APPENDIX B

GEOTECHNICAL INVESTIGATIONS

NORFOLK HARBOR AND CHANNELS, VIRGINIA

LONG-TERM DISPOSAL (INNER HARBOR)

US Army Corps
Of Engineers

Norfolk District
June 1990

Draft Information Report

SECTION 1	***RAISING OF CRANEY ISLAND DISPOSAL AREA DIKES***
SECTION 2	***REPLACEMENT OR EXTENSION OF CRANEY ISLAND DISPOSAL AREA***
SECTION 3	***BORROW SOURCE, INVESTIGATION FOR DIKE CONSTRUCTION***
SECTION 4	***BENEFICIAL USES OF DREDGED MATERIAL***

SECTION 1

APPENDIX B, SECTION 1
RAISING OF CRANEY ISLAND DISPOSAL AREA DIKES

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APPENDIX B, SECTION 1

RAISING OF CRANEY ISLAND DISPOSAL AREA DIKES

INTRODUCTION

1. The Waterways Experiment Station, Corps of Engineers, prepared a report, Miscellaneous Paper GL-87-4, dated May 1987, entitled "Perimeter Dike Stability Analysis, Craney Island, Norfolk, Virginia," (attachment 1) that investigates the stability of existing and proposed perimeter dikes when the crest elevations are raised to elevation (el) +34 feet, mean low water on the west side and to el +40 on the east side. The study quantitatively concluded that it was technically feasible to raise the east and north perimeter dikes to el +40 and the dredge material to el +36 with a safety factor of 1.4 and 1.28, respectively. This paper further concluded that with remedial site work (i.e., construction of waterside and road berms) the west perimeter dike could be raised to el +34 and the dredged material to el +30 with a safety factor of 1.3.

2. In this report the Norfolk District qualitatively evaluates the feasibility of raising the dikes to elevations higher than those determined in the miscellaneous paper. The reason for this evaluation is to determine if raising the dikes is an option for increasing the capacity of the island in support of the long-term study. The evaluation is based on available information from past geotechnical investigations.

EVALUATION

3. Criteria contained in EM 1110-5027, Confined Disposal of Dredged Material, 30 September 1987, (Table 6-6), recommends a minimum safety factor of 1.3. Therefore, the dikes studied in the miscellaneous paper marginally meet the minimum recommended criteria and are at or near maximum elevations. The limiting factor is a very soft foundation (clay) that extends to a considerable depth (+90 feet). If further dike raising can be accomplished, it will require specialized construction techniques to improve the strength of the soft underlying clays.

4. Consolidation tests performed in foundation soils are underconsolidated with respect to the weight of the overlying dikes. A comparison of undrained shear strength

values between 1948, 1971, and 1982 data show no appreciable increase in strength has occurred. This is probably due to the extensive thickness and low permeability of the clay. The excessive pore pressures have not readily dissipated and subsequent strength gain has not yet appreciably occurred. Therefore, the dike's surcharging load is not effectively improving the site conditions. An alternate means is needed to improve the foundation shear strength before further raising of the dikes is feasible.

SPECIAL CONSTRUCTION TECHNIQUES

5. As mentioned, the foundation shear strengths must be improved before any significant raising of the island dikes can be considered. One method to speed up the consolidation process, which is gaining acceptance today, is the use of vertical wick drains. The drains are composed of band-shaped plastic surrounded by filter fabric. The wick drains are installed on a grid pattern over the site and are designed to accelerate the consolidation process by shortening the seepage path that pore water must take to exit the clay layer. As the pore water exits the clay, its shear strength increases. Depending on the degree of increased strength, the elevation of the containment area could be raised using a combination of berms and dike setbacks. The construction of the dike setbacks would require the use of high strength geotextiles in conjunction with the wick drains.

6. There are many uncertainties with such new technologies. In addition, they are very expensive and currently not economical. But with further evaluations and improved costs, they may provide a means to improve the dike stability and allow further raising of the containment area. The Norfolk District will continue to evaluate methods to improve dike stability. However, it is doubtful that such improvements will significantly increase the capacity of the containment area to fully support the long-term disposal needs of Norfolk Harbor.

CONCLUSION

7. At present, the Craney Island dikes are at or near their maximum design height. Capacity calculations for the island and any proposed lateral extension should be based on a dredged material elevation of +30. This is a safe, conservative elevation

controlled by the stability of the west dike. New technologies will provide opportunities to improve its capacity, but such improvements will be insufficient for a 50-year disposal plan. However, its limitations should not preclude it as an option. Sometime in the future, Craney Island could serve as supplemental disposal capacity, easing the demand on other selected alternatives.

ATTACHMENT 1
(SECTION 1)

MISCELLANEOUS PAPER GL-87-4

PERIMETER DIKE STABILITY ANALYSES CRANEY ISLAND DISPOSAL AREA, NORFOLK DISTRICT, NORFOLK, VIRGINIA

by

Jack Fowler, Earl V. Edris, Jr., William L. Hanks,
Tara S. Holloway

Geotechnical Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631

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This study investigates the stability of existing and proposed perimeter dikes at Craney Island disposal area when the crest elevations are raised to el +34 on the west and el +40 on the east side. With these crest elevations, the dredged material could be raised to el +30 on the west side and el +36 on the east side. Dike configurations were developed for the west leg, east leg, north leg, and northwest corner. The west leg required a 2-ft road berm and a water berm to achieve a safety factor of 1.3. The other sections did not require any additional berms or setbacks. By raising the dike on the inward side using the same slopes, the safety factors were above 1.3. Reinforcement of the raised dikes was found not to be feasible.

Dike settlement was evaluated. It was found that the use of wick drains to increase the shear strength of the soft foundation clay was not economically feasible because of the excess depth of the dike cross section. Settlement from raising the east, west, and north perimeter dikes was estimated to be about 4 ft.

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PREFACE

This publication describes the slope stability analyses and recommended designs for the raised perimeter dikes at the Craney Island disposal area in Norfolk, Virginia.

The investigation was performed by the Geotechnical Laboratory (GL), US Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., for the Dredging Management Branch of the US Army Engineer District, Norfolk, during the period May 1986 to October 1986.

The report was written by Dr. J. Fowler, Mr. E. V. Edris, Jr., Mr. W. L. Hanks, and Mrs. T. S. Holloway under the general supervision of Mr. G. B. Mitchell, Chief, Engineering Group, Soil Mechanics Division (SMD), Mr. C. L. McAnear, Chief, SMD, and Dr. W. F. Marcuson III, Chief, GL.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

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CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be coverted to SI (metric) units as follows:

Multiply	By	To Obtain
acres	4046.873	square metres
cubic yards	0.7645549	cubic metres
feet	0.3048	metres
feet per day	0.3048	metres per day
feet per minute	0.3048	metres per minute
inches	0.0254	metres
pounds (force) per square foot	0.04788026	kilopascals
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre
square feet	0.09290304	square metres
square feet per day	0.09290304	square metres per day
square inches	645.16	square millimetres
tons (force) per square foot	95.76052	kilopascals

PERIMETER DIKE STABILITY ANALYSES, CRANEY ISLAND DISPOSAL AREA, NORFOLK DISTRICT, NORFOLK, VIRGINIA

PART I: INTRODUCTION

Background

1. The Craney Island disposal area is a 2,500-acre confined dredged material containment located near Norfolk, Virginia, in Portsmouth, Virginia. A vicinity map is shown in Figure 1. Plans for construction of the site were developed in the early 1940's. Construction was begun in August 1954 and was completed in January 1957. Craney Island was to provide a long-term disposal area for material dredged from channels and ports in the Hampton Roads area by providing storage capacity and adequate sedimentation of dredged material solids to maintain water quality of the effluent.

2. Dredged material has been placed in the disposal area almost continuously since it was completed in 1957. The initial capacity was estimated to be about 100 million cu yd based on an assumed final elevation of +18 ft mlw. Over 180 million cu yd have been placed in the containment to date and the height of dredged material is at an average elevation of +17 ft mlw. Continual upgrading of the perimeter dike system to +26 ft mlw has led to concern for dike stability, possible failure, loss of dredged material, and limited use of the disposal area. An investigation was initiated by the US Army Engineer District, Norfolk (NAO), with US Army Engineer Waterways Experiment Station (WES) assistance to evaluate (a) the stability of the perimeter dike system at the Craney Island Disposal site and (b) the use of innovative design and construction techniques such as geotextile reinforcement and strip drains for improved foundation strength.

Purpose

3. The purpose of this study is to evaluate the stability of the existing and the final perimeter dike cross section based on subsurface investigations conducted by the NAO.

Scope

4. The study included collection and statistical evaluation of in situ field vane shear strength and conventional laboratory shear strength data and boring log information collected from 1948 to 1983. Innovative procedures for improving the foundation strength and techniques for strengthening the final dike sections were evaluated. This study required the identification of several critical dike cross sections for conventional limit equilibrium analysis. As part of the evaluation, an analysis and determination of factors of safety for each of the cross sections based on the shear strengths determined from the statistical analysis were conducted. The determination of potential failure areas provided input for the location of proposed instrumentation. Dike subsidence was also estimated.

Objective

5. The objective of this investigation was to determine if it is technically feasible to incrementally raise the perimeter dikes at Craney Island to the proposed dike height of el 34 ft mlw and to contain dredged material to a height of el 30 ft mlw.

PART II: PERIMETER DIKES

General Topography

6. The Craney Island disposal area is about 10,000 by 10,500 ft in rectangular trapezoidal shape. A peripheral dike 25 to 30 ft high surrounds the entire disposal area, and two dividing dikes running parallel with the shoreline separate the disposal area into three almost equal areas of about 800 acres each.

7. The southernmost section has been filled at the eastern dike to el +27 ft, the middle of this section to el +19 ft, and areas adjacent to the western dike to an average el +17 ft as of 1986.

8. The middle section is filled at the eastern dike to el +19 ft sloping toward the western dike about el +13 ft in the northwestern corner.

9. The northern section slopes from el +22 ft in the east to +16 ft at the western dike.

Development

10. Beginning from the initial construction, the perimeter dike height has increased in two major efforts. The initial change from el +8 to el +17 occurred around 1969 with the second increase to el +26 around 1980. Usually a stepped or benched dike construction technique had been used to incrementally raise the dikes at Craney Island. Adjacent dried dredged material crust along the dike alignment is generally used to raise the dikes and supplemented as required with truck-hauled coarse-grained material. With projections for more containment volume, studies have been made to provide better dredge management or more containment volume.

11. During a study conducted by Palermo (1981) it was recommended that the Craney Island disposal area be subdivided into three separate containment sites for improved dredged material management. Attempts in the past had been made to construct two interior displacement dikes using end dumped wood debris and sand, and hydraulically placed sand. The interior dikes were designed to create three containment areas that would improve sedimentation in the containment area being used and allow the other two containment areas to dry out. Construction of the interior dikes was completed in 1983, and the dredged

material management plan (Palermo 1981) was implemented in 1984 starting with the center compartment. The dredged material management plan consists of management of surface and ground water through the use of ditches made in the newly placed dredged material to promote the rate of consolidation. The west perimeter dike heights for the center compartment were raised to about el 26, and the division dikes were raised to about el +22 because it was anticipated that dredged material would be stored to about el +17. Filling of the center compartment began in late 1985.

12. A feasibility study by the Norfolk District in 1971 concerning the raising of the perimeter dikes to el +30 was performed. The results, based on geotechnical data from 1971 borings, indicated that a bench or setback of about 1,000 ft was needed for the west perimeter dike. Their proposed section is shown in Figure 2. The location of the dredging work dictated that the inflow points be located along the eastern dike. The natural slope of the fine-grained dredged material is about 5 ft in 10,000 ft which is the approximate distance between the east and west dikes. This required that the elevations of efficient perimeter dikes be tailored to contain the slope. Palermo in his 1981 report recommended that for an average dike el +30 that the east and west dikes be constructed to crest el +32.5 and +27.5, respectively. The north and south dikes would require a crown elevation sloping from east to west.

13. In 1981, a foundation analysis performed by the Norfolk District indicated that the outside slope along the west perimeter dike needs to be constructed to 1:8 for a dike crest el +30 ft. When the west perimeter dike was constructed to el +26 ft in 1985 and the possibility of deepening the channels at Norfolk was considered, it was recommended that a thorough analysis be conducted for the main retaining dikes at Craney Island. It was also recommended that because rapid loading was anticipated the use of geotextiles and strip drains be considered.

Description

East dike

14. Since most of the coarse-grained material is located along the east dike it provides a convenient location for construction material for continued construction of this dike. Because these coarse-grained materials provide a

firm foundation, progressive raisings of the east dike have experienced no stability problems. This section is now benched westward from the perimeter road center line at el +8 ft approximately 250 ft to a crest el +30 ft. Selective placement of coarse-grained material along the east perimeter dike alignment has almost eliminated truck-hauled material for incremental dike increases. Dragline placement of material along the dike alignment is all that has been necessary. A second perimeter access roadway at about el +16 to +18 ft has been constructed in addition to the original roadway at el +8 ft. This second roadway was set back about 200 ft parallel to the original perimeter roadway.

North dike

15. Coarse-grained dredged material sand has accumulated over an extensive area in both the NE and NW corners of the disposal area and along the inside of the north perimeter dike. A second perimeter access roadway was also constructed at about el +16 to +18 ft and set back about 250 ft parallel to the original roadway at el +8 ft. The dike alignment was set back about 400 ft south of the north perimeter roadway in 1981 to accommodate a borrow area adjacent to the roadway. In 1983 it was suggested that this portion of the north perimeter dike be moved to about 250 ft south of the roadway at el +8 ft to increase the dredged material storage capacity of the disposal area.

16. At the present time this dike is being raised with a dragline on 20- by 20-ft wooden mats using excavating dredged material adjacent to and from within the containment area for raising the crest of the dike. There have never been any stability problems along the north perimeter dike.

West dike

17. Because of the continuously wet condition of fine-grained dredged material adjacent to the west perimeter dike it has been virtually impossible to construct a benched dike section without bearing capacity failure. Incremental dike height has historically been achieved by displacing sand fill into the containment area adjacent to the existing perimeter dike. Coarse-grained dredged sand is truck-hauled and end-dumped on the slope, and a dozer pushes the sand up the slope and into the disposal area creating a large mud wave as the weight of the sand displaces the soft fine-grained dredged material.

18. After the interior division dikes were completed, subdividing the disposal area into three separate containment areas, the middle area began to

dry out. Tracks made by a Riverine Utility Craft and ditches made by a Gemco Trencher kept surface water drained to collection ditches that exited the site through newly constructed weir boxes. Surface subsidence of the dredged material along the inside of the west perimeter dike was below el +13 ft and the invert elevation of the drainage trenches made by the Gemco ditcher was below el +10 ft. Because the invert elevation of the trenches was below the outlet el +10 ft for the newly constructed weirs, one of the older weir structures had to put back in service for continued site drainage. Continued site drainage caused about 12 to 18 in. of crust to develop along the west perimeter dike. The west perimeter dike was raised in late 1985 to about el +26 ft without the displacement type failure toward the inside of the disposal area as experienced in the past because of improved foundation conditions caused by trenching and dewatering of the site. Continued dike raising will conform to the horizontal and vertical location of the newly constructed weir.

Hydrographical Survey

19. Hydrographic surveys were conducted by the Norfolk District to determine the bottom elevations within the Craney Island 1,000-ft right-of-way adjacent to the perimeter dike surrounding the disposal area. Depth of water at the 1,000-ft right-of-way varied in depth of about 9 to 12 ft corresponding fairly close to the values found on the National Oceanic and Atmospheric Administration charts for the Hampton Roads Area. The only difference in the bottom topographic features was found near the northwest corner where bottom depths were found to be over 25 ft deep at a distance of about 500 ft from the corner. This trough was noted in 1979 and appeared to have been caused by fast flowing water currents around the northeast corner of the island. Bottom slopes determined from the hydrographic surveys varied from 1V:30H to 1V:100H.

PART III: GEOTECHNICAL INVESTIGATIONS

20. This section describes the foundation soil conditions below the dredged material deposited within the Craney Island Disposal Area. This section also describes the engineering properties required for the perimeter dike stability analysis.

1953 Investigation

21. An extensive foundation investigation began in 1948 was completed by the Norfolk District in 1953 during the design phases of this project and prior to the beginning of construction. A total of 11 undisturbed sample borings and a large number of general investigative borings were conducted. Laboratory tests on undisturbed samples consisted of several consolidation tests, triaxial shear strength, Atterberg limits, specific gravity, and classification tests on the compressible marine clays underlying the site. The 1953 design report identified four major soil zones as listed in Table 1.

Table 1

Major Foundation Soil Zones (Palermo 1981)

Zone	Soil type	Elevation ft mlw From	Elevation ft mlw To	Natural Densities lb/ft^3 Dry	Natural Densities lb/ft^3 Submerged
A	Grey marine clay	-10	-30	48.8	29.3
B	Grey marine clay	-30	-60	49.7	30.1
C	Marine clay, some silt	-60	-90	57.1	34.3
D	Clay and silt, some sand	-90	-110	60.3	39.9
Below D	Hard compact sand	Below	-110	--	--

1971 Investigation

22. During a feasibility study in 1971 for raising the perimeter dikes at the Craney Island Disposal Area, the Norfolk District conducted a

subsurface investigation beneath the main dike. Location of the borings are shown in a plan view of Craney Island Disposal Area in Figure 3. Several of these borings were taken through the dredged material deposit as well as through the main dike.

1978-1979 Investigations

23. Several other foundation investigations made in or near the Craney Island Disposal Area by the Virginia Department of Transportation and others are summarized in studies prepared for the Virginia Port Authority (Dames and Moore 1978, 1979). Most of the borings taken during these investigations were in search of coarse-grained material borrow sources and did not provide information concerning the engineering properties of the fine-grained dredged materials or marine clay foundation materials.

1980 Investigation

24. Three rotary borings were taken under contract for the Norfolk District at three locations on the western portion of the disposal area in April 1980. A shallow floating barge mounted drill rig was used during this investigation. A number of consolidation and permeability tests were conducted on the fine-grained dredged material samples obtained. Eighteen additional borings were conducted in August 1980 (Pezza and Byrne 1980) to define the quality and volume of the coarse-grained materials at the inflow points shown in Figure 3 that were usable for dike enlargement.

1981-1983 Investigations

25. Because the storage volume of dredged material needed to accommodate the proposed Norfolk harbor and channel deepening, Norfolk District initiated a subsurface investigation of the main perimeter dike in 1981 that was completed in 1983. Seven borings were drilled in 1981 and 20 borings in 1983 to a depth of about 90 to 100 ft penetrating a very dense sand. Location of these soil borings are shown in Figure 3.

26. A generalized plot of the major foundation soil zones is shown in Figure 4 and tabulated in Table 1. Field vane shear strength tests and

laboratory triaxial tests were performed during this investigation and the results of these tests are shown plotted in Figures 5, 6, and 7 for the east, north, and west perimeter dikes, respectively. Soil borings for the east, north, and west perimeter dikes are shown in subsurface profiles for each dike in Figures 8, 9, and 10, respectively. The subsurface stratum shown in the plots are the interpretation of the author.

27. Location of the cross sections investigated during the stability analysis are shown in Figure 11. Foundation shear strengths selected for the east, north, and west perimeter dikes are shown in Figures 12, 13, and 14, respectively, for each dike. These widely varying shear strengths were selected using a linear regression analysis of both the laboratory triaxial and field vane shear strength test results shown in Figures 5, 6, and 7.

28. The marine clay layer is a continuous stratum of recent marine sediments which are normally consolidated, i.e., they have never experienced a greater load than their own present self-load. Therefore, it would be expected that soil unit weight would be lowest (void ratio highest) at the present river bottom (profile line) and would increase (void ratio decrease) with depth. Concomitantly, shear strength should increase with depth. Actual values will vary from point to point as a result of natural variations in sand content within the matrix clay. Tests of samples from the subsurface investigations referenced by Fowler (1986) indicate:

a. Atterberg Limits: Liquid limit ranges from 40 to 105, with typical values of 60 to 90. Plastic Limit ranges from 25 to 40, with typical values of 30 to 35. Plasticity Index ranges from 15 to 65, with typical values of 30 to 60.

b. Saturated unit weight ranges from 90 to 105 pcf. Void ratio ranges from about 2.75 near the profile line to about 1.50 at depth. These are void ratio values (density) after compression under the existing dikes. Initially, before compression under the dike body, the void ratio at each depth is much higher.

c. Values of the compression index, from laboratory consolidation tests of undisturbed samples, ranged from 0.55 to 0.74. A typical value of 0.58 was used in volume estimates by Goforth (1986).

d. Shear strength is expected to vary from zero at the profile line to a maximum at a depth of -90 ft mlw. Test values of cohesion (1/2 of unconfined compressive strength) from the 1953 investigations (Norfolk District, 1953), before construction of the Craney Island dikes, showed (1) that the upper 10 ft or more could not be sampled because of softness and (2) the rate

of increase of cohesion with depth was about 4 to 5 psf per foot of depth.

PART IV: SLOPE STABILITY ANALYSIS

29. Slope stability analyses conducted during this investigation were performed using the two-dimensional slope stability package UTEXAS2, version 1.205 (CAGE et al. 1986 (Draft)). Of the four analysis procedures available in this program, Spencer's procedure was used for all analyses because it satisfies both force and moment equilibrium. The side force inclination is calculated in the Spencer procedure. The phreatic surface is taken as the river level outside the dike toe and the top of the dredge material behind the dikes. A linear change in the phreatic surface is assumed between these two horizontal segments. Circular shear surfaces were used in all analyses. Searches were performed to determine the critical shear surface. The searching was initiated with the tangent search mode using a final grid spacing of 0.3 ft. These analyses will result in recommended design cross sections for each raised dike section. Also, several assumptions made during the study will be evaluated to show the significance of variation in the selected perimeter.

Dike Cross Section for Analysis

30. The dike cross sections used for analysis were selected based on the largest thickness of the soft foundation clay shown on the soil profiles developed in the geotechnical investigation section of this report. Four cross sections were identified with one in the northwest corner and one each on the west, north, and east dikes as shown in Figure 11. The stations of the cross sections identified were 104+00, 80+00, 45+00, and 80+00 for the northwest corner, west, north, and east dikes, respectively. The shear strength of the soft foundation clay at these cross sections are shown in Figures 12-14. The geometry of the cross sections shown in Figures 15-18 was obtained from survey results and foundation investigations.

West Perimeter Dike Stability Analysis

31. The dike section for analysis sta 80+00 is located in the lower half of the north compartment where dredged material has recently been placed. Before dredging began in 1985, the dredged material surface adjacent to the

west dike had an average elevation of about +13 ft. The dredged material elevation is presently about +17. The first scenario, investigating the existing conditions, consisted of the dike at el +26 and the dredged material at el +17. The safety factor for this case was 1.20. The next scenarios increased the dredged material to el +19 and +22. The safety factors decreased from 1.20 to 1.16 at the higher dredged material elevation. The results of these analyses are tabulated in Table 2 with the critical circles shown in Figure 19. These safety factors are above 1.0 but below a design value of 1.3. Thus, some of the berms described for the recommended enlarged dike section could be started to increase the safety factor to 1.3.

Table 2

Effects of Dredged Material Elevation on Safety Factor

			Results of Circular Search					
Stab. Run	Dike Crest El	Dredged Material El	X	Y	Radius	Tang. El	Side Force Incl	Safety Factor
1	26	17	25.5	145.9	199.7	-53.8	3.42	1.20
2	26	19	26.2	147.7	200.6	-52.9	3.49	1.18
3	26	22	26.7	153.6	204.5	-50.9	3.63	1.16
4	34	22	58.3	195.0	253.2	-58.2	3.86	0.99
5	34	30	60.6	210.0	264.1	-54.1	4.09	0.95

32. The next scenarios considered raising the containment dike to el +34 with the dredge material at two elevations. The first case involving the raised dike considered the dredged material at el +22. The resulting safety factor is below 1.0 with a value of 0.99. This result indicates that some or part of the berms necessary for stability when the dredge material is increased to el ±30 should be in place before the dike is raised. When the analysis was performed with the dredged material up to el +30, the safety factor dropped to 0.95. The results of these calculations are shown in Table 2 as runs 4 and 5. The critical circles are shown in Figure 20.

33. The results from the analysis with the dike height at el +34 and the dredged material to el +30 indicate that additional resisting force is

necessary. Three possible solutions were investigated. These are a road berm, a water berm, and a bench or setback distance for the new dike. Each of these potential alternatives will be investigated separately to show the influence and then combined for the recommended design.

34. The existing roadway at el +8 is about 58 ft wide. The road berm consists of a mass of sandy material that increases the road elevation. A slope of 2H:1V was used for the outboard or west side of the berm. The effectiveness of the road berm was evaluated by increasing the berm elevation in 2-ft increments. Figure 21 illustrates how the berms fit in the current configuration and indicates the volume of material contained in each berm. The safety factors increase from 0.95 for the current roadway to 1.01 for an 8-ft berm (top of berm at el +16). The results are listed in Table 3 with the critical circles shown in Figure 22. A plot of safety factor versus berm elevation is shown in Figure 23. The safety factor increased as the berm elevation increased with a change in the rate of increase at +12. The center coordinates for the critical shear surfaces moved outward (lower X value) and upward (larger Y value). This movement tends to counter balance the additional resisting forces generated by the berm.

Table 3

Effect of Road Berm Thickness on Safety Factor

			Results of Circular Search					
Stab. Run	Thickness Road Berm	Elevation of Road Berm	X	Y	Radius	Tang. El	Side Force Incl	Safety Factor
5	0	8	60.6	210.0	264.1	-54.1	4.09	0.95
6	2	18	55.2	219.6	275.2	-55.6	4.05	0.97
7	4	12	48.6	231.0	288.1	-57.1	4.01	0.99
8	6	14	43.2	237.0	295.6	-58.6	3.98	1.00
9	8	16	37.2	246.0	305.5	-59.5	3.94	1.01

35. A water berm is a mass of sand placed at the toe of the dike to increase the stability. This sand material is assumed to displace all the soft bay bottom sediments. There are several variables that are involved in the water berm design. A general schematic of a water berm, illustrating the

terminology is shown in Figure 24. The three variables are the inboard elevation, outboard elevation, and the top width. Three combinations of elevations were used. They are el 0 for both the inboard and outboard values, el 0 for the outboard and el +3 for the inboard value, and el +3 for the outboard and el +6 for the inboard value. For each combination of elevations, three top widths of 100, 300, and 500 ft were evaluated. The results of these computations are shown in Table 4. The critical circles for the berms with el +3 to +6 are shown in Figure 25. There is a significant increase in safety factor when the top width increased to 100 ft. A small increase occurs with an increase from 100 to 300 ft. However, no increase occurs when the berm width is increased to 500 ft. Figure 25 shows that a minimum width of 100 to 150 ft is needed. However, a berm top width of 300 ft was selected for further study

Table 4

Effect of Water Berm on Safety Factor

	Water Berm			Results of Circular Search					
Stab. Run	Outboard El	Top Width	Inboard El	X	Y	Radius	Tang. El	Side Force Incl	Safety Factor
5	-	-	-	60.6	210.0	264.1	-54.1	4.09	0.95
10	0	100	0	65.7	202.2	254.8	-52.6	4.07	0.96
11	0	300	0	66.0	202.0	255.0	-53.0	4.05	0.96
12	0	500	0	65.7	202.2	254.8	-52.6	4.07	0.96
13	0	100	3	50.3	223.4	282.4	-59.0	3.56	1.04
14	0	300	3	68.8	195.8	249.1	-53.3	3.41	1.07
15	0	500	3	71.7	191.8	244.2	-52.4	3.39	1.08
16	3	100	6	66.0	196.8	252.9	-56.1	2.90	1.18
17	3	300	6	81.7	167.2	219.6	-52.4	2.79	1.20
18	3	500	6	82.0	166.9	219.3	-52.4	2.78	1.20
19	0	300	4	70.8	191.5	244.8	-53.3	3.21	1.11
20	3	300	4	77.7	182.0	233.0	-51.0	3.19	1.12
21	0	300	5	74.0	185.7	238.7	-53.0	3.02	1.15
22	3	300	5	80.9	174.8	225.8	-51.0	2.99	1.16
23	0	300	6	77.7	178.3	231.0	-52.7	2.83	1.19

so that a margin against erosion of the berm is provided. Several additional elevation pairs were evaluated for 300-ft-wide berms. These results are also shown in Table 4. The volume of the various berms are listed in Table 5. The safety factor increased more for the water berm than for the road berm, but the volume of material in the water berm is 16 to 70 times larger than the road berm. A plot of the water berm volume versus safety factor is shown in Figure 26. This plot shows that the safety factor is dependent upon the inboard elevation and not the outboard elevation.

Table 5

Water Berm Volumes

Water Berm			Volume Per Foot of	Total Volume*
Outboard El	Top Width	Inboard El	Dike (cy^3)	(cy^3) x 10^6
0	300	0	309.0	3.09
0	300	3	325.7	3.26
3	300	6	395.4	3.95
0	300	4	331.2	3.31
3	300	4	384.3	3.84
0	300	5	336.8	3.37
3	300	5	389.9	3.90
0	300	6	342.3	3.42
0	300	7	347.9	3.48

* Used 10,000 ft for dike length.

36. A setback distance is the horizontal distance from the outboard crest of the el +26 dike to the outboard toe of the el +34 dike. This setback was varied from 0 to 60 ft in intervals of 20 ft. The results are shown in Table 6. A plot of safety factor versus setback distance is shown in Figure 27. Only small increase in safety factor occurs when the dike is setback.

37. Based on the above results, none of the three individual solutions for increasing the resisting force resulted in the safety factor being above 1.3. Thus, combinations of road berm, water berm, and setback will be

Table 6

Effect of West Dike Setback on Safety Factor

Stab. Run	Setback Distance ft	Results of Circular Search X	Y	Radius	Tang. El	Side Force Incl	Safety Factor
5	0	60.6	210.0	264.1	-54.1	4.09	0.95
24	20	66.4	231.6	287.5	-55.9	3.92	0.96
25	40	72.7	248.2	307.0	-58.8	3.75	0.98
26	60	77.6	270.9	331.8	-60.9	3.59	1.00

considered. When combining these three potential solutions it must be noted that there is not a unique solution. The recommended design will be closest to a safety factor of 1.3 and minimize the material in the various berms. The first combination consisted of a water berm 300 ft wide with el +3 to +6 ft and a road berm. The road berm varied from el +16 to el +12. The safety factor for the el +16 berm was 1.34 reducing to 1.29 for the el +12 berm. Notice that the changes in the safety factor calculated individually for each the three solutions can only serve as a guide and can not be added together. Water berms were then combined with a setback distance of 60 ft. The safety factor for a water berm from el +3 to +6 and 300 ft wide was 1.24. When a water berm with el 0 to +3 was considered, the safety factor decreased to 1.19. Because of other constraints such as weirs and reductions in size, setbacks larger than 60 ft were not considered. The optimum design was then a matter of selecting the best water berm and road berm. Four additional combinations were considered. The recommended design consists of a water berm 300 ft wide with el 0 to +7 ft and a road berm to el +10 ft. The safety factor for this combination is 1.30. The results and total volumes for all combinations considered are shown in Table 7. Figure 28 shows the recommended section and the critical circle.

38. There are several assumptions that were made in the course of the analysis. These will be reviewed and examined to determine the significance of the selected value. An assumption concerning the water berm is that the sand material will totally displace the soft bay bottom sediments. This should occur. Pockets of soft material of sufficient size to cause problems

Table 7

Effect of Water Berm and Road Berm Combinations on Safety Factor

Stab. Run	Water Berm El/ Width	Road Berm Elev	Volume Per Foot of Dike	Results of Circular Search X	Y	Radius	Tang. El	Side Force Incl	Safety Factor
27	3-6/300	16	419.4	45.4	226.8	288.4	-61.6	2.79	1.34
28	3-6/300	12	405.6	65.2	198.0	254.4	-56.4	2.82	1.29
29*	3-6/300	8	395.4	102.4	222.1	280.3	-58.2	2.57	1.24
30*	0-3/300	16	366.3	55.8	305.3	373.3	-68.0	2.96	1.19
31	0-6/300	14	359.0	60.0	295.3	365.0	-69.7	2.61	1.31
32	0-7/300	10	352.6	83.5	253.0	317.7	-64.7	2.45	1.30**
33	0-7/300	12	358.1	70.1	276.7	344.6	-67.9	2.49	1.33
34	0-5/300	16	360.8	52.1	310.2	380.8	-70.6	2.71	1.28

* Includes 60-ft setback.
** Recommended design.

should not occur due to the slope of the sand lense under the existing dikes providing a good base for the displacement of the soft material.

39. The shear strength of the foundation clay was selected based on numerous tests (see Figure 7). There is a large degree of scatter in the data. To evaluate the sensitivity of the selected shear strength, values plus and minus 10 psf, 25 psf, and 50 psf of the selected cohesion parameter were used in the analysis of the recommended design. The cohesion value is assigned to the profile describing the top of the clay. All analyses used the same rate of increase for the cohesion. Figure 29 illustrates the relationship between cohesion and the safety factor.

40. The last assumption concerns the side force inclination. For the recommended west dike section, the side force inclination calculated by the Spencer's procedure was nearly horizontal, indicating that the Simplified Bishop procedure would generate about the same results. However, the Modified Swedish force equilibrium procedure with the Corps of Engineers side force assumption of the average outer slope would generate safety factors larger than the rigorous procedure. Spencer's procedure determines the side force inclination that satisfies both moment and force equilibrium. The Modified

Swedish method where different side force inclinations were specified was used to show the influence of the side force inclination. A plot of the results is shown in Figure 30. The side force inclination in the Modified Swedish procedure must be specified by the user. With the surface geometry broken up into many slopes, the proper side force inclination is difficult to determine. Thus, since Spencer's procedure calculates the side force inclination, this method should be used. The side force inclination from Spencer's method can then be used in the Modified Swedish procedure to perform a hand check.

East Perimeter Dike Stability Analysis

41. The dike section for analysis at sta 80+00 along the east perimeter dike is located in the lower half of the north compartment opposite the west dike cross section. A stability analysis was conducted for the raised dike conditions where the dike crest elevation was +40 and the dredged material elevation was +36. The dike crest was set back about 450 ft from the center line of the east perimeter road. The raised dike began at the crest of the existing dike and increased on a slope of 4H:1V. The results of this analysis are plotted in Figure 31. A satisfactory safety factor of 1.40 was obtained for this condition. The search was begun so that the circle passed through the raised dike and moved to the final location during the search process.

42. The practice of reclaiming sandy dredged material by building an outward offset in the perimeter dike has been utilized in the past for this dike section. During an inspection of east dike topographic surveys conducted by the Norfolk District, it was found that a short section of dike about 400 ft long was moved east about 200 ft during dredging activities in early 1985. For the raised dike configuration, this section was analyzed to determine if this practice would cause stability problems. In the analysis it was assumed that the raised dike would begin at the crest of the existing dike and contain no additional setback. The section analyzed consisted of the same foundation cross section as used for sta 80+00. A factor of safety of 0.89 was calculated for this section. This indicates that failure would occur for this configuration. The plot of the critical circle is shown in Figure 32.

43. The difference in the safety factors of the two sections analyzed for the east dike is the distance the dike is set back from the perimeter road

Table 8

Effect of East Dike Setback on Safety Factors

Stab. Run	Setback Distance ft	Results of Circular Search X	Y	Radius	Tang. El	Side Force Incl	Safety Factor
E1	450	-10.5	155.8	245.6	-89.9	1.24	1.40
E2	400	-146.7	522.8	612.6	-89.8	2.08	1.22
E3	350	-126.8	403.9	493.7	-89.8	2.21	1.09
E4	300	-103.2	313.3	403.1	-89.8	2.29	0.98
E5	250	-75.1	253.7	343.5	-89.9	2.27	0.89

center line. To evaluate the setback effect, three intermediate setbacks were considered. These setback distances from the center line of the perimeter road were 300, 350, and 400 ft. The results of these analyses are shown in Table 8 with the resulting safety factors plotted against the setback distance on Figure 33. These results indicate that a setback distance of less than 420 ft will cause the safety factor to drop below 1.3. If a smaller distance is required, a decision can be made based on the results shown in Figure 33. A trade-off between the volume of material available versus the volume needed for a berm would be necessary for those setbacks that generate a safety factor less than 1.0.

North Perimeter Dike Stability Analysis

44. The dike cross section for investigation was located at sta 45+00 on the north perimeter dike. This section is set back about 420 ft from the center line of the perimeter road. The dike crest elevation of +40 with a dredged material elevation of +36 was used in the analysis. The safety factor of 1.28 was calculated. The results of this analysis are shown in Figure 34. The safety factor is close enough to 1.3 that it would not be necessary to construct a berm for additional stability.

45. As along the east dike, there is a small length of dike that is closer to the perimeter road. In this case the dike is 120 ft closer. The setback from the center line of the perimeter road is about 300 ft for this

case. The same foundation cross section was used in this analysis. The safety factor was calculated to be 0.99. This represents an unsafe condition. Since the full setback dike is barely acceptable, outward offsets should not be allowed along this leg of the perimeter dike unless additional stability berms are provided. The results of this analysis are plotted in Figure 35.

Northwest Corner Dike Stability Analysis

46. The dike cross section in the northwest corner located at sta 104+00 was selected for analysis because of the steepness of the slopes within the 1,000-ft right-of-way. Also this area is the transition area for those dikes that require berms to those that do not. Contours from hydrographic investigations conducted by the Norfolk District indicated el -25 located about 450 ft north of the corner. The stability analysis considered the raised crest to be at el +34 with the dredged material at el +30. A satisfactory factor of safety of 1.53 was calculated for this location. The results are plotted in Figure 36. Two reasons for this high a safety factor are the long flat berm resulting from previous dike crest setbacks and the considerable amount of sand found in this area. It is recommended that the dike crest, el +34, be constructed to accommodate the weir at this location because of its relatively high stability.

Reinforcement of Dike Sections

47. The original scope of this project was to investigate reinforcement of the enlarged dike sections. Once the recommended sections shown in Figures 28, 31, 34, and 36 were determined, reinforcement could be considered. The easiest location to install reinforcement would be between the existing dike with crest el +26 and the raised portion. Evaluation of these figures indicates that the critical circles were outside that portion of the raised dike where reinforcement could be installed. Thus, reinforcement of the raised portion of the dike to eliminate a portion of the driving force is not applicable for the perimeter dikes.

PART V: ESTIMATED DIKE SUBSIDENCE, RECOMMENDED INSTRUMENTATION, AND DREDGED MATERIAL MANAGEMENT PLAN

Subsidence

48. Dike subsidence has continued to occur along the perimeter dike alignment since the Craney Island disposal area was completed in 1957. During design and prior to construction it was estimated that dike settlement would exceed 7 ft. Dike subsidence includes a combination of settlement caused by consolidation and displacement of the dike foundation caused by bearing capacity failure and long-term plastic flow of the soft foundation material. An attempt was made during construction to minimize foundation bearing failure by placement of fill material over a very large area in thin lifts of dredged sand using hydraulic dredging with a floating discharge pipe. The floating discharge pipe was controlled by use of a baffle plate positioned at the end of the pipe. The discharge pipe was allowed to swing over a very large arc by manipulation of the angle of the traffic plate that was placed in line with the flow from the discharge pipe. Prior to use of this placement technique large displacement failure occurred in the soft foundation material. Foundation failures along the west perimeter dike (sta 38+00) were as deep as el -60 ft or about 50 ft below the original bottom, -10 ft. After the swinging discharge pipe technique was implemented along with careful monitoring of the subsurface profile, no major failures occurred during construction. Because of continual dike subsidence and loss of survey control points caused by continued placement of fill material to maintain dike height, monitoring of dike subsidence has been hampered.

49. The average depth of the top of the foundation or bay bottom in 1953 before construction of the east, north, and west perimeter dikes was about -10 to -12 ft. The east perimeter dike foundation has subsided to an average elevation of about -25 to -27 ft or an average depth of about 17 ft because of the loads from dredged sand placed along the dike alignment. The base of the north perimeter dike has subsided to an average elevation of about -20 to -27 ft or an average depth of about 13 ft. This was also caused by large quantities of sand fill placed along the north dike. If the failed section at sta 38+00 is included in the base of west perimeter dike, elevation varied from -15 to -17 ft or an average subsidence of about 11 ft since it was

originally constructed. Utilizing the foundation consolidation test results performed by the Norfolk District, it was estimated that an incremental increase in dike height of 10 ft will cause the north and east perimeter foundations to consolidate an additional depth of about 4 ft. Increasing the west perimeter dikes another 8 ft will also cause the foundation materials to consolidate about 4 ft. Incremental raising of the perimeter dikes has been a continuing process at Craney Island over the past 30 years, and it is not quite understood what percentage of the foundation materials are being squeezed out. There has been no discernible increase in foundation shear strength since initial construction.

50. Several innovative construction techniques have been considered such as "wick drains" and geotextile reinforcement. Because the soft materials in the dike foundation cross section are too deep, it was decided that the use of "wick drains" would not be economically feasible. Too much of the "wick drain" would be left in the dike section causing the cost of the project to not be cost effective. The use of geotextiles in incremental dike raising will not have an effect on the overall dike stability because the fabric does not intercept the potential failure plane in the slope stability analysis.

Recommended Instrumentation

51. It is recommended that several settlement rods be installed along the perimeter dike alignment at locations that would be easily accessible to monitor and protected from damage by construction equipment. These settlement rods may be deep-seated cast-in-place in concrete to a depth about 20 ft in the existing dike. A safe location would be at the intersection of the dike outward slope and the edge of the original perimeter road, but a preferred location would be at the height fill as shown in Figure 37. Attempts should be made to align these monuments along an assumed baseline for ease of electronic survey monitoring. Surface monuments for visual observation would be desired along the dike crest and toe, but because of the constant hauling, dumping, and upgrading the dike crest elevation for increased dredged material storage capacity, this type of monuments may have a short life span.

52. It is also recommended that a vertical slope inclinometer tube and at least four piezometers be installed at various depths in the vicinity of the settlement rods (see Figure 37). The vertical slope inclinometers should

be installed to about el -100 ft or about 5 to 10 ft into the dense sand found at about el -90 ft. The piezometer should be evenly spaced within the original marine clay deposits between the base of the perimeter dikes and the dense sand at el -90 ft. Observation of pore water pressure in the piezometers would provide a warning to the Norfolk District when the effective shear stress in the foundation materials changed, thus effecting the factor of safety of the perimeter dike. Changes in pore pressure would also indicate whether or not the dike is simply floating or the dike is consolidating the foundation materials. Two to three piezometers located within the dike fill would help monitor and define the phreatic surface. The vertical slope inclinometer tubes would determine if the dike and foundation were consolidating vertically or were spreading laterally, or if the foundation material was being squeezed out by long-term creep and plastic flow.

Dredged Material Management Plan

53. Incremental raising of the dike heights along the east and north perimeter dikes has historically been by dragline excavating dewatered dredged material from within dredged material disposal area along the dike alignment. It is anticipated that this technique and the quality of fill material will improve because of implementation of the dredged material management plan. Selective placement of the dredged material discharge pipe along these dike alignments have in the past minimized the placement distances and provided areas for borrow sources for truck hauling dredged sand to the west perimeter dike. Historically, fill material for raising the west perimeter dike has been excavated and truck-hauled from the northwest corner or from the north side of the disposal area. Since completion of the interior division dikes, fill material has been excavated and truck-hauled from borrow sources located at the east end of these interior dikes.

54. Implementation of the dredged material management plan will improve the foundation conditions for incremental dike raising along the west perimeter dike. The use of draglines on mats on the dried crust can supplement the amount of fill material that is now being truck-hauled long distances.

55. Sand materials will be required for an 8-ft-high berm constructed on top of the road and for the berm adjacent to the west perimeter dike.

Volume requirements on the 10,000-ft-long road berm will be about 274,000 cu yd, and about 2.5 million cu yd will be required for the 300-ft-wide berm placed in the water adjacent to the west perimeter berm. These materials may be truck-hauled or hydraulically placed depending on which method is the most convenient or economical.

PART VI: CONCLUSIONS AND RECOMMENDATIONS

56. It was concluded that it is technically feasible to raise the west perimeter dike to el +34 and dredged material to el +30 ft with a factor of safety of 1.3 (Figure 28). It was also concluded that it was technically feasible to raise the east and north perimeter dikes to el +40 ft and dredged material to el +36 ft with a factor of safety of 1.4 and 1.28, respectively (Figures 31 and 34). The northwest corner can also be raised to el +34 and dredged material to el +30 ft without the factor of safety dropping below 1.5 (Figure 36).

57. It is recommended that a 300-ft-wide water berm be constructed on the west dike starting at el 0 ft and intercepting the existing dike at el +7 ft and a road berm be constructed to el +10 or 12 ft above the existing roadway. This scenario would not require changing the existing slope of 8H:1V. It was concluded that the east, north, and northwest dikes would not require construction of berms if the present setback distances and slopes are maintained.

58. It was concluded that the use of "wick drains" to increase foundation shear strength was not economically feasible because of excessive depth of dike cross section. If the dike height requirements increase, a reassessment of the use "wick drain" should be conducted based on field trials along the perimeter dike. It was also concluded that the use of geotextile reinforcement in the raised dike sections would not increase the factor of safety because the potential failure plane would not intercept the fabric.

59. Settlement for the east, west, and north perimeter dikes was estimated to be about 4 ft for each dike, respectively.

60. Construction of a road berm on the west perimeter dike is presently being constructed by truck-hauling dredged sand from nearby sand sources to cover the 3-ft-diam weir pipes that cross the road. Covering these weir pipes will more than satisfy the 2-ft berm required. Construction of the water berm may be accomplished by selective placement of dredged sand in thin lifts.

61. Continued and successful implementation of the Craney Island dredged material management plan will provide not only improved foundation conditions as the fine-grained dredged material forms a dried crust but also a good source of fill material for continued incremental dike raising and a fairly impermeable dike.

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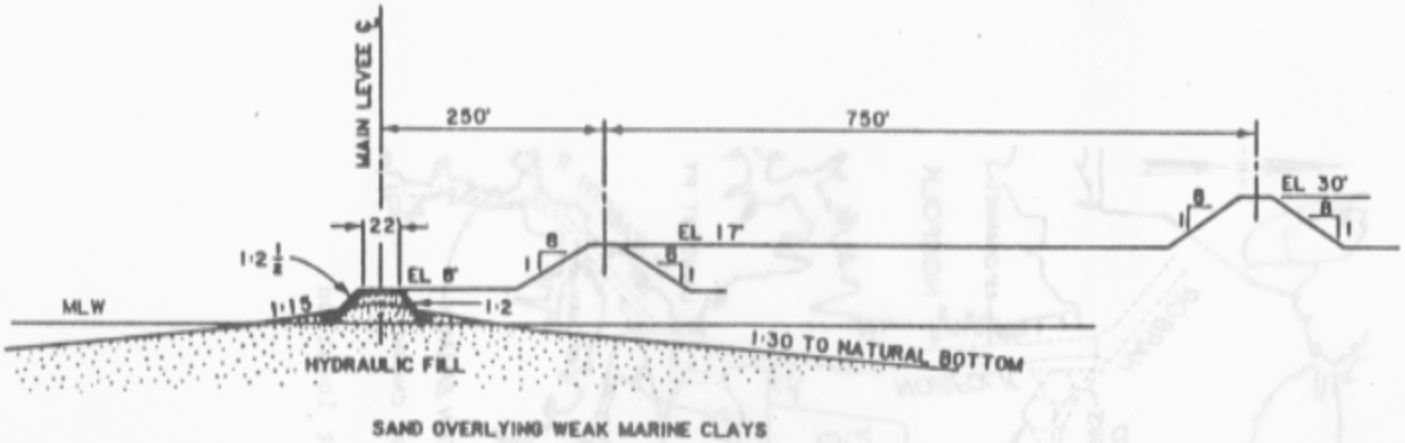
Figure 1. Project location



TYPICAL SECTION THROUGH LEVEE
(NOT TO SCALE)

Figure 2. Proposed benched cross-section for west perimeter dike by Norfolk District

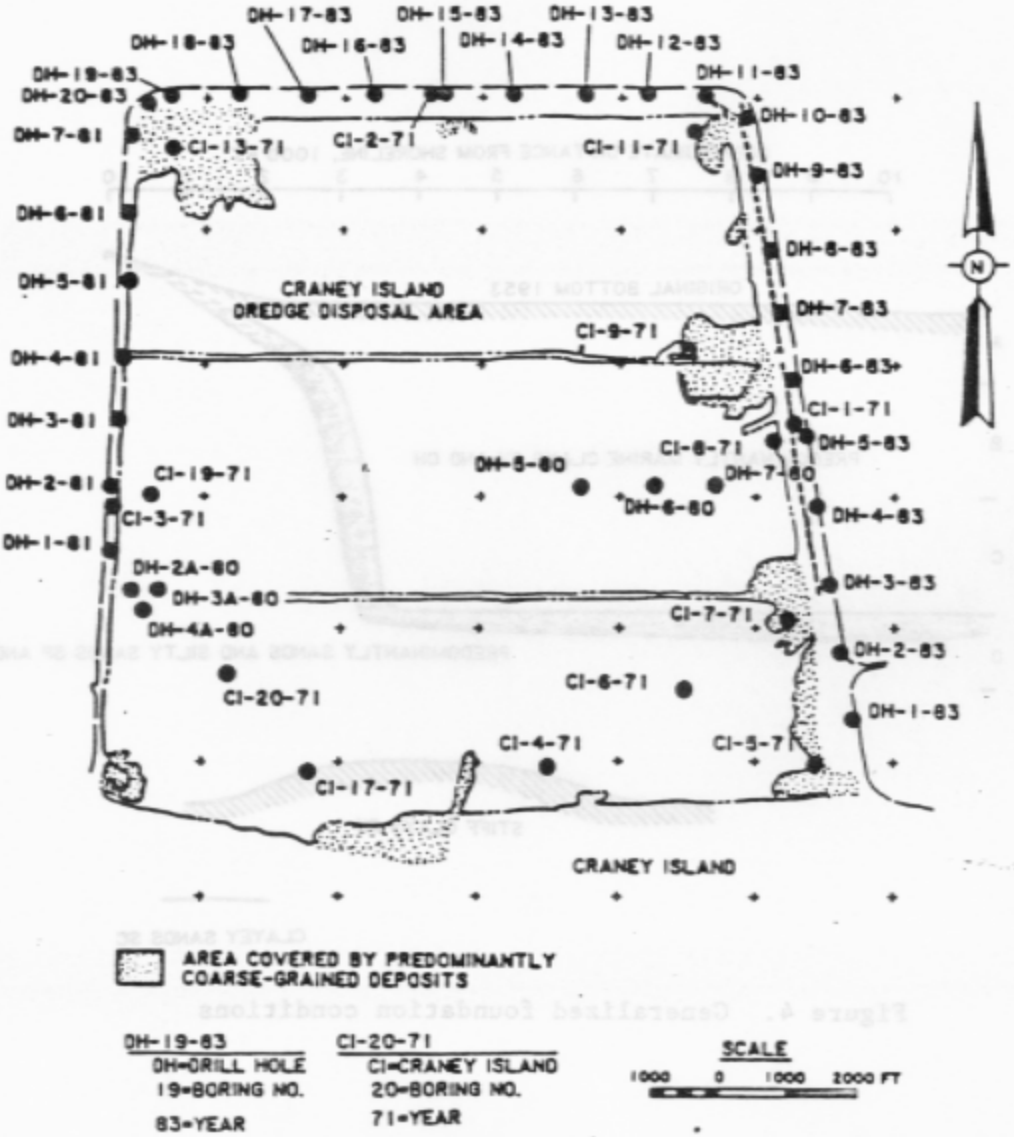


Figure 3. Boring plan and coarse grain material at inflow points

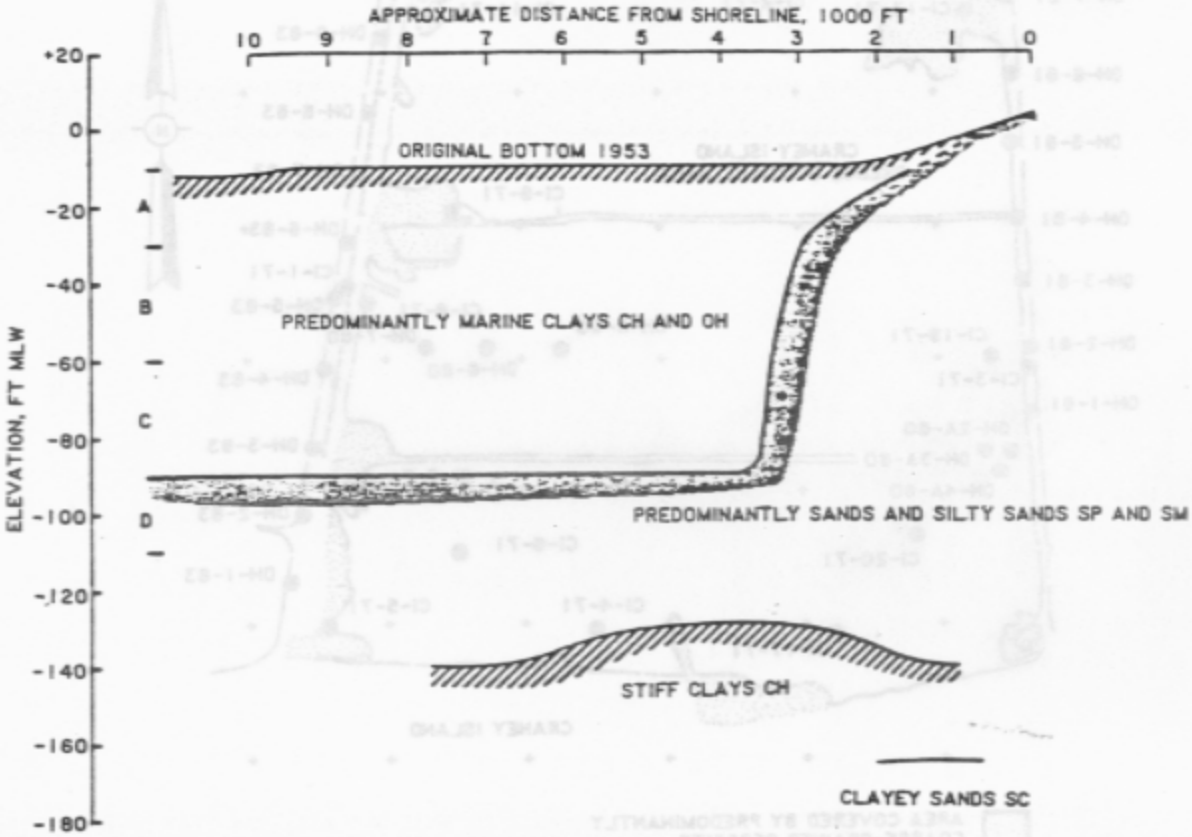


Figure 4. Generalized foundation conditions

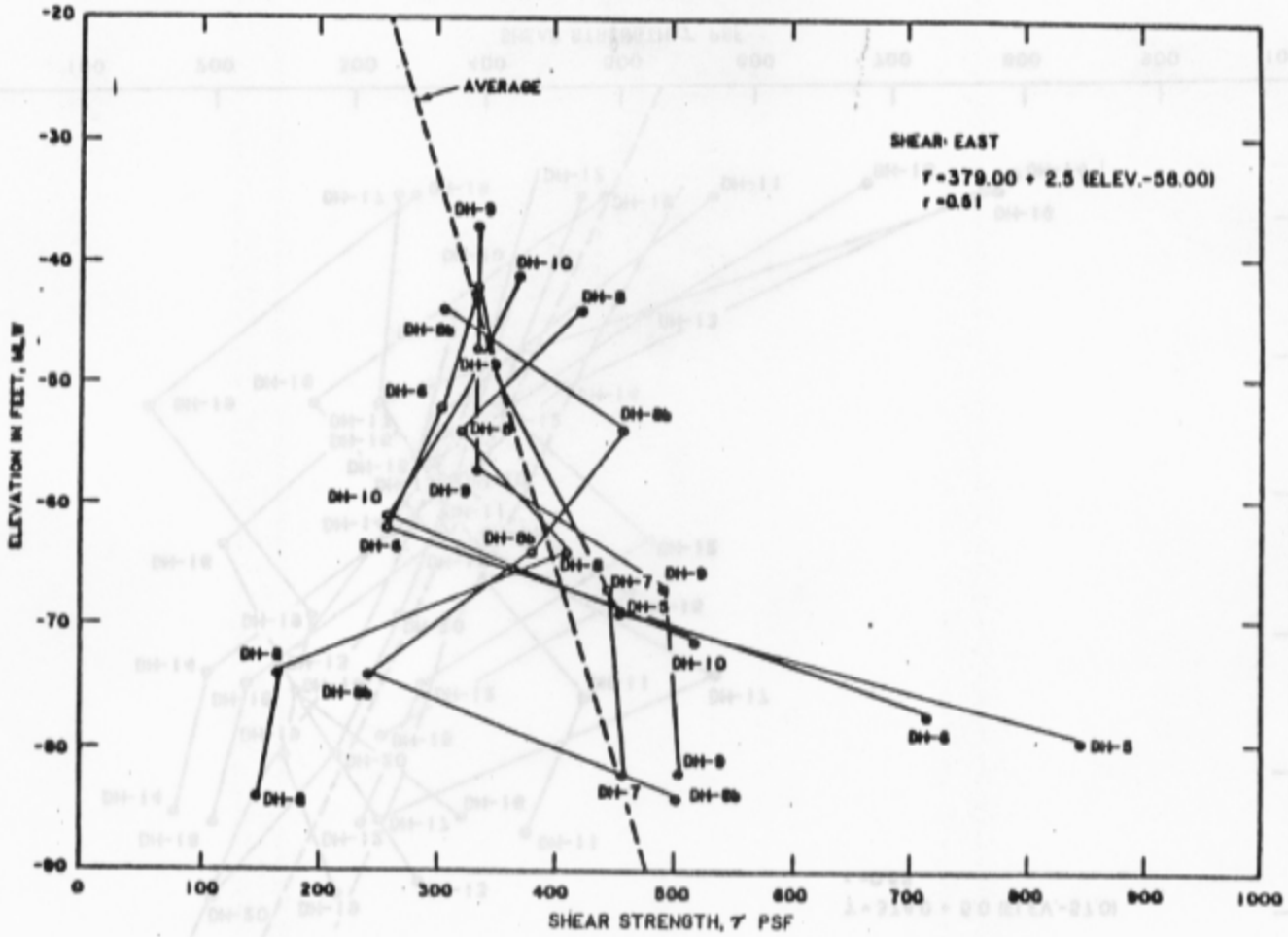


Figure 5. Shear strength versus depth-East

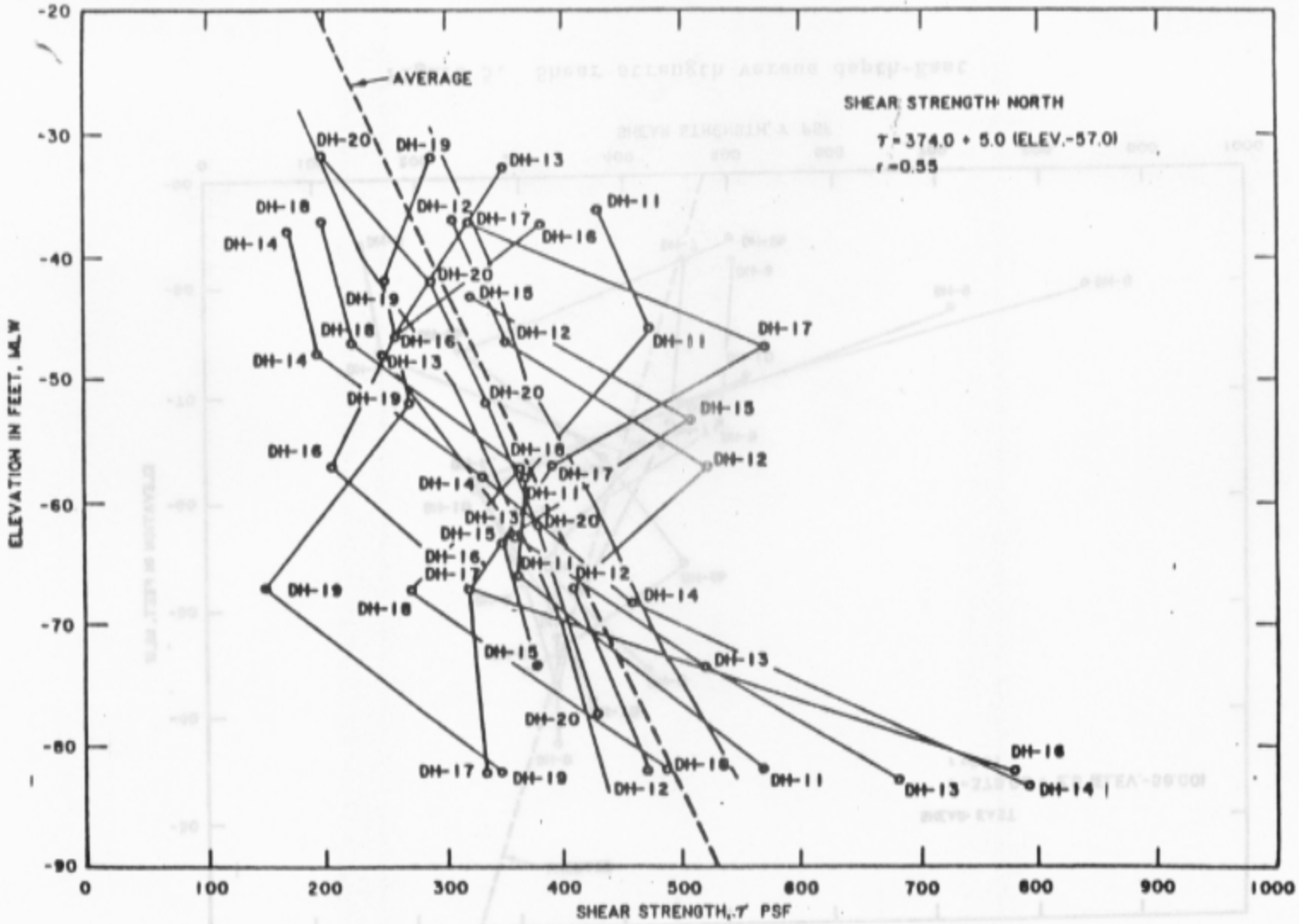


Figure 6. Shear strength versus depth-North

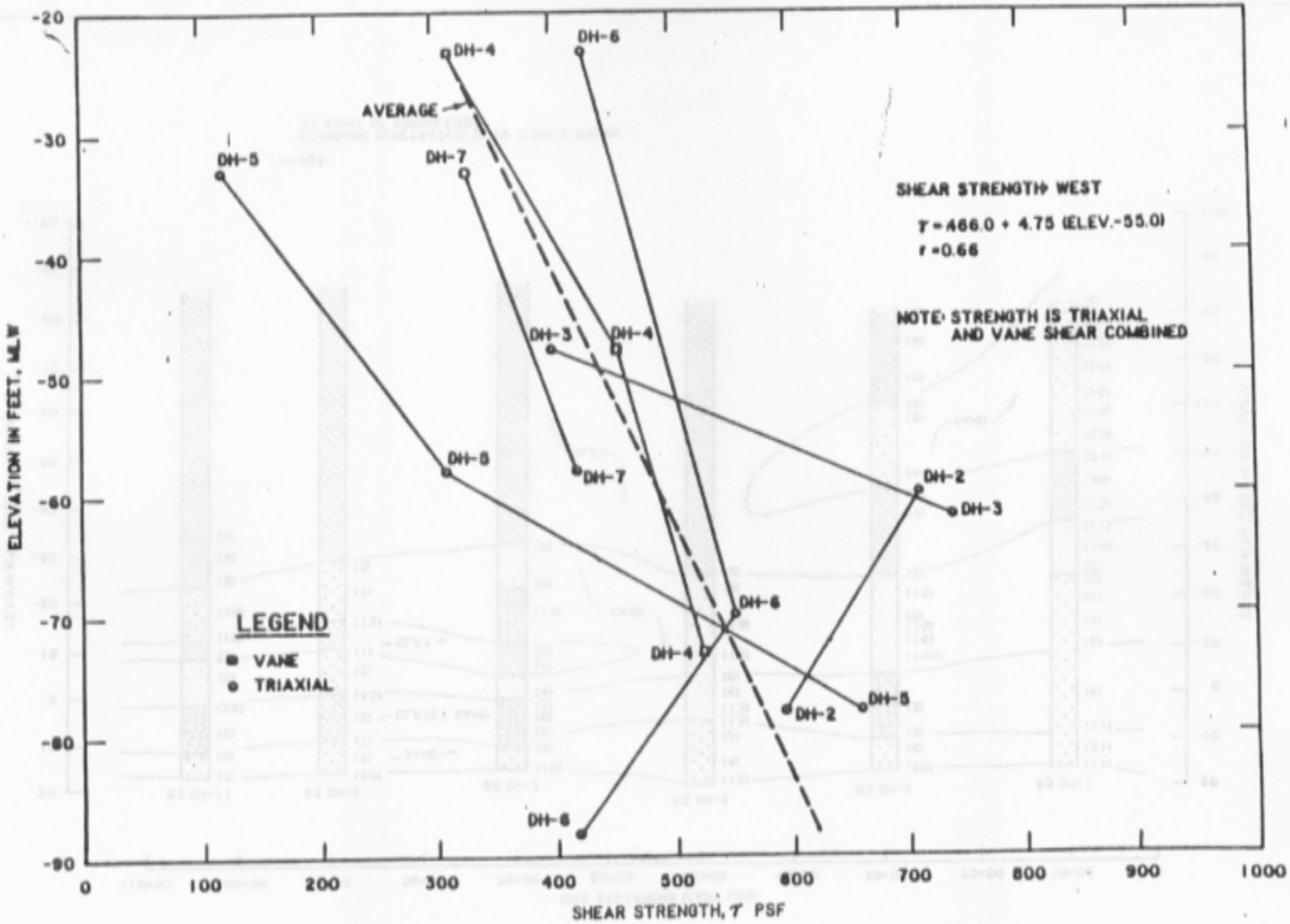


Figure 7. Shear strength versus depth-West

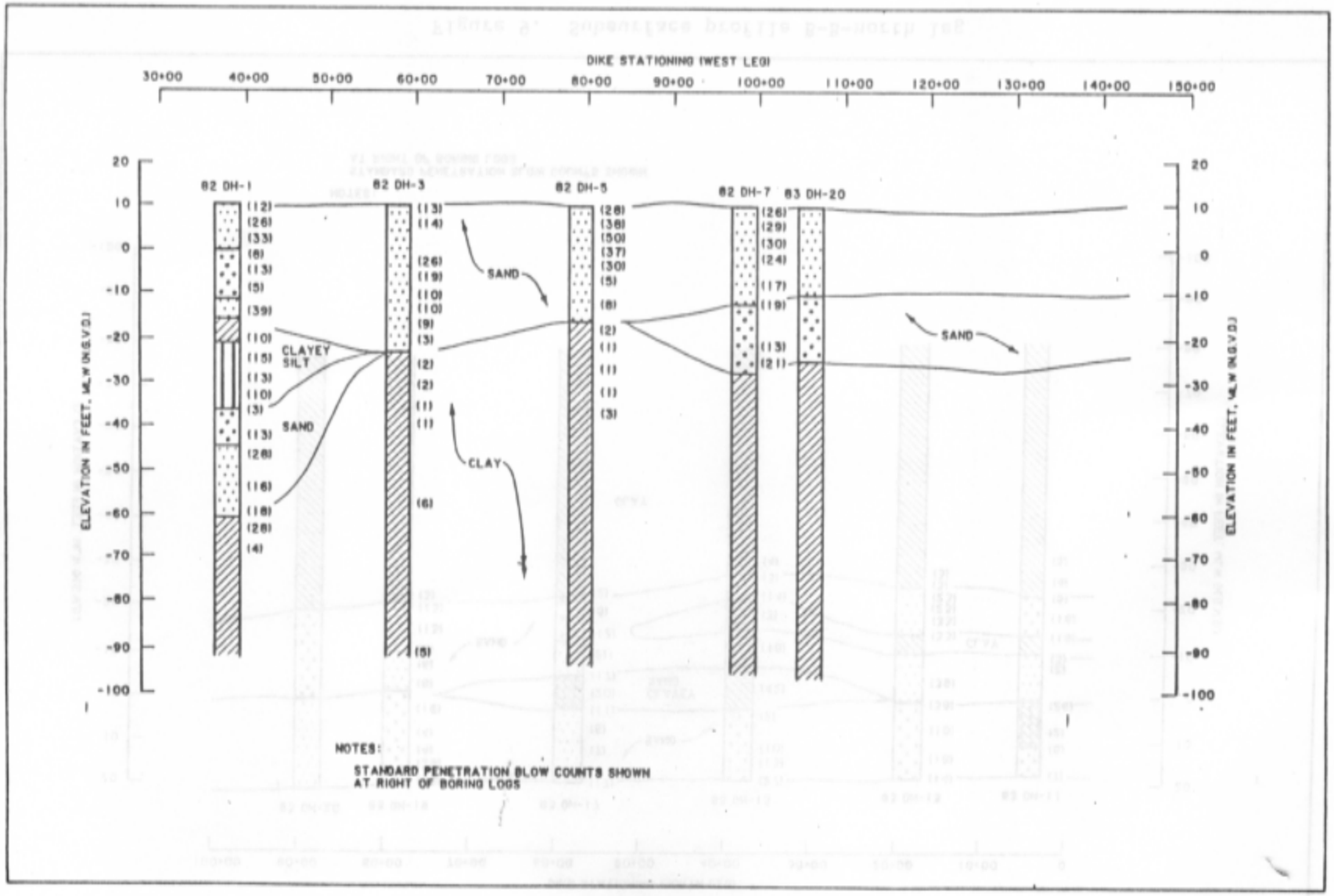


Figure 10. Subsurface profile C-C-west leg

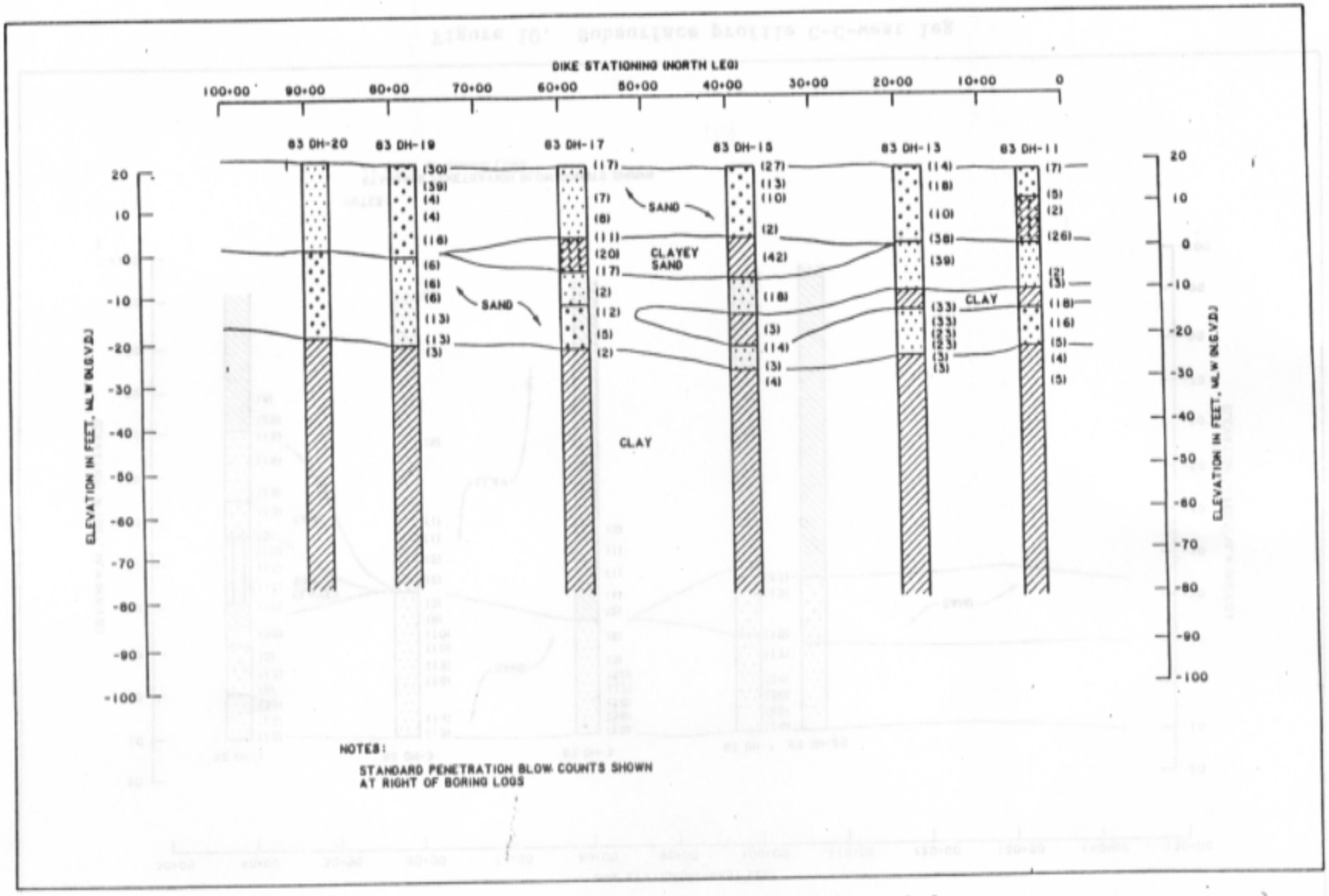


Figure 9. Subsurface profile B-B-north leg

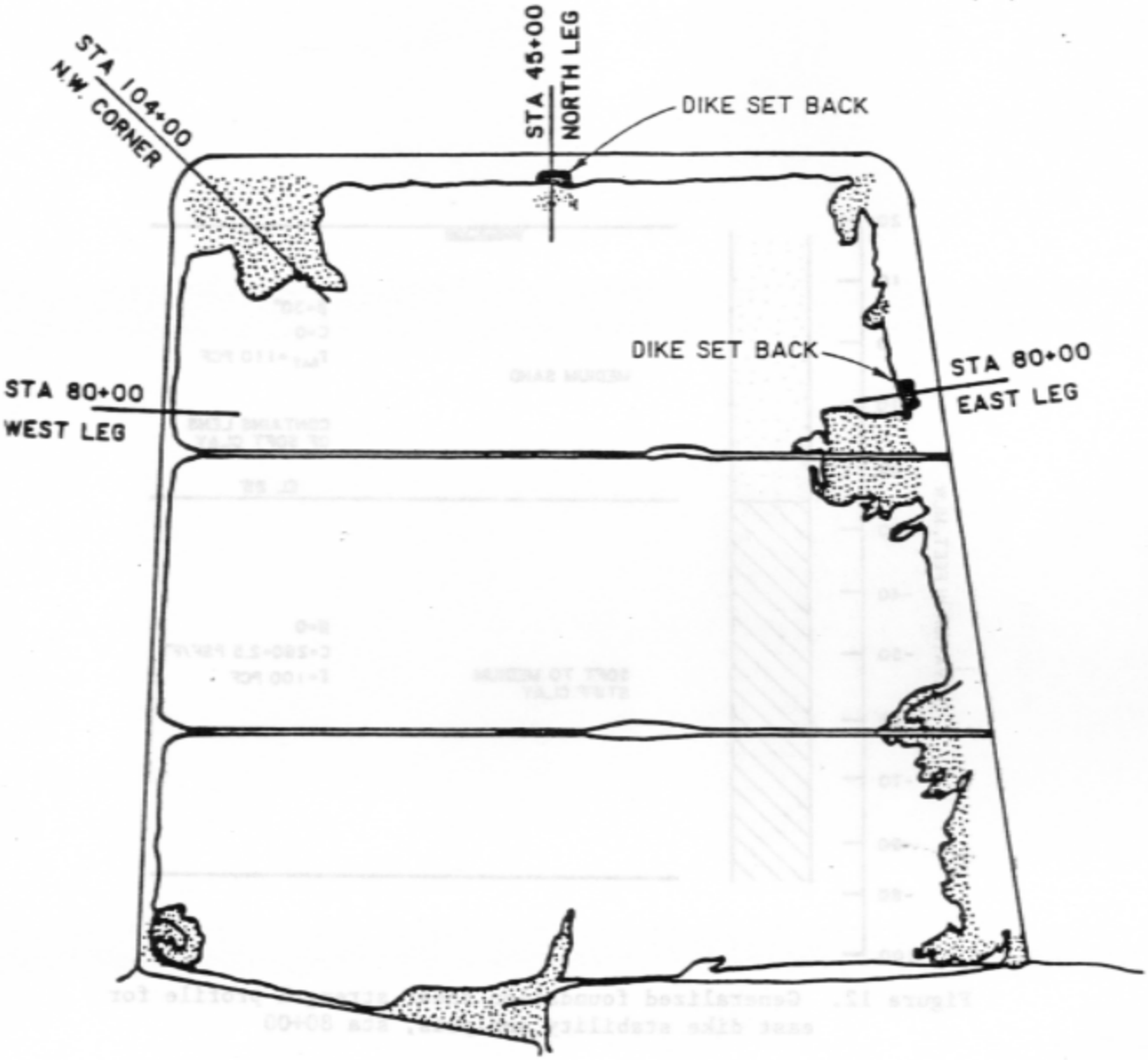


Figure 11. Location of cross section investigated during dike stability analysis

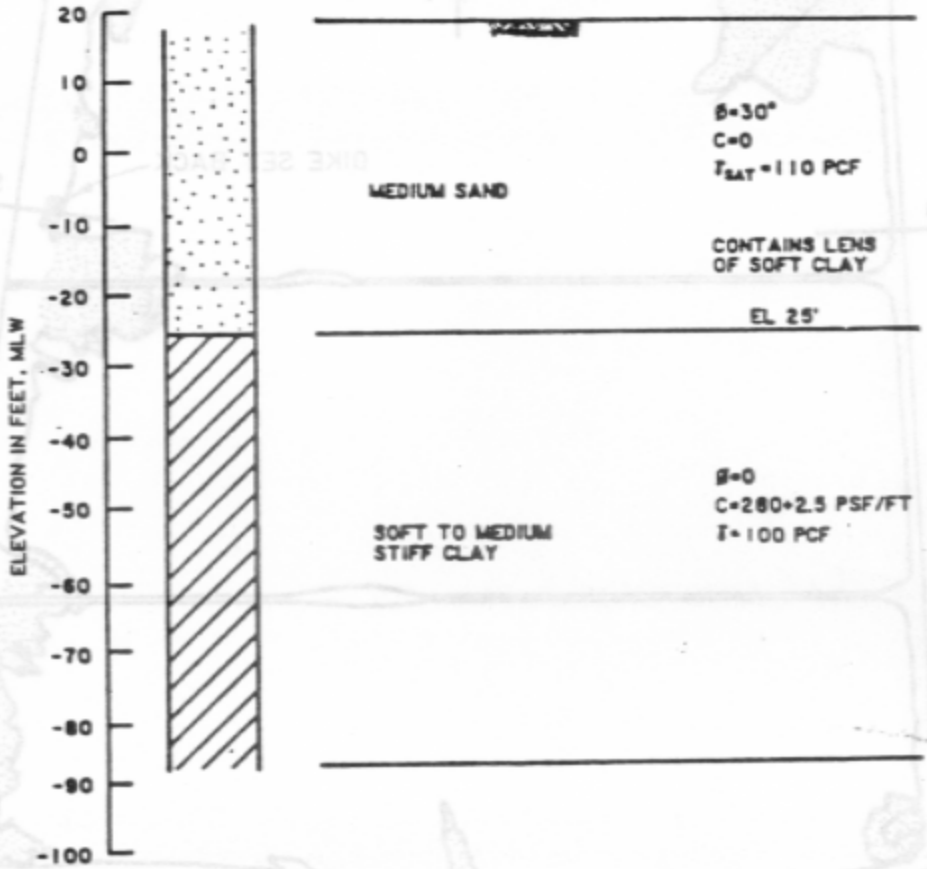


Figure 12. Generalized foundation shear strength profile for east dike stability analysis, sta 80+00

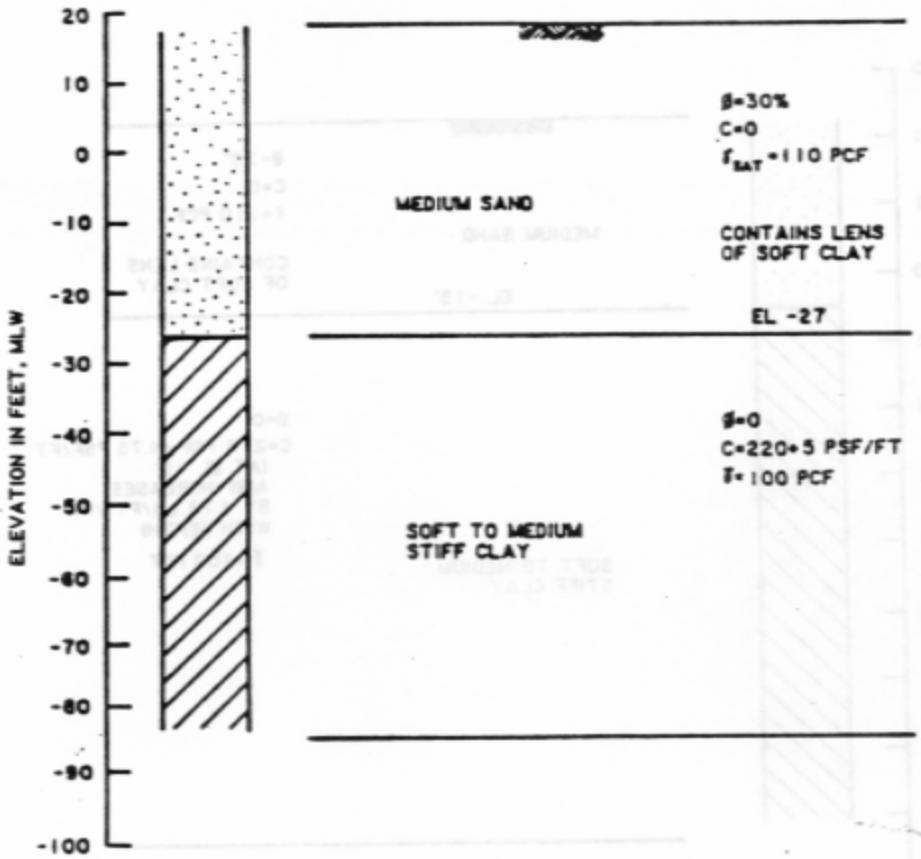


Figure 13. Generalized foundation shear strength profile for north dike stability analysis, north sta 45+00

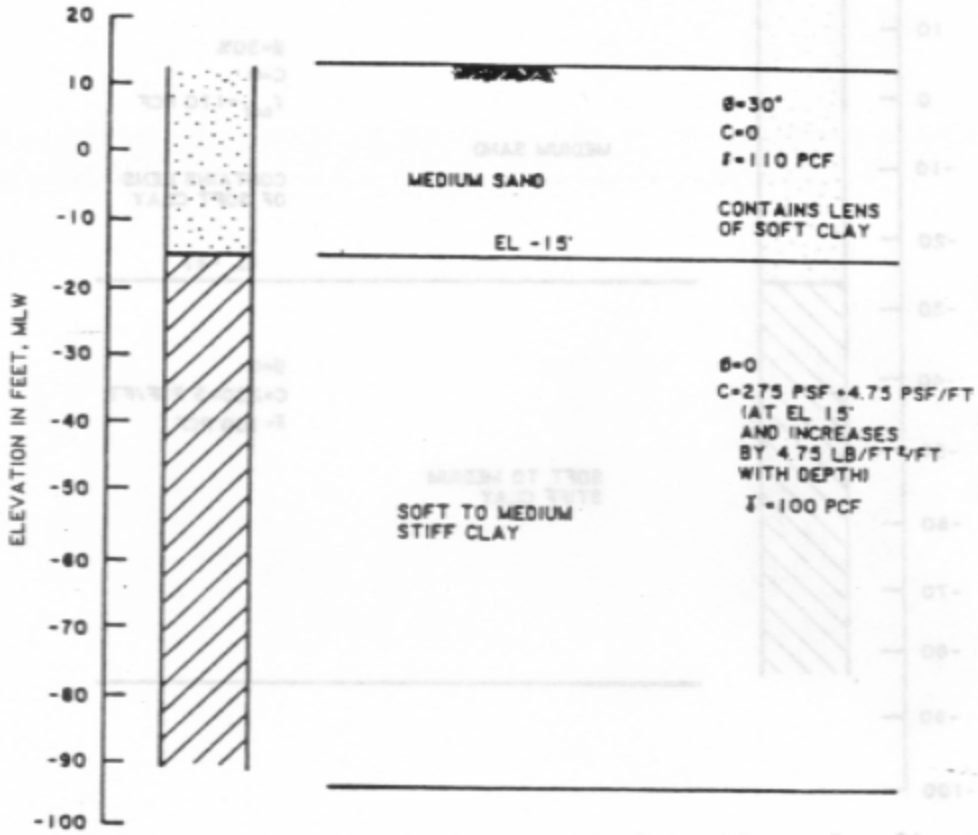


Figure 14. Generalized foundation shear strength profile for west dikes stability analysis, ~~and~~ northwest corner sta ~~80+00~~ 140+00

STA 80+00

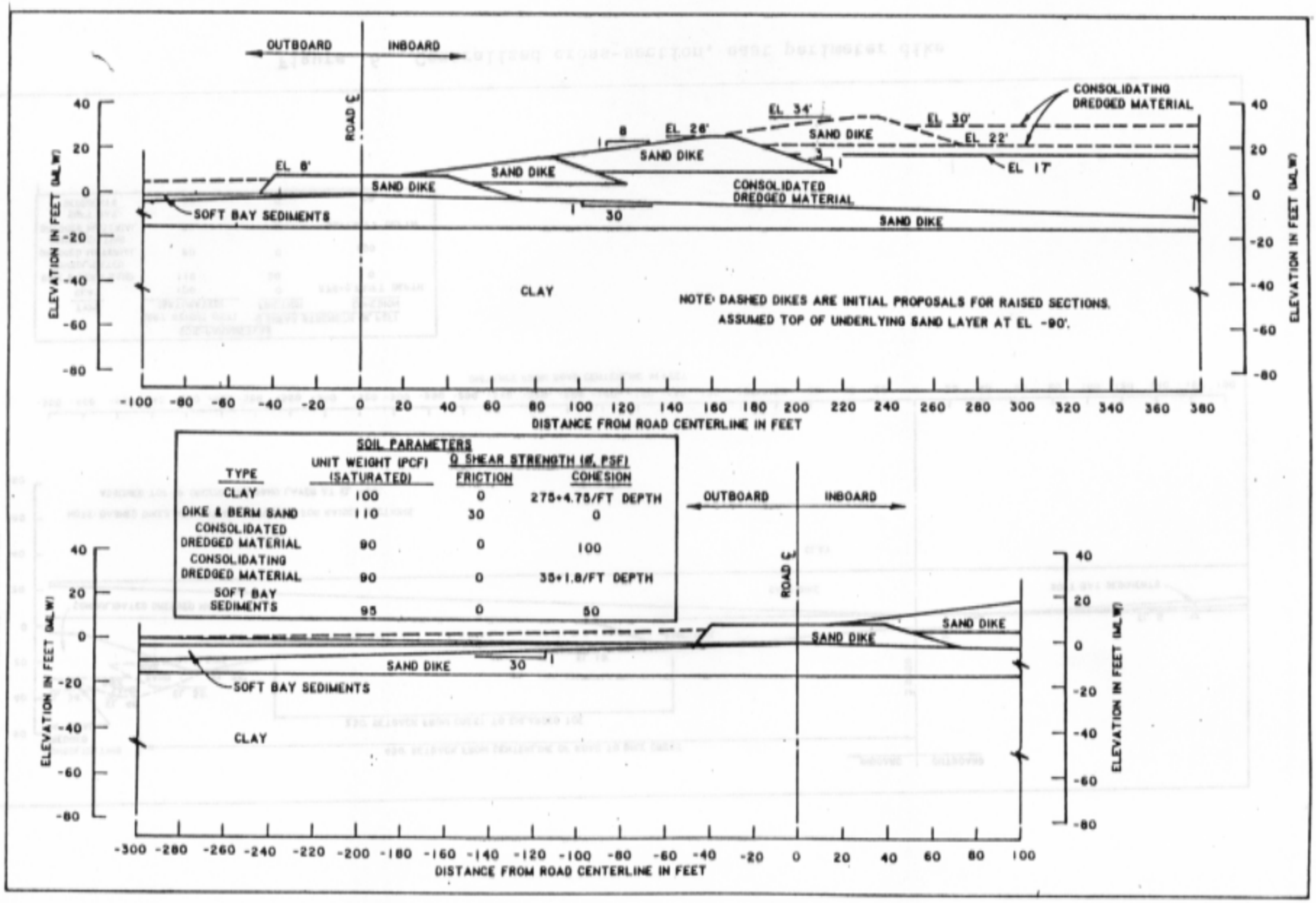
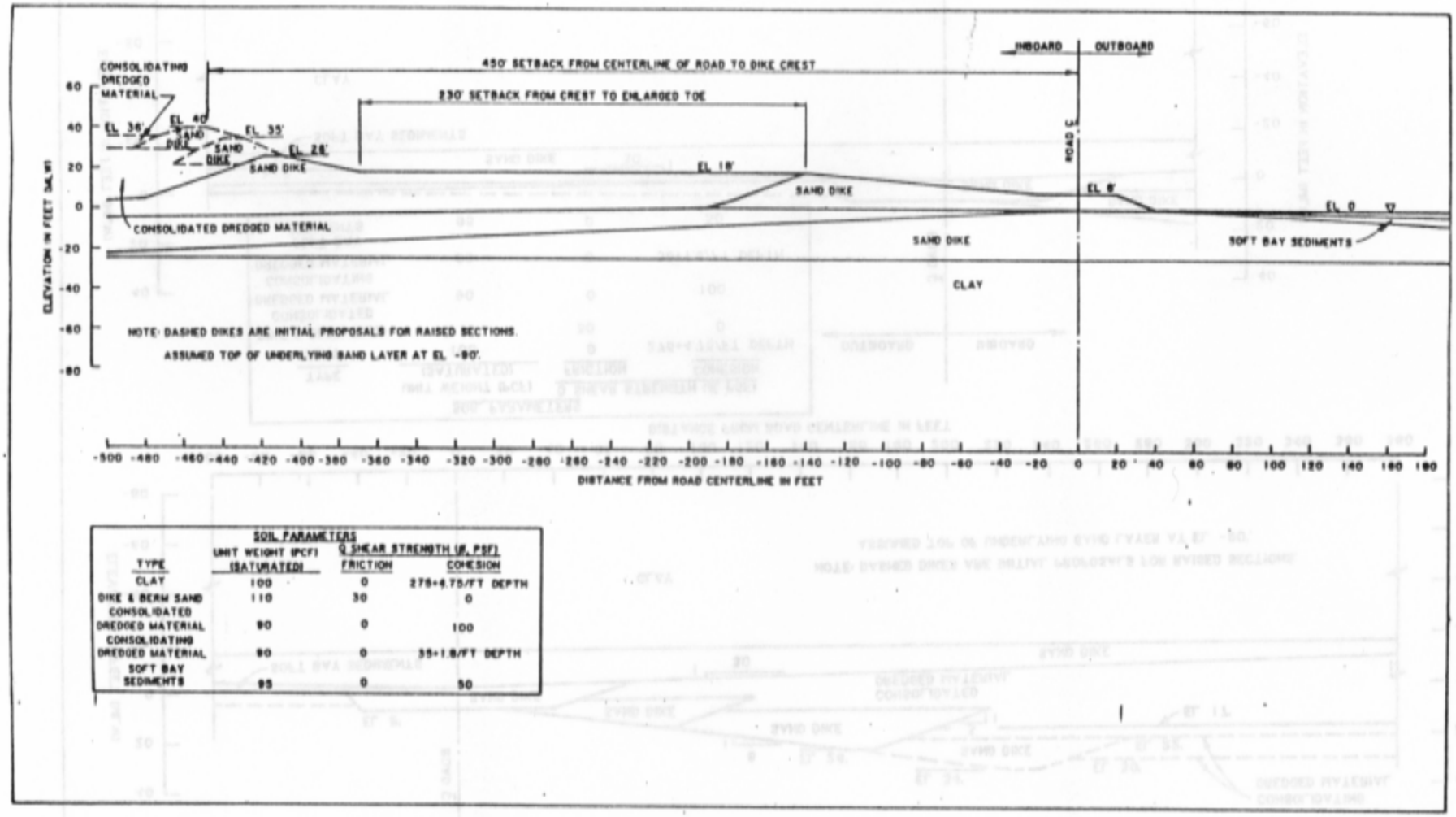


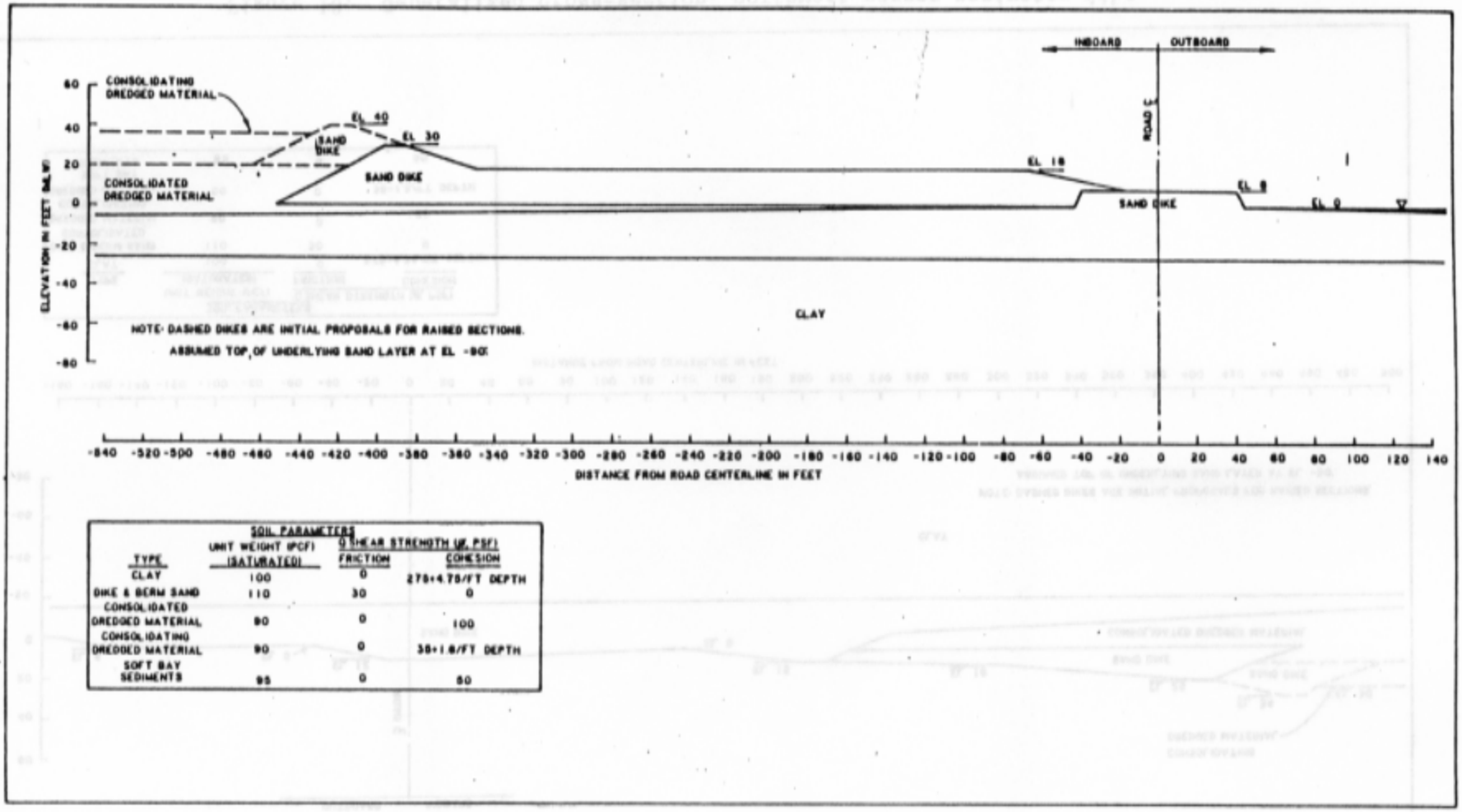
Figure 15. Generalized cross-section, west perimeter dike



SOIL PARAMETERS

TYPE	UNIT WEIGHT (PCF) (SATURATED)	Q SHEAR STRENGTH (Ø, PSF) FRICTION	COHESION
CLAY	100	0	275+4.75/FT DEPTH
DIKE & BERM SAND	110	30	0
CONSOLIDATED DREDGED MATERIAL	90	0	100
CONSOLIDATING DREDGED MATERIAL	80	0	35+1.8/FT DEPTH
SOFT BAY SEDIMENTS	95	0	50

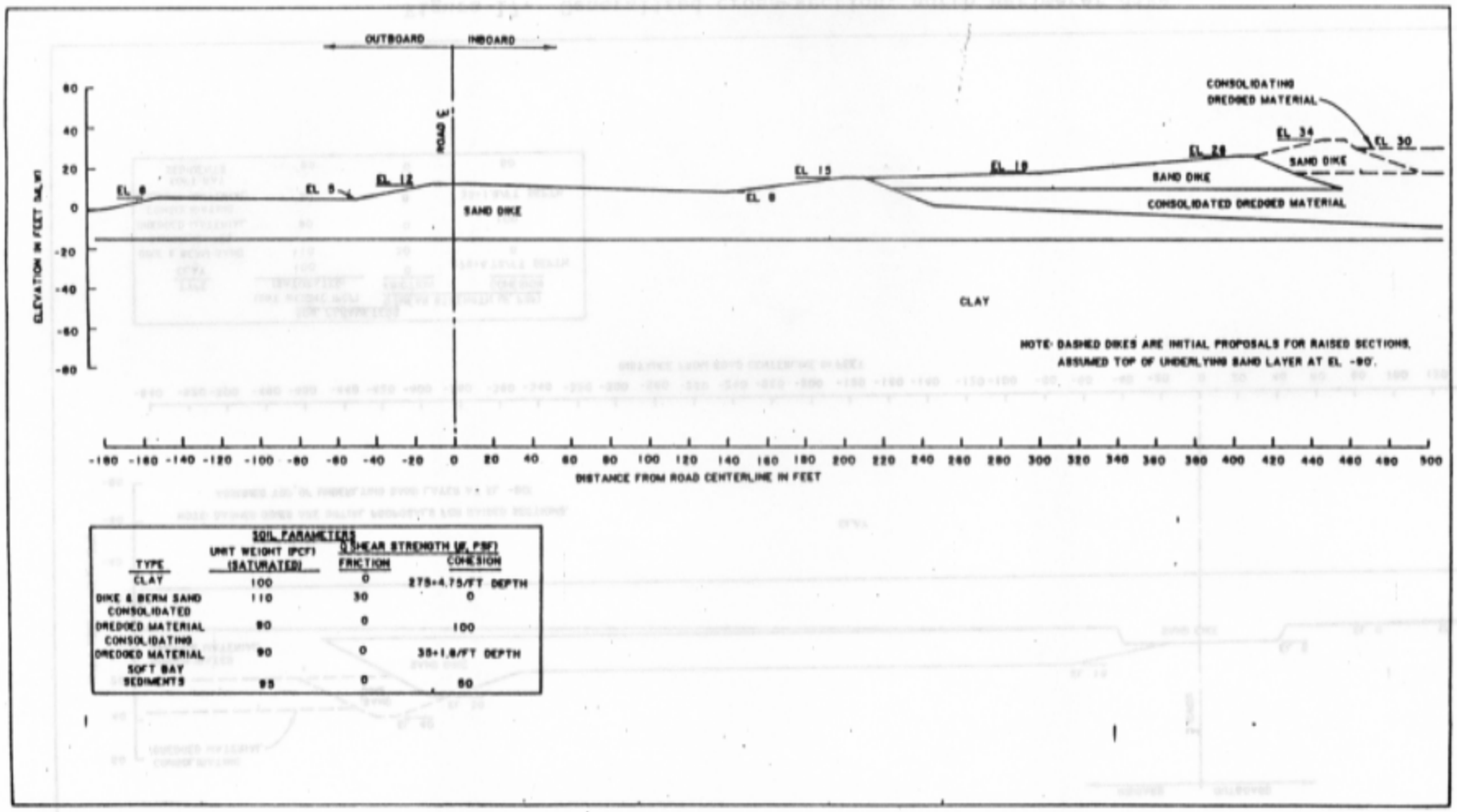
Figure 16. Generalized cross-section, east perimeter dike



SOIL PARAMETERS

TYPE	UNIT WEIGHT (PCF) (SATURATED)	SHEAR STRENGTH (Ø, PSF) FRICTION	SHEAR STRENGTH (Ø, PSF) COHESION
CLAY	100	0	275+4.7S/FT DEPTH
DIKE & BERM SAND	110	30	0
CONSOLIDATED DREDGED MATERIAL	90	0	100
CONSOLIDATING DREDGED MATERIAL	90	0	35+1.6/FT DEPTH
SOFT BAY SEDIMENTS	95	0	50

Figure 17. Generalized cross-section, north perimeter dike



SOIL PARAMETERS

TYPE	UNIT WEIGHT (PCF) (SATURATED)	SHEAR STRENGTH (Ø, PSF) FRICTION	SHEAR STRENGTH (Ø, PSF) COHESION
CLAY	100	0	275+4.75/FT DEPTH
DIKE & BERM SAND	110	30	0
CONSOLIDATED DREDGED MATERIAL	80	0	100
CONSOLIDATING DREDGED MATERIAL	90	0	35+1.8/FT DEPTH
SOFT BAY SEDIMENTS	95	0	60

Figure 18. Generalized cross-section, northwest corner perimeter dike

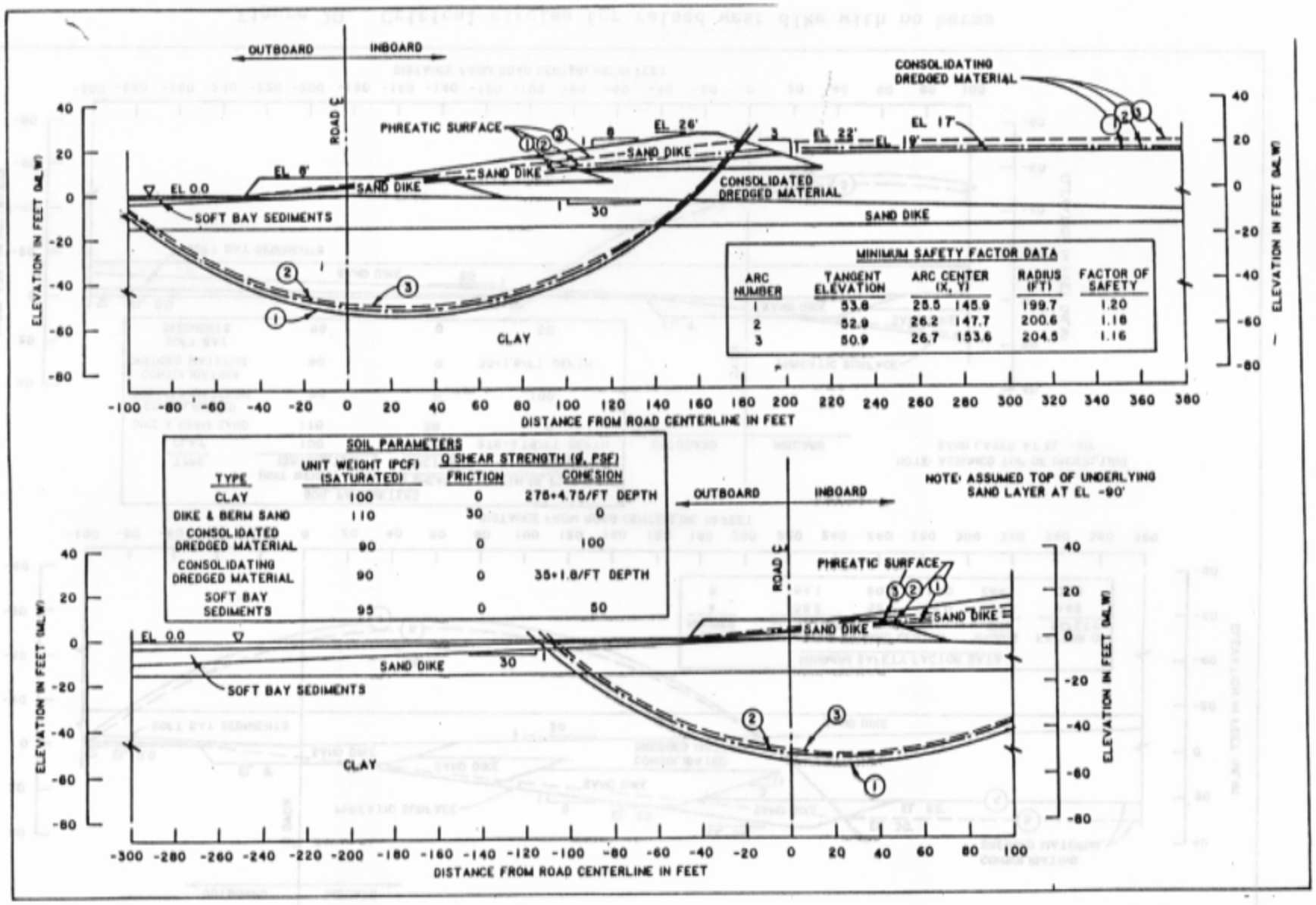


Figure 19. Critical circles for various dredged material elevations using existing west dike configuration

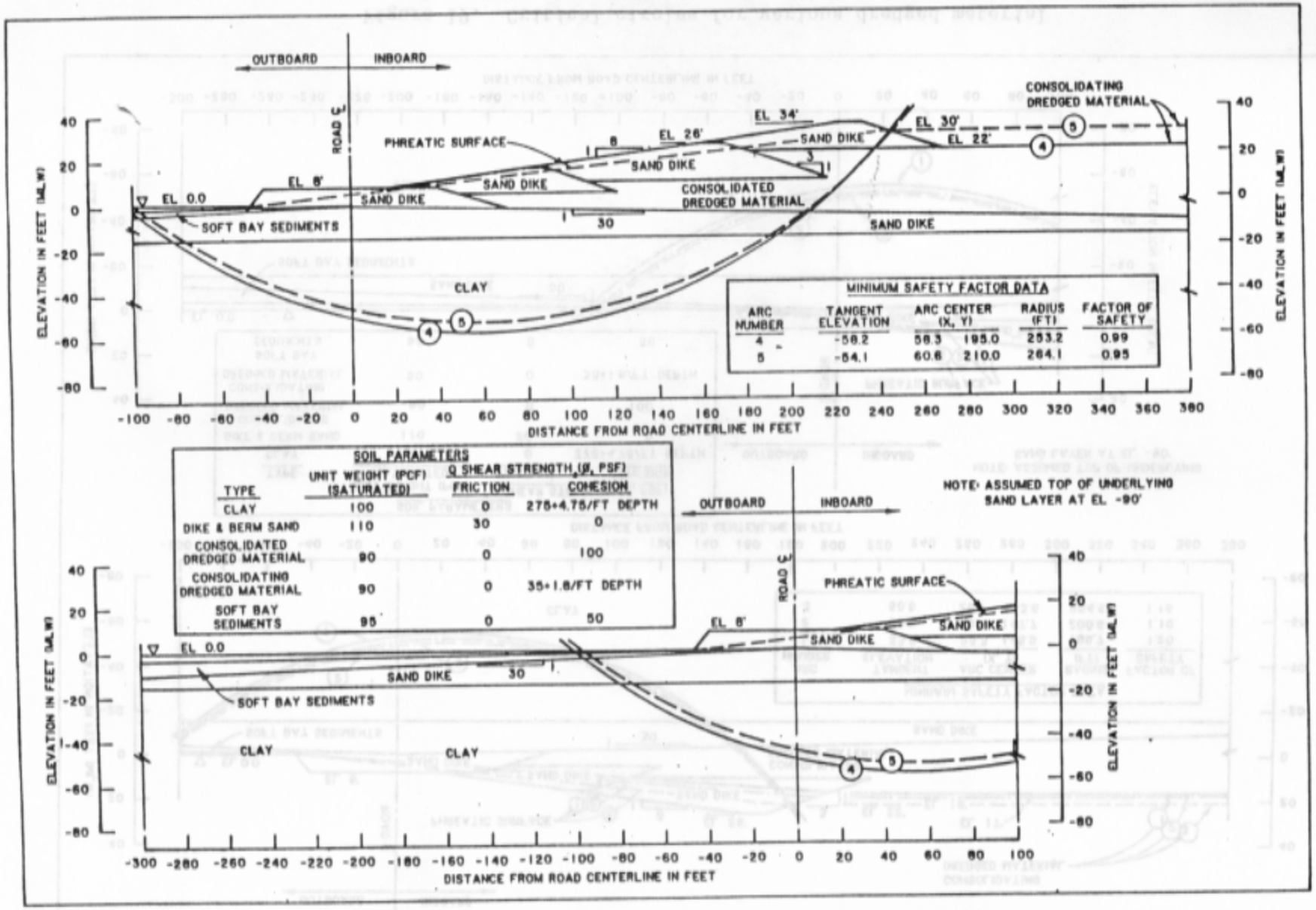


Figure 20. Critical circles for raised west dike with no berms

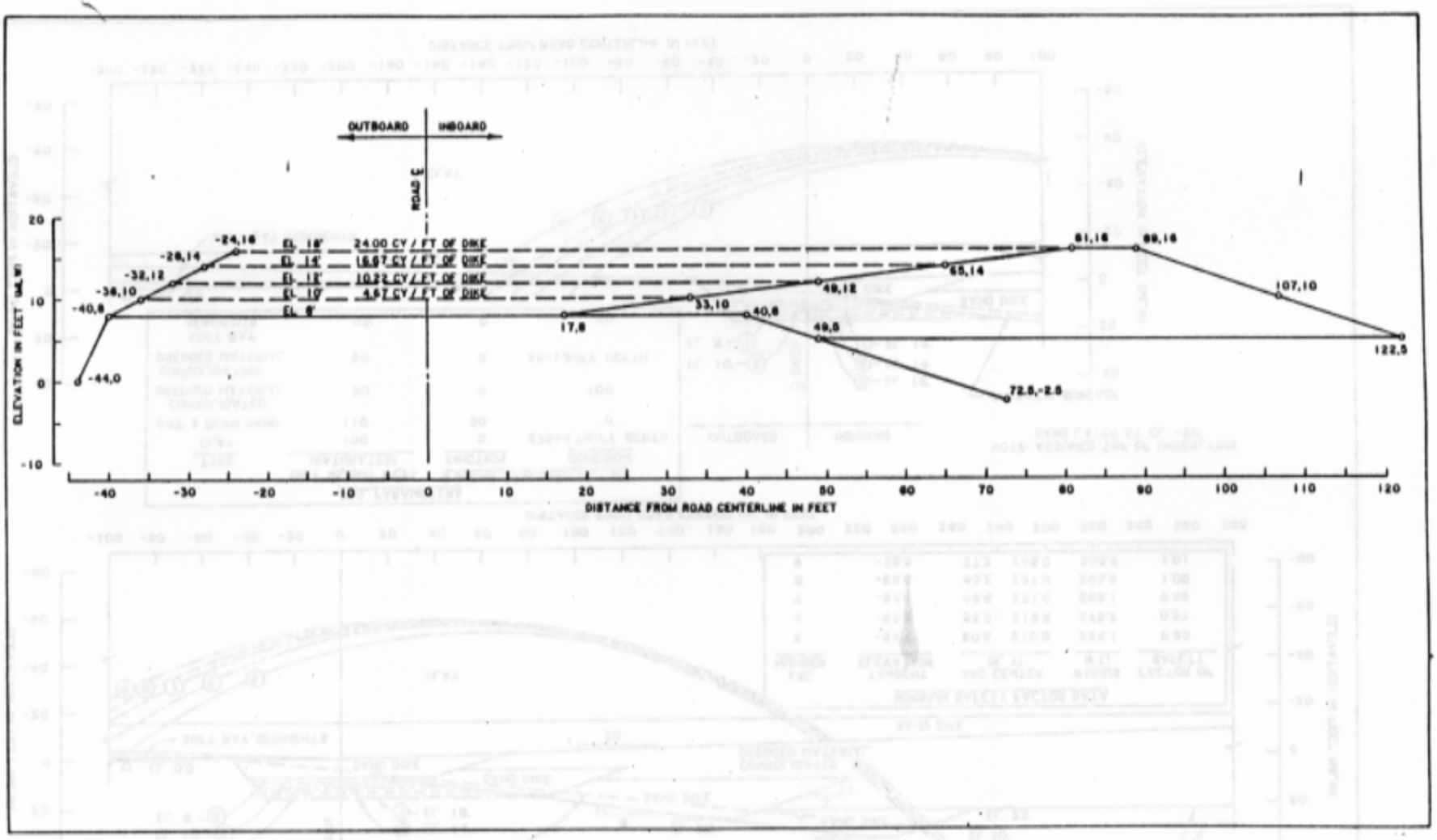


Figure 21. West dike road berm configuration

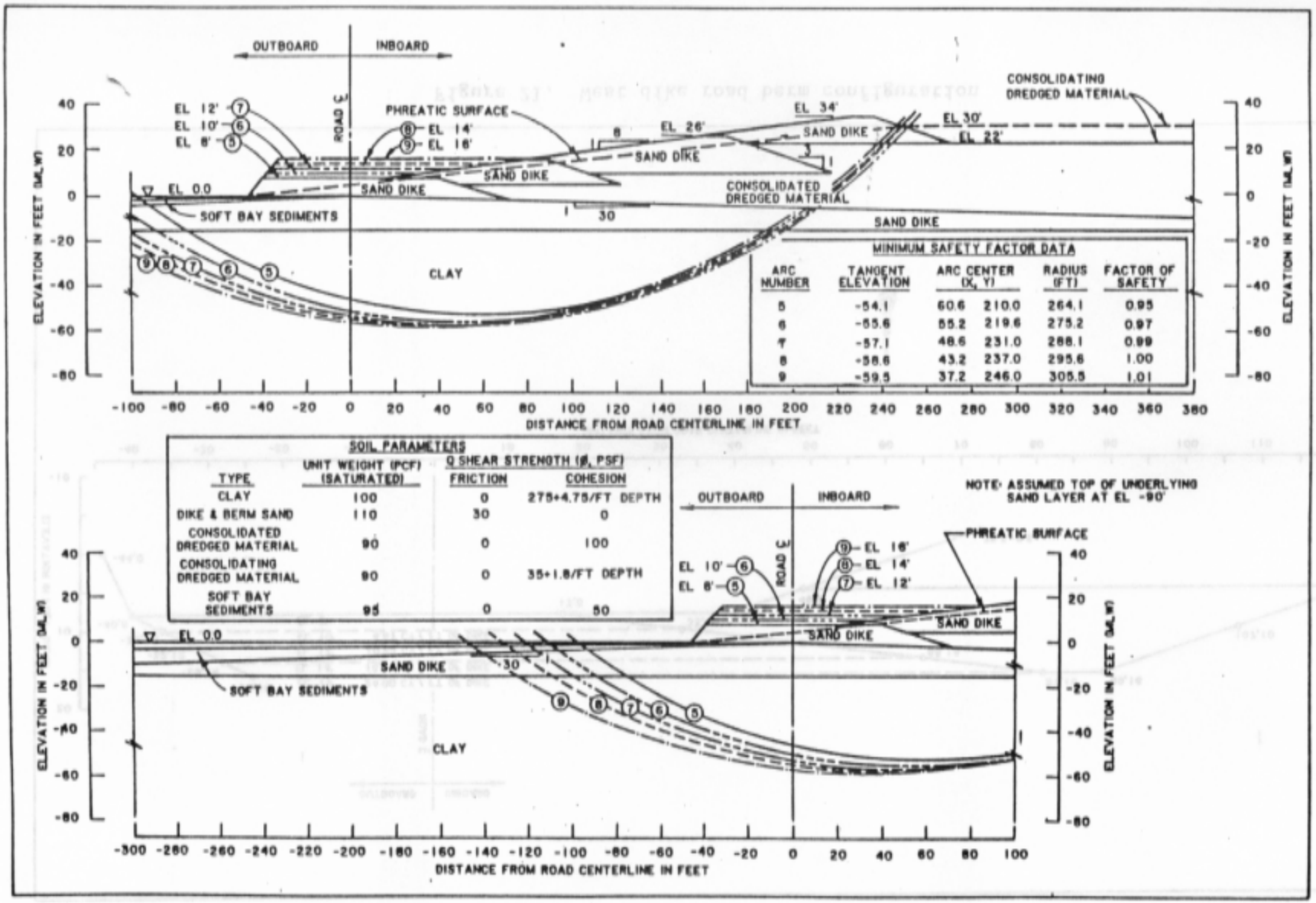


Figure 22. Critical circles for raised west dike with road berms

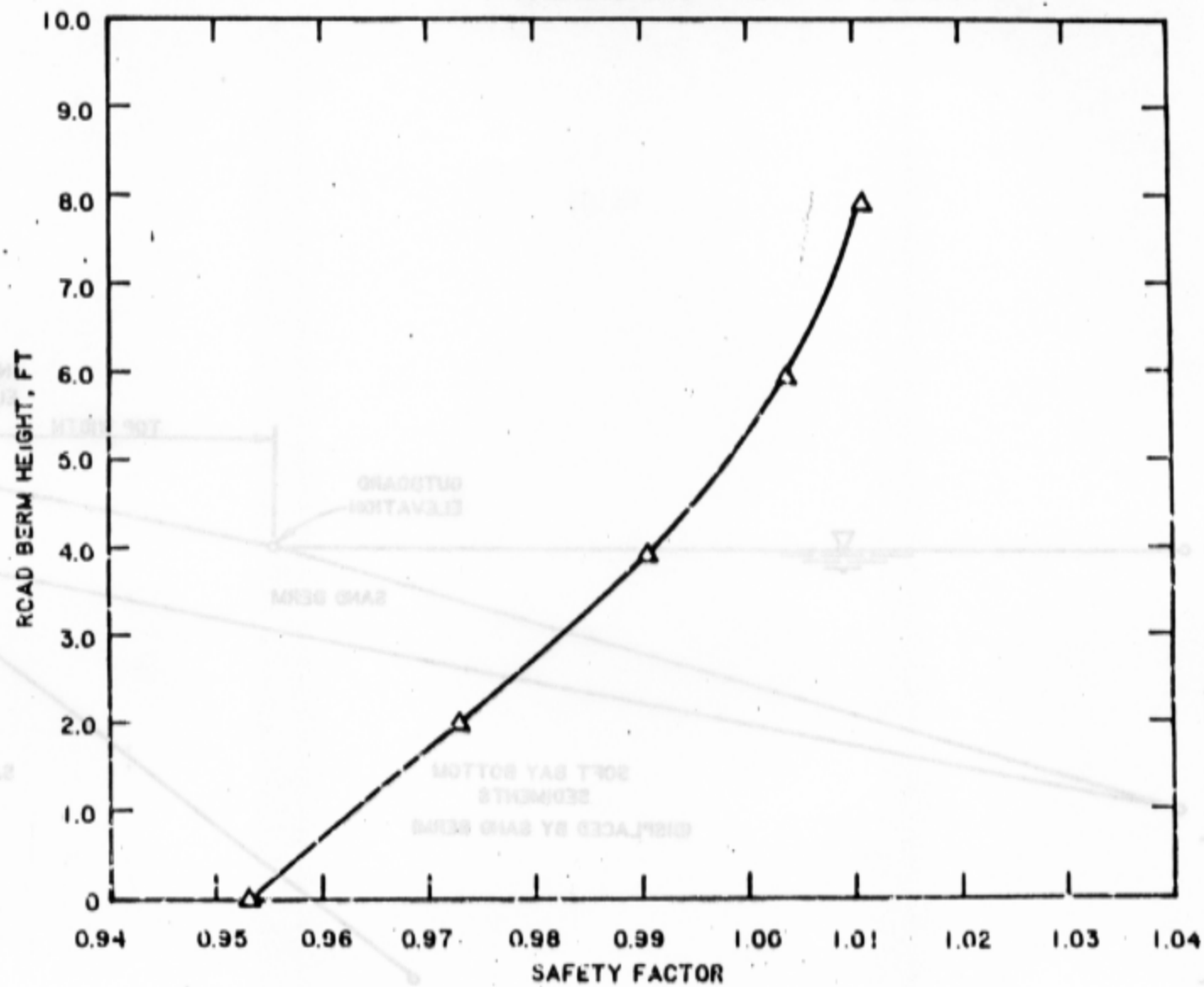


Figure 23. West dike road berm height versus safety factor

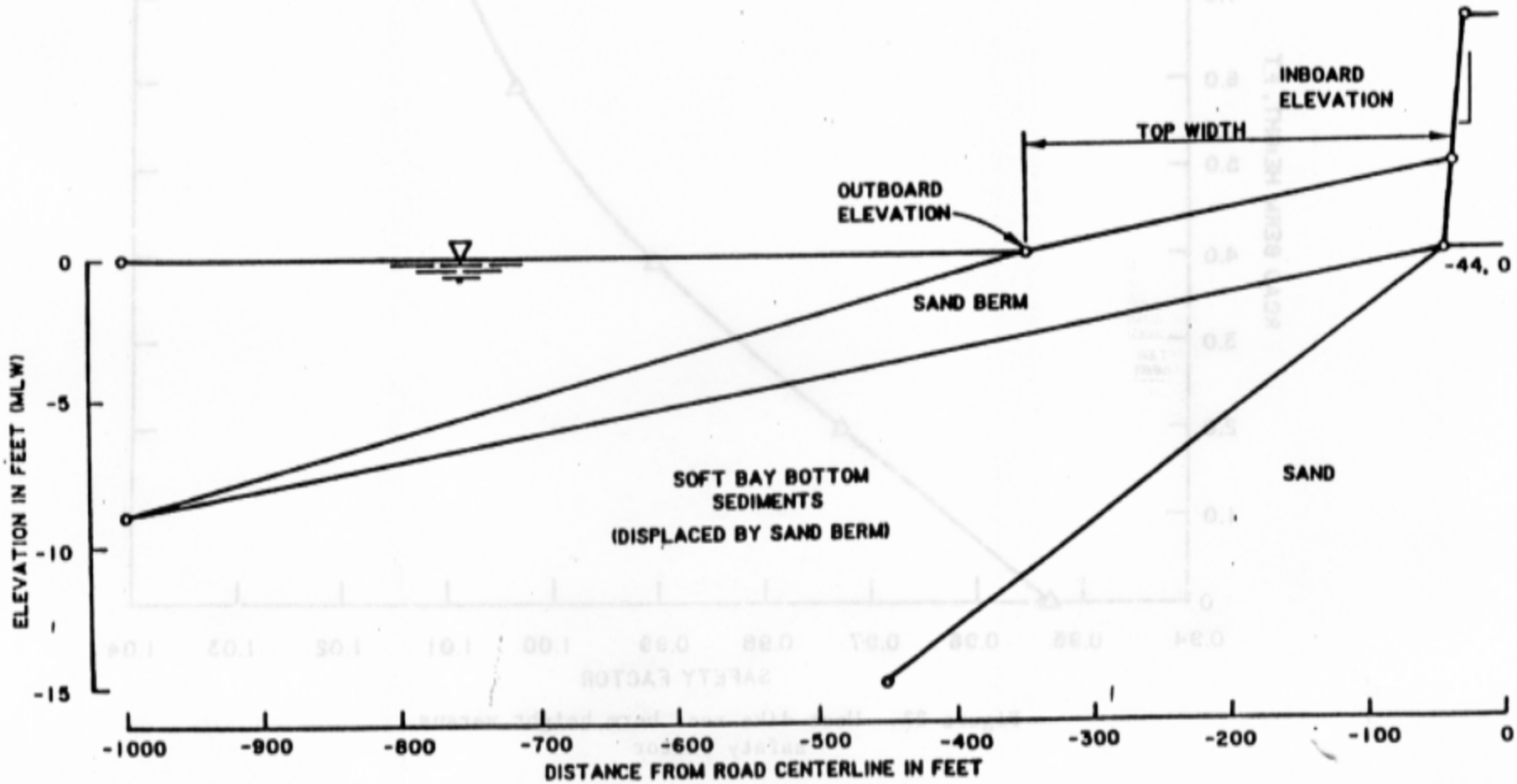


Figure 24. General schematic of a water berm illustrating terminology

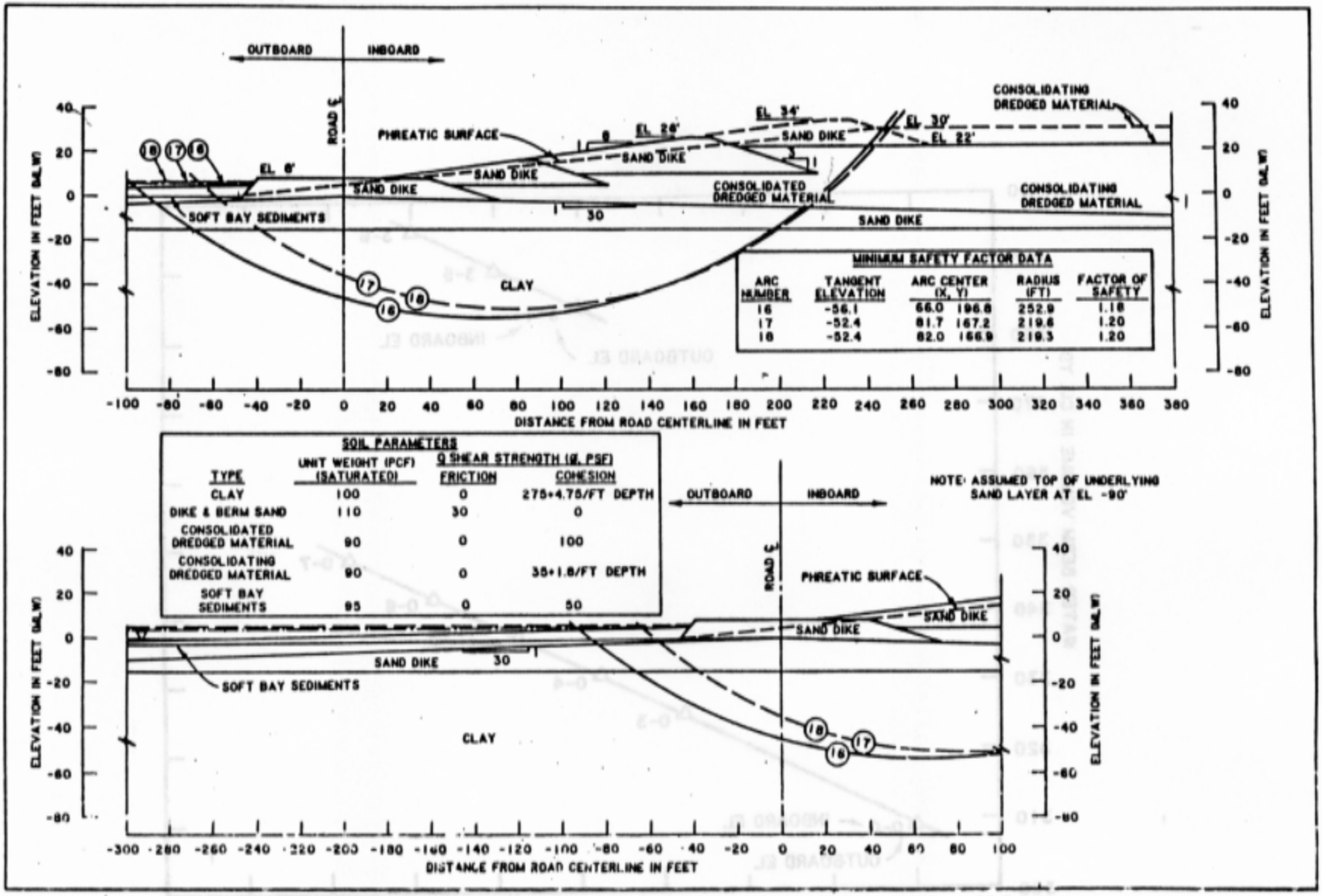


Figure 25. Critical circles for raised west dike with water berm elevations of +3 and +6

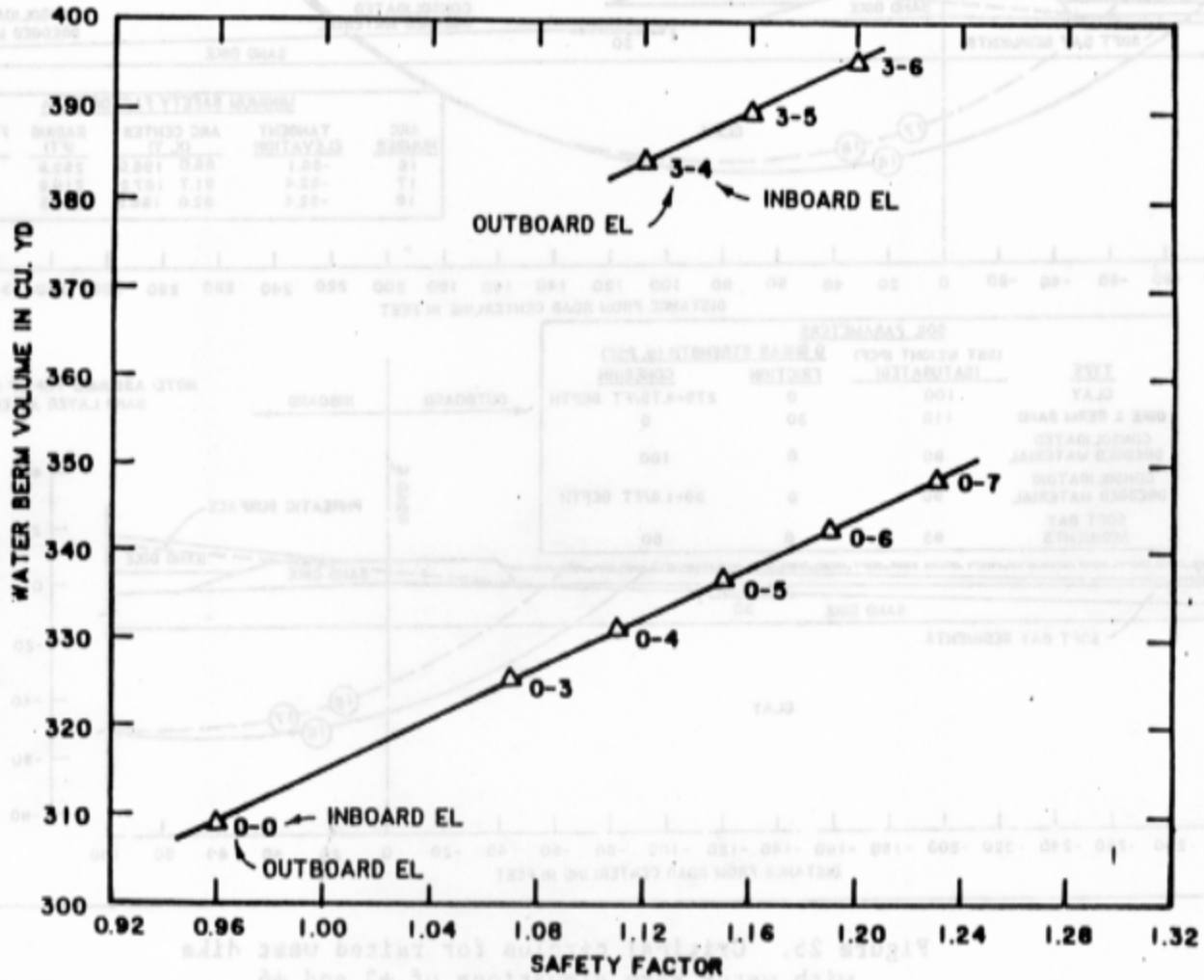


Figure 26. West dike water berm volume versus safety factor

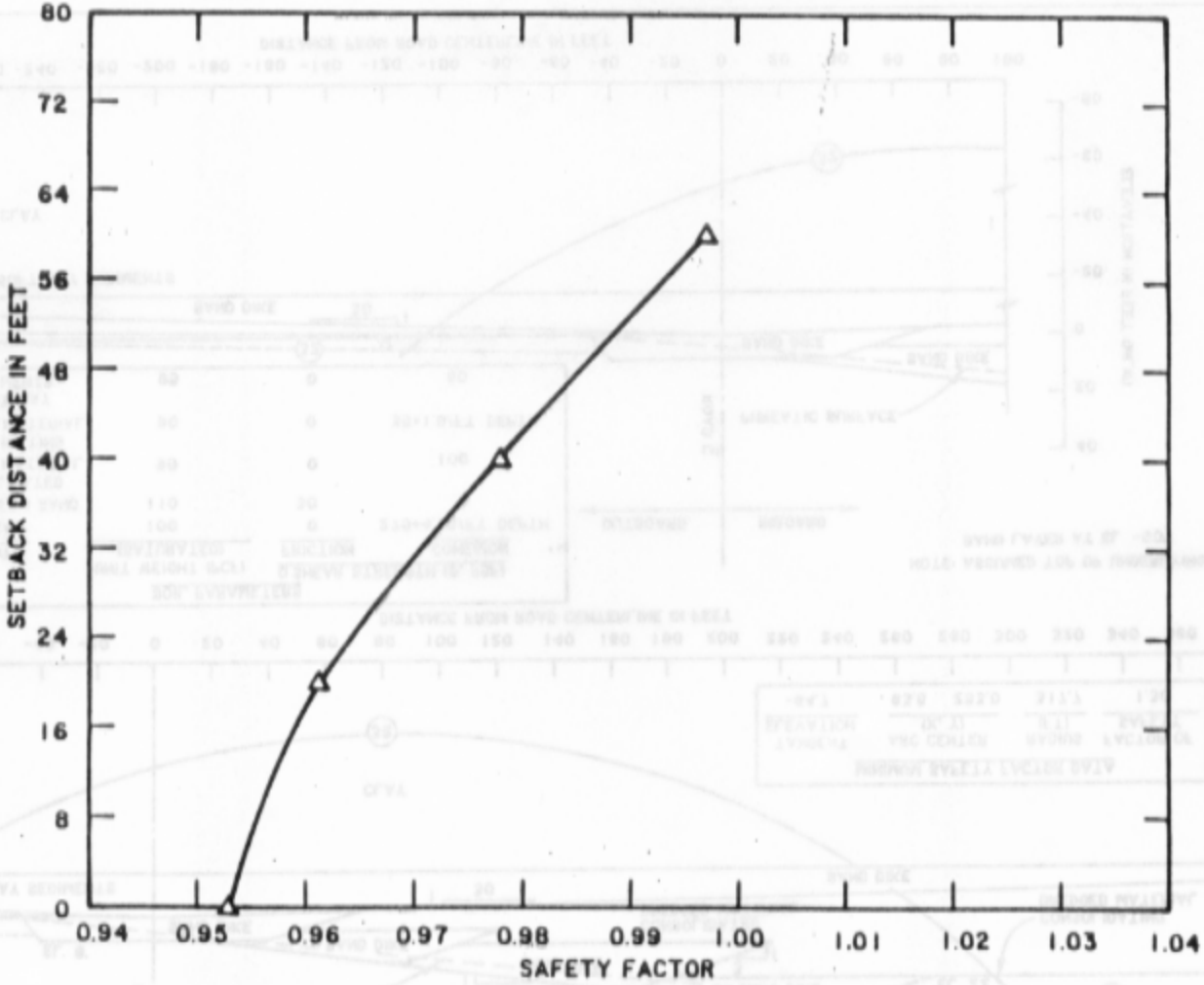


Figure 27. West dike setback versus safety factor

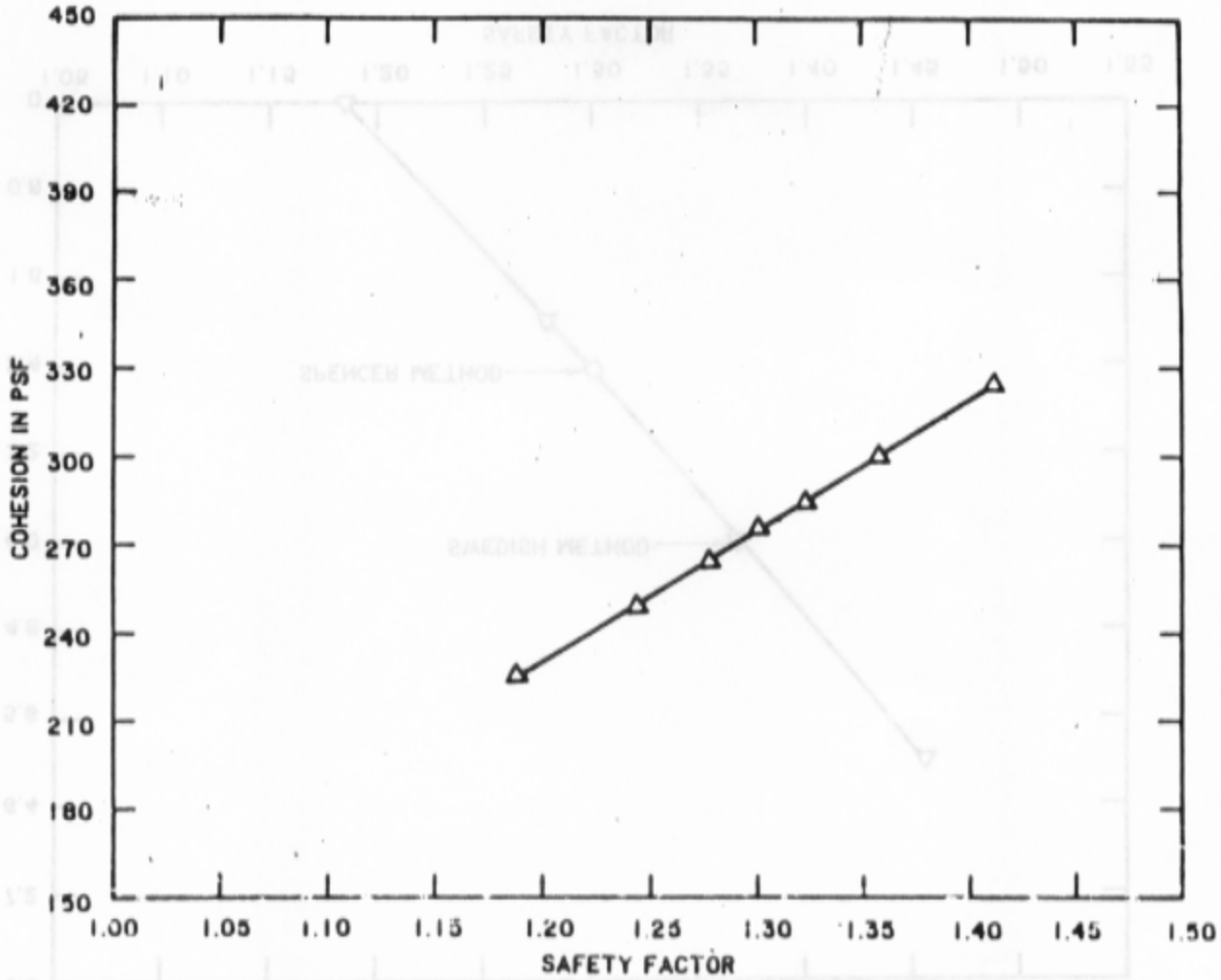


Figure 29. Cohesion of foundation clay under west dike versus safety factor

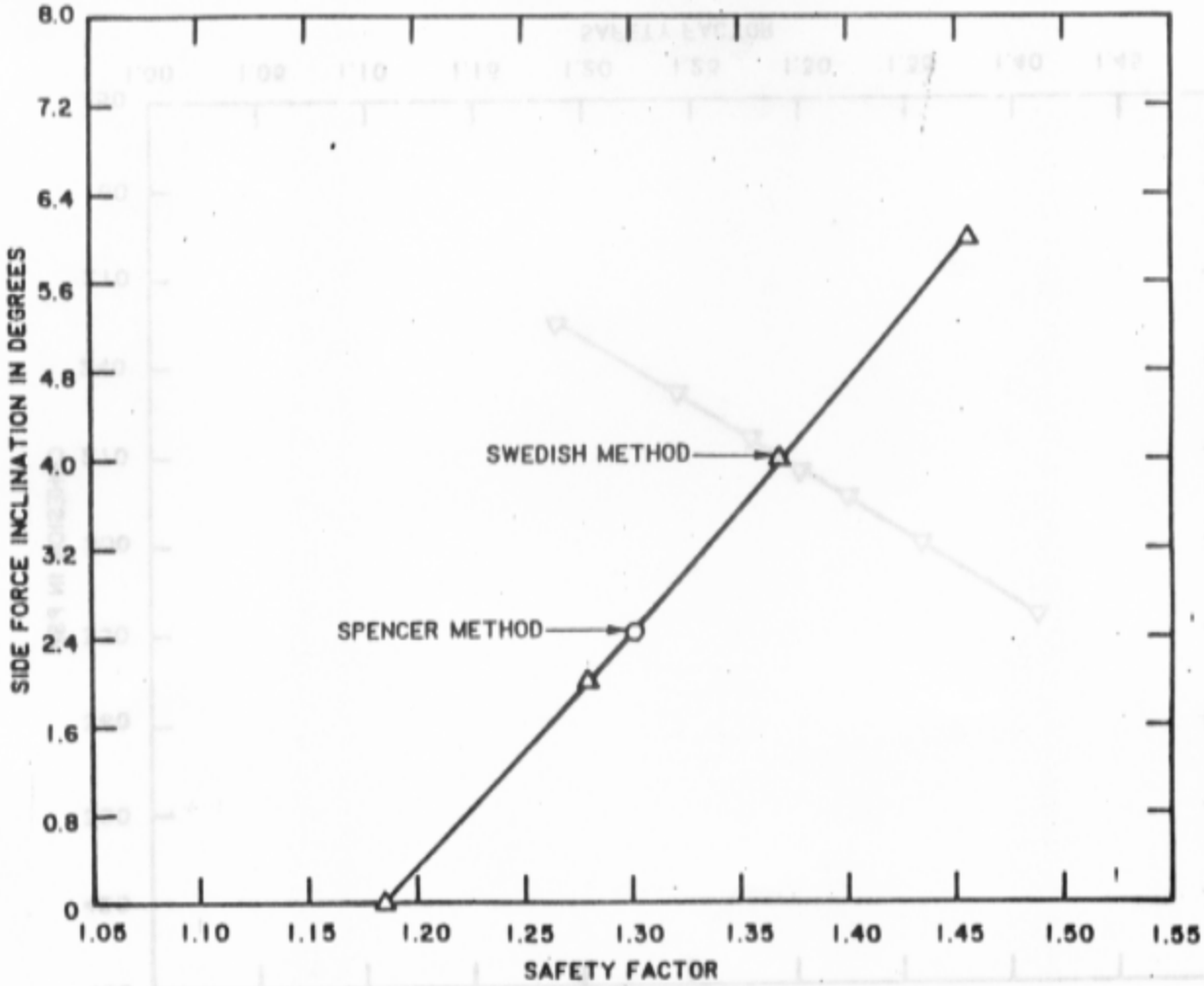
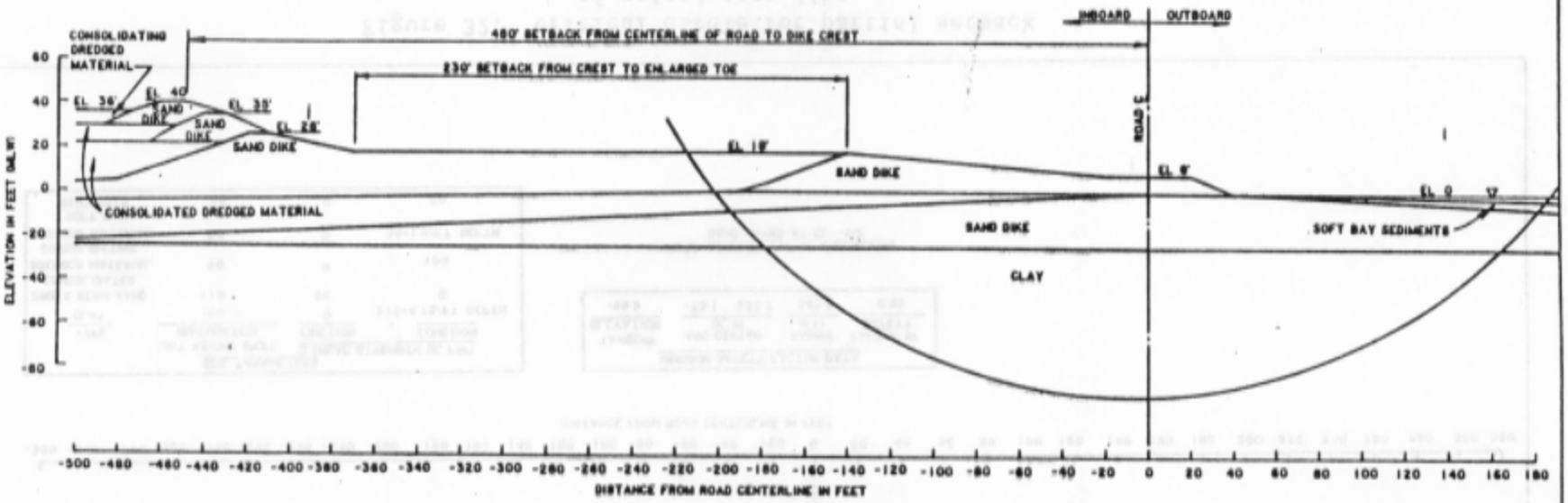


Figure 30. Side force inclination for recommended west dike section versus safety factor



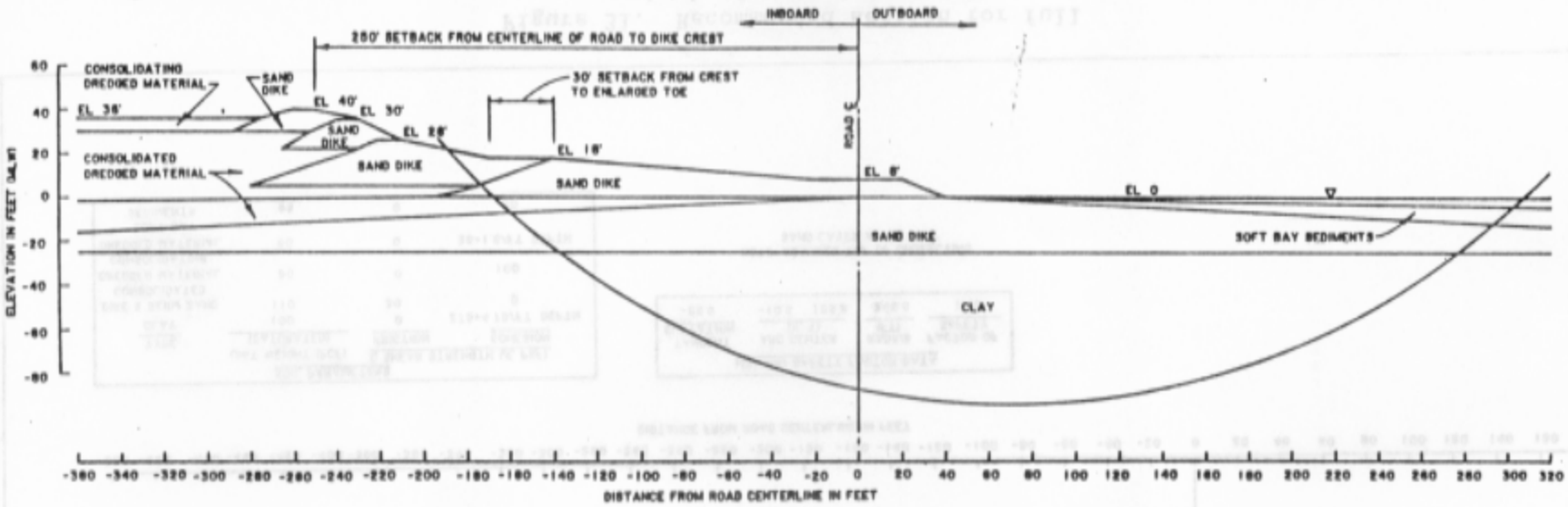
TYPE	SOIL PARAMETERS: UNIT WEIGHT (PCF) (SATURATED)	Q SHEAR STRENGTH (W, PSF): FRICTION	COHESION
CLAY	100	0	270+4.7S/FT DEPTH
DIKE & BERM SAND	110	30	0
CONSOLIDATED DREDGED MATERIAL	90	0	100
CONSOLIDATING DREDGED MATERIAL	90	0	38+1.8/FT DEPTH
SOFT BAY SEDIMENTS	95	0	50

MINIMUM SAFETY FACTOR DATA

TANGENT ELEVATION	ARC CENTER (X, Y)		RADIUS (FT)	FACTOR OF SAFETY
-89.9	-10.5	188.8	245.6	1.40

NOTE: ASSUMED TOP OF UNDERLYING SAND LAYER AT EL -90'

Figure 31. Recommended section for full setback of raised east dike



SOIL PARAMETERS			
TYPE	UNIT WEIGHT (PCF) (SATURATED)	Q SHEAR STRENGTH (Ø, PSF) FRICTION	COHESION
CLAY	100	0	275+4.75/FT DEPTH
DIKE & BERM SAND	110	30	0
CONSOLIDATED DREDGED MATERIAL	90	0	100
CONSOLIDATING DREDGED MATERIAL	80	0	35+1.8/FT DEPTH
SOFT BAY SEDIMENTS	95	0	50

MINIMUM SAFETY FACTOR DATA				
TANGENT ELEVATION	ARC CENTER (X, Y)		RADIUS (FT)	FACTOR OF SAFETY
-89.9	-75.1	253.7	343.9	0.89

NOTE: ASSUMED TOP OF UNDERLYING SAND LAYER AT EL -90'

Figure 32. Critical circle for partial setback of raised east dike

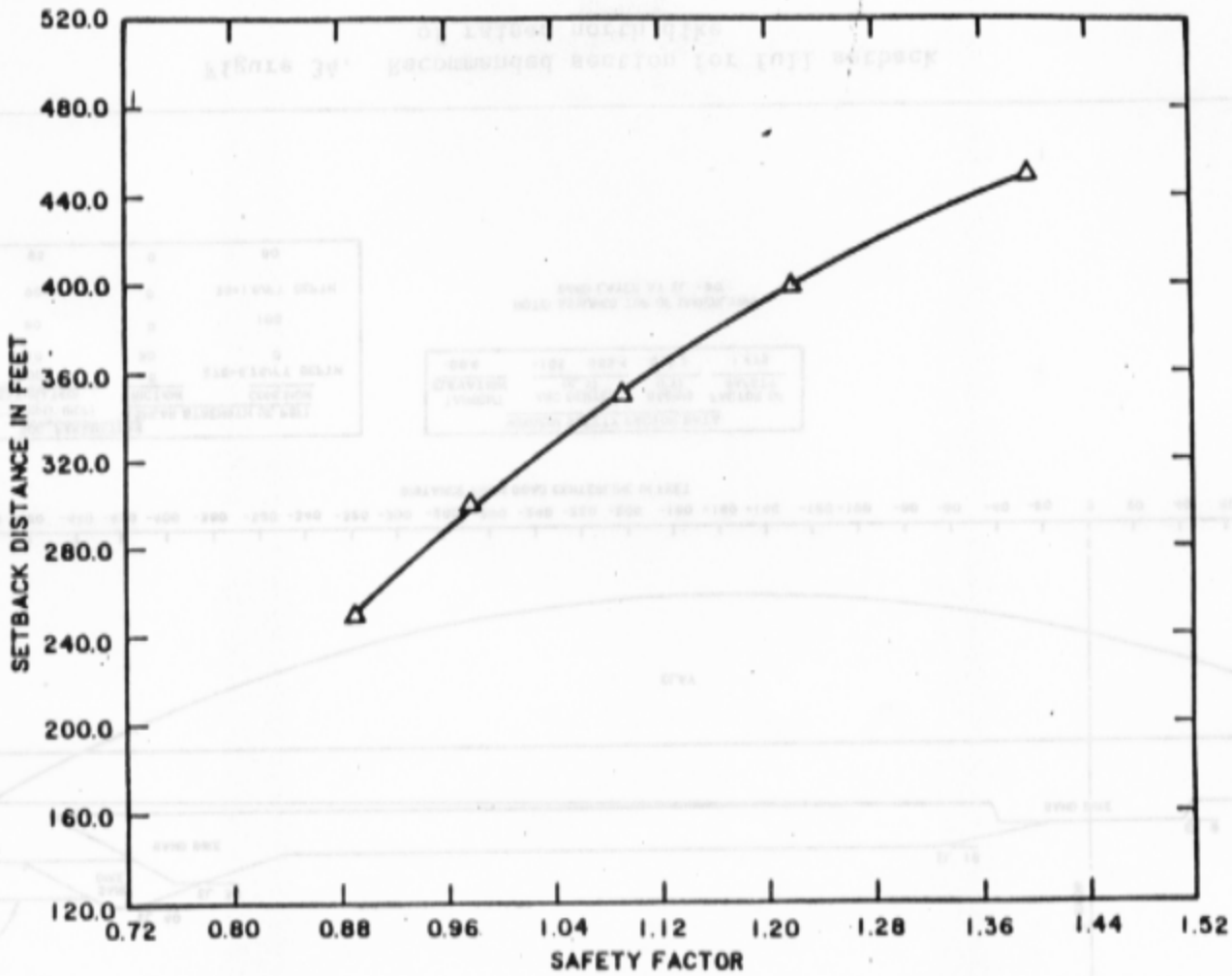
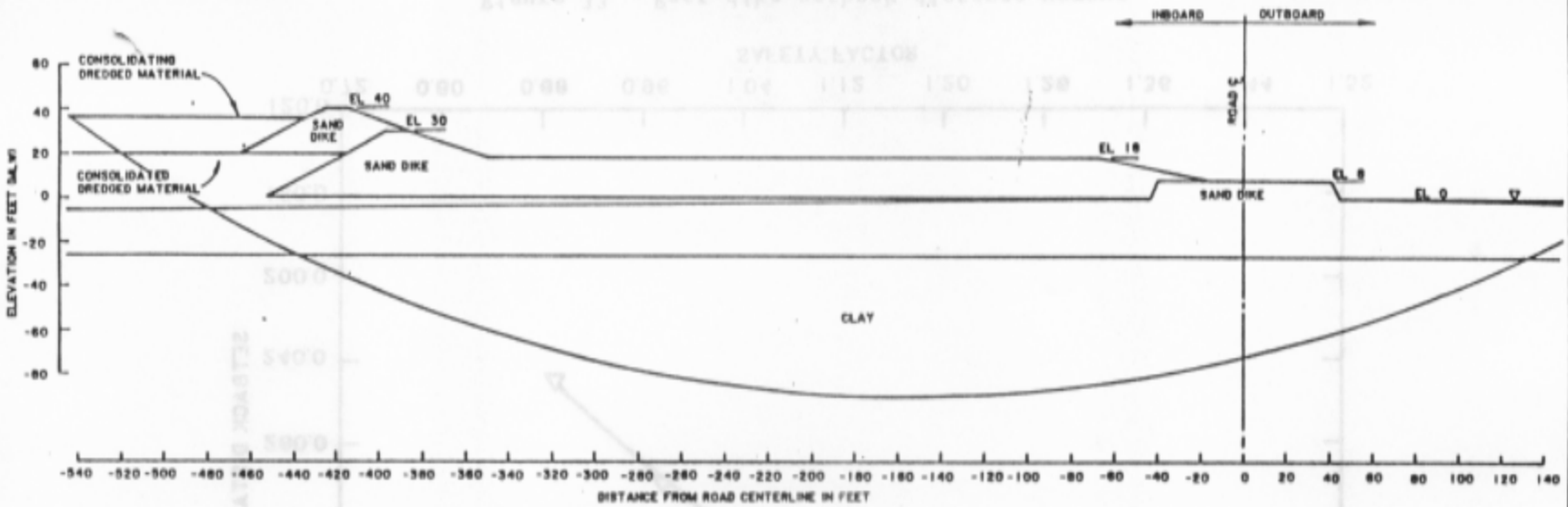


Figure 33. East dike setback distance versus safety factor



SOIL PARAMETERS

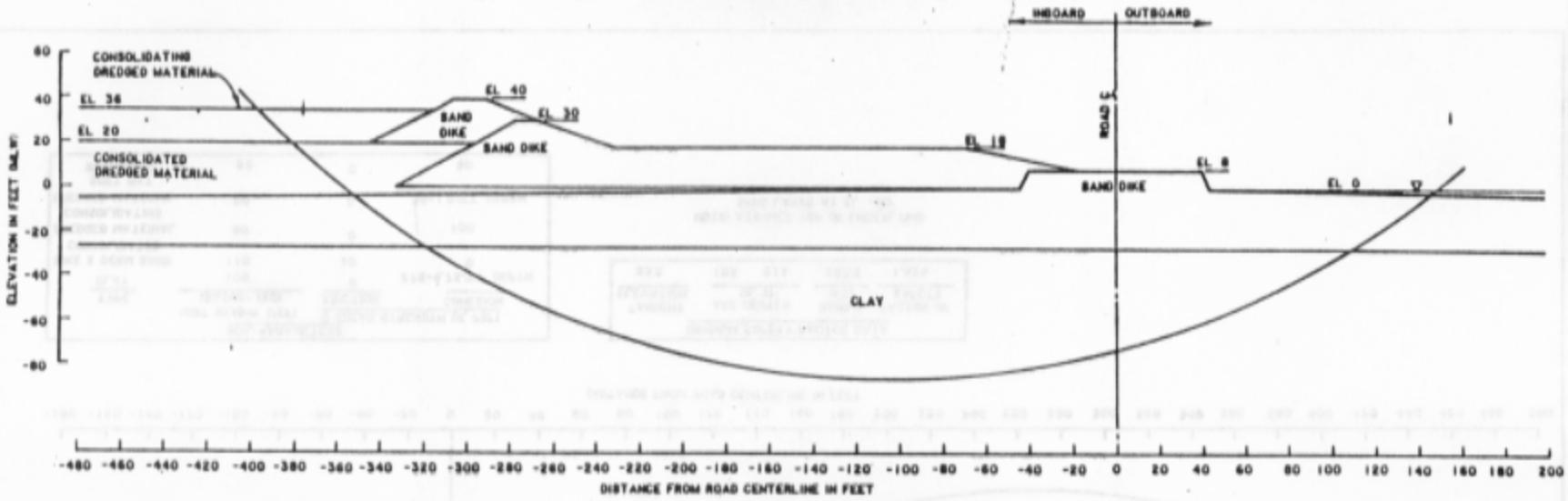
TYPE	UNIT WEIGHT (PCF) (SATURATED)	Q SHEAR STRENGTH (φ, PSF) FRICTION	COHESION
CLAY	100	0	275+4.7S/FT DEPTH
DIKE & BERM SAND	110	30	0
CONSOLIDATED DREDGED MATERIAL	90	0	100
CONSOLIDATING DREDGED MATERIAL	90	0	35+1.8/FT DEPTH
SOFT BAY SEDIMENTS	95	0	50

MINIMUM SAFETY FACTOR DATA

TANGENT ELEVATION	ARC CENTER (X, Y)		RADIUS (FT)	FACTOR OF SAFETY
-88.8	-155	583.4	673.2	1.275

NOTE: ASSUMED TOP OF UNDERLYING SAND LAYER AT EL -90'

Figure 34. Recommended section for full setback of raised north dike

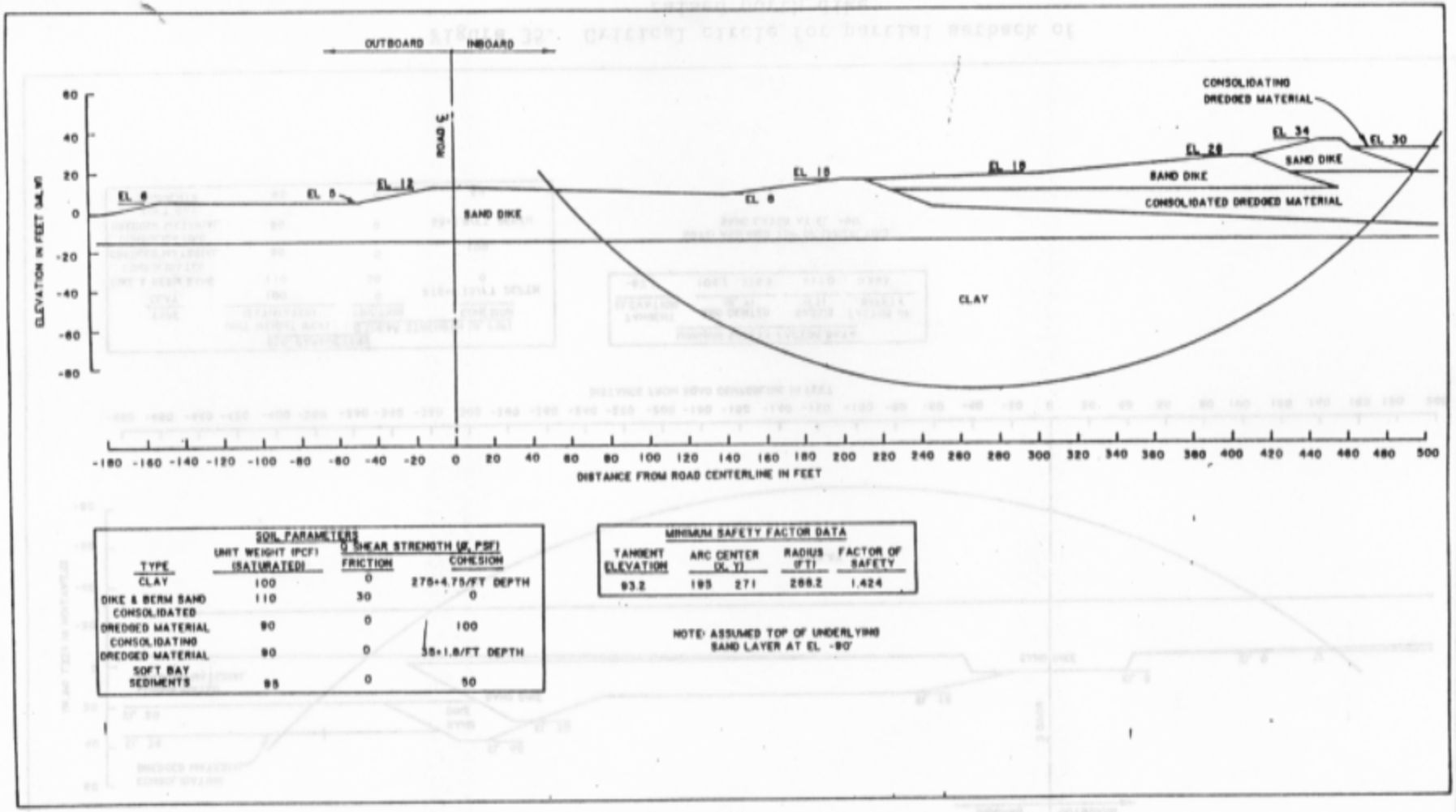


SOIL PARAMETERS			
TYPE	UNIT WEIGHT (PCF) (SATURATED)	SHEAR STRENGTH (#, PSF) FRICTION	COHESION
CLAY	100	0	275+4.75/FT DEPTH
DIKE & BERM SAND	110	30	0
CONSOLIDATED DREDGED MATERIAL	90	0	100
CONSOLIDATING DREDGED MATERIAL	90	0	35+1.8/FT DEPTH
SOFT BAY SEDIMENTS	95	0	50

MINIMUM SAFETY FACTOR DATA				
TANGENT ELEVATION	ARC CENTER (X, Y)		RADIUS (FT)	FACTOR OF SAFETY
-87.1	104.7	329.9	417.0	0.993

NOTE: ASSUMED TOP OF UNDERLYING SAND LAYER AT EL -90'

Figure 35. Critical circle for partial setback of raised north dike



SOIL PARAMETERS

TYPE	UNIT WEIGHT (PCF) (SATURATED)	Φ SHEAR STRENGTH (Φ, PSF) FRICTION	COHESION
CLAY	100	0	275+4.75/FT DEPTH
DIKE & BERM SAND	110	30	0
CONSOLIDATED DREDGED MATERIAL	90	0	100
CONSOLIDATING DREDGED MATERIAL	90	0	35+1.6/FT DEPTH
SOFT BAY SEDIMENTS	95	0	50

MINIMUM SAFETY FACTOR DATA

TANGENT ELEVATION	ARC CENTER (X, Y)		RADIUS (FT)	FACTOR OF SAFETY
93.2	195	271	268.2	1.424

NOTE: ASSUMED TOP OF UNDERLYING SAND LAYER AT EL -90'

Figure 36. Recommended section for raised northwest corner dike

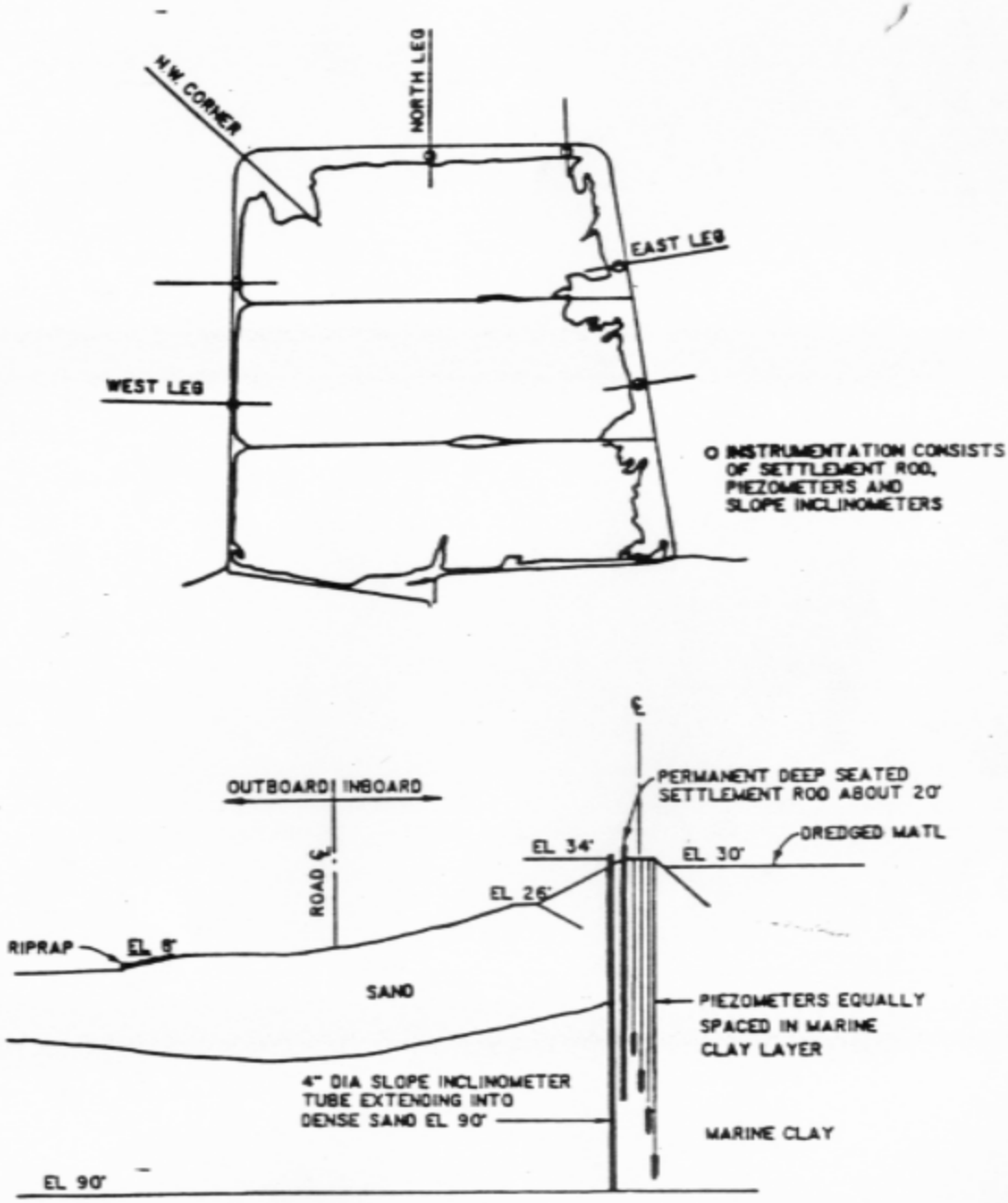


Figure 37. Proposed location for instrumentation

SECTION 2

APPENDIX B, SECTION 2
REPLACEMENT OR EXTENSION OF CRANEY ISLAND DISPOSAL AREA

TABLE OF CONTENTS

Item	Page
INTRODUCTION	2-1
SITE INVESTIGATION	2-1
LABORATORY TESTING	2-2
SUBSURFACE CONDITIONS	2-2
SOIL BORING NOTES	2-3

LIST OF ATTACHMENTS

No.	Title
1	UNDISTURBED PISTON TUBE SAMPLES
2	SOIL PROFILE

APPENDIX B, SECTION 2
REPLACEMENT OR EXTENSION OF CRANEY ISLAND DISPOSAL AREA

INTRODUCTION

1. The geotechnical investigation described herein was conducted in support of Miscellaneous Paper (MP) GL-87-9, dated June 1987, entitled "Geotechnical Feasibility Study Replacement or Extension of the Craney Island Disposal Area, Norfolk, Virginia" (see appendix A). Previous geotechnical investigations conducted at Craney Island, dating back to 1948, are described in MP GL-87-4, dated May 1987, entitled "Perimeter Dike Stability Analysis, Craney Island Disposal Area, Norfolk, Virginia" (copy enclosed in section 1 of this appendix).

2. The purpose of this latest geotechnical investigation, conducted in July 1986, was to determine the soil profile and quantify the engineering properties of the foundation soils. The area investigated is outside the perimeter and influence of the existing disposal area and in the vicinity of the extension alternatives being studied. The scope of the investigation consisted of drilling seven borings at the locations shown in figure 4 of MP GL-87-9. The characteristics of the soil samples obtained from the soil borings were determined by laboratory analyses.

SITE INVESTIGATION

3. The borings were drilled from a truck mounted CME 45B drill rig staged on a floating barge. The borings, labeled 86 DH-1 through 7 were drilled to depths of 86.0 feet to 126.5 feet below mean sea level (m.s.l.). Water depths at the time of drilling ranged from approximately 13.5 feet to 32.0 feet. The holes were cased to approximately 10.0 feet below the mudline. Drilling mud consisting of bentonite and chemical gel was used to support the drillhole below the cased depth. The drillhole was advanced using "wash boring" techniques. Both undisturbed and disturbed soil samples were obtained for laboratory analyses.

LABORATORY TESTING

4. Laboratory testing of disturbed soil samples taken from splitspoon jars consisted of classification tests which included liquid limit, plastic limit, natural water content, sand content and specific gravity. The data obtained from these tests are shown on the soil boring logs. Laboratory testing on undisturbed piston tube samples consisted of triaxial shear strength testing (UU and CU) and consolidation testing. The data obtained from these tests is attached (see attachment 1).

SUBSURFACE CONDITIONS

5. The soil profile consists of very soft (N=WOR), high plastic clay (CH) with variable quantities of sand, silt, and organics, extending from the mudline to depths of 42.0 feet to 98.0 feet or approximate elevations of -78.0 to -116.0 feet m.s.l. Sand contents ranged from 0.1% to 60.3% with an overall average of 8.0%. Specific gravities were fairly consistent ranging between 2.71 and 2.73. Natural water contents were above or in the immediate vicinity of the liquid limit indicating normally or slightly underconsolidated conditions. The liquid limits, plastic limits and natural water contents are plotted with depth on the soil boring logs. Undrained shear strength tests indicated very low shear strengths within the clay layer ranging from a maximum of 720 psf to a minimum of 60 psf with an average of 230 psf. The results of the undrained shear strength tests are shown on the attached soil profile (see attachment 2). The soft clay layer described above is underlain by a predominantly granular material of medium to dense consistency. Standard penetration values (N) within this material range from 2 to 32 with an average of 15. Some of the borings show a clean transition between the clay and granular material (SM-SP), while others show variable amounts of clay mixed with the granular material (SC). Laboratory testing was not conducted in this material as experience indicates the properties of the soft clay control the overall dike stability. The borings were terminated in this material.

SOIL BORING NOTES

1. The soil was classified according to the "Unified Soil Classification System" (ML, CL, SP, etc.) and described utilizing the "Burmister's Method of Material Proportions."

2. The blow column indicates depth of sample and number of blows required to drive a 2-inch O.D. splitspoon sampler 6 inches, unless otherwise noted, into undisturbed soil with a 140 lb. hammer falling 30 inches per ASTM D 1586. The standard penetration "N" value is the sum of the last two 6-inch drives, i.e. 6, 4, 5; N=9 for a 1.5-foot sample and second two 6-inch drives, i.e., 6, 4, 5, 7; N=9 for a 2.0-foot sample.

3. Estimated consistencies (med. stiff, soft, etc.) are from Terzaghi & Peck "Soil Mechanics in Engineering Practice."

4. All elevations and locations are approximate.

5. Coordinates are referenced to the Virginia State Southern Grid System.

6. Abbreviations:

BOH - Bottom of Hole OD - outside diameter
fn - fine PL - plastic limit
in - inch sat - saturated
LIT - little tr - trace
LL - liquid limit Wn - water content
MSL - mean sea level WOH - weight of hammer
N - blow count WOR - weight of rod

ATTACHMENT 1
(SECTION 2)

Hole No. 86DH1

DRILLING LOG	DIVISION CENAD	INSTALLATION CENAO	SHEET 1 OF 1 SHEETS

1. PROJECT	EXTENSION OF CRANEY ISLAND
2. LOCATION (Coordinates or Station)	E2626581 N224102
3. DRILLING AGENCY	BORE AND CORE
4. HOLE NO. (As shown on drawing title and file number)	86 DH-1
5. NAME OF DRILLER	MARK SEILERS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	126.5 ft
10. SIZE AND TYPE OF BIT	2 IN OD SPLITSPOON
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	CME 45 B
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 16; UNDISTURBED 4
14. TOTAL NUMBER CORE BOXES	
15. ELEVATION GROUND WATER	0.0
16. DATE HOLE	STARTED 15 JULY 86; COMPLETED 15 JULY 86
17. ELEVATION TOP OF HOLE	MSL
18. TOTAL CORE RECOVERY FOR BORING	%
19. SIGNATURE OF INSPECTOR	Matthew T Byrne

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d		% SAND	BOX OR SAMPLE NO. f	% WATER
			WATER				50 100
	10						
-13.5			(CH) CLAY high Plastic, very soft, sat, tr.-lit. organics, grey	N=WOR		1	
	20			N=WOR	1.2	2	PL LL Wn
				N=WOR	.3	3	
	30			N=WOR	.1	4	
				N=WOR	.2	5	
	40			N=WOR	.1	6	
				N=WOR	.1	7	
	50			N=WOR	.4	8	
				N=WOR	.4	9	
	60			N=WOR	.5	10	
				N=WOR	.7	11	
	70			N=WOR	.5	12	
				N=WOR	.8	13	
	80			N=WOR	15.1	14	
				N=WOR		15	
-88.5	90		(SC-CH) SAND fine some high Plastic Clay, moist, grey interlayered with high plastic clay, lit. silt	N=4	10.2	16	
				N=5		17	
	100			N=9		18	
				N=6		19	
	110			N=4		20	
				N=7		21	
	120			N=38		22	
-126.5				N=39		23	
			BOH = 126.5 ft				

UNDISTURBED PISTON TUBE SAMPLES TAKEN AT THE FOLLOWING DEPTHS:

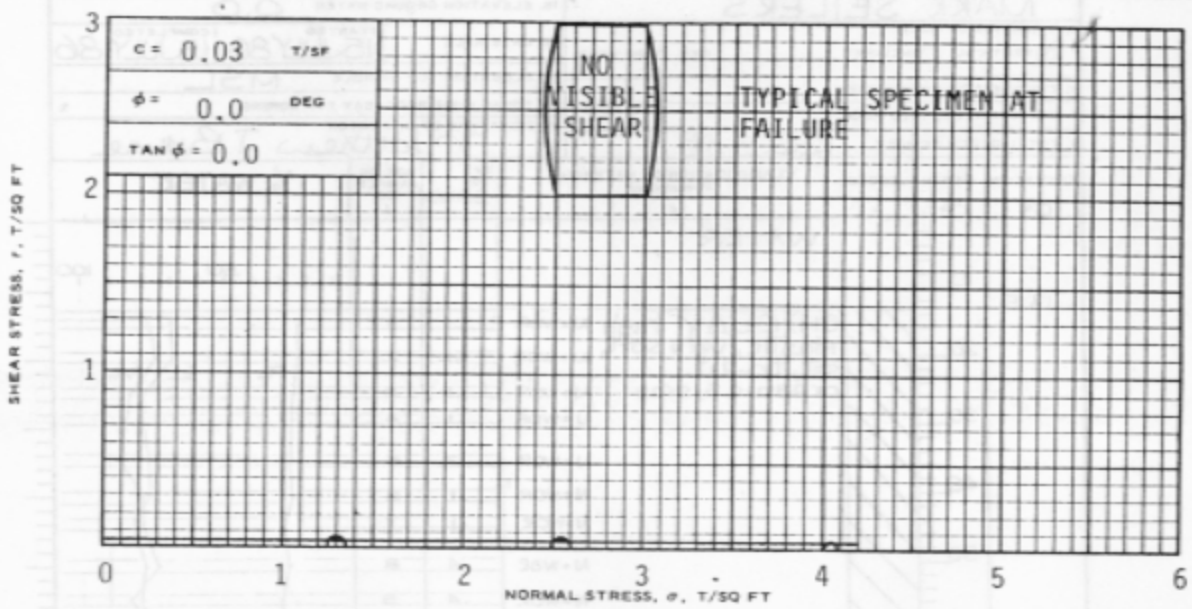
(1) 26.5' - 28.5'
(2) 41.5' - 43.5'
(3) 56.5' - 58.5'
(4) 71.5' - 73.5'

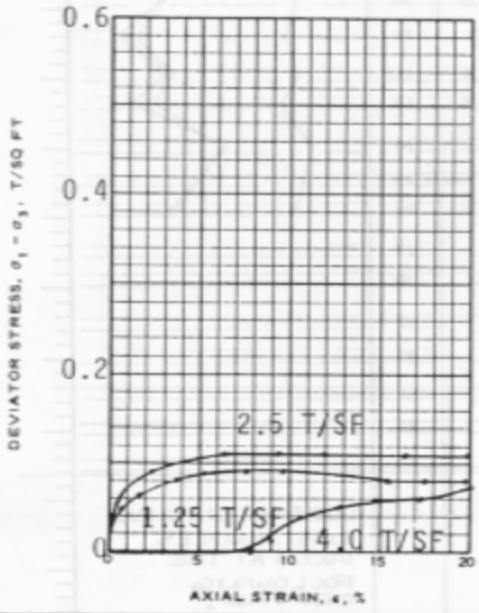
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT EXTENSION OF CRANEY ISLAND | HOLE NO. 86DH1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	88.8	87.7	90.5	
	DRY DENSITY LB/CU FT	γ_{d_o}	49.0	49.9	48.1	
	SATURATION, %	S_o	98.5	99.5	97.5	
	VOID RATIO	e_o	2.437	2.380	2.508	
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--	
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--	
	SATURATION, %	S_c	--	--	--	
	VOID RATIO	e_c	--	--	--	
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.09	0.11	0.06	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	7	8	20	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.08	0.11	0.06	
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38	
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08	

CONTROLLED- Strain (0.74 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray Fat Clay (CH)

LL --NOT REQUESTED PI ---- G_s 2.70

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/463

BORING NO. 86 DH-1 SAMPLE NO. 1

DEPTH 26.5-28.5

LABORATORY SADEN-FL DATE 4 September 1986

TRIAXIAL COMPRESSION TEST REPORT

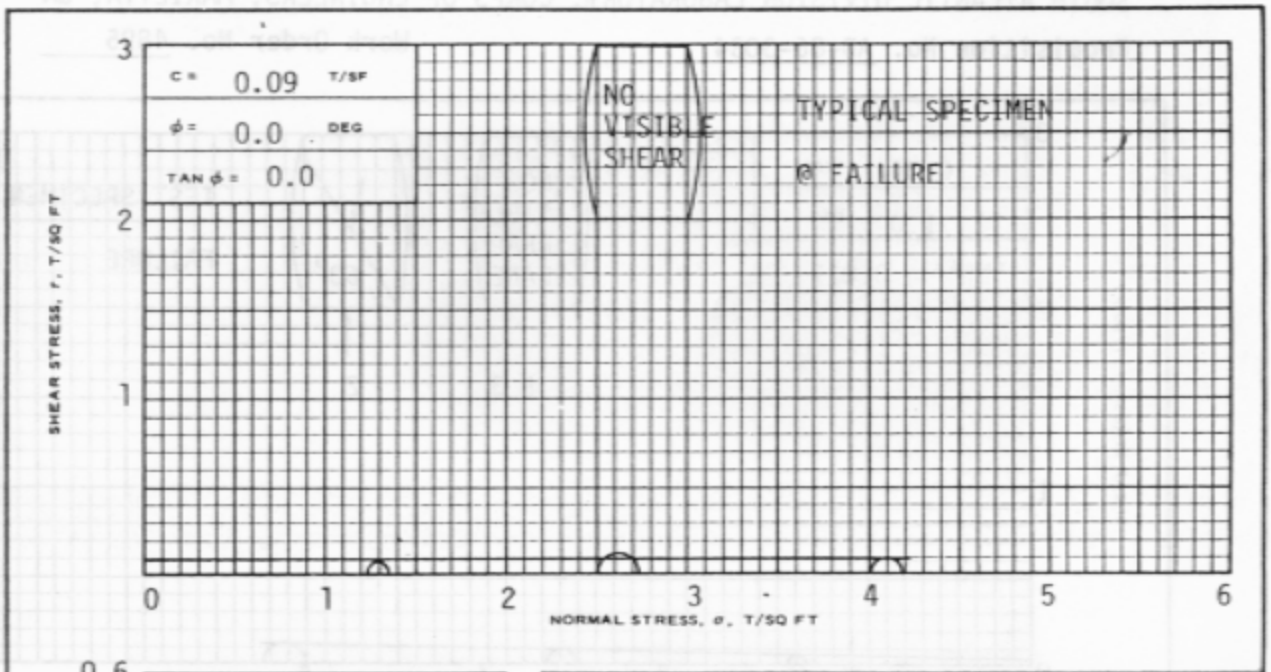
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

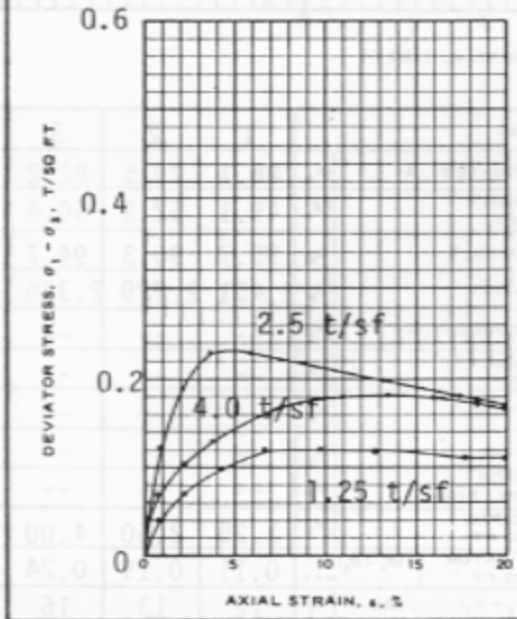
Attachment 1

2

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	80.6	76.9	77.8
	DRY DENSITY LB/CU FT	γ_{d_o}	53.0	54.6	54.2
	SATURATION, %	S_o	100.0	100.0	100.0
	VOID RATIO	e_o	2.159	2.062	2.086
BEFORE SHEAR	WATER CONTENT, %	w_c	-	-	-
	DRY DENSITY LB/CU FT	γ_{d_c}	-	-	-
	SATURATION, %	S_c	-	-	-
	VOID RATIO	e_c	-	-	-
	FINAL BACK PRESSURE, T/SQ FT	U_o	-	-	-
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.12	0.23	0.18
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	9	5	15
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.12	0.19	0.18
INITIAL DIAMETER, IN.		D_o	2.85	2.85	2.86
INITIAL HEIGHT, IN.		H_o	6.16	6.26	6.19

CONTROLLED- Strain(0.74%/min) TEST

DESCRIPTION OF SPECIMENS (Visual) gray, fat clay (CH)

LL -- not requested PL -- G_s 2.68

TYPE OF SPECIMEN Undisturbed TYPE OF TEST U

REMARKS:

PROJECT Craney Island, Norfolk District
Lab No. 141/464

BORING NO. 86 DH-1 SAMPLE NO. 2

DEPTH XXXX 41.5-43.5

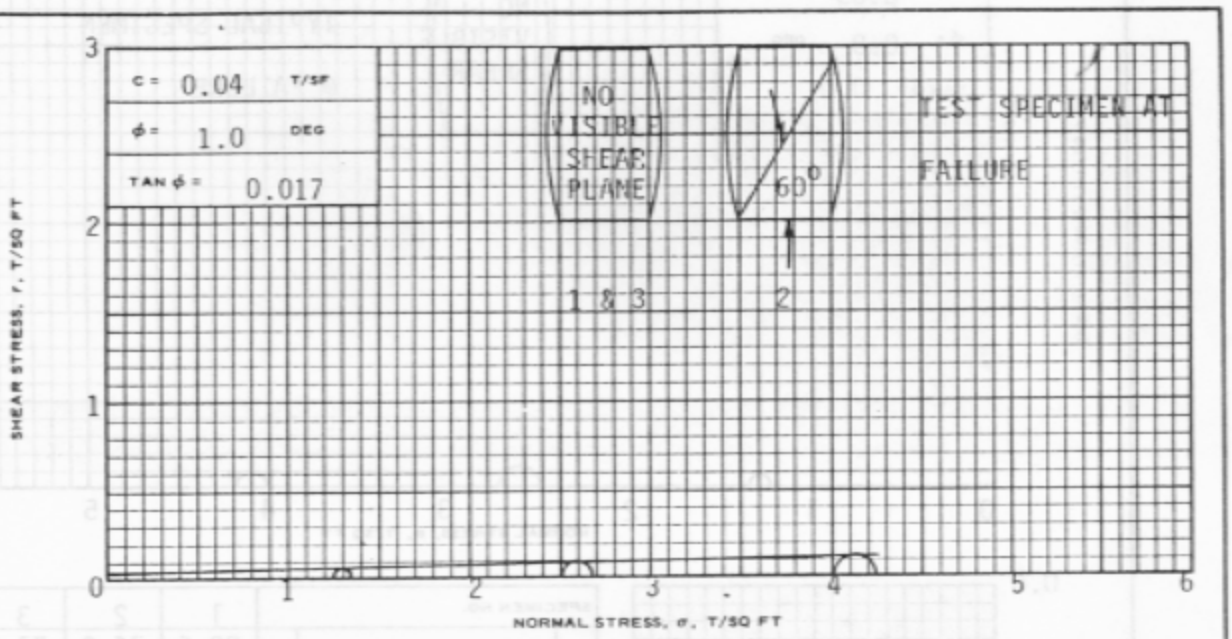
LABORATORY SADEN-FL DATE 4 September 1986

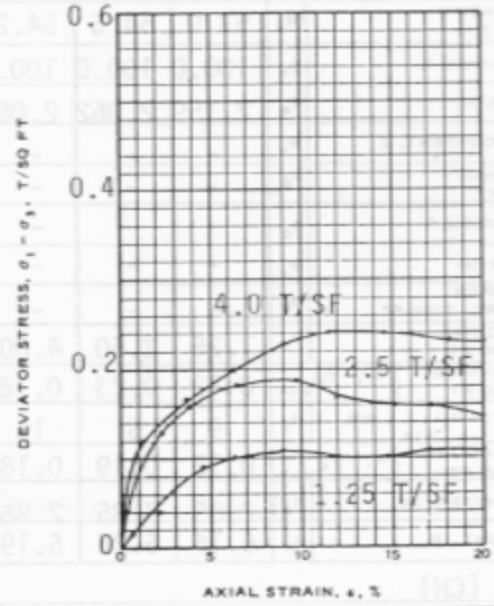
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	86.1	79.5	82.2
	DRY DENSITY LB/CU FT	γd_o	49.1	52.2	50.4
	SATURATION, %	S_o	95.7	96.3	94.7
	VOID RATIO	e_o	2.431	2.229	2.346
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γd_c	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_b	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.11	0.19	0.24
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	12	13	16
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.10	0.16	0.24
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED TEST: Strain (0.74 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.70

TYPE OF SPECIMEN: Undisturbed TYPE OF TEST: Q

REMARKS:

PROJECT: Craney Island, Norfolk District

Lab. No. 141/465

BORING NO. 86 DH-1 SAMPLE NO. 3

DEPTH 56.5 - 58.5

LABORATORY: SADEN-FL DATE: 9 September 1986

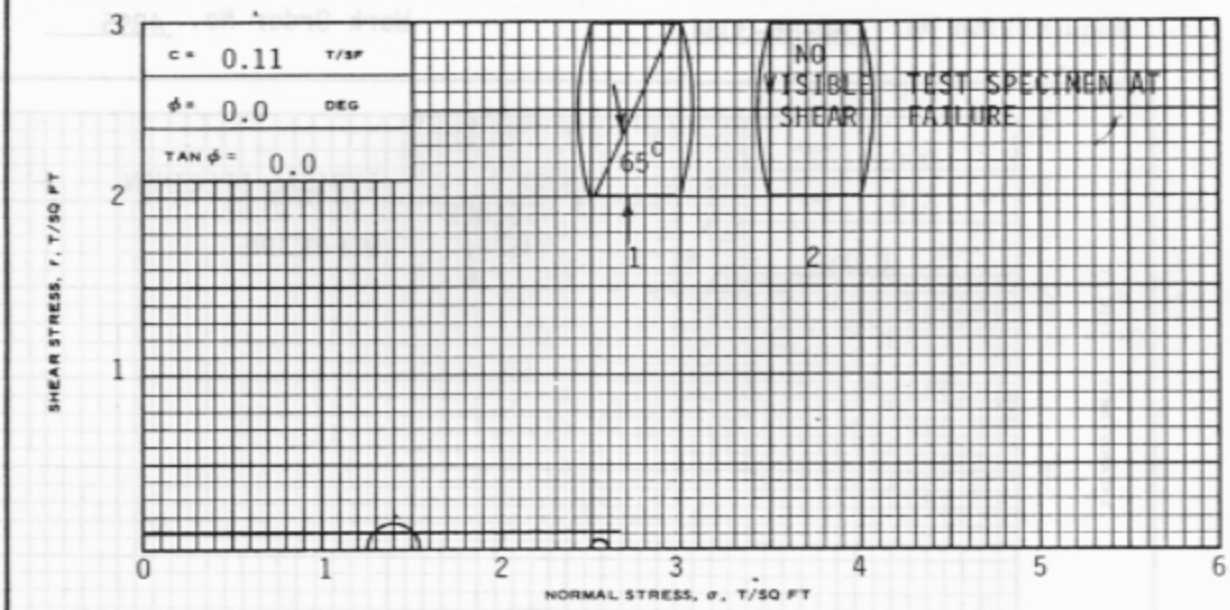
TRIAXIAL COMPRESSION TEST REPORT

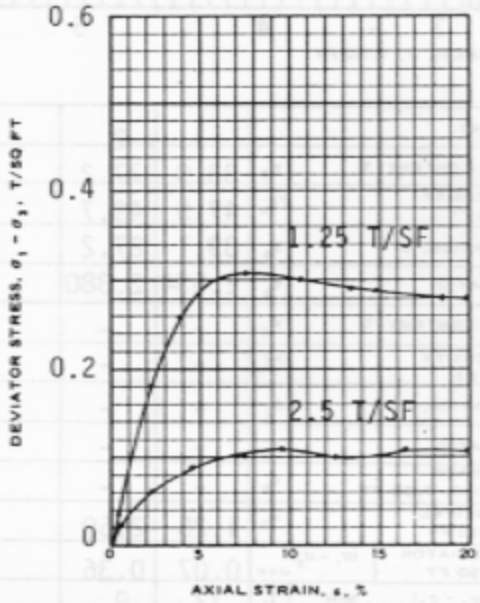
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2		
INITIAL	WATER CONTENT, %	w_o	73.8	80.8		
	DRY DENSITY LB/CU FT	γ_{d_o}	54.9	50.1		
	SATURATION, %	S_o	96.9	92.7		
	VOID RATIO	e_o	2.034	2.327		
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--		
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--		
	SATURATION, %	S_c	--	--		
	VOID RATIO	e_c	--	--		
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--		
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.31	0.11		
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	10	13		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.29	0.10		
INITIAL DIAMETER, IN.		D_o	2.85	2.85		
INITIAL HEIGHT, IN.		H_o	6.22	6.24		

CONTROLLED- Strain (0.74 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL --NOT REQUESTED ---- G_s 2.67

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

Insufficient Material for additional specimen

PROJECT Craney Island, Norfolk District

Lab. No. 141/466

BORING NO. 86 DH-1 SAMPLE NO. 4

DEPTH/~~XXXX~~ 71.5-73.5

LABORATORY SADEN-FL DATE 4 September 1986

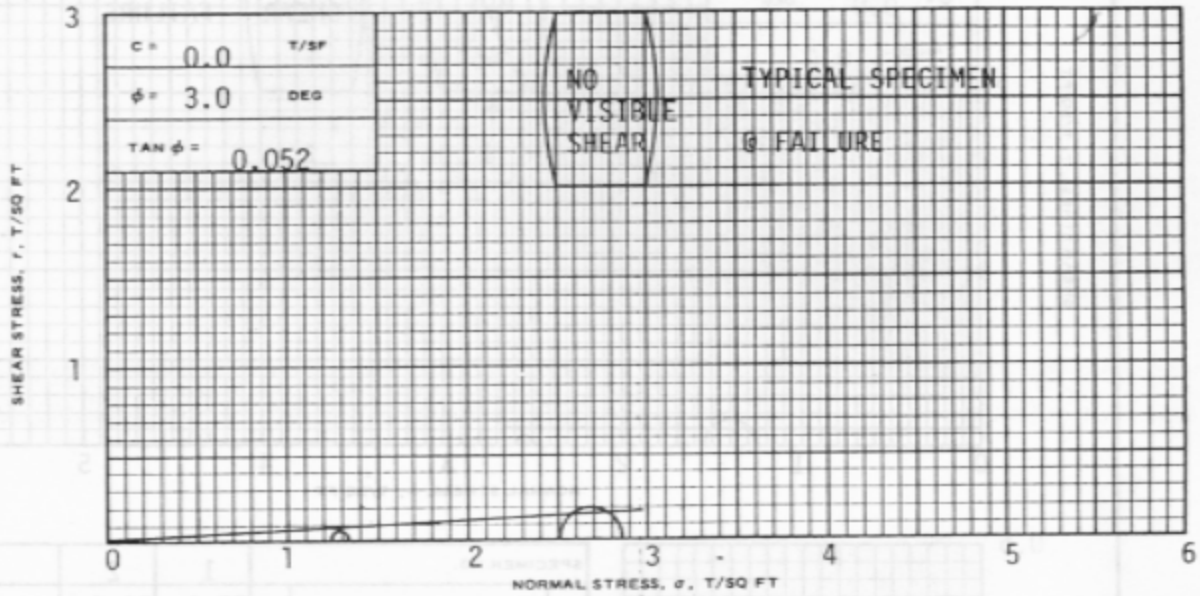
TRIAXIAL COMPRESSION TEST REPORT

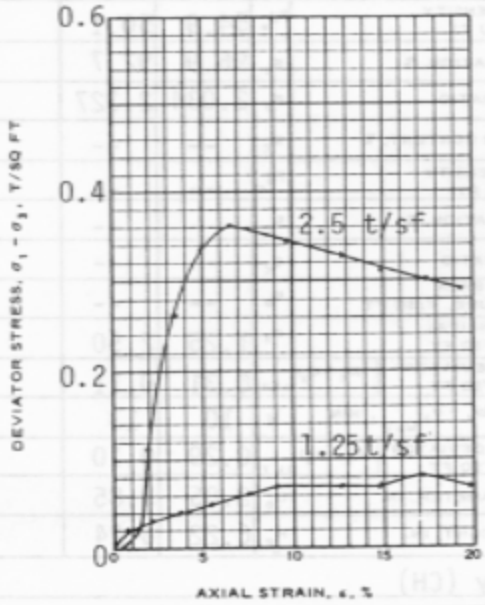
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2		
INITIAL	WATER CONTENT, %	w_o	83.9	77.2		
	DRY DENSITY LB/CU FT	γ_{d_o}	47.5	49.7		
	SATURATION, %	S_o	89.1	87.2		
	VOID RATIO	e_o	2.534	2.380		
BEFORE SHEAR	WATER CONTENT, %	w_c	-	-		
	DRY DENSITY LB/CU FT	γ_{d_c}	-	-		
	SATURATION, %	S_c	-	-		
	VOID RATIO	e_c	-	-		
	FINAL BACK PRESSURE, T/SQ FT	u_b	-	-		
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.07	0.36		
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	12	9		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.07	0.31		
INITIAL DIAMETER, IN.		D_o	2.84	2.85		
INITIAL HEIGHT, IN.		H_o	6.20	6.17		

CONTROLLED TEST: Strain (0.74%/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray, fat clay (CH) w/ sand layers & lenses.

LL -- not requested---- | G_s 2.67 | TYPE OF SPECIMEN Undisturbed | TYPE OF TEST Q

REMARKS: Insufficient material for additional specimen.

PROJECT Craney Island, Norfolk District

Lab. No. 141/467

BORING NO. 86 DH-1 | SAMPLE NO. 5

DEPTH/~~ELEV~~ 86.5-88.5

LABORATORY SADEN-FL | DATE 4 September1986

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

DRILLING LOG	DIVISION CENAD	INSTALLATION CENAO	SHEET 1 OF 1 SHEETS

1. PROJECT: EXTENSION OF CRANEY ISLAND
2. LOCATION (Coordinates or Station): E2626239 N=226111
3. DRILLING AGENCY: BORE AND CORE
4. HOLE NO. (As shown on drawing title and file number): 86DH-2
5. NAME OF DRILLER: MARK SEILERS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 92.5 ft
10. SIZE AND TYPE OF BIT: 2 IN OD SPLITSPOON
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 45B
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12 / UNDISTURBED 4
14. TOTAL NUMBER CORE BOXES: ——
15. ELEVATION GROUND WATER: 0.0
16. DATE HOLE: STARTED / COMPLETED
17. ELEVATION TOP OF HOLE: MSL
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Matthew T Byrne

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d		% SAND	BOX OR SAMPLE NO. f	% WATER
			WATER				
	10						50 100
-16.0	20		(CH) CLAY high plastic very soft, some silt, sat., tr. to little organics, grey	N=WOR	3.6	1	PL LL Wn
				N=WOR	6.8	2	
	30			N=WOR	14.1	3	
	40			N=WOR	.4	4	
				N=WOR	.5	5	
	50			N=WOR	.4	6	
	60			N=WOR	1.3	7	
				N=WOR	.8	8	
	70			N=WOR	8.7	9	
-78	80		(SM-SC) SAND fine tr.-little Silty Clay, moist, grey low to non plastic, interlensed with (SP)	N=20		10	
				N=16		11	
-92.5	92.5		BOH = 92.5 ft	N=17		12	

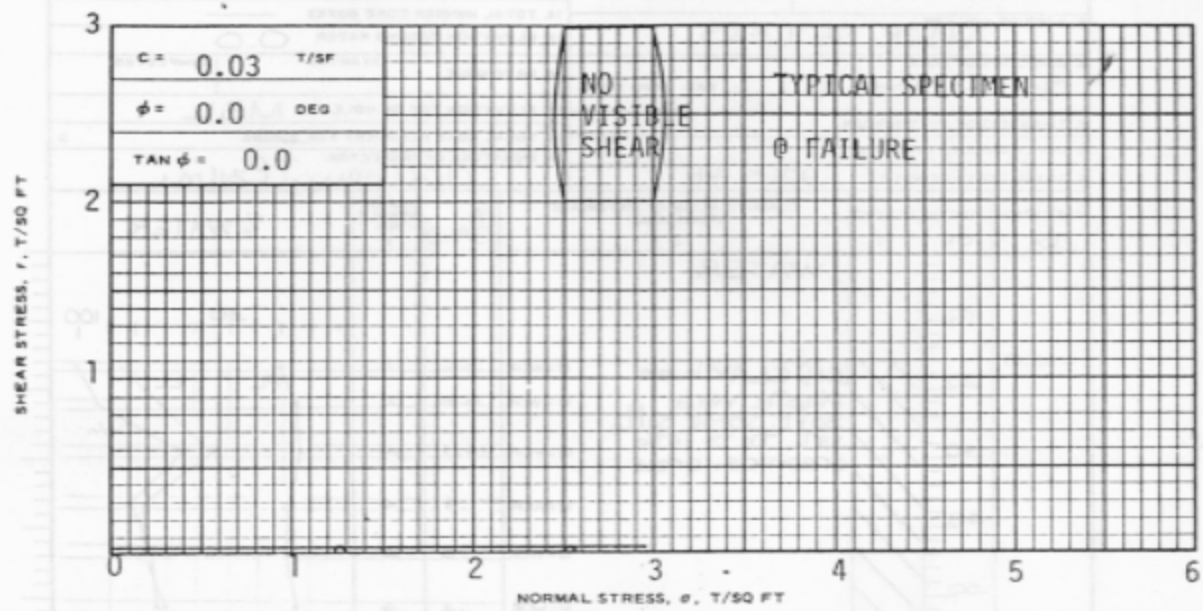
UNDISTURBED PISTON TUBE SAMPLES TAKEN AT THE FOLLOWING DEPTHS:
(1) 26.0' - 28.0'
(2) 41.0' - 43.0'
(3) 56.0' - 58.0'
(4) 71.0' - 73.0'

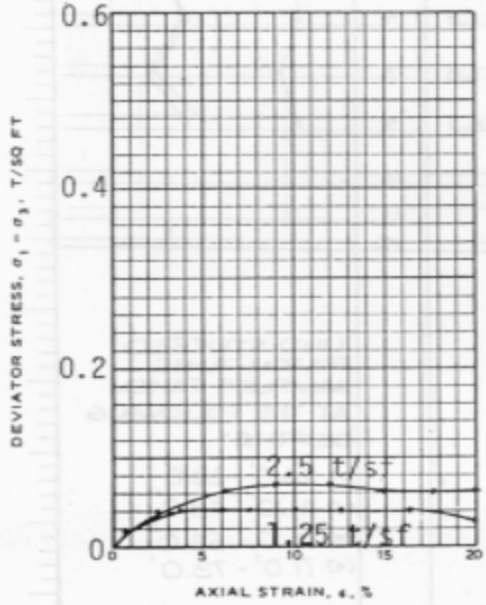
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: EXTENSION OF CRANEY ISLAND | HOLE NO. 86DH 2

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3*	
INITIAL	WATER CONTENT, %	w_o	89.4	81.6		
	DRY DENSITY LB/CU FT	γ_{d_o}	49.4	52.6		
	SATURATION, %	S_o	100.0	100.0		
	VOID RATIO	e_o	2.414	2.202		
BEFORE SHEAR	WATER CONTENT, %	w_c	–	–		
	DRY DENSITY LB/CU FT	γ_{d_c}	–	–		
	SATURATION, %	S_c	–	–		
	VOID RATIO	e_c	–	–		
	FINAL BACK PRESSURE, T/SQ FT	u_o	–	–		
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.04	0.07		
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	5	13		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.04	0.06		
INITIAL DIAMETER, IN.		D_o	2.85	2.86		
INITIAL HEIGHT, IN.		H_o	6.16	6.18		

CONTROLLED-Strain (0.74%/min) TEST

DESCRIPTION OF SPECIMENS (visual) gray fat clay (CH)

LL not - PL requested - - PI - - G_s 2.70

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS: *Insufficient material for third specimen.

PROJECT Craney Island, Norfolk District

Lab. No. 141/469

BORING NO. 86 DH-2 SAMPLE NO. 2

DEPTH/~~ELEV~~ 41.0-43.0

LABORATORY SADEN-FL DATE 4 September 1986

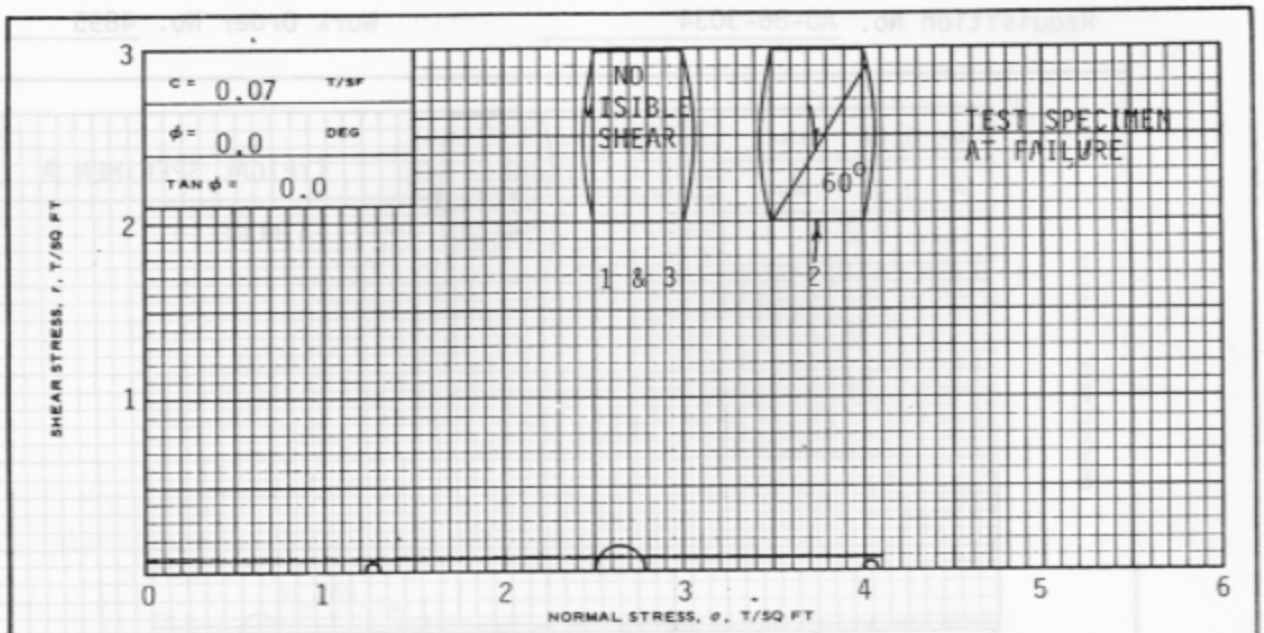
TRIAXIAL COMPRESSION TEST REPORT

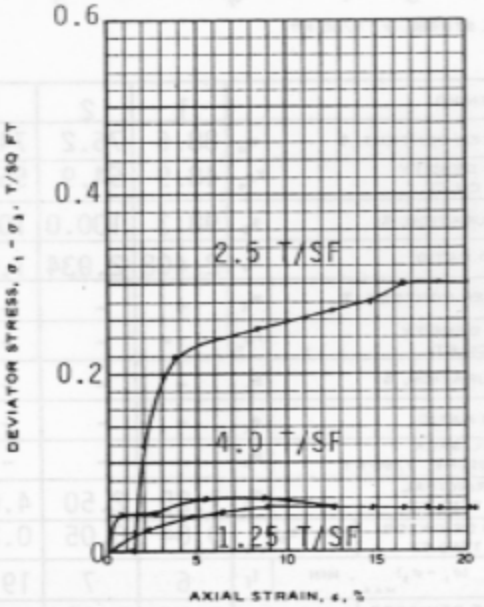
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	88.3	65.6	84.5
	DRY DENSITY LB/CU FT	γd_o	49.5	60.2	51.3
	SATURATION, %	S_o	99.1	98.7	99.9
	VOID RATIO	e_o	2.396	1.788	2.275
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γd_c	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.05	0.28	0.06
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	12	20	7
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.05	0.28	0.05
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED TEST: Strain (0.74 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray Fat Clay (CH)

LL ---NOT REQUESTED---- PL ---NOT REQUESTED---- G_s 2.69

TYPE OF SPECIMEN: Undisturbed TYPE OF TEST: Q

REMARKS:

PROJECT: Craney Island, Norfolk District

Lab. No. 141/470

BORING NO. 86 DH-2 SAMPLE NO. 3

DEPTH 56.0 - 58.0

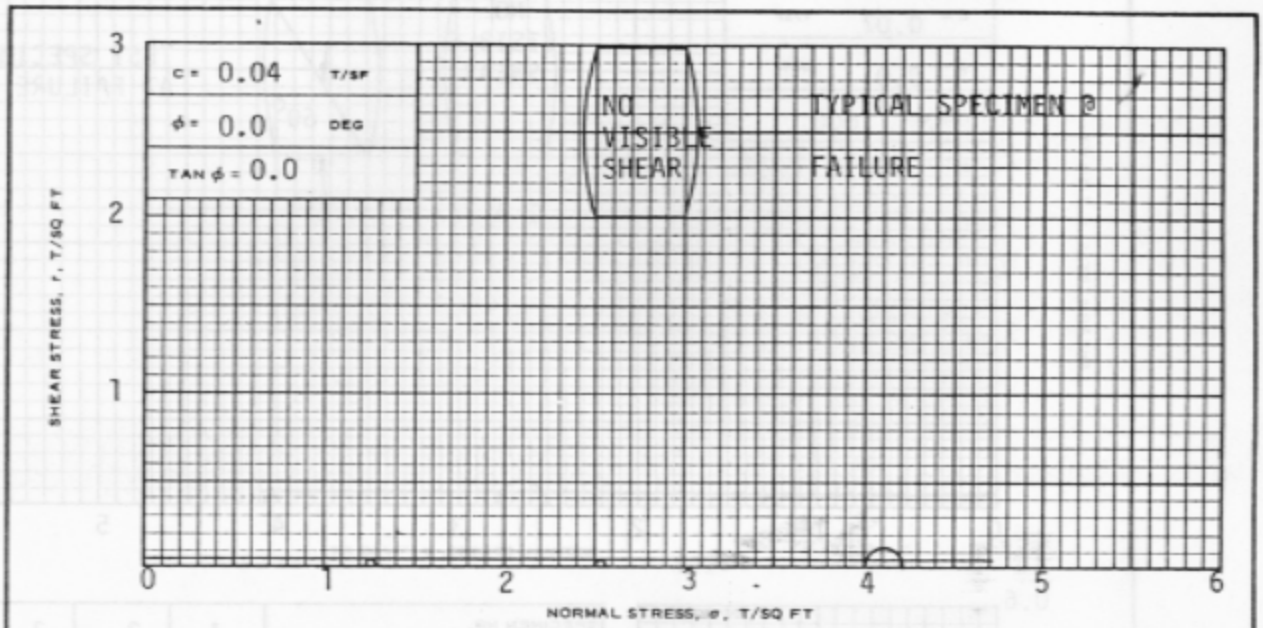
LABORATORY SADEN-FL DATE 4 September 1986

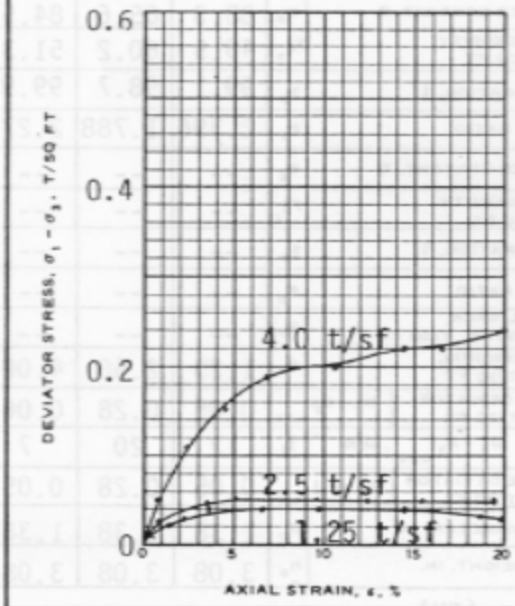
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	88.6	76.2	74.5	
	DRY DENSITY LB/CU FT	γd_o	48.9	54.9	55.8	
	SATURATION, %	S_o	98.3	100.0	100.0	
	VOID RATIO	e_o	2.408	2.034	1.988	
BEFORE SHEAR	WATER CONTENT, %	w_c	–	–	–	
	DRY DENSITY LB/CU FT	γd_c	–	–	–	
	SATURATION, %	S_c	–	–	–	
	VOID RATIO	e_c	–	–	–	
	FINAL BACK PRESSURE, T/SQ FT	u_b	–	–	–	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.04	0.05	0.22	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	6	7	19	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.04	0.05	0.22	
INITIAL DIAMETER, IN.		D_o	2.86	2.85	2.84	
INITIAL HEIGHT, IN.		H_o	6.14	6.24	6.09	

CONTROLLED Strain (0.75%/min) TEST

DESCRIPTION OF SPECIMENS (Visual) gray, fat clay (CH)

LL not - PL requested -- G. 2.67

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/471

BORING NO. 86 DH-2 SAMPLE NO. 4

DEPTH/~~XXXX~~ 71.0-73.0

LABORATORY SADEN-FL DATE 4 September 1986

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

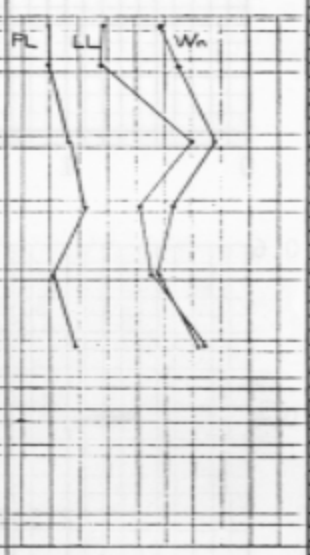
Attachment 1

Hole No. 86DH-3

DRILLING LOG	DIVISION CENAD	INSTALLATION CENAO	SHEET 1 OF 1 SHEETS

1. PROJECT EXTENSION OF CRANEY ISLAND	10. SIZE AND TYPE OF BIT 2 IN OD SPLITSPOON
2. LOCATION (Coordinates or Station) E2623633 N226111	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY BORE AND CORE	12. MANUFACTURER'S DESIGNATION OF DRILL CME 45B
4. HOLE NO. (As shown on drawing title and file number) 86DH3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 10, UNDISTURBED 5
5. NAME OF DRILLER MARK SEILERS	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 17JUL86, COMPLETED 17JUL86
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE MSL
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 99.0 ft	19. SIGNATURE OF INSPECTOR M Matthew T Byrne

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d		% SAND	BOX OR SAMPLE NO. f	% WATER
			WATER				
	10						
	20						
-23.3			(CH) CLAY high plastic, very soft, some silt, sat., trace organic	N=WOR	26.8		
	30			N=WOR	23.7	2	
	40			N=WOR	1.9	3	
	50			N=WOR	3.1	4	
	60			N=WOR	19.9	5	
-69.5	70		(SC-CH) CLAY high plastic, soft interlayered with (SM) fine silty Sand and (SC) fine clayey Sand	N=WOH	25.0	6	
	80			N=2		7	
				N=2		8	
	90			N=2		9	
-99.0			(SP) SAND fine to medium, non plas., tr. shell, trace gravel	N=23		10	
			BOH = 99.0 ft				



UNDISTURBED PISTON TUBE SAMPLES TAKEN AT THE FOLLOWING DEPTHS:

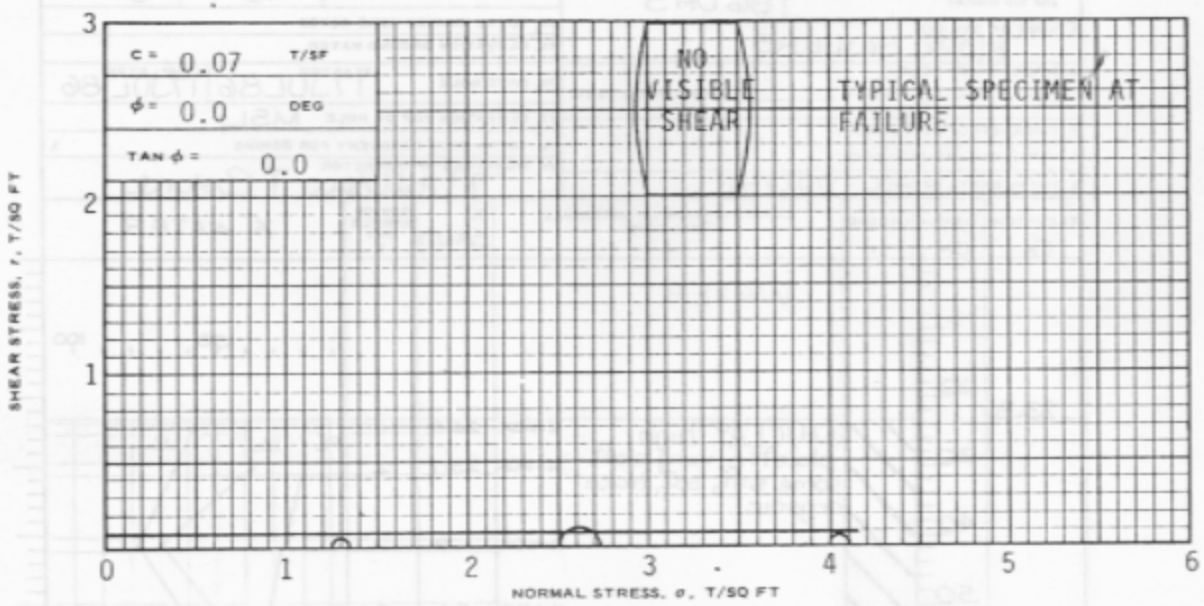
(1) 34.5'-36.5'
(2) 44.5'-46.5'
(3) 54.5'-56.5'
(4) 64.5'-66.5'
(5) 86.0'-88.0'

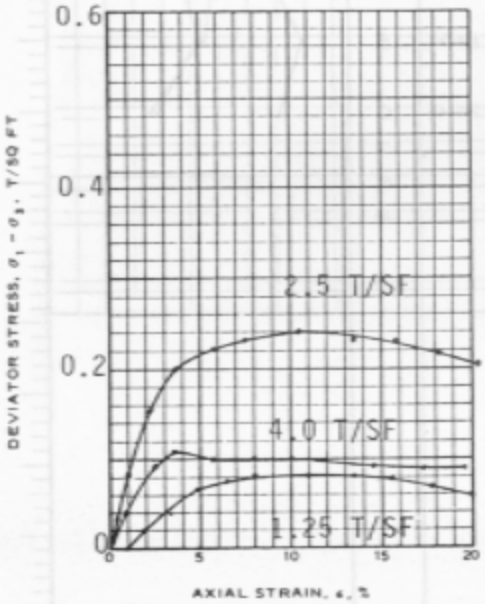
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT EXTENSION OF CRANEY ISLAND | HOLE NO. 86DH-3

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	76.4	51.3	66.7	
	DRY DENSITY LB/CU FT	γd_o	54.1	69.1	60.0	
	SATURATION, %	S_o	97.7	96.5	99.7	
	VOID RATIO	e_o	2.104	1.430	1.799	
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--	
	DRY DENSITY LB/CU FT	γd_c	--	--	--	
	SATURATION, %	S_c	--	--	--	
	VOID RATIO	e_c	--	--	--	
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.08	0.24	0.11	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	11	14	4	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.08	0.23	0.09	
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38	
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08	

CONTROLLED TEST: Strain (0.76 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray Fat Clay (CH)

LL ---NOT PL REQUESTED --- Gs 2.69

TYPE OF SPECIMEN: Undisturbed TYPE OF TEST: Q

REMARKS:

PROJECT: Craney Island, Norfolk District

Lab. No. 141/472

BORING NO. 86 DH-3 SAMPLE NO. 1

DEPTH 34.5 - 36.5

LABORATORY SADEN-FL DATE 4 September 1986

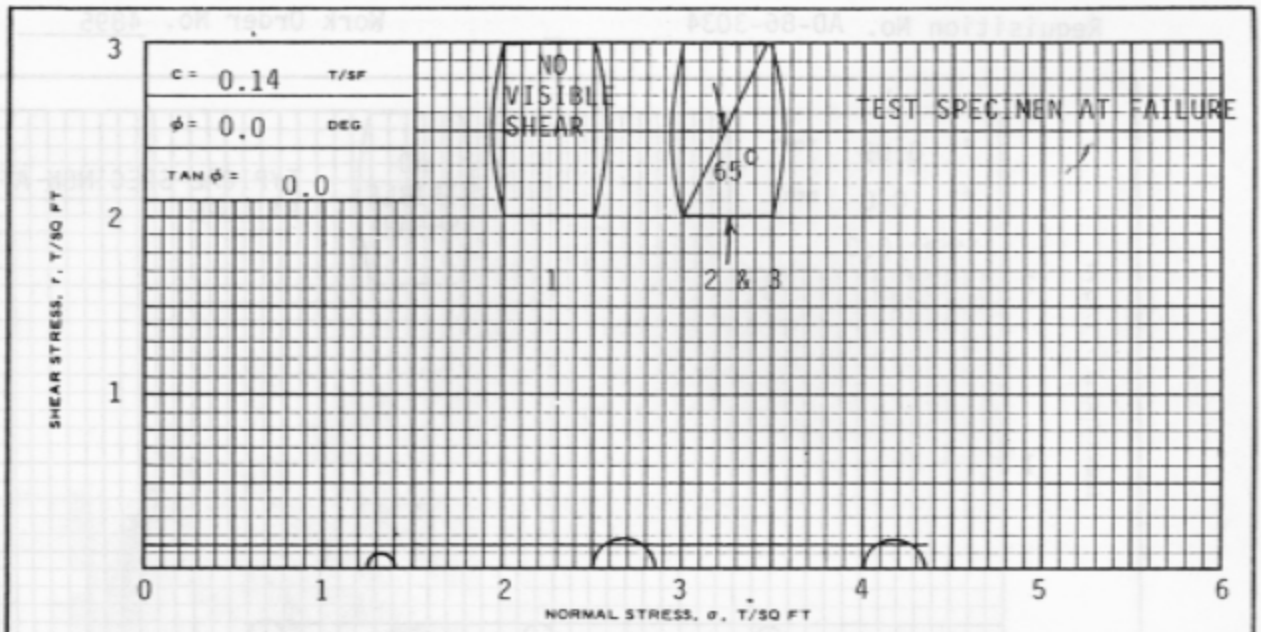
TRIAXIAL COMPRESSION TEST REPORT

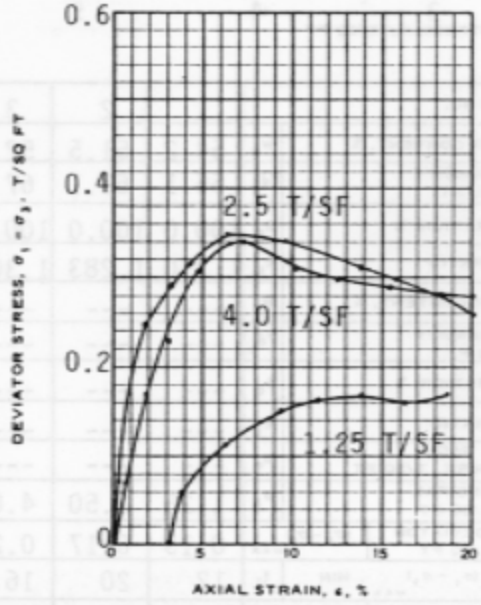
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	73.8	73.9	73.2
	DRY DENSITY LB/CU FT	γ_{d_o}	55.8	55.6	56.0
	SATURATION, %	S_o	98.9	98.6	98.8
	VOID RATIO	e_o	2.000	2.009	1.987
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.17	0.35	0.34
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	19	9	10
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.17	0.30	0.29
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED Strain (0.74 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray Fat Clay (CH)

LL ---NOT REQUESTED--- G_s 2.68

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/473

BORING NO. 86 DH-3 SAMPLE NO. 2

DEPTH XXXX 44.5 - 46.5

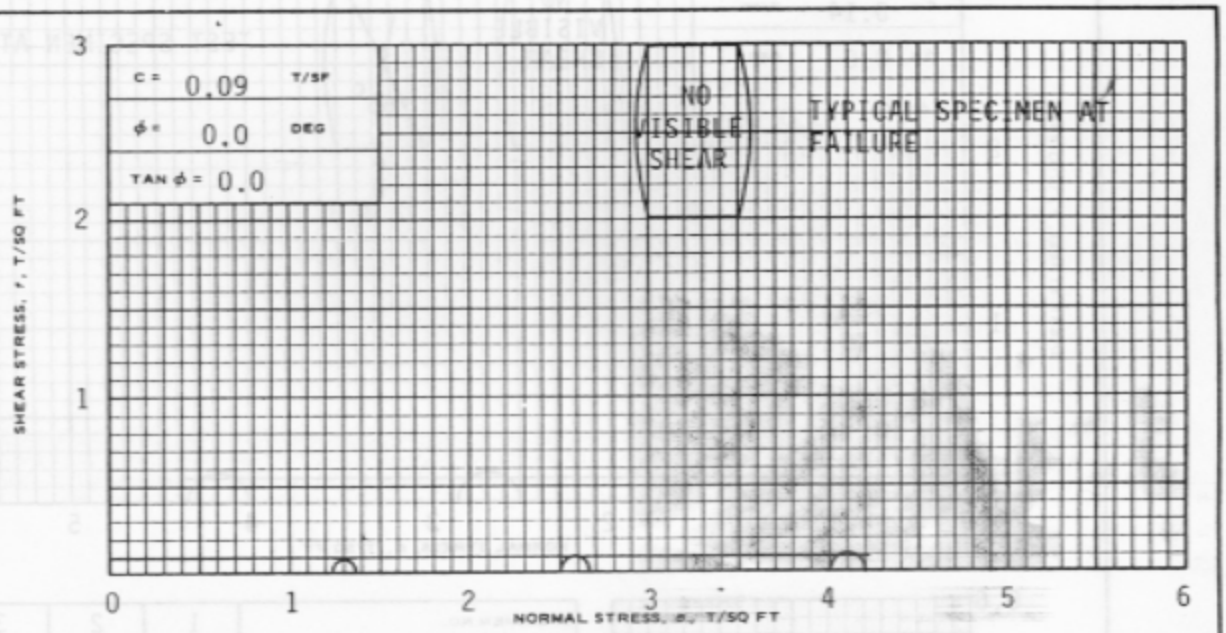
LABORATORY SADEN-FL DATE 4 September 1986

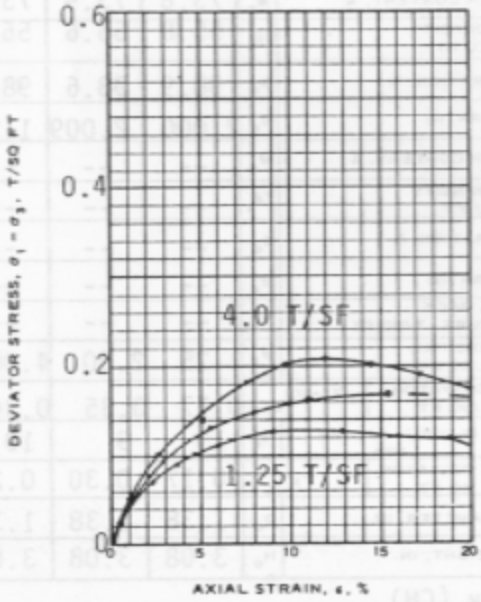
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	54.2	51.5	52.5
	DRY DENSITY LB/CU FT	γd_o	66.1	68.1	67.4
	SATURATION, %	S_o	100.0	100.0	100.0
	VOID RATIO	e_o	1.350	1.283	1.308
BEFORE SHEAR	WATER CONTENT, %	w_c	---	---	---
	DRY DENSITY LB/CU FT	γd_c	---	---	---
	SATURATION, %	S_c	---	---	---
	VOID RATIO	e_c	---	---	---
	FINAL BACK PRESSURE, T/SQ FT	u_b	---	---	---
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.13	0.17	0.21
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	12	20	16
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.12	0.17	0.20
INITIAL DIAMETER, IN.		D_o	2.83	2.84	2.84
INITIAL HEIGHT, IN.		H_o	6.04	6.04	6.15

CONTROLLED- Strain (0.75 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH), w/organic matter

LL ---Not PL Requested----- G_s 2.49

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/474

BORING NO. 86 DH-3 SAMPLE NO. 3

DEPTH 54.5-56.5

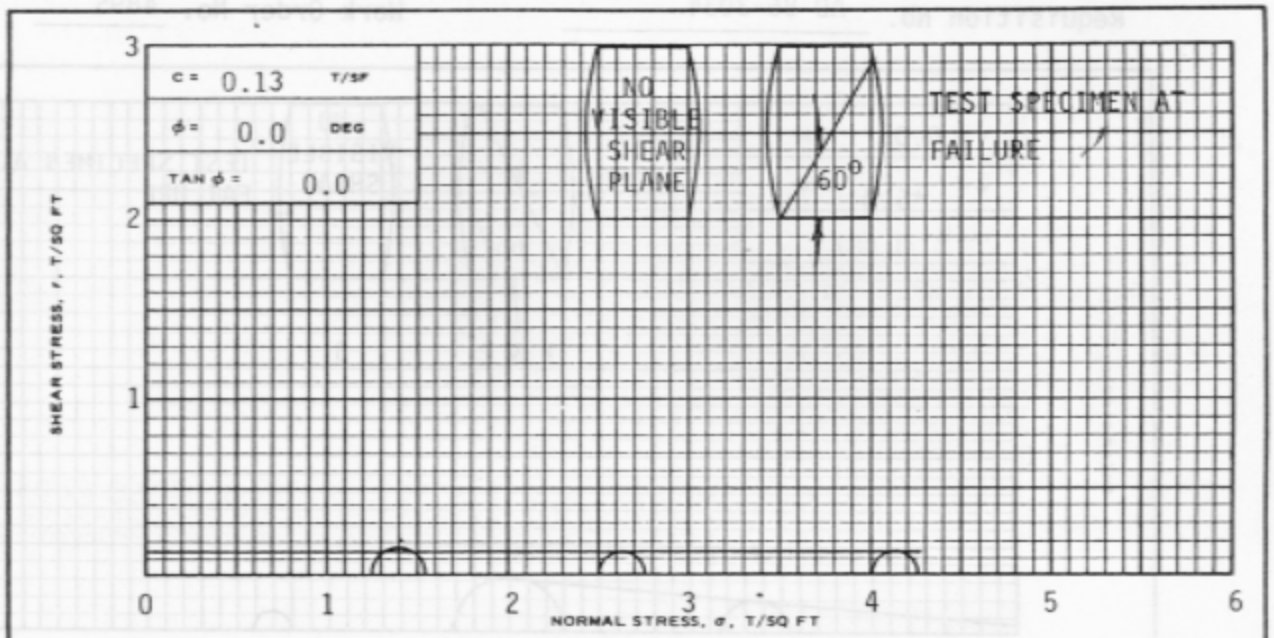
LABORATORY SADEN-FL DATE 4 September 1986

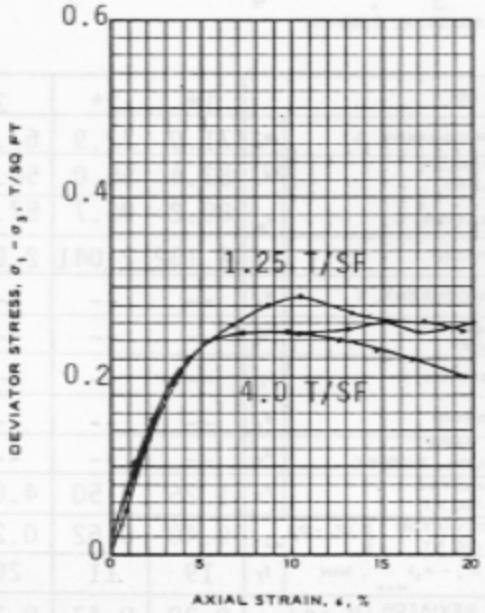
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	61.6	69.2	74.7
	DRY DENSITY LB/CU FT	γ_{d_o}	61.2	57.9	51.5
	SATURATION, %	S_o	95.5	98.4	89.3
	VOID RATIO	e_o	1.723	1.878	2.235
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.29	0.26	0.25
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	14	21	10
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.26	0.26	0.23
INITIAL DIAMETER, IN.		D_o	2.85	2.84	2.85
INITIAL HEIGHT, IN.		H_o	6.16	6.26	6.17

CONTROLLED Strain (0.72 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL ---Not PL Requested PI ------ G_s 2.67

TYPE OF SPECIMEN Unidsturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/475

BORING NO. 86 DH-3 SAMPLE NO. 4

DEPTH 64.5-65.5

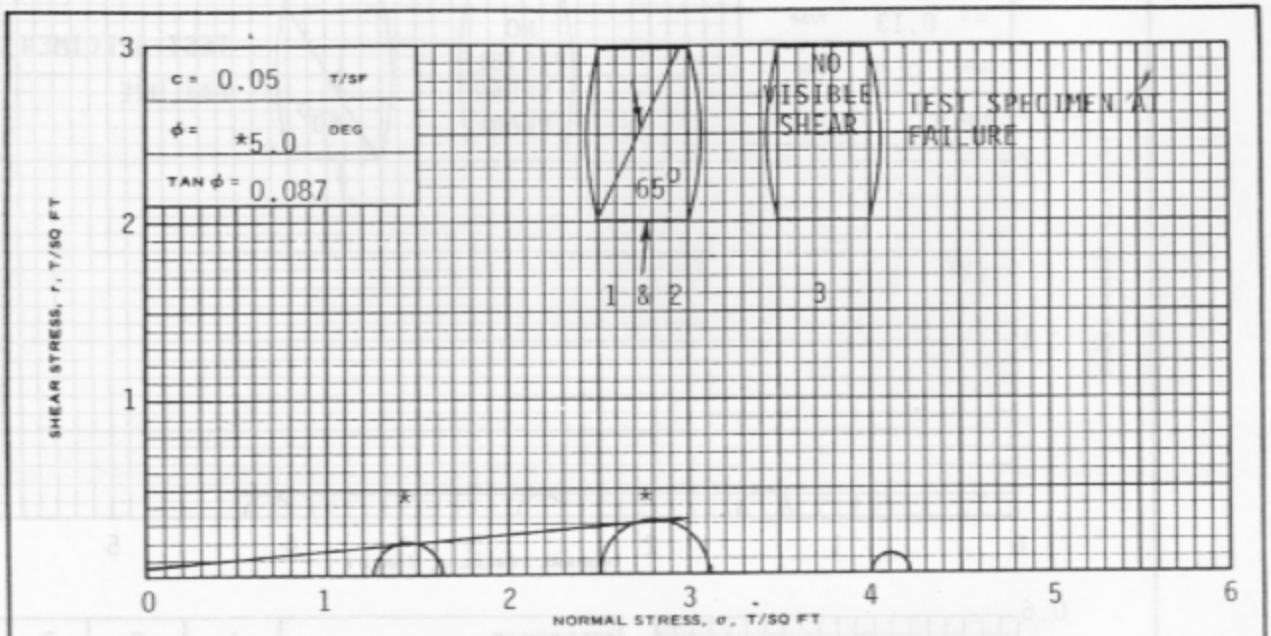
LABORATORY SADEN-FL DATE 4 September 1986

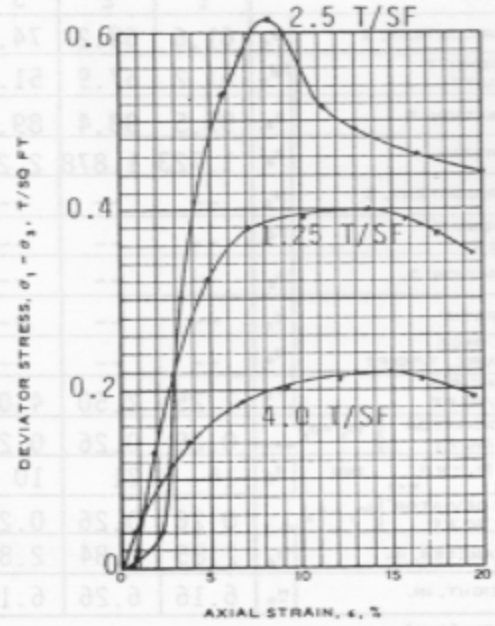
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1*	2*	3
INITIAL	WATER CONTENT, %	w_o	71.0	72.9	67.1
	DRY DENSITY LB/CU FT	γd_o	53.4	55.0	54.9
	SATURATION, %	S_o	89.2	95.7	87.8
	VOID RATIO	e_o	2.132	2.041	2.049
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γd_c	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.40	0.62	0.22
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	19	11	20
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.39	0.47	0.20
INITIAL DIAMETER, IN.		D_o	2.85	2.86	2.85
INITIAL HEIGHT, IN.		H_o	6.22	6.13	6.03

CONTROLLED TEST: Strain (0.74 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray Fat Clay (CH) w/some sand lenses & layers

LL --- NOT REQUESTED --- G_s 2.68

TYPE OF SPECIMEN: Undisturbed TYPE OF TEST: Q

REMARKS: *NOTE: Test Specimens 1 & 2 contained more sand than specimen 3.

PROJECT: Craney Island, Norfolk District

Lab. No. 141/476

BORING NO. 86 DH-3 SAMPLE NO. 5

DEPTH/~~ELEV~~ 84.0 - 86.0

LABORATORY SADEN-FL DATE 4 September 1986

TRIAXIAL COMPRESSION TEST REPORT

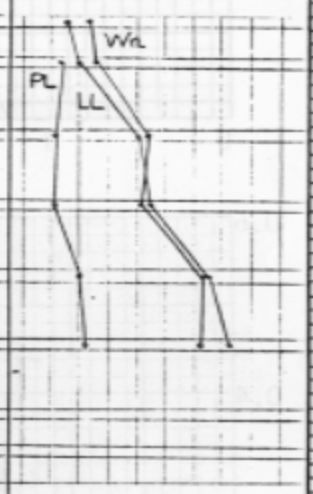
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Hole No. [illegible]

DRILLING LOG	DIVISION CENAD	INSTALLATION CENAO	SHEET 1 OF 1 SHEETS

1. PROJECT EXTENSION OF CRANEY ISLAND	10. SIZE AND TYPE OF BIT 2 IN OD SPLITSPOON
2. LOCATION (Coordinates or Station) E2615983 N222137	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY BORE AND CORE	12. MANUFACTURER'S DESIGNATION OF DRILL CME 45B
4. HOLE NO. (As shown on drawing title and file number) 86DH4	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 8; UNDISTURBED 5
5. NAME OF DRILLER MARK SEILERS	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 22 JUL 86; COMPLETED 22 JUL 86
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE MSL
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 96.5'	19. SIGNATURE OF INSPECTOR Matthew T Byrne

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d		% SAND	BOX OR SAMPLE NO. f	% WATER
0.0	0		WATER				
	10						
	20						
-30.0	30		(SM) SAND fine, some silt, tr. Clay, wet, grey, interlensed w/(SC)	N=WOR	60.3	1	
				N=WOR	41.4	2	
-42.0	40		(CH) CLAY high Plastic, tr. very fine Sand, sat., grey, tr organics, some silt				
	50			N=WOR	12.6	3	
	60			N=WOR	7.5	4	
	70		tr. brown fibrous organics	N=WOR	1.9	5	
	80		tr. fine Sand in lenses	N=WOR	4.1	6	
-86.0	90		(SP-SM) SAND fine to coarse, lt gravel, non Plastic, brown/grey [1]	N=19		7	
-96.5				N=2		8	
			BOH = 96.5 ft				



[1] ATTEMPTED TO WASH TO 96.5' USING CHEMICAL GEL AND BENTONITE.... SAND RAN 30' UP AUGER WHILE RENOVING DRILLROD.

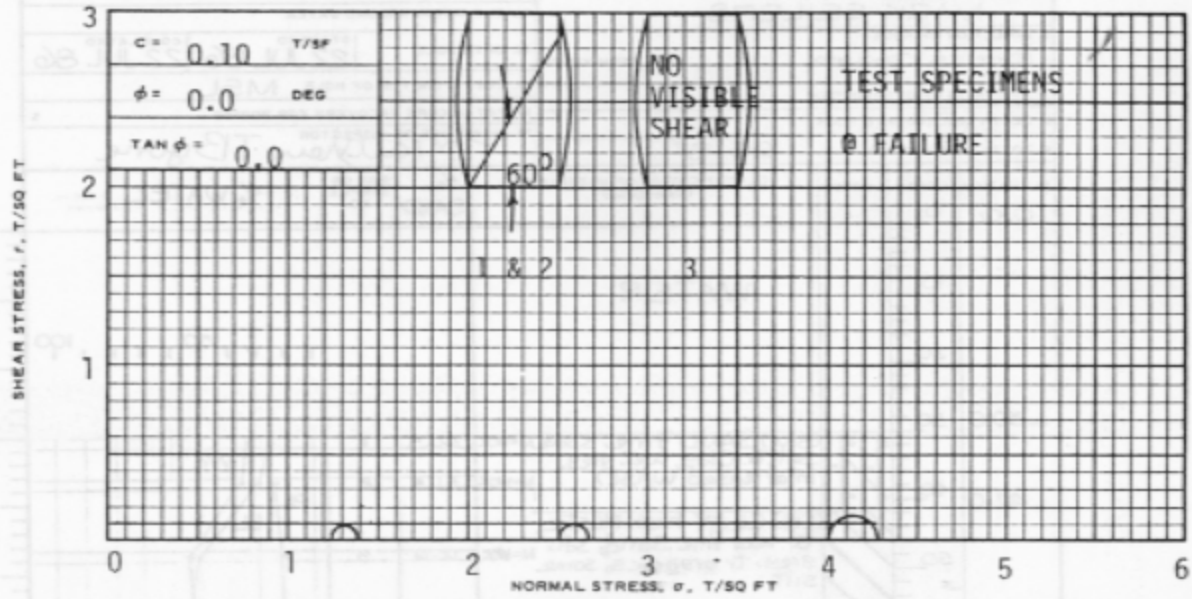
UNDISTURBED PISTON TUBE SAMPLES TAKEN AT THE FOLLOWING DEPTHS:
(1) 41.5'-43.5'
(2) 51.5'-53.5'
(3) 61.5'-63.5'
(4) 71.5'-73.5'
(5) 81.5'-83.5'

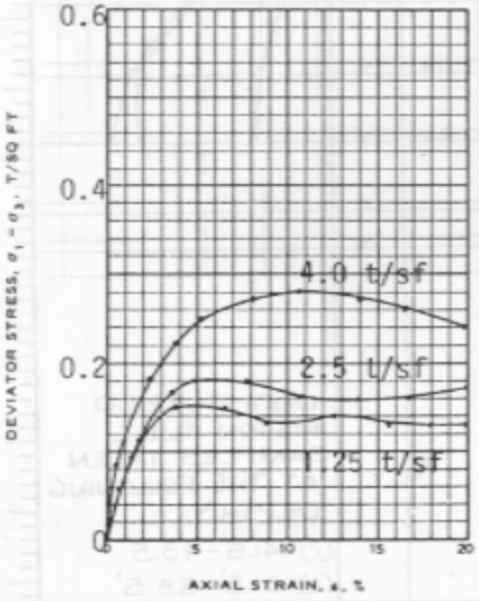
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT EXTENSION OF CRANEY ISLAND | HOLE NO. 86DH4

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	42.9	42.7	39.6
	DRY DENSITY LB/CU FT	γd_o	78.0	78.1	81.3
	SATURATION, %	S_o	100.0	100.0	100.0
	VOID RATIO	e_o	1.154	1.149	1.065
BEFORE SHEAR	WATER CONTENT, %	w_c	-	-	-
	DRY DENSITY LB/CU FT	γd_c	-	-	-
	SATURATION, %	S_c	-	-	-
	VOID RATIO	e_c	-	-	-
	FINAL BACK PRESSURE, T/SQ FT	u_o	-	-	-
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.15	0.18	0.28
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	5	7	14
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.13	0.16	0.27
INITIAL DIAMETER, IN.		D_o	2.85	2.86	2.85
INITIAL HEIGHT, IN.		H_o	6.22	6.16	6.22

CONTROLLED TEST: Strain (0.74%/min)

DESCRIPTION OF SPECIMENS: (Visual) gray, fat clay (CH)

LL -- not requested PL ---- G_s 2.69

TYPE OF SPECIMEN: Undisturbed TYPE OF TEST: Q

REMARKS:

PROJECT: Craney Island, Norfolk District

Lab. No. 141/477

BORING NO. 86 DH-4 SAMPLE NO. 1

DEPTH 41.5-43.5

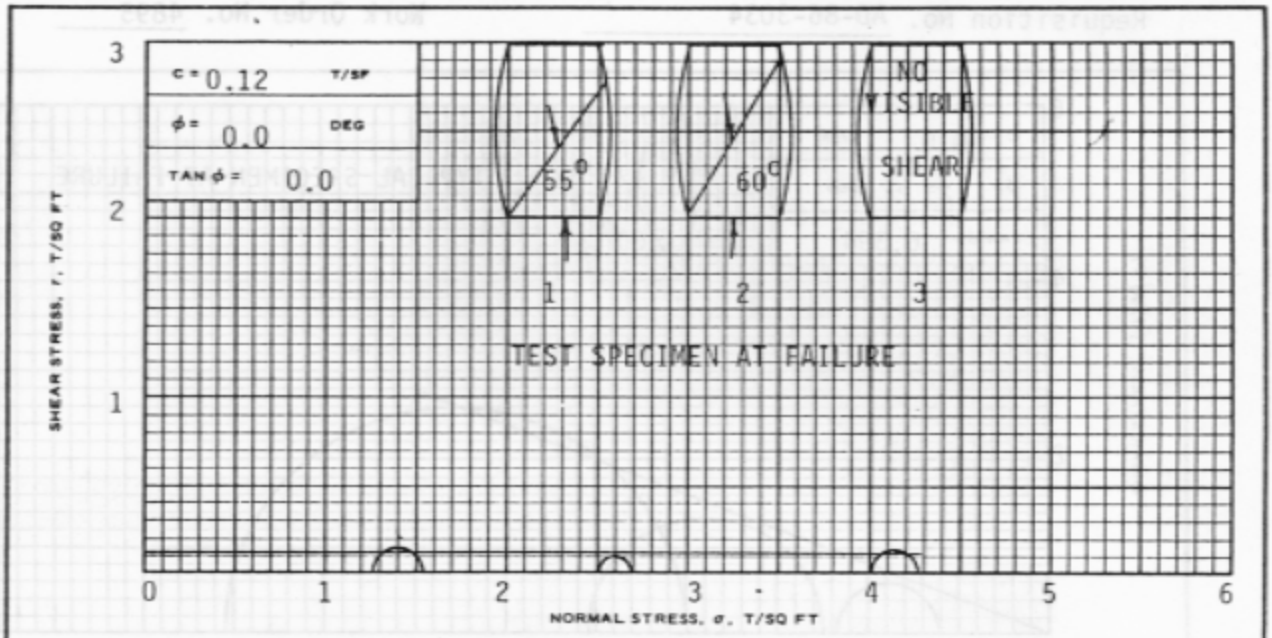
LABORATORY: SADEN-FL DATE: 4 September 1986

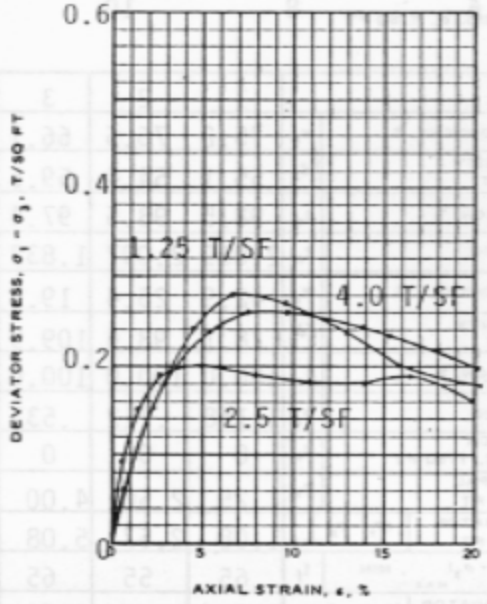
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	59.5	67.2	71.1
	DRY DENSITY LB/CU FT	γd_o	63.9	59.4	57.2
	SATURATION, %	S_o	98.1	98.8	98.6
	VOID RATIO	e_o	1.638	1.837	1.948
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γd_c	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_b	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.28	0.20	0.26
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	9	7	10
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.21	0.18	0.24
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED Strain (0.75 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray Fat Clay (CH)

LL---Not Requested PL----- G_s 2.70

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/478

BORING NO. 86 DH-4 SAMPLE NO. 2

DEPTH 51.5-53.5

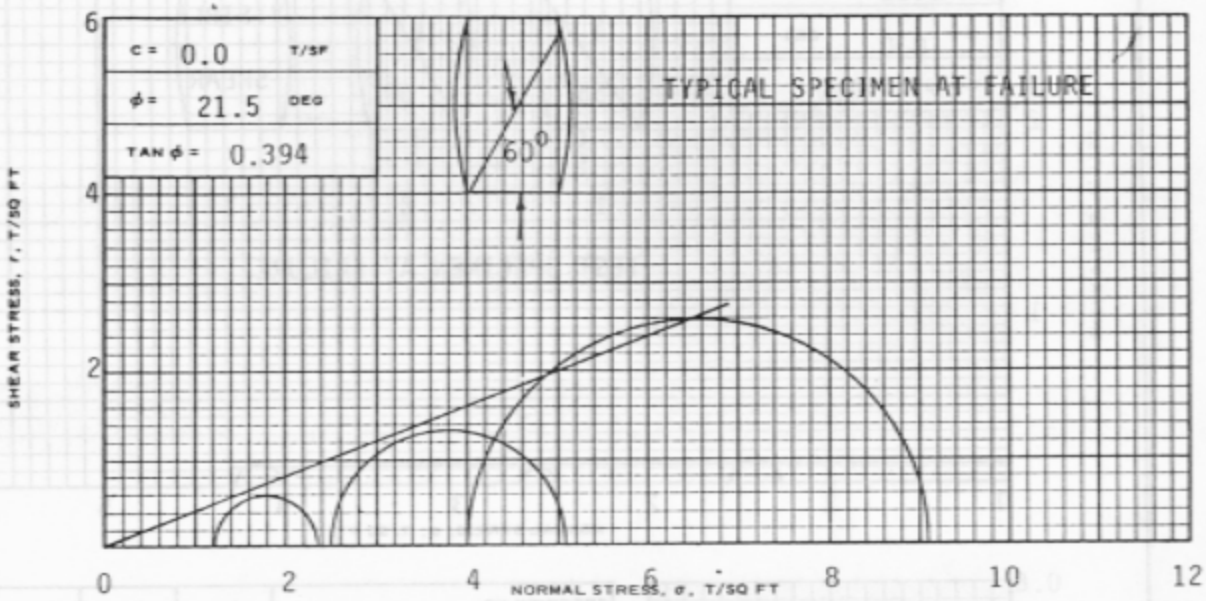
LABORATORY SADEN-FL DATE 4 September 1986

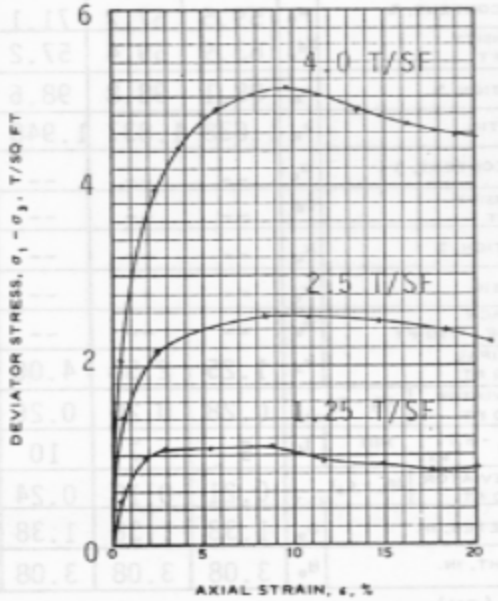
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	75.2	76.5	66.1
	DRY DENSITY LB/CU FT	γ_{d_o}	55.1	54.4	59.5
	SATURATION, %	S_o	98.5	98.5	97.4
	VOID RATIO	e_o	2.059	2.097	1.833
BEFORE SHEAR	WATER CONTENT, %	w_c	42.9	26.4	19.7
	DRY DENSITY LB/CU FT	γ_{d_c}	78.1	98.4	109.9
	SATURATION, %	S_c	100.0	100.0	100.0
	VOID RATIO	e_c	1.158	.712	.533
	FINAL BACK PRESSURE, T/SQ FT	u_o	0	0	0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.08	2.57	5.08
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	65	55	65
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.88	2.45	4.75
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED-Strain (0.15 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray Fat Clay (CH)

LL ----Not Requested---- PL ----- PI ----- G_s 2.70

TYPE OF SPECIMEN Undisturbed TYPE OF TEST NAT R

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/478

BORING NO. 86 DH-4 SAMPLE NO. Tube 2

DEPTH/ELEV 51.5 - 53.5

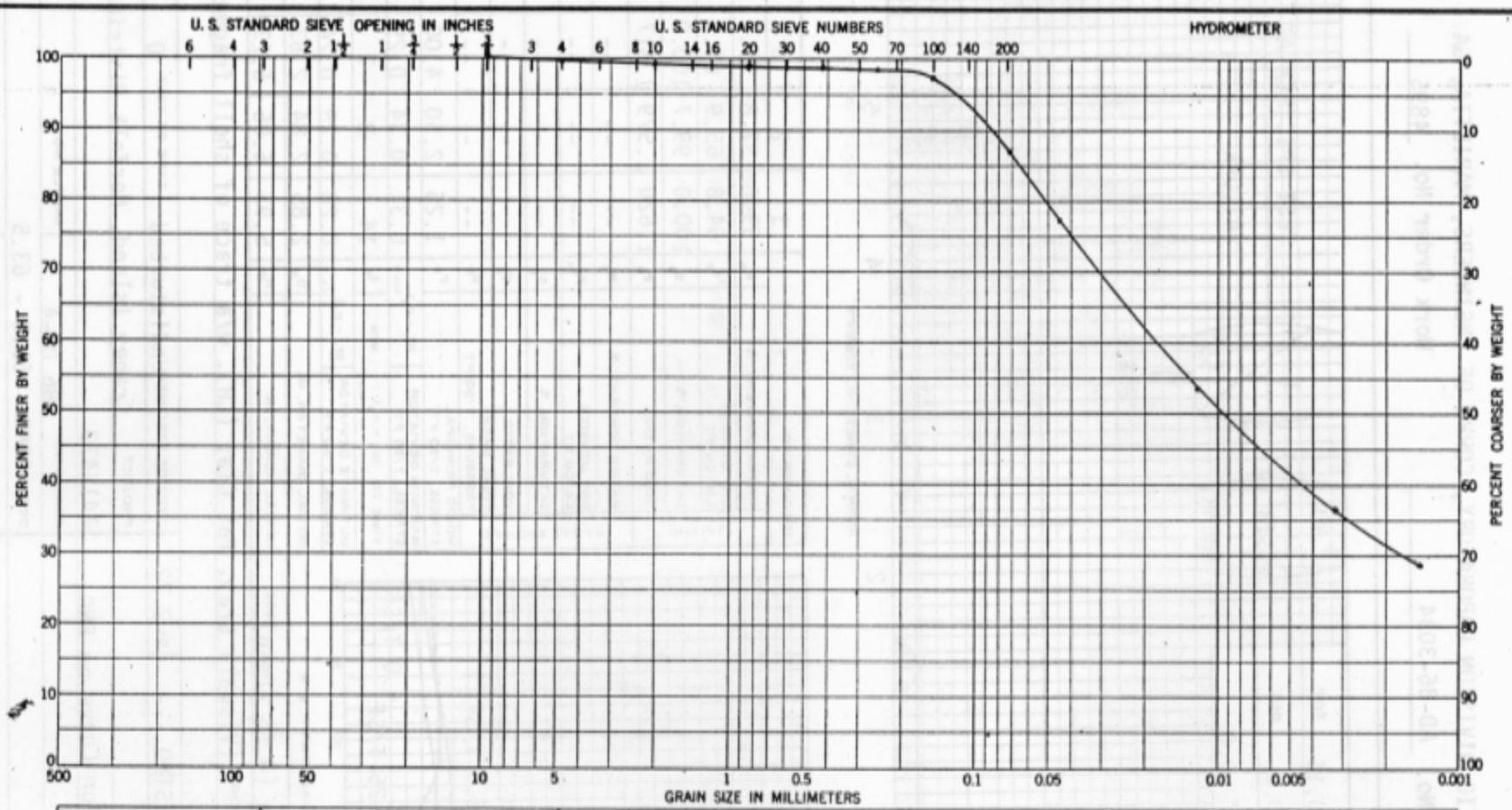
LABORATORY SADEN-FL DATE 4 September 1986

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GEORGIA

Requisition No. AD-86-3034 Work Order No. 4895



Sample No.	Depth	(Visual) Classification	Nat w %	LL	PL	PI
3	61.5 - 63.5	Gray, Fat Clay (CH), w/a trace of shell fragments	58.9	NOT	REQUESTED	

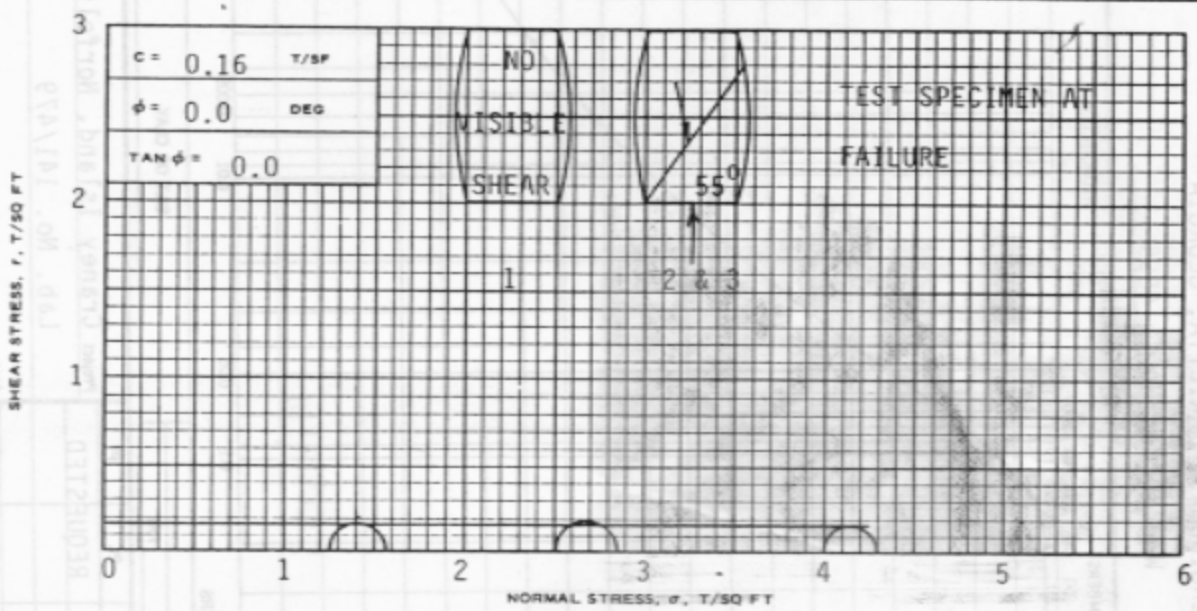
Project Craney Island, Norfolk District
Lab. No. 141/479
Area
Boring No. 86 DH-4, Sample No. 3
Date 4 September 1986

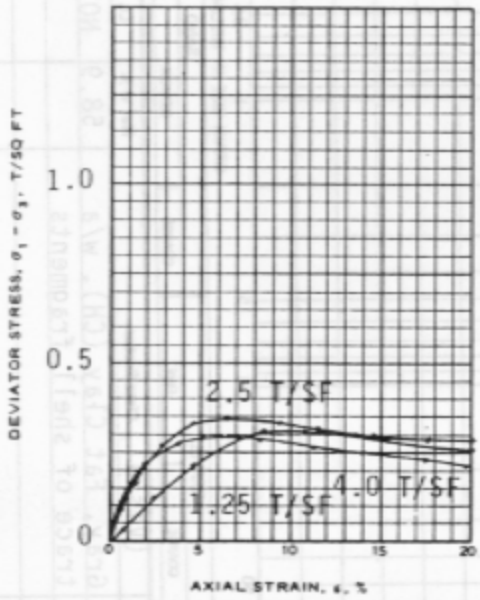
GRADATION CURVES

ENG FORM 1 MAY 63 2087

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	59.6	57.8	59.4
	DRY DENSITY LB/CU FT	γd_o	64.8	65.9	64.9
	SATURATION, %	S_o	100.0	99.7	100.0
	VOID RATIO	e_o	1.620	1.579	1.617
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γd_c	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	U_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.31	0.34	0.29
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	14	8	7
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.28	0.29	0.24
INITIAL DIAMETER, IN.		D_o	2.85	2.84	2.83
INITIAL HEIGHT, IN.		H_o	5.93	6.05	6.23

CONTROLLED TEST: Strain (0.75 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray, Fat Clay (CH), w/a trace of shell fragments.

LL ---NOT REQUESTED--- PL ---NOT REQUESTED--- G_s 2.72

TYPE OF SPECIMEN: Undisturbed TYPE OF TEST: Q

REMARKS:

1. See Gradation Curve on ENG Form 2087.

PROJECT: Craney Island, Norfolk District 141/479

BORING NO. 86 DH-4 SAMPLE NO. 3

DEPTH 61.5 - 63.5

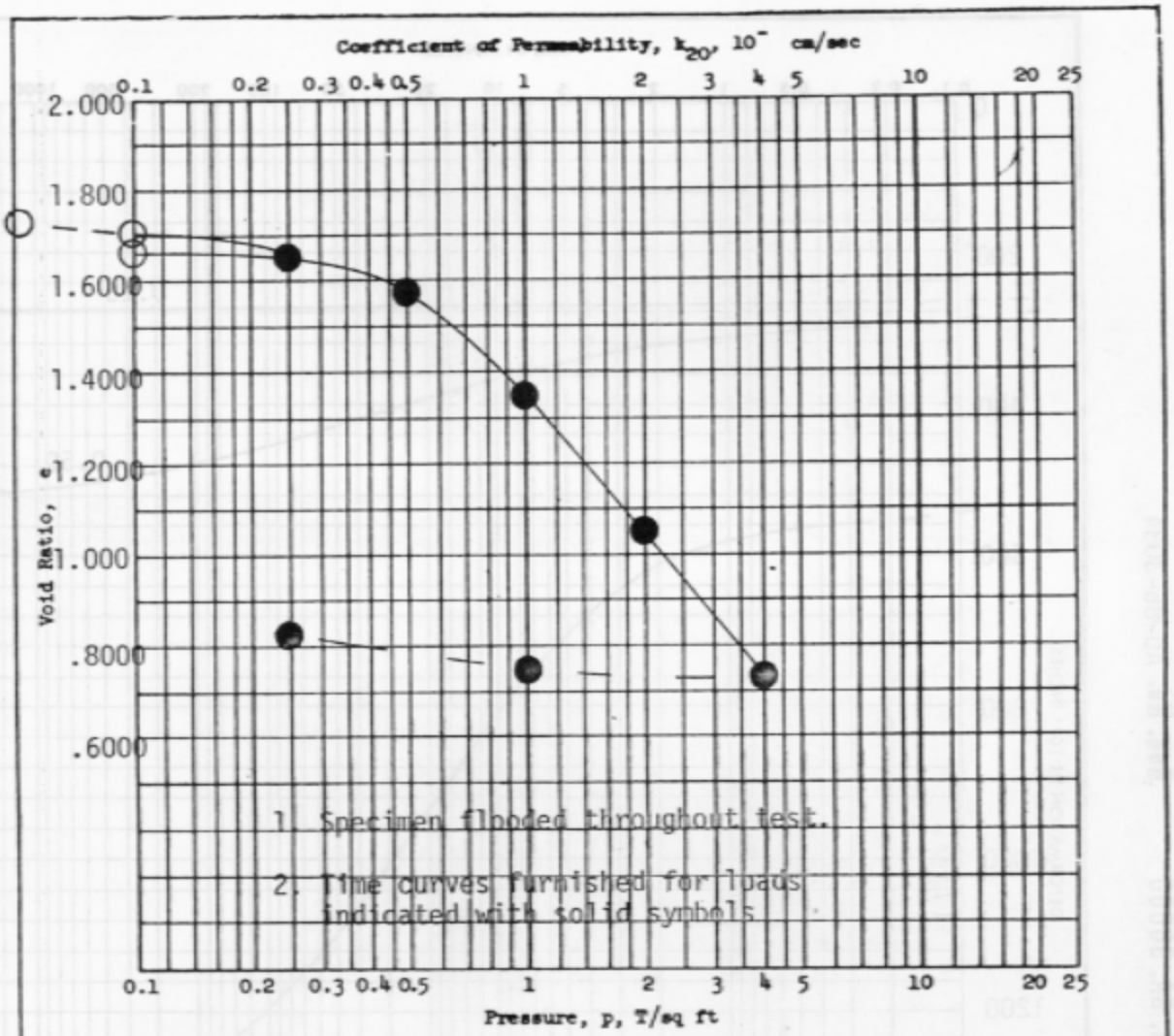
LABORATORY SADEN-FL DATE 4 September 1986

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 4895
REQ. NO. AD-86-3034



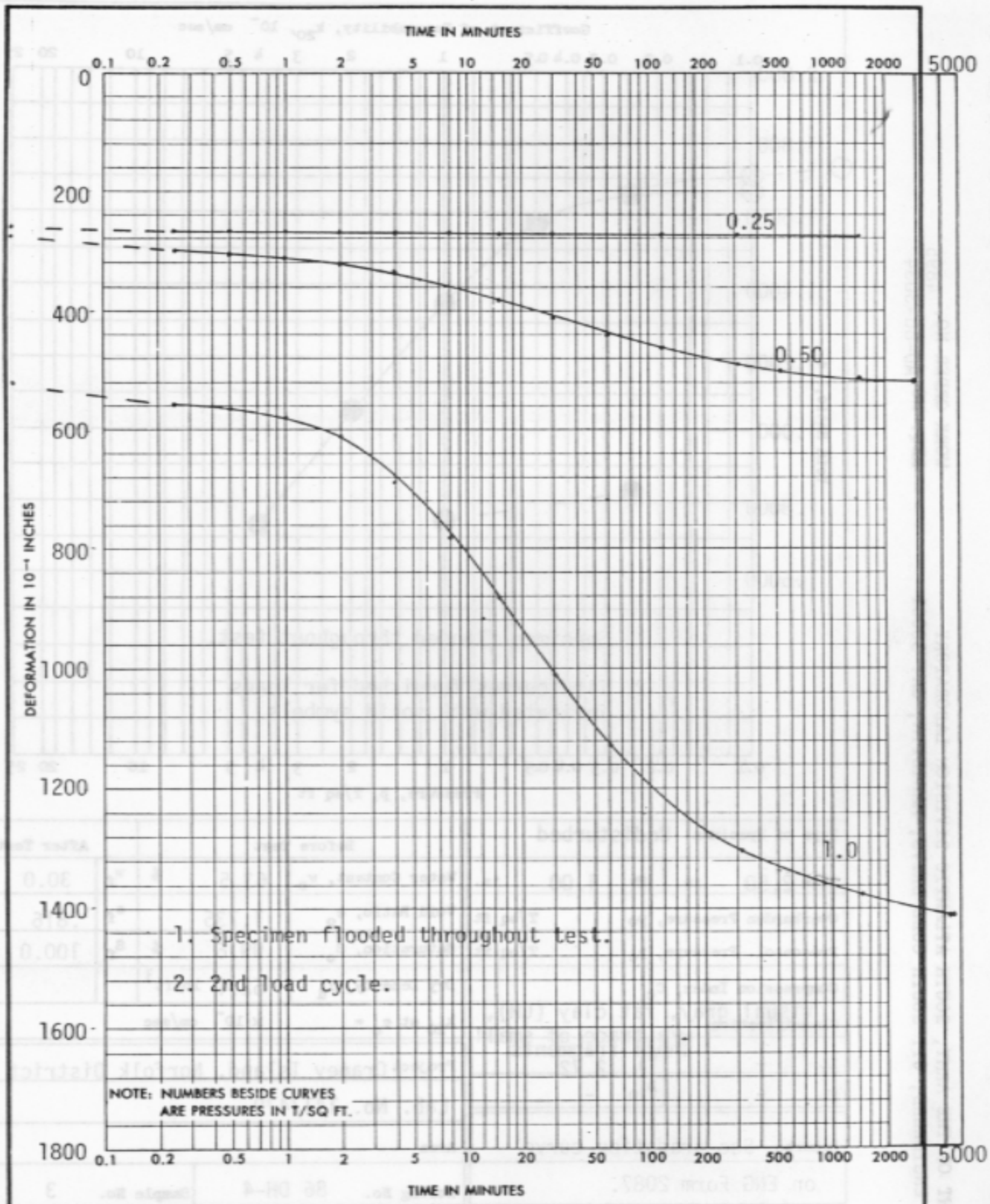
Type of Specimen Undisturbed		Before Test		After Test	
Diam 2.50 in.	Ht 1.00 in.	Water Content, w_o	63.5 %	w_f	30.0 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.735	e_f	.816
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	99.6 %	S_f	100.0 %
Compression Index, C_c		Dry Density, γ_d	62.1 lb/ft^3		
Classification Visual gray, fat clay (CH), w/a trace of small shell fragments		k_{20} at e_o =	× 10^{-} cm/sec		
LL -	G_s 2.72	Project Craney Island, Norfolk District			
PL -	D_{10} -	Lab. No. 141/479			
Remarks See gradation curve on ENG Form 2087.		Area --			
		Boring No. 86 DH-4		Sample No. 3	
		Depth El 61.5-63.5		Date 5 September 1986	

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER NO. 4895
Req. No. AD-86-3034



PROJECT Craney Island, Norfolk District			
AREA Lab. No. 141/479			
BORING NO. 86 DH-4	SAMPLE NO. 3	DEPTH 61.5-63.5	DATE 5 September 1986

ENG FORM 1 MAY 63 2088 PREVIOUS EDITIONS ARE OBSOLETE.

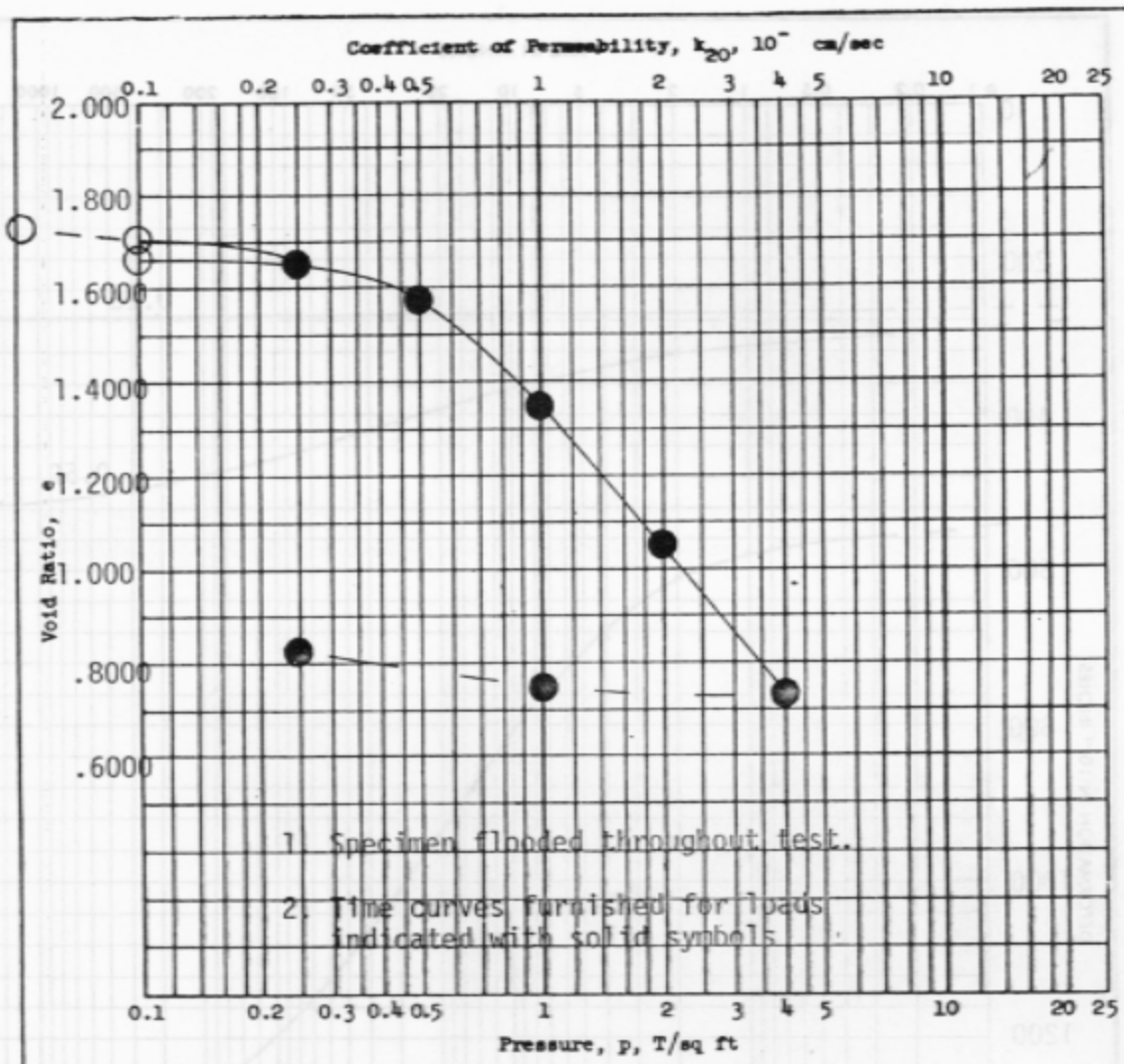
CONSOLIDATION TEST—TIME CURVES (TRANSLUCENT)

* GPO : 1964 OF—715-965

Attachment 1
24

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

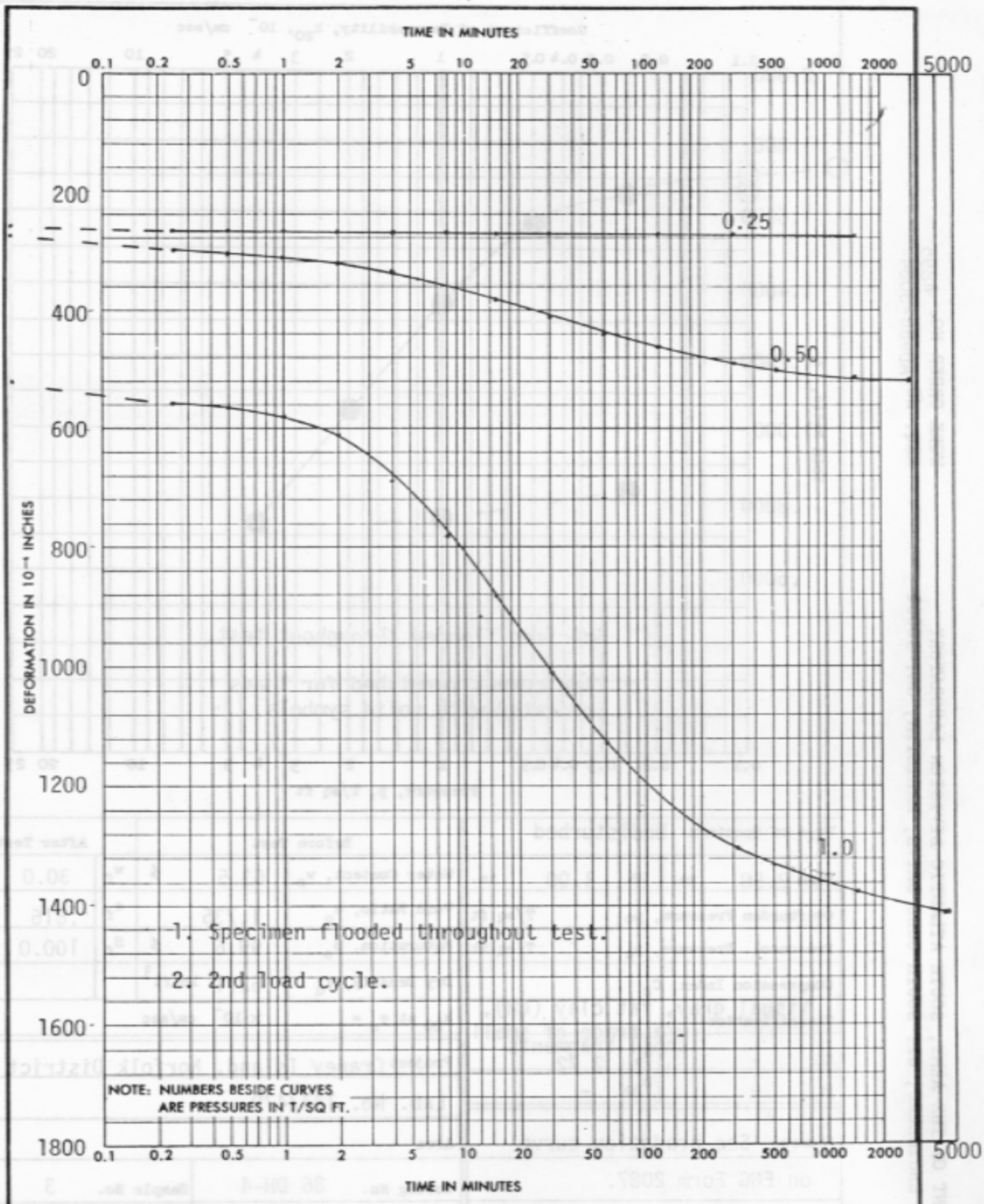
WORK ORDER NO. 4895
REQ. NO. AD-86-3034



Type of Specimen Undisturbed		Before Test		After Test	
Diam 2.50 in.	Ht 1.00 in.	Water Content, w_o	63.5 %	w_f	30.0 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.735	e_f	.816
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	99.6 %	S_f	100.0 %
Compression Index, C_c		Dry Density, γ_d	62.1 lb/ft^3		
Classification Visual gray, fat clay (CH), w/a trace of small shell fragments		k_{20} at e_o =	x 10^{-} cm/sec		
LL -	G_s 2.72	Project Craney Island, Norfolk District			
PL -	D_{10} -	Lab. No. 141/479			
Remarks See gradation curve on ENG Form 2087.		Area --			
		Boring No. 86 DH-4		Sample No. 3	
		Depth El 61.5-63.5		Date 5 September 1986	

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.



PROJECT Craney Island, Norfolk District			
AREA Lab. No. 141/479			
BORING NO. 86 DH-4	SAMPLE NO. 3	DEPTH 61.5-63.5	DATE 5 September 1986

ENG FORM 2088 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

CONSOLIDATION TEST—TIME CURVES (TRANSLUCENT)

★ GPO : 1964 OF—715-965

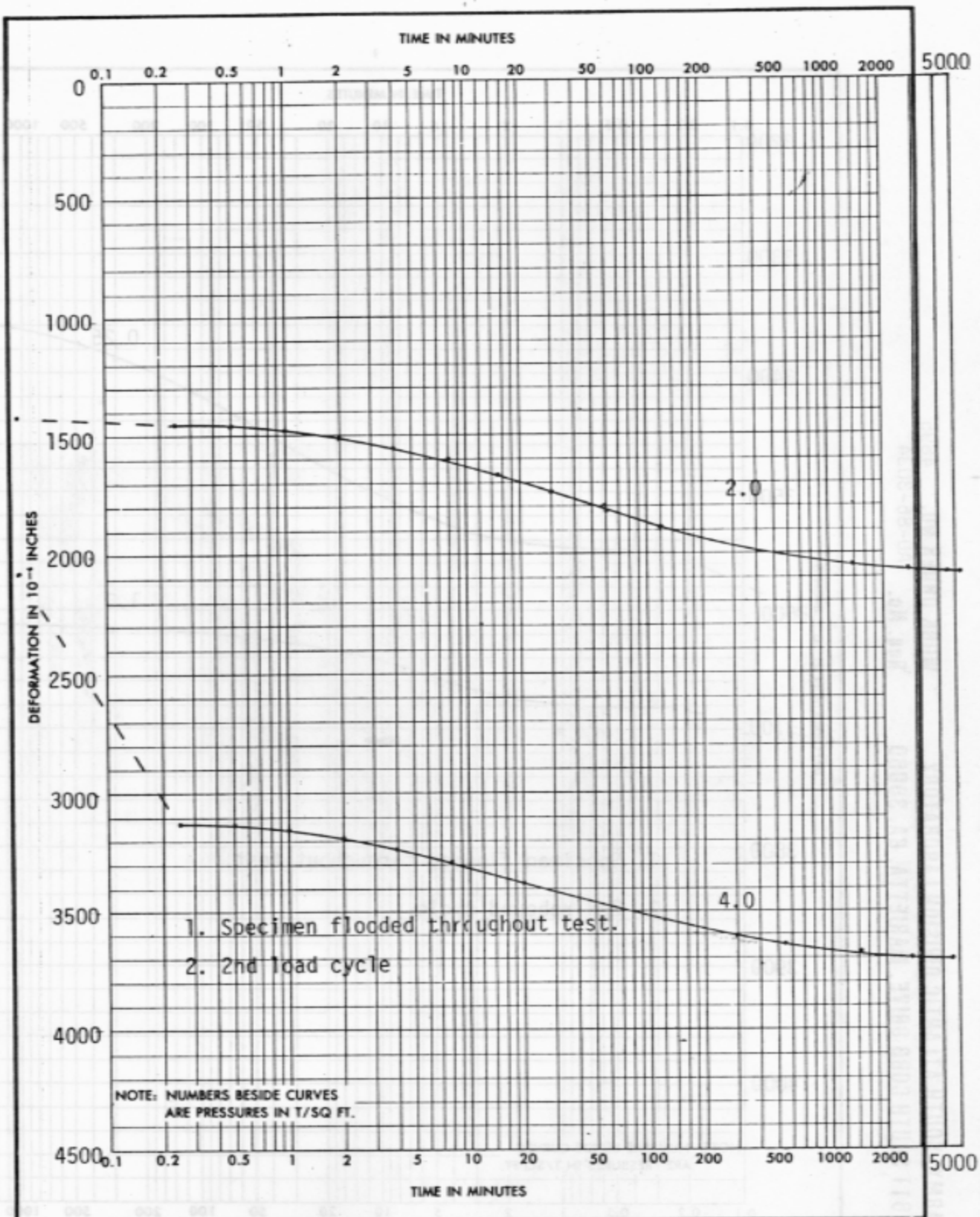
DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER NO. 4895
Req. No. AD-86-3034

Attachment 1
24

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER NO. 4895
Req. No. AD-86-3034

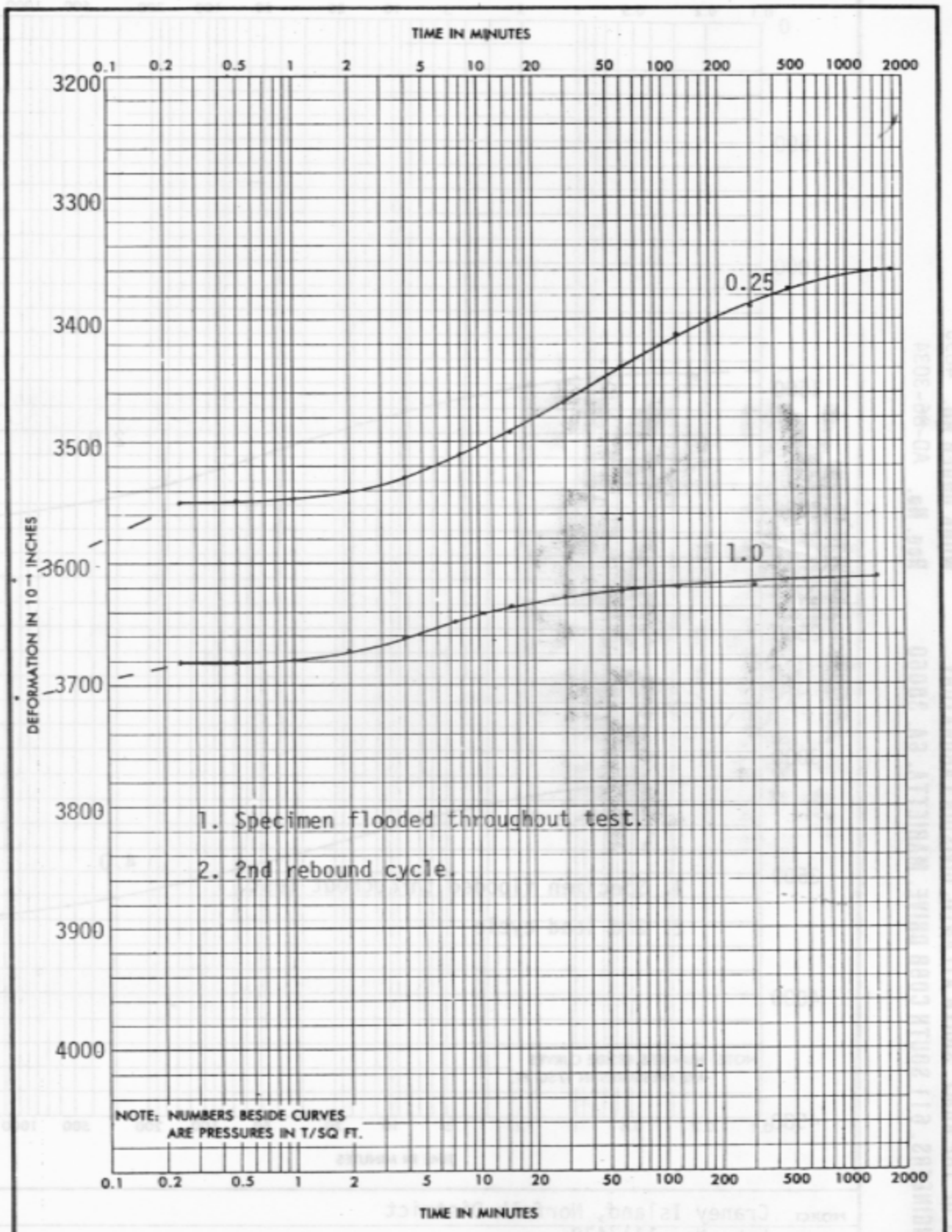


PROJECT Craney Island, Norfolk District			
AREA Lab. No. 141/479			
BORING NO. 86DH-4	SAMPLE NO. 3	DEPTH 61.5-63.5	DATE 5 September 1986

ENG FORM 1 MAY 63 2088 PREVIOUS EDITIONS ARE OBSOLETE.

CONSOLIDATION TEST—TIME CURVES (TRANSLUCENT)

* GPO : 1964 OF—715-965



PROJECT	Craney Island, Norfolk District		
AREA	Lab. No. 141/479		
BORING NO. 86DH-4	SAMPLE NO. 3	DEPTH 61.5-63.5	DATE 5 September 1986

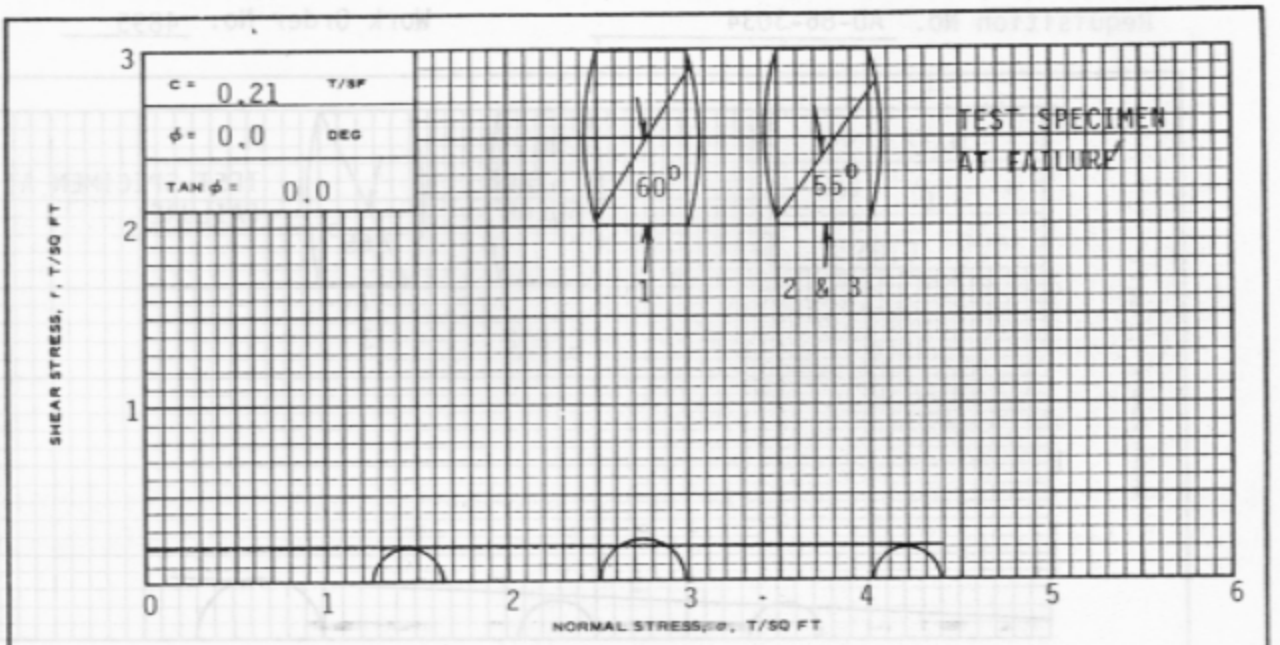
ENG FORM 2088 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. **CONSOLIDATION TEST—TIME CURVES** (TRANSLUCENT)

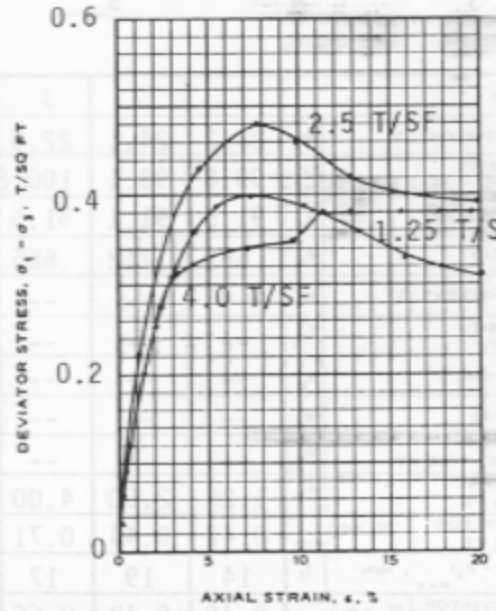
DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

WORK ORDER NO. 4895
Req. No. AD-86-3034

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	71.0	62.7	70.3
	DRY DENSITY LB/CU FT	γ_{d_o}	56.7	60.5	57.6
	SATURATION, %	S_o	97.7	95.4	99.2
	VOID RATIO	e_o	1.941	1.755	1.894
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.40	0.48	0.38
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	10	11	15
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.34	0.40	0.38
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED-TEST Strain (0.74 %/min)

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL ---NOT REQUESTED--- PL ---NOT REQUESTED--- G_s 2.67

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/480

BORING NO. 86 DH-4 SAMPLE NO. 4

DEPTH/~~ELEV~~ 71.5 - 73.5

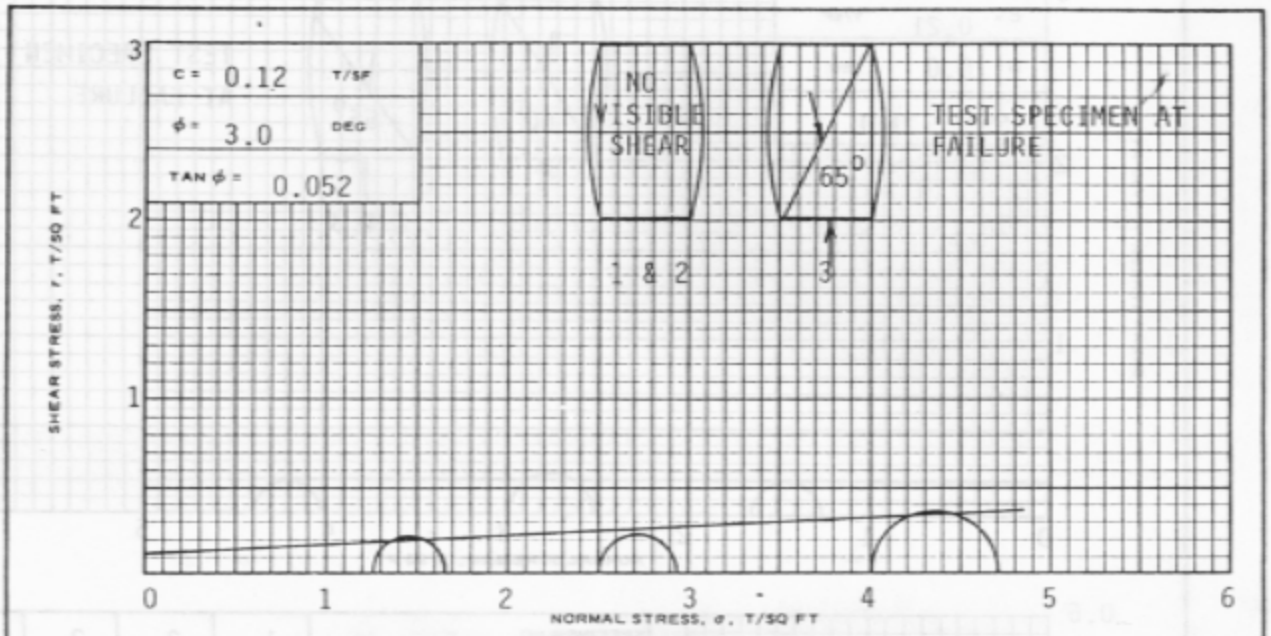
LABORATORY SADEN-FL DATE 4 September 1986

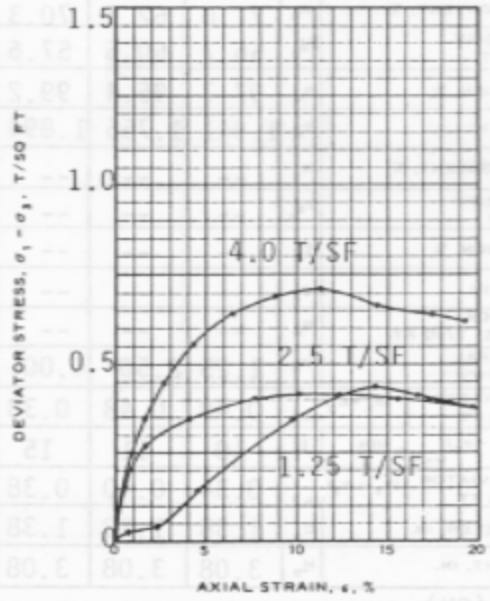
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	23.2	24.1	22.6
	DRY DENSITY LB/CU FT	γd_o	99.8	98.1	100.8
	SATURATION, %	S_o	91.5	91.1	91.5
	VOID RATIO	e_o	.682	.712	.665
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γd_c	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_b	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.42	0.44	0.71
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	14	19	17
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.40	0.43	0.66
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED-TEST Strain (0.73 %/min)

DESCRIPTION OF SPECIMENS (Visual) Gray Clayey Sand (SC)

LL --- NOT PL REQUESTED --- Gs 2.69

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/481

BORING NO. 86 DH-4 SAMPLE NO. 5

DEPTH 81.5 - 83.5

LABORATORY SADEN-FL DATE 4 September 1986

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

DRILLING LOG	DIVISION CENAD	INSTALLATION CENAO	SHEET 1 OF 1 SHEETS

1. PROJECT EXTENSION OF CRANEY ISLAND	10. SIZE AND TYPE OF BIT 2 IN OD SPLITSPOON
2. LOCATION (Coordinates or Station) E 2620982 N226111	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY BORE AND CORE	12. MANUFACTURER'S DESIGNATION OF DRILL CME 45B
4. HOLE NO. (As shown on drawing title and file number) 86DH5	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 8; UNDISTURBED 4
5. NAME OF DRILLER MARK SEILERS	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 18 JUL 86; COMPLETED 18 JUL 86
	17. ELEVATION TOP OF HOLE MSL
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR Matthew T Byrne
9. TOTAL DEPTH OF HOLE 86.0 ft	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d		% SAND	BOX OR SAMPLE NO. f	% WATER
	10		WATER				
	20						50 100
	30						
-32.0			(CH) CLAY high plastic, tr Silt, Tr-lit very fine Sand in lenses, soft, sat., grey	N=WOR	55.3	1	PL LL Wn
	40			N=WOR	2.9	2	
	50			N=WOR	7.7	3	
	60		lit. brown fiberous organics	U-WOR	8.3	4	
	70						
-74.0			(SP) SAND fine to medium, Tr coarse, tr gravel, non plas., sat, grey	N=17		5	
	80			N=26		6	
-86.0				N=26		7	
			BOH = 86.0 ft				

UNDISTURBED PISTON TUBE SAMPLES TAKEN AT THE FOLLOWING DEPTHS:

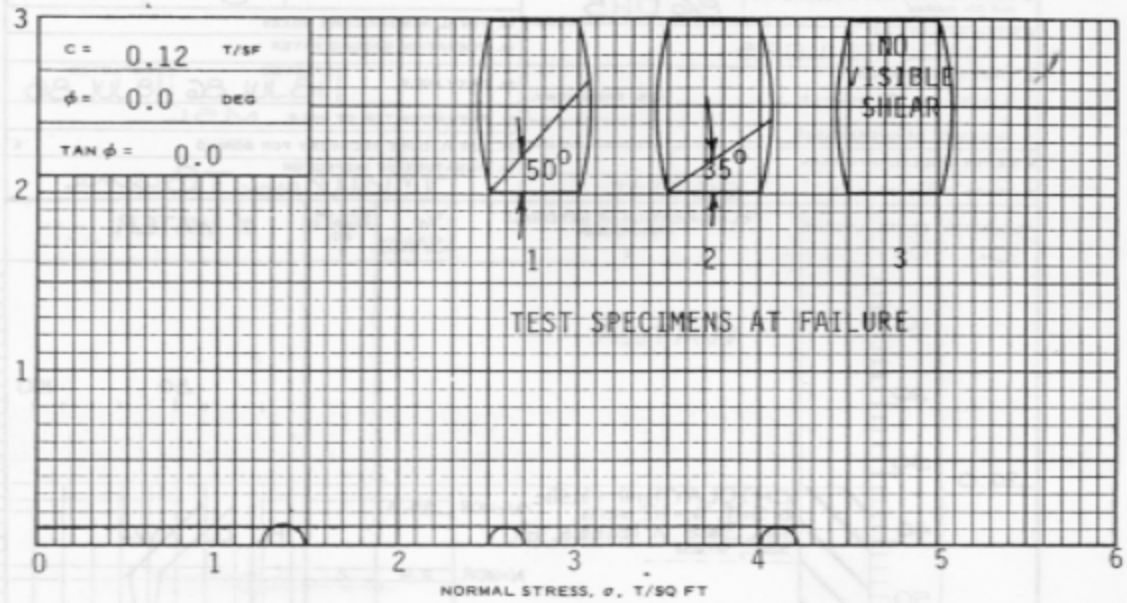
(1) 39.9' - 41.9'
(2) 49.5' - 51.5'
(3) 59.5' - 61.5'
(4) 69.5' - 71.5'

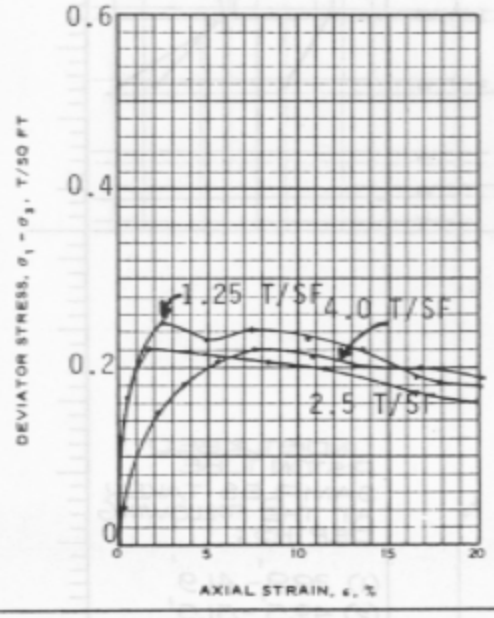
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT EXTENSION OF CRANEY ISLAND | HOLE NO. 86DH5

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	54.7	58.8	51.3
	DRY DENSITY LB/CU FT	γ_{d_o}	67.6	64.7	70.2
	SATURATION, %	S_o	100.0	100.0	100.0
	VOID RATIO	e_o	1.455	1.565	1.365
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_b	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.25	0.22	0.22
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	4	3	10
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.20	0.18	0.20
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED-TEST Strain (0.75 %/min)

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.66

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/482

BORING NO. 86 DH-5 SAMPLE NO. 1

DEPTH 7.9 - 9.9

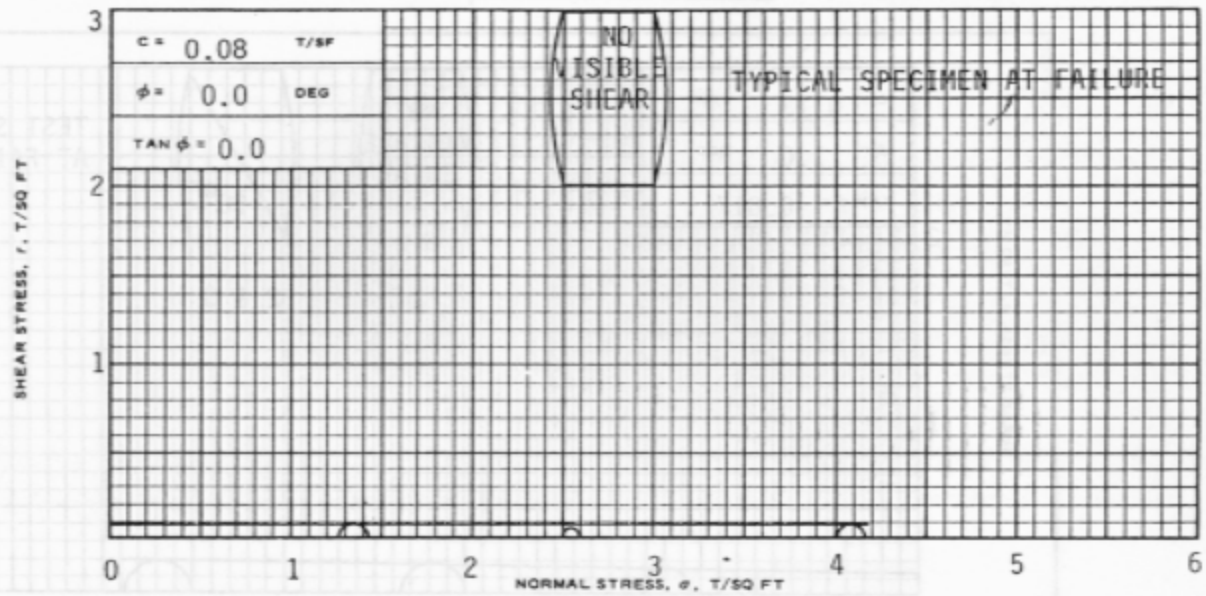
LABORATORY SADEN-FL DATE 4 September 1986

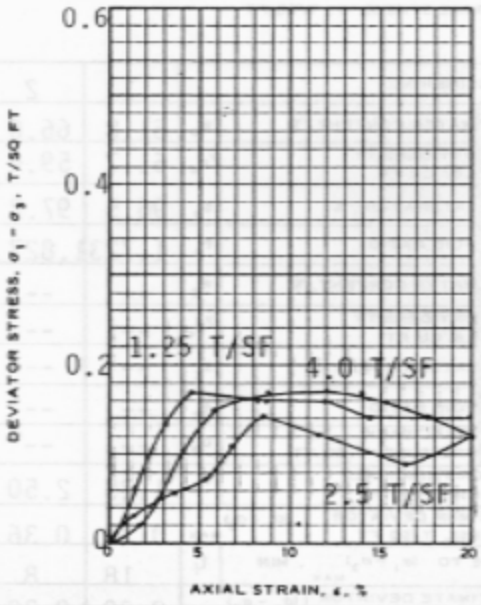
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	60.3	64.5	59.9
	DRY DENSITY LB/CU FT	γ_{d_o}	64.1	61.4	63.9
	SATURATION, %	S_o	100.0	100.0	100.0
	VOID RATIO	e_o	1.621	1.735	1.628
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.17	0.14	0.17
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	7	12	12
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.14	0.10	0.16
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED-TEST Strain (0.74 %/min)

DESCRIPTION OF SPECIMENS (Visual) Gray Fat Clay (CH), w/a trace of shell fragments

LL --- PL NOT REQUESTED --- PI --- G_s 2.69

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/483

BORING NO. 86 DH-5 SAMPLE NO. 2

DEPTH/~~ELEV~~ 17.5 - 19.5

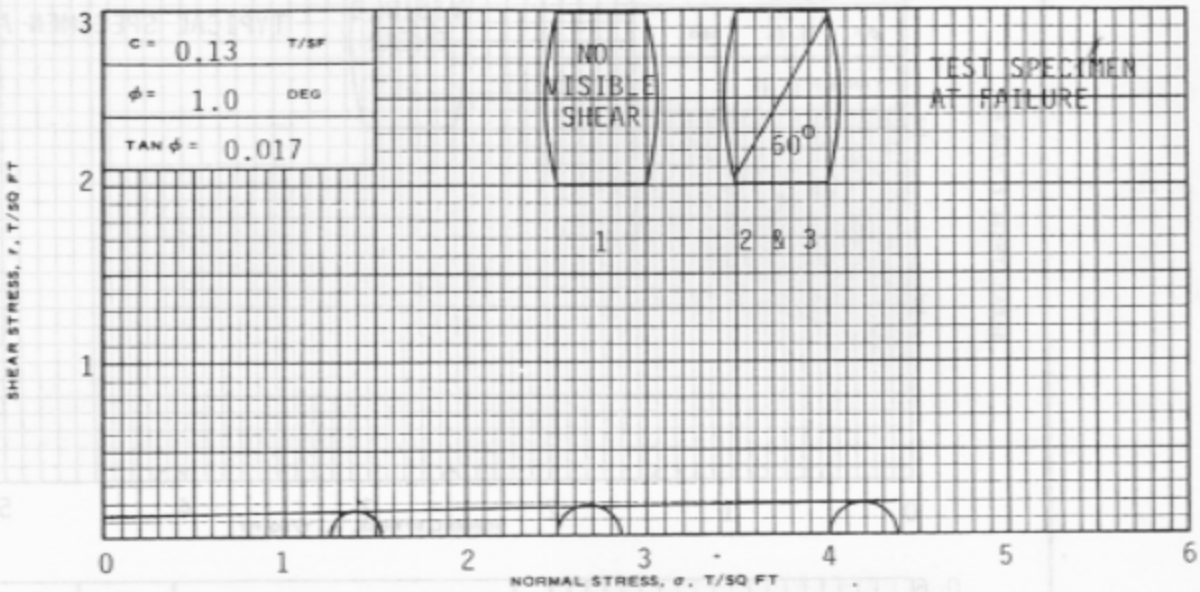
LABORATORY SADEN-FL DATE 4 September 1986

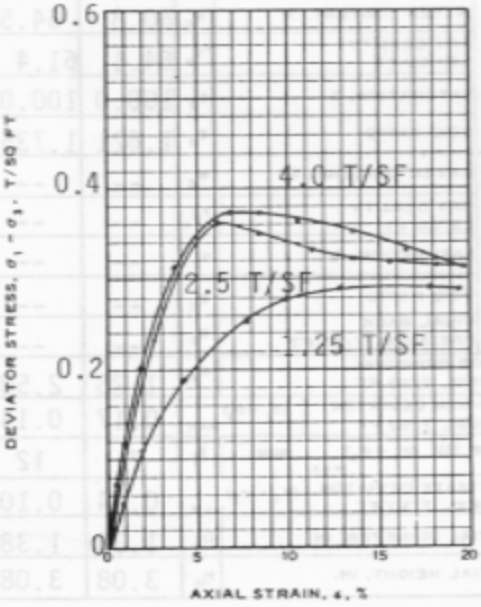
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





			1	2	3
SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	61.8	66.0	61.5
	DRY DENSITY LB/CU FT	γd_o	61.7	59.4	62.3
	SATURATION, %	S_o	96.5	97.2	97.5
	VOID RATIO	e_o	1.723	1.827	1.697
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γd_c	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.29	0.36	0.37
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	18	8	9
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.29	0.32	0.34
INITIAL DIAMETER, IN.		D_o	2.84	2.86	2.87
INITIAL HEIGHT, IN.		H_o	6.37	6.15	6.17

CONTROLLED TEST: Strain (0.74 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.69

TYPE OF SPECIMEN: Undisturbed

TYPE OF TEST: Q

REMARKS:

PROJECT: Craney Island, Norfolk District

Lab. No. 141/484

BORING NO. 86 DH-5

SAMPLE NO. 3

DEPTH/~~BOX~~ 27.5 - 29.5

LABORATORY: SADEN-FL

DATE: 4 September 1986

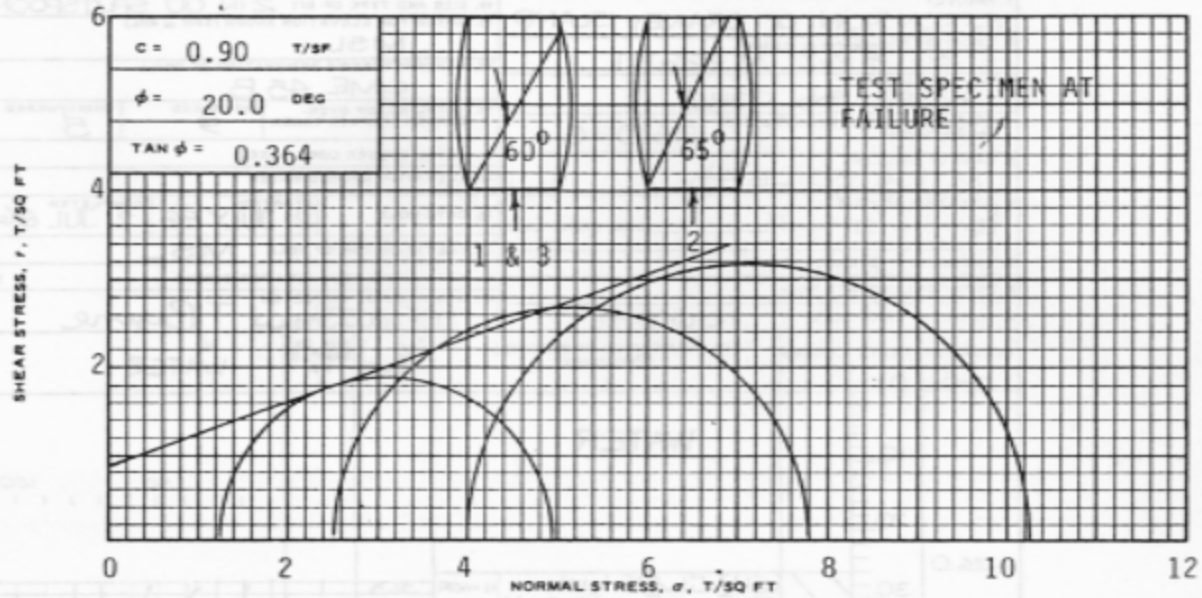
TRIAXIAL COMPRESSION TEST REPORT

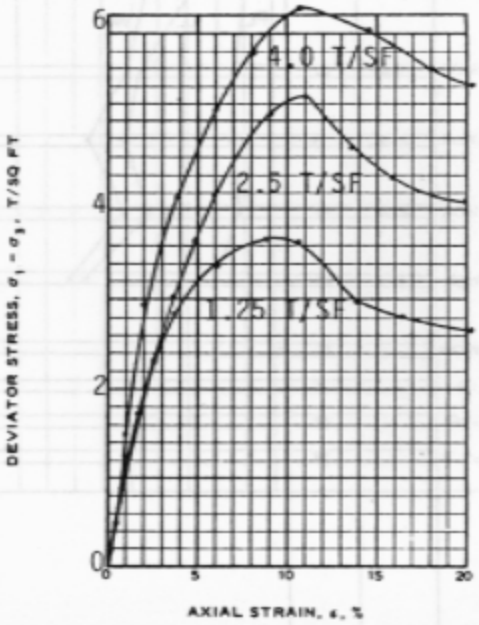
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	24.2	23.2	23.1	
	DRY DENSITY LB/CU FT	γ_{d_o}	97.9	100.2	98.6	
	SATURATION, %	S_o	90.5	91.8	87.8	
	VOID RATIO	e_o	.721	.683	.710	
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--	
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--	
	SATURATION, %	S_c	--	--	--	
	VOID RATIO	e_c	--	--	--	
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	3.67	5.29	6.25	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	13	14	15	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	2.88	4.46	5.97	
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38	
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08	

CONTROLLED TEST: Strain (0.76 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray Silty Sand (SM)

LL --- NOT REQUESTED --- G: 2.70

TYPE OF SPECIMEN: Undisturbed

TYPE OF TEST: 0

REMARKS:

PROJECT: Craney Island, Norfolk District

Lab. No. 141/485

BORING NO. 86 DH-5

SAMPLE NO. 4

DEPTH/~~ELEV~~ 37.5-39.5

LABORATORY: SADEN-FL

DATE: 5 September 1986

TRIAXIAL COMPRESSION TEST REPORT

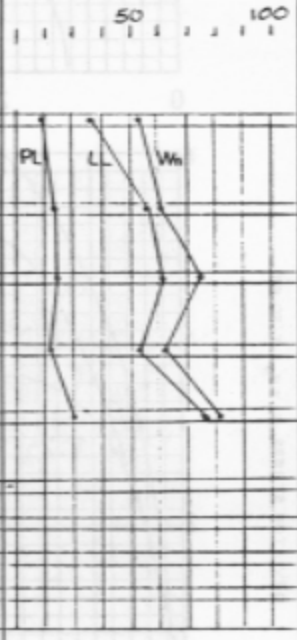
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Hole No. 86DHG

DRILLING LOG	DIVISION CENAD	INSTALLATION CENAO	SHEET 1 OF 1 SHEETS

1. PROJECT	EXTENSION OF CRANEY ISLAND
2. LOCATION (Coordinates or Station)	E 2618162 N 226111
3. DRILLING AGENCY	BORE AND CORE
4. HOLE NO. (As shown on drawing title and file number)	86DHG
5. NAME OF DRILLER	MARK SEILERS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	100.5 ft
10. SIZE AND TYPE OF BIT	2 IN OD SPLITSPOON
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	CME 45 B
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 9 / UNDISTURBED 5
14. TOTAL NUMBER CORE BOXES	
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 21 JULY 86 / COMPLETED 21 JUL 86
17. ELEVATION TOP OF HOLE	MSL
18. TOTAL CORE RECOVERY FOR BORING	%
19. SIGNATURE OF INSPECTOR	Matthew T Byrne

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d		% SAND	BOX OR SAMPLE NO. f	% WATER
0.0	0		WATER				
	10						
	20						
-26.0	30		(CH) CLAY high plastic, sat, soft, tr-lit very fine Sand, tr-lit organics	N=WOR	31.3	1	
	40			N=WOR	5.6	2	
	50			N=WOR	2.2	3	
	60			N=WOR	2.9	4	
	70			N=WOR	1.1	5	
-80.0	80		interlayered w/ very fine Sand (SC-CH) brown fibrous organics →	N=WOR		6	
	90			[1]		7	
			(SM) SAND very fn, lit Silt, sat, non plas, grey/green	N=19		8	
-100.5	100.5			N=27		9	
			[2] BOH = 100.5 ft				



[1] DRILL ROD SLIPPED CAUSING SAMPLING SPOON TO PENETRATE SAMPLING LAYER. NO BLOWS RECORDED

[2] WASHED TO 100.5' USING CHEMICAL GEL AND BENTONITE... SAND CAM UP AUGER WHILE REMOVING DRILL ROD

UNDISTURBED PISTON TUBE SAMPLES TAKEN AT THE FOLLOWING DEPTHS:

(1) 35.5' - 37.5'
(2) 45.5' - 47.5'
(3) 55.5' - 57.5'
(4) 65.5' - 67.5'
(5) 75.5' - 77.5'

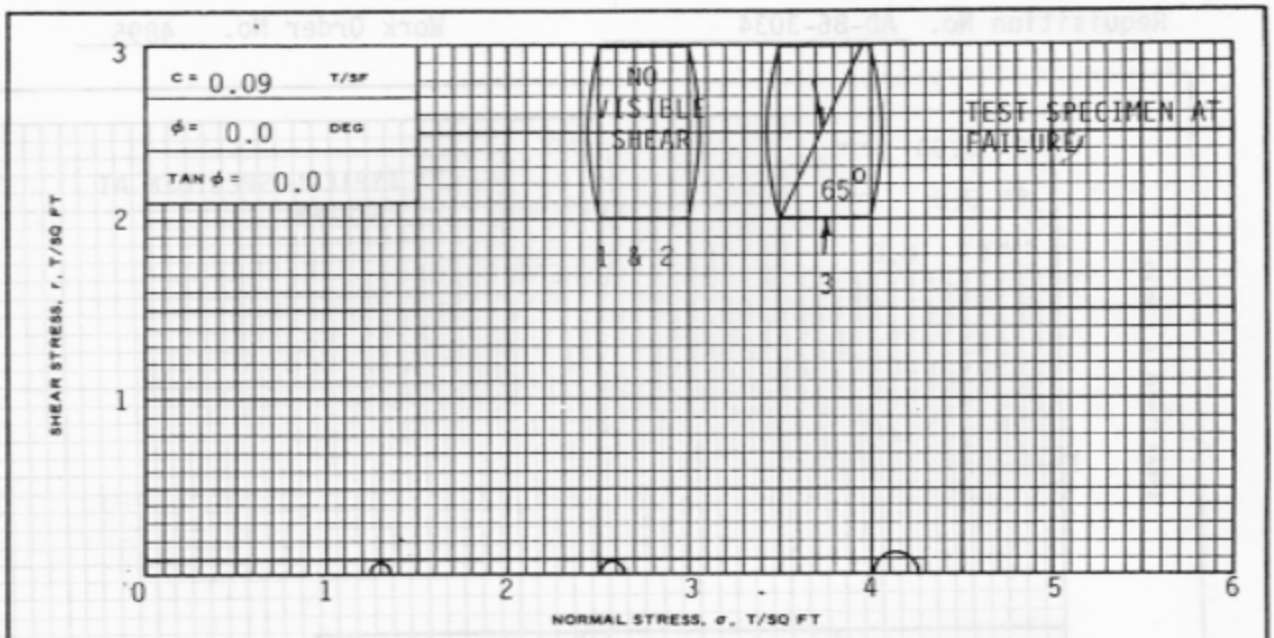
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

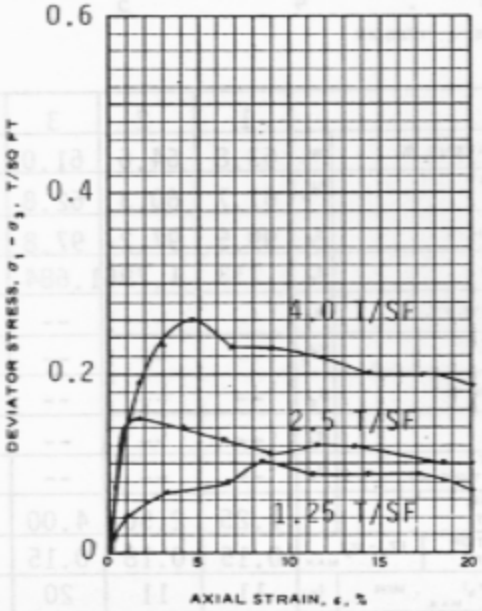
PROJECT: EXTENSION OF CRANEY ISLAND

HOLE NO. 86DHG

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	69.1	55.3	58.7
	DRY DENSITY LB/CU FT	γd_o	58.6	66.7	64.5
	SATURATION, %	S_o	100.0	98.7	98.9
	VOID RATIO	e_o	1.845	1.498	1.585
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γd_c	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.10	0.15	0.26
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	12	3	6
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.09	0.11	0.20
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED TEST: Strain (0.75 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- | G_s 2.67 | TYPE OF SPECIMEN: Undisturbed | TYPE OF TEST: Q

REMARKS:

PROJECT: Craney Island, Norfolk District
Lab. No. 141/486

BORING NO. 86 DH-6 | SAMPLE NO. 1

DEPTH: 35.5 - 37.5

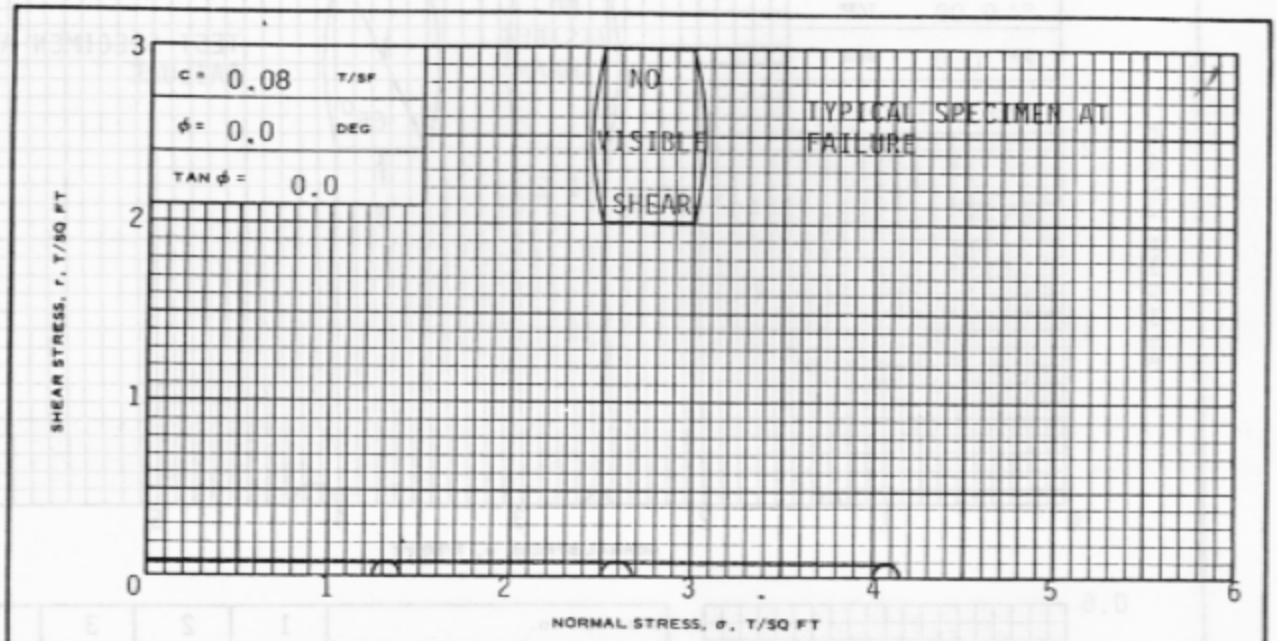
LABORATORY: SADEN-FL | DATE: 5 September 1986

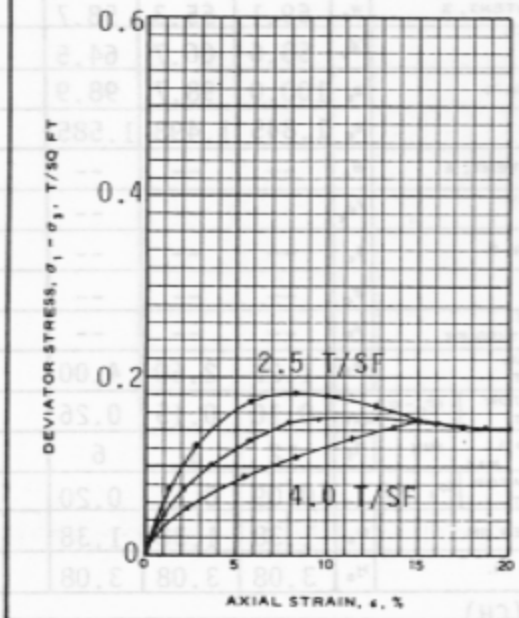
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	63.8	64.6	61.0
	DRY DENSITY LB/CU FT	γ_{d_o}	61.7	60.3	62.8
	SATURATION, %	S_o	99.5	97.2	97.8
	VOID RATIO	e_o	1.733	1.796	1.684
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.15	0.18	0.15
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	11	11	20
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.15	0.15	0.15
INITIAL DIAMETER, IN.		D_o	2.89	2.85	2.85
INITIAL HEIGHT, IN.		H_o	6.06	6.09	6.14

CONTROLLED Strain (0.74 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.70

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/487

BORING NO. 86 DH-6 SAMPLE NO. 1

DEPTH 35.5 - 37.5

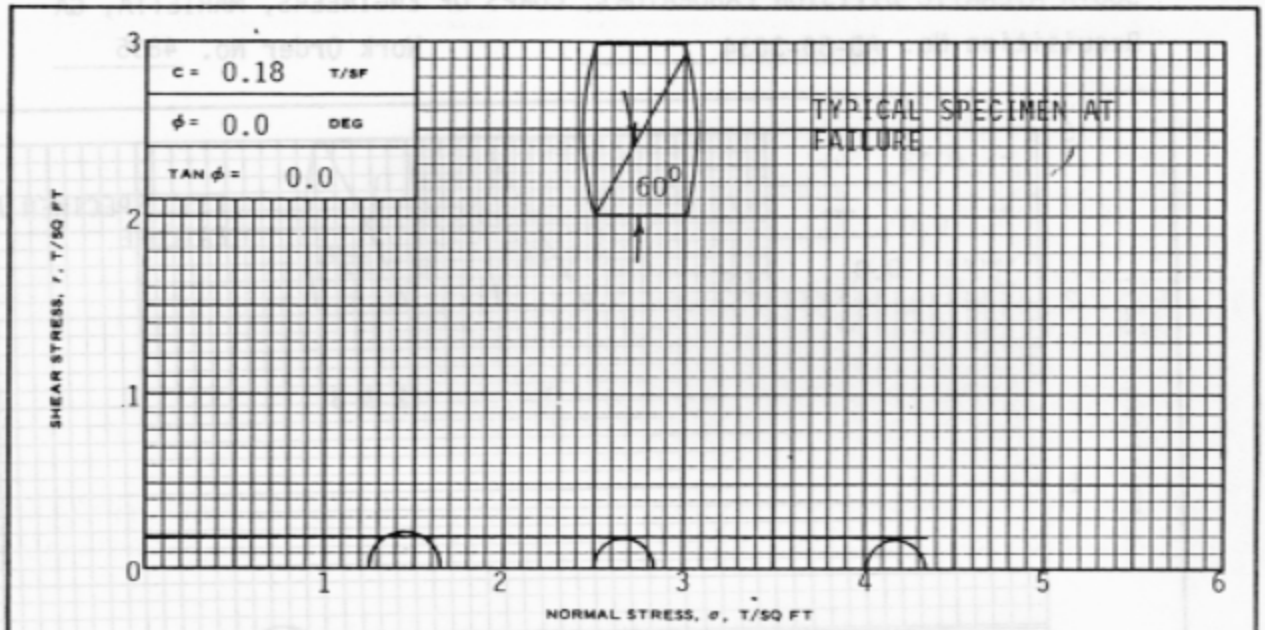
LABORATORY SADEN-FL DATE 5 September 1986

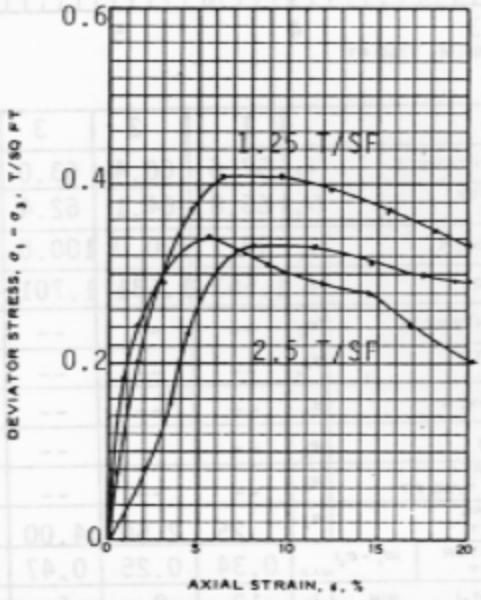
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	50.7	60.8	56.6
	DRY DENSITY LB/CU FT	γ_{d_o}	71.0	63.8	66.6
	SATURATION, %	S_o	99.8	100.0	100.0
	VOID RATIO	e_o	1.373	1.641	1.529
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.41	0.34	0.33
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	9	8	11
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.37	0.27	0.31
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED Strain (0.75 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.70

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/488

BORING NO. 86 DH-6 SAMPLE NO. 3

DEPTH 55.5 - 57.5

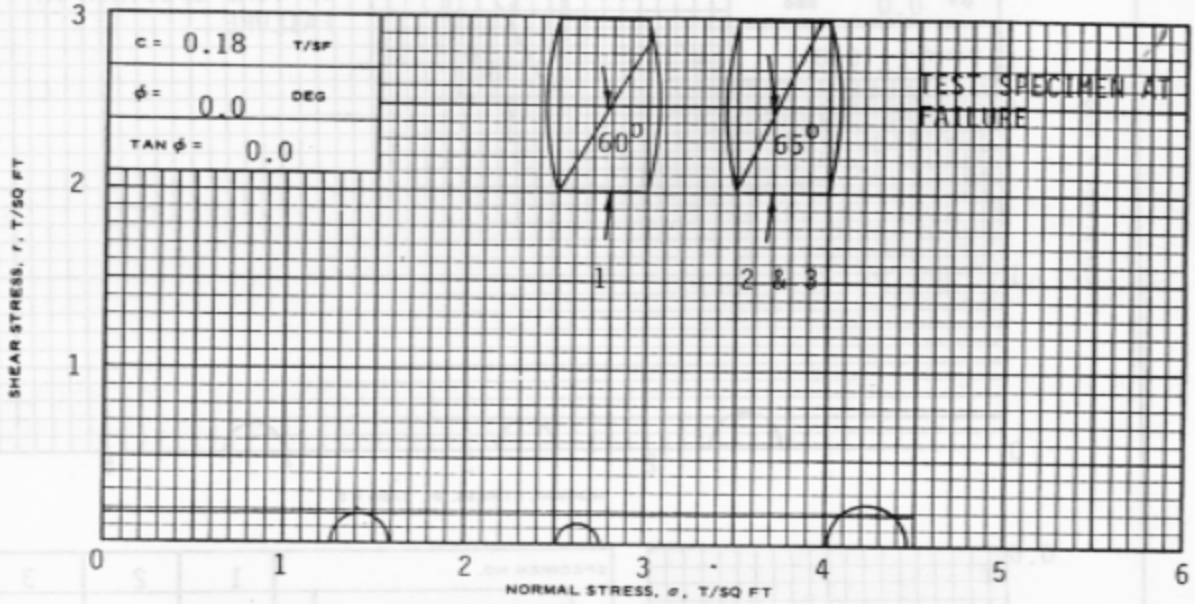
LABORATORY SADEN-FL DATE 5 September 1986

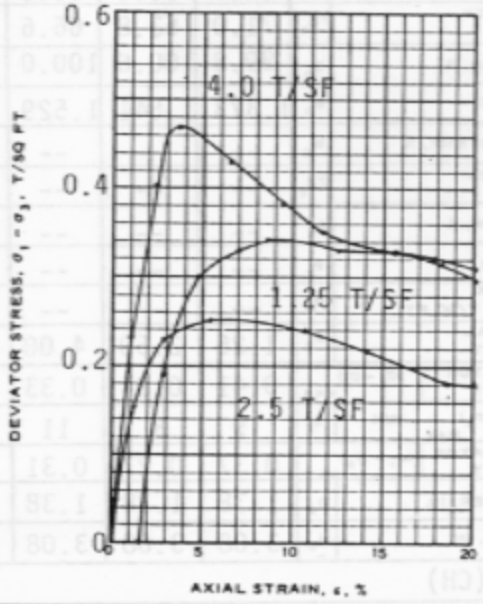
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	57.6	60.4	63.0
	DRY DENSITY LB/CU FT	γ_{d_o}	65.8	64.1	62.4
	SATURATION, %	S_o	99.7	100.0	100.0
	VOID RATIO	e_o	1.561	1.631	1.701
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.34	0.25	0.47
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	12	8	6
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.33	0.21	0.33
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08

CONTROLLED-TEST Strain (0.75 %/min)

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- PL --- G_s 2.70

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/489

BORING NO. 86 DH-6 SAMPLE NO. 4

DEPTH 65.5-67.5

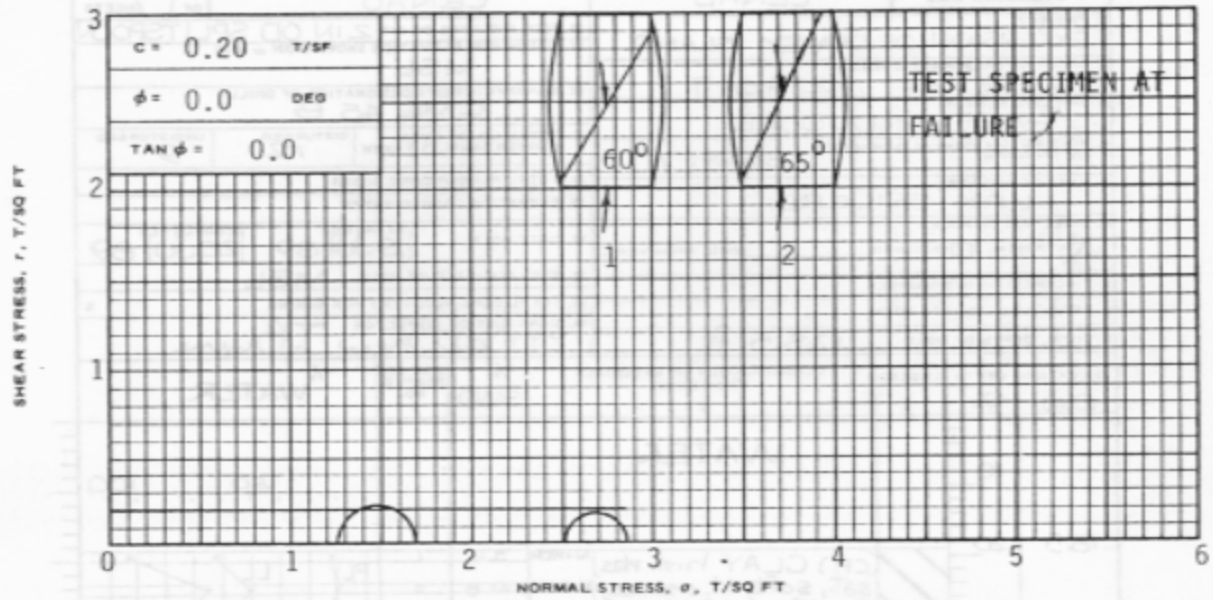
LABORATORY SADEN-FL DATE 8 September 1986

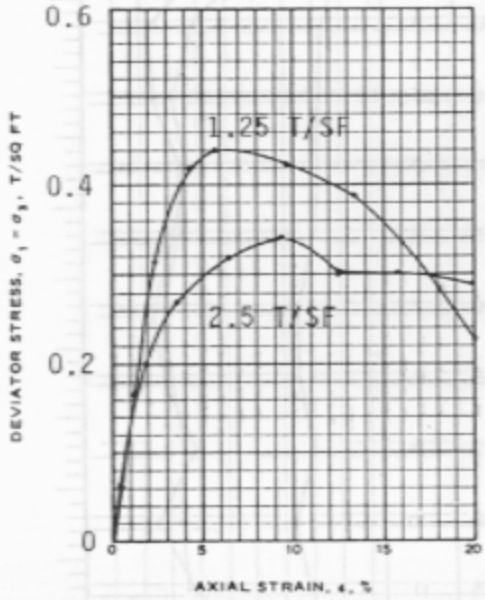
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2		
INITIAL	WATER CONTENT, %	w_o	62.0	66.8		
	DRY DENSITY LB/CU FT	γ_{d_o}	61.0	59.2		
	SATURATION, %	S_o	95.0	97.6		
	VOID RATIO	e_o	1.763	1.849		
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--		
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--		
	SATURATION, %	S_c	--	--		
	VOID RATIO	e_c	--	--		
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--		
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.44	0.34		
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	9	12		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.36	0.30		
INITIAL DIAMETER, IN.		D_o	1.38	1.38		
INITIAL HEIGHT, IN.		H_o	3.08	3.08		

CONTROLLED TEST: Strain (0.75 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.70

TYPE OF SPECIMEN: Undisturbed TYPE OF TEST: Q

REMARKS:

PROJECT: Craney Island, Norfolk District

Lab. No. 141/490

BORING NO. 86 DH-6 SAMPLE NO. 5

DEPTH ~~XXXX~~ 75.5 - 77.5

LABORATORY: SADEN-FL DATE: 5 September 1986

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

DRILLING LOG	DIVISION CENAD	INSTALLATION CENAO	SHEET 1 OF 1 SHEETS

1. PROJECT EXTENSION OF CRANEY ISLAND	10. SIZE AND TYPE OF BIT 2 IN OD SPLITSPOON
2. LOCATION (Coordinates or Station) E 2618024 N224017	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY BORE AND CORE	12. MANUFACTURER'S DESIGNATION OF DRILL CME 45 B
4. HOLE NO. (As shown on drawing title and file number) 86DH7	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12, UNDISTURBED 9
5. NAME OF DRILLER MARK SEILERS	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 19 Jul 89, COMPLETED 20 Jul 89
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE MSL
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 123.5 ft	19. SIGNATURE OF INSPECTOR Matthew T. Byrne

ELEVATION 0.0	DEPTH 0	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% SAND	BOX OR SAMPLE NO.	% WATER
			WATER			
	10					
-18.5	20		(CH) CLAY high plas, sat., soft, lit. organics, tr.-lit. very fn. Sand, lit. silt, grey	N=WOH 5.6	1	
				N=WOH 10.8	2	
	30					
				N=WOR 1.1	3	
	40					
				N=WOR 0.4	4	
	50					
				N=WOR 0.1	5	
	60					
				N=WOR 1.8	6	
	70					
			tr. shell fragments	N=WOR 0.6	7	
	80					
				N=WOR 0.5	8	
	90		[1]			
				N=WOR 3.3	9	
	100					
				N=WOR 1.9	10	
	110					
-116.0				N=WOH 7.3	11	
-123.5	120		(SP) SAND fine to med, lit. some gravel, non plas., wet. grey	N=11	12	
			BOH = 123.5 ft			

[1] THUNDERSTORM FORCED DRILLING OFF HOLE UPON COMPLETION OF SAMPLE 8. REMOBILIZED NEXT DAY AND COMPLETED HOLE

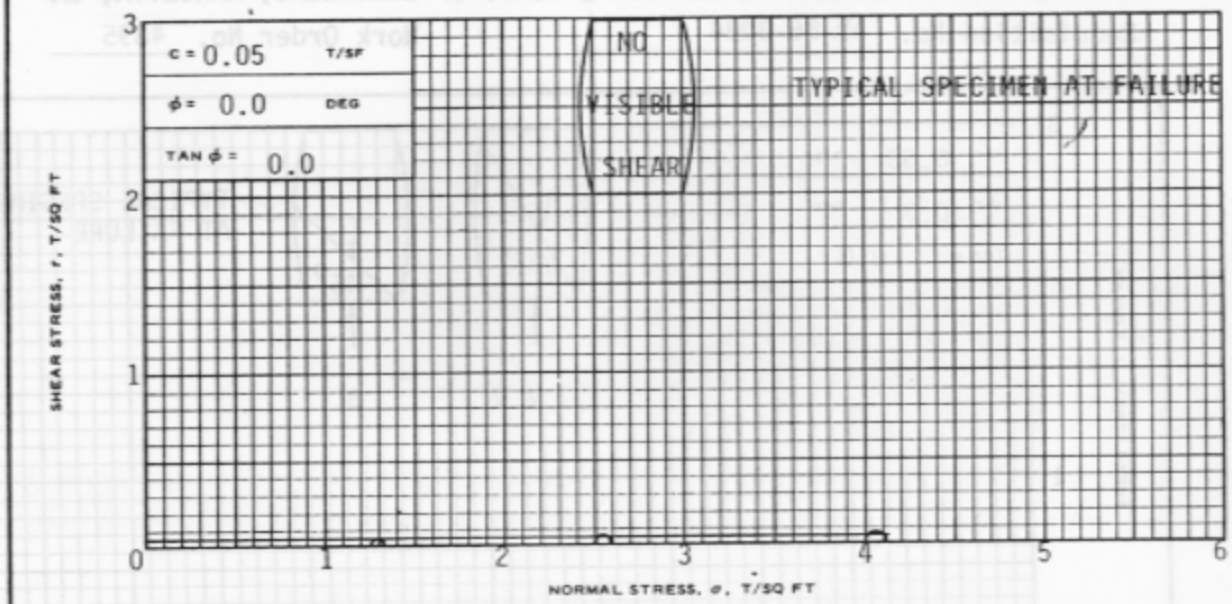
UNDISTURBED PISTON TUBE SAMPLES TAKEN AT THE FOLLOWING DEPTHS:
(1) 28.5'-30.5'
(2) 38.5'-40.5'
(3) 48.5'-50.5'
(4) 58.5'-60.5'
(5) 68.5'-70.5'
(6) 78.5'-80.5'
(7) 88.5'-90.5'
(8) 98.5'-100.5'
(9) 108.5'-110.5'

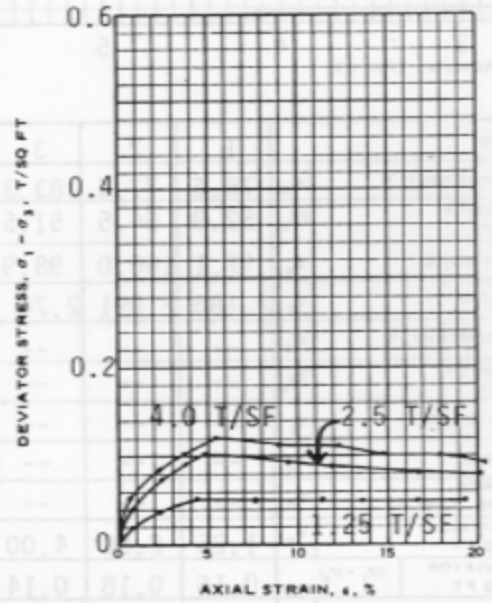
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT EXTENSION OF CRANEY ISLAND | HOLE NO. 86DH7

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	74.1	77.2	72.1
	DRY DENSITY LB/ CU FT	γ_{d_o}	55.8	54.1	56.2
	SATURATION, %	S_o	99.1	98.5	97.3
	VOID RATIO	e_o	2.020	2.114	1.999
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_b	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.05	0.10	0.12
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	6	7	7
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.05	0.08	0.10
INITIAL DIAMETER, IN.		D_o	2.85	2.85	2.85
INITIAL HEIGHT, IN.		H_o	6.11	6.15	5.99

CONTROLLED TEST: Strain (0.77 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.70

TYPE OF SPECIMEN: Undisturbed

TYPE OF TEST: Q

REMARKS:

PROJECT: Craney Island, Norfolk District

Lab. No. 141/491

BORING NO. 86 DH-7 SAMPLE NO. 1

DEPTH/~~XXX~~ 28.5 - 30.5

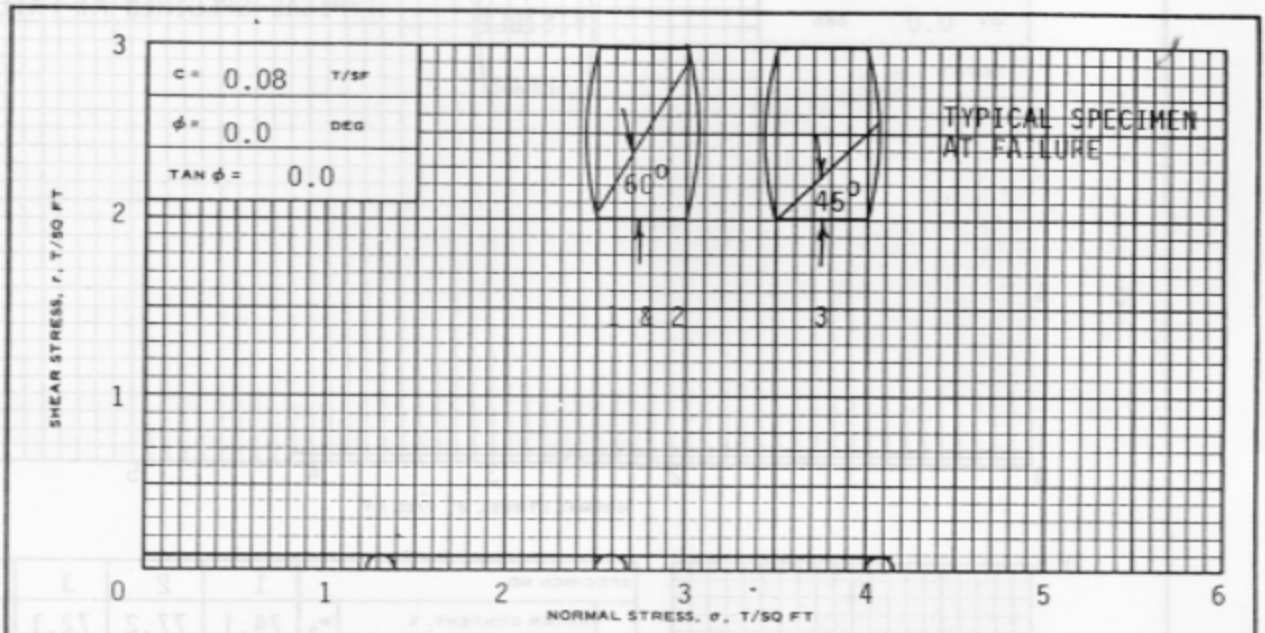
LABORATORY SADEN-FL DATE 5 September 1986

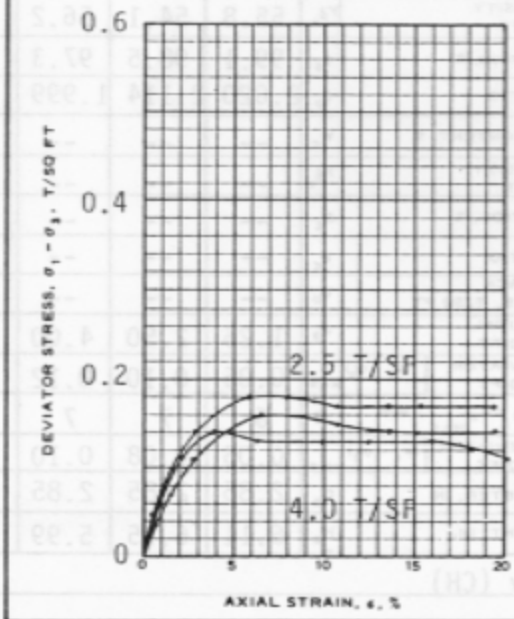
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	78.6	77.4	83.3
	DRY DENSITY LB/CU FT	γ_{d_o}	52.9	54.5	51.5
	SATURATION, %	S_o	97.1	100.0	98.9
	VOID RATIO	e_o	2.186	2.091	2.74
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.16	0.18	0.14
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	9	8	5
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.14	0.17	0.13
INITIAL DIAMETER, IN.		D_o	2.85	2.85	2.84
INITIAL HEIGHT, IN.		H_o	6.08	6.22	5.95

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.70 TYPE OF SPECIMEN Undisturbed TYPE OF TEST .Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/492

BORING NO. 86 DH-7 SAMPLE NO. 2

DEPTH/~~ELEV~~ 38.5 - 40.5

LABORATORY SADEN-FL DATE 5 September 1986

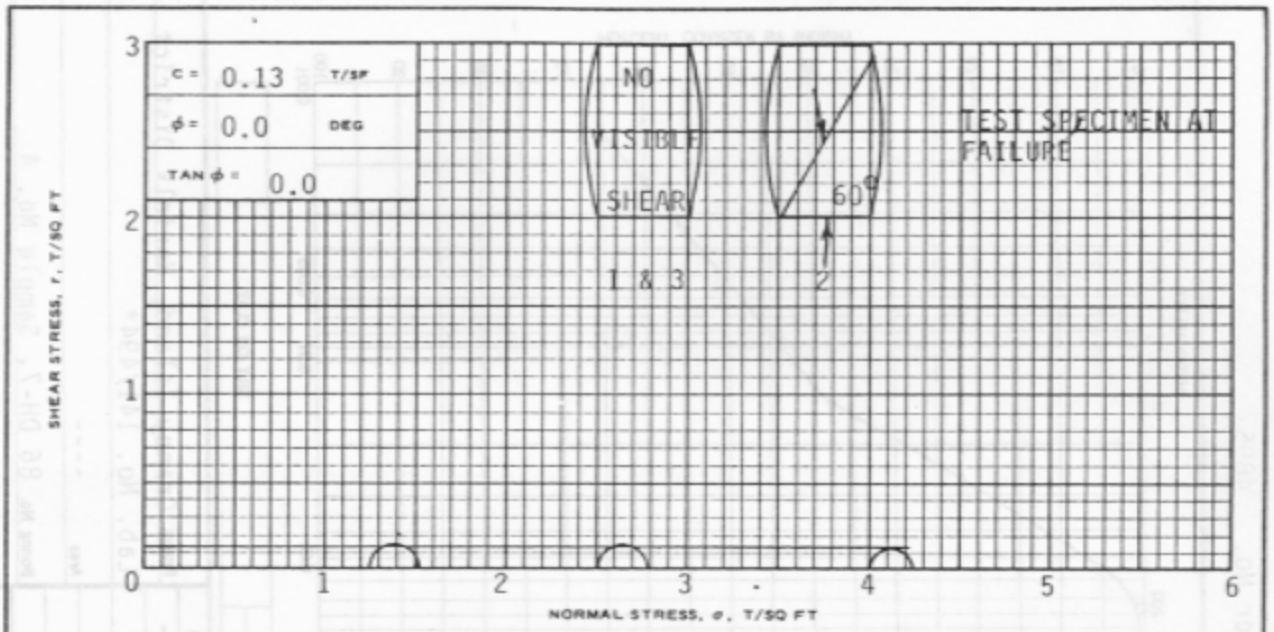
TRIAXIAL COMPRESSION TEST REPORT

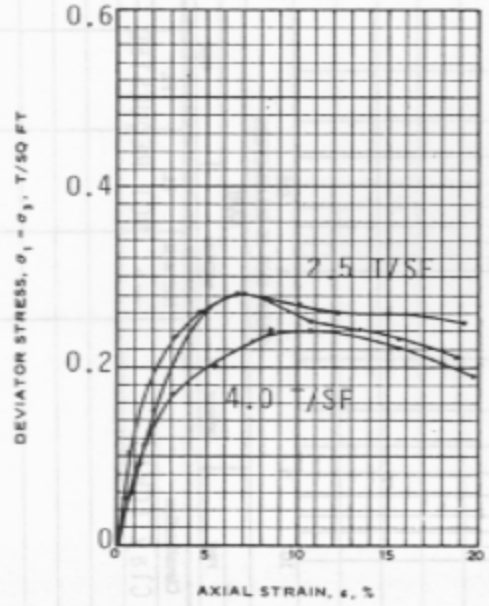
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	84.0	83.6	83.1
	DRY DENSITY LB/CU FT	γ_{d_o}	51.2	51.1	51.4
	SATURATION, %	S_o	99.2	98.4	98.8
	VOID RATIO	e_o	2.268	2.275	2.254
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.28	0.28	0.24
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	10	9	11
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.23	0.26	0.23
INITIAL DIAMETER, IN.		D_o	2.86	2.86	2.85
INITIAL HEIGHT, IN.		H_o	6.29	6.07	6.12

CONTROLLED Strain (0.72 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.68

TYPE OF SPECIMEN Undisturbed TYPE OF TEST U

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/493

BORING NO. 86 DH-7 SAMPLE NO. 3

DEPTH 48.5 - 50.5

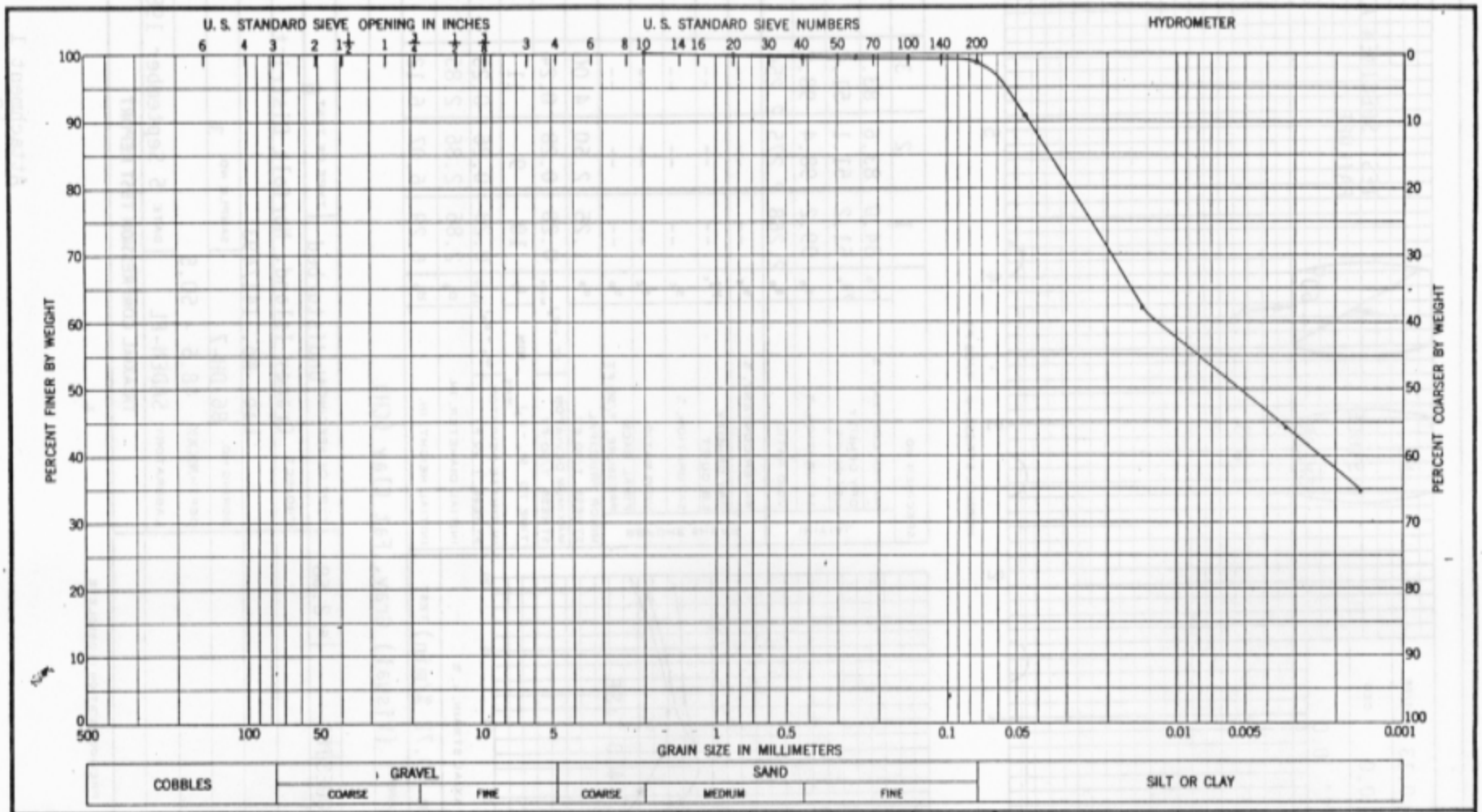
LABORATORY SADEN-FL DATE 5 September 1986

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GEORGIA

Requisition No. AD-86-3034 Work Order No. 4895



Sample No.	Depth	(Visual) Classification	Nat w %	LL	PL	PI
4	58.5 - 60.5	Gray, Fat Clay (CH)	---	NOT REQUESTED		---

Project Craney Island, Norfolk District

Lab. No. 141/494*

Area ----

Boring No. 86 DH-7, Sample No. 4

Date 9 September 1986

GRADATION CURVES

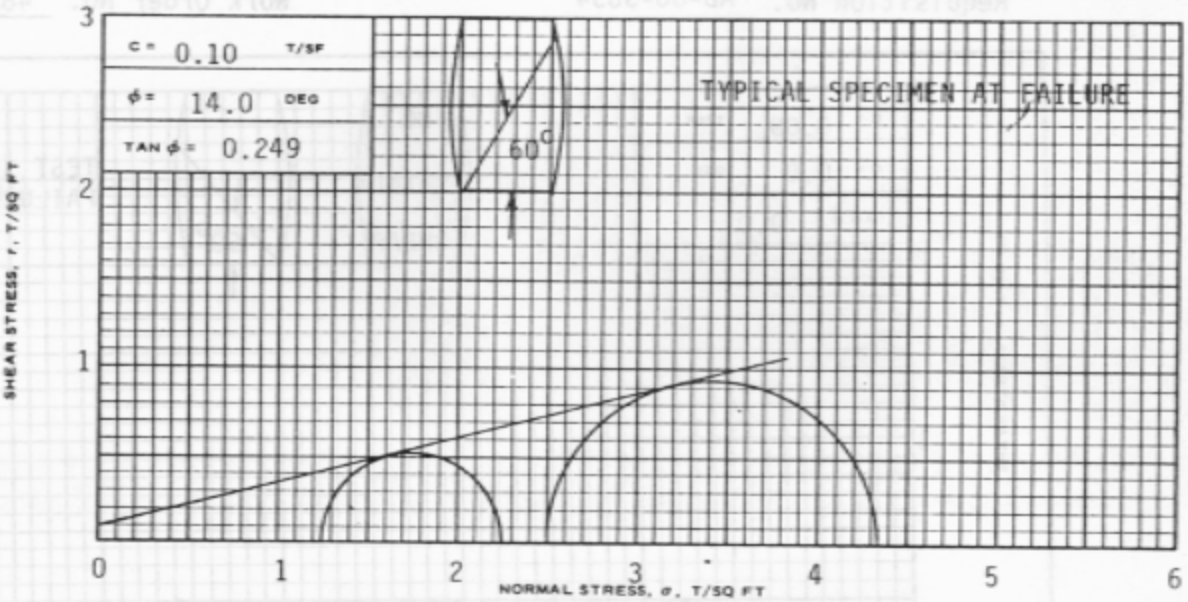
ENG FORM 1 MAY 63 2087

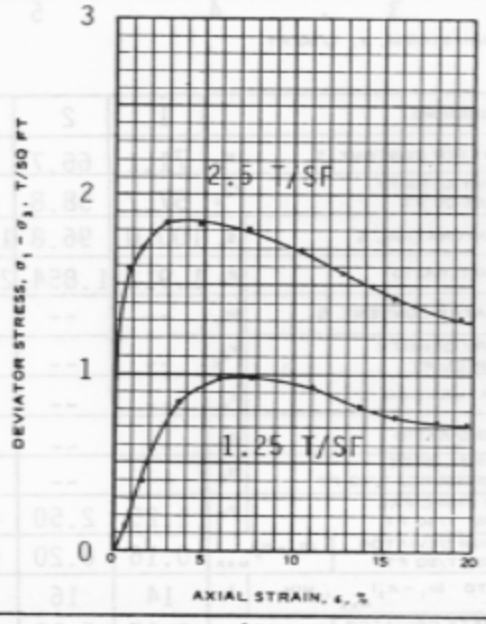
* R Test

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2		
INITIAL	WATER CONTENT, %	w_o	78.7	80.6		
	DRY DENSITY LB/CU FT	γd_o	53.7	52.9		
	SATURATION, %	S_o	100.0	100.0		
	VOID RATIO	e_o	2.102	2.153		
BEFORE SHEAR	WATER CONTENT, %	w_c	56.6	40.7		
	DRY DENSITY LB/CU FT	γd_c	66.4	79.9		
	SATURATION, %	S_c	100.0	100.0		
	VOID RATIO	e_c	1.512	1.086		
	FINAL BACK PRESSURE, T/SQ FT	u_o	0	0		
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.99	1.84		
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	45	15		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.77	1.45		
INITIAL DIAMETER, IN.		D_o	2.84	2.85		
INITIAL HEIGHT, IN.		H_o	6.13	6.13		

CONTROLLED TEST: Strain (0.17 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray Fat Clay (CH)

LL --- NOT REQUESTED PL --- PI --- G_s 2.67

TYPE OF SPECIMEN: Undisturbed TYPE OF TEST: Nat R

REMARKS: NOTE: Insufficient material for three specimens

PROJECT: Craney Island, Norfolk District Lab. No. 141/494

BORING NO. 86 DH-7 SAMPLE NO. 3

DEPTH/~~ELEV~~ 58.5 - 60.5

LABORATORY SADEN-FL DATE 9 September 1986

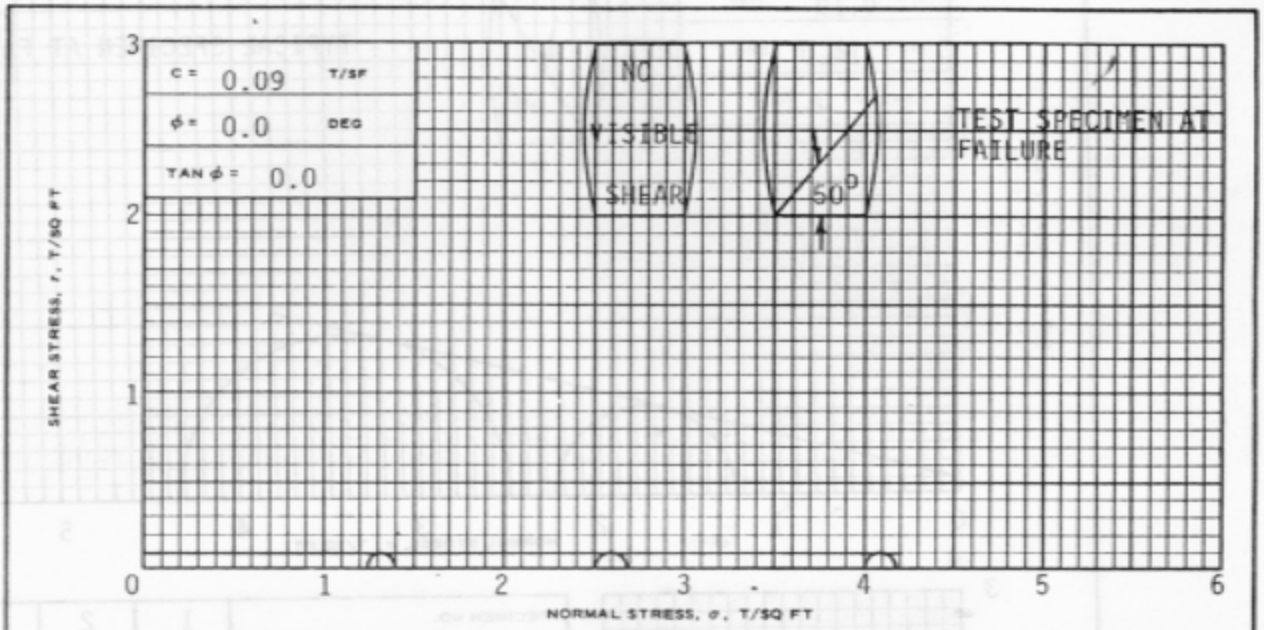
TRIAXIAL COMPRESSION TEST REPORT

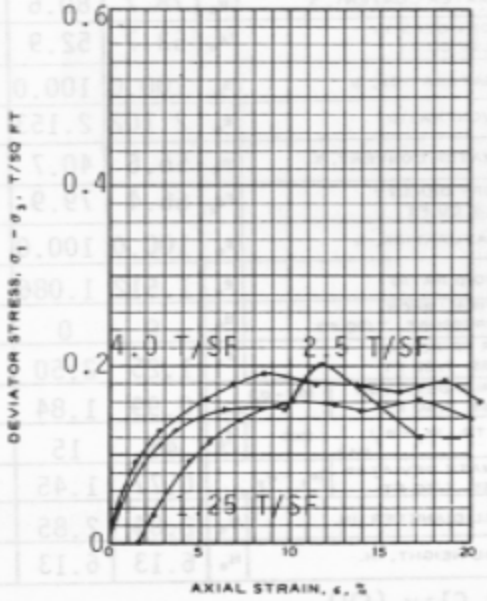
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





			1	2	3	
SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	71.1	66.7	76.1	
	DRY DENSITY LB/CU FT	γd_o	57.7	58.8	55.1	
	SATURATION, %	S_o	100.0	96.8	100.0	
	VOID RATIO	e_o	1.912	1.854	2.048	
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--	
	DRY DENSITY LB/CU FT	γd_c	--	--	--	
	SATURATION, %	S_c	--	--	--	
	VOID RATIO	e_c	--	--	--	
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.16	0.20	0.19	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	14	16	11	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.15	0.15	0.17	
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38	
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08	

CONTROLLED- Strain (0.75 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.69

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/495

BORING NO. 86 DH-7 SAMPLE NO. 5

DEPTH 68.5 - 70.5

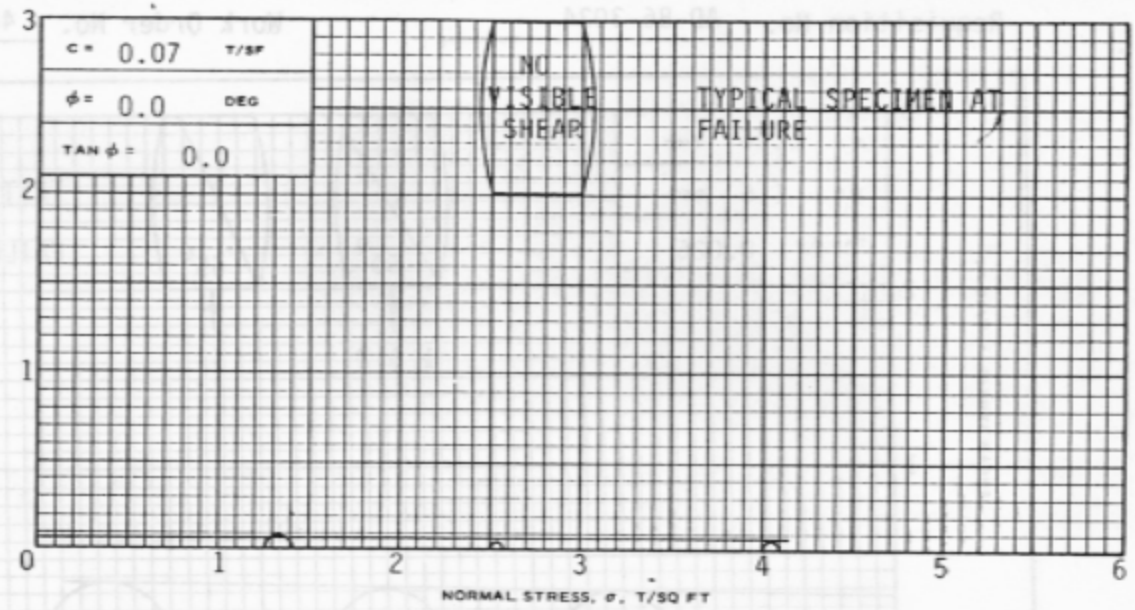
LABORATORY SADEN-FL DATE 8 September 1986

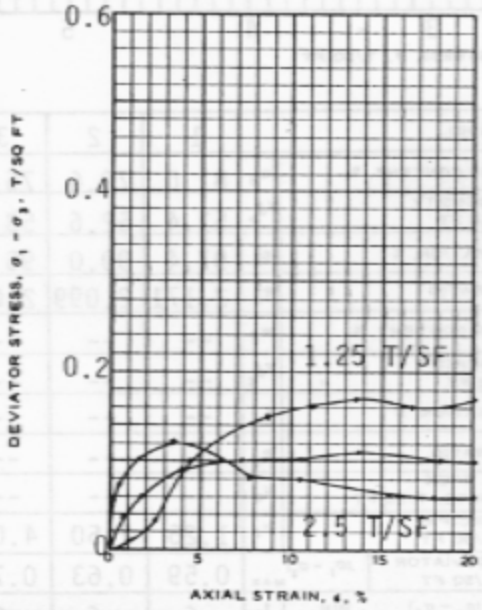
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	82.6	83.7	76.0	
	DRY DENSITY LB/CU FT	γ_{d_o}	51.5	51.5	54.5	
	SATURATION, %	S_o	98.3	99.4	98.1	
	VOID RATIO	e_o	2.271	2.276	2.091	
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--	
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--	
	SATURATION, %	S_c	--	--	--	
	VOID RATIO	e_c	--	--	--	
	FINAL BACK PRESSURE, T/SQ FT	u_b	--	--	--	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.17	0.12	0.11	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	18	5	18	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.17	0.06	0.11	
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38	
INITIAL HEIGHT, IN.		H_o	3.08	3.08	3.08	

CONTROLLED- Strain (0.75 %/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray, Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.70

TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/497

BORING NO. 86 DH-7 SAMPLE NO. 7

DEPTH 88.5 - 90.5

LABORATORY SADEN-FL DATE 8 September 1986

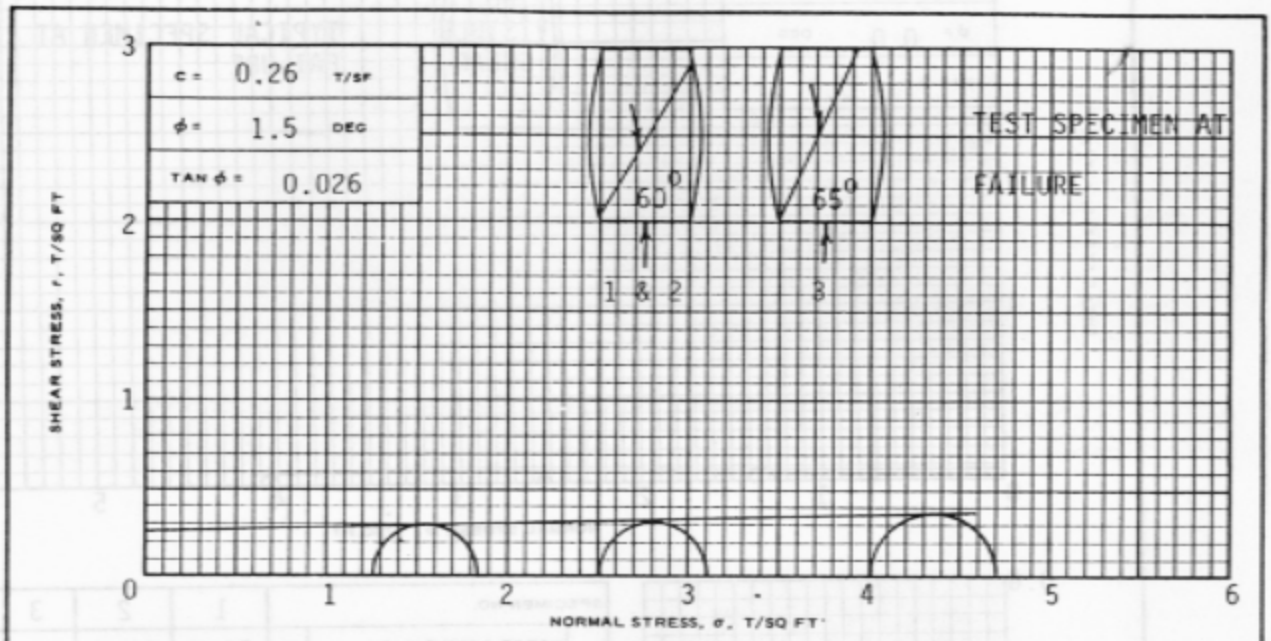
TRIAXIAL COMPRESSION TEST REPORT

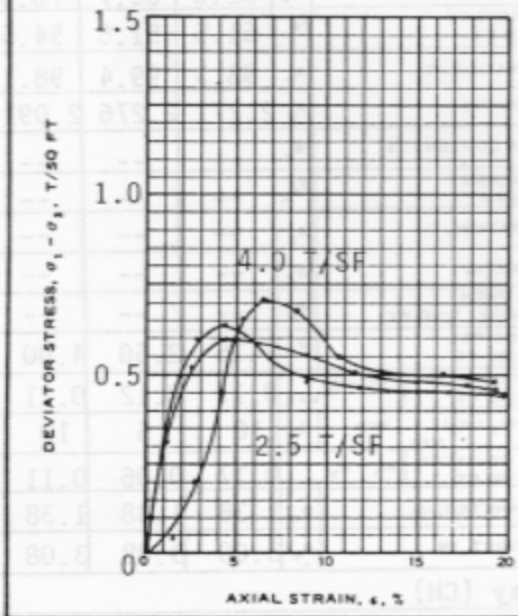
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	81.0	79.6	75.1
	DRY DENSITY LB/CU FT	γ_{d_o}	51.4	52.6	53.4
	SATURATION, %	S_o	97.4	99.0	95.6
	VOID RATIO	e_o	2.171	2.099	2.050
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--
	DRY DENSITY LB/CU FT	γ_{d_c}	--	--	--
	SATURATION, %	S_c	--	--	--
	VOID RATIO	e_c	--	--	--
	FINAL BACK PRESSURE, T/SQ FT	u_b	--	--	--
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.59	0.63	0.71
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	6	6	8
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.48	0.45	0.50
INITIAL DIAMETER, IN.		D_o	2.87	2.86	2.86
INITIAL HEIGHT, IN.		H_o	6.31	6.24	5.66

CONTROLLED- Strain (0.75%/min) TEST

DESCRIPTION OF SPECIMENS (Visual) Gray Fat Clay (CH)

LL --- NOT REQUESTED --- Gs 2.61

TYPE OF SPECIMEN Undisturbed TYPE OF TEST U

REMARKS:

PROJECT Craney Island, Norfolk District

Lab. No. 141/498

BORING NO. 86 DH-7 SAMPLE NO. 8

DEPTH 98.5 - 100.5

LABORATORY SADEN-FL DATE 9 September 1986

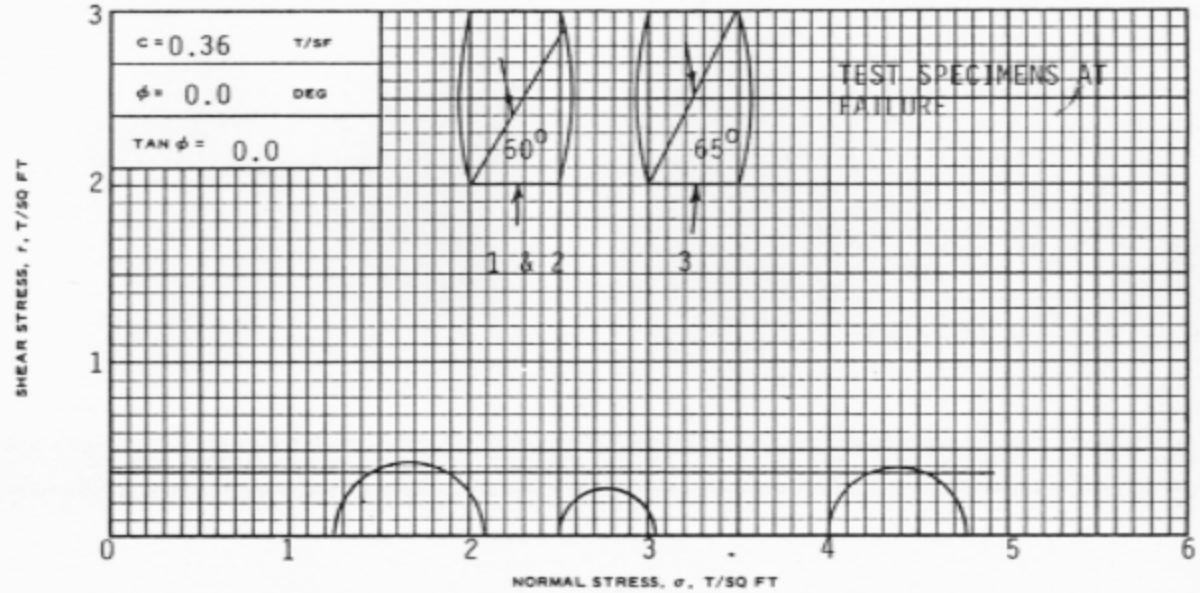
TRIAXIAL COMPRESSION TEST REPORT

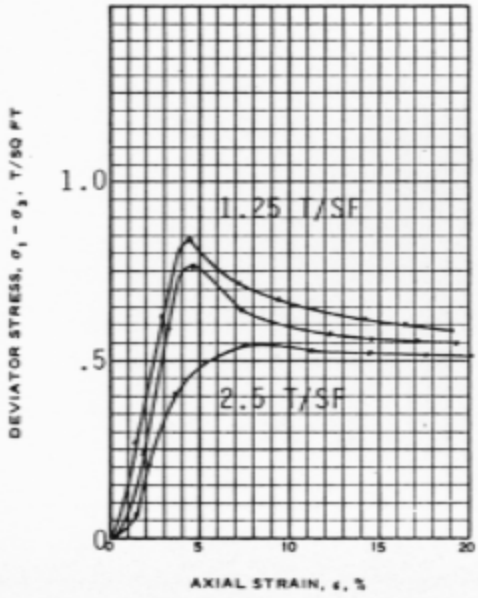
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

Attachment 1

SOUTH ATLANTIC DIVISION LABORATORY, CORPS OF ENGINEERS, MARIETTA, GA

Requisition No. AD-86-3034 Work Order No. 4895





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	77.5	76.3	75.5	
	DRY DENSITY LB/CU FT	γd_o	52.7	53.0	53.9	
	SATURATION, %	S_o	96.6	95.9	97.1	
	VOID RATIO	e_o	2.101	2.084	2.035	
BEFORE SHEAR	WATER CONTENT, %	w_c	--	--	--	
	DRY DENSITY LB/CU FT	γd_c	--	--	--	
	SATURATION, %	S_c	--	--	--	
	VOID RATIO	e_c	--	--	--	
	FINAL BACK PRESSURE, T/SQ FT	u_o	--	--	--	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.25	2.50	4.00	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.84	0.54	0.76	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	7	9	7	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.61	0.53	0.56	
INITIAL DIAMETER, IN.		D_o	2.87	2.85	2.87	
INITIAL HEIGHT, IN.		H_o	6.22*	5.26	6.24	

CONTROLLED TEST: Strain (0.76 %/min)

DESCRIPTION OF SPECIMENS: (Visual) Gray Fat Clay (CH)

LL --- NOT REQUESTED --- G_s 2.62

TYPE OF SPECIMEN: Undisturbed TYPE OF TEST: Q

REMARKS:

*Note Specimen was 6.15 before extruding from shelby tube.

PROJECT: Craney Island, Norfolk District

Lab. No. 141/499

BORING NO. 86 DH-7 SAMPLE NO. 9

DEPTH 108.5 - 110.5

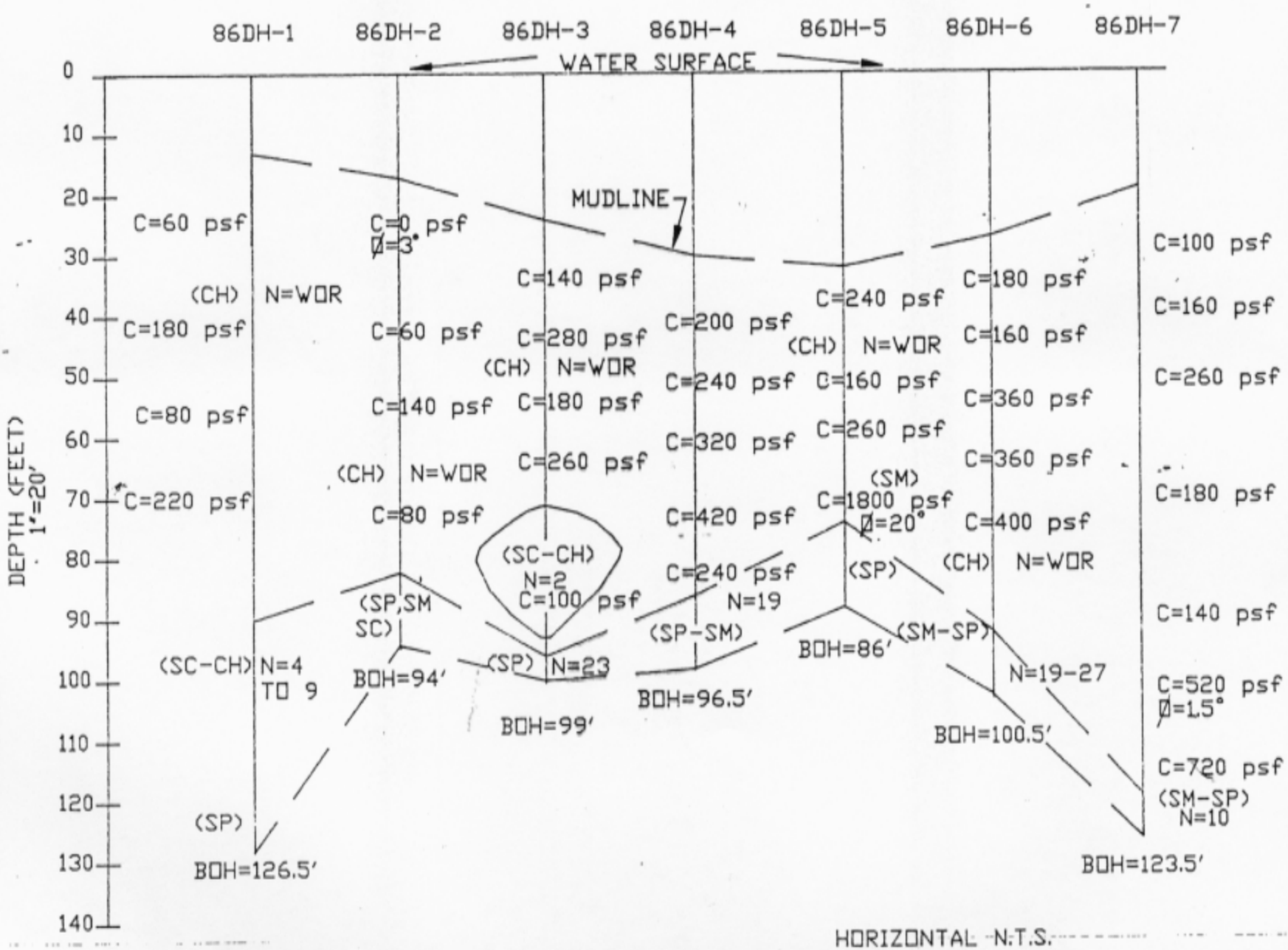
LABORATORY: SADEN-FL DATE: 8 September 1986

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

ATTACHMENT 2
(SECTION 2)

SOIL BORING PROFILE



HORIZONTAL N.T.S.

Attachment 2

SECTION 3

APPENDIX B, SECTION 3
BORROW SOURCE, INVESTIGATION FOR DIKE CONSTRUCTION

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APPENDIX B, SECTION 3
BORROW SOURCE, INVESTIGATION FOR DIKE CONSTRUCTION

INTRODUCTION

1. The scope of this appendix is to discuss the inventory of possible sand sources located in the Inner Harbor of Hampton Roads. The Inner Harbor is described as that body of water bordered on the east by the I-64 bridge-tunnel connecting the cities of Norfolk and Hampton. The mouths of the James and Nansemond Rivers form the western boundary and the southern limit is the entrance to the Elizabeth River. The purpose of this study is to determine the location of mineable quantities of suitable coarse-grained material of sufficient quantity for dike construction for a possible expansion of Craney Island Disposal Area.

2. There are currently six alternative configurations for the expansion of Craney Island Disposal Area. The amount of sediments needed range from 4.5 million to 19.1 million cubic yards depending upon the configuration chosen, (see appendix A for greater detail of this topic). Work on this project was initiated under the presumption that the maximum amount of sediments would be required. Sufficient borrow sites have been determined to fulfill this requirement. Each location was ranked most to least desirable based on transportation distances, amount of overburden, quality of material and secondary benefits of dredging. The effect from an environmental standpoint was not considered in this geotechnical investigation.

GENERAL GEOLOGY

3. The Inner Harbor lies on the Coastal Plain Province of the Atlantic Seaboard. The Coastal Plain Province is composed of a wedge of sedimentary deposits which begin along the ancient pleistocene coastlines, (often termed fall line) approximately 60 miles to the west and thicken to several thousand feet above crystalline rock at the present coastline. Currently, geologic processes are depositing mostly clays and finer sediments from the James and Nansemond Rivers. The large sand bodies encountered in this study were deposited during sea level fluctuations from 25 million to 18,000 years ago.

SITE SELECTIONS

4. The different sites chosen to determine quantity and quality of suitable materials were selected by several different methods. A literature research of publications from the Virginia Department of Transportation, The Virginia Institute of Marine Science, and navigational studies from the Corps of Engineers were used as sources. Conversations with personnel from these organizations about ongoing research or unpublished work and dredging contractors were also used to create this appendix. Exploration programs using vibracores and standard penetration borings were taken during this project to delineate possible borrow sites. Borrow sites adjacent to Craney Island were chosen based on original construction plans of Craney Island and topographic maps of adjacent headlands and other subaerial features to determine possible offshore sand deposits.

EXPLORATION

5. An exploration program consisting of vibracores and standard penetration borings was conducted for this study, (see plates B-1 and B-2, Boring Location Plan). A total of 38 vibracores, (26 vibracores, 20 feet in length and 12 vibracores, 40 feet in length) were taken in June 1988. The work was done by Alpine Ocean Seismic Survey of Norwood, New Jersey. The boring logs are provided in attachment 1, Vibracore logs.

6. Standard Penetration Borings were obtained in two phases--July, 1988 and January 1989. The contractor was McCallum Testing Laboratory of Chesapeake, Virginia. Twenty-four borings were taken in the first phase and twelve borings were taken in the second phase of exploration. All holes were 20 feet in length. The standard penetration borings were taken to sample broad shallow flats adjacent to the coastline inaccessible by the vibracore floating plant. The boring logs are provided in attachment 2, Standard Penetration Logs.

LABORATORY TESTING

7. All laboratory testing was accomplished by the Norfolk District Corps of Engineers sediment laboratory. Identification of the soils was based on the Unified Soils Classification System. Gradations and percentage of coarse material were determined by sieve on the samples that were predominantly sand. Atterberg limits were performed on a few selected clay samples; however, since this was a sand mining study, little other work was performed on the clay samples. A total of eight samples were selected to determine dry and wet densities, specific gravity and to calculate the void ratio. Laboratory data are located on the individual sample logs in attachments 1 and 2 and in attachment 3, laboratory data.

TEXTURAL CHANGES BY DREDGING

8. The terms acceptable or suitable sediments as used in this report are those sediments which will have 20% or less fines, (passing through No. 200 sieve) after dredging, transportation, and deposition at the construction site. For purposes for this study, a maximum limit of 30% fines insitu at the borrow source locations is considered usable or acceptable. Studies have shown that sediments when dredged and transported to another site will tend to coarsen as a percentage of the finer sediments are lost. The loss of sediments usually occurs by sediment elutriation during dredging at the borrow site and placement at the fill project. The sediment slurry used for pumping will carry the finer materials with slower settling rates away from the point of deposition. The amount of material lost is highly variable depending upon the method of dredging, type of transport, and the initial size of the borrow sediments. In this report, an assumption of 20% losses is made. All volumes indicated, unless otherwise stated, reflect a 20% handling loss.

9. Bulking factors, which represent an increase in volume at the deposition site, due to changes in packing of individual grains, are not taken into account in this report. Fine sand has a bulking factor of approximately 1.20 when excavated mechanically and placed at a disposal site. Hydraulic removal by dredging is thought to have a larger bulking factor; however, this value is difficult to determine. For this study, the absence

of a bulking factor is used to create a conservative, but realistic estimate of total yardage needed. The subject of bulking factors will be addressed more thoroughly in the general design phase of this project.

POTENTIAL BORROW SITES

10. There were a total of 15 possible borrow sites studied in this appendix. In this section, each location is assessed individually to determine estimates of sand volumes available. Principal advantages to using a particular site will also be mentioned if notable. The individual areas are numbered from 1 to 15 to facilitate discussion. The number 1 area begins to the west of Craney Island. Each successive site is located in a clockwise direction around the Inner Harbor to area 15. The best sites for use as borrow locations are listed in the "Recommendations" portion of this section.

11. Area 1 is located west of the present Craney Island Disposal Area within the possible expansion area (see figure B-1). This location as a borrow site has two main advantages: first, it is very close to the dike construction site and secondly, removal of material from this location increases storage capacity in the expansion area. During the initial construction of Craney Island Disposal Area in 1954, a grid work of closely spaced borings were drilled west of the disposal area to locate sand deposits for dike construction. These borings indicate sizeable concentrations of sand were present, but some of this material was removed during initial construction. The borings could not be relied on totally and were not included in this report because they were often of insufficient depth, and percentages of fine and coarse materials were based on visual estimation and not laboratory analysis. Ten borings were taken during the exploration phase of this project to validate original borings or determine depth of initial dredging. Current surveys of the area indicate sinkholes where previous dredging occurred. Exploration data indicate concentrations of sand in usable quantities are limited to a maximum distance of 3,500 feet from shore. The nearness of these deposits to the shore suggest that they are the result of coastal erosion during periods of higher sea level. In order to facilitate discussion, Area 1 has been divided into five types of deposits based on the presence of overburden or the thickness of the sand deposit.

12. Type A is composed of approximately 10 feet of clay overburden with an estimated minimum of 10 feet of suitable material. A large portion of the initial dredging took

place in this location in 1954. The maximum dredging depth appears to have been between -20.0 and -22.0 feet, mean low water (m.l.w.). During the last 35 years, the depressions gradually filled with soft clays to -12.0 feet, m.l.w. Borings 89DH-19 and 89DH-21 indicate clean sands of at least 10 feet in thickness remain below the 10-foot clay overburden. The amount of acceptable sands in Type A is estimated at 1.0 million cubic yards, assuming a 20% transport loss.

13. Type B deposits contain a minimum of 25 feet of suitable sand for dike construction with no overburden. This is a relatively small surface area indicated by boring 89DH-23 and collaborated by several borings from the 1954 study. Surveys show no irregularities of the surface to indicate previous dredging. The volume of sand is estimated at 0.6 million cubic yards assuming a transport loss of 20%.

14. Type C materials are composed of 20 feet of coarse-grained sediments with no overburden and are found in three locations in Area 1. In one location, south of Type B, Type C is represented by borings 89DH-22 and 88DH-6A. A second location to the west is illustrated by borings 88DH-5A and 89DH-25. A third location of similar depth with no overburden to the extreme west was noted based on 1954 borings but not included in the volume calculations due to its proximity to the I-64 bridge setback limits. These sediments are mostly fine to medium clean sands with intermittent layers of clayey or silty sands. Separation of these fines by dredging is not warranted. The material after dredging is not expected to exceed the 20 percent maximum content of fines. The estimated volume contained in Type C is 1.0 million cubic yards after subtraction of the 20% transport loss.

15. Type D material has no overburden deposits and an average thickness of 10 feet of suitable sediments. This area is substantiated by borings from the 1954 study with no borings from the recent exploration program. However, bottom surveys do not indicate any disturbance and the original borings are assumed valid. Type D extends from the I-664 perimeter to the west to approximately 3,000 feet in an easterly direction. Type D is estimated to contain approximately 1 million cubic yards of usable sediments after transport losses.

16. The final type of deposit in Area 1 is Type E, which contains no overburden and approximately 7 feet of suitable material for dike construction. It is located furthest offshore, in the western portion of Area 1 and it is represented by boring 89DH-26 and

several borings from the 1954 study. Dredging during the initial construction of the Craney Island Disposal Area cut a circular arc into this depositional type. A second smaller area of Type E is located adjacent to the shoreline in the eastern portion of Area 1. The total amount of acceptable sediments estimated in Type E is 0.8 million cubic yards after the 20% transport loss.

17. Area 1 is marked by an elongated path through the center with relatively little suitable material for construction. This is caused by two factors: first, dredging during the construction of Craney Island removed sediments along a portion of this elongated north to south path. Secondly, Hoffler Creek, which was probably larger during periods of lower sea level, cut a channel through the previously deposited sand. Later, clay and silts were deposited in this depression.

18. Total estimates of sand content in Area 1 are based in part on borings from 1954. It is assumed that the borings located in nondisturbed areas with no records of dredging are still valid. It is strongly suggested that additional borings be performed in this area to determine accuracy of data. Based on present data, the total suitable materials available in Area 1 is 4.4 million cubic yards.

19. Area 2 is located north of Pig Point along the southern perimeter of the entrance to the Nansemond River (see figure B-2). An extensive concentration of clean sands intermixed with acceptable silty sands is located in this area between the shoreline and the 6.0-foot m.l.w. contour. This sand deposit becomes thinner westerly around Pig Point as deposits from the Nansemond River diminish sand quality. To the east, Area 2 is limited by the 2,000-foot setback from the I-664 bridge tunnel which limits dredging adjacent to the structure. Borings 88DH-1, 1A, 2, 2A, 3A and 89DH-27 through 30 all show between 18.0 and 20.0 feet of mostly clean fine sands suitable for dike construction. There is no overburden in the borings or sufficient layers of finer sediments to warrant separation during dredging. Borings 88DH-3, 4, 4A and vibracore 88S1-38 located west and north of the previous borings indicate from 6 to 12 feet of suitable materials with no overburden. For calculation purposes, a bed thickness of 7 feet was used. The total amount of acceptable sediments from Area 2 is estimated at 7.8 million cubic yards with the 20% transportation loss. Pilings from an abandoned ammunition pier approximately 800 feet in length will have to be removed to obtain this estimated volume.

20. Area 3, located on the southern perimeter of the mouth of the Nansemond River, lies between Pig Point and Bennett Creek (see figure B-3). The borings representing this area are located in shallow water of -6.0 feet m.l.w. or less. The only suitable material of sufficient thickness is located in borings 88DH-6 and 88DH-7. Boring 88DH-6 contains clean sands, (SP) or acceptable silty sands to the bottom of the hole (-22.0 feet m.l.w.). Boring 88DH-7 is composed of clean sands and clayey sands, (76% sand), with a 6-foot clay layer from -5.0 to -11.0 feet m.l.w. Moving in a southwesterly direction, the sediments are composed of intermixing clean or clayey sands and clay deposits. Borings 88DH-8 to 88DH-12 do not contain usable construction materials isolated sufficiently for extraction by dredging. In summary, based on these preliminary investigations, Area 3 did not contain enough acceptable sediments to warrant removal.

21. Area 4 is represented by borings 88DH-13 to 88DH-18 and vibracore 88S1-6. They are located east of Cedar, Barrel and Pike Points on the west side of the mouth of the Nansemond River (see figure B-3). Borings 88DH-13 and 14 are composed almost totally of continuous clay (CH) deposits. Borings 88DH-15 and 16 exhibit small amounts of clean or clayey sand intermixed with layers of overlying clay deposits. Borings 88DH-17 and 18 show 20 and 14 feet of clean sands, respectively. Boring 88DH-18 contains a low plastic clay from -14.5 to -19.5 feet, m.l.w. with 49% sand. However, the adjoining deposits are composed of clean sand and separation of these sediments may not be necessary as the resulting composite should contain less than 20% fines. This sand layer is thought to thin rapidly offshore since the vibracore 88S1-6 is composed predominantly of clays. Using a bed thickness of 15 feet, the estimated volume of sand is 5.1 million cubic yards with the transport loss. This volume may be conservative based on the limited area covered by the borings.

22. Area 5 is located in the western portion of the Inner Harbor between the mouths of the Nansemond and James Rivers (see figure B-4). Originally, five vibracores were planned for this area. However, 88S1-1 encountered only soft clays and it was decided that no suitable construction materials would be found at this site and the remaining vibracores were saved for use at alternate locations.

23. Area 6, commonly known as the Newport News Middle Ground, is located south of the Newport News Channel, directly adjacent to the channel (see figure B-5). The principal advantage of this location is the close proximity to the proposed northern dike

alignment in the expansion of Craney Island. A total of 11 vibracores were conducted by the Virginia Department of Transportation during September 1979 and January 1984. The sand deposits in this area are mostly fine grained with irregularities in bed thickness. An overburden of unsuitable silty sand is 10 to 14 feet thick in some areas. Based on the state conducted study, the depth and inconsistency of the sand deposit is a major detrimental factor to removal, despite the proximity of this site to Craney Island. Assuming a 6-foot layer of sand over an estimated 1.2 million square yards, the net volume of acceptable material is 2.4 million cubic yards.

24. Area 7, commonly referred to as the Newport News Bar, is located north of the Newport News Channel (see figure B-5). Eight vibracores were obtained by the Army Corps of Engineers during the exploration phase of this study. Vibracores 88S1-10, 14, and 36 contain 8 to 11 feet of clean sand (SP), in the upper portion of the boring underlain by acceptable clayey sands (SC), to the bottom of the hole. Moving in a northerly direction vibracores 88S1-37 and 88S1-13 contain 6 feet of clay overburden underlain by clean sands with clayey sands occupying the lower portion of each boring. Toward the west, unsuitable clay deposits (CH) dominate vibracores 88S1-12 and 88S1-9. Based on the locations of borings containing the maximum amount of sand, this deposit appears most concentrated along the southern perimeter of the Newport News Bar in a southwest to northeast orientation. To the north, layers of clay and silt overlie suitable clean and silty sands. The dominant sandbed probably extends to the northeast along the 12-foot depth contour; however, this assumption is not included in the volume calculations due to lack of data. Based on presently available borings, it is estimated that 1.1 million net cubic yards is available with no overburden and 0.6 million net cubic yards is obtainable with 6 to 10 feet of clay overburden. These figures are probably conservative based on the limited number of borings available.

25. Area 8 is located in the Newport News navigational channel between stations 155+00 to 290+00, (see figure B-5). Exploration programs were conducted by the Corps of Engineers for the Norfolk Harbor Deepening Study in 1983, 1984 and 1985. Borings indicate suitable silty sands (SM), and clayey sands (SC), between stations 155+00 to 255+00. The approximately 30 or so vibracores located in this area show clean sands (SP) and silty sands with a 20 to 30 percent concentration of fines (see figures B-5A, B-5B, and B-5C). Intermittent layers of shell hash are also located in the channel. Material from this area was dredged in the summer of 1988 and placed on

the west side of Craney Island to stabilize the west dike. For further information on laboratory data and boring logs, consult the Norfolk Harbor Deepening General Design Memorandum 1, Appendix C, Volume 2, dated June 1986.

26. Based on current surveys of the Newport News Channel, removal of sediments to -57.0 feet m.l.w. would result in 1.7 million cubic yards. This figure is based on a channel length of 10,000 feet and channel width of 800 feet, and current elevations. As previously stated, 20% transport loss is assumed in this cubic yardage.

27. Dredging from elevations -57.0 feet to -70.0 feet m.l.w. the length of channel with acceptable material is approximately 13,500 feet (stations 155+00 to 290+00). This 3,500-foot increase in channel length is due to the gradual removal of fines with depth. Thus, assuming a channel length of 13,500 feet, a channel width of 800 feet and removal of 13 feet (-57.0 feet to -70.0 feet), a total of 4.2 million cubic yards would be obtained. This figure also assumes a 20% transport loss. Dredging from -57.0 feet to 70.0 m.l.w., between stations 155+00 to 290+00, approximately 320,000 cubic yards per foot of depth can be obtained after the 20% transport loss has been subtracted.

28. Additional yardage may be obtained along the channel toes as the channel is deepened. Assuming a channel depth of 70 feet m.l.w., a side slope of 1 vertical to 3 horizontal, and a channel length of 13,500 feet, total sediments removed are 337,000 cubic yards. In this instance, a 30% transportation loss has been assumed due to a larger amount of finer materials from above falling into the "box cut." Total sediments obtained from the north and south toe slopes are calculated at 230,000 cubic yards after transportation losses.

29. Total sediments obtained from the Newport News Channel are calculated to be:

-50.0 to -57.0 ft. (m.l.w.)	1.7	million cubic yards
-57.0 to -70.0 ft. (m.l.w.)	4.2	million cubic yards
channel toes to -70.0 ft. (m.l.w.)	.2	million cubic yards
	6.1	million cubic yards

30. Area 9, the eastern portion of the Hampton Flats, is located in the northern perimeter of the Inner Harbor of Hampton Roads (see figure B-6). It is a relatively flat featureless bottom with an average depth between 8.0 and 11.0 feet m.l.w. The Virginia Department of Transportation conducted 16 borings in the location. The predominant sediment is a fine to medium sand with occasional layers of coarse sand and gravel. The sand is clean and has an average thickness of 12.5 feet. Much of this sand is at the surface, though some may have as much as 12 feet of overburden. Total area is approximately 2.1 million square yards. The calculated insitu volume of sand is 8.7 million cubic yards; subtracting 20% for transport loss, leaving 7.0 million cubic yards.

31. Area 10, the Hampton Bar, is located in the northeast portion of the Inner Harbor, (see figure B-6). The average depth of this feature is between 4 and 5 feet with the crest sloping down to 8.0 feet on the perimeter. The State Department of Highways obtained three borings along the crest in 1984. The Corps of Engineers supervised six vibracores along the perimeter for this study. The sediments are composed of fine to medium clean sands with intermittent silty sands. All vibracores taken show no overburden with the exception of 88S1-17 which contained 5 feet of clay (CH) overlying 16 feet of clean sands. Vibracores 88S1-15 and 16, located on the southeastern side of the bar, exhibit clean sands with small amounts of fines throughout the 20-foot length of the borings. Vibracores 88S1-33, 34 and 35 have alternating layers of clean and silty sands in the top 8.0 to 10.0 feet underlain by cleaner sands. The total area available was obtained by tracing the 6-foot depth contour. Volume was calculated by assuming removal of 12 feet of sediment. Total insitu volume of acceptable sediments was determined as 20 million cubic yards, assuming a 20% transport loss, leaving 16 million cubic yards.

32. Area 11, located in the eastern portion of the Inner Harbor, is situated south of the Entrance Reach Channel (see figure B-7). A total of four vibracores were taken in this area. Vibracores 88S1-31 and 32 contained a 3- to 4-foot veneer of sand over a continuous clay deposit. Vibracores 88S1-18 and 20 exhibited a mixture of clean and silty sands with intermixing of unacceptable sediments. Due to the amount of clays, this area was determined not to have sufficient usable sediments to warrant removal, and volume calculations were not performed.

33. Area 12 is located at the extreme northern end of the Naval Operations Base and is the proposed site for Pier 13 (see figure B-7). Anticipated dredging elevation is -50.0 feet m.l.w. while the present elevation ranges from -12.0 feet to -20.0 feet m.l.w. Four 40-foot vibracores, 88S1-21 thru 24, were taken at this location. The sediments sampled in the top 12 to 15 feet of the holes were mostly clean sands (SP), or acceptable clayey sands (SC). Vibracores 88S1-21, 22 and 24 contained a small clay (CH) layer 2 to 5 feet thick near the surface. These clay deposits are thought to be small enough not to require separation by dredging. Below the 12- to 15-foot depth, the sediments became very dense, silty or clayey sand of acceptable quality with cemented shell hash. All four of the vibracores hit penetration refusal between -23.0 and -28.0 feet m.l.w. This material may require a cutterhead for removal. Similar sediments were dredged in the adjacent pier 12 in 1986 and the material was used for beach nourishment of Willoughby Spit. Navy engineers estimate approximately 2.9 million cubic yards of material need to be removed. Allowing 20% for transport losses, this leaves 2.3 million cubic yards available for dike construction.

34. Area 13 is located in the Norfolk Harbor Entrance Channel between stations 145+00 to 186+00 (see figure B-8). No borings were taken during the exploration phase of this project. Vibracores taken in 1983 and 1985 for the Norfolk Harbor Deepening Study indicate a mixture of clean sands (SP), silty sands (SM), clayey sands (SC) and clays (CH). For further laboratory data and information, consult the Norfolk Harbor Deepening General Design Memorandum 1, Appendix C, Volume 1. Some of the silty and clayey sands are considered acceptable while other layers contain more than the prescribed 30% fines. Conversations with personnel from Atkinson Dredging reveal the area is predominantly sand size material. Presently, the quality or quantity of the sediments within this area are undefined. The advantage of this location is its close proximity to the Craney Island Disposal Area and its location in an established navigational channel. Assuming the channel is to be dredged an average of 5 feet as part of the deepening project, the 1,000-foot-wide, 4,100-foot-long segment of channel would yield 0.7 million cubic yards. Subtracting 20% for transport loss would net 0.6 million cubic yards.

35. This area is not recommended as borrow site due to the small amount of material available and the uncertain quality of these sediments. If, however, this dredging is to be conducted as part of a harbor deepening project, then the sediments may be considered for dike construction.

36. Area 14, located to the east of Craney Island is currently owned by the Virginia Port Authority and composed of two sites (see figure B-8). The northern most site (No. 1) is located north of pier number 2 of the Norfolk International Terminals. Dredging is planned in this area to expand present docking facilities for the Norfolk International Terminals. In a second location, (No. 2) adjacent to Tanners Point, a short channel 800 feet wide is anticipated to connect berthing facilities at Tanner Point with the Craney Island Reach Channel. Location 1 was sampled by four vibracores, 88S1-25 through 28, during exploration phases of this project. All of the holes show an overlying clay layer extending from -12.5 to -32.5 feet m.l.w. The average depth of this clay contact is -23.0 feet m.l.w. The underlying strata is a clayey sand (SC) containing an average of 26 percent fines. For calculating purposes, the clay/sandy clay interface is assumed to be -25.0 feet m.l.w. Anticipated dredging depth is -42.0 feet m.l.w., resulting in 1.5 million cubic yards after transport losses. Each additional foot of depth would yield 85,000 cubic yards of acceptable sediments.

37. Location 2, adjacent to Tanner Point, was sampled by vibracores 88S1-29 and 30 during this study. Vibracore 88S1-29, closest to Tanner Point, contained 14 feet of clay overburden overlying clayey sand (SC) with approximately 17 percent fines. Boring 88S1-30 sampled a continuous clay layer to the bottom of the hole. To calculate the amount of acceptable materials, the distance between vibracores was divided equally, with 15 feet of acceptable sediments assumed landward. This location yielded 350,000 cubic yards after transport loss to a dredging depth of -42.0 feet m.l.w.

38. The total amount of sediments suitable for dike construction from Area 14 is estimated at 1.8 million cubic yards. The principal advantage to this site is the close proximity to the possible expansion site.

39. Area 15 is located within the present boundaries of the Craney Island Disposal Area (see figure B-9). Dredge sediments from various projects are routinely pumped into the disposal area across the eastern dike, where the coarser-grained sediments settle out quickly and the finer sediments are carried westward by large volumes of water from the dredge slurry. This sorting system concentrates the coarser sediments along the eastern dike of the disposal area. Boring programs conducted in 1971 and 1980 along the eastern dike show concentrations of acceptable sandy materials from 9 to 17 feet in thickness. Some of the borings were located in excess of 2,000 feet

from the dike. The quality of sand is thought to diminish with increasing distances from the eastern dike. Personal observations of sand mining operations along the eastern dike have indicated bed thickness of acceptable material greater than 20 feet in some areas. Craney Island management personnel have stated that usable material may exist as much as 3,300 feet from the eastern dike. For purposes of estimating sediment volume, it is assumed that an acceptable bed of coarse-grained material exists 10 feet in thickness, 1,500 feet in width, for the entire length of Craney Island, 10,000 feet. This calculation results in 5.6 million cubic yards. Subtracting 20% for transport losses will yield 4.5 million cubic yards for in place dike construction. This is believed to be a conservative estimate; however, a grid work of borings prior to excavation would be necessary to determine more precise volume estimates. The principal advantages of this location are its close proximity to the expansion site and the added capacity for the present disposal area that the removal of these materials would create.

40. Excavation of this site, because it is subaerial, may be more difficult than normal dredging operations and require more costly mobilization. Conversations with dredging contractors have indicated that a 12- to 16-inch dredge may be dismantled, then reassembled inside the disposal area. A second pump would then be used to pump enough water into the site to provide a dredge slurry for pumping material to the expansion site. A second alternative would involve a larger floating plant to dredge its way into the disposal area through the eastern dike. Each method should be studied to determine the most cost effective means of sediment removal.

RECOMMENDATIONS

41. The following areas have been ranked from most to least desirable borrow areas to obtain suitable materials for the possible expansion of Craney Island. This ranking is based on quality and quantity of material available, distance of site from the possible expansion, secondary benefits from the dredging operations. The environmental effects of each area are not considered here.

RANK	AREA	DESCRIPTION	QUANTITY (millions yd. 3)	CUMULATIVE (millions yd. 3)
1	1	Craney Island Expansion	4.4	4.4
2	15	Craney Island Disposal	4.5	8.9
3	8	Newport News Channel 50.0 to 70.0 MLW	6.1	15.0
4	2	Pig Point	7.8	22.8
5	14	NIT Terminals	1.8	24.6
6	12	Navy Pier 13	2.3	
7	6	Newport News Middle Ground	2.4	
8	7	Newport News Bar	1.7	
8	9	East Hampton Flats	7.0	
9	4	Barrel Point	5.1	
9	10	Hampton Bar	1.6	

42. Area 13 (Norfolk Harbor Entrance Channel) can receive further consideration as part of the planned Norfolk Harbor Deepening to -55.0 ft. (m.l.w.) (0.6 million cubic yards) but quantity is too small and quality is questionable to justify use as a borrow source.

43. Areas 3, 5, and 11 will receive no further consideration as possible borrow sources.

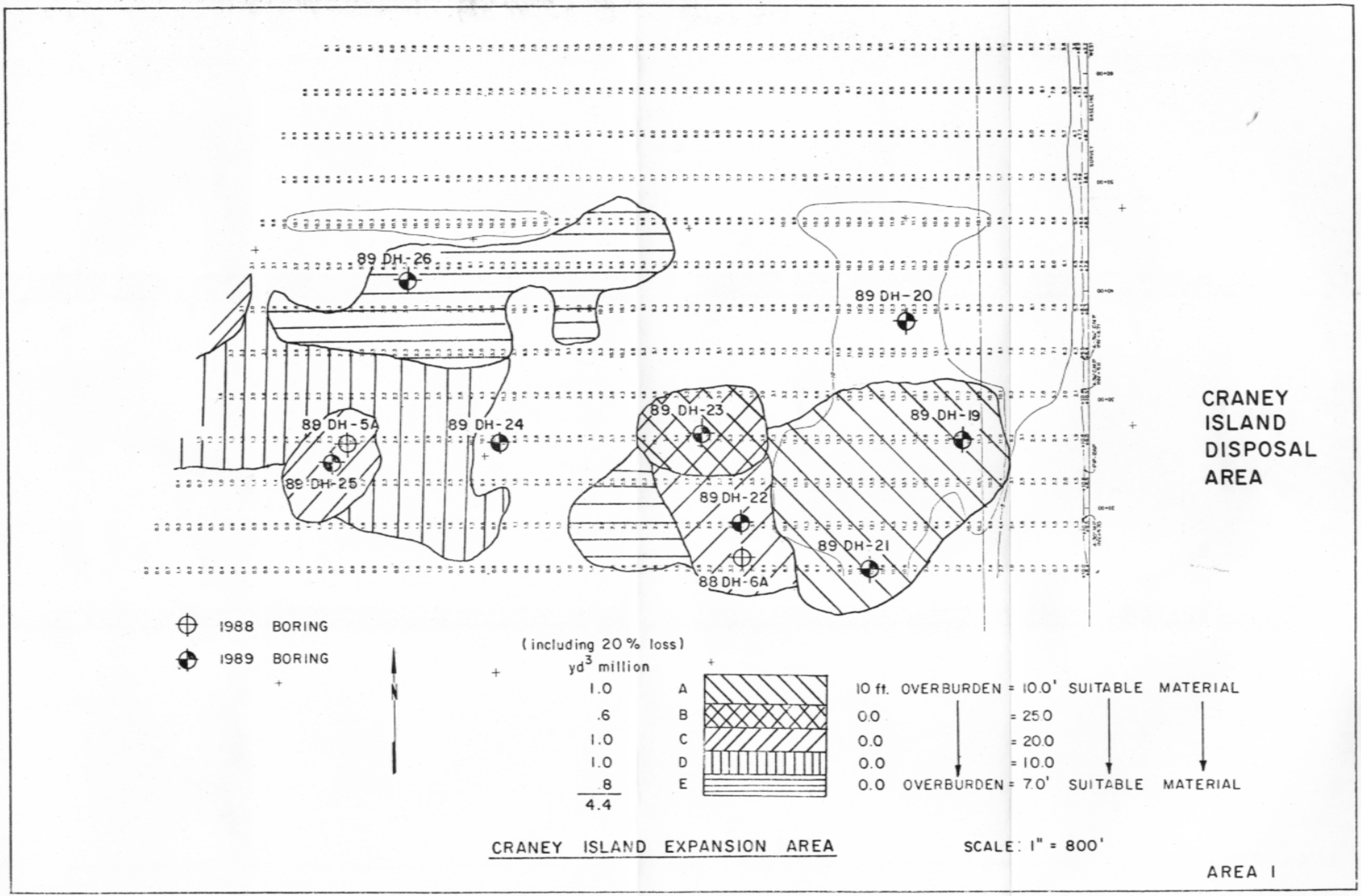

CRANEY ISLAND DISPOSAL AREA
89 DH-26
89 DH-20
89 DH-5A
89 DH-24
89 DH-23
89 DH-19
89 DH-25
89 DH-22
89 DH-21
88 DH-6A
1988 BORING
1989 BORING
(including 20 % loss)
yd³ million
1.0 A
.6 B
1.0 C
1.0 D
.8 E
4.4
10 ft. OVERBURDEN = 10.0' SUITABLE MATERIAL
0.0 = 25.0
0.0 = 20.0
0.0 = 10.0
0.0 OVERBURDEN = 7.0' SUITABLE MATERIAL
CRANEY ISLAND EXPANSION AREA
SCALE: 1" = 800'
AREA I

Figure B-1

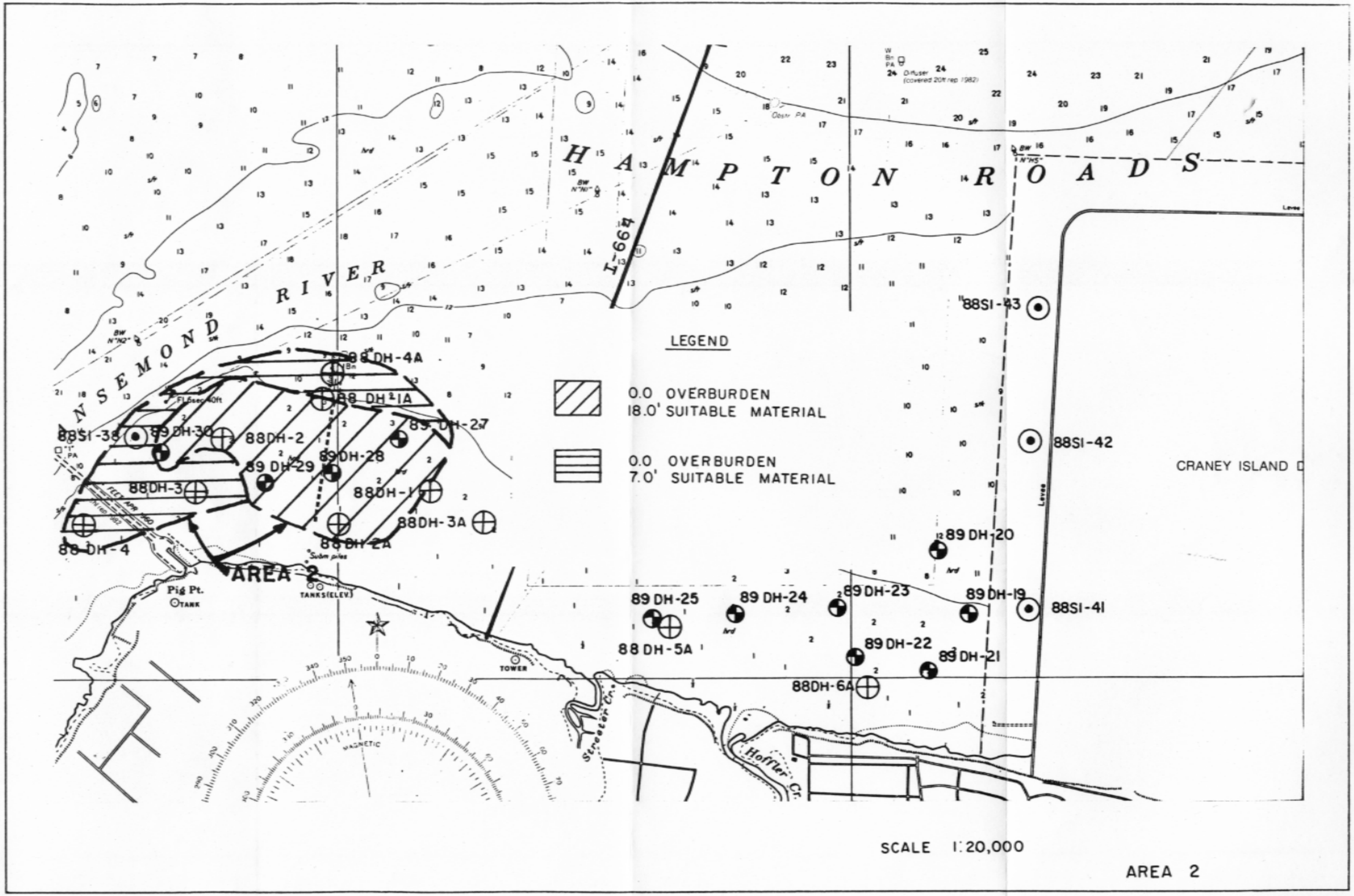
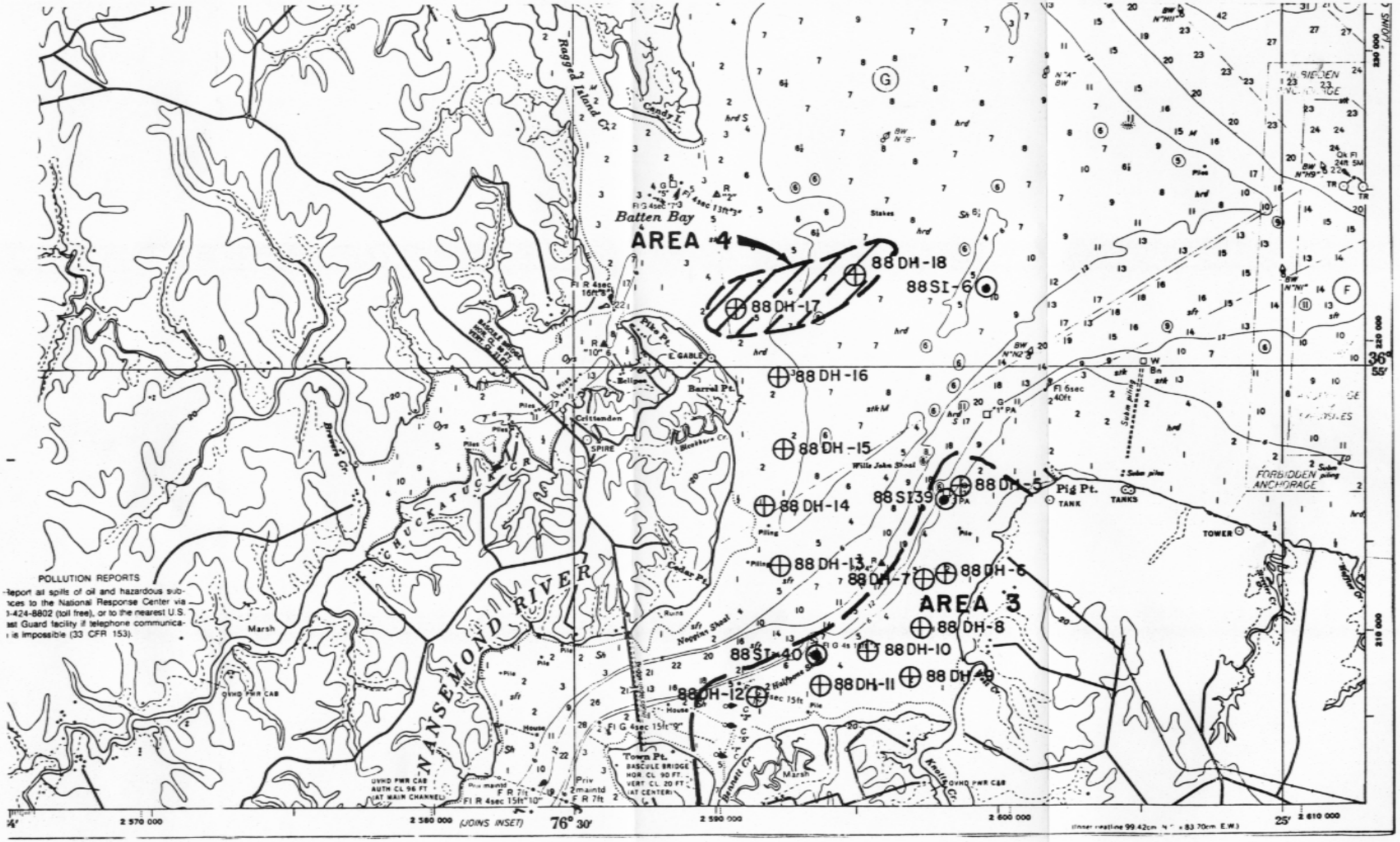

HAMPTON ROADS
NANSEMOND RIVER
499-T
LEGEND
0.0 OVERBURDEN
18.0' SUITABLE MATERIAL
0.0 OVERBURDEN
7.0' SUITABLE MATERIAL
CRANEY ISLAND D
AREA 2
Pig Pt.
TANK
TANKS(ELEV.)
TOWER
Streeter Cr.
Hoffler Cr.
MAGNETIC
88SI-43
88SI-42
88SI-41
88SI-38
88DH-4A
88 DH-1A
89 DH-27
89 DH-30
88DH-2
89 DH-29
89 DH-28
88DH-1
88DH-3
88DH-3A
88 DH-4
88 DH-2A
89 DH-20
89 DH-25
89 DH-24
89 DH-23
89 DH-19
88 DH-5A
89 DH-22
89 DH-21
88DH-6A
SCALE 1:20,000

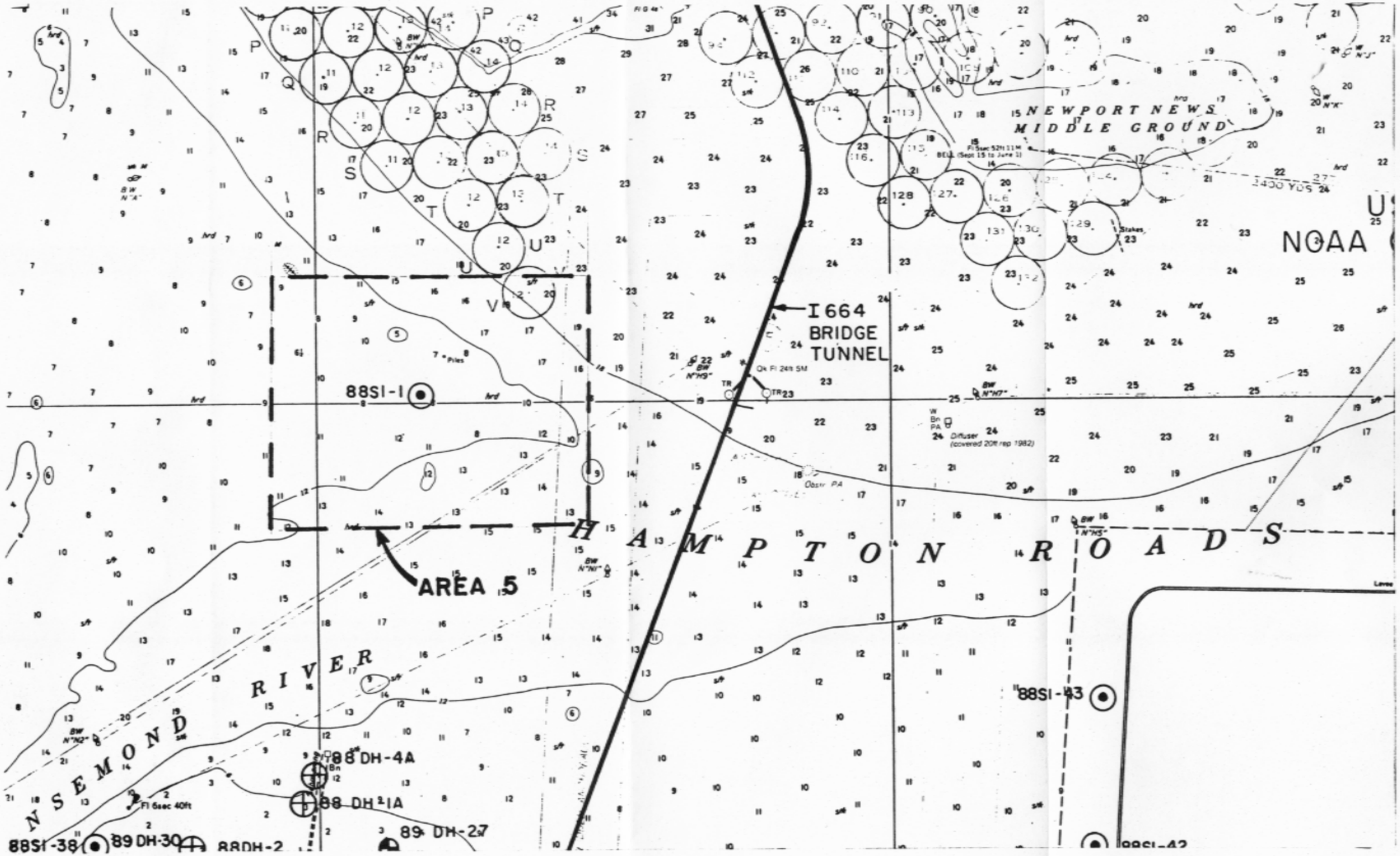
Figure B-2



SCALE 1:40,000

AREAS 3 & 4

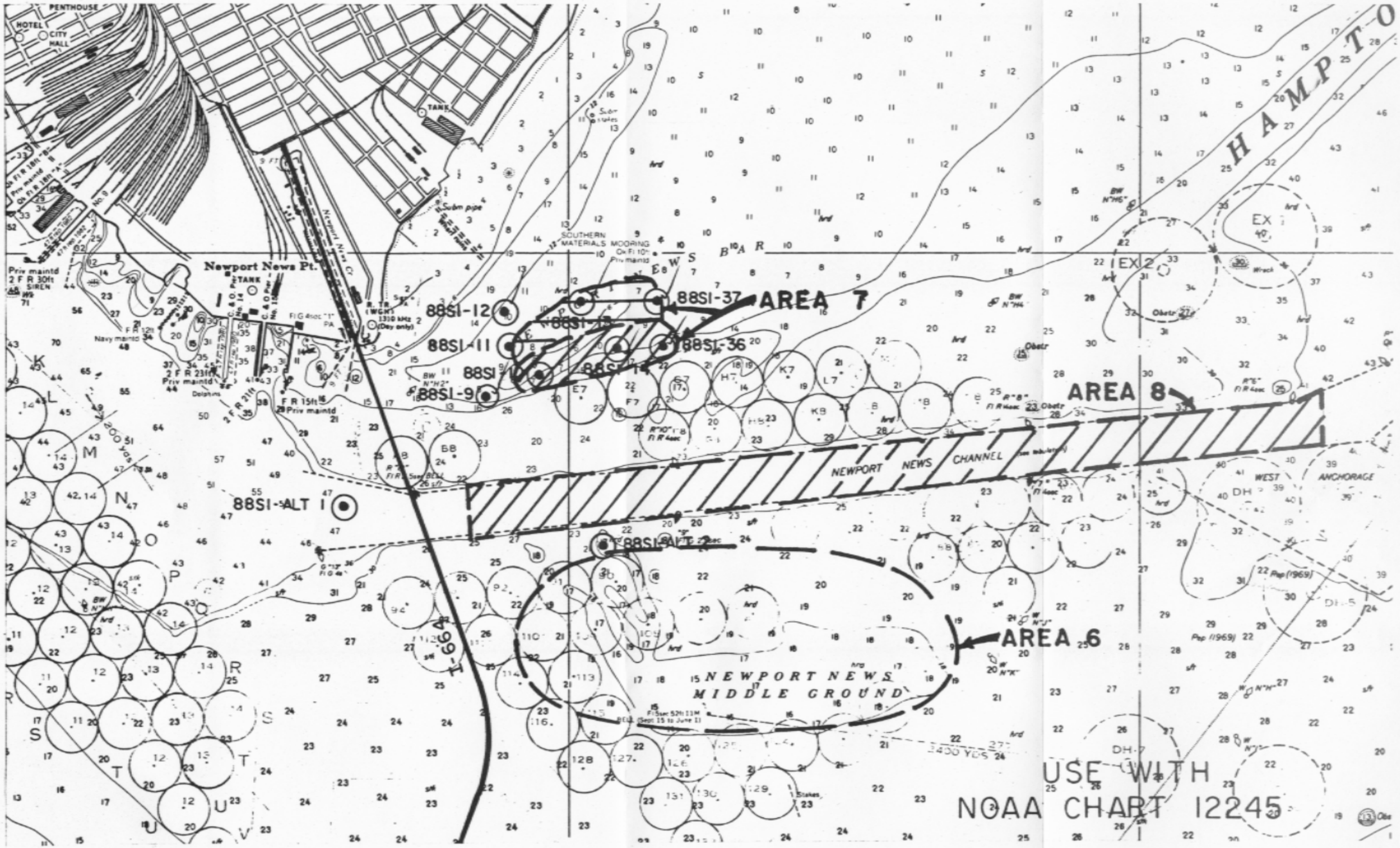
Figure B-3



SCALE 1:20,000

AREA 5

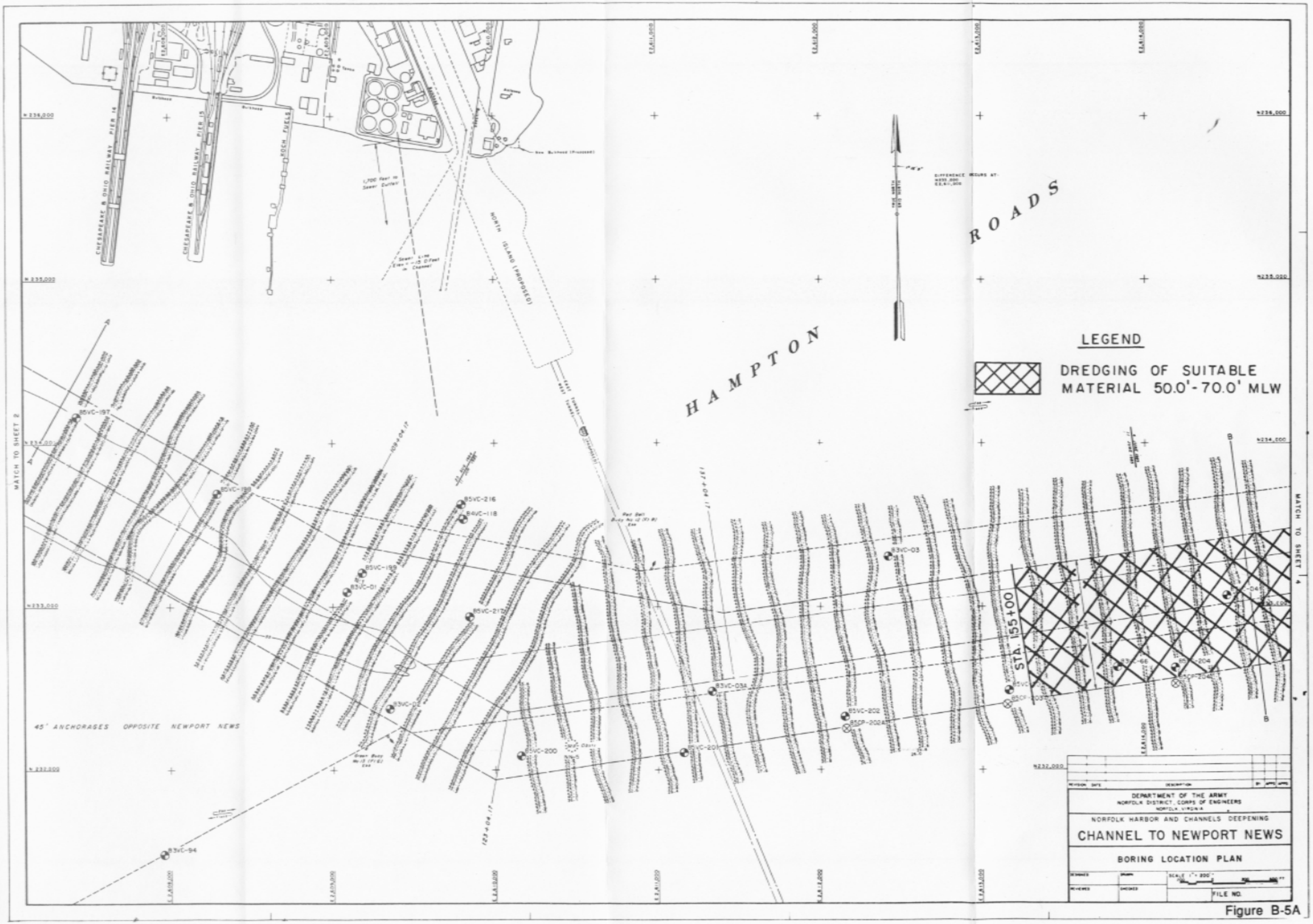
Figure B-4



SCALE 1:20,000

AREAS 6, 7 & 8

Figure B-5



HAMPTON ROADS
LEGEND
DREDGING OF SUITABLE MATERIAL 50.0'-70.0' MLW
STA. 155+00
45' ANCHORAGES OPPOSITE NEWPORT NEWS
MATCH TO SHEET 2
MATCH TO SHEET 4
CHESAPEAKE & OHIO RAILWAY PIER 14
CHESAPEAKE & OHIO RAILWAY PIER 15
KOCH FUELS
NORTH ISLAND (PROPOSED)
DEPARTMENT OF THE ARMY
NORFOLK DISTRICT, CORPS OF ENGINEERS
NORFOLK, VIRGINIA
NORFOLK HARBOR AND CHANNELS DEEPENING
CHANNEL TO NEWPORT NEWS
BORING LOCATION PLAN
FILE NO.

Figure B-5A

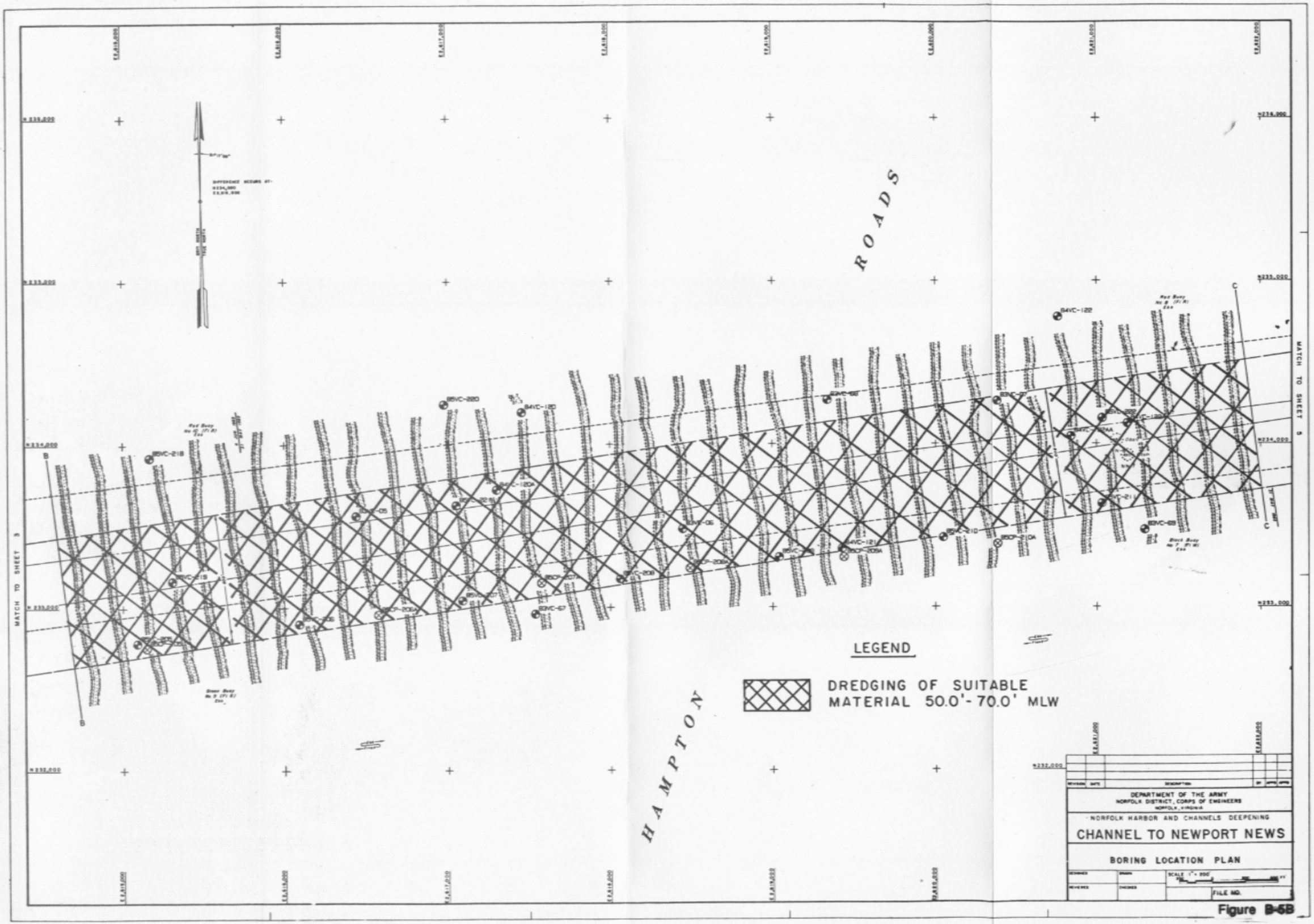

ROADS
HAMPTON
MATCH TO SHEET 3
MATCH TO SHEET 5
LEGEND
DREDGING OF SUITABLE MATERIAL 50.0'-70.0' MLW
DEPARTMENT OF THE ARMY
NORFOLK DISTRICT, CORPS OF ENGINEERS
NORFOLK, VIRGINIA
NORFOLK HARBOR AND CHANNELS DEEPENING
CHANNEL TO NEWPORT NEWS
BORING LOCATION PLAN
FILE NO.

Figure B-5B

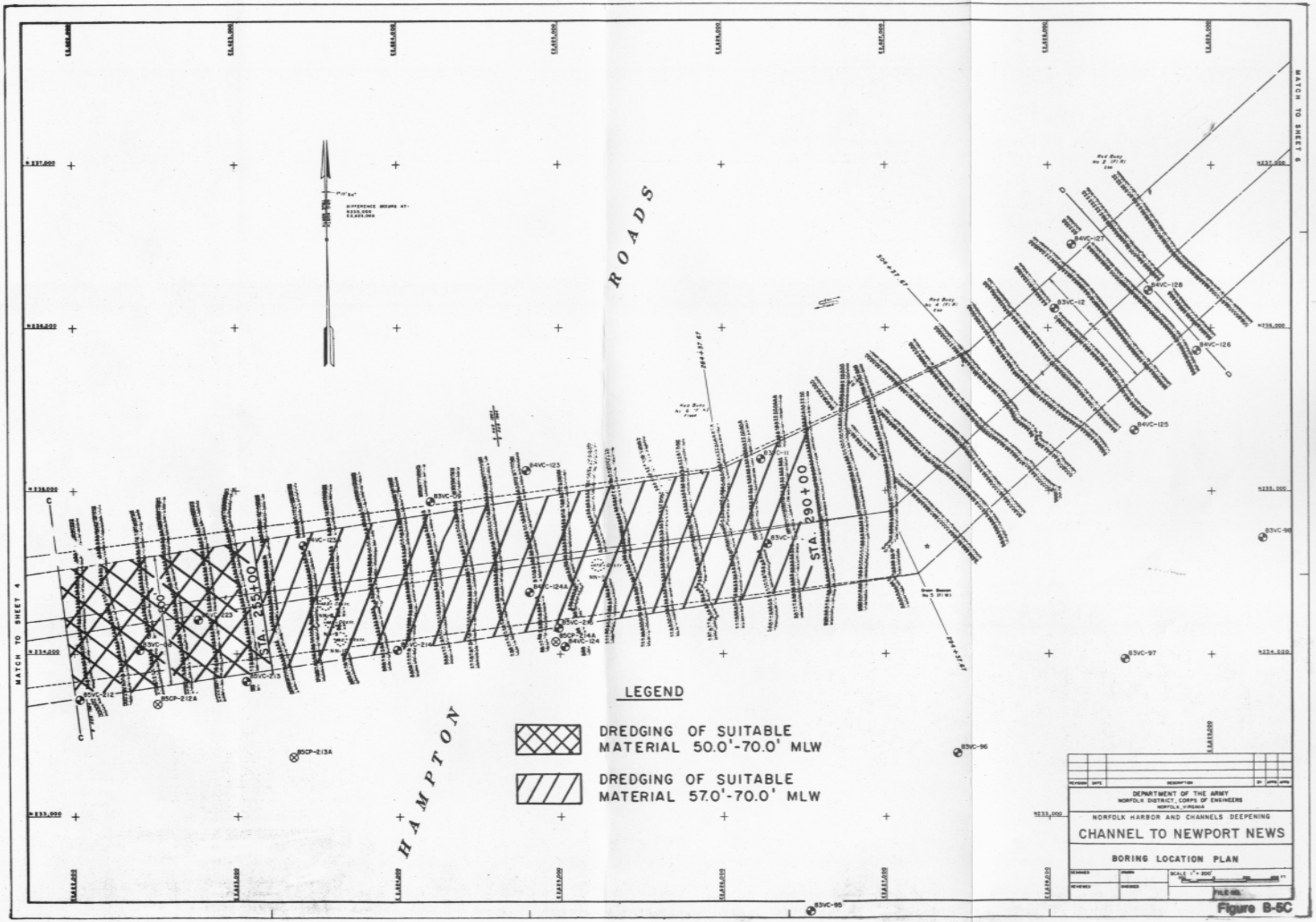
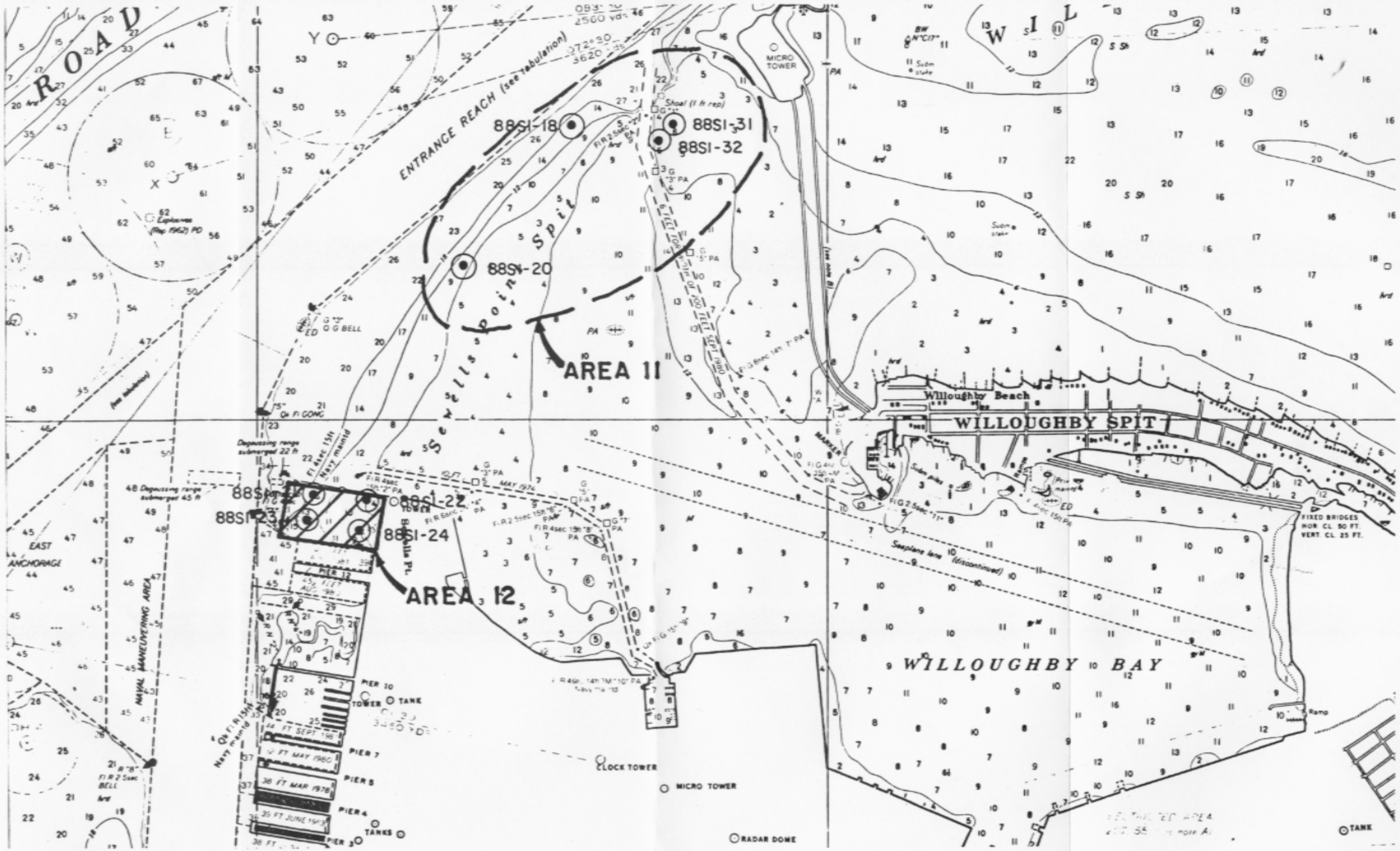

MATCH TO SHEET 4
MATCH TO SHEET 6
HAMPTON ROADS
STA. 255+00
STA. 290+00
LEGEND
DREDGING OF SUITABLE MATERIAL 50.0'-70.0' MLW
DREDGING OF SUITABLE MATERIAL 57.0'-70.0' MLW
DEPARTMENT OF THE ARMY
NORFOLK DISTRICT, CORPS OF ENGINEERS
NORFOLK, VIRGINIA
NORFOLK HARBOR AND CHANNELS DEEPENING
CHANNEL TO NEWPORT NEWS
BORING LOCATION PLAN

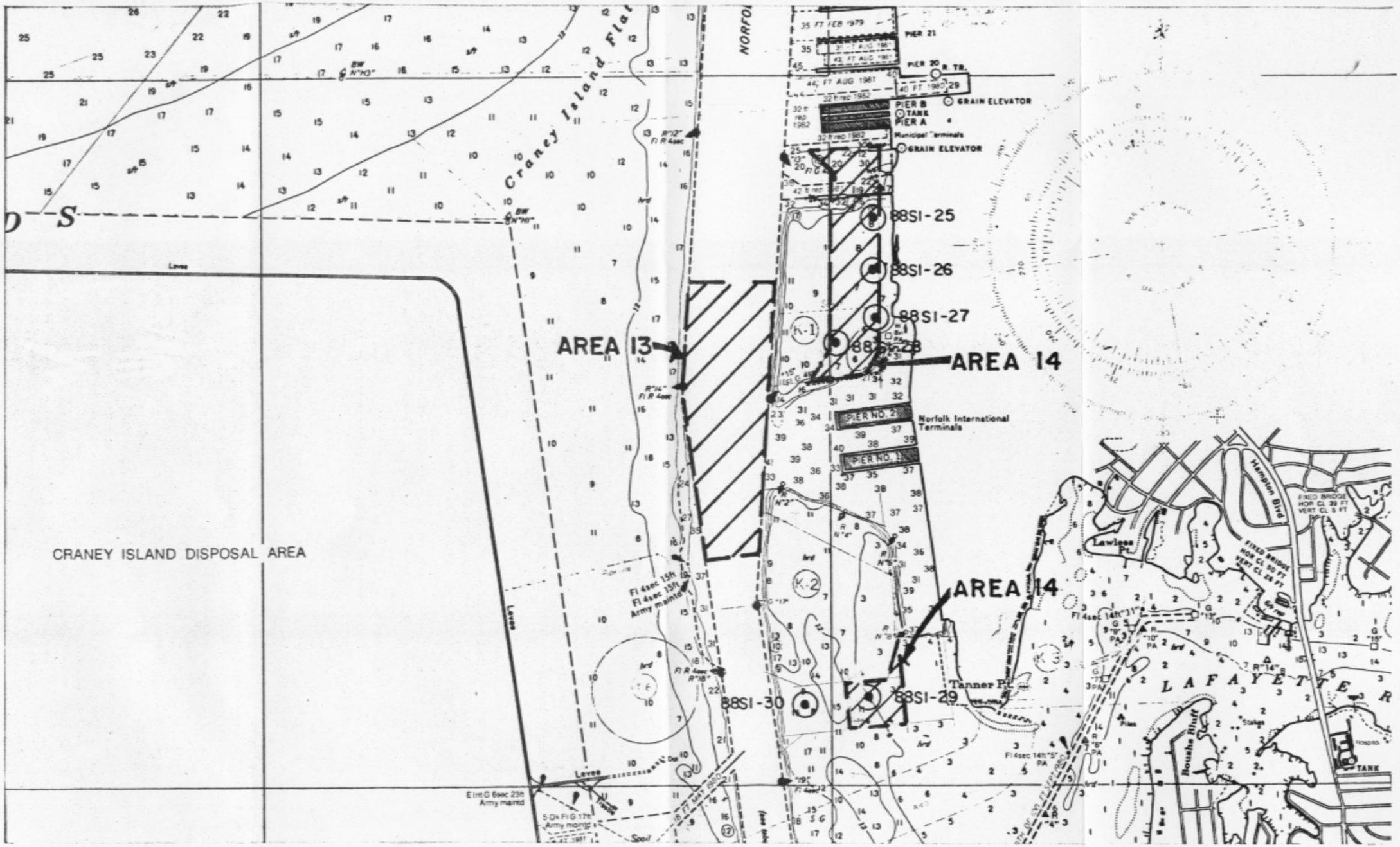
Figure B-5C



SCALE 1:20,000

AREAS 11 & 12

Figure B-7



SCALE 1:20,000

AREAS 13 & 14

Figure B-8

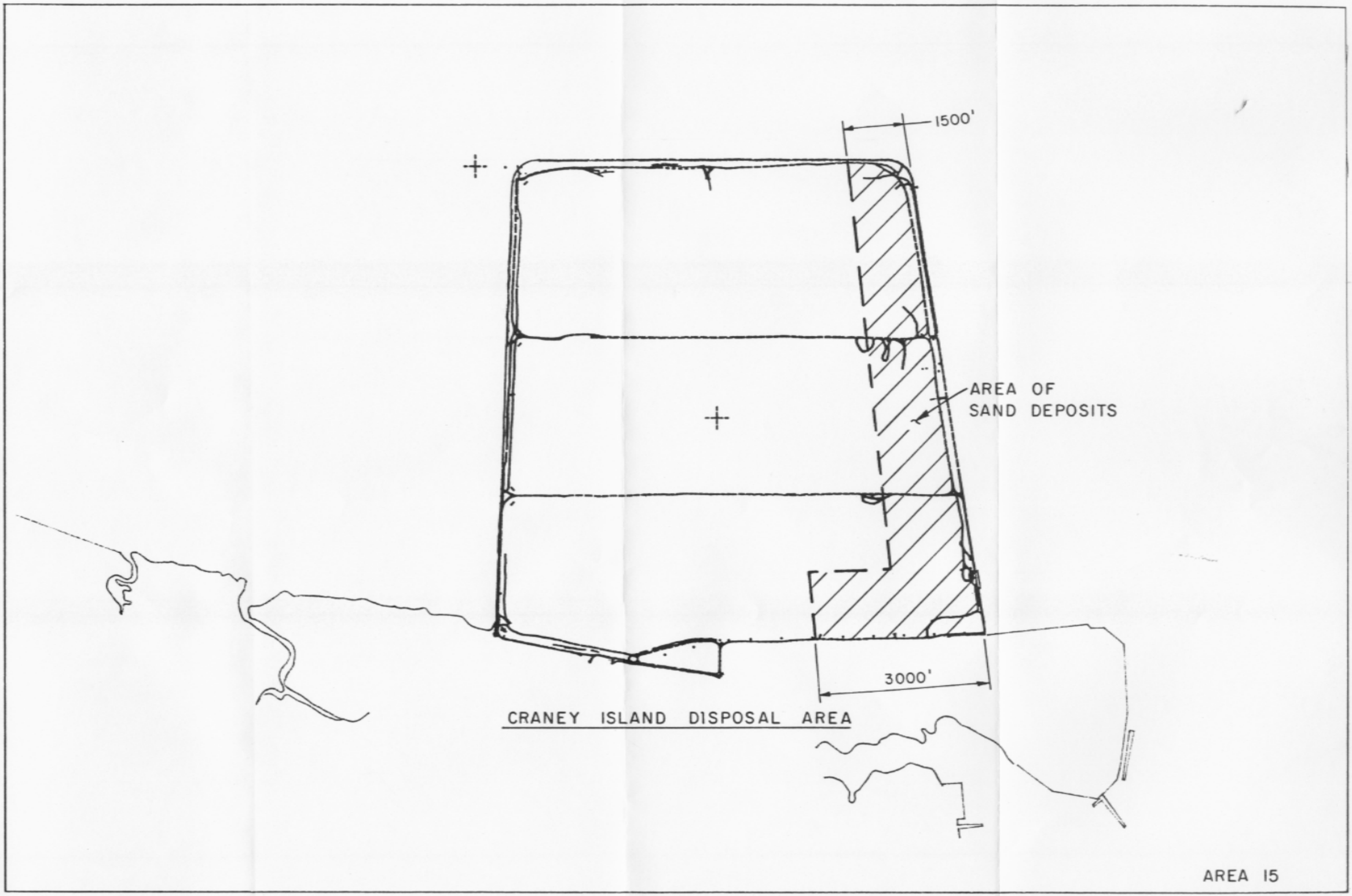
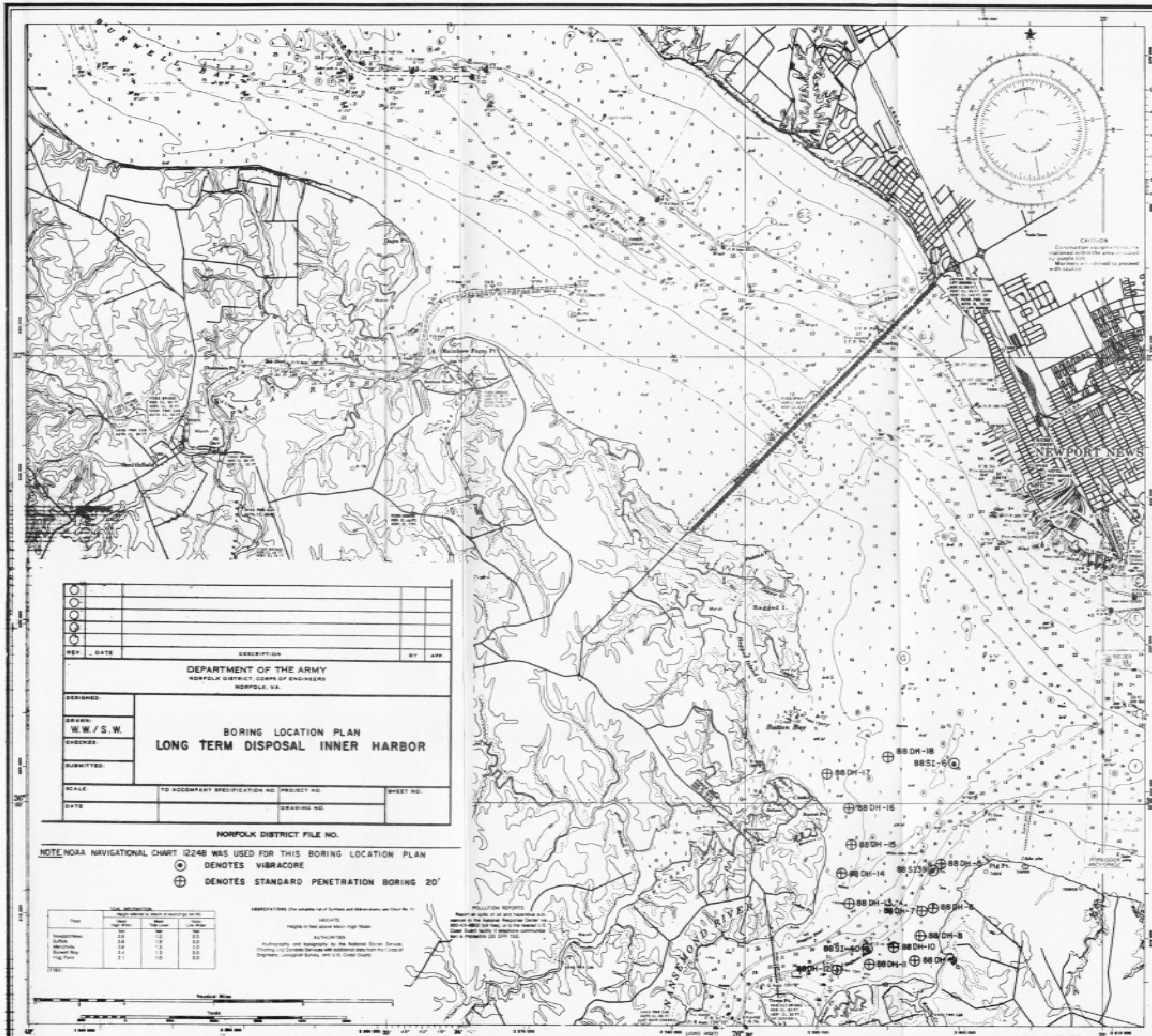

1500'
AREA OF
SAND DEPOSITS
3000'
CRANEY ISLAND DISPOSAL AREA
AREA 15

Figure B-9



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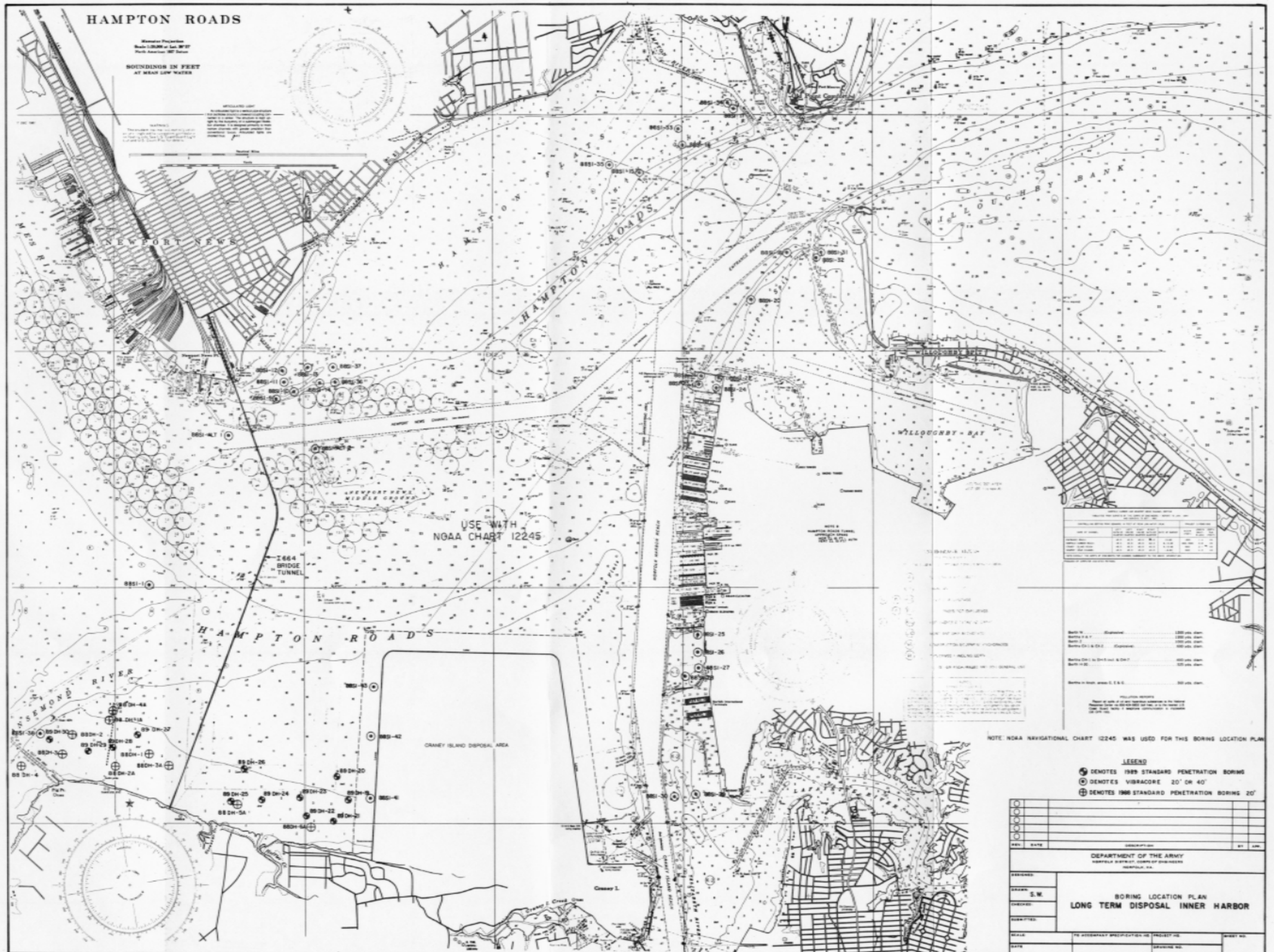
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

(James River, Newport News to Jamestown Island)

SOUNDINGS IN FEET - SCALE 1:40,000

12248

PLATE B-I


HAMPTON ROADS
SOUNDINGS IN FEET
AT MEAN LOW WATER
NEWPORT NEWS
HAMPTON ROADS
WILLOUGHBY BANK
WILLOUGHBY BAY
NEWPORT NEWS MIDDLE GROUND
USE WITH
NOAA CHART 12245
I664
BRIDGE
TUNNEL
HAMPTON ROADS
JAMES RIVER
CRANEY ISLAND DISPOSAL AREA
NOTE: NOAA NAVIGATIONAL CHART 12245 WAS USED FOR THIS BORING LOCATION PLAN
LEGEND
DENOTES 1989 STANDARD PENETRATION BORING
DENOTES VIBRACORE 20' OR 40'
DENOTES 1988 STANDARD PENETRATION BORING 20'
DEPARTMENT OF THE ARMY
NORFOLK DISTRICT, CORPS OF ENGINEERS
NORFOLK, VA.
DESIGNED:
DRAWN: S.W.
CHECKED:
SUBMITTED:
BORING LOCATION PLAN
LONG TERM DISPOSAL INNER HARBOR
SCALE:
DATE:
TO ACCOMPANY SPECIFICATION NO.
PROJECT NO.
DRAWING NO.
SHEET NO.
NORFOLK DISTRICT FILE NO. 12245 PLATE B-8

ATTACHMENT 1
(SECTION 3)

Vibracore Boring Notes

VIBRACORE BORING NOTES

1. The soil was classified according to the "Unified Soil Classification System" (ML, CL, SP, etc.) and described utilizing the "Burmister's Method of Material Proportions."

2. The penetration scale indicates the number of seconds required for vibracorer to penetrate each foot of material. If more than 40 seconds was necessary, the total number of seconds was written on the scale for each foot of penetration.

3. All elevations and locations are approximate.

4. For location of borings, plates B-1 and B-2.

5. Dates shown on logs are completion dates.

6. Samples are stored at the Norfolk District, Corps of Engineers and are available for inspection.

7. Abbreviations:
   - BOH - Bottom of Hole
   - cly - clayey
   - dk - dark
   - fn, f - fine
   - Frag - fragments
   - mst - moist
   - N.G.V.D. National Geodetic Vertical Datum
   - NP - non-plastic
   - sat - saturated
   - slty - silty
   - grn - green
   - gry - gray
   - gvy - gravelly
   - gslk - good slake
   - hrd - hard
   - hi - high (ly)
   - HP - high plasticity
   - lt - light
   - LL - Liquid Limit
   - LP - Low Plasticity
   - med, m - medium
   - MP - medium plasticity
   - tr - trace
   - v - very
   - v.f. - very fine

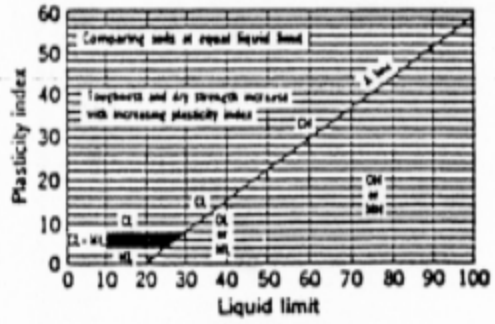
8. Material has dilated due to the vibratory nature of the sampling process such that more sediment was recovered then actually penetrated. This will occur most often in (SM) silty sand deposits.

9. This boring log represents conditions and deposits as believed by the inspector to reflect sedimentary layers as they exist in the subbottom. Additional footage of soft deposits have been added to this log to reconstruct insitu conditions. This reconstruction is based on penetrometer rates; adjacent borings and sediment types. Some of the soft clays lack the necessary shear strength to enter the core barrel and are therefore not sampled.

Unified Soil Classification System

UNIFIED SOIL CLASSIFICATION SYSTEM (U.S.C.S.)

Field Identification Procedures (Excluding particles larger than 75 mm and basing fractions on estimated weights)					Group Symbols[a]	Typical Names	Laboratory Classification Criteria
Coarse-grained soils: More than half of material is larger than 75 μm sieve size* (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels: More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes		GW	Well graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows:[b] Less than 5% GW, GP, SW, SP. More than 12% GM, GC, SM, SC. 5% to 12% Borderline cases requiring use of dual symbols. $C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW
		Gravels with fines (appreciable amounts of fines)	Nonplastic fines (for identification procedures see ML below)		GM	Silty gravels, poorly graded gravel-sand-silt mixtures	Atterberg limits below "A" line, or PI less than 4 — Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			Plastic fines (for identification procedures, see CL below)		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures	Atterberg limits above "A" line, with PI greater than 7
	Sands: More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes		SW	Well graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing		SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (appreciable amounts of fines)	Nonplastic fines (for identification procedures, see ML below)		SM	Silty sands, poorly graded sand-silt mixtures	Atterberg limits below "A" line or PI less than 5 — Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			Plastic fines (for identification procedures, see CL below)		SC	Clayey sands, poorly graded sand-clay mixtures	Atterberg limits below "A" line with PI greater than 7
Fine-grained soils: More than half of material is smaller than 75 μm sieve size	Identification Procedures on Fraction Smaller than 380 μm Sieve Size						Use grain size curve in identifying the fractions as given under field identification
		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)			
	Silts and clays: liquid limit less than 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity	
	Silts and clays: liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			Pt	Peat and other highly organic soils	



Plasticity chart for laboratory classification of fine grained soils

[a] *Boundary classifications*: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

Vibracore Logs

ATTACHMENT 2
(SECTION 3)

Boring Notes

STANDARD PENETRATION BORING NOTES

1. The soil was classified according to the "Unified Soil Classification System" (ML, CL, SP, etc.) and described utilizing the "Burmister's Method of Material Proportions."

2. The blow column indicates depth of sample and number of blows required to drive a 2-inch O.D. splitspoon sampler 6 inches, unless otherwise noted, into undisturbed soil with a 140-lb. hammer falling 30 inches per ASTM D1586. The standard penetration "N" value is the sum of the last two 6-inch drives, (i.e. 6, 4, 5; N=9) in an 18" penetration or the second two 6-inch drives, (i.e., 6, 4, 5, 7; N=9) in a 24" penetration.

3. Estimated consistencies (med. stiff, soft, etc.) are from Terzaghi & Peck "Soil Mechanics in Engineering Practice." Estimated blow counts, noted in the remarks column, are based upon a field test derived by the Norfolk District.

4. All elevations and locations are approximate.

5. For location of borings, see drawings.

6. Dates shown on logs are completion dates.

7. Samples are stored at the Norfolk District, Corps of Engineers and are available for inspection.

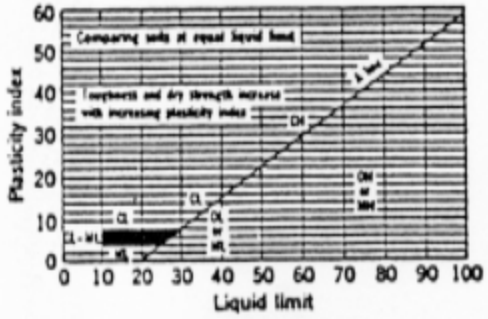
8. Abbreviations:

BOH - Bottom of Hole N.G.V.D. National Geodetic Vertical Datum
cly - clayey NP - nonplastic
dk - dark PI - Plastic Index
dns - dense PL - Plastic Limit
fn, f - fine sat - saturated
frag - fragments (fragmented) sly - silty
HP - high plasticity tr - trace
lt - light v - very
LL - Liquid Limit v.f. - very fine
LP - Low Plasticity w/ - with
med, m - medium WOH - weight of hammer
MP - medium plasticity WOR - weight of rod
mst - moist

Unified Soil Classification System

UNIFIED SOIL CLASSIFICATION SYSTEM (U.S.C.S.)

Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)				Group Symbols[a]	Typical Names	Laboratory Classification Criteria
Coarse-grained soils: More than half of material is larger than 75 μm sieve size[b] (The smallest particle visible to naked eye)	Gravels: More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Use grain size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows:[c] GW, GP, SW, SP — Less than 5%; GM, GC, SM, SC — More than 12%; Borderline cases requiring use of dual symbols — 5% to 12%. $C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see ML below)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures	Atterberg limits below "A" line, or PI less than 4 — Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			Plastic fines (for identification procedures, see CL below)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures	Atterberg limits above "A" line, with PI greater than 7
	Sands: More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	SW	Well graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see ML below)	SM	Silty sands, poorly graded sand-silt mixtures	Atterberg limits below "A" line or PI less than 4 — Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			Plastic fines (for identification procedures, see CL below)	SC	Clayey sands, poorly graded sand-clay mixtures	Atterberg limits below "A" line with PI greater than 7
Fine-grained soils: More than half of material is smaller than 75 μm sieve size (The 75 μm sieve size is about the smallest particle visible to naked eye)	Identification Procedures on Fraction Smaller than 180 μm Sieve Size					
	Silts and clays: liquid limit less than 50	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)		
		None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity
	Silts and clays: liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays
		Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture		Pt	Peat and other highly organic soils	



Plasticity chart for laboratory classification of fine grained soils

[a] *Boundary classifications.* Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

Standard Penetration Logs

HOLE NO. 88DH-1

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	X=2805948.77 Y=216546.41
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-1
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/07/88 / COMPLETED 07/07/88
17. ELEVATION TOP OF HOLE	-4.5
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -4.5 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			SAND (SP) (0.0 – 1.5) FN SAND,SOME MED SAND,TR SILT NP,SAT,DK GRAY 45% FINE SAND		S1	0.0–2.0	1–1–2–3
-6.0	2		SAND CLAY (SC) (1.5 – 5.5) FN SAND AND CLAY HP SAT DK GRAY				
	4		89% FINE TO MED SAND		S2	4.0–6.0	2–2–2–4
-10.0	6		SAND (SP) (5.5 – 9.0) FN TO MED SAND NP SAT WHITE				
	8		74% FINE TO MED SAND		S3	8.0–10.0	1–1–2–1
-13.5	10		CLAY SAND (SC) (9.0 – 12.0) FN SAND SOME CLAY HP MST LT. GRAY TO ORANGE				
-16.5	12		SAND (SP) (12.0 – 17.5) FN TO MED SAND NP MST YELLOW				
	14		95% FINE TO MED SAND		S4	14.0–16.0	5–6–8–9
	16						
-22.0	18		SAND (SP) (17.5 – 20.0) SAME AS ABOVE TR FN GRAVEL		S5	18.0–20.0	1–2–6–6
-24.5	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-1

HOLE NO. 88DH-1A

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2804326.10 218086.40 *
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-1A
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/07/88 / COMPLETED 07/07/88
17. ELEVATION TOP OF HOLE	-2.0
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -2.0 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			SAND (SP) (0.0 - 2.0) FN SAND, LITTLE MED.SAND, TR. TO LITTLE SILT, NP,SAT.,GRAY 96% SAND			DEPTH	BLOWS/6"
					S1	0.0-2.0	2-1-1-0
-4.0	2		SAND (SP) (2.0 - 18.8) FN. TO MED.SAND,TR.FINES,NP., SAT.,LT.GRAY TO WHITE 97% SAND				
	4						
					S2	4.0-6.0	3-6-7-8
	6						
			*THIS LOCATION IS APPROXIMATE				
	8						
					S3	8.0-10.0	5-5-7-9
	10						
	12						
	14						
					S4	14.0-16.0	4-6-6-5
	16						
	18						
-20.8			CLAY (CH) (18.8 - 20.0) CLAY,TR.FN.SAND,HP,MST,GRAY 4% SAND		S5	18.0-20.0	3-2-1-2
-22.0	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-1A

HOLE NO. 88DH-2

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	X=2602001.13 Y=217479.79
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-2
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/21/88 / COMPLETED 07/21/88
17. ELEVATION TOP OF HOLE	-4.0
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -4.0 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g DEPTH	BLOWS PER 6"
			SAND (SP) (0.0 – 3.0) FN.SAND,TR.SILT,NP,SAT.GRAY 95% SAND		S1	0.0–2.0	1–1–2–2
	2						
-3.0			SAND (SP) (3.0 – 12.0) SAME AS ABOVE LITTLE SILT,TR. SHELL FRAGMENTS				
	4		88%SAND		S2	4.0–6.0	2–1–1–1
	6						
	8		90%SAND		S3	8.0–10.0	2–2–1–1
	10						
-12.0	12		CLAY (CH) (12.0 – 20.0) TR.SILT,HP,MOIST				
	14				S4	14.0–16.0	2–2–1–2
	16						
	18		1.3% SAND LL=72 PI=46 PL=26		S5	18.0–20.0	1–1–1–1
-20.0	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-2

HOLE NO. 88DH-2A

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS
1. PROJECT LONG TERM DISPOSAL INNER HARBOR		10. SIZE AND TYPE OF BIT 2"SS	
2. LOCATION (Coordinates or Station) 2604425.00	215800.00	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) N.G.V.D.	
3. DRILLING AGENCY MCCALLUM TESTING		12. MANUFACTURER'S DESIGNATION OF DRILL CME45/BARGE	
4. HOLE NO. (As shown on drawing title and file number) 88DH-2A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED 0
5. NAME OF DRILLER MARTY JOHNSON		14. TOTAL NUMBER CORE BOXES 0	
		15. ELEVATION GROUND WATER WATER SURFACE	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		16. DATE HOLE	STARTED 07/08/88 / COMPLETED 07/08/88
		17. ELEVATION TOP OF HOLE -3.8	
7. THICKNESS OF OVERBURDEN 0.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
8. DEPTH DRILLED INTO ROCK 0.0		19. SIGNATURE OF INSPECTOR P. BOWEN	
9. TOTAL DEPTH OF HOLE 20.0			

ELEVATION -3.8 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
						SAMPLE	DEPTH
			SAND (SP) (0.0 – 1.0) (SP–SM) FN.TO CRS.SAND,SOME FN.GRAVEL,NP,SAT.,DARK GRAY		S1	0.0–2.0	3–1–2–2
-4.8			CLAY (CH) (1.0 – 1.7) AND FN.SAND,HP,MOIST,GRAY				
-5.5							
-5.8	2		CLAY (CH) (1.7 – 2.0)				
			SAND (SP) (2.0 – 2.5)				
-6.3			CLAY (CH) (2.5 – 3.5) MIXED WITH INTERMITTANT LAYERS OF FINE SAND				
-7.3							
			SAND (SP) (3.5 – 4.0)				
-7.8	4		CLAY (CH) (4.0 – 4.5)				
-8.3							
			SAND (SP) (4.5 – 5.0)		S2	4.0–6.0	3–3–3–5
-8.8			CLAY (CH) (5.0 – 7.0) LITTLE FINE SAND,HP,MST, REDDISH BROWN				
	6						
-10.8							
			SAND (SP) (7.0 – 9.5) MED.TO CRS.SAND,SOME FN.GRAVEL NP,SAT,YELLOW				
	8						
			91% SAND		S3	8.0–10.0	4–7–10–15
-13.3							
	10		SHELLY SAND (SP) (9.5–20.0) SHELL MARL,SOME FN.TO MED.SAND AND SHELL,SOME CLAYEY SILT,NP. REDDISH BROWN				
	12						
	14						
			92% SAND SIZE MATERIALS (SAND AND SHELL)		S4	14.0–16.0	10–21–19–15
	16						
	18						
					S5	18.0–20.0	7–7–11–12
-23.8	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-2A

HOLE NO. 88DH-3

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2601516.50 216453.60
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-3
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/21/88 COMPLETED 07/21/88
17. ELEVATION TOP OF HOLE	-3.0
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-3.0						DEPTH	BLOWS
			SAND (SP) (0.0 – 3.0) FINE SAND,TR.SILT,TR.SHELL FRAGS,NP,SAT.,DK.GRAY 92% SAND		S1	0.0–2.0	1–1–1–1
	2						
-6.0							
			SAND (SP) (3.0 – 7.0) SAME AS ABOVE,TR.MED.SAND 92% SAND				
	4				S2	4.0–6.0	2–2–3–2
	6						
-10.0							
			CLAY (CH) (7.0 – 8.0) TR.SILT,TR.PEAT,HP.,MOIST, GRAY				
-11.0	8		CLAY (CH) (8.0 – 20.0) SAME AS ABOVE,NO PEAT				
					S3	8.0–10.0	WOH–1–0–1
	10						
	12						
	14				S4	14.0–16.0	1–0–1–0
	16						
	18				S5	18.0–20.0	1–1–1–1
-23.0	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR HOLE NO. 88DH-3

HOLE NO. 88DH-3A

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT LONG TERM DISPOSAL INNER HARBOR	10. SIZE AND TYPE OF BIT 2"SS
2. LOCATION (Coordinates or Station) 2606966.90 215965.40	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) N.G.V.D.
3. DRILLING AGENCY MCCALLUM TESTING	12. MANUFACTURER'S DESIGNATION OF DRILL CME45/BARGE
4. HOLE NO. (As shown on drawing title and file number) 88DH-3A	13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN DISTURBED 5 UNDISTURBED
5. NAME OF DRILLER MARTY JOHNSON	14. TOTAL NUMBER CORE BOXES 0
	15. ELEVATION GROUND WATER WATER SURFACE
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE STARTED 07/08/88 COMPLETED 07/08/88
7. THICKNESS OF OVERBURDEN 0.0	17. ELEVATION TOP OF HOLE -3.5
8. DEPTH DRILLED INTO ROCK 0.0	18. TOTAL CORE RECOVERY FOR BORING 0.0 %
9. TOTAL DEPTH OF HOLE 20.0	19. SIGNATURE OF INSPECTOR P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-3.5						DEPTH	BLOWS/6"
			SAND (SP) (0.0 - 7.0) -SM FN.SAND,TR.TO LITTLE SILT NP.,MOIST,GRAY 90% SAND		S1	0.0-2.0	2-2-4-5
	2						
	4				S2	4.0-6.0	1-1-2-2
	6						
-10.5			SLTY SAND (SM) (7.0 - 13.0) FINE SAND,LITTLE SILT,NP,MOIST ,GRAY 82% SAND				
	8				S3	8.0-10.0	1-1-0-1
	10						
	12						
-16.5			SLTY SAND (SM) (13.0 - 19.0) SAME AS ABOVE,LITTLE CLAY,LP, MOIST,GRAY 77% SAND				
	14				S4	14.0-16.0	WOH/24"
	16						
	18						
-22.5			CLY SAND (SC) (19.0 - 20.0) FN.SAND,LITTLE TO SOME CLAY, LP,MOIST,GRAY		S5	18.0-20.0	1-0-1-1
-23.5	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR HOLE NO. 88DH-3A

HOLE NO. 88DH-4

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2599410.60 215797.70
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-4
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/25/88 / COMPLETED 07/25/88
17. ELEVATION TOP OF HOLE	-4.5
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-4.5						SAMPLE	DEPTH
			SAND (SP) (0.0 - 3.0) FN.SAND,TR.TO LITTLE SILT, TR.SHELL,NP,SAT.,DK.GRAY 89% SAND		S1	0.0-2.0	2-1-1-2
	2						
-7.5							
			(SP) (3.0 - 5.2) FN.SAND,LITTLE SILT,NP.,SAT, DK.GRAY				
	4						
-9.7					S2	4.0-6.0	1-0-1-0
			SLTY SAND (SM) (5.2 - 12.0) FN.SAND,LITTLE SILT,TR.CLAY ,LP,SAT,DK.GRAY 82% SAND				
	6						
	8						
			80% SAND		S3	8.0-10.0	WOH/24"
	10						
-16.5	12						
			CLAY (CH) (12.0 - 20.0) SOME SILT,TR.VERY FINE SAND, HP.,GRAY				
	14						
					S4	14.0-16.0	WOH/24"
	16						
	18						
			LL=75 PI=49 PL=26 19% SAND		S5	18.0-20.0	WOR/24"
-24.5	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR HOLE NO. 88DH-4

HOLE NO. 88DH-4A

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT LONG TERM DISPOSAL INNER HARBOR	10. SIZE AND TYPE OF BIT 2"SS
2. LOCATION (Coordinates or Station) 2604350.00 218500.00 *	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) N.G.V.D.
3. DRILLING AGENCY MCCALLUM TESTING	12. MANUFACTURER'S DESIGNATION OF DRILL CME45/BARGE
4. HOLE NO. (As shown on drawing title and file number) 88DH-4A	13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 5 UNDISTURBED
5. NAME OF DRILLER MARTY JOHNSON	14. TOTAL NUMBER CORE BOXES 0
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER WATER SURFACE
	16. DATE HOLE: STARTED 07/08/88 COMPLETED 07/08/88
7. THICKNESS OF OVERBURDEN 0.0	17. ELEVATION TOP OF HOLE -3.2
8. DEPTH DRILLED INTO ROCK 0.0	18. TOTAL CORE RECOVERY FOR BORING 0.0 %
9. TOTAL DEPTH OF HOLE 20.0	19. SIGNATURE OF INSPECTOR P. BOWEN

ELEVATION -3.2 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) SAMPLE g	DEPTH
-4.2			SAND (SP) (0.0 - 1.0) FN. SAND,LITTLE SILT,NP,SAT., DK.GRAY 88% SAND				
			SAND (SP) (1.0 - 3.0) FN. SAND,TR.TO LITTLE CLAYEY SILT,LP,SAT.,GREENISH GRAY 88% SAND		S1	0.0-2.0	2-3-3-4
	2						
-6.2			SLTY SAND (SM) (3.0 - 7.0) FN.SAND,LITTLE SILT,NP,SAT., REDDISH BROWN TO DK.GRAY 80% SAND				
	4						
					S2	4.0-6.0	2-2-0-1
	6						
-10.2			CLAY (CH) (7.0 - 15.8) TR.FN.SAND,HP.MOIST,GRAY				
	8						
					S3	8.0-10.0	1-1-1-2
	10		* LOCATION IS APPROXIMATE				
	12						
	14						
					S4	14.0-16.0	2-1-2-2
-19.0	16		SAND (SP) (15.8 - 17.0) FN.SAND,TR.SILT,NP,MOIST,LT. GRAY				
-20.2			CLY SAND (SC) (17.0 - 20.0) FN.TO MED.SAND,LITTLE CLAY, TR.PLAS.,MST.,BROWN TO GRAY 80% SAND				
	18						
					S5	18.0-20.0	2-2-3-3
-23.2	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-4A

HOLE NO. 88DH-5

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2598096.00 214754.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-5
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/25/88 COMPLETED 07/25/88
17. ELEVATION TOP OF HOLE	-5.0
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -5.0 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
						SAMPLE	DEPTH
			SAND (SP) (0.0 - 3.0) FN. SAND,LITTLE SILT,NP,SAT., GRAY 89% SAND		S1	0.0-2.0	1-0-1-0
	2						
-8.0			SLTY SAND (SM) (3.0 - 7.0) FN.SAND AND ORGANIC SILT,LP, SAT.,DK.GRAY, 64% SAND				
	4				S2	4.0-6.0	WOR/24"
	6						
-12.0			CLAY (CH) (7.0 - 20.0) SOME SILT,HP,SOFT,GRAY				
	8				S3	8.0-10.0	WOR/24"
	10						
	12						
	14				S4	14.0-16.0	WOR/24"
	16						
	18				S5	18.0-20.0	WOR/24"
-25.0	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR

HOLE NO. 88DH-5

HOLE NO. 88DH-5A

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2610527.00 214053.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-5A
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/11/88 / COMPLETED 07/11/88
17. ELEVATION TOP OF HOLE	-4.2
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-4.2						SAMPLE	DEPTH
			SAND (SP) (0.0 - 3.0) FN.SAND,TR.TO LITTLE SILT,NP, GRAY TO ORANGISH YELLOW 90% SAND		S1	0.0-2.0	1-2-3-3
	2						
-7.2			CLY SAND (SC) (3.0 - 9.0) FN.SAND,LITTLE CLAY,TR.PLAS., GREENISH GRAY,81% SAND				
	4				S2	4.0-6.0	2-1-2-2
	6						
	8						
-13.2			CLY SAND (SC) (9.0 - 12.5) FN.TO COASE SAND,SOME FN. GRAVEL,SOME CLAY,MP,YELLOW ORANGE		S3	8.0-10.0	3-1-2-3
	10						
	12						
-16.7			(SC) (12.5 - 16.5) FN.SAND,SOME MED.TO CRS.SAND, LITTLE FINE GRAVEL,AND CLAY, HP,MST.,GREENISH GRAY 54% SAND LL=51 PI=32 PL=19				
	14				S4	14.0-16.0	2-2-2-2
	16						
-20.7			(SP) (16.5 - 17.5) MED.TO COARSE SAND AND FN. GRAVEL,NP,SAT.,YELLOW				
-21.7			CLY SAND (SC) (17.5 - 20.0) FN.TO MED.SAND AND CLAY HP,MST LT.GRAY GRADING TO BROWN 61% SAND				
	18				S5	18.0-20.0	1-1-1-2
-24.2	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-5A

HOLE NO. 88DH-6

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS
1. PROJECT LONG TERM DISPOSAL INNER HARBOR		10. SIZE AND TYPE OF BIT 2"SS	
2. LOCATION (Coordinates or Station) 2597677.00	211725.00	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) N.G.V.D.	
3. DRILLING AGENCY MCCALLUM TESTING		12. MANUFACTURER'S DESIGNATION OF DRILL CME45/BARGE	
4. HOLE NO. (As shown on drawing title and file number) 88DH-6		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
5. NAME OF DRILLER MARTY JOHNSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER WATER SURFACE	
		16. DATE HOLE	STARTED 07/25/88 / COMPLETED 07/25/88
		17. ELEVATION TOP OF HOLE -2.0	
7. THICKNESS OF OVERBURDEN 0.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
8. DEPTH DRILLED INTO ROCK 0.0		19. SIGNATURE OF INSPECTOR P. BOWEN	
9. TOTAL DEPTH OF HOLE 20.0			

ELEVATION -2.0 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g) SAMPLE	DEPTH
			SAND (SP) (0.0 – 3.0) FN.SAND,TR.SILT,NP,SAT., DK.GRAY 89% SAND		S1	0.0–2.0	WOH/24"
-5.0	2		SLTY SAND (SM) (3.0 – 7.0) FN.SANDLITTLE SILT,TR.SHELL FRAGS,NP,SAT.,DK.GRAY 85% SAND				
	4				S2	4.0–6.0	WOH/24"
-9.0	6		SLTY SAND (SM) (7.0 – 12.0) FN.SAND LITTLE SILT,TR.SHELL FRAGS,TR.PLAS,SAT.,GRAY 85% SAND				
	8				S3	8.0–10.0	1–1–0–1
-14.0	10		SAND (SP) (12.0 – 15.0) FN.SAND TR.SILT,TR.SHELL FRAGS NP,GRAY				
	12		94% SAND		S4	14.0–16.0	4–5–5–6
-17.0	14		SAND (SP) (15.0 – 20.0) FN.SAND,AND SHELL HASH,LITTLE MED.SAND,NP,BROWN TO GRAY				
	16						
	18		97% SAND		S5	18.0–20.0	2–2–1–1
-22.0	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-6

HOLE NO. 88DH-6A

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2614314.00 212992.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-6A
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/11/88 / COMPLETED 07/11/88
17. ELEVATION TOP OF HOLE	-4.3
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -4.3 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			SAND (SP) (0.0 – 7.0) FN.SAND,TR.TO LITTLE SILT,NP, SAT.,GRAY 97% SAND			SAMPLE	DEPTH
					S1	0.0–2.0	1–0–0–1
	2						
	4						
			97% SAND		S2	4.0–6.0	WOR/24"
	6						
-11.3			CLAY (CH) (7.0 – 11.0) SOME FN.SAND,HP,MOIST,BLACK LL=65 PI=45 PL=20 LOI=4% 29% SAND				
	8				S3	8.0–10.0	WOR/24"
	10						
-15.3			SAND (SP) (11.0 – 17.0) MED.SAND,TR.SILT,NP,STIFF, YELLOW				
	12						
	14						
			92% SAND		S4	14.0–16.0	3–3–3–3
	16						
-21.3			SLTY SAND (SM) (17.0 – 20.0) POSSIBLE YORKTOWN FORMATION, LITTLE SILT,LITTLE SHELL FRAG, NP,STIFF,GRAY 85% SAND				
	18						
					S5	18.0–20.0	11–18–25–31
-24.3	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-6A

HOLE NO. 88DH-7

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS
1. PROJECT LONG TERM DISPOSAL INNER HARBOR		10. SIZE AND TYPE OF BIT 2"SS	
2. LOCATION (Coordinates or Station) 2596920.00	211477.00	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) N.G.V.D.	
3. DRILLING AGENCY MCCALLUM TESTING		12. MANUFACTURER'S DESIGNATION OF DRILL CME45/BARGE	
4. HOLE NO. (As shown on drawing title and file number) 88DH-7		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
5. NAME OF DRILLER MARTY JOHNSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER WATER SURFACE	
		16. DATE HOLE	STARTED 07/25/88 / COMPLETED 07/26/88
7. THICKNESS OF OVERBURDEN 0.0		17. ELEVATION TOP OF HOLE -4.0	
8. DEPTH DRILLED INTO ROCK 0.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 20.0		19. SIGNATURE OF INSPECTOR P. BOWEN	

ELEVATION -4.0 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			SAND (SP) (0.0 – 1.0) FN.SAND,LITTLE SILT,NP,SAT., GRAY			SAMPLE	DEPTH
-5.0			CLAY (CH) (1.0 – 7.0) AND SILT,TR.FN.SAND,HP,MOIST, GRAY		S1	0.0–2.0	WOH/24"
	2						
	4				S2	4.0–6.0	WOR/24"
	6						
-11.0			SAND (SP) (7.0 – 12.0) FN.TO MED.SAND,LITTLE SILT,NP, SAT.,LT.GRAY 93% SAND				
	8				S3	8.0–10.0	5–2–1–0
	10						
-16.0	12		CLY SAND (SC) (12.0 – 17.0) MED.SAND,SOME CLAY,MP,MOIST, REDDISH BROWN				
	14						
			76% SAND		S4	14.0–16.0	3–4–6–11
	16						
-21.0			CLY SAND (SC) (17.0 – 20.0) SHELL HASH,AND FN.TO MED.SAND SOME CLAY,LP,MOIST,REDDISH BROWN 76% SAND				
	18				S5	18.0–20.0	2–4–8–9
-24.0	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-7

HOLE NO. 88DH-8

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2596858.00 209783.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-8
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/27/88 / COMPLETED 72/78/8
17. ELEVATION TOP OF HOLE	-4.0
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -4.0 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			SAND (SP) (0.0 – 3.0) FN.SAND,LITTLE SILT,NP,SAT., GRAY 91% SAND			SAMPLE	DEPTH
					S1	0.0–2.0	2–1–1–0
	2						
-7.0			CLAY (CH) (3.0 – 20.0) SOME FN.SAND,HP,SAT.,GRAY				
	4						
					S2	4.0–6.0	WOR/24"
	6						
	8						
			LL=64 PI=42 PL=22 28% SAND		S3	8.0–10.0	WOR/24"
	10						
	12						
	14						
					S4	14.0–16.0	WOR/24"
	16						
	18						
					S5	18.0–20.0	WOR/24"
-24.0	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-8

HOLE NO. 88DH-9

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2596511.00 208145.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-9
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/27/88 / COMPLETED 07/27/88
17. ELEVATION TOP OF HOLE	-4.5
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-4.5						SAMPLE	DEPTH
			SILTY SAND (SM) (0.0 – 3.0) FN.SAND,LITTLE SILT,TR.CLAY, NP,SAT.,GRAY 83% SAND		S1	0.0–2.0	WOH/18"–2
	2						
-7.5			CLAY (CH) (3.0 – 4.0) LITTLE FN.SAND,HP,MOIST,GRAY				
-8.5	4		CLY SAND (SC) (4.0 – 7.0) FN.SAND,LITTLE CLAY,TR.PLAS., MST,GRAY 79% SAND		S2	4.0–6.0	WOH/24"
	6						
-11.5			CLAY (CH) (7.0 – 17.0) TR.FN.SAND,HP,MOIST,GRAY				
	8				S3	8.0–10.0	WOR/24"
	10						
	12						
	14				S4	14.0–16.0	WOR/24"
	16						
-21.5			CLY SAND (SC) (17.0 – 20.0) FN.SAND,LITTLE CLAY,TR.PLAS., MST.,GRAY				
	18				S5	18.0–20.0	WOR/24"
-24.5	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-9

HOLE NO. 88DH-10

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2595037.00 208965.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-10
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/26/88 / COMPLETED 07/26/88
17. ELEVATION TOP OF HOLE	-5.6
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-5.6						SAMPLE	DEPTH
			CLAY (CH) (0.0 - 4.3) ,TR.FN.SAND,HP,MOIST,GRAY		S1	0.0-2.0	WOR/24"
	2						
	4						
-9.9			SAND (SP) (4.3 - 8.2) FN.TO MED.SAND,LITTLE SILT,NP MOIST,LT.GRAY 90% SAND		S2	4.0-6.0	1-3-3-4
	6						
	8						
-13.8			SAND (SP) (8.2 - 9.0) SAME AS ABOVE,TR.SILT,YELLOW 96% SAND		S3	8.0-10.0	4-5-6-4
-14.6			SAND (SP) (9.0 - 12.0) SAME AS ABOVE,REDDISH BROWN				
	10						
-17.6	12		CLY SAND (SC) (12.0 - 20.0) FN.SAND,SOME TO AND CLAY LITTLE MED.SAND,LP,MOIST,GRAY				
	14						
			68% SAND		S4	14.0-16.0	2-2-3-5
	16						
	18						
			62% SAND		S5	18.0-20.0	3-4-6-7
-25.6	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-10

HOLE NO. 88DH-11

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	258442.00 207751.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-11
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/27/88 COMPLETED 07/27/88
17. ELEVATION TOP OF HOLE	-6.0
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -6.0 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g: SAMPLE	DEPTH
-8.5			CLY SAND (SC) (0.0 - 0.5) SOME CLAY,GRAY				
			CLAY (CH) (0.5 - 3.0) TR.FN.SAND,HP,MOIST,GRAY		S1	0.0-2.0	1-1-0-1
	2						
-9.0			CLAY (CH) (3.0 - 9.5) SAME AS ABOVE,TR.SHELL FRAGS.				
	4						
					S2	4.0-6.0	WOH/12"-1-1
	6						
	8						
					S3	8.0-10.0	1-1-1-2
-15.5			ORG.CLAY (OL) (9.5-15.0) PEATY CLAY,LITTLE FN.SAND,HP, LT.GRAY LL=81 PI=38 PL=53 LOI=15.6% 26.9% SAND				
	10						
	12						
	14						
-21.0			SAND (SP) (15.0 - 19.0) MED.SAND,LITTLE FN.SAND,LITTLE COARSE SAND,LITTLE SILT,NP,SAT LT.GRAY 94% SAND		S4	14.0-16.0	2-2-7-10
	16						
	18						
-25.0			SLTY SAND (SM) (19.0 - 20.0) V.F.SAND SOME SILT,TR.CLAY, TR.PLAS.,GRAY		S5	18.0-20.0	3-2-3-3
-26.0	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR HOLE NO. 88DH-11

HOLE NO. 88DH-12

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2591246.00 207289.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-12
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/27/88 / COMPLETED 07/27/88
17. ELEVATION TOP OF HOLE	-2.5
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -2.5 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
						SAMPLE	DEPTH
			SLTY SAND (SM) (0.0 – 3.0) FN.SAND,LITTLE SILT,NP,SAT., GRAY 91% SAND		S1	0.0–2.0	WOR/24"
	2						
-5.5							
			CLY SAND (SC) (3.0 – 7.0) FN.SAND,AND CLAY,LITTLE SILT, SAT.,VERY SOFT,GRAY				
	4				S2	4.0–6.0	WOH/24"
	6						
-9.5							
			CLY SAND (SC) (7.0 – 13.0) FN.SAND AND CLAY,HP,MOIST, GRAY 60% SAND				
	8				S3	8.0–10.0	WOR/24"
	10						
	12						
-15.5							
			CLAY (CH) (13.0 – 20.0) TR.FN.SAND,HP,MOIST,GRAY				
	14				S4	14.0–16.0	WOR/24"
	16						
	18						
					S5	18.0–20.0	WOR/24"
-22.5	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-12

HOLE NO. 88DH-13

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2591974.00 211861.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-13
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/28/88 / COMPLETED 07/28/88
17. ELEVATION TOP OF HOLE	-3.5
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g SAMPLE	DEPTH
-3.5			CLAY (CH) (0.0 - 17.0) SOME FN.SAND,TR.SHELL FRAGS, HP,MOIST,GRAY		S1	0.0-2.0	WOR/24"
	2						
	4				S2	4.0-6.0	WOR/24"
	6						
	8				S3	8.0-10.0	WOR/24"
			LL=57 PI=37 PL=20 24% SAND				
	10						
	12						
	14				S4	14.0-16.0	WOR/24"
	16						
-20.5			CLAY (CH) (17.0 - 17.5) SAME AS ABOVE AND SHELL FRAGS				
-21.0			CLAY (CH) (17.5 - 20.0) TR.FN.SAND,HP,MOIST,GRAY				
	18				S5	18.0-20.0	3-2-1-1
-23.5	20						

ENG FORM 1836 MAR 75 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-13

HOLE NO. 88DH-14

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT: LONG TERM DISPOSAL INNER HARBOR	10. SIZE AND TYPE OF BIT: 2"SS
2. LOCATION (Coordinates or Station): 2591357.00 213910.00	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): N.G.V.D.
3. DRILLING AGENCY: MCCALLUM TESTING	12. MANUFACTURER'S DESIGNATION OF DRILL: CME45/BARGE
4. HOLE NO. (As shown on drawing title and file number): 88DH-14	13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 5; UNDISTURBED
5. NAME OF DRILLER: MARTY JOHNSON	14. TOTAL NUMBER CORE BOXES: 0
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: WATER SURFACE
	16. DATE HOLE: STARTED 07/28/88; COMPLETED 07/28/88
7. THICKNESS OF OVERBURDEN: 0.0	17. ELEVATION TOP OF HOLE: -9.2
8. DEPTH DRILLED INTO ROCK: 0.0	18. TOTAL CORE RECOVERY FOR BORING: 0.0 %
9. TOTAL DEPTH OF HOLE: 20.0	19. SIGNATURE OF INSPECTOR: P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-9.2						SAMPLE	DEPTH
			CLAY (CH) (0.0 - 3.0) TR.TO LITTLE FN.SAND,LITTLE SHELL FRAGS,HP,MOIST,GRAY		S1	0.0-2.0	WOH/12"-1-0
	2						
-12.2							
			CLAY (CH) (3.0 - 7.0) TR.FN.SAND,HP,MOIST,GRAY				
	4						
					S2	4.0-6.0	WOR/24"
	6						
-16.2							
			CLY SAND (SC) (7.0 - 9.0) FN.SAND,SOME CLAY,MP,SOFT,GRAY LL=28 PI=8 PL=20 74% SAND				
	8						
-18.2					S3	8.0-10.0	WOR/24"
			CLAY (CH) (9.0 - 17.0) SOME FN.SAND,HP,SOFT,GRAY				
	10						
	12						
	14						
			30% SAND		S4	14.0-16.0	WOR/24"
	16						
-26.2							
			CLAY (CH) (17.0 - 20.0) TR.FN.SAND,SAME AS ABOVE				
	18						
					S5	18.0-20.0	WOR/24"
-29.2	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-14

HOLE NO. 88DH-15

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	259202.00 215865.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-15
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/28/88 / COMPLETED 07/28/88
17. ELEVATION TOP OF HOLE	-6.5
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -6.5 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
						SAMPLE	DEPTH
			SAND (SP) (0.0 - 3.0) FN.SAND,LITTLE SILT,NP,SAT, BROWN TO GRAY,92% SAND		S1	0.0-2.0	1-1-1-1
	2						
-9.5			CLAY (CH) (3.0 - 9.0) LITTLE FN.SAND,HP,MOIST,GRAY				
	4						
			LL=71 PI=47 PL=24 14% SAND		S2	4.0-6.0	WOR/24"
	6						
	8						
-15.5			CLY SAND (SC) (9.0 - 13.0) FN.SAND,AND CLAY,HP,STIFF, GRAY,59% SAND		S3	8.0-10.0	3-3-4-5
	10						
	12						
-19.5			CLAY (CH) (13.0 - 14.7) LITTLE TO SOME FN.SAND,LITTLE ORGANICS,STIFF,HP,DK.BROWN				
	14						
-21.2			CLAY (CH) (14.7 - 17.0) TR.FN.SAND,HP,STIFF,MOIST,GRAY		S4	14.0-16.0	3-2-2-2
	16						
-23.5			CLY SAND (SC) (17.0 - 20.0) FN.SAND SOME CLAY,INTERMIXED WITH THIN LAYERS OF(SM)FN.SAND LITTLE SILT,LP,GRAY				
	18						
					S5	18.0-20.0	5-4-6-7
-26.5	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR HOLE NO. 88DH-15

HOLE NO. 88DH-16

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2591790.00 218346.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-16
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	(X) VERTICAL ( ) INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/28/88 COMPLETED 07/28/88
17. ELEVATION TOP OF HOLE	-4.0
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-4.0							
			SAND (SP) (0.0 - 0.5) FN.SAND,TR.SILT,GRAY			SAMPLE	DEPTH
-4.5			CLAY (CH) (0.5 - 12.0) TR.FN.SAND,STIFF,HP,MOIST, GRAY		S1	0.0-2.0	WOH/6"-1-2-2
	2						
	4		LL=63 PI=40 PL=23 3% SAND		S2	4.0-6.0	3-2-4-4
	6						
	8				S3	8.0-10.0	3-2-3-3
	10						
-16.0	12		SAND (SP) (12.0 - 14.5) FN.SAND,TR.SILT,NP,SAT.,BROWN				
	14						
-18.5			CLAY (CH) (14.5 - 17.0) TR.TO LITTLE FN.SAND V.STIFF, BROWN		S4	14.0-16.0	5-2-4-4
	16						
-21.0			SAND (SP) (17.0 - 20.0) FN.TO MED.SAND,TR.SILT,NP, MOIST,BROWNISH GRAY				
	18		92% SAND		S5	18.0-20.0	4-4-7-8
-24.0	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR HOLE NO. 88DH-16

HOLE NO. 88DH-17

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS
1. PROJECT LONG TERM DISPOSAL INNER HARBOR		10. SIZE AND TYPE OF BIT 2"SS	
2. LOCATION (Coordinates or Station) 2590265.00 220699.00		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) N.G.V.D.	
3. DRILLING AGENCY MCCALLUM TESTING		12. MANUFACTURER'S DESIGNATION OF DRILL CME45/BARGE	
4. HOLE NO. (As shown on drawing title and file number) 88DH-17		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 3 / UNDISTURBED
5. NAME OF DRILLER MARTY JOHNSON		14. TOTAL NUMBER CORE BOXES 0	
		15. ELEVATION GROUND WATER WATER SURFACE	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		16. DATE HOLE	STARTED 07/29/88 / COMPLETED 07/29/88
		17. ELEVATION TOP OF HOLE -8.3	
7. THICKNESS OF OVERBURDEN 0.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
8. DEPTH DRILLED INTO ROCK 0.0		19. SIGNATURE OF INSPECTOR P. BOWEN	
9. TOTAL DEPTH OF HOLE 20.0			

ELEVATION -8.3 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
						SAMPLE	DEPTH
			SAND (SP) (0.0 – 3.0) FN.SAND,SOME MED.SAND,TR.TO LITTLE SILT,NP,MOIST,YELLOW 92% SAND		S1	0.0–2.0	WOH/6"–2–4–6
	2						
-11.3			SAND (SP) (3.0 – 7.0) FN.SAND,TR.SILT,NP,SAT,YELLOW 96% SAND				
	4				S2	4.0–6.0	4–4–6–6
	6						
-15.3			SAND (SP) (7.0 – 20.0) MED.SAND,SOME FN.SAND,LITTLE COARSE SAND,NP,SAT.,YELLOW 98% SAND				
	8				S3	8.0–10.0	1–2–4–5
	10						
	12		(NOTE) ENCOUNTERED RUNNING SANDS AT 14.0–16.0 AND 18.0–20.0. CUTTINGS INDICATE SAND CONTINOUS TO THE BOTTOM,HOWEVER NO BLOW COUNTS WERE TAKEN OR SAMPLES RETRIEVED.				
	14						
	16						
	18						
-28.3	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 88DH-17

HOLE NO. 88DH-18

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2594730.00 222328.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	88DH-18
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	N.G.V.D.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 07/29/88 COMPLETED 07/29/88
17. ELEVATION TOP OF HOLE	-7.5
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-7.5						SAMPLE	DEPTH
			CLY SAND (SC) (0.0 - 1.0) FN.SAND,LITTLE TO SOME CLAY, TR.SHELL FRAGS,LP,SAT,GRAY				
-8.5					S1	0.0-2.0	1-2-2-2
			SAND (SP) (1.0 - 7.0) FN.SAND,LITTLE MED.SAND,LITTLE SILT,NP,MOIST,BROWN				
	2						
			• THIS LOCATION IS APPROXIMATE				
	4						
			91% SAND		S2	4.0-6.0	1-2-3-5
	6						
-14.5							
			CLAY/SAND (CL) (7.0 - 12.0) AND FN.SAND SAT.,GRAY/BROWN				
	8						
			49% SAND		S3	8.0-10.0	3-4-4-3
	10						
-19.5	12						
			SAND (SP) (12.0 - 19.0) MED.SAND,SOME FN.SAND,LITTLE COARSE SAND,LITTLE FN.GRAVEL, NP,SAT.,YELLOW				
	14						
			95% SAND		S4	14.0-16.0	7-10-10-13
	16						
	18						
-26.5					S5	18.0-20.0	1-2-4-11
			CLY SAND (SC) (19.0 - 20.0) FN.SAND,AND CLAY,HP,MOIST, GRAY				
-27.5	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR HOLE NO. 88DH-18

HOLE NO. 89DH-19

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT LONG TERM DISPOSAL INNER HARBOR	10. SIZE AND TYPE OF BIT 2"SS
2. LOCATION (Coordinates or Station) 2616420.00 214080.00	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) M.L.W.
3. DRILLING AGENCY MCCALLUM TESTING	12. MANUFACTURER'S DESIGNATION OF DRILL CME45/BARGE
4. HOLE NO. (As shown on drawing title and file number) 89DH-19	13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 5; UNDISTURBED 0
5. NAME OF DRILLER MARTY JOHNSON	14. TOTAL NUMBER CORE BOXES 0
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER WATER SURFACE
	16. DATE HOLE: STARTED 01/24/89; COMPLETED 01/24/89
7. THICKNESS OF OVERBURDEN 0.0	17. ELEVATION TOP OF HOLE -10.9
8. DEPTH DRILLED INTO ROCK 0.0	18. TOTAL CORE RECOVERY FOR BORING 0.0 %
9. TOTAL DEPTH OF HOLE 20.0	19. SIGNATURE OF INSPECTOR P. BOWEN

ELEVATION -10.9 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			CLAY (CH) (0.0 - 9.5) ,TR.FN.SAND,HP.,SAT,SOFT,GRAY			SAMPLE	DEPTH
					S1	0.0-2.0	WOR/24"
	2						
	4						
			LL=133 PL=38 PI=95		S2	4.0-6.0	WOR/24"
	6						
	8						
					S3	8.0-10.0	WOH/24"
-20.4							
	10		CLY SAND (SC) (9.5 - 12.0) FN.SAND,LITTLE CLAY,NP.,SAT., DK.GRAY				
-22.9	12		SAND (SP) (12.0 - 17.0) -SM,FN.SAND,TR.FINES,NP,SAT., LT.GRAY				
	14						
					S4	14.0-16.0 91% SAND	4-4-3-4
	16						
-27.9							
	18		CLY SAND (SC) (17.0 - 18.5) FN.SAND,LITTLE CLAY,NP,SAT., DK.GRAY				
-29.4							
			CLAY (CH) (18.5 - 20.0) ,SOME FN.SAND,STIFF,HP,MOIST, GRAY LL=68 PL=29 PI=39		S5	18.0-20.0	1-1-3-3
-30.9	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 89DH-19

HOLE NO. 89DH-20

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT LONG TERM DISPOSAL INNER HARBOR	10. SIZE AND TYPE OF BIT 2"SS
2. LOCATION (Coordinates or Station) 2615850.00 215200.00	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) M.L.W.
3. DRILLING AGENCY MCCALLUM TESTING	12. MANUFACTURER'S DESIGNATION OF DRILL CME45/BARGE
4. HOLE NO. (As shown on drawing title and file number) 89DH-20	13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 5; UNDISTURBED 0
5. NAME OF DRILLER MARTY JOHNSON	14. TOTAL NUMBER CORE BOXES 0
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER WATER SURFACE
	16. DATE HOLE: STARTED 01/24/89; COMPLETED 01/24/89
7. THICKNESS OF OVERBURDEN 0.0	17. ELEVATION TOP OF HOLE -11.7
8. DEPTH DRILLED INTO ROCK 0.0	18. TOTAL CORE RECOVERY FOR BORING 0.0 %
9. TOTAL DEPTH OF HOLE 20.0	19. SIGNATURE OF INSPECTOR P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-11.7						SAMPLE	DEPTH
			CLAY (CH) (0.0 - 17.5) ,VERY SOFT,TR.FN.SAND,HP.SAT., BLACK TO GRAY		S1	0.0-2.0	WOR/24"
	2						
	4						
			LL=147 PL=43 PI=104		S2	4.0-6.0	WOR/24"
	6						
	8						
					S3	8.0-10.0	WOR/24"
	10						
	12						
	14						
					S4	14.0-16.0	WOR/24"
	16						
-29.2							
	18		CLAY (CH) (17.5 - 18.5) ,SAME AS ABOVE,STIFF				
-30.2							
			SLTY SAND (SM) (18.5 - 20.0) FN.SAND,LITTLE SILT,NP,MOIST, GRAY		S5	18.0-20.0	4-5-7-9
						84% SAND	
-31.7	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 89DH-20

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2815500.00 212890.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	89DH-21
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 01/24/89 COMPLETED 01/24/89
17. ELEVATION TOP OF HOLE	-9.3
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -9.3 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g SAMPLE	DEPTH
			CLAY (CH) (0.0 - 9.0) ,VERY SOFT,TR.FN.SAND,HP,SAT., BLACK		S1	0.0-2.0	WOR/24"
	2						
	4				S2	4.0-6.0	WOR/24"
	6						
	8				S3	8.0-10.0 96% SAND	1-2-3-3
-18.3			SAND (SP) (9.0 - 15.5) FN.TO MEDIUM SAND,SOME SHELL NP,SAT.,GRAY				
	10						
	12						
	14				S4	14.0-16.0 80% SAND	4-5-7-10
-24.8			CLAY (CH) (15.5 - 16.5) ,SOME SAND,LITTLE SHELL,STIFF HP,SAT.,GRAY				
	16						
-25.8			SAND (SP) (16.5 - 20.0) MED.TO COARSE SAND,SOME FN. GRAVEL,NP,SAT.,YELLOW				
	18						(WASHED PAST FIRST 6")
					S5	18.0-20.0 91% SAND	5-7-8
-29.3	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR HOLE NO. 89DH-21

HOLE NO. 89DH-22

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2614300.00 213330.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	89DH-22
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 01/25/89 COMPLETED 01/25/89
17. ELEVATION TOP OF HOLE	-3.1
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -3.1 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
						SAMPLE	DEPTH
			SAND (SP) (0.0 – 3.0) (SP-SM)FN.SAND,TR.SILT,NP,SAT, GRAY		S1	0.0–2.0	WOH/24"
	2						
-6.1			CLY SAND (SC) (3.0 – 7.0) FN.SAND,LITTLE CLAY,LP.,SAT., GRAY TO REDDISH BROWN				
	4				S2	4.0–6.0 78% SAND	3–1–1–3
	6						
-10.1			CLAY (CH) (7.0 – 9.0) ,LITTLE FN.SAND,HP,MOIST,BROWN LL=35 PL=15 PI=20				
	8						
-12.1					S3	8.0–10.0	5–13–9–5
-12.6			GRAVEL (GP) (9.0 – 9.5) LITTLE FN.SAND				
	10		CLY SAND (SC) (9.5 – 10.5) FN.TO MED.SAND,LITTLE CLAY, NP,SAT.,BROWN				
-13.6			SAND (SP) (10.5 – 17.5) FN.TO MED.SAND,TR.FINES,SAT., REDDISH BROWN				
	12						
	14				S4	14.0–16.0 97% SAND	3–2–4–3
	16						
-20.6			GRAVEL (GP) (17.5 – 19.5) AND FN.TO COARSE SAND,YELLOW				
	18				S5	18.0–20.0 96% SAND	14–9–15–17
-22.6							
-23.1	20		CLY SAND (SC) (19.5 – 20.0) FN.SAND,SOME SILTY CLAY,BROWN				

B.O.H.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR

HOLE NO. 89DH-22

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2613940.00 214180.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	89DH-23
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 01/25/89 COMPLETED 01/25/89
17. ELEVATION TOP OF HOLE	-3.9
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -3.9 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g: SAMPLE	DEPTH
			SAND (SP) (0.0 – 3.0) FN.SAND,TR.SILT,NP,SAT., LT.GRAY		S1	0.0–2.0 96% SAND	WOH/24"
	2						
-6.9			CLY SAND (SC) (3.0 – 7.0) FN.SAND AND CLAY,MP,MOIST, LT.GRAY				
	4				S2	4.0–6.0 63% SAND	1–3–3–4
	6						
-10.9			SAND (SP) (7.0 – 12.0) (SP–SC),FN.SAND,LITTLE CLAY, NP,MOIST,LT.GRAY				
	8				S3	8.0–10.0 92% SAND	20–34–23–18
	10						
-15.9	12		CLY SAND (SC) (12.0 – 17.0) FN.TO MED.SAND,LITTLE SHELL FRAGS,LITTLE CLAY,NP,SAT., BROWN				
	14				S4	14.0–16.0 85% SAND	8–3–11–11
	16						
-20.9			CLY SAND (SC) (17.0 – 19.0) SHELL HASH,AND FN.SAND,TR.CLAY ,NP,SAT.,GRAY				
	18				S5	18.0–20.0 91% SAND	10–21–22–16
-22.9			SAND (SP) (19.0 – 20.0) (SP–SC),FN.TO MED.SAND,LITTLE SHELL FRAGS,LITTLE CLAY,NP, SAT.LT.GRAY				
-23.9	20						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR HOLE NO. 89DH-23

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2612000.00 214100.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	89DH-24
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 01/26/89 COMPLETED 01/26/89
17. ELEVATION TOP OF HOLE	-10.4
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	L.JONES

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-10.4						SAMPLE	DEPTH
			CLAY (CH) (0.0 - 3.0) ,LITTLE FN.SAND,HP,SAT.,SOFT, BLACK		S1	0.0-2.0	WOR/24"
	2						
-13.4							
			CLAY (CH) (3.0 - 17.0) ,SAME AS ABOVE,TR.FN.SAND,				
	4						
			LL=135 PL=39 PI=96		S2	4.0-6.0	WOR/24"
	6						
	8				S3	8.0-10.0	WOR/24"
	10						
	12						
	14				S4	14.0-16.0	WOR/24"
	16						
-27.4							
			SLTY SAND (SM) (17.0 - 20.0) FN.SAND,LITTLE SILT,NP.SAT., GRAY				
	18						
					S5	18.0-20.0	WOR/24"
						81% SAND	
-30.4	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR HOLE NO. 89DH-24

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2610420.00 213900.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	89DH-25
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 01/26/89 COMPLETED 01/26/89
17. ELEVATION TOP OF HOLE	-2.9
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -2.9 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g) SAMPLE	DEPTH
			SAND (SP) (0.0 - 3.0) FN.TO.MED.SAND,TR.SILT,NP,SAT. ,BROWN		S1	0.0-2.0 95% SAND	WOH/24"
	2						
-5.9			CLY SAND (SC) (3.0 - 5.5) FN.SAND,LITTLE CLAY,LP,MOIST, WHITE				
	4		LL=33 PL=24 PI=9		S2	4.0-6.0 77% SAND	4-4-6-3
-8.4			SAND (SP) (5.5 - 9.0) FN.SAND,TR.FINES,NP.SAT.,WHITE				
	6						
	8						
-11.9			CLY SAND (SC) (9.0 - 9.5) SAME AS ABOVE		S3	8.0-10.0 74% SAND	2-3-4-4
-12.4	10		CLAY (CH) (9.5 - 10.5) ,SOME SHELL FRAGS,LITTLE FN. TO MED.SAND,MOIST,REDDISH BROWN				
-13.4			SAND (SP) (10.5 - 15.0) SAME AS ABOVE				
	12						
	14						
-17.9			GRAVEL (GP) (15.0 - 17.0) SOME FN.TO COARSE SAND,NP.SAT, YELLOW		S4	14.0-16.0 73% SAND	2-2-3-5
	16						
-19.9			CLY SAND (SC) (17.0 - 20.0) SHELL MARL,LITTLE CLAY,NP,SAT, BROWN				
	18				S5	18.0-20.0 86% SAND	10-10-8-11
-22.9	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR HOLE NO. 89DH-25

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2611120.00 215650.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	B9DH-26
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 01/26/89 COMPLETED 01/26/89
17. ELEVATION TOP OF HOLE	-4.0
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
-4.0						SAMPLE	DEPTH
			SAND (SP) (0.0 - 3.0) FN.SAND,TR.SILT,NP.,SAT.,GRAY		S1	0.0-2.0 98% SAND	3-3-2-2
	2						
-7.0			SAND (SP) (3.0 - 7.0) (SP-SM) SAME AS ABOVE				
	4				S2	4.0-6.0 94% SAND	3-4-4-5
	6						
-11.0			CLY SAND (SC) (7.0 - 9.5) FN.SAND,SOME CLAY,LP,MOIST, GRAY				
	8				S3	8.0-10.0	1-0-1-0
-13.5			CLAY (CL) (9.5 - 15.5) ,LITTLE FN.SAND,HP.,SAT.,GRAY				
	10						
	12						
	14				S4	14.0-16.0	WOH/12" -2-2
-19.5			CLY SAND (SC) (15.5 - 20.0) FN.SAND AND CLAY,HP,MOIST,SOFT ,GRAY				
	16						
	18				S5	18.0-20.0 66% SAND	WOR/24"
-24.0	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR

HOLE NO. B9DH-26

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2805580.00 217420.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	89DH-27
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 01/27/89 COMPLETED 01/27/89
17. ELEVATION TOP OF HOLE	-3.5
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P. BOWEN

ELEVATION -3.5 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g) SAMPLE	DEPTH
			SAND (SP) (0.0 - 3.0) FN.SAND,TR.FINES,NP,SAT.,GRAY				
					S1	0.0-2.0 97% SAND	WOH/24"
	2						
-6.5			SAND (SP) (3.0 - 12.0) (SP-SM) SAME AS ABOVE				
	4						
					S2	4.0-6.0 94% SAND	4-2-3-2
	6						
	8						
					S3	8.0-10.0 93% SAND	2-3-3-5
	10						
-15.5	12		SAND (SP) (12.0 - 17.0) SAME AS ABOVE				
	14						
					S4	14.0-16.0 98% SAND	1-2-2-2
	16						
-20.5			CLAY (CH) (17.0 - 20.0) ,TR.FN.SAND,HP,MOIST,GRAY				
	18						
			LL=71 PL=25 PI=46		S5	18.0-20.0	2-1-2-3
-23.5	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR HOLE NO. 89DH-27

HOLE NO. 89DH-28

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2604330.00 216670.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	89DH-28
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 01/30/89 COMPLETED 01/30/89
17. ELEVATION TOP OF HOLE	-2.6
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	L.JONES

ELEVATION -2.6 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
						SAMPLE	DEPTH
			SAND (SP) (0.0 - 3.0) FN.SAND,TR.SILT,TR.SHELL FRAGS ,NP,SAT.,GRAY		S1	0.0-2.0 96% SAND	WOH/24"
	2						
-5.6			SAND (SP) (3.0 - 7.0) (SP-SM),SAME AS ABOVE				
	4				S2	4.0-6.0 94% SAND	2-2-2-2
	6						
-9.6			SAND (SP) (7.0 - 18.5) SAME AS ABOVE				
	8				S3	8.0-10.0 98% SAND	5-5-7-9
	10						
	12						
	14				S4	14.0-16.0 98% SAND	4-3-3-4
	16						
	18						
-21.1			CLAY (CH) (18.5 - 20.0) ,TR.FN.SAND,HP,MOIST,GRAY		S5	18.0-20.0	2-2-2-2
-22.6	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR

HOLE NO. 89DH-28

DRILLING LOG

DIVISION	NORTH ATLANTIC
INSTALLATION	NORFOLK DISTRICT
SHEET	1 OF 1 SHEETS
1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2603080.00 216500.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	89DH-29
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	(X) VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 4 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 02/03/89 / COMPLETED 02/03/89
17. ELEVATION TOP OF HOLE	-2.0
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P.BOWEN

ELEVATION -2.0 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)	
			SAND (SP) (0.0 - 7.0) (SP-SM),FN.SAND,TR.SILT,NP, SAT.,LT.GRAY			SAMPLE	DEPTH
					S1	0.0-2.0 92% SAND	1-1-0-1
	2						
	4						
			DRILLER ERROR,SAND IN WASH CUTTINGS		S2	4.0-6.0	NO SAMPLE
	6						
-9.0			SAND (SP) (7.0 - 12.0) SAME AS ABOVE				
	8						
					S3	8.0-10.0 98% SAND	10-12-14-14
	10						
-14.0	12		SAND (SP) (12.0 - 17.0) (SP-SM),SAME AS ABOVE				
	14						
					S4	14.0-16.0 92% SAND	3-3-2-3
	16						
-19.0			CLAY (CH) (17.0 - 20.0) ,TR.FN.SAND,HP,MOIST,GRAY				
	18		LL=79 PL=25 PI=54		S5	18.0-20.0	2-1-3-2
-22.0	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: LONG TERM DISPOSAL INNER HARBOR | HOLE NO. 89DH-29

HOLE NO. 89DH-30

DRILLING LOG	DIVISION NORTH ATLANTIC	INSTALLATION NORFOLK DISTRICT	SHEET 1 OF 1 SHEETS

1. PROJECT	LONG TERM DISPOSAL INNER HARBOR
2. LOCATION (Coordinates or Station)	2601080.00 217080.00
3. DRILLING AGENCY	MCCALLUM TESTING
4. HOLE NO. (As shown on drawing title and file number)	89DH-30
5. NAME OF DRILLER	MARTY JOHNSON
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0.0
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	2"SS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M.L.W.
12. MANUFACTURER'S DESIGNATION OF DRILL	CME45/BARGE
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	WATER SURFACE
16. DATE HOLE	STARTED 02/03/89 COMPLETED 02/03/89
17. ELEVATION TOP OF HOLE	-2.5
18. TOTAL CORE RECOVERY FOR BORING	0.0 %
19. SIGNATURE OF INSPECTOR	P.BOWEN

ELEVATION -2.5 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g) SAMPLE	DEPTH
			SAND (SP) (0.0 - 3.0) (SP-SC),FN.SAND,TR.CLAY,LP,SAT ,GRAY		S1	0.0-2.0 94% SAND	1-1-1-1
	2						
-5.5			SAND (SP) (3.0 - 12.0) (SP-SC),SAME AS ABOVE,LITTLE CLAY				
	4				S2	4.0-6.0 89% SAND	WOH/24"
	6						
	8				S3	8.0-10.0 89% SAND	1-0-0-1
	10						
-14.5	12		CLY SAND (SC) (12.0 - 17.0) FN.SAND,LITTLE CLAY,LP,SAT., GRAY				
	14				S4	14.0-16.0 86% SAND	WOH/24"
	16						
-19.5			CLY SAND (SC) (17.0 - 20.0) ,SAME AS ABOVE,TR.SHELL FRAGS				
	18				S5	18.0-20.0 86% SAND	WOH/24"
-22.5	20		B.O.H.				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LONG TERM DISPOSAL INNER HARBOR HOLE NO. 89DH-30

ATTACHMENT 3
(SECTION 3)

Laboratory Test Notes

LABORATORY TEST NOTES

1. The moisture content (w) was performed according to ASTM D 2216. Natural or Moist Unit Weights (γ m) and Dry Unit Weights (γ d) were determined from the test used for moisture contents by using wet and dry samples of known volume.

2. The Specific Gravity (G) was performed according to ASTM D 854.

3. The Liquid Limit (LL) and Plastic Limit (PL) were performed according to ASTM D 4318. Samples were prepared according to ASTM D 2217, the wet method. The Plastic Index (PI) is the difference between the LL and PL.

4. The Void Ratio (e) was calculated based on the following equation:

$$e = \frac{G_s \gamma_w}{\gamma_d} - 1$$

Where w = Unit of Weight of Water

5. The Saturation (S) was calculated based on the following equation:

$$S = \frac{wG}{e}$$

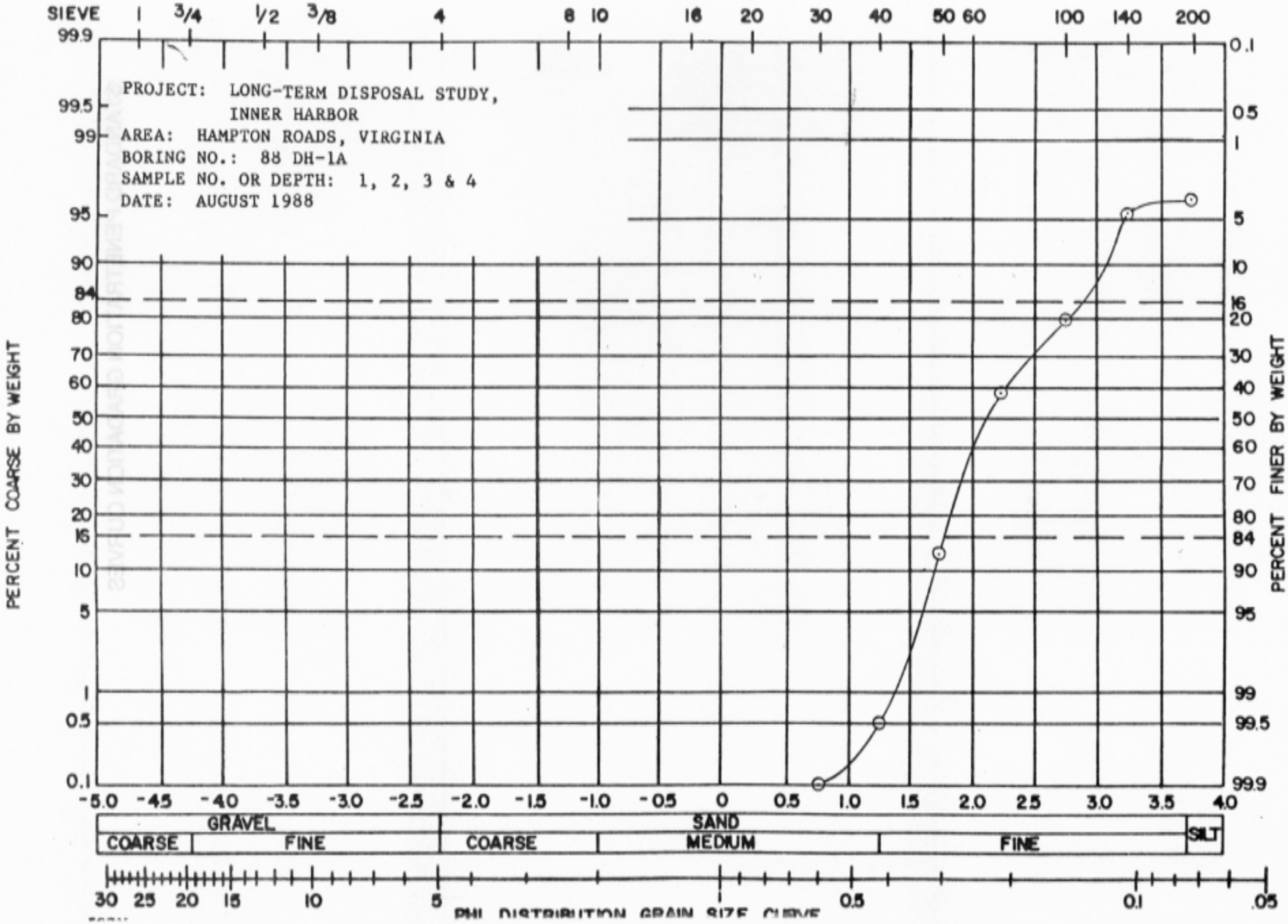
6. The graduation analysis on coarse soils (+ No. 200), such as sand, were performed according to ASTM D 422. For predominantly fine soils (- No. 200), such as clay and silt, the sand fraction was determined by washing specific gravity test samples through the No. 200 (75-mm) sieve. The retained portion is that portion of the sample that was sand.

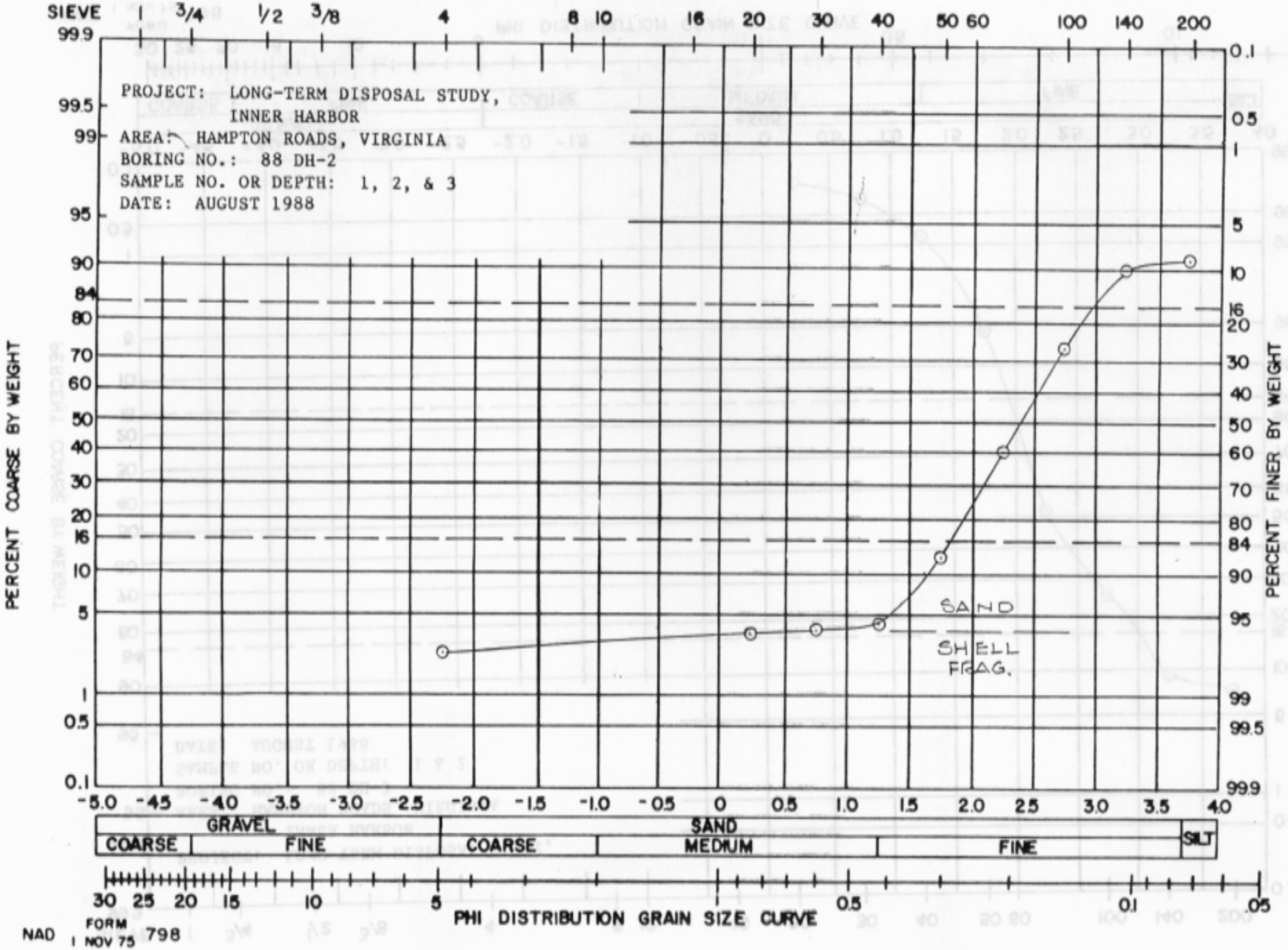
Summary of Laboratory Data

SUMMARY OF LABORATORY DATA

BORING	SAM	SAT. (S) (Assume 100%)	SPECIFIC GRAVITY(G)	DUW. (D) lbs/PCF	VOID RATIO E	MOISTURE(W) %	WUW lbs/PCF
88S1-33	1	100%	2.70	109	.56	20.7	132
88S1-34	2	100%	2.68	105	.61	22.8	129
88S1-36	3	100%	.70	116	.47	17.4	136
88S1-36	4	100%	2.68	115	.47	17.5	135
88S1-41	5	100%	2.691	108	.57	21.2	131
88S1-25	6	100%	2.75	84	1.06	38.6	116
88S1-21	7	100%	2.71	89	.92	34.0	119
88S1-23	8	100%	2.84	95	.88	31.0	124

STANDARD PENETRATION GRADATION CURVES


PROJECT: LONG-TERM DISPOSAL STUDY, INNER HARBOR
AREA: HAMPTON ROADS, VIRGINIA
BORING NO.: 88 DH-1A
SAMPLE NO. OR DEPTH: 1, 2, 3 & 4
DATE: AUGUST 1988
SIEVE
PERCENT COARSE BY WEIGHT
PERCENT FINER BY WEIGHT
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT
PHI DISTRIBUTION GRAIN SIZE CLEVE



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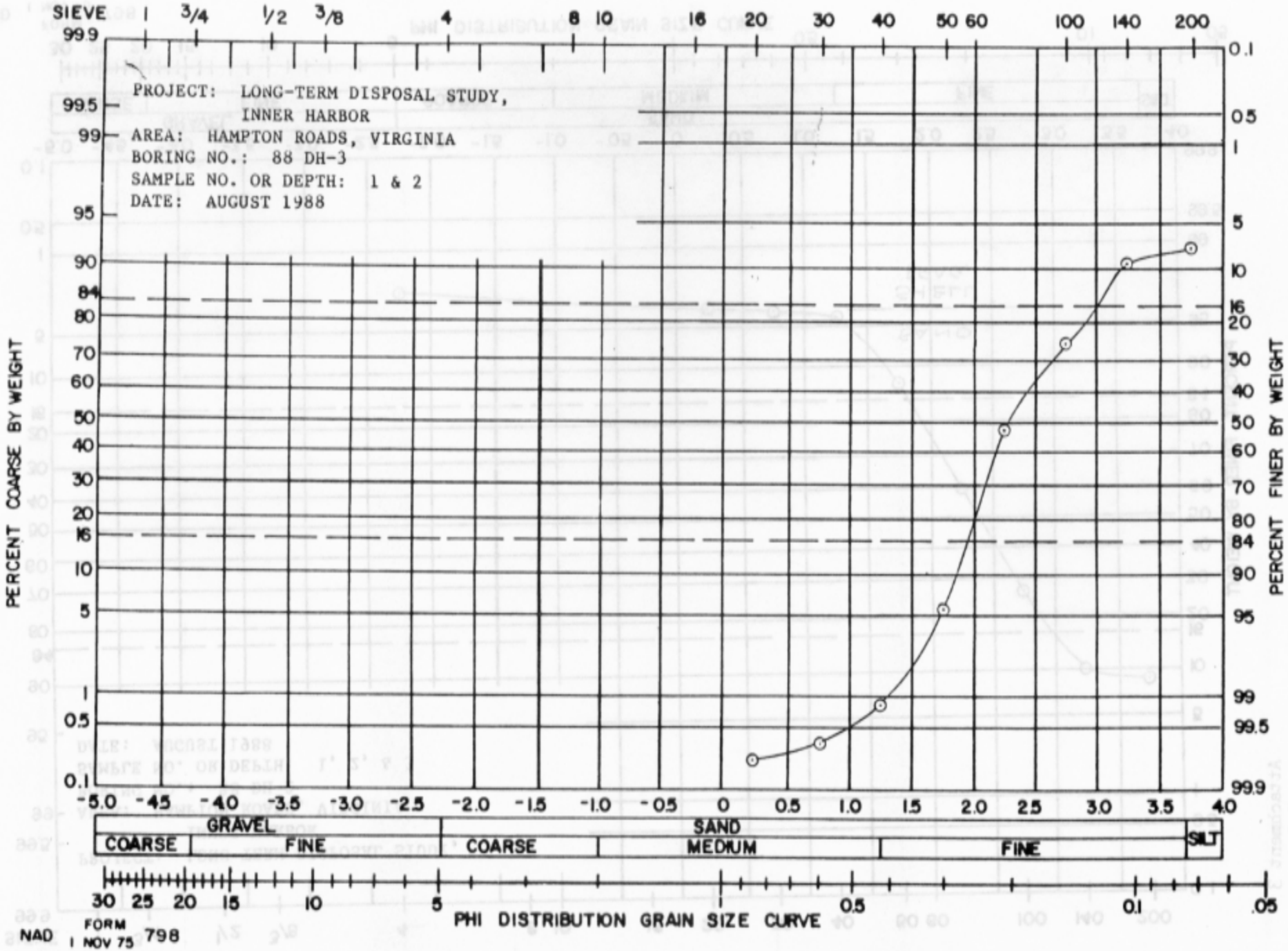

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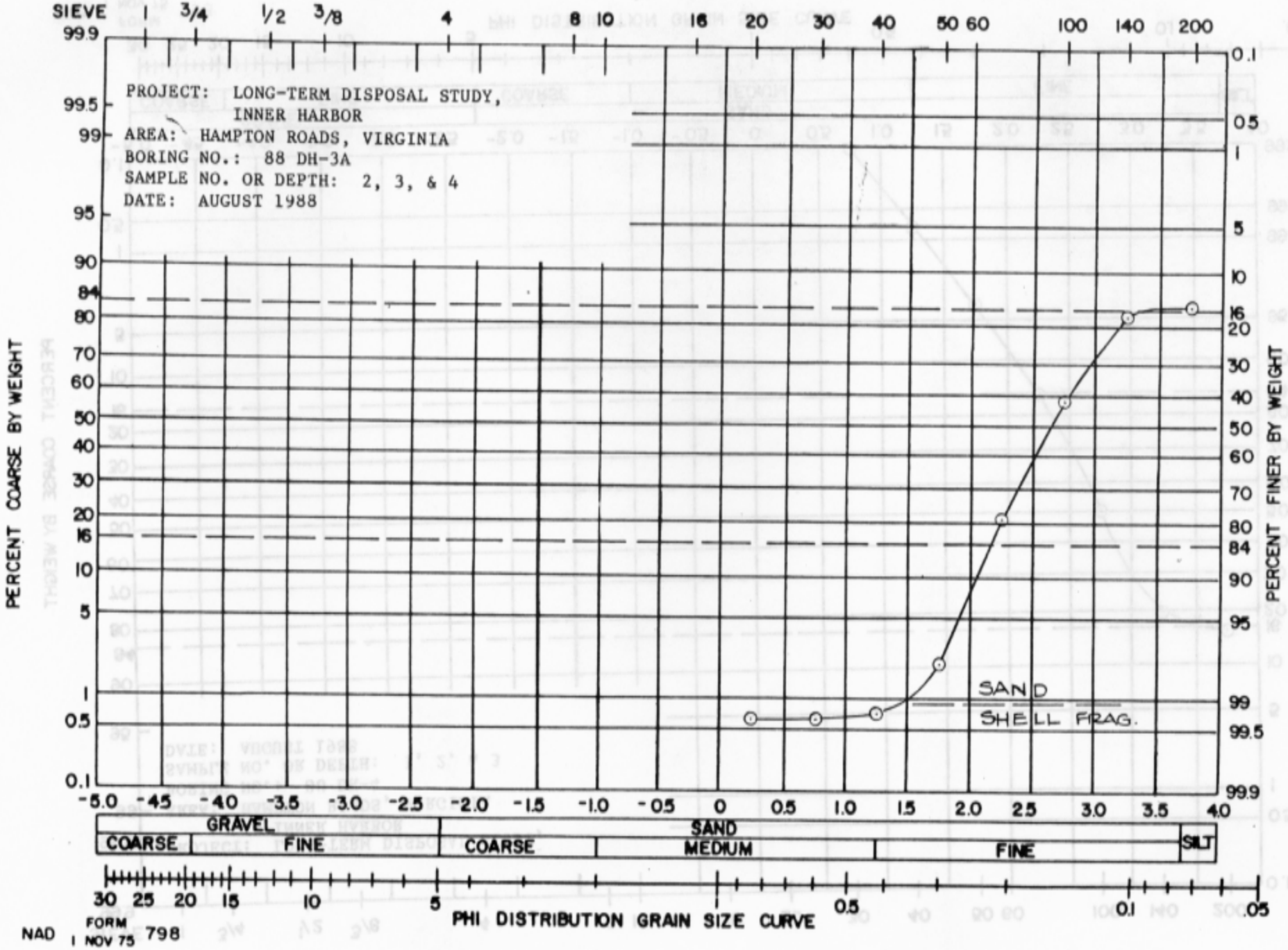

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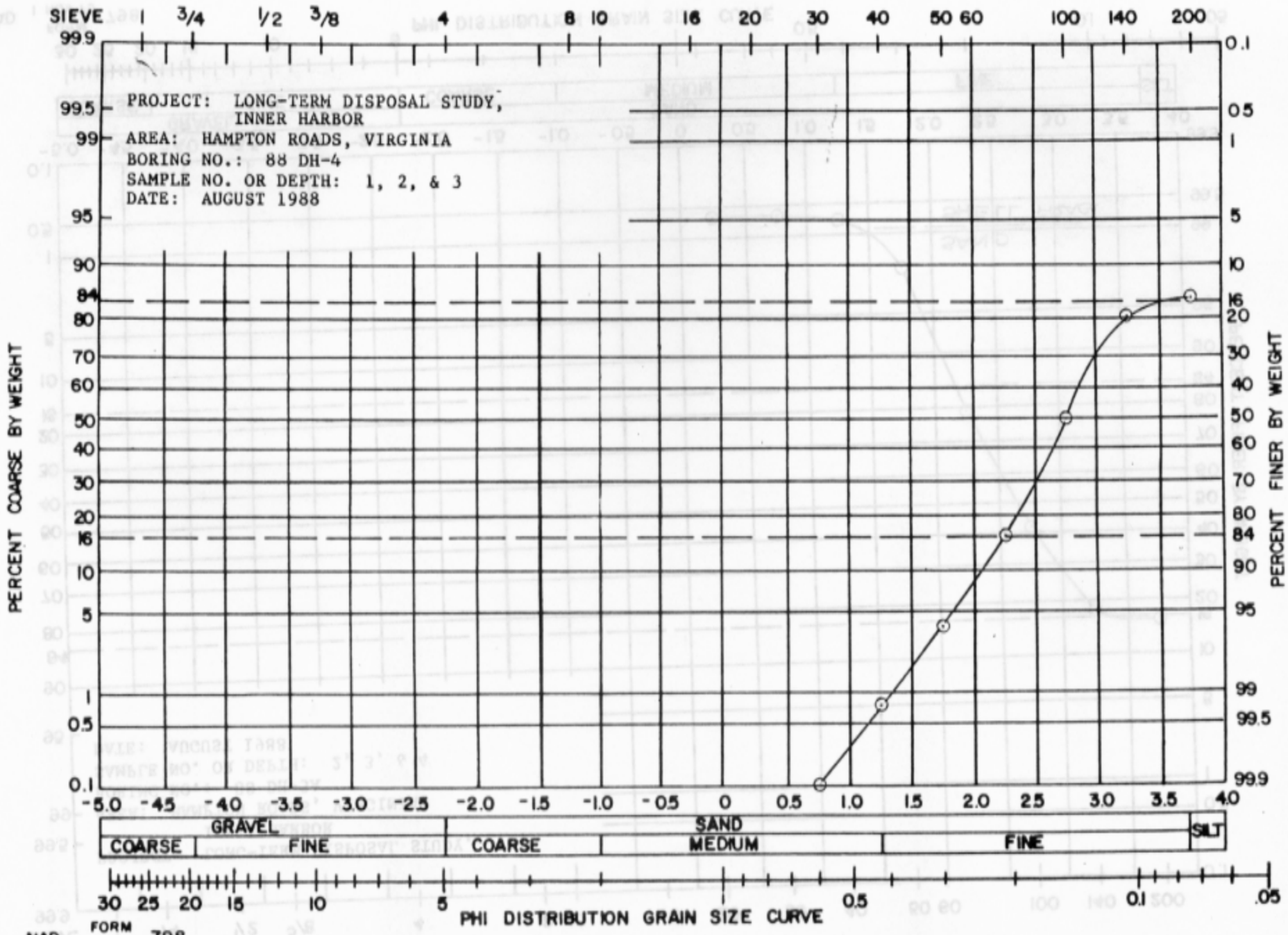

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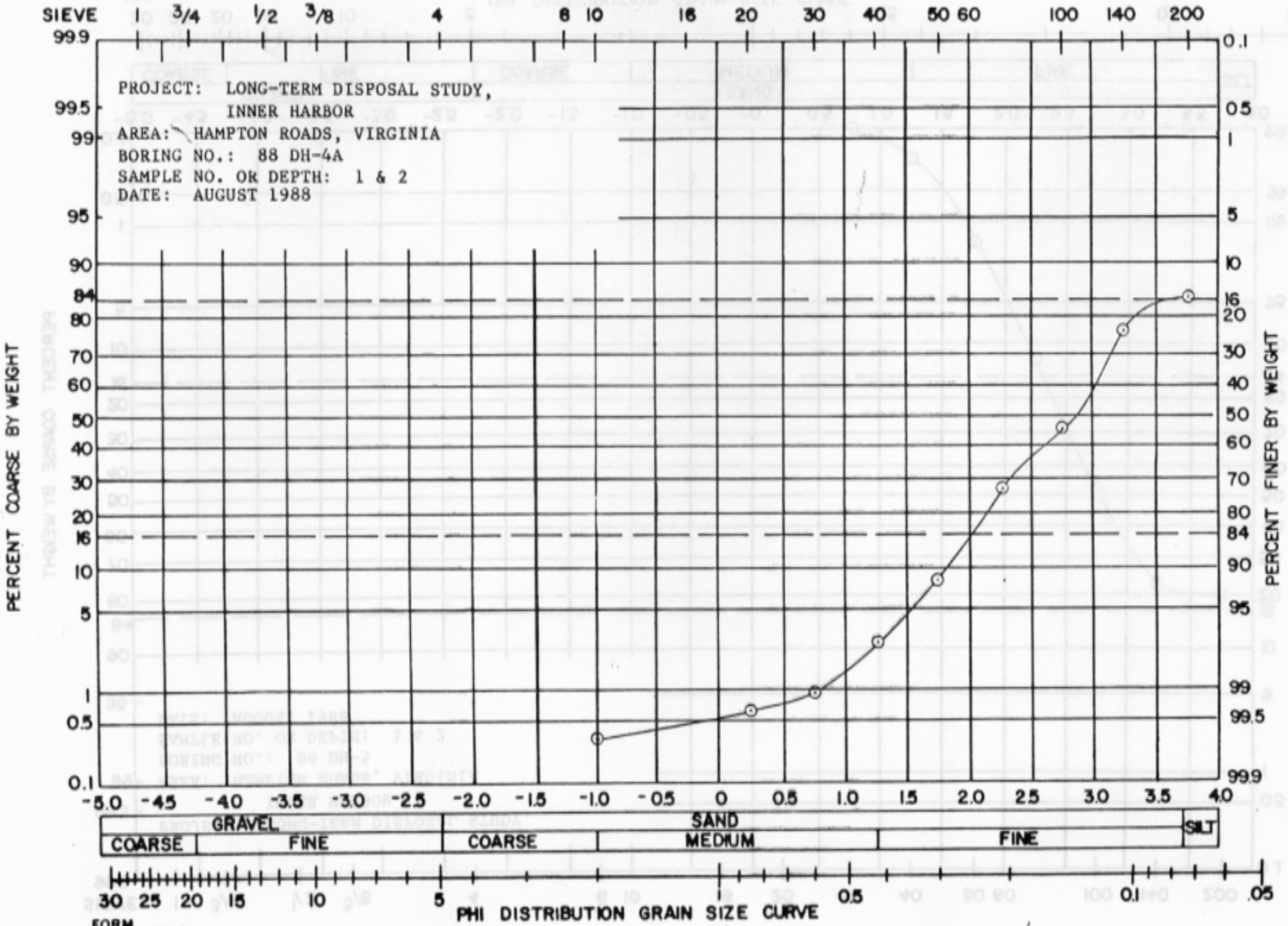

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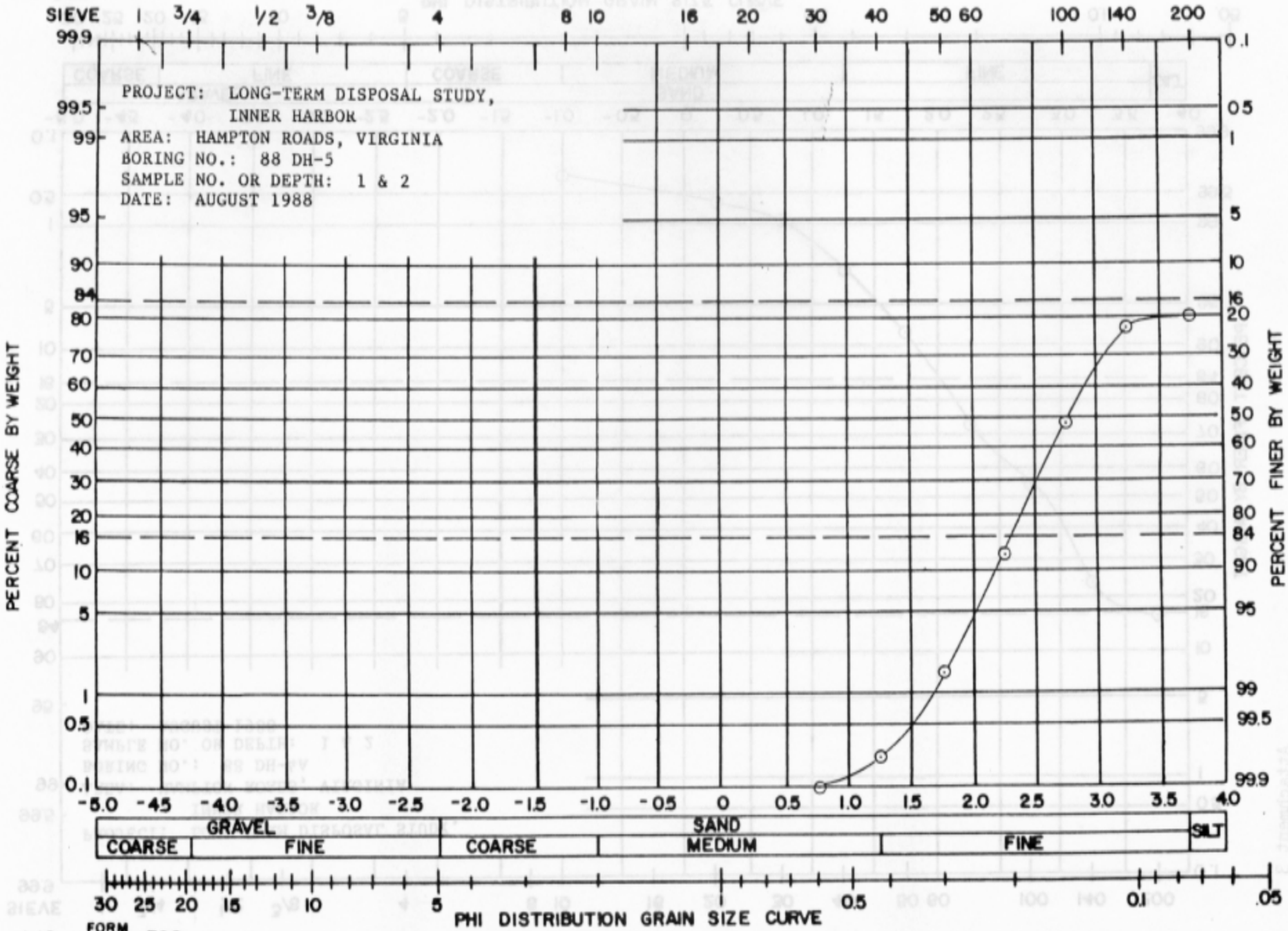

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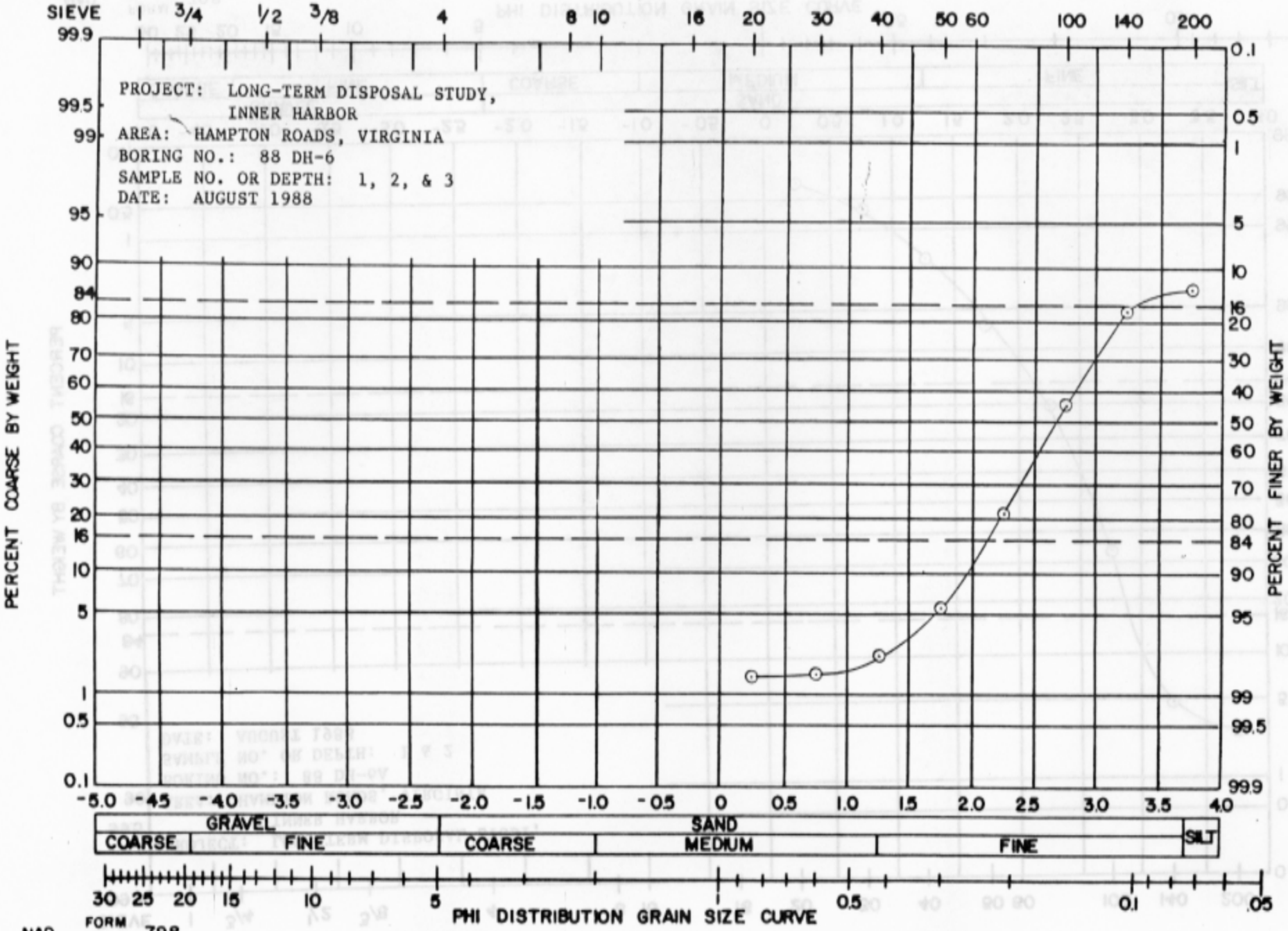

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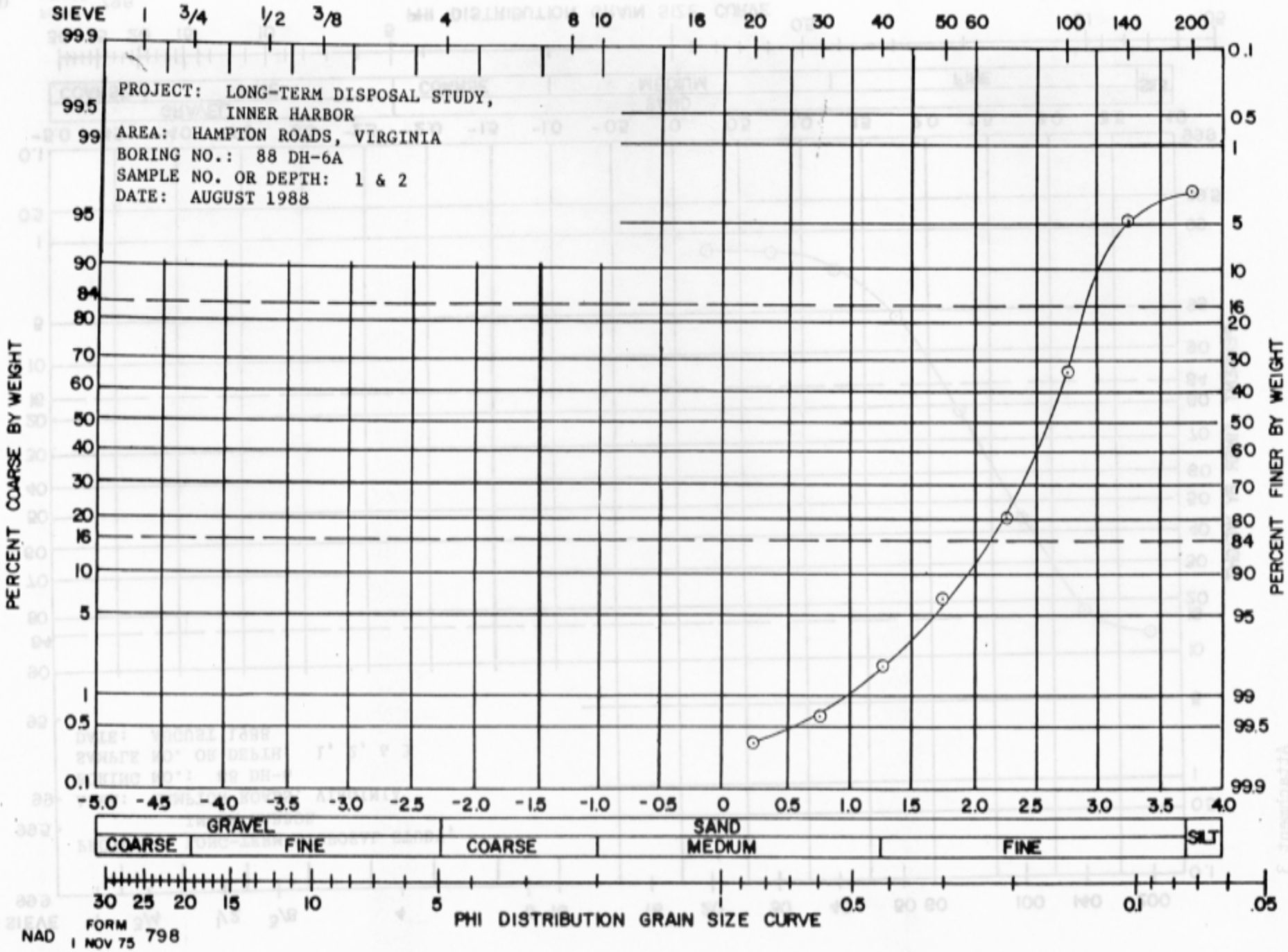

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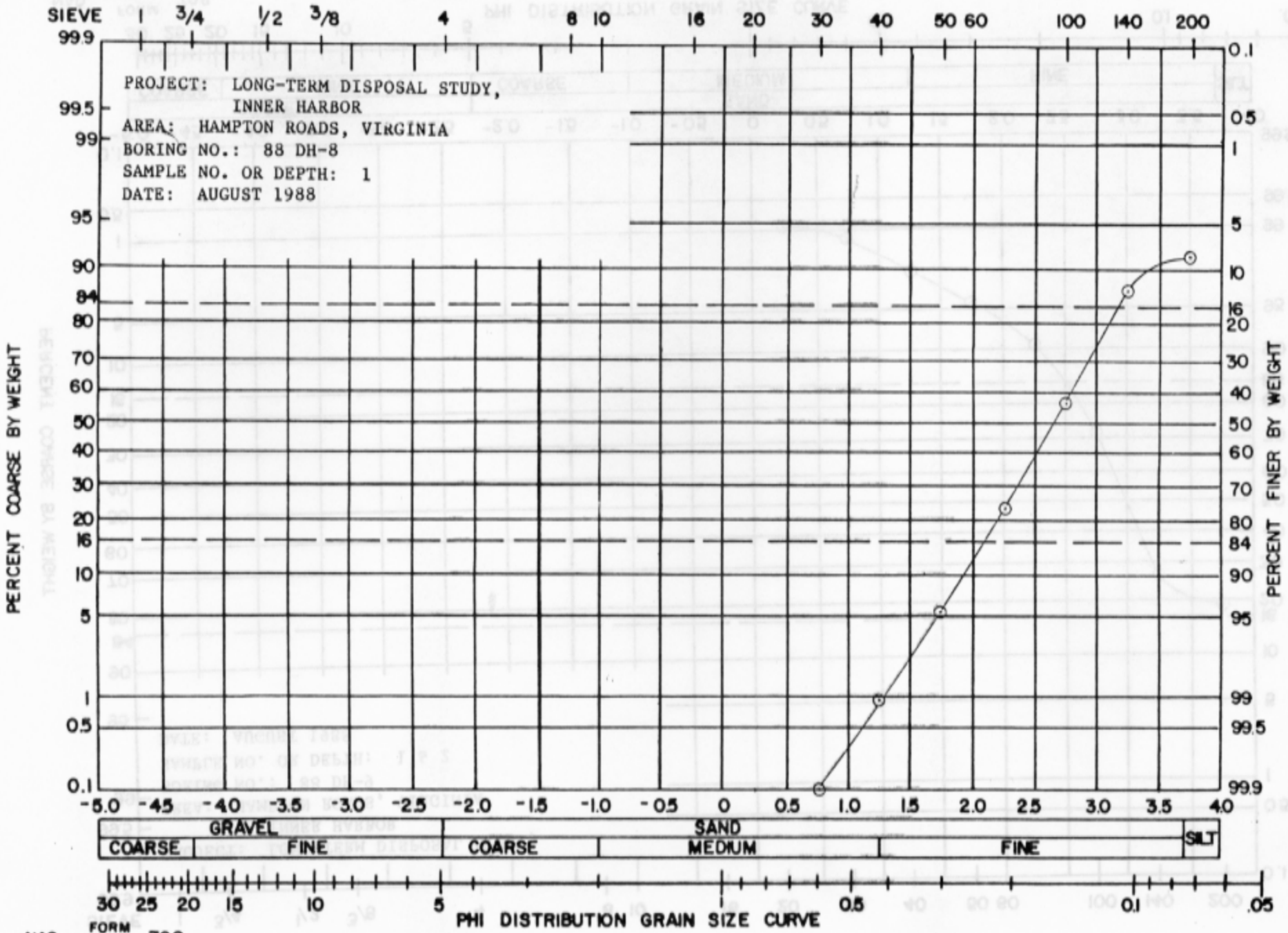

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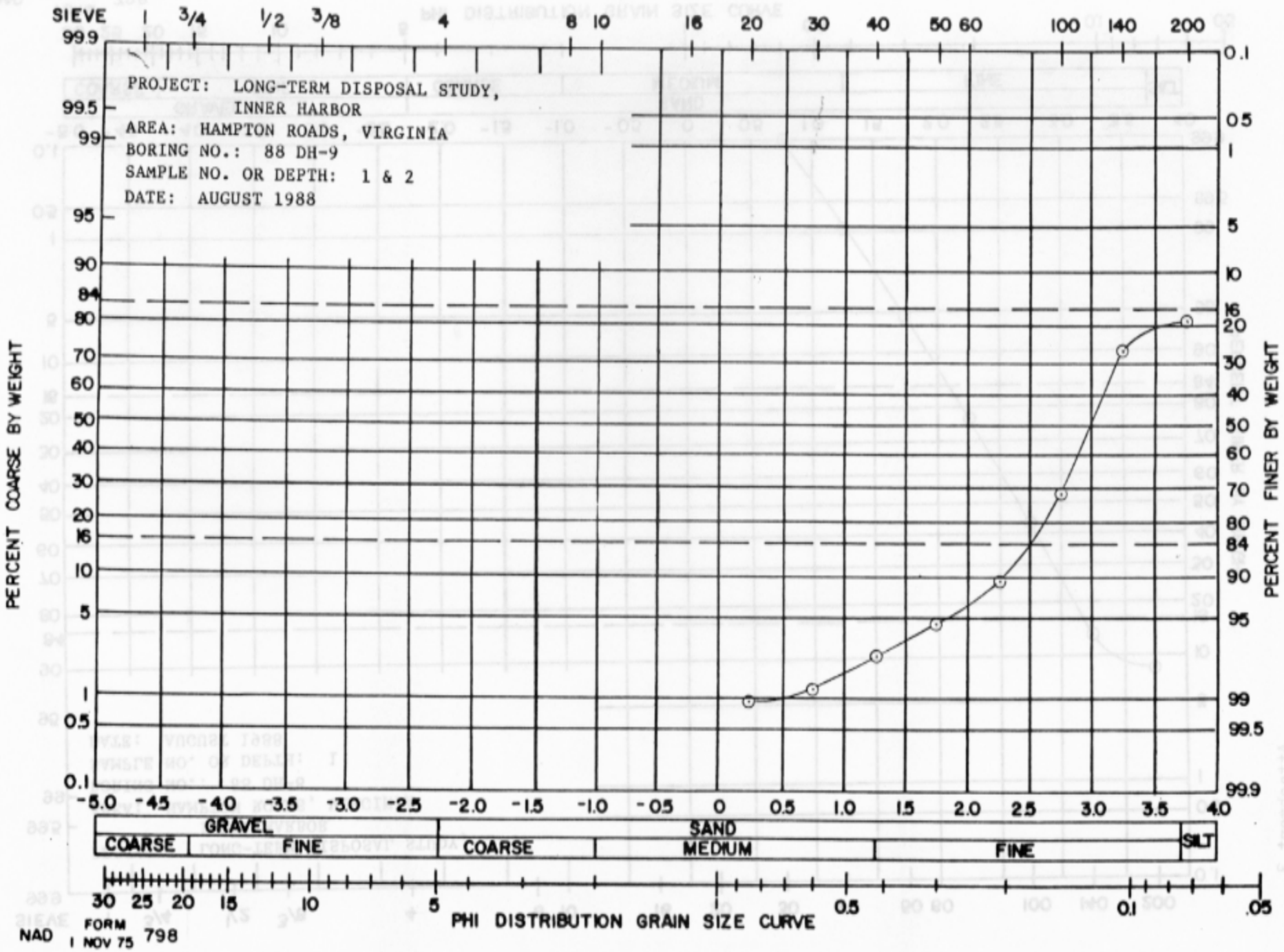

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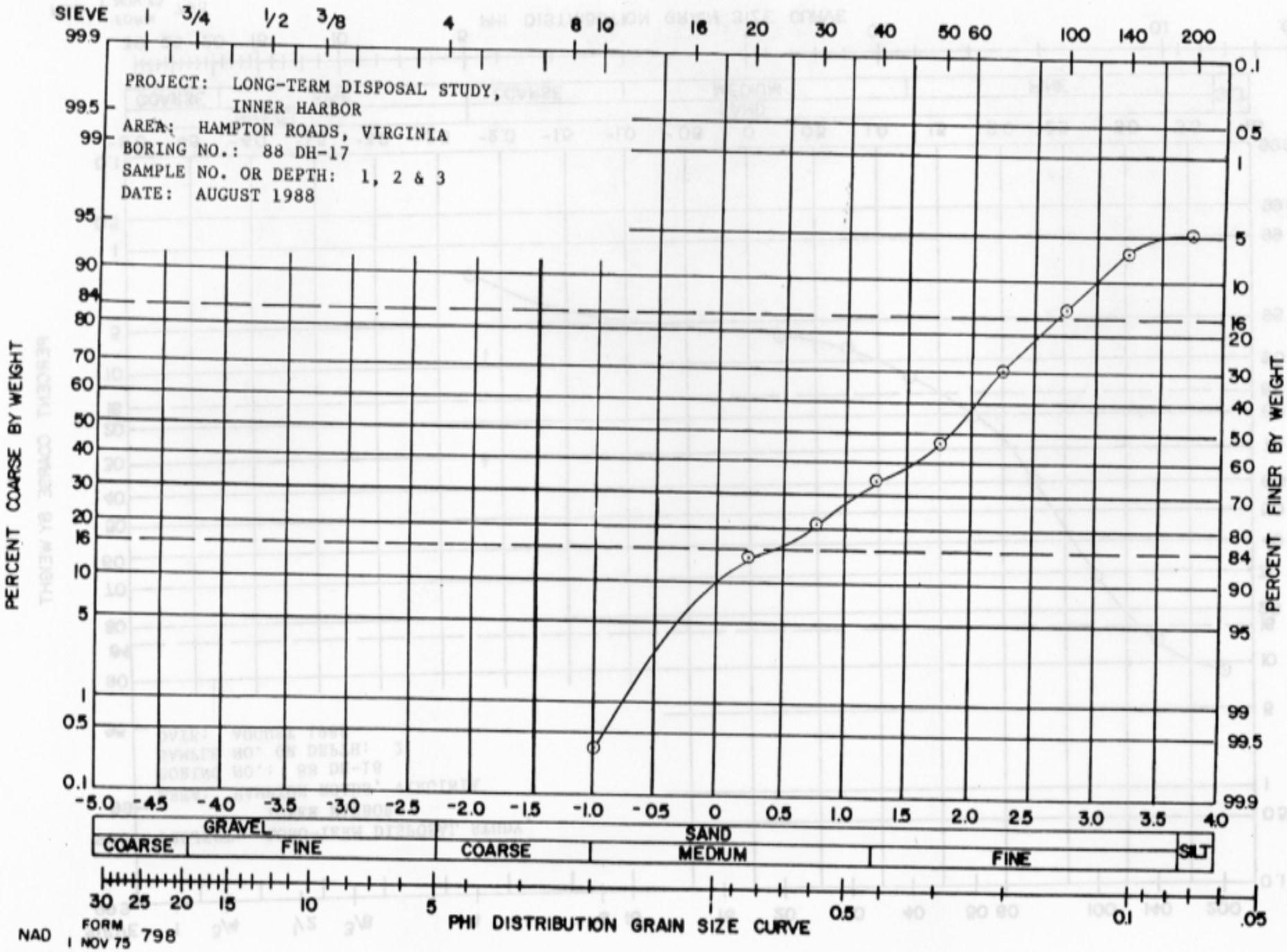

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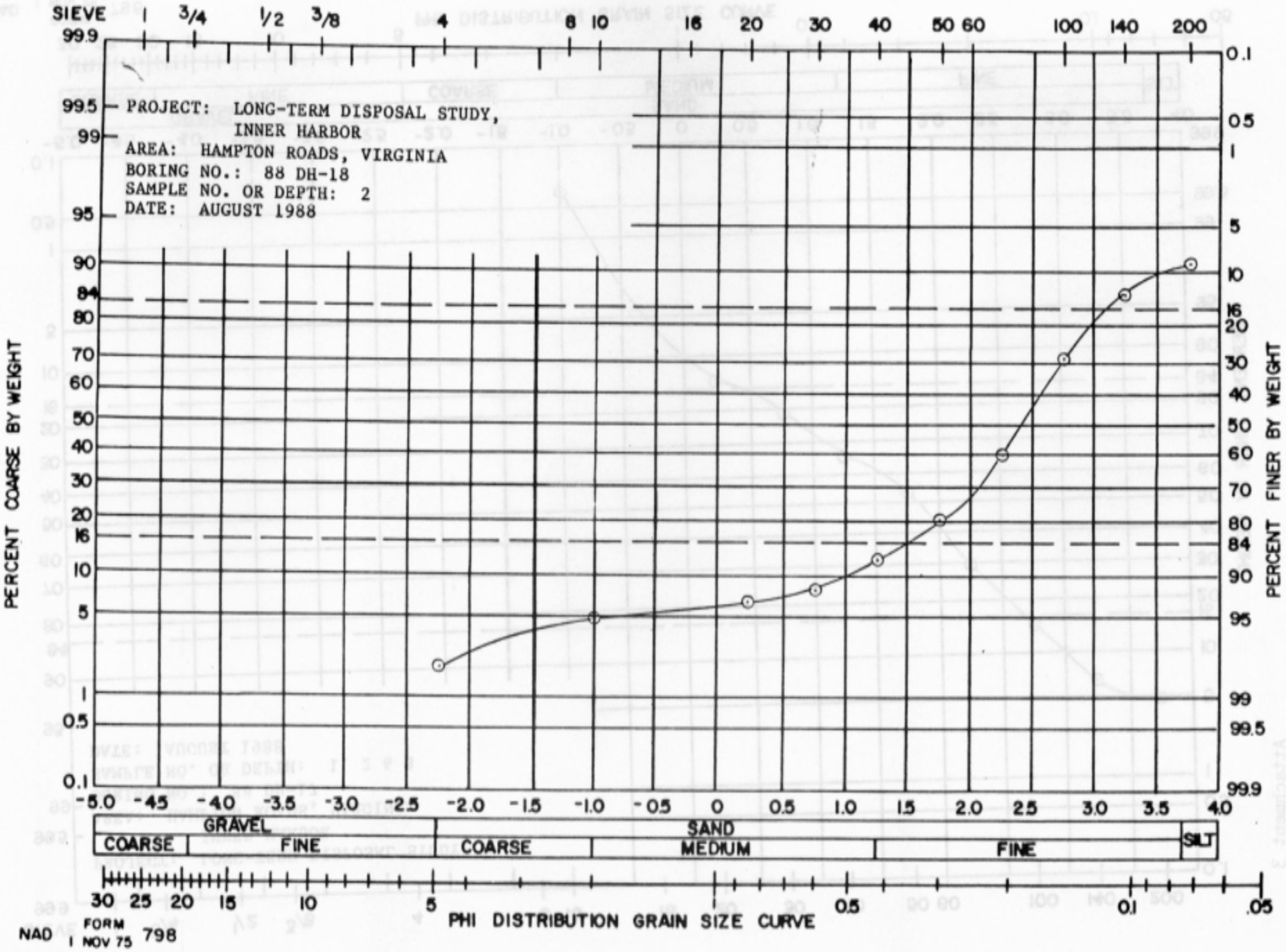

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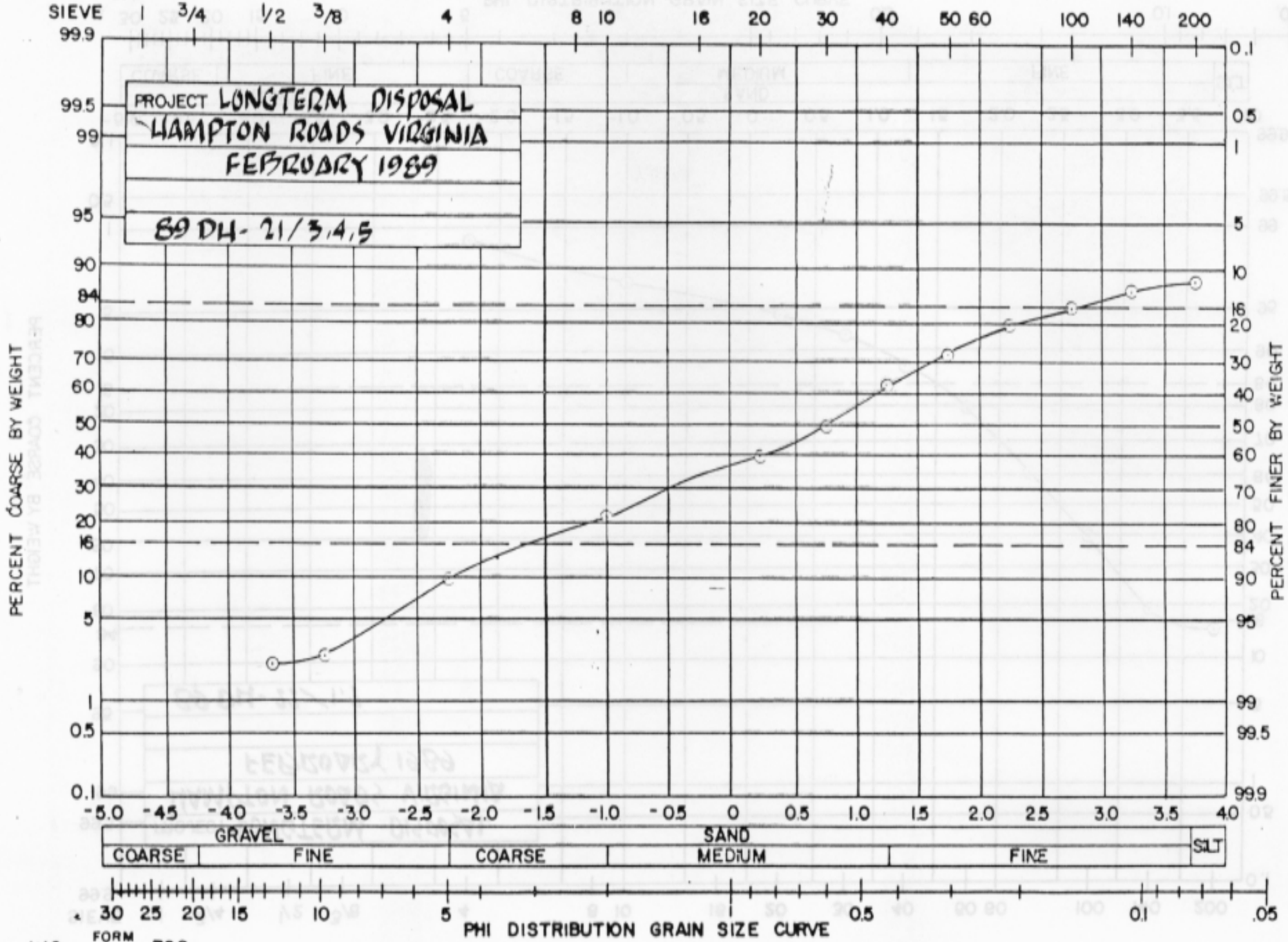

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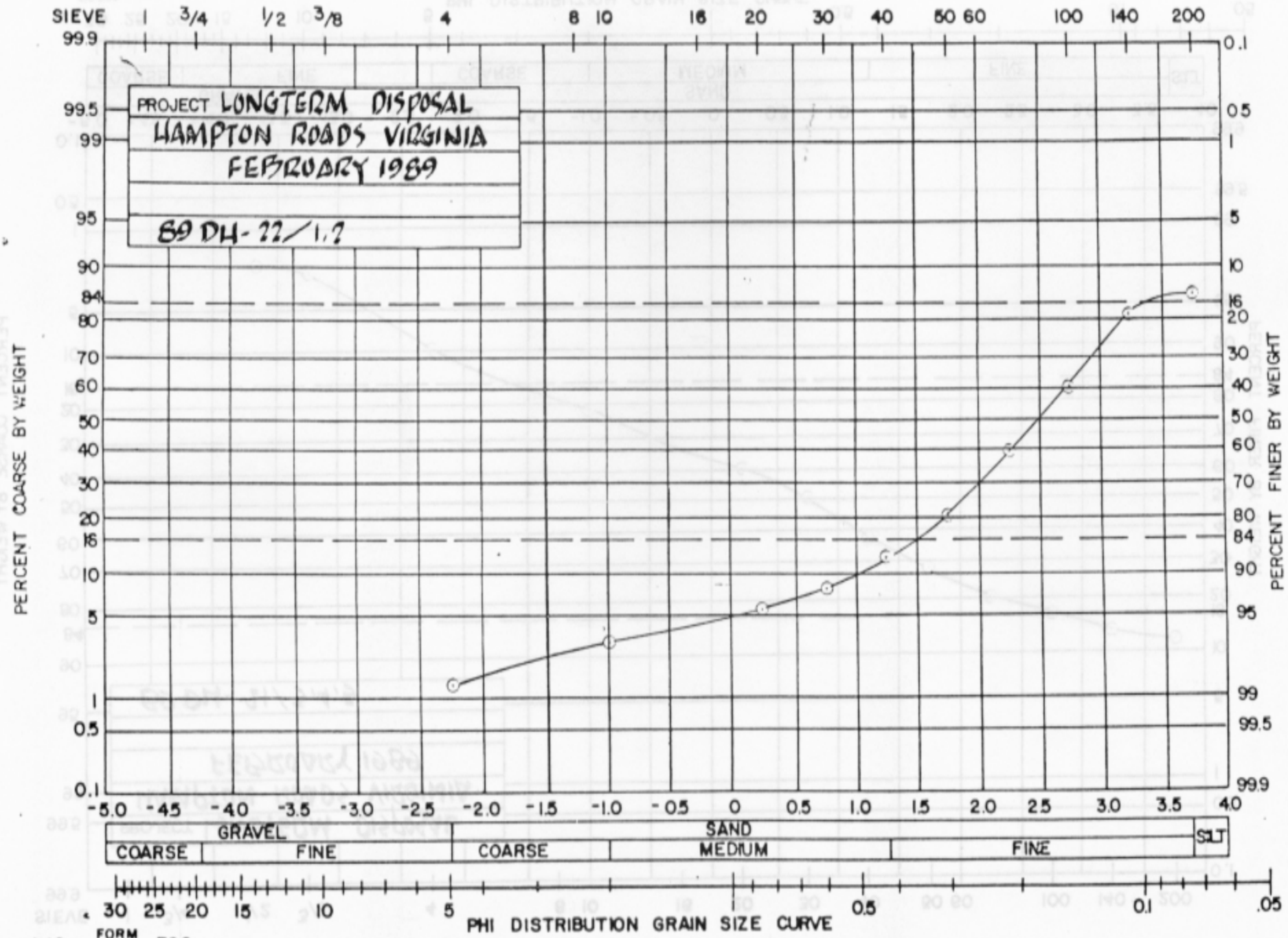
1 NOV 75



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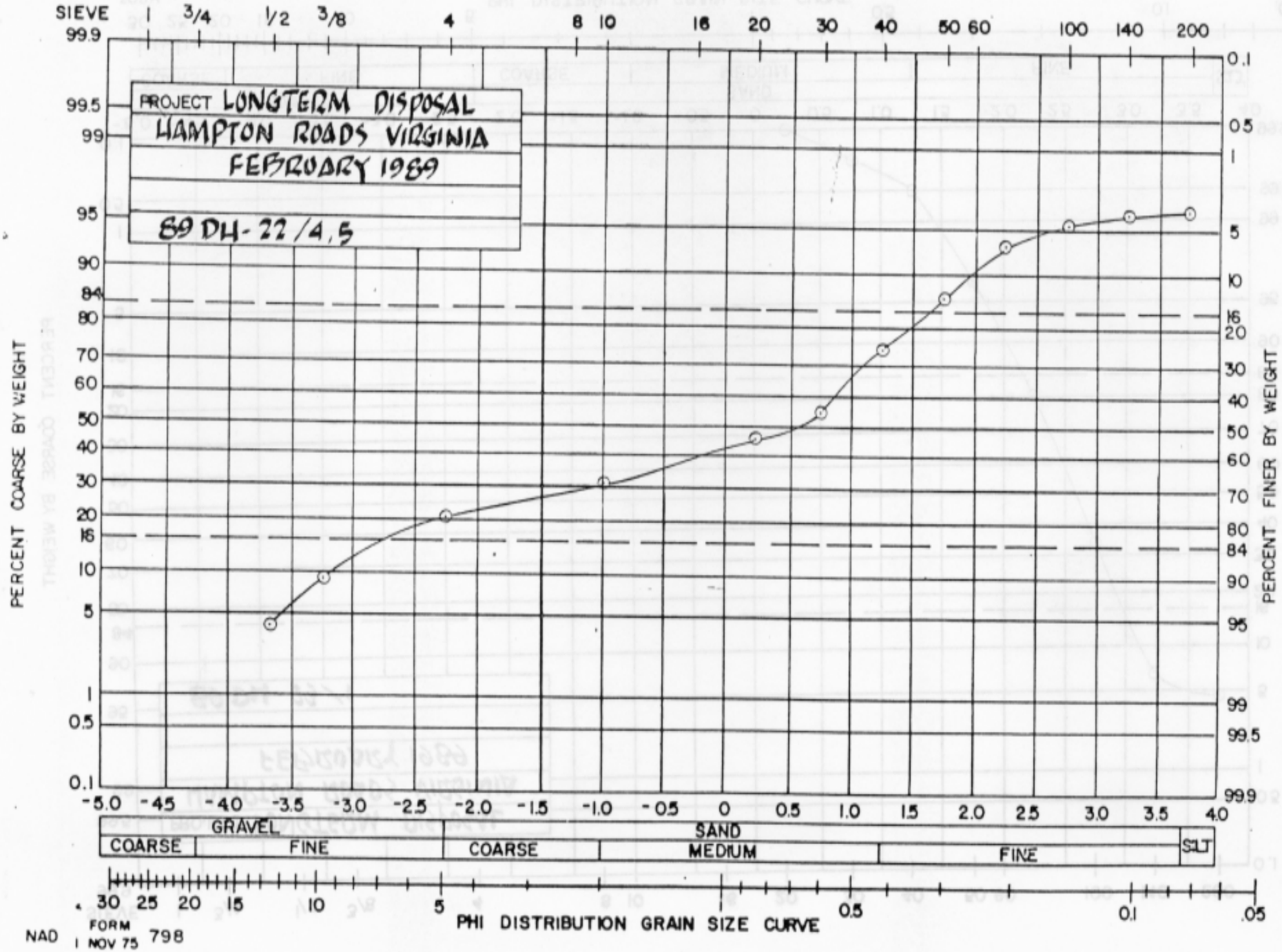

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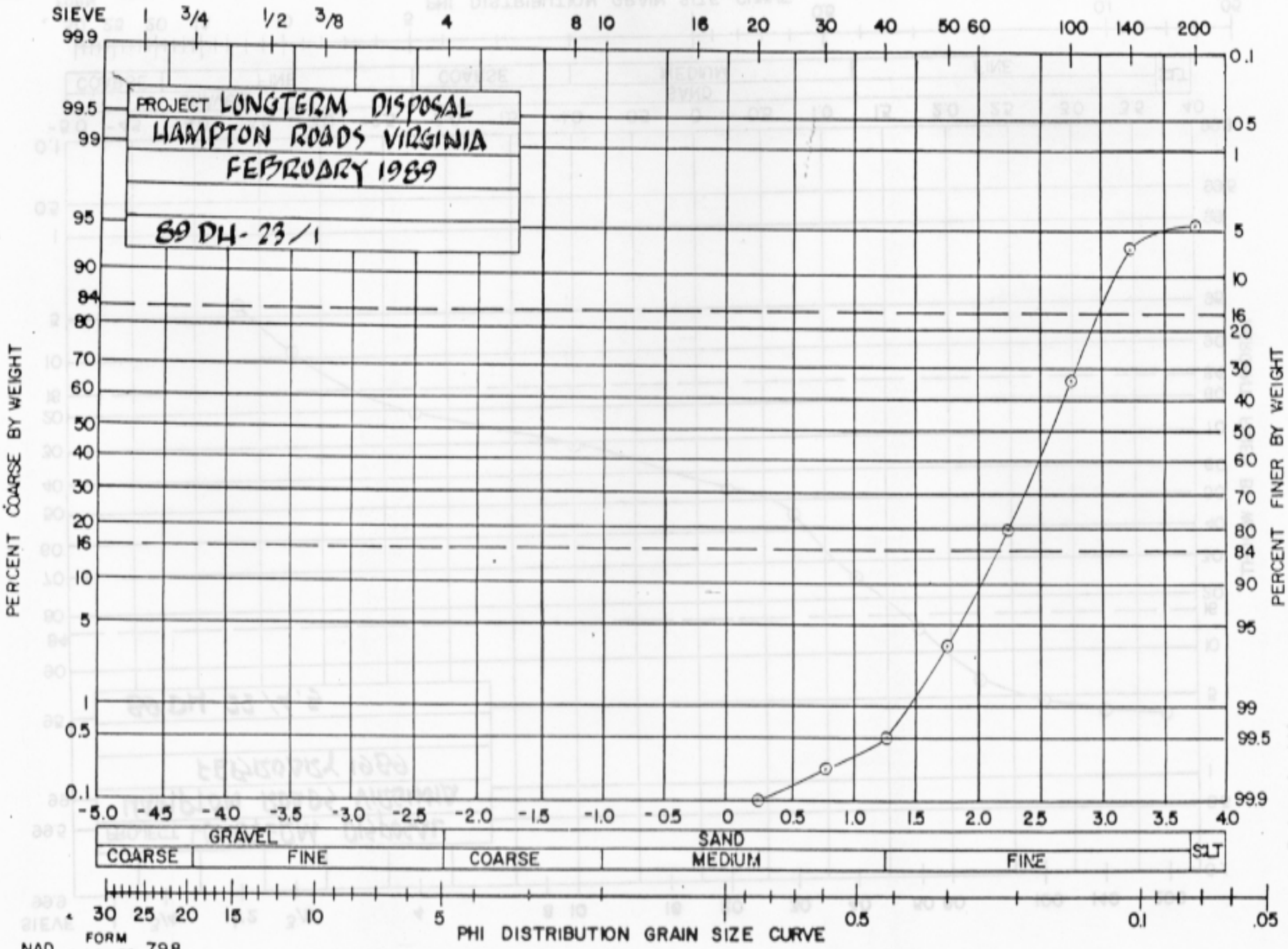

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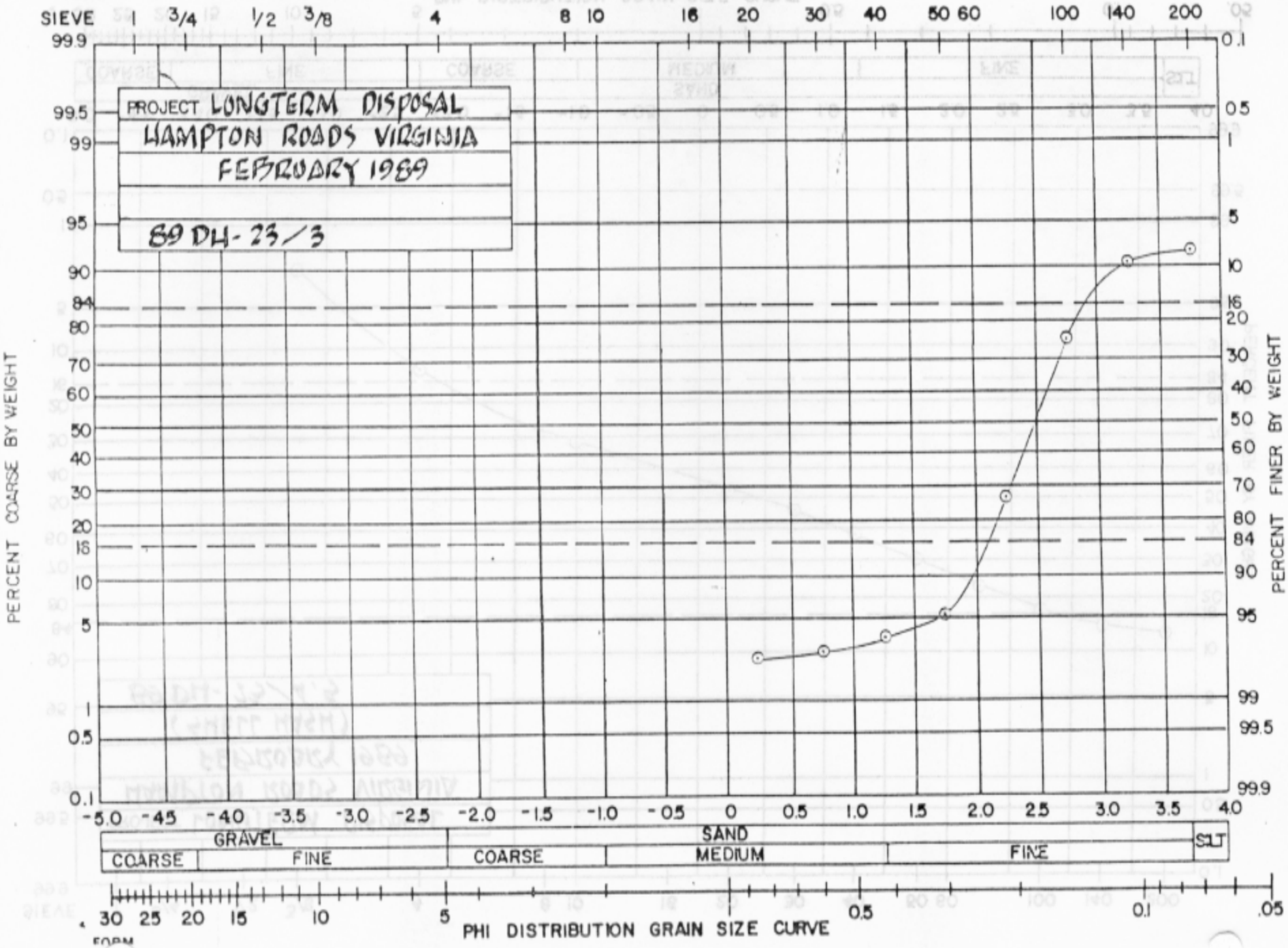
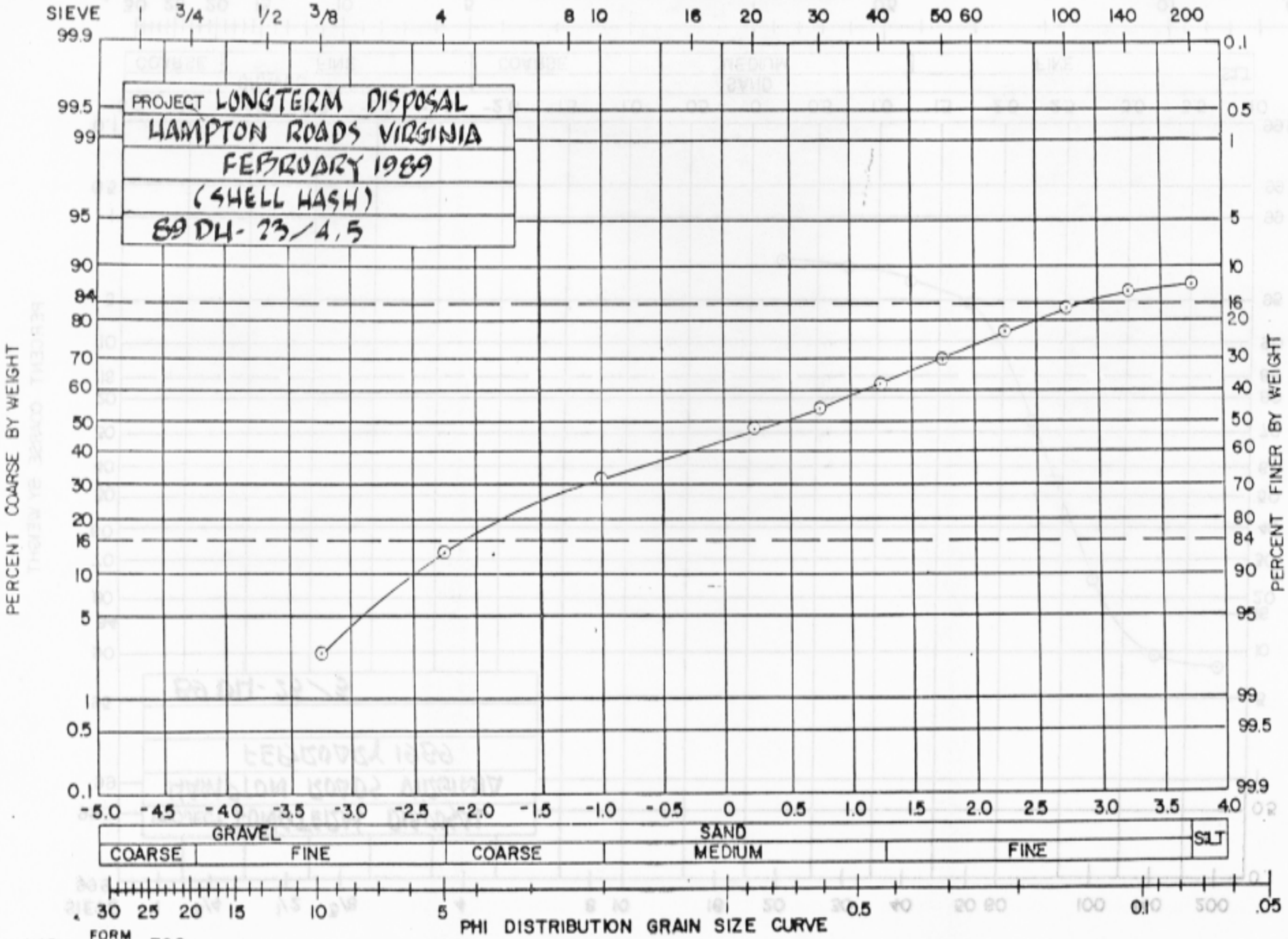

PROJECT LONGTERM DISPOSAL
HAMPTON ROADS VIRGINIA
FEBRUARY 1989
89 DH-23/3
SIEVE
1 3/4 1/2 3/8 4 8 10 16 20 30 40 50 60 100 140 200
PERCENT COARSE BY WEIGHT
PERCENT FINER BY WEIGHT
99.9 99.5 99 95 90 84 80 70 60 50 40 30 20 16 10 5 1 0.5 0.1
0.1 0.5 1 5 10 16 20 30 40 50 60 70 80 84 90 95 99 99.5 99.9
-5.0 -4.5 -4.0 -3.5 -3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT
30 25 20 15 10 5 0.5 0.1 .05
PHI DISTRIBUTION GRAIN SIZE CURVE



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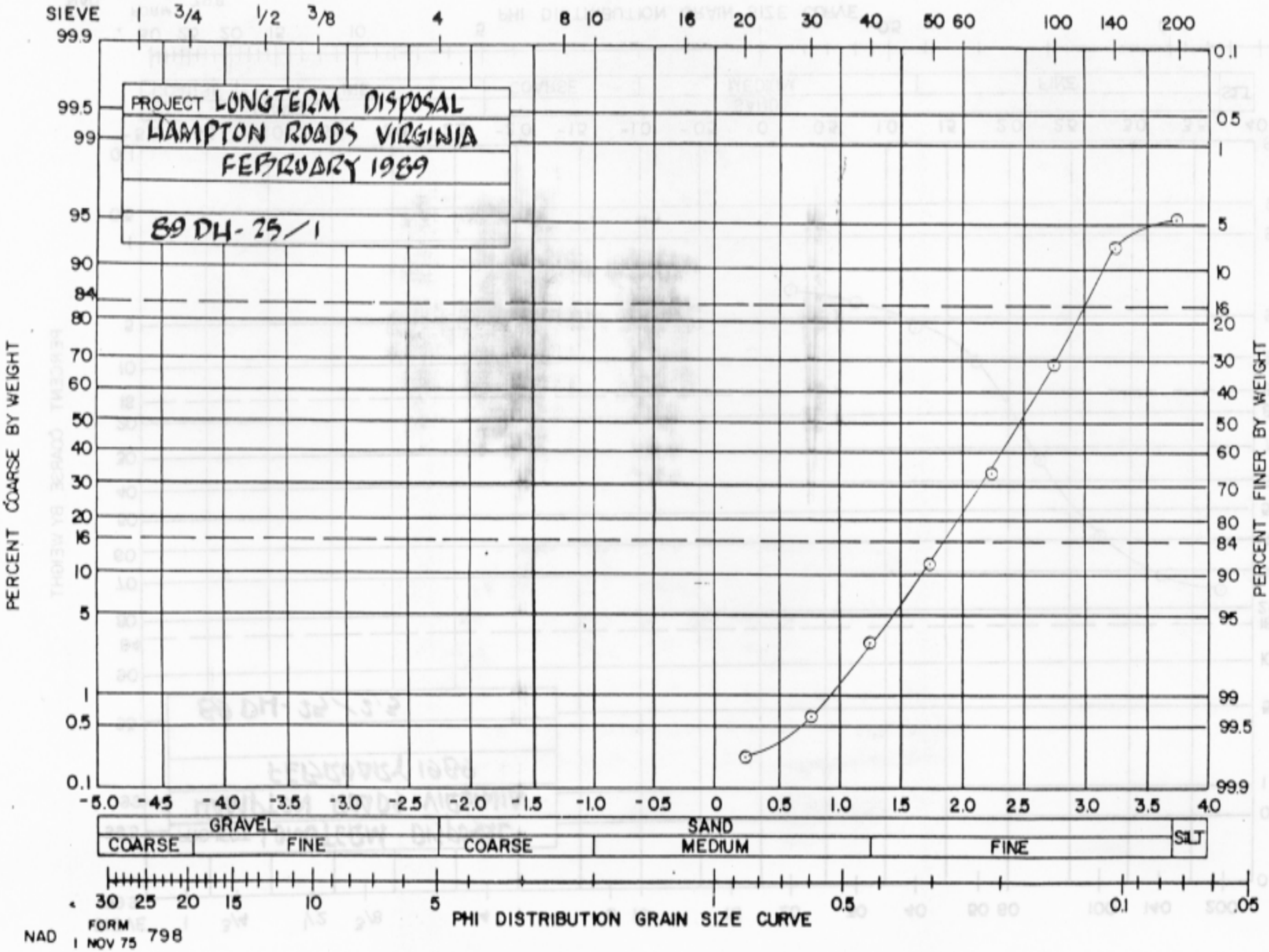

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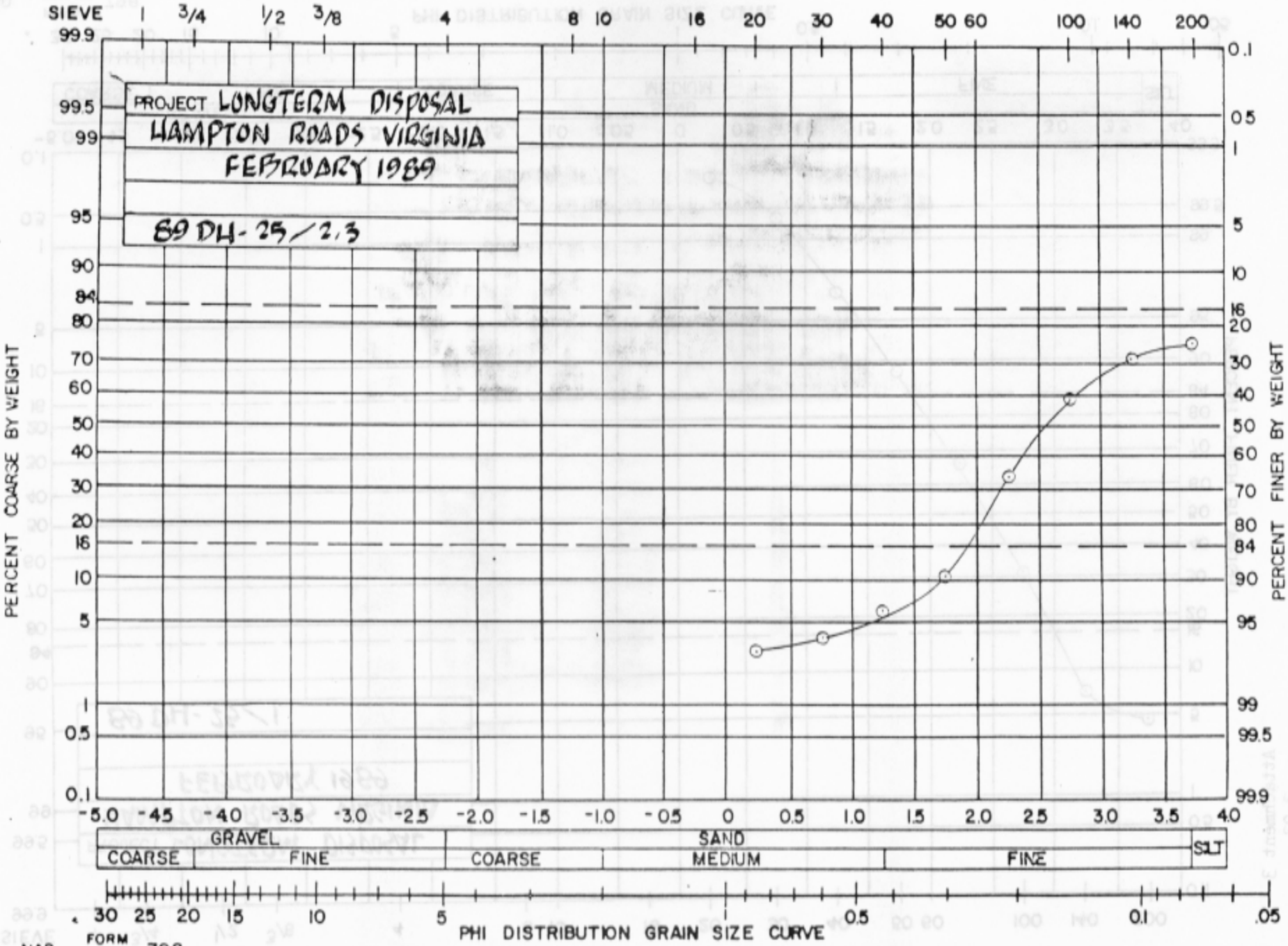

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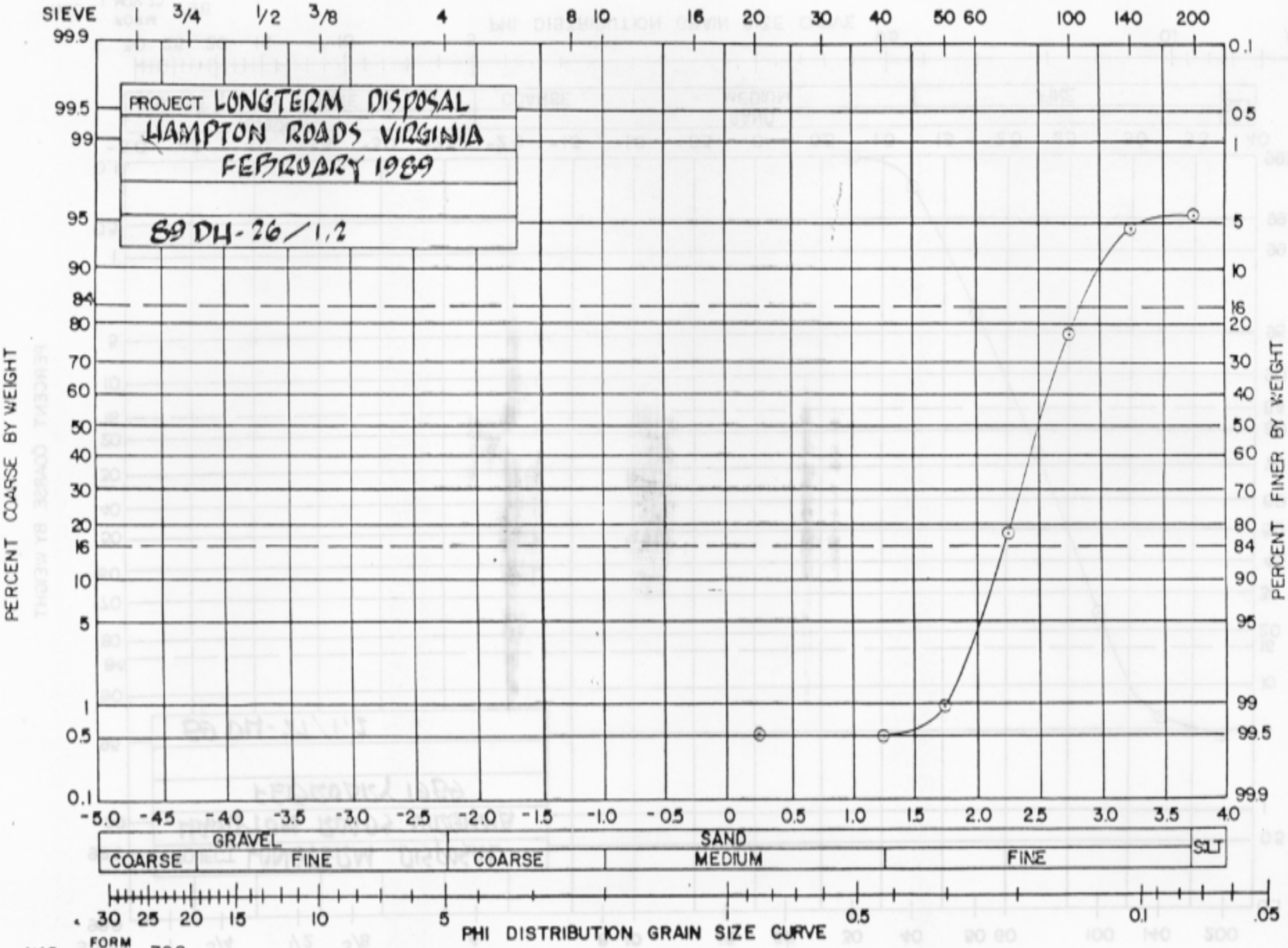

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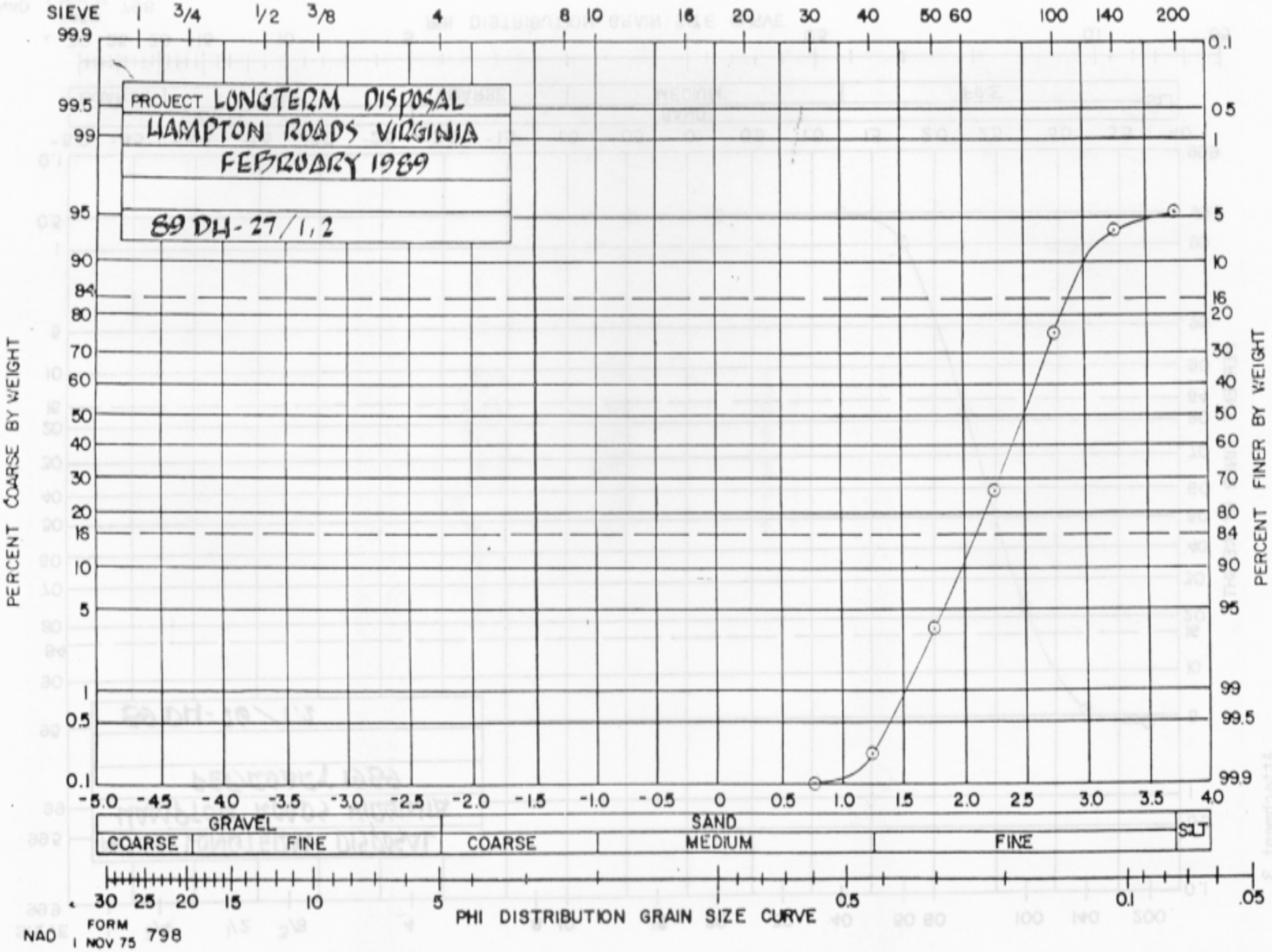

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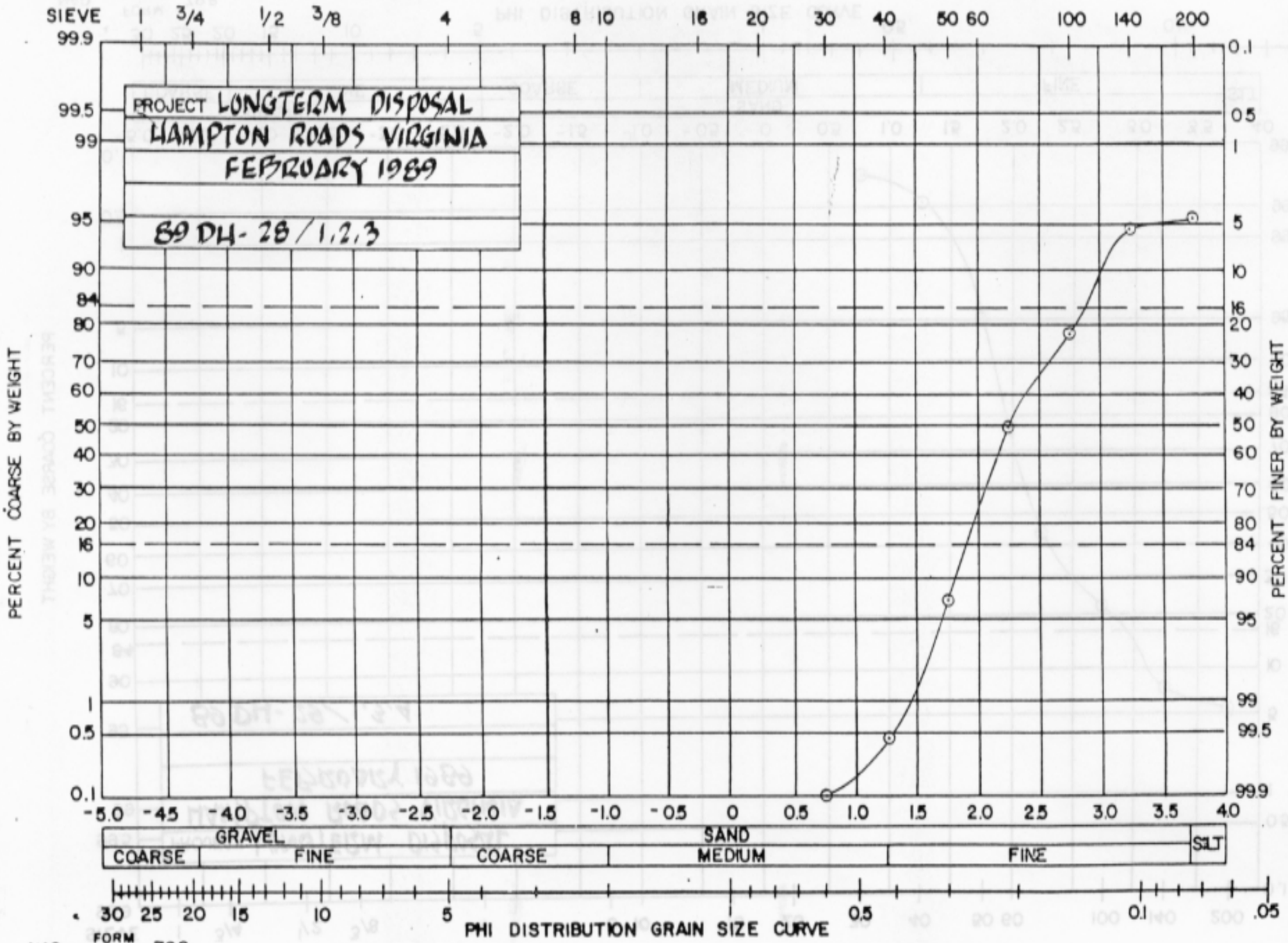
1 NOV 75



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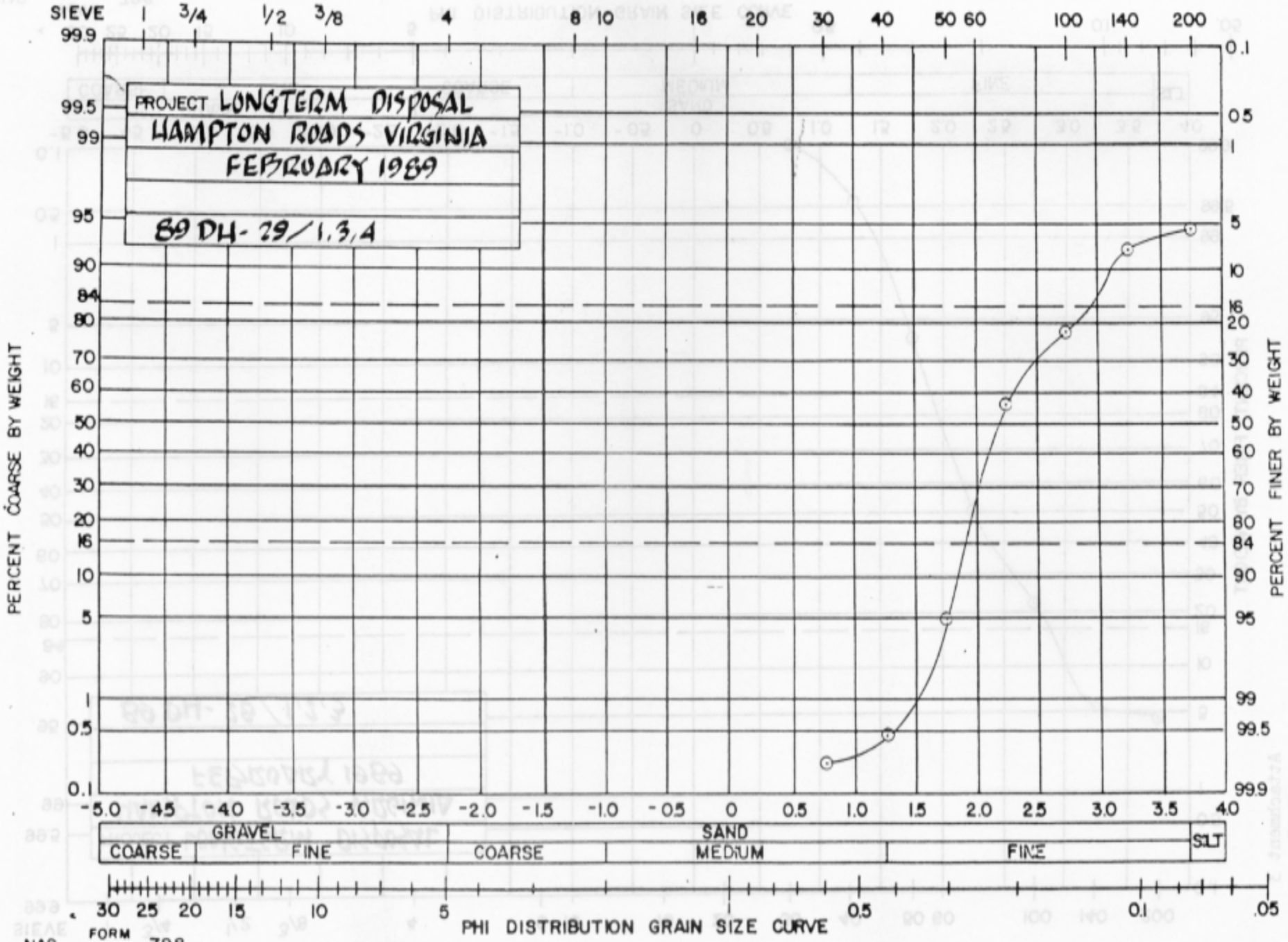
1 NOV 75



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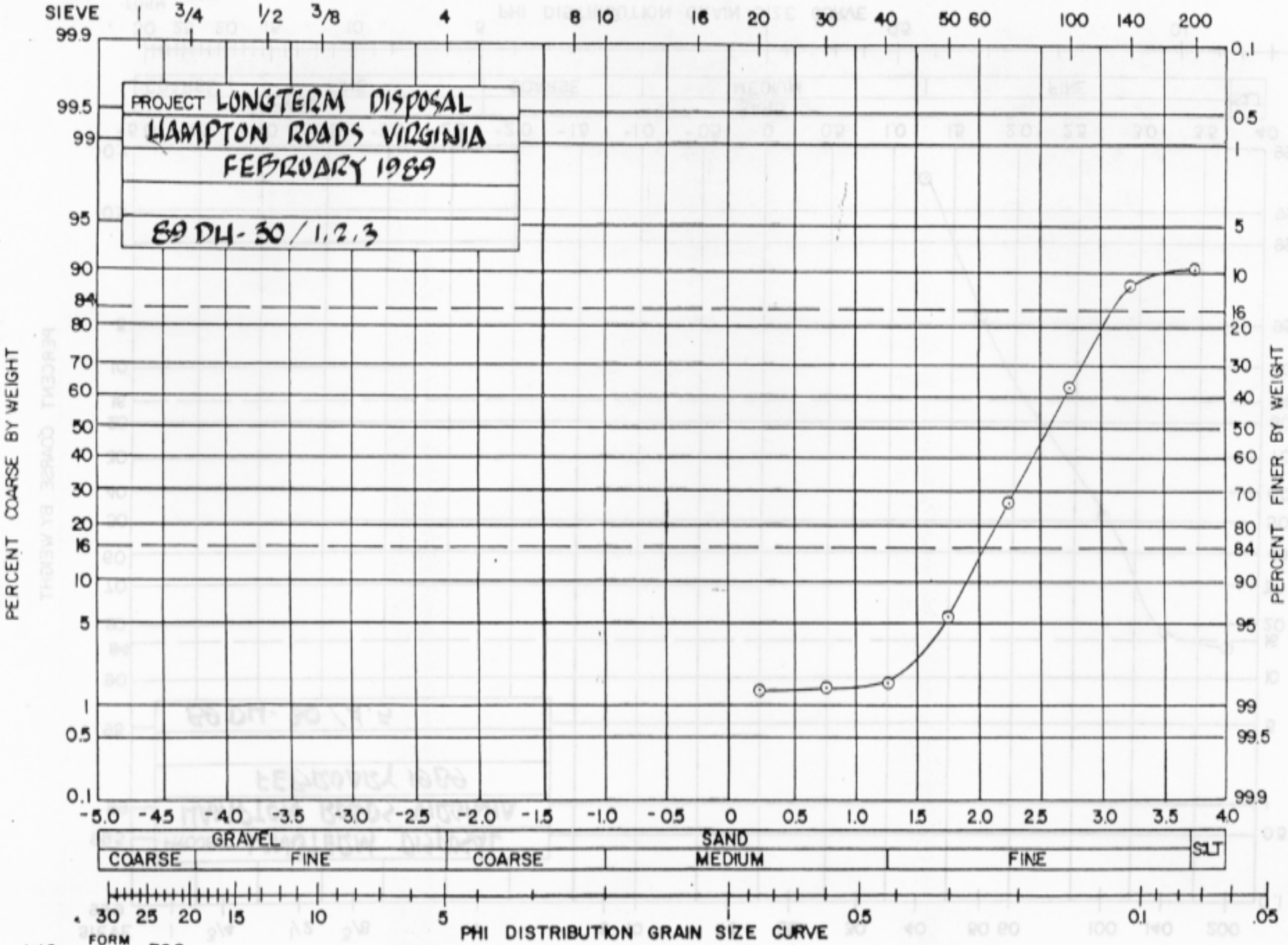

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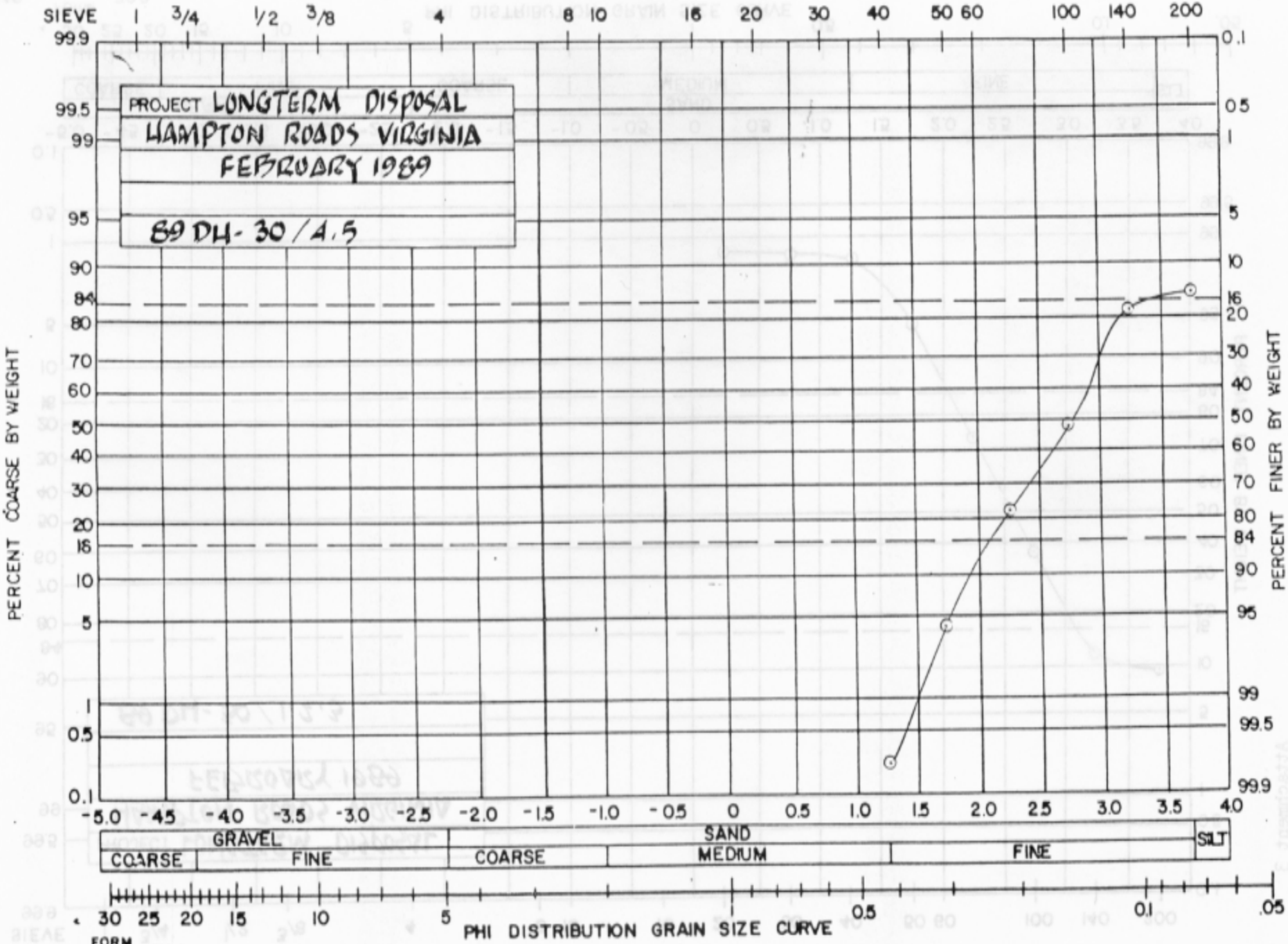

NAD FORM 798 1 NOV 75

SEDIMENT CLASSIFICATION DATA

CORPS OF ENGINEERS, U.S.ARMY NORFOLK DISTRICT

ENGINEERING DIV. DESIGN BRANCH GEOTECH SECTION

PROJECT LONG TERM DISPOSAL SUBJECT 88 DH- 1 thru 18

BY rb. DATE AUG. '88 CHECKED PAGE 1 OF 6

HOLE / SAM	LL	PL	PI	% SAND WASH	% SAND SHAKE	SYM.	DESCRIPTION
1 / 1				45.7		(SM)	fine
1 / 2				89.7		(SP-SC)	fine to med.
1 / 3				74.1		(SC)	fine to med. tr. crse
1 / 4				95.0		(SP)	" " "
1A / 1				96.5		(SP)	fine
1A / 2,3,4				97.1	96.8	(SP)	"
1A / 5				96.1		(SP)	"
2 / 1				95.6		(SP)	"
2 / 2				88.6	91.3	(SP-SM)	"
2 / 3				90.3		(SP-SM)	"
2 / 5	72	26	46	1.3		(CH)	
2A / 3				91.0		(SP-SM)	fine to crse, tr. gravel w/ shell frag.
2A / 4				92.3		(SP-SM)	fine 1 crse SHELL FRAG, w/ concretions

NADN Fm. 882-A Sept. 69

CORPS OF ENGINEERS, U.S.ARMY — NORFOLK DISTRICT

ENGINEERING DIV. DESIGN — BRANCH GEOTECH — SECTION

PROJECT LONG TERM DISPOSAL — SUBJECT 88 DH-1 thru 18

BY rb. DATE AUG. '88 CHECKED _____ — PAGE 2 OF 6

HOLE / SAM.	LL	PL	PI	% SAND WASH	% SAND SHAKE	SYM.	DESCRIPTION
3 / 1,2				92.7	92.7	(SP-SM)	fine
3A / 2				90.3		(SP-SM)	"
3A / 3				82.6	84.5	(SC)	"
3A / 4				77.9		(SC)	"
4 / 1				89.4		(SP-SM)	"
4 / 2				82.8	84.4	(SC-SM)	"
4 / 3				80.2		(SC-SM)	"
4 / 5	75	26	49	18.9		(CH)	"
4A / 1				88.1		(SP-SC)	"
4A / 2				80.4	84.2	(SC)	"
4A / 5				80.7		(SC)	"
5 / 1				89.8		(SP-SM)	"
5 / 2				64.9	79.9	(SC)	"

NADN Fm. 882-A Sept. 69

CORPS OF ENGINEERS, U.S.ARMY NORFOLK DISTRICT

ENGINEERING DIV. DESIGN BRANCH GEOTECH SECTION

PROJECT LONG TERM DISPOSAL SUBJECT 88 DH. 1 thru 18

BY rb. DATE AUG. '88 CHECKED PAGE 3 OF 6

HOLE / SAM.	LL	PL	PI	% SAND WASH	% SAND SHAKE	SYM.	DESCRIPTION
5A / 1				90.5		(SP-SC)	fine
5A / 2				81.9		(SC)	fine tr. crse. & fn. gravel
5A / 4	51	19	32	54.6		(SC-H)	fine
5A / 5				61.0		(SC-H)	"
6 / 1				89.8		(SP-SC)	"
6 / 2				85.6	86.9	(SC)	"
6 / 3				85.8		(SC)	"
6 / 4				94.2		(SP-SM)	fine to crse. tr. gravel
6 / 5				97.5		(SP)	fine to crse SHELL FRAG. w / concretions
6A / 1				97.7		(SP)	fine
6A / 2				97.2	97.4	(SP)	"
6A / 3	65	20	45	28.9		(CH)	LOI = 4.0% fine
6A / 4				92.2		(SP-SM)	fine to crse.

NADN Fm. 882-A Sept. 69

CORPS OF ENGINEERS, U.S.ARMY — NORFOLK DISTRICT

ENGINEERING DIV. DESIGN — BRANCH GEOTECH — SECTION

PROJECT LONG TERM DISPOSAL — SUBJECT 88 DH-1 thru 18

BY rh. DATE AUG. '88 CHECKED _____ — PAGE 4 OF 6

HOLE / SAM.	LL	PL	PI	% SAND WASH	% SAND SHAKE	SYM.	DESCRIPTION
6A / 5				85.8		(SM)	fine to crse. SHELL FRAG.
7 / 3				93.6		(SP-SM)	fine, tr. gravel
7 / 4				76.7		(SC)	fine to med. SHELL
7 / 5				78.7		(SC)	" " "
8 / 1				91.7	91.7	(SP-SM)	fine
8 / 3	64	22	42	27.6		(CH)	"
9 / 1				83.4		(SC)	"
9 / 2				79.7	81.3	(SC)	"
10 / 2				90.4		(SP-SM)	"
10 / 3				96.7		(SP)	"
10 / 4				68.1		(SC)	"
10 / 5				62.4		(SC)	"
11 / 3	91	53	38	26.9		(OH)	LOI = 15.6% fine

CORPS OF ENGINEERS, U.S.ARMY — NORFOLK DISTRICT

ENGINEERING DIV. DESIGN — BRANCH GEOTECH — SECTION

PROJECT LONG TERM DISPOSAL — SUBJECT ~~88~~ DH. 1 thru 18

BY rb. DATE AUG. '~~88~~ CHECKED _____ — PAGE 5 OF 6

HOLE / SAM.	LL	PL	PI	% SAND WASH	% SAND SHAKE	SYM.	DESCRIPTION
11 / 4				94.4		(SP-SM)	fine to crse.
12 / 1				91.6		(SP-SC)	fine
12 / 3				60.5		(SC-H)	"
13 / 3	57	20	37	23.7		(CH)	"
14 / 3	28	20	8	74.8		(SC)	"
14 / 4				30.3		(CH)	"
15 / 1				92.9		(SP-SM)	"
15 / 2	71	24	47	14.0		(CH)	"
15 / 3				59.3		(SC-H)	"
16 / 2	63	23	40	2.9		(CH)	"
16 / 5				92.9		(SP-SM)	"
17 / 1				92.3		(SP-SM)	fine to med.
17 / 2				96.1	95.1	(SP)	" "

NADN Fm. 882-A Sept. 69

CORPS OF ENGINEERS, U.S.ARMY NORFOLK DISTRICT

ENGINEERING DIV. DESIGN BRANCH GEOTECH SECTION

PROJECT LONG TERM DISPOSAL SUBJECT 88 DH- 1 thru 18

BY r.b. DATE AUG. '88 CHECKED _____ PAGE 6 OF 6

HOLE / SAM.	LL	PL	PI	% SAND WASH	% SAND SHAKE	SYM.	DESCRIPTION
17 / 3				98.2		(SP)	fine to med.
18 / 2				91.5	91.1	(SP-SM)	fine to med. tr. crse
18 / 3				49.2		(CL)	fine
18 / 4				95.3		(SP)	fine to crse., tr. gravel
/							
/							
/							
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/							
/							
/							
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NADN Fm. 882-A Sept. 69

ENGINEERING DIV. DESIGN BRANCH GEOTECH SECTION

PROJECT LONGTERM DISPOSAL SUBJECT

BY _____ DATE FEB. 89 CHECKED _____ PAGE 1 OF 5

HOLE/SAM.	SYM.	LL	PL	PI	SAND	MOIST.	DESCRIPTION
19 1	(CH)				0.8%	194%	
2	(CH)	133	38	95	6%	167%	
3	(CH)				4%	150%	
4	(SP-SM)				91%	28%	
5	(CH)	68	29	39	28%	48%	
20 1	(CH)				0.5%	201%	
2	(CH)	147	43	104	0.6%	169%	
3							
4	(CH)				0.5%	140%	
5	(SM)				84%	25%	
21 1	(CH)				5%	220%	
2	(CH)	138	41	97	2%	178%	
3	(SP)				96%	22%	
4	(SC)				80%	13%	
5	(SP-SC)				91%	16%	

NADN Fm. 882-A Sept. 69

ENGINEERING DIV. DESIGN BRANCH GEOTECH SECTION

PROJECT LONGTERM DISPOSAL SUBJECT

BY _____ DATE FEB. 89 CHECKED _____ PAGE 2 OF 5

HOLE/SAM	SYM.	LL	PL	PI	SAND	MOIST.	DESCRIPTION
22 1	(SP-SM)				95%	31%	
2	(SC)				78%	22%	
3	(CL)	35	15	20	31%	31%	
4	(SP)				97%	19%	
5	(SP)				96%	9%	
23 1	(SP)				96%	26%	
2	(CH) & (SC)				63%	26%	
3	(SP-SC)				92%	25%	
4	(SC)				85%	25%	
5	(SP-SC)				91%	23%	

NADN Fm. 882-A Sept. 69

ENGINEERING DIV. DESIGN BRANCH GEOTECH SECTION

PROJECT LONGTERM DISPOSAL SUBJECT

BY _____ DATE FEB. 89 CHECKED _____ PAGE 3 OF 5

HOLE/SAM	SYM.	LL	PL	PI	SAND	MOIST.	DESCRIPTION
24 1	(CH)				18%	162%	
2	(CH)	135	39	96	4%	174%	
3	(CH)				5%	168%	
4	(CH)				25%	104%	
5	(SM)				81%	38%	
25 1	(SP)				95%	30%	
2	(SC)	33	24	9	77%	27%	
3	(SC)				74%	35%	
4	(SC)				73%	26%	
5	(SM)				86%	23%	
26 1	(SP)				98%	30%	
2	(SP-SM)				94%	28%	
3	(CL)	38	20	18	39%	64%	
4	(CL)				32%	61%	
5	(SC)				66%	43%	

NADN Fm. 882-A Sept. 69

CORPS OF ENGINEERS, U.S.ARMY

NORFOLK DISTRICT

ENGINEERING DIV. DESIGN BRANCH GEOTECH SECTION

PROJECT LONGTERM DISPOSAL SUBJECT

BY _____ DATE FEB. 89 CHECKED _____

HOLE/SAM.	SYM.	LL	PL	PI	SAND	MOIST.	DESCRIPTION
27 1	(SP)				97%	27%	
2	(SP-SM)				94%	25%	
3	(SP-SM)				93%	23%	
4	(CH)				0.7%	51%	
5	(CH)	71	25	46	1%	57%	
28 1	(SP)				96%	29%	
2	(SP-SM)				94%	25%	
3	(SP)				98%	23%	
4	(SP)				98%	23%	
5	(CH)	63	23	40	2%	47%	
29 1	(SP-SM)				92%	29%	
2							
3	(SP)				98%	24%	
4	(SP-SM)				92%	26%	
5	(CH)	79	25	54	3%	57%	

NADN Fm. 882-A Sept. 69

CORPS OF ENGINEERS, U.S.ARMY NORFOLK DISTRICT

ENGINEERING DIV. DESIGN BRANCH GEOTECH SECTION

PROJECT LONGTERM DISPOSAL SUBJECT

BY _____ DATE FEB. 69 CHECKED _____ PAGE 5 OF 5

HOLE/SAM.	SYM.	LL	PL	PI	SAND	MOIST.	DESCRIPTION
30 1	(SP-SC)				94%	26%	
2	(SP-SC)				89%	28%	
3	(SP-SC)				89%	28%	
4	(SC)				86%	30%	
5	(SC)				86%	28%	

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SECTION 4

APPENDIX B, SECTION 4
BENEFICIAL USES OF DREDGED MATERIAL

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BENEFICIAL USES OF DREDGED MATERIAL

INTRODUCTION

1. Beneficial uses of suitable dredged material can encompass a variety of projects such as beach nourishment, shoreline stabilization, fill material for low-lying areas, and construction projects. All of these uses require predominantly sandy sediments. An inherent benefit is the decrease in storage capacity needed in designated disposal areas for these sediments. The mean grain size, the amount of fines, and the transportation distances to the receiving site are normally the determining factors for beneficial use of dredged sediments. When suitable materials are expected from a dredging project, an individual plan should be implemented for advantageous utilization. This effort will require prior agreements concerning costs and priorities of need between Federal, state, and local authorities. These prearranged agreements will limit negotiations and facilitate time schedules for individual projects. Ideally, the materials removed from a dredge site should be transferred directly to the receiving location to limit rehandling and reduce costs. Alternatively suitable materials which must be pumped into a designated disposal area should be separated from non-usable sediments for later recovery. Contracts dealing with the pumping of sediments into a disposal area should have provisions to address the separation of suitable and nonsuitable materials by using a "Y" junction and appropriate valves to direct the discharge to different areas. This will facilitate the removal of usable materials and increase the capacity of Craney Island.

DREDGING IN INNER HARBOR OF HAMPTON ROADS

2. Anticipated future dredging in the inner harbor of Hampton Roads is expected to exceed 4 million cubic yards annually. The majority of this work is maintenance dredging from navigation channels and entrances to docks and piers by Federal, state, and private interests. The maintenance material will be composed almost entirely of clay and silt unsuitable for beneficial uses. Thus, the small amount of suitable material from maintenance dredging will have no impact on the long-term disposal plan.

3. The only possibility of obtaining substantial amounts of suitable material in the inner harbor is from new work dredging from areas previously undredged or from locations being dredged to greater depths. The Norfolk Harbor deepening project will result in suitable material from portions of the Newport News Channel, the Norfolk Harbor Channel, and the 40- and 45-foot projects on the Southern Branch of the Elizabeth River.

4. Borings in the Newport News Channel between stations 155+00 to 255+00 indicate suitable silty sands (SM) and clayey sands (SC). Sediments obtained from widening and deepening Newport News Channel in this area were used to stabilize the western dike of the Craney Island Disposal Area. Approximately 1.7 million cubic yards of additional usable sediments may be obtained in deepening the channel from 50.0 to 57.0 feet. See Appendix B, Section 3, paragraphs 25 through 29 for a more detailed explanation.

5. The Norfolk Entrance Channel, between stations 145+00 to 186+00, contains a mixture of clean sands (SP), silty sands (SM), clayey sands (SC) and clays (CH). Due to a lack of adequate borings in this area, the quantity and quality of these sediments is undefined and will require additional borings to delineate the area. Based on present data, it is estimated that the deepening of the Norfolk Harbor Entrance Channel from 50.0 to 57.0 feet would result in 0.6 million cubic yards of suitable material. See Appendix B, Section 3, paragraphs 34 and 35 for a more detailed explanation.

6. Dredged material from the 40- and 45-foot projects on the Southern Branch of the Elizabeth River are composed primarily of unsuitable clays (CH), clayey sands (SC) and silty sands (SM). Underlying these sediments in some portions of the channel is an undulating bed of clean sand (SP) which will fall within the dredging prism for future deepening. The quality of sands to be dredged is unknown. The exact location and delineation of these sand bodies will require additional borings in selected areas. A proposed turning basin, located at the end of the 40-foot project (see plate 7 of main report), is estimated to yield approximately 300,000 cubic yards of clean sand. See the General Design Memorandum No. 2, dated 1989, Southern Branch Elizabeth River, Appendix C, for further details.

7. Other sources of suitable dredged material include small dredging projects which occur throughout the inner harbor area. These projects are usually associated with the creation of new docking facilities or the deepening of existing facilities. Some of these projects have in the past and are expected in the future to yield dredged material suitable for beneficial uses. Each of these projects must be dealt with independently based on quality of material and dredge location to determine maximum benefit.

8. In previous years, 15 to 20 percent of the material pumped into Craney Island has been suitable for dike construction in the disposal area. This means that of the 4 million cubic yards pumped into the disposal site each year, 600,000 to 800,000 cubic yards could be used for this purpose. This material generally has too many fines for road construction or beach nourishment. However, the fines serve as a binder for the sandy sediments and provide excellent material for the construction and maintenance of dikes. The use of this material provides some reduction in the need for storage. This, however should not be the basis for altering long range disposal plans due to the small quantity and uncertain future availability.

9. As the shoreline becomes fully developed, it is expected that a larger percent of future dredging work will be maintenance with less of the material being suitable. While beneficial usage of dredged material should be incorporated as part of any disposal strategy, the diversion of this material from a designated disposal site will not alter the substantial need for a comprehensive long-term disposal plan.