.6°	0.00	CH



CONSOLIDATION DATA

○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

FOR LOCATION OF BORING SEE PLATE 5

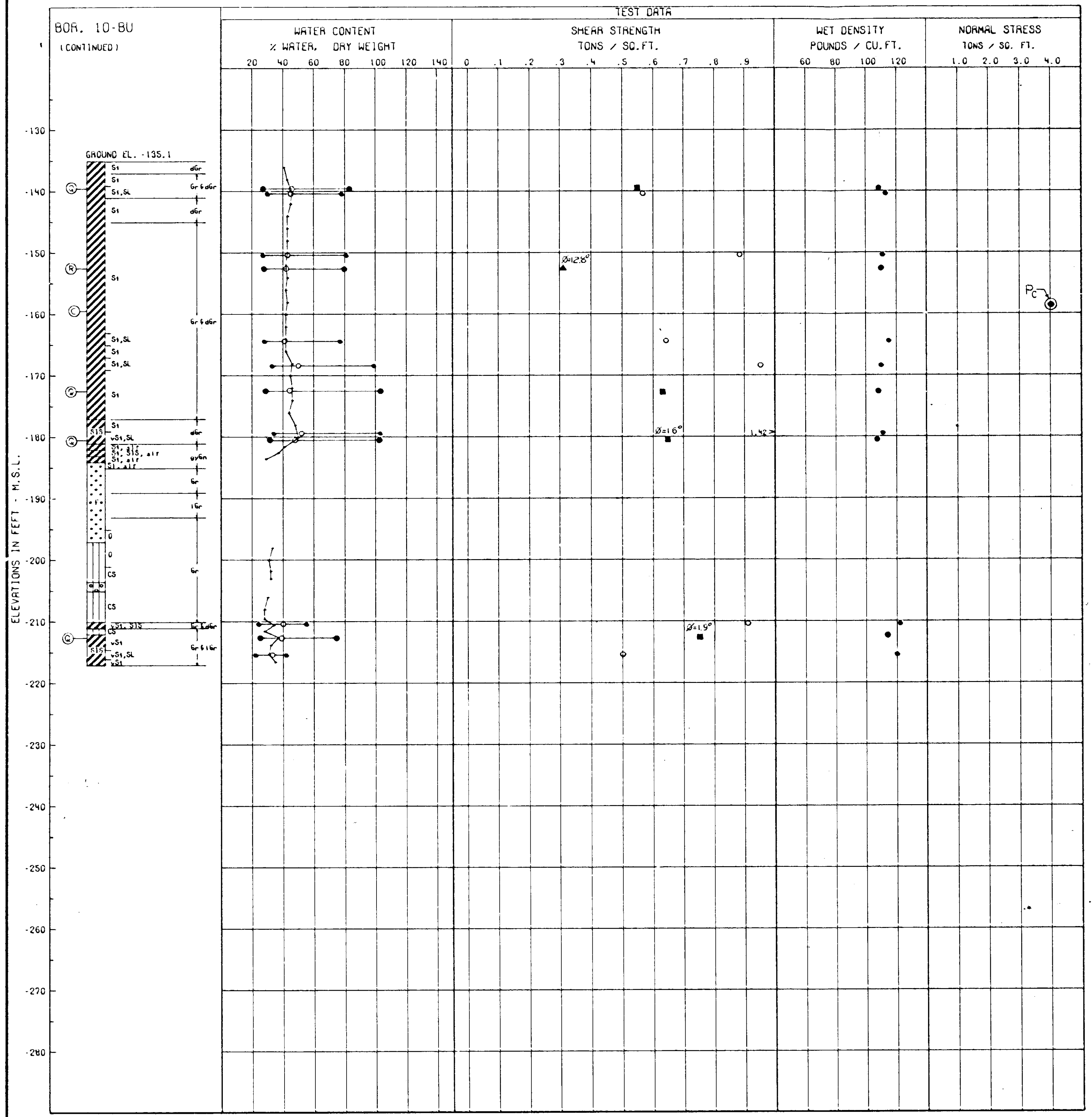
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

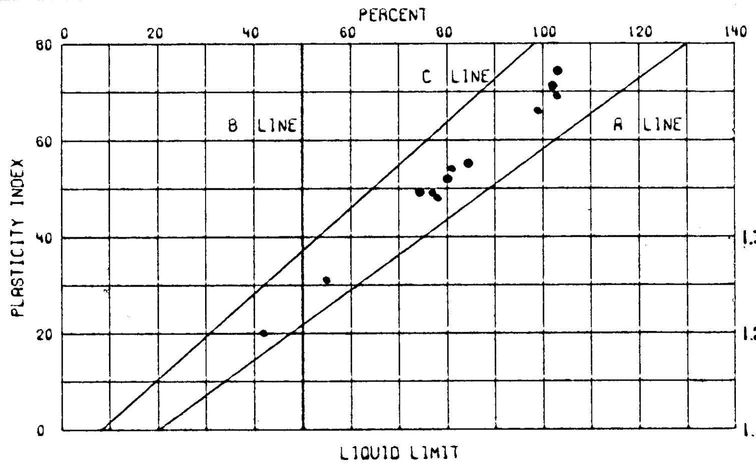
UNDISTURBED BORING 10-BU DATA (Cont.)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

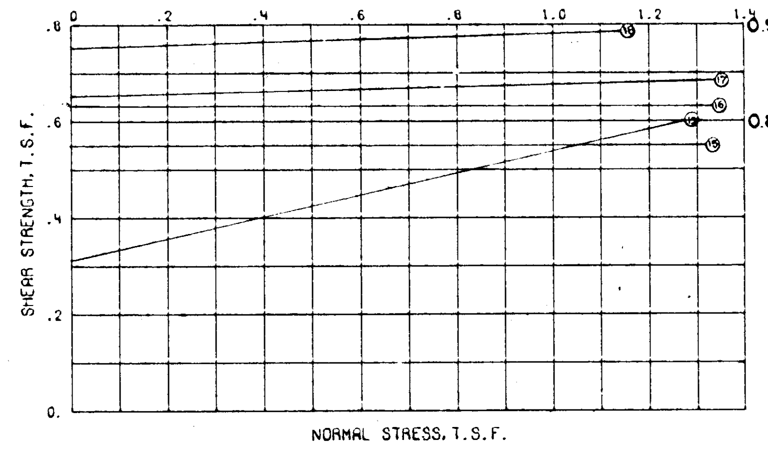
AUGUST 1971 FILE NO. H-2-25712

41



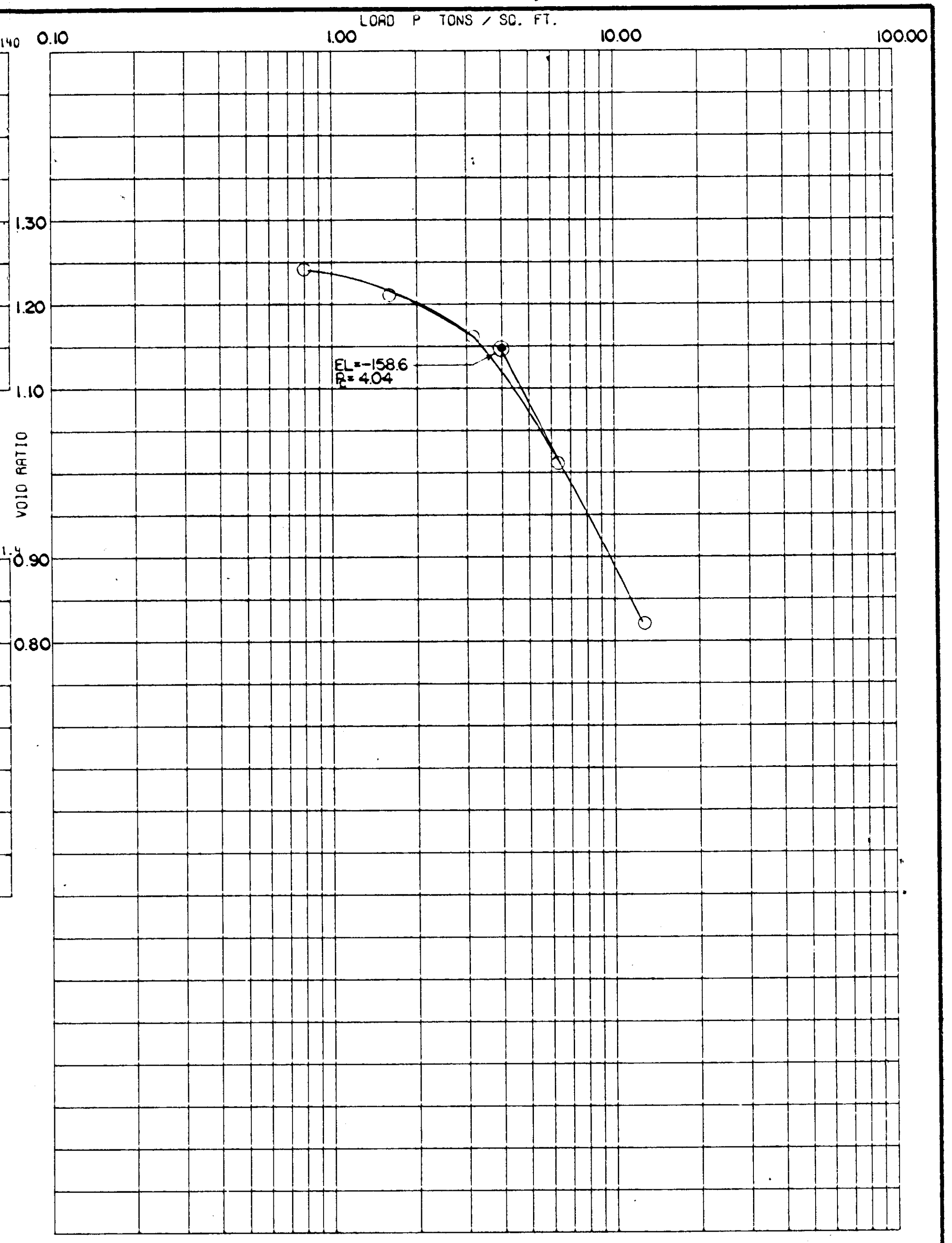


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
10-BU	15	-139.6'	Q	0°	0.55	CH
	16	-172.4'	Q	0°	0.63	CH
	17	-180.5'	Q	1.6°	0.65	CH
	18	-212.6'	Q	1.9°	0.75	CH
	19	-152.6'	R	12.8°	0.31	CH



CONSOLIDATION DATA

○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

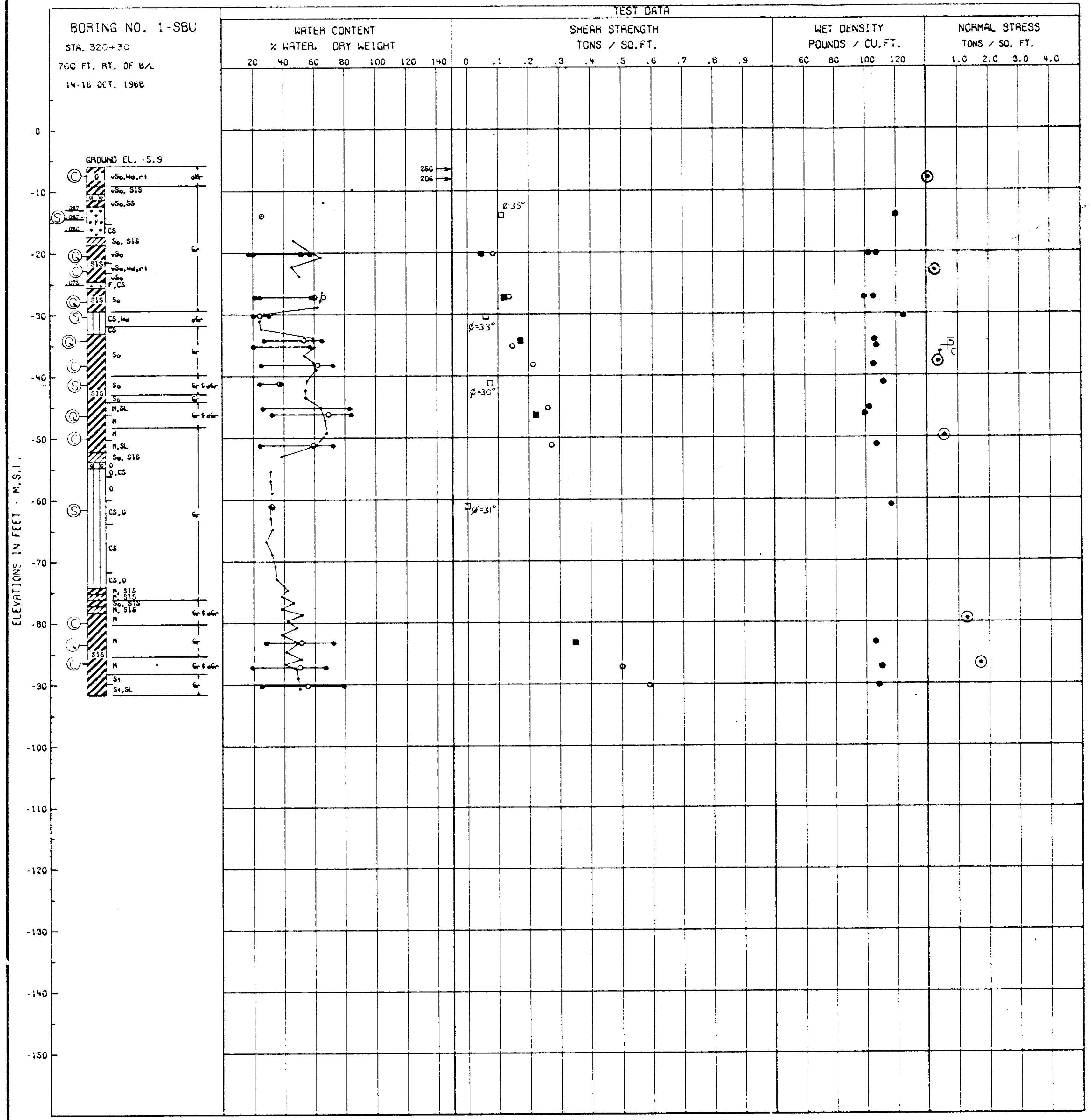
FOR LOCATION OF BORING SEE PLATE 5

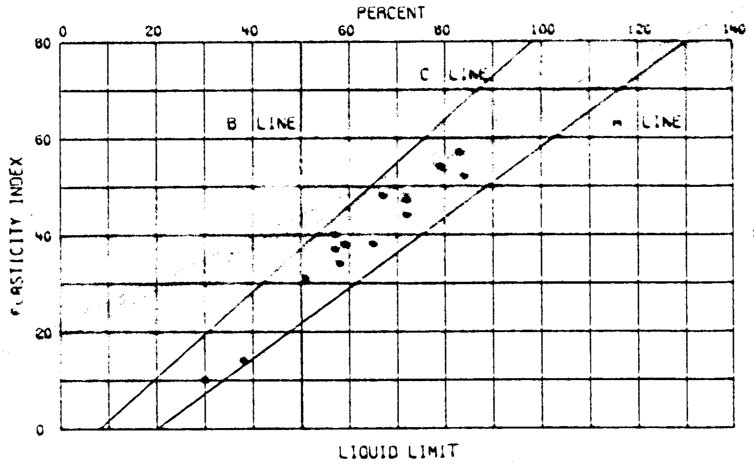
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 10-BU DATA (Cont.)

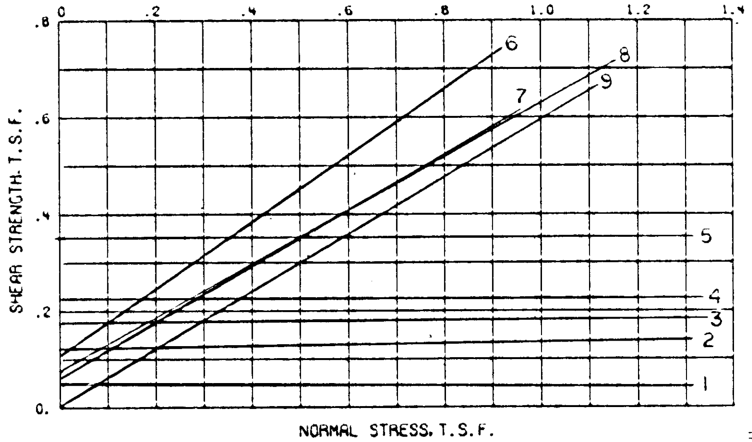
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



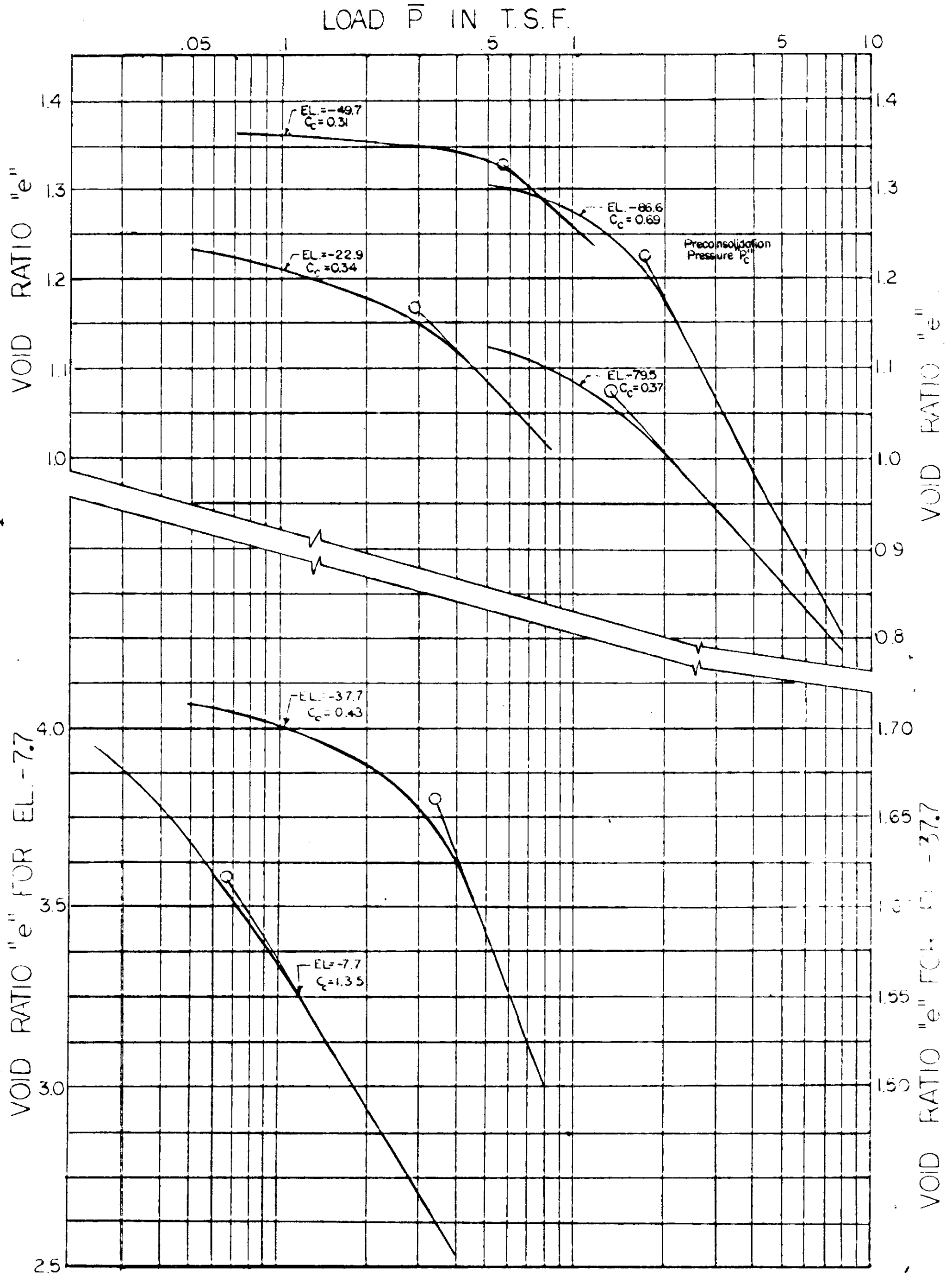


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
1-SBU	1	-20.5	Q	0°	.045	CH
	2	-27.7		.8°	.12	CH
	3	-34.2		.5°	.174	CH
	4	-46.5		0°	.223	CH
	5	-83.4		.25°	.35	CH
	6	-14.3	S	35°	.11	SM
	7	-30.3		33°	.06	CL
	8	-41.0		30°	.07	ML
	9	-61.4		31°	0	ML



○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
△ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

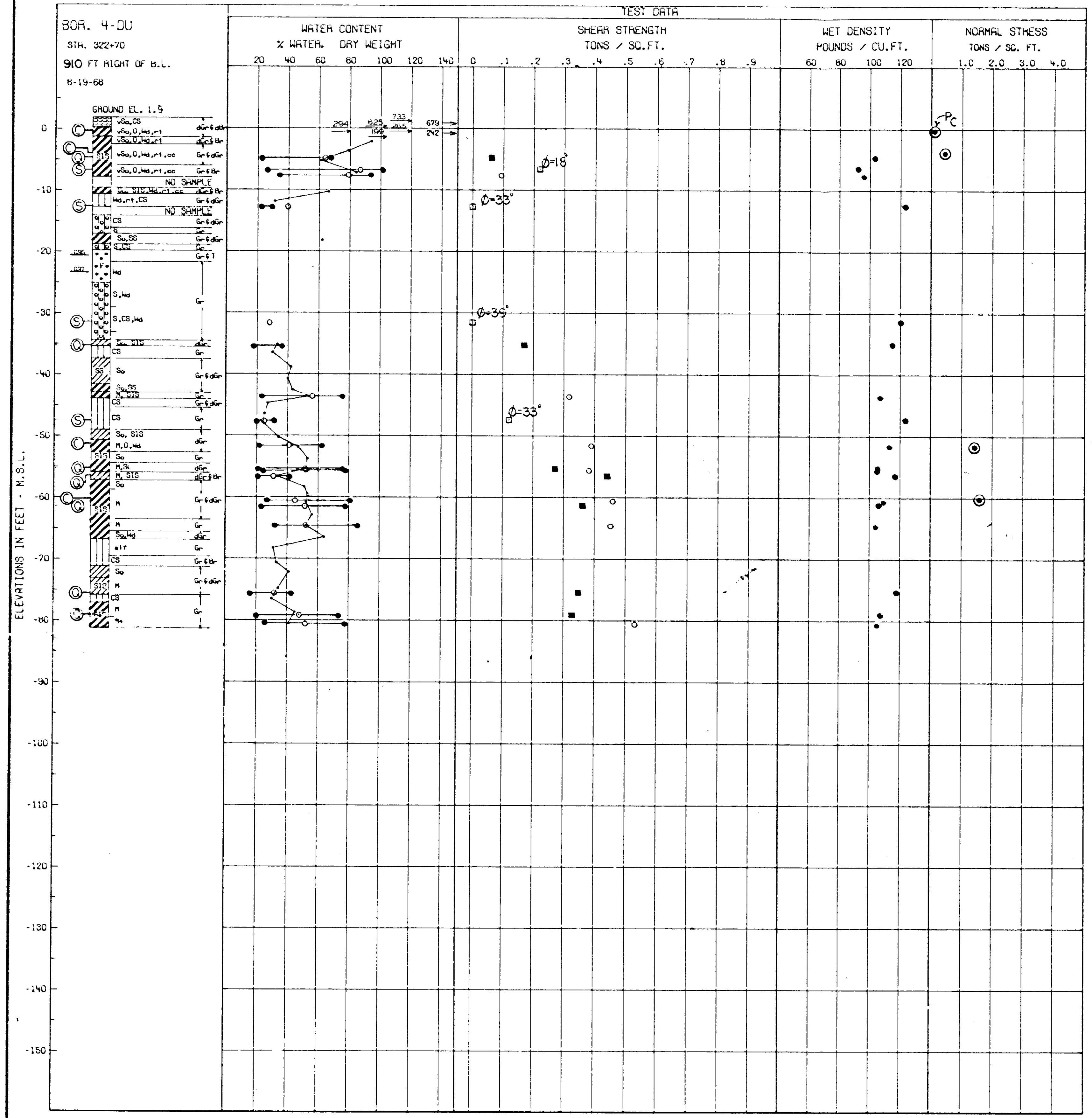
FOR LOCATION OF BORING SEE PLATE 5

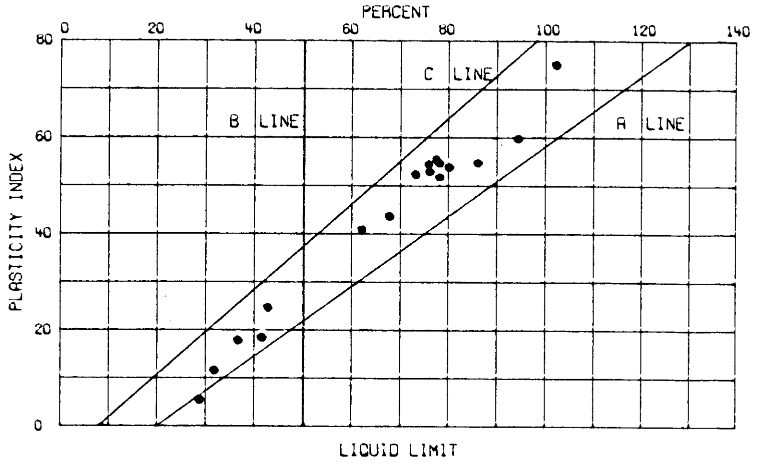
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 1-SBU DATA

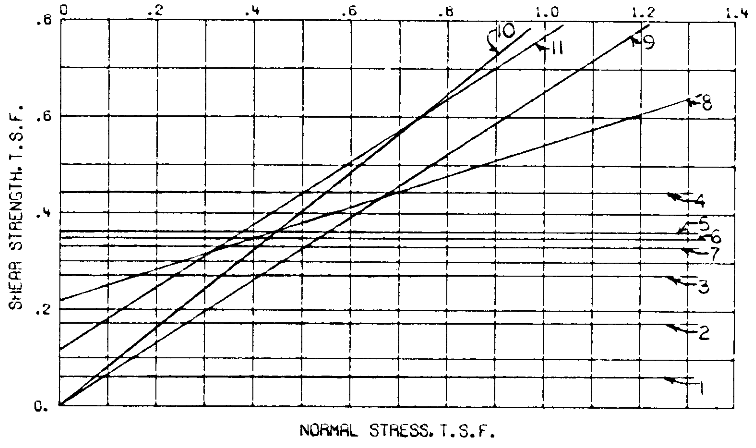
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



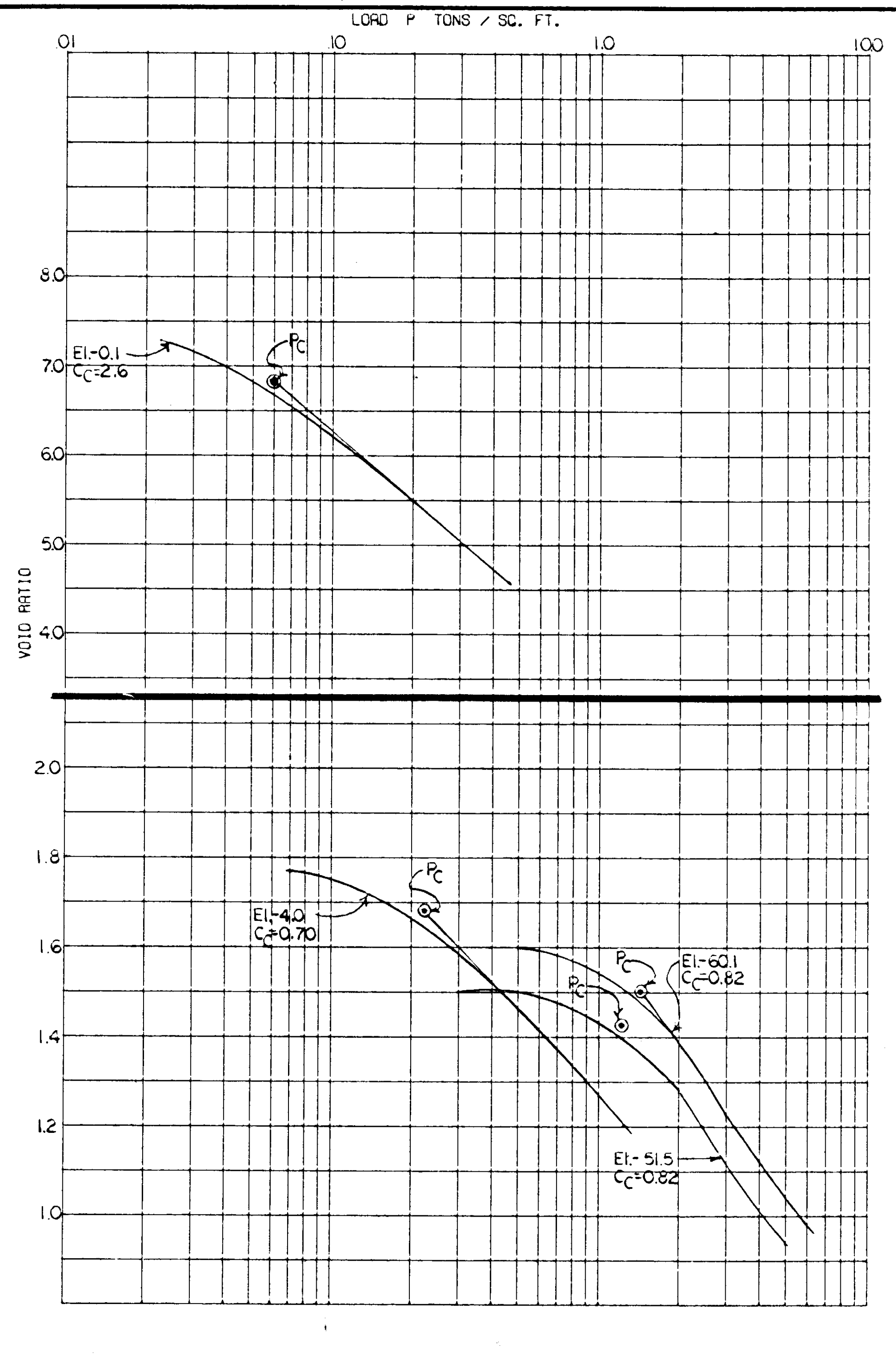


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
4-DU	1	-4.7	Q	0°	.06	CH
	2	-35.1		0°	.17	CL
	3	-55.1		0°	.27	CH
	4	-56.2		0°	.44	CL
	5	-61.2		0°	.36	CH
	6	-75.4		0°	.35	CL
	7	-79.0		0°	.33	CH
	8	-6.5	S	18°	.22	CH
	9	-12.4		33°	0	ML
	10	-31.3		39°	0	SM
	11	-47.2		33°	.12	CL



CONSOLIDATION DATA

○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

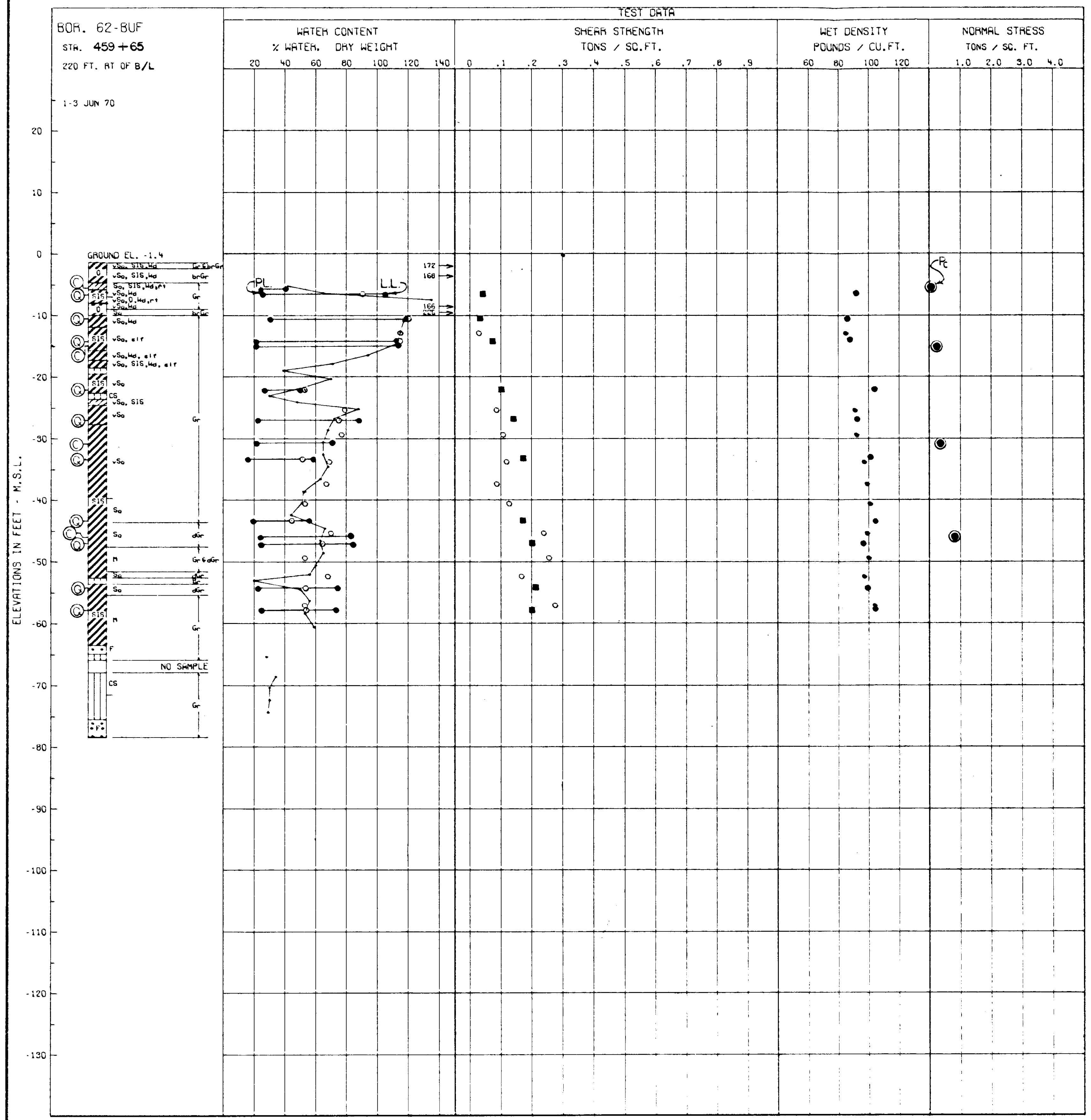
FOR LOCATION OF BORING SEE PLATE 5

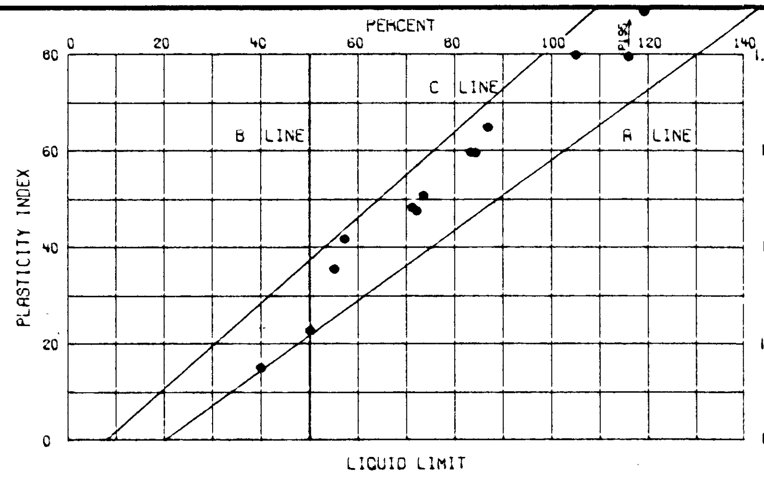
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 4-DU DATA

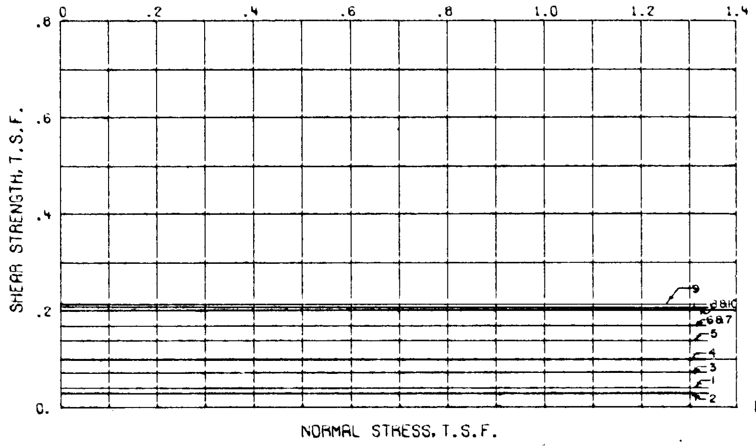
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



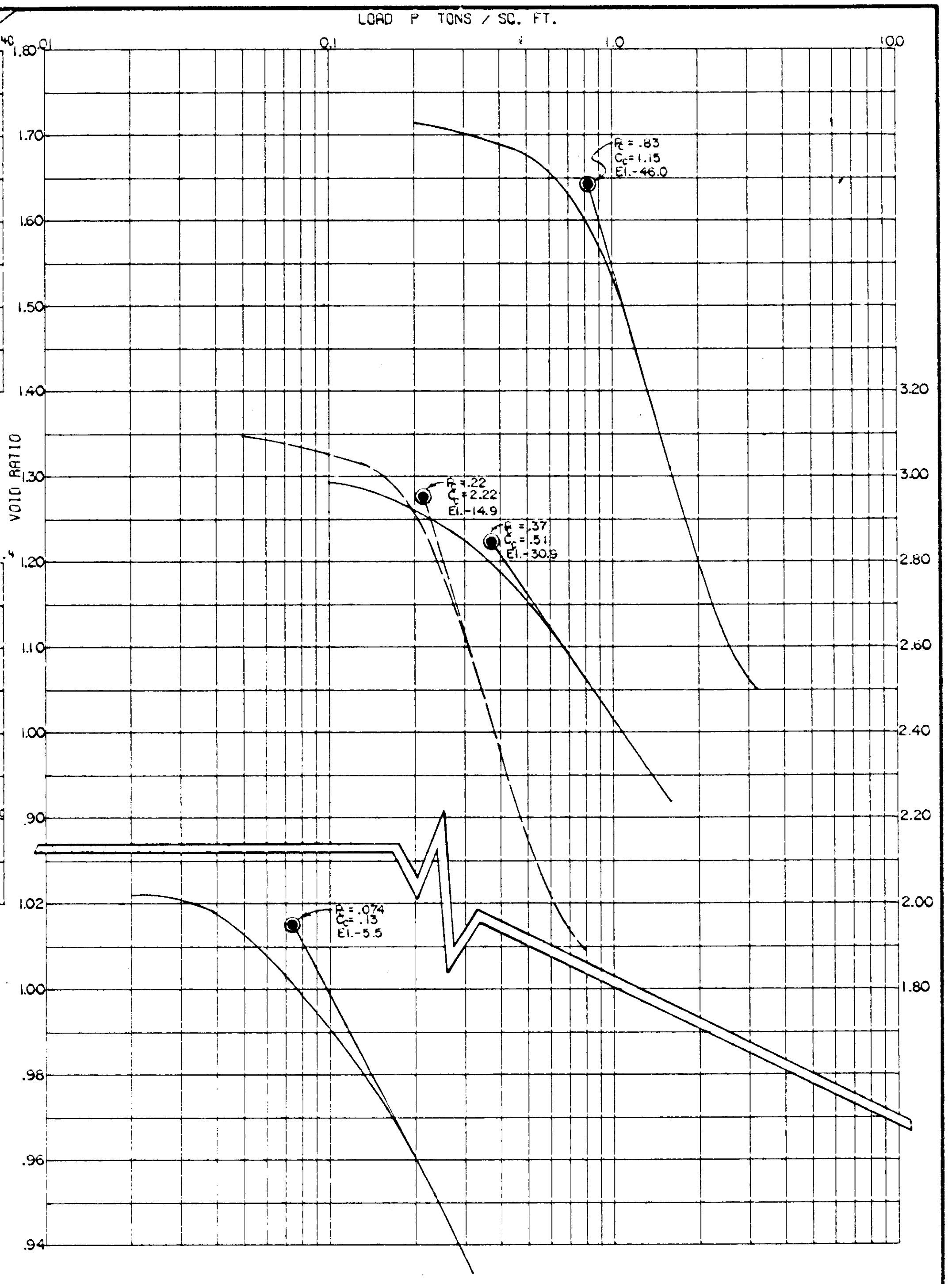


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
62-BUF	1	-6.5	Q	0°	.040	CH
	2	-10.5			.032	
	3	-14.0			.073	
	4	-22.0			.100	
	5	-26.9			.140	
	6	-33.1			.170	
	7	-43.1			.170	
	8	-46.9			.203	
	9	-54.0			.205	
	10	-57.7			.203	



CONSOLIDATION DATA

O - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
- (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

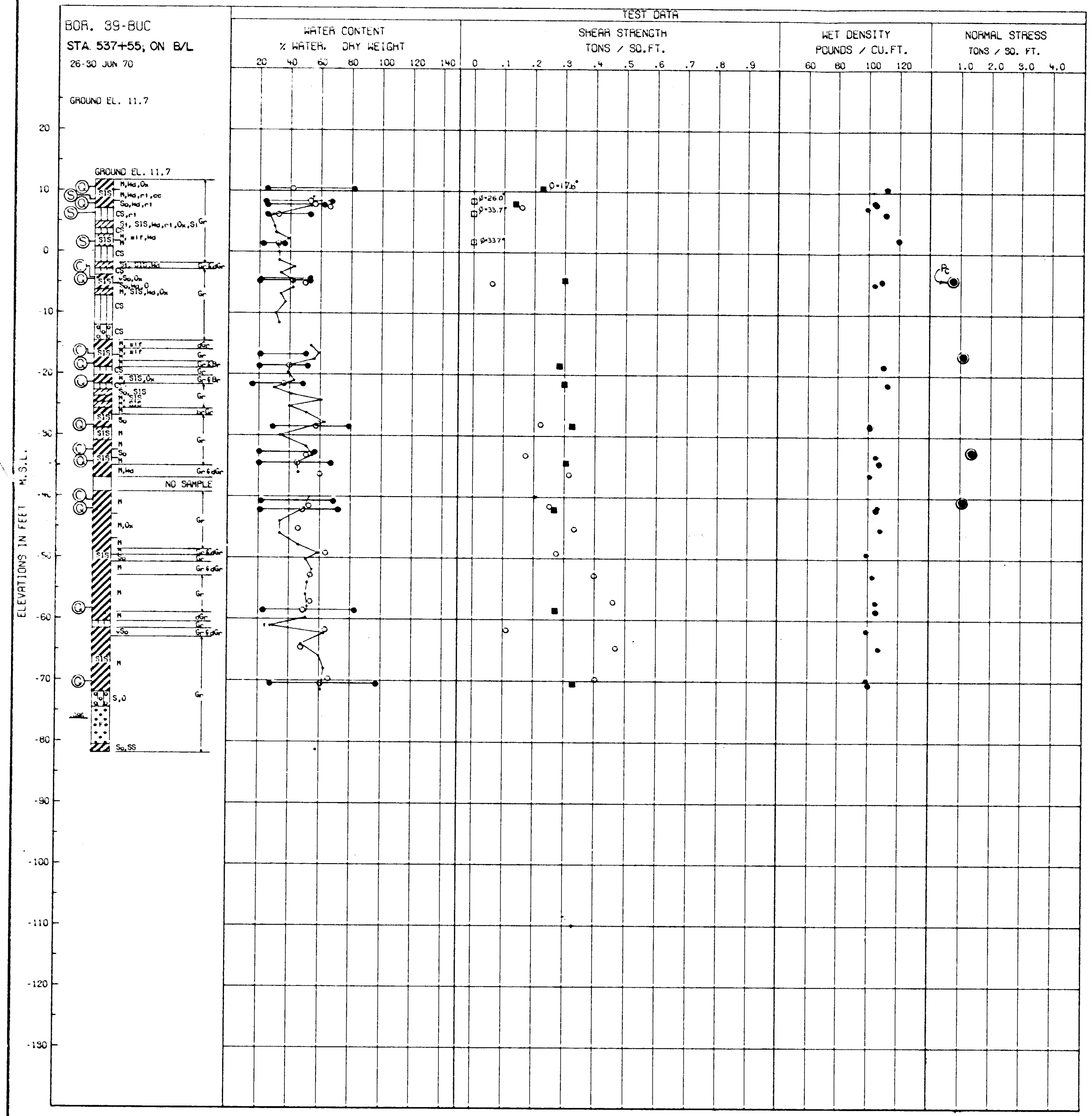
FOR LOCATION OF BORING SEE PLATE 7

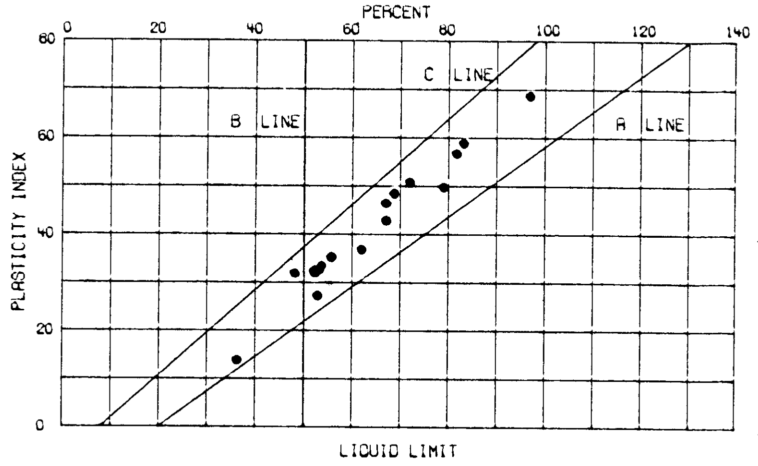
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 62-BUF DATA

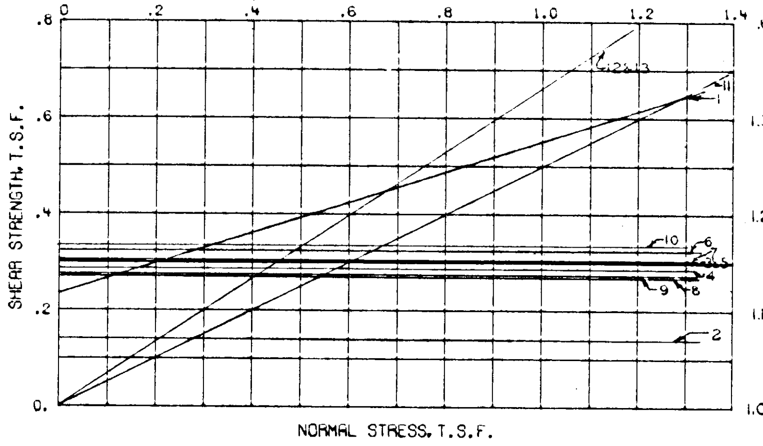
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



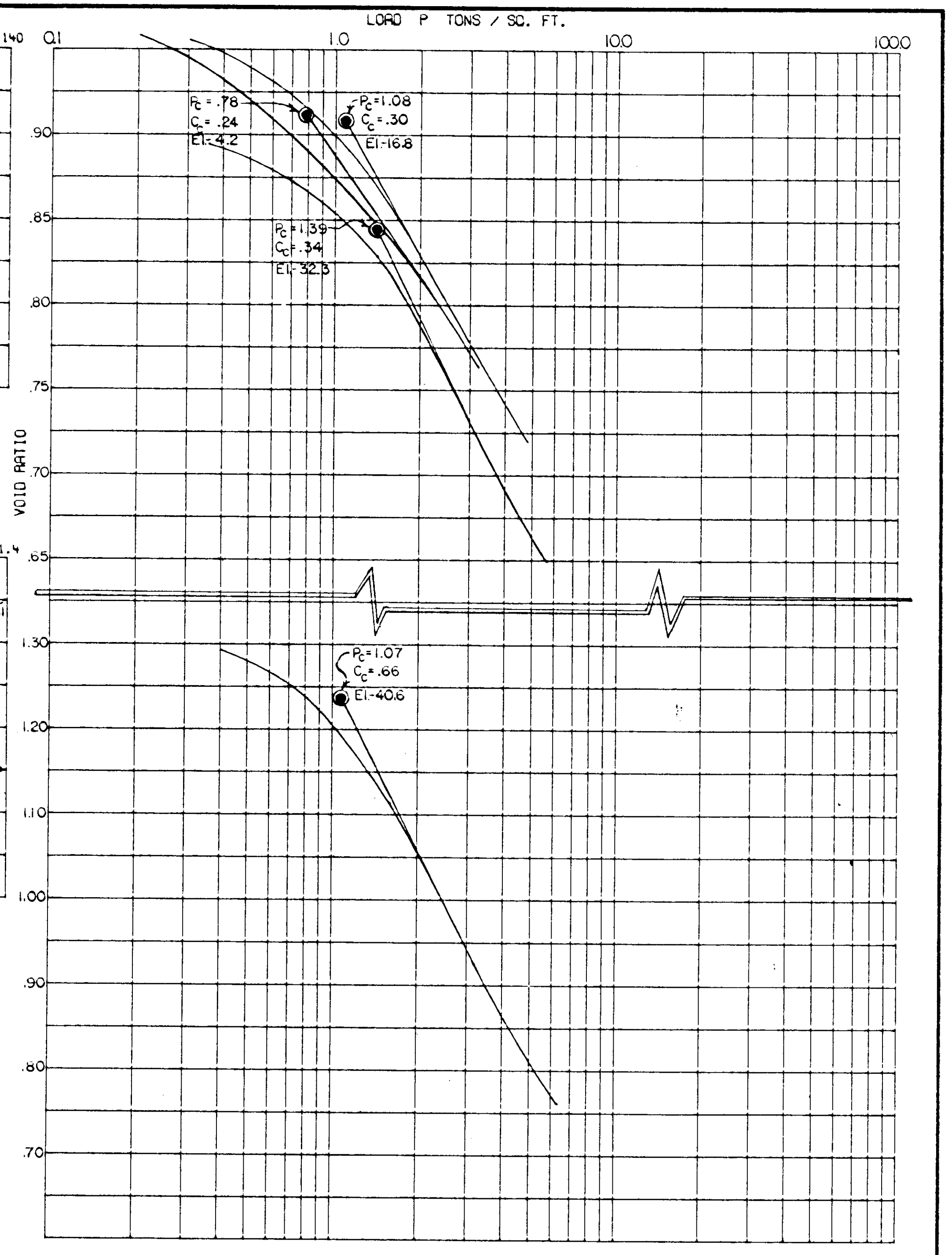


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
39-BUC	1	+10.4	Q	17.6°	.232	CH
	2	+7.9		0°	.140	CH
	3	-4.6		0°	.300	CH
	4	-18.4		0°	.285	CH
	5	-21.4		0°	.300	CH
	6	-28.5		0°	.325	CH
	7	-34.3		0°	.305	CH
	8	-42.1		0°	.270	CH
	9	-58.3		0°	.275	CH
	10	-70.3		0°	.333	CH
	11	+8.4	S	26.0°	0	CH
	12	+6.2		33.7°	0	CH
	13	+1.7		33.7°	0	CL



CONSOLIDATION DATA

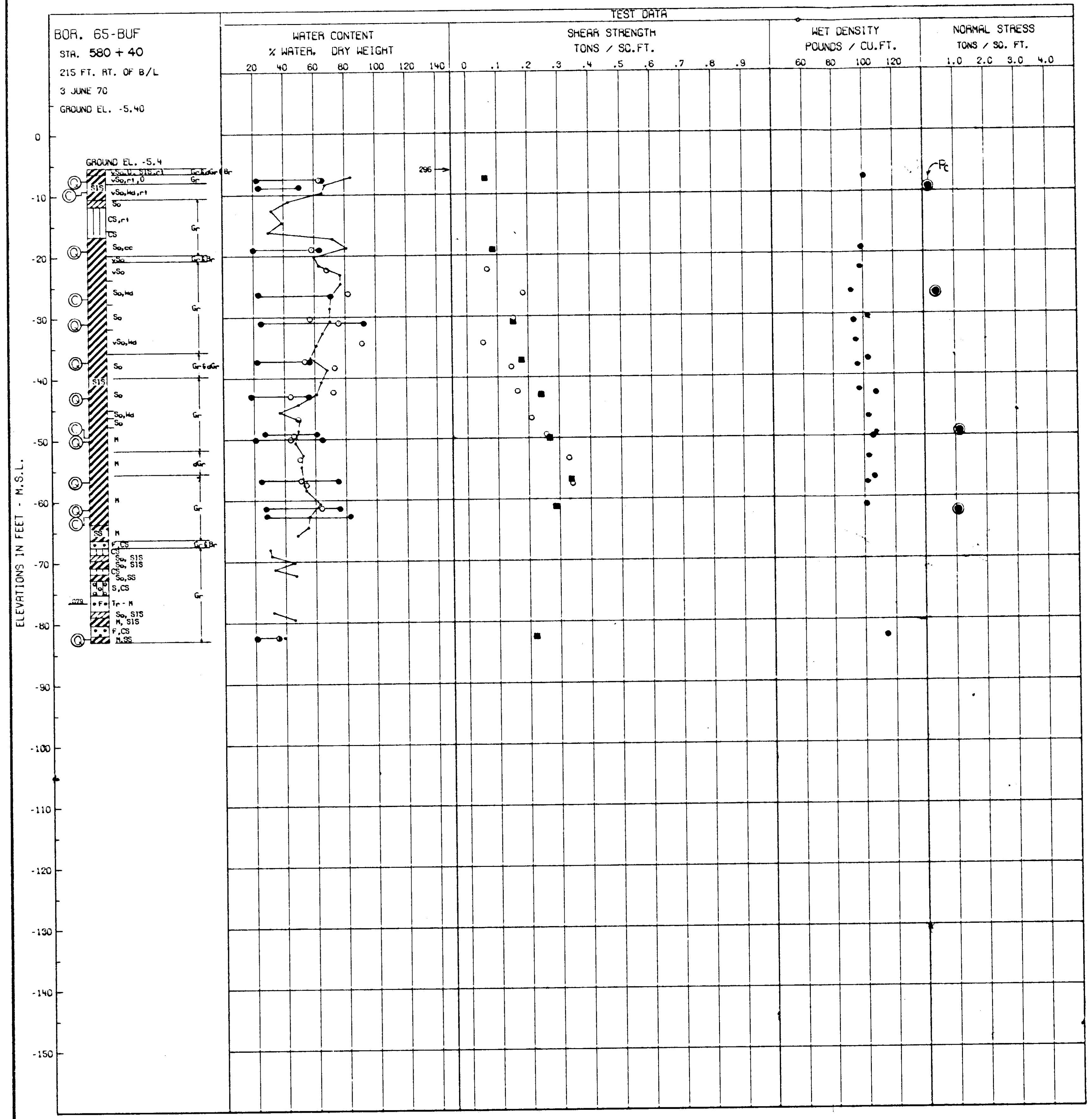
○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST
BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER
FOR SOIL BORING LEGEND SEE PLATE A
FOR LOCATION OF BORING SEE PLATE 7

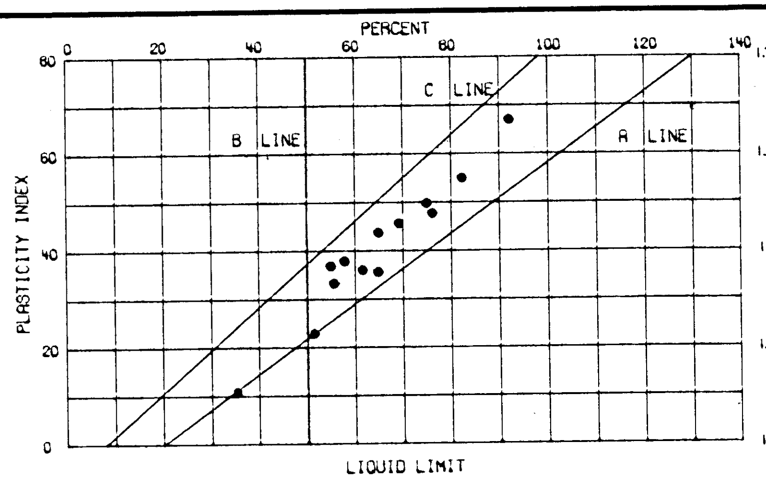
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 39-BUC DATA

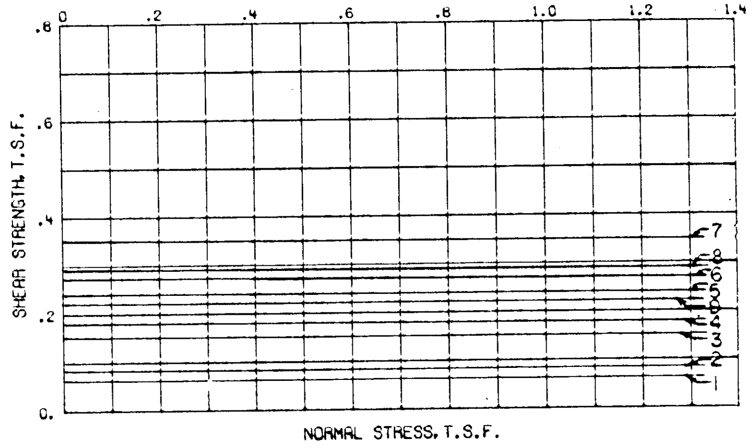
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



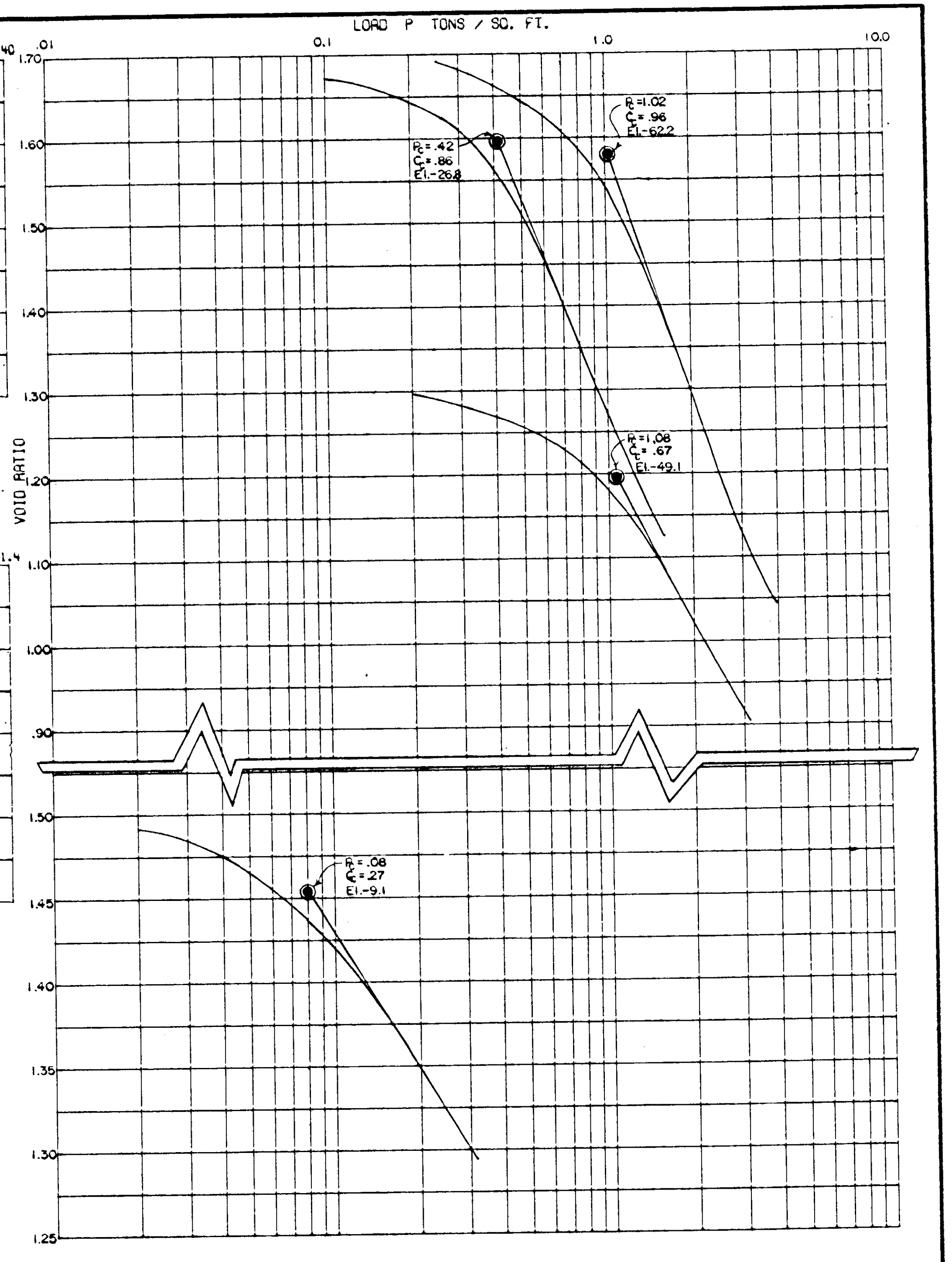


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
65-BUF	1	-7.4	Q	0°	.063	CH
	2	-18.9		0°	.085	CH
	3	-30.9		0°	.145	CH
	4	-37.1		0°	.180	CH
	5	-42.9		0°	.235	CH
	6	-50.0		0°	.265	CH
	7	-56.8		0°	.345	CH
	8	-61.1		0°	.285	CH
	9	-82.3		0°	.220	CL



CONSOLIDATION DATA

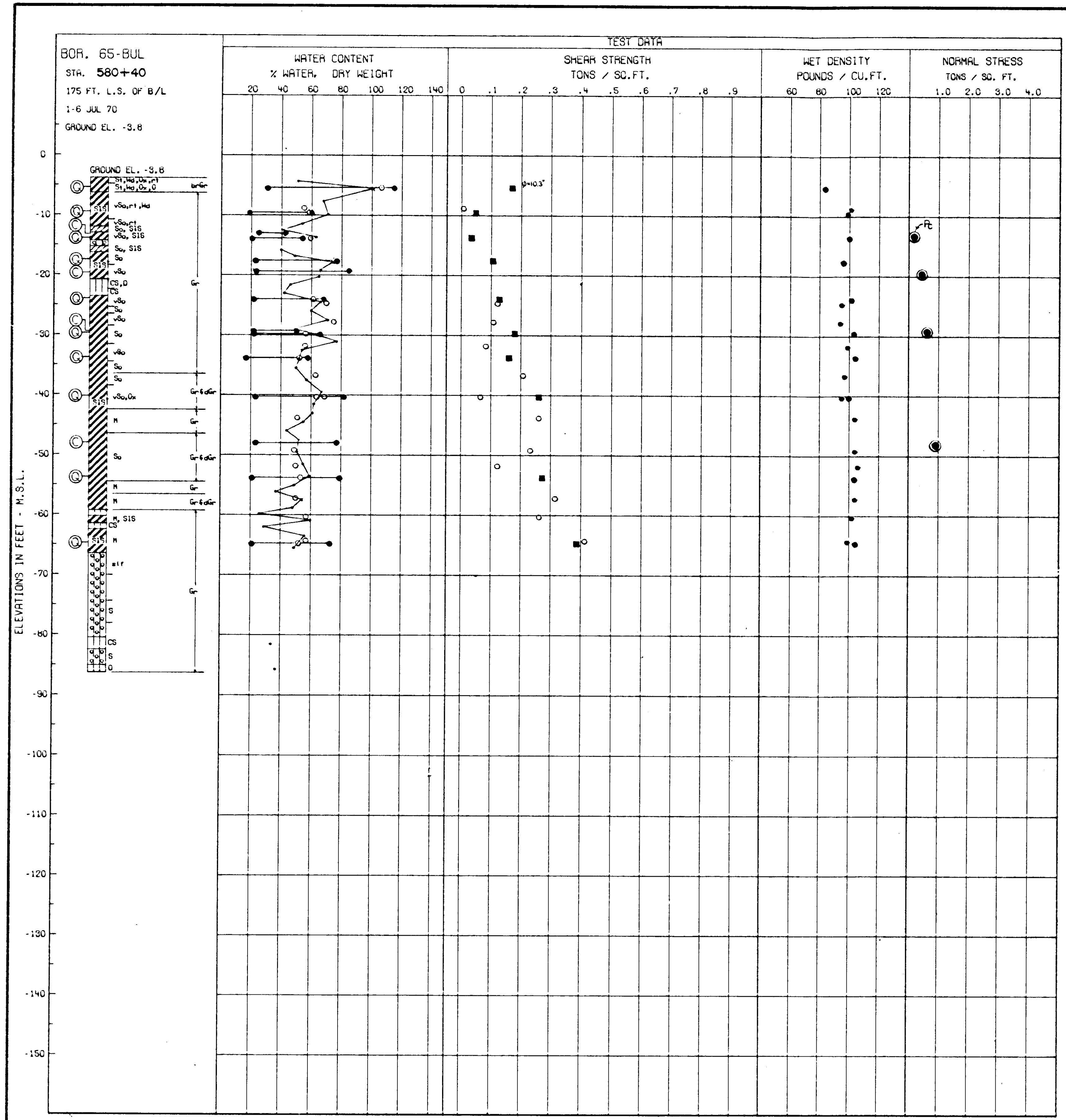
○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
- (S) CONSOLIDATED - DRAINED SHEAR TEST
BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER
FOR SOIL BORING LEGEND SEE PLATE A
FOR LOCATION OF BORING SEE PLATE 8

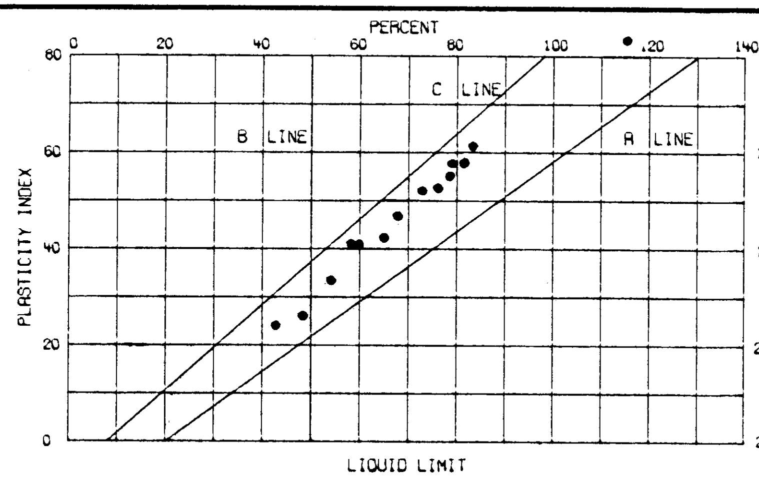
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 65-BUF DATA

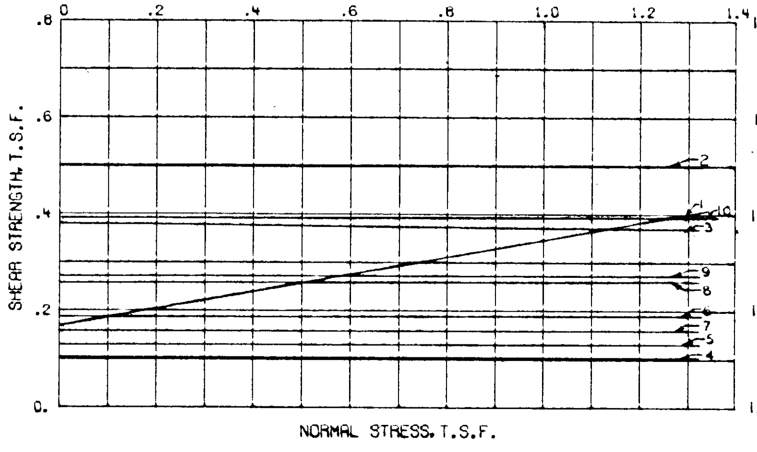
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



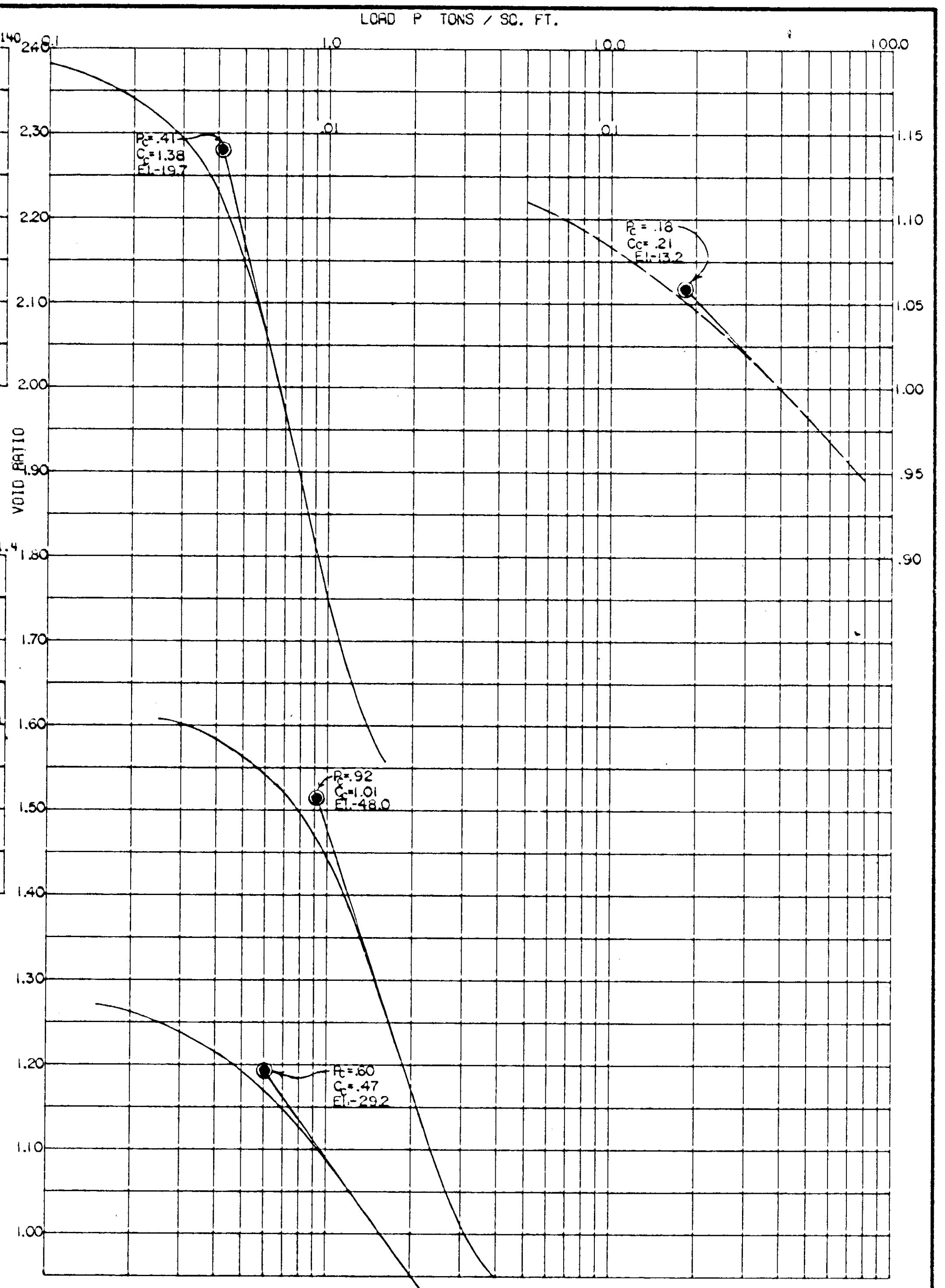


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	EL.	TYPE	STRENGTH Φ	C - TSF	CLASS
65-BUL	1	-5.2		10.3	.169	CH
	2	-9.4		0	.050	CH
	3	-13.9		0	.038	CH
	4	-17.5		0	.105	CH
	5	-24.0		0	.130	CH
	6	-29.8	Q	0	.188	CH
	7	-33.8		0	.160	CH
	8	-40.1		0	.260	CH
	9	-53.8		0	.273	CH
	10	-64.8		0	.390	CH



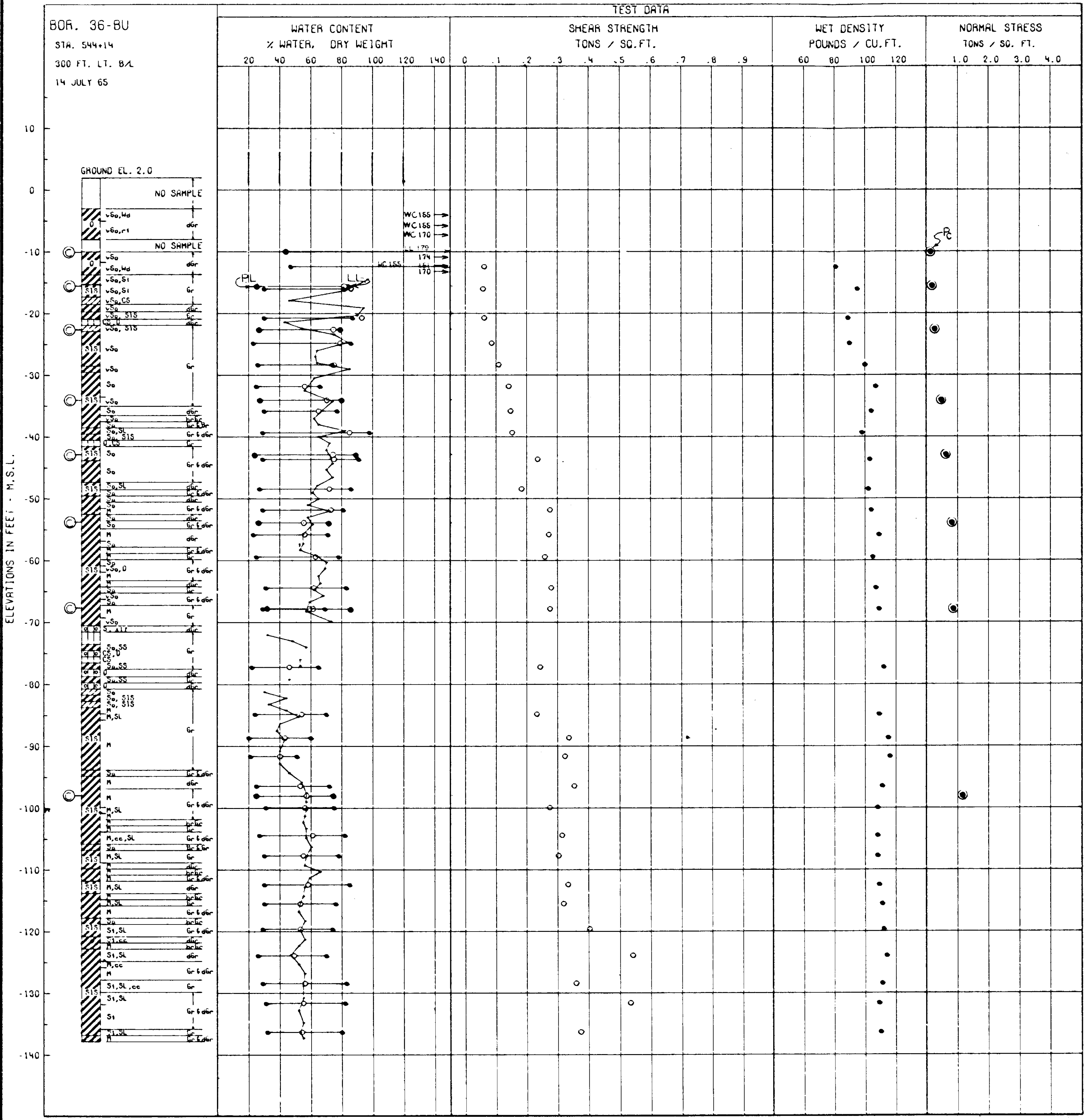
CONSOLIDATION DATA

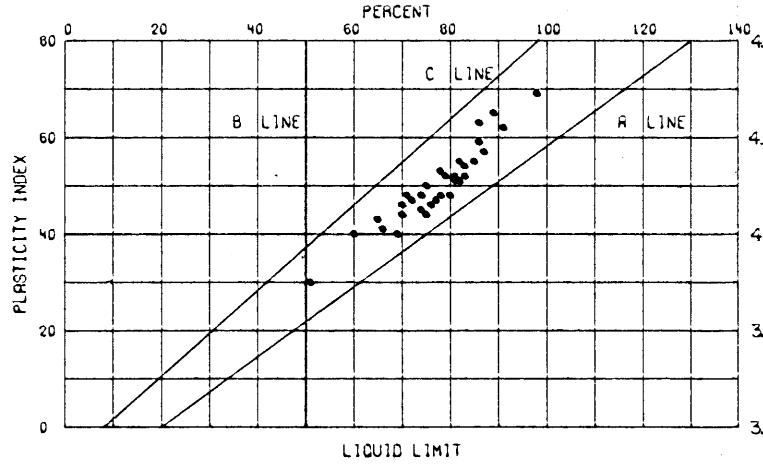
o- (UC) UNCONFINED COMPRESSION TEST
■- (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲- (R) CONSOLIDATED - UNDRAINED SHEAR TEST
- (S) CONSOLIDATED - DRAINED SHEAR TEST
BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER
FOR SOIL BORING LEGEND SEE PLATE A
FOR LOCATION OF BORING SEE PLATE 8

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

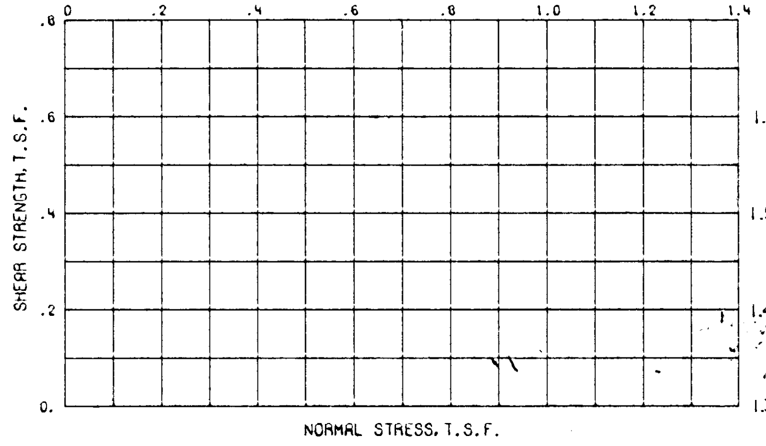
UNDISTURBED BORING 65-BUL DATA

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971
FILE NO. H-2-25712



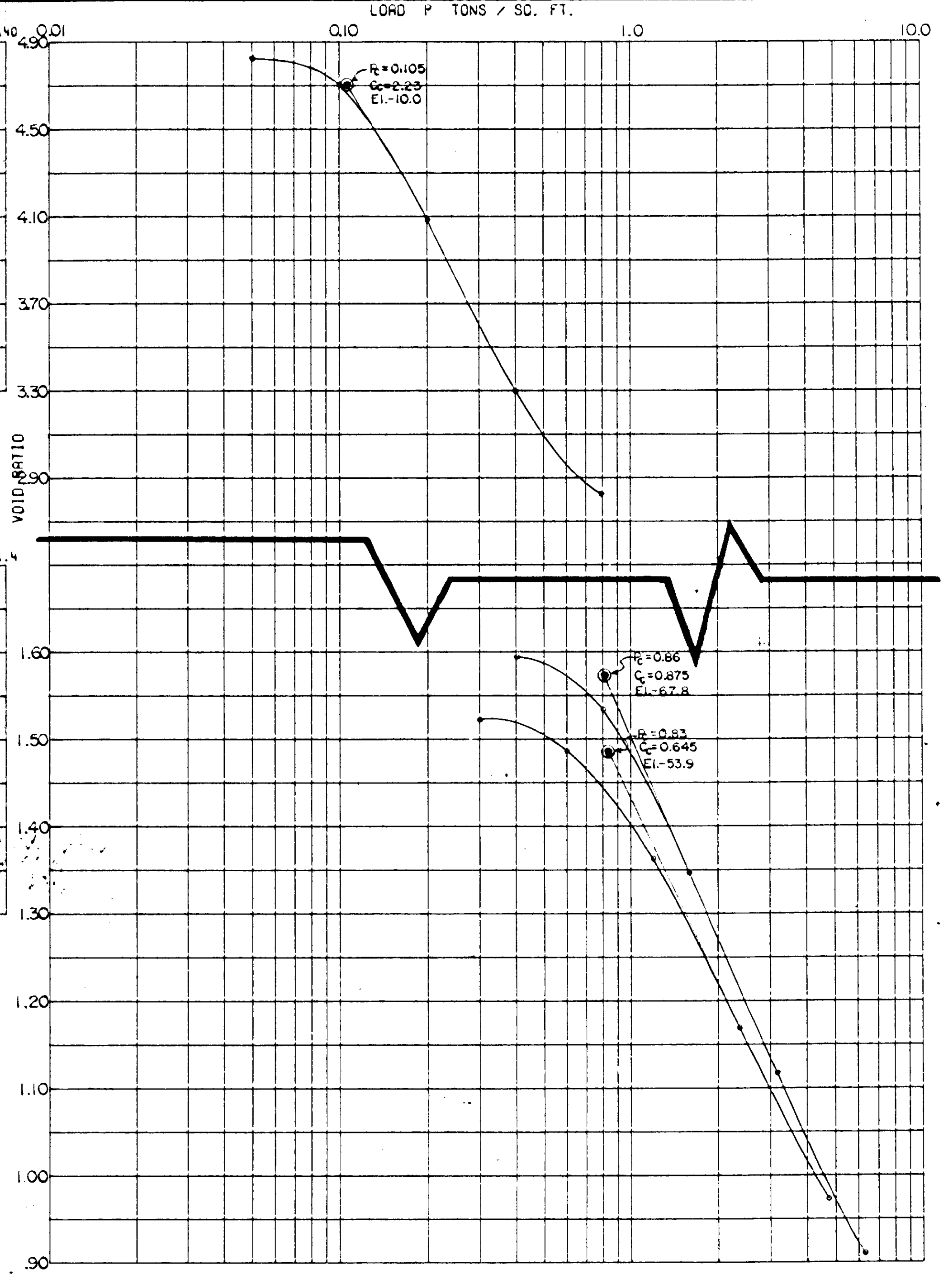


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS



CONSOLIDATION DATA

○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

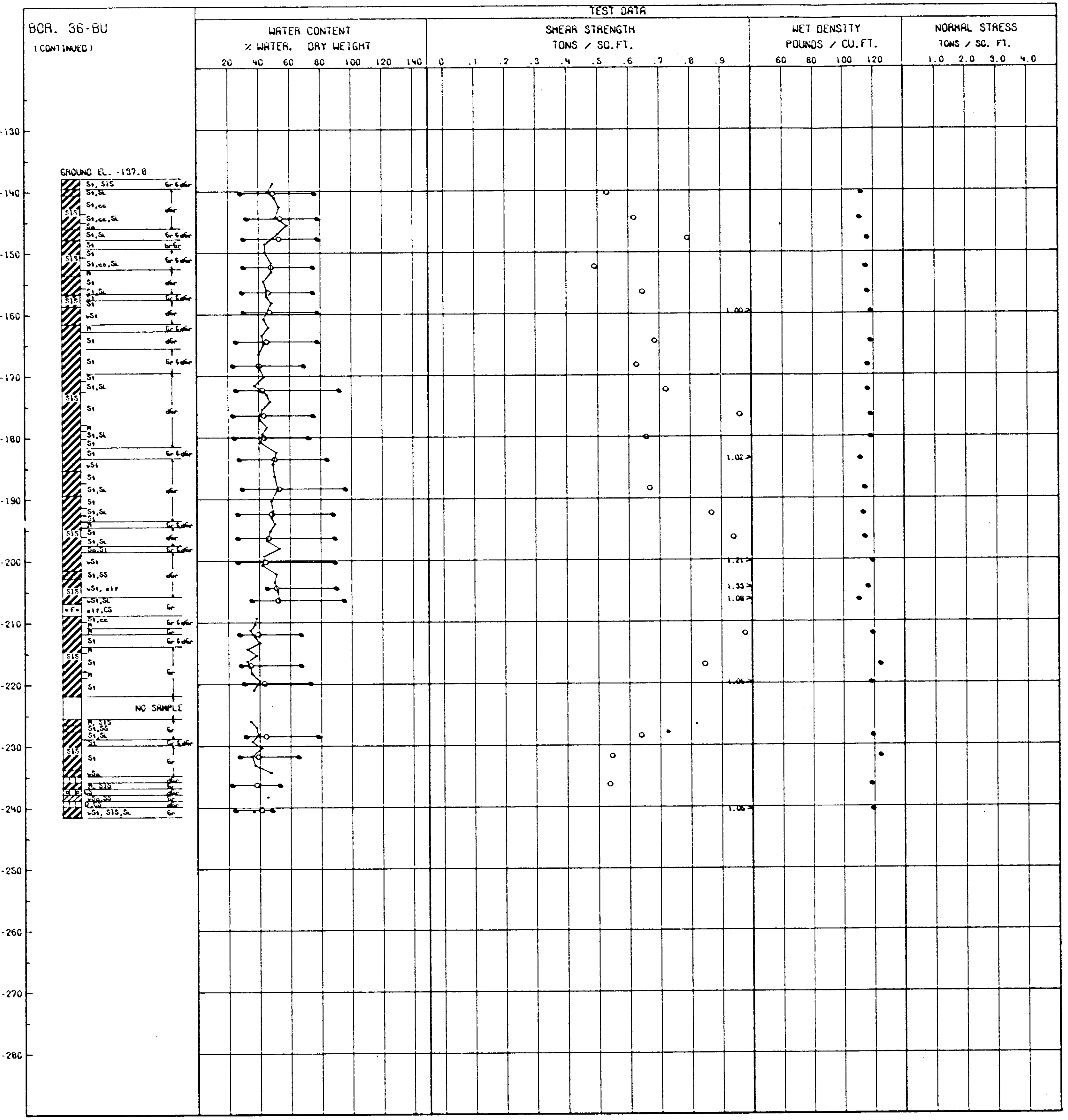
FOR LOCATION OF BORING SEE PLATE 11

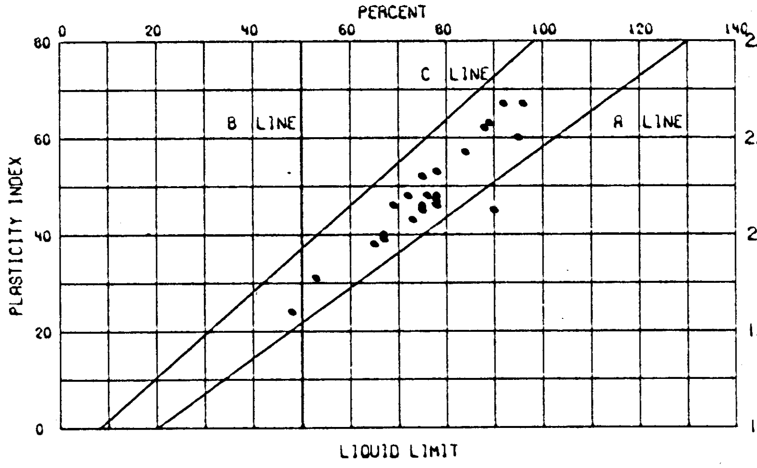
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 36-BU DATA

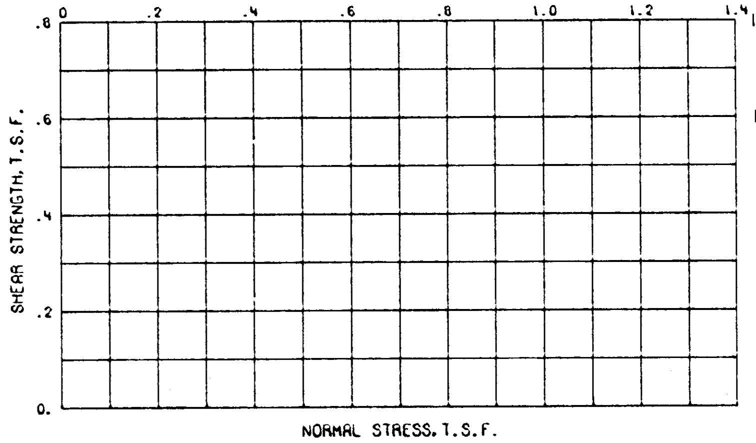
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



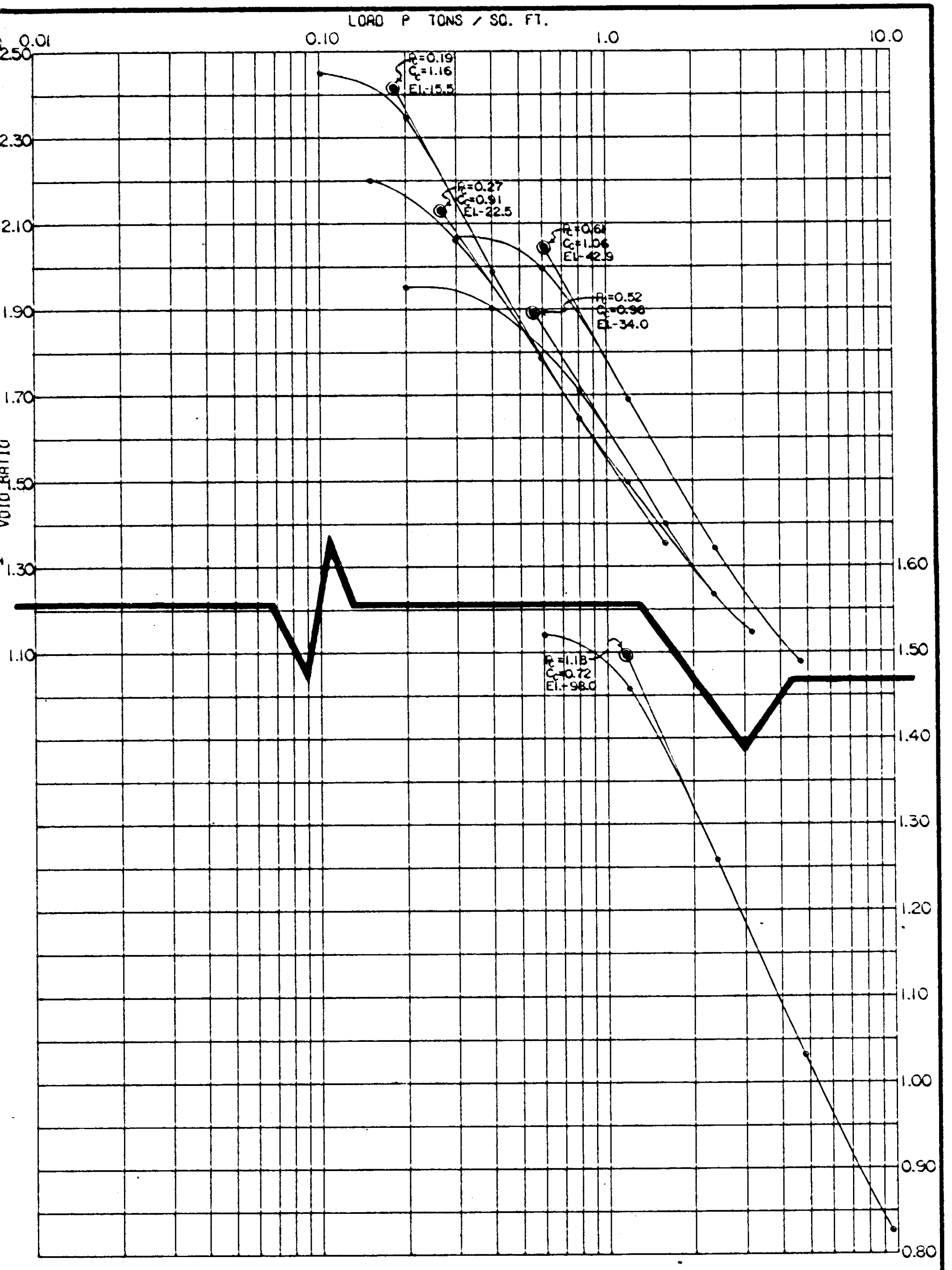


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING	ENVELOPE		TYPE	STRENGTH		CLASS
NO.	NO.	EL.		Φ	C - TSF	



CONSOLIDATION DATA

○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

FOR LOCATION OF BORING SEE PLATE 11

NEW ORLEANS TO VENICE, LA.

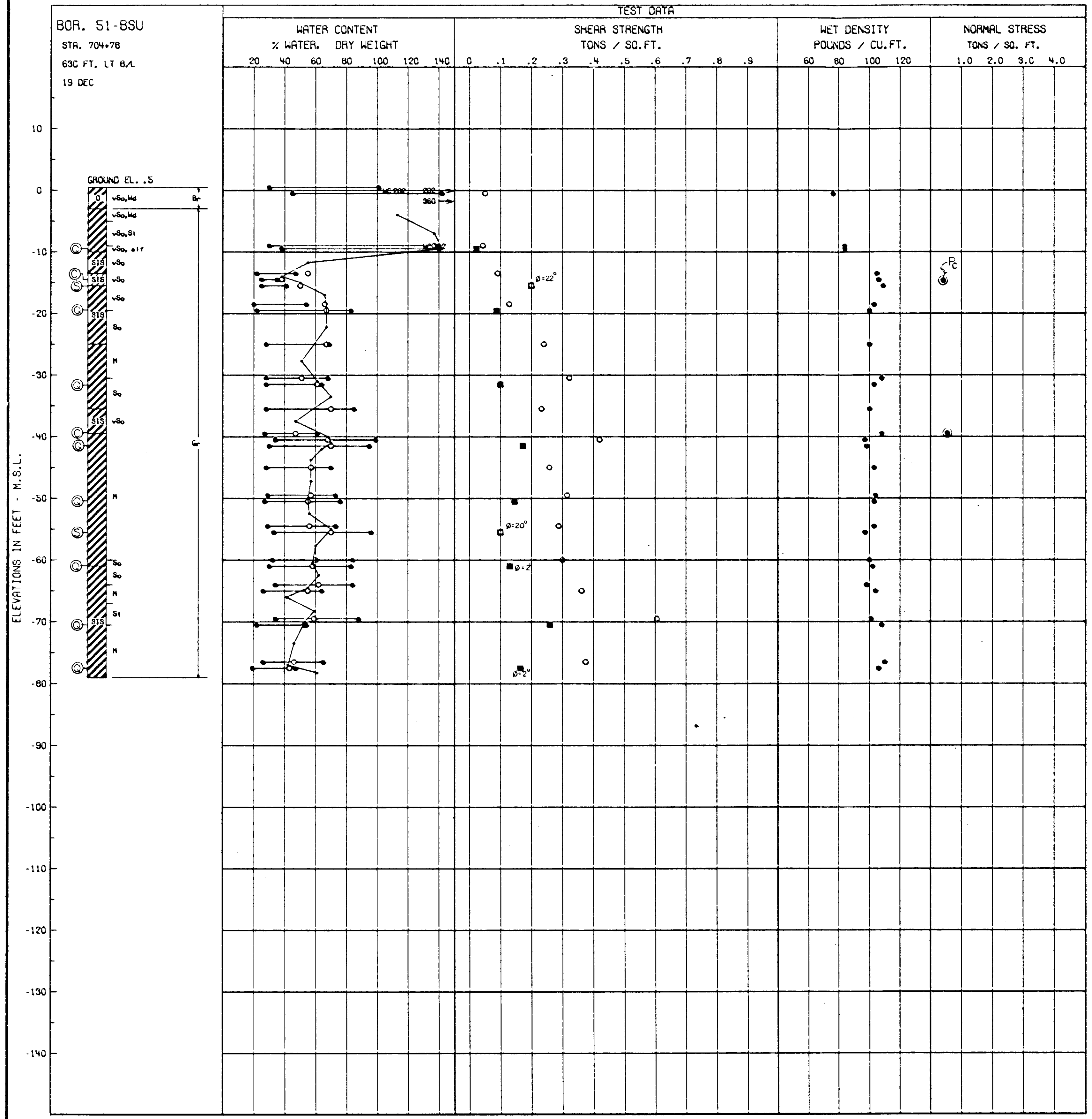
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

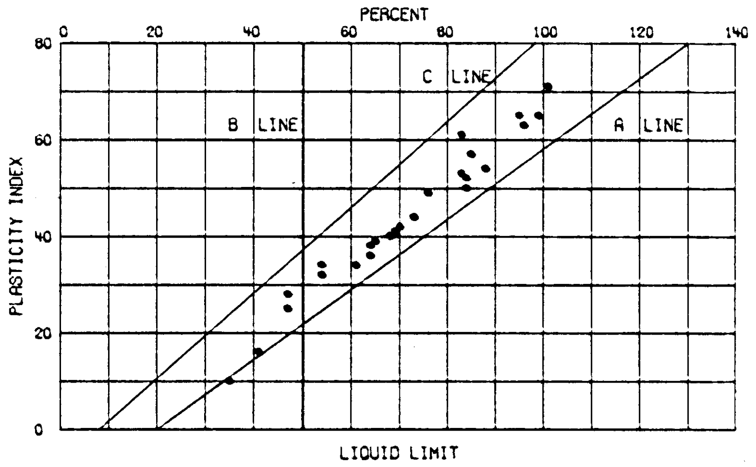
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 36-BU DATA (Cont.)

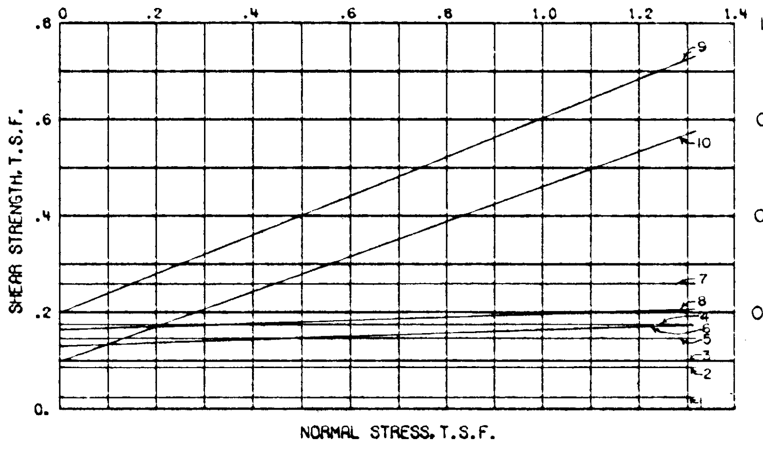
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



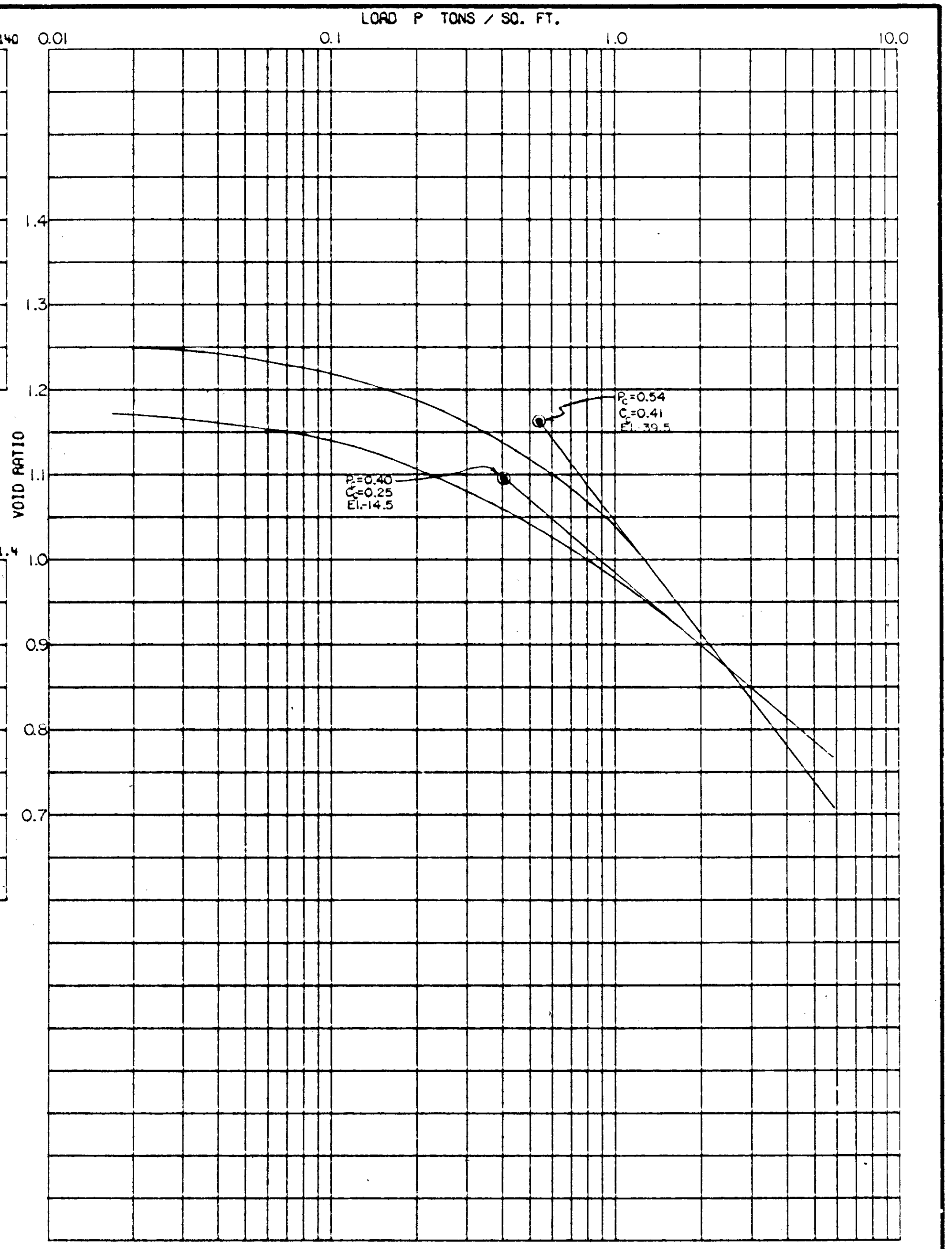


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
51-BSU	1	-9.5	Q	0°	.023	CH
	2	-19.5		0°	.088	CH
	3	-31.0		0°	.100	CH
	4	-40.5		0°	.173	CH
	5	-50.0		0°	.145	CH
	6	-60.5		2°	.130	CH
	7	-70.0		0°	.260	CH
	8	-77.0		2°	.165	CH
	9	-15.5	S	22°	.200	ML
	10	-55.0		20°	.100	CH



CONSOLIDATION DATA

o- (UC) UNCONFINED COMPRESSION TEST
■- (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲- (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□- (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

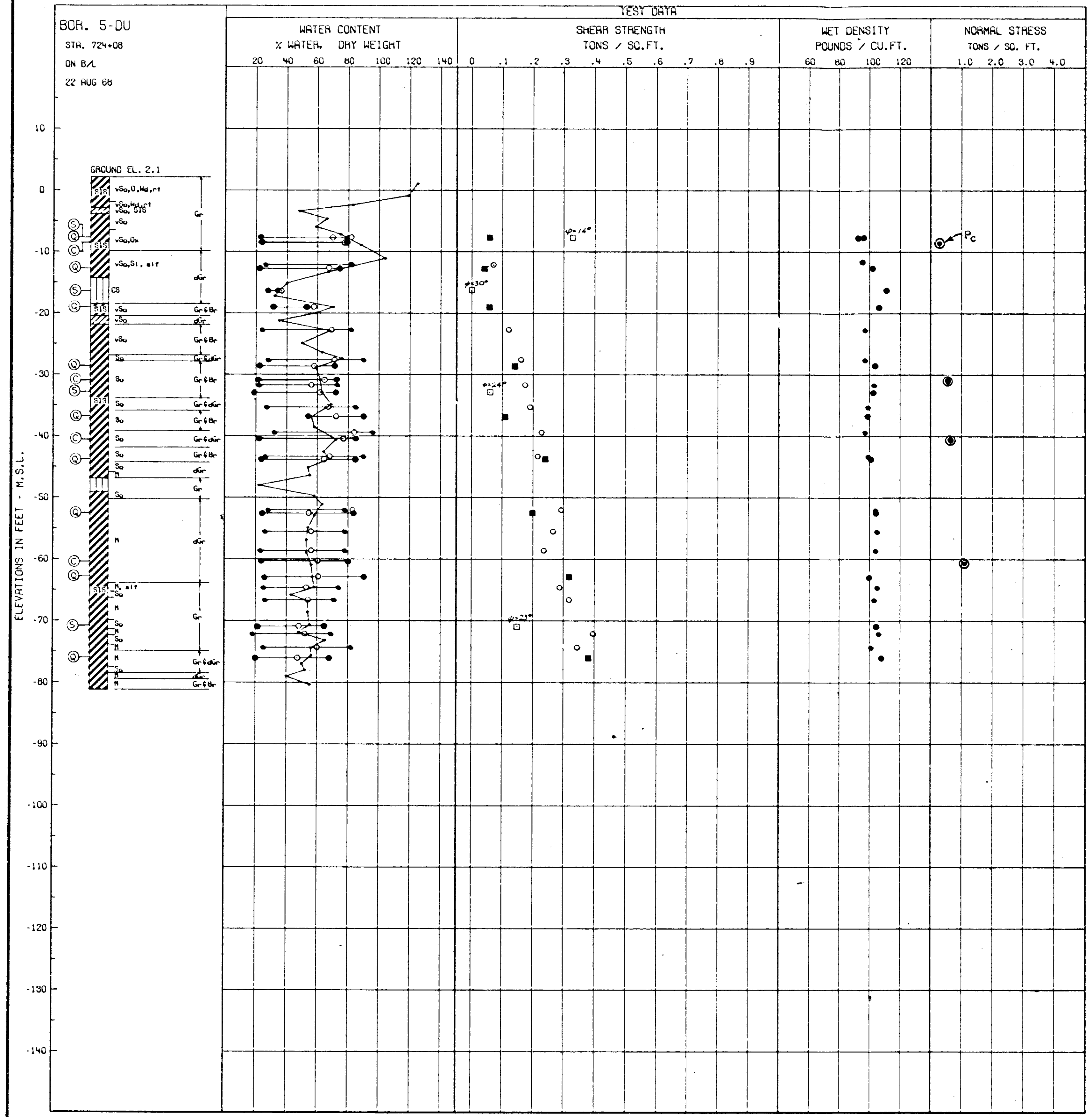
FOR LOCATION OF BORING SEE PLATE 12

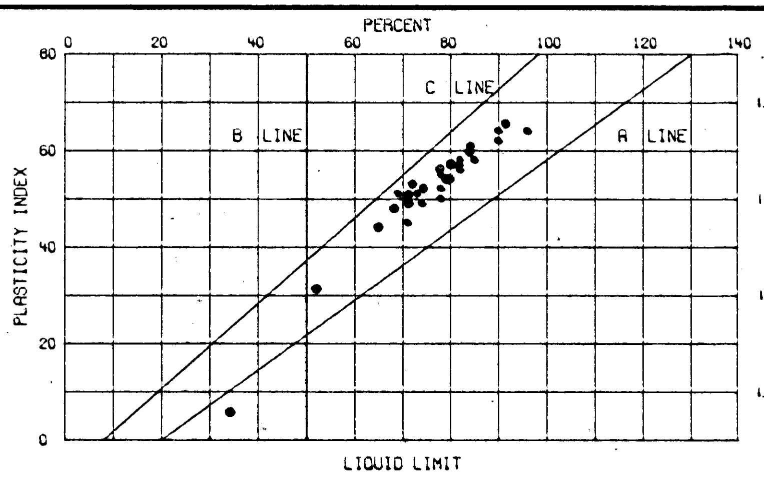
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

UNDISTURBED BORING 51-BSU DATA

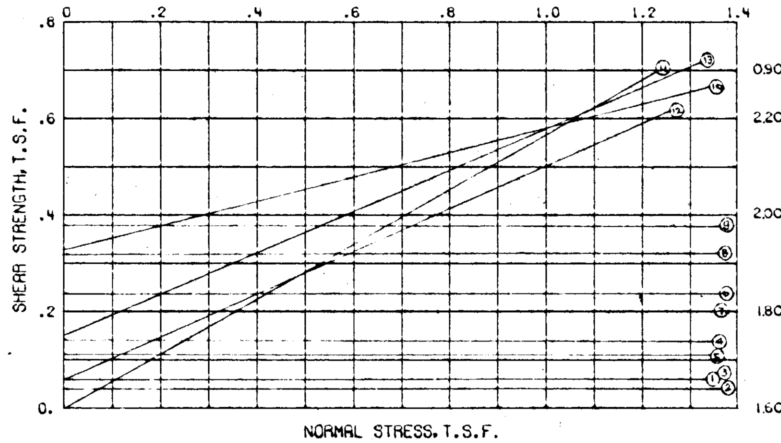
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



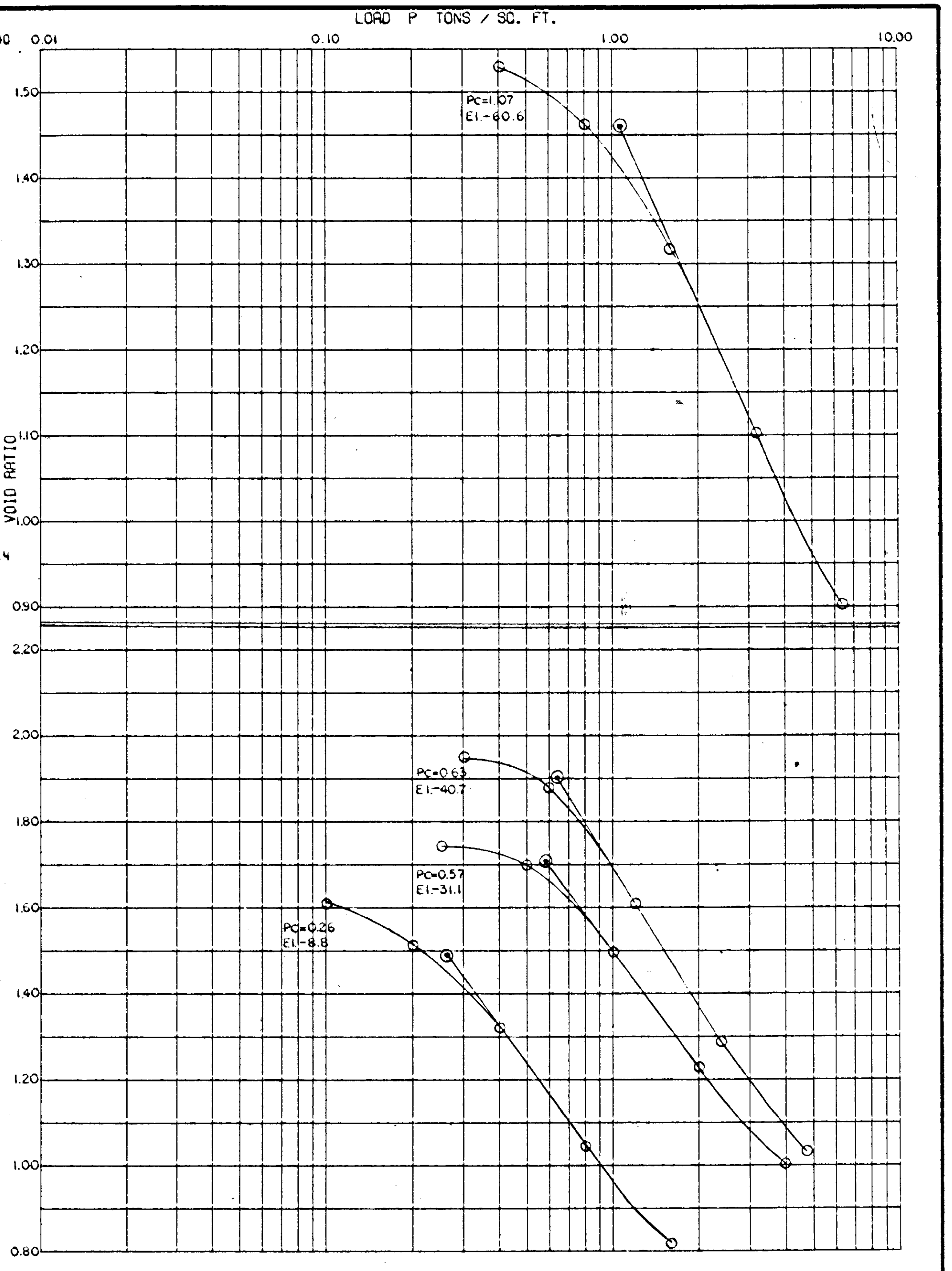


PLASTICITY CHART



SHEAR STRENGTH DATA

BORING NO.	ENVELOPE NO.	ENVELOPE EL.	TYPE	STRENGTH Φ	STRENGTH C - TSF	CLASS
5-DU	1	-7.80	Q	0°	0.06	CH
	2	-12.70	Q	0°	0.04	CH
	3	-18.90	Q	0°	0.06	CH
	4	-28.70	Q	0°	0.14	CH
	5	-36.80	Q	0°	0.11	CH
	6	-43.80	Q	0°	0.24	CH
	7	-52.50	Q	0°	0.20	CH
	8	-62.90	Q	0°	0.32	CH
	9	-76.00	Q	0°	0.38	CH
	10	-7.80	S	14°	0.33	CH
	11	-16.30	S	30°	0.00	ML
	12	32.90	S	24°	0.06	CH
	13	70.90	S	23°	0.15	CH



CONSOLIDATION DATA

○ - (UC) UNCONFINED COMPRESSION TEST
■ - (Q) UNCONSOLIDATED - UNDRAINED SHEAR TEST
▲ - (R) CONSOLIDATED - UNDRAINED SHEAR TEST
□ - (S) CONSOLIDATED - DRAINED SHEAR TEST

BORINGS WERE TAKEN WITH A 5 INCH DIAMETER STEEL TUBE PISTON TYPE SAMPLER

FOR SOIL BORING LEGEND SEE PLATE A

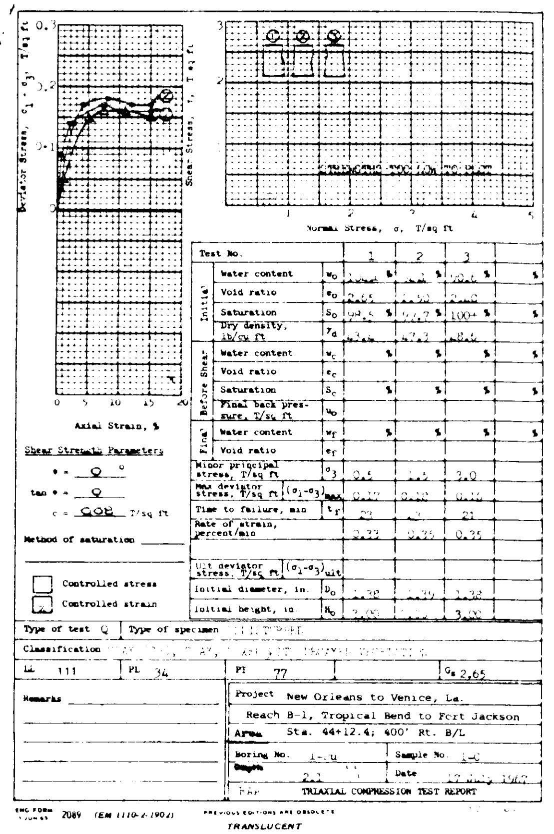
FOR LOCATION OF BORING SEE PLATE 12

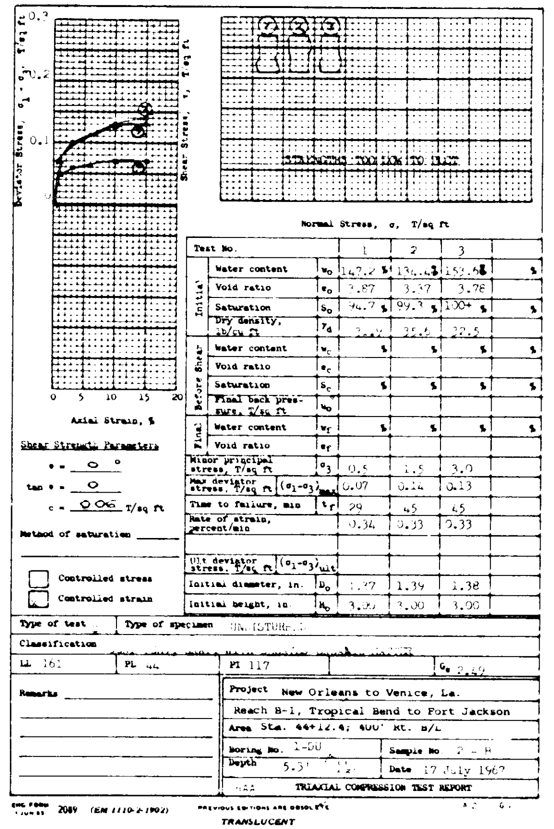
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

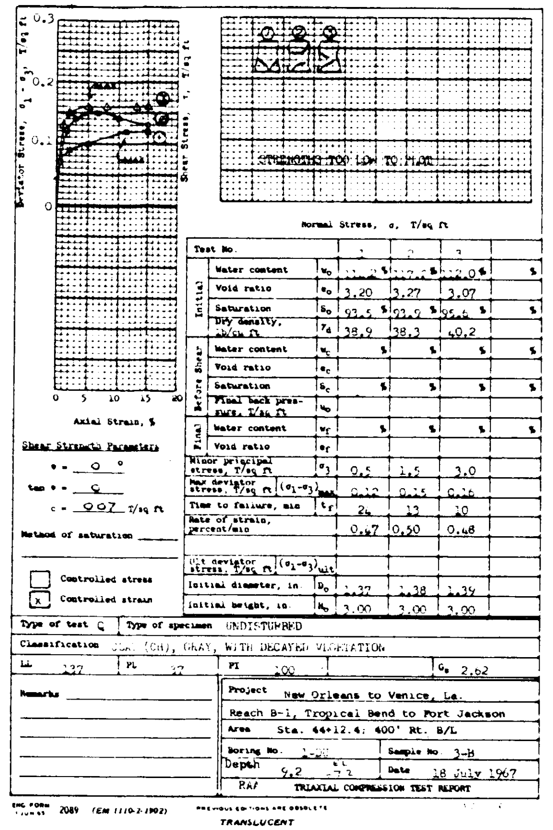
UNDISTURBED BORING 5-DU DATA

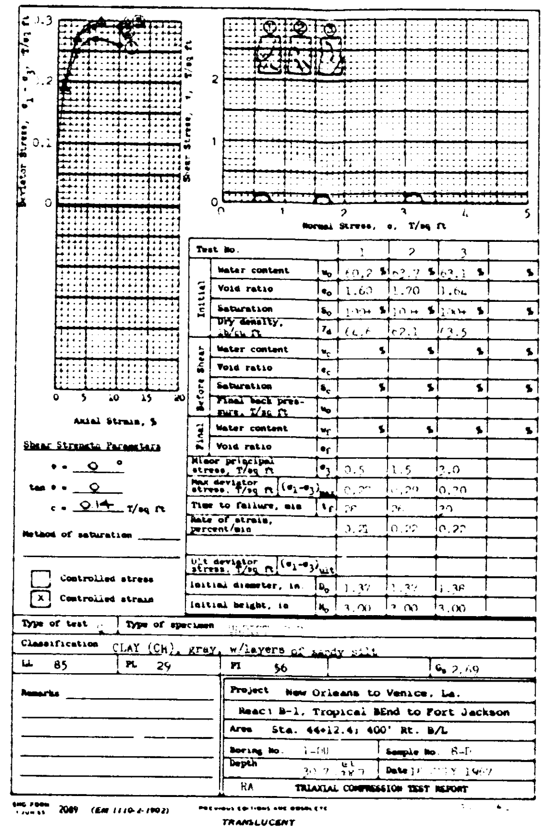
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

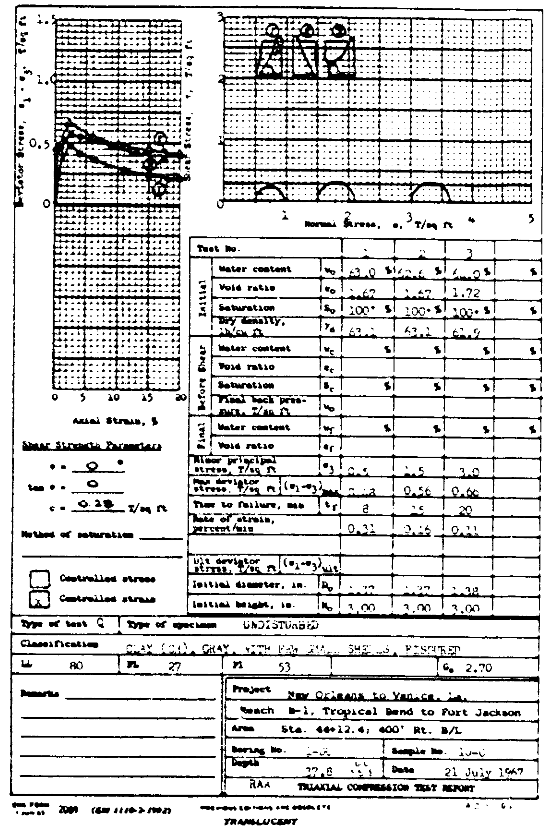
AUGUST 1971 FILE NO. H-2-25712

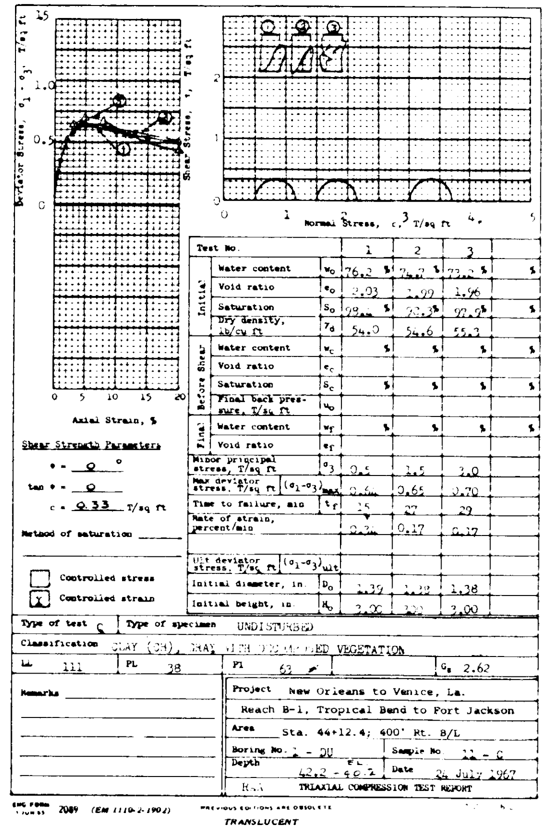


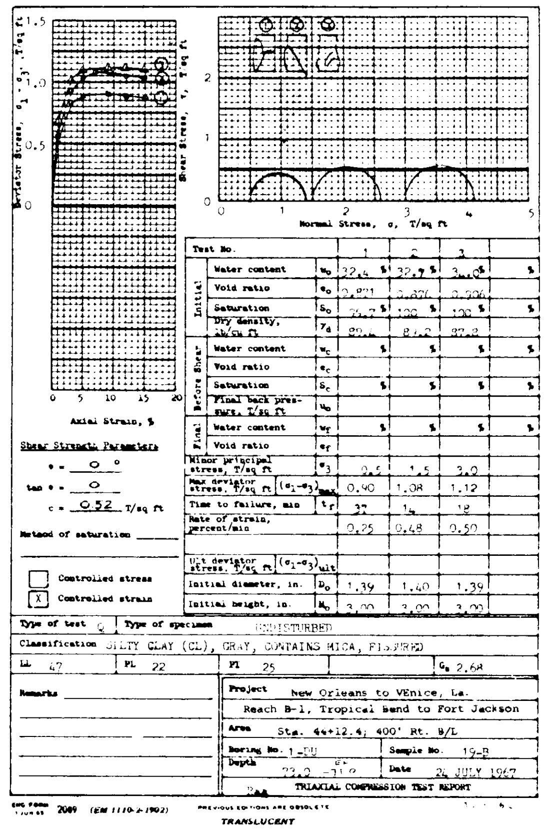


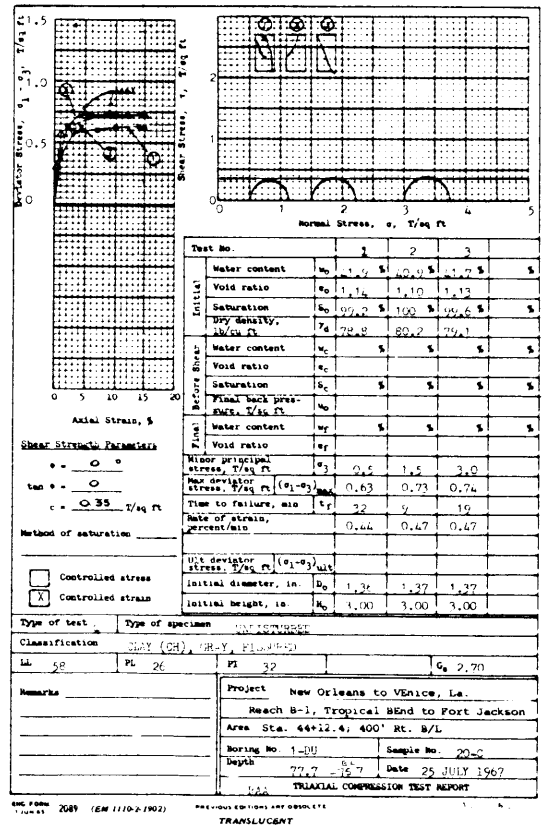


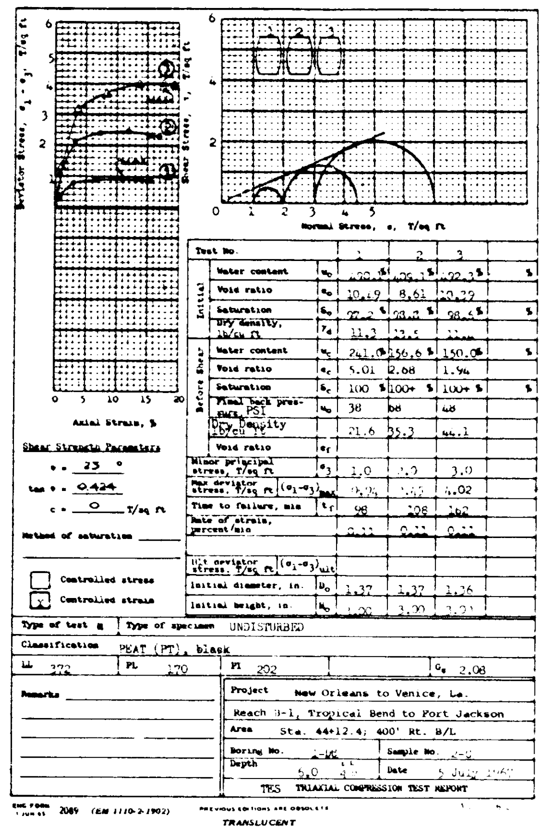


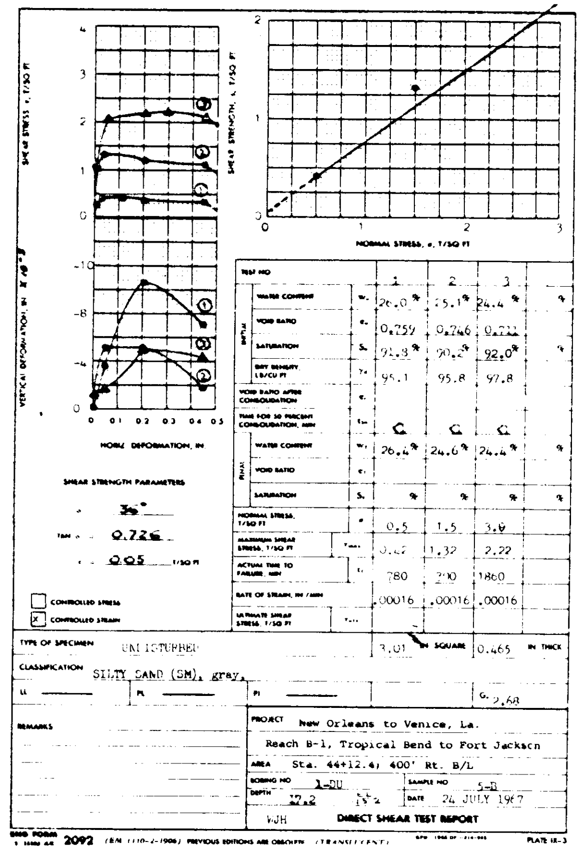












NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

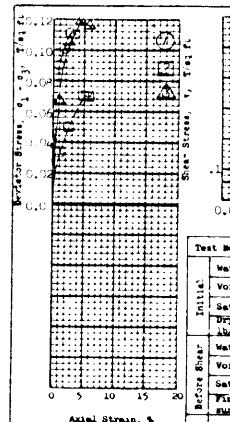
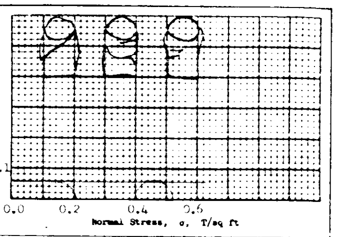
DETAIL SHEAR STRENGTH DATA
BORING I-DU

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 | FILE NO. H-2-25712

DETAIL SHEAR STRENGTH DATA — BORING 1-DU-1 (Triaxial Compression Test Reports)

Sample 1-C

Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.058 T/sq ft

Method of saturation: ____ ; [ ] Controlled stress; [X] Controlled strain

Test No.		1	2	3
Initial: Water content	w_o	60.07 %	57.09 %	62.37 %
Initial: Void ratio	e_o	1.614	1.630	1.658
Initial: Saturation	S_o	99.72 %	93.87 %	100.00 %
Initial: Dry density, lb/cu ft	γ_d	63.96	63.59	62.90
Minor principal stress, T/sq ft	σ_3	0.1	0.2	0.4
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.11	0.07	0.12
Time to failure, min	t_f	3.62	16.04	12.62
Rate of strain, percent/min		0.67	0.31	0.31
Wet Density lb/cu ft		102.40	99.90	102.14
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: vSo(Gr&dGr)CH3;few lns&ars SP;org stks;dw;cc;ox ars;slf

LL 72 | PL 25 | PI 47 | UCT - 145 | G_s 2.6821

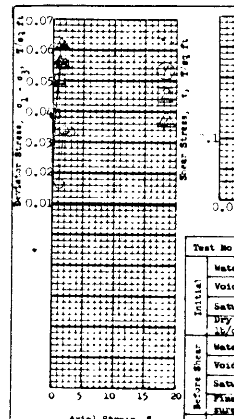
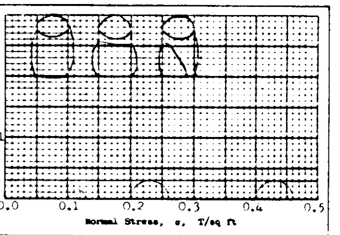
Remarks: NOD Testing Section

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. 1-C — Depth / El. 1.6 / +2.3 — Date 16 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample 2-B

Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.030 T/sq ft

Test No.		1	2	3
Initial: Water content	w_o	67.45 %	61.6 %	59.5 %
Initial: Void ratio	e_o	1.731	1.658	1.595
Initial: Saturation	S_o	100.0 %	100.0 %	99.58 %
Initial: Dry density, lb/cu ft	γ_d	60.99	62.64	64.46
Minor principal stress, T/sq ft	σ_3	0.1	0.2	0.4
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.03	0.06	0.06
Time to failure, min	t_f	2.41	4.00	3.88
Rate of strain, percent/min		0.68	0.30	0.31
Wet Density lb/cu ft		102.40	102.52	102.14
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: vSo(Gr)CH3;lns,lys&ars SP;dw;rt;sl&slf;cc;org stks

LL 57 | PL 21 | PI 36 | UCT - 165 | G_s 2.6677

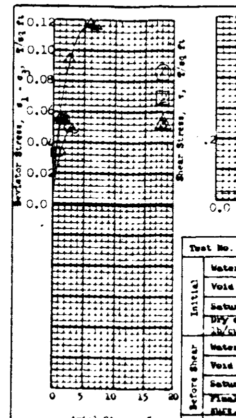
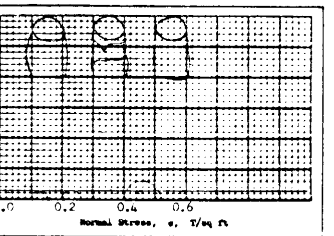
Remarks: NOD Testing Section

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. 2-B — Depth / El. [illegible] — Date 16 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample 2-D

Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.024 T/sq ft

Test No.		1	2	3
Initial: Water content	w_o	59.46 %	59.15 %	59.17 %
Initial: Void ratio	e_o	1.604	1.589	1.549
Initial: Saturation	S_o	98.63 %	100.0 %	100.0 %
Initial: Dry density, lb/cu ft	γ_d	63.84	64.33	65.33
Minor principal stress, T/sq ft	σ_3	0.1	0.2	0.4
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.05	0.06	0.12
Time to failure, min	t_f	3.66	3.51	17.46
Rate of strain, percent/min		0.68	0.30	0.33
Wet Density lb/cu ft		101.86	102.71	104.02
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: vSo(Gr)CH3;lns,lys&ars SP;dw;rt;sl&slf;cc;org stks

LL 57 | PL 21 | PI 36 | * UCT - 145 | G_s 2.6677

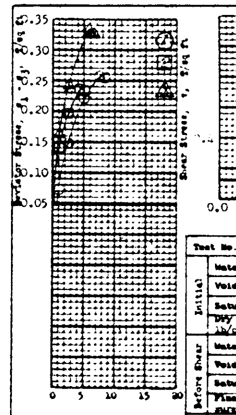
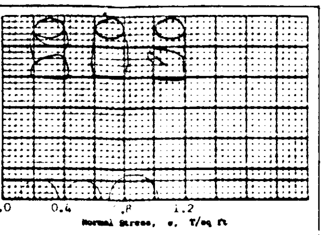
Remarks: NOD Testing Section; * Attb., UCT & G_s from 2-B

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. 2-D — Depth / El. [illegible] — Date 17 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample [illegible] (4th form)

Shear Strength Parameters: φ = 1.9°; tan φ = 0.0332; c = 0.125 T/sq ft

Test No.		1	2	3
Initial: Water content	w_o	66.64 %	68.56 %	69.99 %
Initial: Void ratio	e_o	1.868	1.904	1.887
Initial: Saturation	S_o	95.30 %	96.10 %	96.70 %
Initial: Dry density, lb/cu ft	γ_d	58.12	57.36	57.71
Minor principal stress, T/sq ft	σ_3	0.1	0.4	0.7
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.26	0.24	0.33
Time to failure, min	t_f	11.06	6.22	19.14
Rate of strain, percent/min		0.67	0.66	0.31
Wet Density lb/cu ft		96.84	96.66	100.34
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: So(Gr)CH3;lns&lys ML;lns SP;dw;rt thruout

LL 98 | PL 29 | PI 69 | UCT - [illegible] | G_s 2.6720

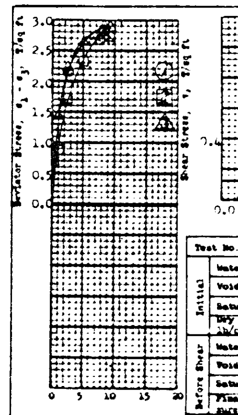
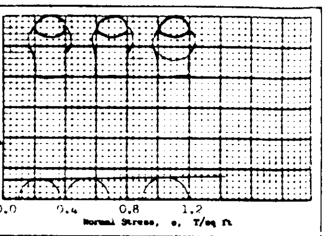
Remarks: NOD Testing Section

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. [illegible] — Depth / El. [illegible] — Date 17 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample [illegible] (5th form)

Shear Strength Parameters: φ = [illegible]; tan φ = [illegible]; c = [illegible] T/sq ft

Test No.		1	2	3
Initial: Water content	w_o	47.05 %	43.55 %	43.8 %
Initial: Void ratio	e_o	1.290	1.216	1.155
Initial: Saturation	S_o	99.29 %	96.83 %	[illegible]
Initial: Dry density, lb/cu ft	γ_d	71.66	75.44	76.19
Minor principal stress, T/sq ft	σ_3	0.1	0.4	0.9
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.27	0.28	0.29
Time to failure, min	t_f	8.30	27.24	26.77
Rate of strain, percent/min		0.69	0.30	0.32
Wet Density lb/cu ft		105.33	[illegible]	[illegible]
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: [illegible]

LL 48 | PL 19 | PI 29 | UCT - 294 | G_s 2.6824

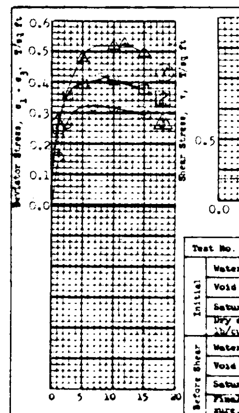
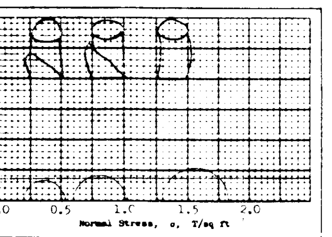
Remarks: NOD Testing Section

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. [illegible] — Depth / El. [illegible] — Date 17 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample 8-B

Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.188 T/sq ft

Method of saturation: ____ ; [ ] Controlled stress; [X] Controlled strain

Test No.		1	2	3
Initial: Water content	w_o	54.21 %	52.80 %	40.68 %
Initial: Void ratio	e_o	1.458	1.404	1.126
Initial: Saturation	S_o	99.60 %	100.0 %	91.79 %
Initial: Dry density, lb/cu ft	γ_d	68.02	69.51	78.62
Minor principal stress, T/sq ft	σ_3	0.2	0.6	1.3
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.33	0.42	0.53
Time to failure, min	t_f	9.76	27.19	39.67
Rate of strain, percent/min		0.69	0.30	0.29
Wet Density lb/cu ft		104.89	106.27	110.64
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: So(Gr)CH3;lns,lys&ars SP & ML

LL 55 | PL 18 | PI 37 | UCT - 421 | G_s 2.6830

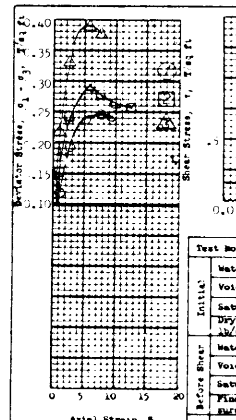
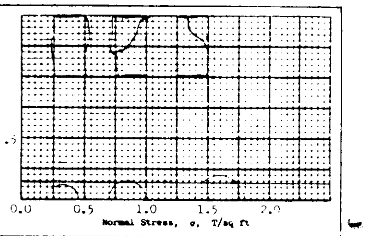
Remarks: NOD Testing Section

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. 8-B — Depth / El. 28.4 / -24.6 — Date 16 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample 9-D

Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.135 T/sq ft

Method of saturation: ____ ; [ ] Controlled stress; [X] Controlled strain

Test No.		1	2	3
Initial: Water content	w_o	53.24 %	57.14 %	53.54 %
Initial: Void ratio	e_o	1.461	1.561	1.473
Initial: Saturation	S_o	97.29 %	97.71 %	97.05 %
Initial: Dry density, lb/cu ft	γ_d	67.70	65.02	67.39
Minor principal stress, T/sq ft	σ_3	0.2	0.7	1.4
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.25	0.29	0.29
Time to failure, min	t_f	10.44	18.37	18.54
Rate of strain, percent/min		0.70	0.32	0.31
Wet Density lb/cu ft		103.71	102.21	103.46
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: So(Gr)CH4;lns & lgr lys ML;ox ars;org stks;spks dw

LL 74 | PL 21 | PI 53 | UCT - 327 | G_s 2.6743

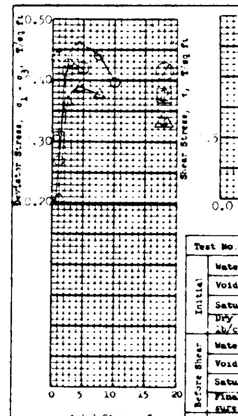
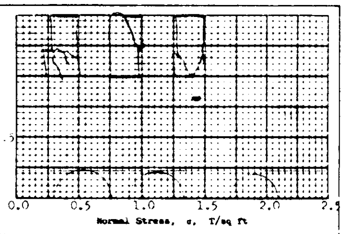
Remarks: NOD Testing Section

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. 9-D — Depth / El. 34.0 / -30.8 — Date 17 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample 11-D

Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.223 T/sq ft

Method of saturation: ____ ; [ ] Controlled stress; [X] Controlled strain

Test No.		1	2	3
Initial: Water content	w_o	63.41 %	62.99 %	63.68 %
Initial: Void ratio	e_o	1.783	1.702	1.730
Initial: Saturation	S_o	96.03 %	99.92 %	99.35 %
Initial: Dry density, lb/cu ft	γ_d	60.54	62.36	61.70
Minor principal stress, T/sq ft	σ_3	0.3	0.9	1.7
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.46	0.43	0.39
Time to failure, min	t_f	6.26	11.23	12.44
Rate of strain, percent/min		0.67	0.30	0.33
Wet Density lb/cu ft		98.97	101.64	100.96
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: M(Gr)CH4;few lns&ars ML;few org stks;slf;spks dw

LL 91 | PL 25 | PI 66 | * UCT - 503 | G_s 2.7038

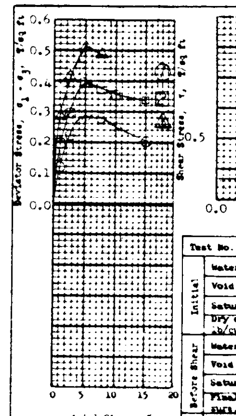
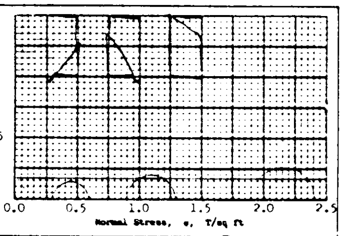
Remarks: NOD Testing Section; * Attb. & UCT from 11-C

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. 11-D — Depth / El. 42.0 / -38.8 — Date 17 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample 13-B

Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.170 T/sq ft

Method of saturation: ____ ; [ ] Controlled stress; [X] Controlled strain

Test No.		1	2	3
Initial: Water content	w_o	64.87 %	66.48 %	61.12 %
Initial: Void ratio	e_o	1.755	1.803	1.659
Initial: Saturation	S_o	99.42 %	99.20 %	99.09 %
Initial: Dry density, lb/cu ft	γ_d	60.93	59.89	63.14
Minor principal stress, T/sq ft	σ_3	0.3	0.9	1.9
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.29	0.39	0.51
Time to failure, min	t_f	16.40	17.10	15.95
Rate of strain, percent/min		0.30	0.29	0.31
Wet Density lb/cu ft		100.46	99.72	101.71
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: M(Gr)CH3;lns&ars ML;org stks;ox ars

LL 62 | PL 19 | PI 43 | UCT - 636 | G_s 2.6922

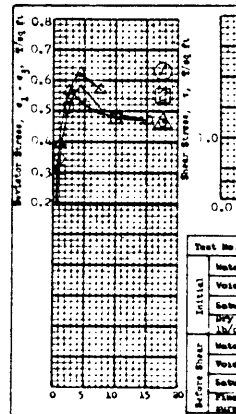
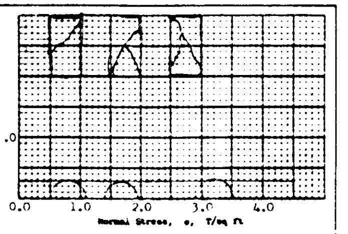
Remarks: NOD Testing Section

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. 13-B — Depth / El. 48.2 / -45.0 — Date 18 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample 18-C

Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.283 T/sq ft

Method of saturation: ____ ; [ ] Controlled stress; [X] Controlled strain

Test No.		1	2	3
Initial: Water content	w_o	47.46 %	49.12 %	49.16 %
Initial: Void ratio	e_o	1.298	1.347	1.353
Initial: Saturation	S_o	98.74 %	98.44 %	98.10 %
Initial: Dry density, lb/cu ft	γ_d	73.32	71.76	71.57
Minor principal stress, T/sq ft	σ_3	0.5	1.4	2.9
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.58	0.55	0.62
Time to failure, min	t_f	6.48	10.66	13.70
Rate of strain, percent/min		0.65	0.30	0.30
Wet Density lb/cu ft		108.14	107.02	106.83
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: M(Gr)CH3;lns,lys&ars ML

LL 56 | PL 24 | PI 32 | UCT - 496 | G_s 2.7024

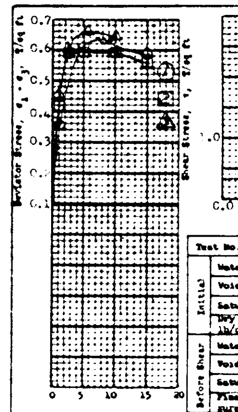
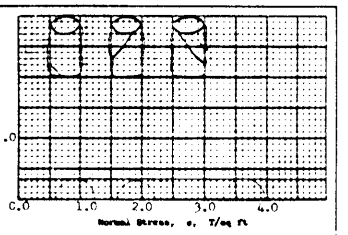
Remarks: NOD Testing Section

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. 18-C — Depth / El. 69.1 / -65.9 — Date 19 June 70

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

Sample 21-C

Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.323 T/sq ft

Method of saturation: ____ ; [ ] Controlled stress; [X] Controlled strain

Test No.		1	2	3
Initial: Water content	w_o	41.99 %	45.14 %	47.59 %
Initial: Void ratio	e_o	1.142	1.231	1.262
Initial: Saturation	S_o	98.14 %	97.90 %	100.0 %
Initial: Dry density, lb/cu ft	γ_d	77.75	74.69	73.63
Minor principal stress, T/sq ft	σ_3	0.6	1.6	3.3
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.63	0.60	0.66
Time to failure, min	t_f	13.30	5.23	9.15
Rate of strain, percent/min		0.56	0.66	0.66
Wet Density lb/cu ft		110.44	108.39	108.70
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Type of test "Q" — Type of specimen 5" Undisturbed

Classification: St(Gr)CH3;lns ML&few org stks;ox ars;yellow cast;SL

LL 67 | PL 25 | PI 42 | * UCT - 715 | G_s 2.6792

Remarks: NOD Testing Section; * Attb. & UCT from 21-B

Project: New Orleans to Venice — Reach B1 Tropical Bend to Fort Jackson — Area Sta. 44+12.4 - 400' F.W.S. B.L. — Boring No. 1-DU-1 — Sample No. 21-C — Depth / El. 81.1 / -77.9 — Date 19 June 70

TRIAXIAL COMPRESSION TEST REPORT

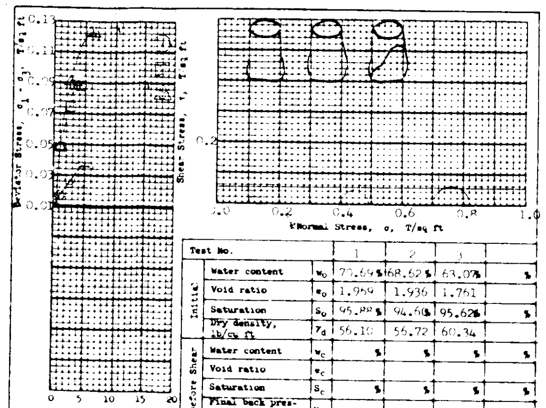
ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA
BORING 1-DU-1

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

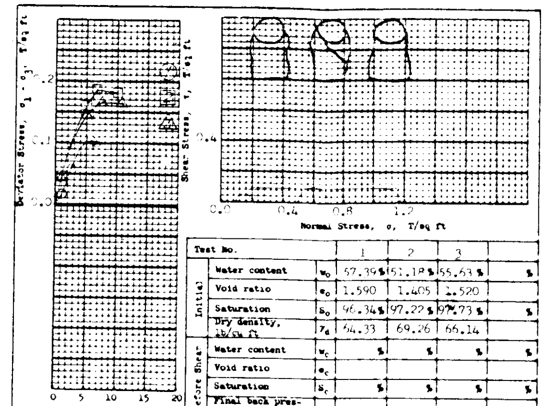
AUGUST 1971 — FILE NO. H-2-25712



Test No.			1	2	3	
Initial	Water content	w_o	70.69 %	68.62 %	63.07 %	%
Initial	Void ratio	e_o	1.969	1.936	1.761	
Initial	Saturation	S_o	95.88 %	94.60 %	95.62 %	%
Initial	Dry density, lb/cu ft	γ_d	56.10	56.72	60.34	
Before Shear	Water content	w_c	%	%	%	%
Before Shear	Void ratio	e_c				
Before Shear	Saturation	S_c	%	%	%	%
Before Shear	Final back pressure, T/sq ft	u_o				
Final	Water content	w_f	%	%	%	%
Final	Void ratio	e_f				
Minor principal stress, T/sq ft		σ_3	0.1	0.4	0.7	
Max deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{max}$	0.04	0.09	0.12	
Time to failure, min		t_f	6.40	10.77	21.02	
Rate of strain, percent/min			0.65	0.29	0.31	
Wet Density lb/cu ft			95.78	95.66	98.40	
Ult deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.		D_o	1.40	1.40	1.40	
Initial height, in.		H_o	3.00	3.00	3.00	

Shear Strength Parameters
φ = 0.0 °
tan φ = 0.0
c = 0.053 T/sq ft
Method of saturation ______
☐ Controlled stress
☒ Controlled strain

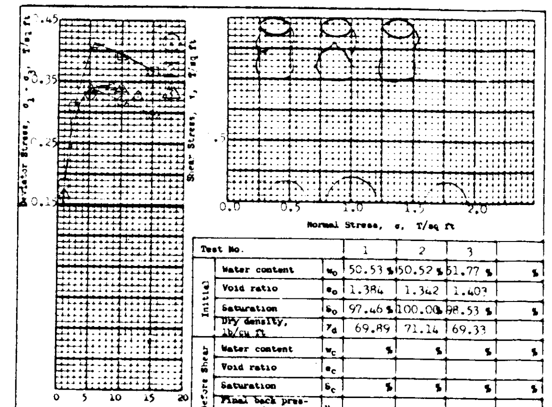
Type of test "Q" | Type of specimen 5" Undisturbed
Classification vSo(Gr)CH3;lns&ars ML;sl&slf;org stks
*LL 98 | PL 26 | PI 72 | * UCT - 151 | G_s 2.6706
Remarks NOD Testing Section
* Attb. & UCT from 4-C
Project New Orleans to Venice, La
Tropical Bend to Fort Jackson
Area Sta. 93+00 - on B.L.
Boring No. 2-DU-1 | Sample No. 4-A
Depth 11.6 El. -5.3 | Date 7 July 70
TRIAXIAL COMPRESSION TEST REPORT
ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT



Test No.			1	2	3	
Initial	Water content	w_o	57.39 %	51.18 %	55.63 %	%
Initial	Void ratio	e_o	1.590	1.405	1.520	
Initial	Saturation	S_o	96.34 %	97.22 %	97.73 %	%
Initial	Dry density, lb/cu ft	γ_d	64.33	69.26	66.14	
Before Shear	Water content	w_c	%	%	%	%
Before Shear	Void ratio	e_c				
Before Shear	Saturation	S_c	%	%	%	%
Before Shear	Final back pressure, T/sq ft	u_o				
Final	Water content	w_f	%	%	%	%
Final	Void ratio	e_f				
Minor principal stress, T/sq ft		σ_3	0.1	0.5	1.0	
Max deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{max}$	0.10	0.19	0.17	
Time to failure, min		t_f	8.88	26.68	26.27	
Rate of strain, percent/min			0.65	0.28	0.28	
Wet Density lb/cu ft			101.21	104.71	102.90	
Ult deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.		D_o	1.40	1.40	1.40	
Initial height, in.		H_o	3.00	3.00	3.00	

Shear Strength Parameters
φ = 0.0 °
tan φ = 0.0
c = 0.090 T/sq ft
Method of saturation ______
☐ Controlled stress
☒ Controlled strain

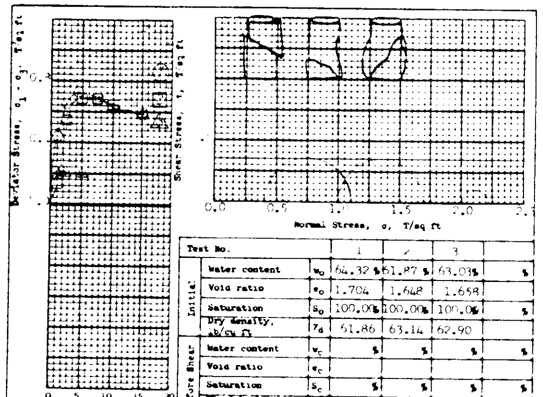
Type of test "Q" | Type of specimen 5" Undisturbed
Classification vSo(Gr)CH2;lns,lvs&ars ML;dw;org stks
LL 53 | PL 26 | PI 27 | UCT - 149 | G_s 2.6720
Remarks NOD Testing Section
Project New Orleans to Venice, La.
Tropical Bend to Fort Jackson
Area Sta. 93+00 - on B.L.
Boring No. 2-DU-1 | Sample No. 6-B
Depth 20.3 El. [illegible] | Date 6 July 70
TRIAXIAL COMPRESSION TEST REPORT
ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT



Test No.			1	2	3	
Initial	Water content	w_o	50.53 %	50.52 %	51.77 %	%
Initial	Void ratio	e_o	1.384	1.342	1.403	
Initial	Saturation	S_o	97.46 %	100.00 %	98.53 %	%
Initial	Dry density, lb/cu ft	γ_d	69.89	71.14	69.33	
Before Shear	Water content	w_c	%	%	%	%
Before Shear	Void ratio	e_c				
Before Shear	Saturation	S_c	%	%	%	%
Before Shear	Final back pressure, T/sq ft	u_o				
Final	Water content	w_f	%	%	%	%
Final	Void ratio	e_f				
Minor principal stress, T/sq ft		σ_3	0.3	0.8	1.6	
Max deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{max}$	0.34	0.41	0.34	
Time to failure, min		t_f	10.28	22.09	28.06	
Rate of strain, percent/min			0.65	0.27	0.29	
Wet Density lb/cu ft			105.21	107.08	105.21	
Ult deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.		D_o	1.40	1.40	1.40	
Initial height, in.		H_o	3.00	3.00	3.00	

Shear Strength Parameters
φ = 0.0 °
tan φ = 0.0
c = 0.170 T/sq ft
Method of saturation ______
☐ Controlled stress
☒ Controlled strain

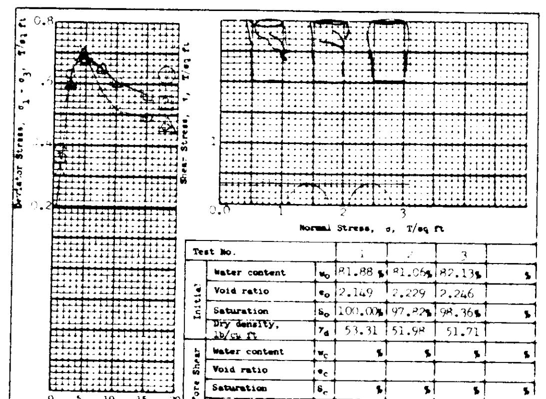
Type of test "Q" | Type of specimen 5" Undisturbed
Classification So(Gr)CH4;lns&lys ML;spcs dw;org stks
*LL 83 | PL 28 | PI 55 | * UCT - 325 | G_s 2.6749
Remarks NOD Testing Section
* Attb. & UCT from 9-C
Project New Orleans to Venice, La.
Tropical Bend to Fort Jackson
Area Sta. 93+00 - on B.L.
Boring No. 2-DU-1 | Sample No. 9-D
Depth 34.0 El. -28.7 | Date 6 July 70
TRIAXIAL COMPRESSION TEST REPORT
ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT



Test No.			1	2	3	
Initial	Water content	w_o	64.32 %	61.87 %	63.03 %	%
Initial	Void ratio	e_o	1.704	1.648	1.658	
Initial	Saturation	S_o	100.00 %	100.00 %	100.00 %	%
Initial	Dry density, lb/cu ft	γ_d	61.86	63.14	62.90	
Before Shear	Water content	w_c	%	%	%	%
Before Shear	Void ratio	e_c				
Before Shear	Saturation	S_c	%	%	%	%
Before Shear	Final back pressure, T/sq ft	u_o				
Final	Water content	w_f	%	%	%	%
Final	Void ratio	e_f				
Minor principal stress, T/sq ft		σ_3	0.4	1.0	2.0	
Max deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{max}$	0.71	0.69	0.72	
Time to failure, min		t_f	7.04	17.40	5.84	
Rate of strain, percent/min			0.63	0.29	0.28	
Wet Density lb/cu ft			101.64	102.21	102.59	
Ult deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.		D_o	1.40	1.40	1.40	
Initial height, in.		H_o	3.00	3.00	3.00	

Shear Strength Parameters
φ = 0.0 °
tan φ = 0.0
c = 0.350 T/sq ft
Method of saturation ______
☐ Controlled stress
☒ Controlled strain

Type of test "Q" | Type of specimen 5" Undisturbed
Classification So(Gr)CH4;lns&ars ML;dw;sl&slf
*LL 84 | PL 26 | PI 58 | * UCT - 456 | G_s 2.6849
Remarks NOD Testing Section
* Attb. & UCT from 12-C
Project New Orleans to Venice, La.
Tropical Bend to Fort Jackson
Area Sta. 93+00 - on B.L.
Boring No. 2-DU-1 | Sample No. 12-C
Depth 45.2 El. -39.9 | Date 7 July 70
TRIAXIAL COMPRESSION TEST REPORT
ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT



Test No.			1	2	3	
Initial	Water content	w_o	81.88 %	81.06 %	82.13 %	%
Initial	Void ratio	e_o	2.149	2.229	2.246	
Initial	Saturation	S_o	100.00 %	97.82 %	98.36 %	%
Initial	Dry density, lb/cu ft	γ_d	53.31	51.98	51.71	
Before Shear	Water content	w_c	%	%	%	%
Before Shear	Void ratio	e_c				
Before Shear	Saturation	S_c	%	%	%	%
Before Shear	Final back pressure, T/sq ft	u_o				
Final	Water content	w_f	%	%	%	%
Final	Void ratio	e_f				
Minor principal stress, T/sq ft		σ_3	0.4	1.1	2.1	
Max deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{max}$	0.71	0.68	0.70	
Time to failure, min		t_f	6.83	18.40	14.78	
Rate of strain, percent/min			0.64	0.28	0.29	
Wet Density lb/cu ft			96.97	94.10	94.16	
Ult deviator stress, T/sq ft		$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.		D_o	1.40	1.40	1.40	
Initial height, in.		H_o	3.00	3.00	3.00	

Shear Strength Parameters
φ = 0.0 °
tan φ = 0.0
c = 0.353 T/sq ft
Method of saturation ______
☐ Controlled stress
☒ Controlled strain

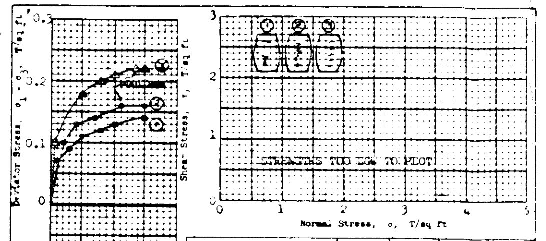
Type of test "Q" | Type of specimen 5" Undisturbed
Classification So(Gr)CH4;lns ML;& few thin lys ML;dw;rt;slf;org ars;SL
*LL 100 | PL 28 | PI 72 | * UCT - 470 | G_s 2.6907
Remarks NOD Testing Section
* Attb. & UCT from 13-C
Project New Orleans to Venice, La.
Tropical Bend to Fort Jackson
Area Sta. 93+00 - on B.L.
Boring No. 2-DU-1 | Sample No. 13-B
Depth 48.3 El. -43.0 | Date 7 July 70
TRIAXIAL COMPRESSION TEST REPORT
ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA
BORING 2-DU-1

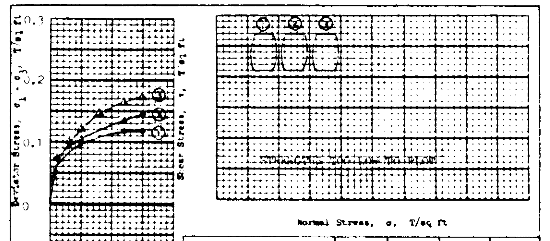
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



Triaxial Compression Test Report: Project New Orleans to Venice, La.; Reach B-1, Tropical Bend to Fort Jackson; Area Sta. 96+05; on B/L; Boring No. 2-DU; Sample No. 1-B; El -0.8; Date 25 July 1967; Type of test Q; Type of specimen UNDISTURBED; Controlled strain. Shear strength parameters: φ = 0°, tan φ = 0, c = 0.08 T/sq ft.

Classification: CLAY (CH), GRAY, WITH DECOMPOSED VEGETATION

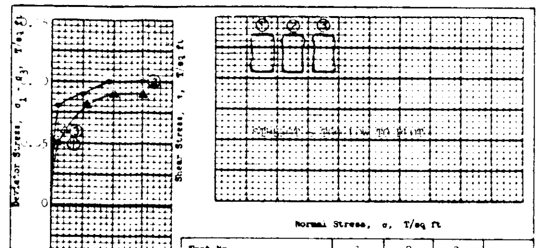


Triaxial Compression Test Report

Field	Value
Type of test	Q
Type of specimen	UNDISTURBED
Classification	PEAT (PT), BROWN
LL	568
PL	278
PI	290
G_s	1.95
Project	New Orleans to Venice, La.
	Reach B-1, Tropical Bend to Fort Jackson
Area	Sta. 96+05; on B/L
Boring No.	2-DU
Sample No.	2-C
El	-4.1
Date	26 JULY 1967

	1	2	3
Rate of strain, percent/min	0.47	0.45	0.48
Initial diameter, in. D_o	1.38	1.37	1.36
Initial height, in. H_o	3.00	3.00	3.00

Controlled strain. Shear strength parameters: φ = 0°, tan φ = 0, c = 0.08 T/sq ft.

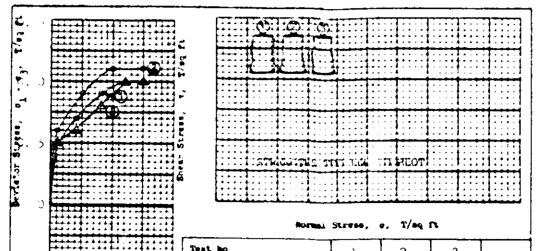


Triaxial Compression Test Report

Field	Value
Type of test	Q
Type of specimen	UNDISTURBED
Classification	CLAY (CH), GRAY, WITH DECOMPOSED VEGETATION
LL	101
PL	35
PI	66
G_s	2.66
Project	New Orleans to Venice, La.
	Reach B-1, Tropical Bend to Ft. Jackson
Area	Sta. 96+05; on B/L
Boring No.	2-DU
Sample No.	3-B
El	-7.5
Date	26 JULY 1967

	1	2	3
Time to failure, min t_f	21	19	20
Rate of strain, percent/min	0.48	0.48	0.50
Initial diameter, in. D_o	1.38	1.38	1.38
Initial height, in. H_o	3.00	3.00	3.00

Controlled strain. Shear strength parameters: φ = 0°, tan φ = 0, c = 0.05 T/sq ft.

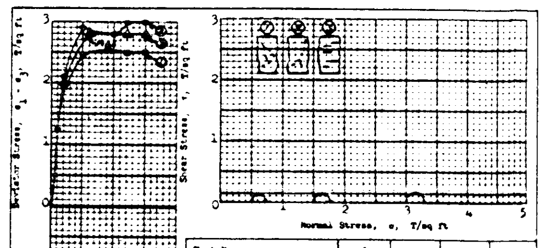


Triaxial Compression Test Report

Field	Value
Type of test	Q
Type of specimen	UNDISTURBED
Classification	SILTY CLAY (CL), GRAY, HOMOGENEOUS
LL	43
PL	20
PI	23
G_s	2.68
Project	New Orleans to Venice, La.
	Reach B-1, Tropical Bend to Fort Jackson
Area	Sta. 96+05; on B/L
Boring No.	2-DU
Sample No.	4-B
El	-11.5
Date	27 JULY 1967

	1	2	3
Rate of strain, percent/min	0.45	0.50	0.50
Initial diameter, in. D_o	1.39	1.39	1.40
Initial height, in. H_o	3.00	3.00	3.00

Controlled strain. Shear strength parameters: φ = 0°, tan φ = 0, c = 0.05 T/sq ft.

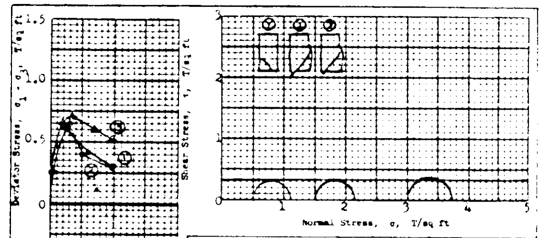


Triaxial Compression Test Report

Field	Value
Type of test	Q
Type of specimen	UNDISTURBED
Classification	SILTY CLAY (CL), GRAY, WITH ALTERNATING LAYERS OF CLAYEY *
LL	46
PL	22
PI	24
G_s	2.69
Remarks	* SILT. CLAY LAYERS 1" to 2" THICK. SILT 1/8" to 1/4" THICK
Project	New Orleans to Venice, La.
	Reach B-1, Tropical Bend to Fort Jackson
Area	Sta. 96+05; on B/L
Boring No.	2-DU
Sample No.	8-B
El	-21.2
Date	27 July 1967

	1	2	3
Time to failure, min t_f	19	15	18
Rate of strain, percent/min	0.47	0.33	0.34
Initial diameter, in. D_o	1.39	1.38	1.39
Initial height, in. H_o	3.00	3.00	3.00

Shear strength parameters: φ = 0°, tan φ = 0, c = 0.14 T/sq ft.

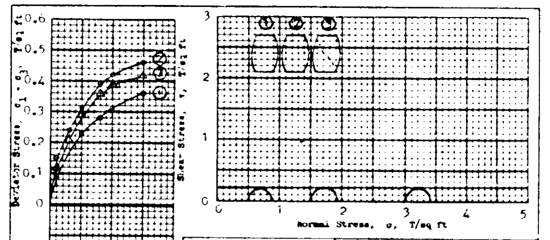


Triaxial Compression Test Report

Field	Value
Type of test	Q
Type of specimen	UNDISTURBED
Classification	CLAY (CH), GRAY, WITH [illegible], FISSURED *
LL	115
PL	43
PI	72
G_s	2.66
Remarks	* ALSO TRACES OF DECOMPOSED VEGETATION
Project	New Orleans to Venice, La.
	Reach B-1, Tropical Bend to Fort Jackson
Area	Sta. 96+05; on B/L
Boring No.	2-DU
Sample No.	12-B
El	-43.5
Date	28 July 1967

	1	2	3
Time to failure, min t_f	16	18	32
Rate of strain, percent/min	0.16	0.21	0.11
Initial diameter, in. D_o	1.38	1.38	1.38
Initial height, in. H_o	3.00	3.00	3.00

Controlled strain. Shear strength parameters: φ = 0°, tan φ = 0, c = 0.32 T/sq ft.

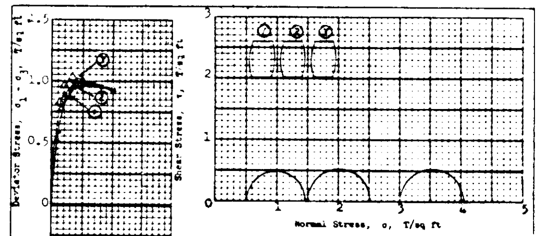


Triaxial Compression Test Report

Field	Value
Type of test	Q
Type of specimen	UNDISTURBED
Classification	[illegible]
LL	35
PL	22
PI	13
G_s	2.68
Project	New Orleans to Venice, La.
	Reach B-1, Tropical Bend to Fort Jackson
Area	Sta. 96+05; on B/L
Boring No.	2-DU
Sample No.	13-D
El	-49.2
Date	31 JULY 1967

	1	2	3
Time to failure, min t_f	22	30	30
Rate of strain, percent/min	0.50	0.50	0.50
Initial diameter, in. D_o	1.38	1.38	1.38
Initial height, in. H_o	3.00	3.00	3.00

Controlled strain. Shear strength parameters: φ = 0°, tan φ = 0, c = 0.21 T/sq ft.

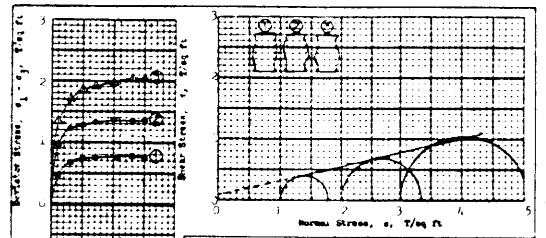


Triaxial Compression Test Report

Field	Value
Type of test	Q
Type of specimen	UNDISTURBED
Classification	CLAY (CH), GRAY, WITH ALTERNATING LAYERS OF CLAY, [illegible] 1" *
LL	59
PL	24
PI	35
G_s	2.71
Remarks	* THICK AND FINE [illegible] (CL) 1/4" THICK
Project	New Orleans to Venice, La.
	Reach B-1, Tropical Bend to Fort Jackson
Area	Sta. 96+05; on B/L
Boring No.	2-DU
Sample No.	20-C
El	-76.5
Date	31 July 1967

	1	2	3
Time to failure, min t_f	30	22	21
Rate of strain, percent/min	0.16	0.16	0.16
Initial diameter, in. D_o	1.38	1.37	1.37
Initial height, in. H_o	3.00	3.00	3.00

Controlled strain. Shear strength parameters: φ = 0°, tan φ = 0, c = 0.50 T/sq ft.

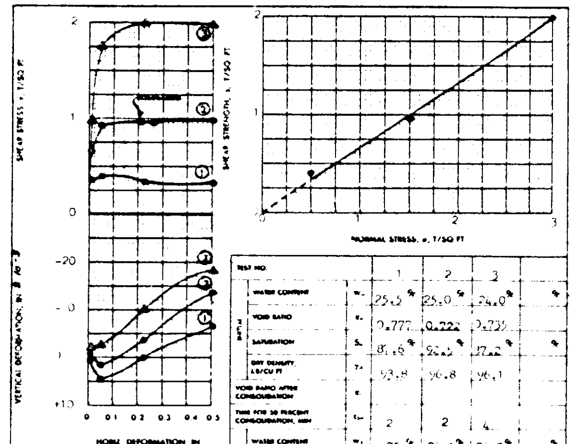


Triaxial Compression Test Report

Field	Value
Type of test	R
Type of specimen	UNDISTURBED
Classification	CLAY (CH), gray, homogeneous
LL	81
PL	26
PI	55
G_s	2.73
Remarks	* Pore pressure response indicated 100% saturation
Project	New Orleans to Venice, La.
	Reach B-1, Tropical Bend to Ft. Jackson
Area	Sta. 96+05; on B/L
Boring No.	[illegible]
Sample No.	[illegible]
El	-24.6
Date	6 JULY 1967

	1	2	3
Time to failure, min t_f	65	59	87
Rate of strain, percent/min	0.20	0.17	0.15
Initial diameter, in. D_o	1.37	1.37	1.37
Initial height, in. H_o	3.00	3.00	3.00

Controlled strain. Shear strength parameters: φ = 13°, tan φ = 0.231, c = 0.08 T/sq ft.



Direct Shear Test Report

Field	Value
Type of specimen	UNDISTURBED; 3.01 in square; 0.465 in thick
Classification	SILTY SAND (SM), gray,
LL	—
PL	—
PI	—
G_s	2.67
Project	New Orleans to Venice, La.
	Reach B-1, Tropical Bend to Fort Jackson
Area	Sta. 96+05; on B/L
Boring No.	2-DU
Sample No.	4-D
El	-12.9
Date	24 JULY 1967

	1	2	3
Time for 50 percent consolidation, min	2	2	4
Final water content, %	25.6	26.5	26.8
Normal stress, T/sq ft	0.5	1.5	3.0
Maximum shear stress, T/sq ft	0.40	0.96	2.00
Actual time to failure, min	360	1230	1320
Rate of strain, in./min	.00018	.00018	.00018

Controlled strain. Shear strength parameters: φ = 34°, tan φ = 0.674, c = 0 T/sq ft.

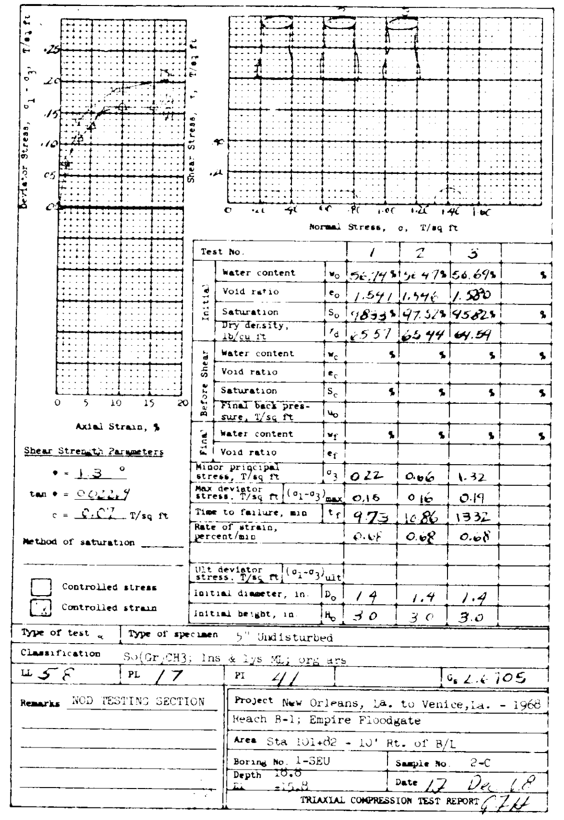
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

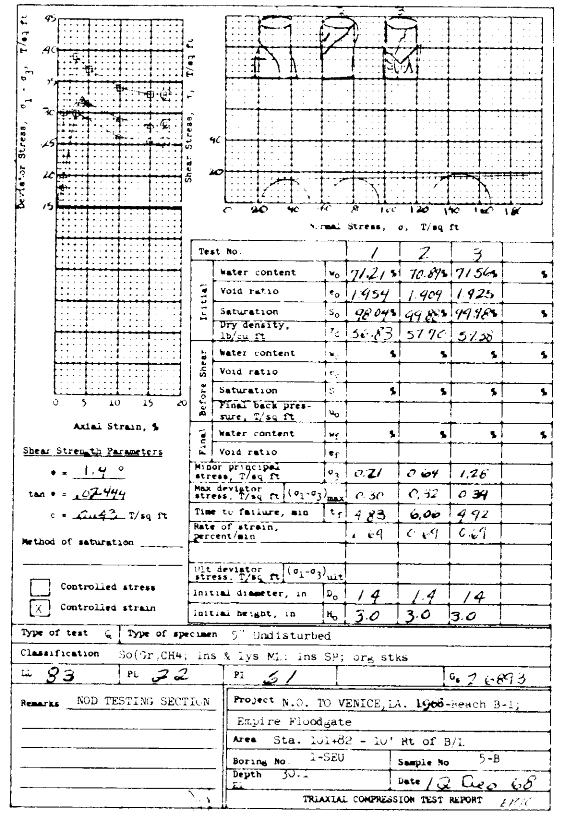
DETAIL SHEAR STRENGTH DATA
BORING 2-DU

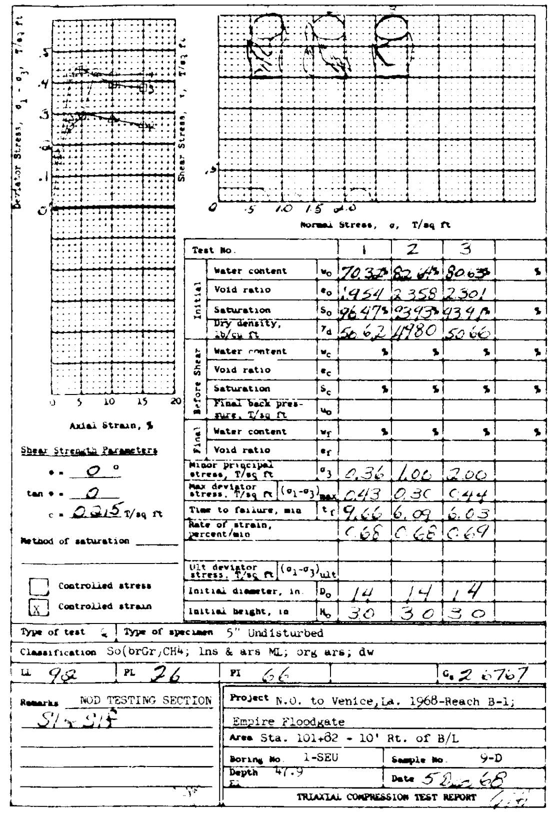
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

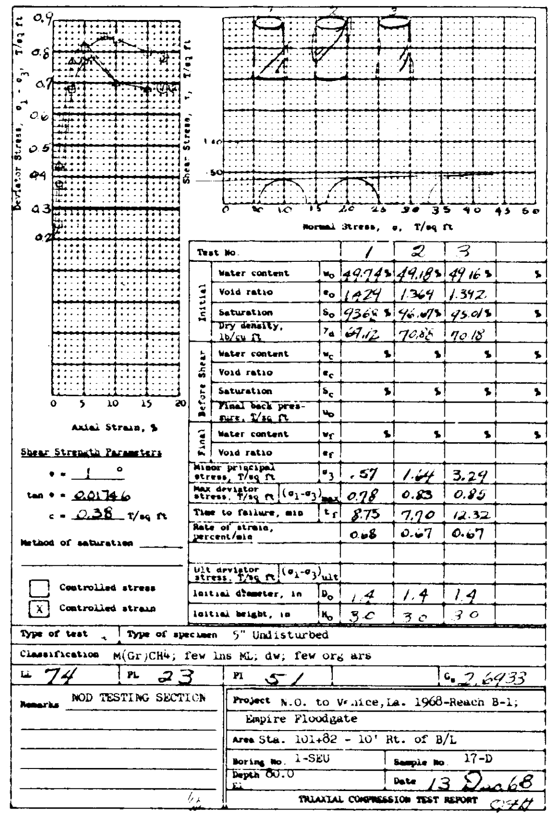
AUGUST 1971 FILE NO. H-2-25712

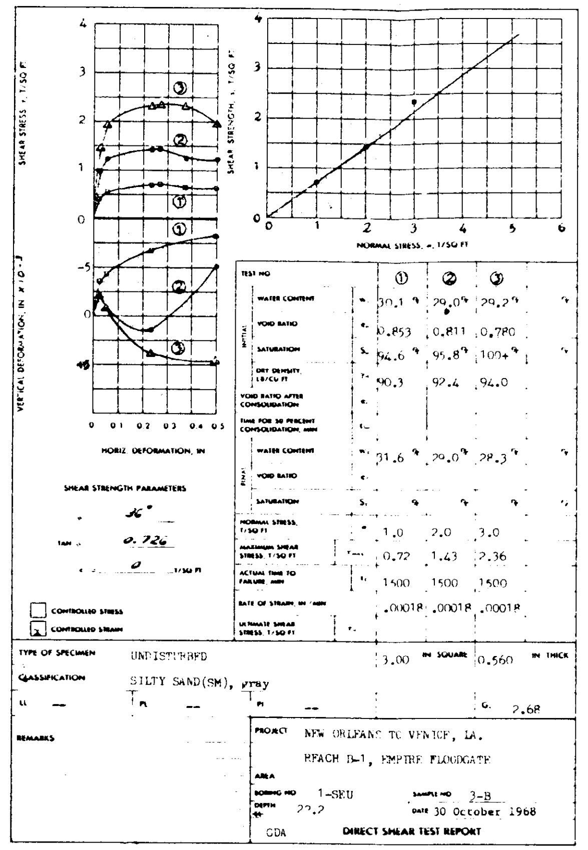
PLATE 73

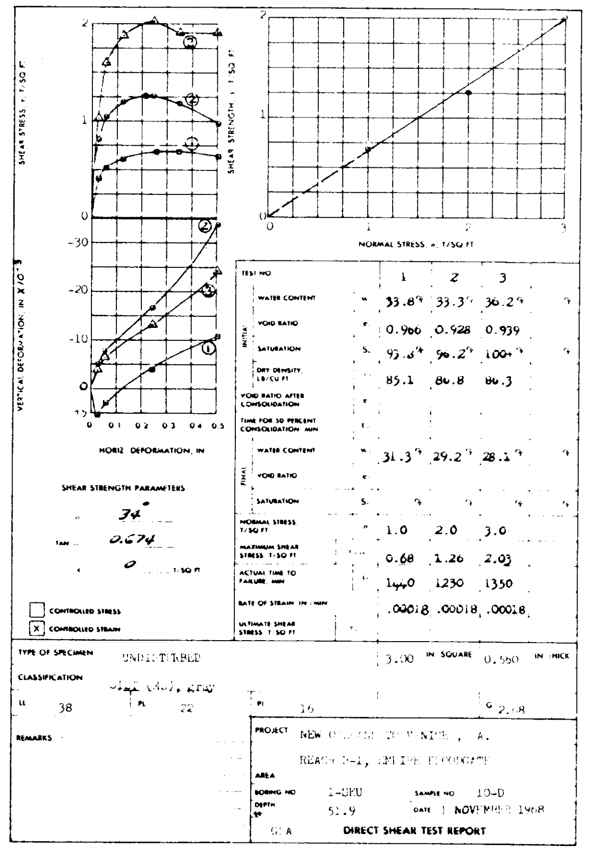


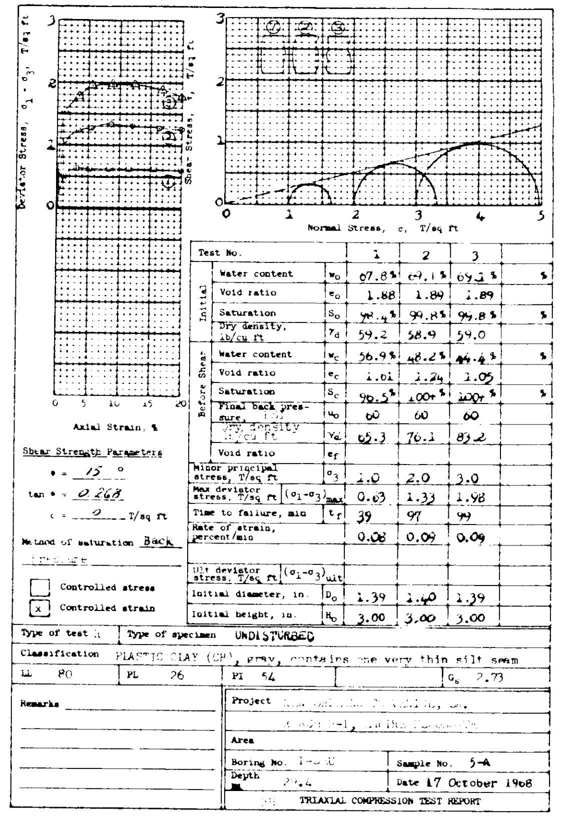


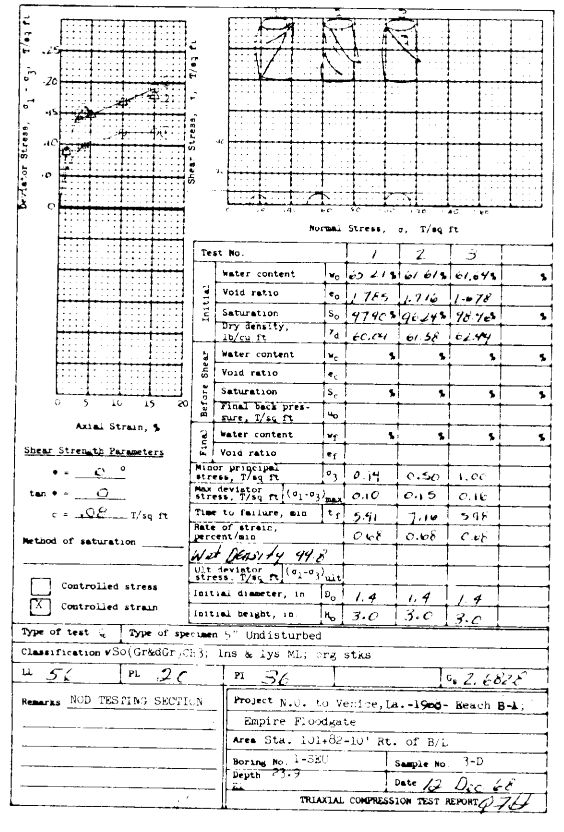


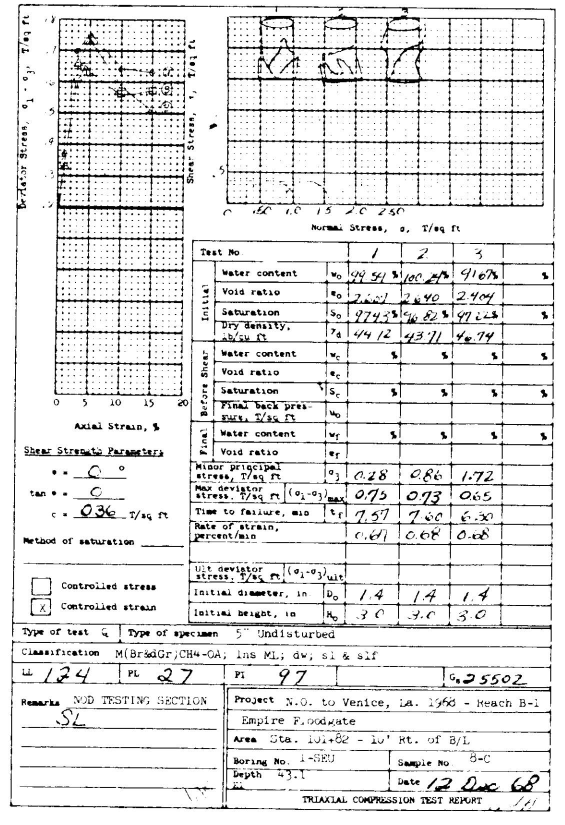


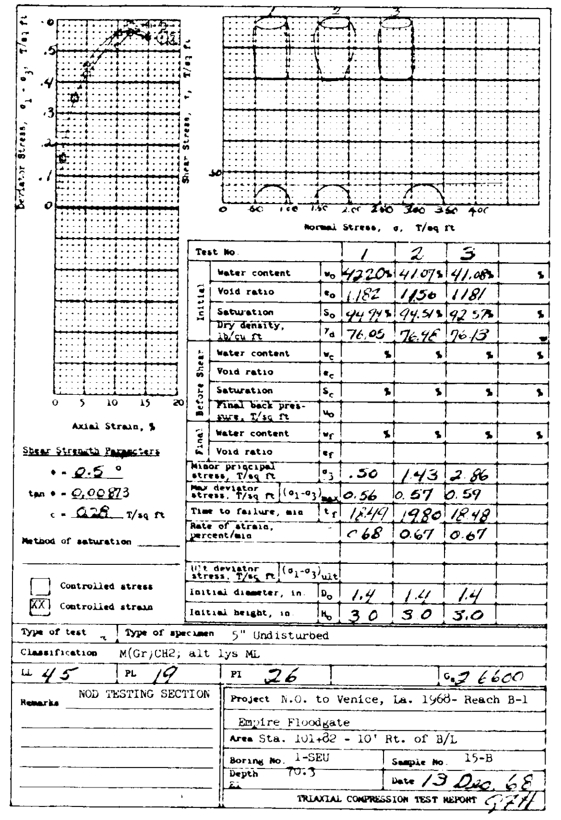


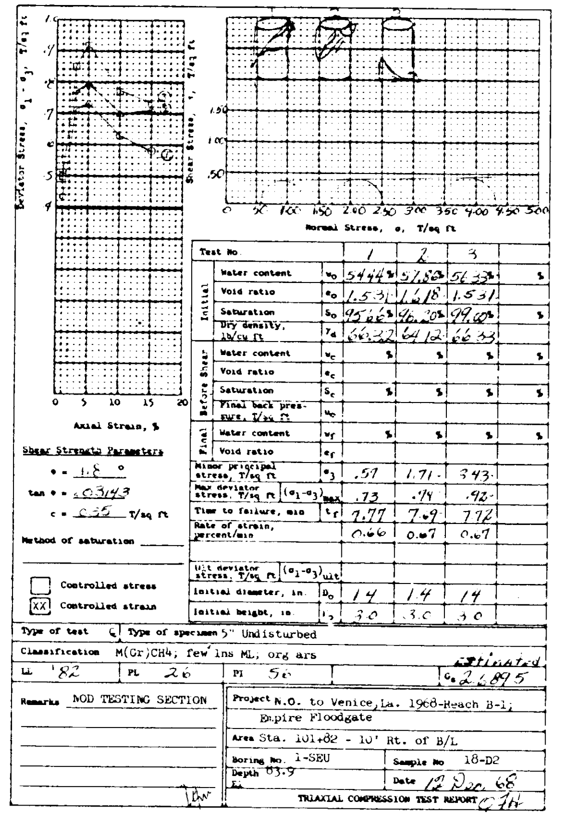


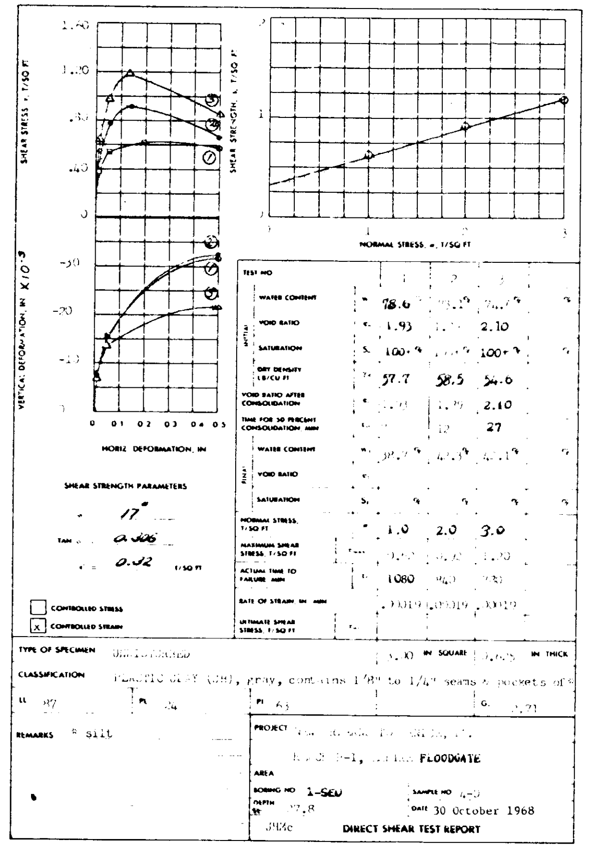


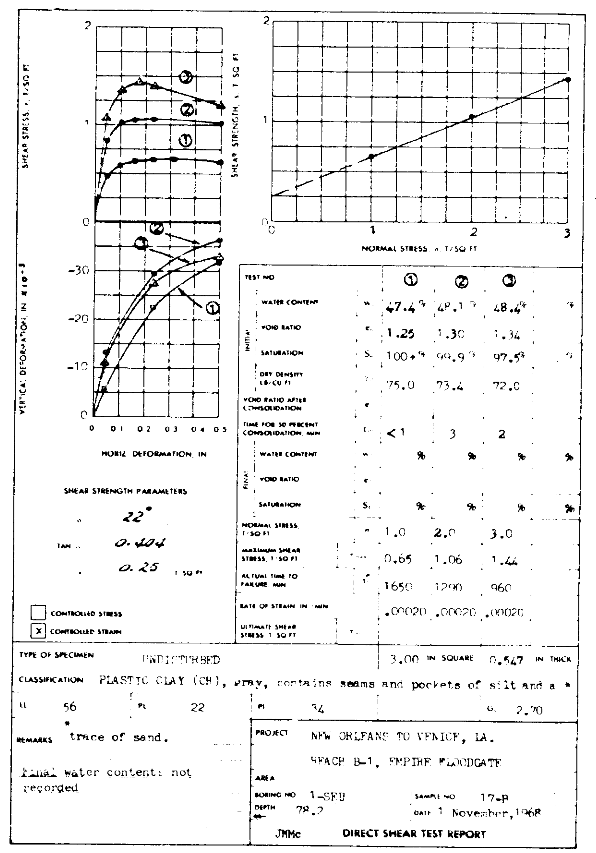












NEW ORLEANS TO VENICE, LA
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN

REACH B1 - TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA
BORING 1-SEU

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

SUMMARY OF LABORATORY TEST RESULTS

BORING 4BSU

Sample No.	Depth in Ft.	Classification	Water Content Percent	Density Lbs./Cu.Ft. Dry	Density Lbs./Cu.Ft. Wet	Unconfined Compressive Strength Lbs./Sq.Ft.	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Type Shear Test
2	0.5	ML - Loose tan; w/trace of roots	35.3	-----	-----	----	--	--	--	--
6	2.5	OH - Very soft gray; w/sand lenses	73.4	55.5	96.2	250	84	26	58	UC
7	3.0	CH - Very soft gray; w/sand lenses & organic matter	73.9	57.1	99.3	Ø=1°c=110	121	28	93	Q
9	5.0	Pt - Soft brown	318.3	-----	-----	----	--	--	--	--
11	6.0	Pt-OH - Very soft brown; w/roots	191.4	26.7	77.8	295	212	44	168	UC
13	7.0	Pt - Soft brown	285.6	-----	-----	----	--	--	--	--
16	9.5	OH - Very soft gray; w/roots	143.7	34.4	83.8	285	154	42	112	UC
18	10.5	CL - Very soft gray; w/silt lenses	41.5	79.6	112.2	Ø=0°c=50	34	26	8	Q
19	11.5	CL - Very soft gray; w/silt lenses	39.1	81.6	113.5	385				UC
24	14.5	ML - Loose gray; w/clay layers	29.5	-----	-----	----	--	--	--	--
28	19.5	ML - Loose gray; w/clay layers	31.7	-----	-----	----	--	--	--	--
30	21.5	CH - Very soft gray; w/silt lenses	52.5	70.9	108.1	355	57	24	33	UC
31	22.0	CH - Soft gray; w/silt lenses	61.8	62.9	101.8	----	51	26	25	--
32	24.0	CH - Very soft gray	61.9	64.7	104.7	Ø=0°c=130	64	22	42	Q
35	25.5	CH - Soft gray; w/silt lenses	45.5	76.0	110.6	Ø=17°c=400	47	23	24	S
36	26.0	CH - Very soft gray; w/silt lenses	62.1	62.4	104.1	450	71	22	49	UC
39	29.5	CH - Very soft gray; w/silt lenses	64.8	-----	-----	----	--	--	--	--
41	30.5	CH - Very soft gray	63.6	61.8	101.1	570	87	27	60	UC
42	31.0	CH - Very soft gray; w/silt lenses	67.5	60.2	100.8	Ø=1°c=100	73	28	45	Q
44	32.0	CH - Soft gray; w/silty sand layers	54.3	-----	-----	----	--	--	--	--
46	34.5	CH - Soft gray; w/silty sand layers	63.2	63.2	103.1	485	82	25	57	UC
49	37.5	CH - Medium stiff gray; w/organic matter	103.3	44.3	90.1	1300	178	45	133	UC
52	39.0	CL - Very soft gray; w/sand lenses	38.6	81.4	112.8	----	34	22	12	--
54	40.5	CH-CL - Very soft gray; w/many silt lenses	38.8	81.0	112.4	265	30	21	9	UC
55	41.0	CL - Very soft gray; w/silt lenses	36.6	84.2	115.0	Ø=1°c=110	29	28	1	Q
56A	44.5	CL - Soft gray; w/sandy silt layers	39.0	-----	-----	----	--	--	--	--
56C	45.5	CH - Medium stiff gray; w/silt lenses	57.8	66.2	104.5	1120	77	27	50	UC
56D	46.0	CH-OH - Medium stiff dark gray; w/organic matter	87.8	49.9	93.7	Ø=17°c=400	114	40	74	S
57	49.0	CH-OH - Medium stiff dark gray; w/organic matter	77.1	-----	-----	----	--	--	--	--
58	49.5	CH - Medium stiff gray	59.2	64.5	102.8	Ø=3°c=250	76	28	48	Q
59	50.0	CH - Medium stiff gray	58.0	65.1	102.9	830	82	24	58	UC
62	51.5	CH - Medium stiff gray; w/silt layers	53.8	-----	-----	----	--	--	--	--
64	54.0	ML - Loose gray; w/clay layers	32.6	-----	-----	-- ----	--	--	--	--
67	55.5	ML - Loose gray; w/clay layers	32.3	89.3	118.0	Ø=4°c=245	33	27	6	Q
69	56.5	SM - Medium dense gray; w/clay layers	32.4	-----	-----	----	--	--	--	--
70	58.0	CH - Medium stiff gray; w/silty sand layers	44.6	-----	-----	----	--	--	--	--
72	60.0	CL - Loose gray; w/clay lenses	37.7	82.5	113.5	Ø=2°c=245	55	27	28	Q
73	60.5	CL - Soft gray; w/silt lenses	56.0	67.0	104.5	----	34	21	13	--
76	64.0	CL - Soft gray; w/silty sand layers	30.5	-----	-----	----	--	--	--	--
78	65.0	CL - Soft gray; w/silty sand layers	40.1	78.8	110.4	515	43	26	17	UC
79	65.5	CL - Soft gray; w/silty sand layers	41.5	77.3	109.2	Ø=0°c=260	41	26	15	Q
83	67.5	ML - Medium dense gray; w/clay layers	33.3	-----	-----	----	--	--	--	--
85	71.0	SM - Loose gray; w/clay lenses	31.4	90.3	118.7	Ø=38°c=0	31	24	7	S
88	73.5	CH - Medium stiff gray; w/silt layers	47.5	74.6	110.0	1395	58	21	37	UC
92	75.5	CH - Medium stiff gray; w/silt layers	47.9	-----	-----	----	--	--	--	--
95	77.5	CL - Soft gray; w/silt layers	37.3	83.8	115.0	505	40	23	17	UC
98	79.0	CH - Medium stiff gray; w/silt lenses	49.5	73.0	109.0	Ø=2°c=375	98	26	72	Q
99	79.5	CH - Medium stiff gray; w/silt lenses	51.2	72.4	109.7	990	72	26	46	UC

NOTES:

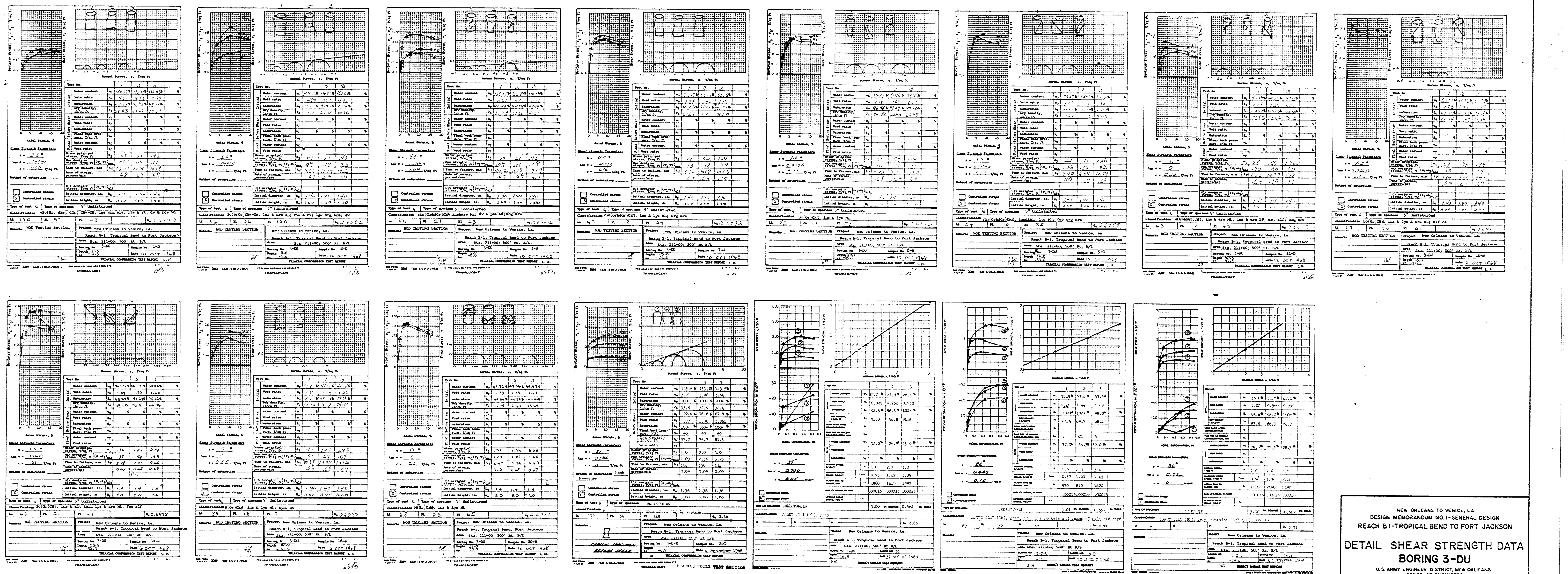
BORING TAKEN BY EUSTIS ENGINEERING COMPANY FOR THE DEPARTMENT OF PUBLIC WORKS, STATE OF LOUISIANA AND PLAQUEMINES PARISH, LOUISIANA.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. I—GENERAL DESIGN
REACH BI-TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA TABLE
BORING 4-BSU

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

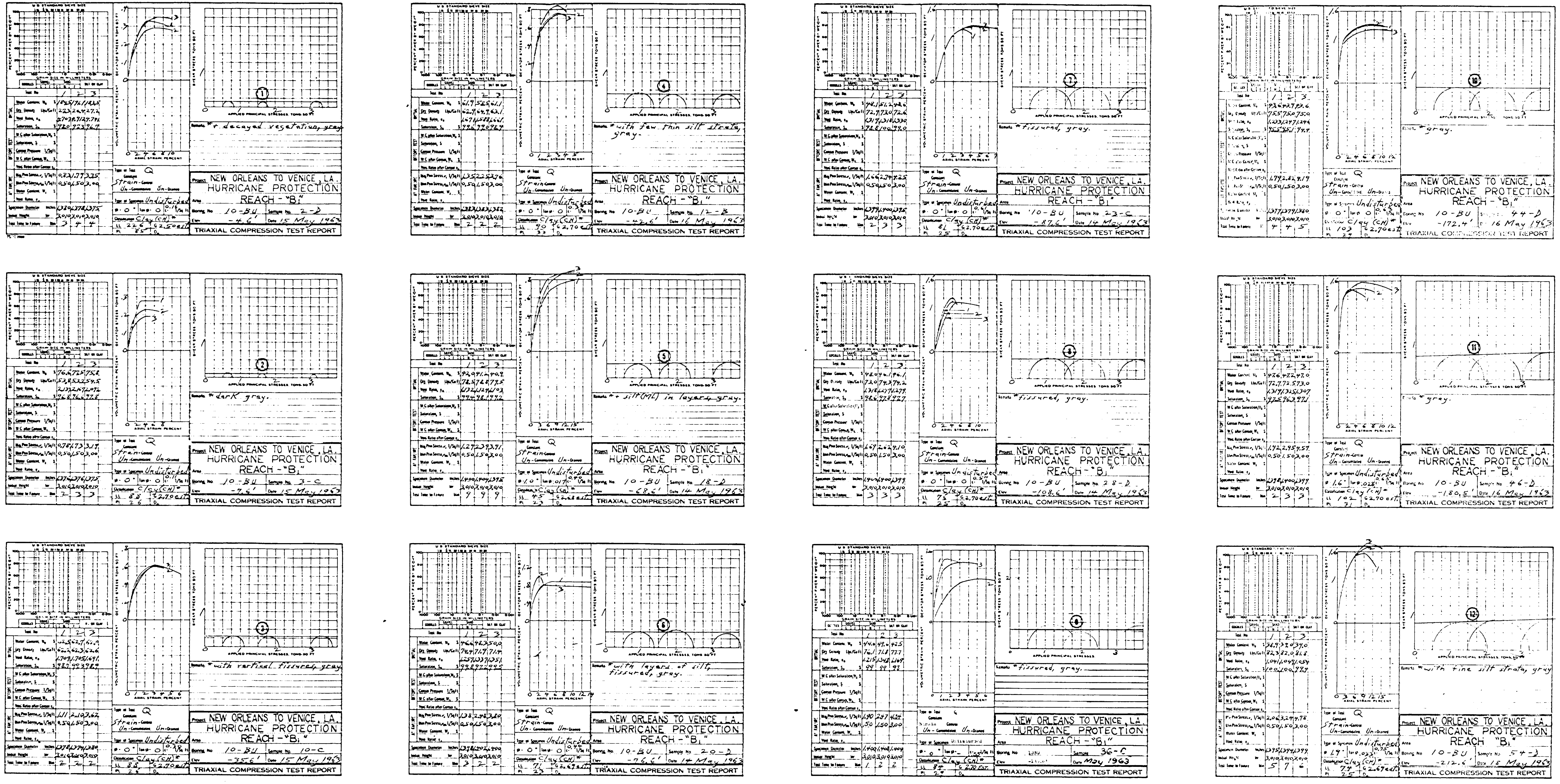


NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA
BORING 3-DU

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



(Q) - UNCONSOLIDATED - UNDRAINED SHEAR TEST

NEW ORLEANS TO VENICE, LA

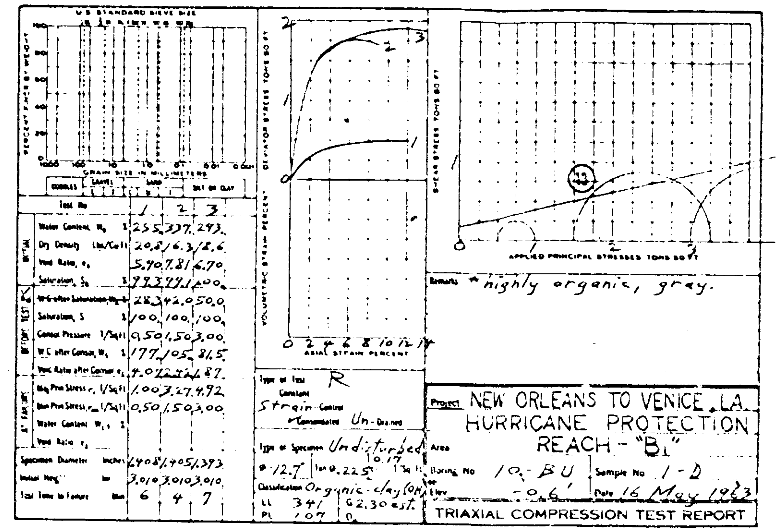
DESIGN MEMORANDUM-NO. 1 - GENERAL DESIGN

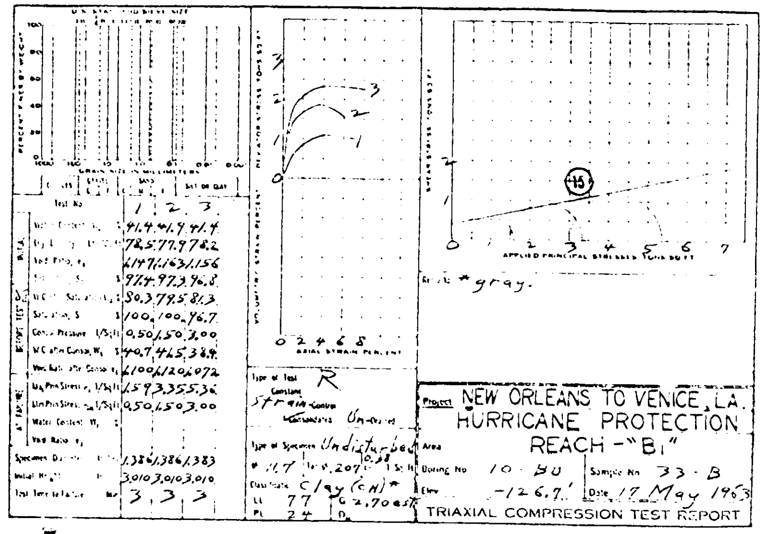
REACH B1 - TROPICAL BEND TO FORT JACKSON

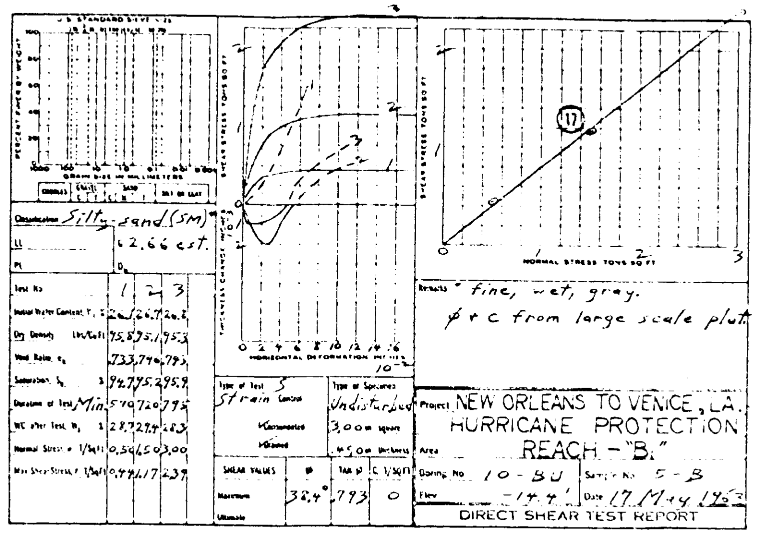
DETAIL SHEAR STRENGTH DATA
BORING 10-BU (CONT)

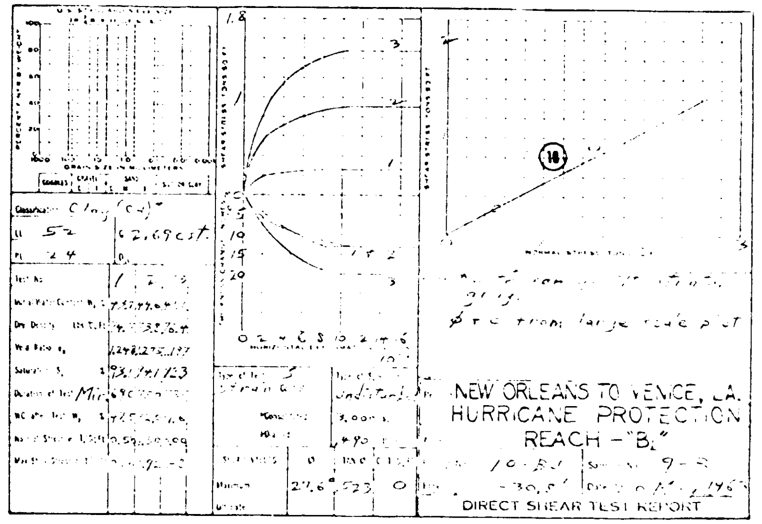
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

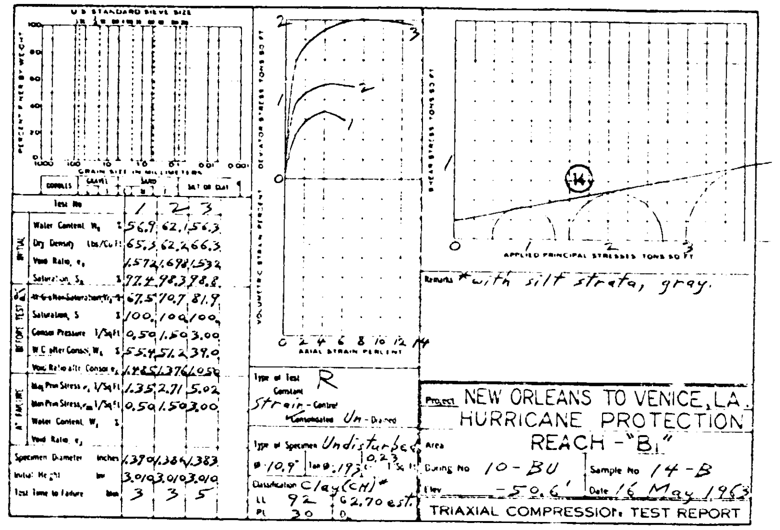


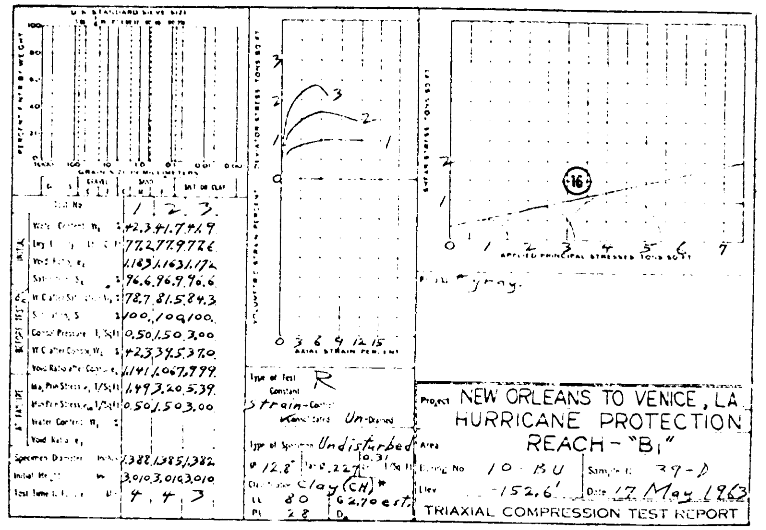


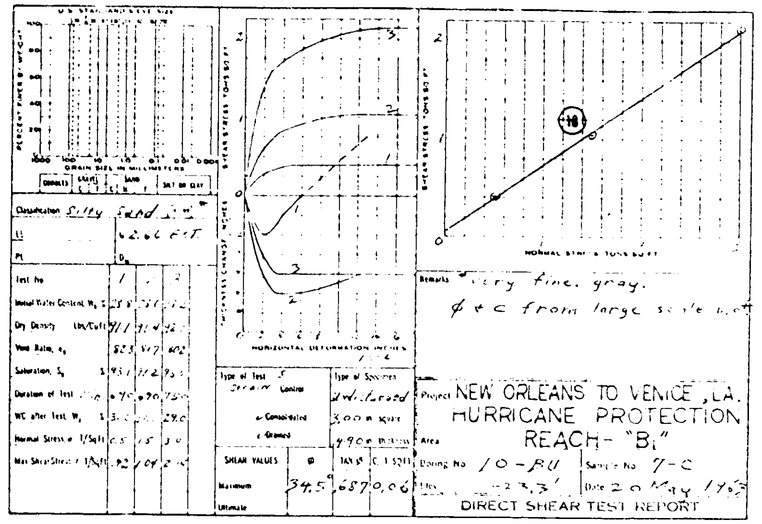




(S) - CONSOLIDATED - DRAINED SHEAR TEST







(R) - CONSOLIDATED - UNDRAINED SHEAR TEST

(S) - CONSOLIDATED - DRAINED SHEAR TEST

NEW ORLEANS TO VENICE, LA

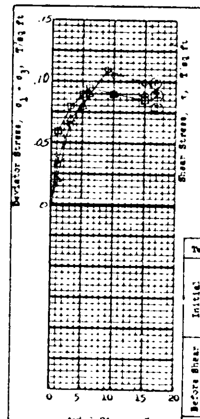
DESIGN MEMORANDUM NO 1 - GENERAL DESIGN

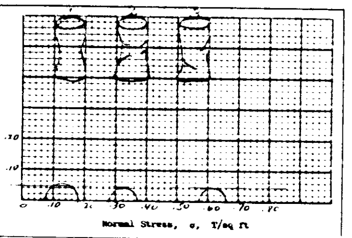
REACH B1 - TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA
BORING 10-BU

U S ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 | FILE NO. H-2-25712





Shear Strength Parameters
φ = 0°
tan φ = 0
c = .045 T/sq ft

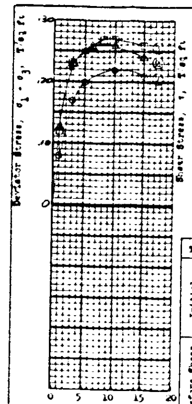
Method of saturation

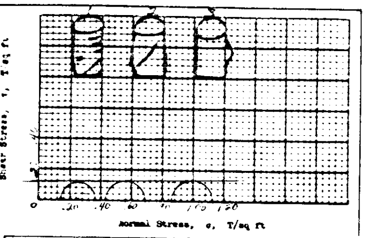
Controlled stress
[XX] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	56.60%	54.95%	54.37%	%
Void ratio	e_o	1.538	1.507	1.604	
Saturation	S_o	97.38%	97.72%	97.56%	%
Dry density, lb/cu ft	γ_d	65.39	66.70	64.24	
Before Shear: Water content	w_c	%	%	%	%
Void ratio	e_c				
Saturation	S_c	%	%	%	%
Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	.07	.28	.57	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	.11	.09	.09	
Time to failure, min	t_f	13.62	9.48	8.58	
Rate of strain, percent/min		0.68	0.67	0.67	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.4	1.4	1.4	
Initial height, in.	H_o	3.0	3.0	3.0	

Type of test Q Type of specimen 5" Undisturbed
Classification VS (Gr)CH3; lns & lys ML
LL 51 PL 20 PI 31 G_s 2.6792
Remarks NOD TESTING SECTION
Project N.O. to Venice, La. Reach B-1
Tropical Bend to Fort Jackson
Area Sta. 320+30; 760' Rt B/L
Boring No. 1-SBU Sample No. 4-D
Depth 14.0 - 20.5 Date [illegible]
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT





Shear Strength Parameters
φ = 0.8°
tan φ = .0139
c = 0.12 T/sq ft

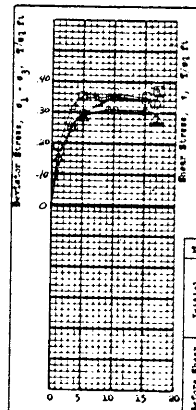
Method of saturation

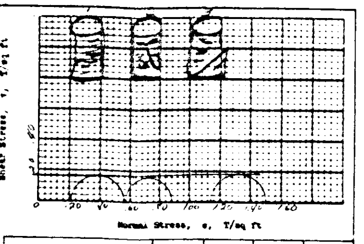
Controlled stress
[XX] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	63.53%	66.57%	66.75%	%
Void ratio	e_o	1.714	1.824	1.821	
Saturation	S_o	98.71%	97.59%	97.07%	%
Dry density, lb/cu ft	γ_d	61.41	59.00	59.07	
Before Shear: Water content	w_c	%	%	%	%
Void ratio	e_c				
Saturation	S_c	%	%	%	%
Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	.14	.43	.86	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	.22	.26	.27	
Time to failure, min	t_f	14.72	8.55	12.04	
Rate of strain, percent/min		0.67	0.67	0.62	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.4	1.4	1.4	
Initial height, in.	H_o	3.0	3.0	3.0	

Type of test Q Type of specimen 5" Undisturbed
Classification So(Gr)CH3; lns & lys ML; spcs dw
LL 58 PL 24 PI 34 G_s 2.6699
Remarks NOD TESTING SECTION
Project N.O. to Venice, La. Reach B-1
Tropical Bend to Fort Jackson
Area Sta. 320+30; 760' Rt B/L
Boring No. 1-SBU Sample No. 6-C
Depth 34.8 Date 16 Dec 68
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT





Shear Strength Parameters
φ = .25°
tan φ = .00273
c = 0.174 T/sq ft

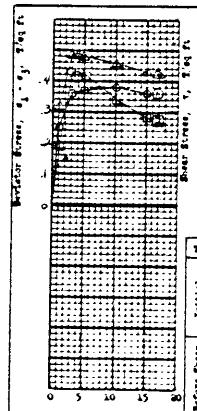
Method of saturation

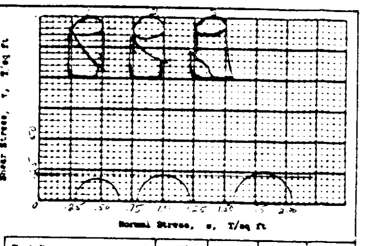
Controlled stress
[XX] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	52.49%	53.79%	51.56%	%
Void ratio	e_o	1.454	1.457	1.376	
Saturation	S_o	98.13%	99.20%	100.00%	%
Dry density, lb/cu ft	γ_d	68.26	68.32	70.64	
Before Shear: Water content	w_c	%	%	%	%
Void ratio	e_c				
Saturation	S_c	%	%	%	%
Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.21	0.57	1.14	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.35	0.31	0.36	
Time to failure, min	t_f	16.11	13.62	9.82	
Rate of strain, percent/min		0.67	0.67	0.67	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.4	1.4	1.4	
Initial height, in.	H_o	3.0	3.0	3.0	

Type of test Q Type of specimen 5" Undisturbed
Classification So(Gr)CH3; lns & lys ML
LL 65 PL 27 PI 38 G_s 2.6928
Remarks NOD TESTING SECTION
Project N.O. TO Venice, La. Reach B-1
Tropical Bend to Fort Jackson
Area Sta. 320+30; 760' Rt B/L
Boring No. 1-SBU Sample No. 8-C
Depth -34.3 Date 17 Dec 68
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT





Shear Strength Parameters
φ = 2°
tan φ = .0349
c = .1225 T/sq ft

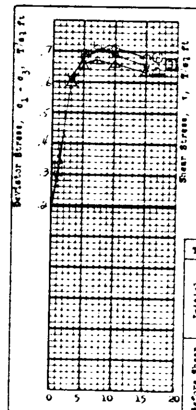
Method of saturation

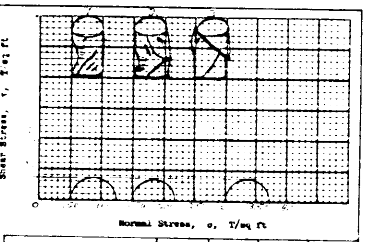
Controlled stress
[XX] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	71.61%	66.26%	70.64%	%
Void ratio	e_o	1.875	1.742	1.898	
Saturation	S_o	99.6%	99.65%	100.00%	%
Dry density, lb/cu ft	γ_d	58.92	60.13	57.91	
Before Shear: Water content	w_c	%	%	%	%
Void ratio	e_c				
Saturation	S_c	%	%	%	%
Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.28	0.79	1.57	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	.36	.43	.49	
Time to failure, min	t_f	5.15	6.31	6.40	
Rate of strain, percent/min					
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.4	1.4	1.4	
Initial height, in.	H_o	3.0	3.0	3.0	

Type of test Q Type of specimen 5" Undisturbed
Classification M(Gr&Gr)CH4; lns & few thin lys ML; org stks
LL 84 PL 32 PI 52 G_s 2.6925
Remarks NOD TESTING SECTION
Project N.O. to Venice, La. Reach B-1
Tropical Bend to Fort Jackson
Area Sta. 320+30; 760' Rt. B/L
Boring No. 1-SBU Sample No. 11-C
Depth 46.5 Date 17 Dec 68
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT





Shear Strength Parameters
φ = .25°
tan φ = .00436
c = 0.35 T/sq ft

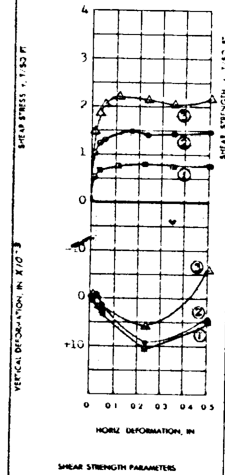
Method of saturation

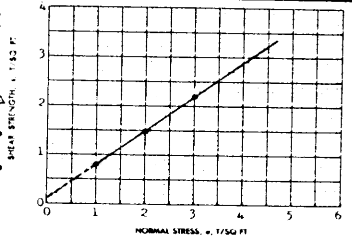
Controlled stress
[XX] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	50.75%	50.82%	50.61%	%
Void ratio	e_o	1.374	1.393	1.396	
Saturation	S_o	99.77%	98.53%	97.87%	%
Dry density, lb/cu ft	γ_d	70.99	70.42	70.32	
Before Shear: Water content	w_c	%	%	%	%
Void ratio	e_c				
Saturation	S_c	%	%	%	%
Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.50	1.50	3.00	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.72	0.67	0.72	
Time to failure, min	t_f	13.85	11.30	11.35	
Rate of strain, percent/min		0.67	0.67	0.66	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.4	1.4	1.4	
Initial height, in.	H_o	3.0	3.0	3.0	

Type of test Q Type of specimen 5" Undisturbed
Classification M(Gr)CH3' lns & thin lys ML
LL 72 PL 28 PI 44 G_s 2.6967
Remarks NOD TESTING SECTION
Project N.O. to Venice, La. Reach B-1
Tropical Bend to Fort Jackson
Area Sta. 320+30; 760' Rt. B/L
Boring No. 1-SBU Sample No. 20-D
Depth 77.7 - 83.4 Date 17 Dec 68
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE
TRANSLUCENT





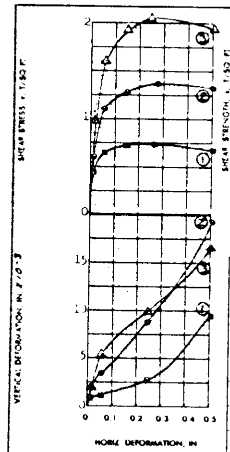
SHEAR STRENGTH PARAMETERS
φ = 35°
TAN φ = 0.700
c = 0.11 T/SQ FT

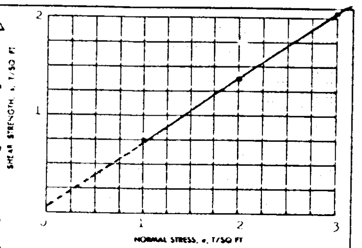
CONTROLLED STRESS
[X] CONTROLLED STRAIN

TEST NO		1	2	3	
INITIAL: WATER CONTENT	w_o	23.8%	24.0%	25.1%	%
VOID RATIO	e_o	0.710	0.714	0.733	
SATURATION	S_o	90.2%	89.4%	9[illegible].1%	%
DRY DENSITY, LB/CU FT	γ_d	97.1	96.9	95.8	
VOID RATIO AFTER CONSOLIDATION	e_c				
TIME FOR 50 PERCENT CONSOLIDATION, MIN	t_{50}				
FINAL: WATER CONTENT	w_f	22.4%	22.4%	21.9%	%
VOID RATIO	e_f				
SATURATION	S_f	%	%	%	%
NORMAL STRESS, T/SQ FT	σ	1.0	2.0	3.0	
MAXIMUM SHEAR STRESS, T/SQ FT	τ_{max}	0.80	1.49	2.20	
ACTUAL TIME TO FAILURE, MIN	t_f	1260	960	660	
RATE OF STRAIN, IN./MIN		.00019	.00019	.00019	
ULTIMATE SHEAR STRESS, T/SQ FT	τ_{ult}				

TYPE OF SPECIMEN UNDISTURBED 3.00 IN. SQUARE 0.547 IN. THICK
CLASSIFICATION SILTY SAND (SM), gray, crumbly
LL - PL - PI - G_s 2.66
REMARKS
PROJECT NEW ORLEANS TO VENICE, LA.
REACH B-1, Tropical Bend to Ft. Jackson
AREA Sta. 320+30; 760' Rt B/L
BORING NO 1-SBU SAMPLE NO 3-B
DEPTH 8.7 DATE 14 NOVEMBER 1968
JHM DIRECT SHEAR TEST REPORT

ENG FORM 1 JUN 66 2092 (EM 1110-2-1906) PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) PLATE III-3





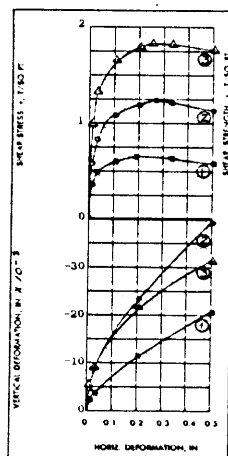
SHEAR STRENGTH PARAMETERS
φ = 33°
TAN φ = 0.649
c = 0.06 T/SQ FT

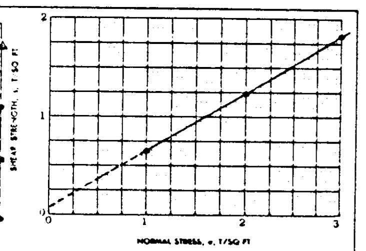
CONTROLLED STRESS
[X] CONTROLLED STRAIN

TEST NO		1	2	3	
INITIAL: WATER CONTENT	w_o	24.0%	23.8%	23.9%	%
VOID RATIO	e_o	0.661	0.663	0.661	
SATURATION	S_o	97.3%	96.2%	96.9%	%
DRY DENSITY, LB/CU FT	γ_d	100.7	100.6	100.7	
VOID RATIO AFTER CONSOLIDATION	e_c				
TIME FOR 50 PERCENT CONSOLIDATION, MIN	t_{50}	<1	<1	<1	
FINAL: WATER CONTENT	w_f	23.5%	23.6%	23.[illegible]%	%
VOID RATIO	e_f				
SATURATION	S_f	%	%	%	%
NORMAL STRESS, T/SQ FT	σ	1.0	2.0	3.0	
MAXIMUM SHEAR STRESS, T/SQ FT	τ_{max}	0.74	1.37	2.08	
ACTUAL TIME TO FAILURE, MIN	t_f	1200	1500	1320	
RATE OF STRAIN, IN./MIN		.00019	.00019	.00019	
ULTIMATE SHEAR STRESS, T/SQ FT	τ_{ult}				

TYPE OF SPECIMEN UNDISTURBED 3.00 IN. SQUARE 0.560 IN. THICK
CLASSIFICATION SILTY CLAY (CL), gray
LL 30 PL 20 PI 10 G_s 2.68
REMARKS
PROJECT NEW ORLEANS TO VENICE, LA.
REACH B-1, Tropical Bend to Ft. Jackson
AREA Sta. 320+30; 760' Rt. B/L
BORING NO 1-SBU SAMPLE NO 7-C
DEPTH 24.7 DATE 14 NOVEMBER 1968
GDA DIRECT SHEAR TEST REPORT

ENG FORM 2092 (EM 1110-2-1906) PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) PLATE III-3





SHEAR STRENGTH PARAMETERS
φ = 30°
TAN φ = 0.577
c = 0.07 T/SQ FT

CONTROLLED STRESS
[X] CONTROLLED STRAIN

TEST NO		1	2	3	
INITIAL: WATER CONTENT	w_o	38.6%	36.9%	37.5%	%
VOID RATIO	e_o	1.05	1.06	1.05	
SATURATION	S_o	98.5%	93.3%	95.7%	%
DRY DENSITY, LB/CU FT	γ_d	81.5	81.1	81.5	
VOID RATIO AFTER CONSOLIDATION	e_c				
TIME FOR 50 PERCENT CONSOLIDATION, MIN	t_{50}				
FINAL: WATER CONTENT	w_f	34.9%	33.9%	32.4%	%
VOID RATIO	e_f				
SATURATION	S_f	%	%	%	%
NORMAL STRESS, T/SQ FT	σ	1.0	2.0	3.0	
MAXIMUM SHEAR STRESS, T/SQ FT	τ_{max}	0.65	1.24	1.83	
ACTUAL TIME TO FAILURE, MIN	t_f	1200	1620	1530	
RATE OF STRAIN, IN./MIN		.00017	.00017	.00017	
ULTIMATE SHEAR STRESS, T/SQ FT	τ_{ult}				

TYPE OF SPECIMEN UNDISTURBED 3.00 IN. SQUARE 0.560 IN. THICK
CLASSIFICATION CLAYEY SILT (ML), gray, contains seams of clay
LL 38 PL 24 PI 14 G_s 2.68
REMARKS
PROJECT NEW ORLEANS TO VENICE, LA.
REACH B-1, Tropical Bend to Fort Jackson
AREA Sta. 320+30; 760' Rt. B/L
BORING NO 1-SBU SAMPLE NO $10\text{-}B_1$
DEPTH 35.4 DATE 21 NOVEMBER 1968
GDA DIRECT SHEAR TEST REPORT

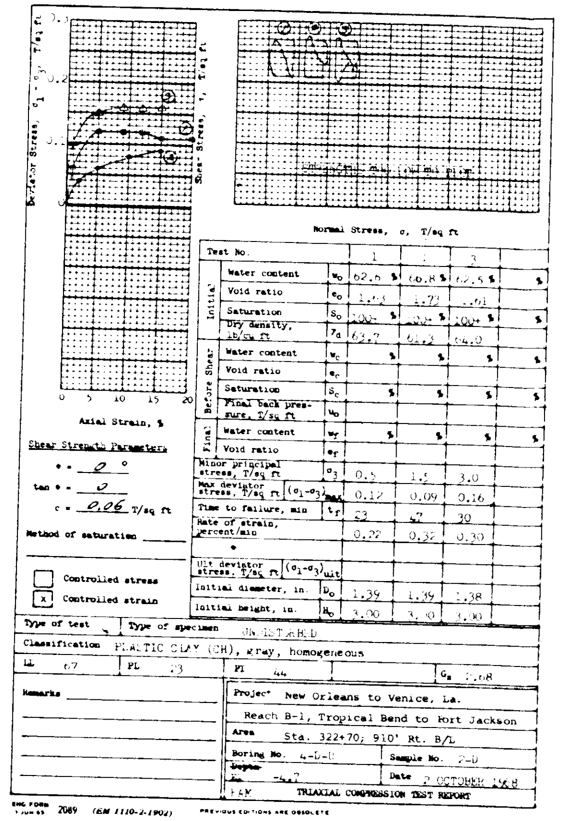
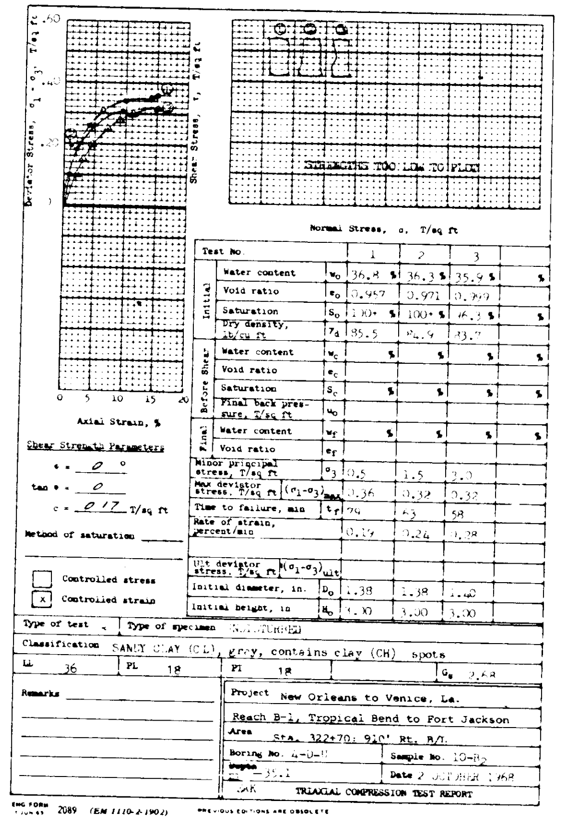
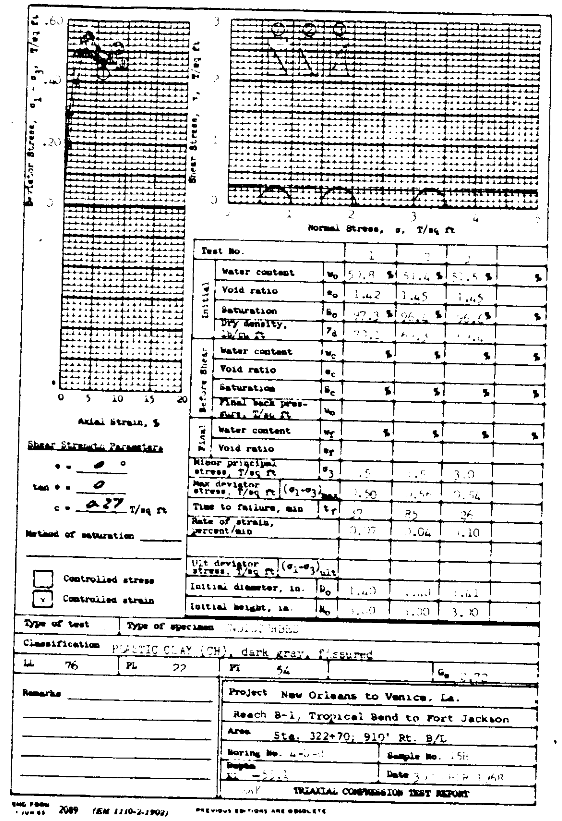
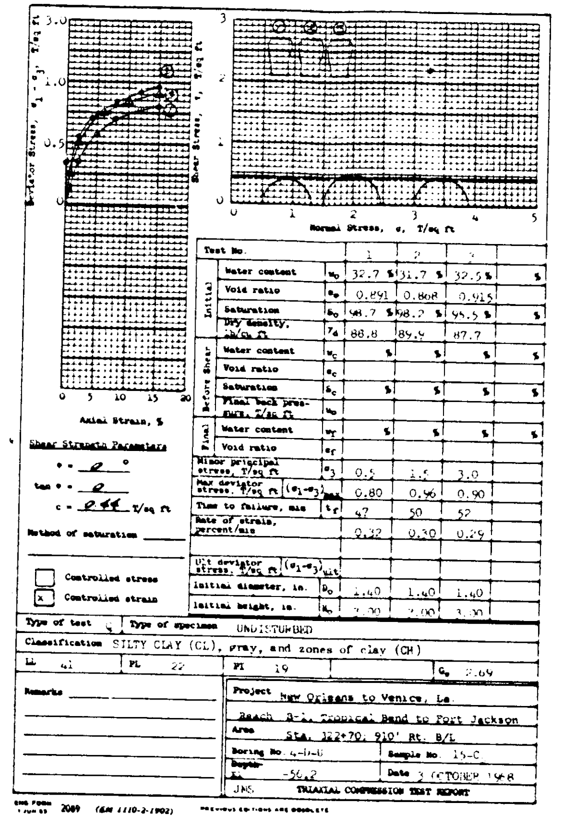
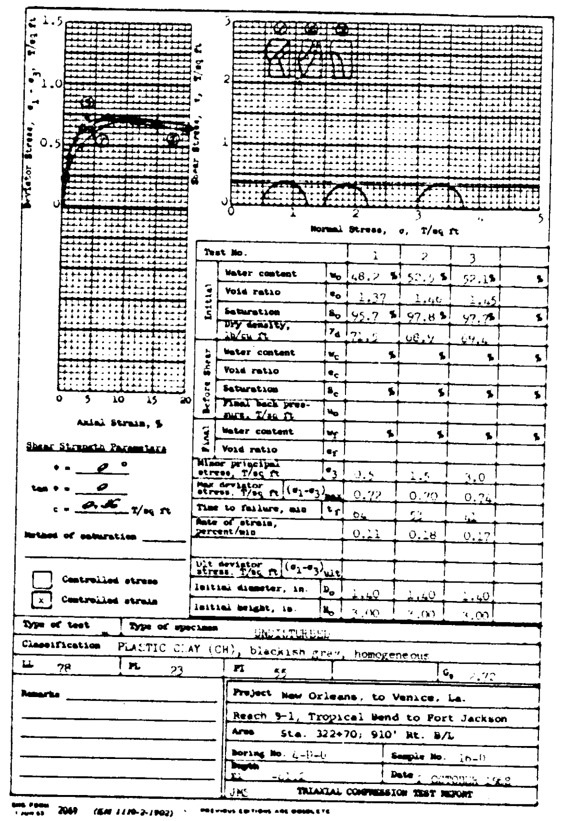
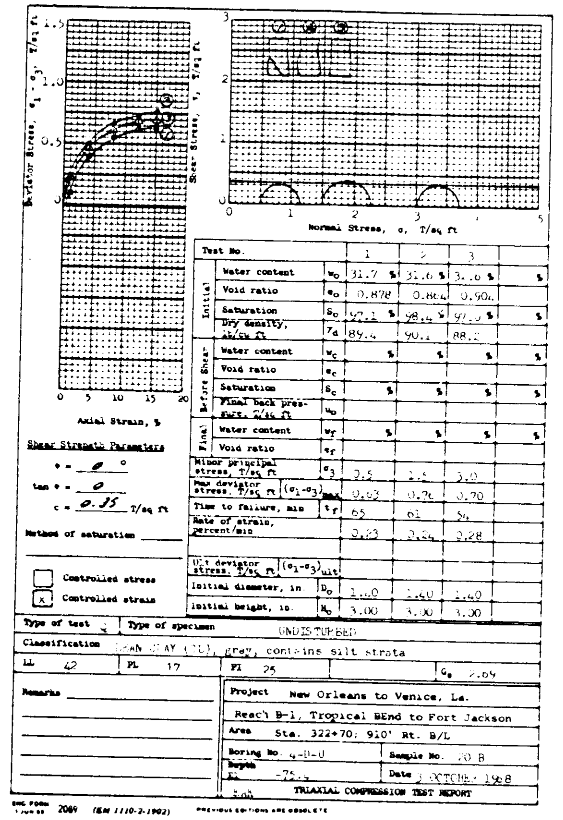
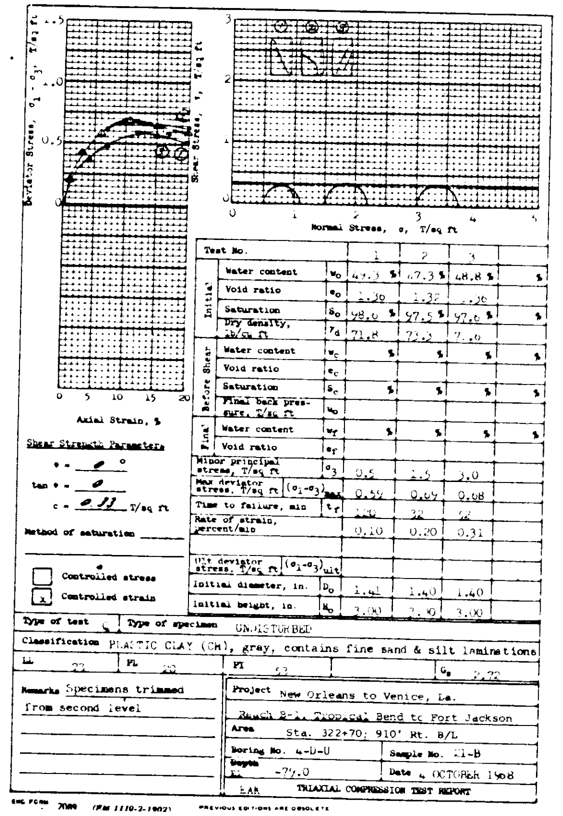
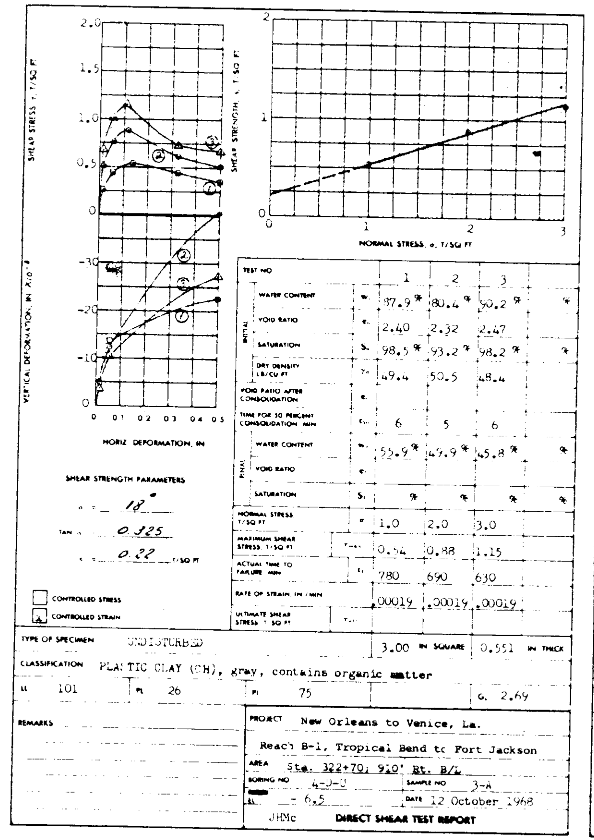
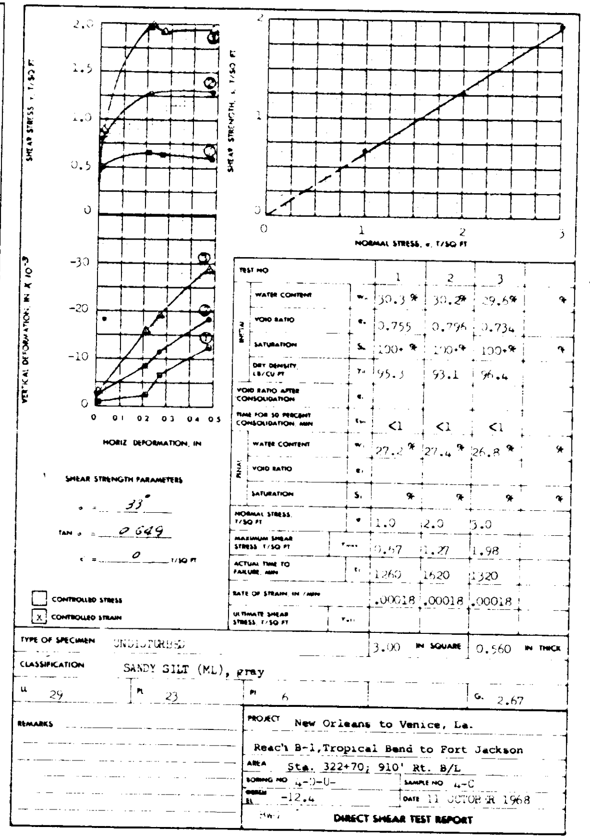
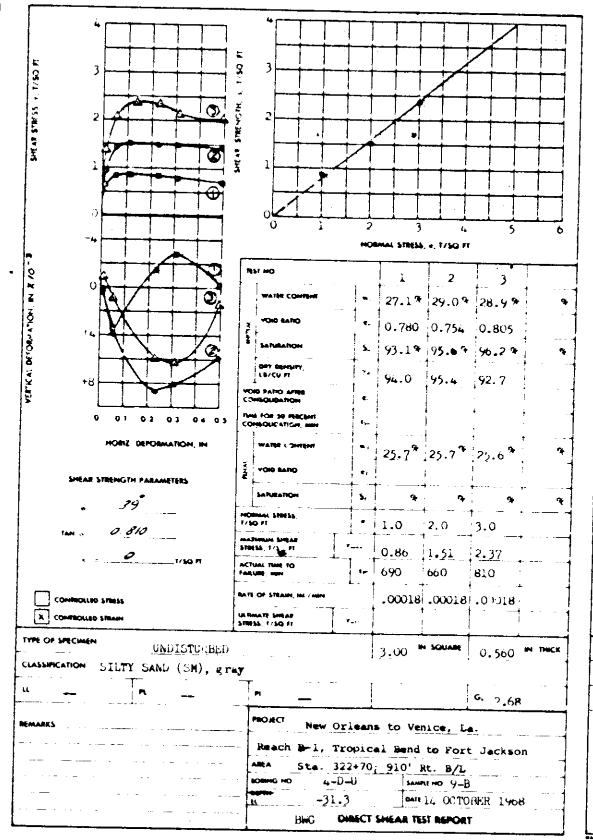
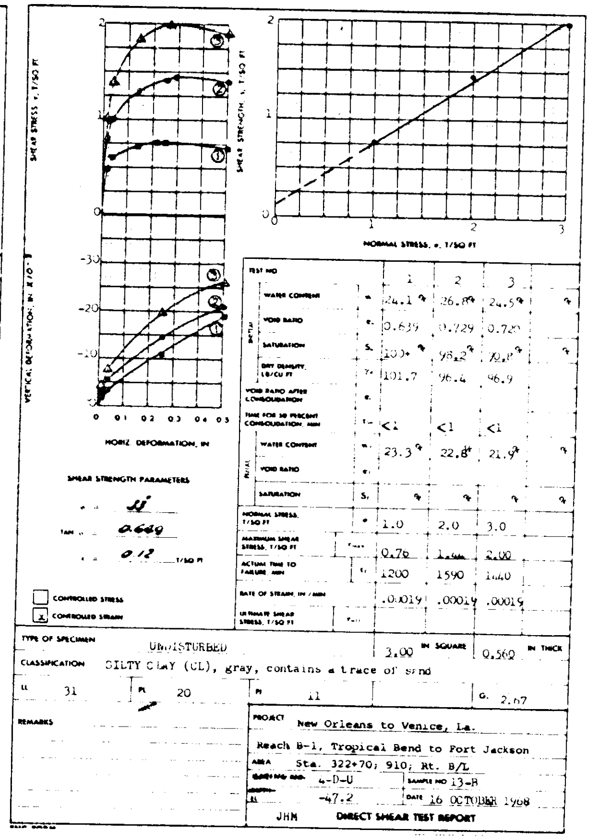
ENG FORM 2092 PLATE III-3

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA
BORING I-SBU

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

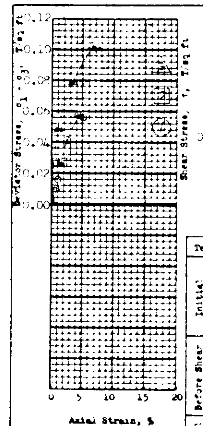
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

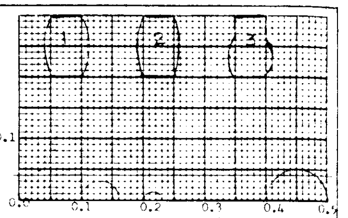
DETAIL SHEAR STRENGTH DATA
BORING 4-DU

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 2-C





Test No.		1	2	3
Initial: Water content	w_o	94.78 %	92.21 %	86.13 %
Initial: Void ratio	e_o	2.708	2.527	2.365
Initial: Saturation	S_o	94.53 %	98.56 %	98.31 %
Initial: Dry density, lb/cu ft	γ_d	45.44	47.78	50.06
Minor principal stress, T/sq ft	σ_3	0.1	0.2	0.4
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.06	0.03	0.10
Time to failure, min	t_f	6.51	3.60	21.84
Rate of strain, percent/min		0.63	0.29	0.30
Wet Density lb/cu. ft.		88.54	91.85	93.16
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.040 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

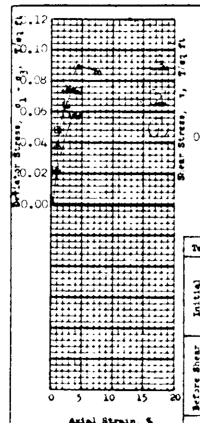
Classification: VSo(Gr)CH3;lns&lysML;dw;few org. stks;rts throughout

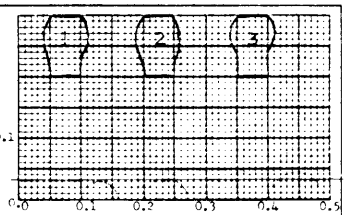
LL 105 | PL 25 | PI 80 | UCT - NT | G_s 2.6989

Remarks: NOD-Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Fort Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 2-C — Depth 5.1-6.5 — Date 31 AUG 70

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 3-C





Test No.		1	2	3
Initial: Water content	w_o	122.54 %	120.80 %	117.7 %
Initial: Void ratio	e_o	3.508	3.279	3.248
Initial: Saturation	S_o	93.63 %	98.74 %	97.19 %
Initial: Dry density, lb/cu ft	γ_d	37.10	39.09	39.38
Minor principal stress, T/sq ft	σ_3	0.1	0.2	0.4
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.06	0.07	0.09
Time to failure, min	t_f	5.14	10.27	13.67
Rate of strain, percent/min		0.64	0.30	0.30
Wet Density lb/cu. ft.		82.56	86.30	85.74
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.032 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

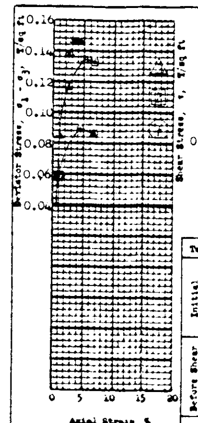
Classification: VSo(Gr)CH4;arsML;org ars;dw

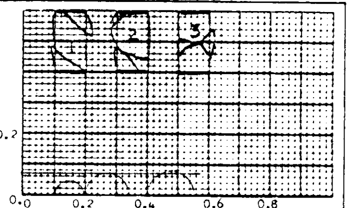
LL 119 | PL 30 | PI 89 | UCT - NT | G_s 2.6801

Remarks: NOD-Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Fort Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 3-C — Depth 9-10.5 — Date 31 AUG 70

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 4-C





Test No.		1	2	3
Initial: Water content	w_o	121.99 %	120.7 %	109.8 %
Initial: Void ratio	e_o	3.208	3.291	2.961
Initial: Saturation	S_o	100.00 %	97.97 %	99.04 %
Initial: Dry density, lb/cu ft	γ_d	39.61	38.83	42.07
Minor principal stress, T/sq ft	σ_3	0.1	0.2	0.4
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.09	0.14	0.15
Time to failure, min	t_f	6.45	16.90	11.20
Rate of strain, percent/min		0.64	0.29	0.30
Wet Density lb/cu. ft.		87.92	85.74	88.29
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.073 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

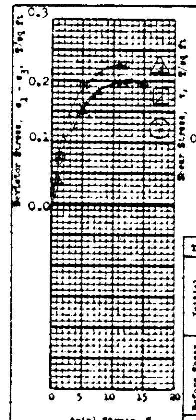
Classification: VSo(Gr)CH4;lnsML;spks dw;few org stks;few slf

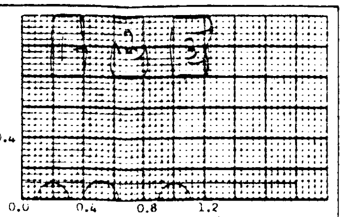
LL 116 | PL 21 | PI 95 | UCT-NT | G_s 2.67148

Remarks: NOD-Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Fort Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 4-C — Depth 12.6-14.0 — Date 31 AUG 70

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 6-C





Test No.		1	2	3
Initial: Water content	w_o	51.72 %	51.35 %	48.83 %
Initial: Void ratio	e_o	1.491	1.443	1.411
Initial: Saturation	S_o	92.62 %	94.98 %	92.43 %
Initial: Dry density, lb/cu ft	γ_d	66.89	68.20	69.14
Minor principal stress, T/sq ft	σ_3	0.1	0.4	0.9
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.20	0.25	0.20
Time to failure, min	t_f	19.74	38.17	37.80
Rate of strain, percent/min		0.63	0.28	0.29
Wet Density lb/cu. ft.		101.46	103.21	102.90
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.100 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

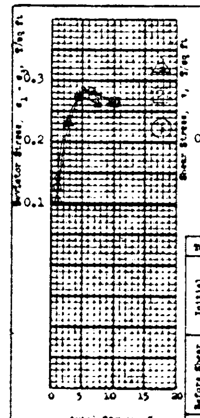
Classification: VSo(Gr)CH2;lnsML;spks dw; org stks

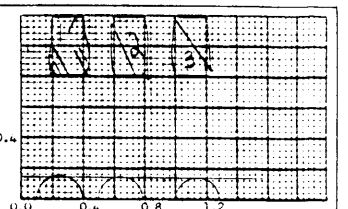
LL 50 | PL 27 | PI 23 | UCT - NT | G_s 2.6743

Remarks: NOD-Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Fort Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 6-C — Depth 34.6-35.0 — Date 31 AUG 70

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 7-D





Test No.		1	2	3
Initial: Water content	w_o	77.25 %	74.03 %	73.28 %
Initial: Void ratio	e_o	2.253	2.164	2.153
Initial: Saturation	S_o	92.61 %	92.33 %	91.93 %
Initial: Dry density, lb/cu ft	γ_d	51.81	53.23	53.44
Minor principal stress, T/sq ft	σ_3	0.1	0.5	1.0
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.29	0.28	0.28
Time to failure, min	t_f	7.89	23.86	13.76
Rate of strain, percent/min		0.64	0.28	0.30
Wet Density lb/cu. ft.		91.83	92.66	92.61
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.140 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

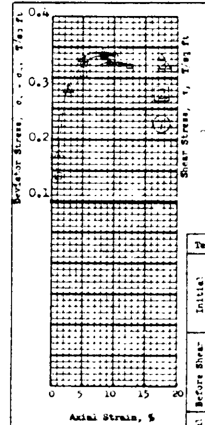
Classification: VSo(Gr)CH4

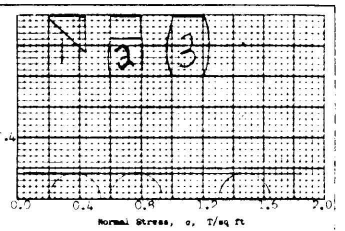
LL 87 | PL 22 | PI 65 | UCT-NT | G_s 2.6954

Remarks: NOD-Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Ft. Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 7-D — Depth 55-56.4 — Date 31 AUG 70

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 9-B





Test No.		1	2	3
Initial: Water content	w_o	51.26 %	51.41 %	50.90 %
Initial: Void ratio	e_o	1.489	1.532	1.513
Initial: Saturation	S_o	92.92 %	90.61 %	90.82 %
Initial: Dry density, lb/cu ft	γ_d	67.70	66.52	67.02
Minor principal stress, T/sq ft	σ_3	0.2	0.5	1.3
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.34	0.31	0.34
Time to failure, min	t_f	15.09	31.40	31.81
Rate of strain, percent/min		0.63	0.29	0.29
Wet Density lb/cu. ft.		102.44	100.78	101.15
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.170 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

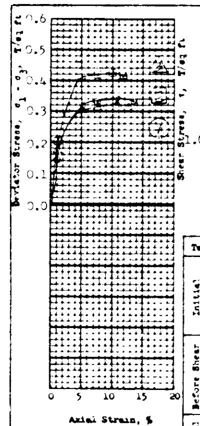
Classification: VSo(Gr)CH3;lns&thin lysML;sks dw;org stks

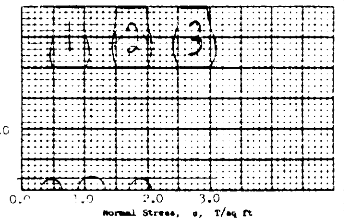
LL 57 | PL 15 | PI 42 | UCT - NT | G_s 2.7033

Remarks: NOD-Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Fort Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 9-B — Depth [illegible] — Date 31 AUG 70

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 11-C





Test No.		1	2	3
Initial: Water content	w_o	63.34 %	63.56 %	64.68 %
Initial: Void ratio	e_o	1.706	1.779	1.707
Initial: Saturation	S_o	98.7 %	91.16 %	91.27 %
Initial: Dry density, lb/cu ft	γ_d	62.32	59.11	59.38
Minor principal stress, T/sq ft	σ_3	0.3	0.9	1.7
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.34	0.42	0.33
Time to failure, min	t_f	17.35	34.96	17.20
Rate of strain, percent/min		0.62	0.29	0.29
Wet Density lb/cu. ft.		103.44	102.26	104.58
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.170 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

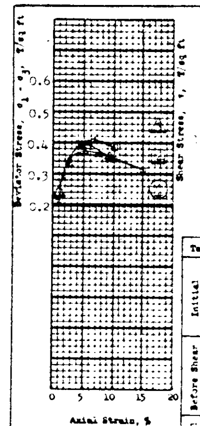
Classification: So(Gr)CH3;lnsML;sks dw;org stks

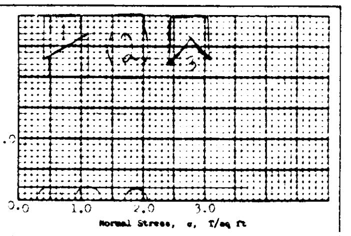
LL 55 | PL 19 | PI 36 | UCT - NT | G_s 2.6707

Remarks: NOD-Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Fort Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 11-C — Depth [illegible] — Date 31 AUG 70

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 12-D





Test No.		1	2	3
Initial: Water content	w_o	52.02 %	50.79 %	51.74 %
Initial: Void ratio	e_o	1.835	1.768	1.970
Initial: Saturation	S_o	91.22 %	91.76 %	93.40 %
Initial: Dry density, lb/cu ft	γ_d	59.41	60.87	56.73
Minor principal stress, T/sq ft	σ_3	0.3	0.9	1.7
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.40	0.41	0.38
Time to failure, min	t_f	9.16	22.81	15.89
Rate of strain, percent/min		0.64	0.29	0.29
Wet Density lb/cu. ft.		96.28	97.45	95.45
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.203 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

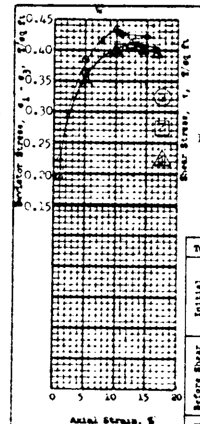
Classification: So(Gr)CH4;lns ML

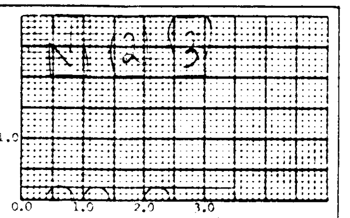
LL 84 | PL 24 | PI 60 | UCT - NT | G_s 2.6606

Remarks: NOD - Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Fort Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 12-D — Depth [illegible] — Date 31 AUG 70

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 14-C





Test No.		1	2	3
Initial: Water content	w_o	51.57 %	52.94 %	52.84 %
Initial: Void ratio	e_o	1.396	1.568	1.523
Initial: Saturation	S_o	89.21 %	89.74 %	92.29 %
Initial: Dry density, lb/cu ft	γ_d	63.96	64.58	65.77
Minor principal stress, T/sq ft	σ_3	0.4	1.0	2.0
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.41	0.41	0.41
Time to failure, min	t_f	15.85	47.50	44.09
Rate of strain, percent/min		0.63	0.28	0.28
Wet Density lb/cu. ft.		96.16	98.78	100.53
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.205 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

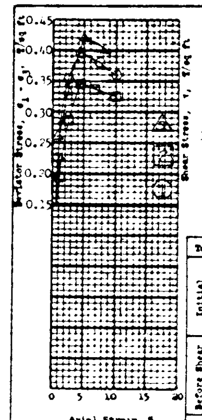
Classification: SO(Gr)CH3;lns ML

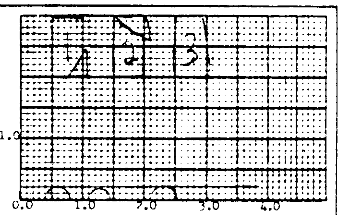
LL 73 | PL 22 | PI 51 | UCT - NT | G_s 2.6601

Remarks: NOD-Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Fort Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 14-C — Depth [illegible] — Date 31 AUG 70

TRIAXIAL COMPRESSION TEST REPORT — Boring 62-BUF, Sample 15-D





Test No.		1	2	3
Initial: Water content	w_o	51.57 %	53.44 %	52.37 %
Initial: Void ratio	e_o	1.509	1.512	1.502
Initial: Saturation	S_o	91.93 %	94.09 %	91.78 %
Initial: Dry density, lb/cu ft	γ_d	64.89	66.83	67.08
Minor principal stress, T/sq ft	σ_3	0.4	1.1	2.1
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.39	0.35	0.42
Time to failure, min	t_f	4.78	14.58	16.32
Rate of strain, percent/min		0.87	0.26	0.30
Wet Density lb/cu. ft.		101.40	104.02	102.21
Initial diameter, in.	D_o	1.40	1.40	1.40
Initial height, in.	H_o	3.00	3.00	3.00

Shear Strength Parameters: ϕ = 0.0°; tan ϕ = 0.0; c = 0.207 T/sq ft

Controlled strain: X

Type of test: Q — Type of specimen: 5" Undisturbed

Classification: M(Gr)CH4;lns&few thin lys ML

LL 72 | PL 24 | PI 48 | UCT - NT | G_s 2.6887

Remarks: NOD-Testing Section

Project: N.O. to Venice Reach B-1, Tropical Bend to Fort Jackson — Area: Sta. 459+65; 220' Rt. B/L — Boring No. 62-BUF — Sample No. 15-D — Depth [illegible] — Date 31 AUG 70

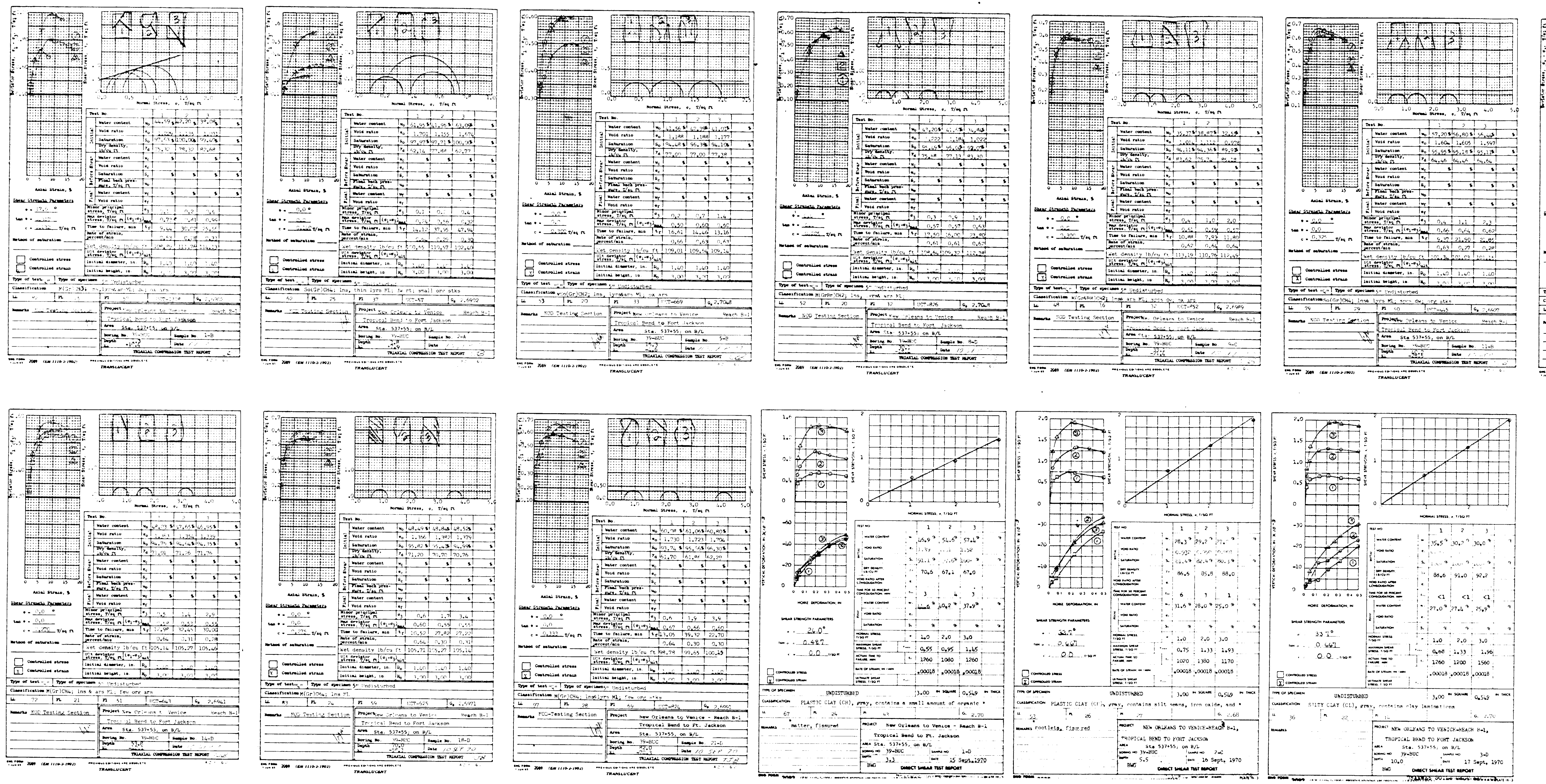
ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA BORING 62-BUF

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 — FILE NO. H-2-25712



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

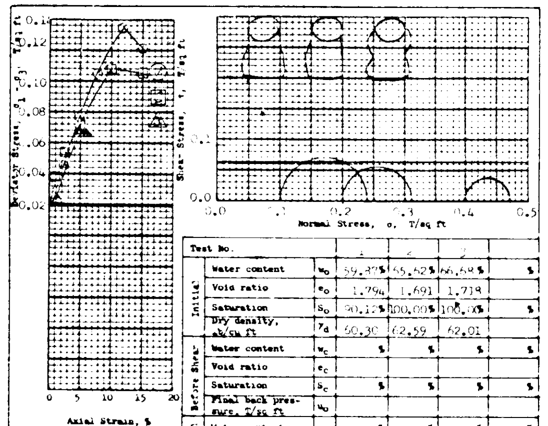
DETAIL SHEAR STRENGTH DATA
BORING 39-BUC

U S ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

TRIAXIAL COMPRESSION TEST REPORTS — BORING 65-BUF

Sample 1-C



Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.062 T/sq ft

Method of saturation ______

[X] Controlled stress
[ ] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	59.37%	65.62%	66.68%	%
Initial: Void ratio	e_o	1.794	1.691	1.718	
Initial: Saturation	S_o	90.12%	100.00%	100.00%	%
Initial: Dry density, lb/cu ft	γ_d	60.30	62.59	62.01	
Before Shear: Water content	w_c	%	%	%	%
Before Shear: Void ratio	e_c				
Before Shear: Saturation	S_c	%	%	%	%
Before Shear: Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Final: Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.1	0.2	0.4	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.14	0.11	0.07	
Time to failure, min	t_f	[illegible]	[illegible]	[illegible]	
Rate of strain, percent/min		0.64	0.29	0.30	
Wet Density lb/cu ft		96.41	103.71	103.33	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.40	1.40	1.40	
Initial height, in.	H_o	3.00	3.00	3.00	

Type of test "Q" | Type of specimen 5" Undisturbed

Classification vSo(Gr)CH4; Ins &ars ML; rt; few org strks; lg; org ars

LL 65 | PL 23 | PI 36 | UCT-114 | G_s 2.7009

Remarks NOD Testing-Section

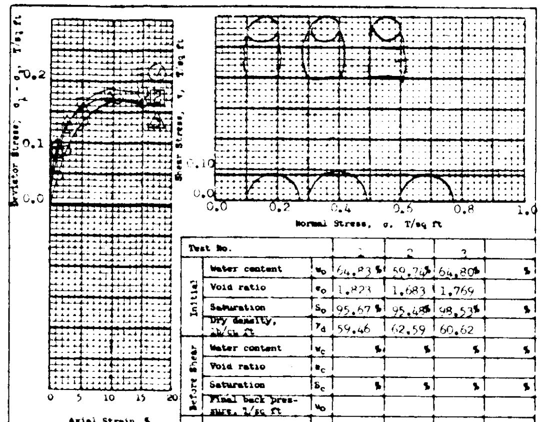
Project N.O. to Venice Reach B-1 (70) — Tropical Bend to Fort Jackson — Sta. 580+40; 215' Rt. C/L

Boring No. 65-BUF | Sample No. 1-C | Depth 5.0 / El. -7.4 | Date 24 AUG 72

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE

Sample 4-D



Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.085 T/sq ft

Method of saturation ______

[X] Controlled stress
[ ] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	64.83%	59.74%	64.80%	%
Initial: Void ratio	e_o	1.823	1.683	1.769	
Initial: Saturation	S_o	95.67%	95.48%	98.53%	%
Initial: Dry density, lb/cu ft	γ_d	59.46	62.59	60.62	
Before Shear: Water content	w_c	%	%	%	%
Before Shear: Void ratio	e_c				
Before Shear: Saturation	S_c	%	%	%	%
Before Shear: Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Final: Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.1	0.3	0.6	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.17	0.19	0.17	
Time to failure, min	t_f	15.66	29.23	30.36	
Rate of strain, percent/min		0.68	0.30	0.29	
Wet Density lb/cu ft		98.03	99.90	99.90	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.40	1.40	1.40	
Initial height, in.	H_o	3.00	3.00	3.00	

Type of test "Q" | Type of specimen 5" Undisturbed

Classification vSo(Gr)CH3; ins, lyrs&ars ML; cc; org ars

LL 58 | PL 20 | PI 38 | UCT-217 | G_s 2.6942

Remarks NOD Testing-Section

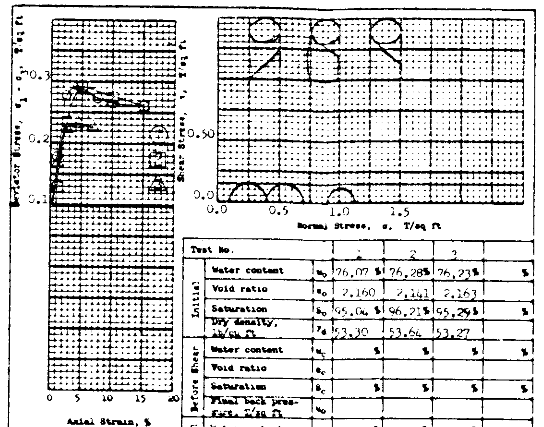
Project N.O. to Venice Reach B-1 (70) — Tropical Bend to Fort Jackson — Sta. 580+40; 215' Rt. C/L

Boring No. 65-BUF | Sample No. 4-D | Depth 13.5 / El. -16.9 | Date 24 AUG 72

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE

Sample 7-D



Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.145 T/sq ft

Method of saturation ______

[X] Controlled stress
[ ] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	76.07%	76.28%	76.23%	%
Initial: Void ratio	e_o	2.160	2.141	2.163	
Initial: Saturation	S_o	95.04%	96.21%	95.29%	%
Initial: Dry density, lb/cu ft	γ_d	53.30	53.64	53.27	
Before Shear: Water content	w_c	%	%	%	%
Before Shear: Void ratio	e_c				
Before Shear: Saturation	S_c	%	%	%	%
Before Shear: Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Final: Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.1	0.4	0.9	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.29	0.29	0.23	
Time to failure, min	t_f	6.20	15.79	12.97	
Rate of strain, percent/min		0.66	0.30	0.31	
Wet Density lb/cu ft		93.84	94.54	93.91	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.40	1.40	1.40	
Initial height, in.	H_o	3.00	3.00	3.00	

Type of test "Q" | Type of specimen 5" Undisturbed

Classification So(Gr)CH4; Ins, lyrs,&small ars ML; dw; org strks

LL 92 | PL 25 | PI 67 | UCT-352 | G_s 2.7011

Remarks NOD Testing-Section

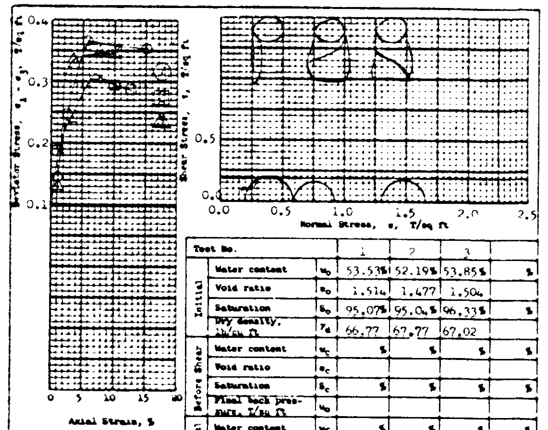
Project N.O. to Venice Reach B-1 (70) — Tropical Bend to Fort Jackson — Sta. 580+40; 215' Rt. C/L

Boring No. 65-BUF | Sample No. 7-D | Depth 25.5 / El. -30.9 | Date 24 AUG 72

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE

Sample 9-D



Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.180 T/sq ft

Method of saturation ______

[X] Controlled stress
[ ] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	53.53%	52.19%	53.85%	%
Initial: Void ratio	e_o	1.514	1.477	1.504	
Initial: Saturation	S_o	95.07%	95.04%	96.33%	%
Initial: Dry density, lb/cu ft	γ_d	66.77	67.77	67.02	
Before Shear: Water content	w_c	%	%	%	%
Before Shear: Void ratio	e_c				
Before Shear: Saturation	S_c	%	%	%	%
Before Shear: Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Final: Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.2	0.6	1.3	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.37	0.31	0.35	
Time to failure, min	t_f	8.86	22.24	24.42	
Rate of strain, percent/min		0.66	0.30	0.30	
Wet density lb/cu ft		102.14	103.14	103.14	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.40	1.40	1.40	
Initial height, in.	H_o	3.00	3.00	3.00	

Type of test "Q" | Type of specimen 5" Undisturbed

Classification So(Gr&dGr)CH3; Ins&small ars ML; few org strks

LL 56 | PL 22 | PI 34 | UCT-419 | G_s 2.6942

Remarks NOD Testing-Section

Project N.O. to Venice Reach B-1 (70) — Tropical Bend to Fort Jackson — Sta. 580+40; 215' Rt. C/L

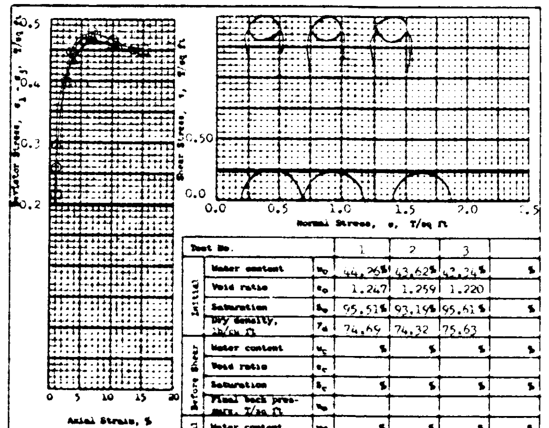
Boring No. 65-BUF | Sample No. 9-D | Depth 31.7 / El. [illegible] | Date [illegible] 72

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE

TRANSLUCENT

Sample 10-D



Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.235 T/sq ft

Method of saturation ______

[X] Controlled stress
[ ] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	44.26%	43.62%	42.24%	%
Initial: Void ratio	e_o	1.247	1.259	1.220	
Initial: Saturation	S_o	95.51%	93.19%	95.61%	%
Initial: Dry density, lb/cu ft	γ_d	74.69	74.32	75.63	
Before Shear: Water content	w_c	%	%	%	%
Before Shear: Void ratio	e_c				
Before Shear: Saturation	S_c	%	%	%	%
Before Shear: Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Final: Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.2	0.7	1.4	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.48	0.47	0.47	
Time to failure, min	t_f	10.48	17.99	23.48	
Rate of strain, percent/min		0.64	0.28	0.28	
Wet Density lb/cu ft		107.76	106.70	108.39	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.40	1.40	1.40	
Initial height, in.	H_o	3.00	3.00	3.00	

Type of test "Q" | Type of specimen 5" Undisturbed

Classification So(Gr)CH4; Ins, lyrs & ars ML; org strks

LL 55 | PL 18 | PI 37 | UCT-506 | G_s 2.6922

Remarks NOD Testing-Section

Project N.O. to Venice Reach B-1 (70) — Tropical Bend to Fort Jackson — Sta. 580+40; 215' Rt. C/L

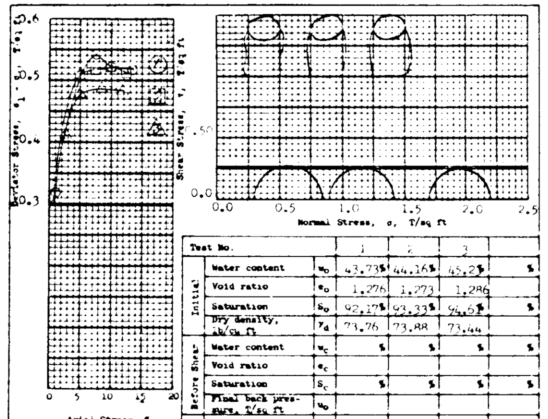
Boring No. 65-BUF | Sample No. 10-D | Depth [illegible] | Date [illegible] 72

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE

TRANSLUCENT

Sample 12-C



Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = [illegible] T/sq ft

Method of saturation ______

[X] Controlled stress
[ ] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	43.73%	44.16%	45.2[illegible]%	%
Initial: Void ratio	e_o	1.276	1.273	1.286	
Initial: Saturation	S_o	[illegible]	[illegible]	[illegible]	%
Initial: Dry density, lb/cu ft	γ_d	73.76	73.88	73.44	
Before Shear: Water content	w_c	%	%	%	%
Before Shear: Void ratio	e_c				
Before Shear: Saturation	S_c	%	%	%	%
Before Shear: Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Final: Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.3	0.9	1.7	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	[illegible]	0.42	[illegible]	
Time to failure, min	t_f	[illegible]	[illegible]	[illegible]	
Rate of strain, percent/min		0.63	0.27	0.29	
Wet Density lb/cu ft		105.96	105.[illegible]	106.64	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.40	1.40	1.40	
Initial height, in.	H_o	3.00	3.00	3.00	

Type of test "Q" | Type of specimen 5" Undisturbed

Classification [illegible](Gr)CH3; Ins,lys &ars ML; stks dw; org strks

LL 65 | PL [illegible] | PI [illegible] | UCT-593 | G_s 2.6886

Remarks NOD Testing-Section

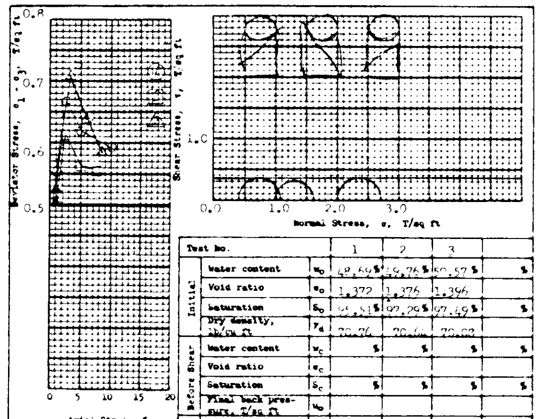
Project N.O. to Venice Reach B-1 (70) — Tropical Bend to Fort Jackson — Sta. 580+40; 215' Rt. C/L

Boring No. 65-BUF | Sample No. 12-C | Depth [illegible] | Date 24 AUG 72

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE

Sample 14-D



Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.345 T/sq ft

Method of saturation ______

[ ] Controlled stress
[X] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	[illegible]	[illegible]	[illegible]	%
Initial: Void ratio	e_o	1.372	1.376	1.356	
Initial: Saturation	S_o	[illegible]	[illegible]	[illegible]	%
Initial: Dry density, lb/cu ft	γ_d	[illegible]	[illegible]	[illegible]	
Before Shear: Water content	w_c	%	%	%	%
Before Shear: Void ratio	e_c				
Before Shear: Saturation	S_c	%	%	%	%
Before Shear: Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Final: Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	[illegible]	1.0	2.0	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.67	0.61	0.73	
Time to failure, min	t_f				
Rate of strain, percent/min		0.63	0.29	0.28	
Wet Density, lb/cu ft		105.26	105.83	105.52	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.4	1.4	1.4	
Initial height, in.	H_o	3.0	3.0	3.0	

Type of test "Q" | Type of specimen 5" Undisturbed

Classification [illegible] Ins ML; org strks

LL 75 | PL 25 | PI 50 | UCT-[illegible] | G_s 2.6[illegible]

Remarks NOD Testing Section

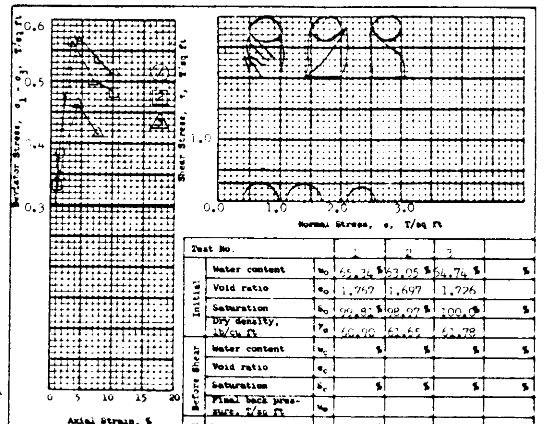
Project New Orleans to Venice, Reach B-1, Tropical Bend to Fort Jackson — Sta. 580+40, 215' Rt. C/L

Boring No. 65-BUF | Sample No. 14-D | Depth 51.4 / El. -56.8 | Date 24 AUG 72

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE

Sample 15-B



Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = 0.285 T/sq ft

Method of saturation ______

[ ] Controlled stress
[X] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	[illegible]	[illegible]	[illegible]	%
Initial: Void ratio	e_o	1.767	1.697	1.726	
Initial: Saturation	S_o	[illegible]	[illegible]	100.0%	%
Initial: Dry density, lb/cu ft	γ_d	[illegible]	[illegible]	[illegible]	
Before Shear: Water content	w_c	%	%	%	%
Before Shear: Void ratio	e_c				
Before Shear: Saturation	S_c	%	%	%	%
Before Shear: Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Final: Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	[illegible]	1.1	2.1	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	0.57	0.57	0.46	
Time to failure, min	t_f	6.95	11.81	14.10	
Rate of strain, percent/min		0.69	0.29	0.30	
Wet Density, lb/cu ft		106.65	100.53	101.44	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.4	1.4	1.4	
Initial height, in.	H_o	3.0	3.0	3.0	

Type of test "Q" | Type of specimen 5" Undisturbed

Classification [illegible] org strks

LL 76 | PL 28 | PI 48 | UCT-723 | G_s 2.6976

Remarks NOD Testing Section

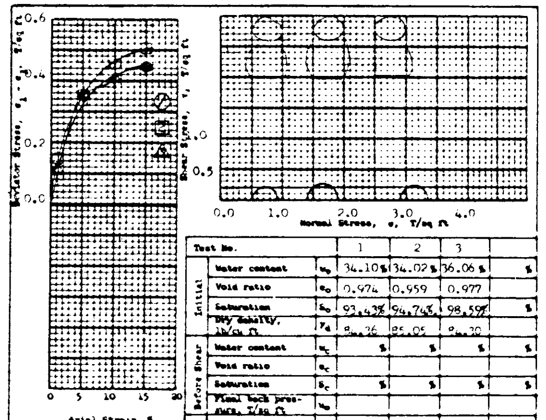
Project New Orleans to Venice, Reach B-1, Tropical Bend to Fort Jackson — Sta. 580+40, 215' Rt. C/L

Boring No. 65-BUF | Sample No. 15-B | Depth 55.7 | Date [illegible] 72

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE

Sample [illegible]



Shear Strength Parameters: φ = 0.0°; tan φ = 0.0; c = [illegible] T/sq ft

Method of saturation ______

[ ] Controlled stress
[X] Controlled strain

Test No.		1	2	3	
Initial: Water content	w_o	34.10%	34.02%	36.06%	%
Initial: Void ratio	e_o	0.974	0.959	0.977	
Initial: Saturation	S_o	[illegible]	[illegible]	[illegible]	%
Initial: Dry density, lb/cu ft	γ_d	[illegible]	[illegible]	[illegible]	
Before Shear: Water content	w_c	%	%	%	%
Before Shear: Void ratio	e_c				
Before Shear: Saturation	S_c	%	%	%	%
Before Shear: Final back pressure, T/sq ft	u_o				
Final: Water content	w_f	%	%	%	%
Final: Void ratio	e_f				
Minor principal stress, T/sq ft	σ_3	0.5	1.4	2.9	
Max deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	[illegible]	0.50	[illegible]	
Time to failure, min	t_f	24.02	23.68	23.81	
Rate of strain, percent/min		0.63	0.66	0.63	
Wet density, lb/cu ft		113.13	114.00	114.69	
Ult deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$				
Initial diameter, in.	D_o	1.4	1.4	1.4	
Initial height, in.	H_o	3.0	3.0	3.0	

Type of test "Q" | Type of specimen 5" Undisturbed

Classification [illegible] lyrs & ars ML

LL [illegible] | PL 21 | PI [illegible] | UCT-[illegible] | G_s 2.67[illegible]

Remarks NOD Testing Section

Project New Orleans to Venice, Reach B-1, Tropical Bend to Fort Jackson — Sta. 580+40, 215' Rt. C/L

Boring No. 65-BUF | Sample No. [illegible] | Depth [illegible] | Date 24 AUG 72

TRIAXIAL COMPRESSION TEST REPORT

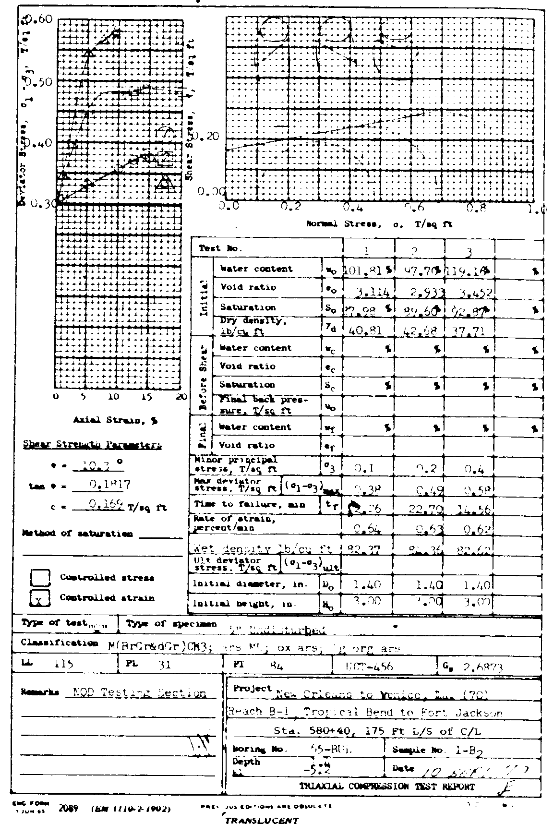
ENG FORM 1 JUN 65 2089 (EM 1110-2-1902) PREVIOUS EDITIONS ARE OBSOLETE

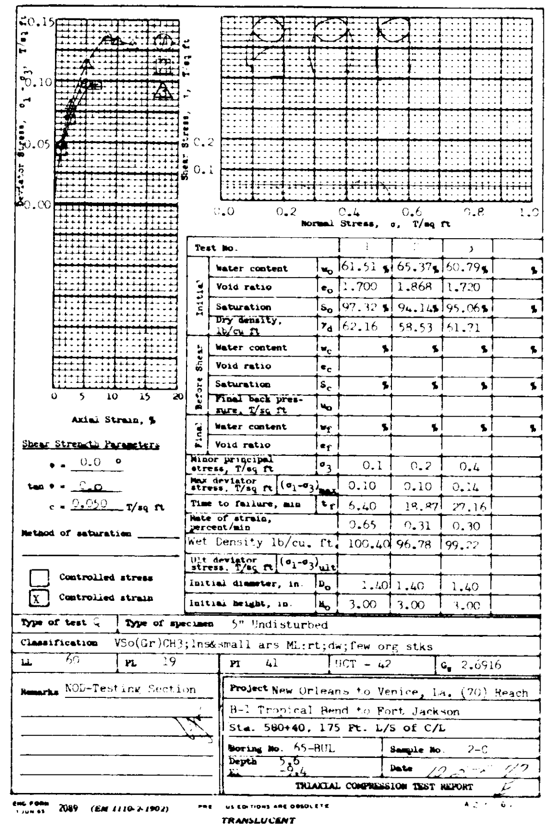
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

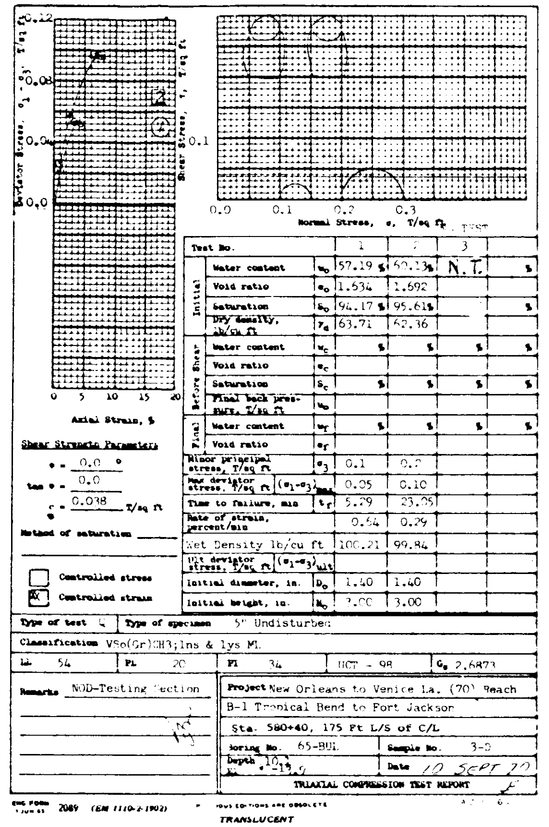
DETAIL SHEAR STRENGTH DATA
BORING 65-BUF

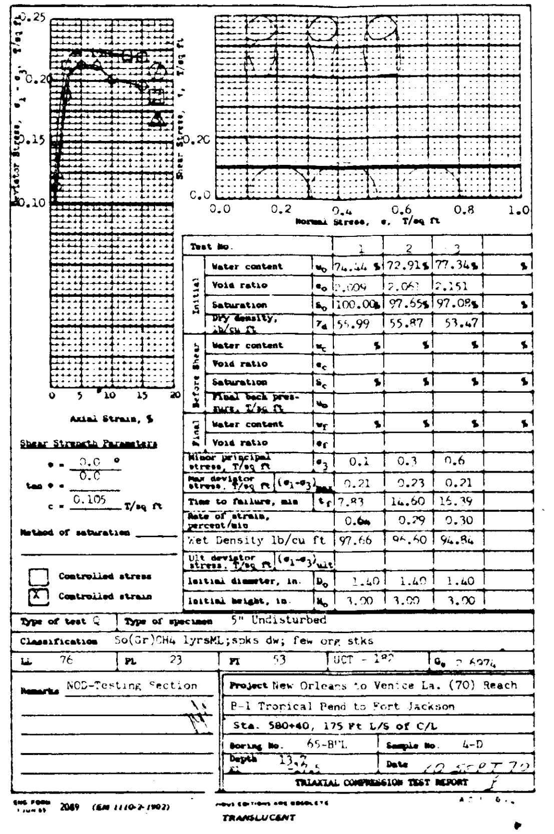
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

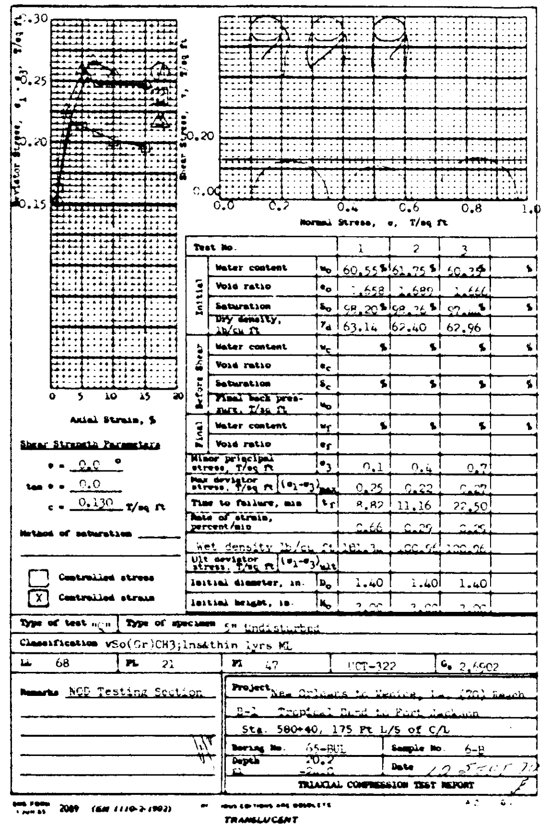
AUGUST 1971 — FILE NO. H-2-25712

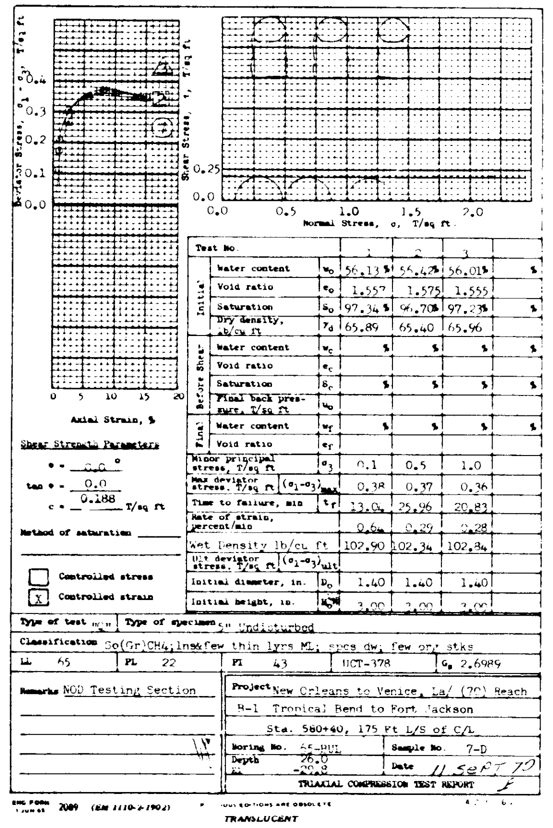


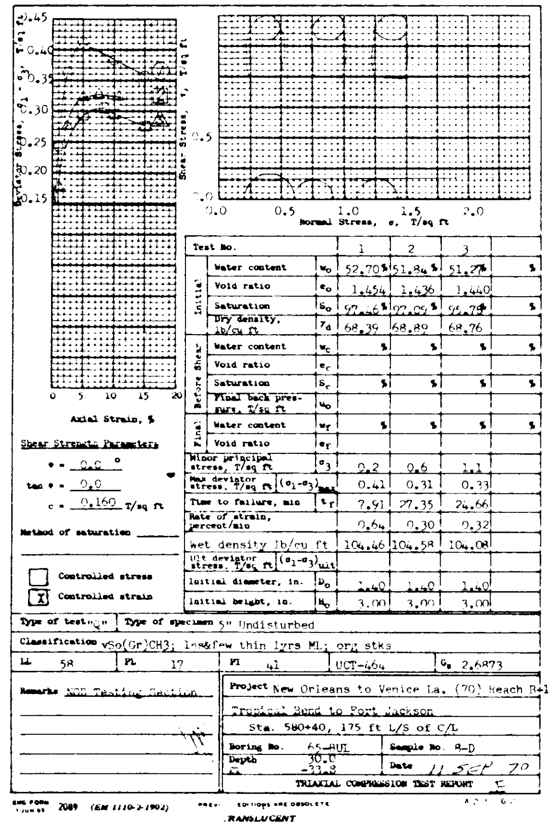


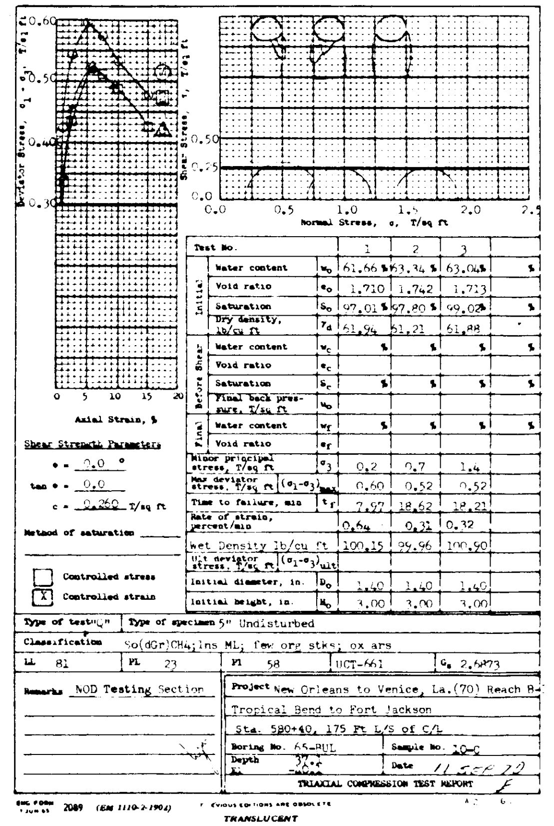


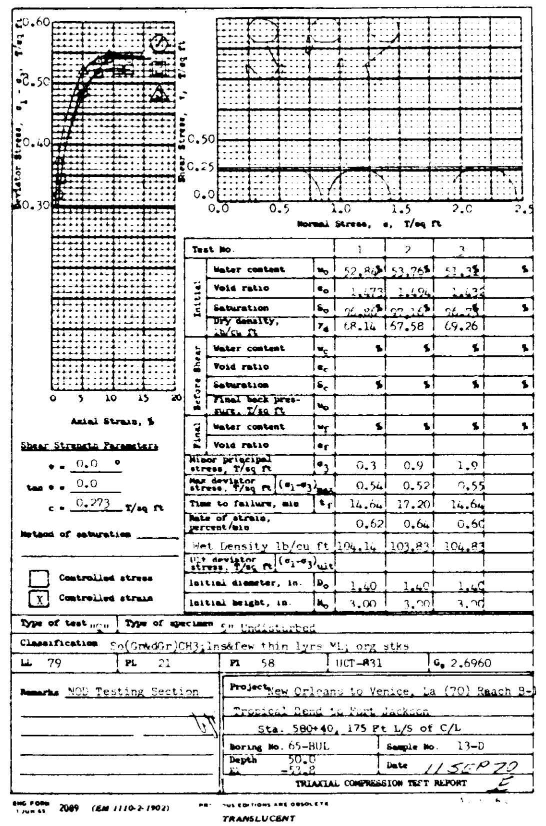


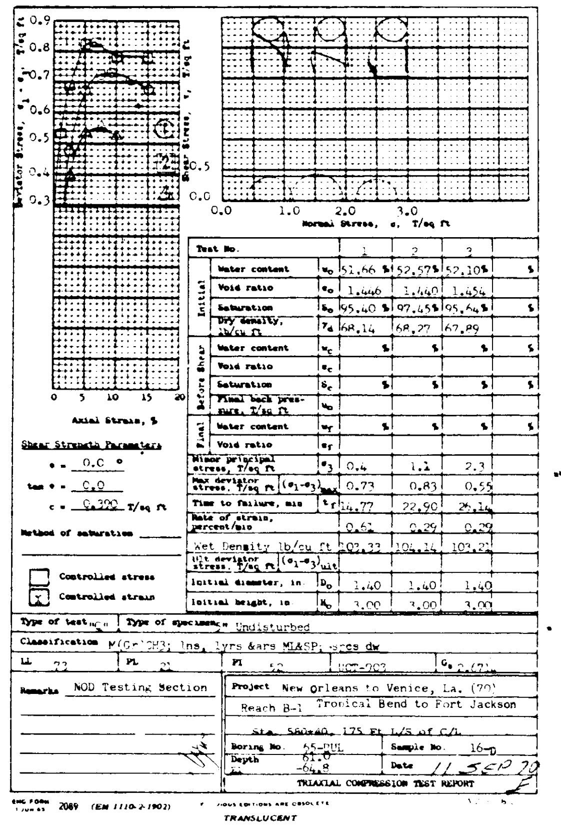












NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA
BORING 65-BUL

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

SUMMARY OF LABORATORY TEST RESULTS

BORING 51BSU

Sample No.	Depth in Ft.	Classification	Water Content Percent	Density Lbs./Cu.Ft. Dry	Density Lbs./Cu.Ft. Wet	Unconfined Compressive Strength Lbs./Sq.Ft.	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Type Shear Test
2	1.0	OH - Very soft brown; w/roots	202.0	25.3	76.4	100	142	45	97	UC
5	3.5	OH - Very soft brown; w/roots	360.2	-----	-----	----	--	--	--	--
8	5.5	CH - Very soft gray; w/roots	112.5	-----	-----	----	101	30	71	--
13	9.5	CH - Very soft gray; w/shells & organic matter	137.1	35.5	84.2	85	140	30	110	UC
14	10.0	CH - Very soft gray; w/shell fragments	142.0	34.7	84.0	Ø=0°c=45	140	38	102	Q
19	14.5	CH - Very soft gray; w/silt lenses	54.7	67.7	104.7	180	47	22	25	UC
20	15.0	CH-ML - Alternate layers very soft gray	38.4	76.8	106.3	----	35	25	10	
22	16.0	ML - Loose gray; w/clay lenses	49.8	72.8	109.1	Ø=22°c=400	41	25	16	S
26	19.5	CH - Very soft gray; w/silt lenses	65.7	62.1	102.9	255	54	20	34	UC
27	20.0	CH - Very soft gray; w/silt lenses	66.5	60.3	100.4	Ø=0°c=175	83	22	61	Q
34	25.5	CH - Very soft gray; w/silt lenses	67.3	59.8	100.0	480	69	28	41	UC
42	31.0	CH - Soft gray	50.6	71.4	107.5	645	68	28	40	UC
43	31.5	CH - Soft gray	61.2	63.8	102.8	Ø=0°c=200	64	28	36	Q
48	36.0	CH - Very soft gray	70.7	58.4	99.7	465	85	28	57	UC
53	40.0	CH - Soft gray; w/silt lenses	47.3	73.4	108.1	----	61	27	34	--
54	40.5	CH - Soft gray	68.2	57.9	97.4	840	99	34	65	UC
55	41.0	CH - Soft gray	69.7	57.6	97.7	Ø=0°c=345	95	30	65	Q
58	42.5	CH - Soft gray	63.9	-----	-----	----	--	--	--	--
61	45.5	CH - Soft gray	57.0	65.5	102.8	515	70	28	42	UC
67	50.0	CH - Soft gray	57.2	66.1	103.9	630	73	29	44	UC
68	50.5	CH - Soft gray	54.9	66.6	103.2	Ø=0°c=290	76	27	49	Q
74	55.0	CH - Soft gray	55.9	65.8	102.6	575	73	29	44	UC
75	55.5	CH - Soft gray	69.8	57.2	97.1	Ø=20°c=200	96	33	63	S
81	60.5	CH - Soft gray	60.3	62.4	100.0	600	84	32	52	UC
82	61.0	CH - Soft gray	57.8	64.4	101.6	Ø=2°c=260	83	30	53	Q
87	64.5	CH - Soft gray; w/silt lenses	62.3	60.1	97.5	----	84	34	54	--
88	65.0	CH - Soft gray; w/silt lenses	54.5	67.5	104.3	725	64	26	28	UC
93	67.5	CH - Soft gray; w/silt layers	41.4	-----	-----	----	--	--	--	--
95	70.0	CH - Medium stiff gray; w/silt lenses	58.5	63.6	100.8	1210	88	34	54	UC
96	70.5	CH - Medium stiff gray; w/silt lenses	52.8	70.8	108.2	Ø=0°c=520	54	22	32	Q
101	77.0	CH - Medium stiff gray; w/silt lenses	46.4	75.2	110.1	750	65	26	39	UC
102	77.5	CH - Medium stiff gray; w/silt lenses	42.7	74.1	105.7	Ø=2°c=330	47	19	28	Q
106	79.5	CH - Medium stiff gray; w/silt lenses	61.2	-----	-----	----	--	--	--	--

NOTES:

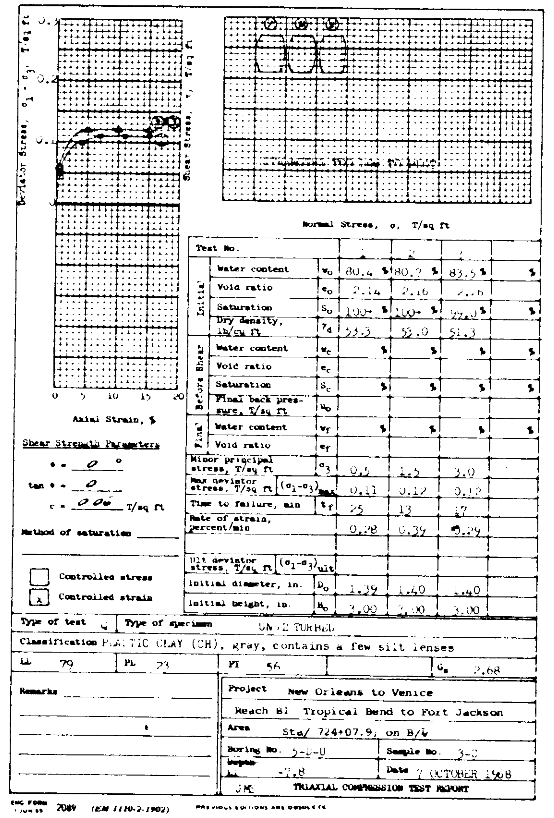
BORING TAKEN BY EUSTIS ENGINEERING COMPANY FOR THE DEPARTMENT OF PUBLIC WORKS, STATE OF LOUISIANA AND PLAQUEMINES PARISH, LOUISIANA.

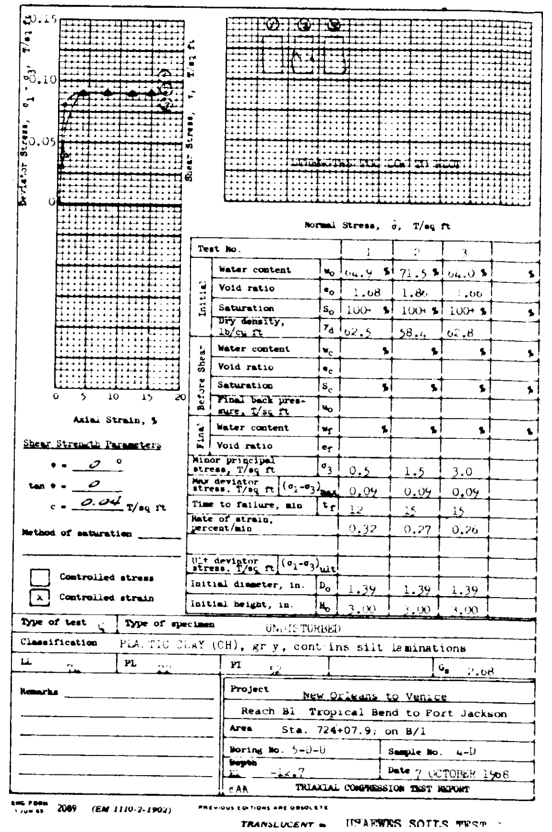
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 — GENERAL DESIGN
REACH B1 — TROPICAL BEND TO FORT JACKSON

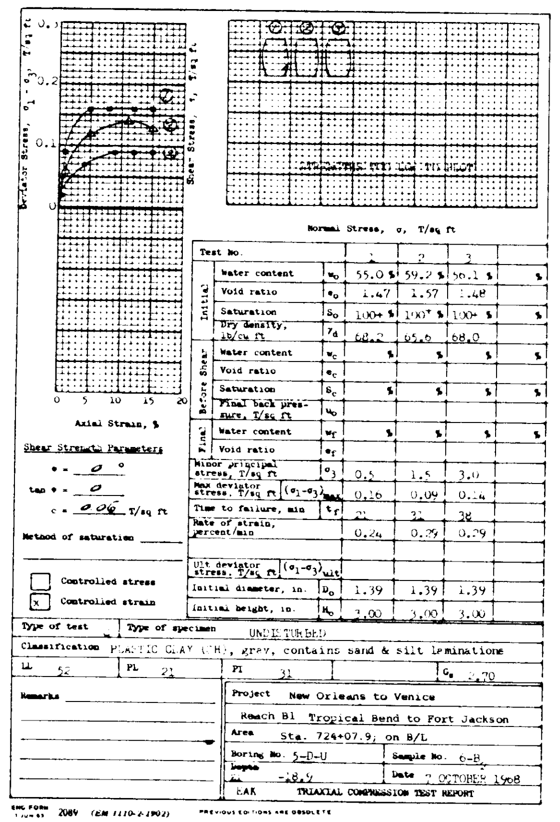
DETAIL SHEAR STRENGTH DATA TABLE

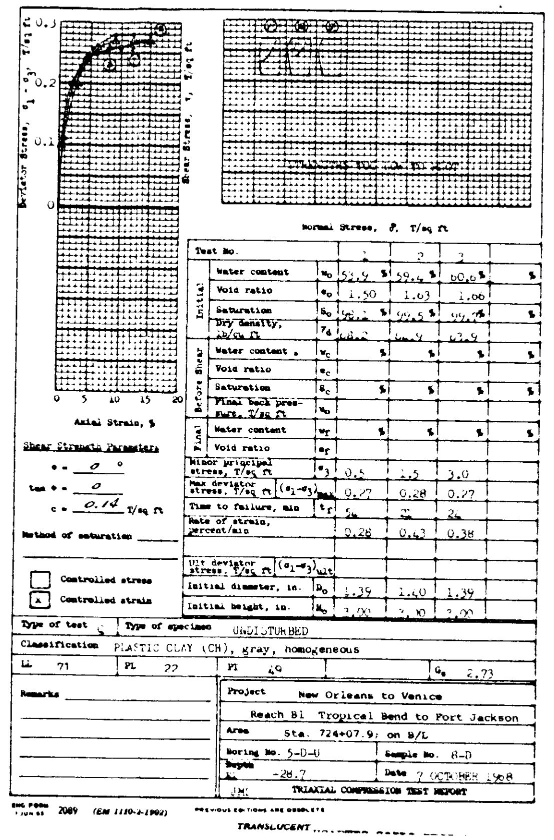
BORING 51-BSU

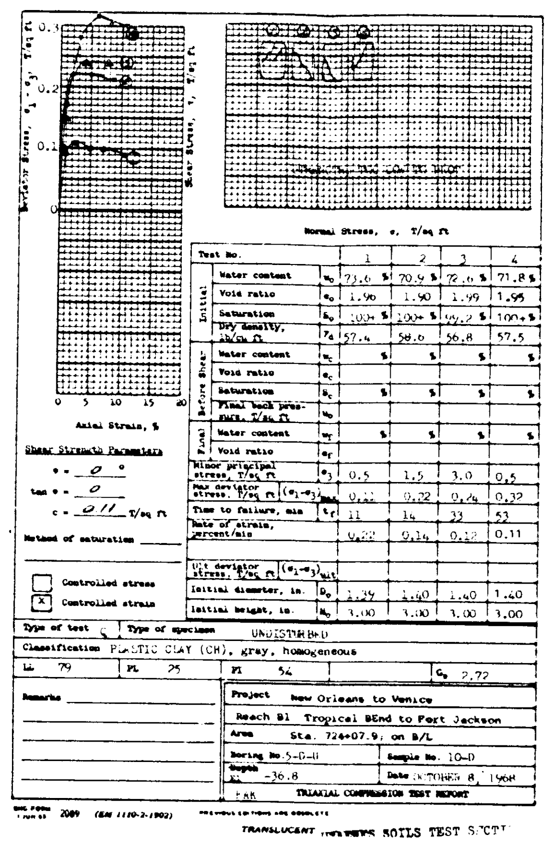
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712

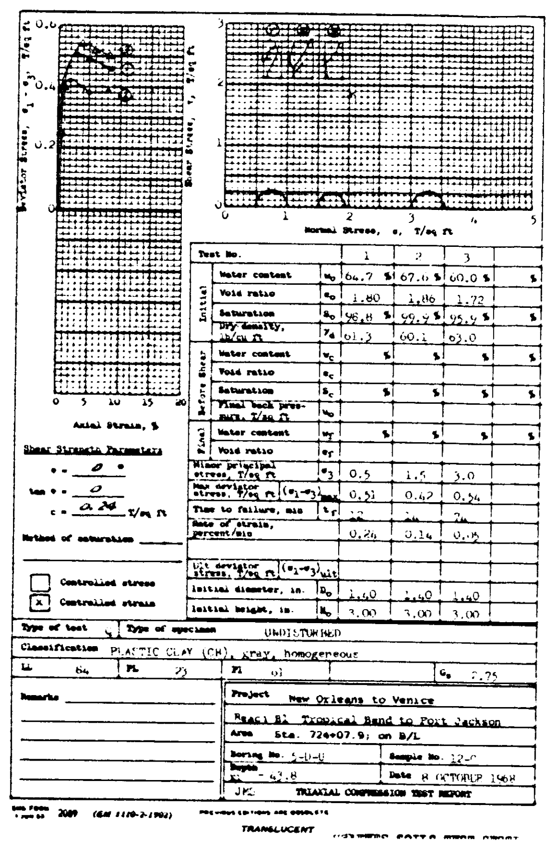


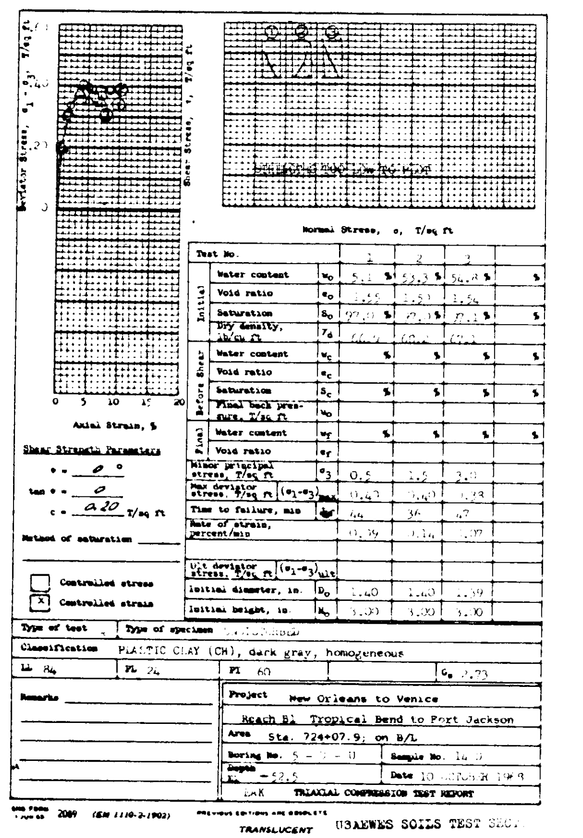


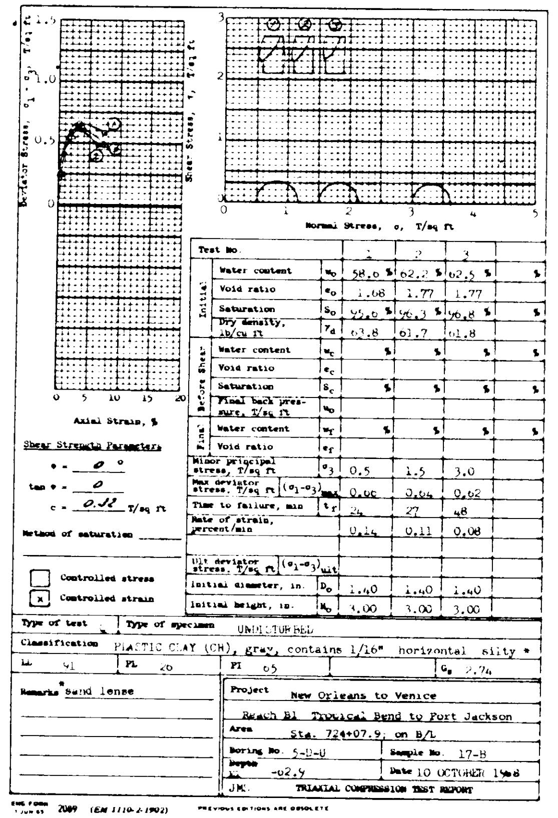


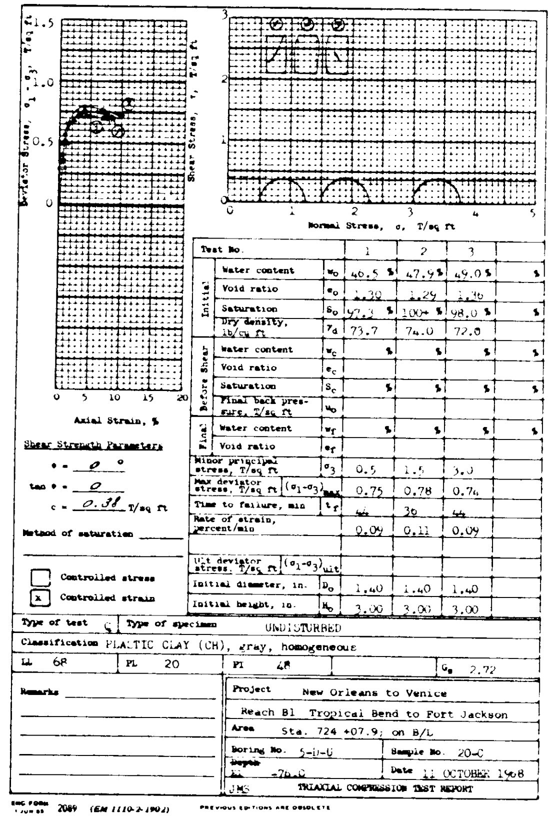


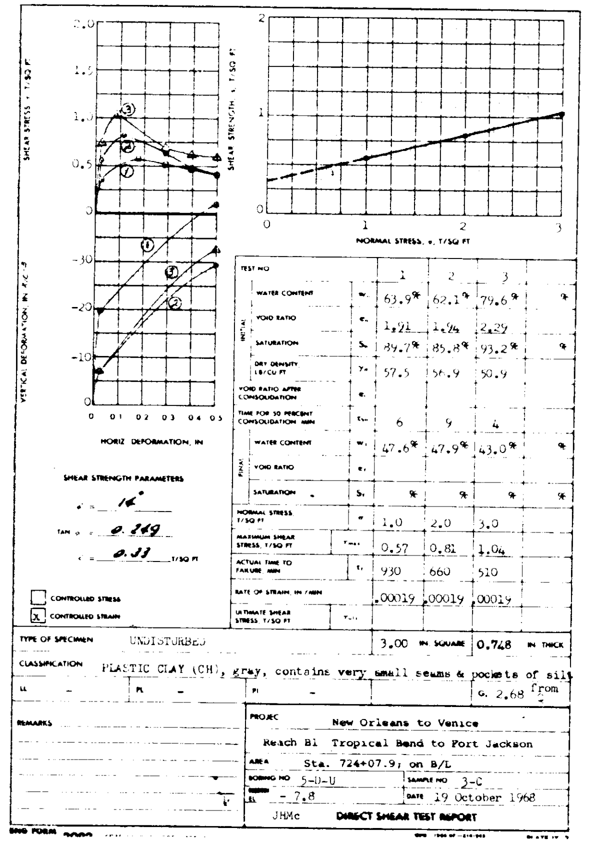


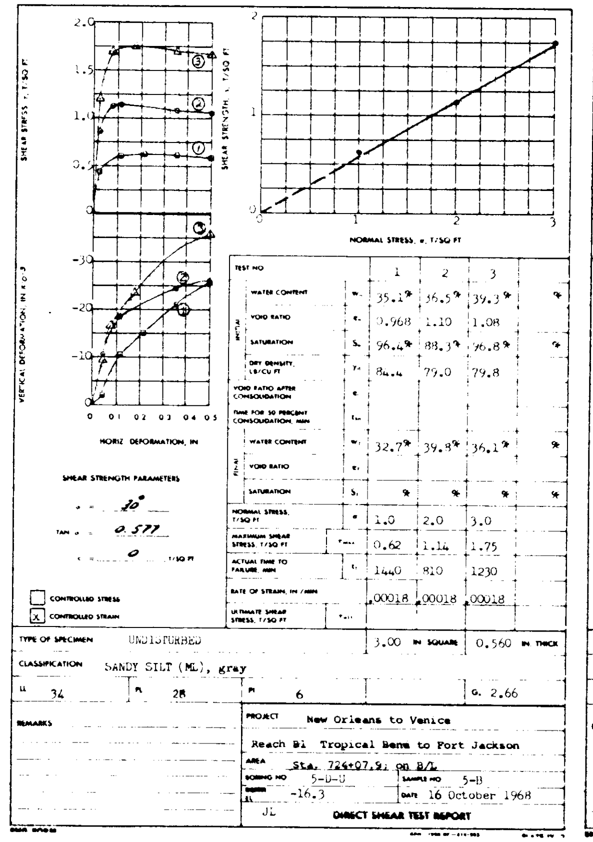


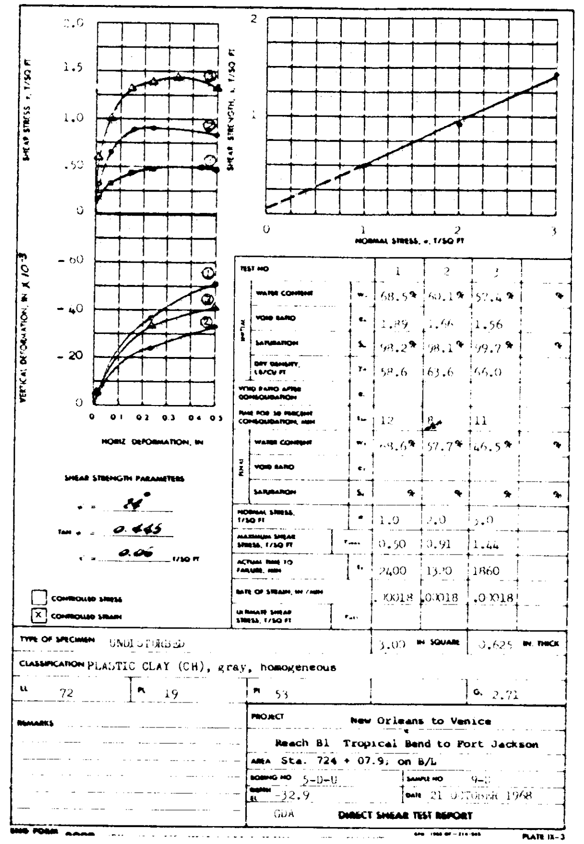


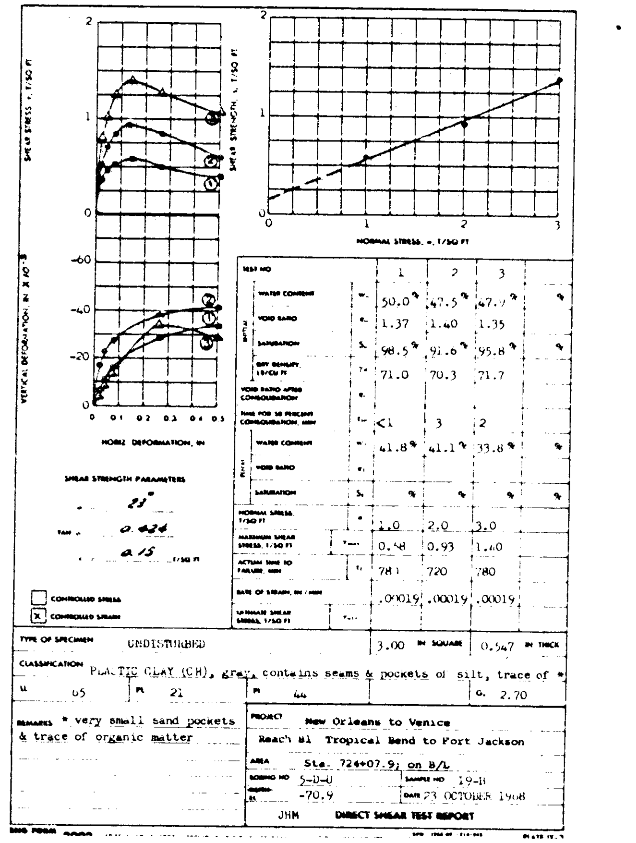










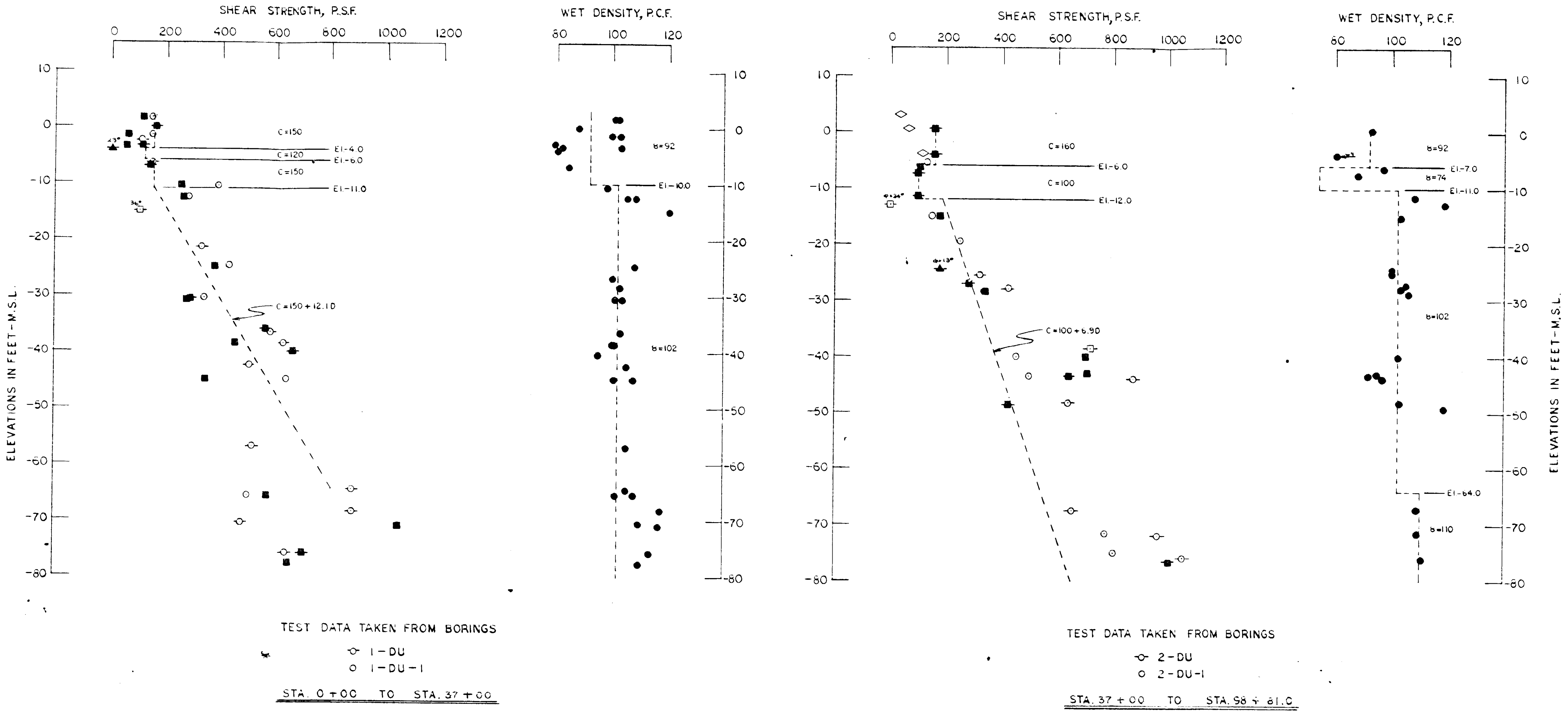


NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

DETAIL SHEAR STRENGTH DATA
BORING 5-DU

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



NOTES:

- ○ - UC UNCONFINED COMPRESSION TEST
- ■ - (Q) UNCONSOLIDATED-UNDRAINED SHEAR TEST
- ◇ - (V) SHEAR VANE TEST
- ▲ - (R) CONSOLIDATED-UNDRAINED SHEAR TEST
- □ - (S) CONSOLIDATED-DRAINED SHEAR TEST

GENERAL NOTES

BORINGS 1-DU-1 AND 2-DU-1 WERE TAKEN IN CONJUCTION WITH THE DESIGN OF THE SECOND LIFT LEVEE FROM STA. 0+00 TO STA. 98+55.3

FOR DETAIL SHEAR TEST DATA, SEE PLATES 70 THRU 73

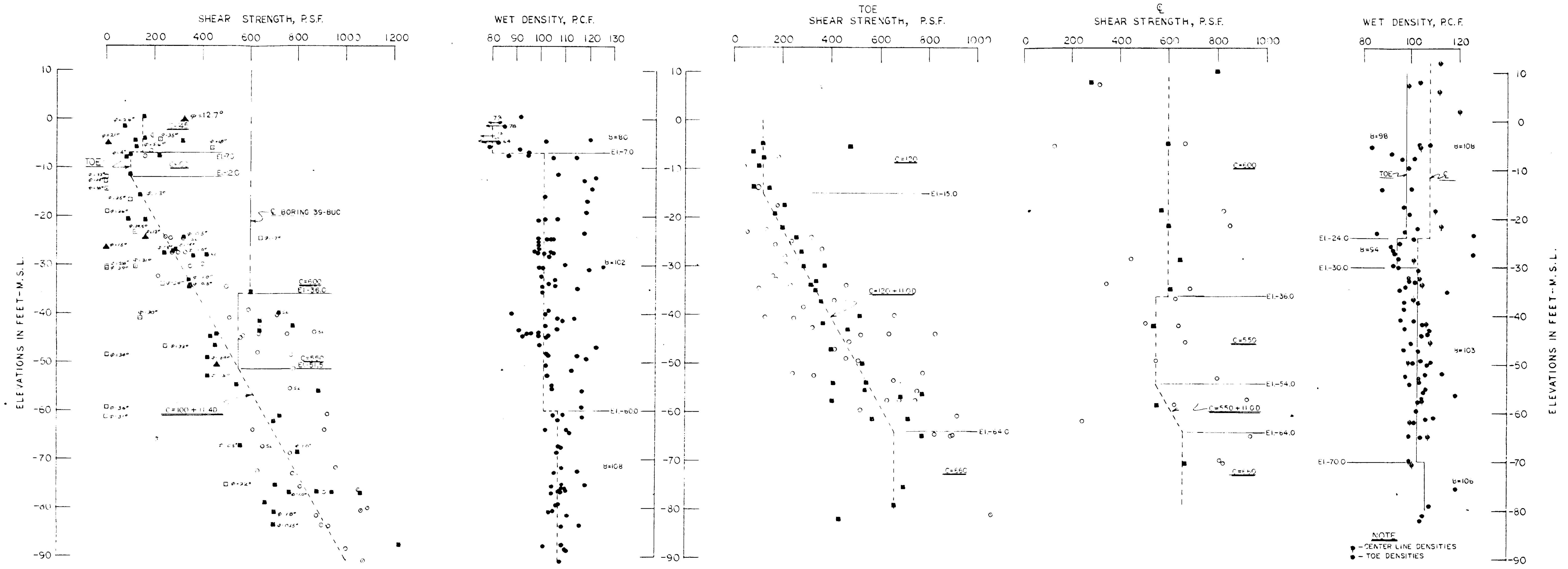
FOR UNDISTURBED BORING LOGS, SEE PLATES 51 THRU 54

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SHEAR STRENGTH AND WET DENSITY DATA PLOTS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



TEST DATA TAKEN FROM
BORINGS 10-BU, 1-SEU, 1-SBU and 2-DU thru 4-DU

STA 107+60 TO STA 337+72

TEST DATA TAKEN FROM
BORINGS 65-BUL, 65-BUF, 62-BUF and 4-DU
BORING 39-BUC

STA 337+72 TO STA 635+72

GENERAL NOTES

FOR DETAIL SHEAR TEST DATA, SEE PLATES 73, 74, & 76 THRU 84.

FOR UNDISTURBED BORING LOGS, SEE PLATES 54, 55, & 57 THRU 65.

NOTES:

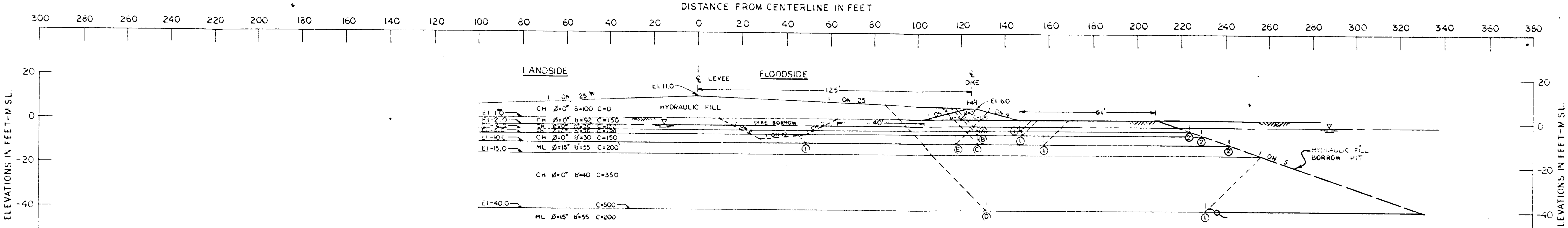
○ - UC-UNCONFINED COMPRESSION TEST.
■ - (Q)-UNCONSOLIDATED-UNDRAINED SHEAR TEST.
▲ - (R)-CONSOLIDATED-UNDRAINED SHEAR TEST.
□ - (S)-CONSOLIDATED-DRAINED SHEAR TEST

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

SHEAR STRENGTH AND WET DENSITY DATA PLOTS

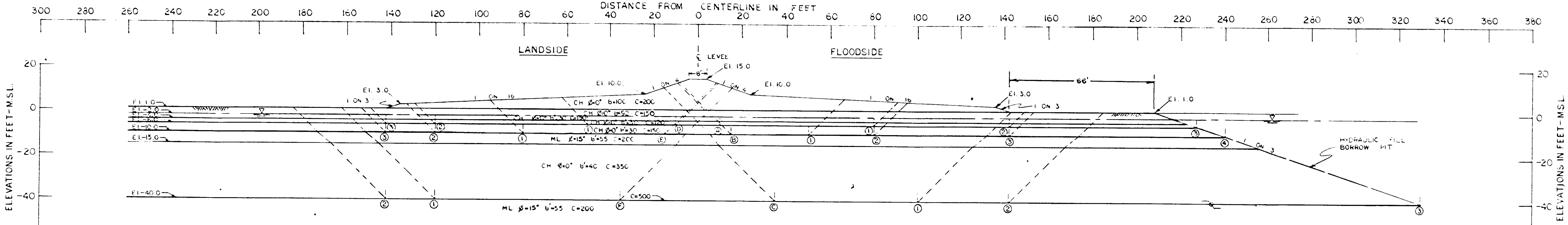
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



FIRST LIFT LEVEE SECTION

Sta. 0+00 TO Sta. 37+00



FINAL LEVEE SECTION

Sta. 0+00 TO Sta. 37+00

ASSUMED FAILURE SURFACES			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.		ELEV.	Ra	Rb	Rp	Da	-Dp	RESISTING	DRIVING	
Ⓐ	①	-4.0	2300	2850	1500	4818	1025	6650	3793	1.735
Ⓐ	②	-4.0	2300	14250	0	4818	0	16550	4818	3.435
Ⓑ	①	-6.0	2700	2400	1980	6600	1757	7080	4843	1.462
Ⓑ	②	-6.0	2700	12120	0	6600	0	14320	6600	2.246
Ⓒ	①	-10.0	3740	4500	3180	10575	3581	11420	6994	1.633
Ⓒ	②	-10.0	3740	16950	0	10575	0	20690	10576	1.957
Ⓓ	①	-40.0	24403	49000	18678	63055	24997	92081	38058	2.419
Ⓓ	②	-40.0	24403	85075	0	63055	0	109478	63052	1.736
Ⓔ	①	-10.0	3900	10350	1118	9532	199	15368	9333	1.647

FIRST LIFT

ASSUMED FAILURE SURFACES			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.		ELEV.	Ra	Rb	Rp	Da	-Dp	RESISTING	DRIVING	
Ⓐ	①	-6.0	7020	8400	3886	20423	6658	19306	13765	1.403
Ⓐ	②	-6.0	7020	15840	1980	20423	1757	24840	18666	1.331
Ⓐ	③	-6.0	7020	26040	120	20423	5	33180	20418	1.625
Ⓑ	①	-10.0	8300	5250	5698	26915	13417	19248	13498	1.426
Ⓑ	②	-10.0	8300	9750	4992	26915	10341	23042	16574	1.390
Ⓑ	③	-10.0	8300	19050	3180	26915	3581	30530	23334	1.308
Ⓑ	④	-10.0	8300	33750	75	26915	1	42125	26914	1.565
Ⓒ	①	-40.0	30059	32500	25520	93096	50676	88079	42420	2.076
Ⓒ	②	-40.0	30059	53500	24865	93096	39120	108424	53976	2.009
Ⓒ	③	-40.0	30059	133259	175	93096	2	163493	93094	1.756
Ⓓ	①	-6.0	7020	4800	4599	20423	9029	16419	11394	1.440
Ⓓ	②	-6.0	7020	13200	2945	20423	4012	23165	16411	1.412
Ⓓ	③	-6.0	7020	15840	1980	20423	1757	24840	18666	1.331
Ⓔ	①	-10.0	8300	9750	4992	26915	10341	23042	16574	1.390
Ⓔ	②	-10.0	8300	15750	4051	26915	6753	28101	20162	1.394
Ⓔ	③	-10.0	8300	19050	3180	26915	3581	30530	23334	1.308
Ⓕ	①	-40.0	30059	42500	24865	93096	43719	97424	49377	1.973
Ⓕ	②	-40.0	30059	53500	24865	93096	39120	108424	53976	2.009

FINAL SECTION

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 87

*SLOPE TO INTERSECT EXISTING BACK LEVEE.

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
∇ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

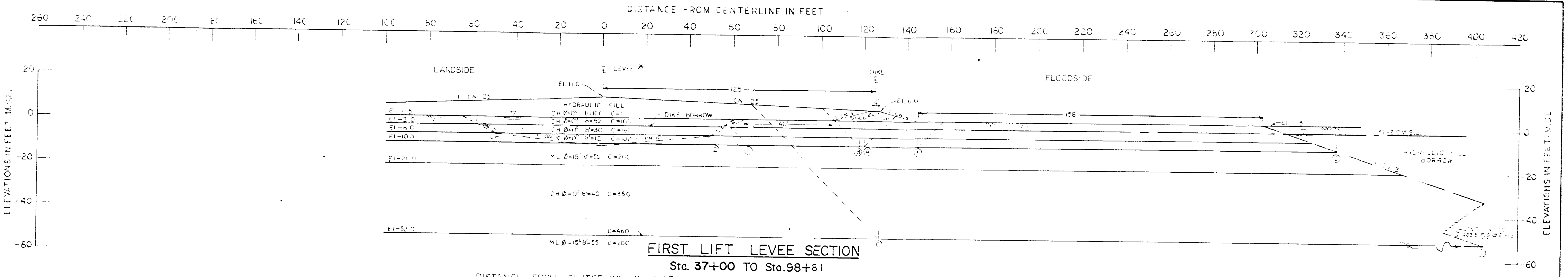
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

FIRST LIFT & FINAL LEVEE SECTIONS
STA 0+00 TO STA. 37+00

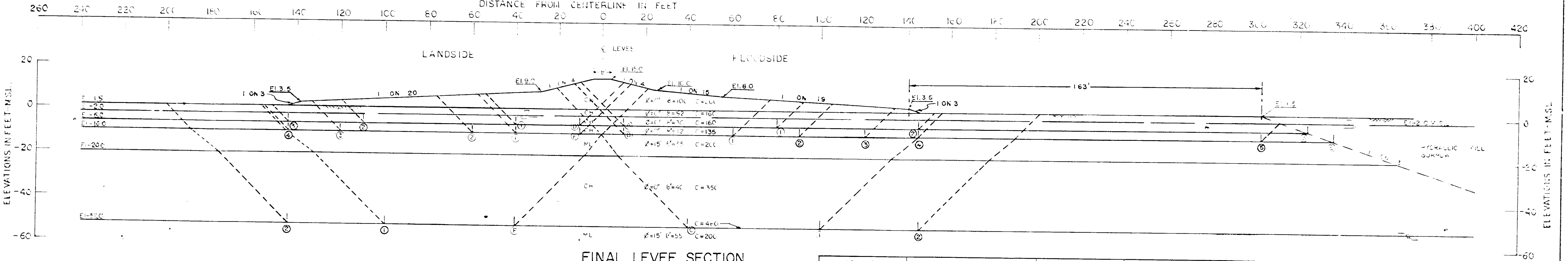
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



FIRST LIFT LEVEE SECTION

Sta. 37+00 TO Sta. 98+81



FINAL LEVEE SECTION

Sta. 37+00 TO Sta. 98+81

ASSUMED FAILURE SURFACES		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	Ra	Rb	Rp	Da	-Dp	RESISTING	DRIVING	
Ⓐ ①	-10.0	3820	5300	1973	9343	1968	11093	7375	1.504
Ⓐ ②	-10.0	3820	6800	727	9343	87	11347	9256	[illegible]
Ⓑ ①	-10.0	3241	27[illegible]	3315	10871	4304	9256	6567	1.409
Ⓑ ②	-10.0	3241	22000	0	10871	0	25241	10871	2.322
Ⓒ ①	-52.0	33384	142765	0	95245	0	176149	95245	1.849

FIRST LIFT

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 87

* SECTION SYMETRICAL ABOUT ℄

ASSUMED FAILURE SURFACES		RESISTING FORCE			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	Ra	Rb	Rp	Da	-Dp	RESISTING	DRIVING	
Ⓐ 1	-[illegible]	7240	11200	4200	20394	6855	22640	13539	1.672
Ⓐ 2	-[illegible]	7240	21600	2400	20394	2094	31240	18300	1.707
Ⓐ ③	-[illegible]	7240	50240	80	20394	1	[illegible]7560	20393	[illegible]
B 1	-10.0	8000	6750	5600	26938	12195	20350	14743	1.380
B ②	-10.0	8000	10600	5000	26938	9661	23800	17277	1.378
Ⓑ ③	-10.0	8000	14850	4400	26938	7364	27250	19574	1.392
B ④	-10.0	8000	18225	3480	26938	3958	29705	22980	1.293
Ⓑ ⑤	-10.0	8000	39487	2680	26938	2633	50167	24305	2.064
Ⓑ ⑥	-10.0	8000	44010	68	26938	0	52078	26938	1.933
Ⓒ ①	-52.0	40028	27600	35781	128361	77541	103409	50820	2.035
Ⓒ ②	-52.0	40028	48300	34835	128361	6[illegible]	123163	62997	1.995
Ⓓ 1	-[illegible]	7240	4800	4886	20394	9150	16926	11244	1.505
Ⓓ [illegible]	-[illegible]	7240	16000	3552	20394	4934	26792	15460	1.733
Ⓓ 3	-[illegible]	7240	21440	2400	20394	2090	31080	18304	1.698
E ①	-10.0	8400	3375	5890	26725	13462	17665	13263	1.332
Ⓔ 2	-10.0	8400	6075	5509	26725	11757	19984	14968	1.335
Ⓔ 3	-10.0	8400	14175	4366	26725	7216	26941	19510	1.381
Ⓔ 4	-10.0	8400	17415	3480	26725	3954	29295	22771	1.286
Ⓕ ①	-52.0	40028	27600	35638	127455	76810	103266	50645	2.039
Ⓕ ②	-52.0	40028	47840	34835	127455	65360	122703	62095	1.976

FINAL SECTION

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
▽ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

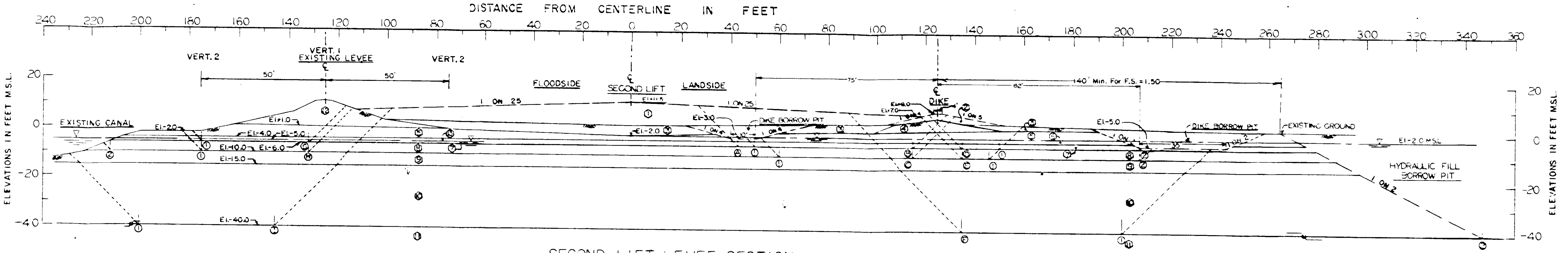
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

FIRST LIFT & FINAL LEVEE SECTIONS
STA. 37+00 TO STA. 98+81

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



SECOND LIFT LEVEE SECTION

Sta. 0+00 TO Sta. 13+00
AND
Sta. 28+00 TO Sta. 37+00

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 87

SHEAR STRENGTHS BETWEEN VERTICALS 1 AND 2 WERE ASSUMED TO VARY LINEARLY BETWEEN THE VALUES INDICATED FOR THESE LOCATIONS.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
1	NEW HYDRA. FILL	100.0	100.0	0	0	0	0	0
2	NEW DIKE	100.0	100.0	50.0	50.0	50.0	50.0	0
3	EXISTING HYDRA. FILL	100.0	100.0	50.0	50.0	50.0	50.0	0
4	EXISTING DIKE	100.0	100.0	100.0	100.0	100.0	100.0	0
5	CH	92.0	92.0	180.0	150.0	180.0	150.0	0
6	CH	30.0	30.0	150.0	120.0	150.0	120.0	0.
7	CH	30.0	30.0	150.0	120.0	150.0	120.0	0
8	CH	30.0	30.0	180.0	150.0	180.0	150.0	0
9	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
10	CH	40.0	40.0	380.0	350.0	530.0	500.0	0
11	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
12	EXISTING LEVEE	100.0	100.0	500.0	500.0	500.0	500.0	0
13	CH	92.0	92.0	150.0	120.0	150.0	120.0	0

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-6.0	780	12840	2164	12978	3802	15784	9176	1.72
B 1	-6.0	3018	7800	780	8895	392	11598	8503	1.36
C 1	-10.0	4100	8250	2198	14014	2590	14548	11424	1.27
D 1	-6.0	3029	1800	2164	8918	3802	6993	5116	1.37
E 1	-10.0	4097	1650	3364	13994	7491	9111	6503	1.40
F 1	-40.0	25287	32500	22167	74064	26066	79954	47998	1.67
F 2	-40.0	25287	87684	0	74064	0	112971	74064	1.53
G 1	-6.0	10546	4290	1080	13148	705	15916	12443	1.28
H 1	-10.0	11340	6654	2280	18951	2169	20274	16782	1.21
H 2	-10.0	11340	12204	870	18951	174	24414	18777	1.30
I 1	-40.0	30731	27770	19678	76465	22204	78179	54261	1.44
D 2	-6.0	3025	8640	240	8918	15	11909	8903	1.34
E 2	-10.0	4097	10800	1440	13994	375	16337	13619	1.20

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
∇ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

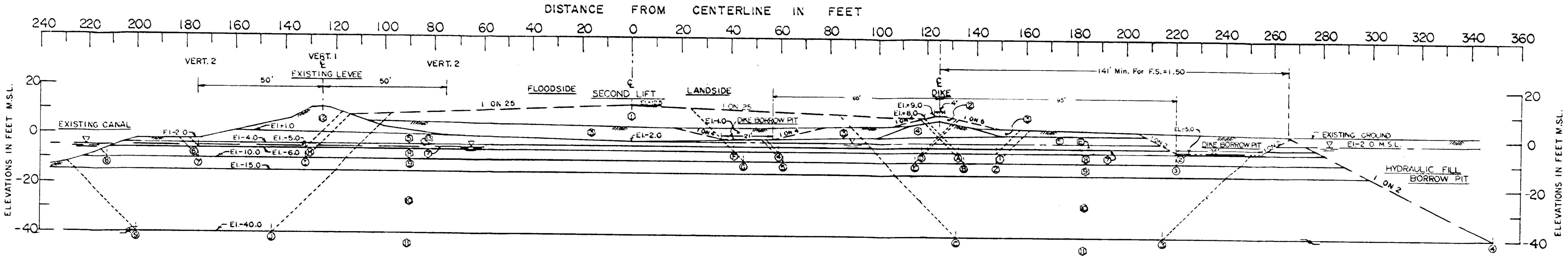
$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

SECOND LIFT LEVEE SECTION
STA 0+00 TO STA 13+00 - STA. 28+00 TO STA 37+00

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712



SECTION LIFT LEVEE SECTION

Sta.13+00 TO Sta.28+00

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 67

SHEAR STRENGTHS BETWEEN VERTICALS 1 AND 2 WERE ASSUMED TO VARY LINEARLY BETWEEN THE VALUES INDICATED FOR THESE LOCATIONS.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
①	NEW HYDRA. FILL	100.0	100.0	0	0	0	0	0
②	NEW DIKE	100.0	100.0	50.0	50.0	50.0	50.0	0
③	EXISTING HYDRA. FILL	100.0	100.0	50.0	50.0	50.0	50.0	0
④	EXISTING DIKE	100.0	100.0	100.0	100.0	100.0	100.0	0
⑤	CH	92.0	92.0	180.0	150.0	180.0	150.0	0
⑥	CH	30.0	30.0	180.0	150.0	180.0	150.0	0
⑦	CH	30.0	30.0	150.0	120.0	150.0	120.0	0
⑧	CH	30.0	30.0	180.0	150.0	180.0	150.0	0
⑨	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
⑩	CH	40.0	40.0	380.0	350.0	530.0	500.0	0
⑪	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
⑫	EXISTING LEVEE	100.0	100.0	500.0	500.0	500.0	500.0	0
⑬	CH	92.0	92.0	150.0	120.0	150.0	120.0	0

ASSUMED FAILURE SURFACE			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.		ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
Ⓐ	①	-6.0	3144	1660	2266	10450	4887	7270	5563	1.31
Ⓑ	②	-10.0	4290	1950	3456	15751	8578	9696	7173	1.35
Ⓒ	③	-40.0	25198	41500	22167	78532	26066	88865	52466	1.69
Ⓓ	④	-6.0	3135	7080	1380	10451	1169	11595	9282	1.24
Ⓔ	⑤	-10.0	4290	8175	2580	15683	3151	15045	12532	1.20
Ⓕ	①	-6.0	1320	12840	2266	15189	4887	16426	10302	1.59
Ⓖ	②	-10.0	2500	15450	3456	21860	8578	21406	13282	1.61
Ⓗ	⑥	-6.0	10546	4290	1080	13148	705	15916	12443	1.28
Ⓘ	⑦	-10.0	11340	6654	2280	18951	2169	20274	16782	1.21
Ⓘ	⑧	-10.0	11340	12204	870	18951	174	24414	18777	1.30
Ⓙ	⑨	-40.0	30731	27770	19678	76465	22204	78179	54261	1.44
Ⓐ	②	-6.0	3144	10500	240	10450	15	13884	10435	1.33
Ⓑ	③	-10.0	4290	12750	1440	15751	375	18480	15376	1.20
Ⓒ	④	-40.0	25198	92600	0	78532	0	117798	78532	1.50

NOTES

ϕ = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
∇ = STATIC WATER SURFACE
D = HORIZONAL DRIVING FORCE IN POUNDS
R = HORIZONAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

FACTOR OF SAFETY = $\frac{R_A + R_B + R_P}{D_A - D_P}$

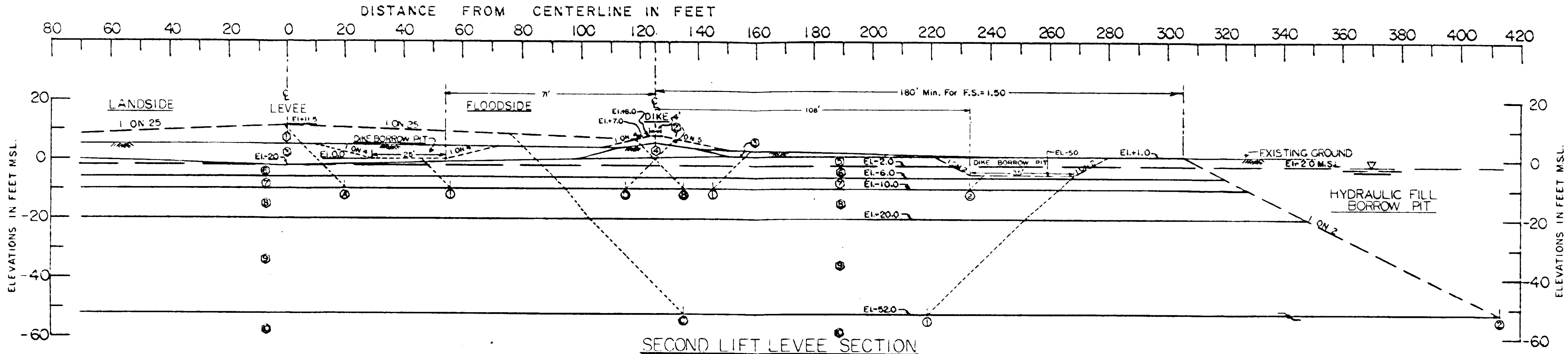
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

SECOND LIFT LEVEE SECTION
STA. 13+00 TO STA. 28+00

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



SECOND LIFT LEVEE SECTION
Sta 37+00 TO Sta 46+00

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
1	NEW HYDRA. FILL	100.0	100.0	0	0	0	0	0
2	NEW DIKE	100.0	100.0	50.0	50.0	50.0	50.0	0
3	EXISTING HYDRA. FILL	100.0	100.0	50.0	50.0	50.0	50.0	0
4	EXISTING DIKE	100.0	100.0	100.0	100.0	100.0	100.0	0
5	CH	92.0	92.0	160.0	160.0	160.0	160.0	0
6	CH	30.0	30.0	160.0	160.0	160.0	160.0	0
7	CH	12.0	12.0	100.0	100.0	100.0	100.0	0
8	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.
9	CH	40.0	40.0	350.0	350.0	460.0	460.0	0
10	ML	55.0	55.0	200.0	200.0	200.0	200.0	15

ASSUMED FAILURE SURFACE			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.		ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A	1	-10.0	2779	12500	3248	19963	6396	18527	13567	1.37
B	1	-10.0	3951	1000	3248	12624	6396	8199	6228	1.32
C	1	-52.0	34361	38640	30317	101419	46798	103318	54621	1.89
C	2	-52.0	34361	117730	0	101419	0	152091	101419	1.50
D	1	-10.0	3948	5900	2500	12517	2472	12348	10045	1.23
B	2	-10.0	3951	9800	1120	12624	231	14871	12393	1.20

NOTES

ϕ = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
∇ = STATIC WATER SURFACE
R = HORIZONTAL RESISTING FORCE IN POUNDS
D = HORIZONTAL DRIVING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

GENERAL NOTES

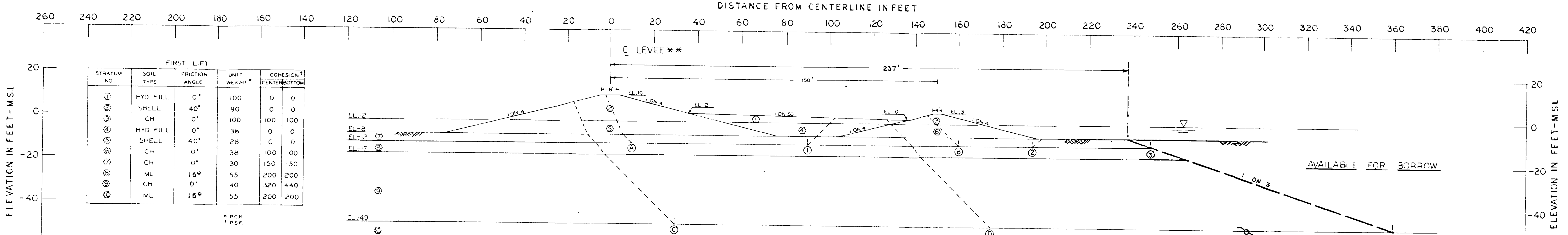
CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 67

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS
SECOND LIFT LEVEE SECTION
STA. 27+00 TO STA. 46+00

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

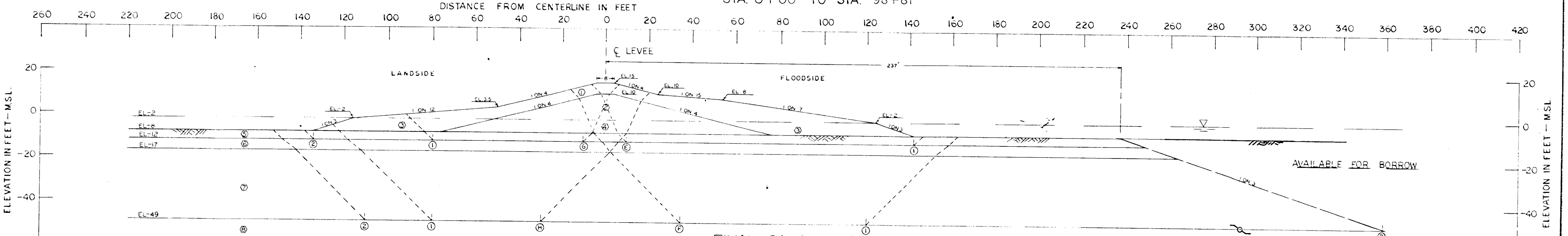


FIRST LIFT

STRATUM NO.	SOIL TYPE	FRICTION ANGLE	UNIT WEIGHT *	COHESION †	
				CENTER	BOTTOM
①	HYD. FILL	0°	100	0	0
②	SHELL	40°	90	0	0
③	CH	0°	100	100	100
④	HYD. FILL	0°	38	0	0
⑤	SHELL	40°	28	0	0
⑥	CH	0°	38	100	100
⑦	CH	0°	30	150	150
⑧	ML	15°	55	200	200
⑨	CH	0°	40	320	440
⑩	ML	15°	55	200	200

* P.C.F.
† P.S.F.

FIRST LIFT CANAL CLOSURE SECTION
STA. 0+00 TO STA. 98+81



FINAL CANAL CLOSURE SECTION
STA. 0+00 TO STA. 98+81

FINAL SECTION

STRATUM NO.	SOIL TYPE	FRICTION ANGLE	UNIT WEIGHT *	COHESION †	
				CENTER	BOTTOM
①	CH	0°	100	200	200
②	SHELL	40°	90	0	0
③	CH	0°	38	170	170
④	SHELL	40°	28	0	0
⑤	CH	0°	30	150	150
⑥	ML	15°	55	200	200
⑦	CH	0°	40	320	440
⑧	ML	15°	55	200	200

* P.C.F.
† P.S.F.

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATES 87

** SECTION SYMETRICAL ABOUT ℄

ASSUMED FAILURE SURFACES		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	Ra	Rb	Rp	Da	−Dp	RESISTING	DRIVING	
Ⓐ ①	−12.0	11667	12000	1200	18246	5019	24867	13225	1.879
Ⓐ ③	−12.0	11667	35850	0	18246	0	47517	18248	2.604
Ⓑ ②	−12.0	3280	5100	1200	7198	259	9560	6939	1.381
Ⓑ ③	−12.0	3280	13350	0	7198	0	16630	7198	2.310
Ⓒ ①	−49.0	33577	137160	0	87639	0	170737	87639	1.948
Ⓓ ①	−49.0	25932	73360	0	57845	0	99292	57845	1.717
Ⓔ ①	−12.0	20439	19800	1200	30384	240	41439	30144	1.375
Ⓕ ①	−49.0	43624	37400	24825	117122	36605	105849	80517	1.315
Ⓕ ②	−49.0	43624	132849	160	117122	2	176633	117120	1.508
Ⓖ ①	−12.0	20439	10500	4040	30384	4634	34979	25750	1.358
Ⓖ ②	−12.0	20439	18600	1200	30384	240	40239	30144	1.335
Ⓗ ①	−49.0	41816	22000	26483	116524	49436	90299	67088	1.346
Ⓗ ②	−49.0	41816	35200	24825	116524	37640	101841	78684	1.294

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
▽ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

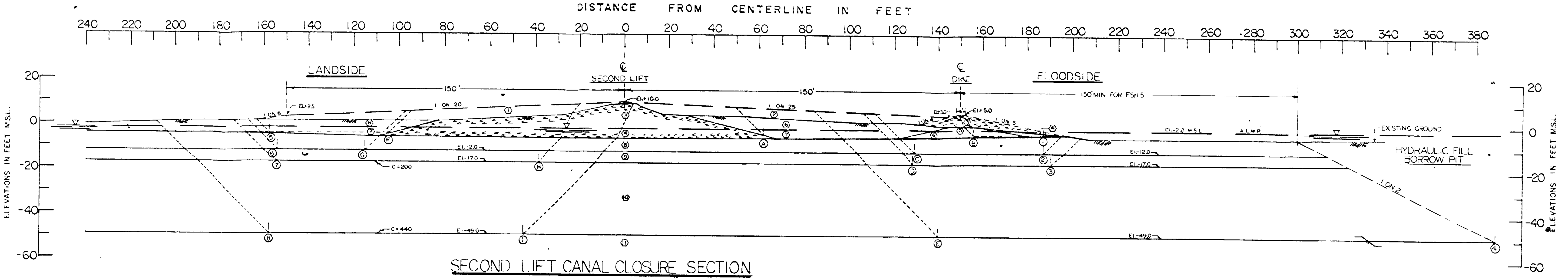
$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS
FIRST LIFT AND FINAL CANAL CLOSURE SECTION
STA. 0+00 TO STA. 98+81

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



SECOND LIFT CANAL CLOSURE SECTION

STA 46+50 TO STA 49+00 (APPROX)

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
①	CASTFILL	100.0	100.0	50.0	50.0	50.0	50.0	0
②	HYDRA. FILL	100.0	100.0	0	0	0	0	0
③	SHELL	90.0	90.0	0	0	0	0	40
④	SHELL	28.0	28.0	0	0	0	0	40
⑤	EXISTING DIKE	100.0	100.0	100.0	100.0	100.0	100.0	0
⑥	EXISTING HYDRA. FILL	100.0	100.0	50.0	50.0	50.0	50.0	0
⑦	EXISTING HYDRA. FILL	38.0	38.0	50.0	50.0	50.0	50.0	0
⑧	CH	30.0	30.0	150.0	150.0	150.0	150.0	0
⑨	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
⑩	CH	40.0	40.0	320.0	320.0	440.0	440.0	0
⑪	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
⑫	EXISTING DIKE	38.0	38.0	100.0	100.0	100.0	100.0	0

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTH, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 87

ASSUMED FAILURE SURFACE NO.		ELEV.	RESISTING FORCES R_A	R_B	R_P	DRIVING FORCES D_A	$-D_P$	SUMMATION OF FORCES RESISTING	DRIVING	FACTOR OF SAFETY
Ⓐ	①	-4.5	770	9050	275	6840	123	10095	6717	1.50
Ⓑ	①	-4.5	1671	2850	275	3483	123	4796	3360	1.43
Ⓒ	②	-12.0	2876	8700	2349	12516	1712	13925	10804	1.29
Ⓓ	③	-17.0	6696	12500	5724	19423	3054	24920	16369	1.52
Ⓔ	④	-49.0	27350	102520	0	86669	0	129870	86669	1.50
Ⓕ	⑤	-4.5	1015	2645	550	4667	1317	4210	3350	1.26
Ⓖ	⑥	-12.0	3050	5925	2744	11184	5264	11719	5920	1.98
Ⓗ	⑦	-17.0	14420	23100	7277	26082	9036	44797	17046	2.63
Ⓘ	⑧	-49.0	36753	49500	27352	101500	55919	113605	45581	2.49

NOTES

Ø=ANGLE OF INTERNAL FRICTION, DEGREES
C=UNIT COHESION, P.S.F.
▽=STATIC WATER SURFACE
R=HORIZONTAL RESISTING FORCE IN POUNDS
D=HORIZONTAL DRIVING FORCE IN POUNDS
A=AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B=AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P=AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

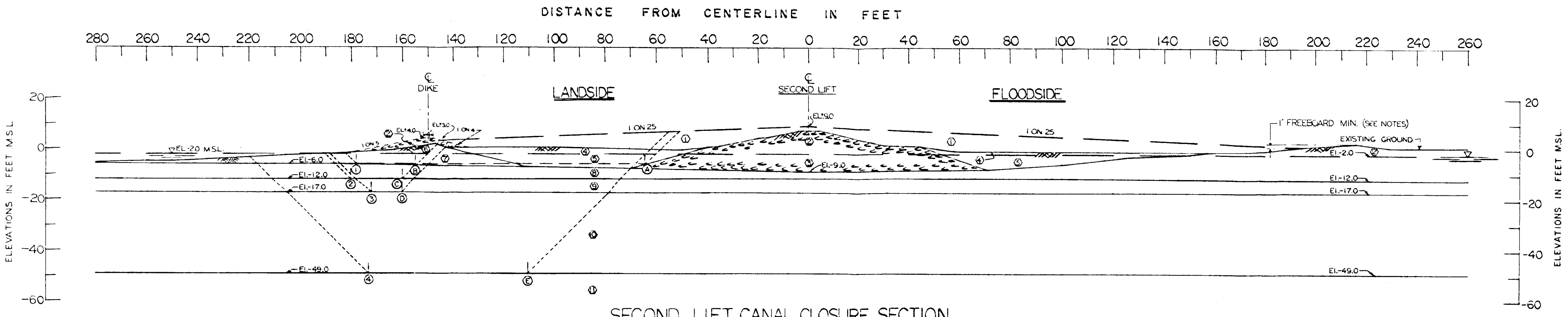
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

SECOND LIFT CANAL CLOSURE SECTION
STA. 46+50 TO STA. 49+00

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



SECOND LIFT CANAL CLOSURE SECTION

STA. 63+50 TO STA 65+00

(APPROX.)

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
1	HYDRA.FILL	100.0	100.0	0	0	0	0	0
2	SHELL	90.0	90.0	0	0	0	0	40
3	SHELL	28.0	28.0	0	0	0	0	40
4	EXISTING HYDRA. FILL	100.0	100.0	50.0	50.0	50.0	50.0	0
5	EXISTING HYDRA. FILL	38.0	38.0	50.0	50.0	50.0	50.0	0
6	EXISTING DIKE	100.0	100.0	100.0	100.0	100.0	100.0	0
7	EXISTING DIKE	38.0	38.0	100.0	100.0	100.0	100.0	0
8	CH	30.0	30.0	150.0	150.0	150.0	150.0	0
9	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
10	CH	40.0	40.0	320.0	320.0	440.0	440.0	0
11	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
12	CH	92.0	92.0	150.0	150.0	150.0	150.0	0

ASSUMED FAILURE SURFACE			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.		ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A	1	-6.0	569	8800	840	7391	525	10209	6866	1.487
B	1	-6.0	1698	2300	840	4127	525	4838	3602	1.343
C	2	-12.0	3411	3000	2660	8437	1940	9071	6497	1.396
D	3	-17.0	6500	2000	6777	13202	5619	15277	7583	2.015
E	4	-49.0	26352	27720	26191	82783	44324	80263	38459	2.087

NOTES

Ø=ANGLE OF INTERNAL FRICTION, DEGREES
C=UNIT COHESION, P.S.F.
▽=STATIC WATER SURFACE
R=HORIZONTAL RESISTING FORCE IN POUNDS
D=HORIZONTAL DRIVING FORCE IN POUNDS
A=AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B=AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P=AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

FACTOR OF SAFETY = $\frac{R_A+R_B+R_P}{D_A-D_P}$

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTH, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 87

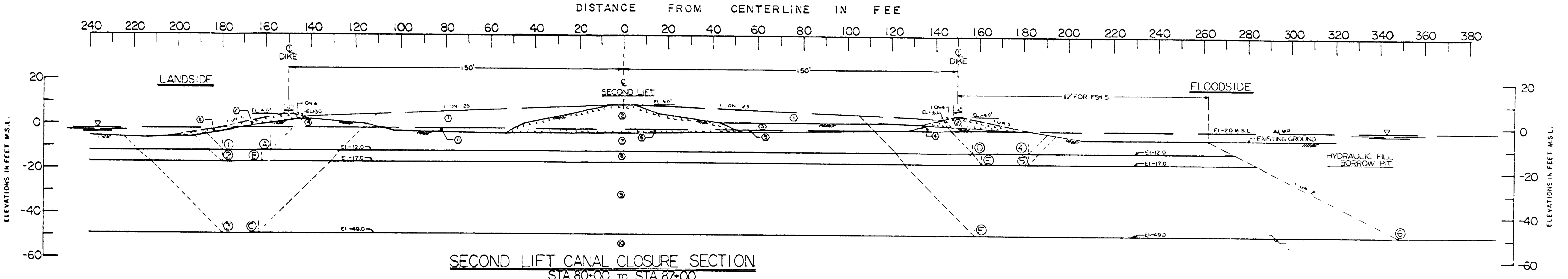
THE NATURAL GROUND SURFACE IN THIS REACH IS HIGH ENOUGH TO PROVIDE A MINIMUM FREEBOARD OF 1' FOR HYDRAULIC FILL PLACEMENT, THEREFORE, NO FLOODSIDE RETAINING DIKE WILL BE CONSTRUCTED IN THIS REACH.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS
SECOND LIFT CANAL CLOSURE SECTION
STA. 63+50 TO STA. 65+00

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



SECOND LIFT CANAL CLOSURE SECTION

STA 80+00 TO STA 87+00
(APPROX.)

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C-UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
1	HYDRA. FILL	100.0	100.0	0	0	0	0	0
2	SHELL	90.0	90.0	0	0	0	0	40
3	EXISTING HYDRA. FILL	100.0	100.0	50.0	50.0	50.0	50.0	0
4	EXISTING DIKE	100.0	100.0	100.0	100.0	100.0	100.0	0
5	EXISTING HYDRA. FILL	38.0	38.0	50.0	50.0	50.0	50.0	0
6	SHELL	28.0	28.0	0	0	0	0	40
7	CH	30.0	30.0	150.0	150.0	150.0	150.0	0
8	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
9	CH	40.0	40.0	320.0	320.0	440.0	440.0	0
10	ML	55.0	55.0	200.0	200.0	200.0	200.0	15

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTH, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 87

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-12.0	3836	3300	2237	8245	1335	9373	6910	1.36
B 2	-17.0	6924	3600	5517	12511	3159	16041	9352	1.72
C 3	-49.0	27146	7480	25393	68590	38235	60019	30655	1.96
D 4	-12.0	3780	3750	2586	8047	1292	10116	6755	1.50
E 5	-17.0	6875	4200	5909	12342	3161	16984	9181	1.85
F 6	-49.0	27269	76880	0	69301	0	104149	69301	1.50

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
∇ = STATIC WATER SURFACE
R = HORIZONTAL RESISTING FORCE IN POUNDS
D = HORIZONTAL DRIVING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

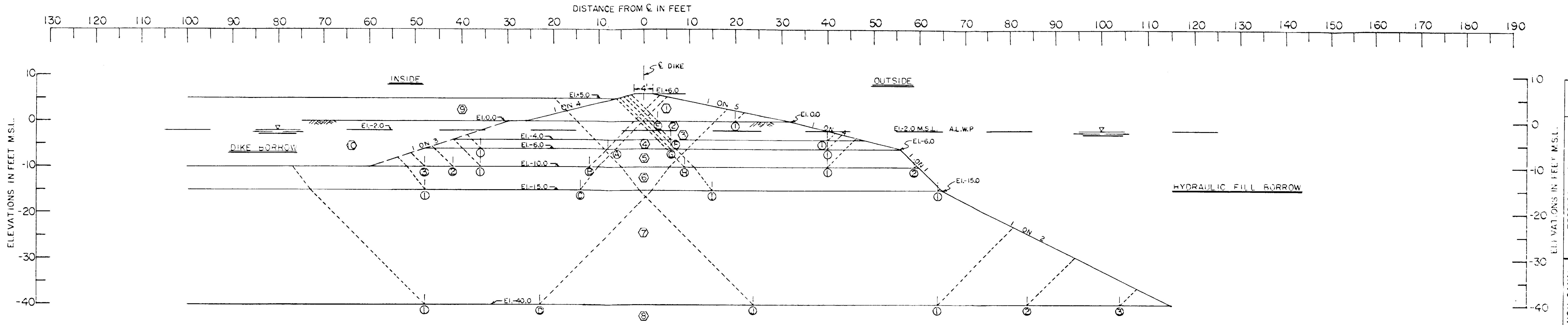
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

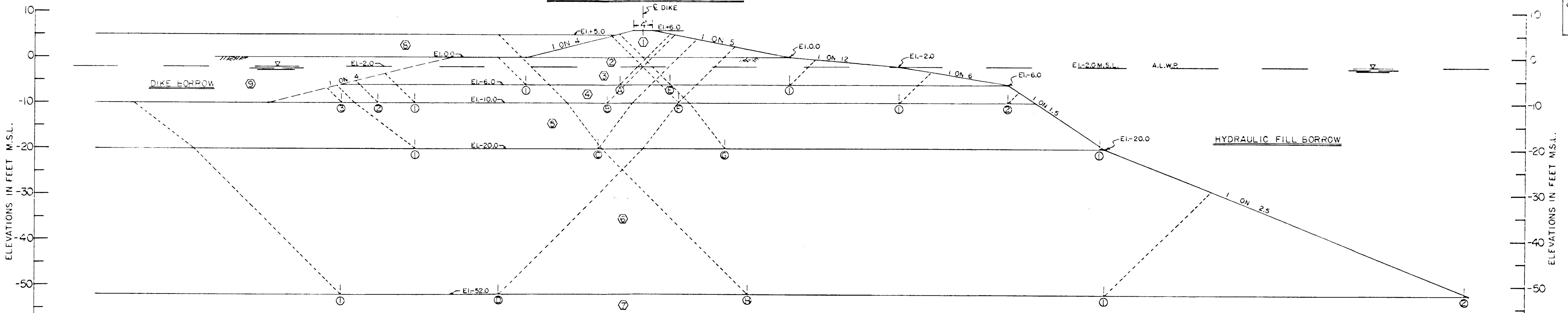
SECOND LIFT CANAL CLOSURE SECTION
STA. 80+00 TO STA. 87+00

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



TROPICAL BEND TO GALMICH CANAL*



GALMICH CANAL TO EMPIRE*

	Assumed failure surface No.		Elev.	Resisting forces R_A	R_B	R_P	Driving forces D_A	$-D_P$	Summation of forces Resisting	Driving	Factor of safety
TROPICAL BEND TO GALMICH CANAL	Ⓐ	①	-6.0	2360	3360	780	5095	180	6500	4915	1.32
	Ⓑ	①	-10.0	3560	3600	1680	7832	719	8840	7113	1.24
	Ⓑ	②	-10.0	3560	4500	1320	7832	405	9380	7427	1.26
	Ⓑ	③	-10.0	3560	5400	900	7832	180	9860	7652	1.29
	Ⓒ	①	-15.0	6785	6800	3803	12294	1161	17388	11133	1.56
	Ⓓ	①	-40.0	24287	12500	20556	48975	19489	57343	29486	1.95
	Ⓔ	①	0.0	696	1380	120	1425	48	2196	1377	1.59
	Ⓕ	①	-4.0	1872	5100	480	3814	48	7452	3766	1.98
	Ⓖ	①	-6.0	2304	4080	840	5226	192	7224	5034	1.44
	Ⓗ	①	-10.0	3480	4650	1800	8266	767	9930	7499	1.32
	Ⓗ	②	-10.0	3480	7500	150	8266	7	11130	8259	1.35
	Ⓘ	①	-15.0	6844	9800	235	12444	12	16879	12432	1.36
	Ⓙ	①	-40.0	24251	20000	11900	51033	8605	56151	42428	1.32
	Ⓙ	②	-40.0	24251	30000	7233	51033	3202	61484	47831	1.29
	Ⓙ	③	-40.0	24251	40000	2567	51033	403	66818	50630	1.32
GALMICH CANAL TO EMPIRE	Ⓐ	①	-6.0	2540	3360	1920	5226	1159	7820	4067	1.92
	Ⓑ	①	-10.0	3320	4200	1568	8114	624	9088	7490	1.21
	Ⓑ	②	-10.0	3320	5000	1056	8114	288	9376	7826	1.20
	Ⓑ	③	-10.0	3320	5800	640	8114	77	9760	8037	1.21
	Ⓒ	①	-20.0	10486	9600	8723	18044	4073	28809	13971	2.07
	Ⓓ	①	-52.0	32869	15640	29511	72644	39047	78020	33597	2.32
	Ⓔ	①	-6.0	2544	4160	1772	5226	1032	8477	4194	2.02
	Ⓕ	①	-10.0	3296	4800	678	8147	678	9810	7469	1.31
	Ⓕ	②	-10.0	3296	7200	480	8147	58	10976	8089	1.36
	Ⓖ	①	-20.0	10174	31120	191	17177	7	41485	17170	2.42
	Ⓗ	①	-52.0	32484	35880	16000	79224	14625	84364	64599	1.31
	Ⓗ	②	-52.0	32484	72220	200	79224	2	104904	79222	1.32

NOTES

Ø - ANGLE OF INTERNAL FRICTION, DEGREES
C - UNIT COHESION, P.S.F.
≚ - STATIC WATER SURFACE
D - HORIZONAL DRIVING FORCE IN POUNDS
R - HORIZONAL RESISTING FORCE IN POUNDS
A - AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B - AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P - AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

	Stratum No.	Soil type	Effective unit wt. P.C.F. Vert. 1	Vert. 2	C - Unit cohesion - P.S.F. Center of stratum Vert. 1	Vert. 2	Bottom of stratum Vert. 1	Vert. 2	Friction angle degrees
TROPICAL BEND TO GALMICH CANAL	1	CH	80.0	80.0	60.0	60.0	60.0	60.0	0
	2	CH	92.0	92.0	150.0	150.0	150.0	150.0	0
	3	CH	30.0	30.0	150.0	150.0	150.0	150.0	0
	4	CH	30.0	30.0	120.0	120.0	120.0	120.0	0
	5	CH	30.0	30.0	150.0	150.0	150.0	150.0	0
	6	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
	7	CH	40.0	40.0	350.0	350.0	350.0	350.0	0
	8	CH	40.0	40.0	1000.0	1000.0	1000.0	1000.0	0
	9	SPOIL	90.0	90.0	0	0	0	0	0
	10	SPOIL	28.0	28.0	0	0	0	0	0

	Stratum No.	Soil type	Effective unit wt. P.C.F. Vert. 1	Vert. 2	C - Unit cohesion - P.S.F. Center of stratum Vert. 1	Vert. 2	Bottom of stratum Vert. 1	Vert. 2	Friction angle degrees
GALMICH CANAL TO EMPIRE	1	CH	80.0	80.0	60.0	60.0	60.0	60.0	0
	2	CH	92.0	92.0	160.0	160.0	160.0	160.0	0
	3	CH	30.0	30.0	160.0	160.0	160.0	160.0	0
	4	CH	12.0	12.0	100.0	100.0	100.0	100.0	0
	5	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
	6	CH	40.0	40.0	350.0	350.0	350.0	350.0	0
	7	CH	40.0	40.0	1000.0	1000.0	1000.0	1000.0	0
	8	SPOIL	90.0	90.0	0	0	0	0	0
	9	SPOIL	28.0	28.0	0	0	0	0	0

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 87

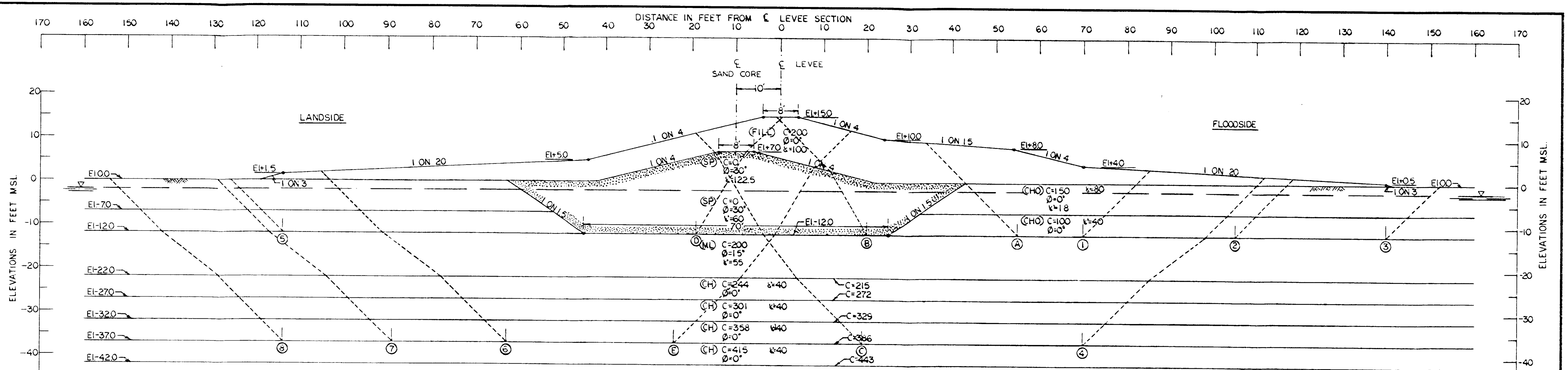
* APPROXIMATE LIMITS

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS
PONDING AREA DIKES
TROPICAL BEND TO EMPIRE

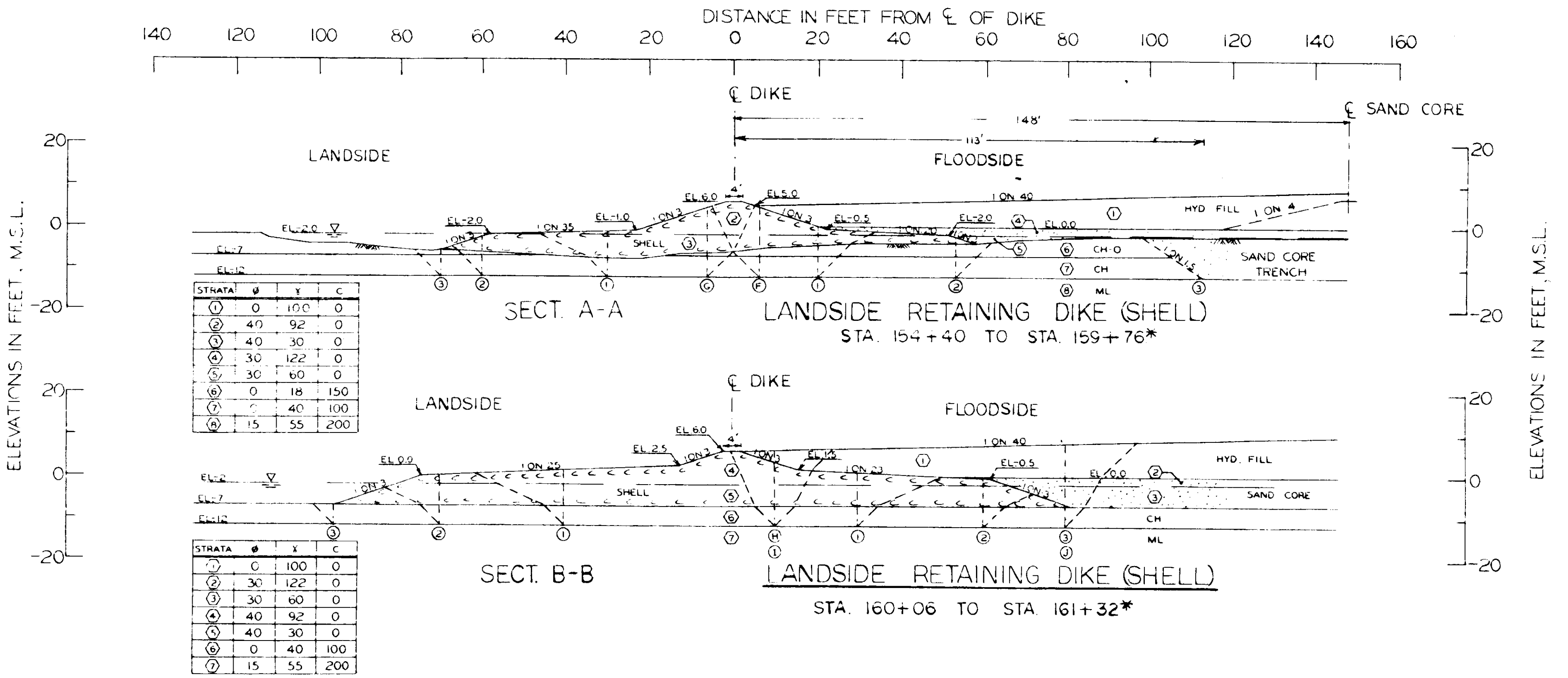
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



FINAL LEVEE SECTION

STA. 104+81 TO STA. 232+41



ASSUMED FAILURE SURFACE NO.		ELEV.	RESISTING FORCES R_A	R_B	R_P	DRIVING FORCES D_A	$-D_P$	SUMMATION OF FORCES RESISTING	DRIVING	FACTOR OF SAFETY
Ⓐ	①	-12.00	6843	1500	4395	17017	7922	12738	9095	1.40
Ⓐ	②	-12.00	6843	5000	3729	17017	5402	15572	11615	1.34
Ⓐ	③	-12.00	6843	8500	3100	17017	2970	18443	14047	1.31
Ⓑ	③	-12.00	20560	15028	3100	30373	2970	38688	27403	1.41
Ⓒ	④	-37.00	46236	19686	25208	106288	40987	91130	65301	1.40
Ⓓ	⑤	-12.00	22904	23969	3100	32556	3272	49973	29284	1.71
Ⓔ	⑥	-37.00	46450	15050	25262	106678	41182	86766	65496	1.32
Ⓔ	⑦	-37.00	46450	25090	23504	106678	34850	95044	71828	1.32
Ⓔ	⑧	-37.00	46450	34740	22405	106678	30016	103595	76662	1.35
Ⓕ	①	-12.00	5900	1400	3117	11262	2748	10417	8514	1.22
Ⓕ	②	-12.00	5900	4700	2020	11262	1084	12620	10178	1.24
Ⓕ	③	-12.00	5900	10600	80	11262	5	16580	11257	1.47
Ⓖ	①	-12.00	5929	2400	3541	11315	2188	11870	9127	1.30
Ⓖ	②	-12.00	5929	5400	1356	11315	1568	12685	9747	1.30
Ⓖ	③	-12.00	5929	6400	1213	11315	724	13542	10591	1.28
Ⓗ	①	-12.00	6451	2000	7076	11266	4207	15527	7059	2.20
Ⓗ	②	-12.00	6451	5000	2010	11266	2036	13461	9230	1.46
Ⓗ	③	-12.00	6451	7000	1000	11266	463	14451	10803	1.34
Ⓘ	③	-12.00	6184	10600	1000	13146	499	17784	12647	1.41
Ⓙ	①	-12.00	6269	12000	8460	18557	4840	26729	13717	1.95
Ⓙ	②	-12.00	6269	15000	3451	18557	2896	24720	15661	1.58
Ⓙ	③	-12.00	6269	17600	1000	18557	499	24869	18058	1.38

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 88

TRANSITION FROM SECTION A-A TO SECTION B-B FROM STA. 159+76 TO STA. 160+06. STATIONS ARE ON B/L. SEE PLATE FOR DIKE LOCATION AND ACTUAL LENGTH.

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
∇ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

REACH B1-TROPICAL BEND TO FORT JACKSON

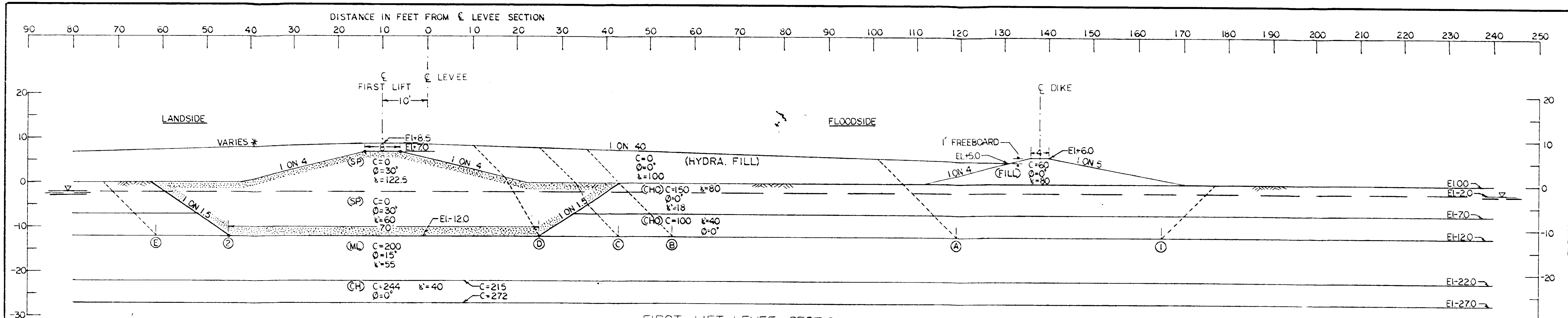
(Q) STABILITY ANALYSIS

FINAL LEVEE SECTION

STA. 104+81 TO STA 232+41

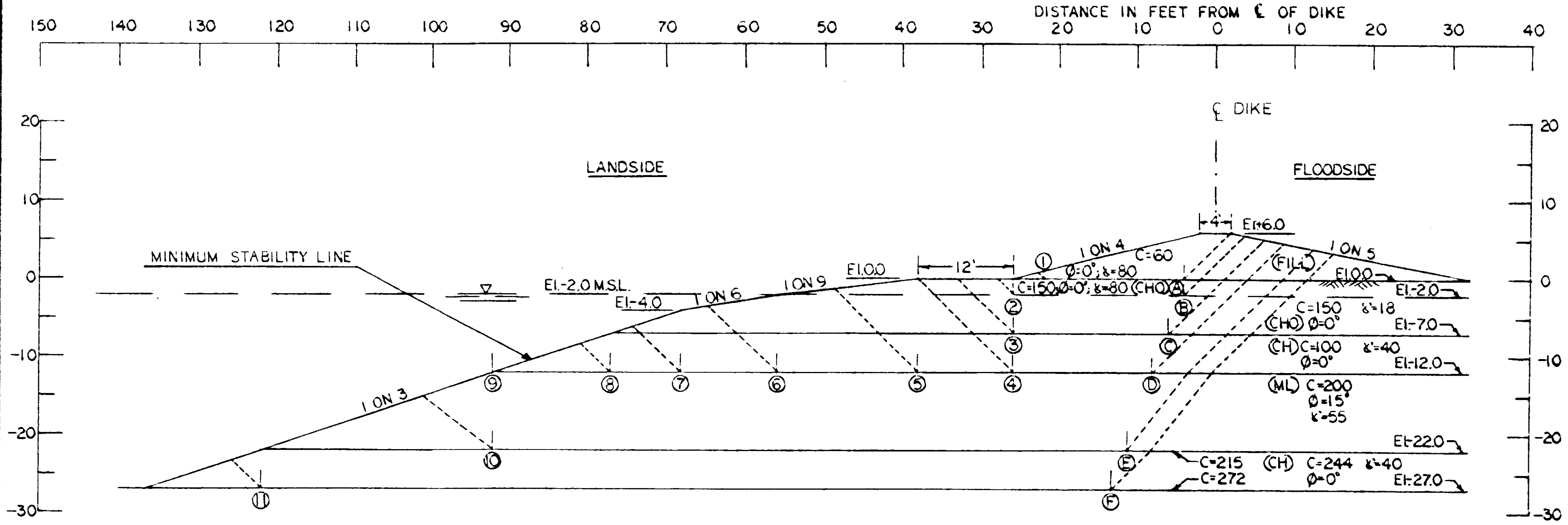
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



FIRST LIFT LEVEE SECTION

STA. 104+81 TO STA. 232+41



RETAINING DIKE

(FLOODSIDE) STA. 104+81 TO STA. 234+05
(LANDSIDE) STA. 104+81 TO STA. 154+40

SECTIONS	ASSUMED FAILURE SURFACE			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
	NO.		ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
FIRST LIFT	Ⓐ	①	-12.00	3100	4600	3100	10996	3133	10800	7863	1.37
	Ⓑ	①	-12.00	3100	11000	3100	14040	3133	17200	10907	1.58
	Ⓒ	①	-12.00	4809	12200	3100	15796	3133	20109	12663	1.59
	Ⓓ	①	-12.00	10592	14000	3100	18177	3133	27692	15044	1.84
	Ⓔ	②	-12.00	3100	1500	30	2875	16	4630	2859	1.62
FLOODSIDE RETAINING DIKE	Ⓐ	①	0.00	720	1080	96	1400	32	1896	1368	1.38
	Ⓑ	②	-2.00	1284	2200	600	3069	160	4084	2909	1.40
	Ⓒ	③	-7.00	3664	3000	2100	6826	1185	8764	5641	1.55
	Ⓓ	④	-12.00	3652	1800	2680	9352	2935	8132	6417	1.27
	Ⓓ	⑤	-12.00	3652	3000	2560	9352	2079	9212	7273	1.27
	Ⓓ	⑥	-12.00	3652	4800	2020	9352	1031	10472	8321	1.26
	Ⓓ	⑦	-12.00	3652	6000	1300	9352	815	10952	8537	1.28
	Ⓓ	⑧	-12.00	3652	6900	740	9352	370	11292	8982	1.26
	Ⓓ	⑨	-12.00	3652	8400	0	9352	0	12052	9352	1.29
	Ⓔ	⑩	-22.00	11156	19135	2882	20086	1381	33173	18705	1.77
	Ⓕ	⑪	-27.00	13749	29684	1806	27317	380	45239	26937	1.68

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT OF COHESION, P.S.F.
∇ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

* USE 1 ON 40 SLOPE FROM STA. 109+60 TO STA. 162+80. USE LEVEL FILL AT El.+8.5 FROM STA. 162+80 TO STA. 232+41.

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 88

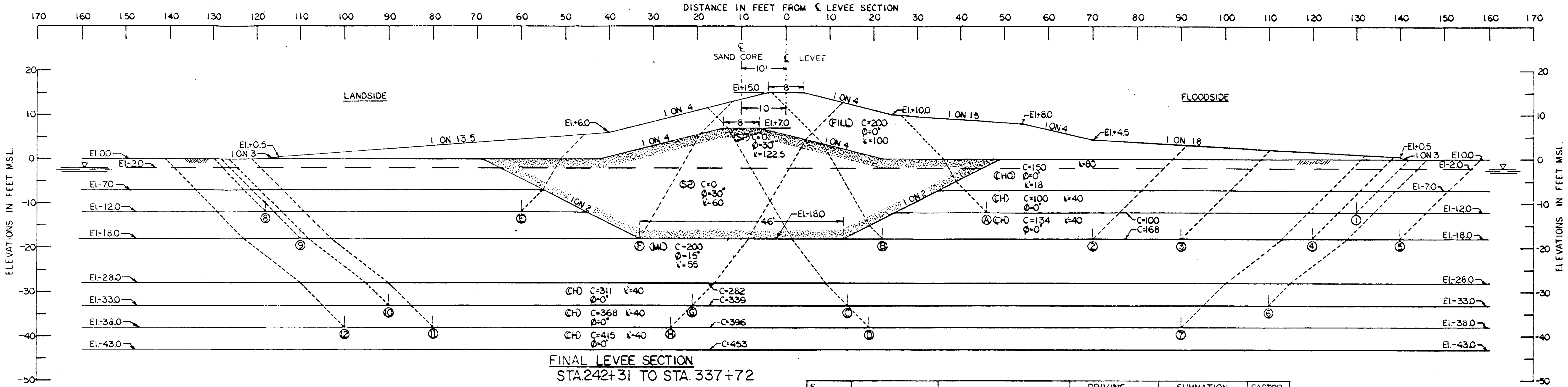
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

FIRST LIFT LEVEE SECTION
STA. 104+81 TO STA. 232+41

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



FINAL LEVEE SECTION
STA.242+31 TO STA. 337+72

SECTIONS	ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
	NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
LEVEE SECTION	Ⓐ ①	-12.00	9407	8400	3100	19645	3748	20907	15897	1.32
	Ⓑ ②	-18.00	26649	8064	5992	44795	13894	40705	30901	1.32
	Ⓑ ③	-18.00	26649	11424	5571	44795	11596	43644	33199	1.31
	Ⓑ ④	-18.00	26649	16464	4940	44795	8369	48053	36426	1.32
	Ⓑ ⑤	-18.00	26649	19824	4708	44795	6389	51181	38406	1.33
	Ⓒ ⑥	-33.00	52649	32544	20835	96025	26273	106028	69752	1.52
	Ⓓ ⑦	-38.00	56329	28116	25476	112217	38502	109921	73715	1.49
	Ⓔ ⑧	-12.00	7137	5800	3100	12688	2933	16037	9755	1.64
	Ⓕ ⑨	-18.00	25854	12936	4708	36400	7084	43498	29316	1.48
	Ⓖ ⑩	-33.00	52792	23391	21095	96153	26856	97278	69297	1.40
	Ⓗ ⑪	-38.00	56472	21384	25008	112011	37454	102864	74557	1.38
	Ⓗ ⑫	-38.00	56472	29304	23842	112011	32627	109618	79384	1.38

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
∑ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL DRIVING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 88.

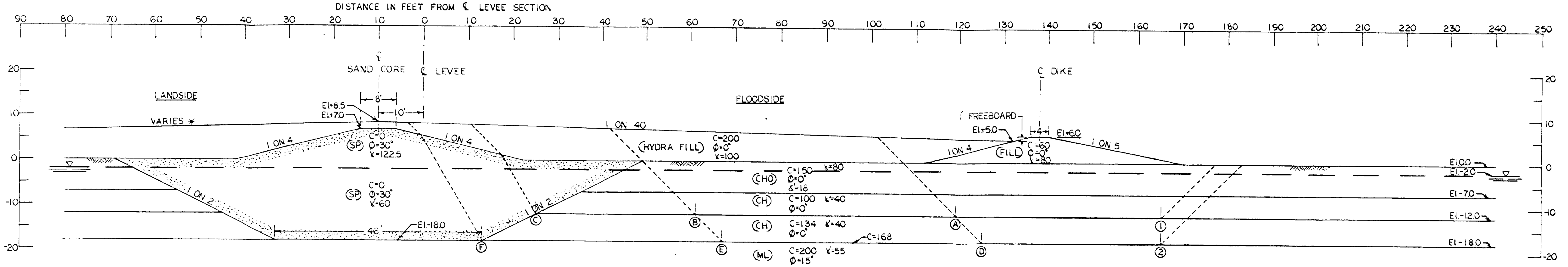
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS
FINAL LEVEE SECTION
STA.242+31 TO STA. 337+72

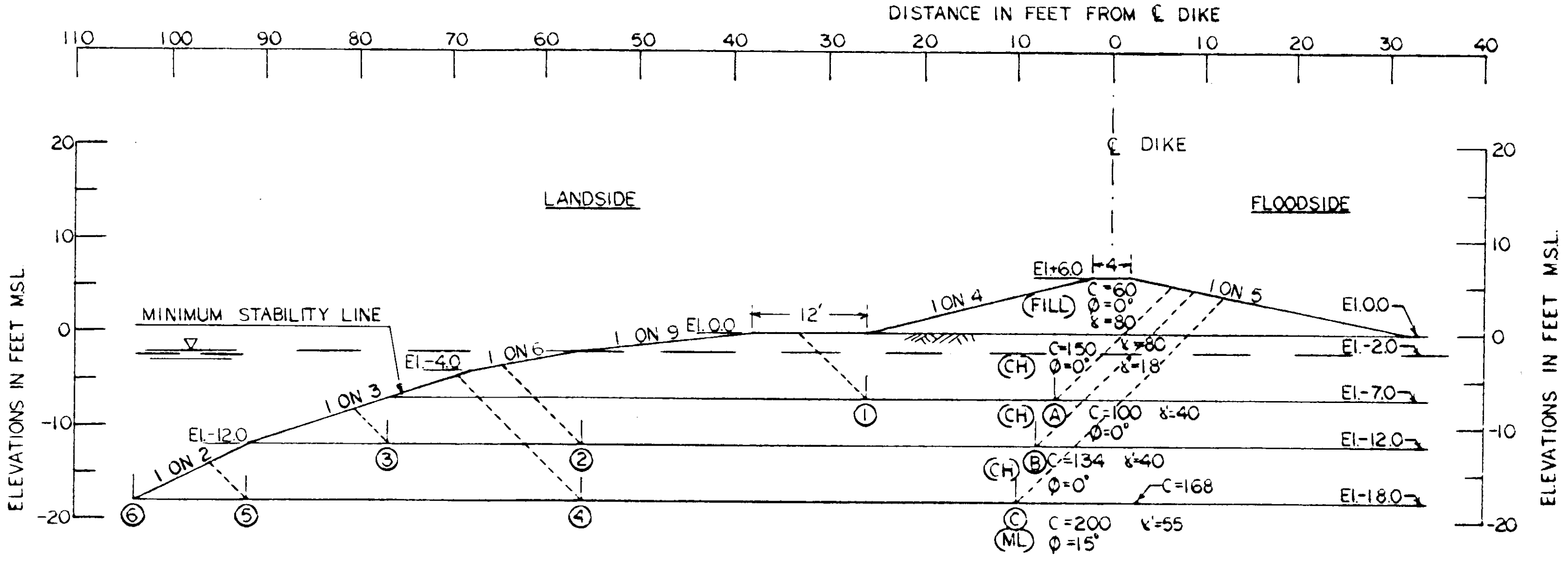
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

84



FIRST LIFT LEVEE SECTION
STA 242+31 TO STA 337+72



FLOODSIDE RETAINING DIKE
STA. 240+73.28 TO STA. 337+72
(EXCEPT AT CANAL CROSSINGS)

SECTIONS	ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
	NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
FIRST LIFT	Ⓐ ①	-12.00	3100	4600	3100	10996	3133	10800	7863	1.37
	Ⓑ ①	-12.00	3100	10400	3100	13715	3133	16600	10582	1.57
	Ⓒ ①	-12.00	10592	14000	3100	18177	3133	27692	15044	1.84
	Ⓓ ②	-18.00	4708	6720	4708	17265	6552	16136	10713	1.51
	Ⓔ ②	-18.00	4708	16464	4708	21189	6552	25880	14637	1.77
	Ⓕ ②	-18.00	20782	25536	4708	31522	6152	51026	24970	2.04
FLOODSIDE RETAINING DIKE	Ⓐ ①	- 7.00	3664	3000	2100	6826	1185	8764	5641	1.55
	Ⓑ ②	-12.00	3652	4800	2020	9352	1031	10472	8321	1.26
	Ⓑ ③	-12.00	3652	6900	740	9352	370	11292	8982	1.26
	Ⓒ ④	-18.00	5188	7728	3358	14835	3302	16274	11553	1.41
	Ⓒ ⑤	-18.00	5188	13776	1072	14835	492	20036	14343	1.40
	Ⓒ ⑥	-18.00	5188	15792	0	14835	0	20980	14835	1.41

NOTES

φ = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
∇ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

* USE 1 ON 40 SLOPE FROM STA. 316+93 TO STA 339+00.
USE LEVEL FILL AT EL+8.5 FROM STA. 242+13.28 TO STA. 316+9. AND FROM STA. 339+00 TO STA. 340 + 20.

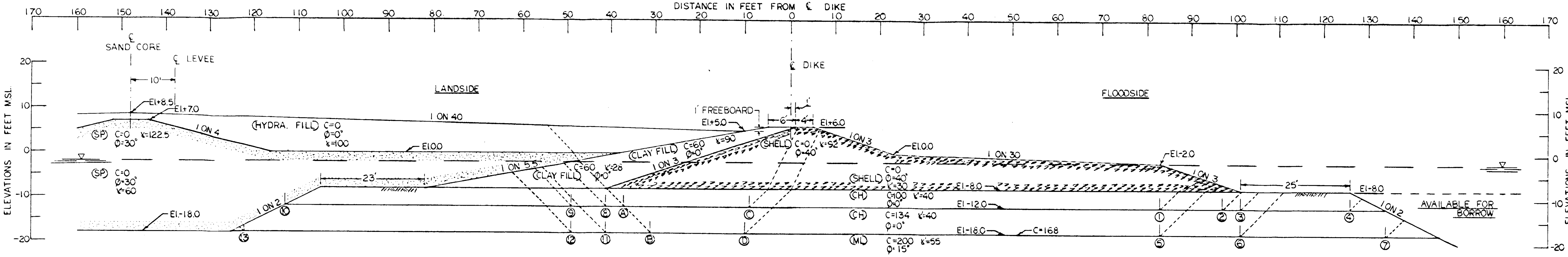
GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 88

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

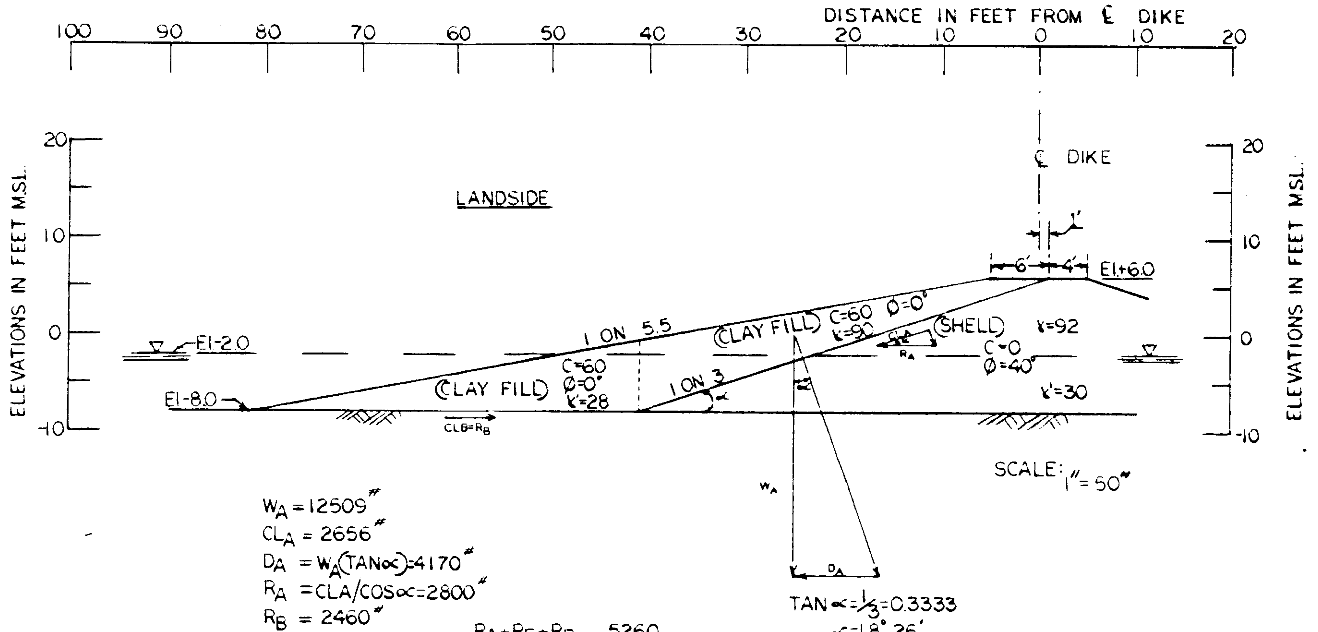
(Q) STABILITY ANALYSIS
FIRST LIFT LEVEE SECTION
STA 242+31 TO STA. 337+72

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712



FLOODSIDE RETAINING DIKE (SHELL)
STA.322+20
END RETAINING DIKE (SHELL)
STA.234+05 & STA.240+70

ASSUMED FAILURE SURFACE			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.		ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
Ⓐ	①	-12.00	2352	12000	1505	12692	1155	15857	11537	1.37
Ⓐ	②	-12.00	2352	13400	800	12692	400	16552	12292	1.34
Ⓐ	③	-12.00	2352	13800	792	12692	303	16944	12389	1.37
Ⓐ	④	-12.00	2352	16200	115	12692	169	18667	12523	1.49
Ⓑ	⑤	-18.00	3960	19152	2650	19824	2726	25762	17098	1.51
Ⓑ	⑥	-18.00	3960	20496	2408	19824	2359	26864	17465	1.53
Ⓑ	⑦	-18.00	3960	27552	1050	19824	554	32562	19270	1.69
Ⓒ	⑧	-12.00	6969	3200	1483	11715	2010	11652	9705	1.20
Ⓒ	⑨	-12.00	6969	4000	1335	11715	1279	12304	10436	1.18
Ⓓ	⑪	-18.00	8545	5208	2980	18759	4567	16733	14192	1.18
Ⓓ	⑫	-18.00	8545	6552	2833	18759	3630	17930	15129	1.19
Ⓒ	⑩	-12.00	6969	10400	0	11715	0	17369	11715	1.48
Ⓓ	⑬	-18.00	8545	18312	536	18759	119	27393	18640	1.47



$W_A = 12509^{\#}$
$CL_A = 2656^{\#}$
$D_A = W_A(TAN\alpha) = 4170^{\#}$
$R_A = CLA/COS\alpha = 2800^{\#}$
$R_B = 2460^{\#}$
$-D_P = 0$
$R_P = 0$

$F.S. = \frac{R_A + R_B + R_P}{D_A - D_P} = \frac{5260}{4170} = 1.26$

CLAY BLANKET

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
∑ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$

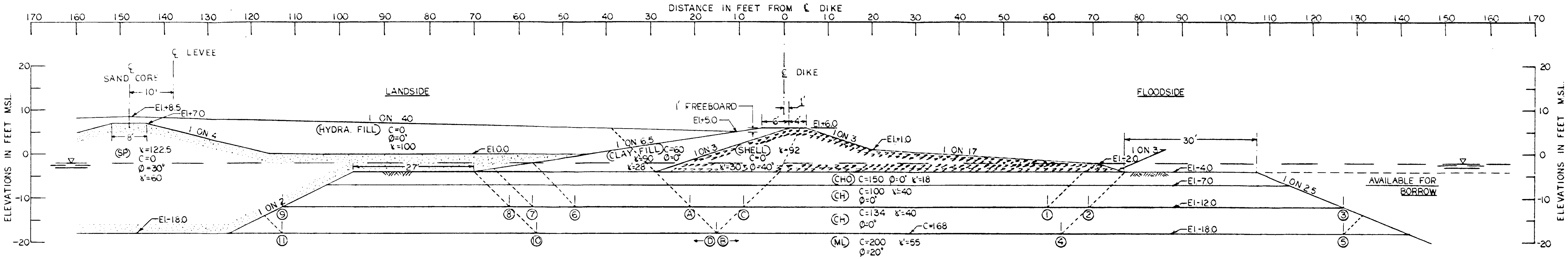
GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 88.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS
RETAINING DIKES
STA. 322+20; STA. 234+05 & STA. 240+70

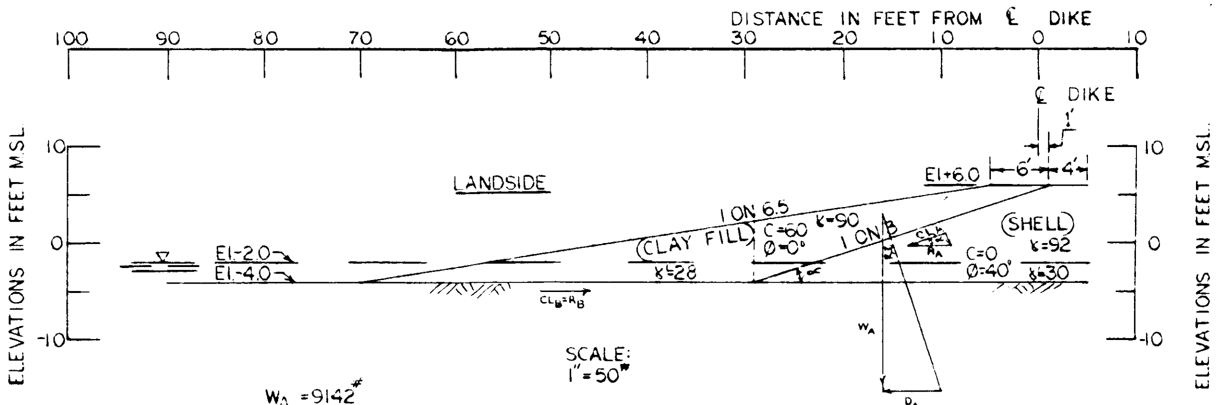
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712



FLOODSIDE RETAINING DIKE (SHELL)

STA.315+95 & STA. 333+30

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
Ⓐ ①	-12.00	2462	8600	2148	11517	1702	13210	9815	1.35
Ⓐ ②	-12.00	2462	9500	1900	11517	1160	13862	10357	1.34
Ⓐ ③	-12.00	2462	15300	0	11517	0	17762	11517	1.54
Ⓑ ④	-18.00	4152	13104	3508	17758	3926	20764	13832	1.50
Ⓑ ⑤	-18.00	4152	23856	1149	17758	513	29157	17245	1.69
Ⓒ ⑥	-12.00	5406	3800	2140	11558	2045	11346	9513	1.19
Ⓒ ⑦	-12.00	5406	4800	1980	11558	1167	12186	10391	1.17
Ⓒ ⑧	-12.00	5406	5300	1900	11558	988	12606	10570	1.19
Ⓒ ⑨	-12.00	5406	10400	0	11558	0	15806	11558	1.37
Ⓓ ⑩	-18.00	7014	6888	3508	17945	3519	17410	14426	1.21
Ⓓ ⑪	-18.00	7014	16464	1072	17945	479	24550	17466	1.41



$W_A = 9142^{\#}$
$CLA = 1897^{\#}$
$DA = WA(TAN\alpha) = 3047^{\#}$
$R_A = CLA/COS\alpha = 2000^{\#}$
$R_B = 2460^{\#}$
$-D_P = 0$
$R_P = 0$

$$FS = \frac{R_A + R_B + R_P}{D_A - D_P} = \frac{4460}{3047} = 1.46$$

CLAY BLANKET

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, PSF.
∇ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE.
B = AS A SUBSCRIPT, REFERS TO CENTRA BLOCK
P = AS A SUBSCRIPT, REFERS TO PASIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

GENERAL NOTES

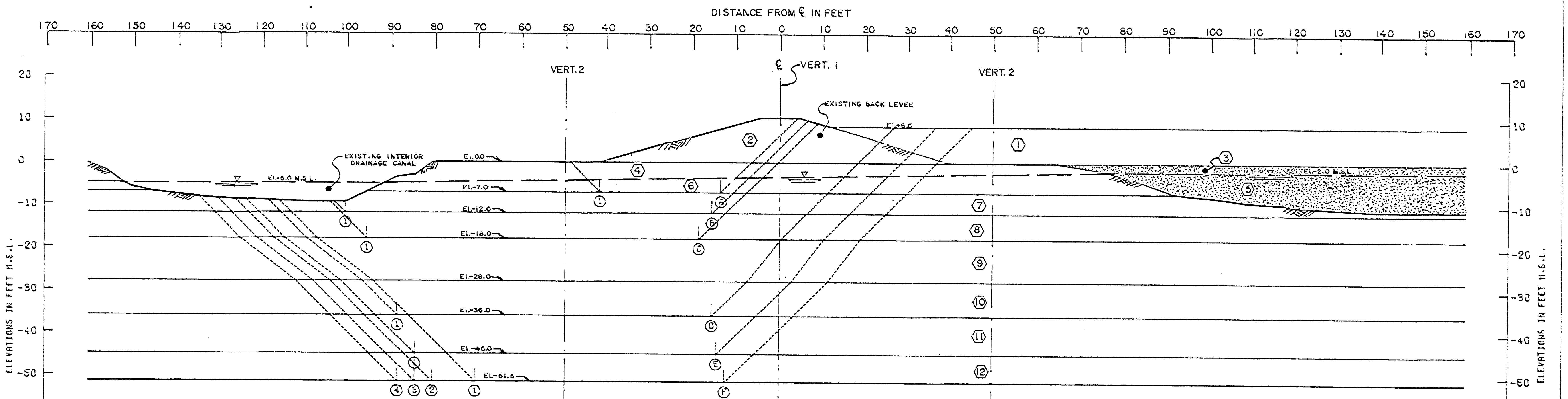
CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 88

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

RETAINING DIKE
STA 315+95 AND STA. 333+30

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971
FILE NO. H-2-25712



EXISTING BACK LEVEE
STA.161+32 TO STA.232+41
&
STA.242+31 TO STA.316+85

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 68.

SHEAR STRENGTHS BETWEEN VERTICALS 1 AND 2 WERE ASSUMED TO VARY LINEARLY BETWEEN THE VALUES INDICATED FOR THESE LOCATIONS.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	DEGREES
1	HYO	100.0	100.0	0.0	0.0	0.0	0.0	0.0
2	CH	108.0	108.0	600.0	600.0	600.0	600.0	0.0
3	SP	122.5	122.5	0.0	0.0	0.0	0.0	30.0
4	CH	108.0	80.0	600.0	150.0	600.0	150.0	0.0
5	SP	60.0	60.0	0.0	0.0	0.0	0.0	30.0
6	CH	46.0	18.0	600.0	150.0	600.0	150.0	0.0
7	CH	46.0	40.0	600.0	100.0	600.0	100.0	0.0
8	CH	46.0	40.0	600.0	134.0	600.0	168.0	0.0
9	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0
10	CH	41.0	40.0	600.0	328.0	550.0	375.0	0.0
11	CH	41.0	40.0	550.0	425.0	550.0	475.0	0.0
12	CH	41.0	40.0	550.0	513.0	550.0	550.0	0.0

ASSUMED FAILURE NO.	SURFACE ELEV.	RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
		R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-7.00	19803	9896	2793	14920	1709	32592	13211	2.467
B 1	-12.00	24264	14625	500	23188	125	39389	23063	1.708
C 1	-18.00	29665	17360	2108	34009	1692	49133	32316	1.520
D 1	-36.00	40067	29519	17032	78444	17338	86618	61106	1.516
E 1	-45.00	49968	34222	24658	104978	31062	108865	73915	1.473
F 1	-51.50	50919	51900	31463	125690	48696	114281	76922	1.465
F 2	-51.50	50919	37400	31383	125630	43798	119681	81832	1.463
F 3	-51.50	50919	39600	31435	125630	42269	121954	83341	1.463
F 4	-51.50	50919	41800	31552	125690	41354	124270	84276	1.475

NOTES

ϕ -- ANGLE OF INTERNAL FRICTION, DEGREES
C -- UNIT COHESION, P.S.F.
▽ -- STATIC WATER SURFACE
D -- HORIZONTAL DRIVING FORCE IN POUNDS
R -- HORIZONTAL RESISTING FORCE IN POUNDS
A -- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B -- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P -- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

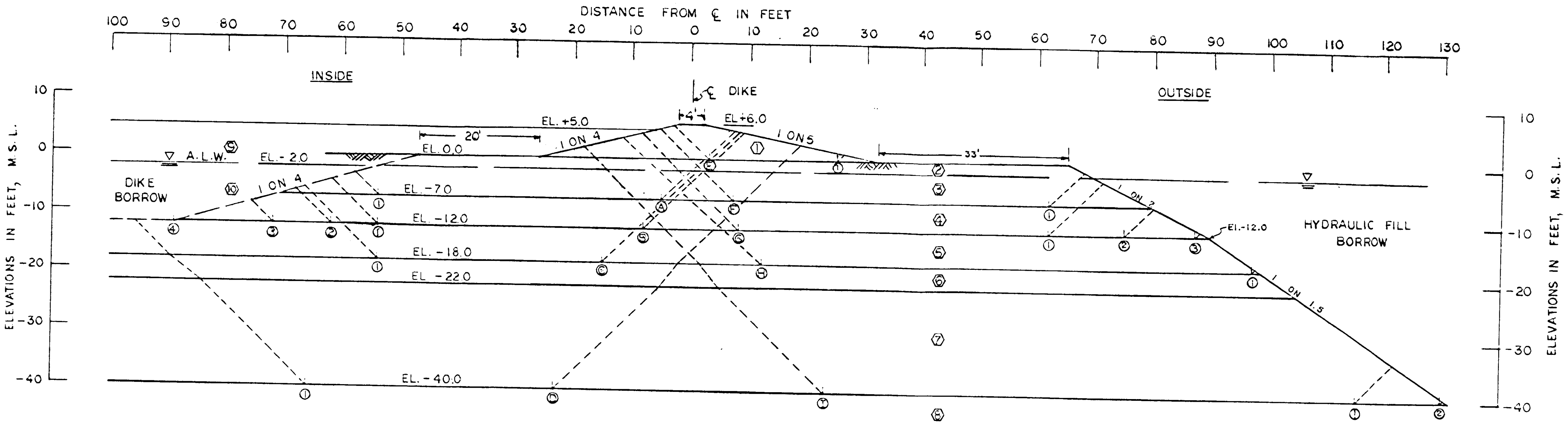
$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

EXISTING BACK LEVEE
STA.161+32 TO STA.232+41
STA.242+31 TO STA.316+85

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712



EMPIRE TO BURAS

ASSUMED FAILURE SURFACE NO.		ASSUMED FAILURE SURFACE ELEV.	RESISTING FORCES R_A	R_B	R_P	DRIVING FORCES D_A	$-D_P$	SUMMATION OF FORCES RESISTING	DRIVING	FACTOR OF SAFETY
(A)	(1)	-7.0	2700	7350	1167	5657	175	11217	5482	2.05
(B)	(1)	-12.0	3660	4600	1833	9351	974	10093	8372	1.20
(B)	(2)	-12.0	3660	5400	1300	9351	691	10360	8660	1.20
(B)	(3)	-12.0	3660	6300	800	9351	404	10760	8947	1.20
(B)	(4)	-12.0	3660	8000	44	9351	1	11704	9350	1.25
(C)	(1)	-18.0	5288	6552	3041	14421	3122	14881	11299	1.32
(D)	(1)	-40.0	19760	18060	16192	45938	19550	54012	26388	2.05
(E)	(1)	0.0	696	1380	140	1425	65	2216	1360	1.63
(F)	(1)	-7.0	2724	8550	1700	5659	986	12974	4673	2.78
(G)	(1)	-12.0	3628	5400	2200	9419	2024	11228	7395	1.52
(G)	(2)	-12.0	3628	6700	933	9419	550	11261	8869	1.27
(G)	(3)	-12.0	3628	7900	133	9419	13	11661	9406	1.24
(H)	(1)	-18.0	5188	14280	107	15063	5	19575	15058	1.30
(I)	(1)	-40.0	19689	39805	4070	48332	1364	63564	46968	1.35
(I)	(2)	-40.0	19689	46090	254	48332	5	66033	48327	1.37

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WEIGHT VERT. 1	VERT. 2	C-UNIT COHESION - P.S.F. CENTER OF STRATUM VERT. 1	VERT. 2	BOTTOM OF STRATUM VERT. 1	VERT. 2	FRICTION ANGLE DEGREES
(1)	CH	80.0	80.0	60.0	60.0	60.0	60.0	0
(2)	CH	80.0	80.0	150.0	150.0	150.0	150.0	0
(3)	CH	18.0	18.0	150.0	150.0	150.0	150.0	0
(4)	CH	40.0	40.0	100.0	100.0	100.0	100.0	0
(5)	CH	40.0	40.0	134.0	134.0	168.0	168.0	0
(6)	ML	55.0	55.0	200.0	200.0	200.0	200.0	15
(7)	CH	40.0	40.0	318.0	318.0	419.0	419.0	0
(8)	CH	40.0	40.0	1000.0	1000.0	1000.0	1000.0	0
(9)	SPOIL	90.0	90.0	0.0	0.0	0.0	0.0	0
(10)	SPOIL	28.0	28.0	0.0	0.0	0.0	0.0	0

NOTES

Ø - ANGLE OF INTERNAL FRICTION, DEGREES
C - UNIT COHESION PSF
▽ - STATIC WATER SURFACE
D - HORIZONTAL DRIVING FORCE IN POUNDS
R - HORIZONTAL RESISTING FORCE IN POUNDS
A - AS A SUBSCRIPT REFERS TO ACTIVE WEDGE
B - AS A SUBSCRIPT REFERS TO CENTRAL BLOCK
P - AS A SUBSCRIPT REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

GENERAL NOTES

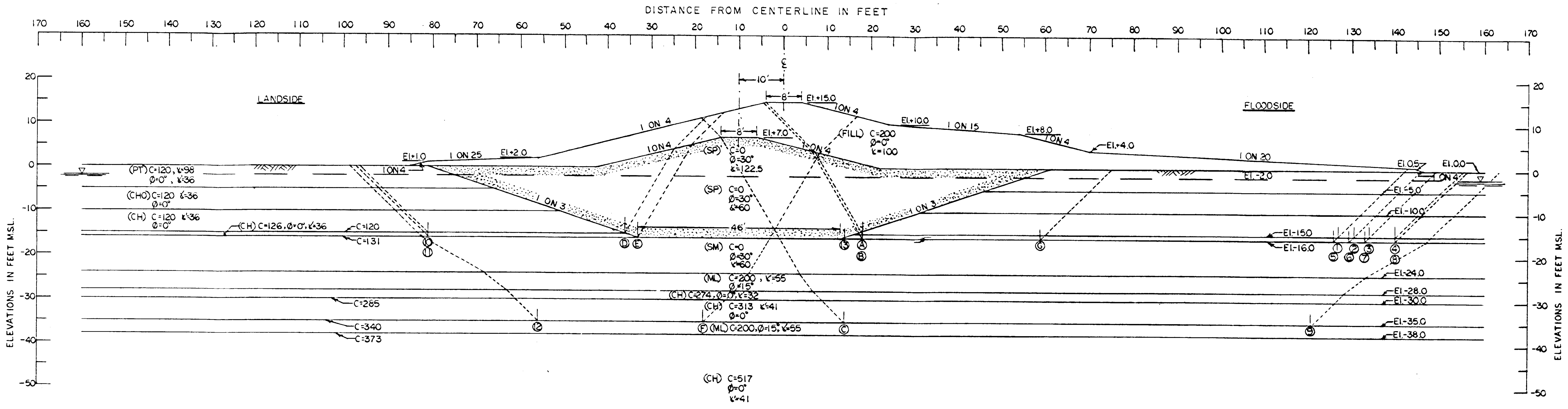
CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 88.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS
PONDING AREA DIKE
EMPIRE TO BURAS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 | FILE NO. H-2-25712



FINAL LEVEE SECTION
STA. 337+72 TO STA. 417+50

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 88.

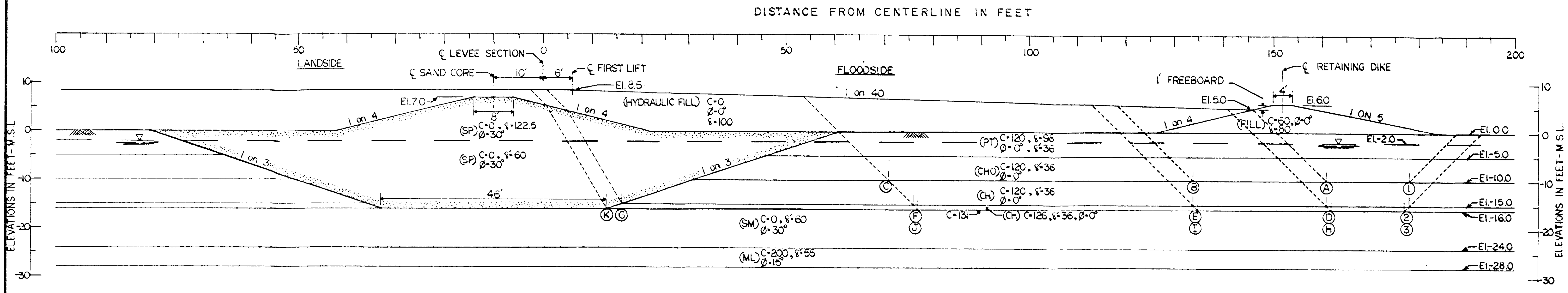
ASSUMED FAILURE SURFACE NO.		ASSUMED FAILURE SURFACE ELEV.	RESISTING FORCES R_A	RESISTING FORCES R_B	RESISTING FORCES R_P	DRIVING FORCES D_A	DRIVING FORCES $-D_P$	SUMMATION OF FORCES RESISTING	SUMMATION OF FORCES DRIVING	FACTOR OF SAFETY
Ⓐ	①	-15.0	25777	13080	3600	39078	6906	42457	32172	1.320
Ⓐ	②	-15.0	25777	13500	3600	39078	6534	42877	32544	1.318
Ⓐ	③	-15.0	25777	13920	3600	39078	6223	43297	32855	1.318
Ⓐ	④	-15.0	25777	14640	3600	39078	5833	44017	33245	1.324
Ⓑ	⑤	-16.0	26690	14148	3852	41856	7705	44690	34151	1.309
Ⓑ	⑥	-16.0	26690	14607	3852	41856	7315	45149	34541	1.307
Ⓑ	⑦	-16.0	26690	15065	3852	41856	6988	45607	34868	1.308
Ⓑ	⑧	-16.0	26690	15982	3852	41856	6515	46524	35341	1.316
Ⓒ	⑨	-35.0	56482	36346	29668	103271	31420	122496	71851	1.705
Ⓓ	⑩	-15.0	19482	5400	3600	25163	6028	28482	19135	1.488
Ⓔ	⑪	-16.0	22584	6288	3852	29860	6709	32724	23151	1.414
Ⓕ	⑫	-35.0	56285	12920	31578	102644	31972	100783	70672	1.426
Ⓖ	⑬	-16.0.	3852	4784	63	6406	1	8699	6405	1.358

NOTES

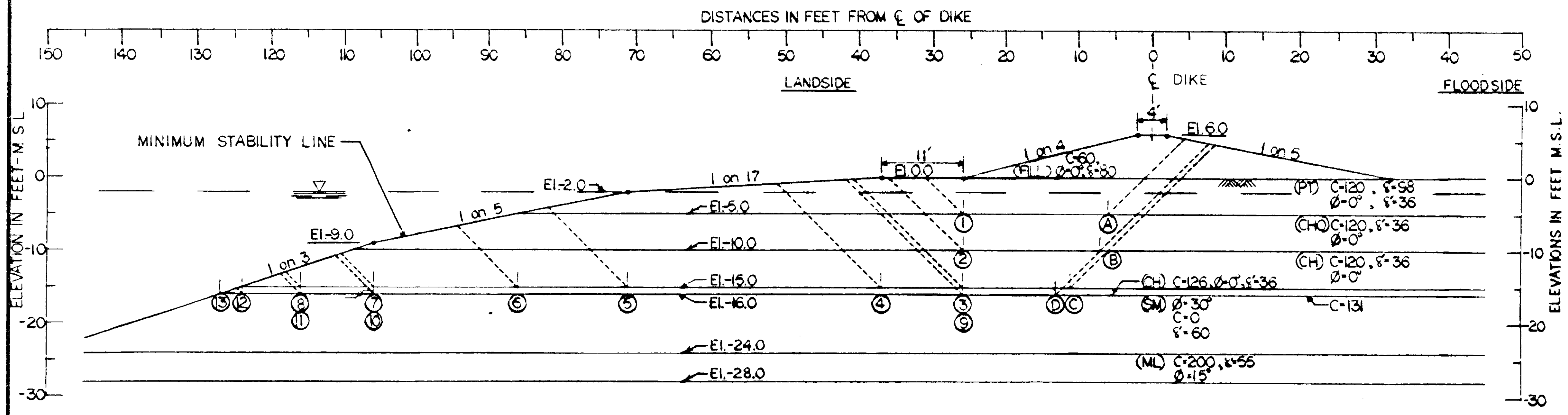
Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, PSF
Σ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON
(Q) STABILITY ANALYSIS
FINAL LEVEE SECTION
STA. 337+72 TO STA. 417+50
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712



FIRST LIFT LEVEE SECTION
STA. 337+72 TO STA. 417+50



FLOODSIDE RETAINING DIKE
STA 337+72 TO STA 417+50

SECTIONS	ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
	NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
FIRST LIFT	Ⓐ ①	-10.0	3000	2040	2400	8564	3204	7440	5360	1.388
	Ⓑ ①	-10.0	2400	5280	2400	9765	3204	10080	6561	1.536
	Ⓒ ①	-10.0	2400	12840	2400	12525	3204	17640	9321	1.893
	Ⓓ ②	-15.0	4080	2040	3600	13527	6175	9720	7352	1.322
	Ⓔ ②	-15.0	3600	5280	3600	15514	6175	12480	9339	1.336
	Ⓕ ②	-15.0	3600	12240	3600	18804	6175	19440	12627	1.540
	Ⓖ ②	-15.0	18240	19440	3600	25765	6175	41280	19590	2.107
	Ⓗ ③	-16.0	4332	1965	3857	14572	6753	10149	7819	1.298
	Ⓘ ③	-16.0	3852	5502	3852	16682	6753	13206	9929	1.330
	Ⓙ ③	-16.0	3852	13100	3852	20158	6753	20804	13405	1.552
	Ⓚ ③	-16.0	19628	18864	3852	28116	6753	42344	21363	1.982
FLOODSIDE RETAINING DIKE	Ⓐ ①	-5.0	1860	2400	1200	4569	945	5460	3624	1.506
	Ⓑ ②	-10.0	2980	2280	2400	8583	2914	7660	5669	1.351
	Ⓒ ③	-15.0	4160	1800	3547	13194	5740	9507	7454	1.275
	Ⓒ ④	-15.0	4160	3120	3400	13194	5171	10680	8023	1.331
	Ⓒ ⑤	-15.0	4160	7200	2600	13194	2533	13960	10661	1.309
	Ⓒ ⑥	-15.0	4160	9000	2000	13194	1498	15160	11696	1.296
	Ⓒ ⑦	-15.0	4160	11400	1080	13194	485	16640	12709	1.309
	Ⓒ ⑧	-15.0	4160	12600	480	13194	96	17240	13098	1.313
	Ⓓ ⑨	-16.0	4432	1703	3785	14056	6397	9920	7659	1.295
	Ⓓ ⑩	-16.0	4432	12183	1272	14056	660	17887	13396	1.335
	Ⓓ ⑪	-16.0	4432	13276	672	14056	181	18380	13875	1.325
	Ⓓ ⑫	-16.0	4432	13664	189	14056	13	18285	14043	1.302
	Ⓓ ⑬	-16.0	4432	13696	0	14056	0	18128	14056	1.290

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGHTS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 68.

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION, P.S.F.
Σ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

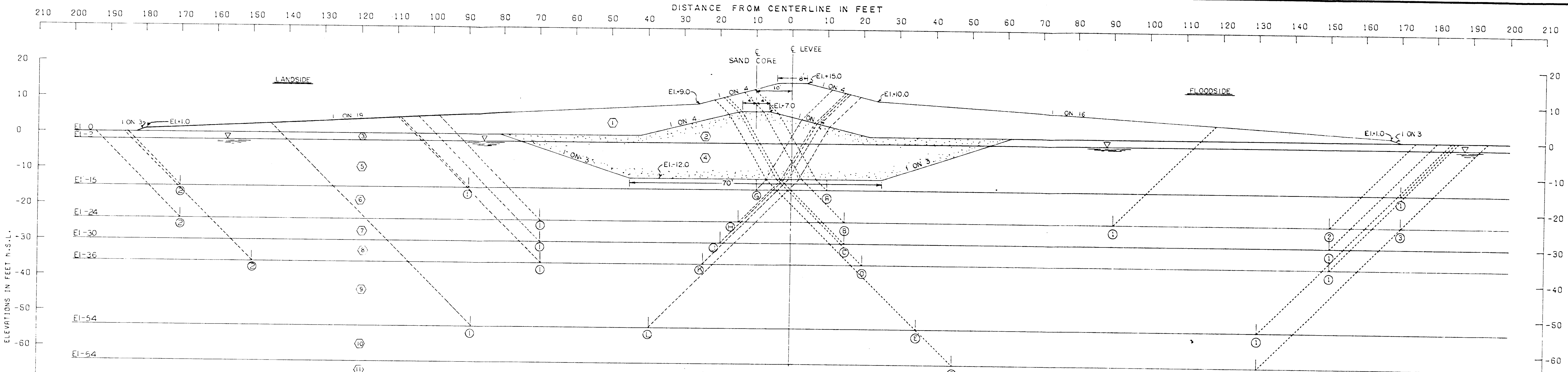
$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS
FIRST LIFT LEVEE SECTION
STA. 337+72 TO STA. 417+50

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



FINAL LEVEE SECTION

STA. 417+50 TO STA. 635+72

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
Nº	ELEV	R_A	R_B	R_P	D_A	D_P	RESISTING	DRIVING	
G 1	-15.00	25132	9600	5418	43273	14650	40151	28623	1.40
G 2	-15.00	25132	19200	3600	43273	6680	47933	36593	1.31
H 1	-24.00	27403	12045	8700	65752	29018	48148	36734	1.31
H 2	-24.00	27403	33945	6660	65752	14113	68008	51639	1.32
J 1	-30.00	30138	14250	11603	81543	38491	55991	43052	1.30
K 1	-36.00	33641	15795	15298	97784	49096	64734	48688	1.33
K 2	-36.00	33641	43875	13500	97784	32140	91016	65644	1.39
L 1	-54.00	48755	27500	30728	152324	82585	106983	69739	1.53

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 88.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
1	CH	100.0	100.0	200.0	200.0	200.0	200.0	0.0
2	SP	122.5	122.5	0.0	0.0	0.0	0.0	30.0
3	CH	98.0	98.0	120.0	120.0	120.0	120.0	0.0
4	SP	60.0	60.0	0.0	0.0	0.0	0.0	30.0
5	CH	36.0	36.0	120.0	120.0	120.0	120.0	0.0
6	CH	36.0	36.0	170.0	170.0	219.0	219.0	0.0
7	CH	32.0	32.0	252.0	252.0	285.0	285.0	0.0
8	CH	41.0	41.0	318.0	318.0	351.0	351.0	0.0
9	CH	41.0	41.0	450.0	450.0	550.0	550.0	0.0
10	CH	41.0	41.0	605.0	605.0	680.0	660.0	0.0
11	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-15.00	25261	19200	3600	42771	5783	48061	36988	1.299
B 1	-24.00	28243	16425	8292	65414	26316	52960	39099	1.355
B 2	-24.00	28243	29565	6660	65414	15974	64468	49440	1.304
B 3	-24.00	28243	33945	6660	65414	13216	68848	52199	1.319
C 1	-30.00	29671	38475	9684	80988	22478	77830	58510	1.330
D 1	-36.00	33090	45630	13500	97528	30295	92220	67234	1.372
E 1	-54.00	48006	52250	29700	152390	68000	129957	84391	1.540
F 1	-64.00	60106	56100	41800	186765	91689	158006	95076	1.662

NOTES

ϕ -- ANGLE OF INTERNAL FRICTION, DEGREES
C -- UNIT COHESION, P.S.F.
∇ -- STATIC WATER SURFACE
D -- HORIZONTAL DRIVING FORCE IN POUNDS
R -- HORIZONTAL RESISTING FORCE IN POUNDS
A -- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B -- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P -- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

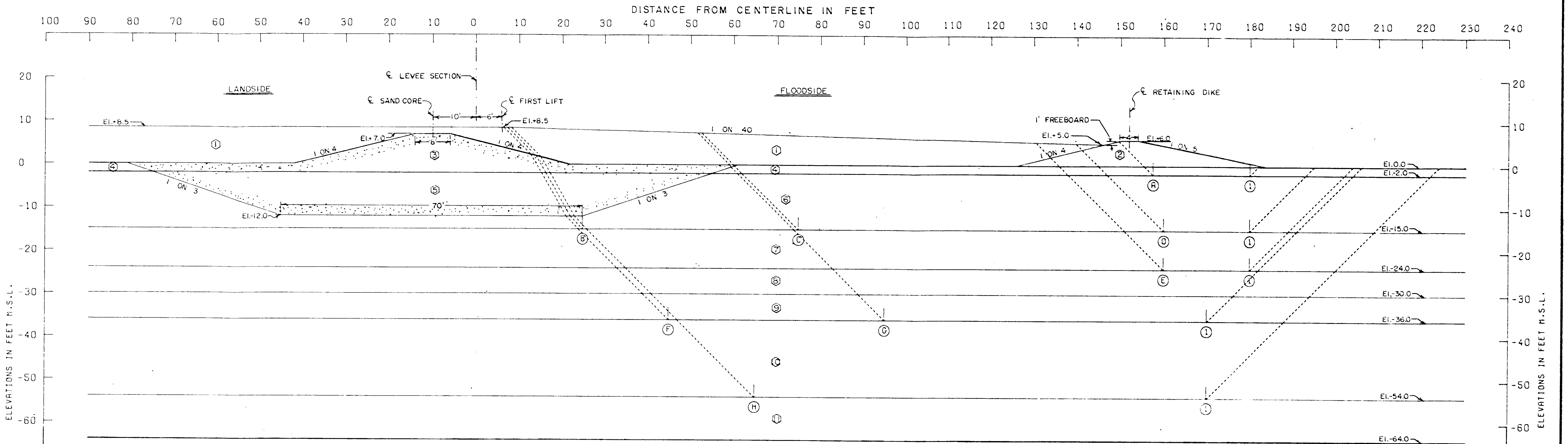
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

FINAL LEVEE SECTION
STA. 417+50 TO STA. 635+72

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



FIRST LIFT LEVEE SECTION

STA. 417+50 TO STA. 532+86 (Bayou Grand Liard)

GENERAL NOTES

CLASSIFICATION. STRATIFICATION. SHEAR STRENGTHS. AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE [illegible] DATA PLATE 88.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
1	HY	100.0	100.0	0.0	0.0	0.0	0.0	0.0
2	CH	80.0	80.0	60.0	60.0	60.0	60.0	0.0
3	SP	122.5	122.5	0.0	0.0	0.0	0.0	30.0
4	CH	98.0	98.0	120.0	120.0	120.0	120.0	0.0
5	SP	60.0	60.0	0.0	0.0	0.0	0.0	30.0
6	CH	36.0	36.0	120.0	120.0	120.0	120.0	0.0
7	CH	36.0	36.0	170.0	170.0	219.0	219.0	0.0
8	CH	32.0	32.0	252.0	252.0	285.0	285.0	0.0
9	CH	41.0	41.0	318.0	318.0	351.0	351.0	0.0
10	CH	41.0	41.0	450.0	450.0	550.0	550.0	0.0
11	CH	41.0	41.0	605.0	605.0	660.0	660.0	0.0
12	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
(A) (1)	-2.00	1188	2700	520	2499	296	4408	2203	2.001
(B) (1)	-15.00	12236	18600	3600	24414	5911	34436	18503	1.861
(C) (1)	-15.00	3662	12600	3600	18859	5911	19862	12948	1.534
(D) (1)	-15.00	4056	2400	3600	13581	5911	10056	7670	1.311
(E) (1)	-24.00	6900	4380	6660	25237	13344	17940	11893	1.508
(F) (1)	-36.00	22332	43875	13500	67134	29103	79707	38031	2.096
(G) (1)	-36.00	13629	26325	13500	54410	29103	53455	25307	2.112
(H) (1)	-54.00	38139	57750	29700	112582	61410	125589	51171	2.454

NOTES

ϕ -- ANGLE OF INTERNAL FRICTION, DEGREES
C -- UNIT COHESION, P.S.F.
∇ -- STATIC WATER SURFACE
D -- HORIZONTAL DRIVING FORCE IN POUNDS
R -- HORIZONTAL RESISTING FORCE IN POUNDS
A -- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B -- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P -- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

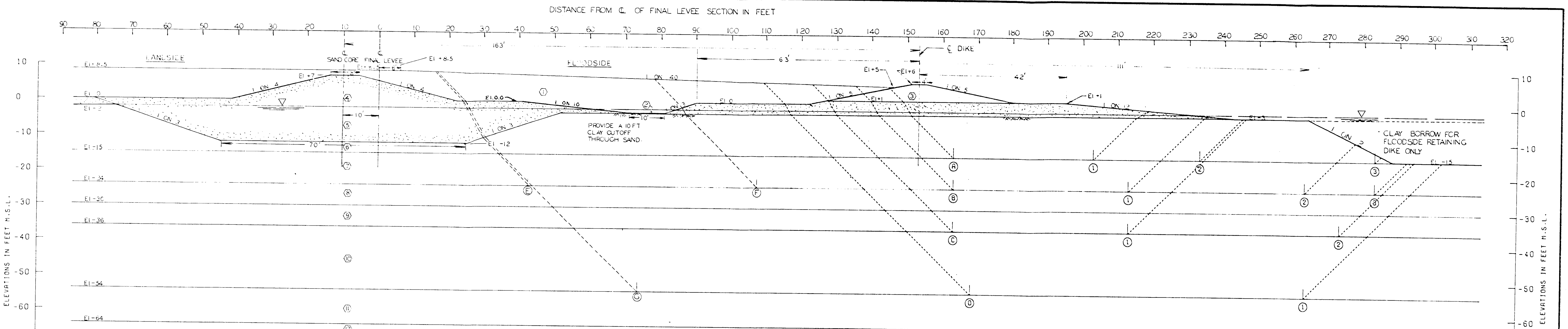
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

FIRST LIFT LEVEE SECTION
STA. 417+50 TO STA. 532+86

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



FIRST LIFT LEVEE SECTION

STA. 539+71 (Bayou Grand Liard) TO STA. 635+72

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 88.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
①	HY	100.0	100.0	0.0	0.0	0.0	0.0	0.0
②	HY	38.0	38.0	0.0	0.0	0.0	0.0	0.0
③	CH	80.0	80.0	60.0	60.0	60.0	60.0	0.0
④	SP	122.5	122.5	0.0	0.0	0.0	0.0	30.0
⑤	SP	60.0	60.0	0.0	0.0	0.0	0.0	30.0
⑥	CH	36.0	36.0	120.0	120.0	120.0	120.0	0.0
⑦	CH	36.0	36.0	170.0	170.0	219.0	219.0	0.0
⑧	CH	32.0	32.0	252.0	252.0	285.0	285.0	0.0
⑨	CH	41.0	41.0	318.0	318.0	351.0	351.0	0.0
⑩	CH	41.0	41.0	450.0	450.0	550.0	550.0	0.0
⑪	CH	41.0	41.0	605.0	605.0	660.0	660.0	0.0
⑫	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0

ASSUMED FAILURE SURFACE			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.		ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
Ⓐ	①	-15.00	4982	4800	3399	15197	6264	13182	8933	1.476
Ⓐ	②	-15.00	4982	8400	2880	15197	2840	16262	12357	1.316
Ⓐ	③	-15.00	4982	14400	400	15197	75	19782	15123	1.308
Ⓑ	①	-24.00	7786	10950	5969	27545	10840	24705	16706	1.479
Ⓑ	②	-24.00	7786	21900	4340	27545	5535	34026	22011	1.546
Ⓑ	③	-24.00	7786	26280	3060	27545	1681	37126	25864	1.435
Ⓒ	①	-36.00	14591	17550	12780	49370	22564	44921	26806	1.676
Ⓒ	②	-36.00	14591	38610	9900	49370	9833	63101	39537	1.596
Ⓓ	①	-54.00	30478	52250	26100	92367	33778	108828	58589	1.857
Ⓔ	③	-24.00	12732	52560	3060	39427	1681	68352	37746	1.81
Ⓕ	③	-24.00	6912	38325	3060	31958	1681	48297	30277	1.60
Ⓖ	①	-54.00	35772	110000	26100	109740	30788	171872	78952	2.18

NOTES

- ϕ -- ANGLE OF INTERNAL FRICTION, DEGREES
- C -- UNIT COHESION, P.S.F.
- ▽ -- STATIC WATER SURFACE
- D -- HORIZONTAL DRIVING FORCE IN POUNDS
- R -- HORIZONTAL RESISTING FORCE IN POUNDS
- A -- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
- B -- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
- P -- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

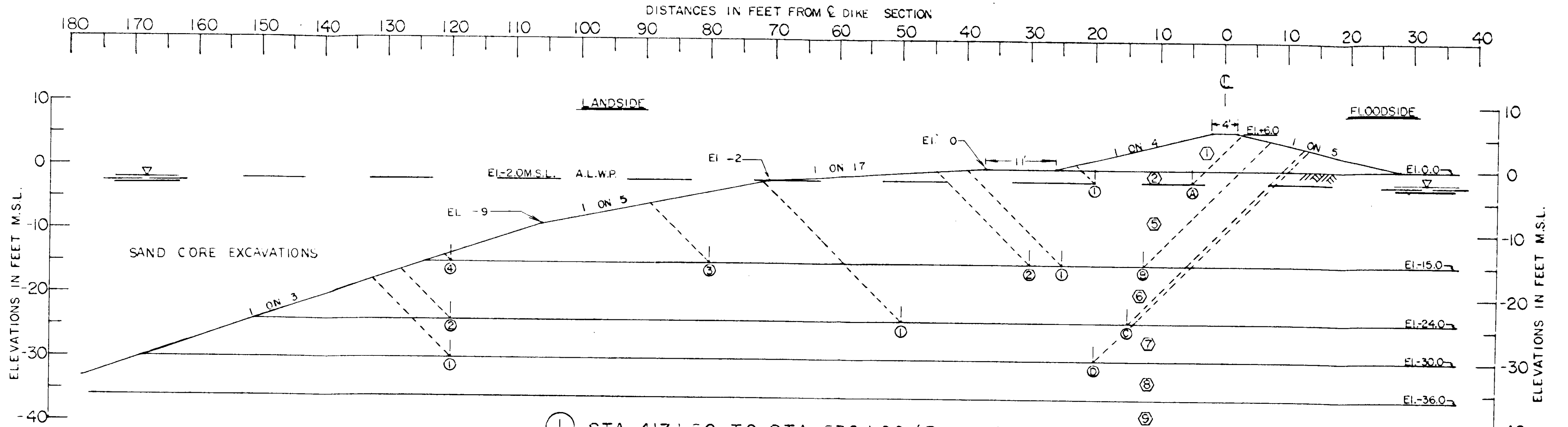
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

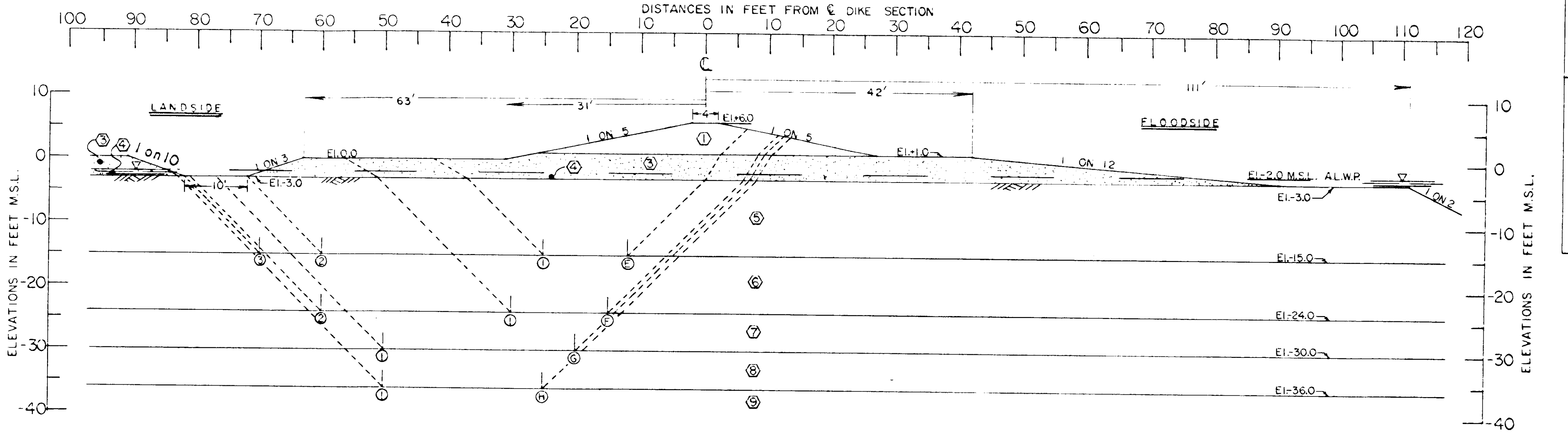
FIRST LIFT LEVEE SECTION
STA. 539+71 TO STA. 635+72

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



① STA. 417+50 TO STA. 532+86 (Bayou Grand Liard)



② STA. 539+71 (Bayou Grand Liard) TO STA. 635+72

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
①	CH	80.0	80.0	60.0	60.0	60.0	60.0	0
②	CH	98.0	98.0	120.0	120.0	120.0	120.0	0
③	SP	122.5	122.5	0	0	0	0	30
④	SP	60.0	60.0	0	0	0	0	30
⑤	CH	36.0	36.0	120.0	120.0	120.0	120.0	0
⑥	CH	36.0	36.0	170.0	170.0	219.0	219.0	0
⑦	CH	32.0	32.0	252.0	252.0	285.0	285.0	0
⑧	CH	41.0	41.0	318.0	318.0	251.0	251.0	0
⑨	CH	41.0	41.0	450.0	450.0	550.0	550.0	0

SECTION	ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
	NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISING	DRIVING	
①	Ⓐ ①	-2.0	1178	1800	576	2500	427	3554	2073	1.714
	Ⓑ ①	-15.0	4174	1500	3560	13010	5770	9234	7240	1.275
	Ⓑ ②	-15.0	4174	2100	3493	13010	5610	9767	7400	1.320
	Ⓑ ③	-15.0	4174	8100	2240	13010	1880	14514	11130	1.304
	Ⓑ ④	-15.0	4174	12900	240	13010	24	17314	12986	1.333
	Ⓒ ①	-24.0	7088	1095	6567	23226	13444	14750	9782	1.506
	Ⓓ ①	-30.0	10089	28500	5149	30858	3528	43738	27330	1.600
②	Ⓔ ①	-15.0	5084	1500	3919	15008	7216	10503	7792	1.348
	Ⓔ ②	-15.0	5084	5700	2880	15008	4499	13664	10509	1.300
	Ⓔ ③	-15.0	5084	6900	2880	15008	2772	14864	12236	1.215
	Ⓕ ①	-24.0	7795	3285	6979	26479	14873	181058	11600	1.556
	Ⓕ ②	-24.0	7795	9855	5940	20479	10093	23590	16380	1.440
	Ⓖ ①	-30.0	10756	8550	8964	35089	18345	28270	16744	1.688
	Ⓗ ①	-36.0	14509	8775	12812	44586	24758	36096	19826	1.820

NOTES

Ø = ANGLE OF INTERNAL FRICTION, DEGREES
C = UNIT COHESION
▽ = STATIC WATER SURFACE
D = HORIZONTAL DRIVING FORCE IN POUNDS
R = HORIZONTAL RESISTING FORCE IN POUNDS
A = AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B = AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P = AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

GENERAL NOTES

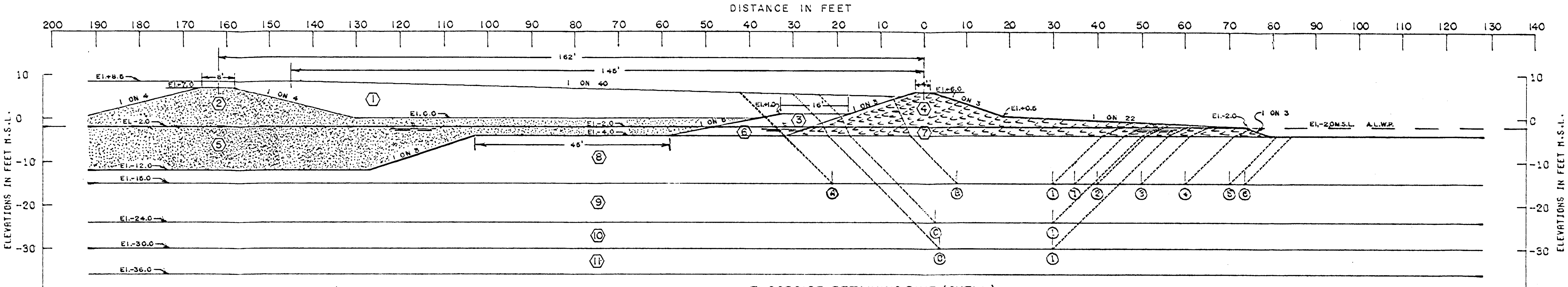
CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS, SEE BORING DATA PLATE 88.

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

RETAINING DIKES
STA. 417+50 TO STA. 532+86
STA. 539+71 TO STA. 635+72
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



FLOODSIDE RETAINING DIKE (SHELL)

STA. 496+50 (APPROX.)

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 88.

SHEAR STRENGTHS BETWEEN VERTICALS 1 AND 2 WERE ASSUMED TO VARY LINEARLY BETWEEN THE VALUES INDICATED FOR THESE LOCATIONS.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	DEGREES
1	HYD	100.0	100.0	0.0	0.0	0.0	0.0	0.0
2	SP	122.5	122.5	0.0	0.0	0.0	0.0	30.0
3	CH	90.0	90.0	60.0	60.0	60.0	60.0	0.0
4	SHL	92.0	92.0	0.0	0.0	0.0	0.0	40.0
5	SP	60.0	60.0	0.0	0.0	0.0	0.0	30.0
6	CH	28.0	28.0	60.0	60.0	60.0	60.0	0.0
7	SHL	30.0	30.0	0.0	0.0	0.0	0.0	40.0
8	CH	36.0	36.0	120.0	120.0	120.0	120.0	0.0
9	CH	36.0	36.0	170.0	170.0	219.0	219.0	0.0
10	CH	32.0	32.0	252.0	252.0	285.0	285.0	0.0
11	CH	41.0	41.0	318.0	318.0	351.0	351.0	0.0

ASSUMED FAILURE SURFACE			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.		ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A	1	-15.00	3160	6120	4016	15356	4967	13296	10389	1.280
A	2	-15.00	3160	7320	3571	15356	4383	14051	10973	1.280
A	3	-15.00	3160	8520	3188	15356	3816	14868	11540	1.288
A	4	-15.00	3160	9720	2862	15356	3266	15742	12090	1.302
A	5	-15.00	3160	10920	2640	15356	2592	16720	12764	1.310
A	6	-15.00	3160	11340	2640	15356	2356	17140	13000	1.318
B	7	-15.00	5568	3240	3786	14134	4673	12594	9461	1.331
C	1	-24.00	8031	5813	6673	26405	11469	20617	14936	1.380
D	1	-30.00	10614	7410	9456	36020	17171	27480	18848	1.458

NOTES

Φ -- ANGLE OF INTERNAL FRICTION, DEGREES
C -- UNIT COHESION, P.S.F.
∇ -- STATIC WATER SURFACE
D -- HORIZONTAL DRIVING FORCE IN POUNDS
R -- HORIZONTAL RESISTING FORCE IN POUNDS
A -- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B -- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P -- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

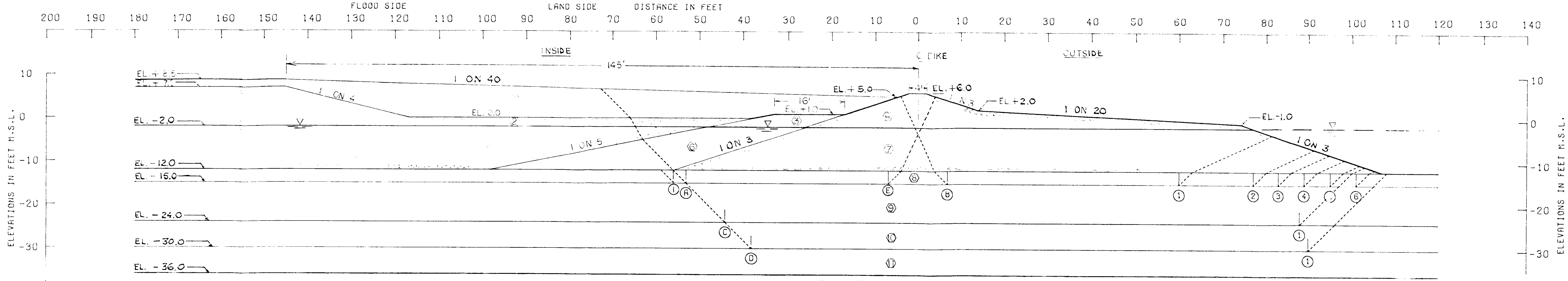
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

RETAINING DIKE
STA. 496+50

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



END RETAINING DIKE (SHELL)

AT STA. 534+90, STA. 538+00 & STA. 635+72

GENERAL NOTES

CLASSIFICATION, STRATIFICATION SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 88.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
⟨1⟩	HYD	100.0	100.0	0.0	0.0	0.0	0.0	0.0
⟨2⟩	SP	122.5	122.5	0.0	0.0	0.0	0.0	30.0
⟨3⟩	CH	90.0	90.0	60.0	60.0	60.0	60.0	0.0
⟨4⟩	SHL	92.0	92.0	0.0	0.0	0.0	0.0	40.0
⟨5⟩	SP	60.0	60.0	0.0	0.0	0.0	0.0	30.0
⟨6⟩	CH	28.0	28.0	60.0	60.0	60.0	60.0	0.0
⟨7⟩	SHL	30.0	30.0	0.0	0.0	0.0	0.0	40.0
⟨8⟩	CH	36.0	36.0	120.0	120.0	120.0	120.0	0.0
⟨9⟩	CH	36.0	36.0	170.0	170.0	219.0	219.0	0.0
⟨10⟩	CH	32.0	32.0	252.0	252.0	285.0	285.0	0.0
⟨11⟩	CH	41.0	41.0	318.0	318.0	351.0	351.0	0.0

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
Ⓐ ①	-15.00	4558	13560	8241	18376	3600	26358	14776	1.784
Ⓐ ②	-15.00	4558	15600	3268	18376	1724	23425	16652	1.407
Ⓐ ③	-15.00	4558	16320	2261	18376	1265	23139	17111	1.352
Ⓐ ④	-15.00	4558	17040	1506	18376	875	23104	17501	1.320
Ⓐ ⑤	-15.00	4558	17760	1003	18376	555	23320	17821	1.309
Ⓐ ⑥	-15.00	4558	18480	751	18376	305	23789	18071	1.316
Ⓑ ⑤	-15.00	9734	10560	1003	14467	555	21297	13912	1.531
Ⓒ ①	-24.00	7618	28908	3551	31084	4197	40477	26887	1.505
Ⓓ ①	-30.00	10642	36480	6804	40729	7202	53926	33528	1.608
Ⓔ ①	-15.00	9734	5880	720	14467	162	16334	14305	1.142

NOTES

Φ -- ANGLE OF INTERNAL FRICTION, DEGREES
C -- UNIT COHESION, P.S.F.
▽ -- STATIC WATER SURFACE
D -- HORIZONTAL DRIVING FORCE IN POUNDS
R -- HORIZONTAL RESISTING FORCE IN POUNDS
A -- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B -- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P -- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

97

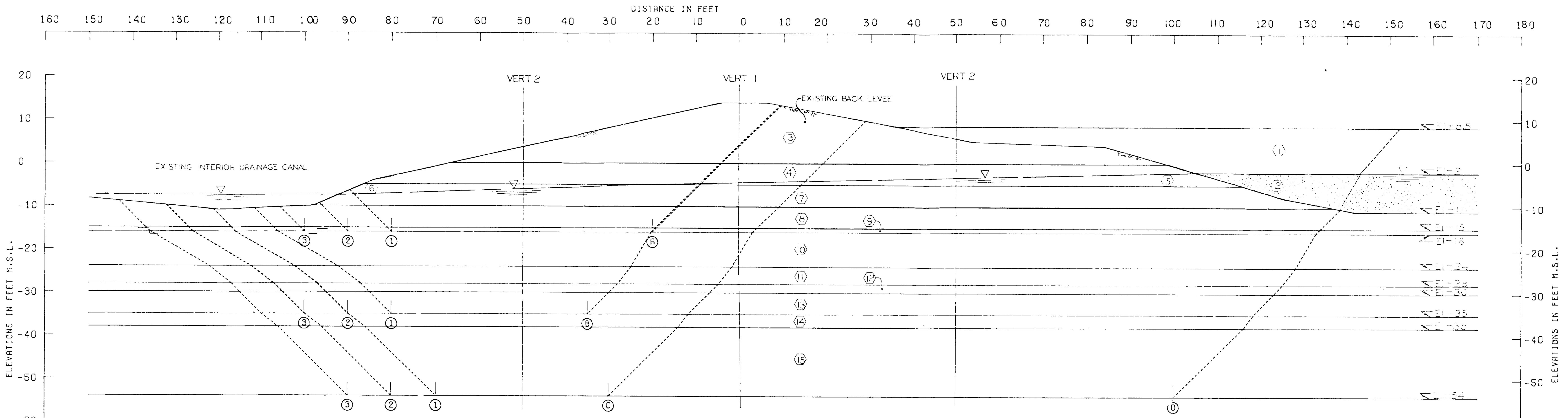
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

RETAINING DIKE
STA. 534+90, STA. 538+00, & STA. 635+72

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



EXISTING BACK LEVEE
STA. 339+ TO 532+86
AND 539+71 TO 635+72

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 88.

SHEAR STRENGTHS BETWEEN VERTICALS 1 AND 2 WERE ASSUMED TO VARY LINEARLY BETWEEN THE VALUES INDICATED FOR THESE LOCATIONS.

THE EXISTING LEVEE SECTION IS A COMPOSITE OF SECTIONS AT STATIONS 400+00, 405+00, AND 410+00.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	DEGREES
1	HY	100.0	100.0	0.0	0.0	0.0	0.0	0.0
2	SP	60.0	60.0	0.0	0.0	0.0	0.0	30.0
3	CH	108.0	108.0	600.0	600.0	600.0	600.0	0.0
4	PT	108.0	98.0	600.0	120.0	600.0	120.0	0.0
5	PT	46.0	36.0	600.0	120.0	600.0	120.0	0.0
6	CHO	108.0	98.0	600.0	120.0	600.0	120.0	0.0
7	CHO	46.0	36.0	600.0	120.0	600.0	120.0	0.0
8	CH	46.0	36.0	600.0	120.0	600.0	120.0	0.0
9	CH	46.0	36.0	600.0	126.0	600.0	131.0	0.0
10	SP	60.0	60.0	0.0	0.0	0.0	0.0	30.0
11	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0
12	CH	41.0	32.0	600.0	274.0	600.0	285.0	0.0
13	CH	41.0	41.0	600.0	313.0	600.0	340.0	0.0
14	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0
15	CH	41.0	41.0	550.0	462.0	550.0	550.0	0.0

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-16.00	31575	12081	2316	41538	3927	45972	37610	1.222
A 2	-16.00	31575	13391	1596	41538	1180	46562	40358	1.154
A 3	-16.00	31575	14684	1369	41538	600	47628	40937	1.163
B 1	-35.00	55405	15885	17939	90080	18524	89229	71556	1.247
B 2	-35.00	55405	19285	16798	90080	15037	91487	75043	1.219
B 3	-35.00	55405	22685	16828	90080	14421	94917	75658	1.255
C 1	-54.00	77933	22000	36347	163820	55081	136281	108739	1.253
C 2	-54.00	77933	27500	35844	163820	49235	141277	114585	1.233
C 3	-54.00	77933	33000	36336	163820	45735	147269	118086	1.247
D 1	-54.00	27917	93500	36347	125132	55081	157764	70051	2.25

NOTES

ϕ -- ANGLE OF INTERNAL FRICTION, DEGREES
C -- UNIT COHESION, P.S.F.
∇ -- STATIC WATER SURFACE
D -- HORIZONTAL DRIVING FORCE IN POUNDS
R -- HORIZONTAL RESISTING FORCE IN POUNDS
A -- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B -- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P -- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

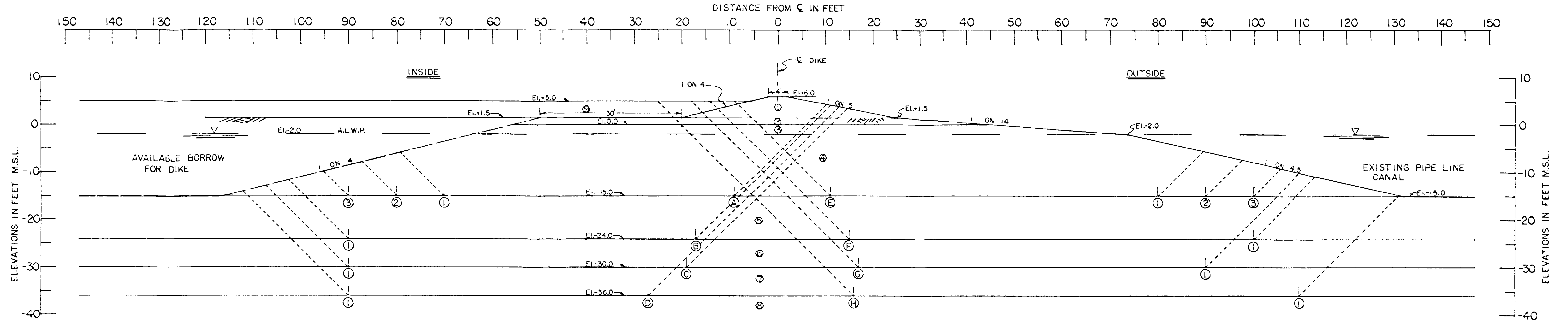
$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

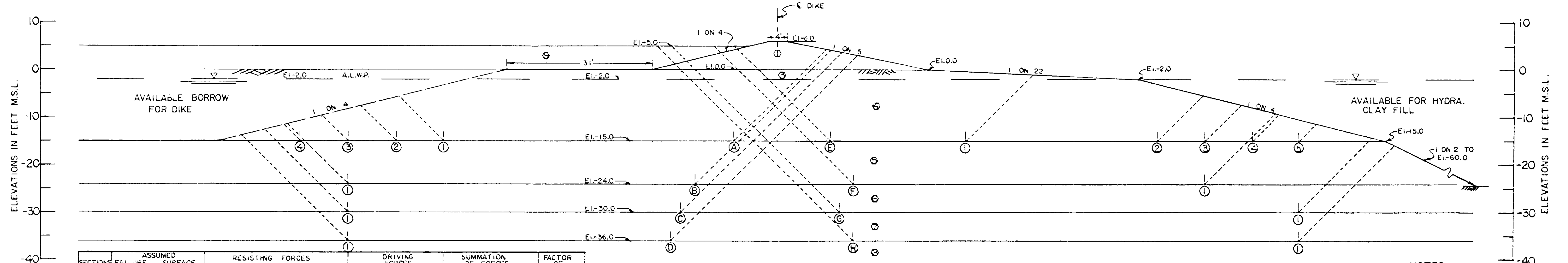
(Q) STABILITY ANALYSIS

EXISTING BACK LEVEE
STA. 339+00 TO STA. 532+86
STA. 539+71 TO STA. 635+72
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



BAYOU GRAND LIARD TO FORT JACKSON



BURAS TO BAYOU GRAND LIARD

SECTIONS	ASSUMED FAILURE NO.		ASSUMED SURFACE ELEV.	RESISTING FORCES R_A	R_B	R_P	DRIVING FORCES D_A	$-D_P$	SUMMATION OF FORCES RESISTING	DRIVING	FACTOR OF SAFETY
GRAND LIARD TO FORT JACKSON	(A)	(1)	-15.0	4300	7320	2208	13272	1903	13828	11369	1.22
	(A)	(2)	-15.0	4300	8520	1728	13272	1166	14548	12106	1.20
	(A)	(3)	-15.0	4300	9720	1248	13272	608	15268	12664	1.21
	(B)	(1)	-24.0	7340	15987	3876	23127	3458	27203	19669	1.38
	(C)	(1)	-30.0	10284	20235	6612	31178	6582	37131	24596	1.51
	(D)	(1)	-36.0	14140	22113	10140	39380	10761	46393	28619	1.62
	(E)	(1)	-15.0	4320	8220	2269	13313	1965	14809	11348	1.31
	(E)	(2)	-15.0	4320	9420	1833	13313	1282	15573	12031	1.29
	(E)	(3)	-15.0	4320	10620	1396	13313	744	16336	12569	1.30
	(F)	(1)	-24.0	7248	18615	4064	24056	3821	29927	20235	1.48
	(G)	(1)	-30.0	10176	20805	7262	32752	8646	38243	24106	1.59
	(H)	(1)	-36.0	13860	32994	9944	43338	9742	56798	33596	1.69
BURAS TO GRAND LIARD	(A)	(1)	-15.0	4120	7320	2256	13272	1987	13696	11285	1.21
	(A)	(2)	-15.0	4120	8520	1776	13272	1231	14416	12041	1.20
	(A)	(3)	-15.0	4120	9720	1296	13272	655	15136	12617	1.20
	(A)	(4)	-15.0	4120	10920	816	13272	260	15856	13012	1.22
	(B)	(1)	-24.0	7160	15987	3924	23127	3571	27071	19556	1.38
	(C)	(1)	-30.0	10124	19950	6660	31021	6738	36734	24283	1.51
	(D)	(1)	-36.0	13860	23868	10188	40107	10960	47916	29147	1.64
	(E)	(1)	-15.0	4128	3480	3360	13350	4800	10968	8550	1.28
	(E)	(2)	-15.0	4128	8280	2310	13350	2080	14718	11270	1.31
	(E)	(3)	-15.0	4128	9480	1834	13350	1310	15442	12040	1.28
	(E)	(4)	-15.0	4128	10680	1358	13350	718	16165	12632	1.28
	(E)	(5)	-15.0	4128	11880	881	13350	302	16889	13048	1.29
	(F)	(1)	-24.0	7092	16206	4465	23905	4954	27763	18951	1.47
	(G)	(1)	-30.0	9900	27645	6251	33377	5458	43796	27919	1.57
	(H)	(1)	-36.0	13644	32994	9900	43340	9226	56538	34114	1.66

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F. VERT. 1	VERT. 2	C - UNIT COHESION -P.S.F. CENTER OF STRATUM VERT. 1	VERT. 2	BOTTOM OF STRATUM VERT. 1	VERT. 2	FRICTION ANGLE DEGREES
(1)	CH	80.0	80.0	60.0	60.0	60.0	60.0	0
(2)	CH	80.0	80.0	120.0	120.0	120.0	120.0	0
(3)	CH	98.0	98.0	120.0	120.0	120.0	120.0	0
(4)	CH	36.0	36.0	120.0	120.0	120.0	120.0	0
(5)	CH	36.0	36.0	170.0	170.0	170.0	170.0	0
(6)	CH	32.0	32.0	252.0	252.0	252.0	252.0	0
(7)	CH	41.0	41.0	318.0	318.0	318.0	318.0	0
(8)	CH	41.0	41.0	450.0	450.0	450.0	450.0	0
(9)	SPOIL	90.0	90.0	0	0	0	0	0

GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 88.

NOTES

Ø- ANGLE OF INTERNAL FRICTION, DEGREES
C- UNIT COHESION, P.S.F.
▽- STATIC WATER SURFACE
D- HORIZONTAL DRIVING FORCE IN POUNDS
R- HORIZONTAL RESISTING FORCE IN POUNDS
A- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

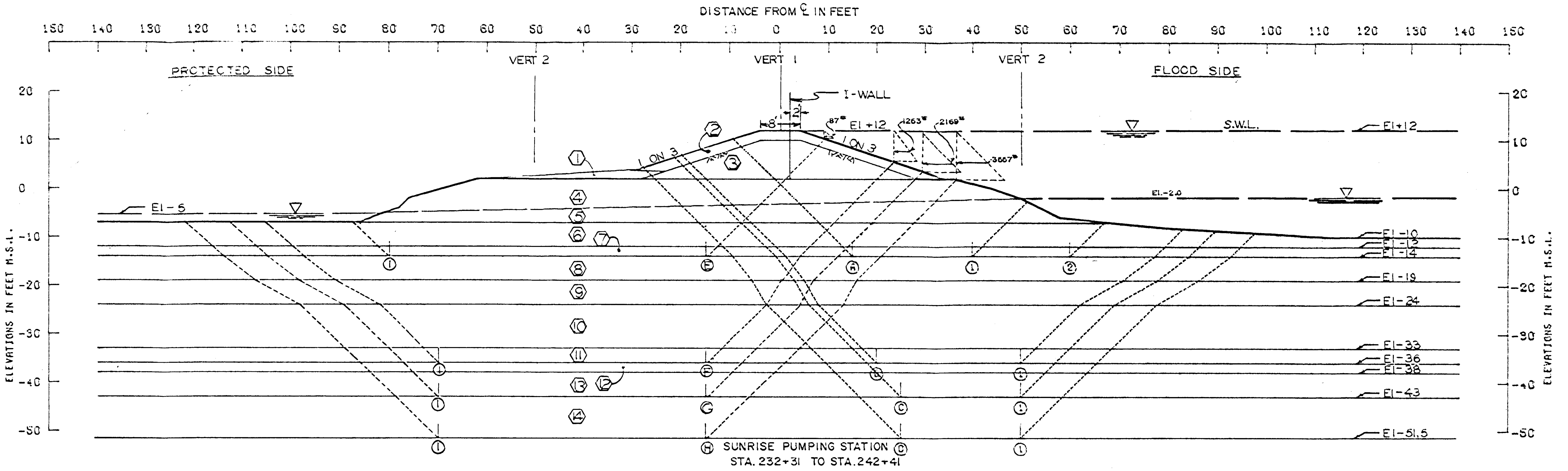
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS

PONDING AREA DIKES
BURAS TO FORT JACKSON

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATE 88.

SHEAR STRENGTHS BETWEEN VERTICALS 1 AND 2 WERE ASSUMED TO VARY LINEARLY BETWEEN THE VALUES INDICATED FOR THESE LOCATIONS.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
1	CH	80.0	80.0	150.0	150.0	150.0	150.0	0.0
2*	CH	100.0	100.0	400.0	400.0	400.0	400.0	0.0
3	CH	108.0	108.0	600.0	600.0	600.0	600.0	0.0
4	CH	108.0	80.0	600.0	150.0	600.0	150.0	0.0
5	CH	46.0	18.0	600.0	150.0	600.0	150.0	0.0
6	CH	46.0	40.0	600.0	100.0	600.0	100.0	0.0
7	CH	46.0	40.0	600.0	111.0	600.0	122.0	0.0
8	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0
9	SM	60.0	60.0	0.0	0.0	0.0	0.0	30.0
10	CH	41.0	40.0	600.0	288.0	600.0	335.0	0.0
11	CH	41.0	40.0	600.0	356.0	550.0	373.0	0.0
12	CH	41.0	40.0	550.0	385.0	550.0	386.0	0.0
13	CH	41.0	40.0	550.0	415.0	550.0	453.0	0.0
14	CH	41.0	40.0	550.0	502.6	550.0	550.0	0.0

* SEMI-COMPACTED FILL

ASSUMED FAILURE SURFACE NO.		ELEV.	RESISTING FORCES R_A	R_B	R_P	DRIVING FORCES D_A	$-D_P$	SUMMATION OF FORCES RESISTING	DRIVING	FACTOR OF SAFETY
A	1	-14.00	26351	8428	3711	29511	3171	38490	26339	1.461
A	2	-14.00	26351	11346	1471	29511	1036	39168	28475	1.376
B	1	-36.00	49192	12783	19560	81104	19822	81535	61281	1.331
C	1	-43.00	55392	11931	24862	99965	29859	92185	70111	1.315
D	1	-51.50	60731	13750	32965	125076	44524	107451	80562	1.334
E	1	-14.00	26935	13785	1444	30547	1131	42164	29416	1.43
F	1	-36.00	47916	22683	20019	86561	22358	90628	64203	1.41
G	1	-43.00	51667	26103	25567	107306	32784	103337	74522	1.39
H	1	-54.00	54970	30250	34101	134098	47907	119321	86191	1.38

NOTES

ϕ -- ANGLE OF INTERNAL FRICTION, DEGREES
C -- UNIT COHESION, P.S.F.
∇ -- STATIC WATER SURFACE
D -- HORIZONTAL DRIVING FORCE IN POUNDS
R -- HORIZONTAL RESISTING FORCE IN POUNDS
A -- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B -- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P -- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

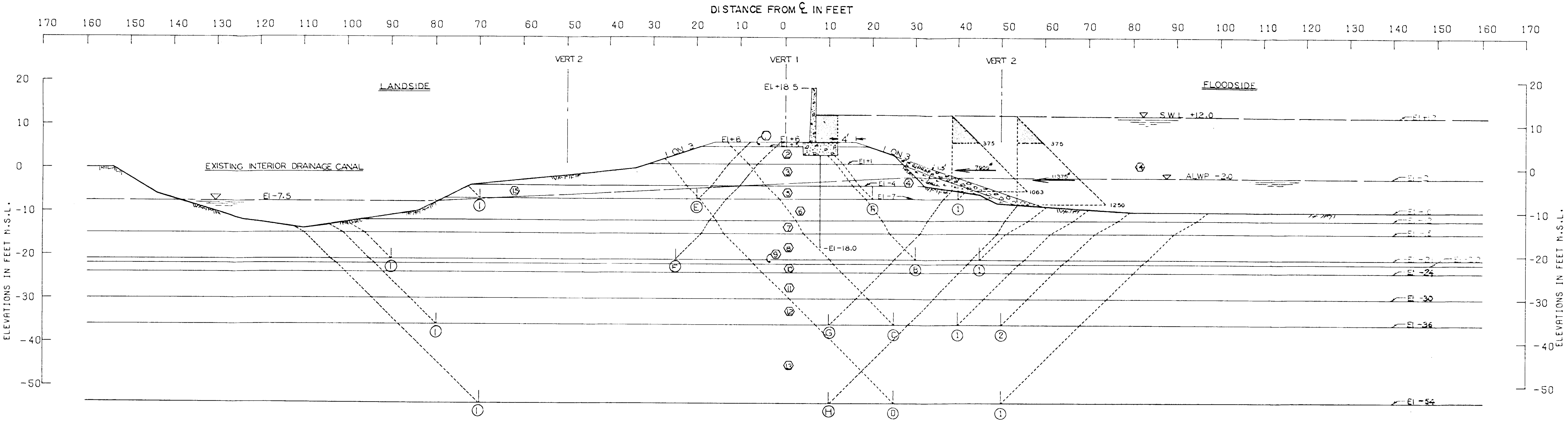
$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

(Q) STABILITY ANALYSIS
SUNRISE PUMPING STATION
STA. 232+31 TO STA. 242+41

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



GENERAL NOTES

CLASSIFICATION, STRATIFICATION, SHEAR STRENGTHS, AND UNIT WEIGHTS OF THE SOIL WERE BASED ON THE RESULTS OF THE UNDISTURBED BORINGS. SEE BORING DATA PLATES. 88

SHEAR STRENGTHS BETWEEN VERTICALS 1 AND 2 WERE ASSUMED TO VARY LINEARLY BETWEEN THE VALUES INDICATED FOR THESE LOCATIONS.

SHADED PORTION OF PRESSURE DIAGRAM IS TAKEN BY THE T-WALL STRUCTURE.

STRATUM NO.	SOIL TYPE	EFFECTIVE UNIT WT. P.C.F.		C - UNIT COHESION - P.S.F.				FRICTION ANGLE DEGREES
				CENTER OF STRATUM		BOTTOM OF STRATUM		
		VERT. 1	VERT. 2	VERT. 1	VERT. 2	VERT. 1	VERT. 2	
1	ML	117.5	117.5	200.0	200.0	200.0	200.0	15.0
2	CH	108.0	108.0	600.0	600.0	600.0	600.0	0.0
3	ML	117.5	117.5	200.0	200.0	200.0	200.0	15.0
4	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0
5	CH	46.0	36.0	600.0	120.0	600.0	120.0	0.0
6	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0
7	SM	60.0	60.0	0.0	0.0	0.0	0.0	30.0
8	CH	46.0	36.0	600.0	153.0	600.0	186.0	0.0
9	ML	55.0	55.0	200.0	200.0	200.0	200.0	15.0
10	CH	46.0	36.0	600.0	208.0	600.0	219.0	0.0
11	CH	41.0	32.0	600.0	252.0	600.0	285.0	0.0
12	CH	41.0	41.0	600.0	318.0	550.0	351.0	0.0
13	CH	41.0	41.0	550.0	450.0	550.0	550.0	0.0
14	WATER	62.5	62.5	0.0	0.0	0.0	0.0	0.0
15	CH	108.0	98.0	600.0	120.0	600.0	120.0	0.0

ASSUMED FAILURE SURFACE			RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.		ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A	1	-7.00	8171	5794	640	7820	49	14605	7772	1.879
B	1	-21.00	18959	4343	5733	24192	4438	29035	19755	1.470
C	1	-36.00	40336	6310	14090	61205	17926	60736	43279	1.403
C	2	-36.00	40336	10019	12927	61205	16410	63282	44795	1.413
D	1	-54.00	56099	13750	28920	111985	42397	98769	69588	1.419
E	I	-7.00	10925	10320	640	8989	442	21885	8547	2.56
F	I	-21.00	23773	14668	2305	31179	2165	40746	29014	1.40
G	I	-36.00	31498	38356	10597	74098	13264	80451	60834	1.32
H	I	-54.00	43515	44000	26558	129749	40710	114073	89039	1.28

NOTES

ϕ -- ANGLE OF INTERNAL FRICTION, DEGREES
C -- UNIT COHESION, P.S.F.
▽ -- STATIC WATER SURFACE
D -- HORIZONTAL DRIVING FORCE IN POUNDS
R -- HORIZONTAL RESISTING FORCE IN POUNDS
A -- AS A SUBSCRIPT, REFERS TO ACTIVE WEDGE
B -- AS A SUBSCRIPT, REFERS TO CENTRAL BLOCK
P -- AS A SUBSCRIPT, REFERS TO PASSIVE WEDGE

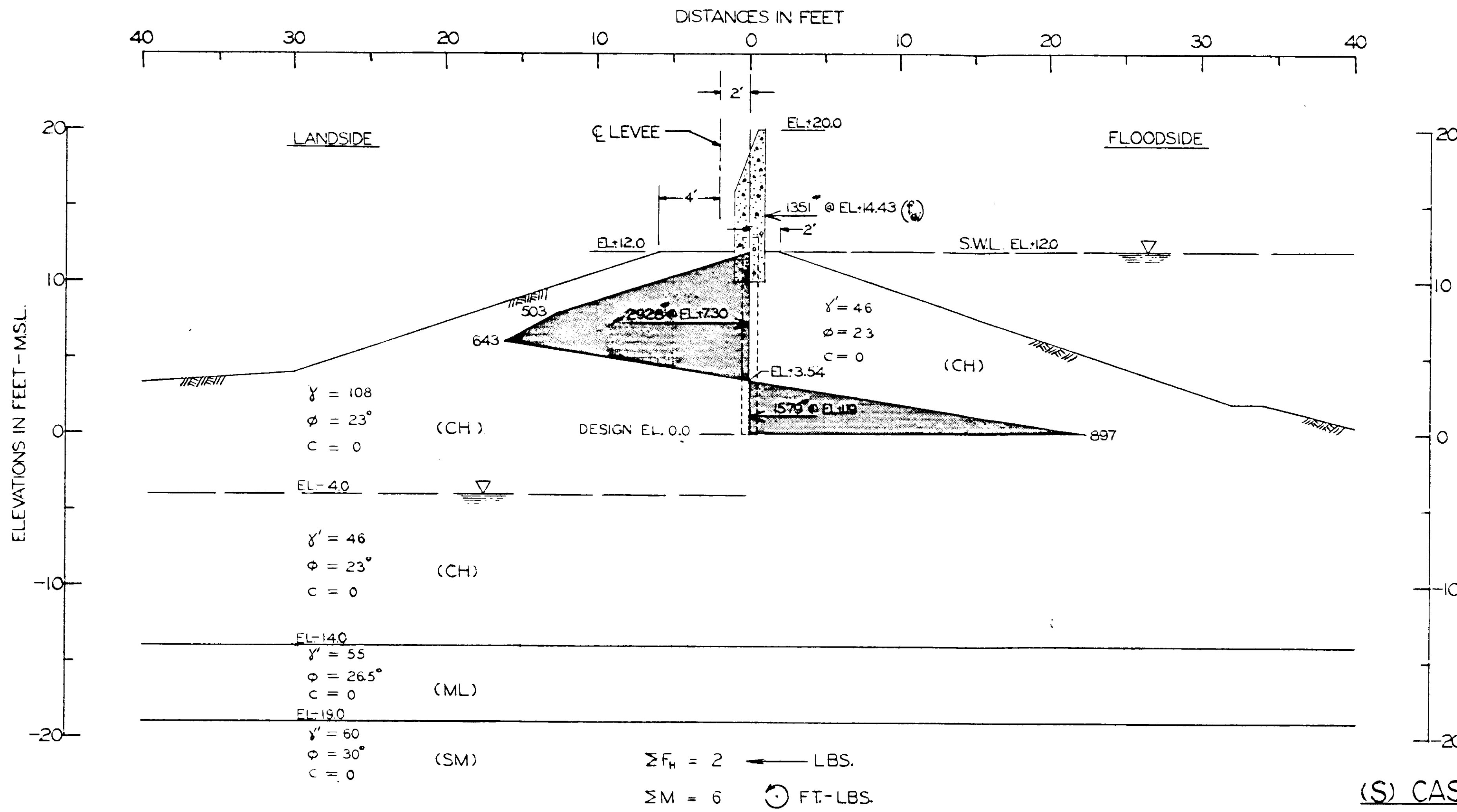
$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

GRAND LIARD PUMPING STATION
STA. 534+27 TO STA. 538+56

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON
(Q) STABILITY ANALYSIS
BAYOU GRAND LIARD PUMPING STATION
BURAS TO FORT JACKSON

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

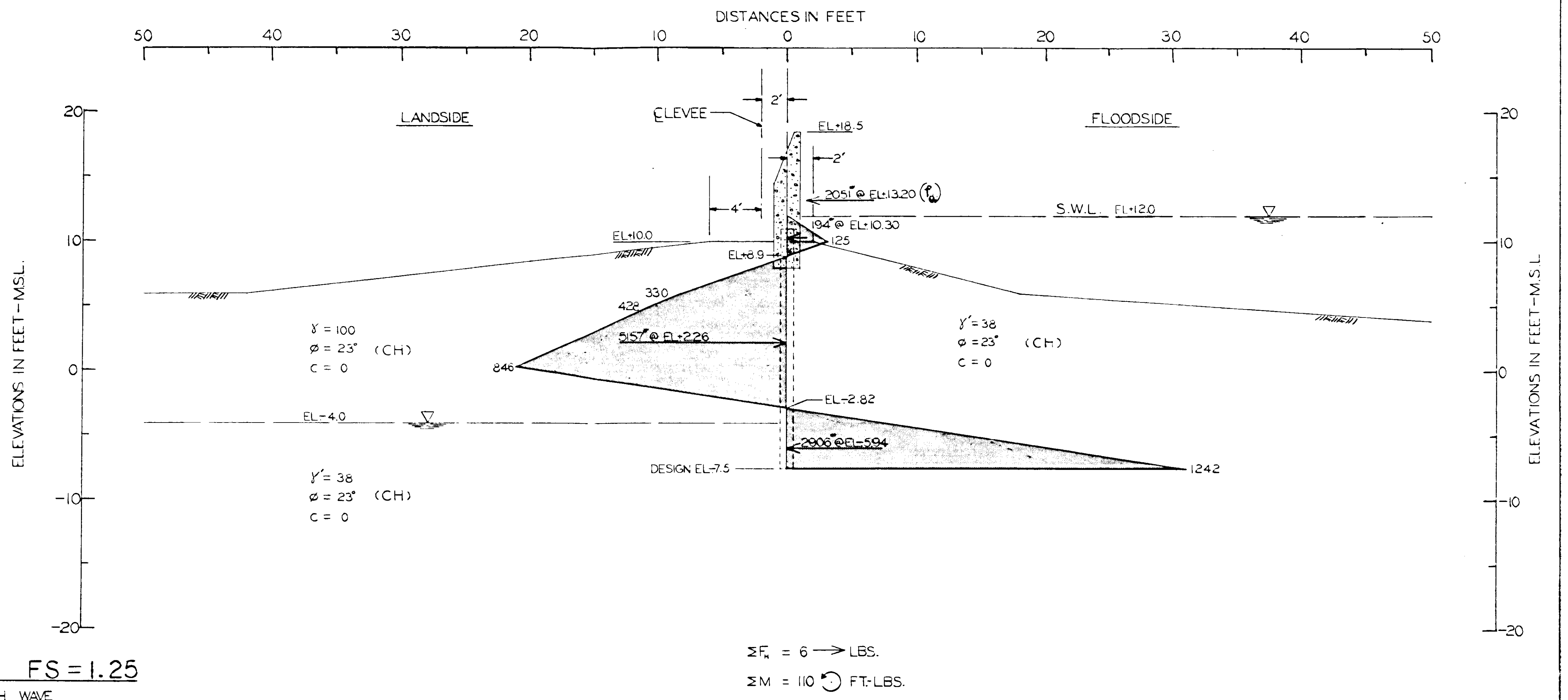


SUNRISE PUMPING STATION

STA. 232+31 TO STA. 236+90
STA. 237+50 TO STA. 242+41

(S) CASE FS = 1.25

WITH WAVE



BAYOU GRAND LIARD PUMPING STATION

STA. 532+76 TO STA. 534+27
STA. 538+56 TO STA. 539+81

GENERAL NOTES

(S) - SHEAR STRENGTH CASE GOVERNED FOR DESIGN STABILITY ANALYSIS BY THE METHOD OF PLANES WITH SURFACES 45 ± $\frac{\phi_D}{2}$ AND F.S = 1.25 APPLIED TO SHEAR STRENGTH OF THE SOIL.

ϕ_A – AVAILABLE ANGLE OF INTERNAL FRICTION IN DEGREES

ϕ_D – DEVELOPED ANGLE OF INTERNAL FRICTION = $\tan^{-1}\left(\frac{\tan \phi_A}{F.S.}\right)$

C_A – UNIT COHESION AVAILABLE

C_D – UNIT COHESION DEVELOPED = $C_A \div$ F.S.

(S) – CONSOLIDATED-DRAINED SHEAR STRENGTH OF SOIL FOR UNDISTURBED SHEAR TEST DATA SEE PLATES:

ΣF_H – SUMMATION OF HORIZONTAL FORCES

ΣM – SUMMATION OF MOMENTS ABOUT THE SHEETPILE TIP.

γ, γ' – UNIT WEIGHTS - P.C.F.

S.W.L. – STILL WATER LEVEL

f_w – WAVE FORCE EFFECTIVE TO TOP OF IMPERVIOUS CLAY LAYER (EL+12)

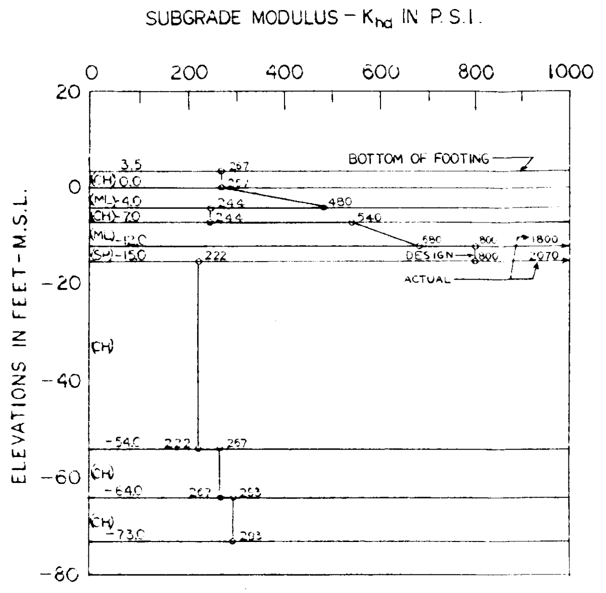
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

CANTILEVER SHEET PILE FLOODWALL STABILITY (S)

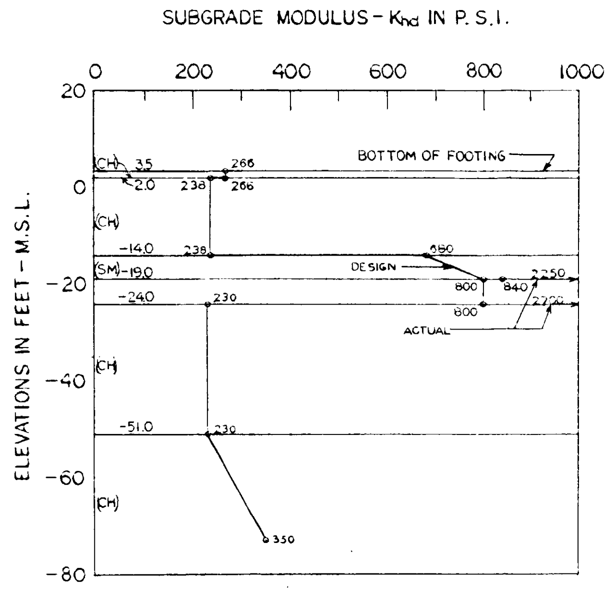
SUNRISE AND GRAND LIARD PUMPING STATIONS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

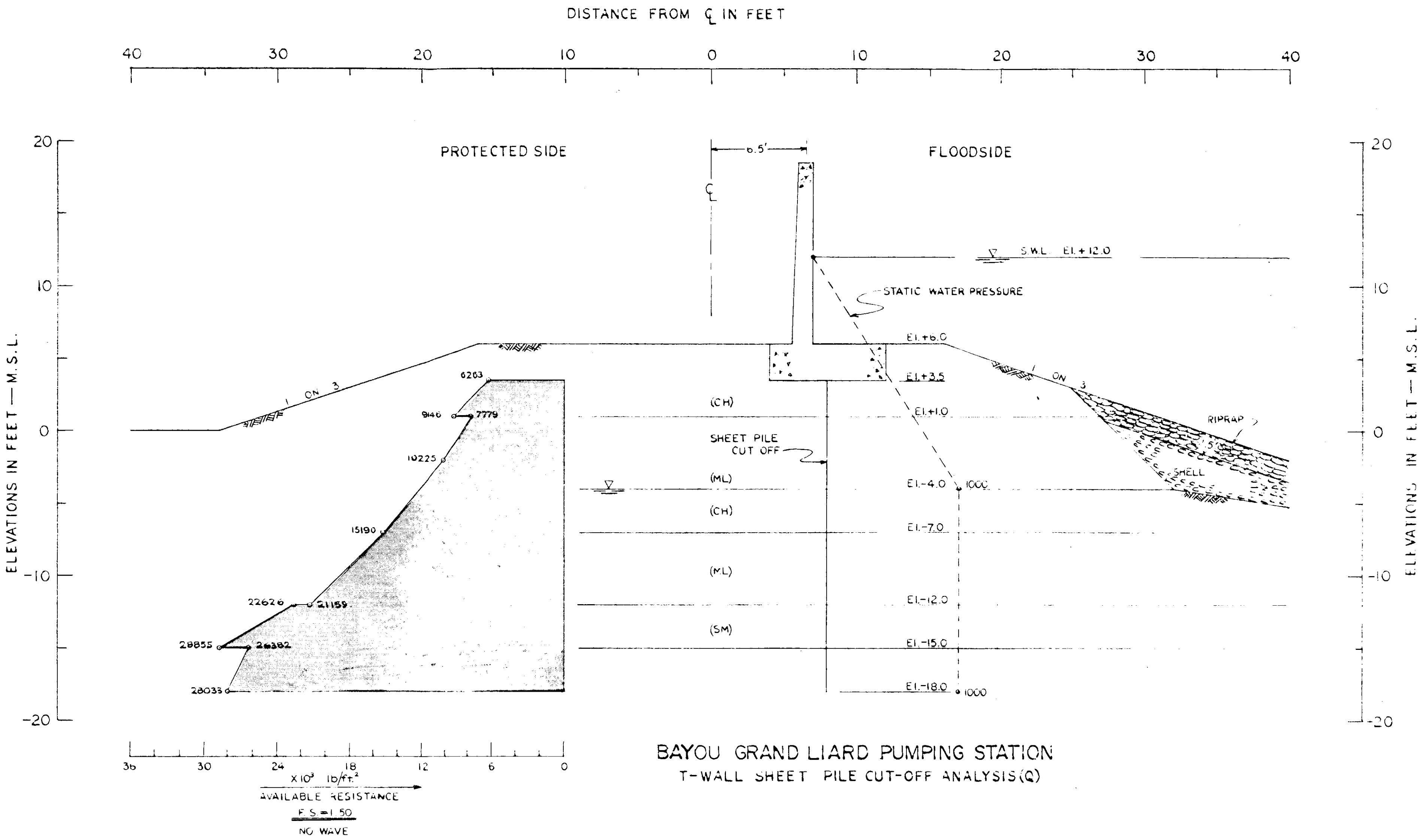
AUGUST 1971 FILE NO. H-2-25712



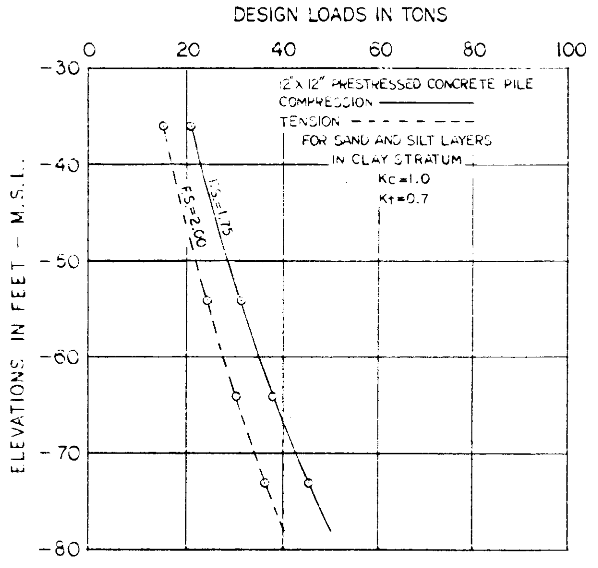
SUBGRADE MODULUS
BAYOU GRAND LIARD PUMPING STATION



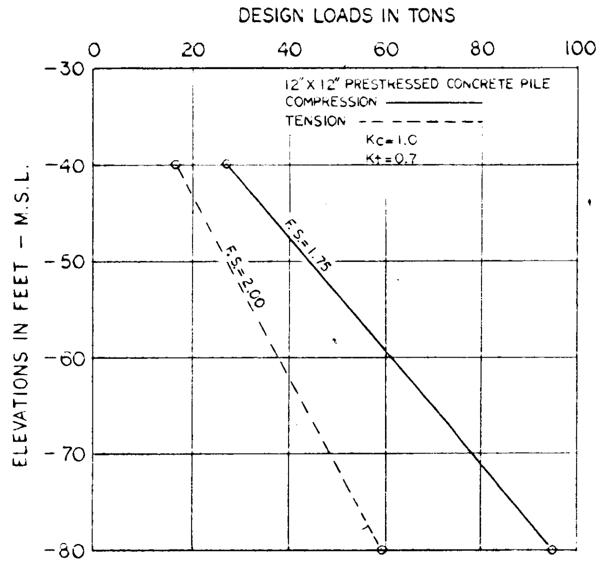
SUBGRADE MODULUS
SUNRISE PUMPING STATION



BAYOU GRAND LIARD PUMPING STATION
T-WALL SHEET PILE CUT-OFF ANALYSIS (Q)



Q-CASE



S-CASE

PILE DESIGN LOAD VS. TIP ELEVATION
SUNRISE AND BAYOU GRAND LIARD
PUMPING STATIONS

GENERAL NOTES

N_h = CONSTANT OF HORIZONTAL SUBGRADE REACTION (p.s.i.)
Δdo = THICKNESS OF STRATA
d = PROJECTED PILE DIAMETER (in)
b = UNIT CONVERSION FACTOR = 12"
Ko = 80 qu (p.s.f.)
C = COHESION
K_{hd} = 0.4 Ko d/b (FOR COHESIVE SOILS)
0.4 = REDUCTION FACTOR FOR CYCLIC LOADING
K_{hd} = 0.5 Nh Δdo d/b (12) [FOR NONCOHESIVE SOILS]
Kc = LATERAL EARTH PRESSURE COEFFICIENT (COMPRESSION)
Kt = LATERAL EARTH PRESSURE COEFFICIENT (TENSION)
K = CONJUGATE STRESS RATIO

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON
SUNRISE AND GRAND LIARD PUMPING STATION
BEARING PILE DESIGN, SUBGRADE MODULUS, AND SHEET PILE CUTOFF ANALYSIS (Q)
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712

UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION		TYPE	LETTER SYMBOL	SYMBOL	TYPICAL NAMES
COARSE - GRAINED SOILS More than half of material is larger than No 200 sieve size.	GRAVELS More than half of coarse fraction is larger than No 4 sieve size	CLEAN GRAVEL (Little or No Fines)	GW		GRAVEL, Well Graded, gravel-sand mixtures, little or no fines
			GP		GRAVEL, Poorly Graded, gravel-sand mixtures, little or no fines
		GRAVEL WITH FINES (Appreciable Amount of Fines)	GM		SILTY GRAVEL, gravel-sand-silt mixtures
			GC		CLAYEY GRAVEL, gravel-sand-clay mixtures
	SANDS More than half of coarse fraction is smaller than No.4 sieve size	CLEAN SAND (Little or No Fines)	SW		SAND, Well-Graded, gravelly sands
			SP		SAND, Poorly-Graded, gravelly sands
		SANDS WITH FINES (Appreciable Amount of Fines)	SM		SILTY SAND, sand-silt mixtures
			SC		CLAYEY SAND, sand-clay mixtures
FINE - GRAINED SOILS More than half the material is smaller than No. 200 sieve size.		SILTS AND CLAYS (Liquid Limit <50)	ML		SILT & very fine sand, silty or clayey fine sand or clayey silt with slight plasticity
			CL		LEAN CLAY; Sandy Clay; Silty Clay; of low to medium plasticity
			OL		ORGANIC SILTS and organic silty clays of low plasticity
		SILTS AND CLAYS (Liquid Limit >50)	MH		SILT, fine sandy or silty soil with high plasticity
			CH		FAT CLAY, inorganic clay of high plasticity
			OH		ORGANIC CLAYS of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			Pt		PEAT, and other highly organic soil
WOOD			Wd		WOOD
SHELLS			Sl		SHELLS
NO SAMPLE					

NOTE: Soils possessing characteristics of two groups are designated by combinations of group symbols

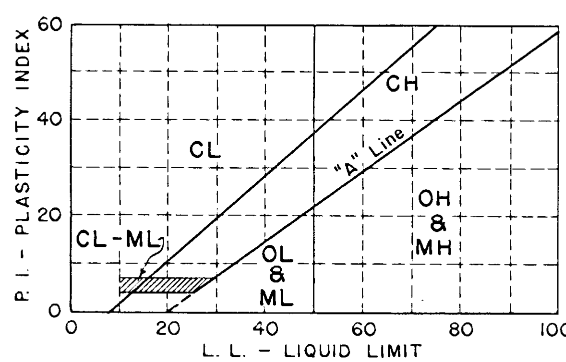
DESCRIPTIVE SYMBOLS

COLOR

COLOR	SYMBOL
TAN	T
YELLOW	Y
RED	R
BLACK	BK
GRAY	Gr
LIGHT GRAY	lGr
DARK GRAY	dGr
BROWN	Br
LIGHT BROWN	lBr
DARK BROWN	dBr
BROWNISH-GRAY	br Gr
GRAYISH-BROWN	gyBr
GREENISH-GRAY	gnGr
GRAYISH-GREEN	gyGn
GREEN	Gn
BLUE	Bl
BLUE-GREEN	BlGn
WHITE	Wh
MOTTLED	Mot

CONSISTENCY FOR COHESIVE SOILS

CONSISTENCY	COHESION IN LBS./SQ.FT. FROM UNCONFINED COMPRESSION TEST	SYMBOL
VERY SOFT	< 250	vSo
SOFT	250 - 500	So
MEDIUM	500 - 1000	M
STIFF	1000 - 2000	St
VERY STIFF	2000 - 4000	vSt
HARD	> 4000	H



PLASTICITY CHART

For classification of fine - grained soils

MODIFICATIONS

MODIFICATION	SYMBOL
Traces	Tr-
Fine	F
Medium	M
Coarse	C
Concretions	cc
Rootlets	rt
Lignite fragments	lg
Shale fragments	sh
Sandstone fragments	sds
Shell fragments	slf
Organic matter	O
Clay strata or lenses	CS
Silt strata or lenses	SIS
Sand strata or lenses	SS
Sandy	S
Gravelly	G
Boulders	B
Slickensides	SL
Wood	Wd
Oxidized	Ox

NOTES:

FIGURES TO LEFT OF BORING UNDER COLUMN "W OR D_{10}"
Are natural water contents in percent dry weight
When underlined denotes D_{10} size in mm *
FIGURES TO LEFT OF BORING UNDER COLUMNS "LL" AND "PL"
Are liquid and plastic limits, respectively
SYMBOLS TO LEFT OF BORING
▽ Ground-water surface and date observed
(C) Denotes location of consolidation test **
(S) Denotes location of consolidated-drained direct shear test **
(R) Denotes location of consolidated-undrained triaxial compression test **
(Q) Denotes location of unconsolidated-undrained triaxial compression test **
(T) Denotes location of sample subjected to consolidation test and each of the above three types of shear tests **
FW Denotes free water encountered in boring or sample
FIGURES TO RIGHT OF BORING
Are values of cohesion in lbs./sq. ft. from unconfined compression tests
In parenthesis are driving resistances in blows per foot determined with a standard split spoon sampler ($1\frac{3}{8}$" I.D., 2" O.D.) and a 140 lb. driving hammer with a 30" drop
Where underlined with a solid line denotes laboratory permeability in centimeters per second of undisturbed sample
Where underlined with a dashed line denotes laboratory permeability in centimeters per second of sample remoulded to the estimated natural void ratio

* The D_{10} size of a soil is the grain diameter in millimeters of which 10% of the soil is finer, and 90% coarser than size D_{10}.

**Results of these tests are available for inspection in the U.S. Army Engineer District Office, if these symbols appear beside the boring logs on the drawings.

GENERAL NOTES:

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and, if encountered, such variations will not be considered as differing materially within the purview of clause 4 of the contract.

Ground-water elevations shown on the boring logs represent ground-water surfaces encountered on the dates shown. Absence of water surface data on certain borings implies that no ground-water data is available, but does not necessarily mean that ground water will not be encountered at the locations or within the vertical reaches of these borings.

Consistency of cohesive soils shown on the boring logs is based on driller's log and visual examination and is approximate, except within those vertical reaches of the borings where shear strengths from unconfined compression tests are shown.

REVISION	DATE	DESCRIPTION	BY
3	5-3-71	ADDED UPPER LIMIT LINE (P.I.=0.9(LL-8)) ON PLASTICITY CHART	LMVED-G LETTER DT'D 29 APRIL 1971
2	6-8-64	SYMBOL FW, NOTE REVISED	ORAL FROM L.M.V.G.G. 5 JUNE 1964
1	9-17-63	1ST. PAR OF GENERAL NOTES REVISED	L M V D MULTIPLE LETTER, DATED 5 SEPT. 1963

SOIL BORING LEGEND

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
FILE NO. H-2-21800

UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION		TYPE	LETTER SYMBOL	SYMBOL	TYPICAL NAMES
COARSE - GRAINED SOILS More than half of material is larger than No 200 sieve size.	GRAVELS More than half of coarse fraction is larger than No 4 sieve size	CLEAN GRAVEL (Little or No Fines)	GW		GRAVEL, Well Graded, gravel-sand mixtures, little or no fines
			GP		GRAVEL, Poorly Graded, gravel-sand mixtures, little or no fines
		GRAVEL WITH FINES (Appreciable Amount of Fines)	GM		SILTY GRAVEL, gravel-sand-silt mixtures
			GC		CLAYEY GRAVEL, gravel-sand-clay mixtures
	SANDS More than half of coarse fraction is smaller than No 4 sieve size	CLEAN SAND (Little or No Fines)	SW		SAND, Well-Graded, gravelly sands
			SP		SAND, Poorly-Graded, gravelly sands
		SANDS WITH FINES (Appreciable Amount of Fines)	SM		SILTY SAND, sand-silt mixtures
			SC		CLAYEY SAND, sand-clay mixtures
FINE - GRAINED SOILS More than half the material is smaller than No. 200 sieve size.		SILTS AND CLAYS (Liquid Limit <50)	ML		SILT & very fine sand, silty or clayey fine sand or clayey silt with slight plasticity
			CL		LEAN CLAY; Sandy Clay; Silty Clay; of low to medium plasticity
			OL		ORGANIC SILTS and organic silty clays of low plasticity
		SILTS AND CLAYS (Liquid Limit >50)	MH		SILT, fine sandy or silty soil with high plasticity
			CH		FAT CLAY, inorganic clay of high plasticity
			OH		ORGANIC CLAYS of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			Pt		PEAT, and other highly organic soil
WOOD			Wd		WOOD
SHELLS			Sl		SHELLS
NO SAMPLE					

NOTE: Soils possessing characteristics of two groups are designated by combinations of group symbols

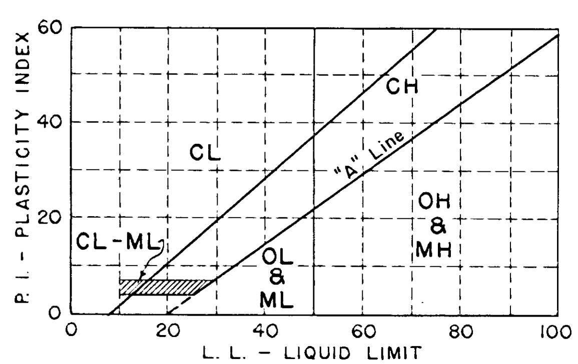
DESCRIPTIVE SYMBOLS

COLOR

COLOR	SYMBOL
TAN	T
YELLOW	Y
RED	R
BLACK	BK
GRAY	Gr
LIGHT GRAY	lGr
DARK GRAY	dGr
BROWN	Br
LIGHT BROWN	lBr
DARK BROWN	dBr
BROWNISH-GRAY	br Gr
GRAYISH-BROWN	gyBr
GREENISH-GRAY	gnGr
GRAYISH-GREEN	gyGn
GREEN	Gn
BLUE	Bl
BLUE-GREEN	BlGn
WHITE	Wh
MOTTLED	Mot

CONSISTENCY FOR COHESIVE SOILS

CONSISTENCY	COHESION IN LBS./SQ.FT. FROM UNCONFINED COMPRESSION TEST	SYMBOL
VERY SOFT	< 250	vSo
SOFT	250 - 500	So
MEDIUM	500 - 1000	M
STIFF	1000 - 2000	St
VERY STIFF	2000 - 4000	vSt
HARD	> 4000	H



PLASTICITY CHART

For classification of fine - grained soils

MODIFICATIONS

MODIFICATION	SYMBOL
Traces	Tr-
Fine	F
Medium	M
Coarse	C
Concretions	cc
Rootlets	rt
Lignite fragments	lg
Shale fragments	sh
Sandstone fragments	sds
Shell fragments	slf
Organic matter	O
Clay strata or lenses	CS
Silt strata or lenses	SIS
Sand strata or lenses	SS
Sandy	S
Gravelly	G
Boulders	B
Slickensides	SL
Wood	Wd
Oxidized	Ox

NOTES:

FIGURES TO LEFT OF BORING UNDER COLUMN "W OR D_{10}"

Are natural water contents in percent dry weight

When underlined denotes D_{10} size in mm *

FIGURES TO LEFT OF BORING UNDER COLUMNS "LL" AND "PL"

Are liquid and plastic limits, respectively

SYMBOLS TO LEFT OF BORING

▽ Ground-water surface and date observed

Ⓒ Denotes location of consolidation test **

Ⓢ Denotes location of consolidated-drained direct shear test **

Ⓡ Denotes location of consolidated-undrained triaxial compression test **

Ⓠ Denotes location of unconsolidated-undrained triaxial compression test **

Ⓣ Denotes location of sample subjected to consolidation test and each of the above three types of shear tests **

FW Denotes free water encountered in boring or sample

FIGURES TO RIGHT OF BORING

Are values of cohesion in lbs./sq. ft. from unconfined compression tests

In parenthesis are driving resistances in blows per foot determined with a standard split spoon sampler ($1\frac{3}{8}$" I.D., 2" O.D.) and a 140 lb. driving hammer with a 30" drop

Where underlined with a solid line denotes laboratory permeability in centimeters per second of undisturbed sample

Where underlined with a dashed line denotes laboratory permeability in centimeters per second of sample remoulded to the estimated natural void ratio

* The D_{10} size of a soil is the grain diameter in millimeters of which 10% of the soil is finer, and 90% coarser than size D_{10}.

**Results of these tests are available for inspection in the U.S. Army Engineer District Office, if these symbols appear beside the boring logs on the drawings.

GENERAL NOTES:

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and, if encountered, such variations will not be considered as differing materially within the purview of clause 4 of the contract.

Ground-water elevations shown on the boring logs represent ground-water surfaces encountered on the dates shown. Absence of water surface data on certain borings implies that no ground-water data is available, but does not necessarily mean that ground water will not be encountered at the locations or within the vertical reaches of these borings.

Consistency of cohesive soils shown on the boring logs is based on driller's log and visual examination and is approximate, except within those vertical reaches of the borings where shear strengths from unconfined compression tests are shown.

REVISION	DATE	DESCRIPTION	BY
3	5-3-71	ADDED UPPER LIMIT LINE (P.I.=0.9(LL-8)) ON PLASTICITY CHART	LMVED-G LETTER DT'D 29 APRIL 1971
2	6-8-64	SYMBOL FW, NOTE REVISED	ORAL FROM L.M.V.G.G. 5 JUNE 1964
1	9-17-63	1ST. PAR OF GENERAL NOTES REVISED	L M V D MULTIPLE LETTER, DATED 5 SEPT., 1963

SOIL BORING LEGEND

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
FILE NO. H-2-21800

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX A
HYDROLOGY AND HYDRAULIC ANALYSIS

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX A
HYDROLOGY AND HYDRAULIC ANALYSIS

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

TABLES

PLATES

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

GLOSSARY

ASTRONOMICAL TIDE - See PREDICTED NORMAL TIDE

ATMOSPHERIC PRESSURE ANOMALY - The difference between atmospheric pressure at any point within the hurricane and normal pressure at the periphery of the hurricane.

BUILDUP - The increase, in feet, over that from other causes, of water surface elevation in a body of water resulting from:

a. Convergence in depth or width
b. Construction of a barrier
c. Ponding

CENTRAL PRESSURE INDEX - A parameter of hurricane intensity which reflects the minimum atmospheric pressure within the eye of a particular hurricane.

FETCH - The continuous area of water over which the wind blows in essentially a constant direction. Often used with FETCH LENGTH.

FETCH LENGTH - The horizontal distance over which the wind from a fixed direction may have unobstructed contact with the water surface.

HURRICANE - A cyclonic storm, usually of tropical origin, containing winds of 75 miles per hour or more.

a. DESIGN HURRICANE - That hurricane selected by the reporting office as a basis for design of the proposed plan of improvement.

b. STANDARD PROJECT HURRICANE - A hypothetical hurricane intended to represent the most severe combination of meteorological conditions that are reasonably characteristic of the region involved, excluding extremely rare combinations.

c. PROBABLE MAXIMUM HURRICANE - A hypothetical hurricane that might result from the most severe combination of meteorological conditions that are considered reasonably possible in the region involved. This hurricane is substantially more severe than the standard project hurricane and is seldom, if ever, used as the controlling consideration in design.

d. MODERATE HURRICANE - A hurricane that may be expected from a combination of meteorological conditions that are frequently experienced in the region.

e. TRANSPOSED HURRICANE - A storm transferred from actually observed location to another location for the purpose of study, with appropriate changes in storm characteristics.

HURRICANE TRACK - The line connecting successive locations of central pressure of the hurricane.

HURRICANE SPEED - The rate of forward movement of the hurricane eye in knots or miles per hour.

HURRICANE SURGE - The mass of water causing an increase in elevation of the water surface above normal tide at the time of a hurricane.

HURRICANE SURGE HEIGHT - The elevation of the stillwater level at a given point resulting from predicted normal tide and from hurricane surge action. It may be the result of one or more of the following components:

a. Predicted normal tide
b. Pressure setup
c. Setup due to winds over the continental shelf
d. Buildup

In inland lakes, hurricane surge height is the average lake level and does not include local wind setup.

HURRICANE TIDE - The elevation of the stillwater level at a given point during a hurricane. In inland lakes it is the sum of hurricane surge height and additional local wind setup.

ISOVEL - Line connecting points of simultaneous equal wind velocities and in this appendix represents a 5-minute average, 30 feet above ground level.

KNOT - A velocity equal to 1 nautical mile (6,080 feet) per hour, or about 1.15 statute miles per hour.

LANDFALL - The arrival of a hurricane center at the coastline.

OVERTOPPING - The amount of water passing over the top of a structure as a result of wave runup or surge action.

PONDING - The storage behind a water-retaining structure of water from interior runoff or from overtopping of a structure.

PREDICTED NORMAL TIDE - The periodic rising and falling of the water that results from gravitational attraction of the moon and sun acting upon the rotating earth.

PRESSURE SETUP - A rise in the surface of a large body of water caused by a measurable reduction in local atmospheric pressure at sea level.

RANGE - An imaginary line representing the centerline of a narrow fetch over which the hurricane surge height is computed.

RUNUP - The vertical elevation above stillwater level to which water rises on the face of a structure as a result of wave action.

SETUP - The vertical rise in the stillwater level, above that which would occur without wind action, caused by wind stresses on the surface of the water.

SIGNIFICANT WAVE - A statistical term denoting waves having the average height and period of the highest one-third waves of a given wave train.

STILLWATER LEVEL - The elevation of the water surface if all wave action were to cease.

STORM SURGE - Same as HURRICANE SURGE, except that it may be caused by storms not of hurricane characteristics as well as by hurricanes.

SURGE REFERENCE LINE - The locus of points where the maximum surge height would be observed along fetches normal to the general coast.

WAVE HEIGHT - The vertical distance between the crest and the preceding trough. (Referenced to significant waves in this report.)

WAVE SETUP - The superelevation of the water surface above the hurricane surge height due to wave action alone.

WAVE TRAIN - A series of waves from the same direction.

WIND SETUP - Same as SETUP.

WIND TIDE LEVEL - Same as STILLWATER LEVEL.

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX A
HYDROLOGY AND HYDRAULIC ANALYSIS

SECTION I - CLIMATOLOGY AND HYDROLOGY

1. Climatology.

a. Climate. The climate of the project area is related to a subtropical latitude and proximity to the Gulf of Mexico. Location of the project area and the limits of its subareas are shown on plate A-1. The climate may be characterized as marine, especially in summer when southerly winds, which produce conditions favorable for the generation of convective thundershowers, prevail. In the colder seasons the area is subjected to frontal movements which produce squalls and sudden temperature drops. Fogs on the Mississippi River are prevalent during the winter and spring when the temperature of the river is generally somewhat colder than the air temperature. Normally, the flood season of the river occurs from December to early June, and the hurricane season is from June to October. Climatological data for this area are contained in monthly and annual publications by the U. S. Department of Commerce, Weather Bureau (now the National Oceanic and Atmospheric Administration, National Weather Service) titled "Climatological Data for Louisiana," and "Local Climatological Data, New Orleans, Louisiana." The temperature and precipitation data are available for several National Weather Service stations. The data for New Orleans, with 98 years of record, and Burrwood, with 56 years of record, were used to compute normals and averages of temperature and precipitation for the area.

b. Temperature. The average annual temperature is 70° Fahrenheit, with monthly means ranging from 57° in January to 83° in July and August. The maximum temperature of 102° was recorded at Belle Chasse on 7 August 1935, at New Orleans on 30 June 1954 and earlier dates, and at Port Sulphur on 31 August 1951. Minimum temperatures of 6° were recorded at Diamond on 12 February 1899 and 7° at New Orleans on 13 February 1899. Normal temperatures by months, determined by averaging Weather Service normals for Burrwood and New Orleans, are as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
56.8	58.2	62.2	68.8	76.0	81.7	83.1	83.2	80.4	73.5	63.6	58.4

c. Rainfall. Precipitation generally is heavy in two fairly definite periods. Summer showers occur from about mid-June to mid-September and winter rains from mid-December to mid-March. Precipitation is greatest in the warm months due to summer thundershowers, and February has a greater average than other winter months. The average annual rainfall is 60.8 inches. At New Orleans a maximum annual rainfall accumulation of 85.73 inches was recorded in 1875 and a minimum of 31.04 inches fell in 1899. Normal monthly rainfall ranges from 7.3 inches in July to 3.3 inches in October. Monthly normals based on averaging records for Burrwood and New Orleans are as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
4.25	4.50	5.22	4.71	4.60	4.87	7.31	6.93	6.83	3.31	3.94	4.34

The maximum monthly rainfall was 29.0 inches, recorded at Belle Chasse in October 1937. Several stations have experienced periods in which no rainfall was recorded in a calendar month. Snow occurs infrequently in the area. New Orleans had an 8.2-inch snowfall on 14-15 February 1895. The last appreciable snowfall in the project area occurred on 12 February 1958 when stations reported from 1.3 inches to 4.0 inches.

2. Hydrology.

a. Tides. The tide along the coast is diurnal and has a mean range of approximately 1 foot under normal conditions. During periods of low flow on the Mississippi River, tidal effects are observed on the river as far as 200 miles upstream from the Gulf of Mexico. Water surface elevations are observed presently at four locations along the Mississippi River within the project limits. These elevations reflect headwater flow and tidal fluctuation. Recording type gages are located at West Pointe a la Hache, 1926 to date; Empire, 1960 to date; and Venice, 1944 to date. Staff gage records are available at Port Sulphur for the period 1934 to date. In addition, daily river stages were obtained at Fort Jackson during the period 1891-1960. Crest stage indicators are maintained at two points landside of the east and landside of the west Mississippi River levees to record the maximum tide reaches during tropical storms. Water surface elevations for the river gages are available in "Stages and Discharges of the Mississippi River and its Outlets and Tributaries," published annually by the Mississippi River Commission; and in "Stages and Discharges of the Mississippi River and Tributaries and Other Streams and Waterways in the New Orleans District," published biennially by the U. S. Army Engineer District, New Orleans.

b. River floods of record. Headwater flooding of the natural banks of the river occurs almost annually, but the area flooded is small and confined by the river levees. The higher stages usually occur during the period February to May. The 1950 high water which produced stages of 10.7 feet and 7.5 feet m.s.l.[1] at Pointe a la Hache and Fort Jackson, respectively, is the maximum of record in the project area. The coincidence of a hurricane occurring with a major river flood is considered to be possible but very improbable.

c. Storm tides. Many severe storms have been experienced in the area east and west of the Mississippi River. Flooding to various depths occurred on one or both sides during the storms of 1856, 1860, 1886, 1887, 1893, 1901, 1906, 1909, 1915, 1916, 1917, 1926, 1940, 1947, 1948, 1956, 1961, 1964, 1965, and 1969. Hurricane Betsy, in September 1965, produced tides in the project area of 14.8 feet at Bohemia; 14.4 feet at West Pointe a la Hache; 12.6 at Ostrica Lock; 9.7 feet at Empire; 7.9 feet at Venice; and 7.6 feet at Grand Ecaille. Hurricane Camille, occurring in August 1969, passed east of the project area and inundated the area on the west side of the Mississippi River from Port Sulphur to Venice and caused almost total destruction to facilities located south of the latitude of Port Sulphur. The Phoenix-Pointe a la Hache-Bohemia area was fortunate in escaping severe flood damage because the hurricane passed a safe distance east of that location. Some of the flood stages caused by Hurricane Camille at and near the project area were: Ostrica Lock, 15.1 feet; Mississippi River mile 48.7 AHP, 10.9 feet; Mississippi River mile 35.5 AHP, 10.6 feet; Bohemia back levee, 10.1 feet; and Pointe a la Hache back levee, 6.0 feet. Since the path of Hurricane Camille passed closer to the project area, damage exceeded that which was experienced from Hurricane Betsy.

SECTION II - TIDAL HYDRAULIC DESIGN

3. Description and verification of procedures.

a. Hurricane memorandums. The Hydrometeorological Branch (HMB), U. S. Weather Bureau (now the National Weather Service) cooperated in the development of hurricane criteria for experienced and potential hurricanes in the project area. Memorandums prepared by the HMB provided isovel patterns, hurricane tracks, pressure profiles, rainfall estimates, frequency data, and various other parameters required for the hydraulic computations. A reevaluation of historical meteorologic and hydrologic data was the basis for memorandums relative to experienced hurricanes. Those relative to potential hurricanes were developed through the use of generalized estimates of hurricane parameters based on the latest research and concepts of hurricane theory. Memorandums applicable to the project area are listed in Section IV - Bibliography.

---

[1]Mean sea level, the datum to which all elevations in this appendix are referenced, unless otherwise indicated.

b. Historical storms used for verification. Three observed storms, with known parameters and effects, were used to establish and verify procedures and relationships for determining hurricane surge heights. These three storms occurred in September of 1915, 1947, and 1956. Isovel patterns for the hurricanes of September 1915(1)[2], September 1947(2), and September 1956(3) are shown on plates A-2, A-3, and A-4, respectively.

(1) The hurricane of 29 September 1915 had a central pressure index (CPI) of 27.87 inches, an average forward speed of 10 knots, and a maximum windspeed of 99 m.p.h. at a radius of 27 nautical miles. This hurricane approached the mainland from the south. A surge height of 12 feet was experienced at Pointe a la Hache while Buras had a surge height of 7.9 feet.

(2) The 19 September 1947 hurricane had a CPI of 28.57 inches, an average forward speed of 16 knots, and a maximum windspeed of 100 m.p.h. at a radius of 33 nautical miles. The direction of approach of this hurricane was approximately from the southeast. Some of the surge heights experienced during this hurricane were 11.2 feet at Shell Beach, 8.2 feet at Bohemia, and 11.5 feet as Ostrica.

(3) Hurricane Flossy, 23 September 1956, had a CPI of 28.76 inches, an average forward speed of 10 knots, and a maximum windspeed of 80 m.p.h. at a radius of 30 nautical miles. Flossy approached the mainland from the southwest. Surge heights of 13 feet and 8 feet occurred at Ostrica and Grand Isle, respectively.

(4) The hurricane of 9 September 1965, Betsy, had a CPI of 27.79 inches, an average forward speed of about 17 knots, and a maximum windspeed of 122 m.p.h. The storm approached land from a southeasterly direction. Some of the maximum surge heights which occurred in and near the project area are described in paragraph 2c.

(5) Hurricane Camille of 17 August 1969 had a 26.61 CPI, an average forward speed of 13 knots, and a maximum windspeed of 146 m.p.h. See paragraph 2c for a description of maximum surge heights for the area.

c. Synthetic storms. Computed hurricane surge heights, resulting from synthetic storms, are necessary for frequency and design computations. Parameters for certain synthetic storms and methods for derivation of others were furnished by the National Weather Service. The standard project hurricane (SPH) for the Louisiana coast was used as the base hurricane since other hurricanes could be derived from it. The probable maximum hurricane (PMH) and moderate hurricane (Mod H) were derived from the SPH.

[2]Numbers in parentheses indicate reference in Section IV of this appendix.

(1) The SPH used in this memorandum was derived by the National Weather Service from a study of 48 hurricanes that occurred in the region over a period of 69 years. Based on subsequent studies of recent hurricanes, the Weather Service revised the original SPH wind field patterns[4][5]. However, the other characteristics of the SPH were not changed. The hurricane track critical to Reach B1, Tropical Bend to Fort Jackson, and the SPH isovel patterns at the critical hour are shown on plate A-5.

(a) The SPH has a frequency of once in 100 years for the Louisiana coastal region. The CPI that corresponds to this frequency is 27.5 inches. CPI probabilities are based on the following relationship[6]

$$P = \frac{100\ (M=0.5)}{Y}$$

where P = percent chance of occurrence per year
M = number of the event (rank)
Y = number of years of record

(b) Radius of maximum winds is an index of hurricane size. The average radius of 12 hurricanes occurring in the vicinity of the project area is 36 nautical miles. From relationships of CPI and radius of maximum winds of gulf coast hurricanes[6], a radius of 30 nautical miles is considered representative for an SPH having a CPI of 27.5 inches.

(c) An average forward speed of 11 knots was used for hurricanes critical to the project area. The forward speeds of hurricanes experienced in the Gulf of Mexico ranged from 5 to 30 m.p.h. and the forward speeds of actual hurricanes vary during their life.

(d) Maximum theoretical gradient wind[6] is expressed as follows:

$$V_{gx} = 73 \sqrt{P_n - P_o} - R\ (0.575\ f)$$

where V_{gx} = maximum gradient windspeed in miles per hour
P_n = asymptotic pressure in inches
P_o = central pressure in inches
R = radius of maximum winds in nautical miles
f = Coriolis parameter in units of $hour^{-1}$

The estimated windspeed (30 feet above ground level) (V_x)[7] in the region of the highest speeds is obtained as follows:

$$V_x = 0.885\ V_{gx} + 0.5T$$

where T = forward speed in miles per hour. From these relationships, a windspeed of approximately 100 m.p.h.[3] was obtained for the SPH.

(2) Synthetic storms with various frequencies and corresponding CPI's are derived from the SPH. The CPI for any frequency except the PMH is obtained from the graph shown on plate A-6. For the PMH, the National Weather Service recommends a CPI of 26.9 inches (8)(9)(10). V_{gx} for all synthetic storms and experienced storms is computed just as for the SPH, but for the PMH, P_n is increased to 31.22 inches(10). Similarly, V_x for any storm is computed from the SPH. Various isovels are adjusted from the SPH pattern using the ratio V_x of any hurricane to V_x of the SPH. Characteristics of some Zone B, large radius, synthetic storms with a moderate speed of translation are listed in table A-1 along with five experienced storms. The track (Des H) for a hurricane most critical to the project area and the paths of some large experienced storms are shown on plate A-7.

TABLE A-1
HURRICANE CHARACTERISTICS

Hurricane[1]	CPI	Radius of max. winds	Forward speed	V_x
	inches	nautical miles	knots	m.p.h.
Sept 1915	27.87	29	10	99
Sept 1947	28.57	33	16	100
Sept 1956	28.76	30	10	80
Sept 1965	27.79	32	17	122
Aug 1969	26.61	15	13	146(@ 25° Lat.)
PMH	26.9	30	11	143(@ 30° Lat.)
SPH	27.6	30	11	100
Mod H	28.3	30	11	83

[1]Tracks are shown on plate A-7.

d. Surges.

(1) Maximum hurricane surge heights along the gulf shore were determined from computations made for ranges extending from the shore out to the continental shelf by use of a general wind tide formula that is based on the steady state conception of water super-elevation(11)(12)(13). In order to reach agreement between computed

[3]Windspeeds represent a 5-minute average, 30 feet above ground level.

maximum surge heights and observed high-water marks, it was necessary to introduce a calibration coefficient or surge adjustment factor (Z) into the general equation which, in its modified form, is:

$$S = 1.165 \times 10^{-3} \frac{V^2 F}{D} N\ Z \cos \theta$$

where S = wind setup in feet
V = windspeed in statute miles per hour
F = fetch length in statute miles
D = average depth of fetch in feet
θ = angle between direction of wind and the fetch
N = planform factor, generally equal to unity
Z = surge adjustment factor

(2) Water surface elevations along a range were determined by incremental summation of wind setup above the water elevation at the gulf end of the range. Initial elevation at the beginning of each range was determined from the predicted normal tide and the setup due to atmospheric pressure anomaly. Typical tidal cycles for the project area are shown on plate A-8. An adjustment was made at the shoreward end of the range to compensate for the difference in pressure setup between the ends of the range. This procedure for the determination of surge height at the coastline was developed for an area along the Mississippi gulf coast where reliable data were available at several locations for more than one severe hurricane. The procedure was then used for the entire Louisiana coastal region. Due to dissimilar shoreline configurations, different surge adjustment factors were required at each location, but identical factors were used at a particular location for each storm. The value of the factor is apparently a function of the distance between the shoreline and deep water and varies inversely with this distance. Comparative computed maximum elevations and observed high-water elevations for the 1915 and 1947 hurricanes at the locations that were used in the development of the procedure are shown in table A-2.

TABLE A-2
HURRICANE SURGE HEIGHTS

Location	Surge adjustment factor (Z)	1915		1947	
		Observed	Computed	Observed	Computed
		feet m.s.l.		feet m.s.l.	
Bay St.Louis, Miss.	0.46	11.8	11.8	15.2	15.1
Gulfport, Miss.	0.60	10.2[1]	9.9	14.1	14.3
Biloxi, Miss.	0.65	10.1[1]	9.8	12.2[1]	12.6

[1]Average of several high-water marks.

(3) The incremental step computation was used to check experienced maximum hurricane surge heights at several locations within the project area. Verification of these surge heights and the surge adjustment factors used in the computations are shown in table A-3.

TABLE A-3
VERIFICATION OF HURRICANE SURGE HEIGHTS

Location	Surge adjustment factor (Z)	Sept 1915 Observed	Sept 1915 Computed	Sept 1956 Observed	Sept 1956 Computed
		feet m.s.l.		feet m.s.l.	
Phoenix	0.52	-	-	8.5	7.8
Pointe a la Hache	0.52	12.0	12.4	10.3	10.2
Ostrica	0.64	-	-	12.1	12.2
Buras	0.80	7.9	8.7	-	-
Grand Isle	0.80	9.0	8.8	3.9	4.1

(4) Surge heights were computed for Hurricane Betsy, September 1965, at locations within the project area where reliable observed surge heights were available. Using the same Z factors as shown in table A-3, the computed surge heights averaged about 2.9 feet higher than the observed surge heights. This apparently was the effect of the higher forward speed of Betsy. A fast-moving hurricane does not allow enough time for the surge heights to approach the steady state of water superelevation(8)(9)(10). However, Z factors derived from the slow-moving hurricanes should be used for design purposes since this type of hurricane is more typical in the project area.

(5) The storms under consideration are accompanied by strong winds. For each surge computation, the average windspeed was determined from isovel charts supplied by the National Weather Service(4)(5) and average depth values were derived from standard hydrographic charts prepared by the U. S. Coast and Geodetic Survey (now the National Oceanic and Atmospheric Administration, National Ocean Survey).

e. Wave runup.

(1) Wave runup on a protective structure depends on the characteristics of the structure (i.e., shape and roughness), the wave characteristics, and the depth of water at the structure. The vertical height to which water from a breaking wave will run up on a given protective structure determines the top elevation to which the structure must be built to prevent wave overtopping.

(2) Computations were made to determine wave runup for protective systems along the authorized alignment. The protective system along the authorized alignment consists of both levees and floodwalls. The configurations of the protective system are shown on plate A-9.

(3) In order to compute wave runup on a protective structure, the significant wave height (H_s) and wave period (T) in the vicinity of the structure must be known. They were determined according to Bretschneider[14] and as described in paragraph 1.25 of reference[11]. The windspeed and depth used in determining H_s and T were average values over a 5-mile fetch. Data used to determine wave characteristics in the vicinity of the protective structures are shown in table A-4.

TABLE A-4
DATA USED TO DETERMINE WAVE CHARACTERISTICS
DESIGN HURRICANE
TROPICAL BEND TO FORT JACKSON

Pertinent factors		Levee	Floodwall
F	- Length of fetch, miles	5	5
U	- Windspeed, m.p.h.	77	77
s.w.l.	- Stillwater elevation, feet	12.0	12.0
d	- Average depth of fetch, feet	6.7	6.7
d_t	- Depth at toe of structure, feet	8.0	8.0

(4) Wave runup was calculated by use of model study data developed by Saville[15][16][17][18] which relate relative runup (R/H_o'), wave steepness (H_o'/T^2), and relative depth (d/H_o'). The average depth (d) of the 5-mile fetch is shown in table A-4 and the significant wave height (H_s) and wave period (T) can be determined from the data in table A-4. The equivalent deepwater wave height (H_o') can be determined from table D-1 of reference[11] which related d/L_o to H/H_o'. The deepwater wave length (L_o) is determined from the equation:

$$L_o = 5.12\ T^2$$

When determining runup from the significant wave, H in the term (H/H_o') is equal to H_s. Wave characteristics used in computing runup from the significant wave are shown in table A-5.

TABLE A-5
WAVE CHARACTERISTICS
DESIGN HURRICANE
TROPICAL BEND TO FORT JACKSON

Characteristics		Levee	Floodwall
H_s	- Significant wave height, feet	3.1	3.1
T	- Wave period, seconds	4.2	4.2
L_o	- Deepwater length, feet	90.3	90.3
d/L_o	- Relative depth	0.07420	0.07420
H_s/H_o'	- Shoaling coefficient	0.9638	0.9638
H_o'	- Deepwater wave height, feet	3.2	3.2
Wave height for structure design, feet			
H_1 $(1.67 \times H_s)$		-	5.2
H_1' $(1.67 \times H_o')$		-	5.3
H_o'/T^2	- Wave steepness	0.181	0.181
d_b	- Breaking depth for H_o' feet	3.8	3.8

(5) With the terms d/H_o' and H_o'/T^2 known, runup on a protective structure can be computed if the slope of the structure is known. The levee configurations used in these computations had stabilizing berms on the water side. These berms broke the continuity of the levee slope and Saville's(18) method of determining wave runup on the composite slopes was used (see plate A-10). In using this method, the actual composite slope is replaced by a hypothetical single constant slope. This hypothetical slope is computed by estimating a value of wave runup and then determining the slope of a line from the point where the wave breaks to the estimated point of runup. The breaking depth is determined from the equation:

$$d_b = \frac{0.667\, H_o'}{(H_o'/T^2)^{1/3}}$$

Using the slope of this line, which is the hypothetical slope, a value of runup is determined. If the value of runup determined is different from the estimated runup, the process is then repeated using the new value of runup to obtain a new hypothetical slope which, in turn, determines a new value of runup. This process is repeated until the estimated value of runup agrees with the computed value of runup.

(6) Protective structures exposed to wave runup will be constructed to an elevation that is sufficient to prevent all overflow from the significant wave and waves smaller than the significant wave accompanying the design hurricane. Waves larger than the significant wave may overtop the protective structures but such overtopping will not endanger the security of the

structures or cause excessive interior flooding. During the time of maximum hurricane surge height the berm on the water side of the levee becomes submerged and waves of lesser height than the significant wave, but of the same period, break farther up the levee slope. Sometimes runup from these smaller waves reach an elevation higher than that from the significant wave; therefore, runup resulting from these smaller waves must also be computed. The equivalent deepwater wave height for the smaller waves breaking on the berms was computed by the equation:

$$H_o' = \frac{1.84}{T} (d_b)^{3/2}$$

Runup was computed for the significant wave and for smaller waves breaking on each berm and the required levee height was determined by adding the highest computed runup value to the maximum stillwater elevation. Design runup values and proposed elevations of protective structures are shown in table A-6.

TABLE A-6
DESIGN WAVE RUNUP AND DESIGN ELEVATIONS
OF PROTECTIVE STRUCTURES
DESIGN HURRICANE
TROPICAL BEND TO FORT JACKSON

Location	Av. depth	Surge height	Design runup	Design elevations protective structures
	ft.	ft.m.s.l.	ft.	ft. m.s.l.
Levees	6.7	12.0	3.0	15.0
Floodwalls	6.7	12.0	6.5-7.7[1]	18.5-20.0[1]

[1]Height of floodwalls will vary between 18.5 and 20.0 feet. Height is dependent on levee configuration on the flood side of the structure.

f. Residual flooding. Protective structures were designed to prevent wave overtopping from the significant or any lower wave that would be experienced during an occurrence of the design hurricane. However, 14 percent of the waves in a spectrum is higher than the significant wave and the maximum wave height to be expected is about 1.65 times the significant wave height. Thus, the protective structures herein will be overtopped by those waves of the spectrum which exceed the significant wave. Studies indicate that no significant flooding will result from such overtopping.

4. Frequency estimates. Procedure.

a. Prior to 1900, information of record dealt primarily with loss of life and damage in the more densely populated areas, with practically no reference to water surface elevations caused by hurricanes. Only since 1900 has detailed information been available on flooding in coastal Louisiana and adjacent areas. Subsequent to the widely destructive September 1915 hurricane, Charles W. Oakey, Senior Drainage Engineer, Office of Public Roads and Rural Engineering, U. S. Department of Agriculture, made a thorough survey of the coastal areas between Biloxi, Mississippi, and Palacios, Texas. The 1915 investigation is the only known area-wide study containing reliable stages until the investigation of Hurricane Flossy, September 1956, was completed. The data indicate that all localities along the Louisiana coast are about equally prone to hurricane attack.

b. Lack of historical data relative to elevation of hurricane surges prohibits the establishment of dependable observed stage-frequency relationships for Reach B1, Tropical Bend to Fort Jackson. Therefore, a procedure was developed to establish synthetic stage-frequency relationships. Grand Isle, located approximately 34 miles west of Reach B1, is the only location west of the Mississippi River near the project area where a sufficient number of observed hurricane stages are available to compute a dependable observed stage-frequency curve for comparison with the results of the synthetic method of computing frequencies. Probabilities for historical data on the curve shown on plate A-11 were calculated by means of the formula:

$$P = 100 \frac{(M-0.5)}{Y}$$

c. The first requirement in the development of synthetic frequency relationships was to select representative critical hurricane tracks for the particular locale in question. Tracks B and D were selected as critical tracks for Reach B1 and Grand Isle, respectively. These tracks are shown on plate A-7. In the process of formulating synthetic frequency relationships, it was necessary to correlate the following hurricane parameters: central pressure indexes, tracks of approach, wind velocities, radii to maximum winds, and forward speeds of translation.

d. Surge heights were then developed for four storms of different CPI values for each track. Each hurricane selected for the representative tracks was assumed to have the same radius of maximum winds, the same forward speed of translation, and the same adjustment for any land effects. Conversion of wind fields of hurricanes of different CPI's requisite to computing surge heights is covered in paragraph 3c. Surge heights for storms with other CPI values were obtained graphically by plotting the above data and reading from the resulting curves.

e. Hurricane characteristics of area-representative storms were developed in cooperation with the National Weather Service. This agency has made a generalized study of hurricane frequencies for a 400-mile zone along the gulf coast, Zone B, from Cameron, La., to Pensacola, Fla., and has presented the results in a memorandum[10]. Frequencies for hurricane central pressure indexes that were presented in the report, as shown on plate A-6, reflect the probability of hurricane recurrence from any direction in the midgulf coastal area. In order to establish frequencies for the locations under study, it was assumed that a hurricane whose track is perpendicular to the coast will ordinarily cause high tides and inundation for a distance of about 50 miles along the coast. Thus, the number of occurrences in the 50-mile subzone would be 12.5 percent of the number of occurrences in the 400-mile zone, provided that all hurricanes traveled in a direction normal to the coast. However, the usual hurricane track is oblique to the shoreline as shown in table 2 of HMS memorandum[6]. The average projection along the coast of this 50-mile swath for the azimuths of 48 Zone B hurricanes is 80 miles. Since this is 1.6 times the width of the normal 50-mile strip affected by a hurricane, the probability of occurrence of any hurricane of the 50-mile subzone would be 1.6 times the 12.5 percent, or 20 percent of the probability for the entire midgulf Zone B. Thus, 20 percent of the Zone B frequencies shown in table B[10] (updated) was used to represent the CPI frequencies in the 50-mile subzone that is critical for each study locality.

f. The azimuths of tracks observed in the vicinity of landfall were divided into quadrants corresponding to the four cardinal points. In Zone B, 29 tracks were from the south, 15 from the east, 3 from the west, and 1 from the north. This indicates that approximately two-thirds of all experienced hurricanes have come from a southerly direction whereas about one-third has come from the east. The average azimuth of tracks from the south is 180° and tracks from the east had an average azimuth of 117°.

g. Due to geographic location and physical features involved in the project area, hurricanes on tracks from the east would generate only minor stages along the back levee of Reach B1. In order to insure the maximum accuracy in the computation of hurricane stage-frequencies, levees of the Mississippi River and azimuths of the critical hurricane tracks are considered the principal determinants for this analysis. Stage-frequencies for Grand Isle and the Tropical Bend to Fort Jackson area were computed for presentation in this appendix and are used to reflect probabilities for the back levee of Reach B1 west of the Mississippi River.

h. The location and physical features of Grand Isle are conducive to critical stages for a hurricane approaching from any direction. Therefore, the full 20 percent of the probabilities for midgulf Zone B was used for computing synthetic frequencies for Grand Isle. Table A-7 illustrates the computation.

TABLE A-7
SYNTHETIC STAGE-FREQUENCY
GRAND ISLE

		Frequency[1]	
CPI in. (1)	Surge height ft. m.s.l. (2)	Zone B (400 miles) occ/100 years (3)	Grand Isle (50-mile subzone) occ/100 years (4)
27.5	9.9	1	0.2
27.7	9.5	2	0.4
28.3	7.9	10	2.0
29.1	5.1	40	8.0

[1]Frequency = $\frac{100}{\text{Return period in years}}$

Col. (4) = 20 percent of Col. (3)

i. The synthetic frequency curve for Grand Isle was shifted to the experienced frequency plot, maintaining as nearly as possible its general shape. Plate A-11 is a graphical presentation of the shift. The shifted curve was then used in determining frequencies at the back levee along Reach B1.

j. Despite the proximity of Reach B1 and Grand Isle, computations of stage-frequencies for those locations differ slightly. Whereas hurricanes approaching from any direction generate critical stages for Grand Isle, only hurricanes approaching from between an azimuth of 160° and due west would generate critical stages for the back levee along Reach B1. Consequently, 27 of the 48 Zone B tracks or 56 percent were used in computations for developing synthetic frequency curves for Reach B1. This means that the most critical surge height along Reach B1 for a Zone B hurricane of given frequency occurs only 56 percent as often as the most critical surge height at Grand Isle for the same hurricane. Therefore, the final stage-frequency curve for Tropical Bend to Fort Jackson was developed by plotting the computed stages for several different Zone B hurricanes at 56 percent of the corresponding probabilities indicated by the shifted Grand Isle curve.

k. Relationships. Based on the above-described procedures, stage-frequency relationships were established for Grand Isle and Tropical Bend to Fort Jackson. Stage-frequency curves are shown on plate A-12.

5. Design hurricane.

a. Selection of the design hurricane. Since the project area is sparsely populated, the hurricane that would produce the 100-year stage was selected as the design hurricane (Des H). A design hurricane of lesser intensity which would indicate a lower levee grade and an increased frequency would expose the protected areas to hazards to life and property that would be disastrous in the event a hurricane with the intensity and destructive capability of the Des H or the SPH occurred.

b. Characteristics. The Des H for Reach B1 has a CPI of 28.02 inches and a maximum windspeed of 91 m.p.h. at a radius of 30 nautical miles. The forward speed of the hurricane is 11 knots.

c. Normal predicted tide. The range of normal predicted tides in the project area is 1 foot and the mean tide varies from 0.4 to 1.0 foot m.s.l. The difference in height of hurricane surge heights for an occurrence of the Des H at high or low tides is only a few tenths of a foot. In determining the elevation of design surge heights, it was assumed that mean normal predicted tide occurs at the initial period of surges.

d. Design hurricane surge height. The hurricane surge height is the maximum stillwater surface elevation experienced at a given location during the passage of a hurricane. It reflects the combined effects of the hurricane surge and, where applicable, the overland flow of the surge. Design hurricane surge heights were computed for conditions reflecting authorized and revised protective works or improvements.

SECTION III - INTERIOR DRAINAGE

6. General. Throughout the project area, back levees have been constructed by local interests. These levees extend generally parallel to the Mississippi River and provide a low degree of protection against hurricane tides originating west of the river. From Tropical Bend to Fort Jackson, the plan of improvement will consist generally of the gulfside enlargement of the existing levees to the grades and cross sections required for adequate hurricane protection. At Empire and Buras, however, the hurricane protection levee will be constructed on the gulfside of the general alignment of the back levees.

7. Interior drainage. The interior drainage of the project area will be furnished by the existing canals and pumping stations and the proposed floodgate at Empire. Runoff from the area between the existing back levee and the Mississippi River levee between the vicinities of Tropical Bend (station 0+00) and Doullut Canal (station 65+00) will be evacuated by the existing pumping station located in Reach A. Runoff from the area between the vicinities of the waterway and Fort Jackson (station 635+72) will be provided for by the existing pumping stations at Sunrise (station 237+00) and Bayou Grand Liard (station 535+00).

8. Floodgate. In the vicinity of Empire, construction of the hurricane levee will intercept drainage from an area of about 365 acres. This area will be enclosed by the hurricane protection levee, the levee along the Mississippi River, and the existing back levees. To meet the requirements of navigation, a floodgate will be constructed to provide an 84-foot width at the sill elevation of -14. This opening is more than adequate to dispose of runoff from intense storms occurring with the floodgate open. Additional data pertinent to the hydraulic analysis of the floodgate are presented in Section II, Design Memorandum No. 2 - Detail Design - Reach B1 - Tropical Bend to Fort Jackson - Empire Floodgate - October 1970.

SECTION IV - BIBLIOGRAPHY

(1) U. S. Weather Bureau, "Revised Wind Fields, Vicinity of Lake Pontchartrain, Hurricane of September 29, 1915," Memorandum HUR 7-39, August 16, 1957.

(2) U. S. Weather Bureau, "Wind Speed and Direction Charts for the Lake Pontchartrain, Chandeleur, and Breton Sounds and Mississippi Delta Regions, September 19, 1947," Memorandum HUR 7-37, June 12, 1957.

(3) U. S. Weather Bureau, "Pressure and Winds over the Gulf of Mexico in Hurricane Flossy, September 23-24, 1956," Memorandum HUR 7-53, June 19, 1958.

(4) U. S. Weather Bureau, "Standard Project Hurricane Wind Field Patterns revised to Replace Existing Patterns in NHRP Report No. 33, for Zones B and C," Memorandum HUR 7-84, August 17, 1965.

(5) U. S. Weather Bureau, "Adjustments to SPH isovel patterns in Memoranda HUR 7-62, 7-62A, 7-63, 7-64, and 7-65," Memorandum HUR 7-85, November 3, 1965.

(6) U. S. Weather Bureau, "Hurricane Frequency and Correlations of Hurricane Characteristics for the Gulf of Mexico Area, P. L. 71," Memorandum No. 2-4, August 30, 1957.

(7) U. S. Weather Bureau, "SPH Parameters and Isovels, Mid-Gulf Coast U. S. Zone B, and SPH Lake Pontchartrain, La.," Memorandum HUR 7-42, October 11, 1957.

(8) U. S. Weather Bureau, "Relationships Between SPH Isovel Patterns and Probable Maximum Events for the New Orleans Area, Memorandum HUR 7-61, August 21, 1959.

(9) U. S. Weather Bureau, "Relationships Between SPH Isovel Patterns and Probable Maximum Events for the New Orleans Area, continued," Memorandum HUR 7-61a, November 15, 1961.

(10) U. S. Weather Bureau, "Interim Report-Meteorological Characteristics of the Probable Maximum Hurricane, Atlantic and Gulf Coasts of the United States," Memorandum HUR 7-97, October 18, 1969.

(11) Coastal Engineering Research Center, "Shore Protection, Planning and Design," Technical Report No. 4, June 1966.

(12) Saville, Thorndike, Jr., "Wind Set-Up and Waves in Shallow Water," Beach Erosion Board, Technical Memorandum No. 27, June 1952.

(13) U. S. Army Engineer District, Jacksonville, "Design Memorandum Wind Tides Produced by Hurricane," Partial Definite Project Report, Central and Southern Florida Project, for Flood Control and Other Purposes, Part IV, Supplement 2, Section 3, July 26, 1956.

(14) Bretschneider, C. L., "Prediction of Wind Waves and Setup in Shallow Water, with Special Application to Lake Okeechobee, Florida," Unpublished Paper, Texas A&M College, August 1954.

(15) Saville, Thorndike, Jr., "Wave Run-Up on Shore Structures," Journal of the Waterways Division of the American Society of Civil Engineers, Vol. 82, No. WW 2, April 1956.

(16) Saville, Thorndike, Jr., "Laboratory Data on Wave Run-Up and Overtopping on Shore Structures," Beach Erosion Board, Technical Memorandum No. 64, October 1955.

(17) Saville, Thorndike, Jr., Inclosure to letter from Beach Erosion Board to U. S. Army Engineer District, New Orleans, 1 July 1958.

(18) Saville, Thorndike, Jr., "Wave Run-Up on Composite Slopes," Proc. of the 6th Conference on Coastal Engineering, Council on Wave Research University of California 1958.

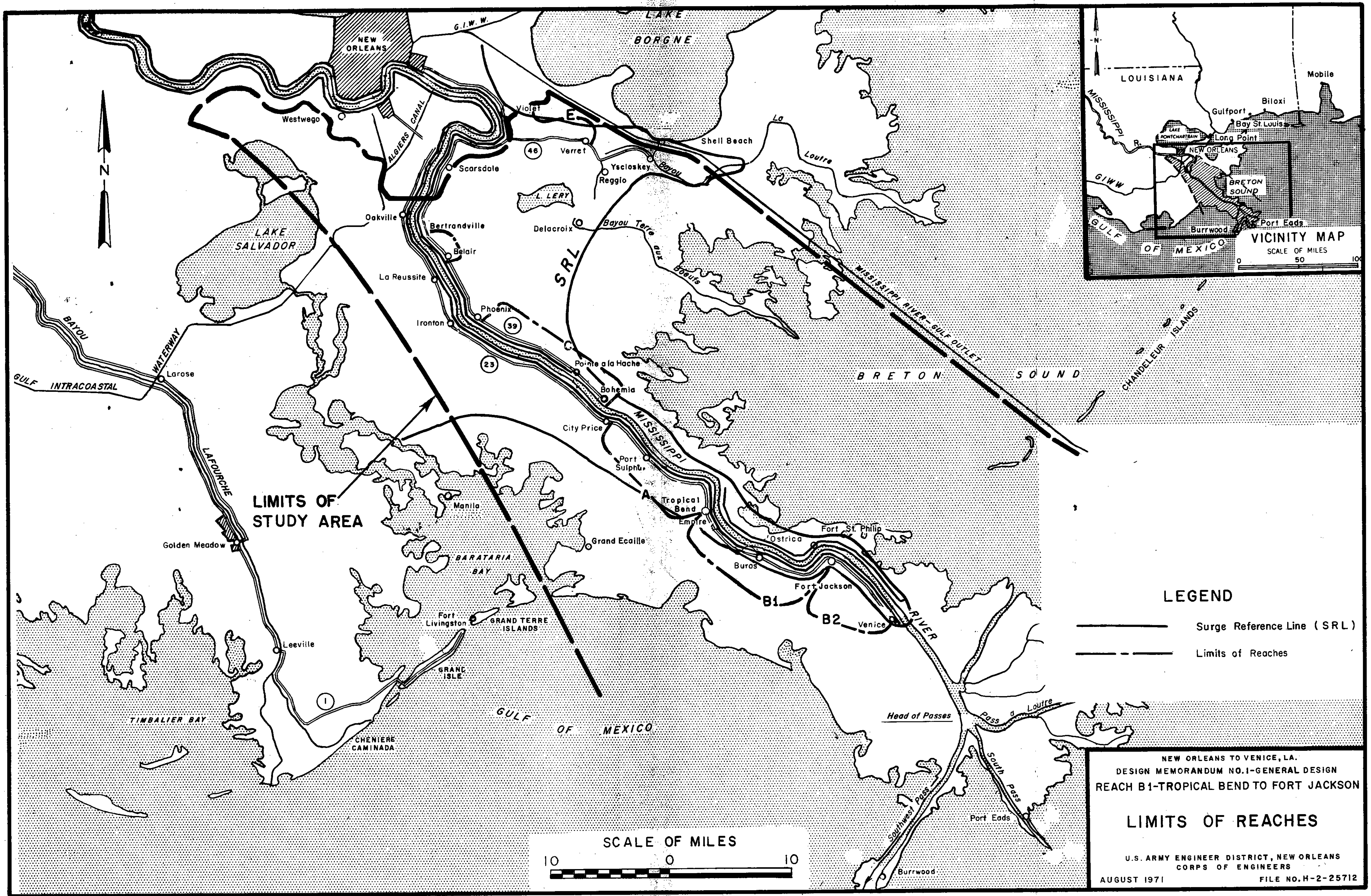
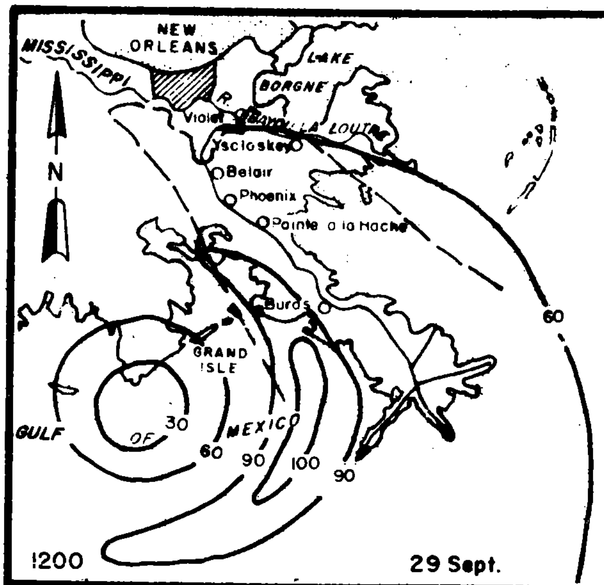
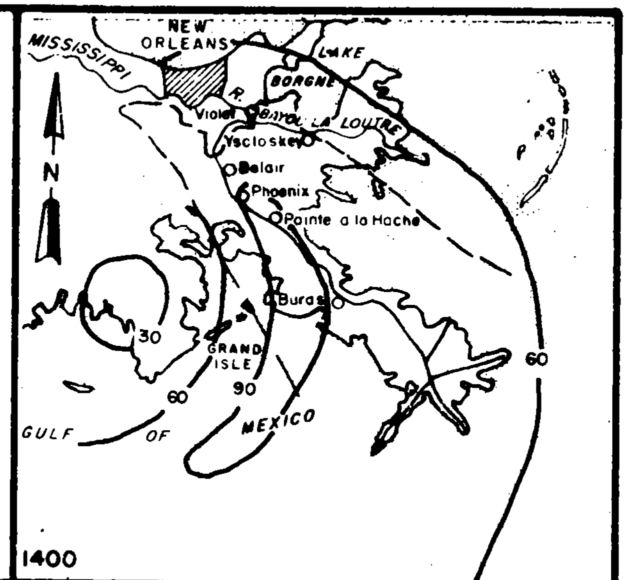
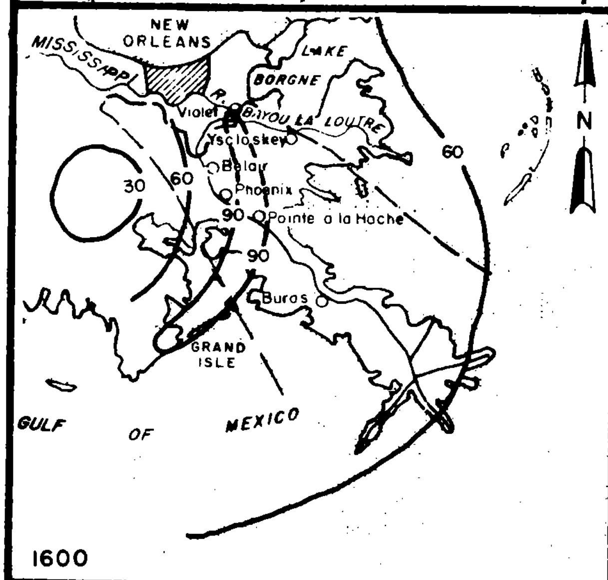
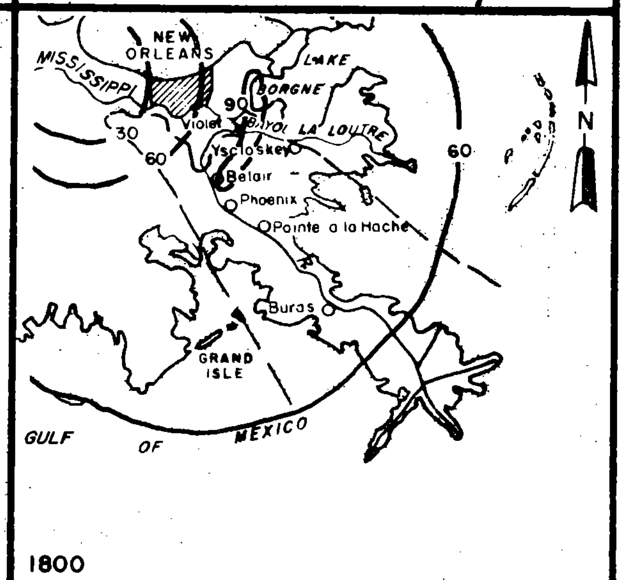

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON
LIMITS OF REACHES
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971
FILE NO. H-2-25712
LEGEND
Surge Reference Line (SRL)
Limits of Reaches
VICINITY MAP
SCALE OF MILES
SCALE OF MILES
LIMITS OF STUDY AREA
LAKE BORGNE
NEW ORLEANS
LAKE SALVADOR
BRETON SOUND
GULF OF MEXICO
BARATARIA BAY
TIMBALIER BAY
CHANDELEUR ISLANDS
MISSISSIPPI RIVER-GULF OUTLET
MISSISSIPPI RIVER
GULF INTRACOASTAL WATERWAY
BAYOU LAFOURCHE
ALGIERS CANAL
G.I.W.W.
SRL
Westwego
Violet
Verret
Shell Beach
Scarsdale
Ycloskey
Reggio
L. LERY
Delacroix
Bayou Terre aux Boeufs
Bayou La Loutre
Oakville
Bertrandville
Belair
La Reussite
Phoenix
Ironton
Pointe a la Hache
Bohemia
City Price
Port Sulphur
Tropical Bend
Empire
Buras
Ostrica
Fort St. Philip
Fort Jackson
Venice
Larose
Golden Meadow
Leeville
Manila
Grand Ecaille
Fort Livingston
GRAND TERRE ISLANDS
GRAND ISLE
CHENIERE CAMINADA
Head of Passes
Pass a Loutre
South Pass
Southwest Pass
Port Eads
Burrwood
LOUISIANA
MISSISSIPPI R.
Mobile
Biloxi
Gulfport
Bay St. Louis
Long Point
LAKE PONTCHARTRAIN
GIWW
E
A
B1
B2

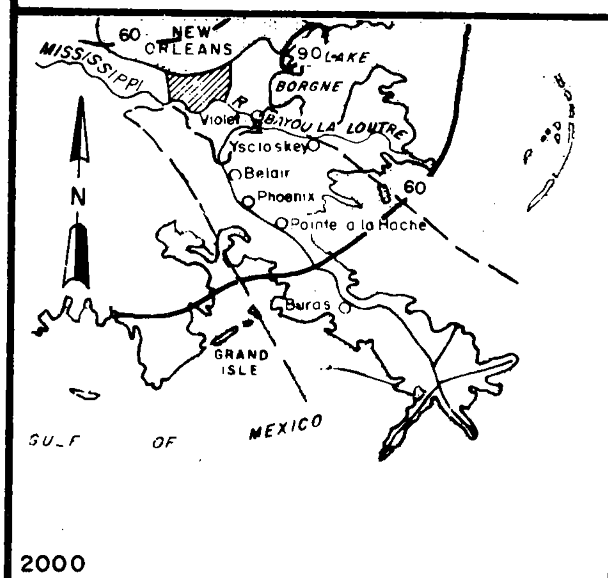
PLATE A-1











LEGEND

— — Project Area

30 Average Wind Velocity in M.P.H.

SCALE OF MILES
25 0 25 50

NEW ORLEANS TO VENICE, LA.

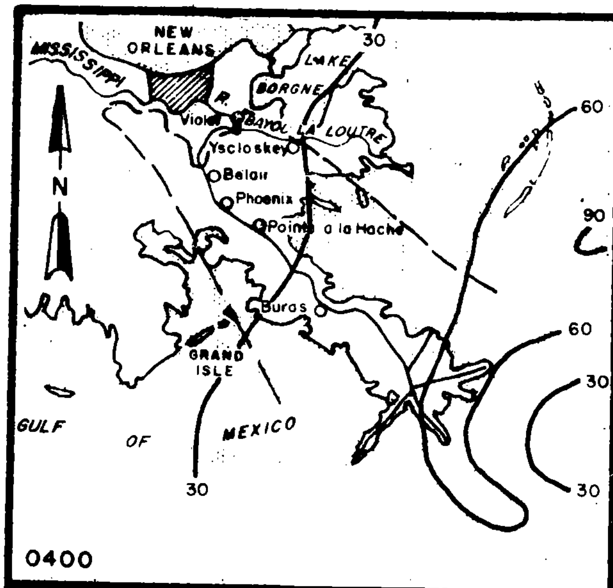
DESIGN MEMORANDUM NO. I – GENERAL DESIGN

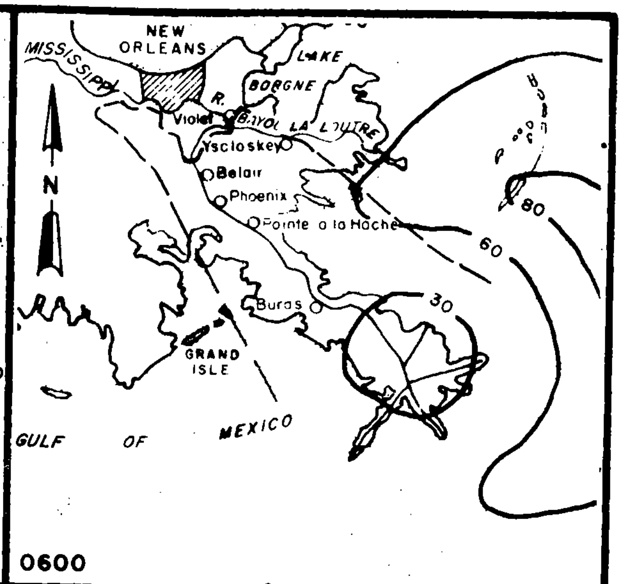
REACH B1–TROPICAL BEND TO FORT JACKSON

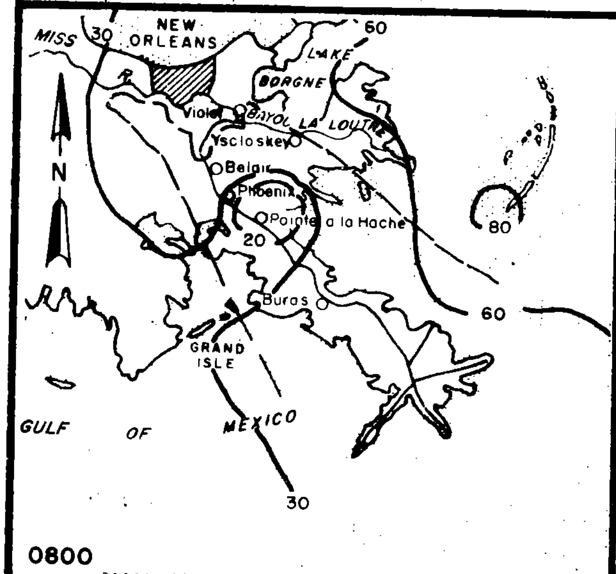
ISOVEL PATTERNS
HURRICANE OF 28 SEPT.–1 OCT. 1915

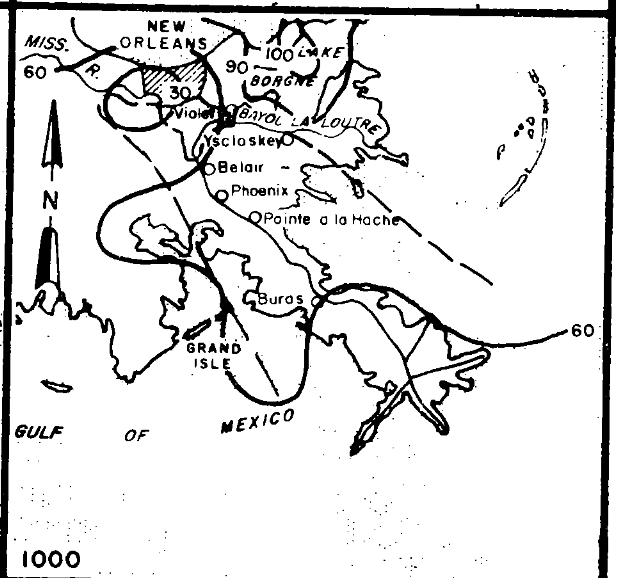
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

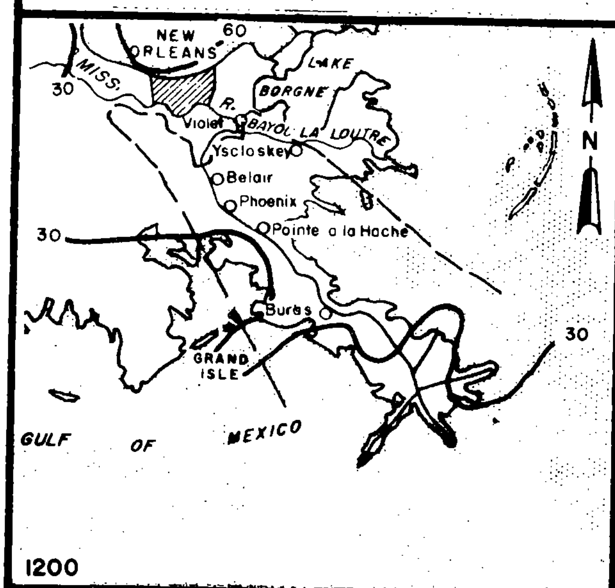
AUGUST 1971 FILE NO. H-2-25712











LEGEND

— — Project Area

30 Average Wind Velocity in M.P.H.

SCALE OF MILES

25 0 25 50

NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. I – GENERAL DESIGN

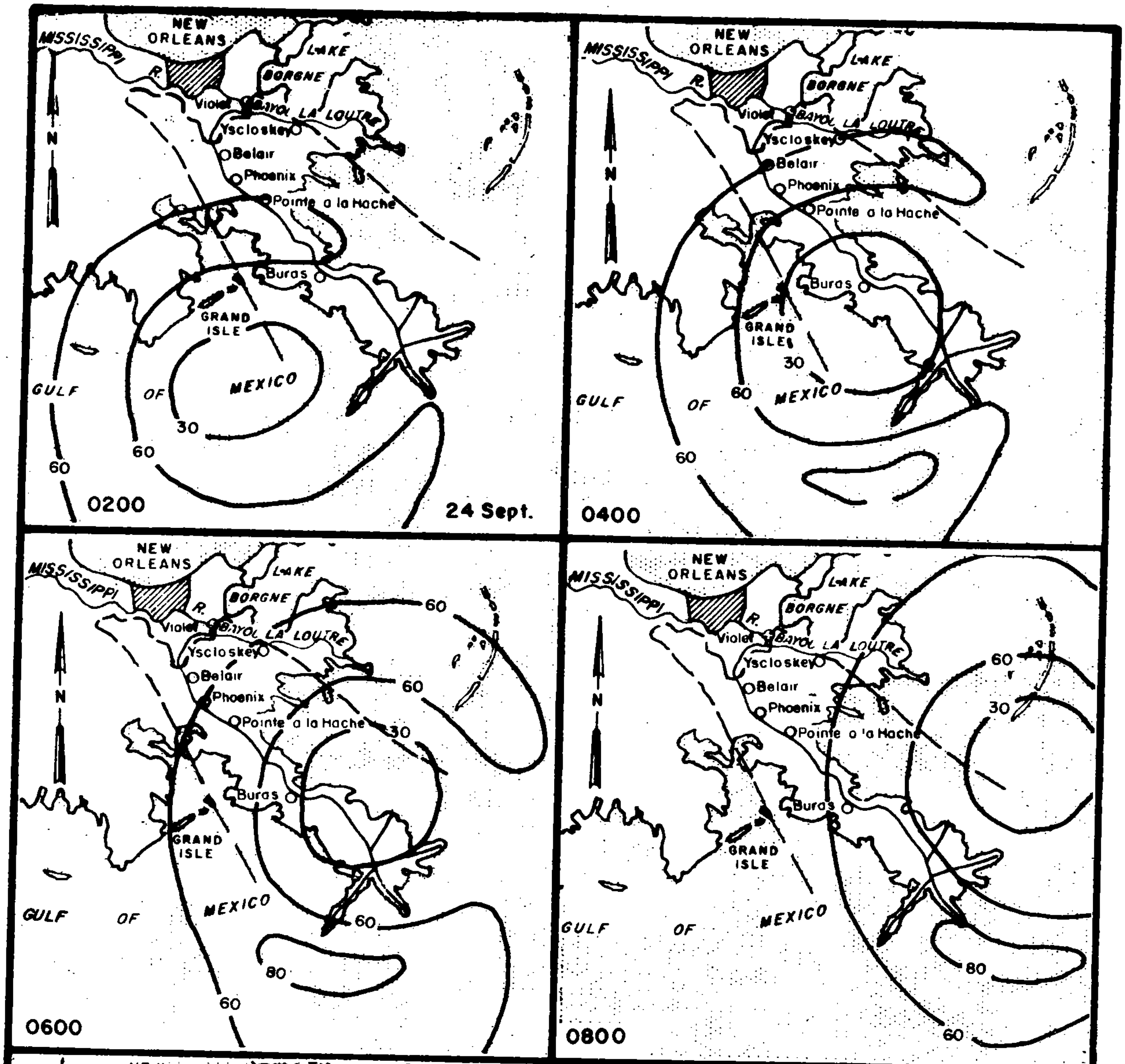
REACH B1-TROPICAL BEND TO FORT JACKSON

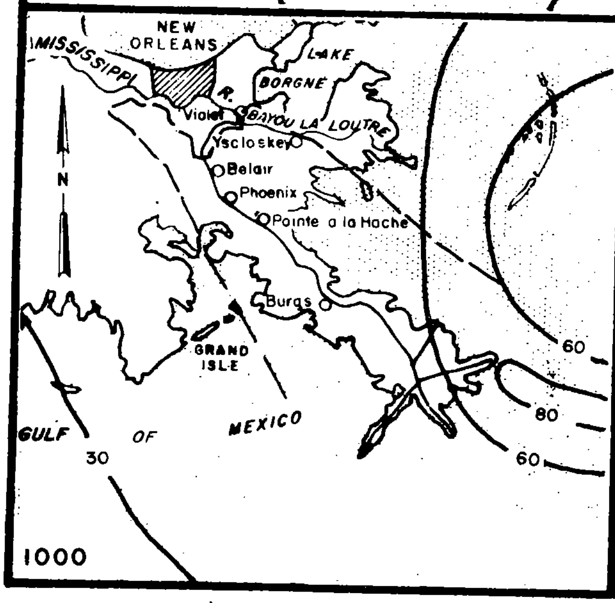
ISOVEL PATTERNS
HURRICANE OF 19 SEPT. 1947

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE A-3





LEGEND

Project Area

30 Average Wind Velocity in M.P.H.

SCALE OF MILES

25 0 25 50

NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. I – GENERAL DESIGN

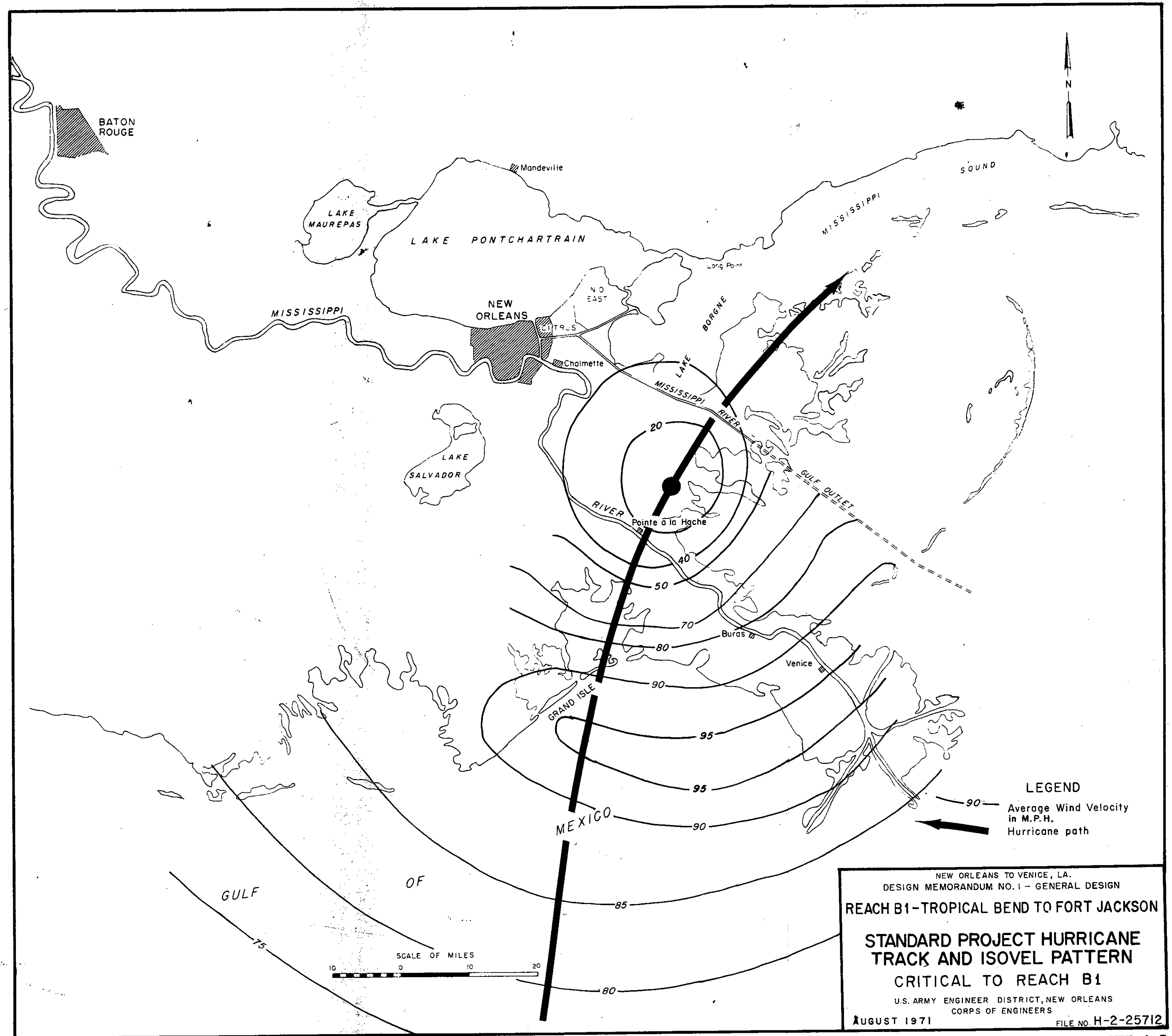
REACH B1–TROPICAL BEND TO FORT JACKSON

ISOVEL PATTERNS
HURRICANE OF 23–24 SEPT. 1956

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE A-4



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. I – GENERAL DESIGN

REACH B1-TROPICAL BEND TO FORT JACKSON

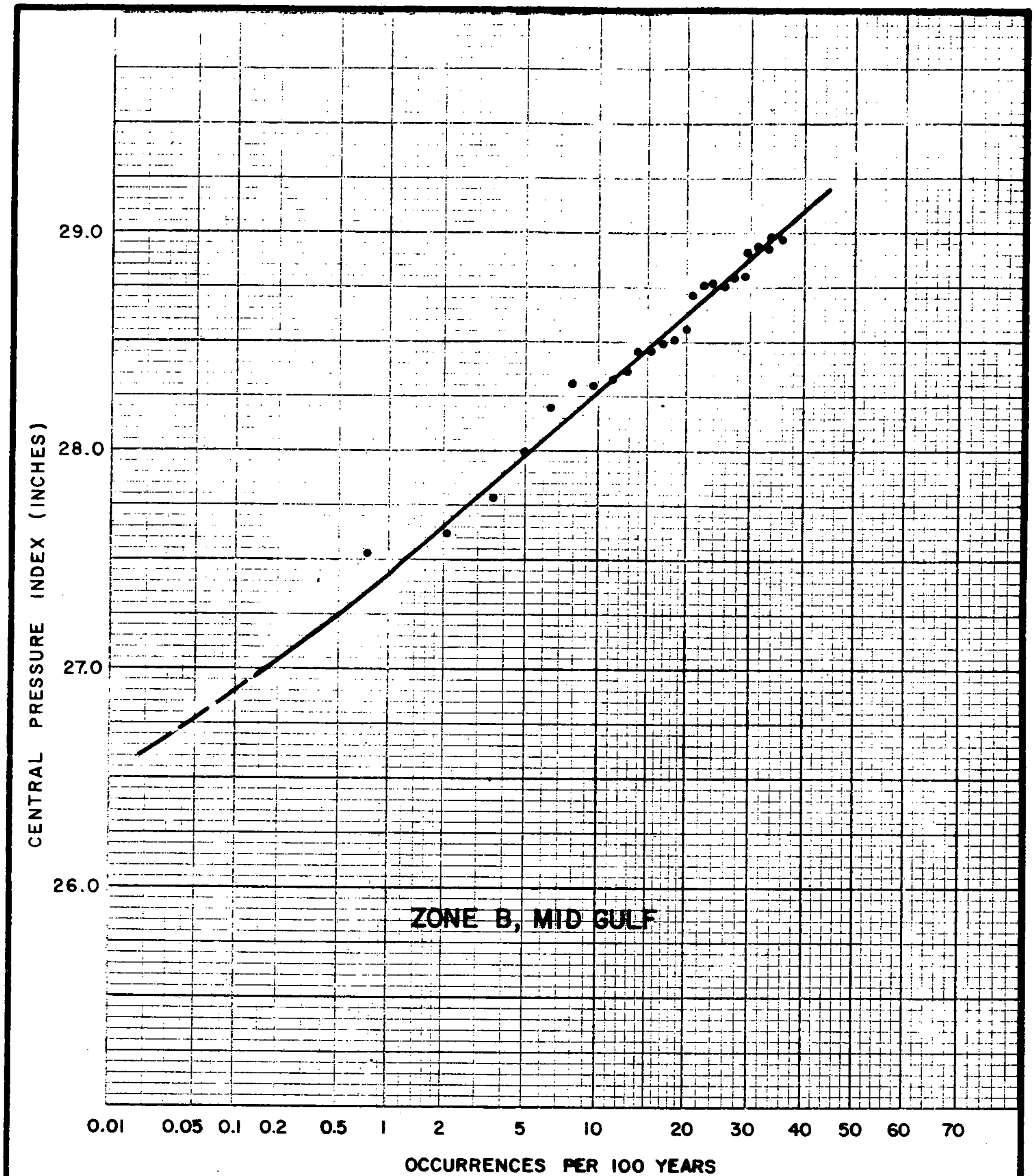
STANDARD PROJECT HURRICANE TRACK AND ISOVEL PATTERN

CRITICAL TO REACH B1

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE A-5

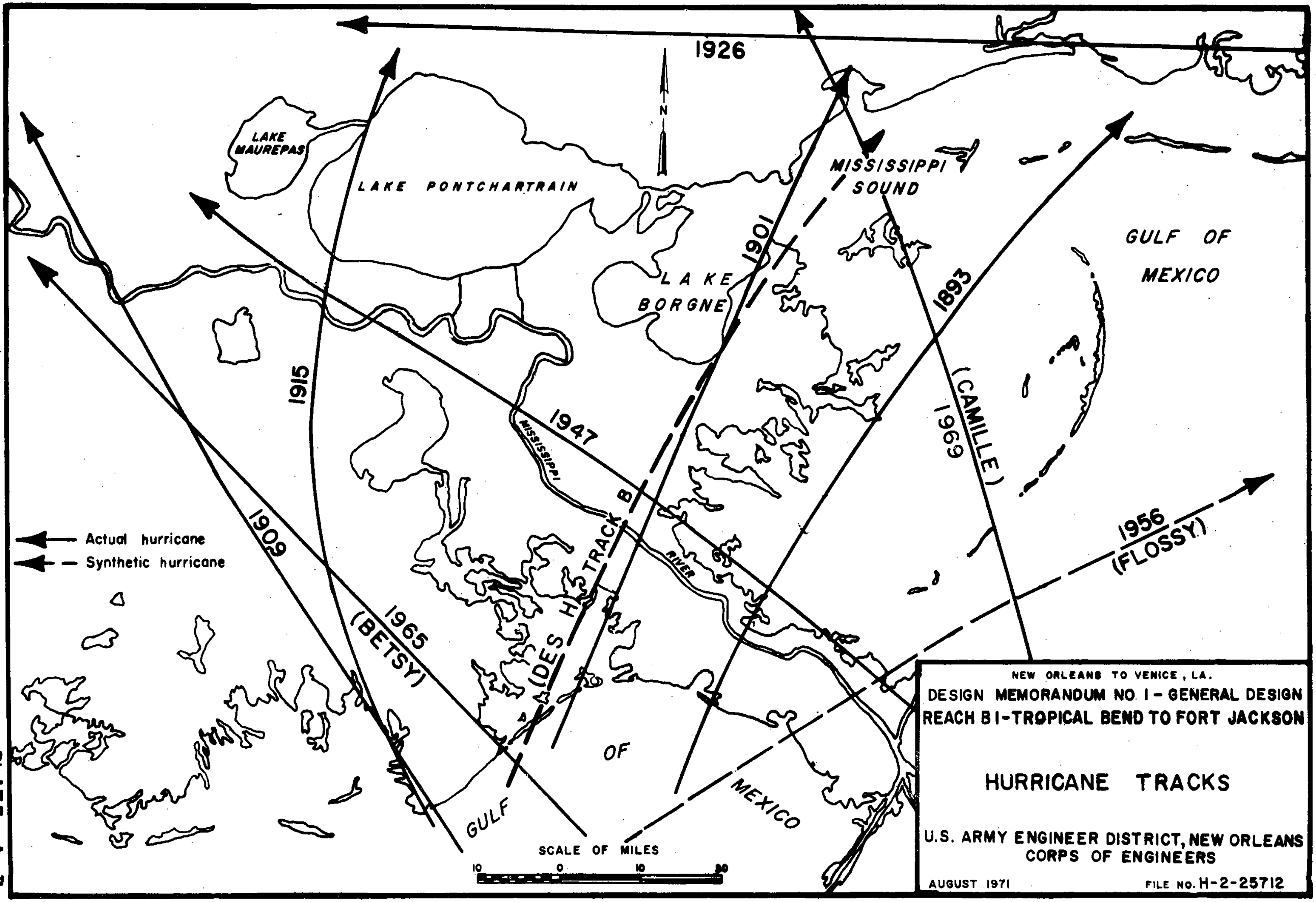


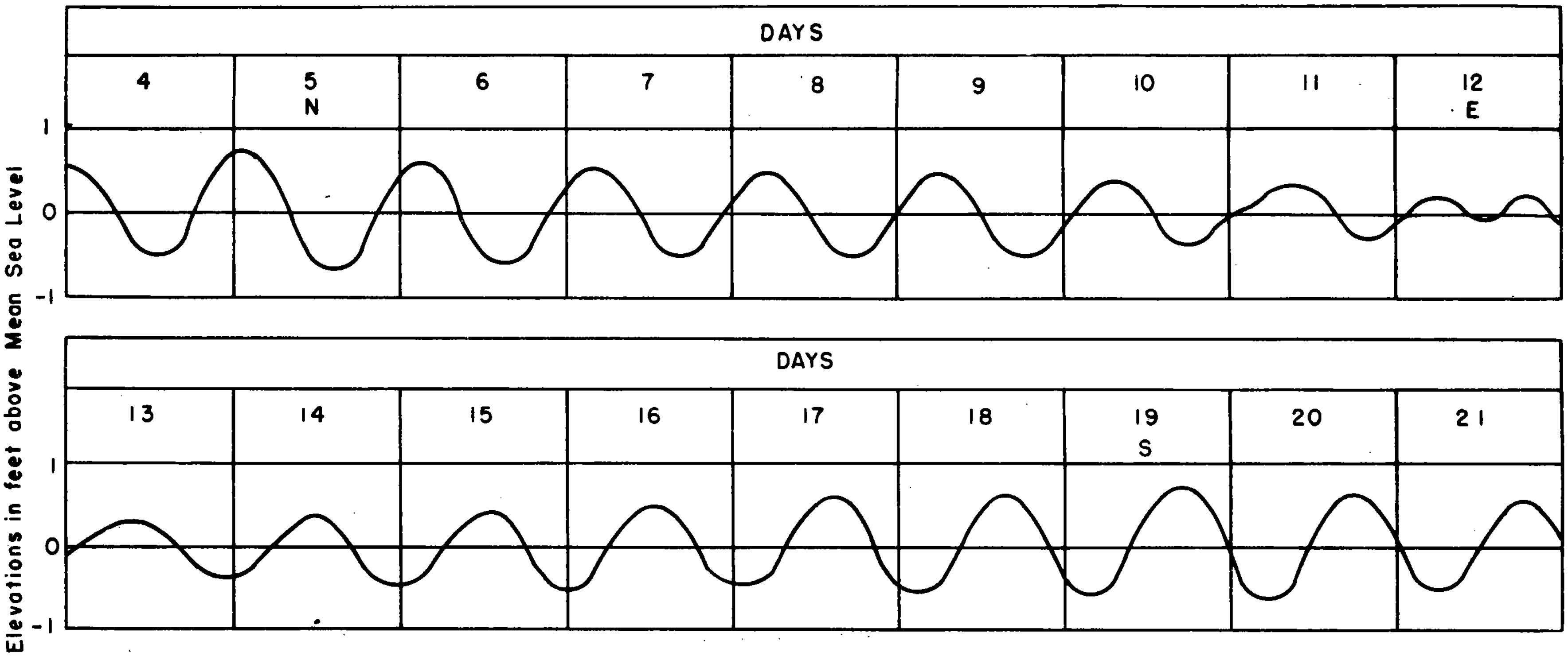
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. I - GENERAL DESIGN
REACH BI-TROPICAL BEND TO FORT JACKSON

FREQUENCY OF HURRICANE CENTRAL PRESSURES ZONE B, MID GULF

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712


1926
N
LAKE MAUREPAS
LAKE PONTCHARTRAIN
LAKE BORGNE
MISSISSIPPI SOUND
GULF OF MEXICO
1915
1947
1901
1893
1969 (CAMILLE)
1956 (FLOSSY)
1909
1965 (BETSY)
(DES H TRACK B
A
MISSISSIPPI
RIVER
GULF OF MEXICO
SCALE OF MILES
10 0 10 20
Actual hurricane
Synthetic hurricane
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. I - GENERAL DESIGN
REACH B I-TROPICAL BEND TO FORT JACKSON
HURRICANE TRACKS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971
FILE NO. H-2-25712



LEGEND

E, moon on the equator

N, S, moon farthest north or south of the equator

NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN

REACH B1 - TROPICAL BEND TO FORT JACKSON

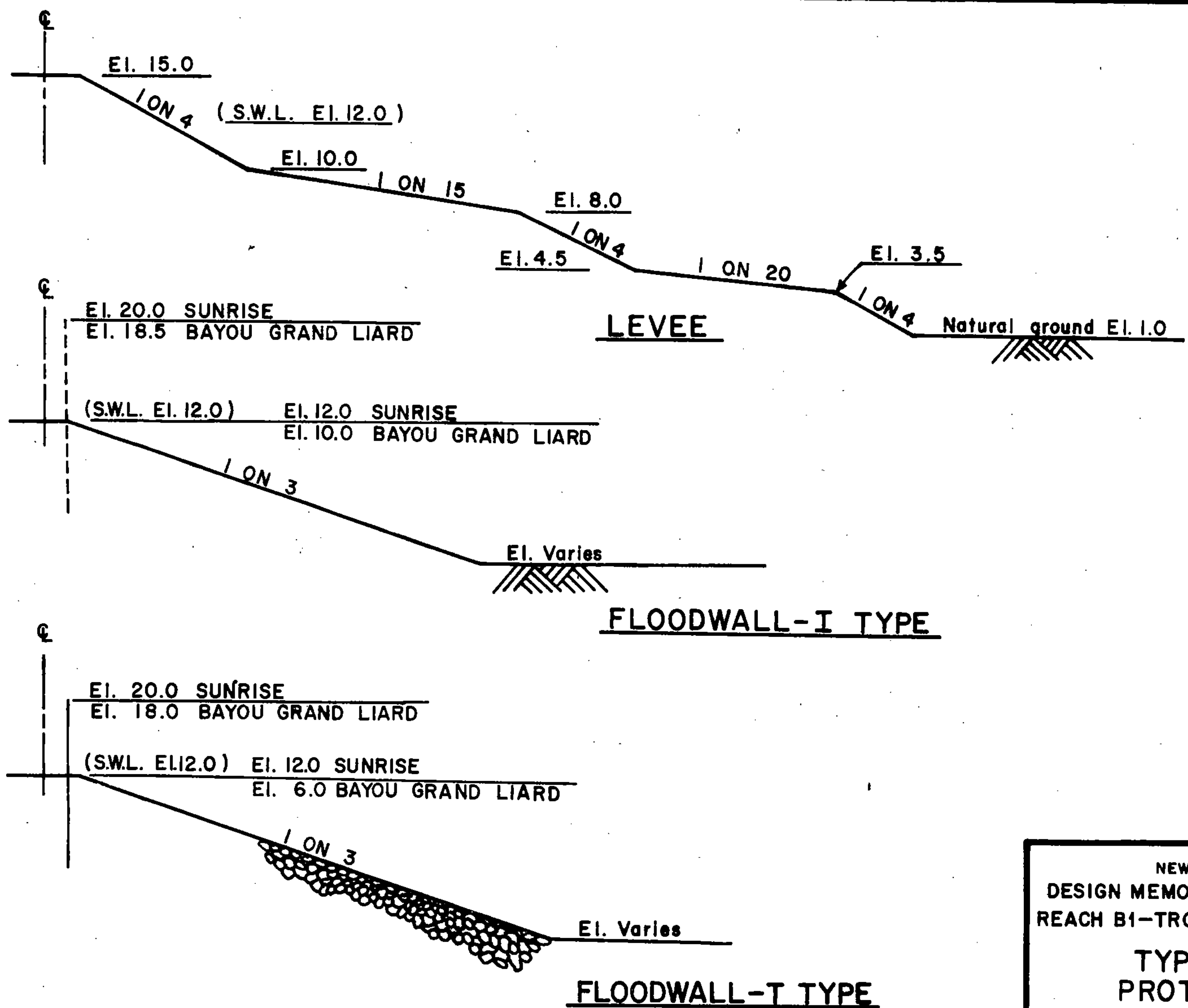
TYPICAL TIDAL CYCLES

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS

CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE A-8



NOTE:
Elevations are in feet and refer to Mean Sea Level

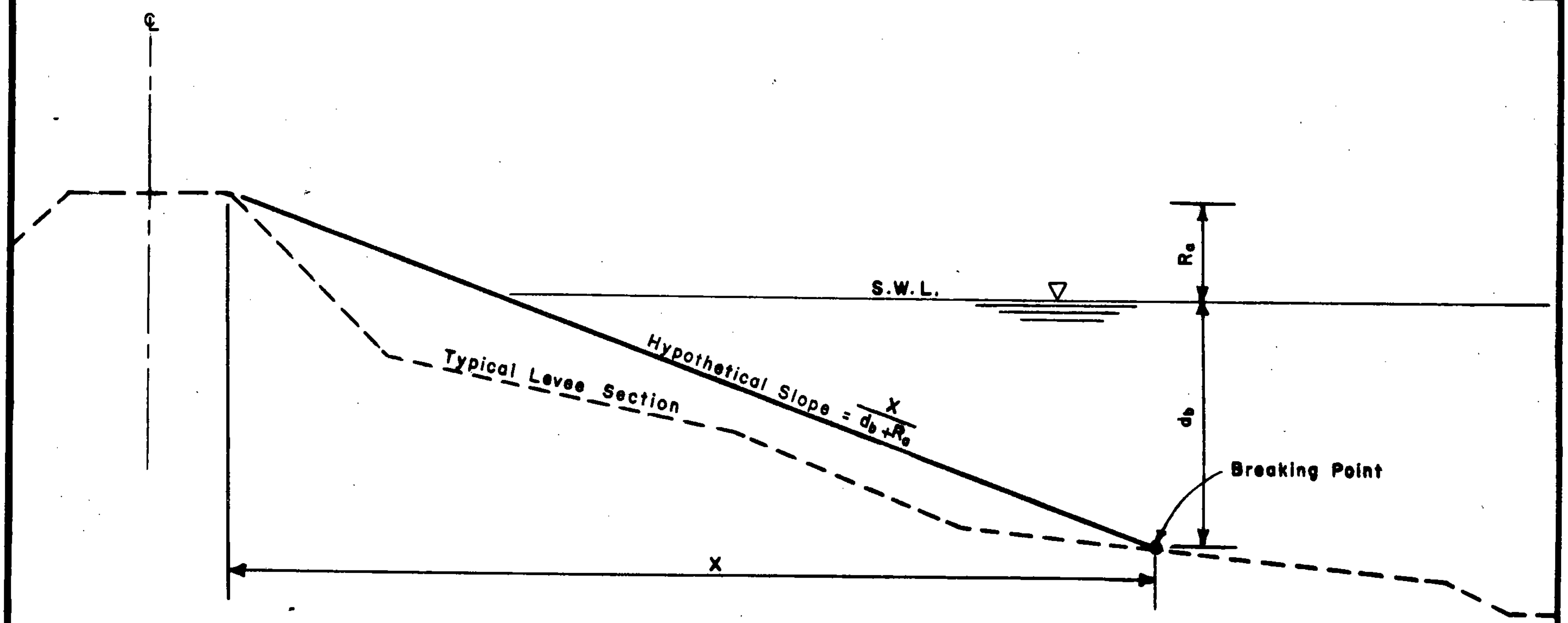
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

TYPICAL SECTIONS PROTECTIVE SYSTEM

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25572

PLATE A-9



LEGEND

R_a = assumed runup

d_b = breaking depth of wave

X = horizontal distance from breaking point to elevation of runup

SWL = still water level

NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN

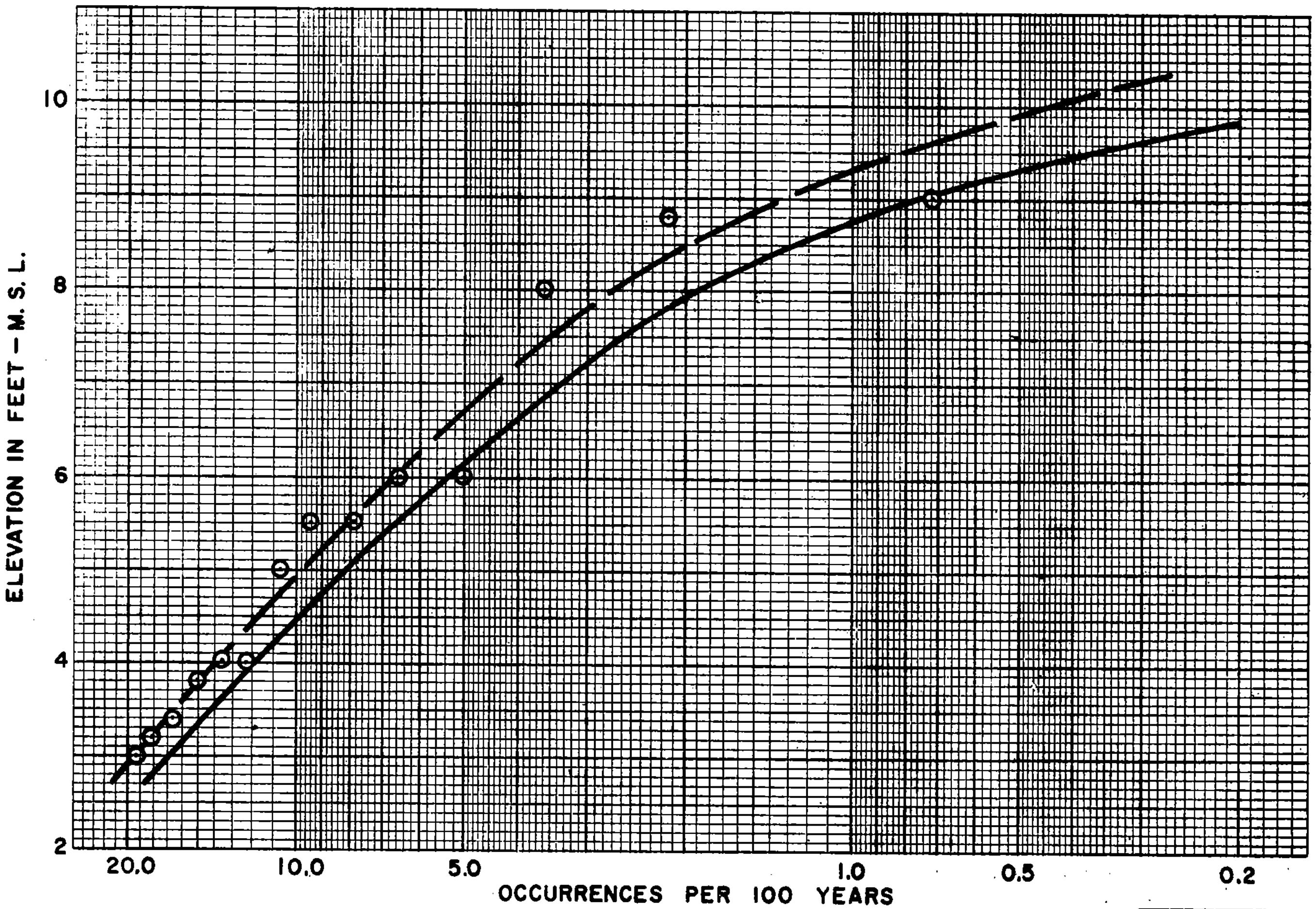
REACH B1-TROPICAL BEND TO FORT JACKSON

DETERMINATION OF HYPOTHETICAL SLOPE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE A-10



LEGEND

- —— Synthetic stage frequency
- — — Shifted to experienced frequency plot
- ⊙ Experienced stage frequency

$$P = \frac{100(M-0.5)}{Y}$$

P = Probability
M = Number of the event (Rank)
Y = Number of years of record (69)

M	YEAR	WTL (FEET)	P
1	* 1915	9.0	0.72
2	1965	8.8	2.17
3	1956	8.0	3.62
4	1919	6.0	5.08
5	** 1915	6.0	6.54
6	1964	5.5	7.94
7	1909	5.5	9.43
8	1901	5.0	10.9
9	1947	4.0	12.4
10	1926	4.0	13.7
11	1940	3.8	15.2
12	1941	3.4	16.7
13	1957	3.2	18.2
14	1969	3.0	19.6

* September 1915
** August 1915

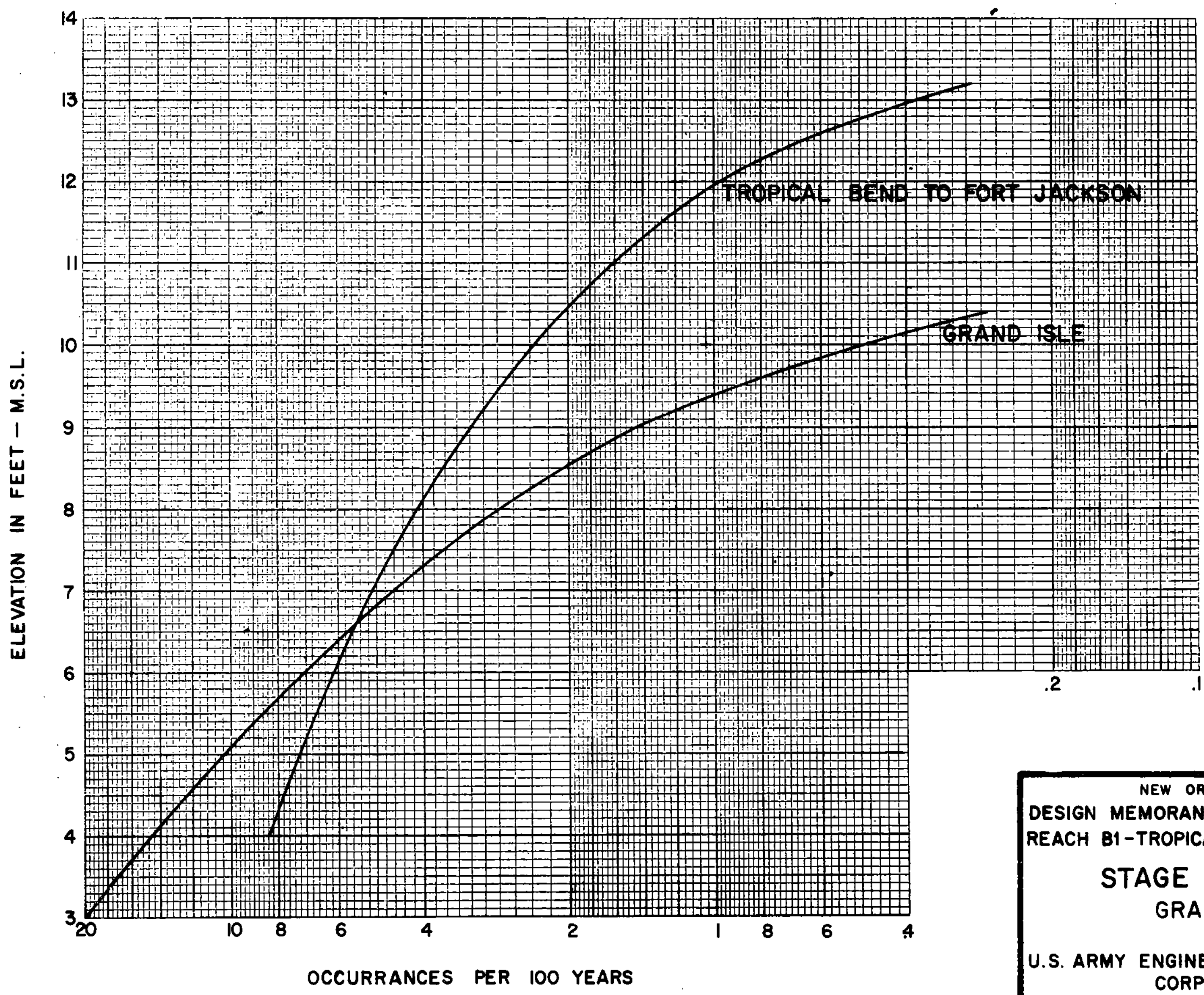
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 — GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

STAGE — FREQUENCY
GRAND ISLE, LA.

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE A-11



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 — GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

STAGE — FREQUENCY
GRAND ISLE, LA.

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE A-12

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX B
ECONOMIC ANALYSES

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX B
ECONOMIC ANALYSES

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

TABLES

PLATES

TABLE OF CONTENTS (cont'd)

PLATES (cont'd)

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX B
ECONOMIC ANALYSES

1. General. This appendix has been organized into five major sections, as follows:

a. Section I - Introduction: Outlines the reasons for making the extensive reanalyses at this time.

b. Section II - Land Use and Development: Contains the supporting rationales for generating data relating to future physical and economic configurations.

c. Section III - Flood Damage Relationships: Explains the derivation of the dollar damages for various depths of flooding.

d. Section IV - Benefits: Presents the procedures used for evaluating hurricane effects in economic and social terms.

e. Section V - Comparison with Prior Analyses: Sets forth the differences between the results and conclusions of these reanalyses and prior studies and explains the bases for these differences.

SECTION I - INTRODUCTION

2. General. The New Orleans to Venice hurricane protection project, as authorized by the Congress, comprises generally a system of improved back levees and new structures to protect developed areas on the east and west banks of the Mississippi River from flooding by hurricane-generated surges. It was designed to provide protection from a hurricane having a return frequency of once in 100 years on the average. Based on the information then available, it was considered that, with minor raising in isolated locations, the river levees would be high enough to exclude any river surges arising incident to passage of the design hurricane.

a. Subsequent to authorization of the project, major hurricanes passed through the area of 1965 (Betsy) and 1969 (Camille). Both produced massive overtopping of the Mississippi River levee system by surges driving from the east. These hurricanes yielded a better appreciation of the requirements for providing adequate protection from surges overtopping the river levees and pointed up the need for further studies to evaluate the economics of providing such protection.

b. In the area below Fort Jackson on the west bank, the devastation wreaked by Camille was nearly total. In other areas the damage was extremely severe. Questions were raised as to what the future use of this flood-prone area would and should be. The need for a full reanalysis of the project economics, both from the standpoint of the increased appreciation of the nature of the flood threat and of future development patterns, was clearly indicated.

c. This economic reanalysis has been made with the above in mind. Close coordination has been maintained with local interests in the matter of future land-use patterns, and local plans for development of the parish were made available for this reanalysis. Extensive field and office work was done in developing and refining stage-damage data. The two major hurricanes provided input data in quantity and quality far beyond the fragmentary information on which the analysis supporting project authorization had been based.

d. Economic analyses have been made for all reaches of the authorized project except Reach E which has been supplanted by a modification of the "Lake Pontchartrain, Louisiana and Vicinity" project. The analyses are based on two independent improvements: (1) enlargement of the back levees to provide protection from tidal surges overtopping the back levees, and (2) a barrier levee on the east bank of the river from Bohemia to mile 10 to provide protection from tidal surges overtopping the west bank river levees. In this study, the barrier levee plan (2) was considered incrementally to the authorized back levees (1).

SECTION II - LAND USE AND DEVELOPMENT

3. General.

a. Recent concern over the quality of the natural environment includes a heightened appreciation that land too is a limited resource and hence must be used wisely if it is to meet the needs of the present and the future. Unlike most other resources, however, including water, little attempt has been made to develop rational policy concerning its use. As a result, land-use decisions are frequently arbitrary in the sense that they are made in response to limited stimuli and without regard to their overall effects.

b. The economics of water resources development projects are very much influenced by assumptions as to future land use. In many cases, prognostications of future use, as required for economic analyses, have been developed by the Corps of Engineers with little or no local input. Unfortunately, most factors influencing land use are local in nature and the validity of such independent projections has suffered as a result.

c. The influence of land-use projections in the economic evaluation of the New Orleans to Venice project is substantial. A significant portion of the developments below Fort Jackson on the west bank was destroyed by Camille and development in this area will be open to many options as a result. The entire parish is in active growth which largely may be expected to continue even without the project. Hence, the dependability of any economic conclusions will depend heavily upon the extent to which land use has been accurately forecast.

d. Fortunately, the governing body of Plaquemines Parish, which is the local sponsor for the project, commissioned a land-use study for the parish following the passage of Camille, and the report on this study has been made available to the Corps of Engineers. Copies of this report are on file in the New Orleans District.

e. The projections needed for economic analyses and evaluations have been generally based on the data and conclusions in the above report and on reasonable inferences and extrapolations drawn from them. In some cases, departures have been made, particularly on the east bank, as regards population growth but, in general, projected data on which the economic evaluations are based are consistent with the findings and conclusions of the local land-use studies.

4. <u>Field investigations</u>. Detailed field investigations were made of the existing development in Reaches A, B1, and B2 some 10 months after the passage of Hurricane Camille. Development prior to the occurrence of that hurricane in all reaches was reconstructed from detailed field surveys made in September 1969. Reconnaissance scope field examinations were made after Hurricane Camille of the improvements existing in Reach C.

5. <u>Future land use</u>.

a. Land use under conditions of development existing as of July 1970 was analyzed and projections of land use were made for the period of the assigned project life, 1978-2078. These projections assumed that only the non-Federal back levees and the main line Mississippi River levees at authorized grades were in place. Land use was categorized into residential, commercial; public and semipublic; light and heavy industrial; and transportation, communication, and utilities. These "without project" projections were the bases for the computations of all flood damage prevention benefits.

b. In preparing projected growth rates for the project reaches, the independent land-use study previously referred to served as an essential base for estimating future development.

That study projected land use for the years 1970 through 1990, based on the assumption that a high degree of flood protection would be made available in the project areas during that period. Detailed analyses of the study indicated that the underlying assumptions were reasonable and its conclusions logical and generally supportable. The conclusions arrived at in this appendix, while consistent with those of the local study, nevertheless reflect the independent analysis and judgment of this office.

c. The economic analysis presented herein is based on two independent improvements, i.e., enlargement of the existing non-Federal back levees and, as an added increment, a barrier levee on the east bank to provide protection to the west bank reaches of the authorized project against tidal surges overtopping the main line west bank river levee. Enlargement of the back levees would not likely influence materially future land use and development in the west bank reaches, but would influence development on the east bank reach. Construction of the barrier levee would extend protection to the west bank reaches against tidal surges overtopping the west bank river levees and would engender some change of land use in these reaches. The land-use data contained in the local report are representative of conditions likely to obtain with both of the independent improvements in place.

d. Residential growth factors were derived directly from projected population growths which in turn were based on both historical trends and the availability of land for future growth in the several project reaches. In projecting commercial land use, it was considered that the number of support facilities and retail outlets would be directly related to the population which these facilities and outlets serve. Thus, equal growth rates were used for projecting corresponding residential and commercial land use.

e. Because of the extent of the damages sustained by residential construction in lower Plaquemines Parish as a result of Hurricanes Betsy (September 1965) and Camille (August 1969), the Plaquemines Parish Commission Council instituted revised building codes in 1970 that call for stronger construction in all of the project areas and include a requirement for raised floor levels for all new homes built in Reach B2 except when waived for medical reasons. The increased floor level requirement specifies that the lowest main floor level of all new residential construction must be elevated at least 10 feet above the final building site grade.

f. Officials of the Department of Safety and Permits for Plaquemines Parish estimate that, of the total amount of new residential construction anticipated in the project areas, about 95 percent would be raised in Reach B2, 20 percent in Reach B1, and 5 percent in Reach A. No significant raised residential construction is anticipated in Reach C. It is considered that these percentages will apply as long as a significant threat of hurricane flooding remains. Specifically, it is considered that they will obtain under existing conditions or with the authorized improvements in place, but would likely be reduced in the west bank reaches if and when protection from river surges is provided.

g. Mobile homes comprise a significant portion of the total residences on the west bank. The projected number of mobile homes in the west bank reaches was based on the proportion of the total residences in those areas that mobile homes constituted prior to Camille. In Reach C, mobile homes represent a very minor segment of the total number of dwellings and have been neglected in the analysis for that reach.

h. The future distribution of homes by type was computed by applying appropriate growth rates to the 1978 base year developments (see paragraph 5i(1)) in accordance with the percentages outlined in f above. Table B-2 outlines the projected number of homes in the various project reaches by year and type.

i. Future land use was determined by applying estimated growth rates to current land use. A summary of growth rates used in projecting land use is shown on table B-1. Explanations of the bases for selection of the various growth rates follow:

(1) Residential and commercial.

(a) Growth rates in these categories were based on projections for each reach. Population in Plaquemines Parish as a whole grew at a rate of 4 3/4 percent between 1950 and 1960. Preliminary 1970 census data indicated a drastic reduction in growth rate in the decade of the 1960's. However, the preliminary parish census reflects a temporary exodus of population from the parish as a result of the extensive devastation inflicted by Hurricane Camille which left many residents homeless.

(b) As a result of the influence of Hurricane Camille, the 1970 census totals provide neither an accurate reflection of recent population trends in the project nor an adequate base from which to project future population growth. Accordingly, it was necessary to develop an estimate of what the 1970 population would have been had Hurricane Camille not occurred. The problem was approached by synthesizing an estimate of population in the parish just prior to the passage of Hurricane Camille. Corps investigations centered upon residential electric and gas connections plus voter registration figures. Interviews and telephone conversations were made with representatives of the various utility companies in the parish and of the voter registrar office. The range of such estimates varied from 27,200 to slightly more than 33,000.

TABLE B-1

PROJECTED GROWTH RATES
BY LAND-USE CATEGORIES

Reach A	1978-1990 (Percent)	1990-2010 (Percent)	2010-2028 (Percent)	2028-2078 (Percent)
1. Residential	3	2	1 1/2	0
2. Commercial	3	2	1 1/2	0
3. Public & semipublic	2	1 1/2	1	0
4. Light & heavy industry	5 1/2	4 3/4	4 3/4	0
5. Trans., comm. & util.	2	1 1/2	1	0
6. Agriculture	0	0	0	0
Reach B1				
1. Residential	2 1/2	1 3/4	1 3/8	0
2. Commercial	2 1/2	1 3/4	1 3/8	0
3. Public & semipublic	4	3 3/8	3 1/8	0
4. Light & heavy industry	4	3 3/8	3 1/8	0
5. Trans., comm. & util.	2	1 1/2	1	0
6. Agriculture	0	0	0	0
Reach B2[1]				
1. Residential	2	1 1/2	1 1/4	0
2. Commercial	2	1 1/2	1 1/4	0
3. Public & semipublic	1 1/2	1	7/8	0
4. Light & heavy industry	2	1 3/4	1 3/4	0
5. Trans., comm. & util.	2	1 1/2	1	0
6. Agriculture	0	0	0	Negative
Reach C				
1. Residential	1 1/4	1	1	0
2. Commercial	1 1/4	1	1	0
3. Public & semipublic	2	1 3/4	1 3/4	0
4. Light & heavy industry	1 1/2	1	7/8	0
5. Trans., comm. & util.	2	1 1/2	1	0
6. Agriculture	0	0	0	0

[1]Maximum development reached in 2020.

TABLE B-2

RESIDENTIAL DETAILS AND PROJECTIONS

Year	Reach	Non-Raised	Raised	Mobile
1978	A	14	1,238	262
1990		41	1,744	374
2010		94	2,569	556
2028		124	3,344	727
1978	B1	98	1,448	658
1990		205	1,874	885
2010		378	2,564	1,252
2028		542+90	3,217+76	1,600+94
			Additions are overflow from Reach B2	
1978	B2	129	562	375
1990		138	738	476
2010		153	1,027	641
2020		161	1,175	725
			Total for Reach C	
1978	C		450	
1990			525	
2010			638	
2028			775	

(c) It was therefore considered that the population which would exist in the parish as of the base year of the project (1978) would, at the very minimum, reach the upper limit of this range, particularly in view of the post-Betsy experience when population growth resumed promptly after the hurricane.

(d) It is likely that by the base year 1978 the post-Camille resettlement will be essentially complete and that the growth rates in the following years will show a consistent pattern, decreasing from an average rate of approximately 3 percent during the period 1978-1990 to about 1 percent after the year 2010. The decreasing rate will occur because of an expanding base for growth and a shrinking amount of usable land available. The 1 percent growth rate used in the later years is in general agreement with the OBE projections for WRPA 10, of which Plaquemines Parish is a part.

(e) Historical population for the parish together with projected growths and the disaggregation of same into project reaches is shown in table B-3.

(2) Light and heavy industry.

(a) Land use in this category was projected after analyzing the expected growth of two indicators for Water Resources Planning Area 0809 (in which the project is located); namely, Value Added by Manufacturing for Major Water User Industries and Value Added by Manufacturing by Petroleum Refining Industry. The growth rates for these indicators, as extracted from the Conditional Economic Forecast for the Lower Mississippi Region Comprehensive Study, December 1970[1] are:

	All manufacturing growth rate	Petroleum refining growth rate
1970-1980	4 3/8 percent	4 3/16 percent
1980-2000	4 1/8 percent	3 7/8 percent
2000-2020	4 percent	3 11/16 percent

(b) The knowledge of recent hurricanes and their effects in Reaches B1 and B2 will very likely act as a constraint

[1]This forecast was prepared by the Economics Subcommittee, a work group under the Lower Mississippi Region Coordinating Committee. This committee is managing the Type I Framework Study of the Lower Mississippi Region.

TABLE B-3

POPULATION STATISTICS
PLAQUEMINES PARISH

Year	Parish Population	Growth Rate
1950	14,239 (Actual)	
		4 3/8% (Actual)
1960	22,545 (Actual)	
		2 1/8%
1978	33,000	
		3%
1990	47,100	
		2%
2010	70,000	
		1%
2030	85,400	

PROJECT REACHES
(Growth rates are shown in table B-1 under residential category)

Year	Reach A	Reach B1	Reach B2	Reach C	Total Project Reaches (Rounded)
1978	6,207	9,036	4,370	1,845	21,500
1990	8,851	12,152	5,543	2,152	28,700
2010	13,197	17,195	7,466	2,615	40,500
2028	17,199	23,037	8,450	3,177	51,900

on development in these reaches. Furthermore, these reaches are now heavily developed industrially, and hence industrial development will likely be slower in these reaches than in Reach A as a more balanced development is achieved in each. On the other hand it is expected that this same tendency toward balanced growth will result in growth rates in Reach A exceeding those of the selected indicators. Accordingly, growth rates approximately 25 percent greater than those for the indicators were used in Reach A, rates slightly less than those of the indicators were used in Reach B1, and rates about one-half of those of the indicators were used in Reach B2.

(c) Reach C has historically developed at much lower rates than the reaches on the west bank. No factors are extant or reasonably prospective which would indicate any substantial departure from this situation. Accordingly, light and heavy industrial growth in Reach C was projected to grow at a somewhat lower rate than the minimum rate assigned on the west bank.

(3) Transportation, communications, and utilities. The geographic configuration of Plaquemines Parish in the project area necessarily will restrict future development for these purposes to areas immediately contiguous to existing land use. Highway 23 on the west bank is currently being widened to four lanes. As development of highway-oriented business (motels, shopping centers, restaurants, etc.) takes place along this improved highway, there will be a need for additional land use for communications and utilities. The growth rates selected were based primarily on this requirement, and to a lesser degree on judicious application and extrapolation of the employment growths between the years 1960 and 1967 for Louisiana in the categories of Transportation (excluding railroad) 2 3/8 percent, and Communication, Electric, Gas, Sanitary Service Employees, 1 11/32 percent. As can be seen in table B-1, the growth rate selected for this category between the years 1978 and 1990 was between these two indicators and closer to the lower rate in view of the land availability in the project areas for future growth.

(4) Public and semipublic. Normally it would be expected that public and semipublic land use will exhibit growth rates similar to those for population. In Reaches A and B1, however, existing facilities are large in terms of existing population and hence will accommodate increased growth without major additions thereto. On the other hand existing facilities in Reaches B1 and C are generally more modest, and the rates of public and semipublic land-use growth in these reaches can be expected to exceed those of residential and population growth.

SECTION III - FLOOD-DAMAGE RELATIONSHIPS

6. General. The passage of two major hurricanes within the past 5 years has provided a wealth of data for assessing flood-damage relationships. In addition, the District has been involved in the preparation of 10 flood insurance studies for the Federal Insurance Agency. In the course of these studies, a substantial body of knowledge has been developed concerning the effects of hurricane flooding on structures of various types. The data developed in these studies have been used extensively in the analyses presented herein.

7. Field surveys. Extensive field surveys were undertaken following Hurricanes Betsy and Camille and flood-damage reports detailing the results of these surveys were available for the current analysis. In addition, an in-depth survey of existing development was made during 1970. All commercial and residential improvements were inventoried in this survey, which included hundreds of interviews with local government officials, homeowners, and representatives of commercial and industrial establishments, concerning the nature and extent of damages from Hurricane Camille.

8. Stage-damage curves. The economic analysis presented herein is based on two independent improvements, i.e., enlargement of the existing non-Federal back levees and, as an added increment, a barrier levee on the east bank to provide protection to the west bank reaches of the authorized project against tidal surges overtopping the main line west bank river levee. The enlargement of the back levees would not likely influence materially future land use and development in the west bank reaches, but would influence development on the east bank reach. The provision of protection to the west bank reaches against tidal surges overtopping the west bank river levees would engender some change of land use in these reaches. The land-use data contained in the local report are representative of conditions likely to obtain with both of the independent improvements in place. The installation of the authorized improvements is not expected to materially influence future development in the west bank reaches. The land-use data contained in the local report are considered representative of conditions likely to obtain with the authorized improvements and the protection from river surges both in place on the west bank, and the authorized improvements in place on the east bank. Drawing on the data described in preceding paragraphs, stage-damage curves reflecting conditions of development as the base year of 1978 were developed for hydrologically independent areas within each reach. Stage-damage data were developed for each type of land use, and these then combined to yield a single stage-damage relationship for each area. The growth rates developed in Section II of this report were then applied to the corresponding stage-damage data for each land use and the combining process repeated to develop corresponding stage-damage curves for various years throughout the assigned project life of 100 years. Stage-damage curves for the project reaches are shown on plates B-1 through B-7.

9. Stage-frequency data. Stage-frequency curves were developed by a procedure outlined in appendix A of this design memorandum for each of the hydrologically-independent areas. Stage-frequency curves were developed for "without project" conditions, i.e., existing back levees and Mississippi River levees to authorized grade in place, and the above plus authorized improvements. Stage-frequency curves are shown on plates B-8 through B-13. Hydraulic analyses made for this design memorandum demonstrated that with the back levees and the East Bank Barrier levee in place, only minor flooding would occur from hurricanes having intensities slightly more severe than the design hurricane, and that significant flooding to depths of 1± foot would not occur even for hurricanes equal to or slightly in excess of the Standard Project Hurricane. Estimates of residual damages were found to be negligible and therefore neglected in this economic analysis.

10. Damage-frequency data. Damage-probability curves were developed by integration of the respective stage-damage and stage-frequency curves. Stage-probability curves based on without-project conditions and with the authorized back levees in place are shown on plates B-14 through B-26.

SECTION IV - BENEFITS

11. Flood damages.

a. General. Average annual flood damages for with- and without-project conditions were computed for each reach using the damage-probability curves described in the preceding section. The detailed computations for Reach Bl are included in this appendix. Computations for the other reaches were performed in a similar manner.

b. Without authorized project--Reach Bl. The average annual damage computations for Reach Bl, for without-project conditions, follow:

Reach B1 (miles 30.5 - 29.0)
Average annual damages without project

Year	Average annual damage
1978	$ 90,500
1990	117,900
2010	170,200
2028-78	220,000

Constant		$ 90,500
1978-90	($117,900 - $90,500) / 12 yrs. x 61.80567 x .03054 =	4,310
1990-2078	($117,900 - $90,500) x .31.91120 x .71168 x .03054 =	19,004
1990-2010	($170,200 - $117,900) / 20 yrs. x 143.92510 x .71168 x .03054 =	8,180
2010-2078	($170,200 - $117,900) x 29.72096 x .40372 x .03054 =	19,165
2010-2028	($220,000 - $170,200) / 18 yrs. x 121.49106 x .40372 x .03054=	4,144
2028-2078	($220,000 - $170,200) x 26.35179 x .24239 x .03054 =	9,715
		$155,018
	(Rounded)	$155,000
	Less annual damage on present development (rounded)	-90,000
	Annual damage on future development	$ 65,000

Reach B1 (miles 29.0 - 25.0)
Average annual damages without project

Year	Average annual damage
1978	$2,328,000
1990	3,166,000
2010	4,576,000
2028-78	6,242,000

Constant		$2,328,000
1978-90	$\frac{(\$3,166,000-\$2,328,000)}{12 \text{ yrs.}} \times 61.80567 \times .03054 =$	131,817
1990-2078	$(\$3,166,000-\$2,328,000) \times 31.91120 \times .71168 \times .03054 =$	581,220
1990-2010	$\frac{(\$4,576,000-\$3,166,000)}{20 \text{ yrs.}} \times 143.92510 \times .71168 \times .03054 =$	220,538
2010-2078	$(\$4,576,000-\$3,166,000) \times 29.72096 \times .40372 \times .03054 =$	516,695
2010-2028	$\frac{(\$6,242,000-\$4,576,000)}{18 \text{ yrs.}} \times 121.49106 \times .40372 \times .03054 =$	138,642
2028-2078	$(\$6,242,000-\$4,576,000) \times 26.35179 \times .24239 \times .03054 =$	324,989
		$4,241,901
	(Rounded)	$4,242,000
	Less annual damage on present development	-2,328,000
	Annual damage on future development	$1,914,000

Reach B1 (miles 25.0-21.0)
Average annual damages without project

Year	Average annual damage
1978	$1,397,000
1990	1,832,000
2010	2,585,000
2028-78	3,270,000

Constant		$1,397,000
1978-90	$\frac{(\$1,832,000-\$1,397,000)}{12\text{ yrs.}}$ x 61.80567 x .03054 =	68,424
1990-2078	($1,832,000-$1,397,000) x 31.91120 x .71168 x .03054=	301,708
1990-2010	$\frac{(\$2,585,000-\$1,832,000)}{20\text{ yrs.}}$ x 143.92510 x .71168 x .03054=	117,776
2010-2078	($2,585,000-$1,832,000) x 29.72096 x .40372 x .03054=	275,935
2010-2028	$\frac{(\$3,270,000-\$2,585,000)}{18\text{ yrs.}}$ x 121.49106 x .40372 x .03054=	57,005
2028-2078	($3,270,000-$2,585,000) x 26.35179 x .24239 x .03054=	133,624
		$2,351,472
	(Rounded)	$2,351,000
	Less annual damage on present development	-1,397,000
	Annual damage on future development	$ 954,000

Reach B1
Summation of annual damages without project

Miles	Existing development	Future development	Total damages
30.5-29.0	$ 90,000	$ 65,000	$ 155,000
29.0-25.0	2,328,000	1,914,000	4,242,000
25.0-21.0	1,397,000	954,000	2,351,000
	$3,815,000	$2,933,000	$6,748,000

c. <u>Without authorized project--all reaches</u>. The following table contains a summary of the damage computations for without-project conditions for each of the reaches.

TABLE B-4

AVERAGE ANNUAL FLOOD DAMAGES WITHOUT PROJECT

Reach	Existing development	Future development	Total damage	Percent on future development
A	$1,474,000	$1,504,000	$2,978,000	50.5
B1	3,815,000	2,933,000	6,748,000	43.5
B2	1,479,000	617,000	2,096,000	29.4
C	440,000	174,000	614,000	28.3

The lower percentage of flood damage on future development in Reach B2 primarily reflects the building code requirements for home construction in this reach while that in Reach C reflects the lower growth rates anticipated in that area.

d. <u>With authorized back levee in place--Reach B1</u>. The computations for the determination of average annual damages for Reach B1 for the condition of authorized back levees in place follow:

Reach B1 (miles 30.5-29.0)
Average annual damages with authorized back levee in place

Year	Average annual damage
1978	$ 51,100
1990	68,200
2010	96,050
2028-78	122,950

Constant		$51,100
1978-90	($68,200-$51,100) / 12 yrs. x 61.80567 x .03054 =	2,690
1990-2078	($68,200-$51,100) x 31.91120 x .71168 x .03054=	11,860
1990-2010	($96,050-$68,200) / 20 yrs. x 143.92510 x .71168 x .03054=	4,356
2010-2078	($96,050-$68,200) x 29.72096 x .40372 x .03054=	10,206
2010-2028	($122,950-$96,050) / 18 yrs. x 121.49106 x .40372 x .03054=	2,239
2028-2078	($122,950-$96,050) x 26.35179 x .24239 x .03054=	5,247
		$87,698
	(Rounded)	$88,000
	Less annual damage on present development(rounded)	-51,000
	Annual damage on future development	$37,000

Para 11d

Reach B1 (miles 29.0-25.0)
Average annual damages with authorized back levee in place

Year	Average annual damage
1978	$ 973,000
1990	1,335,000
2010	1,898,000
2028-2078	2,565,000

Constant		$ 973,000
1978-90	$\frac{(\$1{,}335{,}000-\$973{,}000)}{12 \text{ yrs.}}$ x 61.80567 x .03054=	56,941
1990-2078	($1,335,000-$973,000) x 31.91120 x .71168 x .03054=	251,076
1990-2010	$\frac{(\$1{,}898{,}000-\$1{,}335{,}000)}{20 \text{ yrs.}}$ x 143.92510 x .71168 x .03054=	88,058
2010-2078	($1,898,000-$1,335,000) x 29.72096 x .40372 x .03054=	206,310
2010-2028	$\frac{(\$2{,}565{,}000-\$1{,}898{,}000)}{18 \text{ yrs.}}$ x 121.49106 x .40372 x .03054=	55,507
2028-2078	($2,565,000-$1,898,000) x 26.35179 x .24239 x .03054=	130,113
		$1,761,005
	(Rounded)	$1,761,000
	Less annual damages on present development	-973,000
	Annual damage on future development	$ 788,000

Reach B1 (miles 25.0-21.0)
Average annual damages with authorized back levee in place

Year	Average annual damage
1978	$ 608,500
1990	797,500
2010	1,100,500
2028	1,381,500

Constant		$ 608,500
1978-90	($797,500-$608,500) / 12 yrs. x 61.80567 x .03054 =	29,729
1990-2078	($797,500-$608,500) x 31.91120 x .71168 x .03054 =	131,087
1990-2010	($1,100,500-$797,500) / 20 yrs. x 143.92510 x .71168 x .03054=	47,392
2010-2078	($1,100,500-$797,500) x 29.72096 x .40372 x .03054=	111,034
2010-2028	($1,381,500-$1,100,500) / 18 yrs. x 121.49106 x .40372 x .03054=	23,384
2028-2078	($1,381,500-$1,100,500) x 26.35179 x .24239 x .03054=	54,815
		$1,005,941
	(Rounded)	$1,006,000
	Less annual damage on present development(rounded)	-609,000
	Annual damage on future development	$ 397,000

Reach B1
Summation of annual damages with authorized back levee in place

Miles	Existing development	Future development	Total damages
30.5-29.0	$ 51,000	$ 37,000	$ 88,000
29.0-25.0	973,000	788,000	1,761,000
25.0-21.0	609,000	397,000	1,006,000
	$1,633,000	$1,222,000	$2,855,000

Para lle

e. <u>With authorized back levees in place--all reaches.</u> The average annual damages in each reach, with only the authorized back levees in place, are summarized in table B-5.

TABLE B-5

AVERAGE ANNUAL FLOOD DAMAGES
WITH AUTHORIZED BACK LEVEES IN PLACE

Reach	Existing development	Future development	Total	Percent on future development
A	$ 860,000	$ 849,000	$1,709,000	49.7
B1	1,633,000	1,222,000	2,855,000	42.8
B2	816,000	355,000	1,171,000	30.3
C	0	0	0	N/A

12. <u>Flood damages prevented.</u>

a. <u>With authorized back levees in place</u>. The average annual flood damages prevented by the authorized back levees in place are tabulated in table B-6.

TABLE B-6

AVERAGE ANNUAL FLOOD DAMAGES
PREVENTED BY AUTHORIZED BACK LEVEES

Reach	Existing development	Future development	Total	Percent on future development
A	$ 614,000	$ 655,000	$1,269,000	51.6
B1	2,182,000	1,711,000	3,893,000	44.0
B2	663,000	262,000	925,000	28.3
C	440,000	174,000	614,000	28.3

b. <u>With authorized back levees and East Bank Barrier levee in place</u>. As stated in paragraph 9 of this appendix, with the back levees and the East Bank Barrier levee in place, annual residual flood damages were found to be negligible. Accordingly, the flood damages prevented by the East Bank Barrier plan as an added increment to the plan are equal to the residual damages in Reaches A, B1, and B2 with only the authorized back levee in place as shown above in table B-5.

13. Enhancements.

a. As is indicated in Section II, substantial additional growth in the project reaches is anticipated for without-project conditions. Detailed discussion of future growth patterns are contained in that section of the report. This continued growth is based on the area's favorable geographical location with respect to Louisiana's enormous mineral reserves and the many advantages provided by the Mississippi River.

b. The project area is unique in that none of it is suitable for developed use without provision of protection from both fluvial and tidal flooding. Thus, detailed analysis of alternative sites is not required to establish the validity of treating as project benefits those increases in land value which are likely to eventuate purely as a result of project construction. Rather, the validity of so treating such increases rests only on a supported determination that the area to be protected is, in fact, required for developed use. The data presented in Section II of this report indicate that the protected areas of the project which are rather intensively developed at this time, and which will not be enlarged as a result of project construction, will become highly developed during the anticipated project life.

c. Where project improvements will reduce the threat of hurricane overflow to minor significance, residential and commercial construction with the project in place will be of higher types than the construction likely without the project. Development of marsh areas as well as the higher alluvial ridges will occur more rapidly. Conversely, where proposed improvements will leave a residual threat of significant proportions, little change in the type of development is likely.

d. In Reach C, the project works will provide a very high degree of protection with residual damage occurring incident to minor levee overtopping in extreme storms only. In Reaches A, B1, and B2, construction of the proposed back levee improvements will remove the threat of flooding from the west, but will leave these reaches still vulnerable to the type of massive overflow from the east such as occurred in Hurricanes Betsy and Camille. The construction of the East Bank Barrier levee will essentially remove this threat. Thus, project-induced increases in land value may be attributed to the back levee improvements in Reach C, and to the East Bank Barrier levee in Reaches A, B1, and B2.

e. Annual land enhancement benefits were computed as the equivalent net return (6%) on the increase in land values resulting from project installation. Preproject and postproject land values were based on analyses of land values solely in Plaquemines and the surrounding parishes of Orleans, St. Bernard, and Jefferson.

Care was taken to identify, isolate, and exclude from the computed increases in land value any increments which, in fact, will result from subsequent construction of the drainage facilities, roadways, utilities, and other improvements requisite to full utilization of the project area. The computed increase, therefore, represents the increment directly attributable to construction of the project improvements.

f. The equivalent net return on the increased land value does not necessarily represent an immediate cash return on the part of the landholder since the land involved must be sold to effect such return. Nevertheless, the increase in value created by the project installation is real and tangible and constitutes a definite and measurable gain that can be converted to cash by the owner should he so decide. The option of holding ownership or relinquishing title by sale of the property rests entirely with the individual owner. To sell represents a desire to realize the immediate profit for purposes of consumption or alternative investment. To maintain ownership indicates a desire to speculate on further gains that will accrue from the installation of additional improvements in the area. Since the gain is realized upon project completion and irrespective of whether the land changes hands, it can be equated, in monetary form, to the return on the increase in value without discounting.

g. The computations for land enhancement are shown below:

TABLE B-7

ENHANCEMENT COMPUTATIONS

Reach	Ac.	Present market value/ac	Present market value	Enhanc. value per/ ac.	Enhanc. value	Total enhancement	Avg. ann. return on enh. (6%)	Ann. return total for reach
		$	$	$	$	$	$	$ (Rounded)
A	4,300	5,500	23,650,000	7,500	32,250,000	8,600,000	516,000	516,000
B1	3,400	11,250	38,250,000	16,875	57,375,000	19,125,000	1,147,500	
	400	100	40,000	300	120,000	80,000	4,800	1,152,000
	3,800							
B2	2,300	8,000	18,400,000	15,000	34,500,000	16,100,000	966,000	966,000
C	242	3,000	726,000	4,000	968,000	242,000	14,520	
	1,532	750	1,149,000	1,000	1,532,000	383,000	22,980	
	454	2,250	1,021,500	3,000	1,362,000	340,500	20,430	
	551	750	413,250	1,000	551,000	137,750	8,265	
	1,721	5,000	8,605,000	6,500	11,186,500	2,581,500	154,890	221,000
	4,500							

92,254,750
$ 92,000

14. Indirect economic effects.

a. Area redevelopment benefits are not applicable to the benefit-cost analysis under current directives since the area is not presently labeled as chronically depressed. This is not to say, however, that as a result of the project there are no favorable indirect economic effects on the national objectives of economic development, social well being, and regional development. Quite the contrary, there are several favorable effects on these objectives as outlined below. A portion of the project expenditure to labor will draw upon labor resources underemployed and/or unemployed. To the extent this takes place, a favorable effect upon national economic development, income in the project region, and social well being for those otherwise unemployed will be felt as a result of project construction.

b. To provide an estimate of the extent that unemployed and/or underemployed labor resources will be used as a result of project construction, reference is made to Haveman and Krutilla's study of numerous and varied water resource projects as embodied in their text "Underemployment, Idle Capacity, and the Evaluation of Public Expenditures," 1968, Johns Hopkins. On page 91 of this text, it is stated that "...it is reasonable to expect that the social cost of public investment in water resource facilities is significantly overstated when market prices or contract costs are used to represent opportunity costs under conditions of less than full employement...." In analyzing a full range of water resource projects, Haveman and Krutilla will have found that "shadow" labor costs (i.e., real labor costs) for levee projects approximate 86 percent of the market labor costs. The contention is that factor market costs for labor are therefore overstated by 14 percent. Considering this 14 percent as an expenditure toward the use of otherwise underemployed and/or unemployed labor resources, we find that the national economic development account is enhanced by an amount of 14 percent of the project expenditure for labor, .14 x $24,928,000 or $3,490,000. When amortized for a 100-year period at 2 7/8 percent, the annual indirect effect is found to be a total of $107,000 for the entire back levees project. The amount attributable to any separate reach is simply a direct multiplication of this total by the proportional cost to the total which the reach constitutes. By a similar computation, the annual indirect benefits attributable to the East Bank Barrier plan total about $10,000.

c. The provision of the improvements will stimulate a more rapid growth in the project area. The protection against flood hazards is an obvious incentive for developers and residents who would not be willing to locate in the project area under "without-project" conditions.

d. Project construction will likely lead to some easing of existing zoning regulations, particularly for the area of Reach B2. The relaxing of these requirements would reduce the costs of residential construction and provide the opportunity for families to make use of the ensuing savings for other urgent items such as education.

e. Multiplier and accelerator effects.

(1) The economic concepts of the multiplier and accelerator are discussed at some length in Chapters 6 and 7 of the text "Understanding Macro-Economics" by R. Heilbroner. Much of what follows concerning these concepts has been directly drawn from that text and the underlying principles expounded therein.

(2) The question has been raised as to how so small a tail as investment wags so large a dog as CNP. The answer is the multiplier. The multiplier describes the fact that additions to spending (or diminutions in spending) have an impact on income that is greater than the original increase or decrease in spending itself. In other words, even small increments in spending can multiply their effects (whence the name). How large the multiplier will be depends in large measure on the spending and saving habits of income receivers with respect to additions to (or subtractions from) their income. The more they are inclined to save as income rises, the less will be available for respending and the smaller will be the multiplier. Conversely, the less they save out of increases in income, the greater will be the multiplier.

(3) It is only when we have idle resources (unemployed labor or unused machines or land) that the respending impetus of the multiplier is useful. Then each round of new expenditure can now bring idle resources into use, creating not only new incomes but new production and employment. The situation is considerably different when there are no, or few, idle men or machines. Then the expenditure rounds of the multiplier bring higher money incomes, but these are not matched by the increased output and the results are solely inflationary as the increased spending results in higher income and higher prices but not in higher output.

(4) The multiplier has been seen to describe the effect that investment has on income via consumption spending; the accelerator principle describes the effect that consumption can have on income via investment spending. When consumption is rising and plant capacity is already tight, investment is likely to be induced, and this induced investment in turn will generate still additional incomes through the multiplier effect. Thus the multiplier effect and the acceleration principle can interact to yield even larger "secondary" impacts than either alone.

(5) It is most interesting to note that when the Council of Economic Advisers was arguing for the Kennedy tax cut before the Joint Committee of the 88th Congress, they estimated that the pure miltiplier effect on GNP was only a little over 2, but that the combined multiplier-accelerator effect was 3 to 4.

(6) In the foregoing the magnitude of idle resources employed as a result of the project expenditure was estimated. This amount will be subject to the effects of the multiplier and accelerator principles and will likely be more significant in the regional area of the project than in the nation as a whole since the idle resources employed are located primarily in the project region.

15. Benefit summary.

a. The total tangible economic benefits, evaluated in the preceding paragraphs and creditable to the national account, are summarized in the following tables. No indirect effects are included in these summaries.

TABLE B-8

AVERAGE ANNUAL BENEFITS--AUTHORIZED BACK LEVEES

Reach	Existing development	Future development	Enhancements	Total benefits
	$	$	$	$
A	614,000	655,000	-	1,269,000
B1	2,182,000	1,711,000	-	3,893,000
B2	663,000	262,000	-	925,0000
C	440,000	174,000	221,000	835,000

TABLE B-9

AVERAGE ANNUAL BENEFITS--BARRIER LEVEE

Reach	Existing development	Future development	Enhancements	Total benefits
	$	$	$	$
A	860,000	849,000	516,000	2,225,000
B1	1,633,000	1,222,000	1,152,000	4,007,000
B2	816,000	355,000	966,000	2,137,000
C	0	0	0	0
	3,309,000	2,426,000	2,634,000	8,369,000

5,735,000

b. From table B-8, it can be seen that enhancements are a consideration in the back levee benefit determinations only for Reach C. In that reach, the flood damages prevented ($614,000) exceed the average annual project costs ($399,200) by a wide margin.

c. It may also be determined from table B-9 that, while a substantial portion of the total benefits (31.5%) for the barrier levee is related to land enhancements, the flood damages prevented ($5,735,000) are far in excess of the annual project costs ($297,400).

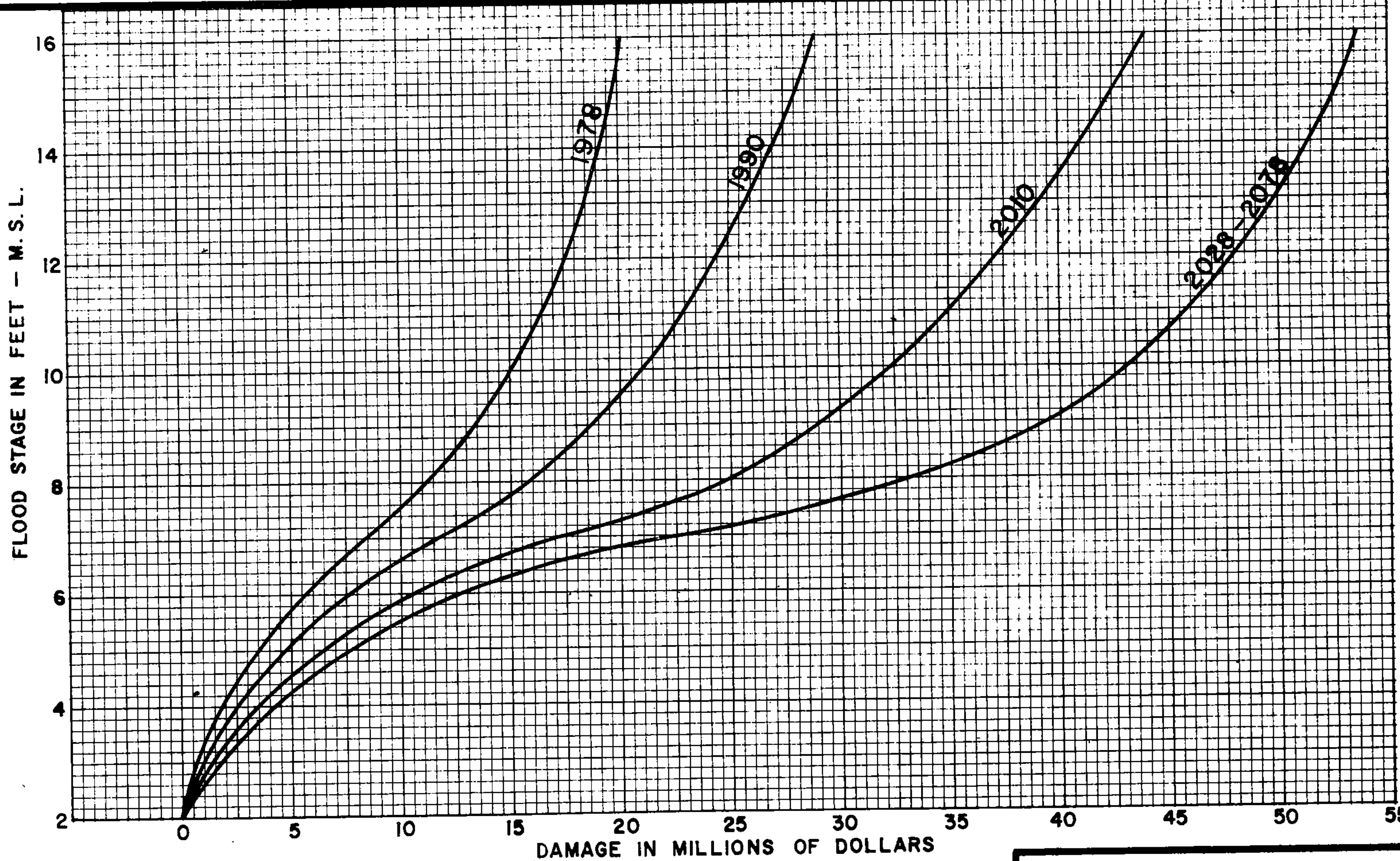
SECTION V - COMPARISON WITH PRIOR ANALYSES

16. The comparison of the benefits estimated for the authorized plan in this reanalysis and the most recent prior analyses (LMV Form 23 dated 9 June 1970) is shown below:

Reach	LMV Form 23	Reanalysis
A	$1,078,200	$1,269,000
B1	1,789,500	3,893,000
B2	631,000	925,000
C	525,300	835,000

17. The major increases in benefits reported in this reanalysis for Reaches A, B1, and B2 are primarily the result of revisions in stage-damage relationships with changes in stage-frequency data a secondary contributing cause. As previously outlined herein, revisions to the previously-used stage-damage relationships reflect a much higher incidence of development in the area, plus increases in the unit rates of dollar damage for a given flood stage. As an example of the inadequacy of prior stage-damage data, it may be observed that the actual damages in Hurricane Camille in Reach B2 were more than triple the damages computed using the stage-damage curves on which the prior benefit analysis was based.

18. Changes in computed benefits for Reach C (without consideration as to the inclusion of enhancements in the reanalysis) have been of lesser magnitude than those in the west bank reaches since in this area current and anticipated developmental patterns have changed much less dramatically than on the west bank.



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1–GENERAL DESIGN
REACH B1–TROPICAL BEND TO FORT JACKSON

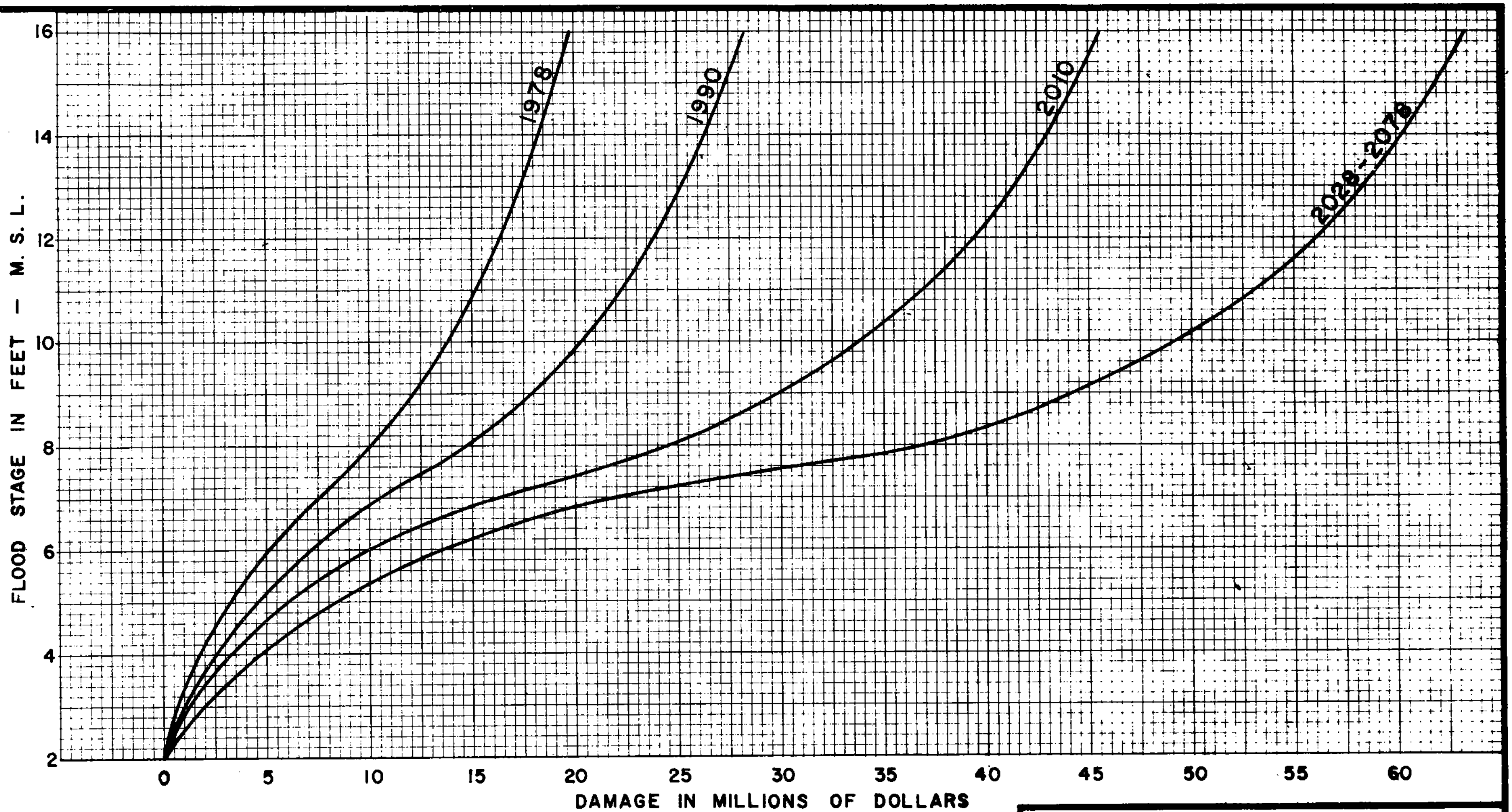
STAGE-DAMAGE CURVES

REACH A (MILE 44.0 TO MILE 39.0)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-1



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

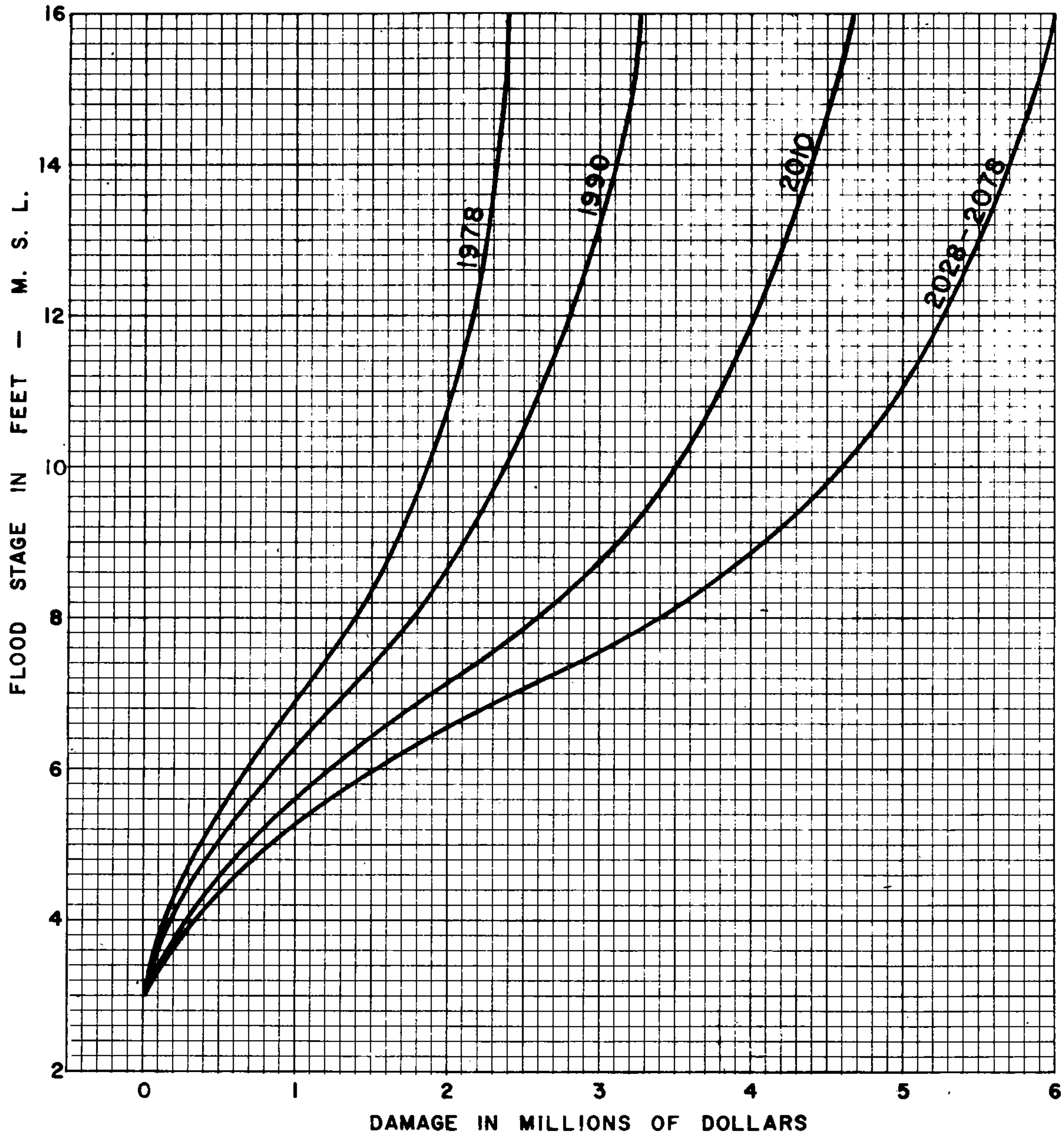
STAGE DAMAGE CURVES

REACH A (MILE 39.0 TO MILE 30.5)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-2



NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO.1-GENERAL DESIGN

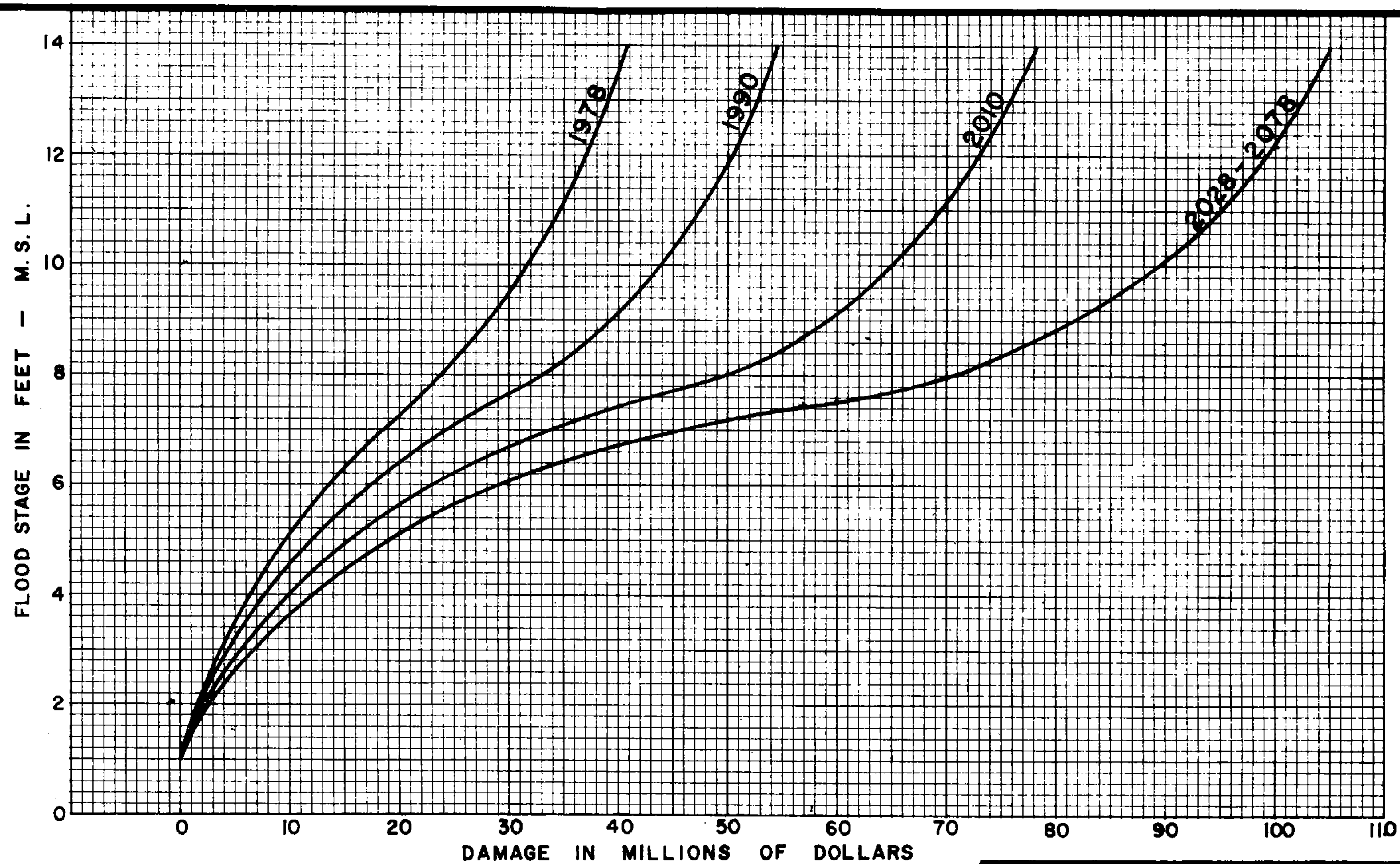
REACH B1-TROPICAL BEND TO FORT JACKSON

STAGE-DAMAGE CURVES

REACH B1 (MILE 30.5 TO MILE 29.0)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

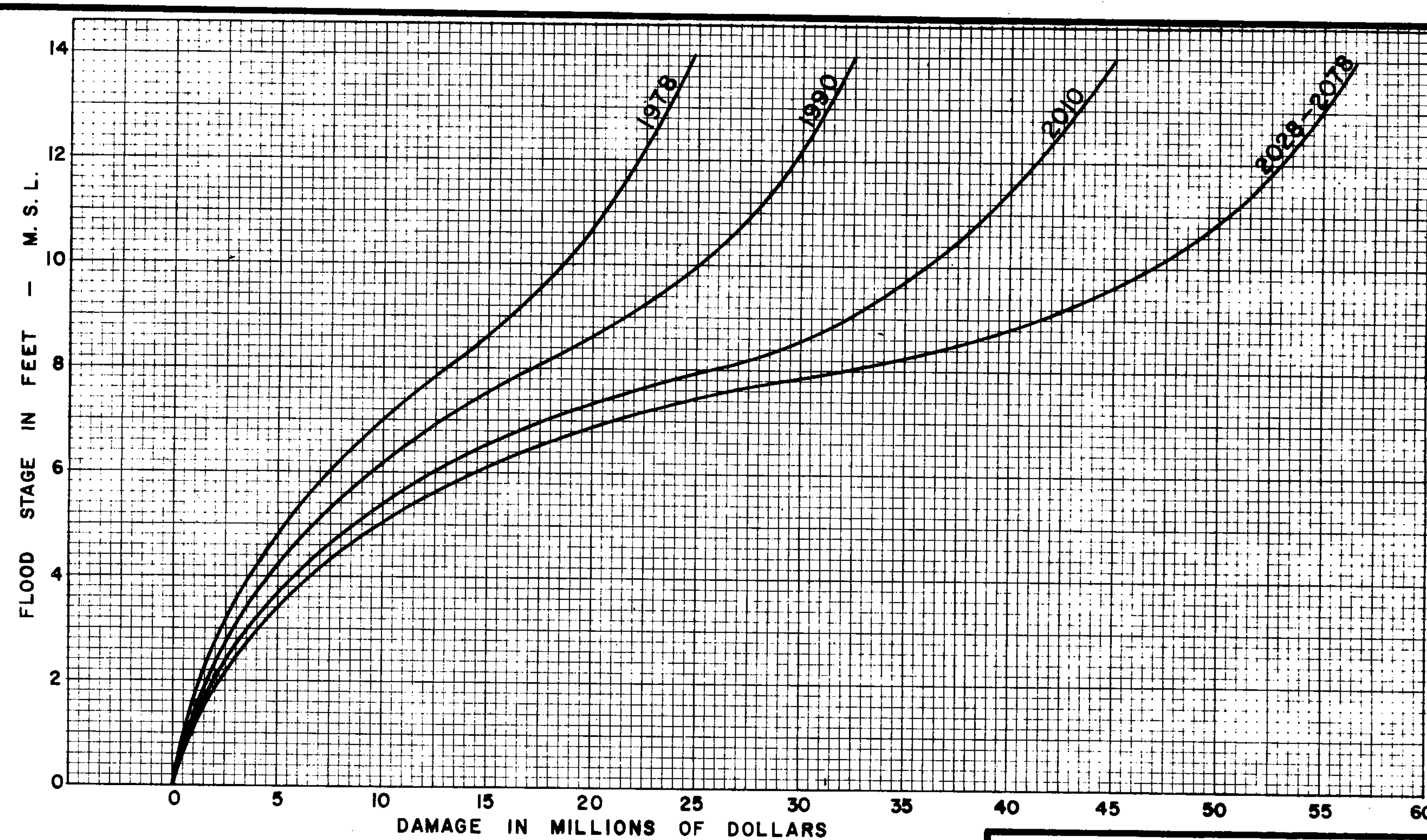
STAGE-DAMAGE CURVES

REACH B1 (MILE 29.0 TO MILE 25.0)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-4



NEW ORLEANS TO VENICE, LA.

DESIGN MEMORANDUM NO.1-GENERAL DESIGN

REACH B1-TROPICAL BEND TO FORT JACKSON

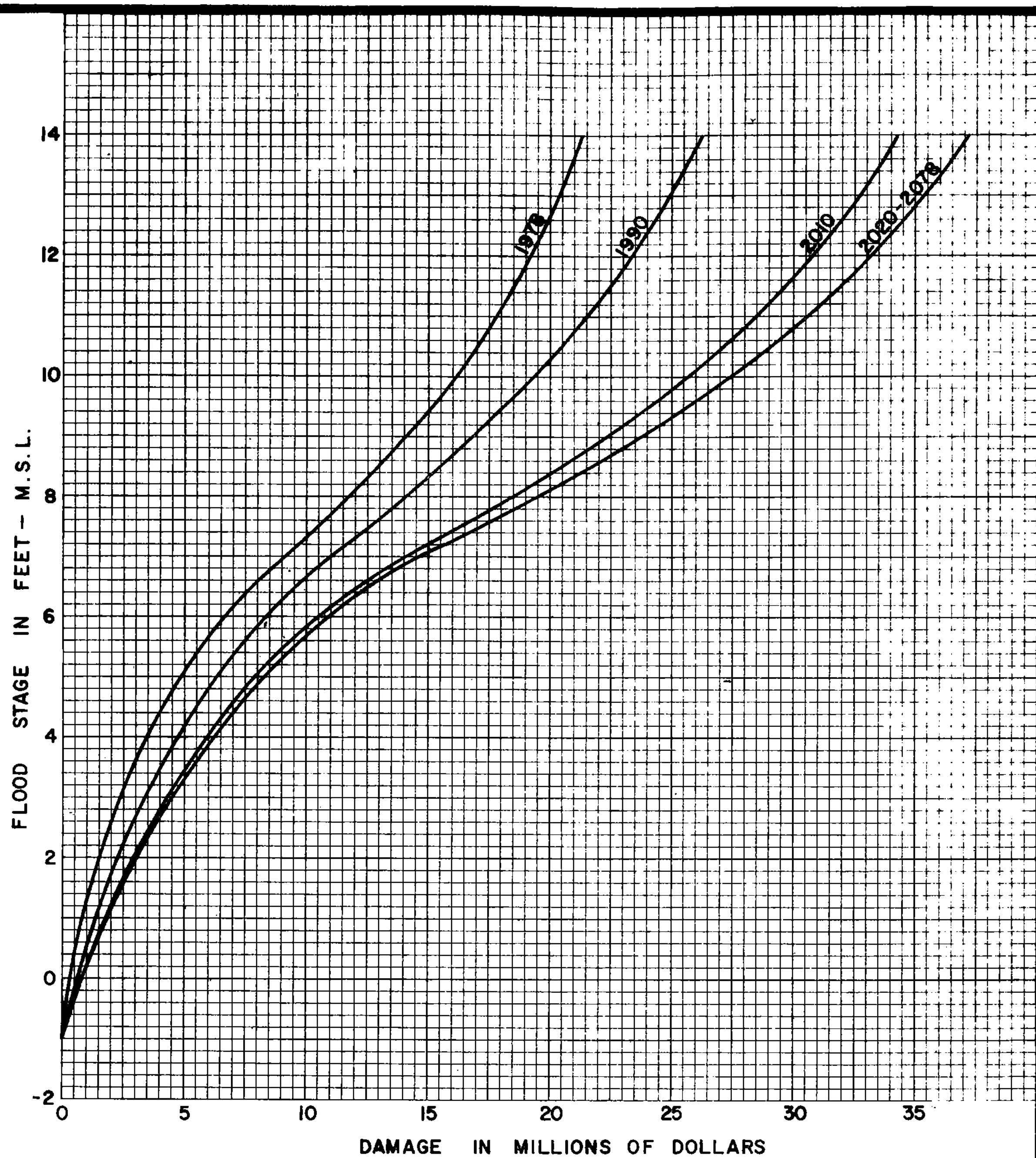
STAGE-DAMAGE CURVES

REACH B1 (MILE 25.0 TO MILE 21.0)

U.S.ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-5

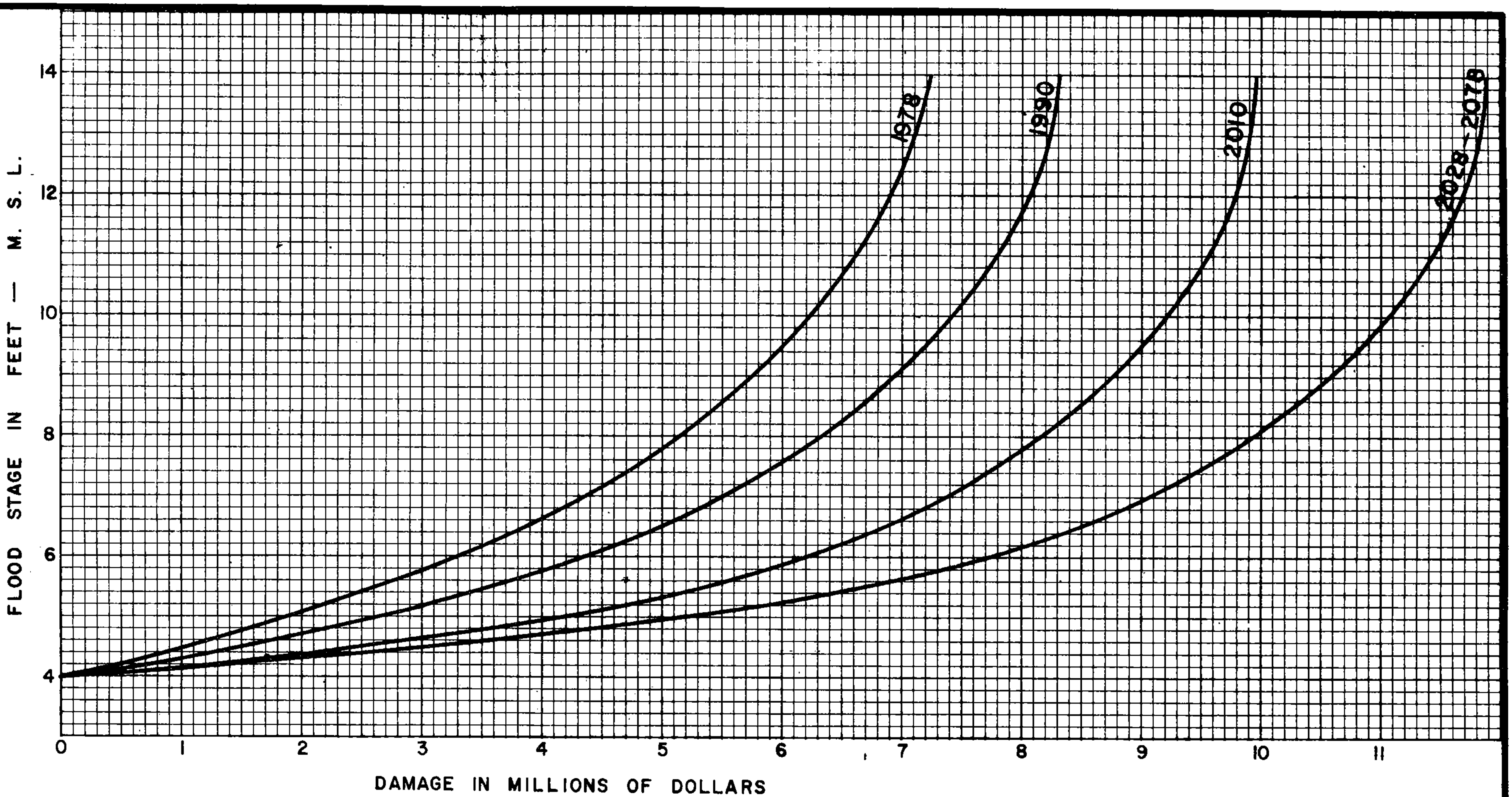


NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B 1-TROPICAL BEND TO FORT JACKSON

STAGE - DAMAGE CURVES

REACH B2 (MILE 21.0 TO MILE 10.8)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712



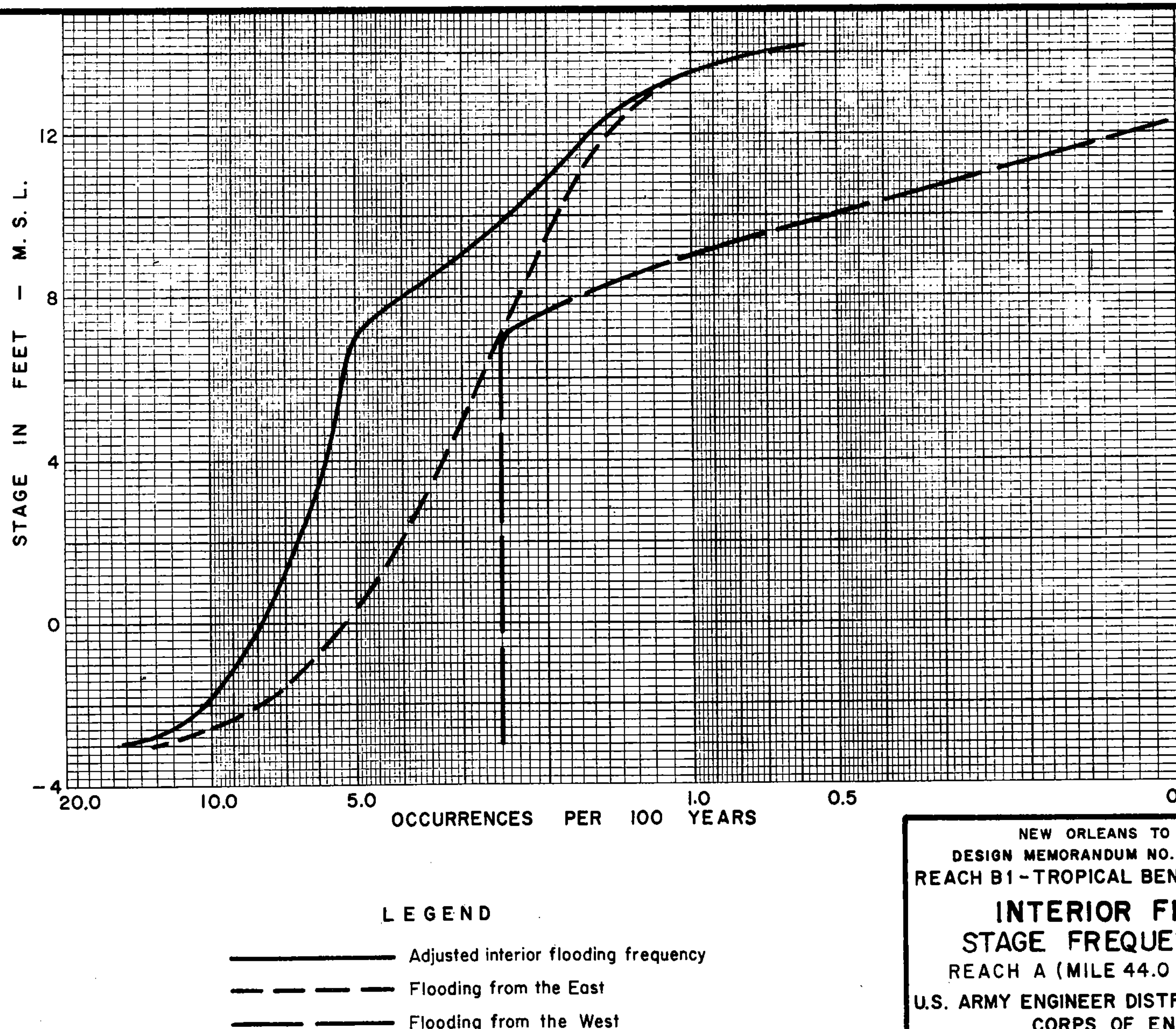
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

STAGE-DAMAGE CURVES
REACH C

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-7



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

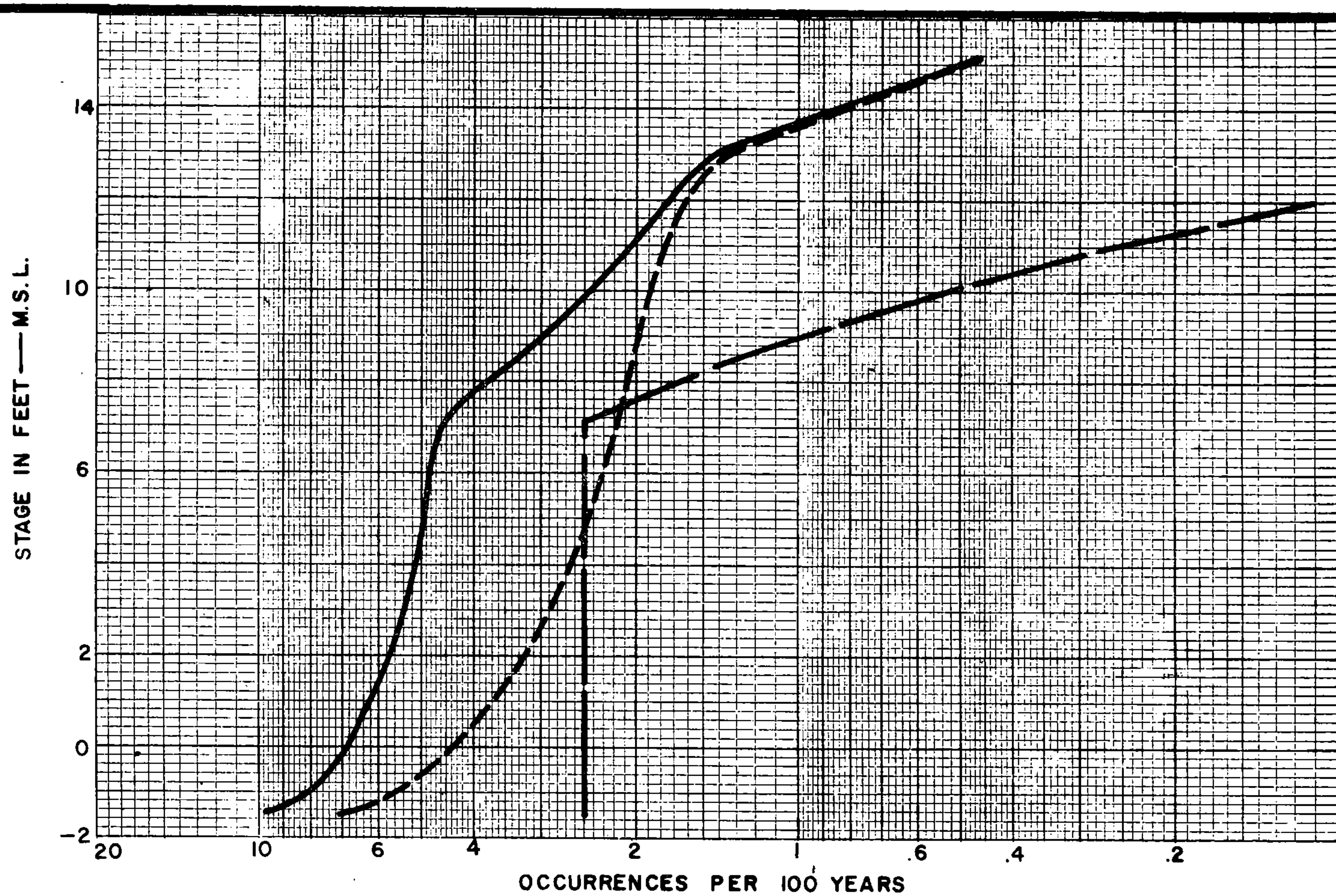
INTERIOR FLOODING
STAGE FREQUENCY CURVE

REACH A (MILE 44.0 TO MILE 39.0)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-8



LEGEND

- Adjusted interior flooding frequency (solid line)
- Flooding from the East (short-dash line)
- Flooding from the West (long-dash line)

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

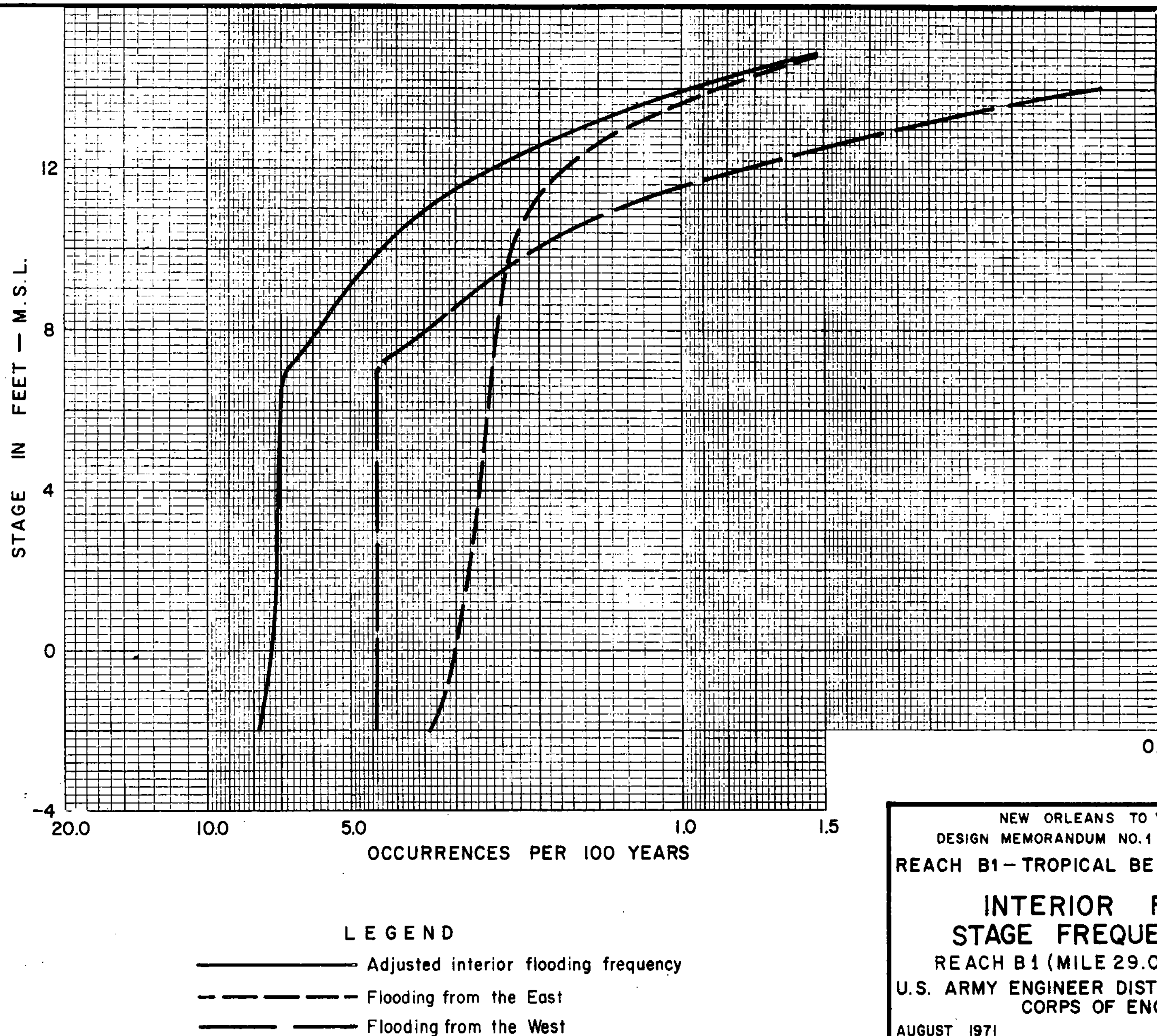
INTERIOR FLOODING STAGE FREQUENCY CURVE

REACH A (MILE 39.0 TO MILE 30.5)
REACH B1 (MILE 30.5 TO MILE 29.0)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-9



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 — GENERAL DESIGN
REACH B1 — TROPICAL BEND TO FORT JACKSON

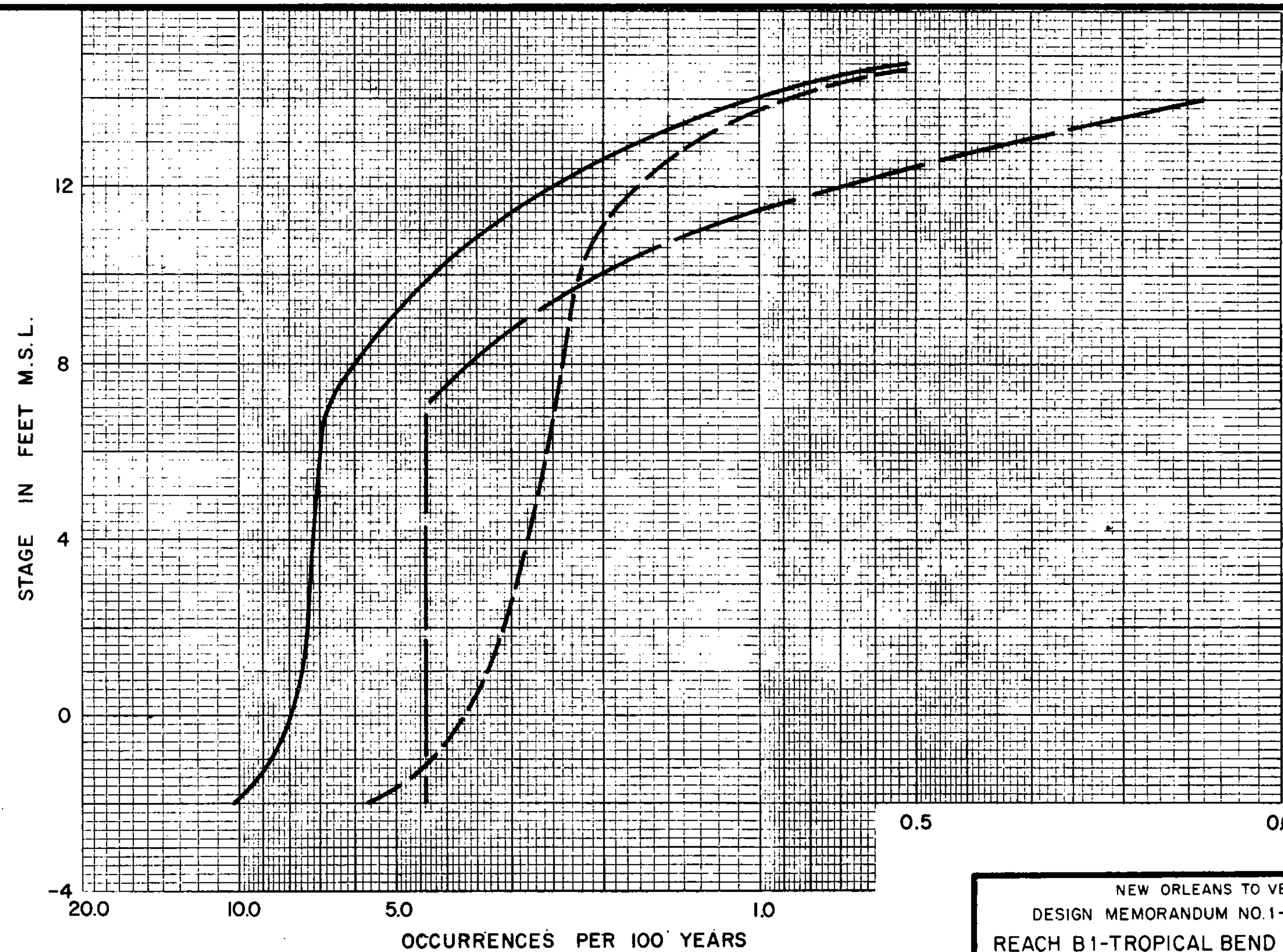
INTERIOR FLOODING STAGE FREQUENCY CURVE

REACH B1 (MILE 29.0 TO MILE 25.0)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-10



LEGEND

- Adjusted Interior Flooding Frequency
- Flooding from the East
- Flooding from the West

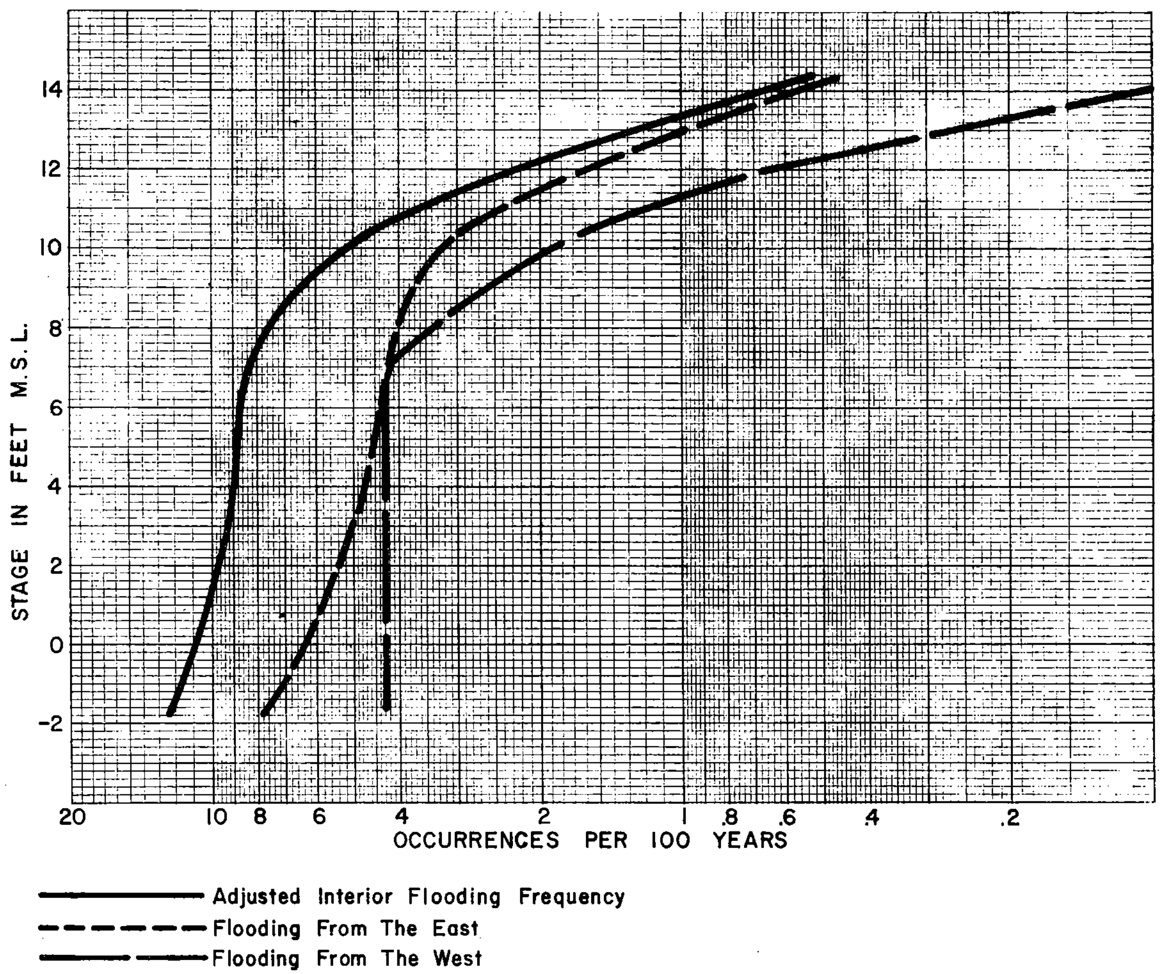
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

INTERIOR FLOODING
STAGE FREQUENCY CURVE
REACH B1 (MILE 25.0 TO MILE 21.0)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-11



NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. I-GENERAL DESIGN
REACH B I-TROPICAL BEND TO FORT JACKSON

INTERIOR FLOODING

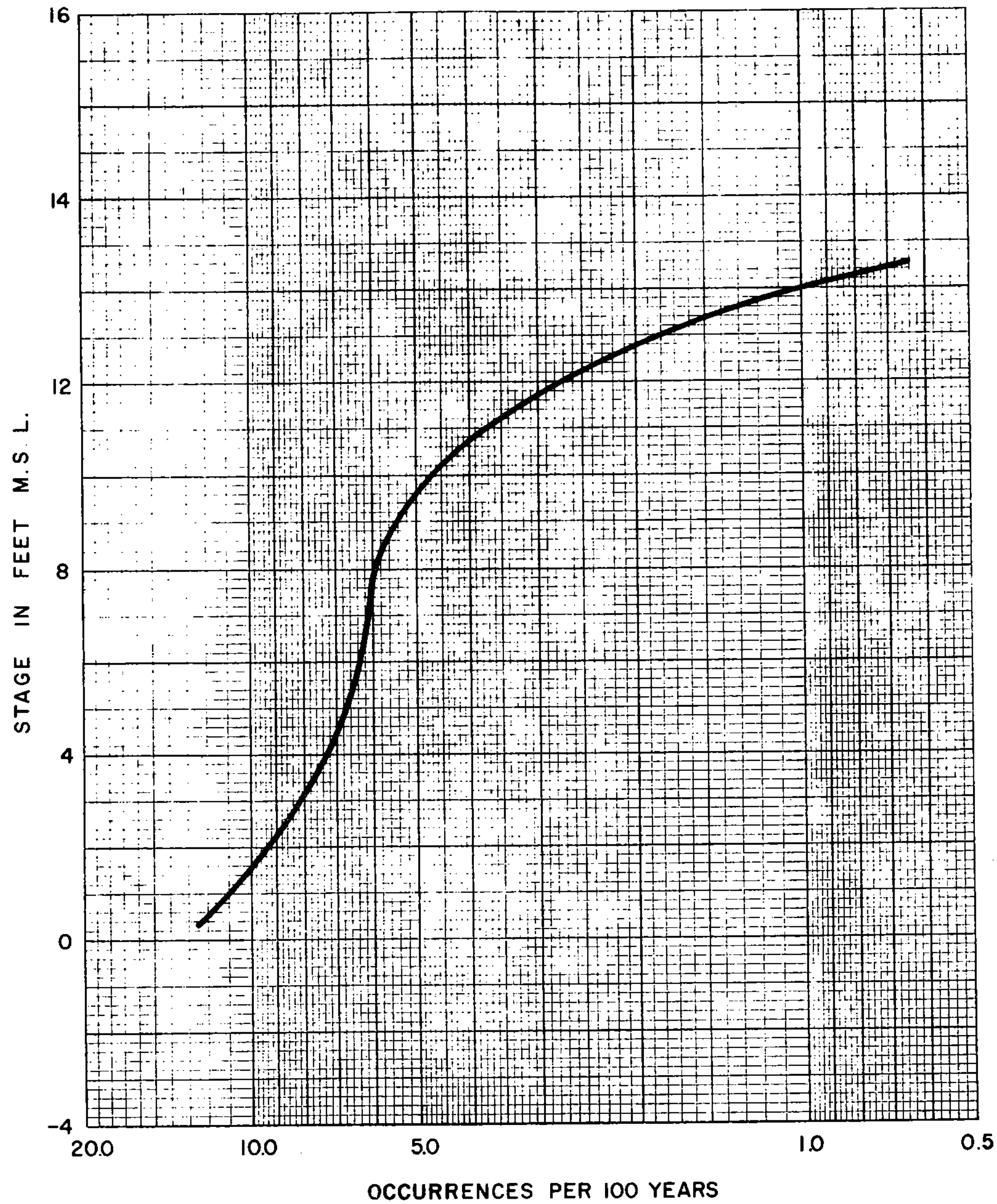
STAGE FREQUENCY CURVE

REACH B2 (MILE 21.0 TO MILE 10.8)

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-12



NEW ORLEANS TO VENICE, LA

DESIGN MEMORANDUM NO. 1-GENERAL DESIGN

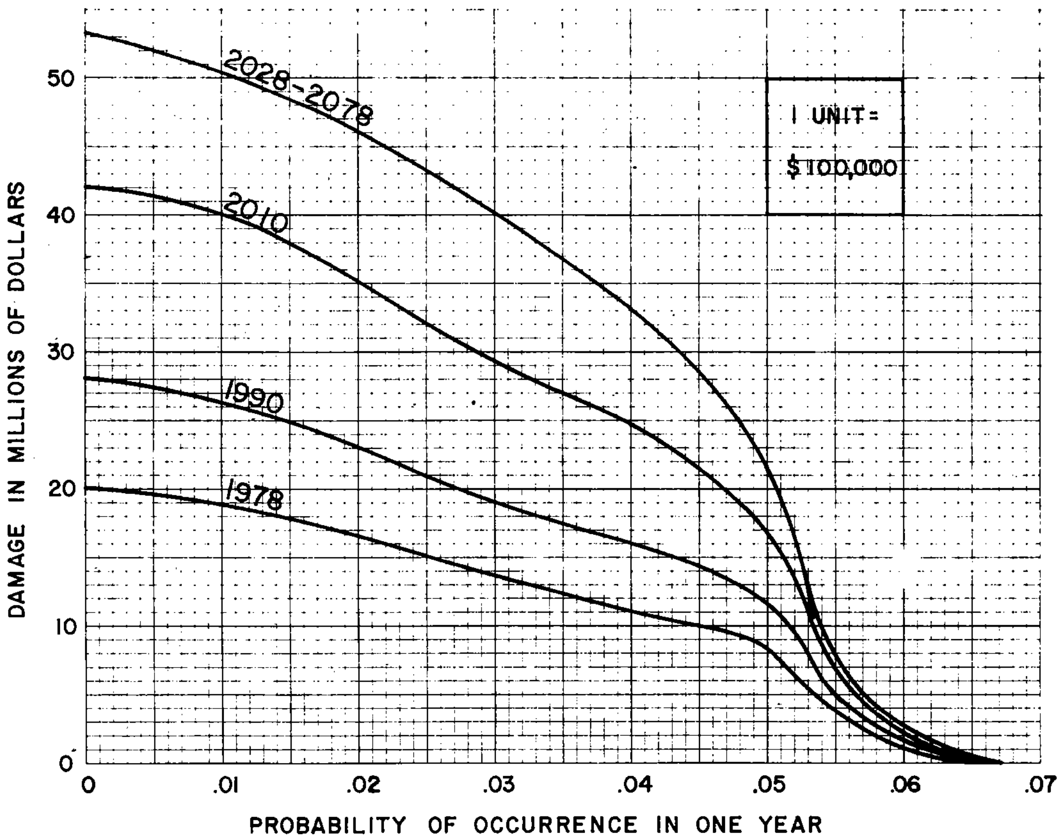
REACH B1-TROPICAL BEND TO FORT JACKSON

INTERIOR FLOODING STAGE FREQUENCY CURVE

REACH C

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



AVERAGE ANNUAL DAMAGES

1978 = 7.79 ◻ X $100,000 = $ 779,000
1990 = 11.13 ◻ X $100,000 = $1,113,000
2010 = 16.79 ◻ X $100,000 = $1,679,000
2028-2078 = 21.91 ◻ X $100,000 = $2,191,000

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

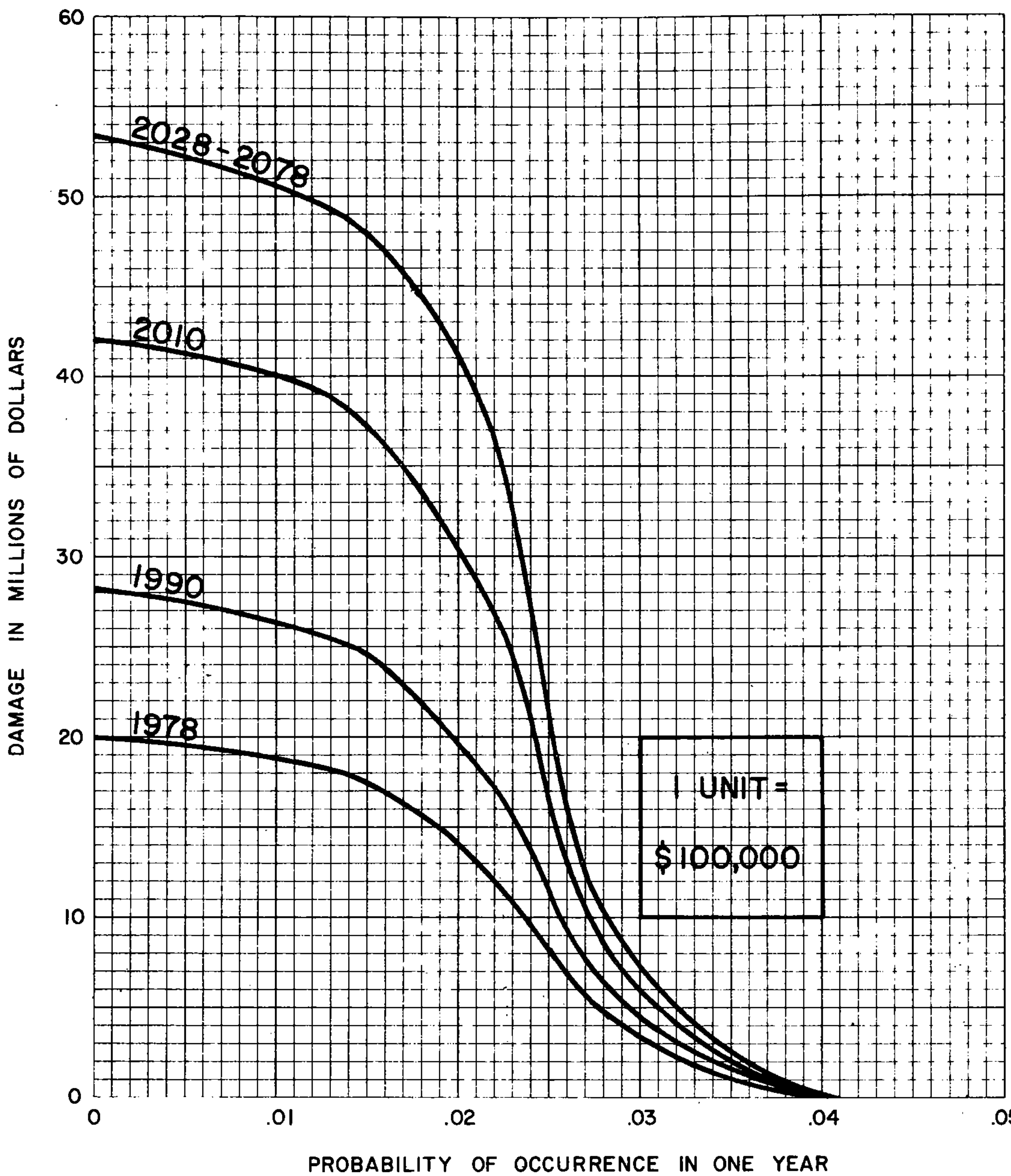
DAMAGE - PROBABILITY CURVES

REACH A (MILE 44.0 TO MILE 39.0)
WITHOUT AUTHORIZED PROJECT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-14



AVERAGE ANNUAL DAMAGES

1978 =	4.66 □	X	$100,000 =	$	466,000
1990 =	6.56 □	X	$100,000 =	$	656,000
2010 =	9.79 □	X	$100,000 =	$	979,000
2028-2078 =	12.65 □	X	$100,000 =	$	1,265,000

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

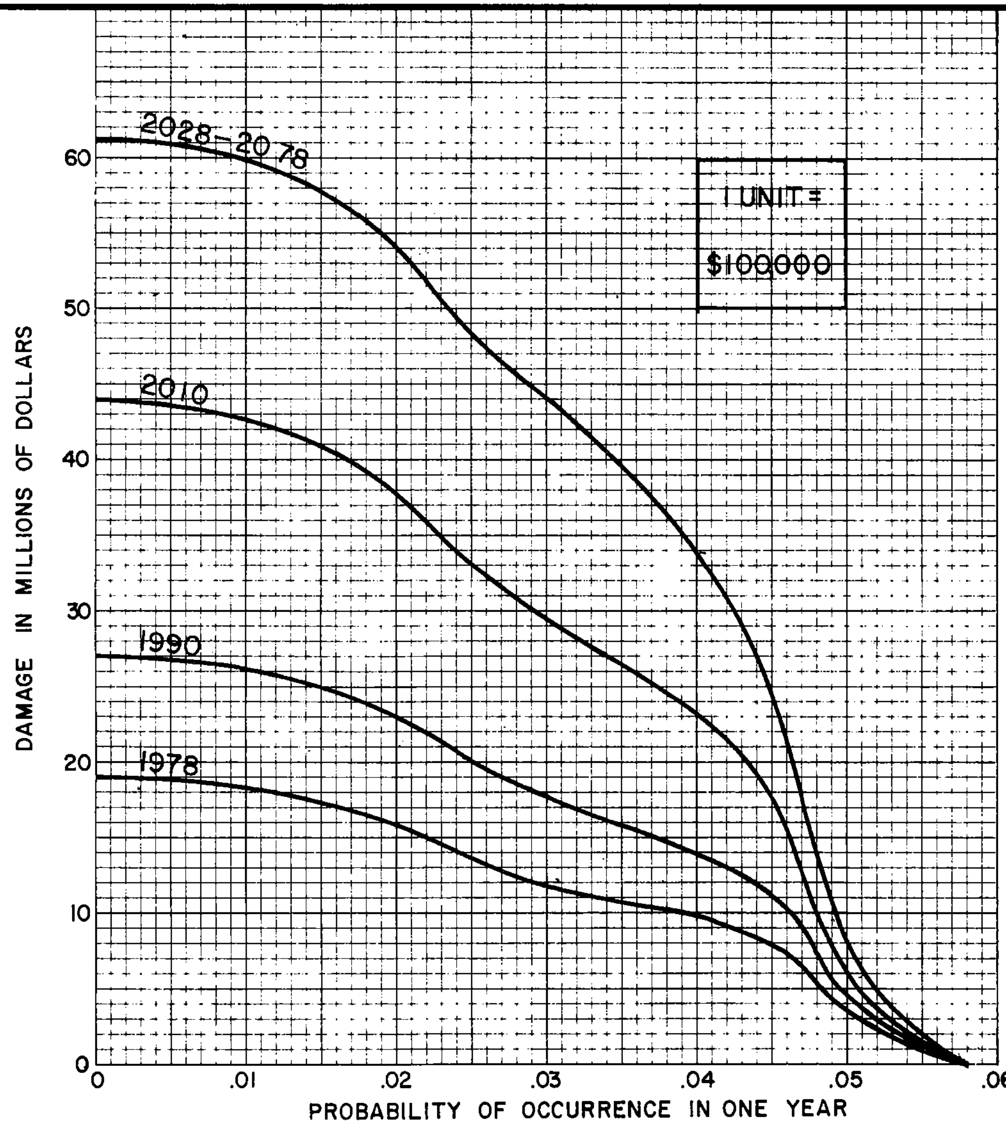
DAMAGE-PROBABILITY CURVES

REACH A (MILE 44.0 TO MILE 39.0)
WITH AUTHORIZED BACK LEVEE IN PLACE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-15



AVERAGE ANNUAL DAMAGES

1978 = 6.95 □ X $100,000 = $ 695,000
1990 = 9.97 □ X $100,000 = $ 997,000
2010 = 16.19 □ X $100,000 = $1,619,000
2028-2078 = 23.34 □ X $100,000 = $2,334,000

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

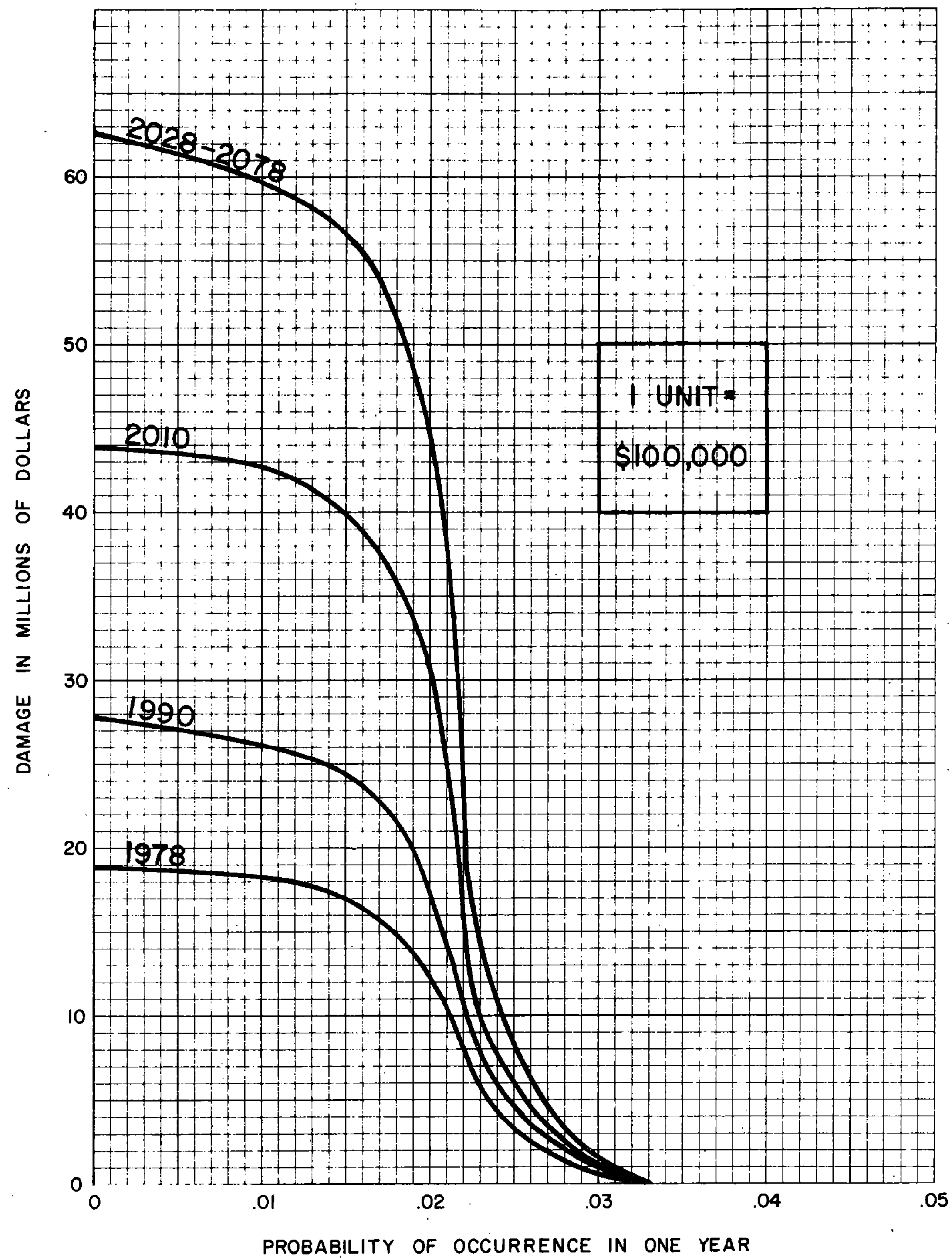
DAMAGE—PROBABILITY CURVES

REACH A (MILE 39.0 TO MILE 30.5)
WITHOUT AUTHORIZED PROJECT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-16



AVERAGE ANNUAL DAMAGES

1978 = 3.94 □X $100,000 = $ 394,000
1990 = 5.77 □X $100,000 = $ 577,000
2010 = 9.11 □X $100,000 = $ 911,000
2028-2078 = 13.01 □X $100,000 = $ 1,301,000

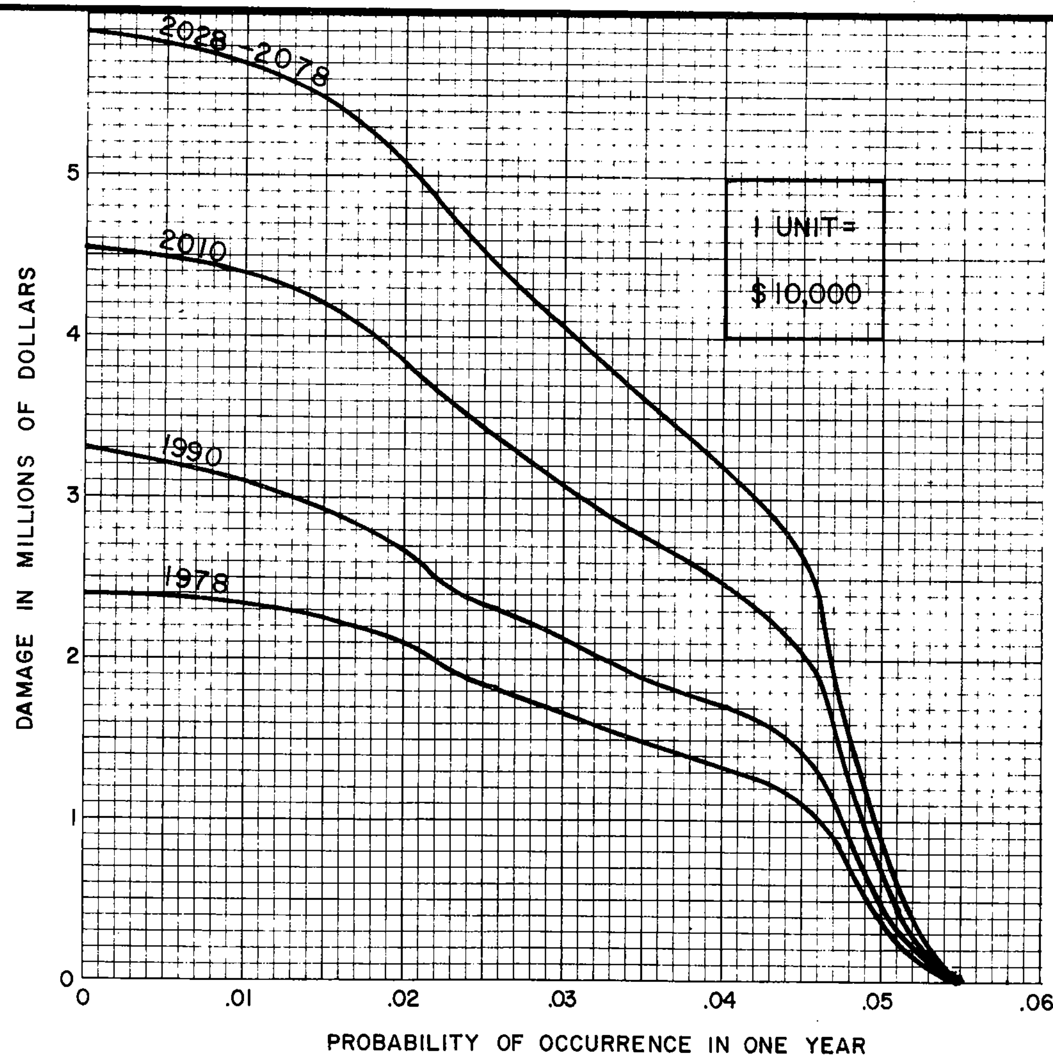
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

DAMAGE-PROBABILITY CURVES

REACH A (MILE 39.0 TO MILE 30.5)
WITH AUTHORIZED BACK LEVEE IN PLACE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

FILE NO. H-2-25712



AVERAGE ANNUAL DAMAGES

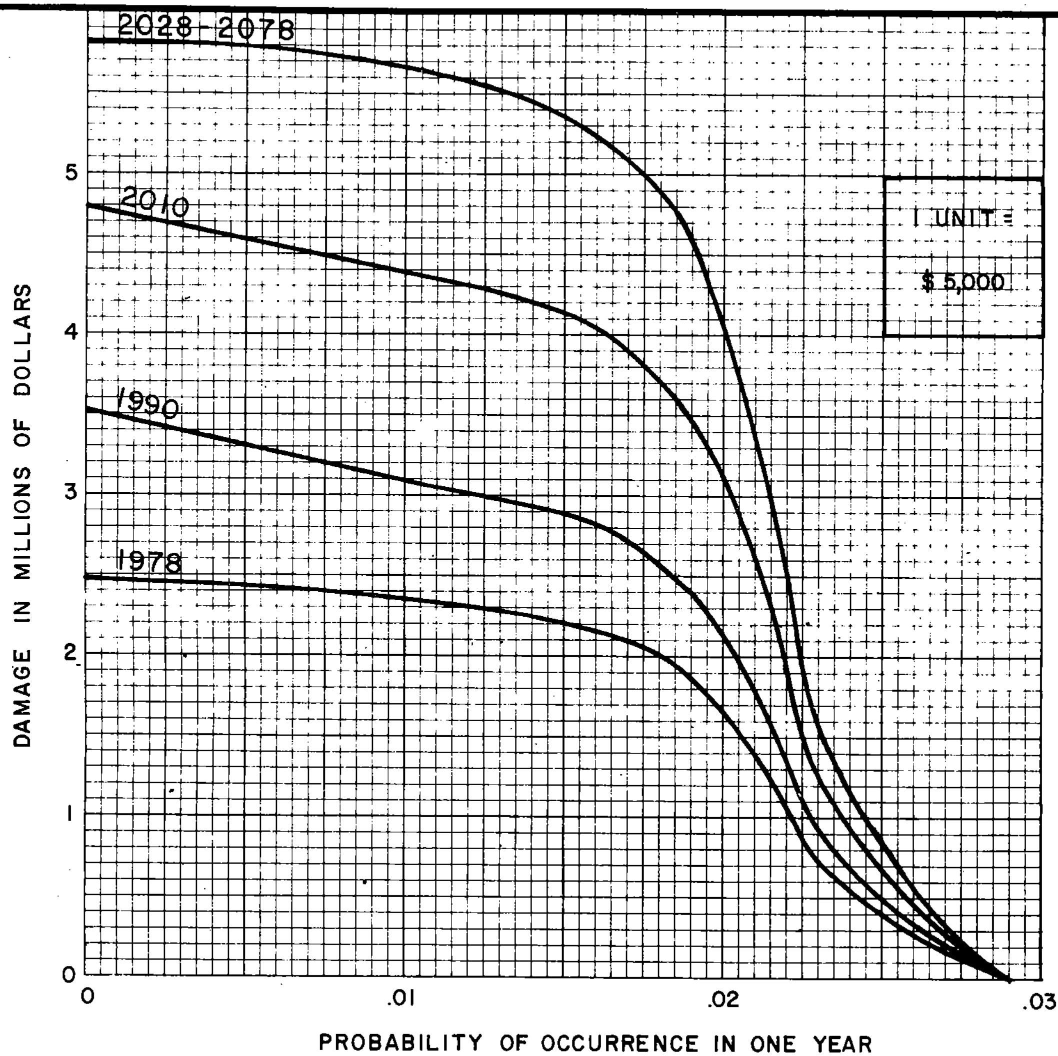
1978 = 9.05 □ X $10,000 = $ 90,500
1990 = 11.79 □ X $10,000 = $ 117,900
2010 = 17.02 □ X $10,000 = $ 170,200
2028-2078 = 22.00 □ X $10,000 = $ 220,000

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

DAMAGE-PROBABILITY CURVES

REACH B1 (MILE 30.5 TO MILE 29.0)
WITHOUT AUTHORIZED PROJECT
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712

PLATE B-18



AVERAGE ANNUAL DAMAGES

1978 = 10.22 □ X $5,000 = $ 51,100
1990 = 13.64 □ X $5,000 = $ 68,200
2010 = 19.21 □ X $ 5,000 = $ 96,050
2028-2078 = 24.59 □ X $ 5,000 = $122,950

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B 1-TROPICAL BEND TO FORT JACKSON

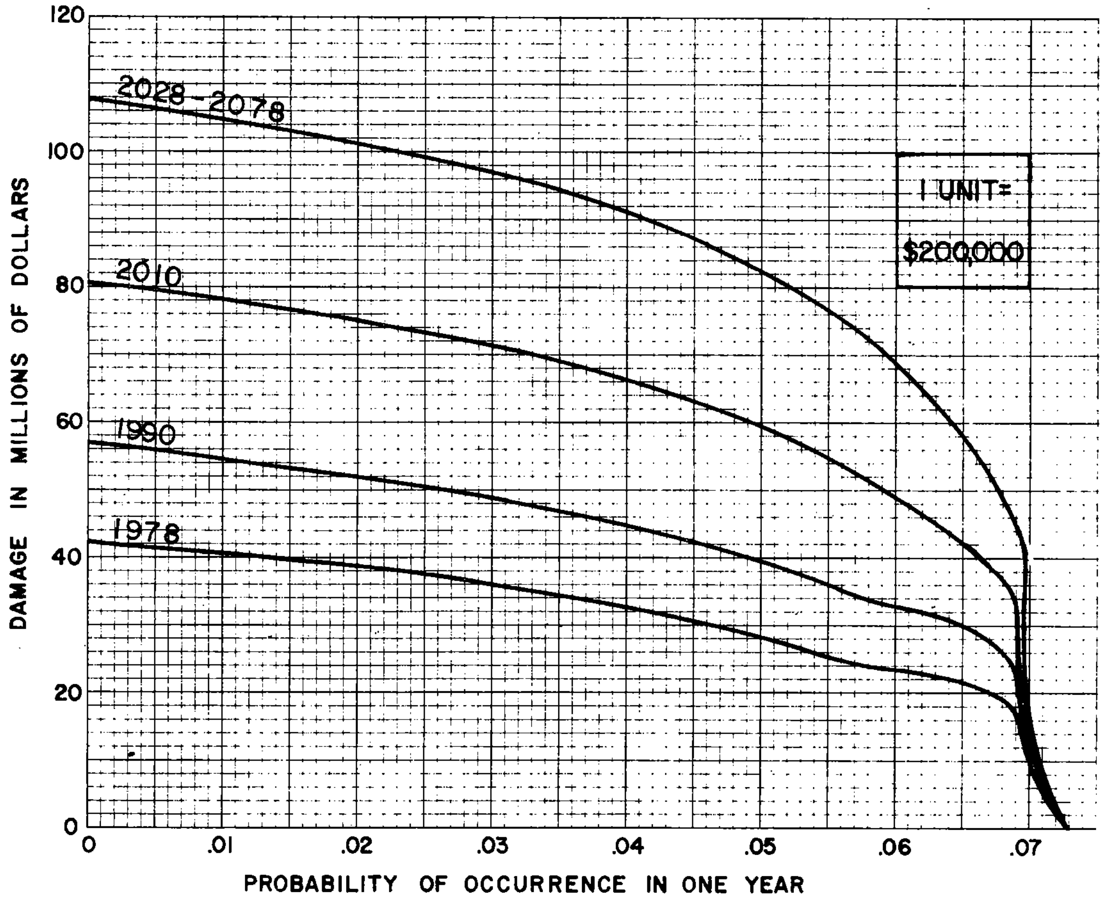
DAMAGE - PROBABILITY CURVES

REACH B1 (MILE 30.5 TO MILE 29.0)
WITH AUTHORIZED BACK LEVEE IN PLACE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-19



AVERAGE ANNUAL DAMAGES

1978 = 11.64 □ X $200,000 = $2,328,000
1990 = 15.83 □ X $200,000 = $3,166,000
2010 = 22.88 □ X $200,000 = $4,576,000
2028-2078 = 31.21 □ X $200,000 = $6,242,000

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

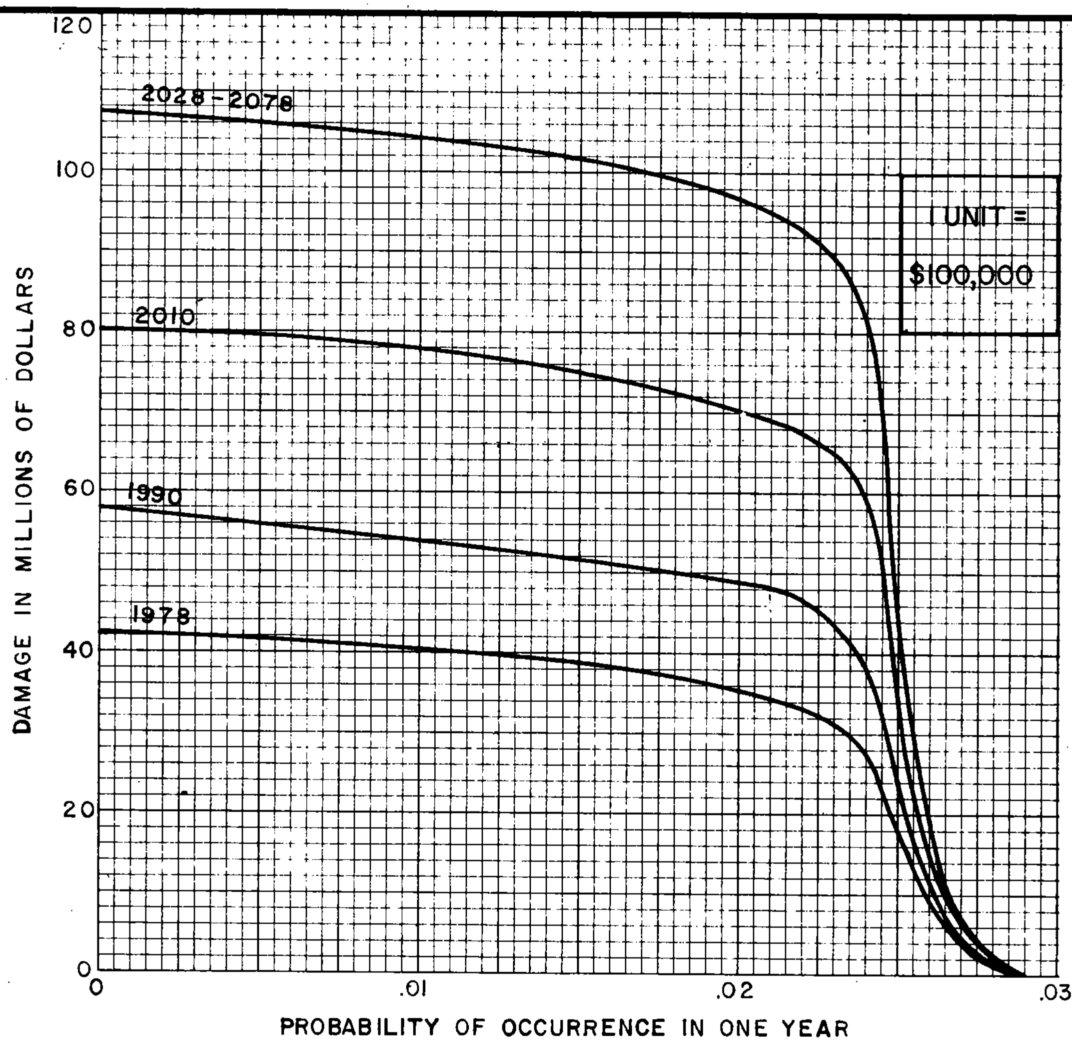
DAMAGE-PROBABILITY CURVES

REACH B1 (MILE 29.0 TO MILE 25.0)
WITHOUT AUTHORIZED PROJECT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-20



AVERAGE ANNUAL DAMAGES

1978 = 9.73□ X $100,000 = $ 973,000
1990 = 13.35□ X $100,000 = $1,335,000
2010 = 18.98□ X $100,000 = $1,898,000
2028-2078 = 25.65□ X $100,000 = $2,565,000

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

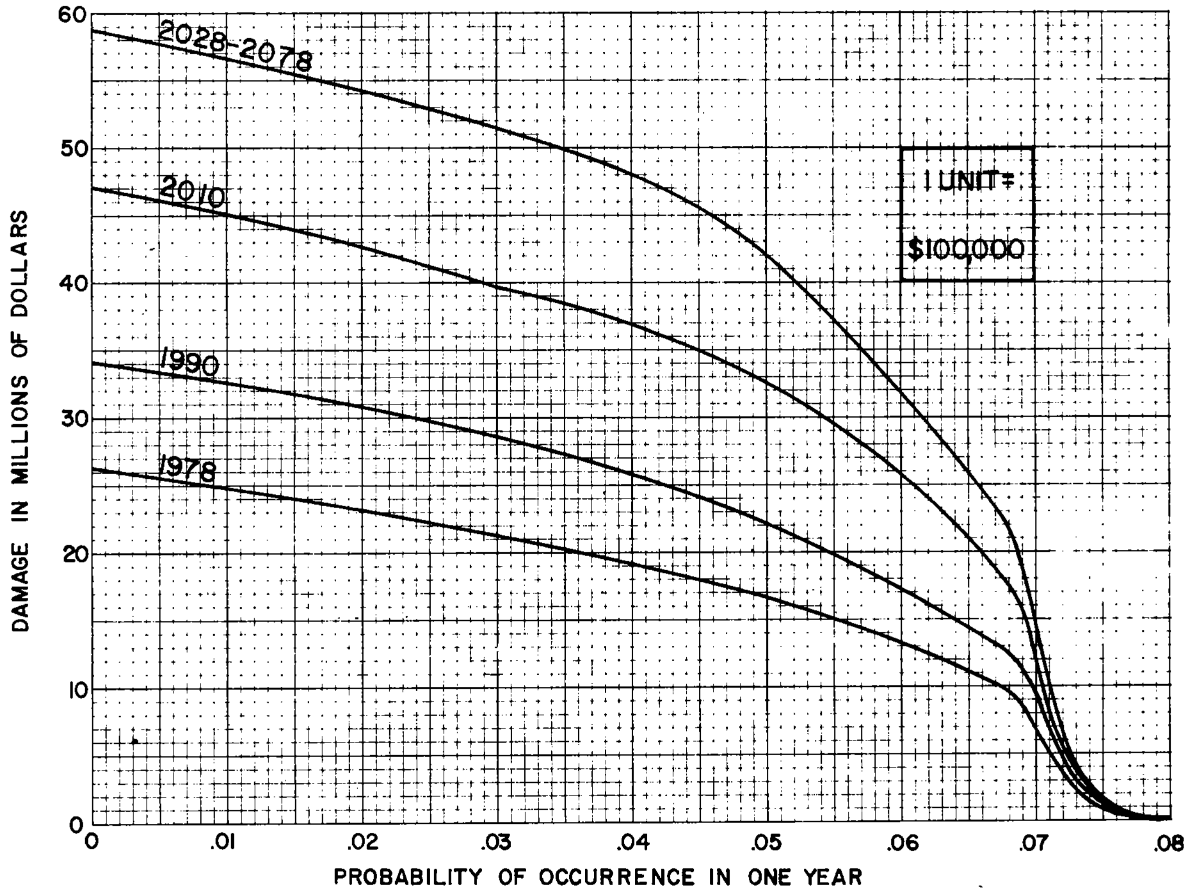
DAMAGE - PROBABILITY CURVES

REACH B1 (MILE 29.0 TO MILE 25.0)
WITH AUTHORIZED BACK LEVEE IN PLACE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-21



AVERAGE ANNUAL DAMAGES

1978 = 13.97 □ X $100,000 = $1,397,000
1990 = 18.32 □ X $100,000 = $1,832,000
2010 = 25.85 □ X $100,000 = $2,585,000
2028-2078 = 32.70 □ X $100,000 = $3,270,000

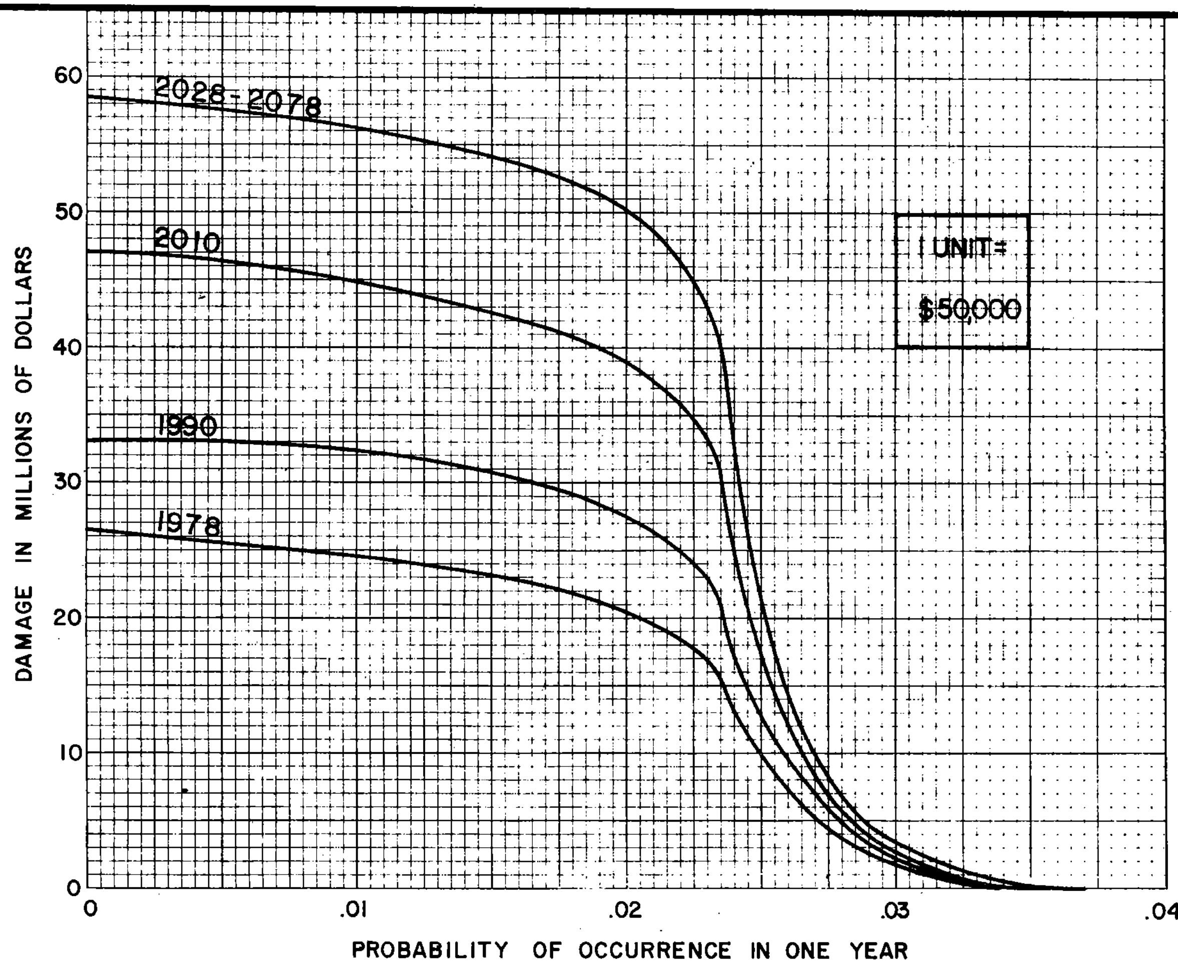
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

DAMAGE - PROBABILITY CURVES

REACH B1 (MILE 25.0 TO MILE 21.0)
WITHOUT AUTHORIZED PROJECT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
AUGUST 1971 FILE NO. H-2-25712

PLATE B-22



AVERAGE ANNUAL DAMAGES

1978 = 12.17□ X $50,000 = $ 608,500
1990 = 15.95□ X $50,000 = $ 797,500
2010 = 22.01□ X $50,000 = $1,100,500
2028-2078 = 27.63□ X $50,000 = $1,381,500

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

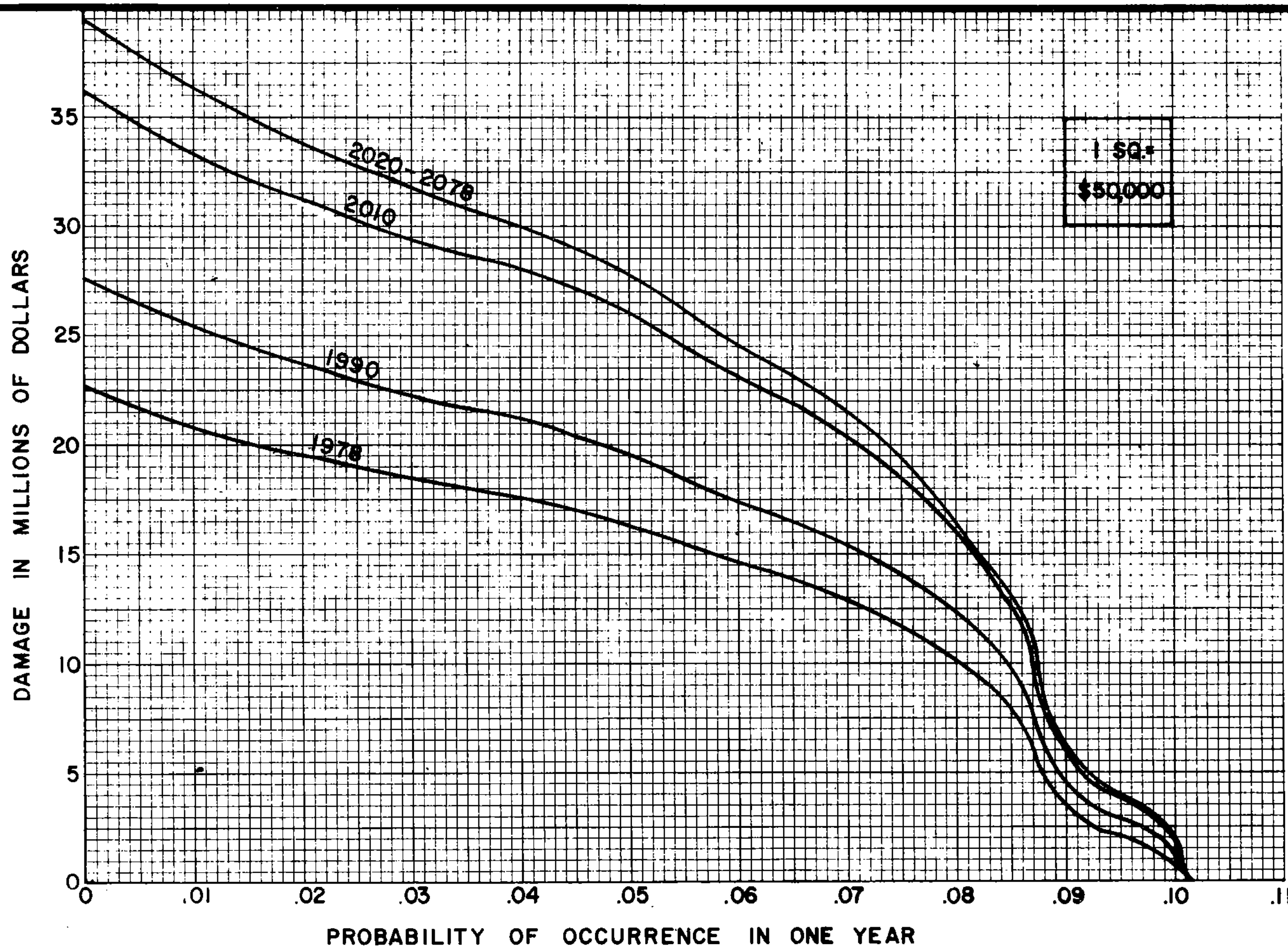
DAMAGE-PROBABILITY CURVES

REACH B1 (MILE 25.0 TO MILE 21.0)
WITH AUTHORIZED BACK LEVEE IN PLACE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-23



AVERAGE ANNUAL DAMAGES

1978 = 29.57□ X $50,000 = $1,478,500
1990 = 35.87□ X $50,000 = $1,793,500
2010 = 47.15□ X $50,000 = $2,357,500
2020-2078 = 50.62□ X $50,000 = $2,531,000

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

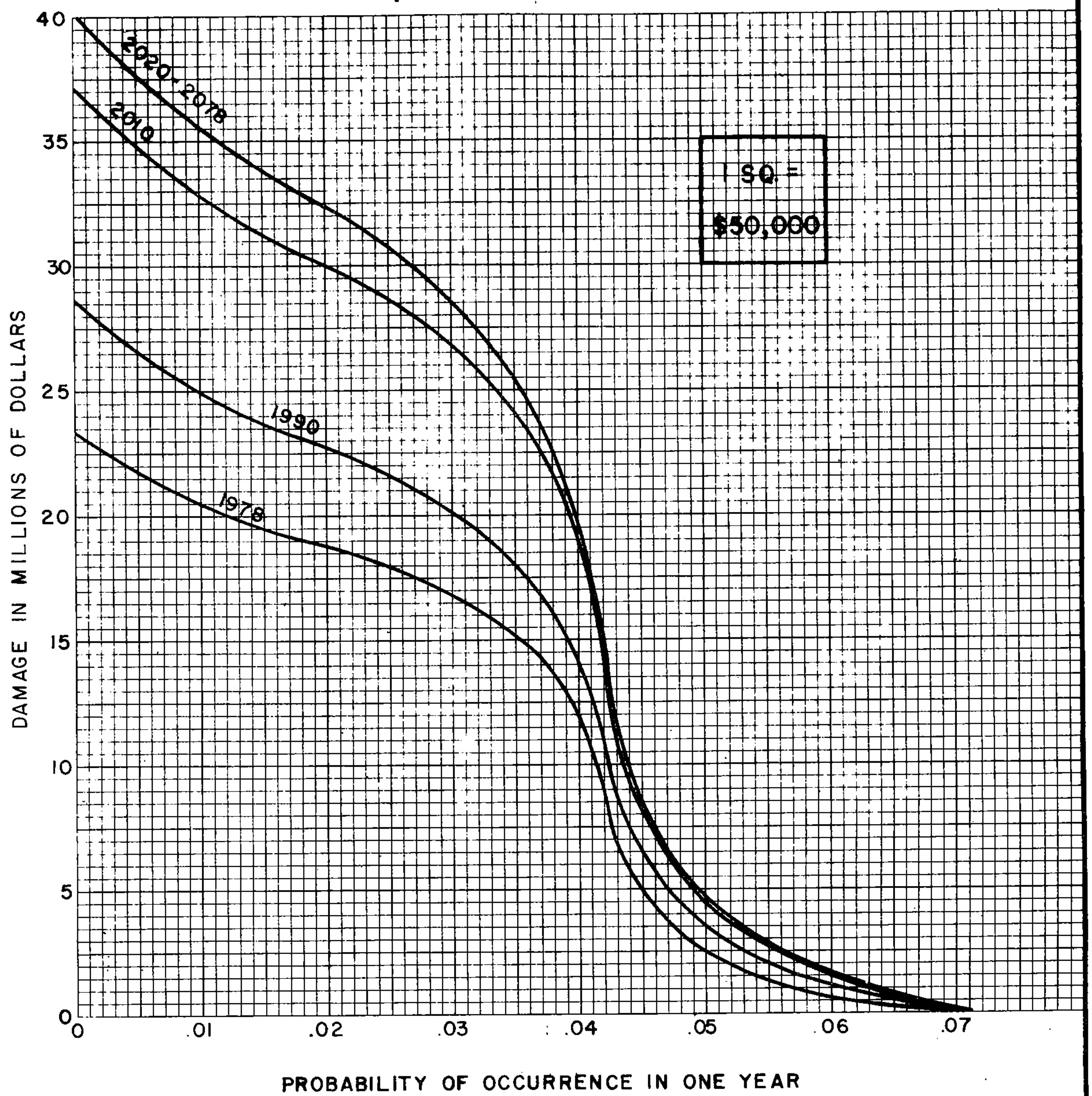
DAMAGE-PROBABILITY CURVES

REACH B2 (MILE 21.0 TO MILE 10.8)
WITHOUT AUTHORIZED PROJECT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-24



AVERAGE ANNUAL DAMAGES

1978 = 16.31 □ X $50,000 = $ 815,500
1990 = 20.05 □ X $50,000 = $1,002,500
2010 = 26.46 □ X $50,000 = $1,323,000
2020-2078 = 28.27 □ X $50,000 = $1,413,500

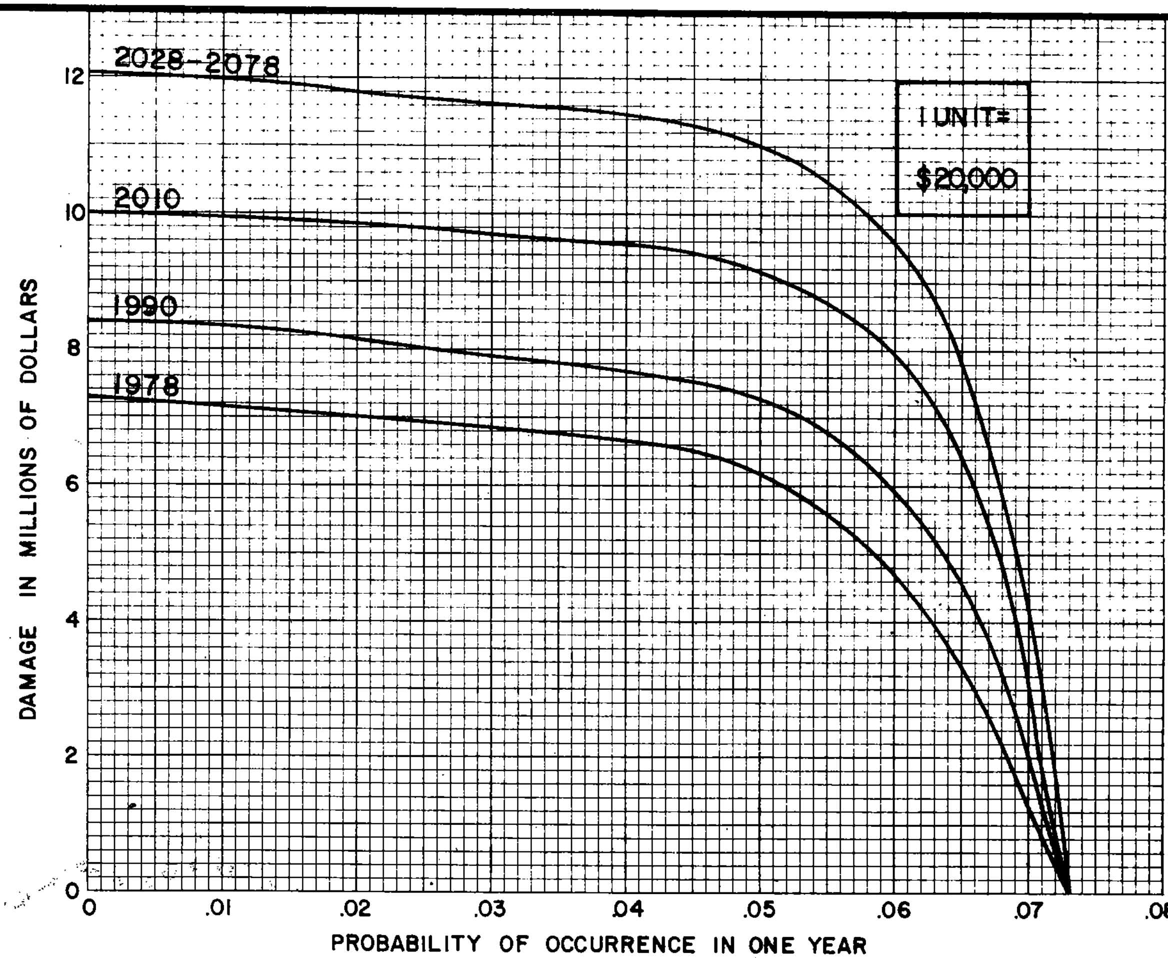
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B 1-TROPICAL BEND TO FORT JACKSON

DAMAGE - PROBABILITY CURVES

REACH B2 (MILE 21.0 TO MILE 10.8)
WITH AUTHORIZED BACK LEVEE IN PLACE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712



AVERAGE ANNUAL DAMAGES

1978 = 22.02 □ X $20,000 = $ 440,400
1990 = 26.11 □ X $20,000 = $ 522,200
2010 = 32.45 □ X $20,000 = $ 649,000
2028-2078 = 39.21 □ X $20,000 = $ 784,200

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO.1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

DAMAGE-PROBABILITY CURVES
REACH C

WITHOUT AUTHORIZED PROJECT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

PLATE B-26

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX C
DETAILED COST ESTIMATES
PART 1 - REACH B1
PART 2 - REACHES A, B2, C, AND EAST BANK
BARRIER LEVEE

APPENDIX C

TABLE OF CONTENTS

TABLES

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

PART 1
REACH B1

TABLE C-1
DETAILED ESTIMATE OF FIRST COST
REACH B1

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
11	Levees and floodwall				
	1. Levee embankment(all hydraulic clay)				
	a. Sta. 0+00 to sta. 98+81				
	(1) First lift (completed)				
	Mob. & demob.	-	Lump sum	-	65,000.00
	Hydraulic fill clay	533,276.0	cu.yd.	0.773	412,222.35
	Canal closures, shell	65,554.11	cu.yd.	3.62	237,305.88
	Channel excav.	53,426.0	cu.yd.	0.40	21,370.40
	Access nav.chan.	111,535.0	cu.yd.	0.358	39,929.53
	Fixed costs included in deleted work	-	Lump sum	-	3,630.00
	Subtotal				779,500.00[1]
	(2) Second lift				
	Mob. & demob.	-	Lump sum	-	25,000.00
	Clearing	57.0	acre	100.00	5,700.00
	Hydraulic fill clay	400,000.0	cu.yd.	1.10	440,000.00
	Shell dikes	16,000.0	cu.yd.	5.00	80,000.00
	Subtotal				550,700.00
	(3) Third lift				
	Mob. & demob.	-	Lump sum	-	25,000.00
	Clearing	57.0	acre	100.00	5,700.00
	Hydraulic fill clay	300,000.0	cu.yd.	1.10	330,000.00
	Shell(core for Doullut Canal)	15,000.0	cu.yd.	5.00	75,000.00
	Subtotal				435,700.00
	(4) First shape-up				
	Mob. & demob.	-	Lump sum	-	3,000.00
	Clearing	57.0	acre	100.00	5,700.00
	Shape-up(hydraulic material)	19,700.0	cu.yd.	0.50	9,850.00
	Subtotal				18,550.00

[1]Actual cost for completed work

TABLE C-1 (cont'd)

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
	(5) Final levee				
	Mob. & demob.	-	Lump sum	-	6,000.00
	Clearing	57.0	acre	100.00	5,700.00
	Shape-up (back levee degrading & 50% haul)	140,000.0	cu.yd.	0.75	105,000.00
	Seeding & fertilizing	24.0	acre	150.00	3,600.00
	Subtotal				120,300.00
	2. Levee embankment(sand core)				
	a. First lift				
	(1) Sta. 104+70 to sta. 340+20(under construction)				
	Mob. & demob.	-	Lump sum	-	72,775.00[1]
	Clearing	-	Lump sum	-	50,524.00[1]
	Hydraulic fill clay	1,642,500.0	cu.yd.	1.06	1,741,050.00[2]
	Hydraulic fill sand	1,495,576.0	cu.yd.	1.24	1,854,514.24[1]
	Shell dikes	65,930.69	cu.yd.	5.10	336,246.52[1]
	Excavation	1,548,810.0	cu.yd.	0.30	464,643.00[1]
	Development & utilization of add'l area for spoil of waste mat'l	-	Lump sum	-	225,040.10
	Subtotal				4,744,800.00
	(2) Sta. 339+00 to sta. 377+50(under construction)[3]				
	Mob. & demob.	-	Lump sum	-	1.00[1]
	Clearing	-	Lump sum	-	5,000.00[1]
	Hydraulic fill clay	284,000.0	cu.yd.	1.04	295,360.00[2]
	Hydraulic fill sand	395,005.0	cu.yd.	0.97	383,154.85[2]
	Shell dikes	4,275.0	cu.yd.	4.75	20,306.25[2]
	Excavation	187,225.0	cu.yd.	0.30	56,176.50[2]
	Subtotal				760,000.00
	(3) Sta. 377+50 to sta. 635+72.3				
	Mob. & demob.	2.0	contract	50,000	100,000.00
	Clearing	96.0	acre	200.00	19,200.00
	Hydraulic fill clay	2,429,600.0	cu.yd.	1.10	2,672,560.00
	Hydraulic fill sand	2,333,500.0	cu.yd.	1.25	2,916,875.00
	Shell dikes	33,900.0	cu.yd.	5.00	169,500.00
	Excavation	460,200.0	cu.yd.	0.30	138,060.00
	Subtotal				6,016,195.00

[1]Actual cost for completed work
[2]Bid price for work under construction
[3]Contracted by Plaquemines Parish

TABLE C-1 (cont'd)

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
	b. Final levee				
	Sta. 104+81 to sta. 635+72.3				
	Mob. & demob.	3.0	contract	5,000	15,000.00
	Clearing	497.0	acre	100.00	49,700.00
	Shape-up (12% hauling)	2,047,600.0	cu.yd.	0.55	1,126,180.00
	Seeding & fertilizing	365.0	acre	150.00	54,750.00
	Subtotal				1,245,630.00
	3. Foreshore protection				
	Riprap	52,000.0	ton	9.00	468,000.00
	Shell	8,300.0	cu.yd.	5.50	45,650.00
	Subtotal				513,650.00
	Subtotal levees (completed and work under contract-items 1a(1),2a(1), & 2a(2))				6,284,300.00
	Subtotal levees (future construction-items 1a(2), 1a(3), 1a(4), 1a(5), 2a(3), 2b, & 3)				8,900,725.00
	Contingencies (20%±)				1,767,975.00
	Subtotal				10,668,700.00
	Subtotal levee embankment & foreshore protection				16,953,000.00
	E&D (12%±)				2,038,000.00
	S&A (7%±)				1,187,000.00
	Total levee embankment (all hydraulic clay, sand core), foreshore protection				20,178,000.00
	4. Floodwall at pumping stations				
	a. Sunrise pumping station				
	Degrade existing back levee	16,000.0	cu.yd.	0.75	12,000.00
	Levee fill	12,000.0	cu.yd.	1.00	12,000.00
	Structure excavation	1,200.0	cu.yd.	2.50	3,000.00
	Structure backfill	950.0	cu.yd.	2.50	2,370.00
	Piling steel sheet MA-22	900.0	sq.ft.	4.50	4,050.00
	Piling steel sheet Z-27 (epoxy coated)	14,600.0	sq.ft.	6.00	87,600.00
	Piling concrete pre-stressed 12"x12"	1,000.0	lin.ft.	10.00	10,000.00
	Concrete in stab.slab	6.0	cu.yd.	50.00	300.00
	Concrete in T-wall base	50.0	cu.yd.	50.00	2,500.00

TABLE C-1 (cont'd)

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
	a. Sunrise pumping station (cont'd)				
	Concrete in walls	800.0	cu.yd.	100.00	80,000.00
	Portland cement	1,200.0	bbls.	5.50	6,600.00
	Steel reinforcement	78,800.0	lbs.	0.25	19,700.00
	Waterstops	400.0	lin.ft.	3.50	1,400.00
	Concrete slab removal	60.0	cu.yd.	30.00	1,800.00
	Compacted shell road	200.0	cu.yd.	8.50	1,700.00
	Riprap slope protection	300.0	tons	15.00	4,500.00
	Shell bedding layer	60.0	cu.yd.	8.00	480.00
	Subtotal a.				250,000.00
	b. Bayou Grand Liard pumping station				
	Test pile	-	Lump sum	-	10,000.00
	Degrade existing back levee	11,000.0	cu.yd.	0.75	8,250.00
	Levee fill	5,500.0	cu.yd.	1.00	5,500.00
	Structure excav.	1,000.0	cu.yd.	2.50	2,500.00
	Structure backfill	500.0	cu.yd.	2.50	1,250.00
	Piling, steel sheet MA-22	10,200.0	sq.ft.	4.50	45,900.00
	Piling steel sheet, Z-27 (epoxy coated)	7,800.0	sq.ft.	6.00	46,800.00
	Piling, concrete pre-stressed 12"x12"	7,200.0	lin.ft.	10.00	72,000.00
	Concrete stab.slab	40.0	cu.yd.	50.00	2,000.00
	Concrete in T-wall base	340.0	cu.yd.	50.00	17,000.00
	Concrete in walls	560.0	cu.yd.	100.00	56,000.00
	Portland cement	1,280.0	bbls.	5.50	7,040.00
	Steel reinforcement	104,800.0	lbs.	0.25	26,200.00
	Waterstops	314.0	lin.ft.	3.50	1,100.00
	Compacted shell road	146.0	cu.yd.	8.50	1,240.00
	Riprap slope protection	320.0	tons	15.00	4,800.00
	Shell bedding layer	65.0	cu.yd.	8.00	520.00
	Subtotal b.				308,100.00
	Subtotal floodwall (a&b)				558,100.00
	Contingencies (20%±)				112,500.00
	Subtotal floodwalls				670,600.00
	E&D (11.2%±)				75,400.00
	S&A (9.8%±)				66,000.00
	Total floodwalls				812,000.00

TABLE C-1 (cont'd)

Cost acct. No.	Item	Quantity	Unit	Unit price $	Total cost $
	5. Empire Floodgate (as shown in DM #2 - Detail Design - escalated to July 1971 prices)				2,312,000.00
	Contingencies (20%±)				462,000.00
	Subtotal floodgate construction cost				2,774,000.00
	E&D (11.4%±)				316,000.00
	S&A (10.2%±)				280,000.00
	Total floodgate				3,370,000.00
	Subtotal (items 1 thru 5)				18,055,125.00
	Subtotal contingencies				2,342,475.00
	Subtotal				20,397,600.00
	Subtotal E&D				2,429,400.00
	Subtotal S&A				1,533,000.00
	Total items 1 thru 5				24,360,000.00
	6. Lands and damages				
	a. Levee & borrow area R/W				
	Camp sites	1	acre	3,500.00	3,500.00
	Marshland	15	acre	300.00	4,500.00
	Marshland	104	acre	100.00	10,400.00
	Marshland	1,020	acre	50.00	51,000.00
	Improvements		Lump sum		36,500.00
	b. Construction easement				
	Landside of existing levee	113	acre	25.00	2,825.00
	Ponding area	2,490	acre	12.50	31,125.00
	c. Severances		Lump sum		322,000.00
	Subtotal				461,850.00
	Contingencies (20%±)				92,250.00
	Acquisition				62,500.00
	Total lands and damages				616,600.00

TABLE C-1 (cont'd)

Item	Quantity	Unit	Unit price	Total cost
			$	$
7. Relocations				
a. Pipelines				
4" Ø gas pipeline		Lump sum		17,300.00
8" Ø gas pipeline		Lump sum		40,200.00
20" Ø crude oil pipeline		Lump sum		185,000.00
12" Ø crude oil pipeline	2	each	36,400	72,800.00
6" Ø butane-propane pipeline		Lump sum		17,300.00
6" Ø gasoline pipeline		Lump sum		17,300.00
4" Ø fuel oil pipeline		Lump sum		12,400.00
6" Ø gas pipeline		Lump sum		24,600.00
Subtotal				386,900.00
Contingencies (20%±)				76,800.00
Subtotal construction cost				463,700.00
E&D (10.5%±)				48,500.00
S&A (7%±)				31,800.00
Total pipelines				544,000.00
b. Facilities				
Wholesale seafood outlet		Lump sum		30,650.00
Phillips Pet. Co. - Loading & unloading fac.		Lump sum		13,700.00
Esso Oil Co., fuel line & unloading dock		Lump sum		29,650.00
Docking fac. for shrimp boats		Lump sum		1,400.00
Boat launching fac.		Lump sum		29,000.00
Docking fac. for shrimp boats		Lump sum		11,600.00
Boat pier		Lump sum		1,400.00
Docking fac. for shrimp boats		Lump sum		21,500.00
Boat shed		Lump sum		2,500.00
Getty Oil Co. - fuel loading & boat dock		Lump sum		14,550.00
Boat yard		Lump sum		18,050.00
Subtotal facilities				174,000.00
Contingencies (20%±)				34,500.00
Subtotal construction cost				208,500.00
E&D (10.5%±)				21,800.00
S&A (7%±)				14,300.00
Total facilities				244,600.00
Total relocations				788,600.00

TABLE C-1 (cont'd)

Item	Quantity	Unit	Unit price	Total cost
			$	$
8. Pumping station modification				
a. Sunrise pumping station				
Modify two 36" Ø disch.pipes		Lump sum		7,000.00
b. Bayou Grand Liard pumping sta.				
Modify three 48" Ø disch.pipes		Lump sum		17,000.00
Subtotal				24,000.00
Contingencies (20%±)				4,800.00
Subtotal				28,800.00
E&D (11.2%±)				3,200.00
S&A (9.8%±)				2,800.00
Total pumping station modification				34,800.00
Total lands & damages and relocations				1,440,000.00
TOTAL PROJECT COST				25,800,000.00

TABLE C-2
APPORTIONMENT OF COST BETWEEN
FEDERAL & NON-FEDERAL INTERESTS FOR REACH B1

1. Project first cost

Construction	$24,360,000
Lands, damages, & relocations	1,440,000
Total	$25,800,000

2. Apportionment of cost

	Federal	Non-Federal
	70%	30%
	$18,060,000	$ 7,740,000
Less cost of lands & damages, relocations, & pumping station modifications		1,440,000
Subtotal cash contribution		$ 6,300,000
Less cost of 1st lift construction sta. 339+00 to sta. 377+50		-760,000
Cash contribution		$ 5,540,000

TABLE C-3

COST COMPARISON ESTIMATE INSIDE & OUTSIDE EMPIRE

REACH B1

Item	Quantity Inside	Quantity Outside	Unit	Unit price	Total cost Inside	Total cost Outside
				$	$	$
FEDERAL						
Levees & floodwall						
1. Levee embankment (haul)						
1st lift	384,070	-	cu.yd.	3.50	1,344,245	-
2d lift	132,947	-	cu.yd.	3.50	465,315	-
Shapeup	51,381	-	cu.yd.	0.50	25,690	-
Seeding & fertilizing	24.1	-	acre	150.00	3,615	-
2. Levee embankment (hydraulic)						
a. All hydraulic clay						
1st lift						
Hydraulic fill clay	291,298	347,000	cu.yd.	1.10	320,430	381,700
Canal closures - shell	-	65,555	cu.yd.	5.00	-	327,775
Excavation	-	53,426	cu.yd.	0.30	-	16,030
2d lift						
Hydraulic fill clay	63,400	260,000	cu.yd.	1.10	69,740	286,000
Dikes - shell	-	16,000	cu.yd.	5.00	-	80,000
3d lift						
Hydraulic fill clay	-	195,000	cu.yd.	1.10	-	214,500
Shell core for Doullut Canal	-	15,000	cu.yd.	5.00	-	75,000
1st shapeup	18,988	12,000	cu.yd.	0.50	9,500	6,000
Final levee	9,494	91,000	cu.yd.	(.50 inside) (.75 outside)	4,750	68,250
Seeding & fertilizing	16	13.6	acre	150.00	2,400	2,040
Foreshore protection			Lump sum			513,650

TABLE C-3 (cont'd)

COST COMPARISON ESTIMATE INSIDE & OUTSIDE EMPIRE (cont'd)

Item	Quantity Inside	Quantity Outside	Unit	Unit price	Total cost Inside	Total cost Outside
				$	$	$
b. Sand core						
1st lift						
Hydraulic fill clay	-	220,000	cu.yd.	1.10	-	242,000
Hydraulic fill sand	-	327,000	cu.yd.	1.25	-	408,750
Shell dikes	-	30,000	cu.yd.	5.00	-	150,000
Excavation	-	220,000	cu.yd.	0.30	-	66,000
Final levee	-	186,500	cu.yd.	0.55	-	102,575
Seeding & fertilizing	-	32	acre	150.00	-	4,800
3. Retaining dikes (cast)	77,101	Included in hyd. clay	cu.yd.	0.40	30,840	-
4. Floodwall (I-type)	388	-	lin.ft.	250.00	97,000	-
"	9,518	-	lin.ft.	300.00	2,855,400	-
5. Pumping station alteration	1	-	Lump sum	-	50,000	-
Structures						
1. Floodgate	-	1	Lump sum		-	2,312,000
2. Access gates through floodwall	8	-	each	30,000	240,000	-
3. Ramps over the levee	2	-	each	45,000	90,000	-
4. Highway crossings	2	-	each	75,000	150,000	-
5. Railroad crossings	2	-	each	36,000	72,000	-
Subtotal levees & floodwall and structures					5,830,925	5,257,070
Contingencies (20%±)					1,166,175	1,051,930
Subtotal construction cost					6,997,100	6,309,000
E&D (12%±)					839,800	758,000
S&A (7%±)					489,800	423,000
Total Federal cost					8,326,700	7,490,000

TABLE C-3 (cont'd)

COST COMPARISON ESTIMATE INSIDE & OUTSIDE EMPIRE (cont'd)

Item	Quantity Inside	Quantity Outside	Unit	Unit price $	Total cost Inside $	Total cost Outside $
NON-FEDERAL						
1. Lands & improvements						
Commercial sites	33	-	acre	18,300	603,900	-
Camp sites	-	1	acre	4,270	-	4,270
Marshland						
R/W	60	350	acre	50	3,000	17,500
Ponding area	120	120	acre	12.50	1,500	1,500
Improvements			Lump sum		363,600	43,000
Severance					140,300	-
Subtotal					1,112,300	66,270
Contingencies (20%±)					222,500	13,230
Acquisition cost					8,600	12,000
Subtotal lands & improvements					1,343,400	91,500
2. Relocations						
Pipeline modifications	10	-	each	750	7,500	-
Subtotal					7,500	-
Contingencies (20%±)					1,500	-
Subtotal					9,000	-
E&D (6%±)					540	-
S&A (4%±)					360	-
Subtotal relocations					9,900	-
Total non-Federal cost					1,353,300	91,500
Total cost					9,680,000	7,581,500

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

PART 2
REACHES A, B2, C, AND EAST BANK BARRIER LEVEE

TABLE C-4
DETAILED ESTIMATE OF FIRST COST
REACH A

Cost acct. No.	Item	Quantity	Unit	Unit price $	Total cost $
11	Levees and Floodwalls				
	Levee embankment				
	Cast	2,549,000	c.y.	0.70	1,784,300
	Haul	115,700	c.y.	4.00	462,800
	Hydraulic	1,000,000	c.y.	1.10	1,100,000
	Hydraulic (sand, shaping included)	4,350,000	c.y.	1.25	5,437,500
	Ponding area dike	1,071,750	c.y.	0.70	750,225
	Fertilizing & seeding	300	acre	150.00	45,000
	Mandatory excavations & stockpile	3,153,000	c.y.	0.35	1,103,500
	Subtotal				10,683,325
	Contingencies 25%±				2,723,675
	Subtotal levees				13,407,000
	Floodwalls				
	Freeport Sulphur docks				
	I-wall	1,500	l.f.	250.00	375,000
	T-wall	700	l.f.	400.00	280,000
	Homeplace pumping station		Lump sum		230,000
	Hayes pumping station		Lump sum		230,000
	Subtotal				1,115,000
	Contingencies 25%±				275,000
	Subtotal floodwalls				1,390,000
	Closure structures (Upper return levee)				
	Swing gate (RR crossing)		Lump sum		50,000
	Two overhead roller gates (highway crossing)		Lump sum		180,000
	Port Sulphur Canal floodgate		Lump sum		2,000,000
	Subtotal				2,230,000
	Contingencies 25%±				560,000
	Subtotal closure structures				2,790,000
	Subtotal levees and floodwalls				17,587,000
30	E&D 12%±				2,171,000
31	S&A 7%±				1,242,000
	Total levees and floodwalls				21,000,000

REACH A (cont'd)

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
01	Lands and damages				
	Land and improvements				
	Levee rights-of-way				
	Open land	3.5	acre	2,000.00	7,000
	Marshland	414	acre	50.00	20,700
	Marina	3.5	acre	32,000.00	112,000
	Marina	1.6	acre	35,000.00	56,000
	Improved land	9.0	acre	5,000.00	45,000
	Easements				
	Open land	2	acre	500.00	1,000
	Potential campsites	38	acre	25.00	950
	Marshland	2,393	acre	12.50	29,913
	Improvements		Lump sum		60,000
	Severance				20,000
	Subtotal				352,563
	Contingencies 20%±				69,937
	Acquisition cost				32,500
	Total land and improvements				455,000
02	Relocations				
	Utility crossings				
	36" gas pipeline		Lump sum		159,700
	30" gas pipeline		Lump sum		135,100
	26" gas pipeline		Lump sum		114,700
	2" gas pipeline		Lump sum		7,000
	4" water line		Lump sum		8,900
	6" gas pipeline		Lump sum		30,800
	10" oil pipeline		Lump sum		17,850
	Telephone and powerline		Lump sum		1,950
	2" water line		Lump sum		1,200
	12" water line	3	each	6,250.00	18,750
	6" gas pipeline		Lump sum		5,000
	12" gas pipeline		Lump sum		54,100
	20" oil pipeline		Lump sum		87,800
	12" oil pipeline		Lump sum		51,600
	Pumping station pipeline modifications				10,000
	Subtotal				704,450
	Contingencies 25%±				177,560
	Subtotal				882,000
	E&D 10.5%±				90,000
	S&A 7%±				63,000
	Total relocations				1,045,000
	Total project cost				22,500,000

TABLE C-5
APPORTIONMENT OF COST BETWEEN FEDERAL
AND NON-FEDERAL INTERESTS
REACH A

1. Project first cost

Construction		$21,000,000
Lands, damages, and relocations		1,500,000
Total		$22,500,000

2. Apportionment of cost

	Federal	Non-Federal
	70%	30%
	$15,750,000	$ 6,750,000
Less cost of lands, damages, and relocations		1,500,000
Cash contribution		$ 5,250,000

TABLE C-6
DETAILED ESTIMATE OF FIRST COST
REACH B2

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
11	Levees and floodwalls				
	Levee embankment				
	Mandatory excavation & stockpile	1,333,000	c.y.	0.35	466,550
	Hydraulic fill (sand, includes shaping)	3,580,000	c.y.	1.25	4,475,000
	Levee embankment(cast)	1,104,850	c.y.	0.70	773,400
	Levee embankment (hydraulic)	5,025,000	c.y.	1.10	5,527,500
	Levee shaping	1,333,000	c.y.	0.50	666,500
	Fertilizing & seeding	400	acre	150.00	60,000
	Ponding area dike	1,100,000	c.y.	0.70	770,000
	Subtotal				12,738,950
	Contingencies 25%±				3,244,050
	Subtotal levees				15,983,000
	Floodwalls				
	Venice pumping station		Lump sum		230,000
	Contingencies 25%±				54,000
	Subtotal pumping station				284,000
	Subtotal levees and floodwalls				16,267,000
30	E&D 12%±				2,033,000
31	S&A 7%±				1,200,000
	Total levees and floodwalls				19,500,000

REACH B2 (cont'd)

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
01	Lands and damages				
	Land and improvements				
	Levee rights-of-way				
	Open land	6	acre	500.00	3,000
	Marina	2.4	acre	30,000.00	72,000
	Marsh	266	acre	50.00	13,300
	Easements				
	Open land	1	acre	125.00	125
	Land landside of existing levee	30	acre	25.00	750
	Marsh	2,800	acre	12.50	35,000
	Marsh (borrow area)	450	acre	50.00	22,500
	Open land (borrow area)	15	acre	500.00	7,500
	Improvements		Lump sum		40,000
	Subtotal				194,175
	Contingencies 25%±				48,550
	Acquisition cost				23,275
	Total land and improvements				266,000
02	Relocations				
	Utility crossings				
	8" gas pipeline		Lump sum		26,400
	8" gas pipeline		Lump sum		19,700
	10" gas pipeline		Lump sum		25,000
	8" oil pipeline		Lump sum		31,500
	12" oil pipeline		Lump sum		46,700
	6" oil pipeline		Lump sum		23,400
	12" gas pipeline		Lump sum		50,700
	Pumping station pipeline modification				5,000
	Subtotal relocations				228,400
	Contingencies 25%±				54,600
	Subtotal				283,000
	E&D 10.5%±				30,000
	S&A 7%±				21,000
	Total relocations				334,000
	Total project cost				20,100,000

TABLE C-7
APPORTIONMENT OF COST BETWEEN FEDERAL
AND NON-FEDERAL INTERESTS
REACH B2

1. Project first cost

Construction	$19,500,000
Lands, damages, and relocations	600,000
Total	$20,100,000

2. Apportionment of cost

	Federal	Non-Federal
	70%	30%
	$14,070,000	$ 6,030,000
Less cost of lands, damages, and relocations		600,000
Cash contribution		$ 5,430,000

TABLE C-8
DETAILED ESTIMATE OF FIRST COST
REACH C

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
11	Levees and floodwall				
	First lift levee (14' el., includes drainage structures)		Lump sum		6,104,428.00[1]
	Drainage ditch		Lump sum		300,000.00[2]
	Second lift levee				
	Levee embankment	925,000	c.y.	1.65	1,526,250.00
	Manhole modification	job	Lump sum		10,050.00
	Clearing	350	acre	75.00	26,250.00
	Seeding & fertilizing	450	acre	150.00	67,500.00
	Subtotal (second lift)				1,630,050.00
	Contingencies 20%±				333,522.00
	Subtotal (second lift)				1,963,572.00
	Subtotal (first & second lifts)				8,368,000.00
	E&D 9.3%±				780,000.00
	S&A 7%±				587,000.00
	Total levees and floodwalls				9,735,000.00
01	Lands and damages				
	Lands and improvements (July 1967 price levels)				
	Rights-of-way	90	acre	250.00	22,500.00
	Rights-of-way	368	acre	500.00	184,000.00
	Construction easement	30	acre	62.50	1,875.00
	Construction easement	105	acre	125.00	13,125.00
	Construction easement	140	acre	50.00	7,000.00
	Severance	None			-
	Severance	None			-
	Subtotal				228,500.00
	Contingencies 20%±				45,100.00
	Acquisition costs				32,400.00
	Total lands and damages				306,000.00

Cost acct. No.	Item	Quantity	Unit	Unit price $	Total cost $
02	Relocations				
	First lift levee relocations				
	Pipelines				
	Texas Pipeline Company				
	6" pipeline		Lump sum		6,960.00
	United Gas Pipeline Company				
	Two 2", one 8", & one 20" pipelines		Lump sum		121,250.00
	United Texas Petroleum Corp.				
	3" pipeline		Lump sum		12,990.00
	Perry R. Bass, Inc.				
	Three 2", one 3", five 4", two 6", & one 14" pipelines		Lump sum		332,160.00
	Southern Natural Gas Company				
	One 8" and one 20" pipelines		Lump sum		289,440.00
	Powerlines				
	Distribution line		Lump sum		4,800.00
	Transmission line		Lump sum		3,800.00
	Total pipelines and powerlines				771,400.00[3]
	Access bridges	8	each	20,575.00	202,900.00
		2	each	7,000.00	14,000.00
	Subtotal				216,900.00
	Contingencies 10%±				23,700.00
	Subtotal				240,600.00
	E&D 10%±				25,000.00
	S&A 8%±				19,000.00
	Total bridges				284,600.00
	Total relocations first lift				1,056,000.00
	Second lift levee relocations				
	6" pipeline	350	l.f.	30.00	10,500.00
	2" water line	300	l.f.	3.30	1,000.00
	Distribution line	4,200	l.f.	0.80	3,500.00
	Ramp and road crossing	90,000	c.y.	2.20	198,000.00
	Subtotal				213,000.00
	Contingencies 20%±				44,500.00
	Subtotal				257,500.00
	E&D 10%±				25,800.00
	S&A 8%±				19,700.00
	Total second lift levee relocations				303,000.00
	Total lands, damages, and relocations				1,665,000.00
	Total Federal and non-Federal cost				11,400,000.00

[1]Represents Contractor's bid price for work approved for levee construction performed under contract between the Louisiana Department of Highways, an agent for the Plaquemines Parish Commission Council, and the joint-venture, Atlas Construction Company-Jahncke Service, Inc., in 1966-68.

[2]Represents Government estimate for drainage canal construction done by the Louisiana Department of Highways prior to the levee contract.

[3]Represents Contractor's bid prices for relocations relating to levee construction, performed under contract between the Louisiana Department of Highways, an agent for the Plaquemines Parish Commission Council, and the utility owners shown under pipeline relocations.

TABLE C-9
APPORTIONMENT OF COST BETWEEN FEDERAL
AND NON-FEDERAL INTERESTS
REACH C

1. Project first cost

Construction	$ 9,735,000
Lands, damages, and relocations	1,665,000
Total	$11,400,000

2. Apportionment of cost

	Federal	Non-Federal
	70%	30%
	$7,980,000	$ 3,420,000
Less cost of lands, damages, and relocations		1,665,000
Cash contribution		$ 1,755,000

TABLE C-10
DETAILED ESTIMATE OF FEDERAL FIRST COST
FOR
THE EAST BANK BARRIER LEVEE PLAN

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
	East Bank Section				
11	Levees and floodwalls				
	Levee embankment				
	Cast (side borrow)	4,884,000	c.y.	0.75	3,663,000
	Haul (avg. 500')	51,500	c.y.	1.25	64,375
	Shaping, fertilizing, & seeding (berm area not included)	420	acre	300.00	126,000
	Clearing & grubbing	128	acre	200.00	25,600
	Foreshore protection				
	Shell base (4' access water)	2,700	c.y.	4.50	12,150
	Riprap (4' access water)	16,800	ton	7.00	117,600
	Berm revetment				
	Shell base (6' access water)	260	c.y.	4.50	1,170
	Riprap (6' access water)	520	ton	7.00	3,640
	Subtotal				4,013,535
	Contingencies 20%±				786,765
	Subtotal levees				4,800,300
	Drainage structures				
	36" CMP (lined)	225	ft.	36.00	9,180
	36" flap gate (C.I.)	1	ea.	600.00	600
	Subtotal				9,780
	Contingencies 20%±				1,920
	Subtotal drainage structures				11,700
	Foreshore protection		Lump sum		1,722,000
	Contingencies 20%±				344,000
	Subtotal foreshore protection				2,066,000

TABLE C-10 (cont'd)

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
11	Levees and floodwalls (cont'd)				
	Subtotal levees & floodwalls				6,878,000
	E&D 10.0%±				685,000
	S&A 7.8%±				536,000
	Total levees & floodwalls				8,099,000
	Structures				
	Bohemia salinity control structure		Lump sum		147,000
	Contingencies 20%±				29,000
	Subtotal Bohemia structure				176,000
	Bayou Lamoque fresh-water diversion structure		Lump sum		38,500
	Contingencies 20%±				7,500
	Subtotal Bayou Lamoque structure				46,000
	Little Coquille salinity control structure		Lump sum		122,000
	Contingencies 20%±				24,000
	Subtotal Little Coquille structure				146,000
	Ostrica floodgate		Lump sum		1,722,000
	Contingencies 20%±				344,000
	Subtotal Ostrica floodgate				2,066,000
	Subtotal structures				2,434,000
	E&D 11.9%±				290,000
	S&A 10.3%±				250,000
	Total structures				2,974,000
	Total 11 Acct.				11,073,000
01	Lands and improvements	1,945.5	acre	varies	415,000
	Contingencies 20%±				83,000
	Real estate hired labor costs				2,000
	Acquisition cost by others				14,000
	Total lands and improvements				514,000

TABLE C-10 (cont'd)

Cost acct. No.	Item	Quantity	Unit	Unit price	Total cost
				$	$
02	Relocations				
	Powerlines, 34,000 volt 4 wires on 45-ft. marsh poles	39,000	ft.	3.50	136,500
	Powerline-levee crossings	4	ea.	1,000.00	4,000
	Transformer switching facilities	1	ea.	5,000.00	5,000
	Communication lines mounted on powerlines	2,000	ft.	2.00	4,000
	Buried cable (18" depth)	15,000	ft.	2.00	30,000
	Subtotal relocations				179,500
	Contingencies 20%±				35,500
	Total relocations				215,000
	Total East Bank section				11,802,000
	West Bank Section				
11	Levees and floodwalls				
	Levee embankment (barge)	238,000	c.y.	2.50	595,000
	Clearing and grubbing	100	acres	100.00	10,000
	Fertilizing and seeding	100	acres	150.00	15,000
	Subtotal				620,000
	Contingencies 20%±				127,000
	Subtotal levees and floodwalls				747,000
30	Engineering and design 10%±				74,000
31	Supervision and administration 7.8%±				64,000
	Total levees and floodwalls				885,000
01	Lands	7.6	acres	6,100.00	46,360
		8.4	acres	7,800.00	65,520
		3.0	acres	22,000.00	66,000
	Subtotal				177,880
	Contingencies 20%±				35,120
	Total				213,000
	Total West Bank section				1,098,000
	Total East Bank Barrier levee plan				12,900,000

TABLE C-11

APPORTIONMENT OF COST BETWEEN
FEDERAL AND NON-FEDERAL INTERESTS
EAST BANK BARRIER LEVEE PLAN

1. Project first cost

Construction	$11,958,000
Lands, damages, and relocations	942,000
Total	$12,900,000

2. Apportionment of cost

	Federal	Non-Federal
	70%	30%
	$9,030,000	$3,870,000
Less cost of lands, damages, and relocations		942,000
Cash contribution		$2,928,000

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX D

COMMENTS OF U. S. FISH AND WILDLIFE SERVICE
AND
LOUISIANA WILD LIFE AND FISHERIES COMMISSION

United States Department of the Interior
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
PEACHTREE-SEVENTH BUILDING
ATLANTA, GEORGIA 30323

April 30, 1971

District Engineer
U.S. Army, Corps of Engineers
P.O. Box 60267
New Orleans, Louisiana 70160

Dear Sir:

Reference is made to your letter of March 15, 1971, requesting our comments relative to a recent modification of the proposed levee location in Reach B-1 of the New Orleans to Venice, Louisiana, Hurricane Protection project.

Our most recent comments concerning this portion of the levee were transmitted in our letter of March 15, 1968. At that time, the proposed alignment of the levee in Reach B-1 was to roughly coincide with the existing back levee, except at Empire where the levee would be constructed marshward. The levee from Buras to Fort Jackson was to be shifted marshward from the existing levee to enlarge the protected area. A navigation canal would parallel the levee between Empire and Buras.

The current plan for Reach B-1 provides for the hurricane protection levee to be located generally along the existing back levee, except at Empire where the levee will be constructed marshward of the existing levee. The plan provides for a navigation gate in the levee at Empire and a navigation channel connecting the Empire and Buras areas. At the request of the Plaquemines Parish Commission Council, the levee between Buras and Fort Jackson will be constructed along the existing back levee with the Buras floodgate eliminated.

Our comments concerning the fish and wildlife aspects of the proposed Reach B-1 levee were adequately considered in previous reports from this office. We do note, however, that location of the proposed Buras to Fort Jackson levee to coincide with the existing back levee will encompass considerably less marsh habitat than the original plan. Construction of the levee in this location will therefore be less damaging to fish and wildlife resources.

1871 1971

The opportunity to provide these comments for inclusion in the revised general design memorandum is appreciated. Should further assistance be needed, please reply.

Sincerely yours,

C. Edward Carlson

C. Edward Carlson
Regional Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
PEACHTREE-SEVENTH BUILDING
ATLANTA, GEORGIA 30323

November 29, 1965

CE-LM-po

District Engineer
U. S. Army, Corps of Engineers
New Orleans, Louisiana

Dear Sir:

This is in reply to your letter of July 27, 1965, requesting our views and comments on the fish and wildlife aspects of the modified plan of protection for Reach B-1 of your Hurricane Study Area II at and below New Orleans, Louisiana. The Bureau's comments, submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), have been prepared in cooperation with the Louisiana Wild Life and Fisheries Commission.

The Bureau provided you with a letter, dated February 7, 1963, concerning Reaches A, B, and C. Our information at that time indicated that plans for Reach B would have been accomplished by the enlargement of the existing back levee system. We are now advised that Reach B has been subdivided into B-1 and B-2, and you are now proceeding with detailed planning of B-1. Your most recent plan for development involves shifting the original levee alignment to enlarge the protected area. This plan includes a navigation channel paralleling the levee between Empire and Buras, Louisiana, and floodgates in the levee at Empire and Buras designed to handle boat passage. The floodgates would remain open except during storms of hurricane intensity (plate 1).

The marshes south of the project area are very important for oyster production, crabbing, shrimping, sport fishing, and hunting. The water bottom of Adams Bay, which lies directly adjacent to the proposed levee, is almost entirely leased for oyster production.

Review of the proposed plans discloses that the levee embankment will block several waterways now providing hunting and fishing access. The major closure occurs in the waterway between Empire and the Gulf of Mexico. However, it is our understanding that access to these waterways will be provided so that existing navigation patterns will not be disrupted.

The magnitude of adverse effects on fish and wildlife stemming from the project will depend upon the manner in which dredging, spoil handling, and spoil disposal is accomplished. According to information provided, hydraulic dredging will be used in the segment from near Buras to the existing levee near Fort Jackson. This could create conditions detrimental to fish and wildlife unless spoil is controlled. In these coastal lowlands, movement of spoil effluents from hydraulic dredging may be widespread, blanketing large areas of adjacent marshlands and causing extensive shoaling and siltation in open water areas. Such conditions could cause particular damage to the oyster industry.

Every effort should be made to preserve this important fish and wildlife habitat. In order to reduce siltation from project construction, spoil from hydraulic dredging should be contained by retention dikes. Spillways for discharging excess water from spoil areas should be located as far from the point of spoil discharge as possible, and should be designed with a crest at the highest feasible elevation so as to minimize refluxing of spoil.

The Bureau therefore recommends that, in order to minimize adverse project effects on fish and wildlife resources, your final plans for hydraulic dredging provide the following spoil-control measures:

1. Adequate spoil dikes with effective spillways.

2. Careful handling to prevent refluxing.

The Louisiana Wild Life and Fisheries Commission and the Bureau of Commercial Fisheries have reviewed this report and have indicated concurrence. We have attached a copy of Director Hair's letter concerning the project. You will note the particular concern he expresses about possible damages to oysters and needed precautionary measures.

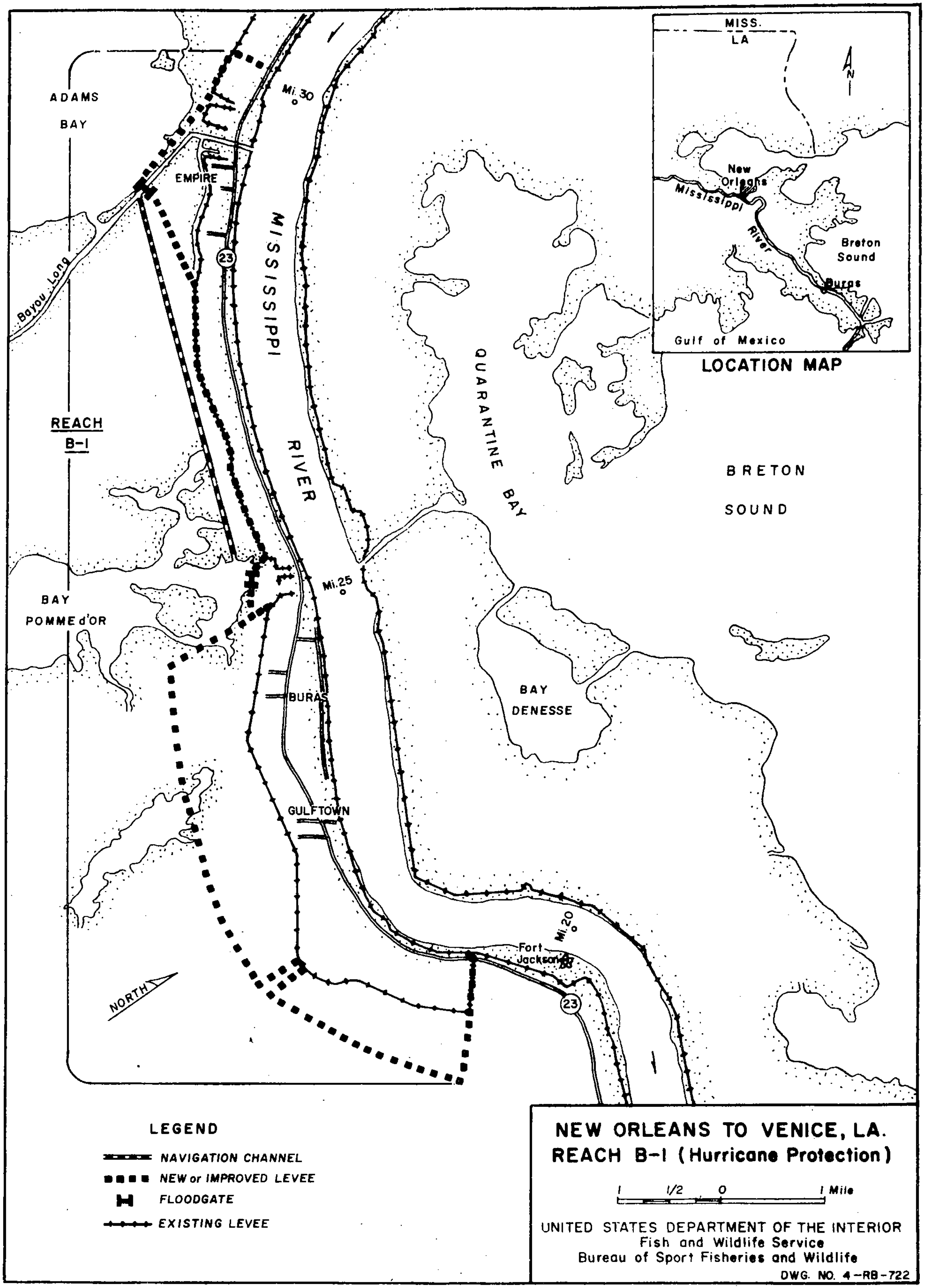
We appreciate the opportunity to cooperate in the planning for Reach B-1 of the Hurricane Study Area at and below New Orleans, and our personnel will be available for further assistance as may be required.

Sincerely yours,

Walter A. Gresh

Walter A. Gresh
Regional Director

Attachments 2



ADAMS BAY
EMPIRE
Bayou Long
Mi. 30
23
MISSISSIPPI RIVER
REACH B-I
QUARANTINE BAY
BRETON SOUND
BAY POMME d'OR
Mi. 25
BURAS
BAY DENESSE
GULFTOWN
Mi. 20
Fort Jackson
NORTH
MISS.
LA
N
New Orleans
Mississippi River
Breton Sound
Buras
Gulf of Mexico
LOCATION MAP
LEGEND
NAVIGATION CHANNEL
NEW or IMPROVED LEVEE
FLOODGATE
EXISTING LEVEE
NEW ORLEANS TO VENICE, LA.
REACH B-I (Hurricane Protection)
1 1/2 0 1 Mile
UNITED STATES DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife
DWG. NO. 4-RB-722

PLATE I

LOUISIANA WILD LIFE AND FISHERIES COMMISSION
P. O. BOX 44095
CAPITOL STATION
BATON ROUGE, LOUISIANA 70804

July 21, 1971

District Engineer
United States Army Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160

Dear Sir:

Reference is made to your letter of April 2, 1971, requesting our comments on the proposed modification in the plan for Reach B-1 of the New Orleans to Venice Hurricane Protection project.

We wish to concur with the comments of the Bureau of Sport Fisheries and Wildlife in their letter of April 30, 1971 to you.

We appreciate the opportunity to review and comment on these revisions in the design of the project.

Sincerely yours,

Clark M. Hoffpauer

Clark M. Hoffpauer
Director

CMH:REM/ib

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1, GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX E

STRUCTURAL DESIGN CALCULATIONS

PROJECT	Page	COMPUTED BY	DATE
NEW ORLEANS TO VENICE- REACH B-1	Page 1 of 2	H.C.A	06-01-71
SUBJECT		**CHECKED BY**	**DATE**
SUNRISE PUMING STATION		DAM	06-8-71

WAVE LOADING (From TR-4) I-WALL & T-WALL

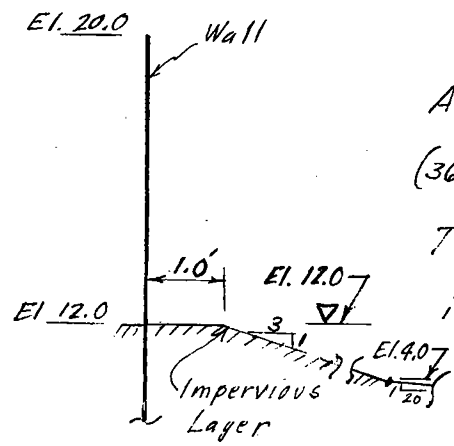
Design for max. 1% wave $H_1' = 1.67 \times 3.2 = 5.34'$

$H_1 = 1.67 \times 3.1 = 5.18'$

$d_b = 0.667 (H_1' T)^{2/3} = 5.30'$ (Form. 1-38)

$T = 4.2$ sec

$L_0 = 90.3$



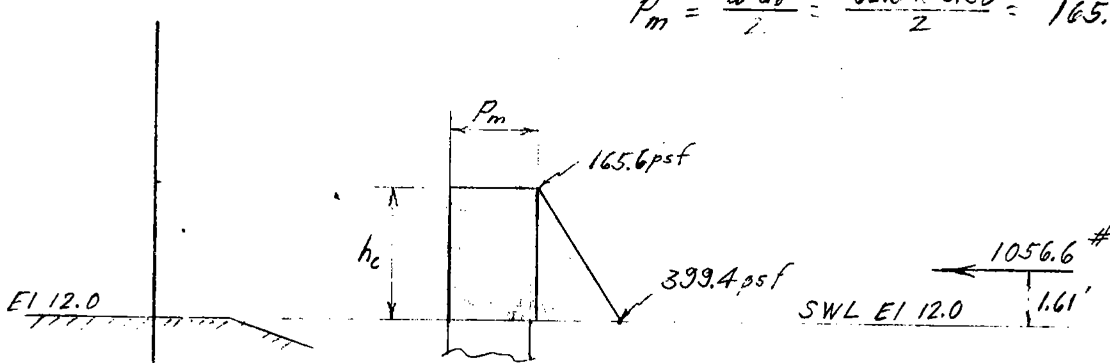
At seven breaker heights from wall (36') water depth is $8.5' > d_b$. Therefore assume 1% standing wave is possible at wall. Breaking wave will not act on the total structure (See WES Research Report H-68-2).

Critical loading is from standing or broken wave.

Check Broken Wave

$H_1' = 5.34$ $h_c = 0.7 H_1' = 3.74'$

$P_m = \frac{w\, d_b}{2} = \frac{62.5 \times 5.30}{2} = 165.6$ psf.



Pressure Diagram

Resultant

WAVE LOADING CONT'D   I-WALL & T-WALL

Check Standing Wave

Average water depth = fetch depth = d = 6.7'

$L_o = 90.3'$ $H_1 = 5.18'$ SWL = El. 12.0

$$\frac{2\pi d}{L_o} = 0.466$$

$$\sinh \frac{2\pi d}{L_o} = \frac{1.5936 - 0.6275}{2} = 0.483$$

$$\cosh \frac{2\pi d}{L_o} = \frac{1.5936 + 0.6275}{2} = 1.111$$

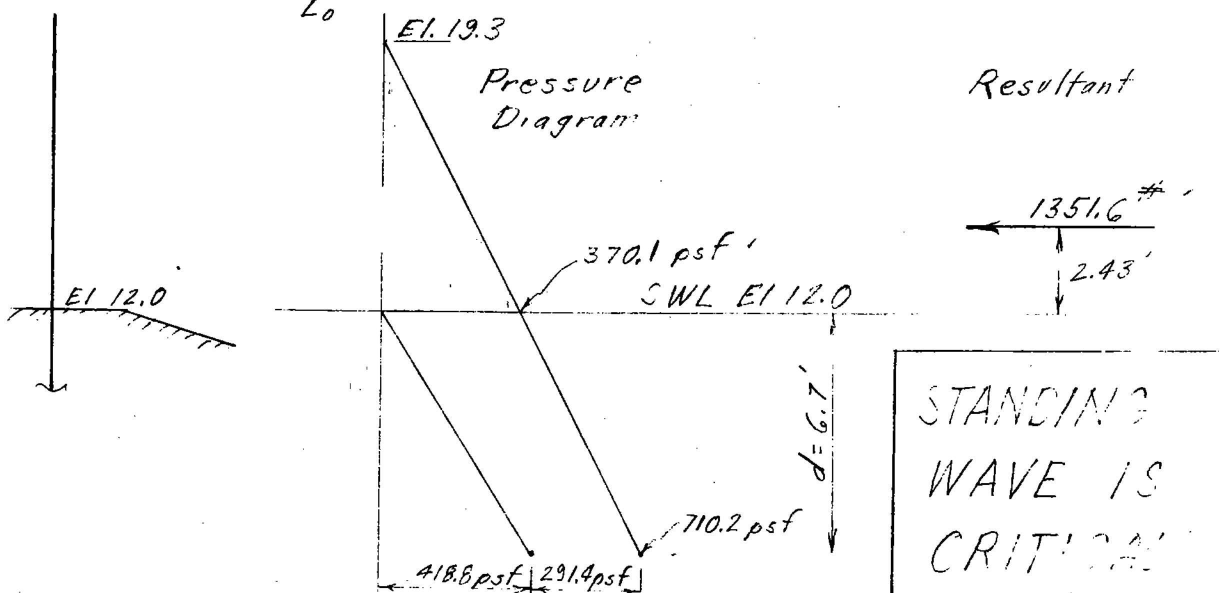
$$\tanh \frac{2\pi d}{L_o} = \frac{0.483}{1.111} = 0.435$$

$$\coth \frac{2\pi d}{L_o} = \frac{1}{0.435} = 2.300$$

$$h_o = \frac{\pi H_1^2}{L_o} \coth \frac{2\pi d}{L_o} = \frac{3.1416 \times \overline{5.18}^2}{90.3} \times 2.3 = 2.15'$$

Elev. of top of pressure diagram = SWL + H_1 + h_o = El. 19.3

$$P_1 = \frac{w H_1}{\cosh \frac{2\pi d}{L_o}} = \frac{62.5 \times 5.18}{1.111} = 291.4 \text{ psf}$$



STANDING WAVE IS CRITICAL

PROJECT NEW ORLEANS TO VENICE - REACH B-1	Page 1 of 2	COMPUTED BY H.C.A	DATE 06-?3-71
SUBJECT BAYOU GRAND LIARD PUMPING STATION		CHECKED BY DAM	DATE 06-08-71

WAVE LOADING (From TR-4) T-WALL

Design for max. 1% wave

$H_1' = 1.67 \times 3.2 = 5.34$

$H_1' = 1.67 \times 3.1 = 5.18'$

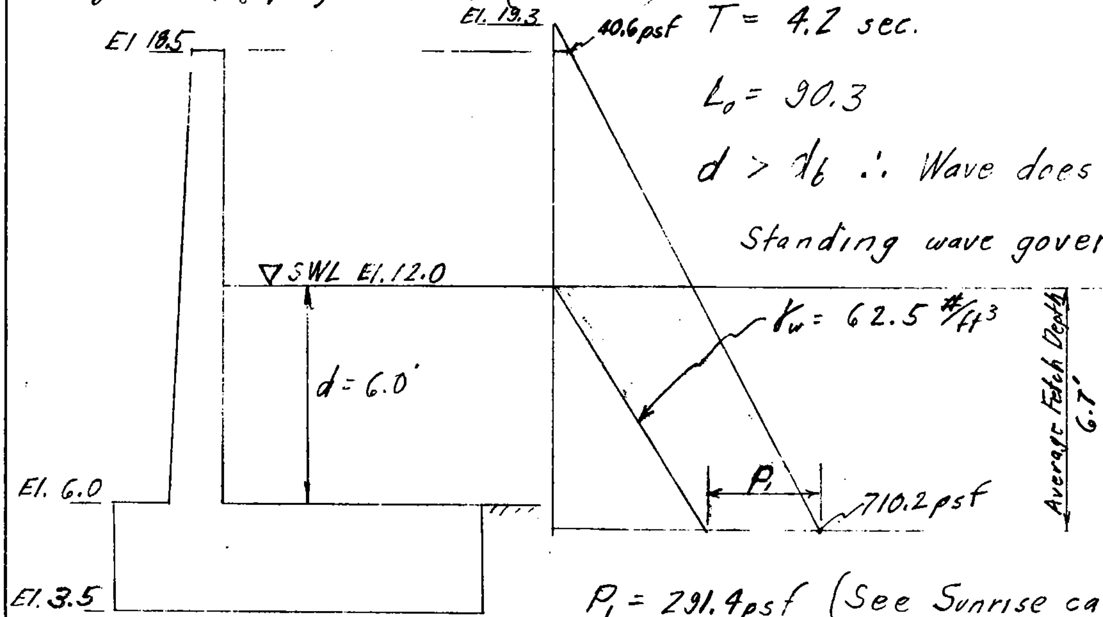
$d_b = 0.667 (H_1' T)^{2/3} = 5.30'$ (Form 1-38)

$T = 4.2$ sec.

$L_0 = 90.3$

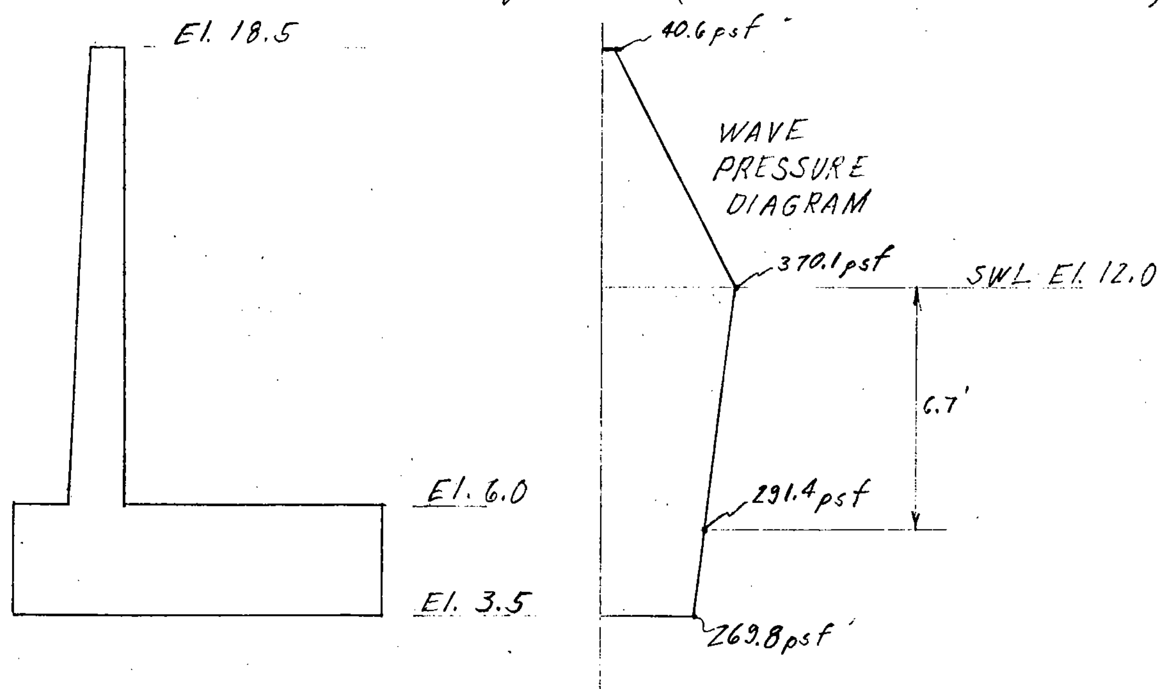
$d > d_b$ ∴ Wave does not break

Standing wave governs



$P_1 = 291.4$ psf (See Sunrise calculations)

$h_0 = 2.15'$ (See Sunrise calculations)



PROJECT		COMPUTED BY	DATE
NEW ORLEANS TO VENICE - REACH B-1	Page 2 of 2	H.C.A	06-11-71
SUBJECT BAYOU GRAND LIARD PUMPING STATION		CHECKED BY DQM	DATE 06-11-71

WAVE LOADING (From TR-4) I-WALL

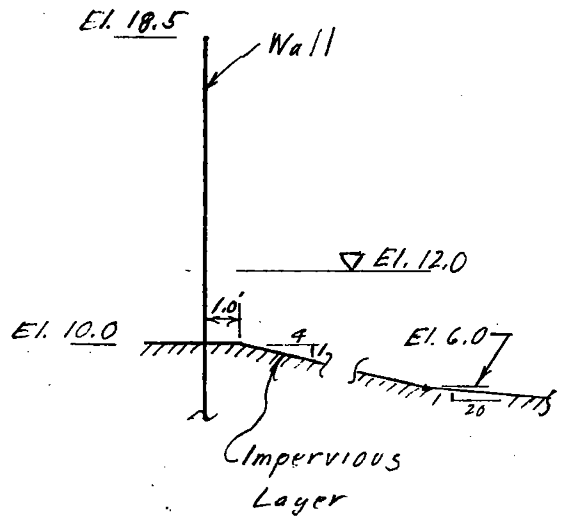
Design for max. 1% wave

$T = 4.2$ sec $L_o = 90.3$

$H_1' = 1.67 \times 3.2 = 5.34$

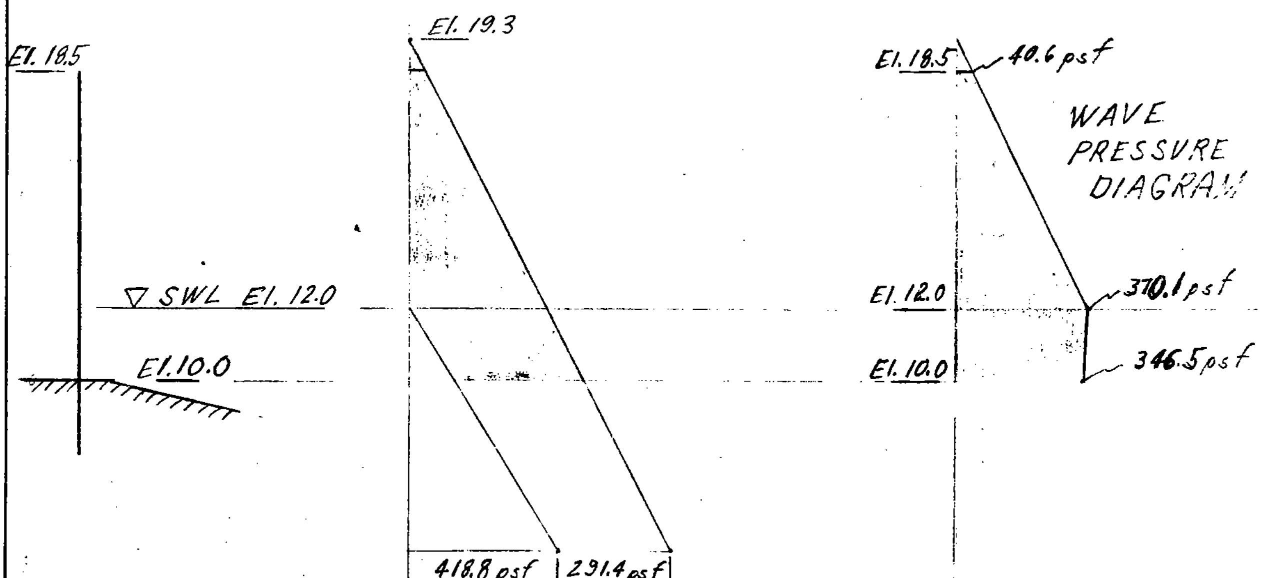
$H_1 = 1.67 \times 3.1 = 5.18$

$d_b = 0.667 (H_1' T)^{\frac{2}{3}} = 5.30'$ (Form. 1-38)



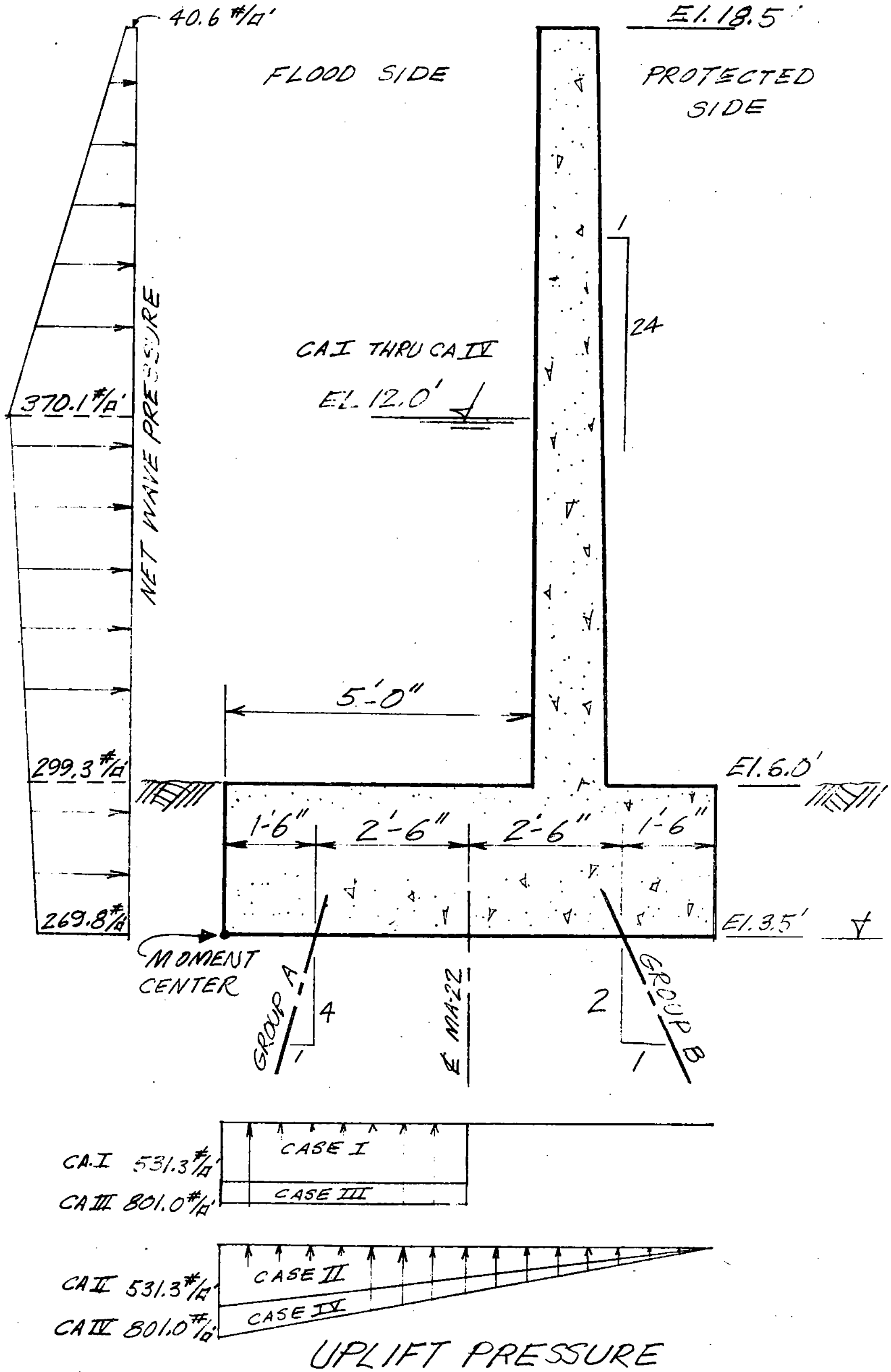
At seven breaker heights from wall (36') water depth is 7.0' > d_b. Therefore assume 1% standing wave is possible at wall. Breaking wave will not act on the total structure (See WES Research Report H-68-2)

Critical loading is from standing or broken wave.
Standing wave is larger by observation. (See Sunrise calculations)



PROJECT		COMPUTED BY	DATE
GRAND LAIRD PUMPING STATION	Page 1 of 7	EJM	8 JUNE 71
SUBJECT		**CHECKED BY**	**DATE**
T WALL - CONCRETE DESIGN		H.C.A.	10 JUNE 71

TYPICAL "T" WALL DESIGN (ALL LOADS ARE PER FOOT OF WALL)



PROJECT		COMPUTED BY	DATE
GRAND LAIRD PUMPING STATION	Page 2 of 7	EVM	7 JUN 71
SUBJECT "T"-WALL – CONCRETE DESIGN		CHECKED BY H.C.A	DATE 10 JUNE 71

RESULTANT FORCES + MOMENTS ON "T" WALL

LOADING CASES

CASE I : F.S. El. 12.0, P.S. El. 3.5, NO SOIL LOAD
IMPERVIOUS SHEET PILING, NO WAVE LOAD

CASE II : SAME AS CASE I EXCEPT PERVIOUS SHEET PILE

CASE III : F.S. El. 12.0, P.S. El. 3.5, NO SOIL LOAD
IMPERVIOUS SHEET PILING, WITH WAVE LOAD

CASE IV : SAME AS CASE III EXCEPT PERVIOUS SHEET PILE

CASE I

ITEM	CALCULATION	V KIP	H KIP	X OR Y	M KIP-FT
WALL STEM	.150(12.5)	1.875		5.5	10.313
" "	.150(12.5)(.52)(.5)	0.488		6.17	3.011
BASE SLAB	.150(8)(2.5)	3.000		4.00	12.000
V. WATER	.0625(5)(6)	1.875		2.50	4.688
H. WATER	$.0625(8.5)^2(.5)$		2.258	2.83	6.397
UPLIFT(I)	.0625(8.5)(4)	-2.125		2.00	-4.250
		5.113	2.258		32.159

CASE II

ITEM	CALCULATION	V KIP	H KIP	X OR Y	M KIP-FT
CASE I		5.113	2.258		32.159
- UPLIFT(I)		2.125			4.250
UPLIFT(II)	.0625(8.5)(8)(.5)	-2.125		2.67	-5.671
		5.113	2.258		30.738

CASE III ①

ITEM	CALCULATION	V KIP	H KIP	X OR Y	M KIP-FT
CASE I		5.113	2.258		32.159
-UPLIFT(I)		2.125		2.00	4.250
V. WAVE	.2993(5)	1.496		2.5	3.741
H. WAVE	.0406(6.5)		0.264	11.75	3.102
" "	.3295(6.5)(.5)		1.071	10.67	11.427
" "	.2698(8.5)		2.293	4.25	9.745
" "	.1003(8.5)(.5)		0.426	5.67	2.417
UPLIFT(III)	(.2698+.5313)(4)	-3.204		2.00	-6.408
		5.547	6.312		60.433

CASE IV ①

ITEM	CALCULATION	V KIP	H KIP	X OR Y	M KIP-FT
CASE III		5.547	6.312		60.433
-UPLIFT(III)		3.204			6.403
UPLIFT(IV)	.801(8)(.5)	-3.204		2.67	-8.555
		5.547	6.312		58.286

① TO ALLOW FOR A 33 1/3 % INCREASE IN ALLOWABLE STRESSES WHEN GROUP II LOADS WERE INVESTIGATED, THE ACTUAL GROUP II LOADS ABOVE WERE REDUCED BY 25% AND THE SAME ALLOWABLE STRESSES WERE USED IN ALL CASES TO OBTAIN THE PILE LOADINGS.

PILE LOADS WERE COMPUTED BY THE HRENNIKOFF METHOD ② OF ANALYSIS OF PILE FOUNDATIONS WITH BATTER PILES UTILIZING A G.E. 400 DATA PROCESSING SYSTEM.

② PAPER NO. 2401 OF A.S.C.E. TRANSACTIONS - "ANALYSIS OF PILE FOUNDATIONS WITH BATTER PILES" BY A. HRENNIKOFF.

A SUMMARY OF THE CRITICAL PILE LOADS IS TABULATED BELOW.

COMPUTED PILE LOADS BY HRENNIKOFF METHOD				
CASE NO.	GROUP A		GROUP B	
	AXIAL	TRANSVERSE	AXIAL	TRANSVERSE
I	.233 k	.047 k	5.436 k	.0793 k
II	.503 k	-.0477 k	5.17 k	-.024
III*	-3.747	.0166	8.693	.0519
IV*	-3.459	-.0846	8.409	-.0586

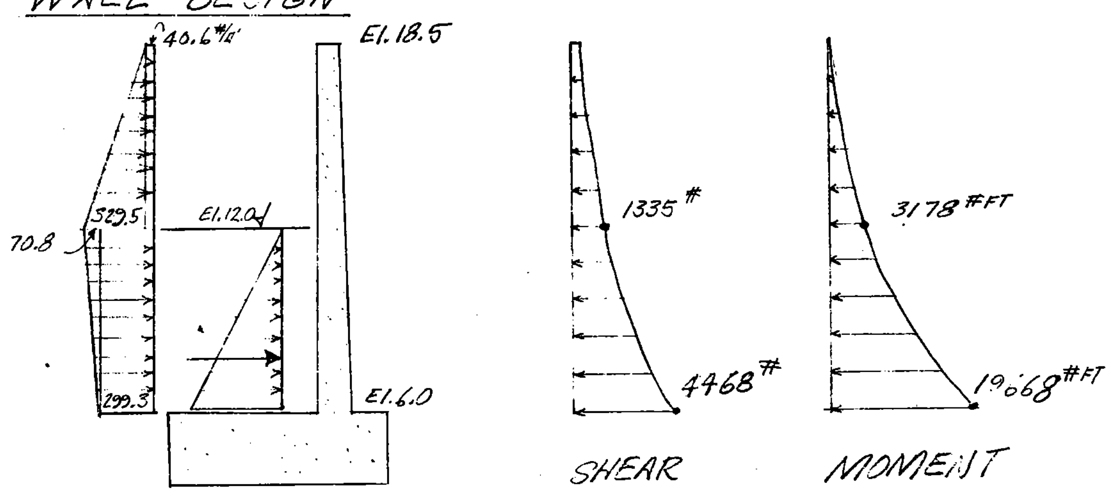
* GROUP II LOADINGS (REDUCED VALUES ARE SHOWN)

ALLOWABLE LOADING FOR 70' LONG PILE

55 k TENSION, 70 k COMPRESSION

PILE SPACING: 10' c to c TENSION, 8' c to c COMPRESSION

WALL DESIGN



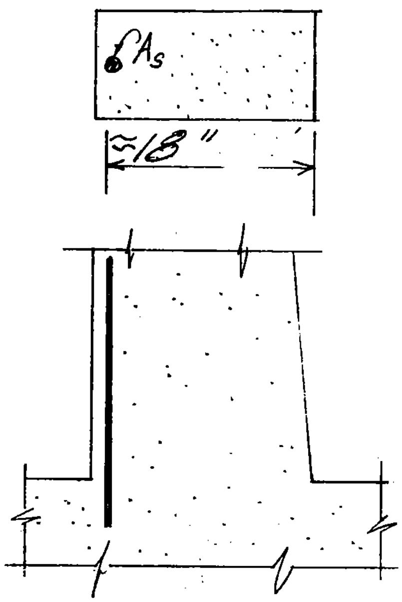
V = 4468 #/.

M = 19668 # FT/.

STEM DESIGN - CON'T.

$\frac{3}{4}M = 14.751^{KFT}$ $\frac{3}{4}V = 3.351^{K}$

CRITERIA FROM "REINFORCED CONCRETE DESIGN HANDBOOK - WORKING STRESS METHOD"



FROM TABLE 1 FOR:
20000/9.2/1050

$K = 152$

$\therefore F = \frac{M}{K} = \frac{14.751}{152} = .097$

FROM TABLE 4 FOR F = .100 AND b = 12"
GIVES d = 10"
CLEAR COVER = 2.5"
$d \cong 13" < 18" \therefore OK$

SIZE STEEL:

$A_S = \frac{M}{ad} = \frac{14.751}{1.44(14)} = .731 \square''/FT$

USE #8 @ 12" FOR TENSILE STEEL
HOOK BARS TO SLAB STEEL

CHECK SHEAR
("d" DISTANCE FROM BASE SLAB)

$d \cong 17.5 - 3.0 = 14.5"$ $v = \frac{V}{bd} = \frac{3.351}{12(14.5)} = 19.26 \#/\square''$

CUTOFF
STOP #8 BARS @ EL. 12.0
CONTINUE WITH #6 BARS @ 12" O.C.

$d @ EL\ 12.0 = 9 + \frac{6.5}{24}(12) = 12.25"$

$A_S = \frac{M}{ad} = \frac{3.178(3/4)}{1.44(12.25)} = .135 \square''/FT$

CHECK MINIMUM TENSILE STEEL.

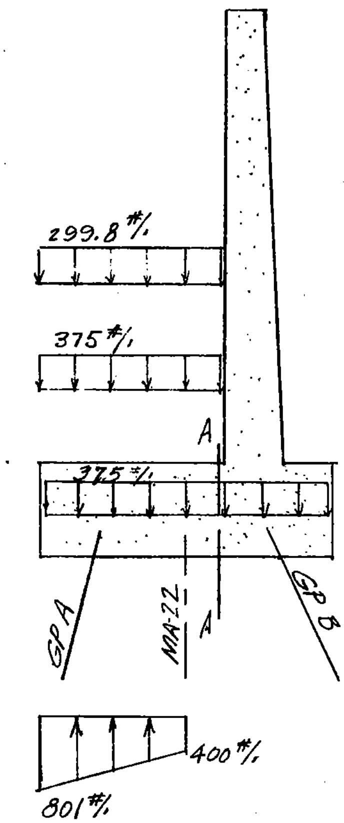
$A_S = .0025\, bd = .0025(12)(12.25) = .3675 \square''/FT$

USE #6 BAR ($A_S = .44 \square''/FT$)
LAP #6 BARS 24" ON #8 BARS.

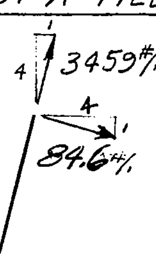
USE #6 BARS FOR VERTICAL + HORIZONTAL STEEL IN COMPRESSION FACE.

BASE SLAB DESIGN

CASE IV CRITICAL



GROUP A PILE LOADS



$\frac{3}{4} V_A = 3459\left(\frac{4}{4.123}\right) - 84.6\left(\frac{1}{4.123}\right)$

$\frac{3}{4} V_A = 3335$

$V_A = 4446$ #/'

DESIGN TRANSVERSE STEEL

SECTION A-A

$M = 1049.8(5^2)(.5) + 4446(3.5) - 400(4)(3) - 400(4)(.5)(3.67)$

$M = 20947$ #FT/'

$\frac{3}{4}M = 15712$ #FT/'

DESIGN TOP STEEL

CRITERIA FROM (R.C.D.H.)

FROM TABLE 1

FOR: $f_s = 20000$ $n = 9.2$

$f_c' = 1050$

GIVES $K = 152$

$F = \frac{M}{K} = \frac{15,710}{152} = .104$

FROM TABLE 4

FOR $b = 12$, $F = .110$

GIVES $d = 10\frac{1}{2}''$

$d_{SLAB} \cong 26''$

REQUIRED STEEL:

$A_s = \frac{M}{ad} = \frac{15.710}{1.44(26)} = .419$ □"/'

CHECK MIN. TENSILE STEEL

$A_s = .0025\ bd = .0025(12)(26)$

$A_s = .78$ □"/'

BOTTOM FACE STEEL

USE TEMPERATURE STEEL

$A_s = .002\ bt = .002(12)(30)$

$A_s = .72$ □"/'

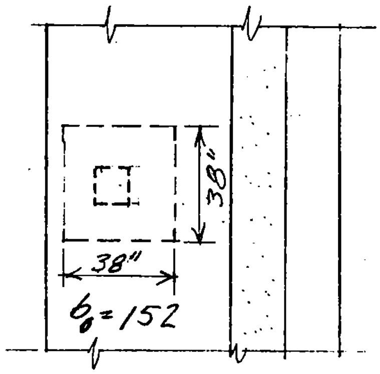
RECAP:

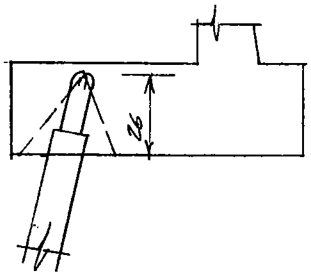
USE #8 BARS @ 12" O.C. (A = .79 □"/')
FOR BOTH TOP + BOTTOM
TRANSVERSE STEEL.

PROJECT		COMPUTED BY	DATE
GRAND LAIRD PUMPING STATION	Page 7 of 7	EVM	11 JUNE 71
SUBJECT "T" WALL - CONCRETE DESIGN		CHECKED BY GDA	DATE 17 June 71

CHECK PERIPHERIAL SHEAR AT GROUP A PILES

SECTION 1207 (b), ACI STANDARD 318-63





LOAD CASE III

ASSUME MAXIMUM PILE SPACING OF 10'

$V = 3675(10) = 36750\#$

$v = \dfrac{V}{b_o d} = \dfrac{36750}{152(26)} = 9\ psi$

SIZE BARS IN PILE

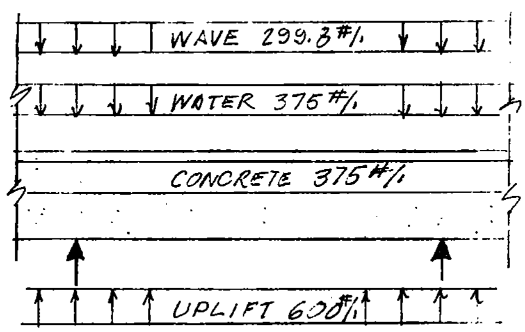
FROM EXPERIENCE WITH EXISTING PILES TRY 4-#7 HOOKED BARS

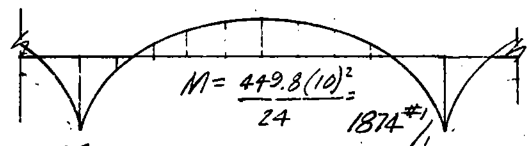
$A_S = .60 \square''$

$P_A = 20000(4)(.6) = 48000\#$

O.K. SINCE $P_{MAX} \cong 37000\#$

LONGITUDINAL STEEL





$M = \dfrac{449.8(10)^2}{24} = 3748\#'/'$ WIDTH

ASSUME A 3' WIDE BEAM.

$M = 3748(3) = 11244\#'$

$3/4 M = 8433\#'$

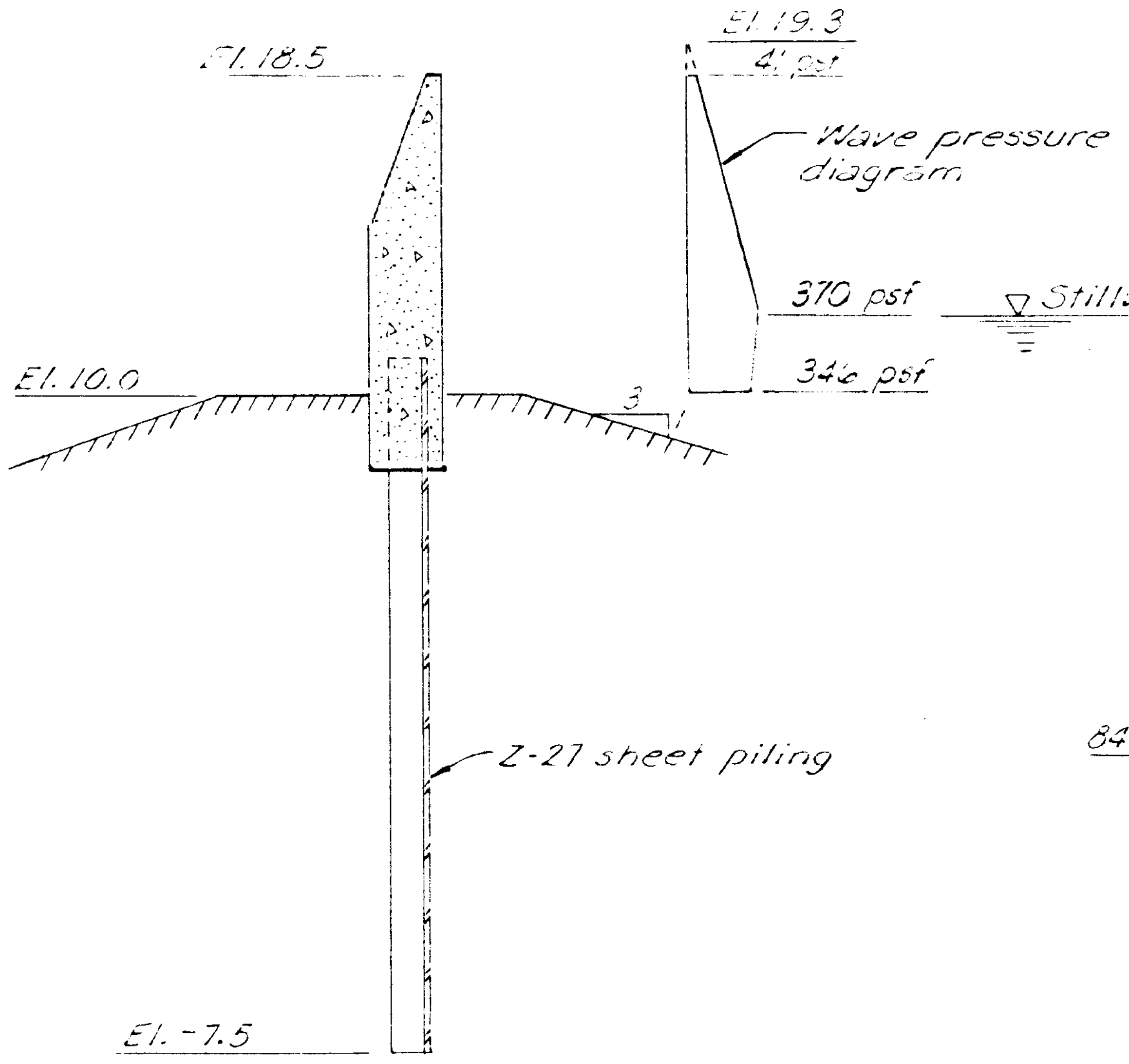
$A_s = \dfrac{M}{ad} = \dfrac{8.433}{1.44(26)} = .225 \square''$

MINIMUM TENSILE STEEL

$A_S = .0025\left(\frac{36}{3}\right)(26) = .78 \square''/'$

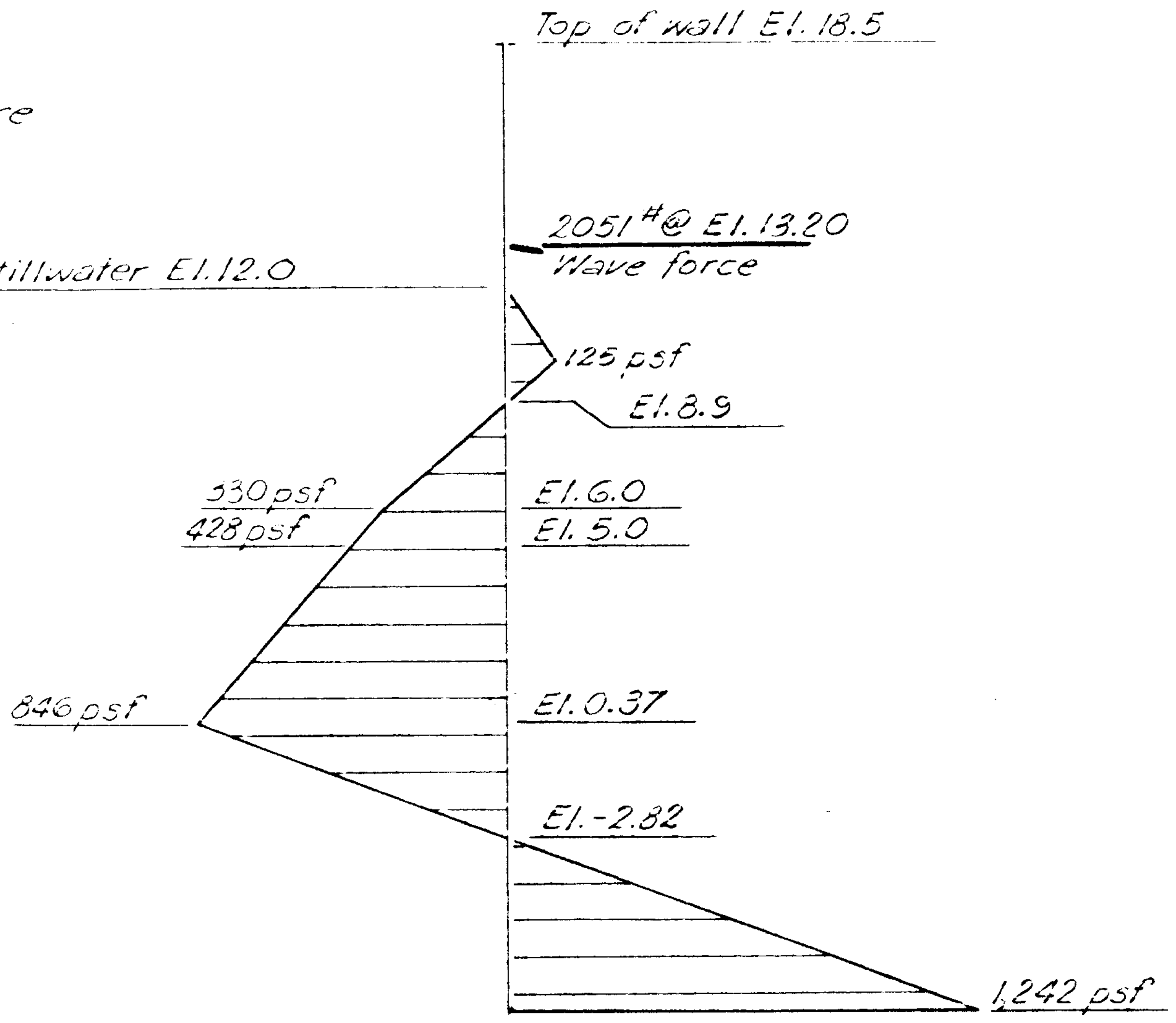
USE #8, 12" O.C. TOP & BOTTOM

LMV FORM 1 AUG 68 107a COMPUTATION SHEET



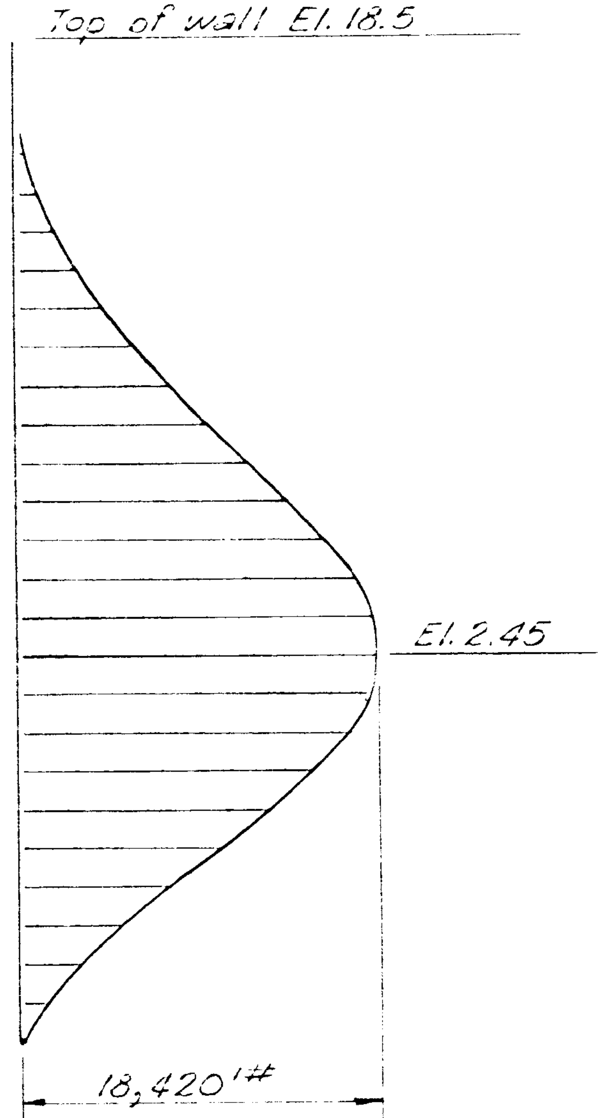
TYPICAL SECTION

Scales: 1"=5'
1"= 1,000 psf



NET PRESSURE DIAGRAM (F.S.=1.25-S CASE)

Scales: 1"=5'
1"= 500 psf



MOMENT DIAGRAM (F.S.=1.25

Max. deflection at top of wall = 1.03"
Scales: 1"=5'
1"=10,000'#

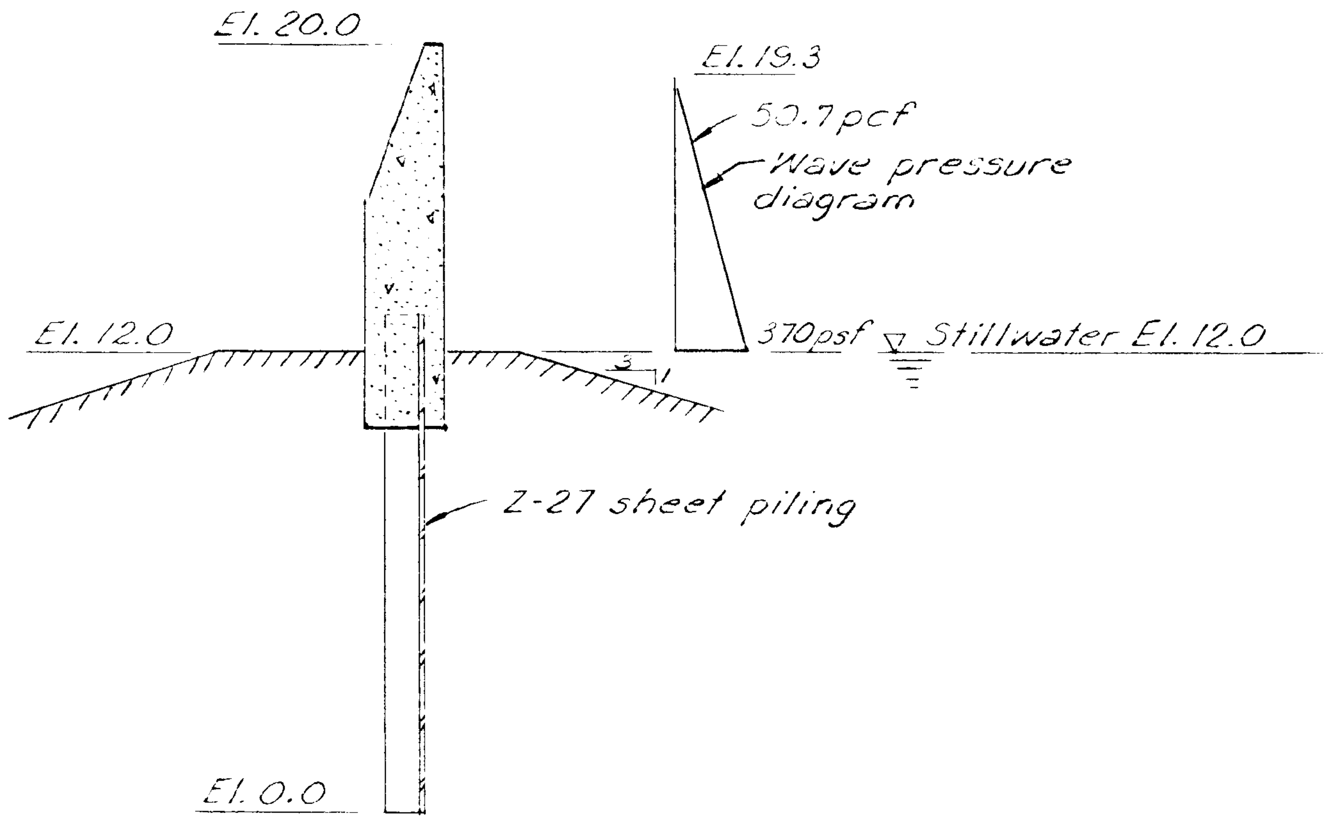
NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

I-WALL DESIGN ANALYSIS
VICINITY OF BAYOU GRAND LIARD
PUMPING STATION

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

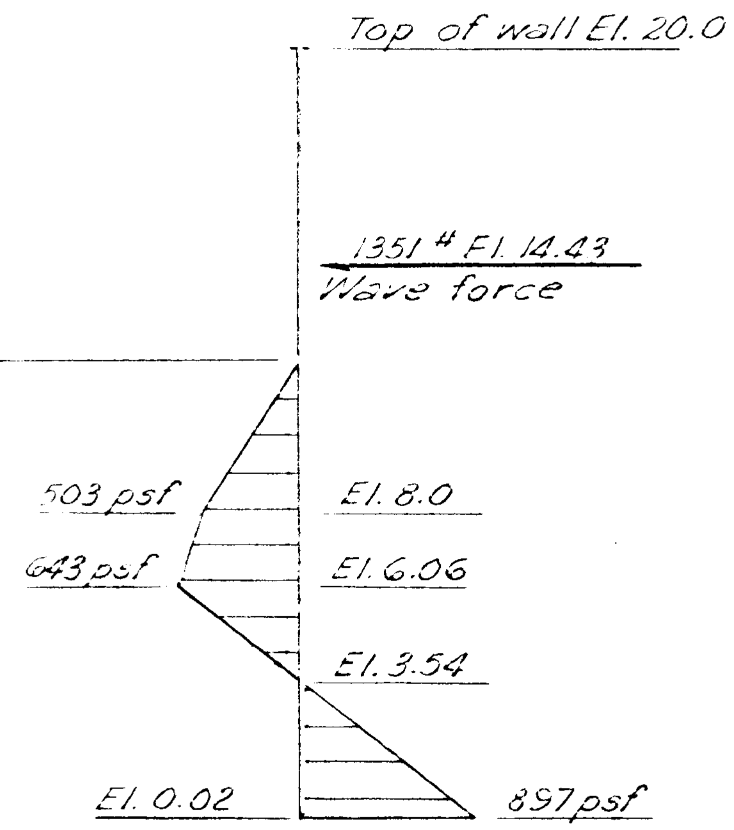
AUGUST 1971 FILE NO. H-2-25712

FIGURE E-12



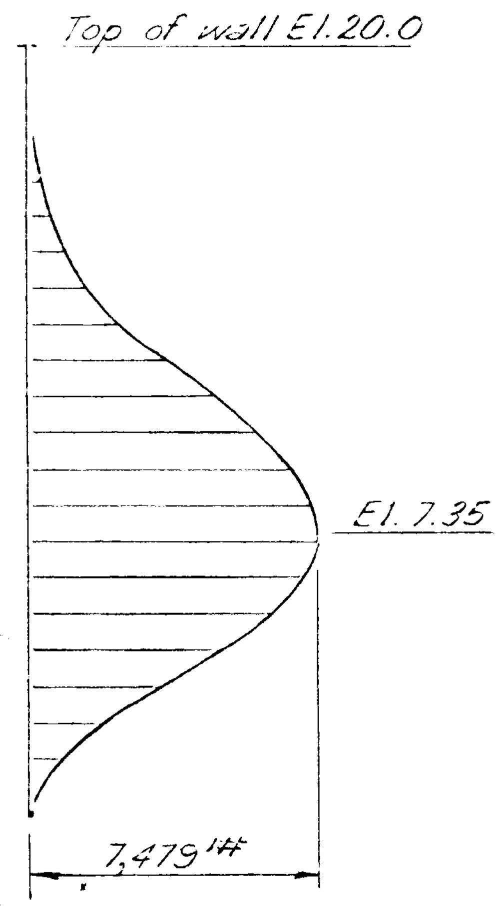
TYPICAL SECTION

Scales: 1" = 5'
1" = 1,000 psf



NET PRESSURE DIAGRAM (F.S. = 1.25-S CASE)

Scales: 1" = 5'
1" = 1,000 psf



MOMENT DIAGRAM (F.S. = 1.25)

Max. deflection at top of wall = 0.21"

Scales: 1" = 5'
1" = 5,000'#

NEW ORLEANS TO VENICE, LA.
DESIGN MEMORANDUM NO. 1-GENERAL DESIGN
REACH B1-TROPICAL BEND TO FORT JACKSON

I-WALL DESIGN ANALYSIS

VICINITY OF SUNRISE PUMPING STATION

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

AUGUST 1971 FILE NO. H-2-25712

FIGURE E-13

NEW ORLEANS TO VENICE, LOUISIANA
DESIGN MEMORANDUM NO. 1 - GENERAL DESIGN
REACH B1 - TROPICAL BEND TO FORT JACKSON

APPENDIX F

CORRESPONDENCE WITH PLAQUEMINES PARISH
COMMISSION COUNCIL

C O P Y

LMNGP-P

15 December 1964

Mr. Leander H. Perez, President
Plaquemines Parish Commission Council
Pointe a la Hache, Louisiana

Dear Mr. Perez:

Reference is made to discussions yesterday between you and Mr. J. C. Baehr and other members of our staff relative to the manner in which Reach "C," Phoenix to Bohemia, New Orleans to Venice, La., hurricane protection levee will be constructed.

Our understanding of the construction and credit process is as follows:

a. The State of Louisiana, Department of Highways, will construct the Reach "C," New Orleans to Venice, La., hurricane protection levee in accordance with criteria furnished by the U. S. Army Engineer District, New Orleans. Funds from the Plaquemines Parish Royalty Road fund will be used to construct the levee.

b. The Plaquemines Parish Commission Council, representing local interests, will be given a credit equal to the costs of constructing the Reach "C" levee along the authorized alignment, as estimated by us, both as to quantities and unit costs, subject to review of the estimate by you or your agents. As used above, the term "authorized alignment" is the alignment shown in the project document with such modifications as may be required in the interest of formulating a sound engineering plan under the physical conditions existing at the time that the cost estimate is made.

c. The above credit will be applied in lieu of all or a portion of the required cash contribution on the overall project. The credit is applicable only to the required cash contribution and no reimbursement will be made for credit in excess of the required cash contribution.

15 December 1964

Your confirmation of the above will be appreciated.

Sincerely yours,

THOMAS J. BOWEN
Colonel, CE
District Engineer

C O P Y

LMNGP-P

18 March 1965

Mr. Leander H. Perez, President
Plaquemines Parish Commission Council
Pointe a la Hache, Louisiana

Dear Mr. Perez:

Reference is made to our conference on 16 March 1965 relative to the New Orleans to Venice, La., Hurricane Protection Project, Reaches A, B, and C.

Based on information developed at the conference, we now conclude that you have selected a firm alignment for Reach B1, Tropical Bend to Fort Jackson. As we now understand it, this alignment is as shown on the inclosed map (inclosure 1). It is our further understanding that you agree that, in addition to the local cooperation included in the authorizing law, any costs over and above those required for constructing the levee along the authorized alignment between Tropical Bend and Fort Jackson, as estimated by us and subject to your review, shall be borne by the Plaquemines Parish Commission Council. The authorized alignment is shown on inclosure 2.

Current estimates indicate that the total cost of the levee along the authorized alignment between Tropical Bend and Fort Jackson is $4,670,500, of which the Federal share is $3,269,300 and the non-Federal share is $1,401,200. The estimated breakdown on the non-Federal cost is $441,300 for lands and relocations and $959,900 cash contribution to construction. In addition to the above, if Reach B1 is to be constructed as a separate unit, tie-in or stub levees will be required at each end of the levee to close the loop. The total cost of these tie-in levees is estimated to be $491,900, including construction, lands, and relocations, all of which must be borne by local interests. The total cost to local interests for constructing a loop levee between Tropical Bend and Fort Jackson would therefore be $1,893,100.

 18 March 1965

Current estimates also indicate that the total cost, exclusive of the tie-in levees, for constructing the levee between Tropical Bend and Fort Jackson along the modified alignment selected by you (inclosure 1) is $6,988,100, of which the Federal share would be the same as that under the authorized alignment, or $3,269,300, and the non-Federal share would be $3,718,800. The estimated breakdown of the non-Federal cost is $411,300 for lands and relocations and $3,307,500 cash contribution to construction. The tie-in levees also would be required with your modified alignment, so that the total cost to local interests for constructing a loop levee from Tropical Bend to Fort Jackson along your modified alignment would be $4,210,700. The difference in total cost to local interests would therefore be $4,210,700-$1,893,100, or $2,317,600. With further reference to the tie-in levees, we would agree to construction of the levees by local interests, if desired, provided the construction is in accordance with plans approved by this District.

With respect to the detailed location of the levee along the 40-arpent line (Pt B to Pt C on incl 1), it is our understanding that the outside toe of the levee will coincide with the 40-arpent line, and that a berm 300 feet wide will be provided between the outside levee toe and the inner edge of the outside borrow pit.

In the remaining portions of the modified alignment, we propose to locate the levee in the following manner: Between Buras and the 40-arpent line (Pt A to Pt B on incl 1), the outside toe of the levee will coincide with the line shown on the map. A 300-foot berm will be provided from the outside levee toe to the inner edge of the outside borrow pit. East of Bayou Grand Liard and along the existing shallow pond (Pt E to Pt F on incl 1), the levee will be located so as to take maximum advantage of the existing abandoned levee which forms the south boundary of the pond. A 300-foot berm between the outside levee toe and the outside borrow area will be provided. Along the pipeline canal between Bayou Dum Bar and the lower end of the tie-in levee (Pt F to Pt G on incl 1), the levee will be located as close as practicable to the pipeline canal. Borrow will be taken from the opposite side of the canal.

Your confirmation of the above is requested. In addition, it is requested that you confirm our understanding of the construction and credit process on Reach C, Phoenix to Bohemia, as outlined in our letter dated 15 December 1964.

Sincerely yours,

2 Incl
As listed

THOMAS J. BOWEN
Colonel, CE
District Engineer

C O P Y

PLAQUEMINES PARISH COMMISSION COUNCIL
POINTE-A-LA-HACHE, LA.

April 22, 1965

Colonel Thomas J. Bowen
U. S. Army Engineer District
Corps of Engineers
Foot of Prytania Street
New Orleans, Louisiana

Dear Colonel Bowen:

This will acknowledge receipt of your letter of 18 March, 1965, relative to Hurricane Protection Project, Reaches A, B and C in Plaquemines Parish, Louisiana.

As stated by you, we have selected a firm alignment for Reach BI, Tropical Bend to Fort Jackson as shown on your enclosed map (inclosure 1), which shows the authorized alignment from Tropical Bend to Buras, including navigation gates at Empire and Buras, and also the modified alignment from Buras to Fort Jackson.

It is our understanding, and we agree, that the Plaquemines Parish Commission Council will bear 30 per cent of the cost of constructing the levee and gates along the authorized alignment between Tropical Bend and Buras as provided in our Act of Assurance dated March 6, 1964.

It is further understood and agreed that in addition to the 30 per cent of the cost required for constructing the levee along the authorized alignment between Buras and Ft. Jackson as estimated by you, and subject to our review and approval, the Parish Commission Council shall bear all costs of constructing the levee along the modified alignment, (Pt A, B, C, D, E, F, G on Map, inclosure I) over and above said approved estimated cost of construction of levee along the authorized alignment between Buras and Fort Jackson.

In response to your request that we confirm our understanding of the construction and credit process on Reach C, Phoenix to Bohemia, referred to in your letter of 15 December 1964, this is to advise that it is understood, and we agree, that the Project for Hurricane Flood Protection Levees, Reaches A, B, C and E shall be considered as one overall Project. The Plaquemines Parish Commission Council, representing local interest, will be given credit for its payment of the cost of Reach C to apply to all said Reaches A, B, C and E equal to the cost of constructing Reach C Levee along the authorized alignment

PLAQUEMINES PARISH COMMISSION COUNCIL

To: Colonel Thomas J. Bowen
U. S. Army Engineer District

as estimated by you, subject to review and approval of the estimates by us or our agents. The above credit will be applied to pay its portion of the required 30 per cent contribution on the overall project. No reimbursement will be made for credit in excess of the required 30 per cent contribution.

Very respectfully,

Plaquemines Parish Commission Council

/s/ L. H. Perez
President

LHP:dml