LAKE PONTCHARTRAIN, LA.
AND VICINITY
HURRICANE PROTECTION PROJECT

RELOCATION OF IH-NC FLOOD PROTECTION FRANCE ROAD TERMINAL NEW ORLEANS, LOUISIANA

Design Memorandum No. 2

General Design

Supplement No. 8A

VOLUME II - APPENDICES A-C

October 15, 1997

FINAL REPORT

Submitted By:

PORT OF NEW ORLEANS

Prepared By:

Pyburn & Odom, Inc.
Engineers · Scientists · Planners · Surveyors · GIS Specialists

10/15/97

FINAL REPORT

RELOCATION OF IH-NC FLOOD PROTECTION
FRANCE ROAD TERMINAL
NEW ORLEANS, LOUISIANA
GENERAL DESIGN MEMORANDUM NO. 2
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GEOTECHNICAL INVESTIGATION

FRANCE ROAD TERMINAL

FLOOD PROTECTION

NEW ORLEANS, LOUISIANA

FOR
PYBURN & ODOM, INC.
BATON ROUGE, LOUISIANA

4 JUNE 1997

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4 June 1997

Pyburn & Odom, Inc.
Suite A
8178 GSRI Avenue
Baton Rouge, Louisiana 70820

Attention Mr. Raul Gonzalez

Gentlemen:

Geotechnical Investigation
France Road Terminal
Flood Protection
New Orleans, Louisiana

Transmitted are three copies of our revised engineering report covering a geotechnical investigation for the subject project.

Thank you for asking us to perform these services.

Yours very truly,

EUSTIS ENGINEERING COMPANY, INC.

John R. Eustis

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REVISED GEOTECHNICAL INVESTIGATION

FRANCE ROAD TERMINAL

FLOOD PROTECTION

NEW ORLEANS, LOUISIANA

FOR
PYBURN & ODOM, INC.
BATON ROUGE, LOUISIANA

By
Eustis Engineering Company, Inc.
Metairie, Louisiana

4 JUNE 1997

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GEOTECHNICAL INVESTIGATION
FRANCE ROAD TERMINAL
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NEW ORLEANS, LOUISIANA

INTRODUCTION

1. This report contains the results of a geotechnical investigation performed for the proposed flood protection at France Road Terminal in New Orleans, Louisiana. The investigation was performed in accordance with Eustis Engineering Company, Inc.'s letters of proposal dated 29 October 1990 and 30 June 1993 and subsequent verbal revisions. The proposal letters and revisions were verbally accepted by Mr. Lyn Denton representing Berger, Barnard & Thomas, Inc., (presently Barnard & Thomas, Inc., a Subsidiary of Pyburn & Odom, Inc.) consulting engineers for the project.

2. This report has been prepared in accordance with generally accepted geotechnical engineering practice for the exclusive use of Barnard & Thomas, Inc., for specific application to the subject project. In the event that any changes in the nature, design, or location of the proposed floodwall are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report are modified or verified in writing. Should these data be used by anyone other than Barnard and Thomas, Inc., they should contact Eustis Engineering for interpretation of data and to secure other information that may be pertinent to this project.

3. The analyses and recommendations contained in this report are based in part on data obtained from the soil borings. The nature and extent of variations in the subsoil conditions that may exist between and away from the boring locations may not become evident until construction. If variations then appear, it will be necessary to reevaluate the recommendations contained in this report.

4. Recommendations and conclusions contained in this report are to some degree subjective and should not be included in the contract plans and specifications. However, the results of the soil borings and laboratory tests contained in the Appendix of this report may be included in the plans and specifications.

SCOPE

5. The investigation included the drilling of undisturbed sample type soil test borings to determine subsoil conditions and stratification, and to obtain samples of the various strata encountered. Soil mechanics laboratory tests were performed on samples obtained from the borings to evaluate their physical properties. Engineering analyses were made to evaluate a cofferdam at Slip No. 3, cantilever I-type floodwalls, allowable pile load capacities for T-wall and gate structures, slope stability, estimates of settlement, and other pertinent requirements.

SOIL BORINGS

6. A total of nine undisturbed sample type soil test borings, designated 19 through 27 were drilled during the periods 6-7 July 1992 and 27 August to 2 September 1993 at the locations shown on Figure 1. Borings 1 through 18 were

drilled between 23 April and 2 May 1990 for a previous investigation. The borings were drilled using a truck mounted rotary type drill rig, each to a depth of 70 feet below the existing ground or water surface. Borings 21 and 22 were drilled from a barge in Slip No. 4 and Slip No. 3, respectively. The results of the borings are shown in both tabular and graphical form on the detailed descriptive logs in the Appendix.

7. Undisturbed samples of cohesive or semi-cohesive subsoils were obtained at close intervals or changes in stratum using a 3-in. diameter thinwall Shelby tube sampling barrel. The samples were extruded in the field, inspected, and visually classified by Eustis Engineering's soil technician. Representative portions of the samples were placed in moisture proof containers for preservation.

8. Cohesionless soils were sampled during the performance of in situ Standard Penetration Tests. This test consists of driving a 2-in. diameter splitspoon sampler into the soil using blows of a 140-lb weight dropped 30 inches. The number of blows required to drive the sampler 1 foot after it is first seated 6 inches is recorded on the boring logs under the column heading "SPT." This test gives an indication of the relative density of cohesionless soils. Samples obtained during the tests were placed in glass jars for preservation.

LABORATORY TESTS

9. Soil mechanics laboratory tests consisting of natural water content, unit weight, and either unconfined compression shear or unconsolidated undrained triaxial compression shear were performed on undisturbed samples obtained from the borings. The results of these laboratory tests are summarized in tabular form

on the boring logs. A grain size analysis was performed on a sample of the shell fill and the results are shown graphically in the form of a grain size distribution curve in the Appendix.

DESCRIPTION OF SUBSOIL CONDITIONS

10. Fill materials were encountered at all seven of the land borings and extended to depths ranging from 9 to 26 feet below the existing ground surface. The fill consists mainly of very loose to very dense gray and white shells and sand which contain miscellaneous materials such as limestone, concrete and wood. The water depth at the two borings drilled in the slips was 18 feet. At Boring 21 in Slip No. 4, the mud bottom consisted of 9 feet of shells.

11. Beneath the fill is a stratum of very soft to medium stiff gray clay that extends to depths ranging from 42 to 51.5 feet below the existing ground or water surface. Following this is a stratum of soft to stiff gray, greenish-gray or gray and tan clay and sandy clay that extends to depths ranging from 51.5 to 67 feet. This, in turn, is underlain by a stratum of loose to dense gray silty sand and clayey sand and loose to medium compact gray clayey silt and sandy silt. Except for Boring 19, this stratum extends to the bottom of the borings which terminate at the 70-ft depth. At Boring 19, this stratum extends to the 64-ft depth and is underlain by soft gray clay to the 70-ft depth.

Ground Water Conditions

12. In order to determine ground water conditions at the time of the field exploration, an auger hole was drilled without the use of water during the drilling

process at a location approximately 25 feet south of Boring 19. Ground water was first encountered at the 6-ft depth. A measurement made six hours after completion of drilling operations indicated ground water had risen to the 4-ft depth. The depth to ground water will vary with the water level in the Inner Harbor Navigation Canal, climatic/seasonal conditions, drainage improvements, and other factors. If important to construction, the depth to ground water should be established by the contractor immediately prior to initiation of the work.

PREVIOUS INVESTIGATION

13. Eustis Engineering has previously performed a geotechnical investigation at the site for a secondary floodwall intended to protect only property of the Board of Commissioners of the Port of New Orleans (Dock Board). The results of this previous investigation are contained in our report entitled, "Geotechnical Investigation, France Road Terminal, Flood Protection, New Orleans, Louisiana," dated 22 June 1990. For convenience, detailed descriptive logs of 17 borings drilled for this investigation are included in the Appendix of this report. The borings are designated as 1 through 7 and 9 through 18. Several attempts were made to drill Boring 8 but were not successful due to the presence of miscellaneous fill material including pieces of steel and concrete. The locations of these borings are shown on Figure 1.

FOUNDATION ANALYSES

Soil Parameters

14. Four soil reaches have been assigned for performance of geotechnical engineering analyses. The soil parameters assigned for each soil reach are shown graphically on Figures 2 through 5 along with the borings on which they are based. It should be noted that Reach IV applies only to the circular cofferdam across Slip No. 3. It should also be noted that soil parameters for Reach II assume shells extend from the ground surface and varies in depth from el -20 to -33 NGVD. An angle of internal friction of 30° and a saturated unit weight of 105 pcf is assigned to the shells. Below the shells, soil parameters for Reach II are the same as Reach I.

Cofferdam at Slip No. 3

15. Design Conditions. A cross-section of the proposed cofferdam closure of Slip No. 3 is shown on Figure 6 along with relevant elevations. Also shown are the assigned Reach IV soil stratification and parameters used for the computations.

16. Analyses. Cofferdam analyses were based on methods described in the NAVFAC DM-7.2 Design Manual. Based on the results of the computations, Eustis Engineering recommends a minimum 36-ft diameter circular-type cellular cofferdam utilizing 45° connecting arcs. In order to provide adequate bearing support, penetration of the steel sheetpiles forming the cofferdam should be at least el -65 resulting in 80-ft long sheetpiles. Straight web steel sheetpiles with an ultimate interlock tension capacity of at least 3.5 kips per linear inch should be

used. Results of both external and internal stability analyses are shown on Figure 6 as factors of safety against various modes of failure. The recommended factors of safety are also shown. A copy of the detailed computations can be furnished upon request. The maximum bulging of cells occurs at approximately one-fourth of the height above the mud bottom and the cells tilt approximately 0.02 to 0.03 radians due to the difference in lateral loads on the outboard and inboard phases.

17. Fill. Fill material within the cells should consist of locally available pumped river sand. Specifications should require this material to be free of wood, roots, clay lumps, organic matter and debris, and not contain more than 10% by weight of material passing a U.S. Standard No. 200 sieve. Sand fill placed below the water level may be dumped into place. The remaining fill above the water level should be placed in uniform lifts not exceeding 3 feet in thickness. Compaction of the fill above the water level beyond that which occurs during placement and spreading is not necessary.

18. Settlement. It is estimated the ultimate settlement of the fill surface may be on the order of 8 to 10 feet. This estimate assumes there will be periodic additions of fill throughout the life of the structure. It is recommended that fill be added when the surface settles to el 13 in order to maintain the design grade of el 15. It is further estimated settlement of the sheetpiles may be on the order of 1 to 3 inches.

19. Corrosion. When cofferdams are used as permanent structures, corrosion occurs from the top of the splash zone to a point just below mean low water level. Unless the effects of corrosion are included in the design of the

sheetpiles, the use of protective coating, corrosion resistance steel, and/or cathodic protection is recommended.

20. Drainage. Considering the short term duration of the high water condition, we do not believe that installation of weep holes on the inboard sheeting is necessary to drain the fill within the cells.

21. Construction. It is important the contractor selected be experienced in the field of cofferdam installation. Close field supervision should be maintained throughout construction by qualified and experienced personnel to ensure that proper construction procedures are followed. It is important the integrity of the interlocks are maintained throughout the entire length of the sheetpiles in order to ensure a stable cofferdam.

22. Other Considerations. An earthen access ramp was proposed adjacent to the cofferdam. However, analyses indicated the proximity of the ramp to Slip No. 4 would result in an unstable bank. Therefore, the use of an earth ramp was eliminated from the project and other means will be utilized to gain access to the cofferdam.

Slope Stability

23. Typical Cross-Section. Slope stability analyses were performed using the Corps of Engineers' computer program "Uplift." Stability analyses were performed with respect to the Inner Harbor Navigation Canal for Reaches I, II and III soil parameters. Stability analyses were also performed with respect to Slip Nos. 3 and 4 based on Reaches I and II soil parameters. Reach III soil parameters are

not applicable at these slips since they are based on the results of Borings 19 and 20 only which are located at the north end of the project. The purpose of the stability computations were to determine a recommended typical cross-section to provide a minimum factor of safety of 1.3 against a potential slope stability failure. Additionally, computations were made to determine the recommended distances from the proposed floodwall for various surcharge loads.

24. Inner Harbor Navigation Canal. The results of the slope stability computations are shown on Figures 7 through 9, along with the locations of the critical active and passive wedges. It should be noted the typical cross-section for Reaches I and II are the same.

25. It is the intent the recommended typical cross-section be used as a template to determine the required cut and fill at each cross-section taken along the floodwall alignment throughout the soil reach. The control point for the template is the floodwall. Using Reaches I and II to illustrate, this can be accomplished by superimposing the typical cross-section template on the existing profile so that the typical floodwall location coincides with the desired floodwall location. Above el -5, the existing profile that is higher than the typical cross-section must be degraded. However, if the existing profile is lower than the typical cross-section, filling is not necessary. Below el -5, the existing profile that is lower than the typical cross-section must be filled. However, if the existing profile is higher than the typical cross-section, degrading is not necessary. This procedure is illustrated on Figure 10 wherein the typical cross-section is superimposed on the existing profile "GG."

26. It is understood a 36-in. diameter storm water drain pipe is located within one segment of the Reach I soil parameters. It is desirable to shift the location of the proposed floodwall closer to the Inner Harbor Navigation Canal than that indicated by the typical cross-section in order to avoid having to relocate this existing drain pipe. In this regard, stability analyses were made for the furnished cross-section at Station N4 and the results of the computations are shown on Figure 11.

27. Stability at Slip No. 3. Computations were made to determine the recommended degrading of the bank adjacent to Slip No. 3 to provide a minimum factor of safety of 1.3 against a potential slope stability failure. The results of the computations are shown on Figure 12 along with the locations of the critical active and passive wedges. The computations indicate the side slope of the slip should not be steeper than 1 vertical on 3 horizontal. Further, the top of the bank should be degraded to el 0.0 for horizontal distance of 36 feet from the top of the side slope. The analyses on Figure 12 are based on Reach I soil conditions. Previous slope stability analyses show that Reach II soil conditions do not govern slope stability. Degrading operations must begin at the highest elevation and proceed down toward the lowest elevation. Spoil material must not be stockpiled and instead should be immediately removed from the site.

28. Stability at Slip No. 4. Furnished drawings indicate dredging will be required in Slip No. 4 to accommodate a ramp barge and seagoing notch barge. Computations were made to determine a typical cross-section that will provide a minimum factor of safety of 1.3 against a potential slope stability failure into the dredged slip. The results of the computations are shown on Figure 13 along with

the locations of the critical active and passive wedges. Based on the computations, the recommended horizontal distances measured from the centerline of the slip are:

- 50 feet maximum to the toe of the slope,
- 115 feet minimum to the top of the bank,
- 165 feet minimum to the floodwall, and
- 210 feet minimum to the edge of a 500 psf surcharge loading.

The side slope should not be steeper than 1 vertical on 3.25 horizonal and the ground surface should not be higher than el 5 between the top of the bank and the toe of the floodwall berm.

I-Type Floodwall

29. Design Conditions. Computations to determine the required sheetpile penetration for an I-type floodwall were based on the following Corps of Engineers' criteria. Case 1 conditions include a factor of safety of 1.5 applied to the soil shear strengths for the still water level (SWL) load condition. Case 2 conditions include a factor of safety of 1 applied to the SWL plus 2 feet of freeboard load condition. Also, a minimum "penetration to head" ratio of 3 to 1 is required where the head is the water depth at the floodwall based on the SWL. All floodwall analyses were performed using the Corps of Engineers' computer program "CWALSHT" using the net design grade and not the construction grade which includes a 6-in. overbuild. Computer printouts for the various loading cases can be furnished upon request.

30. Berm. The computations assume that a berm will be constructed to provide additional support for the sheetpiles except in the vicinity of the Area 1 pump stations. We recommend, where possible, the crown of the berm be constructed to a uniform elevation throughout the project to minimize variations in sheetpile embedment. According to the furnished "design and cost estimate" drawings, the crown of the berm will be constructed to a uniform grade of el 8. To satisfy slope stability requirements at Station N4, the crown of the berm will be lowered to el 6.5 as shown on Figure 11. Furnished drawings also show the average existing ground surface along the floodwall alignment typically ranges from el 3 to el 6. Ground water was assumed to be at the ground surface for the purpose of the computations.

31. Analyses. The results of the computations based on Reach I soil parameters are shown graphically on Figures 14 through 16. Since the minimum penetration to head ratio of 3 to 1 governs, the required embedment for Reach I also applies to Reach III where shear strength of the upper strata are higher than Reach I. As shown on Figures 14 and 15, a sheetpile penetration to el -7 is required based on the crown of the berm at el 8. The lateral pressure diagram shown on Figure 14 should be used to determine the shear, moment, and deflection diagrams.

32. The use of a supporting berm will be eliminated for the 20 to 30-ft long segments of floodwall across the front of the Area 1 pump stations to reduce differential settlement between these two facilities. Furnished drawings indicate the average existing ground surface is typically at el 6 at these locations. The results of the computations for this condition are shown on Figure 16. A sheetpile penetration to el -15 is required, and the lateral pressure diagram shown should be used to determine the shear, moment, and deflection diagrams.

33. The results of the computations for the berm lowered to el 6.5 at Station N4 are shown on Figure 17. A sheetpile penetration to el -17.75 is required and the lateral pressure diagram shown should be used to determine the shear, moment, and deflection diagrams.

34. The results of the computations for Reach II soil parameters are shown on Figures 18 and 19. A sheetpile penetration to el -24 is required to satisfy seepage analyses based on ground surface at el 3. Seepage analyses were performed using the Harr method described in "Ground Water and Seepage by M. E. Harr." The lateral pressure diagram shown on Figure 19 should be used to determine the shear, moment and deflection diagrams.

35. <u>Installation.</u> It is believed steel sheetpiles should penetrate the deposits of sand and shell fill without excessive hard driving. Considering the history of the site, as well as the types and amounts of miscellaneous fill materials that have been encountered, interference during sheetpile installation by near surface and subsurface obstructions should be expected. We believe excavation of a 3-ft wide, 4-ft deep inspection trench made along the floodwall alignment should uncover a majority of shallow obstructions.

36. As previously mentioned, several attempts to drill Boring 8 were unsuccessful due to the probable presence of large pieces of steel or concrete. Based on these attempts, we believe the tops of the obstructions are within a few feet of the ground surface but may extend laterally 50 feet or more from Boring 8. The depths of the obstructions are unknown. It is possible a large segment of the floodwall alignment adjacent to the scrap metal yard area may be underlain by steel or other obstructions. Excavation of a series of trenches may be necessary to

determine the extent of obstructions between the locations of Borings 6 and 9 around Slip No. 3 adjacent to the yard area. These trenches should be spaced parallel and perpendicular to the floodwall alignment.

37. The purpose of all trench excavations is to uncover the nature, depth, and extent of obstructions in order to determine if the obstruction can be removed by an open excavation. If the presence of obstructions are suspected at depths below the inspection trenches, seismic methods or probe borings should be employed. Also, seismic methods and/or probe borings may be used initially to locate suspicious areas where a series of trenches can subsequently be excavated. We recommend inspection trenches, seismic methods, and probe borings to uncover obstructions, and excavation operations to remove obstructions be performed under a separate work contract prior to initiation of construction at the floodwall. Where the nature, depth, or extent of an obstruction makes removal by excavation impractical, it may be necessary to reroute the floodwall.

38. Backfill for the 2-ft wide, 6-ft deep inspection trench along the floodwall alignment should be a compacted cohesive soil. Specifications should require cohesive backfill to have a liquid limit (LL) between 40 and 60% and a plasticity index (PI) between 15% and 30%. Backfill should be placed in 10 to 12-in. thick lifts and each lift compacted to at least 95% of the maximum dry density at optimum water content in accordance with ASTM D 698. It is the intent all sheetpiles forming the floodwall be driven through a 2-ft wide by 6-ft deep plug of relatively impervious soil. Beyond this, in situ soils may be used for backfill. In situ backfill should be placed in 10 to 12-in. thick lifts and compacted to a density equal to or greater than the adjacent soils.

Sheetpile Cutoff Walls

39. Penetration. Analyses have been made to determine the recommended tip penetration for sheetpile cutoff walls located beneath proposed T-wall and floodgate structures. The computations utilized Lanes Weighted Creep Ratio method of seepage analyses wherein the length of the flow path is compared to the differential hydrostatic head. Acceptable values of creep ratio are 4.0 and 6.5 for the organic clays of Reach I and the sandy shells of Reach II, respectively. The results of the computations indicate minimum tip penetrations of el -15.5 in Reaches I and III, and el -28 in Reach II.

40. Surcharge Load. Stability analyses were made to determine the factor of safety against a potential deep seated failure beneath the base of T-wall and floodgate structures. In Reaches I and III, the factor of safety exceeds the minimum acceptable value of 1.3. Therefore, the sheetpile cutoff wall will not impose a lateral surcharge load on structures located in the Reaches I and III soil parameters.

41. In Reach II, the factor of safety against a deep seated stability failure is less than 1.3. Therefore, the sheetpile cutoff must provide the additional resistance necessary to improve the factor of safety to 1.3. The portion of the resistance developed by the cutoff wall will be transferred to the structure as a lateral surcharge load. The magnitude of the load is 22 plf which is imposed at the base of the structure.

42. Typical cross-sections along with the applicable stability, sheetpiles, and seepage analyses are shown on Figure 20 for Reaches I and III and Figure 21

Reach II. Recommendations pertaining to the installation of sheetpiles for I-walls also apply to cutoff walls.

Pile Foundations

43. Furnished Information. Square, precast concrete piles will be used to support T-walls and floodgates.

44. Ultimate Pile Load Capacity. Computations to determine the estimated ultimate compressive and tensile pile capacities for vertical piles were made using a computer program developed by Eustis Engineering. The results of the computations are shown in tabular form on Figures 22 through 24. The estimated pile load capacities in this report are based on a soil-pile relationship only. Therefore, the structural capacity of the piles and their connections to transmit the loads must be determined by a structural engineer. All lateral loads must be resisted by batter piles. The axial capacity and horizontal component of batter piles can be determined with the formula shown on Figure 25.

45. For planning purposes, a factor of safety of 2 may be applied to the value shown on Figures 22 through 24. Use of a factor of safety of 2 for planning assumes a pile load test will be performed to verify the design load. If a pile load test will not be performed, a factor of safety of 3 must be used to determine the design capacity.

46. Pile Embedments Below Bottom of Boring. Furnished information subsequent to drilling operations indicates an allowable pile load capacity of 70 tons is required for precast concrete piles. This allowable capacity requires a pile

embedment below the bottom of the borings. To assist Barnard & Thomas, Inc., in development of preliminary design plans, conservative computations for pile embedments below the bottom of the borings were made assuming a cohesive soil with a cohesion of 1,000 psf. Therefore, it is important estimated pile load capacities for embedments deeper than el -65 are verified by test piles and a pile load test and/or additional borings prior to selection of final pile lengths.

47. Soil Modulus. The modulus of horizontal subgrade reaction "K_h" versus elevation is plotted on Figure 26 for Reaches I, II, and III. Since it is possible some piles may penetrate only 1 to 3 feet into the sand, we recommend the curve of the overlying clay be extended down below el -60 for conservative purposes.

48. Pile Groups. The single pile load capacity should be reduced for the effective group action when piles are driven in rows or groups. In this regard, the capacity of a group or row of piles should be evaluated on the basis of group perimeter shear by the formula shown on Figure 27. This reduction should apply to all piles except for compressive piles firmly seated in dense sand with a tip embedment of approximately -65 as shown on Figures 22 through 24. The minimum center to center spacing between piles in a row or group should be determined in accordance with Figure 27 but should not be less 3 feet.

49. Estimated Settlement. Since pile loads and layouts are not available at this time, we have assumed piles will be driven in single rows spaced at least 7 feet between rows or in small groups in which the largest dimension of the group is less than 20% of the pile length. We have also assumed individual pile groups will have a center to center spacing no closer than twice the largest group

dimension. Eustis Engineering should be notified to determine the need for additional analyses if the actual pile layouts do not conform to these assumptions.

50. Based on these assumptions and a minimum pile embedment to el -55, settlement of pile supported foundations should be small and not exceed ¼ to ¾ inch. This estimate is based on consolidation of the subsoils and does not include elastic deformation of the piles. The elastic deformation can be estimated at 67% to 75% of the column strain.

51. Pile Driving. Precast concrete piles should be driven with a single acting air hammer developing 19,500 ft-lbs of energy per blow. Also, precast concrete piles should be driven using an air hammer in which the ram weight is one-half to two-thirds of the pile weight and the drop of the ram does not exceed 3 feet. Once the pile type, size, length, and installation equipment have been established, a dynamic analysis, "WEAP," can be performed to estimate driving stresses and to evaluate driveability. This analysis may be supplemented by a dynamic pile test using a pile driving analyzer to monitor test piles and/or selected job piles during installation. Data accumulated by the pile driving analyzer may be used to determine actual driving stresses and to evaluate the integrity and capacity of the job piles. The pile driving analyzer can also evaluate driving efficiency by determining energy transferred to the pile.

52. Jetting. It is difficult to predict the driving resistance of concrete batter piles during penetration of the loose sandy shells of Reach II soil conditions. The need for jetting must be determined by a test pile program. If required, jetting should be accomplished through PVC tubes cast into the pile using water pumped from the adjacent canal and should terminate 2 to 3 feet above the bottom of the

shells. The water pressure should be varied to prevent the blow count from falling below 8 to 12 blows per foot while driving through the shells to minimize the possibility of damage to the concrete piles due to tension waves. Jetting operations should be performed under the supervision of an experienced individual knowledgeable in jetting/pile installation techniques. Jetting should not be permitted for installation of piles in Reaches I and III soil conditions.

53. Test Piles and Pile Load Tests. A comprehensive test pile program should be implemented to develop more definitive information regarding proper pile driving equipment, anticipated driving resistance, requirements for jetting, exact pile lengths, effects of vibrations, and to verify the estimated pile load capacities. Test piles should be driven using the same equipment and techniques that will be used to drive the job piles. After all test piles have been installed, several of each type that will be used for construction should be selected for performance of a pile load test to failure in accordance with the Orleans Parish Building Code. The loading procedure should not begin earlier than 21 days after all reaction piles are installed.

Vibrations

54. Sheetpile installation and pile driving operations, as well as other construction operations, will cause vibrations which may affect nearby structures, pavements, and underground utilities. All adjacent facilities should be carefully inspected by a registered structural engineer prior to these various construction operations. Inspection should include photographic or videotaped documentation of the exteriors and, if possible, the interiors of adjacent structures.

55. Eustis Engineering recommends the magnitude of vibrations be monitored with a seismograph and recorded during all pile driving operations. These measurements will provide useful information in assessing the need for changes or adjustments in driving operations that may be necessary to minimize vibrations to adjacent facilities.

56. Peak particle velocities of 0.25 in./sec as measured by the seismograph at adjacent facilities are generally regarded as a vibration level uncomfortable to human perception. Also, peak particle velocities of 0.25 in./sec may densify near surface cohensionless soils. Structures founded in or above such soils may settle as a result of this densification. Peak particle velocities in excess of 0.5 in./sec may induce damage to nearby adjacent facilities. For sustained peak particle velocities in excess of 0.25 in./sec measured at any structure of concern, pile driving operations should be terminated and Eustis Engineering consulted to determine if modifications to pile driving procedures are necessary to reduce the intensity of vibrations.

<u>Earth Work</u>

57. <u>Cut and Fill.</u> Where degrading of the existing cross-section is required for slope stability purposes, this operation should begin at the highest elevation and proceed down the slope. Where backfilling is required for stability, this operation should begin at the lowest elevation and proceed up the slope.

58. <u>Materials for Backfill.</u> Backfill placed beneath el -5 should consist of crushed limestone meeting the requirements for stone bedding contained in Section

1003.3(d) of the Louisiana Standard Specifications for Roads and Bridges, 1992 edition (LSSRB).

59. Berm. The supporting berm for the floodwall should consist of locally available pumped river sand. Specifications should require this material to be free of wood, roots, clay lumps, organic matter, and debris. Pumped river sand should be placed in 10 to 12-in. loose layers and each layer should be compacted to at least 98% of the maximum dry density at optimum water content in accordance with ASTM D 698. The crown of the berm should be slightly raised at the floodwall to facilitate drainage of surface water. The side slopes should not be steeper than 1 vertical on 3 horizontal. The crown and side slopes must be protected against erosion by seeding, sodding, asphalt treatment, or other appropriate means.

60. As an alternative to the sand berm, consideration may be given to the use of a compacted clay berm. The clay fill should conform with the material requirements given in Paragraph 38 for backfilling the inspection trenches along the floodwall alignment. The clay fill should be placed in loose lift thicknesses not exceeding 12 inches and compacted to 95% of the maximum dry density using ASTM D 698. The moisture range can vary from 3% below to 5% above optimum moisture content.

61. Subgrade Preparation. The existing ground surface beneath the berm should be stripped of all vegetation, loose topsoil, debris, organic matter, and any other deleterious materials to the minimum depth necessary to remove these materials. Clearing operations should not be attempted when the site is wet or during periods of rainy weather.

62. <u>Settlement of Fill.</u> Computations were made to determine estimates of settlement due to the weight of the berm. The results indicate settlement should be negligible at a distance of 15 feet from the toe of the longitudinal slope at the end of the berm. Therefore, fill for the berm should not be closer than 15 feet from the discharge pipe or other facilities of the pump station where it is desirable to reduce differential settlement. Estimates of settlement at several locations on the berm are shown on Figure 28.

63. It should be noted that some differential settlement will occur between the floodwall and pump station due to ongoing aerial subsidence at the site. Normal fluctuations in the ground water level and possible lowering of the ground water level due to improved drainage conditions will also contribute to differential settlement. Therefore, design plans must include some provisions for long term post construction differential settlement.

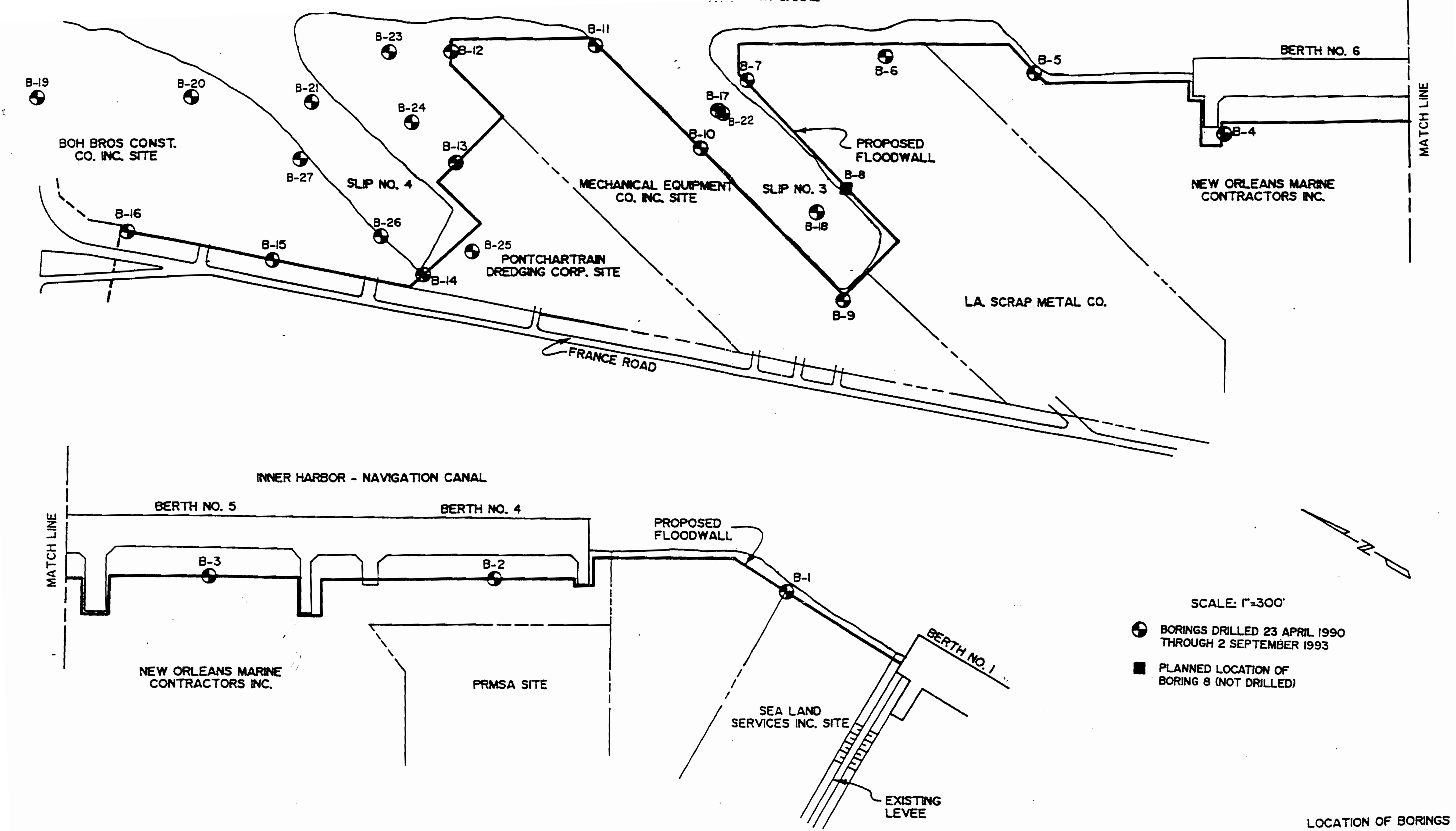
64. Estimated settlement due to ground water lowering may be on the order of 1 inch per foot of permanent lowering of the ground water level. Estimated settlement due to aerial subsidence will depend mainly on the thickness of fill materials over the site. Except for the shells used to fill portions of Slip Nos. 3 and 4, the thickness of fill generally ranges between 10 and 16 feet. We estimate ultimate settlement may be approximately 50% to 60% of the fill thickness or about 5 to 10 feet. However, much of this settlement will be deep seated and only a portion will contribute to differential settlement between the floodwall and pump station. Further, a substantial amount of the ultimate settlement has occurred and the remaining settlement should occur slowly over a long period of time.

ADDITIONAL GEOTECHNICAL SERVICES

65. To provide continuity between the investigation, design, and construction phases, Eustis Engineering should be retained to provide additional services which may include inplace density tests, inspection of piles, measuring vibrations, logging the driving of test piles and job piles, performance of pile load tests, concrete testing and inspection, and any other soil and materials testing services which will provide quality control during construction and conformance to design specifications.

66. Eustis Engineering can provide consulting services regarding development of a pile load program and evaluate driveability of job piles prior to the test pile program. Eustis Engineering can provide dynamic pile test services as discussed under "Pile Driving."

67. In summary, Eustis Engineering should be retained to monitor all geotechnical related work performed by the contractor. This permits the geotechnical engineer to be available quickly, evaluate unanticipated conditions, conduct additional tests, if required, and formulate alternative solutions to problems when necessary. This is recommended to avoid construction cost overruns or disputes on the project.

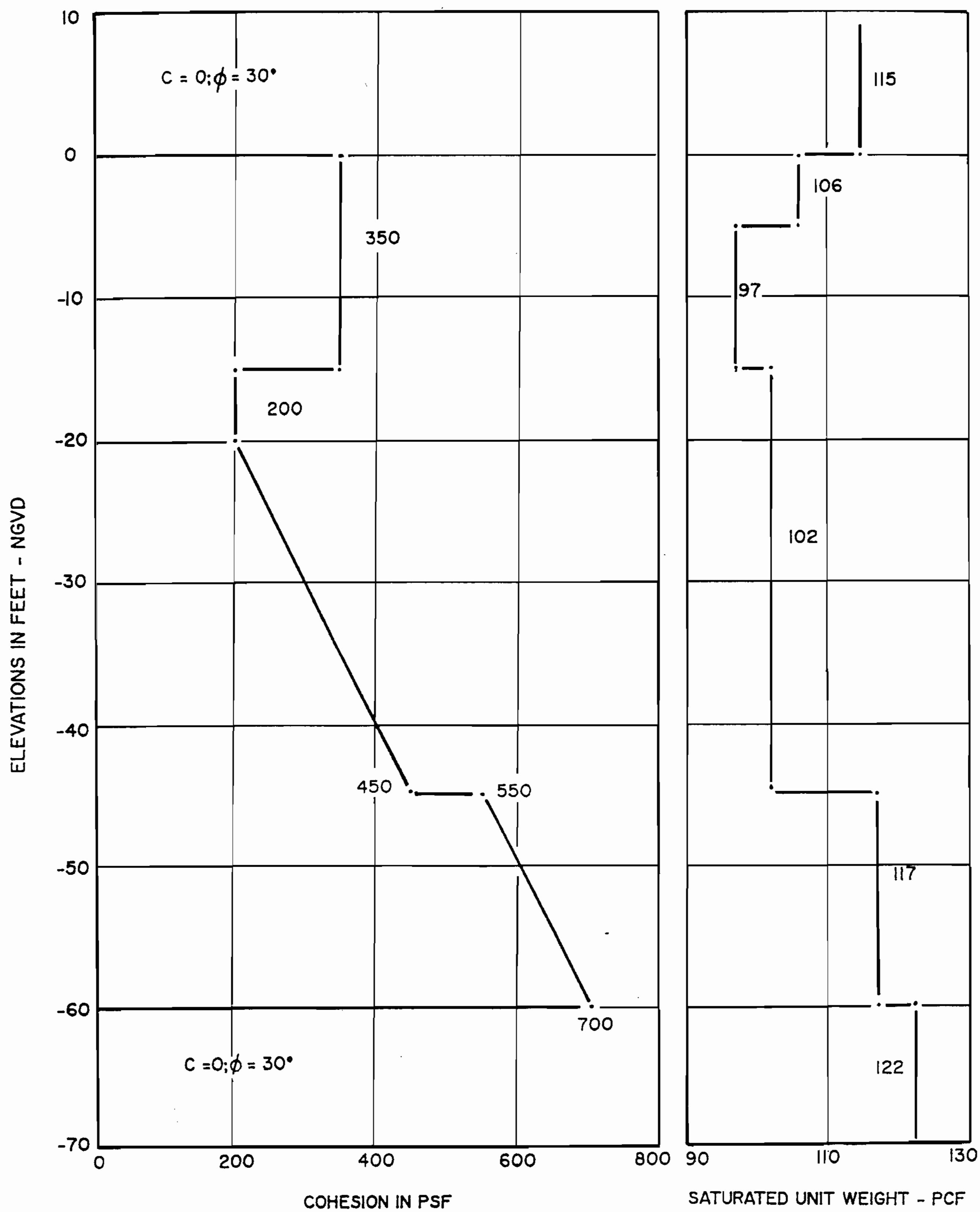


LOCATION OF BORINGS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.

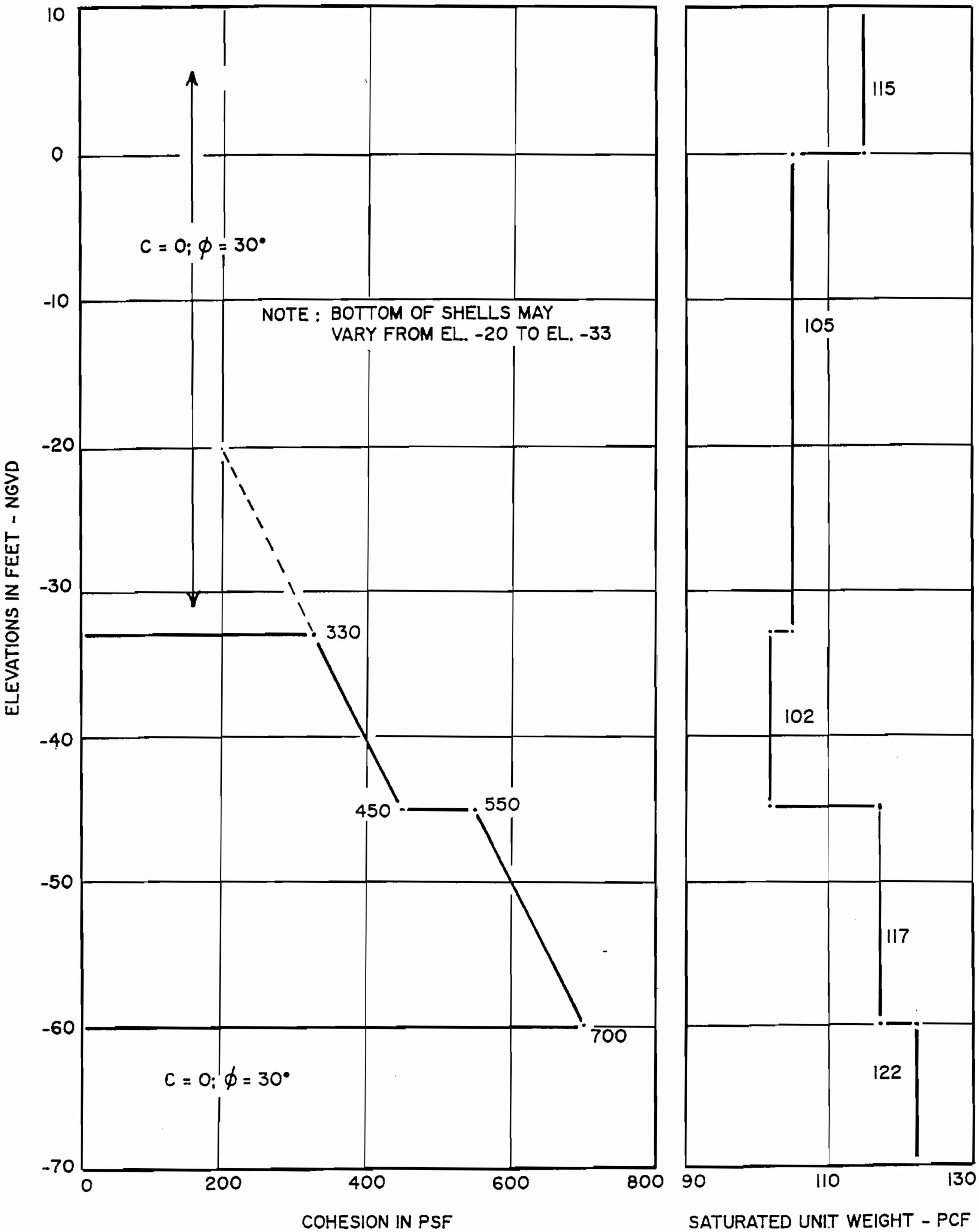
FIGURE 1



BASED ON BORINGS :
1 THROUGH 3; 5 THROUGH 7;
9 THROUGH 12; 14 THROUGH 16;
& 25 THROUGH 27.

REACH I SOIL PARAMETERS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA



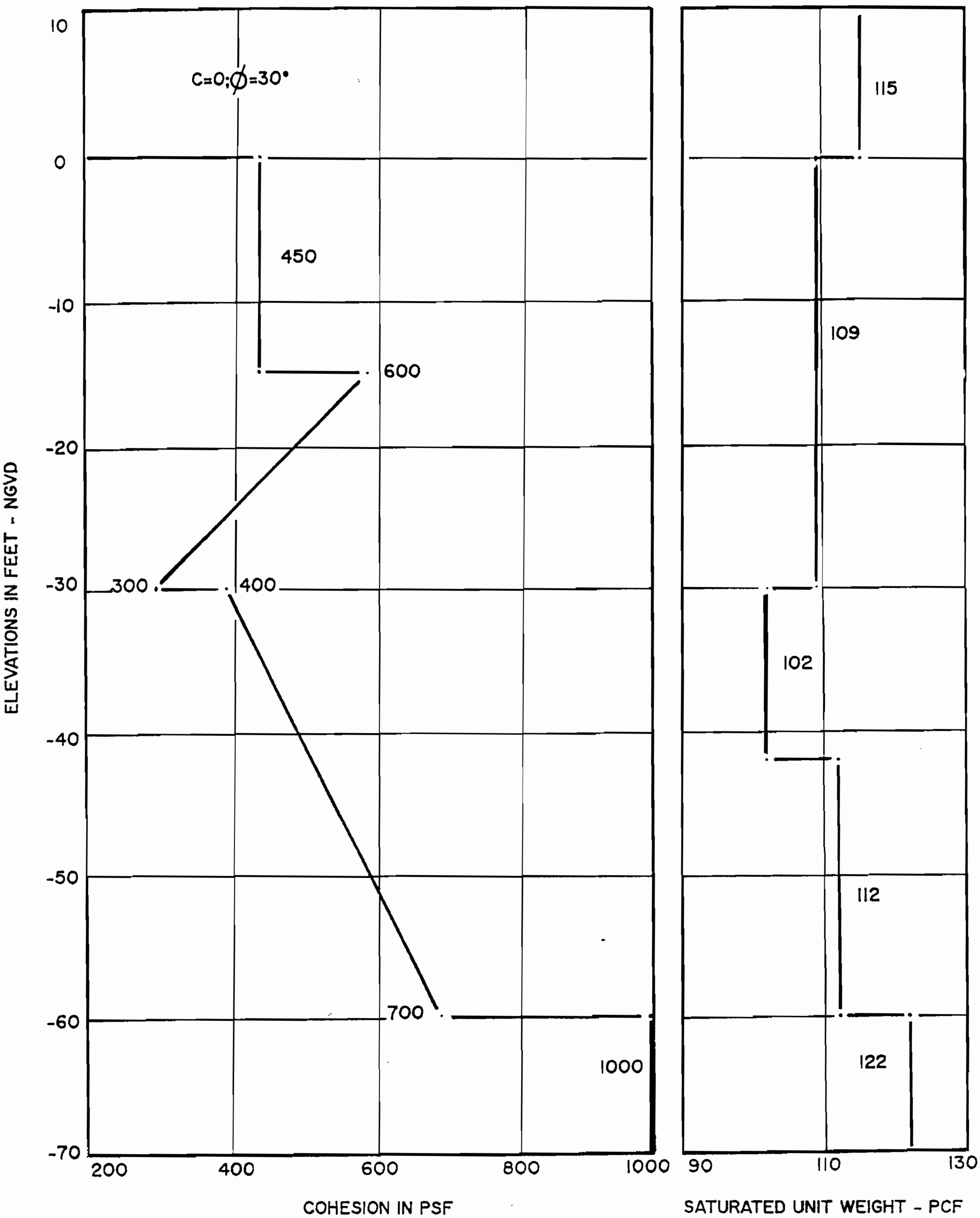
BASED ON BORINGS :
4; 8*; 13; 23; & 24.

* NOT DRILLED

REACH II SOIL PARAMETERS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

FIGURE 3



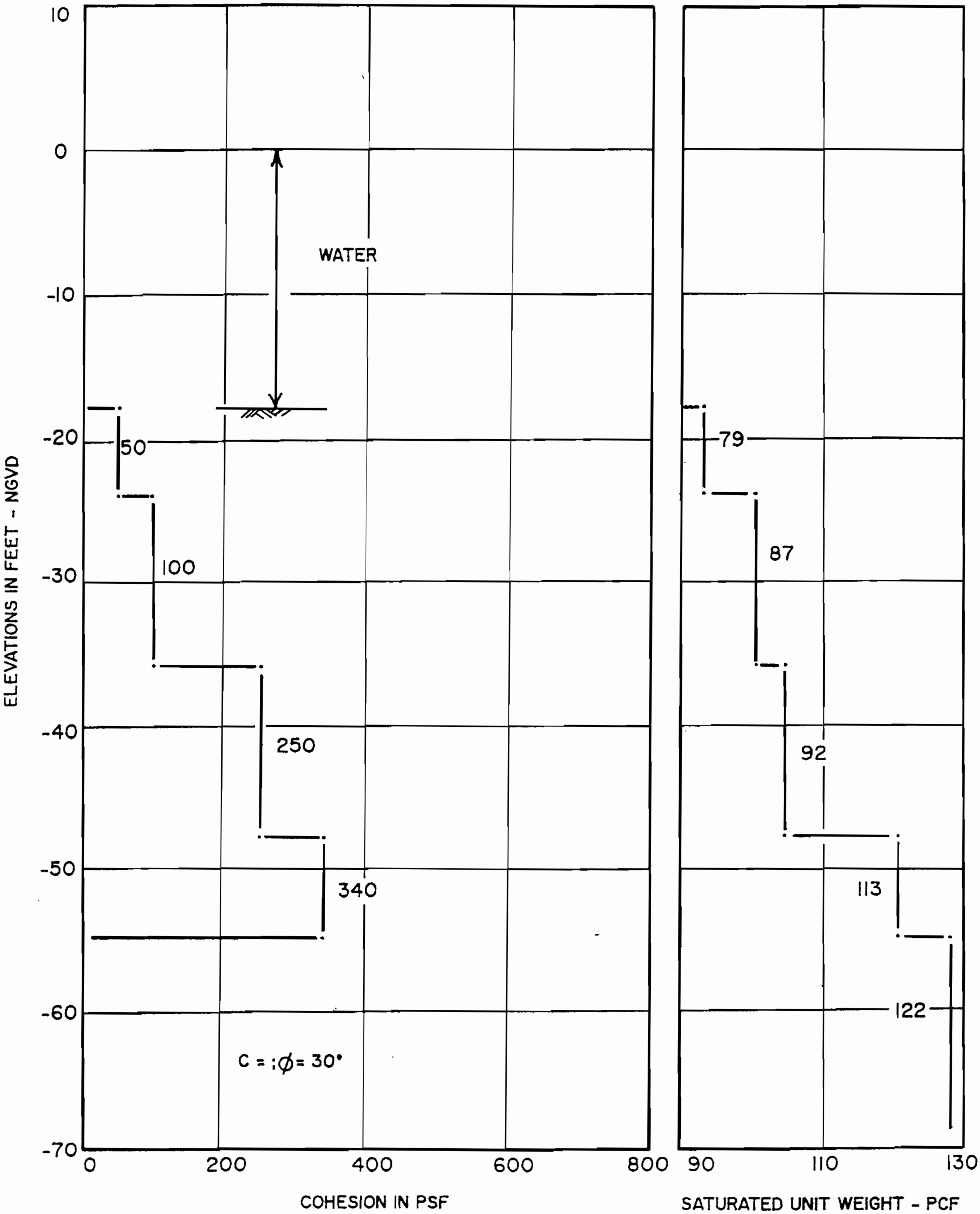
BASED ON BORINGS 19 & 20

REACH III SOIL PARAMETERS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

FIGURE 4

EUSTIS ENGINEERING COMPANY, INC.



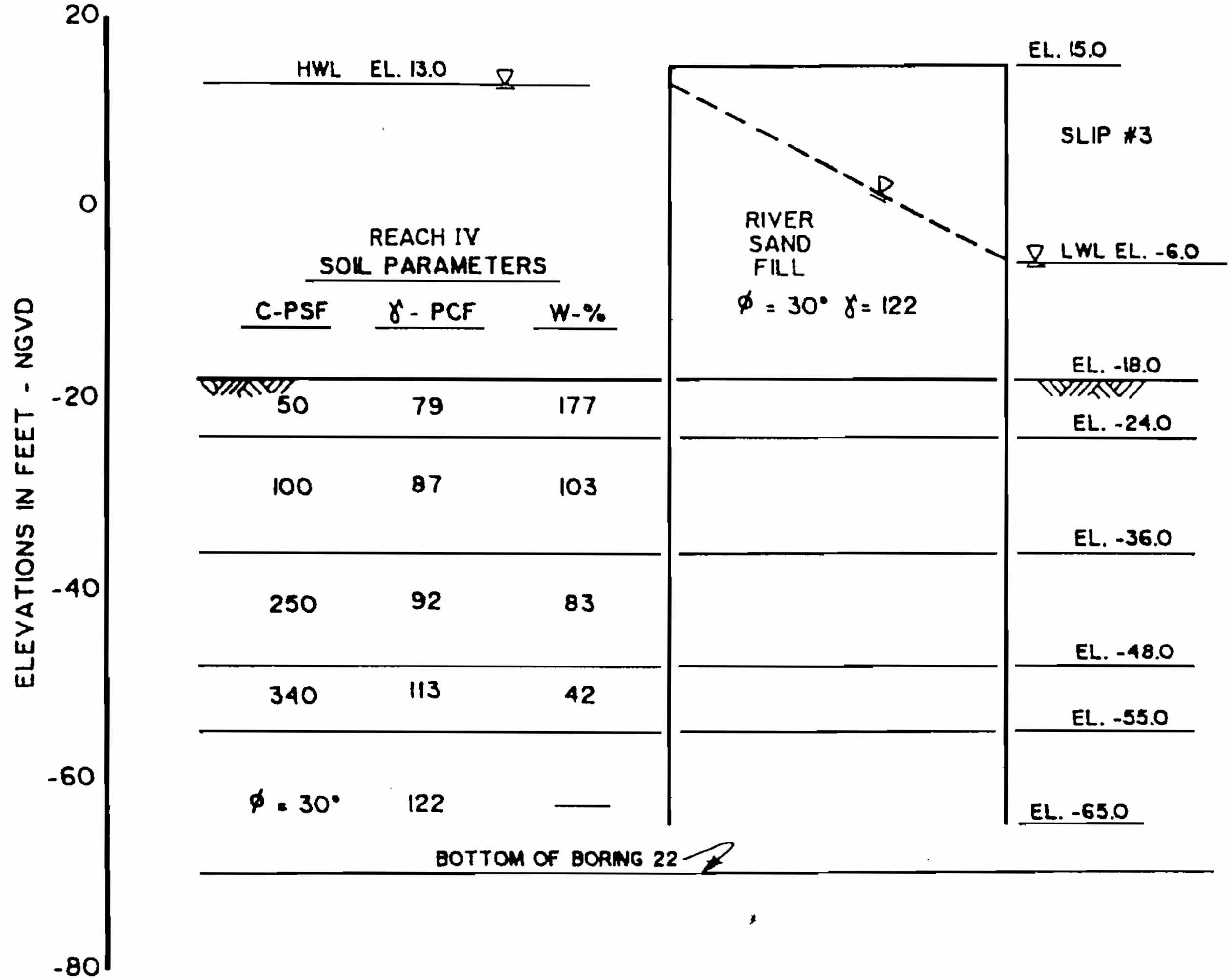
BASED ON BORINGS :
17 & 18;
& 21 & 22.
(PRIMARILY B-22)

REACH IV SOIL PARAMETERS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.

FIGURE 5



COFFERDAM: 36' DIAMETER CIRCULAR TYPE WITH 45° CONNECTING ARCS USING 80' LONG STRAIGHT WEB SHEETPILES WITH ULTIMATE INTERLOCK TENSION CAPACITY > 3.5K/LI

SAFETY FACTORS:		
	OVERTURNING	4.57 > 3.5
	VERTICAL SHEAR	1.72 > 1.25
	TILTING	1.29 > 1.25
	FILL SHEAR	3.07 > 1.25
	BEARING	4.48 > 2.0
	PULLOUT	NOT CRITICAL

SETTLEMENT: SHEETPILES ≈ 1 TO 3 INCHES

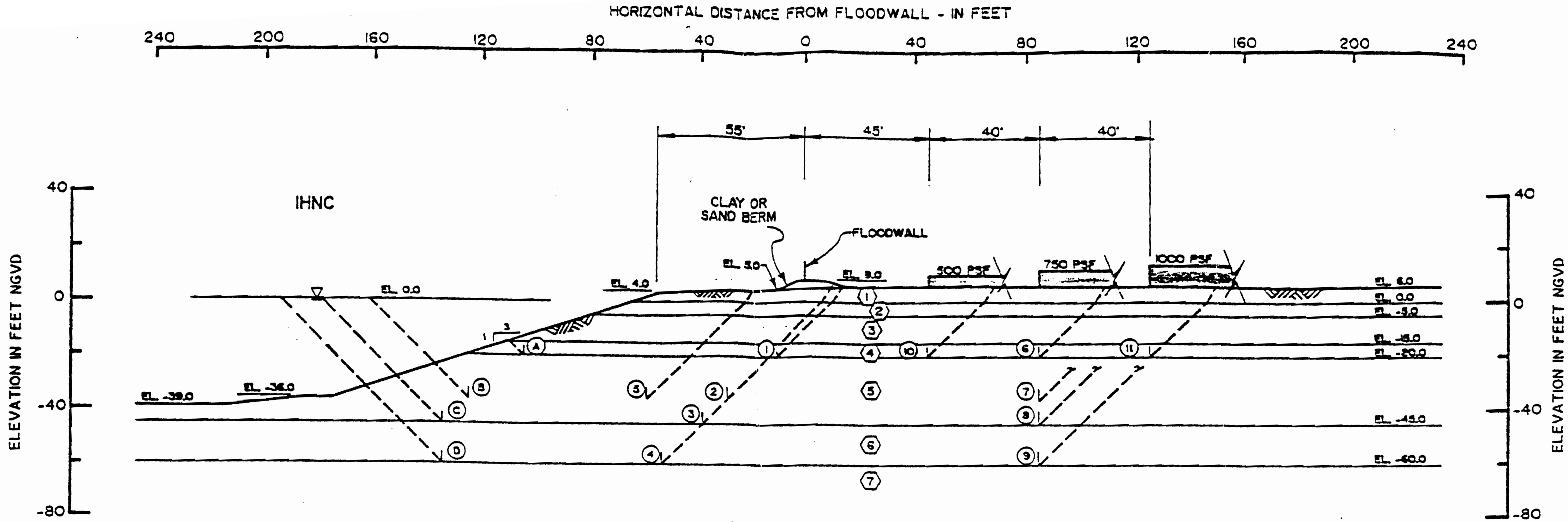
CELL FILL ≈ 8 TO 10 FEET (ASSUMES PERIODIC ADDITION OF FILL TO MAINTAIN DESIGN GRADE)

COFFERDAM AT SLIP #3

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.

FIGURE 6



SOIL PARAMETERS

ST. NO.	γ PCF	Ø DEG	C_A PSF	C_{RB} PSF
BERM	120	30	0	0
1	115	30	0	0
2	106	0	350	350
3	97	0	350	350
4	102	0	200	200
5	102	0	280	360
6	102	0	405	450
7	117	0	625	700
8	120	30	0	0

STABILITY ANALYSES

SLIP SURFACE		ELEV.	ΣR	ΣD	F.S.
1	A	-20	35596	26905	1.32
2	B	-36	65031	49104	1.32
3	C	-45	85585	64272	1.33
4	D	-60	134235	88859	1.51
5	B	-36	54918	40949	1.34
6	A	-20	57203	42558	1.34
7	B	-36	108414	79357	1.37
8	C	-45	143736	103116	1.39
9	D	-60	234137	142026	1.65
10	A	-20	48212	35993	1.34
11	A	-20	66195	49125	1.35

LEGEND

ELEV. = ELEVATION IN FEET - NGVD

ΣD = SUMMATION OF DRIVING FORCES IN LBS.

ΣR = SUMMATION OF RESISTING FORCES IN LBS.

FS = FACTOR OF SAFTEY = ΣR / ΣD

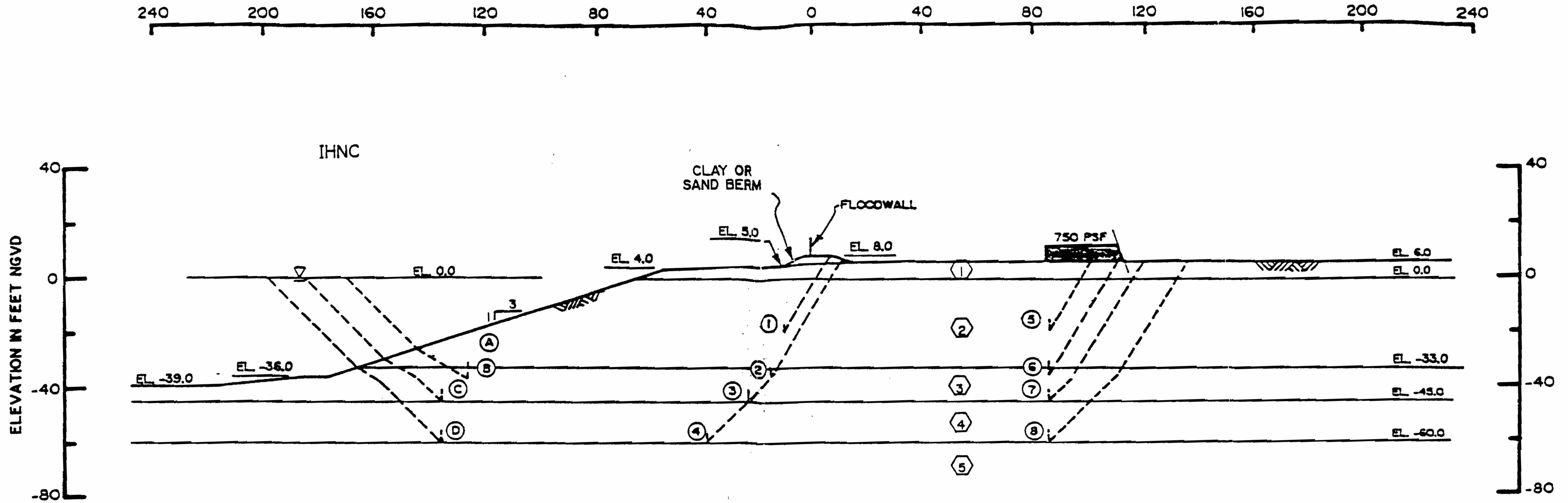
STABILITY ANALYSES AT IHNC
REACH I

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

FIGURE 7

EUSTIS ENGINEERING CO., INC.

HORIZONTAL DISTANCE FROM FLOODWALL - IN FEET



SOIL PARAMETERS

ST NO.	γ PCF	Ø DEG	CA PSF	CRB PSF
BERM	120	30	0	0
⟨1⟩	115	30	0	0
⟨2⟩	105	30	0	0
⟨3⟩	102	0	390	450
⟨4⟩	117	0	625	700
⟨5⟩	122	30	0	0

STABILITY ANALYSES

SLIP SURFACE		ELEV.	Σ R	Σ D	F.S.
(1)	(A)	-20	76855	28639	2.68
(2)	(B)	-36	96476	55655	1.73
(3)	(C)	-45	106202	71626	1.48
(4)	(D)	-60	158591	98418	1.61
(5)	(A)	-20	173735	43991	3.95
(6)	(B)	-36	158993	82301	1.93
(7)	(C)	-45	173575	106755	1.63
(8)	(D)	-60	263973	147281	1.79

LEGEND

ELEV. = ELEVATION IN FEET - NGVD

ΣD = SUMMATION OF DRIVING FORCES IN LBS.

ΣR = SUMMATION OF RESISTING FORCES IN LBS.

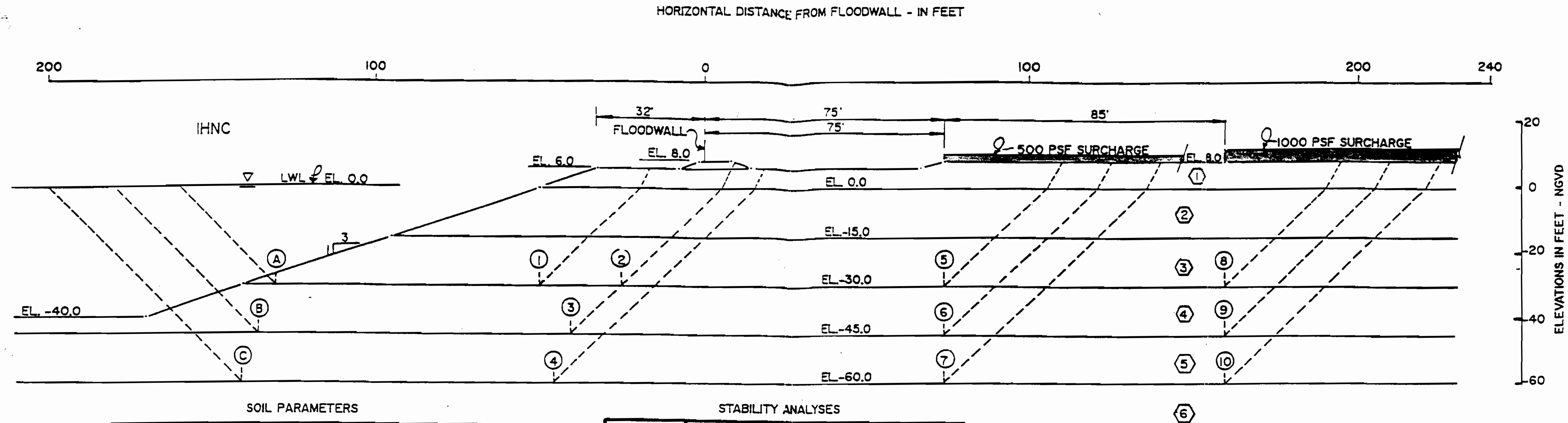
FS = FACTOR OF SAFTEY = ΣR / ΣD

STABILITY ANALYSES AT IHNC
REACH II

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

FIGURE 8

EUSTIS ENGINEERING COMPANY, INC.



SOIL PARAMETERS

ST NO.	γ PCF	Ø DEG	CA PSF	CRB PSF
BERM	120	30	0	0
1	115	30	0	0
2	109	0	450	450
3	109	0	450	300
4	102	0	475	550
5	112	0	625	700
6	122	0	1000	1000

STABILITY ANALYSES

SLIP SURFACE	ELEV.	ΣR	ΣD	F.S.
1 A	-30	54312	37795	1.44
2 A	-30	63257	48489	1.30
3 B	-45	107883	79412	1.36
4 C	-60	153816	112918	1.36
5 A	-30	95960	72730	1.32
6 B	-45	173840	116007	1.50
7 C	-60	241595	162858	1.48
8 A	-30	124119	93188	1.33
9 B	-45	225246	143936	1.55
10 C	-60	303748	198249	1.53

LEGEND

ELEV. = ELEVATION IN FEET - NGVD

ΣD = SUMMATION OF DRIVING FORCES IN LBS.

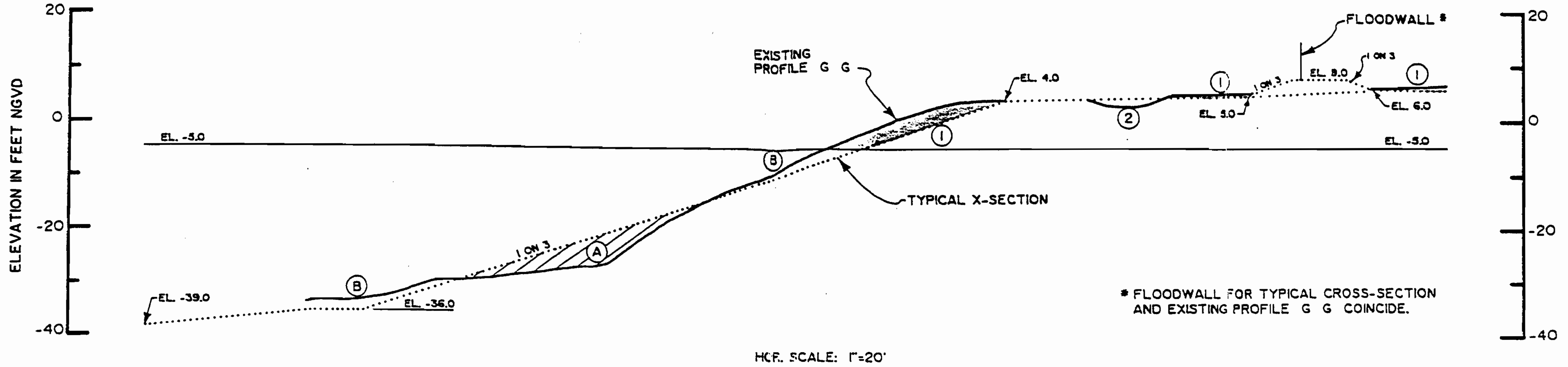
ΣR = SUMMATION OF RESISTING FORCES IN LBS.

FS = FACTOR OF SAFTEY = ΣR / ΣD

STABILITY ANALYSES AT IHNC
REACH III

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.



ABOVE EL. -5

(1) EXISTING PROFILE HIGHER THAN TYPICAL - DEGRADING REQUIRED.

(2) EXISTING PROFILE LOWER THAN TYPICAL - FILLING NOT NECESSARY

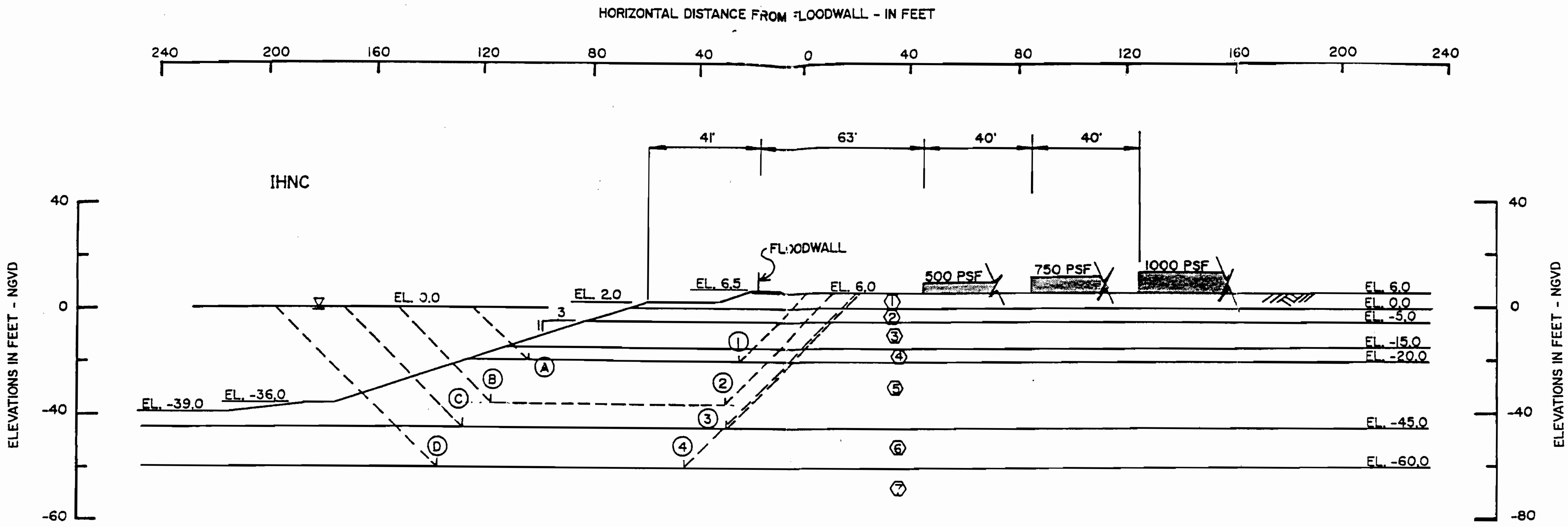
BELOW EL. -5

(A) EXISTING PROFILE LOWER THAN TYPICAL - FILLING REQUIRED

(B) EXISTING PROFILE HIGHER THAN TYPICAL - DEGRADING NOT NECESSARY

OVERLAY PROCEDURE
REACHES I & II

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA



STABILITY ANALYSES

SLIP SURFACE		ELEV.	ΣR	ΣD	F.S.
①	Ⓐ	-20	32180	23723	1.36
②	Ⓑ	-36	63320	47199	1.34
③	Ⓒ	-45	88109	64264	1.37
④	Ⓓ	-60	144360	89392	1.61

NOTE : SEE FIGURE 7 FOR ANALYSES OF SURCHARGE LOADS, SOIL PARAMETERS & LEGEND

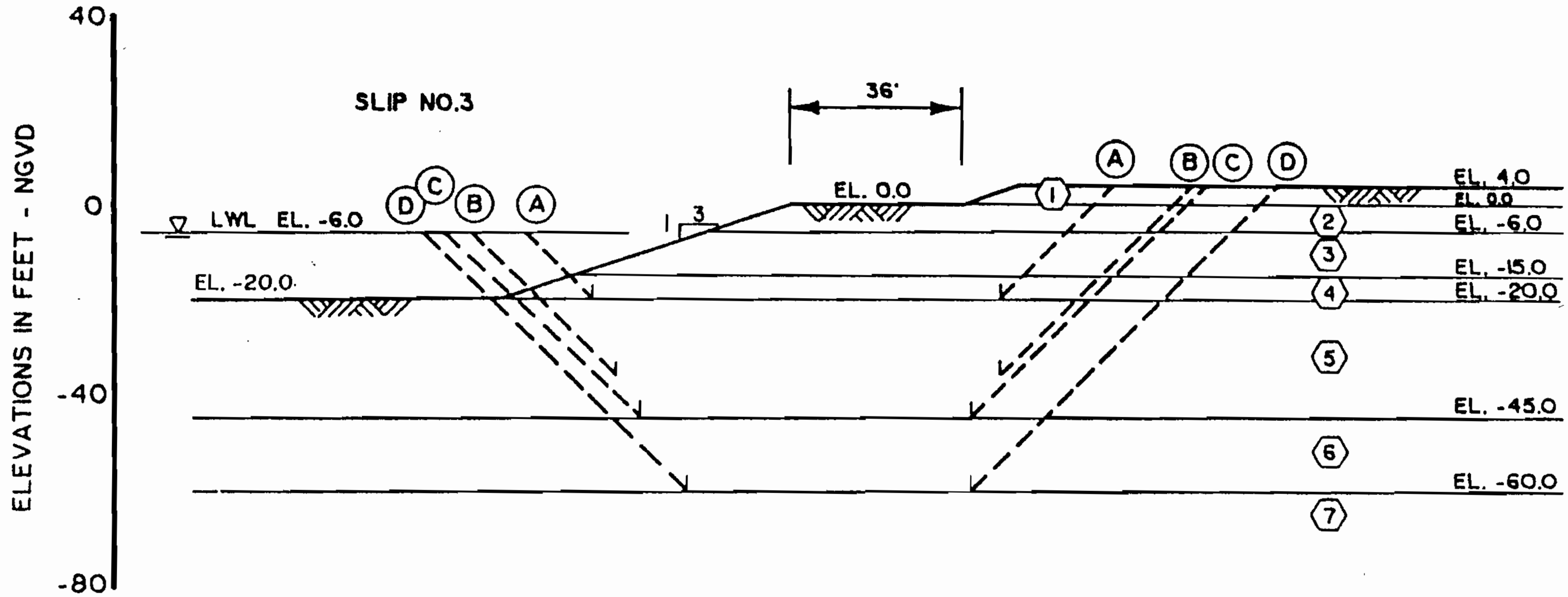
STABILITY ANALYSES AT IHNC
STA. 160+00 & STA. N4
REACH I

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.

FIGURE 11

REACH I & II



STABILITY ANALYSIS *

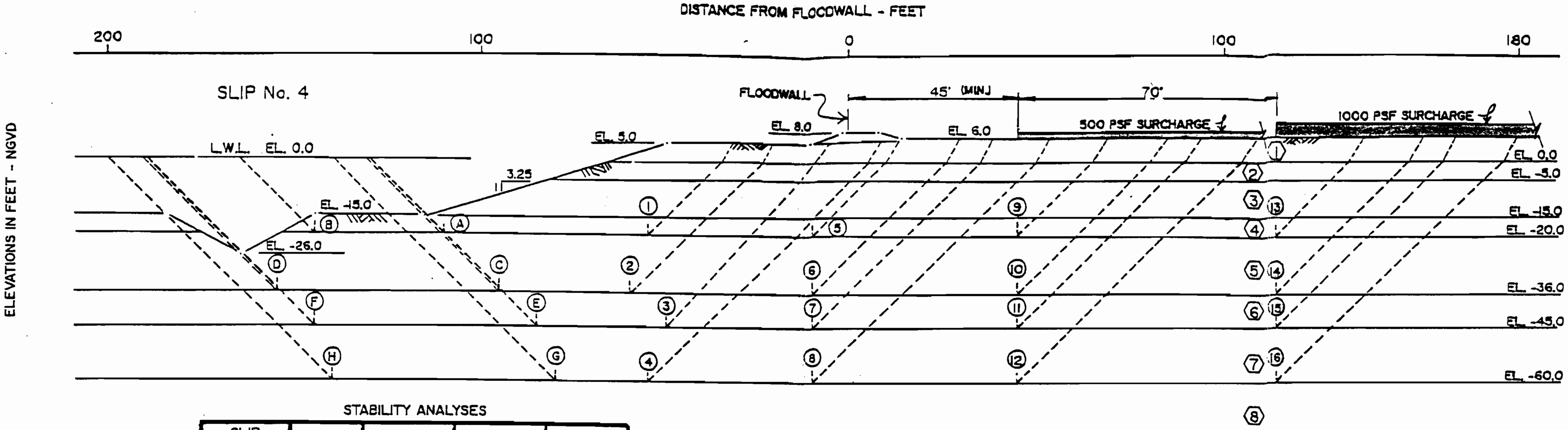
SLIP SURFACE		ELEV.	ΣR	ΣD	F.S.
(A)	(A)	-20	31812	23417	1.36
(B)	(B)	-36	60433	46583	1.30
(C)	(C)	-45	76313	57889	1.32
(D)	(D)	-60	124122	78000	1.59

* ANALYSES ARE BASED ON REACH I SOIL CONDITIONS. PREVIOUS SLOPE STABILITY ANALYSES SHOW THAT REACH II SOIL CONDITIONS DO NOT GOVERN.

NOTE : SEE FIGURE 7 FOR SOIL PARAMETERS & LEGEND

SLOPE STABILITY AT SLIP No. 3

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA



STABILITY ANALYSES

SLIP SURFACE	ELEV.	ΣR	ΣD	FS
1 A	-20	26458	19607	1.35
1 B	-20	32742	19915	1.64
2 C	-36	45978	34497	1.33
2 D	-36	62223	42245	1.47
3 E	-45	65053	46653	1.39
3 F	-45	86892	57685	1.51
4 G	-60	104454	65184	1.60
4 H	-60	146112	80302	1.82
5 A	-20	36247	27038	1.34
5 B	-20	42531	27346	1.57
6 C	-36	64401	44894	1.43
6 D	-36	80646	52642	1.53
7 E	-45	82130	53554	1.53
7 F	-45	103969	64586	1.61
8 G	-60	136863	76584	1.79
8 H	-60	178521	91702	1.95
9 A	-20	48868	36148	1.35
10 C	-36	86192	62195	1.39
11 E	-45	108875	75343	1.45
12 G	-60	175378	99894	1.76
13 A	-20	64866	49838	1.30
14 C	-36	113400	83914	1.35
15 E	-45	142380	101573	1.40
16 G	-60	226379	133656	1.69

LEGEND

ELEV. = ELEVATION IN FEET - NGVD

ΣD = SUMMATION OF DRIVING FORCES IN LBS.

ΣR = SUMMATION OF RESISTING FORCES IN LBS.

FS = FACTOR OF SAFTEY = ΣR / ΣD

NOTE : SEE FIGURE 7 FOR SOIL PARAMETERS

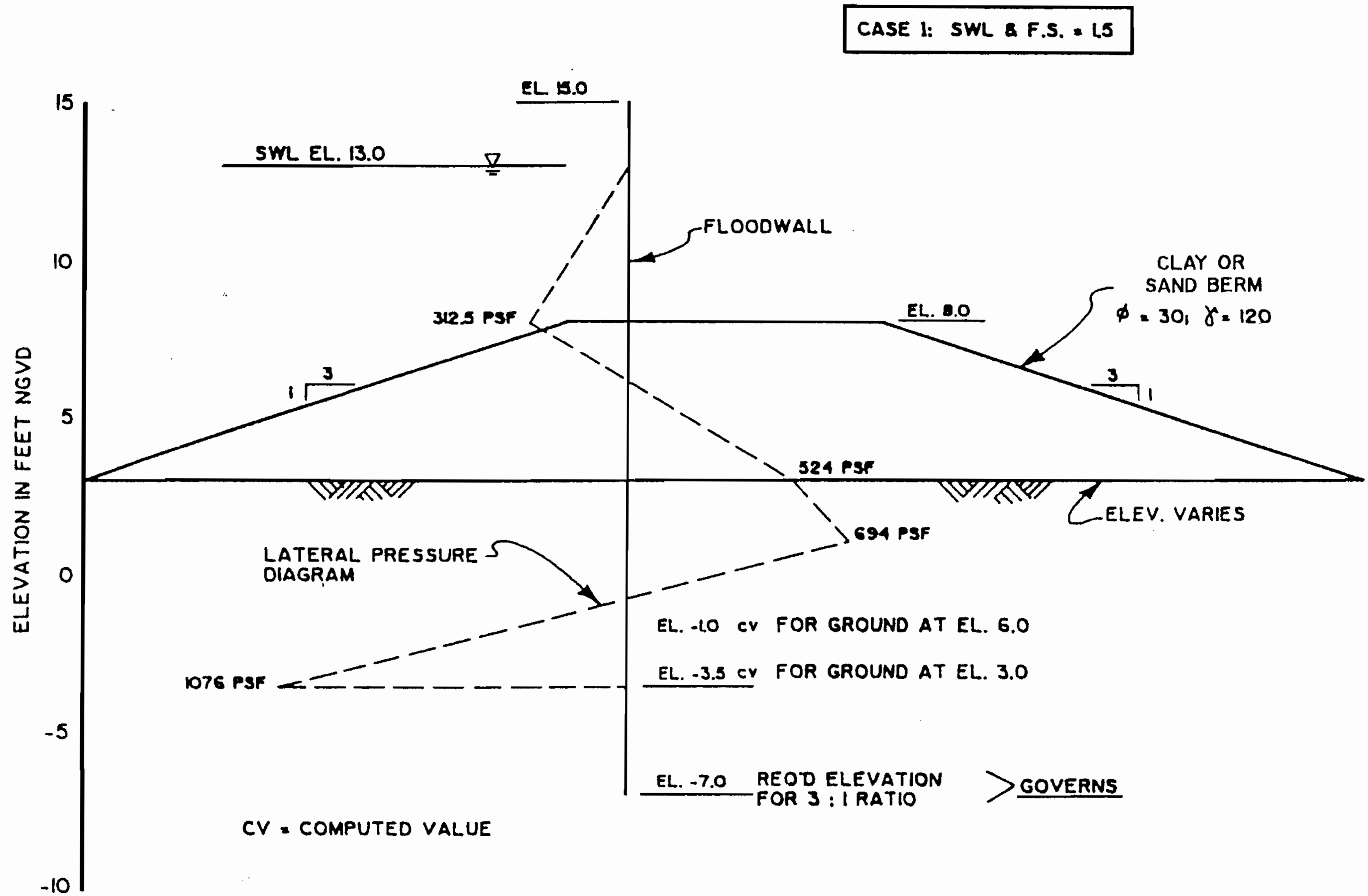
STABILITY ANALYSES AT SLIP No. 4
REACH I & II

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.

FIGURE 13

REACH I & III SOIL PARAMETERS



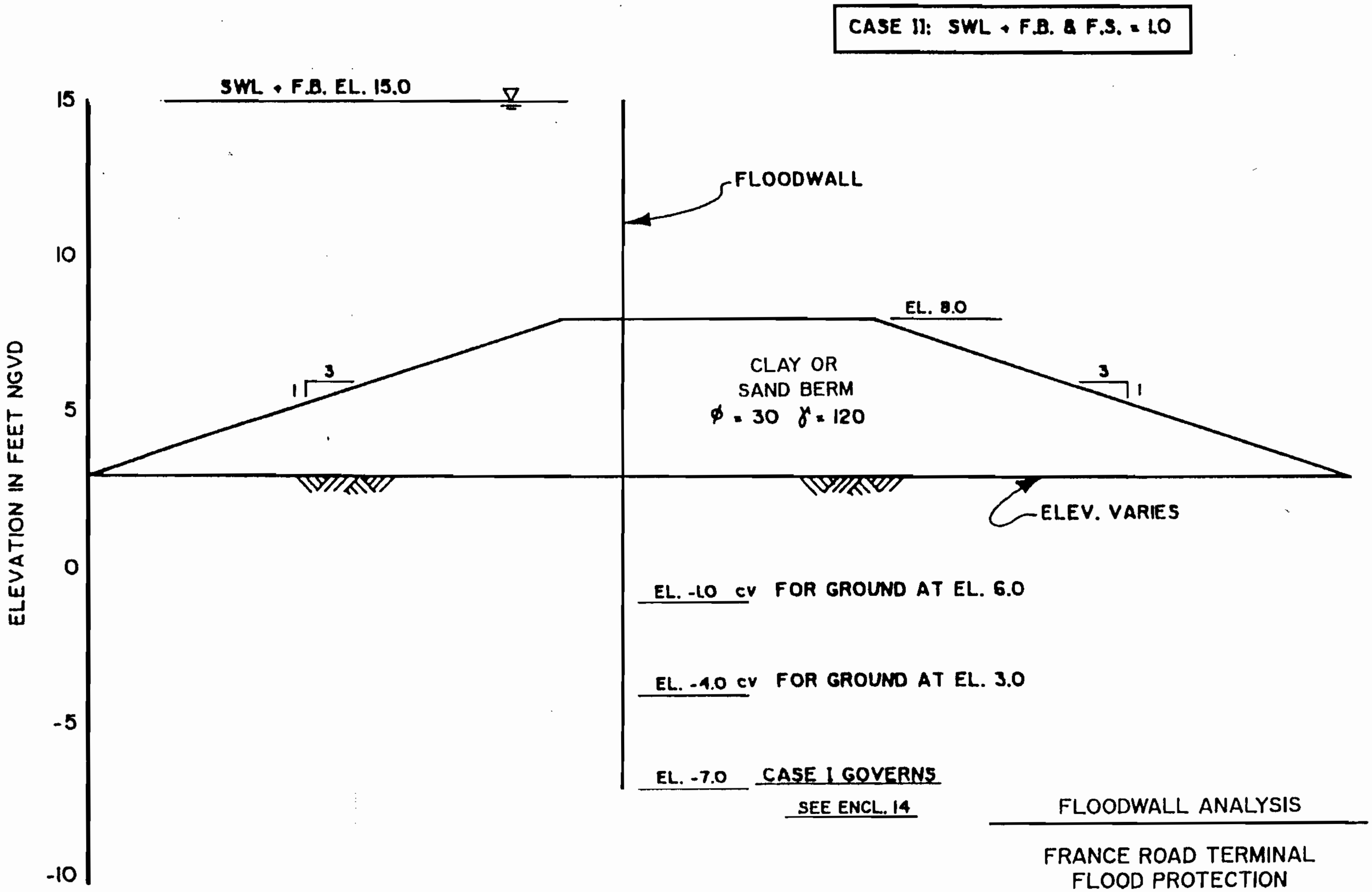
FLOODWALL ANALYSIS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.

FIGURE 14

REACH I & III SOIL PARAMETERS



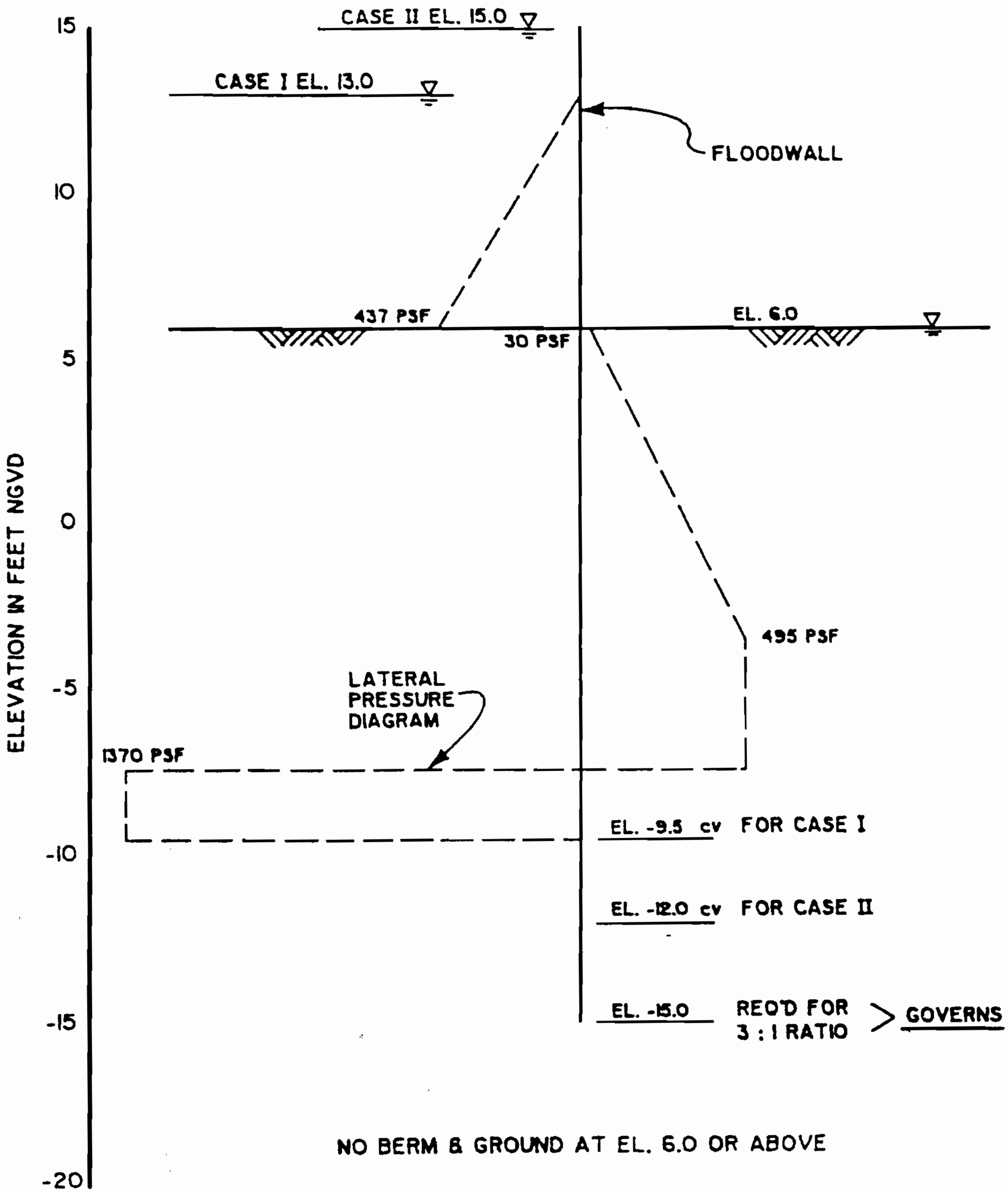
FLOODWALL ANALYSIS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

FIGURE 15

EUSTIS ENGINEERING COMPANY, INC.

REACH I & III SOIL PARAMETERS



FLOODWALL ANALYSIS

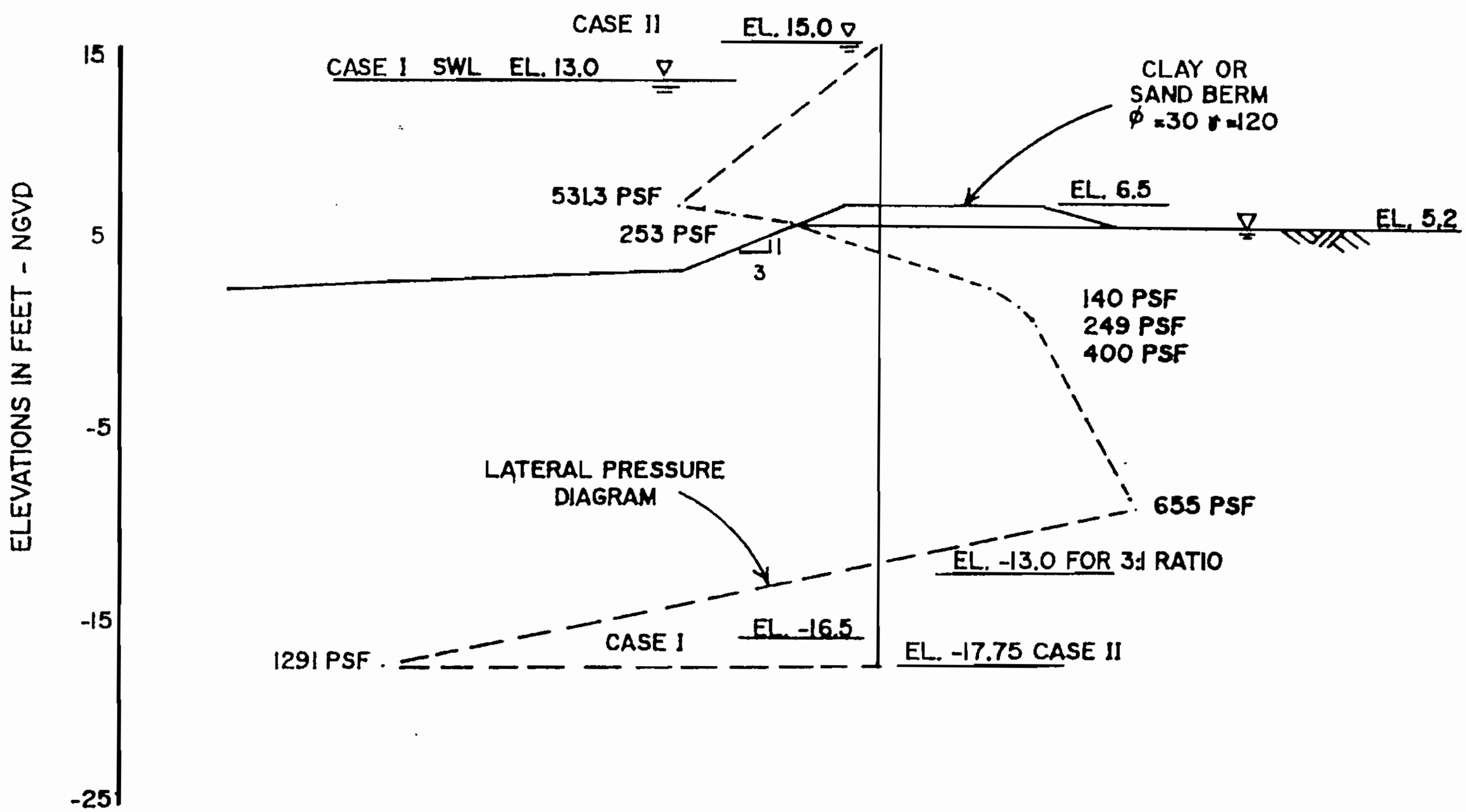
FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

FIGURE 16.

EUSTIS ENGINEERING COMPANY, INC.

REACH I SOIL PARAMETERS

STATION N4



FLOODWALL ANALYSES

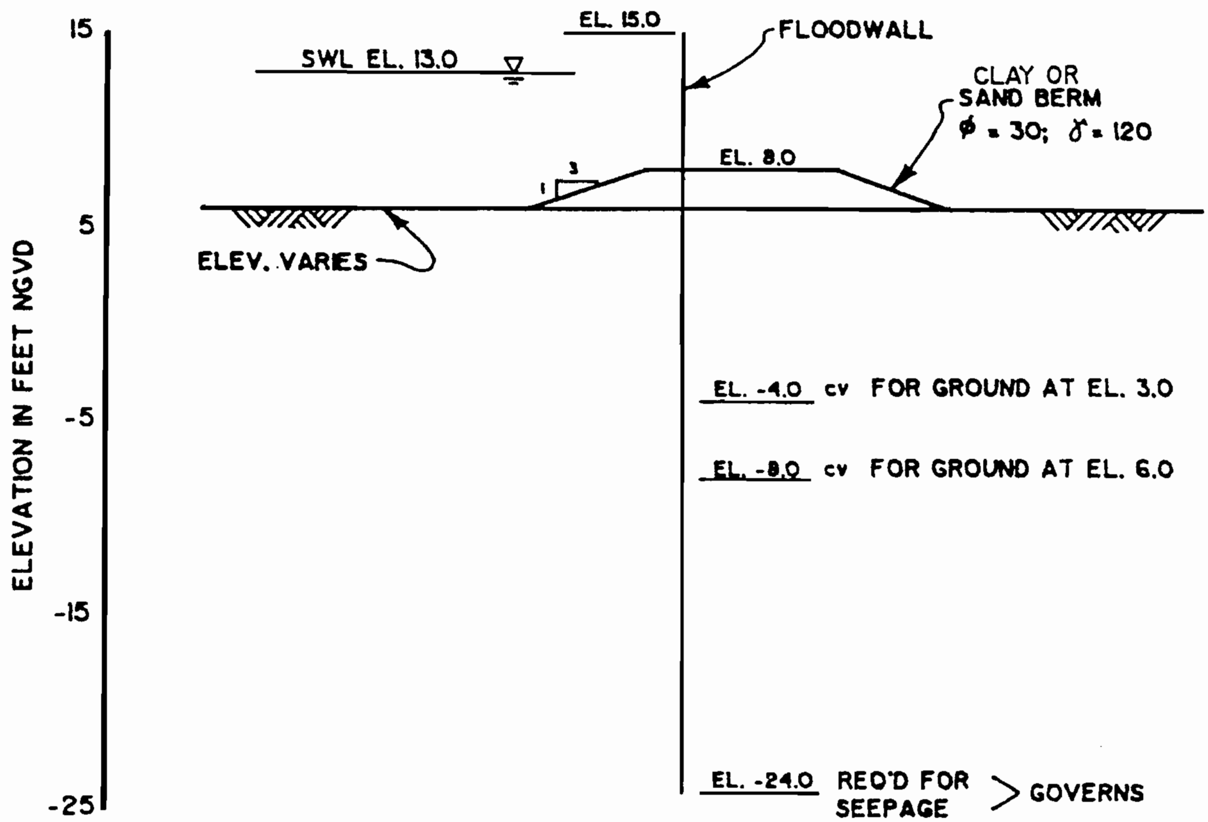
FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.

FIGURE 17

REACH II SOIL PARAMETERS

CASE 1: SWL & F.S. = 1.5



HARR ANALYSIS:

$S = 27'$; $T = 42'$; $S/T = 0.64$; $hm = 5'$

$I_E (S/hm) = 0.57 \therefore I_E = 0.106$

$I_c = \frac{\gamma'}{62.4} = 0.68$

$F.S. = I_c / I_E = 6.4 > 6.0$ OK

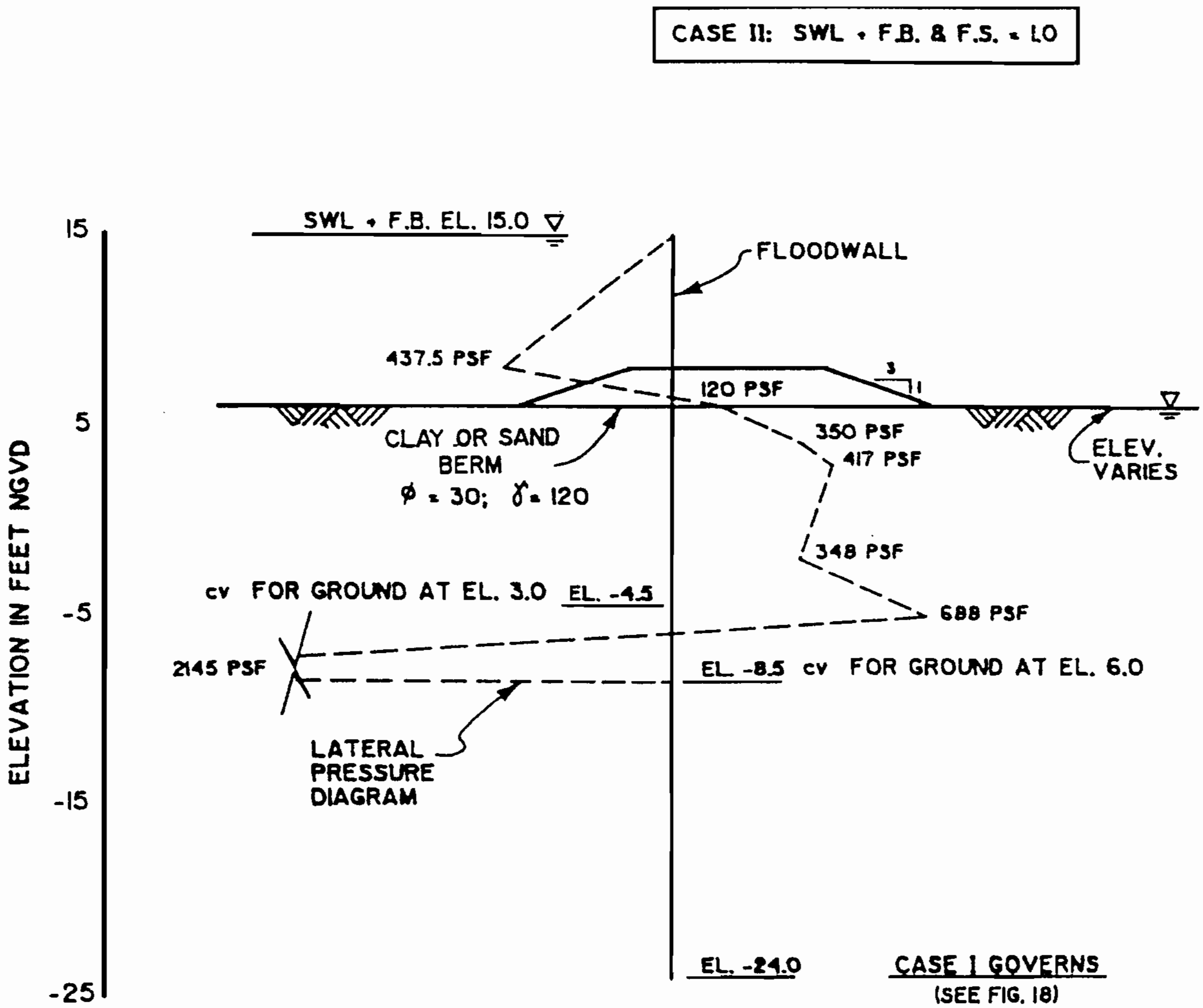
LEGEND

S	=	SHEETPILE PENETRATION BELOW GROUND SURFACE
T	=	THICKNESS OF PERVIOUS STRATUM
I_E	=	EXIT GRADIENT
I_{CR}	=	CRITICAL GRADIENT
hm	=	DIFFERENTIAL HYDROSTATIC HEAD
FS	=	FACTOR OF SAFETY

FLOODWALL ANALYSIS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

REACH II SOIL PARAMENTERS

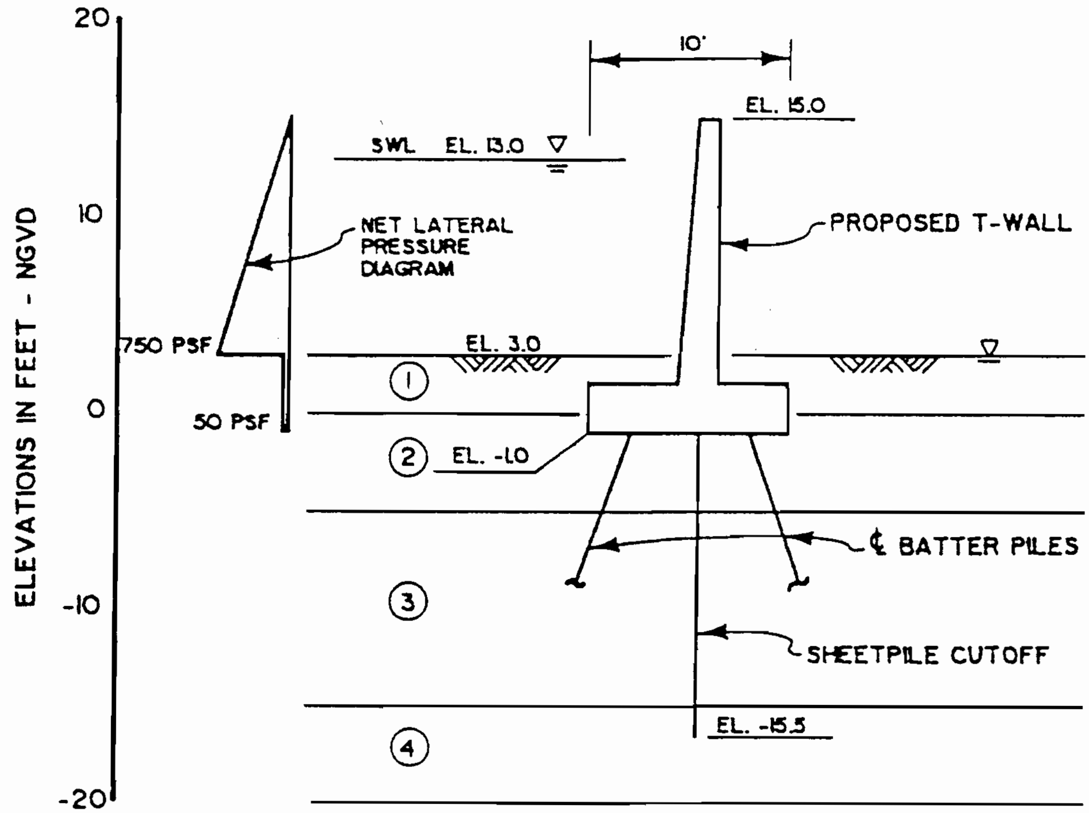


FLOODWALL ANALYSIS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

FIGURE 19

EUSTIS ENGINEERING COMPANY, INC.



LANE'S WEIGHTED CREEP RATIO METHOD

SEEPAGE ANALYSIS: $\frac{L}{H} = \frac{2\ (3 + 15.5) + 10/3}{13-3} = 4.03$ OK

STABILITY ANALYSIS:

EL.	ΣD	—	ΣR*	=	F_N	ΔF_N
-1	5619		7000		-1381	——
-5	8117		11308		-3191	-1810
-15	14363		27200		-12837	-9646
-20	17488		31200		-13712	-875

*INCLUDES F.S. = 1.3 APPLIED TO SOIL

NO SURCHARGE ON STRUCTURE FROM CUTOFF

TOTAL FORCE ON STRUCTURE

$F_T = 0.5\ (750)\ 12 + 4\ (50) = 4700$ #/LF

LEGEND

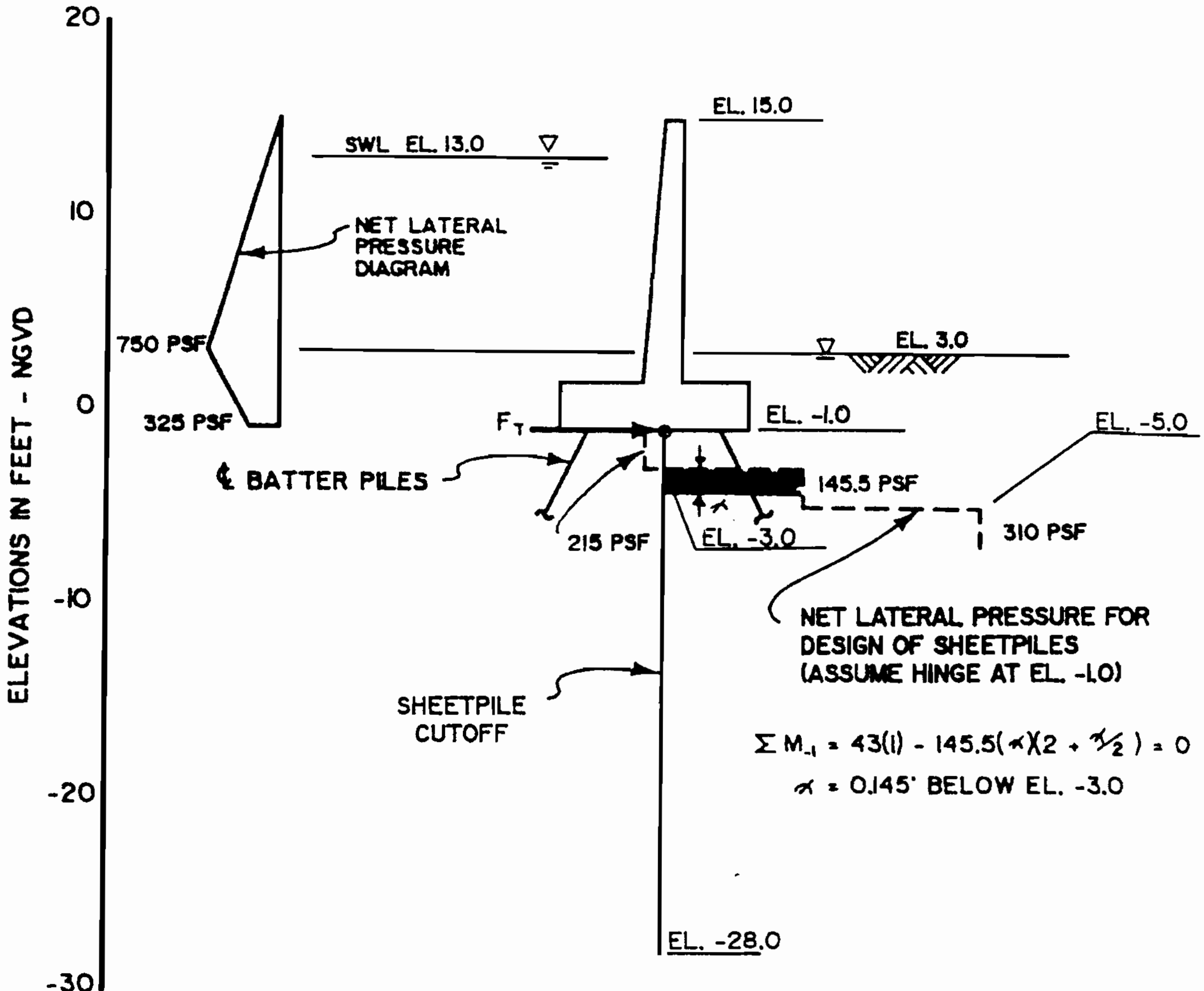
ΣD & ΣR = SEE FIGURE 7

F_N = NET FORCE

ΔF_N = CHANGE IN NET FORCE / FT. DEPTH

T-WALL AND FLOODGATE ANALYSES
REACH I & III

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA



$\Sigma M_{-1} = 43(1) - 145.5(\alpha)(2 + \alpha/2) = 0$

$\alpha = 0.145'$ BELOW EL. -3.0

STABILITY ANALYSIS:

EL.	ΣD	− ΣR*	= F_N	ΔF_N	$P_N = \Delta F_N / H$
-1	5618	1419	4199	—	—
-3	6867	2625	4242	+43	215 PSF
-5	8116	4165	3951	-291	(-) 145.5 PSF
-7	9365	6034	3331	-620	(-) 310.0 PSF (H = 2')

* INCLUDES F.S. = 1.3 APPLIED TO SOIL

SHEETPILE ANALYSIS:

SURCHARGE LOAD ON WALL FROM SHEETPILE CUTOFF

$F_{SL} = 2\,(21.5) - 0.145\,(145.5) = 22$ PLF

LANE'S WEIGHTED CREEP RATIO METHOD

SEEPAGE ANALYSIS:

$$\frac{L}{H} = \frac{2\,(4 + 27) + 10/3}{13 - 3} = 6.53 \text{ OK}$$

TOTAL FORCE ON STRUCTURE

$F_T = 0.5\,(750)\,12 + 0.5\,(750 + 325)\,4 + 22 = 6672$ #/LF

LEGEND

ΣD & ΣR = SEE FIGURE 7
F_N = NET FORCE
ΔF_N = CHANGE IN NET FORCE / FT.

T-WALL AND FLOODGATE ANALYSES
REACH II

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

REACH I

TYPE AND SIZE OF PILE	PILE TIP ELEVATION NGVD	ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITY IN TONS FACTOR OF SAFETY = 1	
		COMPRESSION	TENSION
12-In. Square Precast Concrete	-55	44	28
	-65	90**	47
	-75*	92	61
	-85*	112	75
	-95*	130	88
14-In. Square Precast Concrete	-55	51	33
	-65	110**	55
	-75*	108	71
	-85*	131	87
	-95*	152	102
18-In. Square Precast Concrete	-55	67	43
	-65	153**	70
	-75*	141	92
	-85*	171	112
	-95*	198	131

* Computations for pile embedments below the bottom of the borings assume a cohesive stratum with a cohesion of 1,000 psf.

** Assumes pile tip firmly seated in dense sand.

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

REACH II

TYPE AND SIZE OF PILE	PILE TIP ELEVATION NGVD	ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITY IN TONS FACTOR OF SAFETY = 1	
		COMPRESSION	TENSION
12-In. Square Precast Concrete	-55 -65 -75* -85* -95*	42 90** 90 110 128	27 46 60 74 86
14-In. Square Precast Concrete	-55 -65 -75* -85* -95*	49 109** 106 129 150	32 53 70 86 101
18-In. Square Precast Concrete	-55 -65 -75* -85* -95*	65 153** 138 168 195	41 69 90 111 130

* Computations for pile embedments below the bottom of the borings assume a cohesive stratum with a cohesion of 1,000 psf.

** Assumes pile tip firmly seated in dense sand.

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

REACH III

TYPE AND SIZE OF PILE	PILE TIP ELEVATION NGVD	ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITY - TONS FACTOR OF SAFETY = 1	
		COMPRESSION	TENSION
12-In. Square Precast Concrete	-55 -65 -75* -85* -95*	55 70 90 110 130	36 45 59 73 87
14-In. Square Precast Concrete	-55 -65 -75* -85* -95*	65 82 105 129 152	42 53 69 86 102
18-In. Square Precast Concrete	-55 -65 -75* -85* -95*	85 108 138 168 198	55 68 89 110 131

* Computations for pile embedments below the bottom of the borings assume a cohesive stratum with a cohesion of 1,000 psf.

AXIAL AND HORIZONTAL RESISTANCE OF BATTER PILES

ESTIMATED FROM ALLOWABLE VERTICAL LOAD CAPACITY

L = VERTICAL COMPONENT OF BATTER PILE EMBEDMENT LENGTH.

V = ESTIMATED ALLOWABLE SINGLE PILE LOAD CAPACITY OF A PILE DRIVEN VERTICALLY WITH EMBEDMENT LENGTH, L.

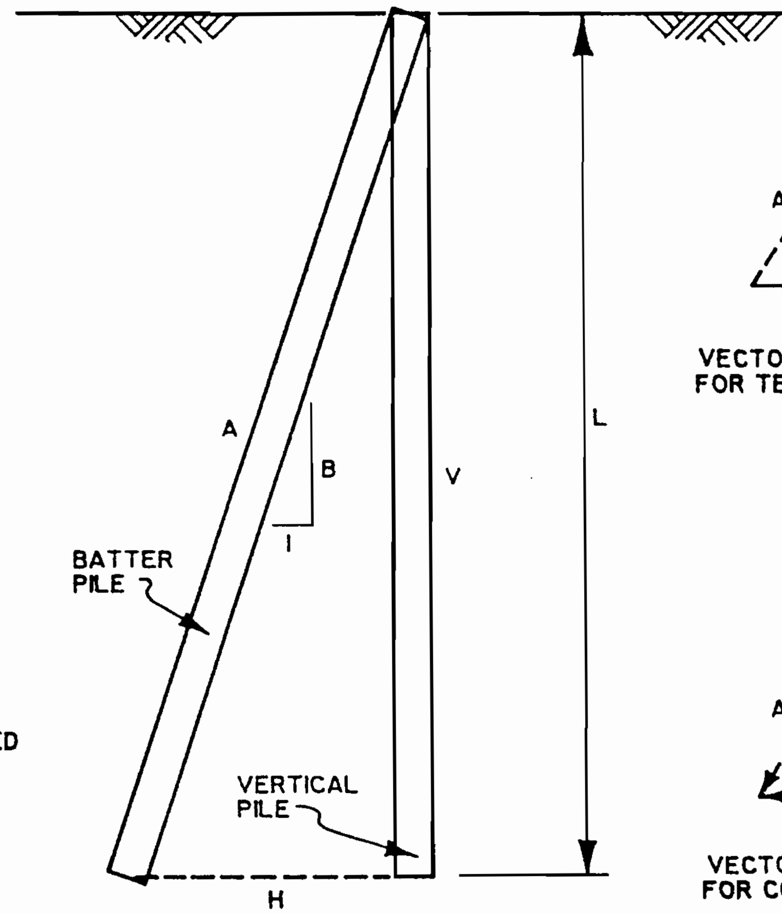
B = BATTER OF PILE EXPRESSED AS A RATIO OF VERTICAL DISTANCE TO ONE FOOT HORIZONTAL DISTANCE.

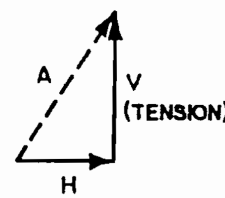
H = HORIZONTAL RESISTANCE OF BATTER PILE ESTIMATED AS FOLLOWS:

$$H = \frac{V}{B}$$

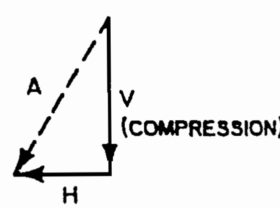
A = ALLOWABLE AXIAL PILE LOAD CAPACITY OF A SINGLE BATTER PILE ESTIMATED AS FOLLOWS:

$$A = \sqrt{V^2 \left(1 + \frac{1}{B^2}\right)}$$





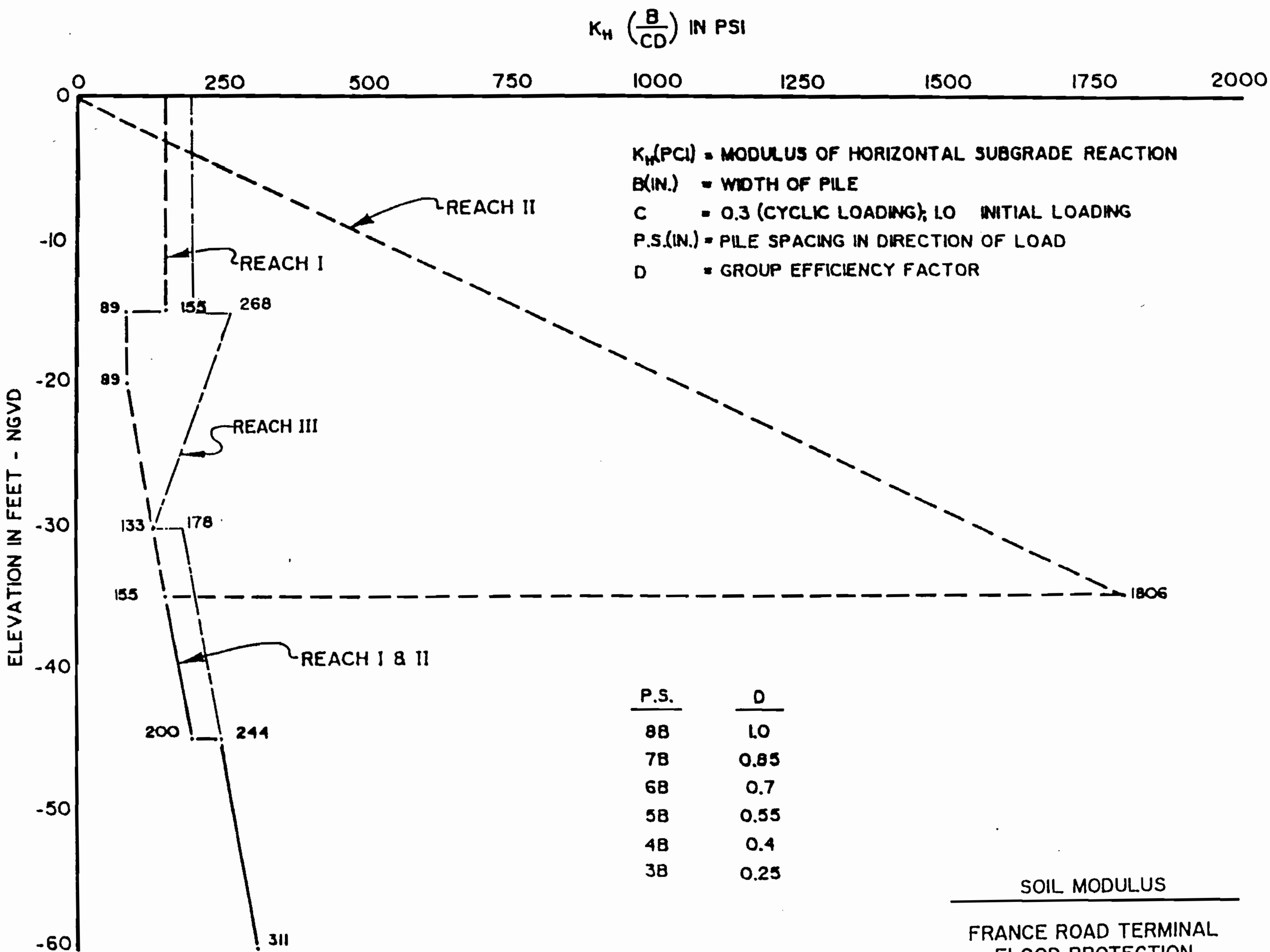
VECTOR DIAGRAM FOR TENSION PILE



VECTOR DIAGRAM FOR COMPRESSION PILE

NOTE: THE AXIAL LOAD RESISTANCE OF A VERTICAL PILE, V, IS DEPENDENT ON THE TYPE OF LOADING--TENSION OR COMPRESSION. CAUTION SHOULD BE EXERCISED TO INSURE THAT THE CORRECT VERTICAL CAPACITY IS USED.

THE AXIAL CAPACITY OF BATTERED PILES SHOULD BE LIMITED TO THE VERTICAL COMPONENT.



K_H(PCI) = MODULUS OF HORIZONTAL SUBGRADE REACTION
B(IN.) = WIDTH OF PILE
C = 0.3 (CYCLIC LOADING); 1.0 INITIAL LOADING
P.S.(IN.) = PILE SPACING IN DIRECTION OF LOAD
D = GROUP EFFICIENCY FACTOR

P.S.	D
8B	1.0
7B	0.85
6B	0.7
5B	0.55
4B	0.4
3B	0.25

SOIL MODULUS

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

FIGURE 26

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CAPACITY OF PILE GROUPS

The maximum allowable load carrying capacity of a pile group is no greater than the sum of the single pile load capacities, but may be limited to a lower value if so indicated by the result of the following formula.

$$Q_a = \frac{P \times L \times c}{(FSF)} + \frac{2.6\, q_u \left(1 + 0.2 \frac{w}{b}\right) A}{(FSB)}$$

In Which:

Q_a	=	Allowable load carrying capacity of pile group, lb
P	=	Perimeter distance of pile group, ft
L	=	Length of pile, ft
c	=	Average (weighted) cohesion or shear strength of material between surface and depth of pile tip, psf
q_u	=	Average unconfined compressive strength of material in the zone immediately below pile tips, psf (unconfined compressive strength = cohesion x 2)
w	=	Width of base of pile group, ft
b	=	Length of base of pile group, ft
A	=	Base area of pile group, sq ft
(FSF)	=	Factor of safety for the friction area = 2
(FSB)	=	Factor of safety for the base area = 3

The values of c and q_u used in this formula should be based on applicable soil data shown on the Log of Boring and Test Results for this report. In the application of this formula, the weight of the piles, pile caps and mats, considering the effect of buoyancy, should be included.

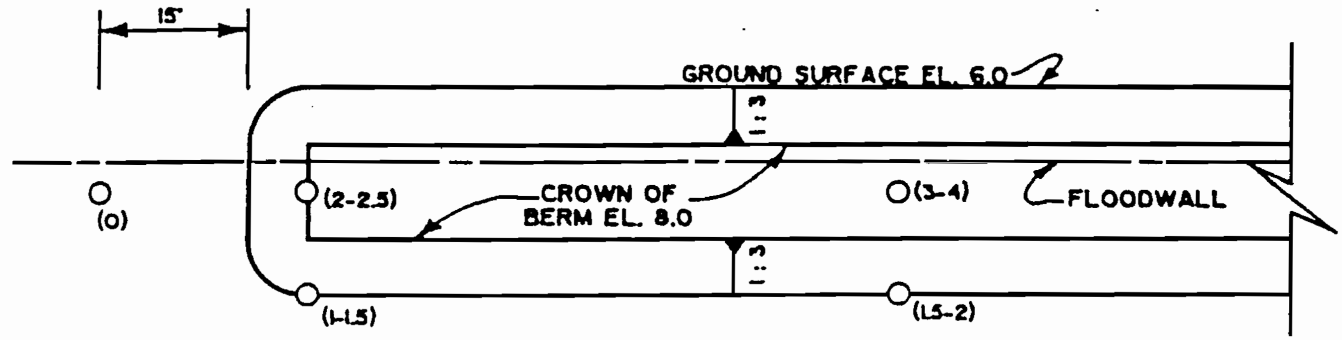
SPACING WITHIN PILE GROUPS

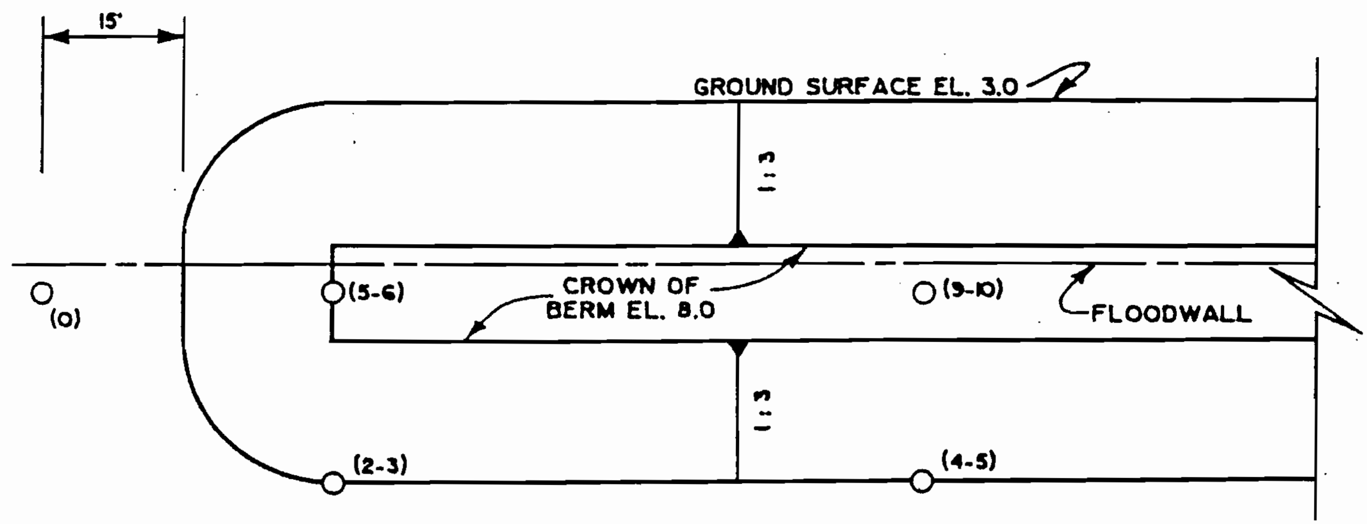
SPAC = $0.05\,(L_1) + 0.025\,(L_2) + 0.0125\,(L_3)$

In Which:

SPAC	=	Center to center of piles, feet
L_1	=	Pile penetration up to 100 feet
L_2	=	Pile penetration from 101 to 200 feet
L_3	=	Pile penetration beyond 200 feet

NOTE: Minimum pile spacing = 3 feet or 3 pile diameters, whichever is greater





( ) INDICATES RANGE OF ANTICIPATED SETTLEMENT IN INCHES

ESTIMATED SETTLEMENT

FRANCE ROAD TERMINAL
FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

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APPENDIX

LEGEND AND NOTES FOR
LOG OF BORING AND TEST RESULTS

PP Pocket penetrometer resistance in tons per square foot

TV Torvane shear strength in tons per square foot

SPT Standard Penetration Test. Number of blows of a 140-lb. hammer dropped 30 inches required to drive 2-in O.D., 1.4-in. I.D. sampler a distance of one foot into the soil, after first seating it 6 inches

SPLR Type of Sampling Shelby SPT Auger No Sample

SYMBOL Clay Silt Sand Humus Predominant type shown heavy; Modifying type shown light

DENSITY Unit weight in pounds per cubic foot

USC Unified Soil Classification

TYPE

TYPE	UC	Unconfined compression shear
	OB	Unconsolidated undrained triaxial compression shear on one specimen confined at the approximate overburden pressure
	UU	Unconsolidated undrained triaxial compression shear
	CU	Consolidated undrained triaxial compression shear
	DS	Direct shear
	CON	Consolidation
	PD	Particle size distribution
	k	Coefficient of permeability in centimeters per second
	SP	Swelling pressure in pounds per square foot

ϕ Angle of internal friction in degrees

c Cohesion in pounds per square foot

Other laboratory test results reported on separate figure

Ground Water Measurements ▼ Initial ▽ Final

GENERAL NOTES

(1) At the time the borings were made, ground water levels were measured below existing ground surface. These observations are shown on the boring logs. However, ground water levels may vary due to seasonal and other factors. If important to construction, the depth to ground water should be determined by those persons responsible for construction, immediately prior to beginning work.

(2) While the individual logs of borings are considered to be representative of subsurface conditions at their respective locations on the dates shown, it is not warranted that they are representative of subsurface conditions at other locations and times.

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana

Ground Elev.: 6.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 5/01/90 Boring: 1 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			MISC. FILL	Miscellaneous fill w/sand, gravel, shells & wood		1	0-2											
		7		Soft gray clay w/sand, shells & wood (fill)	CH	2	2-3.5											
5				Loose gray shells	GP	3	4-6											
	0.40			Very soft to soft gray clay w/wood & organic matter	CH	4	8-9	60	65	104	UC	—	240	93	25	68		
10																		
	0.40			w/sandy silt lenses & organic matter		5	11-12	69	60	101	UC	—	280					
				Very soft gray clay w/organic matter & roots	CH													
15	0.25					6	14-15	98	46	91	UC	—	130	138	30	108		
				Very soft black organic clay w/much wood	OH													
20						7	19-20	384										
				Very soft gray clay w/silt lenses	CH													
25						8	24-25	68	61	101	UC	—	195					
30				w/sandy silt lenses		9	29-30	75	57	99	UC	—	150					
				Soft gray clay w/silt lenses	CH													
35						10	34-35	73	57	99	UC	—	265					
40						11	39-40	60	64	103	UC	—	245	79	20	59		
45						12	44-45	67	60	100	UC	—	335					
				Medium stiff gray clay w/silty sand layers & pockets	CH													
50						13	49-50	64	62	101	UC	—	585					

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 6.0 | Datum: NGVD | Gr. Water Depth: See Text | Job No: 11031 | Date Drilled: 5/01/90 | Boring: 1 | Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Medium stiff gray clay w/silty sand layers & pockets	CH													
				Very loose gray sand w/shell fragments & trace of clay	SP													
55						14	54-55											
		15		Medium dense gray sand	SP	15	55-56.5											
		21				16	57.5-59											
60																		
		34		Dense gray sand	SP	17	61-62.5											
65																		
		33				18	65-66											
				Medium dense gray silty sand w/clay layers	SM													
70		19				19	68.5-70											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 4.4 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 5/02/90 Boring: 2 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		15		Medium dense gray sand w/roots, clay pockets & shells (fill)	SP	1	1-2											
5		18				2	3-4											
		3		Soft gray clay w/trace of organic matter & silt lenses	CH	3	6-7	44										
10	0.20			w/roots & shell fragments		4	8-9	57	67	105	UC	—	405					
	0.10			Very soft to soft gray clay w/organic matter, roots & silty clay layers	CH	5	11-12	72	58	100	UC	—	305	94	24	70		
15						6	14-15	68										
				w/organic matter, roots, concrete & shells														
20	0.05			Very soft gray & brown organic clay w/much wood & humus	OH	7	18-19	185	27	78	UC	—	155	190	44	146		
25	0.05			Soft brown humus w/organic clay & wood	Pt	8	23-24	350										
30	0.05			Very soft gray clay w/silty clay layers & wood	CH	9	28-29	70	60	101	UC	—	170					
35	0.05			Soft gray clay w/trace of organic matter	CH	10	33-34	59	67	106	UC	—	280					
40	0.10			w/silt lenses		11	38-39	70	60	102	UC	—	370					
45	0.10					12	43-44	66	62	103	UC	—	450					
50	0.10			Medium stiff gray clay w/sand layers	CH	13	48-49	73	57	100	UC	—	510					

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 4.4 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 5/02/90 Boring: 2 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Sample	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
					Loose gray clayey sand w/silty sand layers & shells	SC	14	52-53	28	94	121	OB	—	245					
55		32			Dense tan & gray silty sand w/few shells	SM	15	54-55											
60		34			Dense tan silty sand	SM	16	59-60											
65		9			Soft gray sandy clay	CL	17	64-65	35										
	0.25				Soft gray clay w/sandy clay layers & shells	CH	18	68-69	39	83	116	UC	—	350					
70																			

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 5.4 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 5/01-02/90 Boring: 3 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Compact light gray shells	GP													
		5	Medium stiff gray sandy clay w/shells & roots	CL	1	1-2	31										
5	0.50		Medium stiff gray & tan clay w/shells & roots	CH	2	5-6	35										
			Loose light gray shells w/clay & some roots	GP	3	8-9	21										
10			Loose gray silty sand w/clay pockets & shells & wood	SM	4	11-12	32										
15			Wood w/organic clay layers	Wd	5	18-19											
20			Very soft gray clay w/silty sand layers	CH													
25	0.15				6	23-24	67	60	101	UC	—	160					
30	0.10				7	28-29	57	67	106	UC	—	235					
			Soft gray clay	CH													
35	0.10				8	33-34	65	61	101	UC	—	275					
40	0.10				9	38-39	62	63	102	UC	—	400					
45	0.10				10	43-44	64	62	101	UC	—	355					
			Medium stiff gray clay w/silty sand lenses & clayey sand layers	CH													
50	0.20				11	48-49	52	71	108	OB	—	620					

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 5.4 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 5/01-02/90 Boring: 3 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Medium stiff gray clay w/silty sand lenses & clayey sand layers	CH													
55	0.20				Very soft gray clay w/silty sand & clayey sand lenses & layers	CH	12	53-54	64	62	101	UC	—	225					
60	0.20				Soft gray sandy clay	CL	13	58-59	32	91	121	UC	—	450					
65	0.75				Medium dense gray clayey sand w/sandy clay layers	SC	14	63-64	24	103	127	OB	—	1060					
70					Loose gray silty sand	SM	15	68-69											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana

Ground Elev.: 7.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/30 & 5/01/90 Boring: 4 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Split	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Medium dense tan sandy shells	GP													
		30					1	2-3											
5		28					2	4-5											
		8			Loose tan crushed shells	GP	3	6-7											
							4	8-9											
10																			
		5					6	11-12											
15		6					7	14-15											
								16-17											
		2					8	18-19											
20								20-21											
								23-24											
25																			
		8					9	26-27											
								29-30											
30																			
								33-34											
35																			
40							10	39-40											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 6.3 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/30/90 Boring: 5 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Medium dense tan sand w/shells	SP													
		28			1	2-3											
5		17			2	5-6											
		50=2"	Very dense gray sandy shells w/crushed shells	GP	3	8-9											
10			Soft gray clay w/wood, humus & roots	CH	4	11-12											
15					5	14-15	66						109	28	81		
20					6	18-19											
			Very soft gray clay w/wood, humus & silt layers	CH	7	23-24	50										
25			Soft gray clay w/silty sand lenses	CH													
30	0.30				8	28-29	56	68	107	UC	—	310					
35	0.30				9	33-34	67	61	102	UC	—	430	81	24	57		
40	0.35				10	38-39	61	65	104	UC	—	380					
45	0.40				11	43-44	71	58	100	UC	—	375					
			Medium stiff dark gray clay	CH													
50	0.45				12	48-49	70	57	98	UC	—	600					

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 6.3 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/30/90 Boring: 5 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
									Dry	Wet	Type	ø	C	LL	PL	PI		
				Medium stiff dark gray clay	CH													
55	0.50			Medium dense gray clayey sand w/shells	SC	13	53-54	27	96	122	CB	—	700					
60	0.40			Medium stiff gray sandy clay w/shell fragments	CL	14	58-59	33										
65	0.35			& silty sand layers		15	63-64	36	85	116	CB	—	565					
70	0.50			Medium dense gray clayey sand w/clay layers	SC	16	68-69	29	97	125	CB	—	720					

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 4.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/23/90 Boring: 6 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Miscellaneous fill														
5			Medium stiff gray & tan clay w/shells & wood	CH	1	5-6	41										
			Soft gray silty clay w/wood & humus layers	CL	2	8-9	60										
10			Wood w/humus & some clay	Wd													
15																	
20	0.05		Extremely soft to very soft gray clay w/silty sand layers, wood & organic matter	CH	3	19-20	53	69	105	UC	—	110					
25	0.05		w/silty sand layers & wood		4	23-24	43	79	112	UC	—	155	50	20	30		
30	0.15		Soft gray clay w/silty clay layers	CH	5	28-29	42	79	112	UC	—	290					
35	0.15				6	33-34	44	77	111	UC	—	360					
40	0.20				7	38-39	64	63	103	UC	—	425					
45	0.20		Medium stiff gray clay	CH	8	43-44	74	57	99	UC	—	525					
50	0.25		Medium stiff gray sandy clay w/clayey sand pockets & layers & shells	CL	9	48-49	30	90	117	CB	—	505					

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 4.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/23/90 Boring: 6 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Medium stiff gray sandy clay w/clayey sand pockets & shells	CL													
55	0.40					10	53-54	36	84	114	OB	—	540					
				Medium stiff gray clay w/silty sand pockets & layers	CH													
60	0.30					11	58-59	39	82	114	UC	—	705					
				Loose gray sand	SP	12	62-63											
65		43		Dense gray sand	SP	13	64-65											
		35				14	66-67											
70		33				15	69-70											

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 8.1 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/23/90 Boring: 7 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Miscellaneous fill														
5	0.30				Soft dark gray clay w/shells, concrete & wood	CH	1	5-6	78										
	0.25				Loose dark gray clayey silt w/some wood, clay & organic matter	ML	2	8-9	48	72	107	OB	—	415					
10					Loose brown humus w/very soft gray clay layers & wood	Pt	3	11-12	254										
15	0.05				Very soft gray clay w/wood, humus & organic clay layers	CH	4	14-15	103	43	88	UC	—	215					
20	0.10				Soft dark gray clay w/humus layers & roots & wood	CH	5	18-19	149	32	80	UC	—	405					
25	0.10				Very soft gray clay w/silty fine sand lenses & layers & few roots	CH	6	23-24	59	66	104	UC	—	175					
					Soft gray clay	CH													
30	0.10						7	28-29	67	60	101	UC	—	205					
35	0.10						8	33-34	55	68	106	UC	—	265	60	21	39		CON
40	0.15						9	38-39	67	61	101	UC	—	295					
45	0.15				w/few silty fine sand lenses		10	43-44	80	53	96	UC	—	250					
50					Loose gray clayey sand w/shells	SC	11	48-49	29	92	119								

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 8.1 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/23/90 Boring: 7 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Soft gray sandy clay w/shells & clayey sand layers	CL													
55	0.35				12	53-54	49	72	107	OB	—	430					
			Soft gray clay w/sandy clay & sand pockets & layers	CH													
60	0.30				13	58-59	41	80	120	UC	—	475					
			Loose to medium dense gray silty sand	SM	14	62-63											
65		11			15	64-65											
		13			16	66-67											
70		17	Medium stiff gray clay	CH	17	69-70											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 5.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 9 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			MISC. FILL	Miscellaneous fill (shells, gravel, wire)														
5				Very soft gray clay w/roots, wood, organic matter & thin humus layers	CH	1	5-6	102	46	93	UC	—	155					
10																		
15	0.20			w/roots, organic matter & few humus pockets		2	14-15	122										
	0.25			Medium compact gray clayey silt w/sandy silt layers & few clay lenses	ML	3	18-19	33	89	119	OB	—	540					
20																		
	0.30			w/clay layers & few roots		4	23-24	35	87	117	OB	—	525					
25				Soft gray clay w/clayey silt lenses	CH													
	0.25					5	28-29	50	72	107	UC	—	295					
30																		
	0.25			Soft gray clay		6	33-34	63	63	103	UC	—	250					
35																		
	0.30					7	38-39	71	59	100	UC	—	280					
40																		
	0.30			w/clayey silt & sandy silt lenses		8	43-44	72	57	98	UC	—	485					
45																		
	0.40			w/fine sand pockets & shell fragments		9	48-49	44	78	112	UC	—	435					
50																		

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 5.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 9 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Soft gray sandy clay w/few sand & clay pockets	CL													
	0.40				10	53-54	40	82	114	OB	—	460					
55			Medium dense gray silty sand	SM													
					11	57-58											
60		25			12	59-60											
		25			13	62-63											
65		9	Medium stiff to stiff gray clay	CH	14	65-66											
			Medium compact gray clayey silt	ML													
	0.70				15	68-69											
70																	

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 7.3 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 10 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	PL	PI		Other Tests
0–10			Miscellaneous fill (shells, gravel, brick fragments, etc.)														
10–22			Very soft gray clay w/roots & wood	CH													
	0.40		Loose gray clayey silt	ML	1	23-24											
			Soft gray clay	CH													
	0.25				2	28-29	69	60	101	UC	—	240					
	0.25		w/few clayey silt lenses		3	33-34	64	62	103	UC	—	320					
	0.30				4	38-39	68	60	101	UC	—	335					
	0.30				5	43-44	65	62	102	UC	—	485					
	0.40		w/fine sand pockets, shell fragments & trace of organic matter		6	48-49	41	80	112	UC	—	495					

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 7.3 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 10 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Soft gray clay w/fine sand pockets, shell fragments & trace of organic matter	CH													
55	0.40			Medium stiff gray clay w/fine sand pockets	CH	7	53-54	32	90	118	UC	—	570					
				Medium dense gray silty sand w/clay layers	SM													
60						8	58-59	24	102	126								
65						9	63-64											
70						10	68-69	23	103	126								

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 3.8 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/28/90 Boring: 11 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Loose dark gray sandy shells w/gravel, wood & miscellaneous fill		1	1-2											
			Concrete fill														
5			Soft gray clay w/silt layers & fill	CH	2	5-6											
	0.60				3	8-9	56	66	103	UC	—	425					
10			Soft brown humus w/wood & roots	Pt													
	0.25				4	11-12	319										
15			Very soft gray clay w/wood & organic matter	CH	5	14-15											
	0.30				6	18-19	81	53	95	UC	—	210					
20																	
	0.30				7	23-24	62	63	102								
25																	
	0.10		Very soft gray clay		8	28-29	66	61	101	UC	—	195					
30			Soft gray clay	CH													
	0.20				9	33-34	74	57	98	UC	—	275					
35																	
	0.20				10	38-39	75	56	98	UC	—	275					
40																	
	0.20				11	43-44	72	57	97	UC	—	310					
45			Soft gray sandy clay w/shell fragments	CL													
	0.55				12	48-49	39	82	114	OB	—	370					
50																	

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 3.8 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/28/90 Boring: 11 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Soft gray sandy clay w/shell fragments	CL													
				Soft to medium stiff gray clay w/sand pockets & shell fragments	CH													
	0.40					13	53-54	51	70	106	UC	—	555					
55																		
	0.40					14	58-59	38	83	115	UC	—	455					
60																		
				Very dense gray silty sand w/organic matter	SM	15	61-62											
		50=8"				16	63-64											
65																		
		50=6"		Very dense gray sand	SP	17	66-67											
70		50=5"				18	69-70											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 4.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 12 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Dark black sandy shells w/gravel, brick & fill	GP	1	1-2											
5	1.10			Medium stiff gray clay w/wood & shells	CH	2	5-6	42	79	112	UC	—	610					
	0.75			Soft gray clay w/organic matter & shells & wood	CH	3	8-9	52	70	107	UC	—	390					
10	0.55					4	11-12	86	52	96								
15	0.50					5	14-15	73	58	100	UC	—	280					
	0.40			Soft gray clay w/organic matter, roots & wood	CH	6	18-19	100	46	91	UC	—	265	131	32	99		
20	0.20			w/roots & organic matter		7	23-24	79	55	98								
25	0.20					8	28-29	74	58	100	UC	—	250					
30	0.20					9	33-34											
35	0.20					10	38-39	62	64	103	UC	—	430					
40	0.20					11	43-44	74	57	99	UC	—	375					
45	0.40			Soft gray sandy clay w/shell fragments	CL	12	48-49	51	70	106	UC	—	445					
50																		

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 4.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 12 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Soft gray sandy clay w/shell fragments	CH													
						13	53-54											
55																		
						14	57-58											
60		50=8"		Very dense gray sand	SP	15	59-60											
65		50=6"				16	64-65											
70		50=8"				17	69-70											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 6.5 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 13 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		50=6"	Very dense tan sand w/shells & gravel & fill	SP	1	2-3	5										
5		55	Stiff gray sandy clay w/shells, gravel & miscellaneous fill	CL	2	4-5	14										
					3	7-8											
10		30	Medium dense light gray sandy shells	GP	4	9-10	17										
		28			5	11-12											
15		11	Loose light gray sandy shells	GP	6	14-15	25										
20		12	Loose dark gray crushed reef shells	GP	7	19-20	19										
25		16	Loose to medium dense gray sand	SP	8	24-25	23										
30		22	Medium dense light gray crushed shells	GP	9	29-30	25										
35		10	Medium stiff gray clay	CH	10	34-35											
	0.30				11	38-39	59	67	106	UC	—	510					
40			Soft gray clay	CH													
45	0.30				12	43-44	70										
50	0.30		w/sand layers		13	48-49	62	64	104	UC	—	395					

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 6.5 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 13 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	PL	PI		Other Tests
			Soft gray clay w/sand layers	CH													
			Medium stiff gray clay w/shell fragments	CH													
55	0.60				14	53-54	46	75	110	UC	—	710					
			Medium stiff gray sandy clay w/shell fragments	CL													
60	0.70				15	58-59	33	91	120	UC	—	560					
					16	62-63											
65		40	Dense gray silty sand	SM	17	64-65											
70		36			18	69-70											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 4.3 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/28/90 Boring: 14 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Very dense light gray sandy shells w/gravel	GP	1	0-1	6										
		50=2"			2	2-3											
5		50=2"			3	4-5											
		14	Medium dense light gray crushed shells w/sand	GP	4	7-8	17										
10		4	Soft gray clay w/few shells	CH	5	9-10	65										
			w/roots & wood		6	11-12											
15	0.30				7	14-15	79	54	96	UC	—	285	122	25	97		
20	0.45		& organic matter		8	18-19	60	64	103	UC	—	445					
25	0.30		w/roots & wood & organic clay layers		9	23-24	100	46	92	UC	—	295					
30	0.30		w/silt lenses		10	28-29	73	58	101	UC	—	315	84	23	61		CON
35	0.30				11	33-34	62	65	104	UC	—	360					
40	0.25		Soft gray clay		12	38-39	69	60	102	UC	—	330					
45	0.30				13	43-44	76	57	100	UC	—	445					
50	0.30		Soft gray sandy clay w/shell fragments	CL	14	48-49	37	87	119	OB	—	325					

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana

Ground Elev.: 4.3 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/28/90 Boring: 14 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Soft gray sandy clay w/shell fragments	CL													
	0.55				Medium stiff gray clay w/sand pockets & shell fragments	CH	15	53-54	47	75	111	OB	—	590	72	22	50		CON
55					Medium stiff gray sandy clay w/sand layers & concretions	CL													
	0.55						16	58-59	36	87	119	OB	—	635					
60					Medium dense light gray silty sand w/clay layers	SM													
	0.40						17	63-64	29	95	123								
65																			
	0.40				w/trace of organic matter		18	68-69	29	95	122								
70																			

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 2.6 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/26/90 Boring: 15 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Dense gray sandy shells w/clay	GP													
		35				1	2-3	15										
5		5		Medium compact brown humus w/roots & organic clay layers	Pt	2	4-5											
	0.30					3	8-9	295	18	69	UC	—	715	405	180	225		
10				Soft gray clay w/roots	CH													
	0.70					4	11-12	55	69	107	UC	—	420					
15	0.75			& organic matter & wood		5	14-15	57	68	107	UC	—	340					
	0.55					6	18-19	56	69	108	UC	—	415					
20																		
	0.20			w/silty sand layers		7	23-24	55	70	108	UC	—	390					
25																		
	0.20					8	28-29	62	64	104	UC	—	415					
30																		
	0.20					9	33-34	71	59	101	UC	—	355					
35																		
	0.15					10	38-39	75	57	100	UC	—	445					
40																		
				Medium stiff gray clay w/sand lenses	CH													
	0.30					11	43-44	70	59	101	UC	—	590					
45				Medium stiff gray sandy clay	CL													
	0.35					12	48-49	40	83	116	QB	—	635					
50																		

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 2.6 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/26/90 Boring: 15 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Medium stiff gray sandy clay	CL													
55	0.70		Medium stiff light gray sandy clay w/sand layers	CL	13	53-54	31	93	122	OB	—	510					
60	0.75		Stiff gray & tan clay w/trace of sand	CH	14	58-59	36	88	119	UC	—	1240					
					15	62-63											
65		39	Dense tan sand	SP	16	64-65											
		35			17	66-67											
70		3	Medium stiff gray & tan clay w/sand layers	CH	18	69-70											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 3.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/26/90 Boring: 16 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Soft gray clay w/shells, gravel & miscellaneous fill	CH													
	0.75					1	2-3	23										
5	0.25			w/humus layers & shells		2	5-6	50										
	0.25			w/organic matter & wood		3	8-9	74										
10	1.10			Stiff gray clay w/wood, roots & silt pockets	CH	4	11-12	32	91	120	UC	—	1045					
15	0.25			Loose to medium compact gray clayey silt w/roots	ML	5	14-15	33	90	120	OB	—	490	31	22	9		
	0.30			w/clay layers		6	18-19	32	91	121	OB	—	805					
20																		
	0.30			Medium stiff gray clay w/organic matter & roots	CH	7	23-24	71	59	101	UC	—	510					
25				Soft gray clay w/sand layers	CH													
	0.30					8	28-29	50	74	110	UC	—	330					
30																		
	0.20			& roots		9	33-34	58	67	106	UC	—	390					
35																		
	0.20					10	38-39	69	61	102	UC	—	485					
40																		
	0.30			w/sand lenses		11	43-44	73	58	100	UC	—	480					
45																		
	0.30					12	48-49	77	56	99								
50																		

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 3.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/26/90 Boring: 16 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Soft gray clay w/sand lenses	CH													
55	0.70			Medium stiff gray clay w/sand pockets, shell fragments & concretions	CH	13	53-54	54	70	108	UC	—	915					
60	0.30			Soft gray & tan sandy clay w/clayey sand pockets	CL	14	58-59	34	89	119	OB	—	435	43	20	23		
65	0.45			Soft gray clay w/silty sand layers	CH	15	63-64	46	77	112	UC	—	365					
70	0.25			Medium dense gray silty sand w/clay layers	SM	16	68-69	35	88	119	OB	—	525					

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 4.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 12 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Dark black sandy shells w/gravel, brick & fill	GP	1	1-2											
5	1.10				Medium stiff gray clay w/wood & shells	CH	2	5-6	42	79	112	UC	—	610					
	0.75				Soft gray clay w/organic matter & shells & wood	CH	3	8-9	52	70	107	UC	—	390					
10	0.55						4	11-12	86	52	96								
15	0.50						5	14-15	73	58	100	UC	—	280					
	0.40				Soft gray clay w/organic matter, roots & wood	CH	6	18-19	100	46	91	UC	—	265	131	32	99		
20	0.20				w/roots & organic matter		7	23-24	79	55	98								
25	0.20						8	28-29	74	58	100	UC	—	250					
30	0.20						9	33-34											
35	0.20						10	38-39	62	64	103	UC	—	430					
40	0.20						11	43-44	74	57	99	UC	—	375					
45	0.40				Soft gray sandy clay w/shell fragments	CL	12	48-49	51	70	106	UC	—	445					
50																			

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LOG OF BORING A... TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana

Ground Elev.: 4.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 12 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
				Soft gray sandy clay w/shell fragments	CH													
						13	53-54											
55																		
						14	57-58											
60		50=8"		Very dense gray sand	SP	15	59-60											
65		50=6"				16	64-65											
70		50=8"				17	69-70											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 6.5 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 13 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		50=6"		Very dense tan sand w/shells & gravel & fill	SP	1	2-3	5										
5		55		Stiff gray sandy clay w/shells, gravel & miscellaneous fill	CL	2	4-5	14										
						3	7-8											
10		30		Medium dense light gray sandy shells	GP	4	9-10	17										
		28				5	11-12											
15		11		Loose light gray sandy shells	GP	6	14-15	25										
20		12		Loose dark gray crushed reef shells	GP	7	19-20	19										
				Loose to medium dense gray sand	SP													
25		16				8	24-25	23										
30		22		Medium dense light gray crushed shells	GP	9	29-30	25										
				Medium stiff gray clay	CH													
35		10				10	34-35											
	0.30					11	38-39	59	67	106	UC	—	510					
40				Soft gray clay	CH													
	0.30					12	43-44	70										
45																		
	0.30			w/sand layers		13	48-49	62	64	104	UC	—	395					
50																		

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 6.5 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/27/90 Boring: 13 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Soft gray clay w/sand layers	CH													
			Medium stiff gray clay w/shell fragments	CH													
55	0.60				14	53-54	46	75	110	UC	—	710					
			Medium stiff gray sandy clay w/shell fragments	CL													
60	0.70				15	58-59	33	91	120	UC	—	560					
					16	62-63											
65		40	Dense gray silty sand	SM	17	64-65											
70		36			18	69-70											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 4.3 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/28/90 Boring: 14 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Very dense light gray sandy shells w/gravel	GP	1	0-1	6										
		50=2"			2	2-3											
5		50=2"			3	4-5											
		14	Medium dense light gray crushed shells w/sand	GP	4	7-8	17										
10		4	Soft gray clay w/few shells	CH	5	9-10	65										
			w/roots & wood		6	11-12											
15	0.30				7	14-15	79	54	96	UC	—	285	122	25	97		
20	0.45		& organic matter		8	18-19	60	64	103	UC	—	445					
25	0.30		w/roots & wood & organic clay layers		9	23-24	100	46	92	UC	—	295					
30	0.30		w/silt lenses		10	28-29	73	58	101	UC	—	315	84	23	61		CON
35	0.30				11	33-34	62	65	104	UC	—	360					
40	0.25		Soft gray clay		12	38-39	69	60	102	UC	—	330					
45	0.30				13	43-44	76	57	100	UC	—	445					
50	0.30		Soft gray sandy clay w/shell fragments	CL	14	48-49	37	87	119	OB	—	325					

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 4.3 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/28/90 Boring: 14 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Soft gray sandy clay w/shell fragments	CL													
55	0.55		Medium stiff gray clay w/sand pockets & shell fragments	CH	15	53-54	47	75	111	OB	—	590	72	22	50		CON
			Medium stiff gray sandy clay w/sand layers & concretions	CL													
60	0.55				16	58-59	36	87	119	OB	—	635					
			Medium dense light gray silty sand w/clay layers	SM													
65	0.40				17	63-64	29	95	123								
70	0.40		w/trace of organic matter		18	68-69	29	95	122								

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 2.6 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/26/90 Boring: 15 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Dense gray sandy shells w/clay	GP													
		35			1	2-3	15										
5		5	Medium compact brown humus w/roots & organic clay layers	Pt	2	4-5											
	0.30				3	8-9	295	18	69	UC	—	715	405	180	225		
10			Soft gray clay w/roots	CH													
	0.70				4	11-12	55	69	107	UC	—	420					
15	0.75		& organic matter & wood		5	14-15	57	68	107	UC	—	340					
	0.55				6	18-19	56	69	108	UC	—	415					
20																	
	0.20		w/silty sand layers		7	23-24	55	70	108	UC	—	390					
25																	
	0.20				8	28-29	62	64	104	UC	—	415					
30																	
	0.20				9	33-34	71	59	101	UC	—	355					
35																	
	0.15				10	38-39	75	57	100	UC	—	445					
40			Medium stiff gray clay w/sand lenses	CH													
	0.30				11	43-44	70	59	101	UC	—	590					
45			Medium stiff gray sandy clay	CL													
	0.35				12	48-49	40	83	116	CB	—	635					
50																	

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 2.6 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/26/90 Boring: 15 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Medium stiff gray sandy clay	CL													
55	0.70		Medium stiff light gray sandy clay w/sand layers	CL	13	53-54	31	93	122	OB	—	510					
60	0.75		Stiff gray & tan clay w/trace of sand	CH	14	58-59	36	88	119	UC	—	1240					
					15	62-63											
65		39	Dense tan sand	SP	16	64-65											
		35			17	66-67											
70		3	Medium stiff gray & tan clay w/sand layers	CH	18	69-70											

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 1 of 2)

Ground Elev.: 3.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/26/90 Boring: 16 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.75		Soft gray clay w/shells, gravel & miscellaneous fill	CH	1	2-3	23										
5	0.25		w/humus layers & shells		2	5-6	50										
	0.25		w/organic matter & wood		3	8-9	74										
10	1.10		Stiff gray clay w/wood, roots & silt pockets	CH	4	11-12	32	91	120	UC	—	1045					
15	0.25		Loose to medium compact gray clayey silt w/roots	ML	5	14-15	33	90	120	OB	—	490	31	22	9		
	0.30		w/clay layers		6	18-19	32	91	121	OB	—	805					
20																	
	0.30		Medium stiff gray clay w/organic matter & roots	CH	7	23-24	71	59	101	UC	—	510					
25			Soft gray clay w/sand layers	CH													
	0.30				8	28-29	50	74	110	UC	—	330					
30																	
	0.20		& roots		9	33-34	58	67	106	UC	—	390					
35																	
	0.20				10	38-39	69	61	102	UC	—	485					
40																	
	0.30		w/sand lenses		11	43-44	73	58	100	UC	—	480					
45																	
	0.30				12	48-49	77	56	99								
50																	

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LOG OF BORING AND TEST RESULTS

France Road Terminal, Flood Protection, New Orleans, Louisiana (Sheet 2 of 2)

Ground Elev.: 3.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11031 Date Drilled: 4/26/90 Boring: 16 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Soft gray clay w/sand lenses	CH													
55	0.70		Medium stiff gray clay w/sand pockets, shell fragments & concretions	CH	13	53-54	54	70	108	UC	—	915					
60	0.30		Soft gray & tan sandy clay w/clayey sand pockets	CL	14	58-59	34	89	119	OB	—	435	43	20	23		
65	0.45		Soft gray clay w/silty sand layers	CH	15	63-64	46	77	112	UC	—	365					
70	0.25		Medium dense gray silty sand w/clay layers	SM	16	68-69	35	88	119	OB	—	525					

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: See Text Job No.: 11320 Date Drilled: 7/6/92 Boring: 19 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		20			Medium compact miscellaneous fill (Asphalt, grave & shells) w/some clay & sand		1	1-2											
		9					2	3-4											
5	1.70				Medium stiff brown & gray clay w/silt pockets & gravel & shells (fill)	CH	3	5-6	24										
	1.10						4	8-9	48	74	109	UC	--	500					
10	1.20				Medium stiff gray & brown clay w/silt pockets	CH	5	11-12											
15	1.50				w/few roots		6	14-15	29	95	123	UC	--	965					
	1.50				& clayey silt layers		7	18-19											
20																			
25	1.10				w/silt pockets		8	23-24	54	69	105	UC	--	535					
30	0.50				Soft gray clay w/sandy silt & silty sand lenses & layers	CH	9	28-29	41	78	111	UC	--	410					
35	0.30				Soft gray clay		10	33-34	57	66	104	UC	--	335					
40	0.30						11	38-39											
45	0.40				w/silt lenses & pockets		12	43-44	61	62	101	UC	--	440					
50	0.40				Soft gray sandy clay w/shells	CL	13	48-49											

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: See Text Job No.: 11320 Date Drilled: 7/6/92 Boring: 19 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Soft gray sandy clay w/shells	CL													
					Medium stiff gray clay w/shell fragments & sand pockets	CH													
	0.45						14	53-54	41	80	112	UC	--	655					
55																			
					Medium stiff gray & tan clay w/silty sand & sandy clay layers	CH													
	0.70						15	58-59											
60																			
					Loose to medium dense gray silty sand w/clay layers	SM	16	63-64											
					Soft gray clay w/sandy clay layers	CH													
65																			
	0.40						17	68-69											
70																			
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: See Text Job No.: 11320 Date Drilled: 7/6/92 Boring: 20 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Ø	C	LL	PL	PI	Other Tests
			Crushed rock													
		28	Medium compact light gray & tan shells w/sand	SI	1	1-2										
		30	Medium compact light gray shells		2	3-4										
5	0.60		Soft to medium stiff gray clay w/few shells, gravel & sand (fill)	CH	3	5-6	45	76	110	UC	--	670				
	0.50		w/gravel, sand layers & roots		4	8-9	51	71	107	UC	--	365				
10	0.30		Soft gray clay w/roots, wood & organic clay layers & silty clay layers	CH	5	11-12	57	67	104	UC	--	360				
15	0.55		Soft gray clay w/silt layers & roots	CH	6	14-15	47	74	109	UC	--	450				
	1.20		Medium stiff gray clay w/silty clay layers	CH	7	18-19	58	67	105	UC	--	520				
20																
	0.50				8	23-24	37	85	115	UC	--	815				
25																
	0.20		Soft gray clay w/silt & silty clay lenses & layers	CH	9	28-29	53	69	106	UC	--	375				
30																
	0.25				10	33-34										
35			Medium stiff gray clay w/silt lenses	CH												
	0.30				11	38-39	61	63	101	UC	--	555				
40																
	0.40				12	43-44										
45			Soft gray sandy clay w/shells	CL												
	0.30				13	48-49	34	84	113	UC	--	285				
50																

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.: 11320** **Date Drilled: 7/6/92** **Boring: 20** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Soft gray sandy clay w/shells	CL													
55	0.45				Medium stiff gray clay w/silt lenses & sandy clay layers & shells	CH	14	53-54											
60	0.25				Soft gray sandy clay w/large clay pockets & shells	CL	15	58-59	36	82	112								
65	0.35				Soft gray clay w/sandy clay pockets & silty sand layers	CH	16	63-64											
70					Loose to medium dense gray silty sand w/clay layers	SM	17	68-69											
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

(SHEET 1 Of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.:** 11320 **Date Drilled:** 7/7/92 **Boring:** 21 **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
5 10 15					Water														
20					Shells	SI	1	19–20											
25							2	23–24											
30					Very soft gray clay w/shells & wood	CH	3	28–29											
35	0.50				Soft gray clay w/silt layers	CH	4	33–34	81	53	96	UC	--	265					
40	0.50				w/silt pockets		5	38–39	91	49	93	UC	--	300					
45					Loose gray sandy silt w/shell fragments	ML	6	43–44											
50	0.50				Medium stiff gray clay w/silt pockets & lenses	CH	7	48–49	46	76	110	UC	--	635					

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: Job No.: 11320 Date Drilled: 7/7/92 Boring: 21 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Ø	C	Atterberg Limits LL	PL	PI		Other Tests
					Medium stiff gray clay w/silt pockets & lenses	CH													
					Medium compact light gray clayey silt w/sandy silt layers	ML	8	53-54	37	81	112	UC	--	235					
55																			
					Compact gray sandy silt w/clay layers	ML	9	58-59											
60																			
		31			Compact gray sandy silt		10	61-62											
		23					11	63-64											
65		13			Medium compact sandy silt w/clay layers	ML	12	65-66											
		31			Compact gray sandy silt w/silty sand layers	ML	13	67-68											
70		13			Medium compact gray sandy silt w/silty sand layers & wood particles	ML	14	69-70											
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

(SHEET 1 Of 2)

Ground Elev.: Datum: Gr. Water Depth: Job No.: 11320 Date Drilled: 7/7/92 Boring: 22 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	Ø	C	LL	PL	PI		
					Water														
20					Extremely soft gray clay	CH	1	19-20											
25							2	23-24	177	28	79	UC	--	25					
30							3	28-29	109	41	86	UC	--	55					
35							4	33-34	97	44	87	UC	--	35					
40	0.10				Very soft gray clay w/much wood	CH	5	38-39	78										
45	0.50				Soft gray clay w/silty sand lenses	CH	6	43-44	88	49	91	UC	--	250					
50	0.50						7	48-49	47	75	109	UC	--	315					

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION
NEW ORLEANS, LOUISIANA

(SHEET 2 Of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.: 11320** **Date Drilled: 7/7/92** **Boring: 22** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Soft gray clay w/silty sand lenses	CH													
					Soft gray & tan clay w/silty sand lenses & layers	CH													
55	0.75						8	53-54	36	86	117	UC	--	370					
							9	55-56											
		14			Medium dense gray silty sand	SM													
60		20					10	59-60											
		27					11	62-63											
65		28					12	64-65											
70		18			w/sandy silt layers & wood particles		13	69-70											
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 11320** **Date Drilled: 8/27/93** **Boring: 23** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Dense gray crushed concrete														
		42			Dense gray & white shells	SI	1	1-2											
5		--			Dense brown & gray crushed concrete w/rubber, wood, sand & gravel		2	4-5											
		9			Loose tan & white fine sand w/shells & trace of gravel	SP	3	7-8											
10		10			w/shells		4	10-11											PD
15		4			Very loose gray & white sandy shells	SI	5	14-15											
20		2					6	19-20											
25		3					7	24-25											
					Soft gray clay w/roots & clayey silt pockets	CH													
30	0.60						8	28-29	49	73	109	UC	--	365					
35	0.60				w/clayey silt layers & few lenses		9	33-34	50	72	107	UC	--	460					
40	0.50				w/few clayey silt lenses		10	38-39											
45	0.50				w/silt lenses		11	43-44	65	61	100	UC	--	340					
					Medium stiff gray clay w/fine sand pockets, layers & shell fragments	CH													
50	0.50						12	48-49											

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 11320** **Date Drilled: 8/27/93** **Boring: 23** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Medium stiff gray fine sand w/fine sand pockets & shell fragments	SP													
	0.50						13	53-54	38	83	114	UC	--	510					
55																			
	0.50				Medium stiff greenish-gray & tan clay w/fine sand & silty sand lenses	CH	14	58-59	34	88	118	UC	--	695					
60																			
					Loose to medium dense gray silty sand	SM	15	63-64											
65																			
					w/sandy silt layers		16	68-69											
70																			
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: See Text Job No.: 11320 Date Drilled: 8/30/93 Boring: 24 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		60=4" (Seal)			Very dense concrete, shells & limestone		1	1-2											
5		50=3" (Seal)					2	4-5											
		50=7"			Very dense concrete & gravel		3	7-8											
10		25			Medium dense gray shells	SI	4	10-11											
15		8			Loose gray & white shells	SI	5	14-15											
20	0.50				Soft gray clay w/silt pockets, roots & wood	CH	6	18-19	57	66	105	UC	--	490					
25	0.50				w/wood & roots		7	23-24	76	54	96	UC	--	470					
30	0.50				w/trace of wood		8	28-29	68	60	101	UC	--	355					
35	0.25				w/wood		9	33-34											
40	0.25						10	38-39	50	71	106	UC	--	495					
45	0.35						11	43-44											
					Medium stiff gray clay w/sand lenses	CH													
50	0.25						12	48-49	62	62	100	UC	--	685					

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 11320** **Date Drilled: 8/30/93** **Boring: 24** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Medium stiff gray clay w/sand lenses	CH													
55	0.25				Soft gray sandy clay w/shells	CL	13	53-54											
60	0.25				Loose greenish-gray sandy silt w/clay pockets	ML	14	58-59	31	89	117	OB	--	310					
65					Medium dense greenish-gray & tan clayey sand w/silty sand layers	SC	15	63-64											
70					Medium dense gray silty sand	SM	16	68-69											
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 11320** **Date Drilled: 9/02/93** **Boring: 25** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Ø	C	Atterberg Limits LL	PL	PI		Other Tests
					Soft gray clay w/sand pockets & shell fragments	CH													
55	1.00				Medium stiff greenish-gray sandy clay	CL	13	53-54	31	92	121	UC	--	545					
					Medium dense gray silty sand	SM	14	57-58											
60		31			Dense gray silty sand	SM	15	59-60											
		28			Medium dense gray silty sand	SM	16	62-63											
65		20					17	65-66											
70		25					18	69-70											
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

(SHEET 1 Of 2)

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 11320** **Date Drilled: 9/02/93** **Boring: 25** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		50=4" (Seat)	Very dense white shells & gravel	SI	1	1-2											
5		15	Medium dense white shells	SI	2	4-5											
		20	w/gravel & silt		3	7-8											
10		25	Wood w/limestone & shells	Wd	4	10-11											
15		1	Very soft gray clay w/wood	CH	5	14-15											
			Soft gray clay w/wood	CH													
20	0.25				6	18-19	70	60	101	UC	--	415					
25	0.25				7	23-24											
30	0.25		w/silt lenses		8	28-29	69	59	100	UC	--	345					
35	0.25				9	33-34											
40	0.25		w/wood		10	38-39	67	61	101	UC	--	340					
45	0.25		w/clayey silt lenses		11	43-44											
			Soft gray clay w/shell fragments & sand pockets	CH													
50	0.50				12	48-49	39	82	113	UC	--	470					

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 11320** **Date Drilled:** 9/01/93 **Boring: 26** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Ø	C	Atterberg Limits LL	PL	PI		Other Tests
		50=3"			Very dense gray shells w/clay layers	SI	1	1-2											
5		50=-2"			w/gravel		2	4-5											
		25			Very dense gray shells & gravel	SI	3	7-8											
10																			
		3			Very soft gray clay w/silt lenses & humus layers	CH	4	11-12											
15					Soft brown humus w/wood, roots & organic clay	Pt	5	14-15	335										
	0.20				Very soft to soft gray clay w/wood, organic matter & roots	CH	6	18-19	73	57	98	UC	--	270					
20																			
	0.25				w/wood & organic matter		7	23-24	74	57	99	UC	--	215					
25					Soft gray clay w/much wood	CH													
							8	28-29											
30																			
	0.30				w/trace of silt lenses		9	33-34	65	61	101	UC	--	335					
35																			
	0.30						10	38-39	67	60	101	UC	--	340					
40																			
	0.50						11	43-44											
45																			
	0.50						12	48-49	71	58	100	UC	--	485					
50																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: See Text Job No.: 11320 Date Drilled: 9/01/93 Boring: 26 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Soft gray clay w/silt lenses	CH													
55	0.60				Medium stiff gray clay w/shell fragments & sand pockets	CH	13	53-54	44	77	111	UC	--	835					
60					Medium compact gray sandy silt w/silty sand layers	ML	14	58-59											
					Loose gray sandy silt w/silty sand & thin clay layers	ML	15	62-63											
65		20			Medium dense gray fine silty sand w/sandy silt layers	SM	16	64-65											
70		28			Medium dense gray fine silty sand		17	69-70											
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 11320** **Date Drilled: 8/31/93** **Boring: 27** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		50=3" (Seal)			Very dense limestone, concrete & shells		1	1-2											
5		25			Medium dense white shells w/limestone	SI	2	4-5											
		10			Loose white shells w/gravel & limestone	SI	3	7-8											
10		10			w/gravel & clay		4	10-11											
15		3			Soft gray clay w/wood	CH	5	14-15											
					Medium stiff gray clay w/wood	CH													
20	0.75						6	18-19	48	75	111	UC	--	720					
					Soft gray clay w/silty clay layers & wood	CH													
25	0.25						7	23-24	68	60	101	UC	--	365					
30	0.25				w/silty clay lenses & wood		8	28-29	59	66	106	UC	--	480					
					Soft to medium stiff gray clay w/silty clay layers	CH													
35	0.25						9	33-34											
40	0.25						10	38-39	65	62	103	UC	--	550					
45	0.25				w/silt lenses		11	43-44	68	61	102	UC	--	420					
					Medium stiff gray clay w/shell fragments & sand pockets	CH													
50	0.25						12	48-49	40	82	114	UC	--	565					

EUSTIS ENGINEERING COMPANY, INC.

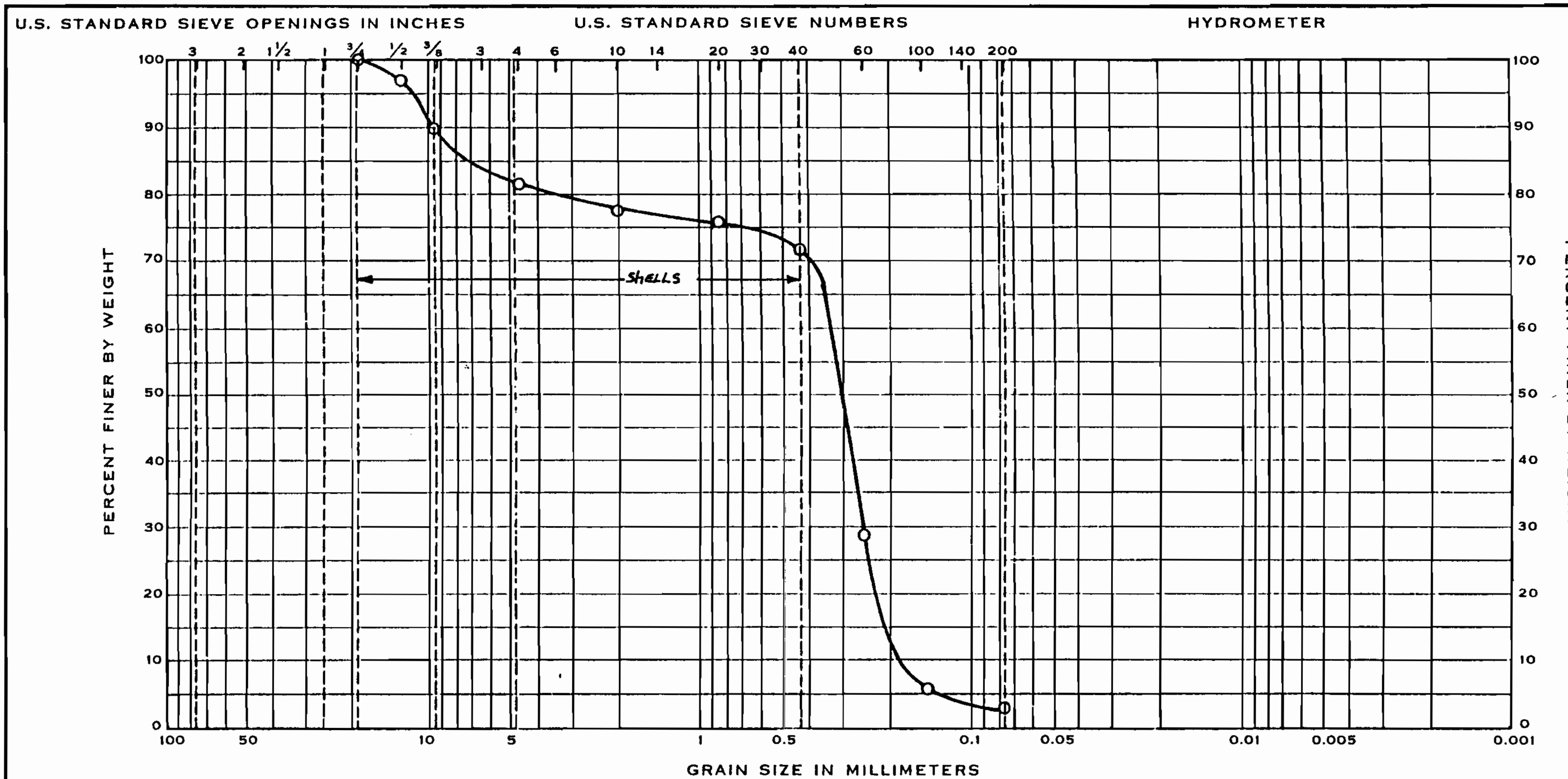
LOG OF BORING AND TEST RESULTS

FRANCE ROAD TERMINAL, FLOOD PROTECTION, SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: See Text Job No.: 11320 Date Drilled: 8/31/93 Boring: 27 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Medium stiff gray clay w/shell fragments & sand pockets	CH													
					Medium stiff gray sandy clay w/shell fragments	CL													
	0.50						13	53-54											
55																			
					Stiff greenish-gray & tan sandy clay w/silty sand layers	CL													
	1.75						14	57-58											
60		28			Medium dense greenish-gray silty sand	SM	15	59-60											
		11					16	62-63											
65		6			Loose gray silty sand	SM	17	65-66											
							18	68-69											
70																			
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING

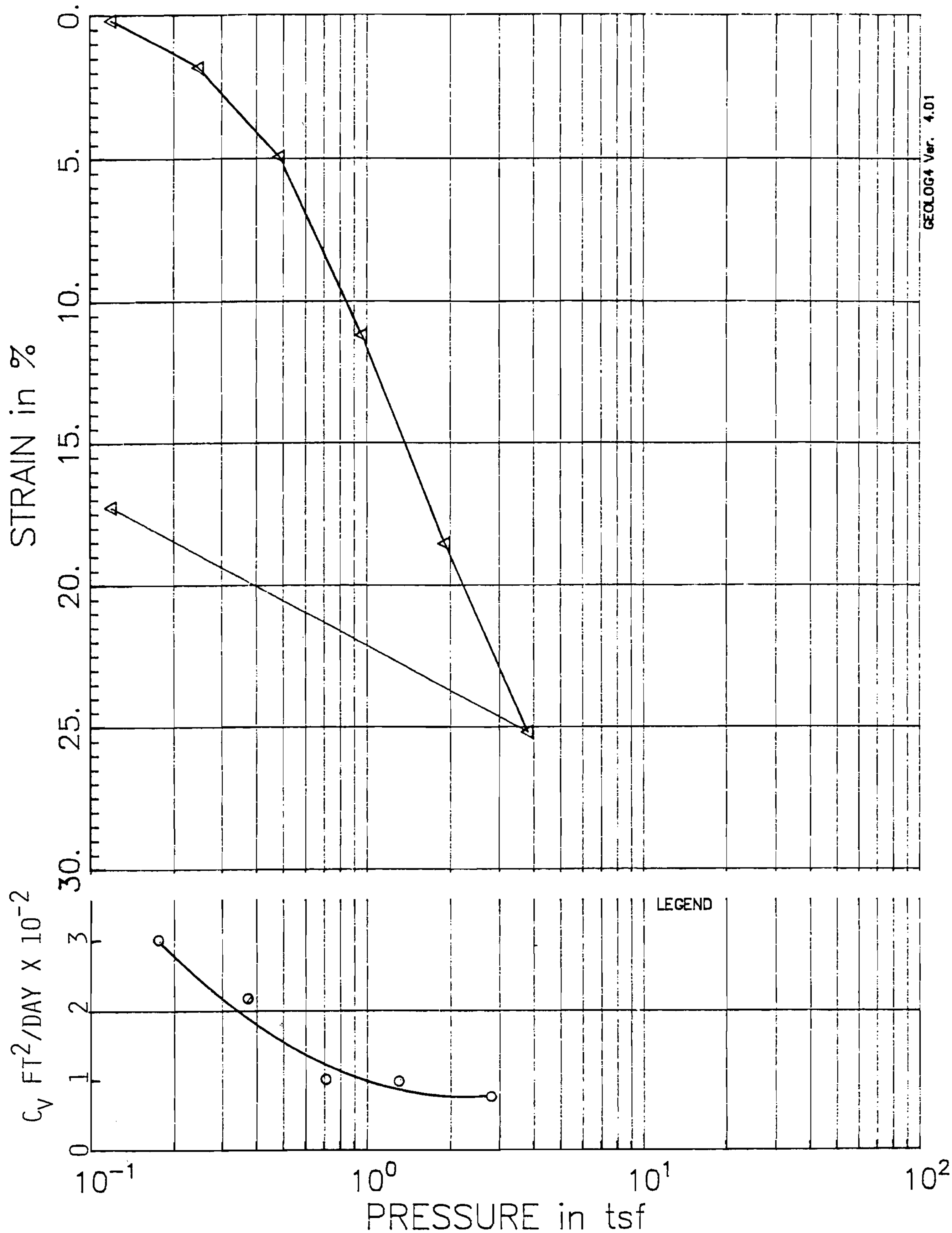


UNIFIED	GRAVEL			SAND			SILT OR CLAY	
	COARSE		FINE	COARSE	MEDIUM	FINE		
AASHO	GRAVEL			SAND			SILT	CLAY
	COARSE	MEDIUM	FINE	COARSE		FINE		

GRAIN SIZE ANALYSIS

CURVE NO.	BORING NO.	SAMPLE NO.	DEPTH IN FT.	NATURAL WATER CONTENT	ATTERBERG LIMITS LL	PL	PI
	23	4	10-11				

PROJECT FRANCE ROAD TERMINAL
FLOOD PROTECTION
SLIP NO. 4 REALIGNMENT
NEW ORLEANS, LOUISIANA



SOIL DESCRIPTION: SO G CL

BORING: 7 SAMPLE: 8 DEPTH: 33–34'

WATER CONTENT %: 58.1
DRY DENSITY PCF: 64.7
WET DENSITY PCF: 102.3
INITIAL VOID RATIO: 1.64

ATTERBERG LIMITS

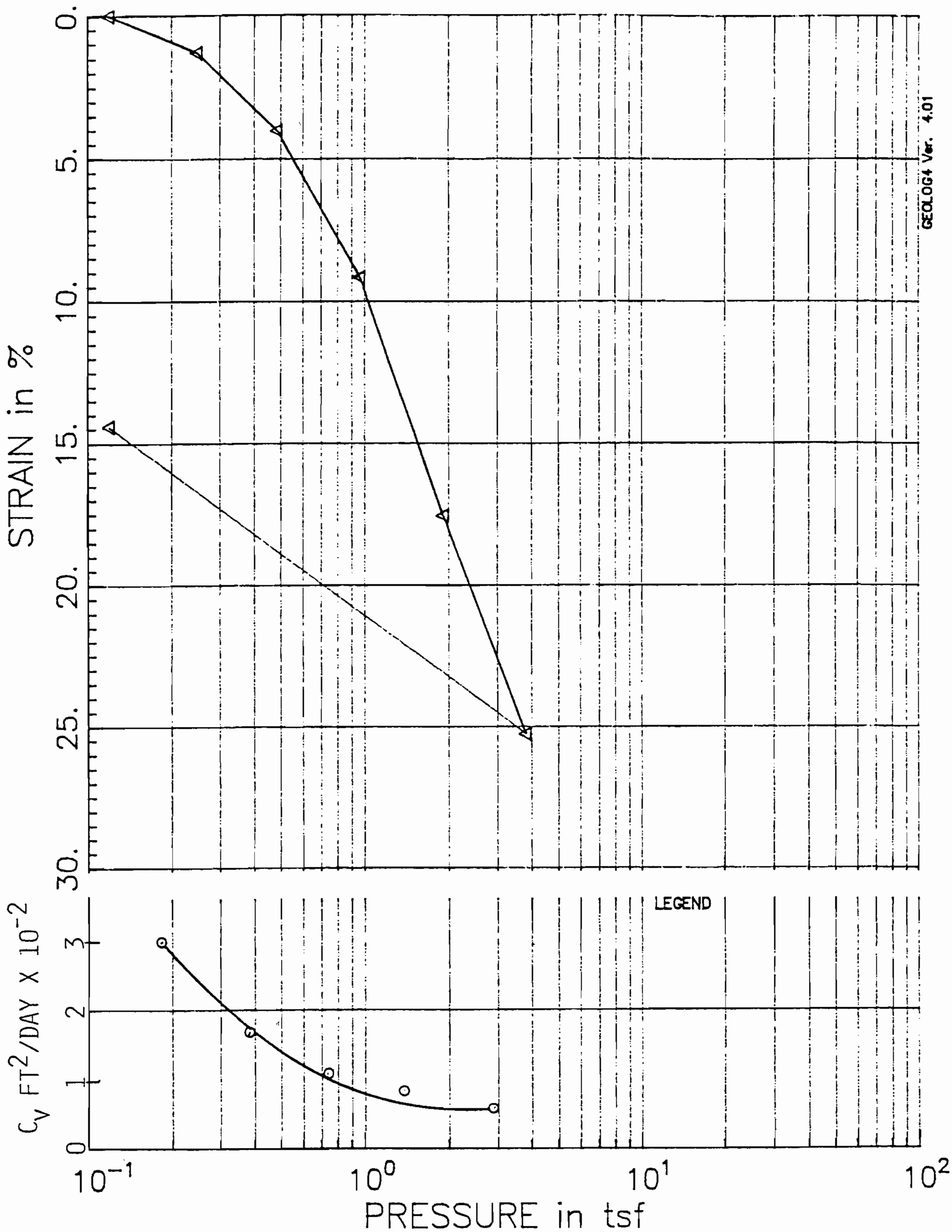
LL	PL	PI
60	21	39

PROJECT: FRANCE RD TERMIN FLOOD PROTECTION
FILE NO: 11031
DATE: 4–25–90

CONSOLIDATION TEST NO: 1

Testname: C224

EUSTIS ENGINEERING



SOIL DESCRIPTION: SO G CL
W/FEW SA LEN

BORING: 14 SAMPLE: 10 DEPTH: 28–29'

WATER CONTENT %: 72.8
DRY DENSITY PCF: 56.7
WET DENSITY PCF: 97.9
INITIAL VOID RATIO: 2.00

ATTERBERG LIMITS

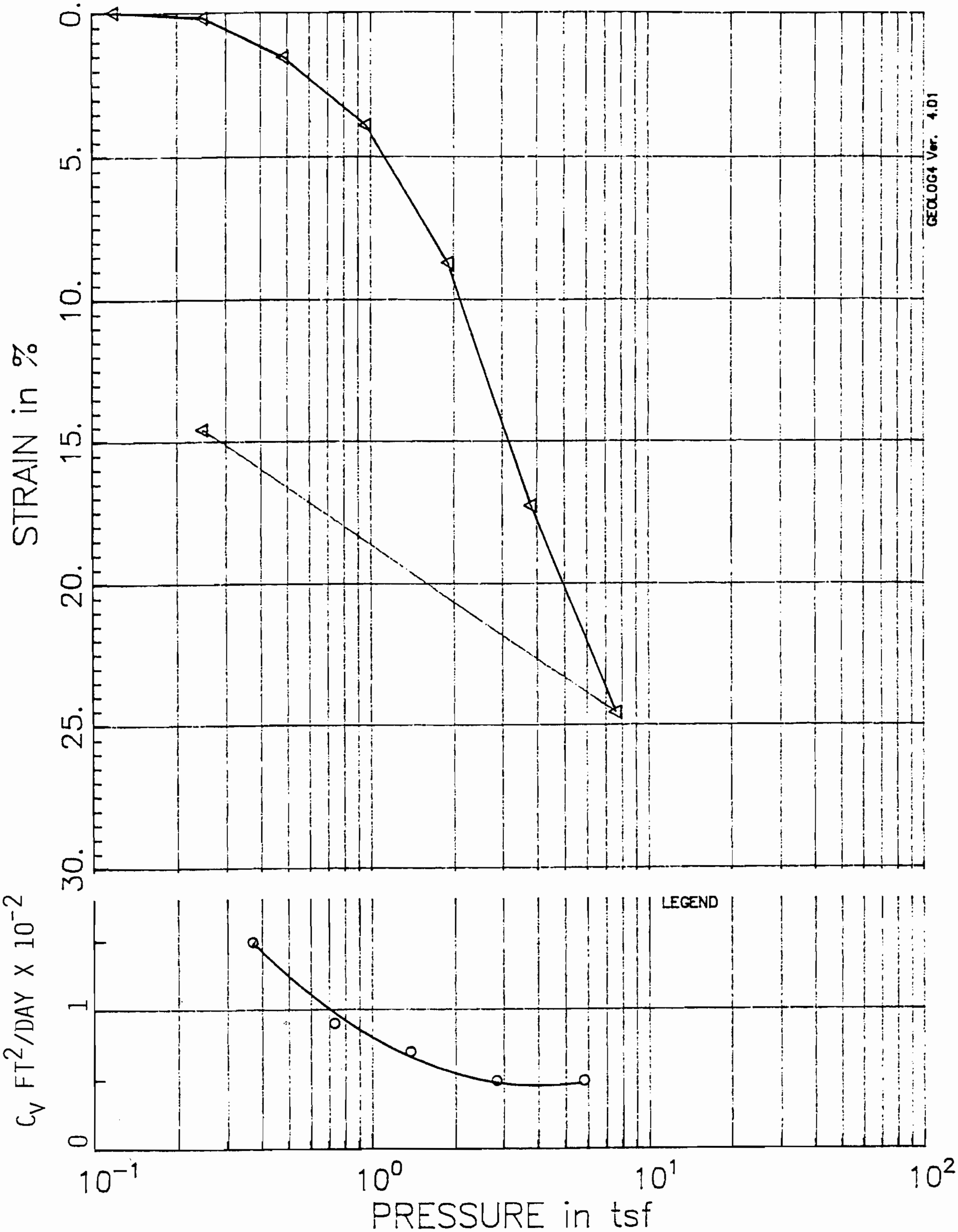
LL	PL	PI
84	23	61

PROJECT: FRANCE RD TERMIN FLOOD PROTECTION
FILE NO: 11031
DATE: 5–2–90

CONSOLIDATION TEST NO: 2

Testname: C228

EUSTIS ENGINEERING



SOIL DESCRIPTION: ST G CL W/ SA POC & SH FRAG

BORING: 14 SAMPLE: 15 DEPTH: 53–54'

WATER CONTENT %: 54.2
DRY DENSITY PCF: 68.0
WET DENSITY PCF: 104.8
INITIAL VOID RATIO: 1.50

ATTERBERG LIMITS

LL	PL	PI
72	22	50

PROJECT: FRANCE RD TERMIN FLOOD PROTECTION
FILE NO: 11031
DATE: 5–2–90

CONSOLIDATION TEST NO: 3
Testname: C229
EUSTIS ENGINEERING

APPENDIX B

CORPS OF ENGINEERS DESIGN CRITERIA AND GUIDANCE

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

REPLY TO
ATTENTION OF:

November 4, 1994

Engineering Division
Structures Branch

Mr. Larry A. LeBlanc, P.E.
Barnard & Thomas, Incorporated
8178 GSRI Avenue
Baton Rouge, Louisiana 70820

Dear Mr. LeBlanc:

Please reference your letter of October 19, 1994, to Mr. Jorge Romero of our office, in which you provided for our review, the new proposed floodwall alignment for the Drainage and Floodwall Improvements, France Road Terminal, Port of New Orleans. The floodwall is proposed as a replacement of the existing Lake Pontchartrain, Louisiana and Vicinity, Hurricane Protection Project, France Road Floodwall, Orleans Parish, Louisiana.

Your proposal for moving the floodwall closer to the Inner Harbor Navigation Canal (IHNC) than you previously presented to us is acceptable, since, as you noted in your letter, the floodwall would be on the land side of the existing wharves. We also have no objection to lowering the flood side berm to Elevation +2.0 NGVD.

During our meeting of October 13, 1994, Messrs. Jorge Romero and James Richardson of our office, informed you that, provided you account for the presence of the 36 inch diameter drainage pipe (located along the protected side of the wall within the levee embankment) in the stability and seepage analysis of the flood protection, we would have no objection to this layout. We will provide our comments on the stability computations to Eustis Engineering after we review the analysis.

During our meeting you also requested our recommendation on the appropriate title for the design memorandum for this work. We recommend the following:

LAKE PONTCHARTRAIN, LOUISIANA AND VICINITY
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 2 - GENERAL DESIGN
SUPPLEMENT NO. 8A
RELOCATION OF IHNC FLOOD PROTECTION
FRANCE ROAD TERMINAL
NEW ORLEANS, LOUISIANA

We are enclosing a sample title block for your use.

If we can be of further assistance on this matter, please let us know.

Sincerely,

W. Eugene Tickner
Chief, Engineering Division

Enclosure

LAKE PONTCHARTRAIN, LOUISIANA AND VICINITY
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 2 - GENERAL DESIGN
SUPPLEMENT NO. 8A
RELOCATION OF I.H.N.C. FLOOD PROTECTION
FRANCE ROAD TERMINAL
NEW ORLEANS, LOUISIANA

*** DRAWING TITLE ***

SUBMITTED TO: U.S. ARMY CORPS OF ENGINEERS, NEW ORLEANS DISTRICT
AND
BOARD OF COMMISSIONERS OF THE ORLEANS LEVEE DISTRICT

SUBMITTED BY: BOARD OF COMMISSIONERS, PORT OF NEW ORLEANS, LA

PREPARED BY: BARNARD & THOMAS, INC., BATON ROUGE, LA

DESIGNED BY: DRAWN BY: CHECKED BY:	PLOT SCALE:	PLOT DATE:	CADD FILE:
	DATE:		FILE NO.

PLATE 1

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

June 14, 1994

REPLY TO
ATTENTION OF:
Engineering Division
Structural Design Section

Mr. Larry A. LeBlanc, P.E.
Barnard and Thomas, Incorporated
8178 GSRI Avenue
Baton Rouge, Louisiana 70820

Dear Mr. LeBlanc:

Please reference your letter of May 23, 1994, to Mr. Jorge Romero of our office, in which you provided for our review, the plans and specifications for the Drainage and Floodwall Improvements, France Road Terminal, Port of New Orleans. The floodwall is proposed as a replacement of the existing Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection Project, France Road Floodwall, Orleans Parish, Louisiana.

Our comments are described in enclosure 1, with additional comments marked in red on the attached specifications (enclosure 2).

Please provide us with three copies of the final plans and specifications for this work. If we can be of any further assistance on this matter, please let us know.

Sincerely,

W. Eugene Tickner
Chief, Engineering Division

Enclosures

Lake Pontchartrain, LA & Vic Hurricane Prot. Proj,
France Road Floodwall Replacement by the Port of New Orleans,
Orleans Parish, LA
P&S Review Comments
3 Jun 94

1. Pg 2232-1, para 4. Delete this paragraph and replace it with "This material shall be stone and conform to the requirements of 1992 Edition of LSSRB (Louisiana Standard Specifications for Roads and Bridges), Section 1003.04 (a).

2. Pgs 2367-1 and 2367-2, paras 2.02, 2.03, 2.05 and 2.06. Update the standards as shown marked in red.

3. Pg 2367-6, para 6.06. In the tenth sentence, change "SSHB 4.25" to "SSHB 8.12.2".

4. Pg 2367-7, para 6.08 (a). In the third sentence, change "if" to "provided".

5. Pg 3250-1, para 3. Update the standard as shown marked in red.

6. Pgs 3300-1, 3300-2 and 3300-3, para 2. Update the standards as shown marked in red.

7. Pg 3300-4 and 3300-5, para 3.01 (b). Replace the list of approved aggregate sources with the contents of attachment 1.

8. Dwg. No. M11-7043-S11, GENERAL NOTES. In item 1, change "STANDARD SPECIFICATIONS FOR ROADS AND BRIDGES 1982 EDITION" to "LOUISIANA STANDARD SPECIFICATIONS FOR ROADS AND BRIDGES, 1992 EDITION".

1. ~~Page 2223-1 para 4.01. Delete "and sands (SW,SP,SM)" from the last sentence of the paragraph.~~ ok

2. Page 2223-2 para 4.04. Change "shall be placed in successive layers not to exceed 4 inches" to "shall be placed in successive layers not to exceed 8 inches" in the second sentence.

3. Page 2223-2 para 4.04. The drawings do not show an excavation section for the T-wall. The contractor may excavate material more than two feet away from the wall. How will this excavated material be backfilled?

3. Page 2223-2 para 4.04. What quality control testing will be done to insure 95% compaction of the backfill?

4. Page 2367-9 para 8. The last sentence of the paragraph allows predrilling to a depth of 25 ft. for Pump Station No. 2. Is Pump Station No. 2 the same as Pump Station P6? There was no mention of predrilling

piles in the soils report. Were the pile capacity curves reduced because of predrilling? We will not allow predrilling or jetting unless the test pile is also predrilled or jetted. Since your design computations are based on a F.S. = 3.0 (no pile test) no jetting or predrilling will be allowed for this contract.

5. Page 2368-8 para 8.05. Change "cement-bentonite slurry" to cement-sand-bentonite slurry" in the first sentence. Delete the last sentence and add the following : The Contractor shall backfill with a cement-sand-bentonite slurry by the tremie or pump down method such that any water in the void is not mixed with but displaced by the slurry. The slurry shall consist of one part cement and two parts bentonite, and three parts sand mixed with sufficient water to produce a slurry liquid enough to thoroughly fill voids but have no less than twelve pounds of solids per gallon. The sand portion of the slurry shall meet the following gradation:

SAND GRADATION

U.S. STANDARD SIEVE SIZE	REQUIRED PERCENT PASSING BY WEIGHT
3/8-inch	100
No. 4	100 - 90
No. 200	20 - 0

6. Page 2510-1 para 3. If crushed stone will be used as cofferdam fill, the stability of the circular cell cofferdam analyses must be analyzed for the larger unit weight of crushed stone. The settlement analyses for the cofferdam sheet pile and fill must also be recomputed.

7. Show the benchmark and the epoch on the plans.

8. We do not recommend the circular cell cofferdam and the T-wall be tied together until the settlement of the cofferdam is substantially complete or at least until the last phase of construction of the floodwalls along the France Road Terminal. The circular cells will settle and rotate away from the T-wall since the fill is deepest at the centerline of the slip. Will the connection between the circular cell sheet pile and T-wall be able to withstand the one to three inches of settlement and rotation of the circular cell sheet pile?

9. Dwg. Nos. M11-7043-W4 & M11-7038-S4. What is the ground elevation at the T-wall?

10. Dwg. No. M11-7043-W4. Change "EL. 4.0" to "EL. 0.0" between the circular cell and the intake basin to correspond with the stability analysis shown in Eustis Engr's 2nd interim report contained in the "T-WALL DESIGN at Area 1 pump stations 2,3,4 & 5" report.

LIST OF APPROVED AGGREGATE SOURCES

October 1993

Producer	Nearest Town to Pit *	Pit Designation
A. B. Chisum Gravel Co.	Sicily Island, LA	A. B. Chisum Sand & Gravel
American Sand & Gravel Co.	Hattiesburg, MS	Plant A
American Sand & Gravel Co.	Hattiesburg, MS	Plant E
B & B Gravel, Inc.	Grangeville, LA	Hornsby Pit
Blain Sand & Gravel, Inc.	Crystal Spring, MS	Harris Pit
D. & J. Construction	Aimwell, LA	Aimwell Pit
Dravo Basic Materials Co., Inc.	Smithland, KY	Three Rivers Quarry
Feliciana Sand & Gravel Co.	Jackson, LA	Harvey Pit
Feliciana Sand & Gravel Co.	Jackson, LA	Mckowen Pit
Feliciana Sand & Gravel Co.	Jackson, LA	Thompson Pit
Jackson Ready-Mix Concrete Co.	Crystal Springs, MS	Pit # 715-11
Lambert Gravel Co., Inc.	Bains, LA	G-2 (Butler Pit)
Louisiana Industries, Inc.	DeRidder, LA	Anacoco Pit
Louisiana Industries, Inc.	Grangeville, LA	Dinkman Plant
Louisiana Industries, Inc.	Grangeville, LA	Hatcher Plant
Louisiana Industries, Inc.	Grangeville, LA	Hornsby Plant
Louisiana Industries, Inc.	Grangeville, LA	Odom Plant
Louisiana Industries, Inc.	Ball, LA	Paradise Pit
Louisiana Industries, Inc.	Perryville, LA	Perryville Pit
Louisiana Industries, Inc.	Enon, LA	Price Plant
Louisiana Industries, Inc.	Woodworth, LA	Woodworth Plant
Mears Sand & Gravel Co.	Watson, LA	Penny & Easterly leases
Mid-State Material Co., Inc.	Woodworth, LA	Woodworth Plant
Quick Sand & Gravel, Inc.	Watson, LA	Easterly lease
Rebel Sand & Gravel Co.	Watson, LA	Plant 6
Rebel Sand & Gravel Co.	Watson, LA	Plant 6c

Rebel Sand & Gravel Co.	Watson, LA	Plant 9
Reed Crushed Stone Co., Inc.	Gilbertsville, KY	Gilbertsville Quarry
Standard Gravel Co.	Pearl River, LA	Nicholson Plant (Nic-7)
Standard Gravel Co.	Enon, LA	Enon Pit (C-10 & CZ-30 leases)
Thomas Sand & Gravel Co., Inc.	Grangeville, LA	Carter #2 Pit
T. L. James & Co., Inc.	Pearl River, LA	Pit # 1
T. L. James & Co., Inc.	Pearl River, LA	Pit # 3

* "Nearest Town to Pit" according to LDOTD Official State Highway Map.

Futher information on these pits can be obtained from the Geology Section of the U. S. Army Corps of Engineers District Office in New Orleans. For any additions or reinstatements of pits to this list please contact Geology Section (Tim Creasy at (504) 862-1024).

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

REPLY TO
ATTENTION OF:

March 24, 1994

Engineering Division
Structural Design Section

Mr. Larry A. LeBlanc, P.E.
Berger and Associates - South, Incorporated
8178 GSRI Avenue
Baton Rouge, Louisiana 70820

Dear Mr. LeBlanc:

Please reference your letter of March 4, 1994 to Mr. Jorge Romero of our office, in which you requested our verification of design criteria for preparing the Design Memorandum for the Drainage and Floodwall Improvements, France Road Terminal, Port of New Orleans. The floodwall is proposed as a replacement of the existing Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection Project, France Road Floodwall, Orleans Parish, Louisiana.

The design criteria you describe in your letter is correct. However, please note the following:

Item 2.a.(4), Kicker piles. During a telephone conversation with Mr. Romero on April 14, you informed him that you will not use the I-wall with kicker piles concept but will opt for T-walls, where necessary. This is acceptable to us.

Item 3.c, Calculations, please add the following:

"(5) Diagrams for I-wall bending moment, shear, wall deflection and wall pressure will be included with the wall computations." Please note that these diagrams are obtained as output from the CWALSHT computer program.

We request that you provide for our review, three copies of the in-progress Design Memorandum at the 35% and 65% design effort. This will help expedite our review and approval of the final memorandum.

If we can be of any further assistance on this matter, please let us know.

Sincerely,

W. Eugene Tickner
Chief, Engineering Division

BERGER AND ASSOCIATES - SOUTH, INC.
ENGINEERS • ECONOMISTS • PLANNERS
8178 GSRI AVENUE
BATON ROUGE, LA 70820
TEL. (504) 766-6700
FAX. (504) 769-7680

March 4, 1994
File No. 504-003

Department of the Army
New Orleans District Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160

Attention: Mr. Jorge Romero

Re: Port of New Orleans
France Road Terminal
Hurricane Protection System

Dear Mr. Romero:

Our work on the Design Memorandum for the subject project is now being finalized. During our work to date, numerous meetings and discussions between members of the Corps' staff and members of our staff have been very valuable and are much appreciated.

This correspondence is intended to summarize and confirm various criteria and other guidance from these meetings for the final preparation of the Design Memorandum. Enclosed is a summary of our understanding of the criteria/guidance for which we would appreciate your review and confirmation.

Sincerely,

BERGER AND ASSOCIATES - SOUTH, INC.

Larry A. LeBlanc, P.E.

LAL/bar
Enclosure

xc: Mrs. Deborah Keller

CRITERIA SUMMARY

1. **Protection Criteria**

   a. Top of Wall Elevation is 15' NGVD.
   b. Still Water Elevation is 13' NGVD.
   c. Wave Run-up Requirements - None.

2. **Wall Types and Height Limitations**

   a. I-Wall

      (1) It is preferable to limit the height above the ground to 8 feet or less. However, heights as high as 8.5 feet have been allowed in special situations. For this project, an 8.5-foot height will be proposed in certain reaches in order to minimize settlements caused by the berm, thus allowing immediate capping of the wall.

      (2) Sheet pile penetration below the ground line shall be a minimum of three times the retained water depth.

      (3) Analysis will be performed by the Corps' CSHTWALL computer programs.

      (4) It is permissible to exceed the above heights for I-walls which are braced with additional "kicker piles". These additional piles should be designed to limit wall translation at the ground line to 3 to 4 inches. These "kicker piles" will be designed to resist horizontal loads only with no vertical loads induced in the I-wall. Caps for the "kicker piles" will be separated from the I-wall with a "slip joint".

   b. T-Wall

      (1) These are to be used wherever I-walls are not feasible. Analysis will be by the Corps' CPGA and CPGC programs.

2. **Wall Settlement and Capping**

   a. I-Wall

      (1) It is normal practice to allow a geotechnically estimated amounts of the settlement to occur before capping. However, where it is important to the Port to expedite completion of the wall, walls which are predicted to settle less than 6 inches can be capped immediately. Where predicted settlements are greater than 6 inches, the walls will remain uncapped until sufficient settlement has occurred.

      (2) I-walls will be constructed to 6 inches above design grade where expected settlements are 6 inches or less.

(3) I-walls will be constructed to 12 inches above design grade where expected settlements exceed 6 inches.

(4) Any berms also will be overbuilt to the same amounts.

b. T-Wall

(1) Pile-supported T-walls will be constructed to design grade.

3. Format of Design Memorandum

a. Format

(1) There is not a rigid format as long as the information is well organized, consistent, legible, and addresses the Corps' design criteria.

(2) The document will reference previous design memoranda prepared for the existing protection system.

b. Drawings

The Design Memorandum will include drawings depicting:

(1) Alignment and profile.
(2) Typical cross sections.
(3) General arrangement of typical walls and gates.
(4) Pile layouts.
(5) Typical and unusual details.

c. Calculations

The Design Memorandum will include sample calculations for:

(1) Gates - one of each type.
(2) Pile foundations.
(3) Each type of wall.
(4) Unique designs.

d. Geotechnical

The Design Memorandum will include an appendix of geotechnical data and analysis for:

(1) Deep-seated bank stability.
(2) Pile capacities.
(3) Wall pressures.
(4) Seepage analysis.

e. Hydraulic/Hydrologic

The Design Memorandum will summarize the changes in hydrology caused by the additional drainage area that will now be on the protected side.

f. Environmental

(1) An environmental assessment will be made based on general evaluation of available observable data and an opinion of environmental factors affecting the project.

(2) The assessment will not include a full environmental impact statement and will exclude soil, air, and water quality investigations as well as cultural resource and archeological surveys.

g. Structural Design Criteria

(1) Concrete design will be in accordance with EM 1110-2-2104 strength design for hydraulic structures. Normal use is 3000 psi concrete and Grade 60 steel.

(2) Steel design will be in accordance with the AISC Manual and EM 1110-2-2105. Normal use is A36 steel. Minimum material thickness of 5/16".

(3) Wind load shall be 50 psf.

(4) Piling shall be prestressed concrete, 12, 14, or 16 inches; other types will be considered in exceptional situations. Pile spacing shall be 4.5 times the pile diameter. Minimum translation of pile caps shall be less than 1/2".

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS LOUISIANA 70160-0267

REPLY TO ATTENTION OF: March 22, 1994

Engineering Division
Structural Design Section

Mr. Larry A. LeBlanc, P.E.
Berger and Associates - South, Incorporated
8178 GSRI Avenue
Baton Rouge, Louisiana 70820

Dear Mr. LeBlanc:

Please reference your letter of March 1, 1994 to Mr. Jorge Romero of our office, in which you provided for our review, the plans and specifications for the Drainage and Floodwall Improvements, France Road Terminal, Port of New Orleans. The floodwall is proposed as a replacement of the existing Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection Project, France Road Floodwall, Orleans Parish, Louisiana.

The following are our comments on the subject plans and specifications:

DRAWINGS

1. The details for the discharge pipes at the four pumping stations, show the pipes supported at the ends by sheet pile founded structures, subject to settlement. Your design provides special pipe couplings to accommodate axial expansion and contraction, as well as for some vertical movement of the pipes. However, since the discharge pipes pass through the T-walls stems with a rigid connection between the T-walls and the pipes, we believe that the concrete will crack around the pipe due to settlement of the pipe supports. Therefore, we recommend that you provide independent pile founded pipe supports near the T-walls.

2. Drawing number S5. On the Typical T-Wall Section depicting the wall reinforcement, delete the shear key from the horizontal construction joint located 4 inches above the base slab.

3. Drawing number S5. On detail "B", the reinforcement around the pipe should be provided in a radial arrangement to preclude weak, unreinforced areas.

SPECIFICATIONS

4. Section 2368, paragraph 8.01.a. Unless you expect hard driving conditions, you should consider allowing the use of cold formed steel sheet piling as a substitute for PZ-22. Cold formed sheet piling may be a lower cost alternative.

5. Section 2368, paragraph 8.02.a. The use of 3NA, BZ-12, PZ-35 and PZ-40 for fabricated connections is not required on this contract since only PZ-22 or appropriate substitutes are specified for sheet piling.

6. Section 3100, paragraph 5.01.a. Delete "I-walls" from the first sentence.

Please provide us with three copies of the final plans and specifications for this work. If we can be of any further assistance on this matter, please let us know.

Sincerely,

Daniel Morador

W. Eugene Tickner
Chief, Engineering Division

APPENDIX C

PERTINENT CORRESPONDENCE

(REVIEW COMMENTS)

C PROJECT FILE
504-006

Attention: **Johnathan Hopkins**
Date: **Thursday, January 23, 1997 11:39am**

To: Johnathan Hopkins
From: Bruce LeLong
Department: CELMN-ED-TF
Voice #: 2684
Fax #: 504-862-1585.

For your information, a preliminary copy of the comments provided by Flood Control Structures Section follows. The final draft that will be provided via the Dock Board may include comments from other sections of the New Orleans District.

1. Design Methods, paragraph 33.

a. Replace "ETL 1110-2-312, dated March 10, 1988" with "EM1110-2-2104 dated 30 June 1992". Make necessary design changes to meet this criteria.

b. State design Method for "Structural Steel".

c. Give any specific loading requirement - example: HS20-16 AASHTO, etc.

2. Design Loads & General Notes, Plate S1. We recommend you delete this plate. Design criteria stated above should be sufficient for the Design Memorandum.

3. Plate S2. The profile shows top of wall El. as 15.00 (net grade) which does not agree with the El. 15.50 shown here and on subsequent drawings. Please verify this and revise as necessary.

4. Plate S3. Please verify the top elevation 15.5 and revise as necessary. Also revise the bonding note, 4th line, from "piles 3" below" to "piles 7" below".

5. Plate S4. Complete the "ferule schedule", "corrosion protection detail" and notes.

6. Plate S4. Pile spacing seems too close. Recommend you revise the pile spacing such that it is not less than four times the pile diameter or width in the direction of the load.

7. Plate S6. Please revise pile spacing as

recommended in comment 6 above.

8. Plate S7B. Please revise pile spacing; see comment 6 above.

9. Plate S8. See comment 6.

10. Plates 12A, 12B, 12C, 13,14, 15 22. Please replace "L6x6x3/8" with "L4x4x3/8". The change is due to recent Value Engineering Study.

11. Plate 11, Section 1, please verify top elevation 15.5.

12. Plate 15: We recommend you replace the anchor strap with a threaded anchor bar screwed into tube welded to the plate. The strap may corrode and separate from the plate.

13. Plate S17: We recommend you revise the pile layout for Gate No. 5 Monolith. All flood side and protected side piles under the gate columns should be battered at the same slope in the direction parallel to the ramp's centerline. Avoiding pile interference will necessitate that the re-constructed flood side portion of the approach ramp have a different pile layout from that shown in the plate.

14. Plate S18: Please verify that the sections detailed in this plate match actual existing conditions. We observed during site visit of 12/13/96 that a portion of earthwork designated in the sections as "existing grade excavated to act as formwork" actually will have to be backfilled because the existing ramp's elevation is below the required elevation designated in these sections.

15. Plate S19: See comment 13.

16. Plate S20: See comment 14.

17. Plate S21: See comment 13.
18. Plate S22: Please define earthwork symbology used in Section 2 for "New Approach Slab." Also, see comment 14.

19. Plate S26c: We recommend plate stiffeners in lieu of WT sections. WT sections are harder to paint, and hence more susceptible to corrosion.

20. Plate S40: Please provide designated distances "N" and "L."

22. Plate S42: Details presented are opposite hand to sections taken in "Plan of Seal Plate..." Please verify.

23. Plate S42: Please revise section lettering.

24. Plate S42: Please designate to which gate the given distances apply for "Plan of Track Support..."

25. Plate S46: Please define in notes each symbology used.

26. Plate S46: Please verify that the I-wall features shown in "Gate No. 6--General Arrangement"

correspond to the details shown in Section 3, Plate S41, and revise as necessary.

27. Plate S46: The removable gate post location shown is on the wrong side of the monolith. Please verify and revise the layout detail as required. Also, please provide post detail.

28. Plate S46: Numerous discrepancies exist between features depicted in the plan view, "Gate No. 6--General Arrangement," and the two sections provided in Plates 46a. Please revise both plate S46 and S46a.

29. Plate S46a: See comment 28.

30. Plate S49: Top girder size shown does not agree with the size designated in design calculations, Appendix D. Please verify and revise all relevant drawings.

31. Plate S49: No bearing stiffeners appear to be provided at the center line of the gate. Please verify and revise the gate as necessary to provide adequate bearing capacity at the removable post.

32. Plate S49: See comment 19.

33. Plate S52: Top and bottom girder sizes do not match sizes designated in design calculations, Appendix D. Please revise all relevant drawings.

34. Plate S52: See comment 19.

35. Plate S55: Please reference specifically where "End Section ..." is taken.

36. Plate W2: Offset distances to P.I. 1 through 5,7, and 8 should be negative. Please revise.

37. Plate W3: Please delete unused base lines.

38. Appendix D:

a. Please check anchor bolts for combined shear and tension.

b. Please verify the design of the welds and base plate for Gate No. 6 removable gate post. The weld size and base plate size appear to be based on a moment coefficient that underestimates the actual load by 25%.

PORT OF
NEW ORLEANS

November 4, 1996

Mr. Larry Leblanc
Pyburn and Odom, Inc.
8178 GRSI Avenue
Baton Rouge, Louisiana 70820

RE: Work Order 1-632
France Road Terminal Flood Protection

Dear Mr. Leblanc:

We have reviewed the General Design Memorandum submitted on October 10, 1996. Copies were transmitted to the Orleans Levee District, Public Works and Flood Control of LADOTD, and the N.O. District COE for their review.

Attached is the letter of comments received from the OLD for your response and resolution. The Port's comments are as follows:

The correct name of the canal is the Inner Harbor-Navigation Canal (IH-NC).

1. The correct name is the Orleans Levee District (OLD).
2. The correct name is the Public Works and Flood Control of the Louisiana Department of Transportation and Development.
3. Refer to the various berths at France Road Terminal as "Berths Nos." 1,2,etc. and not "Ship Berths" 1, 2, etc.
4. Page 2- Change the last sentence of paragraph 2. to read, "After acceptance of the new floodwall system by the OLD, ..."
5. Page 2- Add to the end of paragraph 3., "A determination of consistency with the Louisiana Coastal Resource Program will also be obtained by the Port of New Orleans."
6. Page 3-Change the second to last sentence in paragraph 5. to read, "The terminal serves primarily as a container terminal. North of that terminal is an industrial equipment manufacturer and a site for bulk materials handling."
7. Page 11-When the additional soils information is available, the last sentence of paragraph 19 will need to be deleted.
8. Page 13- Paragraph 23. The pile test program by Gulf South Piling and Construction will begin in November. Test pile information will be available before the GDM is resubmitted. That data will need to be furnished in the next issue of the GDM.
9. Page 18-Paragraph 24. Check the directions referenced in the second sentence. West should be east and north should be south.

10. Page 23-Paragraph 43. Change "the France Road Terminal" to read "property".
11. Page 23-Paragraph 45. Change the first sentence to read, "Presently, the terminal, manufacturing plant, and bulk storage areas are east and north of the existing floodwall to be relocated, south of the Interstate Highway I-10, and west of the IH-NC. Change the fourth and fifth sentences to read, "The remaining area is unused open land which is proposed by the Port as a future ship berth. That portion of the site is presently a grassed area with little vegetation and has been preloaded with riversand in anticipation of future development." Change "IHNC-Mississippi River Lock" to read "IH-NC from the Mississippi River Lock".
12. Page 24, Paragraph 45. Delete the word "Authority" after the word "Port".
13. Page 26, Paragraph 51. There needs to be a table showing the deletion of maintaining the floodwall reaches that are no longer serving as the flood protection system after the new floodwall is accepted. Also, there will be several floodgates taken out of service because of the new floodgates. These deletions need to be total and then a **net** increase or decrease in O&M costs to the OLD needs to be shown.
14. Plate W4- There are problems with the P.I., and B/L stations in the Wall Line Layout table. The numbers don't correspond and add correctly.
15. Plates W14, 15, 16- The PBRR track which is between France Road and the new floodwall will be abandoned, but should be shown on the drawings since the contractor may be removing portions to facilitate construction of the floodwall.
16. Plate W23 and Plate S7A-The cofferdam was never tied into the portion of floodwall built with the pumping station discharge lines and needs to be called out as work to be done now, not in the future.

With regards to the comments of the OLD, the response is that Pontchartrain Materials has requested and the Port has agreed that in order to avoid relocating the internal operations of the Boh Bros. plant and PMC, the sill would be low enough so that the floodgate would be as close to France Road is possible and have a gentle ramp from France Road to the floodgate sill. To accomplish this the sill needs to be El. 5.5. PMC and the Port recognize the more frequent closings of Gate #1 than Gate #2, but it is the only workable solution to the tenants' operations.

BOARD OF COMMISSIONERS OF THE PORT OF NEW ORLEANS

Post Office Box 60046 • New Orleans, Louisiana 70160 • Tel: 504 522-2551 • Fax: 504 524-4156 • Telex: 58-7496

With regards to the OLD comment on double swing gates, I hope that you have in writing your previous discussions with the OLD. If you will recall, over a year ago I questioned double swing gates and you told me that you had confirmation from the OLD that they had no problem with them and you were encouraged by the OLD to use them. I expressed my surprise to you and agreed that if you had worked this out with the OLD, then I would not object.

Please contact Frank Mineo or Stevan Spencer immediately about this issue. All other comments referenced herein are minor and are a matter of semantics.

I take this opportunity to remind P&O of the contract requirement of submitting an advanced set of check plans and specifications on the project to me by November 15, 1996. The GDM was due September 9 and arrived four weeks late. If the advanced set of check plans and specifications are not delivered on time, the Port will miss its milestone date with the LADOTD for Statewide Flood Control funds. Your contract also requires 90% complete plans and specifications by March 1, 1997.

I am transmitting to you (in hard copy and Wordperfect diskette)for your reference, the portions of the specifications which the Port of New Orleans is providing (the non-technical contract documents) and the bid form which you must complete.

As soon as we receive comments from the other reviewing agencies, I will contact you.

Sincerely,

Deborah D. Keller, P.E.
Manager, Engineering Design

c:\wpwin5.2\1996\p&o2

BOARD OF COMMISSIONERS OF THE PORT OF NEW ORLEANS
INTER-OFFICE COMMUNICATION

TO: Deborah D. Keller
Design Engineering Manager

FROM: Brenton T. Morse, Jr.
Permits Manager

DATE: October 25, 1996

C.C.: Ms. Dunn
Ms. Fant
Mr. Gallwey
*Mr. Masson
Mr. Mayeaux
*Mr. Morse
*Mr. Territo
*w/attachment

SUBJECT: Tidewater Area Floodwall
Statewide Flood Control
State Project No. 576-36-0005
Inner Harbor-Navigation Canal
Station 97+00 to 170+00, 2.52
Miles From Mississippi River
France Road Terminal Flood
Protection, Relocate Western
Hurricane Protection Floodwall
Stations 16+58.38 to 143+18.96
OLD Permit PG 96-48

Transmitted herewith is your copy of Orleans Levee District letter dated October 24, 1996 in response to our request for comments on Design Memorandum No. 2, Supplement No. 8A. The most serious request on their part is redesign of most floodgates to eliminate the center post or conversion to rolling gates.

When they brought up this point during our telephone conversation, I mentioned to them that we are under a time constraint, in that we have to submit final design documents to DOTD by June 24, 1997. They mentioned that those center posts are their biggest headache with floodgates. They either get separated from the gate or the hole gets clogged up with debris or both.

If I can help in any way, let me know.

BTM/
(N3)FLODAPPL43

Attachment

Copy of Spencer/Morse ltr dated 10/24/96.

The Board of Commissioners

OF THE

Orleans Levee District

SUITE 202 - ADMINISTRATION BUILDING

6001 STARS AND STRIPES BLVD.

New Orleans, La.

70126-8006

TEL. 504-243-4000

PROTECTING YOU AND YOUR FAMILY

October 24, 1996

Mr. Brenton Morse
Port of New Orleans
P. O. Box 60046
New Orleans La 70160

RE: OLB Project No. 26901
France Road Floodwall
State Project No. 576-36-0005

Dear Sir:

We have your October 15, 1996 submittal for the "Preliminary Draft, Final Report" on the subject project. Upon review we have several comments as follows:

Volume 1, Page 7, Table 1

1. The sill elevation proposed for Gate 1 is shown at Elev. 5.50'. It appears that this sill elevation should match that of Gate 2. This then would make access to the floodside property equal and would reduce the closure frequency and size of Gate 1.

2. Please clarify as to the location of Gates 3 and 4 since they are missing from the table.

3. Does Gate 6 have a removable post?

Volume 1, Plate S49

Title says "Gate 6". Elevation says "Gate 7". Please clarify.

Volume 1, Page 7

If possible, we would suggest and request the elimination of double gates with center posts. Our first preference is for single swing gates. The opening width of Gates 1, 2, 5, 7, 8 and 9 appear to be within range of a single swing gate, and Gate 6 within the range of a single bottom roller. It is noted that it appears that storage space is available for the open gate in some cases and possible with the re-alignment of the floodwall. If center posts are required, storage behind the open gate should be provided and the size must be such that two men may install without equipment.

Page 8, Paragraph 10

Water Surface Elevations: You should mention that +15.0' NGVD will meet FEMA flood protection requirements.

Please contact either Frank Mineo or me if you have any questions.

Sincerely,

Stevan G. Spencer, P.E.
Chief Engineer

SGS:FPM:pns

xc: Enrique Medina
Max Hearn
Brian Keller, USACE
Geneva Grille, LADOTD