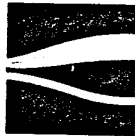


APPENDIX D-11:
LEROY CRANDALL AND ASSOCIATES,
“GEOTECHNICAL STUDIES, AREA D, T.T. 49104,”
FOR MAGUIRE THOMAS PARTNERS,
JANUARY 3, 1991



January 3, 1991

Maguire Thomas Partners
13250 Jefferson Boulevard
Los Angeles, California 90094

(LCA L90328.AEO)

Attention: Mr. Joel H. Stensby
Construction Manager

Gentlemen:

We are pleased to submit our report entitled "Geotechnical Studies, Proposed Playa Vista Project - Area D, Tentative Tract No. 49104, Jefferson Boulevard Between Lincoln and Centinela Avenues, Los Angeles, California, for Maguire Thomas Partners." We have performed various investigations involving the proposed tract. The current studies were authorized to update the prior studies and to present the previously developed data in a new report.

The scope of the investigation was planned in collaboration with Mr. Joel H. Stensby. The results of our investigation and preliminary information were discussed with the parties concerned as the data became available.

The results of our investigation and preliminary design recommendations are presented in the report. The report has been prepared in three basic sections: Section 1 gives the introduction and background; Section 2 covers the preliminary geotechnical evaluation of the overall project; and Section 3 covers the bluff stability investigation. The results of the field explorations and laboratory tests for the preliminary evaluation are presented in Appendix A; geologic and seismic reference data are presented in Appendix B; details of the Charnock fault hazard evaluation are presented in Appendix C; the results of the field explorations and laboratory tests for the bluff stability investigation are presented in Appendix D; and a list of recommended planting material is presented in Appendix E.

January 3, 1991
(LCA L90328.AEO)

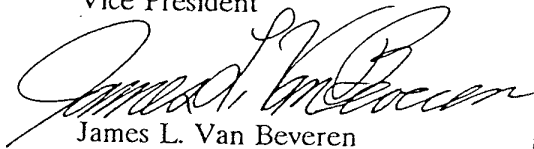
It has been a pleasure to be of professional service to you on this project. Please call if you have any questions or if we can be further assistance.

Respectfully submitted,

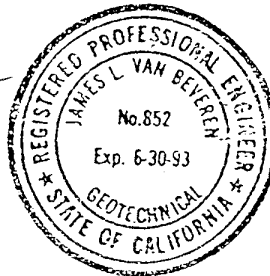
LeROY CRANDALL AND ASSOCIATES



Mervin E. Johnson
Director of Geological Services
Vice President



James L. Van Beveren
Principal Engineer
Vice President



R28/sle
(6 copies submitted)

cc: (2) Psomas & Associates
Attn: Mr. Jacob Lipa

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GEOTECHNICAL STUDIES
PROPOSED PLAYA VISTA PROJECT - AREA D

TENTATIVE TRACT NO. 49104

JEFFERSON BOULEVARD BETWEEN
LINCOLN AND CENTINELA AVENUES
LOS ANGELES, CALIFORNIA

FOR

MAGUIRE THOMAS PARTNERS

SUMMARY

We have performed comprehensive geotechnical studies for Tentative Tract No. 49104. The proposed tract, which is part of the proposed Playa Vista Project, will be developed for mixed-use residential, office, retail, hotel, research park, public use facilities, and recreational uses. The locations of the proposed buildings on the site and the structural features of the proposed buildings have not been established at this time.

The site is considered suitable for the development as contemplated. There are no geologic hazards or adverse soil or ground water conditions that would preclude the development. Although the site has potential problems related to both liquefaction and compressible soils, the hazards can be mitigated by proper engineering design and construction. All of the lots on the site are considered buildable, and detailed recommendations for design and construction of the project can be provided when the individual building locations are known.

Heavy, settlement-sensitive structures should be supported on driven piling. With proper grading of the site, light, flexible structures could be supported on spread footings; footings should be underlain by a minimum thickness of properly compacted fill.

The liquefaction potential needs to be considered in the design of the project. Mitigation alternatives could include either densification of the site to eliminate the possibility of liquefaction, or strengthening the foundation system to resist the effects of liquefaction.

Our analyses of the stability of the bluff adjacent to the southern boundary of the project show the bluff to be grossly stable. However, some areas will require remedial grading or a setback from the toe of the slope. If the grading or setback recommendations are followed, the presence of the bluff should not adversely affect the planned development.

SECTION 1.0: INTRODUCTION

1.1 PURPOSE

This report covers our geotechnical evaluation of Tentative Tract No. 49104, and incorporates data obtained during our prior investigations performed for the tentative tract. This report supersedes our prior reports and includes all of the data previously submitted to the City of Los Angeles and our prior responses to their comments.

The report has been prepared in three basic sections: Section 1 gives the introduction and background; Section 2 covers the preliminary geotechnical evaluation of the overall project; and Section 3 covers the bluff stability investigation. The results of the field explorations and laboratory tests for the preliminary evaluation are presented in Appendix A; geologic and seismic reference data are presented in Appendix B; details of the Charnock fault hazard evaluation are presented in Appendix C; the results of the field explorations and laboratory tests for the bluff stability investigation are presented in Appendix D; and a list of recommended planting material is presented in Appendix E.

1.2 PLANNED DEVELOPMENT

Proposed Tract No. 49104 of the proposed Playa Vista Project will be developed for mixed-use residential, office, retail, hotel, research park, public use facilities, and recreational uses. The locations of the buildings on the site and the structural features of the proposed buildings have not been established at this time.

A riparian corridor is planned at the toe of the bluff. The corridor includes an unlined drainage channel (stream) that will direct a portion of the runoff and treated water into the freshwater wetlands west of the subject tract. The depth of the channel will vary from about 5 to 7 feet.

Based on plans furnished to us, the planned grading will involve placing compacted fill up to about 20 feet in thickness, and will include filling of streets to allow for below-grade parking and fill for at-grade use.

1.3 PRIOR LCA GEOTECHNICAL STUDIES

We have performed various studies involving the proposed tract. Reports covering the prior studies involved with the current submittal are listed below.

Report of Preliminary Geotechnical Investigation, Proposed Playa Vista Project, Tentative Tract No. 44857, Area D, Jefferson and Lincoln Boulevards, Los Angeles, California; dated November 6, 1986 (LCA AE-86125).

Report of Preliminary Geotechnical Investigation, Proposed Playa Vista Project, Tentative Tract No. 44857, Lots 4 through 148; dated December 5, 1986 (LCA AE-86125-B).

Report of Geotechnical Evaluation, Location of Drainage Channel and Hughes Way, Playa Vista Project, Tentative Tract 44857, South of Jefferson Boulevard Between Lincoln Boulevard and Centinela Avenue; dated January 29, 1987 (LCA AE-86421).

Report of Soil Investigation, Proposed Sewer, Playa Vista Project, near Jefferson Boulevard and Centinela Avenue; dated February 25, 1987 (LCA A-86125-D).

Report of Preliminary Geotechnical Investigation, Proposed Playa Vista Project, Tentative Tract No. 44857, Lots 4 through 122 and 133 through 148; dated March 11, 1987 (LCA AE-86125-E).

Report of Preliminary Geotechnical Investigation, Proposed Playa Vista Project, Tentative Tract No. 44857; dated May 4, 1987 (LCA AE-86125-F).

Report of Preliminary Geotechnical Investigation, Proposed Playa Vista Development, Jefferson Boulevard and Centinela Avenue; dated June 12, 1987 (LCA AE-86125-H).

Report of Soil Investigation, Proposed Sewer, Playa Vista Project, Jefferson Boulevard Between Beethoven Street and Inglewood Boulevard; dated July 20, 1987 (LCA A-86125-D1).

Fault Hazard Evaluation, Proposed Playa Vista Project, Tentative Tract No. 44857, Jefferson Boulevard and Centinela Avenue; dated August 7, 1987 (LCA E-86125-K)

Fault Hazard Evaluation, Proposed Playa Vista Project, Tentative Tract Nos. 44857 and 44880, Jefferson and Lincoln Boulevards; dated November 2, 1987 (LCA E-86125-K2)

Report on Dewatering Requirements, Proposed Sewer, Playa Vista Project, Jefferson Boulevard Between Beethoven Street and Inglewood Boulevard; dated February 11, 1988 (LCA AE-86125-D2).

Report of Preliminary Geotechnical Investigation, Proposed Playa Vista Development, Jefferson Boulevard and Centinela Avenue; dated February 29, 1988 (LCA AE-86125-H1).

Report of Geotechnical Studies, Tentative Tract No. 44857, Jefferson Boulevard Between Lincoln and Centinela Avenue; dated May 25, 1988 (LCA AE-86125-L).

Report of Bluff Stability Investigation, Tentative Tract Nos. 44857, 43415, and 43416, South of Jefferson Boulevard, Between Lincoln Boulevard and Centinela Avenue; dated October 16, 1987 (LCA AE-86125-I)

Report on Monitoring of Import Soil Stockpiling, Playa Vista Project - Quad 4; dated June 27, 1988 (LCA B-87144).

Some of these reports have been submitted to the City of Los Angeles Grading Division for review. The city has issued written comments on three of the reports; those letters are dated May 14, June 15, 1987, and October 17, 1988. The results of the prior studies and our response to the city's comments are incorporated in this report.

We were furnished the following reports by others to review as part of our investigation:

Comprehensive Geotechnical Report, Playa Vista Parcel, Marina del Rey Area, by Converse Consultants, dated May 29, 1981.

Interim Compaction Report, Runway Area, Lincoln and Jefferson Boulevards, Los Angeles, California, by Kovacs-Byer and Associates, Inc., dated March 20, 1984.

Interim Compaction Report, 29-Acre Site, Corner of Lincoln and Jefferson Boulevard, Los Angeles, California, by Kovacs-Byer and Associates, Inc., dated February 5, 1985.

Compaction Report, Hughes Airport, Hughes Way and Lincoln Boulevard, Los Angeles, California by Kovacs-Byer and Associates, Inc., dated October 24, 1985.

Interim Compaction Report, Hughes Airport, Hughes Way and Lincoln Boulevard, Los Angeles, California, by Kovacs-Byer and Associates, Inc., dated June 26, 1986.

Interim Compaction Report, Hughes Airport (East End), Hughes Way and Lincoln Boulevard, Los Angeles, California, by Kovacs-Byer and Associates, Inc., dated April 24, 1987.

1.4 SCOPE OF CURRENT LCA STUDIES

The current studies were authorized to update the prior geotechnical study for Tentative Tract No. 49104, as presented in our report dated May 25, 1988, and to present the previously developed data in a new report. This report was to include all the data previously submitted to the city and our prior responses to their comments. The following items were to be included in the report:

- a site plan showing the tract limits and our exploration borings,
- the results of the 26 borings drilled within the level portion of the tract and the laboratory tests on the samples obtained from these borings,
- the results of the seven exploration borings drilled within the bluff along the south property line, and the results of the stability analyses of the bluff,
- a complete description of the soil and ground water conditions within the tract,
- the results of the geologic-seismic studies performed for the tract including the fault studies,
- the results of the liquefaction studies,

- preliminary foundation design data, including measures to mitigate any effects of liquefaction, and
- grading design recommendations, including site preparation, fill compaction, and surcharge requirements.

The scope of the investigation did not include the evaluation of the presence of hazardous materials on or beneath the site. Such studies have been performed by others.

The recommendations contained herein are based on the results of our field explorations and laboratory tests, the engineering analyses based thereon, and on the geologic studies. Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report.

SECTION 2.0:
PRELIMINARY GEOTECHNICAL EVALUATION - OVERALL PROJECT

2.1 SCOPE

The preliminary evaluation was authorized to sufficiently address the geotechnical aspects of the site to support the proposed subdivision. This evaluation was to include identification of any geologic hazards, including fault hazards and liquefaction potential, current ground water conditions, earthwork requirements for site preparation, and general foundation requirements, although detailed foundation design information for specific structures is not included. We were to estimate the amount and rate of settlement due to the placing of fills at the site and to develop criteria for the placing of surcharge fills to preconsolidate the underlying soils and accelerate the rate of settlement.

2.2 SITE CONDITIONS

The location of the site is shown on Plate 2-1, Site Plan. Part of the site was previously used as a private industrial airport; the runway has been removed. There are industrial buildings on the southern part of the site. Former buildings were on the northeast portion of the site adjacent to Centinela Avenue.

The site occupies the nearly flat historical Ballona flood plain at the base of the bluff identified as the Ballona Escarpment. The bluff has a maximum height of 120 to 140 feet and slopes at 1¾:1 to 2½:1 (horizontal to vertical).

Easements for a storm drain and a sanitary sewer are located along the southern edge of the site. Underground telephone and power conduits and gas and water lines are located beneath the eastern portion of the site.

2.3 EXPLORATIONS AND TESTING

Field exploration consisted of subsurface drilling and sampling of 26 borings. (Seven additional borings were drilled during our investigation of the bluff stability, as discussed in Section 3.) All boring locations are shown on Plate 2-1. The locations of other borings drilled for a previously proposed sewer are also shown on Plate 2-1. The logs of the borings are presented in Appendix A.

Laboratory tests were performed on representative soil samples to define the engineering properties of the various materials encountered. The results of the laboratory tests are presented in Appendix A. The results of corrosion studies by M. J. Schiff & Associates are also presented in Appendix A.

2.4 GEOLOGY

2.4.1 General

The project site is located on the Los Angeles Coastal Plain within the Peninsular Ranges geomorphic province of California, which extends from Baja California on the south to the Transverse Ranges on the north. The Peninsular Ranges geomorphic province is characterized by northwest-southeast trending mountain ranges composed predominantly of Mesozoic igneous and metamorphic rocks and Cenozoic sedimentary rocks.

The site is situated in the Ballona Creek Flood Plain at the north end of the El Segundo Sand Hills. The Ballona Escarpment, which is an erosional feature caused by the ancient Los Angeles River that flowed through Ballona Gap, is located adjacent to the south side of the site. The Ballona Escarpment rises approximately 120 to 140 feet above the flood plain and is composed of Pleistocene sediments, dune sand deposits, and the underlying San Pedro Formation sand.

The site is located approximately 2 to 4 miles southwest of the Baldwin Hills, which are part of a northwest-trending succession of hills that represent the surface expression of the Newport-Inglewood structural zone.

The Pacific Ocean is located approximately 2½ miles west-southwest of the site. Site elevations range from about 10 to 25 feet above mean sea level (U.S.G.S. datum).

The site is shown in relation to regional geologic features on Plate 2-2, Regional Geology. The geology and topography in the vicinity of the site are shown on Plate 2-3, Local Geology. The site is shown in relation to major fault zones and earthquake epicenters on Plate 2-4, Regional Seismicity.

Additional background information regarding faults, seismicity, and ground shaking and geologic-seismic reference data are presented in Appendix B. Details regarding the Charnock fault study are presented in Appendix C.

2.4.2 Geologic Materials

Fill

Fill soils, varying from 2 to 13 feet in thickness, were encountered in 21 of our 26 borings. The fill consists of clay, silt, silty sand, and clayey sand. Most of the fill was observed and tested by Kovacs-Byer and Associates during placement. The limits of the compacted fill are shown on Plate 2-1. There is no evidence that the remaining fill was inspected and tested during placement. Deeper and/or poorer quality fill could occur between boring locations.

The upper portion of the compacted fill contains some hydrocarbons. The fill material in this area was imported from the vicinity of the La Brea Tar Pits near Wilshire Boulevard and Curson Avenue. The hydrocarbons are naturally occurring asphalts within the soil deposits and do not represent organic wastes.

After completion of the exploration borings, a considerable amount of fill material has been imported to the site and is currently being stockpiled on the eastern portion of the site adjacent to Jefferson Boulevard. The placing of this stockpile was monitored by our firm.

Alluvium

The natural soils underlying the site within the flood plain appear to be fairly consistent throughout the parcel. The flood plain is underlain by approximately 100 feet of recent alluvium. The upper 30 to 60 feet are composed primarily of silt and clay with lesser layers of silty sand. The silt and clay contain varying amounts of organic debris including several interbedded peat layers. A deposit of very compressible peat was encountered in Boring 2 of a prior investigation between depths of 35 and 45 feet (LCA A-86125-D).

Underlying the clays is a zone of sand and gravel approximately 30 to 50 feet thick. These sediments were described by Poland (1959) as the "50-foot gravel," a ground water aquifer.

Pleistocene Sediments and Dune Sand

The bluff along the south side of the project is composed of Pleistocene age sediments, locally capped or covered with dune sand. The Pleistocene sediments consist primarily of sand with occasional gravel and clay layers. These sediments are generally consolidated and uncemented.

San Pedro Formation

Below the recent alluvium in the flood plain are San Pedro Formation sediments of Pleistocene age. These sediments consist of approximately 300 feet of poorly consolidated, medium to coarse-grained sand and gravel. These sediments are underlain by consolidated sedimentary and metamorphic rocks.

2.4.3 Ground Water

The site is situated within the Santa Monica Hydrologic Subarea of the Coastal Plain of Los Angeles. Historic regional ground water levels are generally near or slightly above sea level.

Water was measured in our borings at depths of 6½ to 24½ feet, corresponding to Elevations +15 to -6½. The water level in Boring 16 is not consistent with the remainder of the borings on the site and is believed to be affected by conditions local to the boring location, such as runoff from Lincoln Boulevard. The water levels are indicated on the boring logs in Appendix A, and are summarized in the table on the following page. Pipe was installed in 15 of the borings to permit future water level readings; those borings with pipe installations are noted in the table.

The water level on the east side of the site (Borings 4, 5, 25, and 26) is depressed and is known to be influenced by pumping from nearby water wells. Significant variations in the water levels occurred between borings on the west side of the site; the variations are believed to be due to relatively slow infiltration into the borings, and due to the borings being drilled at different times of the year.

Nearly all ground water from the Ballona Gap Subunit beneath the site has been degraded. This degradation has been attributed to seawater intrusion resulting from overpumping of ground water in the past.

Ground Water Levels

<u>Boring Number</u>	<u>Depth to Water (Feet)</u>	<u>Elevation of Water Surface</u>	<u>Date of Water Level Reading</u>	<u>Pipe Installed</u>
1	6½	+ 4½	5/20/86	No
2	8	+ 4	5/20/86	No
3	11½	+ 2½	5/20/86	No
4	23	- 5	5/20/86	No
5	24½	- 5½	7/29/86	No
6	15	0	8/18/86	No
7	10	0	8/19/86	No
8	14	- 3	8/19/86	No
9	15½	- 3½	8/19/86	No
10	11	+ 2	8/19/86	No
11	13	+ 1½	9/19/90	Yes
12	12½	+ 1½	9/19/90	Yes
13	10½	+ 2½	9/19/90	Yes
14	11	0	9/19/90	Yes
15	13½	+ 1	9/19/90	Yes
16	7	+15	9/19/90	Yes
17	13	+ 3	4/06/87	Yes
18	11½	+ ½	9/19/90	Yes
19	13½	- 4	9/19/90	Yes
20	8½	+ 5	2/20/87	No
21	8½	+ 2	4/06/87	Yes
22	10½	0	9/19/90	Yes
23	11½	0	4/06/87	Yes
24	15½	- 1	4/06/87	Yes
25	24	- 6½	9/19/90	Yes
26	not within 34	--	4/06/87	Yes

2.4.4 Geologic Hazards

General

Geologic hazards in the vicinity of the site include flooding, mass wasting of the bluff to the south, and hazards resulting from earthquakes. The major cause of damage from earthquakes is the violent shaking resulting from earthquake waves; damage due to actual displacement or fault movement beneath a structure is much less frequent. The violent shaking resulting from a nearby major seismic event would occur not only immediately adjacent to the earthquake epicenter, but for many miles in all directions.

Faults - General

The numerous faults in Southern California are categorized as active, potentially active, and inactive. Detailed information concerning the faults in the area is presented in Tables B-1, B-2, and B-3 in Appendix B.

The closest fault to the site considered to be active is the Inglewood Fault of the Newport-Inglewood fault zone, located 2 miles to the east-northeast of the site. The large number of earthquake epicenters on or near the Newport-Inglewood fault zone indicate it is active at least at depth. The 1933 Long Beach earthquake (magnitude 6.3) occurred on the Newport-Inglewood fault zone. The active Malibu Coast fault is located about 7 miles north-northwest of the site. The major San Andreas fault is located about 43 miles north-northeast of the site.

The Charnock fault, which has been considered potentially active, has been mapped at depth beneath the eastern portion of the site. This fault is discussed in more detail in the following section. Other nearby potentially active faults include the Overland fault, 0.8 mile to the east-northeast; the Santa Monica-Hollywood fault, 5 miles to the northwest; and the Palos Verdes fault, 5 miles to the south.

The California Division of Oil and Gas report (1974) on the Playa del Rey Oil Field indicates six small inactive faults between the site and the Pacific Ocean. These faults are depicted as offsetting Miocene age bedrock, but not displacing Pliocene age sediments. This indicates that the faults have been inactive since the beginning of Pliocene (5 million years) time. The potential for surface rupture from these inactive faults is extremely low.

The site is not within a currently established Alquist-Priolo Special Studies Zone, nor within a City of Los Angeles Fault Rupture Study Zone. No fault or fault-associated features were observed on or adjacent to the site during our field investigation. In our opinion, there is little probability of surface rupture due to faulting occurring beneath the proposed development.

Charnock Fault

The postulated location of the potentially active Charnock fault is shown on Plate 2-3. This fault is a northwest-trending fault that passes from the north end of the El Segundo Sand Hills, across Ballona Creek, and through the alluvial narrows southwest of Beverly Hills. The trace of the fault is concealed beneath the Holocene age alluvium underlying the site. The fault's existence north of the project is indicated by differences in ground water elevations across this structure as described by Poland, et al., 1959. The Charnock fault exhibits up to 140 feet of offset within Pleistocene age aquifers, but no indication of offset in the "50-foot" aquifer of Holocene age was observed in materials penetrated by our borings drilled on both sides of the projected fault trace. The absence of surface expression and water level effects in the recent deposits indicates the fault has been inactive at least since the beginning of Holocene time (11,000 years).

A fault hazard evaluation was undertaken to ascertain the presence or absence of the Charnock fault beneath the site, and if possible, to determine the recency of activity of the fault. The fault hazard evaluation is discussed in more detail in Appendix C. We also reviewed reports prepared by Kovacs-Byer and Associates dated August 5, 1987 and

revision dated October 19, 1987 covering their investigation for the Charnock fault along the bluff immediately upslope and south of the site. Based on the findings from our exploratory borings and the results of the Kovacs-Byer and Associates investigation, it appears the Charnock fault either does not exist beneath the Playa Vista site or is buried by materials that are late Pleistocene age or older. These findings are consistent with the previous opinions presented by Poland et al. (1959) and Smith (1978). Therefore, it is concluded that the Charnock fault is not active and does not present a hazard to future development within the subject tract. No further studies on the possible presence of the fault or its activity are considered necessary. -

Seismicity

The epicenters of earthquakes with magnitudes greater than or equal to 4.0 within a radius of 100 kilometers of the site are shown in Table B-4 in Appendix B. Other pertinent information regarding these earthquakes is also shown in Table B-4. The historic seismic record indicates that 306 earthquakes of Richter magnitude 4.0 and greater have occurred between the years 1932 and 1981 within about 100 kilometers of the site. The earthquake data in Table B-4 were used to develop the recurrence curve for the site, which is presented on Plate 2-5, Recurrence Curve. The recurrence curve indicates that a magnitude 6.6 earthquake would occur on the average of once during a 100-year period.

Liquefaction and Seismically Induced Settlement

Liquefaction potential has been found to be the greatest where the ground water level is shallow and loose fine sands occur within a depth of about 50 feet or less. Liquefaction potential decreases with increasing grain size and clay and gravel content, but increases as the ground acceleration and duration of shaking increase. The County of Los Angeles Seismic Safety Element shows the project site is in an area subject to potential liquefaction.

The natural soils consist of soft to medium stiff deposits of clay and silt, 30 to 60 feet in thickness, with medium dense sand and silty sand underlain by dense sand and gravel. The

relative density of the sands and silty sands within the upper 30 to 60 feet varies from about 50% to 75%. The looser layers of sand and silty sand are up to 7 feet in thickness and are confined within layers of cohesive clay and silts. The relative density of the sand and gravel below the 30- to 60-foot depth is greater than 90%.

Water was measured in our borings at depths of 6½ to 24 feet, corresponding to an elevation of 15½ feet above sea level to 6½ feet below sea level.

In the event a severe earthquake occurred on one of the nearby capable faults, liquefaction of the looser sand and silty sand deposits in the upper 30 to 60 feet could occur. The liquefaction would not be extensive across the site, but would occur within isolated layers with maximum thicknesses of about 7 feet. Because the potentially liquefiable soils are confined within cohesive layers, sand boils are not expected to develop and the liquefaction would not result in widespread damage. Rather, it would result in isolated areas of settlement of about 1 to 2 inches.

Seismically induced differential settlement (consolidation of loose soils due to earthquake vibrations) is not considered to be a potential problem.

Subsidence

The site is not located in an area of known ground subsidence. Subsidence has not been associated with oil extraction at the Playa Del Rey Oil Field located about one-half mile to the west of the site. Oil extraction is no longer occurring, and the former oil reservoir is being pressurized for natural gas storage. Accordingly, the potential for subsidence occurring beneath the site is considered remote. Subsidence related to the extraction of ground water is considered remote, as ground water withdrawals have markedly decreased since the 1930s. This reduced pumping was instituted in response to sea water intrusion that had degraded ground water supplies in the area.

Peat

Subsidence in peat soils is a common phenomenon. Settlement of these compressible deposits can be induced by loading, oxidation of peat layers, and by shrinkage in the event of drying. Peat was encountered in several of the exploration borings at various depths below the ground water level. Under these conditions, we do not anticipate settlement problems resulting from oxidation or drying of the peat layers. The potential compression of the peat soil under load has been considered in this investigation.

Collapsible Soils

Collapsible soils are those soils subject to increased consolidation with increase in moisture content. The majority of the soils at the site are either below water level or have been subjected to higher water levels in the past. Collapsible soils were not encountered in our investigation.

Stability

The natural slopes along the south side of the site do not contain any indications of deep-seated instability. Some mass wasting of the natural slopes has occurred in the form of incised erosion gullies. The sediments composing the bluff to the south of the project site are predominantly cohesionless sands, which are highly erodible and subject to gullying if drainage is not properly controlled.

Lurching involves movement of level ground at right angles to a cliff or, more commonly, to a stream bank or artificial embankment. Such motions cause materials to yield in the unsupported direction, forming a series of more or less parallel cracks separating the ground into rough blocks. This bluff was essentially in its present condition during the 1933 Long Beach and 1857 Fort Tejon earthquakes. If lurching had occurred during these events, the relic blocks would be visible; none were found. The natural slope angle of the bluff south of the site reduces the potential for lurching although this phenomenon could

occur. The bluff is sufficiently remote from the area to be developed that lurching is not a significant hazard to development.

The bluff (Ballona Escarpment) has been designated as a City of Los Angeles Slope Stability Study Area.

Tsunamis, Seiches, and Flooding

The site is located in a very low-lying coastal area but is above any elevation considered subject to inundation by earthquake-generated sea waves, known as tsunamis. According to the City of Los Angeles Seismic Safety Element, the maximum expected run-up from a tsunami wave in the Venice Beach area is 9.6 feet in a 100-year interval. The site is located in an area south of Venice Beach where the run-up potential is slightly less. Information presented in "Technical Report H-74-3, Type 16 Flood Insurance Study: Tsunami Prediction for Pacific Coast Communities," by the U.S. Army Engineer Waterways Experiment Station, May 1974, indicates that the 100-year run-up in the project area is 7.9 feet. Locally generated tsunamis have the potential for greater run-up, although there have been no historic tsunamis generated from local offshore earthquakes.

Seiches are oscillations in a body of water caused by earthquake shaking. The site is not located near any bodies of water that would be subject to seiches.

Flooding could possibly occur at the site during periods of intensive rainfall when existing drainage structures cannot handle the quantity of surface runoff.

2.5 CONCLUSIONS

2.5.1 General

The site is considered suitable for the development as contemplated. There are not any geologic hazards or adverse soil or ground water conditions that would preclude the development. Although the site has potential problems related to both liquefaction and compressible soils, the hazards can be mitigated by proper engineering design and construction. All of the lots on the site are considered buildable, and detailed recommendations for design and construction of the projects can be provided at the time the individual building locations are known.

The conclusions and recommendations presented below are preliminary and necessarily general in nature. Additional studies will be required to provide detailed recommendations prior to preparing final plans for site development.

2.5.2 Geology

The location of the site in relation to known active faults indicates the site is not exposed to greater seismic risk than other locations within the Los Angeles Coastal Plain. The presence of the potentially active Charnock fault is not considered a factor in the proposed development. The effects of ground shaking will be mitigated if the buildings are designed and constructed in conformance with current building codes and engineering practice.

Although there are soil zones susceptible to liquefaction within the upper 30 to 60 feet, these zones vary from less than 1 foot to about 7 feet in thickness and are limited in extent. The effects of liquefaction could be mitigated by either densifying the soils in-place or by designing the structures to resist the effects of liquefaction.

The potential for flooding at the site can be reduced by increasing the site elevation or by improving drainage facilities within and around the site.

2.5.3 Streets

To provide uniform support for the proposed streets, any existing uncompacted fill and any disturbed natural soils should be excavated and replaced as properly compacted fill, and all required fill should be properly compacted. The streets are planned to be above the existing grades, and the weight of the required compacted fills will cause areal settlements; these settlements will occur slowly. The settlements can be accelerated by the placing of temporary surcharge fills.

2.5.4 Bluff

Details on our bluff stability evaluation are presented in Section 3.0 of this report. We conclude that the bluff is grossly stable, but there is a potential for shallow sloughing and erosion, which would result in an accumulation of soil debris at the toe of the slope. This shallow sloughing and erosion potential can be reduced to an acceptable level by covering the portion of the slope below Cabora Road with an erosion-resistant matting.

2.5.5 Foundations

General

Heavy, settlement-sensitive structures should be supported on driven piling, developing their support within the dense sand and gravel below the 30- to 60-foot depth. For estimating purposes, a 14-inch-square precast concrete pile driven 15 feet into the dense sand and gravel (45 to 75 feet below existing grade) will develop a downward capacity of about 200 kips.

Light, flexible structures up to two to four stories in height could be supported on spread footings, if any existing uncertified fill were excavated along with the upper natural soils beneath the footings and replaced as properly compacted fill. A bearing value of 2,000 pounds per square foot may be used for planning purposes. The effects of ground water have been considered in determining the estimated soil-bearing capacity and pile frictional resistance.

The liquefaction potential needs to be considered in the design of the project. There are two alternatives that could be considered in liquefaction mitigation. The site could be densified to eliminate the possibility of liquefaction, or the foundation system could be strengthened to resist the effects of liquefaction. These alternatives are discussed in the following sections.

Both of the following alternatives address foundation and floor slab support. It should be realized that if liquefaction were to occur, settlement outside the building areas could also occur. That settlement, which could be about 2 inches, could affect sidewalks, patios, utilities, other hardscape, and landscape.

Site Densification

The site could be densified to eliminate the possibility of liquefaction. For this alternative, there are several methods that could be considered, including:

- (a) Impact Densification, where a large weight is dropped on the ground surface from height. This method is effective to a considerable depth, but causes disturbance of the ground surface and shaking of the adjacent sites. Furthermore, the presence of the silt and clay deposits will reduce the effectiveness of this method.
- (b) Vibroflotation, where a vibrating probe is jetted into the ground to the desired depth at a spacing of about 5 to 10 feet. The vibration causes densification and settlement of those soils susceptible to liquefaction. The reduced volume is replaced with sand or gravel as the probe is withdrawn. This method uses large amounts of water, which must be handled during the operation.
- (c) Terra Probe, where a large-diameter, open-ended casing is vibrated into the ground at a spacing of about 5 to 10 feet. Similar to the vibroflotation method, the vibration causes densification and settlement of the surrounding soil. Sand or gravel is added as the casing is withdrawn. This method does not require water during operation, but it is difficult to penetrate cohesive layers.

Foundation Strengthening

The structures could be strengthened to resist liquefaction. The strengthening method will depend on the type of structure and foundations.

(a) Driven Pile Foundations

- The supporting capability of the soils in that zone susceptible to liquefaction should be ignored. This would require ignoring the supporting capability of the upper 30 to 60 feet. If a 14-inch-square pile 70 feet long had a capacity of 200 kips without considering liquefaction, a length of about 80 feet would be required when considering liquefaction.
- Downdrag loads should be added to the design loads on the piles. For estimating purposes, a downdrag load of about 40 kips is anticipated.
- The allowable lateral capacity of the piles should be reduced. We estimate that when considering liquefaction, the allowable lateral capacity of a 14-inch-square pile foundation would be about 7 kips. If sufficient lateral capacity cannot be obtained, batter piles could be used.
- Pile foundations should be interconnected.
- Consideration should be given to settlement of floor slabs on-grade and the surrounding grades. If settlement of about 1 to 2 inches would not be acceptable, the floor slabs and utilities could be structurally supported. Alternatively, it may be possible to thicken and reinforce the floor slabs on-grade, making them more resistant to settlement.

(b) Spread Footings

If light, flexible structures are planned and spread footings are feasible, liquefaction resistance can be provided by interconnecting the foundations throughout the structure, including extending footings beneath doorways and open areas. Additional resistance can be provided by constructing the floor slabs monolithically with the footings. The same floor slab settlement consideration mentioned in the driven pile section would apply to spread footings.

2.5.6 Subterranean Construction

The depth to ground water varies across the site. Generally, ground water should be anticipated in any subterranean construction extending below about Elevation +5. Permanent subdrains will be required where basement construction extends below ground water, or the subterranean portion should be designed to resist the resulting hydrostatic pressure.

2.5.7 Floor Slabs

The building floor slabs may be supported on grade. No special requirements are anticipated. Where a capillary break is considered necessary, the floor slabs may be supported on a layer of gravel or on an impermeable membrane.

2.5.8 Earthwork

General

To provide support for shallow spread footings, floor slabs, and paving, the existing uncompacted fill and any disturbed natural soils should be excavated and replaced with properly compacted fill. (The existing stockpiled fill has not been uniformly compacted and will have to be excavated as part of any grading operation.) Where shallow footings are to be used, overexcavation and recompaction of the natural soils beneath footings will be required. Any required additional fill should be properly compacted. The on-site natural soils and existing fill soils that are free of organic material may be used in required structural fills.

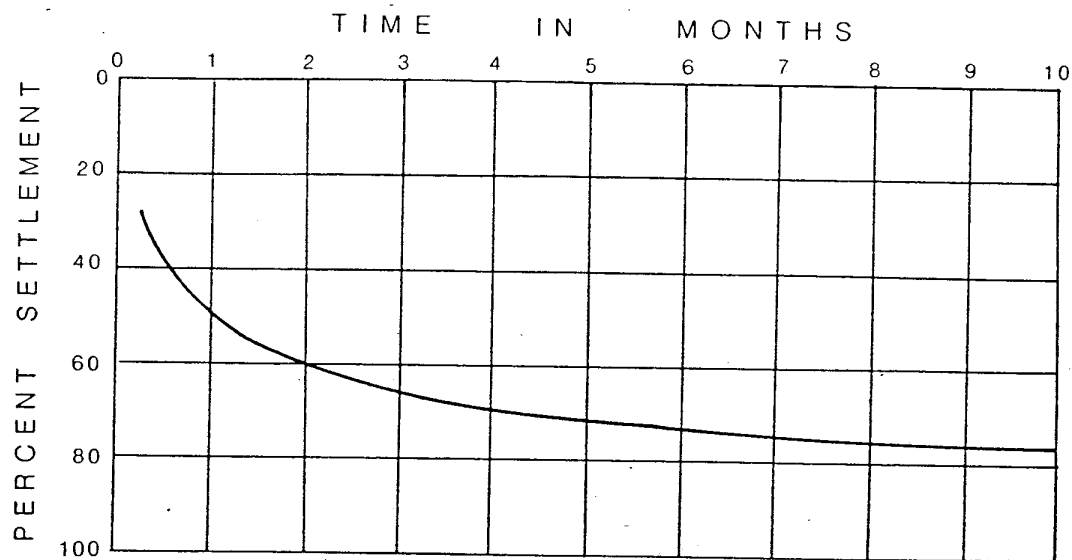
Slopes

Permanent cut and fill slopes that are properly drained may be constructed at 2:1 (horizontal to vertical). Unlined slopes for the drainage channel in the riparian corridor should not be steeper than 3:1. Erosion protection will need to be carefully addressed for all unlined slopes. Recommendations regarding the bluff south of the site are presented in Section 3 of this report.

Estimated Settlements

The weight of the planned compacted fill will cause areal settlement as a result of compression of the underlying soils. The settlement is estimated to range from about 3/4 to 1½ inches per foot of fill. We estimate that the average areal settlement of the site will be about 1 inch for each foot of compacted fill placed, and that 50% of this settlement will occur within one month after completion of this fill.

The rate of settlement will vary across the site, being slowest in areas with the highest water level. Our estimate of the average rate of settlement across the site is presented in the following figure.



Surcharge Fill

The weight of the planned compacted fill will cause areal settlement as a result of compression of the underlying soils. An average settlement of about 1 inch per foot of compacted fill is anticipated. As discussed in the previous section, we estimate 50% of this settlement will occur within one month after completion of the fill. This means there will

still be about 5 inches of potential settlement about one month after completion of the grading for each 10 feet of fill placed. To reduce the effects of this settlement, the filled areas could be covered with a temporary surcharge fill after completion of grading. The thickness of the surcharge fill and the length of time the fill is left in place will depend on the construction schedule. The required thicknesses of surcharge fill (fill thickness in addition to design height of embankment) for time periods of 1, 3, 6, 9, and 12 months are shown below.

Time Available for Surcharging (Months)	Thickness of Surcharge Fill (% of Height of Embankment Fill)
1	100
3	50
6	35
9	30
12	25

Depending on the location of the existing fill stockpiles in relation to the streets, the stockpiles may have already surcharged the site sufficiently, so that additional surcharging in those areas will not be necessary.

The surcharge fill should be placed after placing compacted fill to bring the selected areas to about 2 feet above the desired grades. (This will allow settlement to occur and maintain compacted fill above the desired grade. The 2-foot thickness may be considered part of the total surcharge thickness.) The surcharge fill need not be thoroughly compacted, but should be placed in layers not more than 1 foot in thickness and rolled with earth moving equipment. It is expected the surcharge fill will have a moist density of at least 100 pounds per cubic foot. The top of the surcharge fill should extend at least 10 feet beyond the top of the area to be surcharged; beyond these limits, the surcharge fill may be sloped down at 1:1.

Settlement monuments should be placed in the surcharge fill to observe the rate and the magnitude of the actual settlement that occurs. A suggested detail for a typical settlement monument is presented on Plate 2-6, Settlement Monument Detail. The monuments should be placed at about 200-foot intervals.

The elevations of the settlement monuments should be determined by surveying the initial position of the monuments. The 2-inch-diameter steel pipe shown on the detail should be attached to the monument to enable elevation readings to be taken after the monument is covered and as the surcharge fill is placed. Additional sections of pipe can be added, as necessary, as the surcharge fill is placed.

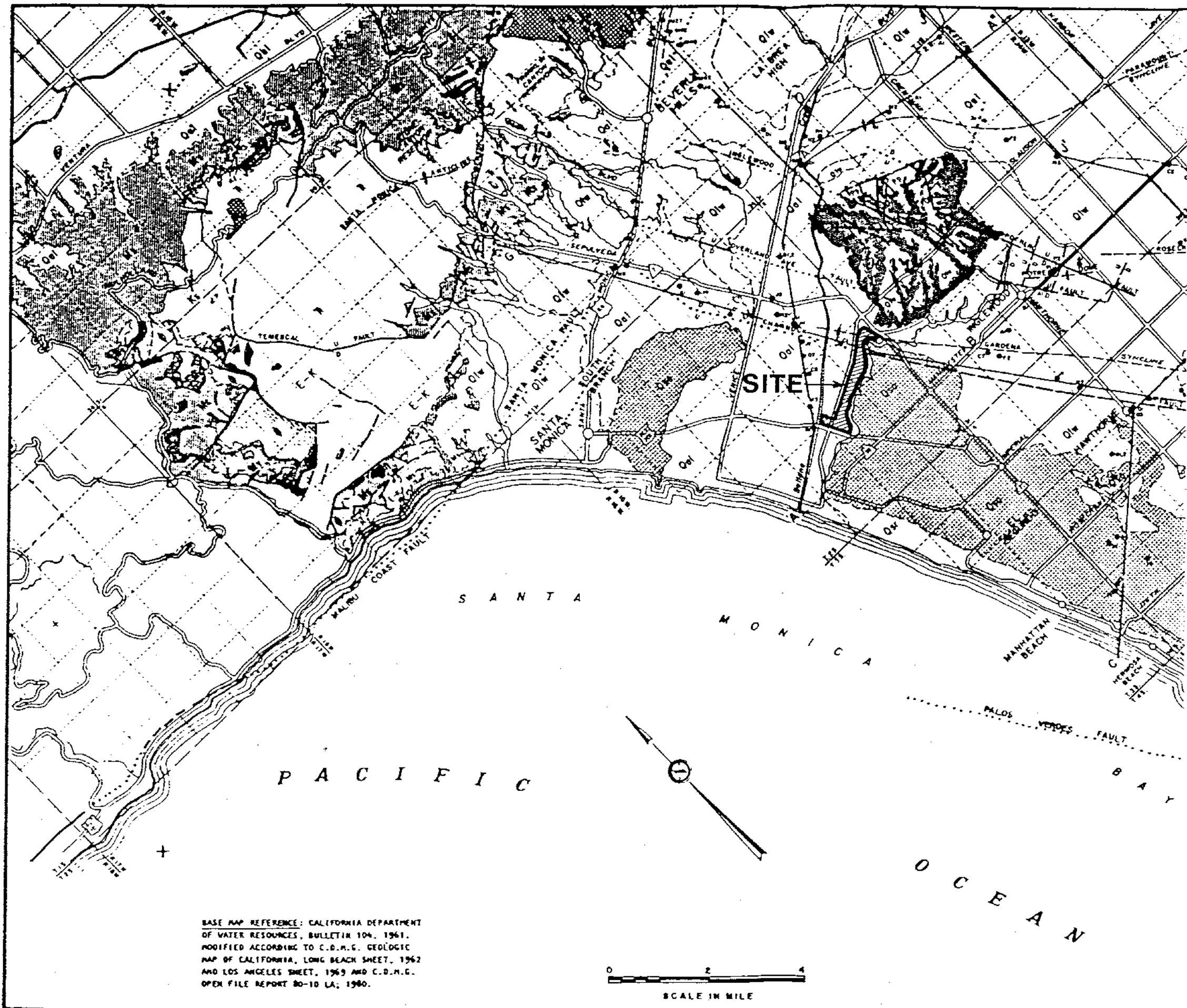
The elevations of the settlement monuments should be determined by a licensed surveyor. The elevations should be determined immediately after construction of the monuments and prior to the placing of any surcharge fill. The elevations should be determined at one-week intervals thereafter. Following completion of the surcharge fills, the elevation readings should continue to be taken until the desired time period has elapsed. Our firm should be provided with copies of the elevation data immediately after the data are obtained. The surcharge fill should not be removed until we have verified that the fill has been in place a sufficient period of time.

Settlement of Existing Utilities

There are four major existing underground utilities beneath the site: a Southern California Gas Company line, a City of Los Angeles Department of Water and Power water line, two Southern California Edison power cables, and two General Telephone telephone lines. We understand the utilities are shallow, buried less than 5 feet below the existing grade.

Compacted fill up to 8 feet in thickness is to be placed over the gas line, the water line, the power cables, and one of the telephone lines. Up to 15 feet of fill is to be placed over the other telephone line.

The utilities can be expected to settle about 1 inch for each foot of fill placed over them. Settlement of the utilities can be expected to range from about 8 inches to 15 inches.



BASE MAP REFERENCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, BULLETIN 104, 1961. MODIFIED ACCORDING TO C.D.W.R. GEOLOGIC MAP OF CALIFORNIA, LONG BEACH SHEET, 1962 AND LOS ANGELES SHEET, 1969 AND C.D.W.R. OPEN FILE REPORT 80-10 LA, 1980.

0 2 4
SCALE IN MILE

REGIONAL GEOLOGY

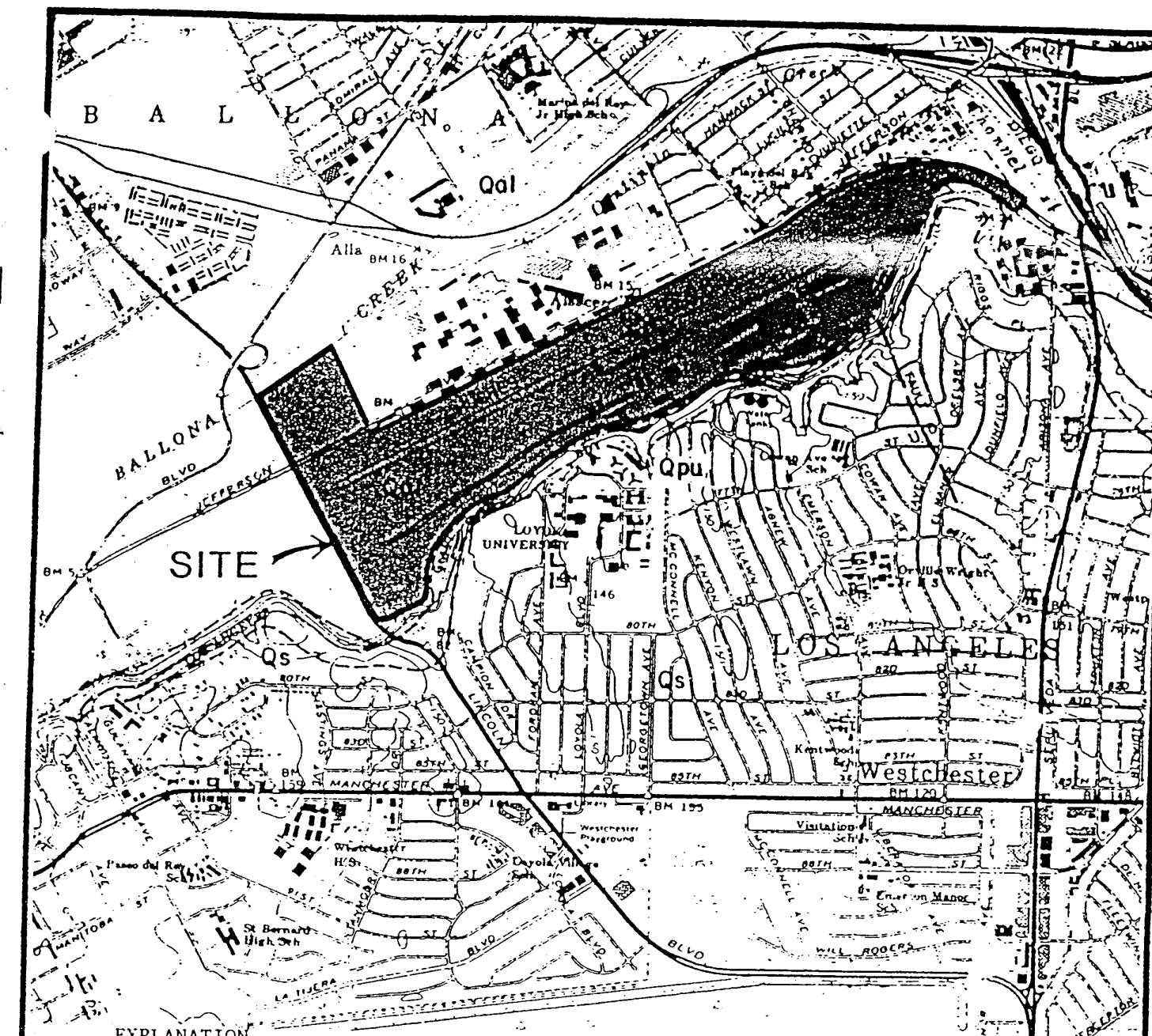
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PLATE 2-2

LEGEND

SEDIMENTARY ROCKS

QUATERNARY	RECENT	Qal	ALLUVIUM GRAVEL, SAND, SILT, AND CLAY
		Qm	ACTIVE DUNE SAND WHITE OR OFF-WHITE, WELL SORTED SAND
PLEISTOCENE	UPPER	Qiu	OLDER DUNE SAND FINE TO MEDIUM SAND WITH SILT, AND GRAVEL LENSES LAKEWOOD FORMATION INCLUDES "TERRACE DEPOSITS": "PALOS VERDES SAND" AND "UNNAMED UPPER" PLEISTOCENE DEPOSITS MARINE AND CONTINENTAL GRAVEL, SAND, SILT, SILT, AND CLAY WITH SHALE MIDDLES
	LOWER	Qlo	SAN PEDRO FORMATION INCLUDES "LA HABRA CONGLOMERATE" AND PART OF "SAUCUS FORMATION" MARINE AND CONTINENTAL GRAVEL, SAND, SILT, SILT, AND CLAY
PLOCENE		Qp-Pp	UNDIFFERENTIATED SAN PEDRO FORMATION AND/OR P.C.O. FORMATION MARINE, PARTIALLY CONSOLIDATED GRAVEL, SAND, SILT, AND CLAY
		Pp	P.C.O. FORMATION MARINE SAND, SILT, AND CLAY INTERBEDDED WITH GRAVEL
TERTIARY			REPETTO FORMATION MARINE SILTSTONE WITH LAYERS OF SANDSTONE AND CONGLOMERATE
			(SANTA MONICA MOUNTAINS) MODELO FORMATION MARINE CONGLOMERATE, SANDSTONE, AND SHALE TOPANBA FORMATION MARINE CONGLOMERATE, SANDSTONE, AND SHALE
PALEOCENE/PALEOGENE			(PALOS VERDES HILLS) MONTEREY FORMATION SANDSTONE, BUTTLE, AND SHALE
			(ELYSIAN HILLS, REPETTO HILLS, AND PUENTE HILLS) PUENTE FORMATION MARINE SILTSTONE, SANDSTONE, SHALE, CONGLOMERATE, LIMESTONE, AND LIGNITE
CENOZOIC			VADUERO AND SESPE FORMATIONS CONTINENTAL AND CONGLOMERATE AND SANDSTONE
			MARTINEZ FORMATION MARINE CONGLOMERATE, SANDSTONE, SANDY SHALE, AND SHALE
CENOZOIC			UNDIVIDED MARTINEZ AND CHICO FORMATIONS
			CHICO FORMATION UPPER MARINE MEMBER - SAND CONGLOMERATE, SANDSTONE, AND SHALE LOWER CONTINENTAL MEMBER - MARINE CONGLOMERATE AND SANDSTONE
CENOZOIC			IGNEOUS AND METAMORPHIC ROCKS
			MIDDLE MIocene VOLCANIC ROCKS VOLCANIC FLOWS, BRECCIAS, TUFFS, AND HYDROLYSED CRYSTALLINE BASALTIC AND ANDESITIC WITH OCCASIONAL ACID ROCKS GENERALLY ASSOCIATED WITH TOPANBA, MODELO, OR PUENTE FORMATIONS
			(SANTA MONICA MOUNTAINS) INTRUSIVES OF DIABASE AND GRANODIORITE
CENOZOIC			(PALOS VERDES HILLS) COTANBA SILTSTONE COMPARED WITH FRANCISCAN FORMATION OF THE COAST RANGES NAMED TYPES OF SILTSTONE ROCKS
			SANTA MONICA SLATE GRAY TO BLACK SLATE, SPOTTED SLATE, HIGH SILICA WITH QUARTZ VENE
CENOZOIC			FAULT (DASHED WHERE APPROXIMATELY LOCATED, U-UPTHROWN SIDE; D-DOWNTOWN SIDE)
			CONCEALED FAULT
CENOZOIC			ANTICLINE (DASHED WHERE APPROXIMATELY LOCATED)
			SYNCLINE (DASHED WHERE APPROXIMATELY LOCATED)
CENOZOIC			CONTACT (DASHED WHERE APPROXIMATELY LOCATED)
			WELLS USED IN PREPARATION OF GEOLOGIC SECTIONS
CENOZOIC			LINE LOCATION OF GEOLOGIC SECTIONS SHOWN ON PLATES 6A THROUGH 6C



EXPLANATION

- Qal HOLOCENE ALLUVIUM
- Qs QUATERNARY DUNE SAND
- Qpu UPPER PLEISTOCENE TERRACE DEPOSITS - SAND
- GEOLOGIC CONTACT, APPROXIMATELY LOCATED
- FAULT, DASHED WHERE APPROXIMATE, DOTTED WHERE CONCEALED, QUERIED WHERE DOUBTFUL
- U = UPTHROWN SIDE
- D = DOWNTOWN SIDE

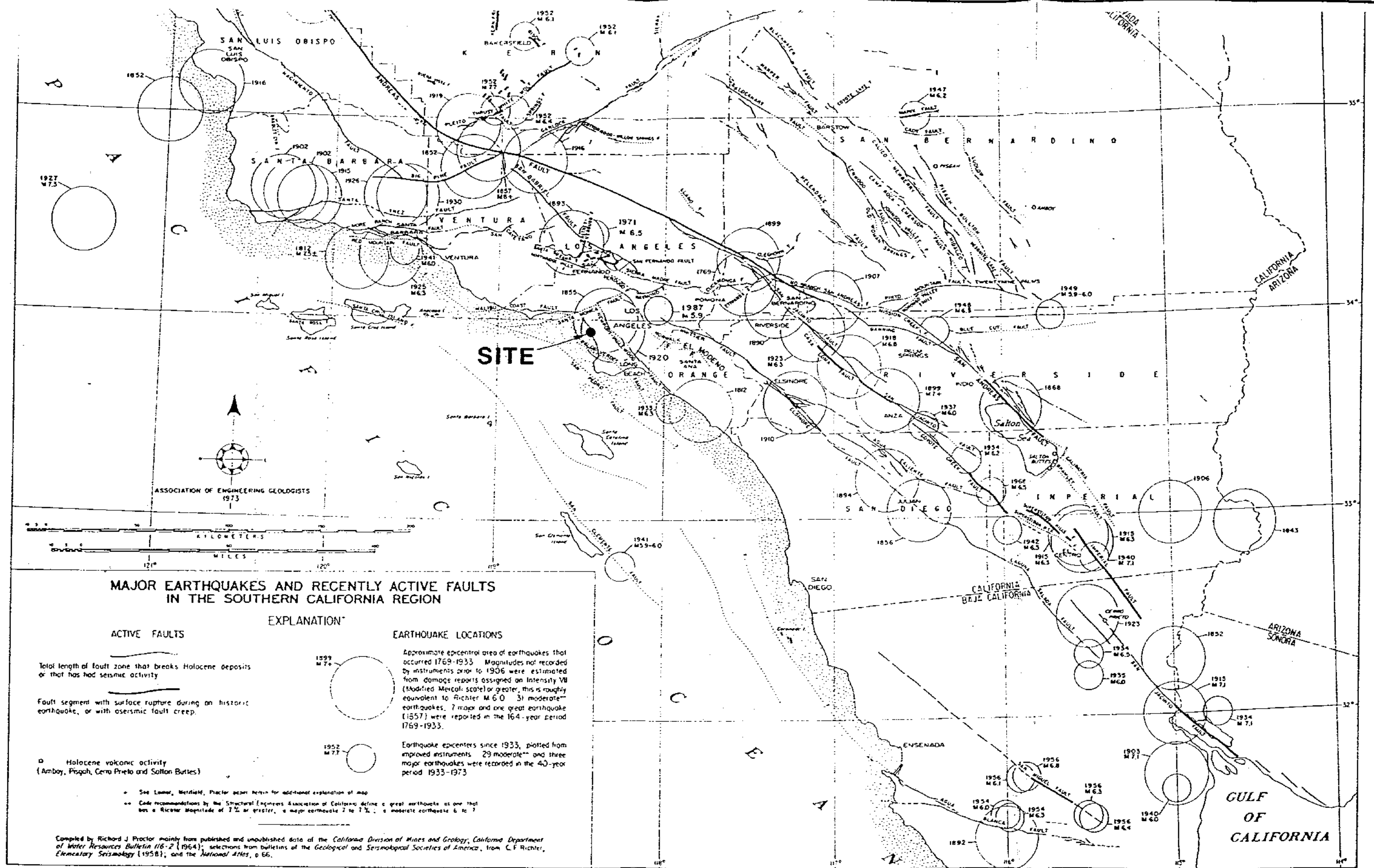
REFERENCE: BASE MAP FROM U.S.G.S. 7.5' VENICE QUADRANGLE 1964, PHOTOREVISED 1981. GEOLOGY ADAPTED FROM U.S.G.S. WATER SUPPLY PAPER 461 (1959)

NOTE: LOCAL AREAS OF FILL NOT SHOWN

LOCAL GEOLOGY

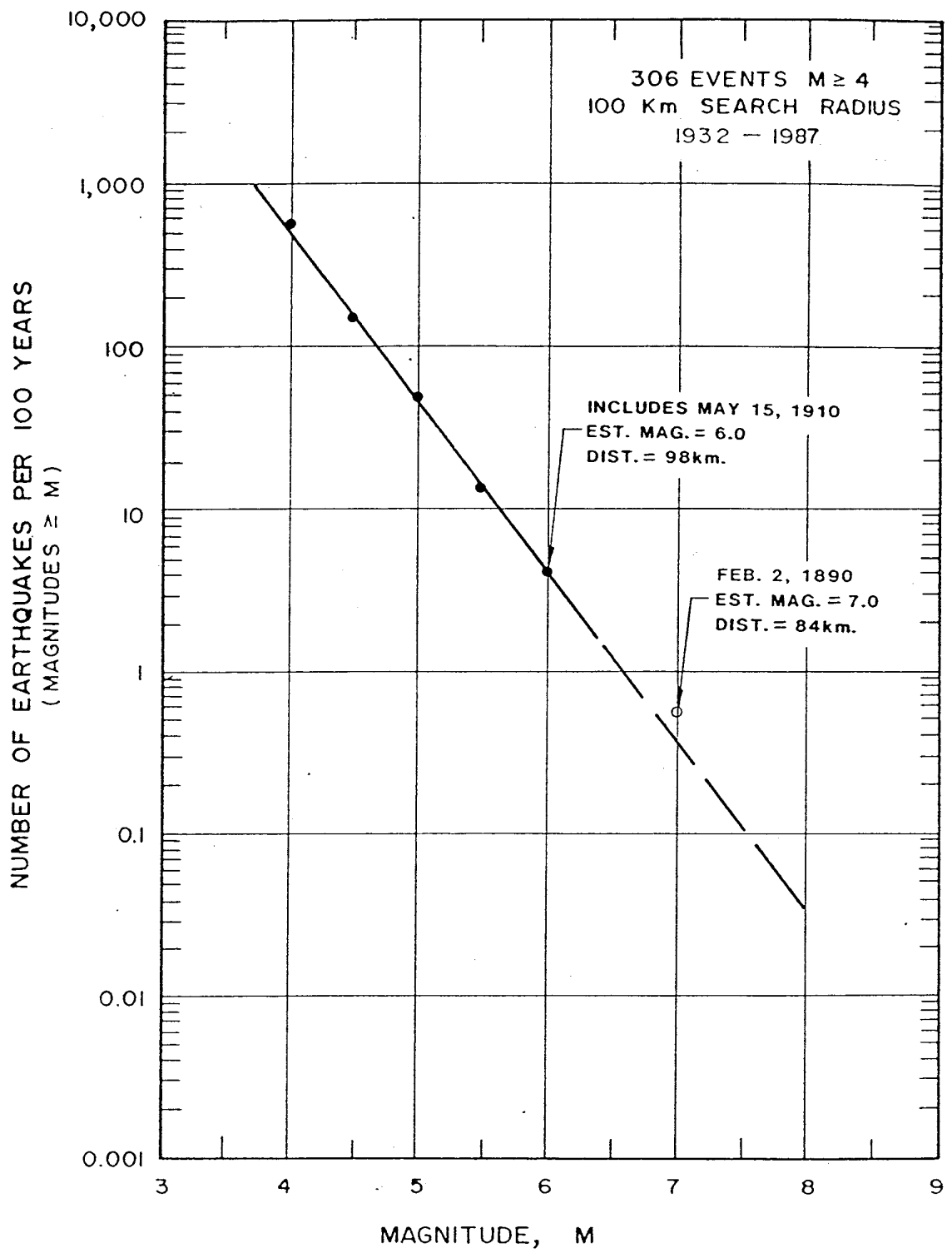
SCALE 1" = 2000'

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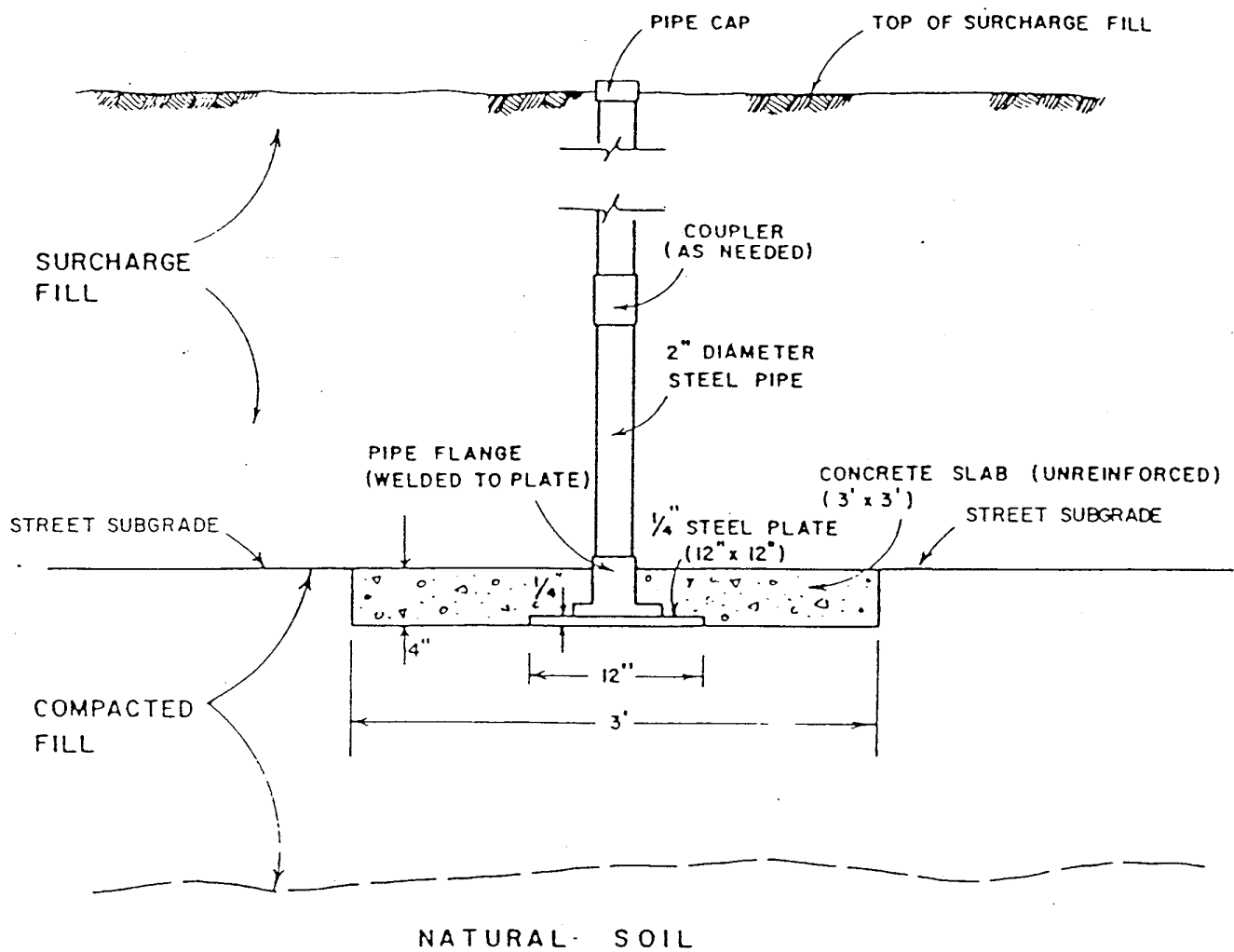
REGIONAL SEISMICITY

LeROY CRANDALL AND ASSOCIATES



RECURRENCE CURVE

O REPRESENTS SINGLE EVENT, AND THEREFORE
HAS BEEN DISCOUNTED IN PREDICTION.



SETTLEMENT MONUMENT DETAIL

SCALE 1" = 1'

LEROY CRANDALL AND ASSOCIATES

SECTION 3.0: BLUFF STABILITY INVESTIGATION

3.1 SCOPE

This phase of the geotechnical studies involves the stability of the bluff adjacent to the southern boundary of the Playa Vista Project. The bluff is shown on Plate 3-1, Location Plan, and on Plates 3-2.1 through 3-2.4, Geologic Map. Although only a portion of the bluff is within the subject tract, the stability investigation was undertaken to determine any hazard the bluff presented to the subject tract and the effects of any planned grading on the bluff stability.

Our investigation was authorized to determine the static physical characteristics of the soils within the bluff to enable a determination of the bluff stability. The investigation included geologic mapping of the surface of the bluff to identify the general characteristics and distribution of the geologic units, and to locate areas of water seepage, erosion, slumps, and other indications of potential instability. The investigation also included exploring the soil conditions by drilling exploration borings and determining the strength of the materials by performing laboratory tests on the undisturbed samples. We also reviewed prior reports by our firm and by Kovacs-Byer and Associates as part of the investigation.

3.2 BLUFF DESCRIPTION

The bluff is a north-facing slope formed by erosion by the ancestral Los Angeles River. The top of the bluff varies from approximately Elevation 130 to 160 feet above sea level; the base of the bluff varies from approximately Elevation 10 to 25 feet. The average slope of the face of the bluff varies from about 1¾:1 to 2½:1 (horizontal to vertical).

The existing City of Los Angeles North Outfall Sewer is located within the bluff some 30 to 50 feet above the toe. The sewer is described in more detail in a following section.

The bluff is composed principally of late Pleistocene age dune sand. Although classified as "dune sand," these soils actually contain varying amounts of fines; much of the materials are classified as silty sand. These natural deposits are somewhat cemented and although bedding was observed in these materials, the bedding is relatively flat.

Fill soils were encountered over the sewer and on the portion of the slopes below the sewer.

3.3 PRIOR INVESTIGATIONS

We have performed several investigations on the adjacent properties at the top of the western portion of the bluff. Reports covering these prior investigations are:

Report of Preliminary Geotechnical Investigation, Proposed University Expansion, Fordham Road and 78th Street, Los Angeles, California, for the Loyola-Marymount University, dated October 27, 1982 (LCA AE-82255).

Report of Preliminary Foundation Investigation, Proposed Corporate Headquarters, Lincoln Boulevard South of Jefferson Boulevard, Los Angeles, California, for the Hughes Aircraft Company, dated February 9, 1983 (LCA A-82139-B).

Report of Geotechnical Investigation, Proposed Corporate Headquarters, Lincoln Boulevard South of Jefferson Boulevard, Los Angeles, California, for the Hughes Aircraft Company, dated April 19, 1983 (LCA ADE-83049).

The locations of our prior borings are shown on Plates 3-2.1 through 3-2.4.

Prior investigations near the eastern portion of the bluff have been performed by Kovacs-Byer and Associates. We were furnished copies of the following documents for our review:

Preliminary Geologic and Soils Engineering Exploration, 85-Lot Single Family Residential Subdivision, North of the Terminus of Dunbarton Avenue, Westchester, California, for Howard Hughes Realty, Inc., September 19, 1983, KG 7607-G.

Preliminary Geologic and Soils Engineering Exploration, 120-Lot Single Family Residential Subdivision, West of the Intersection of Kentwood Avenue and Riggs Place, Westchester, California, for Howard Hughes Realty, Inc., May 14, 1984, KG 7606-G.

Additional Geotechnical Exploration, Slope Stability Evaluation, Tentative Tracts 43415 and 43416, Westchester, California, for Howard Hughes Realty, Inc., August 5, 1987, KG 7606-G and KG 7607-G.

Additional Geotechnical Exploration, Slope Stability Evaluation, Tentative Tracts 43415 and 43416, Westchester, California, for Howard Hughes Realty, Inc., Revised August 31, 1987, August 5, 1987, KB 7607-G.

Additional Geotechnical Exploration, Slope Stability Evaluation, Tentative Tracts 43415 and 43416, Westchester, California, for Howard Hughes Realty, Inc., Revised October 9, 1987, August 5, 1987, KB 7606-G and KB 7607-G.

Updated Geologic and Soils Engineering Exploration, Tentative Tract 43415, 85-Lot Single Family Residential Subdivision, North of the Terminus of Dunbarton Avenue, Westchester, California, for Howard Hughes Realty, Inc., dated January 25, 1988, KG 7607-G.

Updated Geologic and Soils Engineering Exploration, Tentative Tract 43416, 120-Lot Single Family Residential Subdivision, West of the Intersection of Kentwood Avenue and Riggs Place, Westchester, California, for Howard Hughes Realty, Inc., dated January 25, 1988, KG 7606-G.

3.4 GEOLOGIC MAPPING

A detailed geologic map was prepared of the bluff surface. The geologic mapping was performed to ascertain the general characteristics and distribution of geologic units, and to locate areas of erosion, slumps, and other indications of potential instability. The mapping included observing areas of water seepage or evidence of water seepage, such as the presence of water-loving vegetation. The results of the geologic mapping are presented on Plates 3-2.1 through 3-2.4.

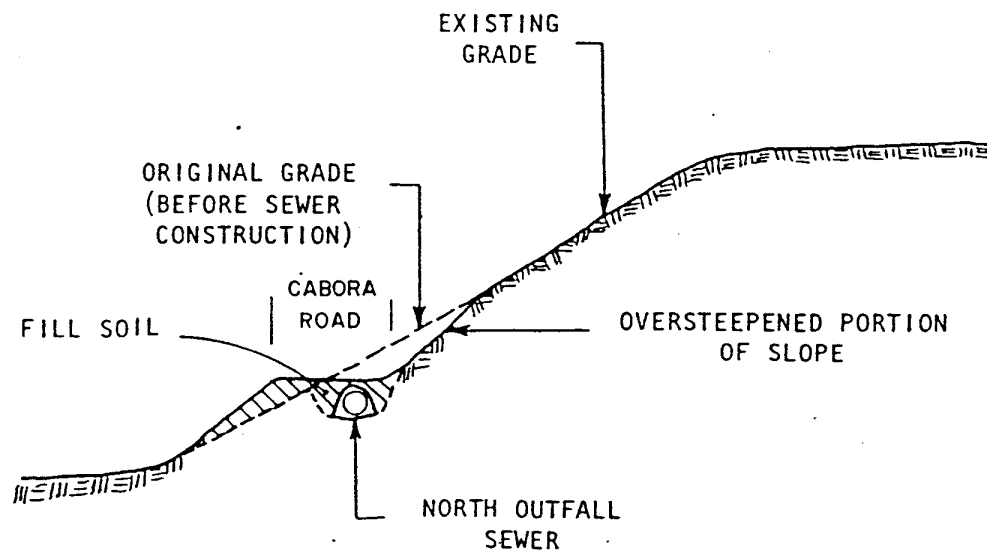
3.5 SITE CONDITIONS

3.5.1 Physiography

The bluff between Lincoln Boulevard and Centinela Avenue forms the approximate southern boundary of the Playa Vista Development over a length of about 10,000 feet. The bluff varies from approximately 120 to 140 feet in height; the average slope of the face of the bluff varies from $1\frac{3}{4}:1$ to $2\frac{1}{2}:1$ (horizontal to vertical).

3.5.2 North Outfall Sewer

The existing City of Los Angeles, North Outfall Sewer is located within the lower portion of the bluff. The sewer construction and maintenance road, known as Cabora Road, is located over the sewer some 30 to 50 feet above the toe of the bluff. Based on drawings furnished to us, the sewer was constructed in 1925 and is semi-elliptical in shape, 10½ feet high, and is constructed of cast-in-place concrete with a vitrified clay block lining. The sewer was designed to be bedded entirely within natural materials. Within most of the bluff, the sewer was constructed in an open excavation that was subsequently backfilled. The sewer is a tunnel along the easternmost 2,000 feet of the bluff. The exact location of the sewer within Cabora Road has not been defined on the survey drawings provided to us, but its general location can be established by the locations of manholes within the road. The location of the sewer on the bluff is shown in the following sketch; the approximate original grade is also shown.



Although the sewer trench was subsequently backfilled, the roadway was preserved and the oversteepened cut portion of the slope remained. The present height of the oversteepened portion of the slope, which is most evident east of Boring B-3, varies from about 25 feet to 40 feet. The slope of this oversteepened portion varies from about 1:1 to 1½:1 (horizontal to vertical).

3.5.3 Adjacent Properties

The south property line for a portion of the Playa Vista Development is located approximately along Cabora Road. The adjacent properties at the top of the bluff are occupied (from west to east) by the Hughes Aircraft Headquarters Facility, Loyola-Marymount University, and residential development. The locations of these properties are identified on Plate 3-1.

The Hughes Aircraft Headquarters Facility was constructed within the upper portion of the bluff, significantly reducing the total slope height in this area. The remnants of a secondary access road from Cabora Road to a former building are present on the slope below the planned Leavey Campus of Loyola-Marymount University. This secondary road has been breached by erosion.

Tentative Tracts 43415 and 43416 are shown on Plate 3-1. These tracts were investigated by Kovacs-Byer and Associates.

3.5.4 Vegetation

The existing vegetation adjacent to and below the Hughes Aircraft Headquarters Building and the Loyola-Marymount Leavey Campus is generally sparse, consisting of scattered grasses and weeds with some light brush. A relatively heavy growth of vegetation was observed immediately above Cabora Road south of the Leavey Campus. A portion of the slope above Cabora Road and immediately below the primary Loyola-Marymount campus and the residential development to the east of the campus has been planted with ice plant.

There are significant bare portions of the slope, principally below Cabora Road and on the easternmost portion of the bluff.

3.6 EXPLORATIONS AND TESTING

The bluff materials were investigated by drilling seven exploration borings (Borings B-1 through B-7) to depths of 19 to 60 feet. The locations of the borings are shown on Plates 3-2.1 and 3-2.2. The locations of borings from our nearby projects on the adjacent properties at the top of the bluff are also shown. The logs of the borings and the results of laboratory tests performed on representative samples are presented in Appendix D.

3.7 GEOLOGY

3.7.1 General

The bluff, known as the Ballona Escarpment, is an erosional feature formed by downcutting of the ancestral Los Angeles River, which has since been redirected to the south. The bluff is composed principally of late Pleistocene age dune sand, which has been generally interpreted as ancient offshore bars modified by wind and stream action since their emergence from the ocean (Poland et al., 1959). According to Poland et al., these deposits were probably formed during a high level of the sea immediately before the latest Pleistocene withdrawal, which instituted the cutting of the present escarpment. The dune sand is underlain by marine and continental deposits of the late Pleistocene age Lakewood and San Pedro Formations (Department of Water Resources, 1961).

The geologic materials exposed in the bluff and mapped during this investigation are identified on Plates 3-2.1 through 3-2.4. Other features mapped during the investigation, such as slumps, bedding attitudes, and a spring, are also shown.

3.7.2 Geologic Materials

General

Sections at each of the boring locations have been prepared and are presented on Plates 3-3.1 through 3-3.7, Geologic Section. The geologic conditions observed in this investigation and the topography of the existing bluff are shown on the sections.

Fill Soils

Up to 20 feet of fill was encountered in our exploration borings adjacent to the North Outfall Sewer. The fill consists primarily of silty sand and sandy silt and is backfill placed over the sewer, which was constructed in an open excavation in this area.

Additional fill deposits overlie the lower portions of the slope. These fill deposits are a result of prior sewer construction and maintenance of Cabora Road, where soil debris has accumulated on the road and has been cast over the side of the road, and construction of the Hughes Aircraft headquarters building.

Only minor deposits of fill (less than 1 foot thick) were observed on the adjacent properties at the top of the bluff.

Alluvium

The flood plain adjacent to the base of the bluff is underlain by approximately 100 feet of recent alluvium deposited by the ancestral Los Angeles River. The upper 20 to 30 feet of alluvium is composed primarily of soft silty clay and clay with layers of silt and sand. Underlying the soft surficial deposits is another 20- to 30-foot thickness of firmer silt and clay sediments. The lowermost 30 to 50 feet of sediments are composed of sand and gravel, and are described by Poland et al. (1959) as the "50-foot gravel," a ground water aquifer.

The alluvium was not encountered in our exploration borings, which were drilled in the bluff above the flood plain.

Dune Sand

The bluff above Cabora Road is capped by a variable thickness of late Pleistocene dune sands. These sands are well sorted and clean. Continuous bedding structure within the dune sand is generally poorly developed or absent. Cross-bedding, however, is common.

Lakewood Formation

Underlying the dune sands is the Lakewood Formation, which is described by Poland et al. (1959) as consisting of sand and gravel with some silty layers. The sediments are only slightly cemented and are highly erodible. The Lakewood Formation in the bluff area is similar to the overlying Pleistocene sands, and the contact has not been identified on either the geologic map or the boring logs. The Lakewood Formation unconformably overlies the early Pleistocene age San Pedro Formation at depth.

3.8 GROUND WATER OCCURRENCE

3.8.1 Ground Water

Water was measured in five of our borings at depths of 50 to 55 feet, corresponding to an elevation of 1 to 3 feet above mean sea level (Elevation +1 to +3). This water level is at least 15 feet below the toe of the bluff and is consistent with water levels observed elsewhere within the Playa Vista development. As a result, ground water will not adversely impact the bluff stability.

3.8.2 Springs

Surface waters percolating through the dune sand occasionally resurface as springs in the bluff face, and may contribute to slope erosion. One spring was observed crossing Cabora Road approximately 260 feet west of Boring B-2 (see Plate 3-2.1, Geologic Map). Accelerated erosion does not appear to have resulted from the spring flow, although water-loving vegetation associated with the spring may mask or discourage erosion.

3.9 SLOPE STABILITY

3.9.1 General

The geologic mapping of the bluff did not reveal the presence of any deep-seated rotational or translational landslide failures. There was no indication of failure of the slopes below Cabora Road. Shallow slumps were observed in a secondary road cut made above Cabora Road. Deeply incised erosion gullies were found in areas where surface water runoff has been allowed to flow over the edge of the bluff.

3.9.2 Slumping and Slope Retreat

The bluff within the study area varies in height from approximately 120 to 140 feet. The upper portions of the slope are generally inclined from $1\frac{3}{4}$:1 to $2\frac{1}{2}$:1 (horizontal to vertical). The slope below Cabora Road has inclinations varying from $1\frac{3}{4}$:1 to 3:1. Localized erosion gullies are steeper.

The naturally weathered slopes do not contain any indications of deep-seated instability, and the layering within the sedimentary materials was observed to dip in a favorable direction into the slope. The bluff appears to have reached an essentially stable slope configuration prior to the construction of the sewer outfall. Cabora Road and the secondary access road were cut into the slightly cemented sands at inclinations of $\frac{1}{2}$:1 to 1:1 (horizontal to vertical). The oversteepened portions of the slopes have subsequently retreated by shallow slumping (mass wasting). The cut slopes are likely to continue slumping until a stable configuration is reestablished, probably when the slopes reach an inclination of $1\frac{1}{2}$:1 to 2:1. Many of the old road cuts appear to have already stabilized at inclinations of approximately $1\frac{1}{2}$:1.

3.9.3 Slope Erosion

Steeply incised erosion gullies have formed where surface water runoff has drained over the edge of the bluff. An example of this process has formed immediately to the north of the central depression in the Loyola-Marymount University proposed Leavey Campus site. Mass wasting occurred as rainwater accumulated in a depression at the top of the bluff and

drained over the edge. The runoff resulted in an erosion gully by direct scouring, and by secondary slumping of adjacent sediments into the widening chasm. A small access road on the bluff slope was completely breeched, and a 100-foot section of steel pipe was placed to carry surface water across the chasm. Secondary slumping into the gully is still continuing. The runoff from the top of the slope at this location has been directed westerly by placement of an earth berm and excavation of a diversion channel.

3.10 STABILITY ANALYSES

3.10.1 Shear Strength

Direct shear tests were performed to determine the shear strength of the bluff materials. The tests were performed on undisturbed samples of the fill and natural soils and on remolded samples of the on-site soils compacted to 90%. The shear tests are described in Appendix D.

Based on the direct shear tests, the following shear strength parameters were used in our analyses:

Gross Stability

Natural Soil:

Cohesion = 250 pounds per square foot
Angle of Internal Friction = 33 degrees

Existing Fill Soil:

Cohesion = 100 pounds per square foot
Angle of Internal Friction = 32 degrees

Compacted Fill Soil:

Cohesion = 300 pounds per square foot
Angle of Internal Friction = 33 degrees

Surficial StabilityNatural Soil:

Cohesion = 200 pounds per square foot
Angle of Internal Friction = 30 degrees

Existing Fill Soil:

Cohesion = 100 pounds per square foot
Angle of Internal Friction = 30 degrees

Compacted Fill Soil:

Cohesion = 300 pounds per square foot
Angle of Internal Friction = 33 degrees

The shear strength determinations are based on samples tested both at field and optimum moisture contents and on samples that were soaked prior to testing. The shear strengths used in our gross stability analyses are based on a low average of the weaker tests. However, the strengths used in the surficial analyses are based on the weakest of the wet samples tested. The weakest strengths are more appropriate to a surficial analysis than to a gross stability analysis.

It should be noted that some cohesion is used in all of the analyses. The cohesion is justified by the shear tests and is obvious when observing the materials in place in the bluff. In fact, recent trenching within the easterly portion of the bluff by Kovacs-Byer and Associates for a fault study showed that the materials will stand vertically for heights of more than 10 feet for extended periods of time. Cohesion is clearly present in the materials at field moisture content and we believe cohesion is also present when these materials become wet. (The cohesion value used in the analyses is deliberately relatively low.) The cohesion is a result of intergranular cementation between the soil particles by the mineral content and by the amount of fines in the soils (see Plate D-4 in Appendix D).

3.10.2 Gross Stability

Analyses were performed for various sections along the slope as presented on Plates 3-3.1 through 3-3.7. The most critical conditions occur along Section 4 where the slope is about 125 feet in height and the average inclination of the slope is about 1.8:1 (horizontal to vertical). The results of the gross stability analyses are summarized on Plate 3-4.1, Stability Analyses (Gross Stability), with the calculations presented on Plates 3-4.2 through 3-4.10.

As shown, the most critical potential failure circle is through the toe of the slope above Cabora Road where the slope was oversteepened by the sewer construction. For this case, the slope has a static factor of safety of 1.4 and a factor of safety of 1.1 when subjected to a 0.15g lateral seismic force. The slope has a factor of safety of 1.5 for a potential failure through the toe of the bluff at its full height.

These analyses are consistent with the observed performance of the slope, where the prior sewer excavation resulted in an oversteepened slope above Cabora Road.

The analyses by Kovacs-Byer and Associates for the slopes below and immediately adjacent to Tentative Tracts 43415 and 43416 show similar, but slightly lower, factors of safety because of their slightly greater slope height.

3.10.3 Surficial Stability

The surficial stability analyses are summarized on Plate 3-5.1, Stability Analyses (Surficial Stability), with the calculations presented on Plate 3-5.2. The analyses were performed to determine the steepest slope possible to achieve a factor of safety of 1.5 against surficial failure. The allowable slope inclinations (horizontal to vertical) for this factor of safety are:

Natural Slopes: 1¼:1

Existing Fill Slopes: 2½:1

Compacted Fill Slopes: 1¼:1

The analyses actually gave a factor of safety of 2.0 for a 1½:1 compacted fill slope, but we do not believe that steeper compacted fill slopes would be appropriate.

3.11 CONCLUSIONS

The natural materials encountered in the bluff are dense, slightly cemented, sandy deposits. The natural deposits do not contain adverse geologic structure that could create slope stability problems. Fill soils occur on the portion of the slope below the sewer, and are the result of both sewer construction and maintenance of the sewer access road.

The bluff is considered grossly stable (not potentially subject to deep seated sliding). However, construction of the North Outfall Sewer along the bluff has resulted in some oversteepened portions of the slope above the sewer with subsequent slumping of some portions of this slope. Such slumping will continue to occur until the portion of the slope above the sewer reaches a stable inclination.

The soils in the bluff are susceptible to erosion. Localized erosion has occurred where runoff drainage has been directed over the top of the bluff.

The potential hazard for development at the toe of the bluff is related to the accumulation of soil debris at the toe of the slope. Such debris is a result of shallow surficial slumping and erosion within the lower slope below the sewer. The sewer maintenance road is at least 30 feet wide and serves as an effective catchment for soil debris from the upper slope. There are several alternatives that can be used to reduce the slumping and erosion hazard at the toe of the slope. These include flattening the lower portion of the slope, removing the fill soils below Cabora Road, placing a compacted fill on the face of the slope below Cabora Road, or placing an erosion control matting on the face of the slope. We understand that the use of an erosion control matting is preferred. Recommendations for placement of this matting are discussed in a following section.

The potential hazard for development at the top of the bluff is the gradual retreat of the edge of the bluff as a result of both erosion and slumping at the oversteepened portions of the slope. In our opinion, there is little likelihood of the slumping ever reaching the top of the bluff, and therefore the bluff does not pose a hazard to the existing development at the top of the bluff.

It is currently planned to excavate the top of the bluff at Tentative Tract No. 43415 up to 12 feet and flatten the existing 1½:1 (horizontal to vertical) slope above the existing 10-foot wide haul road above the North Outfall Sewer to 2:1.

It is also planned to excavate the top of the bluff at Tentative Tract No. 43416 up to 10 feet. Remedial grading and placement of drainage devices only are planned for the bluff face above the sewer. Elsewhere, compacted fills with 2:1 slopes are planned.

It is our conclusion that the proposed grading on the subject tentative tracts will not have an adverse effect on the Playa Vista development. In fact, the planned lowering and flattening of the slope will actually improve the bluff stability.

3.12 RECOMMENDATIONS

3.12.1 General

If the recommendations provided below are followed, we believe the presence of the bluff will not adversely affect the Playa Vista development (Tentative Tract 49104).

Additional grading is not required above Cabora road; the 30-foot-wide easement for the maintenance road provides sufficient catchment area for soil debris. In effect, the road is a setback for the site from the upper slope.

To reduce the hazard of soil debris accumulation, the slope below Cabora Road could be regraded by either flattening the existing slope or by excavation and the placing of a stabilization fill. Alternatively, a building setback could be used at the toe of the slope in

lieu of remedial grading. However, personnel at the City of Los Angeles Grading Division have indicated that a building setback would not be an acceptable alternative to improve the slope. We recommend an erosion-resistant matting be placed over the slope to reduce the hazard of soil debris accumulation.

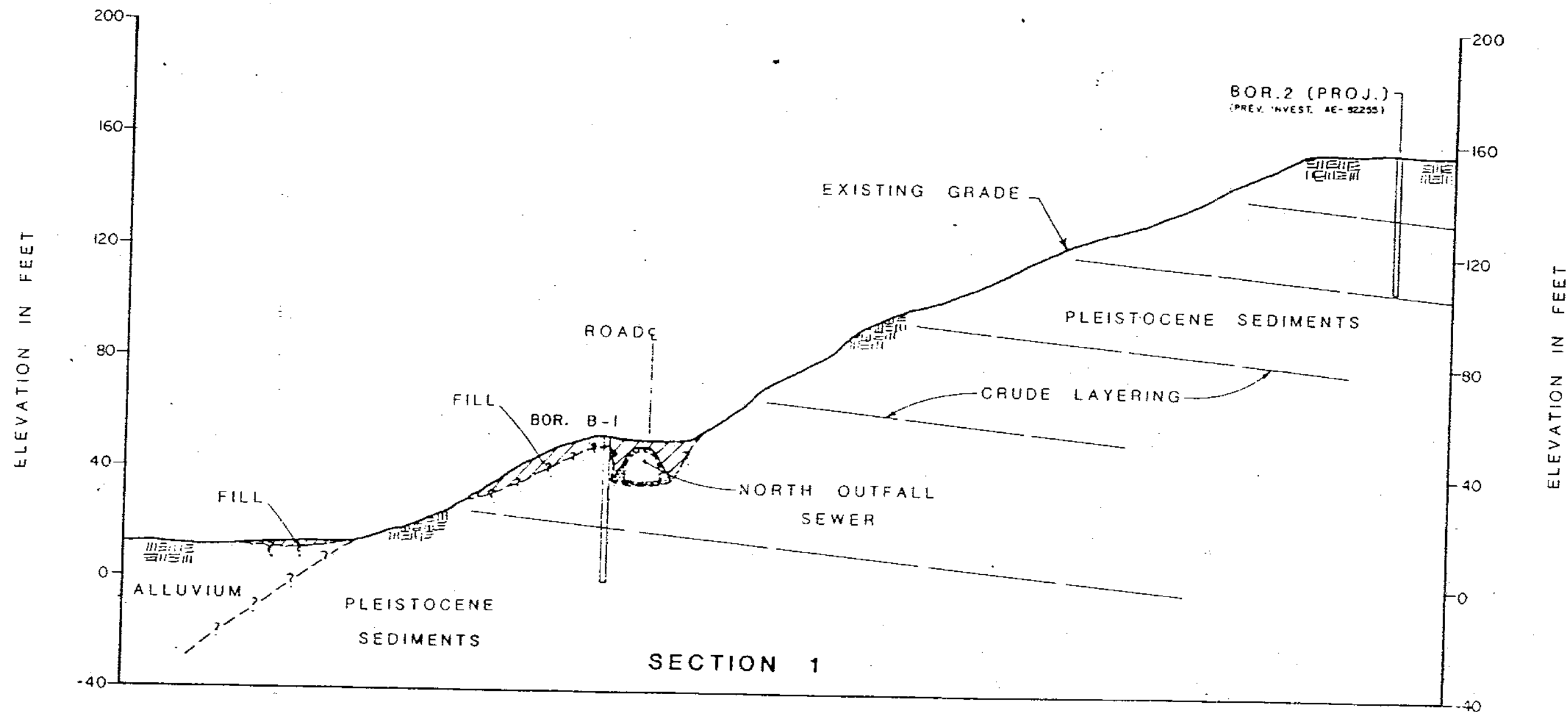
Excavation below Cabora Road could pose some hazard to the existing sewer, and aesthetics could dictate that the slope be left in its present condition without regrading.

If any areas are regraded, they will have to be replanted. A list of recommended planting material is presented in Appendix E.

3.12.2 Erosion-Resistant Matting

A soil erosion-resistant matting is recommended for the portion of the slope below Cabora Road to reduce the soil hazard potential to an acceptable level. A proprietary product, such as Miramat, Enkamat, Tensar Erosion Mat, Bon Terra Blankets, or similar products, could be used. We understand the vegetation on the slope will be removed and the slope replanted. To minimize disturbing the soils, we recommend the heavier brush and trees be cut at or near the ground surface and not pulled. The matting should be placed after removing the vegetation and prior to replanting. The vegetation should be selected from the list provided in Appendix E. The matting installation should be done in accordance with the manufacturer's instructions.

A planting scheme will need to be developed by a landscape architect for all slopes. This is particularly important for the slopes below Cabora Road where erosion is a potential problem.



NOTES:

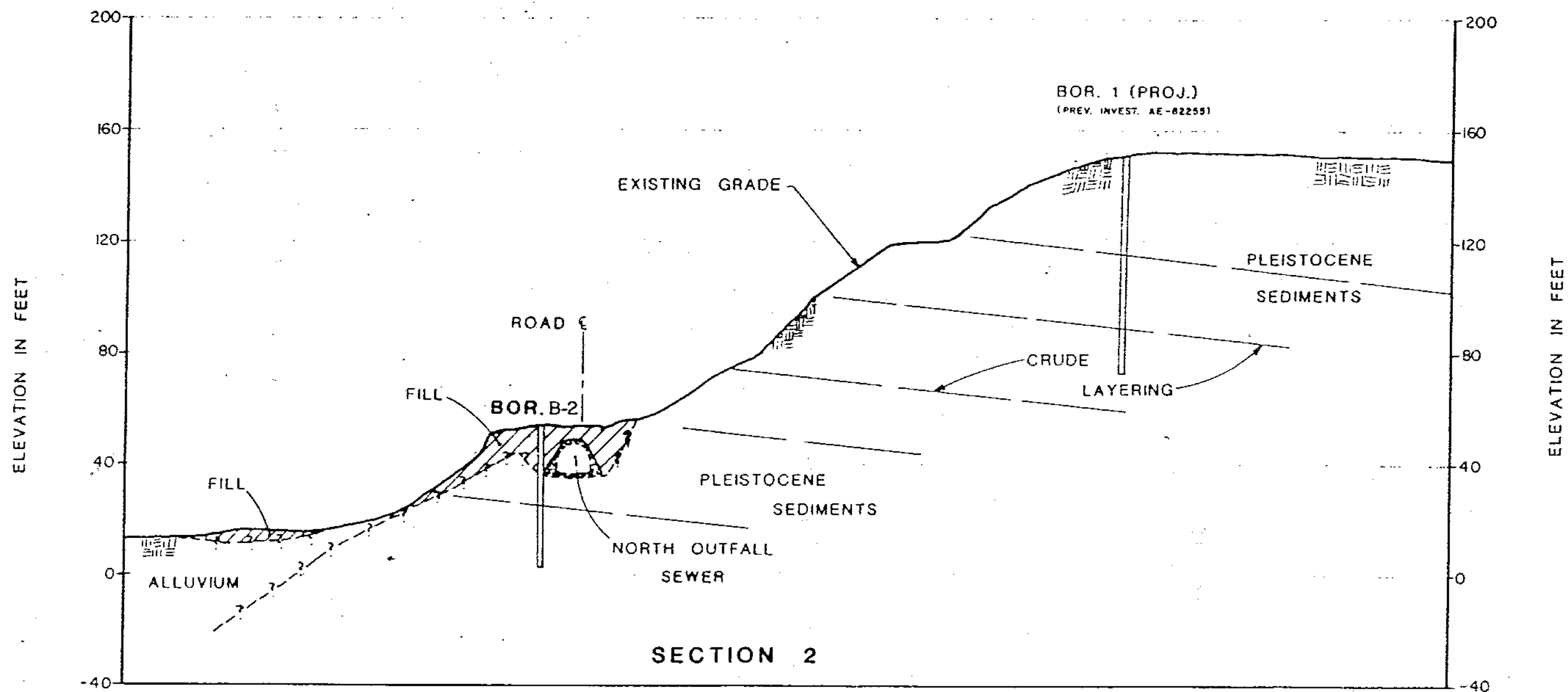
- 1.) THE SECTION IS BASED ON GEOLOGIC CONDITIONS AT BORING LOCATIONS AND AT SURFACE EXPOSURES MAPPED DURING THE INVESTIGATION. THE GEOLOGIC CONDITIONS BETWEEN SUCH LOCATIONS HAVE BEEN INTERPOLATED. LOCALIZED VARIATIONS COULD OCCUR. THE SECTION IS INTENDED FOR DESCRIPTIVE PURPOSES ONLY.
- 2.) SEE PLATE 3-2.1 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES

PLATE 3.2.1



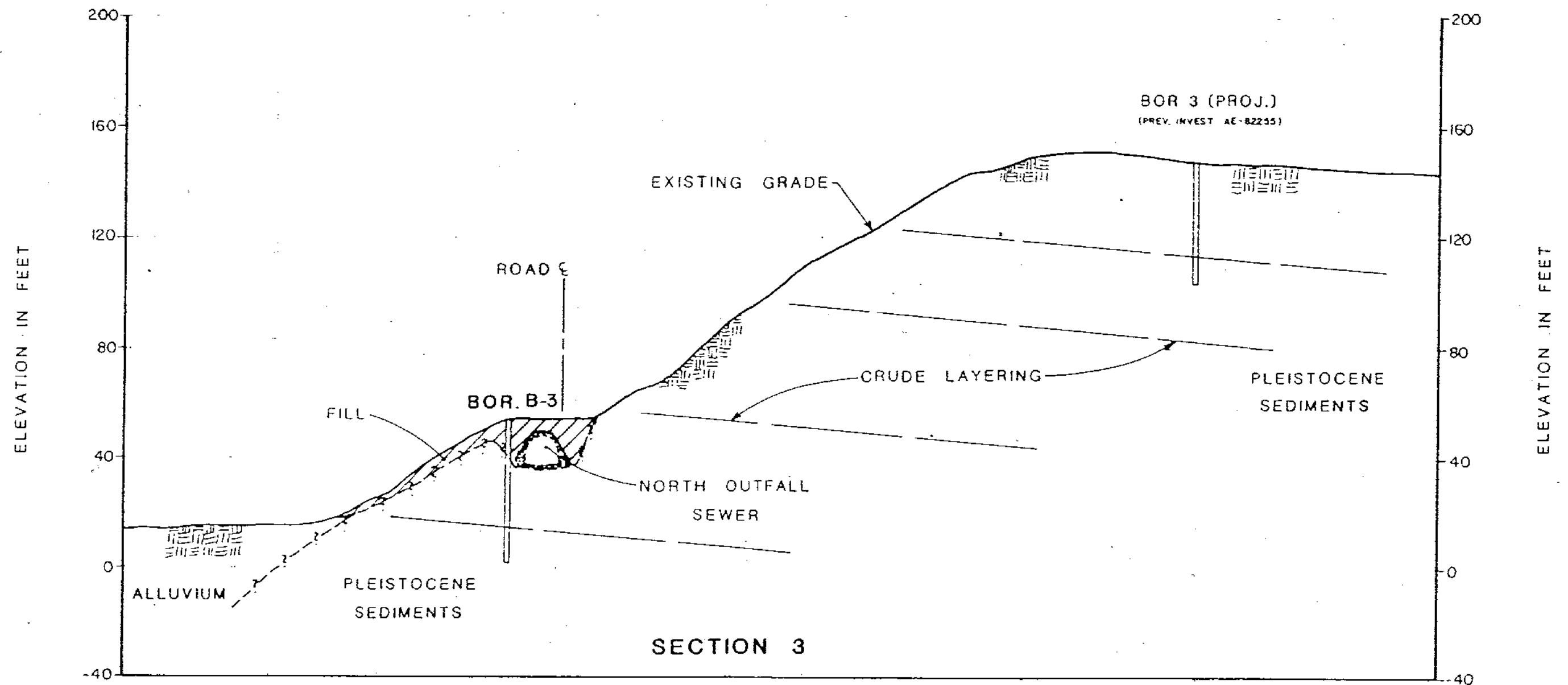
NOTES:

- 1.) THE SECTION IS BASED ON GEOLOGIC CONDITIONS AT BORING LOCATIONS AND AT SURFACE EXPOSURES MAPPED DURING THE INVESTIGATION. THE GEOLOGIC CONDITIONS BETWEEN SUCH LOCATIONS HAVE BEEN INTERPOLATED. LOCALIZED VARIATIONS COULD OCCUR. THE SECTION IS INTENDED FOR DESCRIPTIVE PURPOSES ONLY.
- 2.) SEE PLATE 3-2.1 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES



NOTES:

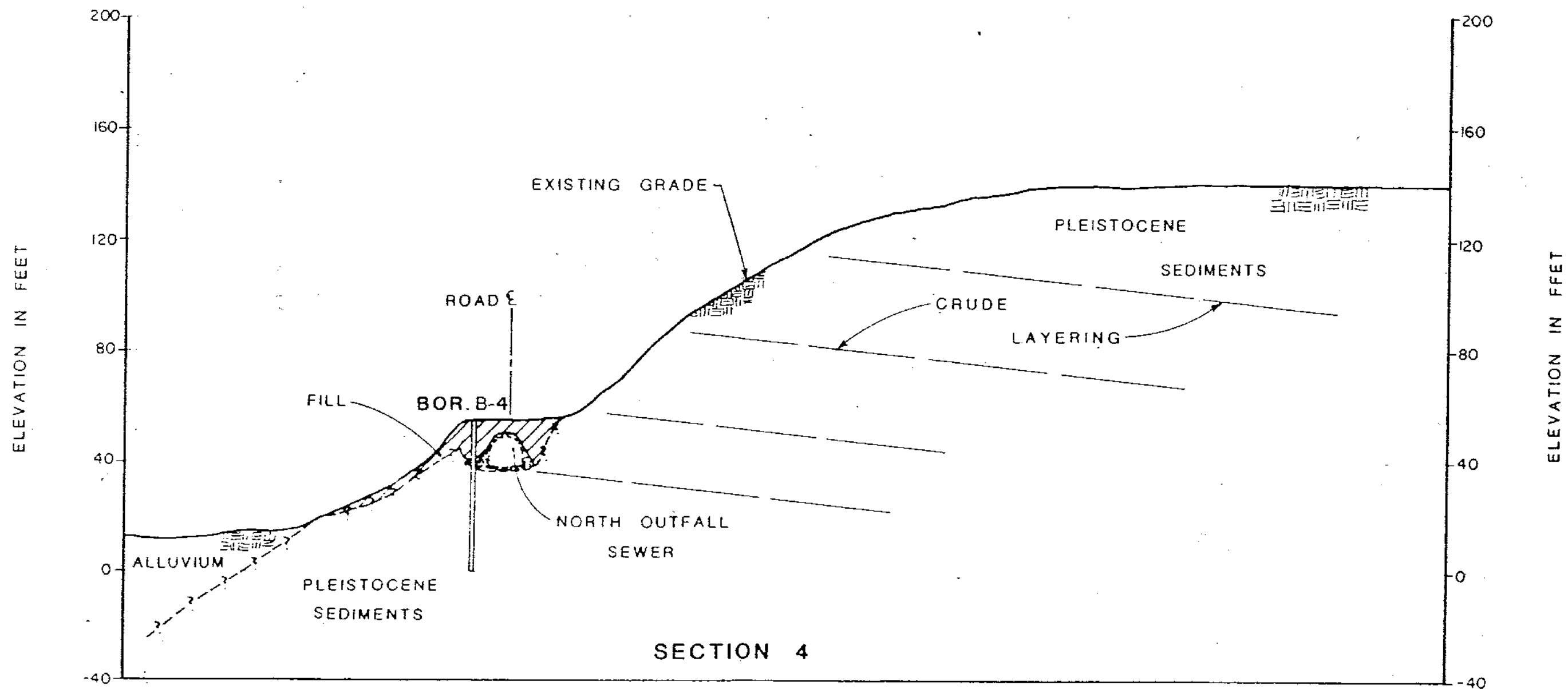
- 1.) THE SECTION IS BASED ON GEOLOGIC CONDITIONS AT BORING LOCATIONS AND AT SURFACE EXPOSURES MAPPED DURING THE INVESTIGATION. THE GEOLOGIC CONDITIONS BETWEEN SUCH LOCATIONS HAVE BEEN INTERPOLATED. LOCALIZED VARIATIONS COULD OCCUR. THE SECTION IS INTENDED FOR DESCRIPTIVE PURPOSES ONLY.
- 2.) SEE PLATE 3-2.1 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES

PLATE 3-3.3



NOTES:

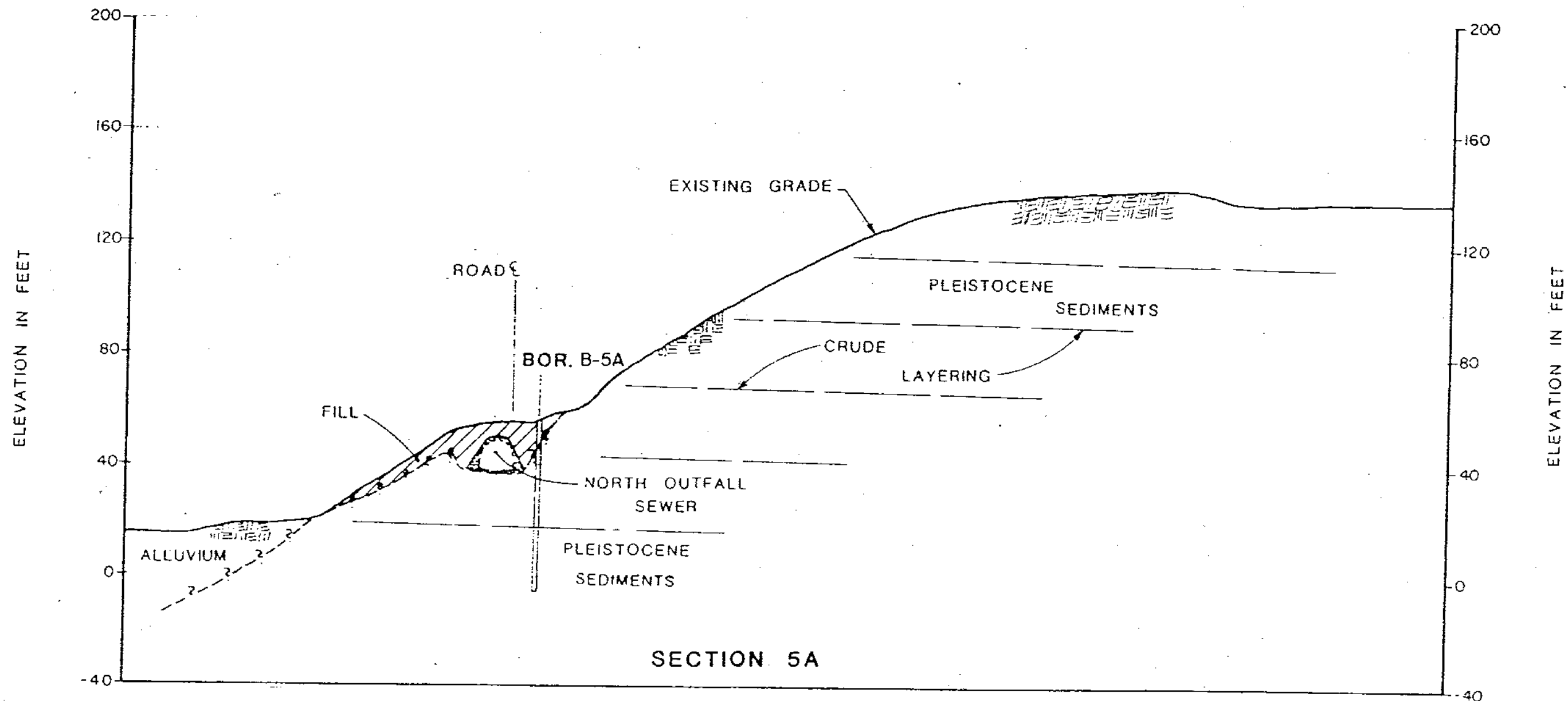
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- 2.) SEE PLATE 3-2.1 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES

PLATE 3-3.4



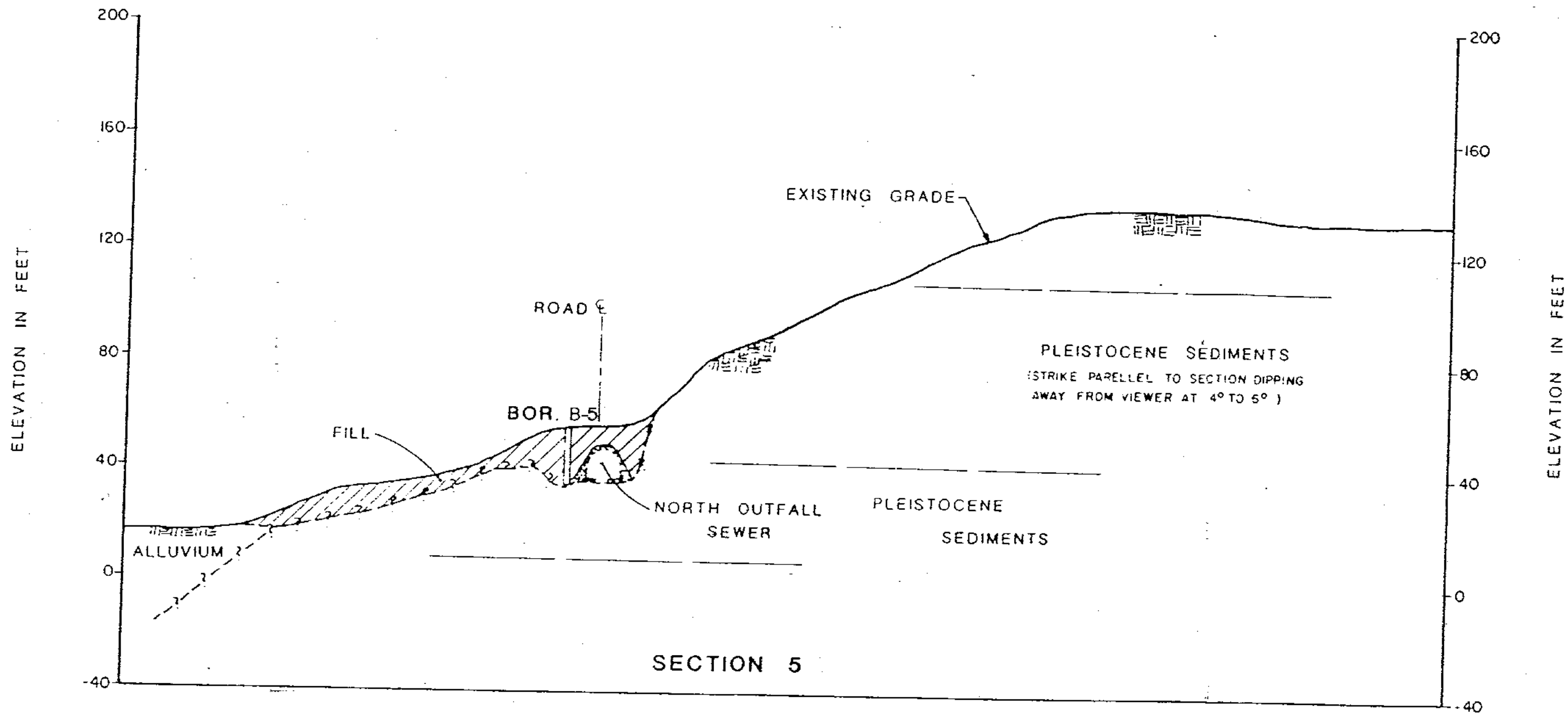
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- 1.) THE SECTION IS BASED ON GEOLOGIC CONDITIONS AT BORING LOCATIONS AND AT SURFACE EXPOSURES MAPPED DURING THE INVESTIGATION. THE GEOLOGIC CONDITIONS BETWEEN SUCH LOCATIONS HAVE BEEN INTERPOLATED. LOCALIZED VARIATIONS COULD OCCUR. THE SECTION IS INTENDED FOR DESCRIPTIVE PURPOSES ONLY.
- 2.) SEE PLATE 3-2.2 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES



NOTES:

1.) THE SECTION IS BASED ON GEOLOGIC CONDITIONS AT BORING LOCATIONS AND AT SURFACE EXPOSURES MAPPED DURING THE INVESTIGATION. THE GEOLOGIC CONDITIONS BETWEEN SUCH LOCATIONS HAVE BEEN INTERPOLATED. LOCALIZED VARIATIONS COULD OCCUR. THE SECTION IS INTENDED FOR DESCRIPTIVE PURPOSES ONLY.

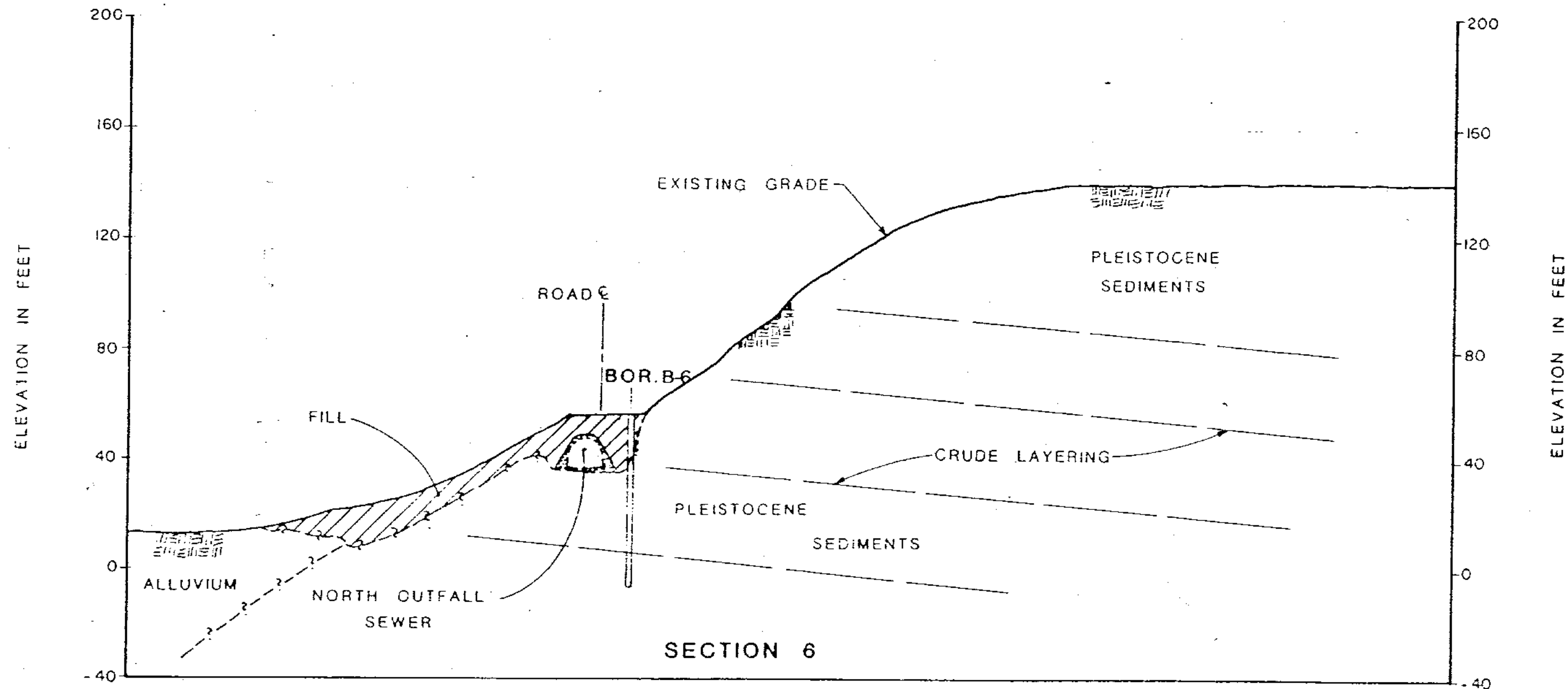
2.) SEE PLATE 3-2.2 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LEROY CRANFALL AND ASSOCIATES

PLATE 3-3.6



NOTES:

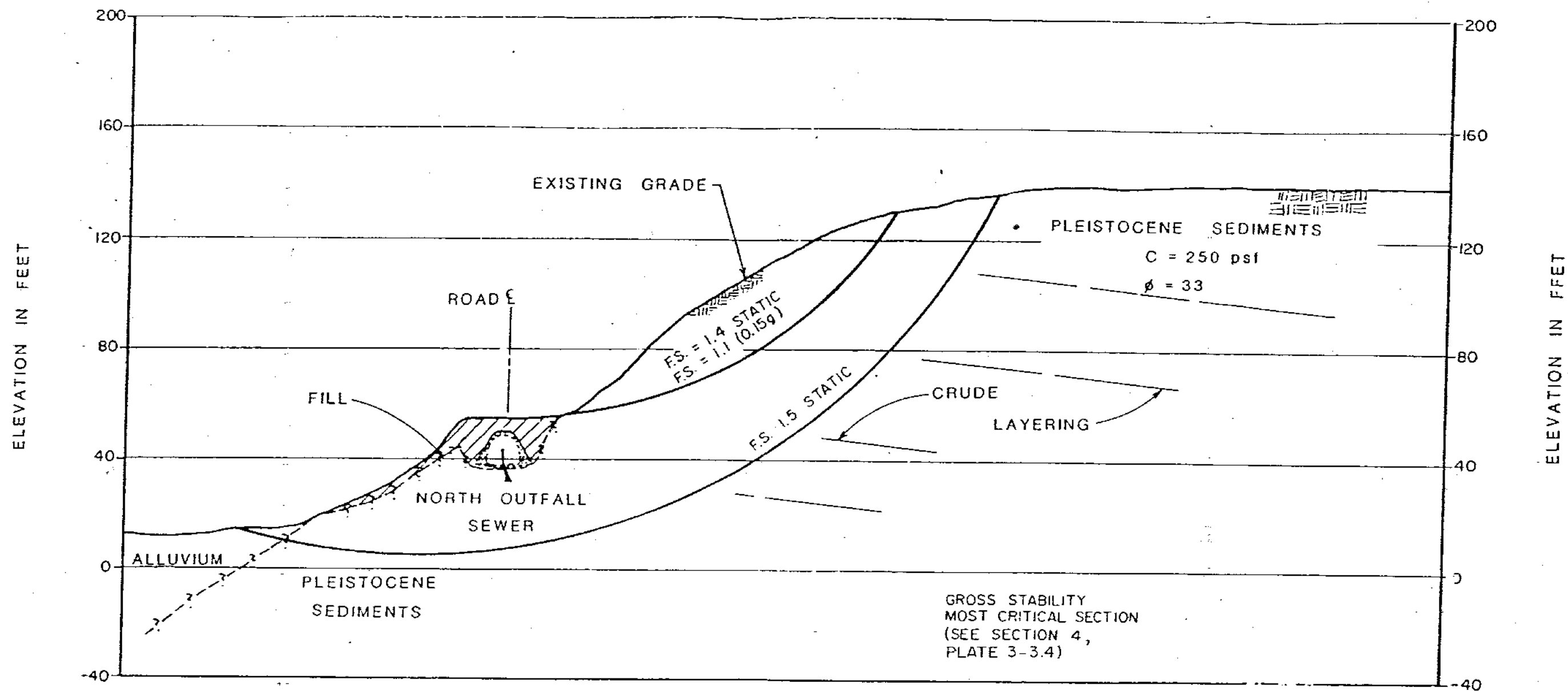
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- 2.) SEE PLATE 3-2.2 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES

PLATE 3-3.7



STABILITY ANALYSES

(GROSS STABILITY)

SCALE 1" = 40'

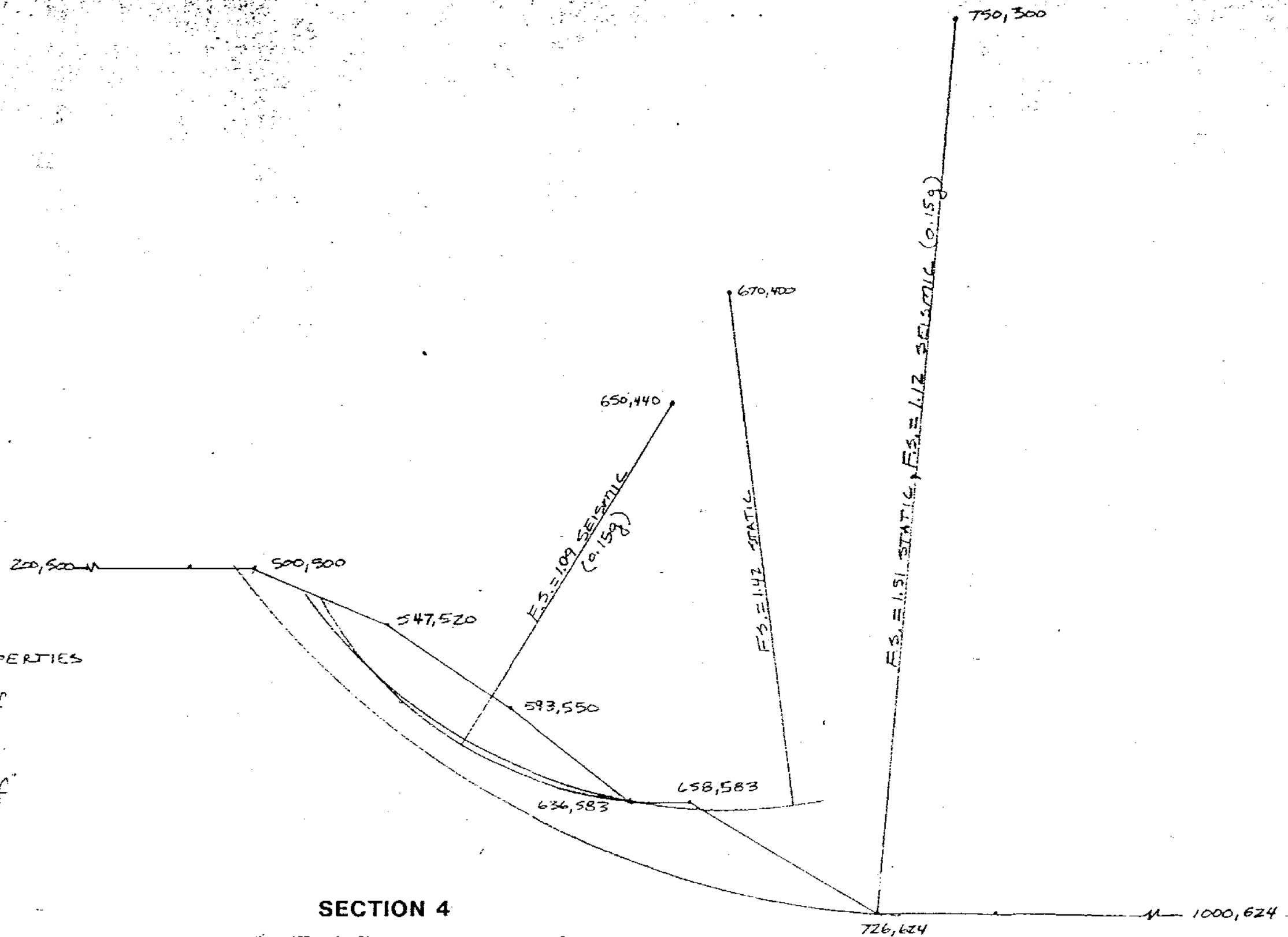
LeROY CRANDALL AND ASSOCIATES

MATERIAL PROPERTIES

$c = 250 \text{ psf}$
 $\phi = 33^\circ$
 $\gamma = 120 \text{ pcf}$

SECTION 4

SCALE 1" = 40'



GROSS SLOPE STABILITY

Playa Vista Project

LeROY CRANDALL AND ASSOCIATES

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*****
* *****
* *
* * ----- * *
* * TSTAB slope stability analysis * *
* * Revision 2.52 - 01/06/86 * *
* * ----- * *
* *
* * copyright (c) 1983,84,85 TAGA * *
* * copyright (c) 1983,84,85 DPMS * *
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* *****
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*****
L90328.AEO - Section 4-4, Toe, Static
*****

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HBL ✓ BK

***** INPUT DATA FOR ANALYSIS BY BISHOP'S SIMPLIFIED METHOD

CONTROL DATA,

```

AUTOMATIC SEARCH FOR CRITICAL CIRCLE
NUMBER OF DEPTH LIMITING TANGENTS      0
NUMBER OF VERTICAL SECTIONS            8
NUMBER OF SOIL LAYER BOUNDARIES        2
NUMBER OF POINTS DEFINING COHESION PROFILE 0
NUMBER OF CURVES DEFINING COHESION ANISOTROPY 0
NUMBER OF BOUNDARY LINE LOADS          0
NUMBER OF BOUNDARY PRESSURE LOADS      0

```

```

SEISMIC COEFFICIENT      =      .000
ATMOSPHERIC PRESSURE     =      .000
UNIT WEIGHT OF WATER     =     62.400
UNIT WEIGHT OF WATER IN TENSION CRACK =     62.400

```

SEARCH STARTS AT CENTER (650.0, 420.0), WITH FINAL GRID OF 20.0

ALL CIRCLES PASS THROUGH THE POINT (726.0, 624.0)

GEOMETRY

SECTIONS	200.00	500.00	547.00	593.00	636.00	658.00	726.00	1000.00
T. CRACKS	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
W IN CRACK	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 1	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 2	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	120.00	250.00	33.00	.00

 L90328.AEO - Section 4-4, Toe, Static

***** RESULTS

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	637.7	217.7	650.0	420.0	1.942
2	654.7	234.7	610.0	420.0	2.507
3	635.6	255.6	650.0	380.0	1.979
4	627.2	207.2	690.0	420.0	1.630
5	640.8	180.8	650.0	460.0	1.965
6	626.6	246.6	690.0	380.0	1.637
7	624.0	204.0	730.0	420.0	1.660
8	627.9	167.9	690.0	460.0	1.695
9	631.5	211.5	670.0	420.0	1.748
10	626.9	226.9	690.0	400.0	1.624
11	624.6	204.6	710.0	420.0	1.590
12	627.5	187.5	690.0	440.0	1.654
13	624.6	224.6	710.0	400.0	1.566
14	624.0	204.0	730.0	420.0	1.660
15	624.7	184.7	710.0	440.0	1.637
16	626.9	226.9	690.0	400.0	1.624
17	624.5	244.5	710.0	380.0	1.555
18	624.0	224.0	730.0	400.0	1.588
19	626.6	246.6	690.0	380.0	1.637
20	624.5	264.5	710.0	360.0	1.559
21	624.0	244.0	730.0	380.0	1.548
22	624.0	264.0	730.0	360.0	1.529
23	625.2	245.2	750.0	380.0	1.650
24	624.0	224.0	730.0	400.0	1.588
25	624.5	264.5	710.0	360.0	1.559
26	624.0	284.0	730.0	340.0	1.520
27	625.1	265.1	750.0	360.0	1.574
28	624.5	284.5	710.0	340.0	1.578
29	624.0	304.0	730.0	320.0	1.527
30	625.0	285.0	750.0	340.0	1.534
31	624.4	304.4	710.0	320.0	1.605
32	624.9	304.9	750.0	320.0	1.515
33	625.1	265.1	750.0	360.0	1.574
34	624.5	264.5	710.0	360.0	1.559
35	624.9	324.9	750.0	300.0	1.506
36	627.2	307.2	770.0	320.0	1.577
37	624.0	324.0	730.0	300.0	1.547
38	624.8	344.8	750.0	280.0	1.513
39	627.0	327.0	770.0	300.0	1.535
40	624.0	344.0	730.0	280.0	1.574
41	626.8	346.8	770.0	280.0	1.514
42	627.2	307.2	770.0	320.0	1.577
43	624.0	304.0	730.0	320.0	1.527

F.S. MINIMUM= 1.506 FOR THE CIRCLE OF CENTER (750.0, 300.0)

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* * TSTAB slope stability analysis *
* * Revision 2.52 - 01/06/86 *
* * ----- *
* *
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* * copyright (c) 1983,84,85 DPMS *
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L90328.ARO - Section 4-4, Toe, Siesmic
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HB ✓ BK

**** INPUT DATA FOR ANALYSIS BY BISHOP'S SIMPLIFIED METHOD

CONTROL DATA,

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AUTOMATIC SEARCH FOR CRITICAL CIRCLE
NUMBER OF DEPTH LIMITING TANGENTS      0
NUMBER OF VERTICAL SECTIONS             8
NUMBER OF SOIL LAYER BOUNDARIES         2
NUMBER OF POINTS DEFINING COHESION PROFILE 0
NUMBER OF CURVES DEFINING COHESION ANISOTROPY 0
NUMBER OF BOUNDARY LINE LOADS           0
NUMBER OF BOUNDARY PRESSURE LOADS       0

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SEISMIC COEFFICIENT      =      .150
ATMOSPHERIC PRESSURE     =      .000
UNIT WEIGHT OF WATER     =      62.400
UNIT WEIGHT OF WATER IN TENSION CRACK =      62.400

```

SEARCH STARTS AT CENTER (650.0, 420.0), WITH FINAL GRID OF 20.0

ALL CIRCLES PASS THROUGH THE POINT (-726.0, 624.0)

GEOMETRY

SECTIONS	200.00	500.00	547.00	593.00	636.00	658.00	726.00	1000.00
T. CRACKS	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
W IN CRACK	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 1	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 2	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	120.00	250.00	33.00	.00

 L90328.AEO - Section 4-4, Toe, Seismic

***** RESULTS

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	637.7	217.7	650.0	420.0	1.431
2	654.7	234.7	610.0	420.0	1.781
3	635.6	255.6	650.0	380.0	1.430
4	627.2	207.2	690.0	420.0	1.218
5	640.8	180.8	650.0	460.0	1.476
6	626.6	246.6	690.0	380.0	1.212
7	624.0	204.0	730.0	420.0	1.230
8	627.9	167.9	690.0	460.0	1.271
9	630.3	250.3	670.0	380.0	1.307
10	626.4	266.4	690.0	360.0	1.221
11	624.5	244.5	710.0	380.0	1.156
12	626.9	226.9	690.0	400.0	1.209
13	624.5	264.5	710.0	360.0	1.155
14	624.0	244.0	730.0	380.0	1.152
15	624.6	224.6	710.0	400.0	1.167
16	624.0	264.0	730.0	360.0	1.136
17	625.2	245.2	750.0	380.0	1.223
18	624.0	224.0	730.0	400.0	1.181
19	624.5	264.5	710.0	360.0	1.155
20	624.0	284.0	730.0	340.0	1.127
21	625.1	265.1	750.0	360.0	1.170
22	624.5	284.5	710.0	340.0	1.163
23	624.0	304.0	730.0	320.0	1.129
24	625.0	285.0	750.0	340.0	1.140
25	624.4	304.4	710.0	320.0	1.177
26	624.9	304.9	750.0	320.0	1.124
27	625.1	265.1	750.0	360.0	1.170
28	624.5	264.5	710.0	360.0	1.155
29	624.9	324.9	750.0	300.0	1.115
30	627.2	307.2	770.0	320.0	1.172
31	624.0	324.0	730.0	300.0	1.138
32	624.8	344.8	750.0	280.0	1.116
33	627.0	327.0	770.0	300.0	1.140
34	624.0	344.0	730.0	280.0	1.152
35	626.8	346.8	770.0	280.0	1.122
36	627.2	307.2	770.0	320.0	1.172
37	624.0	304.0	730.0	320.0	1.129

F.S. MINIMUM= 1.115 FOR THE CIRCLE OF CENTER (750.0, 300.0)


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* * TSTAB slope stability analysis * *
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L90328.AEO - Section 4-4, Bench, Static
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4.6L ✓ BK

***** INPUT DATA FOR ANALYSIS BY BISHOP'S SIMPLIFIED METHOD

CONTROL DATA,

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AUTOMATIC SEARCH FOR CRITICAL CIRCLE
NUMBER OF DEPTH LIMITING TANGENTS      0
NUMBER OF VERTICAL SECTIONS             8
NUMBER OF SOIL LAYER BOUNDARIES         2
NUMBER OF POINTS DEFINING COHESION PROFILE 0
NUMBER OF CURVES DEFINING COHESION ANISOTROPY 0
NUMBER OF BOUNDARY LINE LOADS           0
NUMBER OF BOUNDARY PRESSURE LOADS       0

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SEISMIC COEFFICIENT      =      .000
ATMOSPHERIC PRESSURE     =      .000
UNIT WEIGHT OF WATER     =     62.400
UNIT WEIGHT OF WATER IN TENSION CRACK =     62.400

```

SEARCH STARTS AT CENTER (650.0, 420.0), WITH FINAL GRID OF 20.0

ALL CIRCLES PASS THROUGH THE POINT (636.0, 583.0)

GEOMETRY

SECTIONS	200.00	500.00	547.00	593.00	636.00	658.00	726.00	1000.00
T. CRACKS	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
W IN CRACK	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 1	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 2	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	120.00	250.00	33.00	.00

 L90328.AEO - Section-4-4, Bench, Static

***** RESULTS

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	583.6	163.6	650.0	420.0	1.445
2	585.1	165.1	610.0	420.0	1.763
3	583.5	203.5	650.0	380.0	1.506
4	591.7	171.7	690.0	420.0	1.577
5	583.8	123.8	650.0	460.0	1.431
6	583.1	123.1	630.0	460.0	1.498
7	583.7	143.7	650.0	440.0	1.428
8	587.6	127.6	670.0	460.0	1.577
9	583.9	103.9	650.0	480.0	1.481
10	583.1	143.1	630.0	440.0	1.517
11	583.6	163.6	650.0	420.0	1.445
12	587.0	147.0	670.0	440.0	1.473
13	583.1	163.1	630.0	420.0	1.548
14	586.5	166.5	670.0	420.0	1.426
15	587.6	127.6	670.0	460.0	1.577
16	583.1	123.1	630.0	460.0	1.498
17	586.1	186.1	670.0	400.0	1.424
18	591.7	171.7	690.0	420.0	1.577
19	583.5	183.5	650.0	400.0	1.468
20	585.8	205.8	670.0	380.0	1.439
21	590.8	190.8	690.0	400.0	1.473
22	583.5	203.5	650.0	380.0	1.506
23	590.1	210.1	690.0	380.0	1.439
24	591.7	171.7	690.0	420.0	1.577
25	583.6	163.6	650.0	420.0	1.445

F.S. MINIMUM= 1.424 FOR THE CIRCLE OF CENTER (670.0, 400.0)

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* * TSTAE slope stability analysis * *
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L90328.AEO - Section 4-4, Bench, Seismic
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436 ✓ 68

***** INPUT DATA FOR ANALYSIS BY BISHOP'S SIMPLIFIED METHOD

CONTROL DATA.

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AUTOMATIC SEARCH FOR CRITICAL CIRCLE
NUMBER OF DEPTH LIMITING TANGENTS      0
NUMBER OF VERTICAL SECTIONS             8
NUMBER OF SOIL LAYER BOUNDARIES         2
NUMBER OF POINTS DEFINING COHESION PROFILE 0
NUMBER OF CURVES DEFINING COHESION ANISOTROPY 0
NUMBER OF BOUNDARY LINE LOADS           0
NUMBER OF BOUNDARY PRESSURE LOADS       0

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SEISMIC COEFFICIENT      =      .150
ATMOSPHERIC PRESSURE     =      .000
UNIT WEIGHT OF WATER     =     62.400
UNIT WEIGHT OF WATER IN TENSION CRACK =     62.400

```

SEARCH STARTS AT CENTER (650.0, 420.0), WITH FINAL GRID OF 20.0

ALL CIRCLES PASS THROUGH THE POINT (636.0, 583.0)

GEOMETRY

SECTIONS	200.00	500.00	547.00	593.00	636.00	658.00	726.00	1000.00
T. CRACKS	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
W IN CRACK	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 1	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 2	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	120.00	250.00	33.00	.00

 L90328.AEO - Section 4-4, Bench, Seismic

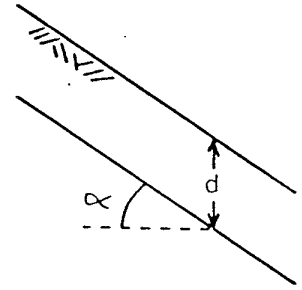
***** RESULTS

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	583.6	163.6	650.0	420.0	1.097
2	585.1	165.1	610.0	420.0	1.304
3	583.5	203.5	650.0	380.0	1.125
4	591.7	171.7	690.0	420.0	1.225
5	583.8	123.8	650.0	460.0	1.104
6	583.1	163.1	630.0	420.0	1.164
7	583.5	183.5	650.0	400.0	1.106
8	586.5	166.5	670.0	420.0	1.093
9	583.7	143.7	650.0	440.0	1.092
10	583.1	143.1	630.0	440.0	1.151
11	587.0	147.0	670.0	440.0	1.139
12	583.8	123.8	650.0	460.0	1.104
13	583.1	163.1	630.0	420.0	1.164
14	586.5	166.5	670.0	420.0	1.093
15	587.6	127.6	670.0	460.0	1.229
16	583.1	123.1	630.0	460.0	1.147

F.S. MINIMUM= 1.092 FOR THE CIRCLE OF CENTER (650.0, 440.0)

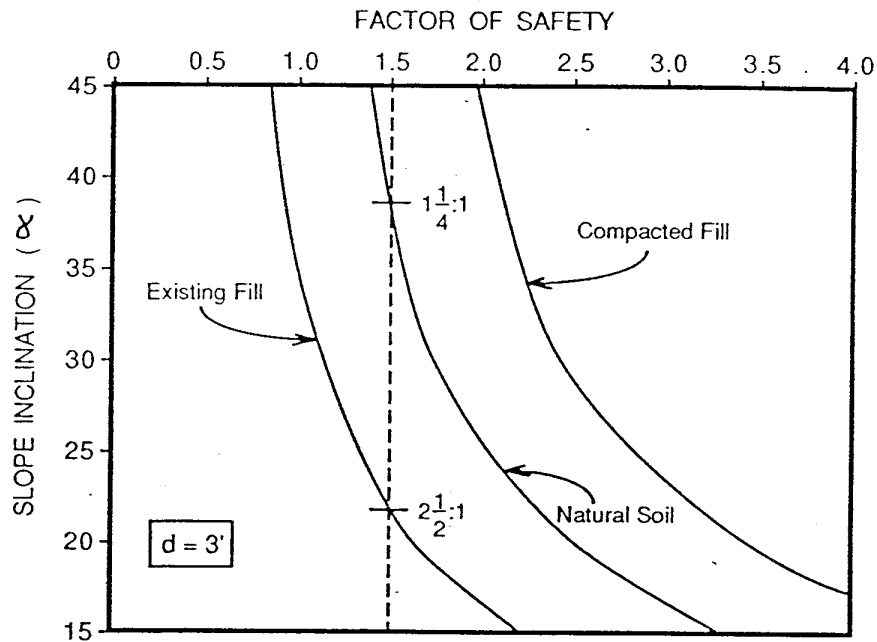
Surficial Stability

$$\text{Factor of Safety} = \frac{C + (\gamma_t - \gamma_w) \cdot d \cdot \cos^2 \alpha \tan \phi}{\gamma_t \cdot d \cdot \cos \alpha \sin \alpha}$$



Shear Strength

Natural Soil : C = 200 psf; $\phi = 30^\circ$
 Existing Fill : C = 100 psf; $\phi = 30^\circ$
 Compacted Fill : C = 300 psf; $\phi = 33^\circ$



STABILITY ANALYSES (SURFICIAL STABILITY)

LeROY CRANDALL AND ASSOCIATES

CLIENT: Maguire/Thomas Partners

JOB NO.: L90328.AEO

BY: bk

DATE: 09/19/90

TITLE: Analysis of Infinite Slope with Parallel Seepage

$$F.S. = \frac{C + (UNITWT - UNITWT \cdot WATER) \cdot H \cdot (\cos \alpha) + \frac{1}{2} \cdot \tan(\phi) \cdot H}{UNITWT \cdot H \cdot (\cos \alpha) + (\sin \alpha)}$$

Effective Cohesion PSF	Effective Friction Degrees	Total Unit Wt PCF	Vertical Depth Feet	Slope Angle Degrees	Slope Inclination (h:v)	Factor of Safety

Natural Soils

200.0	30.0	120.0	3.00	45.00	1.0:1	1.39
200.0	30.0	120.0	3.00	42.30	1.1:1	1.42
200.0	30.0	120.0	3.00	33.70	1.5:1	1.62
200.0	30.0	120.0	3.00	26.60	2.0:1	1.94
200.0	30.0	120.0	3.00	21.80	2.5:1	2.30
200.0	30.0	120.0	3.00	18.40	3.0:1	2.69
200.0	30.0	120.0	3.00	15.90	3.5:1	3.08
200.0	30.0	120.0	3.00	14.00	4.0:1	3.48

Existing Fill Soils

100.0	30.0	120.0	3.00	45.00	1.0:1	0.89
100.0	30.0	120.0	3.00	30.50	1.7:1	1.11
100.0	30.0	120.0	3.00	26.60	2.0:1	1.25
100.0	30.0	120.0	3.00	21.80	2.5:1	1.50
100.0	30.0	120.0	3.00	19.00	2.9:1	1.71
100.0	30.0	120.0	3.00	18.40	3.0:1	1.76
100.0	30.0	120.0	3.00	14.00	4.0:1	2.30

Compacted Fill Soils

300.0	33.0	120.0	3.00	45.00	1.0:1	1.98
300.0	33.0	120.0	3.00	33.70	1.5:1	2.27
300.0	33.0	120.0	3.00	26.60	2.0:1	2.70
300.0	33.0	120.0	3.00	18.40	3.0:1	3.72
300.0	33.0	120.0	3.00	14.00	4.0:1	4.80

SURFICIAL STABILITY

APPENDIX A:**EXPLORATIONS AND LABORATORY TESTS****A.1 EXPLORATIONS**

The soil conditions beneath the level portion of the site were explored by drilling 26 borings (Borings 1 through 26) at the locations shown on Plate 2-1. (Borings 1 through 10 were drilled in May and August of 1986; Borings 11 through 26 were drilled in February of 1987.) The borings were drilled to depths of 47 to 71 feet below the existing grade using 5-inch-diameter rotary wash-type drilling equipment. Drilling mud was used with the rotary wash-type equipment to prevent caving. Supplementary borings were drilled adjacent to Borings 4 and 5 using 20-inch-diameter bucket-type drilling equipment and adjacent to Borings 7, 9, and 10 using 8-inch-diameter auger-type equipment for additional water level information. About 15 to 20 feet of perforated PVC pipe was installed in Borings 11 through 19 and 21 through 26 to allow continued monitoring of water levels.

The soils encountered were logged by our field technician, and undisturbed samples were obtained for laboratory inspection and testing. The logs of the borings are presented on Plates A-1.1 through A-1.26; the depths at which undisturbed samples were obtained are indicated to the left of the boring logs. The energy required to drive the sampler 12 inches is indicated on the logs. The soils are classified in accordance with the Unified Soil Classification System described on Plate A-2.

A.2 LABORATORY TESTS

The field moisture content and dry density of the soils encountered were determined by performing tests on the undisturbed samples. The results of the tests are shown to the left of the boring logs.

To determine the liquid limit and plasticity index of the soils and to aid in classifying the soils, the Atterberg Limits were determined for selected samples. The results of the tests are presented on the boring logs.

Direct shear tests were performed on numerous undisturbed samples to determine the strength of the soils. The tests were performed at field and at nearly saturated moisture contents (after soaking for 24 hours) and at various surcharge pressures. The yield-point values determined from the direct shear tests are presented on Plates A-3.1 and A-3.2, Direct Shear Test Data.

Confined consolidation tests were performed on 29 undisturbed samples to determine the compressibility of the soils. Water was added to seven of the samples during the tests to illustrate the effect of moisture on the compressibility. The results of the tests are presented on Plates A-4.1 through A-4.15, Consolidation Test Data.

Expansion tests were performed on six undisturbed samples to determine volume change of the soils due to changes in the moisture content. The samples were confined under a nominal surcharge pressure, soaked, and the resulting expansion was measured. Next, the samples were allowed to air-dry and the resulting shrinkage was measured. The results of the expansion tests are presented on Plates A-5.1 and A-5.2, Expansion Test Data.

To determine the particle size distribution of the soils and to aid in classifying the soils, mechanical analyses were performed on 17 samples. The results of the mechanical analyses are presented on Plates A-6.1 through A-6.9, Particle Size Distribution.

Soil corrosivity studies were performed for us by M. J. Schiff & Associates. Schiff's report, dated March 19, 1987, is presented on Plates A-7.1 through A-7.4.

JOB L9032AED DATE 8/27/90 DR. O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN-TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
10		18.6	108	9			CL
							ML
5		44.8	76	2			CL
		29.6	94	6			SM
							ML
0		34.0	88	2			CH
		46.8	73	< 1			
-5							
		39.2	82	1			
-10							CL
		28.9	90	3			
-15							SP
		21.3	106	26			SM
-20							
		11.9	118	32			
-25							
		29.3	95	16			CL
-40							

BORING 1

DATE DRILLED: May 20, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 11*

COMPACTED FILL - SILTY CLAY - some Silt and Silty Sand, brown

COMPACTED FILL - SANDY SILT - mottled very dark grey and brown

SILTY CLAY - traces of organic matter, dark grey

WATER LEVEL 5/20/86

SILTY SAND - fine, dark grey

CLAYEY SILT - light brownish grey
Layers of Clay

CLAY - some organic matter, dark grey

(LL = 67%; PI = 38%)

More organic matter, black

SILTY CLAY - dark grey

GRAVELLY SAND - fine to coarse, about 30%
Gravel, some fines, dark grey

About 40% Gravel and Cobbles

*Elevations refer to datum of reference
survey; see Plate 1.Elevations of Borings 11 through 15 and
17 through 26 provided by Psomas & Assoc.
Layers of Silty Clay

SILTY CLAY - very dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.1a

JOB L-90328 AED DATE 8/27/90 DR. O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-30							
	45	13.4	119	58			
-35							
	50	8.9	133	74			
-40							
	55	10.5	130	74			
-45							
	60	11.8	125	84			

BORING 1 (CONTINUED)

DATE DRILLED: May 20, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

SANDY GRAVEL - well graded, about 50% Sand,
some fines, dark grey

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 6 1/2' 30 minutes after removal of mud; bottom of boring at 28'.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.1b

JOB L90328AEQ DATE 8/27/90 PR. O.E.

FORM 1-6

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
(ft.)	(ft.)		(% of dry wt.)	(lb./cu. ft.)	(ft.-lbs./ft.)		
10		5.9	116	7			SM ML
5		36.9	80	3			ML
5		35.6	84	2			ML
10		19.0	109	5			ML
0							ML
15		22.3	107	8			SM
-5							ML
20		24.8	99	3			GP
-10							ML
25							ML
-15							ML
30		34.5	88	3			ML
-20							ML
35		42.1	80	5			SW
-25							SW
40							SW

BORING 2

DATE DRILLED: May 20, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 12

FILL - SILTY SAND and CLAYEY SILT - brown and very dark grey

CLAYEY SILT - black

(LL = 58%; PI = 27%)

X WATER LEVEL 5/20/86

SILT - some Sand, dark grey

SANDY SILT - dark grey

SILTY SAND - fine, dark grey

CLAYEY SILT - cemented nodules, dark grey

SANDY GRAVEL - fine, grey

SANDY SILT - grey

CLAYEY SILT - some organic matter, some shells, very dark grey

(LL = 34%; PI = 9%)

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, light grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.2a

JOB 29050AEO DATE 8/27/90 DR OE

... 12.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 2 (CONTINUED)

DATE DRILLED: May 20, 1986
EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30		16.4	111	37			
45		24.8	94	47			
-35							
50		7.5	127	58			
-40							
55		21.6	107	82			SP
-45							
60		20.9	105	58			
-50							
65		15.4	116	84			
-55							
70		14.3	117	140			
-60							
75							

Layers of fine Sand

SAND - fine to medium, few Gravel, light grey

Fine Sand

Fine to medium Sand

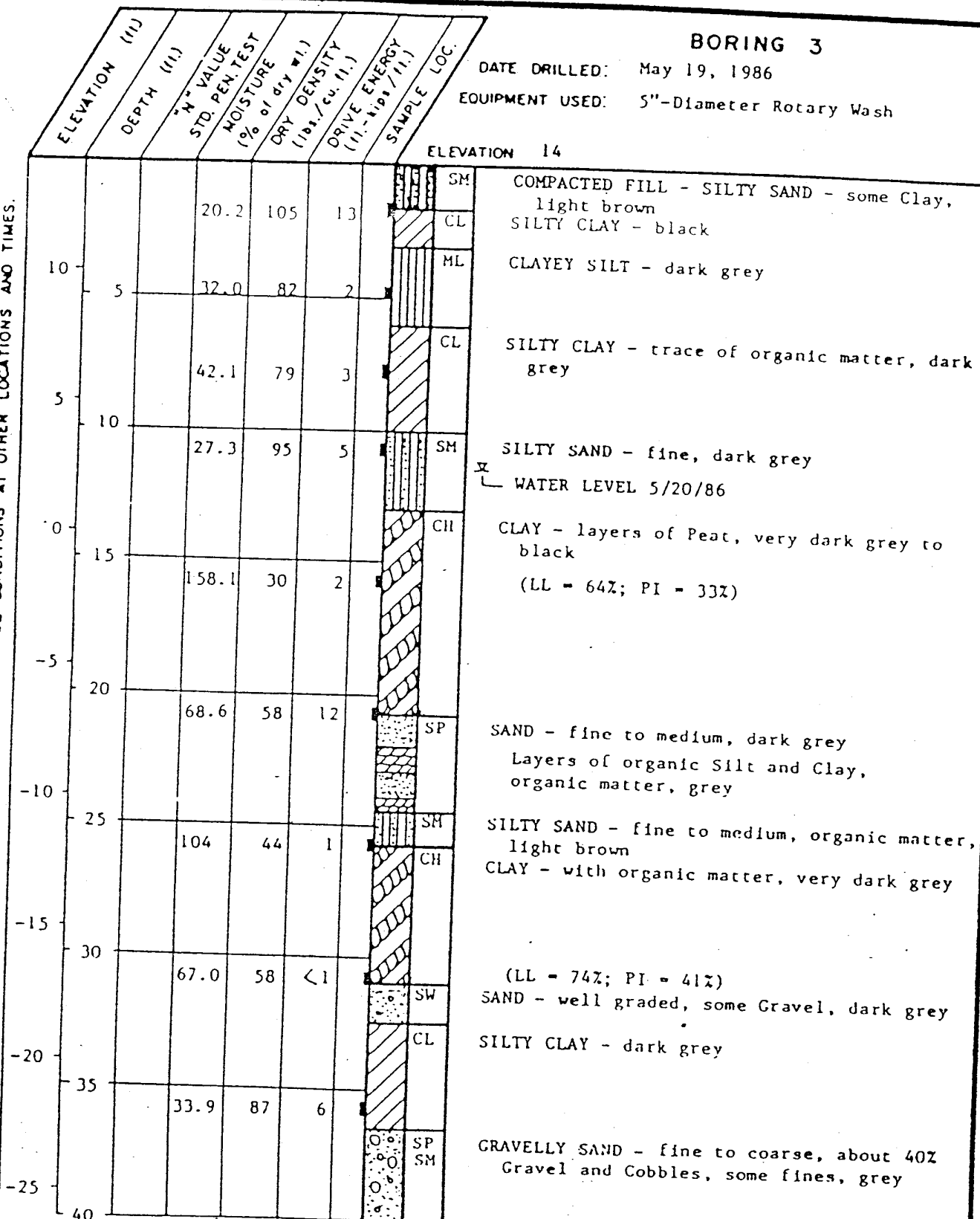
NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 8' 4 hours after removal of mud; bottom of boring at 39'.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOBS 420528/460 DATE 8/27/90 DR. OF

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB 440328 AED DATE 8/27/90 DR. O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
		8.3	134	58			
-30	45	13.2	124	84			
-35	50	1.3	142	70			
-40	55	8.5	136	105			
-45	60	8.7	130	126			
-50	65						

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 11 1/2' 16 hours after removal of mud; bottom of boring at 32'.

BORING 3 (CONTINUED)
DATE DRILLED: May 19, 1986
EQUIPMENT USED: 5"-Diameter Rotary Wash

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.3b

JOB 190328 AEO DATE 8/27/90 DR O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
15		24.4	95	7		CL
5		23.8	89	5		ML
10		37.4	82	3		CH
10		18.2	109	5		CL
5						
15		15.5	109	12		SH
0						
20		18.6	111	12		CL
-5						SP
25		17.1	113	26		
-10						
30		23.3	97.1	32		
-15						
35		17.0	105	26		
-20						
40						SW

BORING 4

DATE DRILLED: May 19, 1986
EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 18

SILTY CLAY - black

SANDY SILT - greyish brown

CLAY - traces of organic matter, dark grey
(LL = 65%; PI = 43%)

SILTY CLAY - very dark grey

SILTY SAND - fine, greyish brown
Some coarser Sand

SILTY CLAY - dark grey

SAND - fine to medium, light brown
WATER LEVEL 5/20/86

Grey

Layers of Silty Clay

SAND - well graded, about 40% Gravel and
Cobbles, grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.4a

BORING 4 (CONTINUED)

DATE DRILLED: May 19, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-25			18.8	108	42		
45			10.5	130	84		
-30							
50			7.8	128	180		
-35							
55							
-40							SP
60							

Dark grey

SAND - fine, grey

- NOTES: 1) Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 23' 17 hours after removal of mud; bottom of boring at 24'.
- 2) Drilled 20"-diameter bucket boring to 27' depth on July 29, 1986. Water seepage encountered at 23½'. Water level at 25½' 10 minutes after completion of drilling.

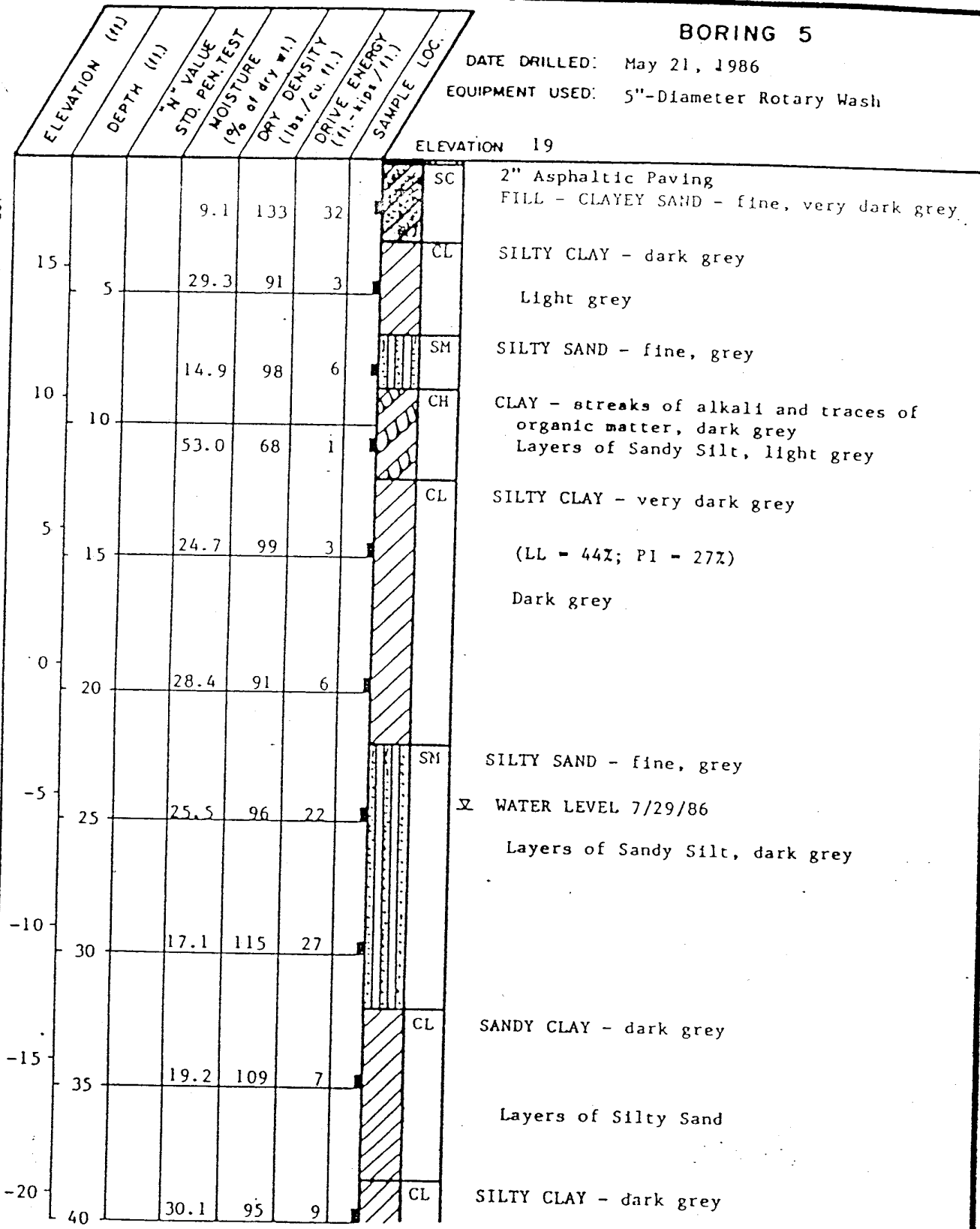
LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.4b

DATE 2/27/90 DR UE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB

L 90323 AEO DATE 8/27/90 DR. RE

124

FORM

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-25	45	8.2	136	82			SW SM
-30	50	8.7	135	58			
-35	55	7.1	133	84			
-40	60						SP

BORING 5 (CONTINUED)

DATE DRILLED: May 21, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

GRAVELLY SAND - well graded, about 30%
Gravel and Cobbles, some fines, grey

Boulder

SAND - fine, some fines, light grey

NOTES: 1) Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 35'. Water level measured at 25' 30 minutes after removal of mud; bottom of boring at 25'.

2) Drilled 20"-diameter bucket boring to 26 1/2' depth on July 29, 1986. Water seepage encountered at 26'. Water level at 24 1/2' 10 minutes after completion of drilling.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.5b

Form 125
 JOB 190328 AFO DATE 8/27/90 DR. OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

							BORING 6	
							DATE DRILLED:	August 18, 1986
							EQUIPMENT USED:	5"-Diameter Rotary Wash
ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.	
							ELEVATION 15	
10	5	13.9	123	7			SM	COMPACTED FILL - SILTY SAND and SILTY CLAY - some Cobbles, pieces of concrete dark brown
							CL	Layers of Gravel
		10.4	123	6			CL	COMPACTED FILL - SILTY CLAY - some Sand, dark grey
5	10	12.7	119	6				Some pieces of brick or asphaltic paving
							ML	COMPACTED FILL - SANDY SILT - some Silty Sand, some Gravel, dark greyish brown
		11.0	118	8				
0	15	35.1	84	2			ML	CLAYEY SILT - grey
							CL	SILTY CLAY - traces of organic matter, some Sandy lenses, dark grey
								WATER LEVEL 8/18/86
-5	20	39.2	84	2			ML	CLAYEY SILT - traces of organic matter, grey
								Lenses of Clay
							ML	SANDY SILT - some Gravel, dark grey
-10	25	20.3	109	2				Layers of coarse Sand with Gravel
							SP	SAND - fine to coarse, about 20% Gravel, dark grey
		24.7	101	14				
-15	30						ML	SANDY SILT - dark grey
		34.2	90	3				
							CH	CLAY - dark grey
-20	35							Lenses of Sand
		31.4	93	4				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB. 4-10342 A-1. DATE 8/14/86. VK. CUS.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
-30	45		37.3	85	3		
-35	50		29.6	96	6		
-40	55		30.5	93	6		
-45	60		6.6	133	38		SP

BORING 6 (CONTINUED)

DATE DRILLED: August 18, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

(LL = 53%; PI = 27%)

Layer of fine Sand

SAND - fine and medium, large amount of Gravel and Cobbles, grey

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 15' after removal of mud; bottom of boring at 17½'.

LOG OF BORING

LeROY CRANDALE AND ASSOCIATES

PLATE A-1.6b

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.	
(ft.)	(ft.)		(% of dry wt.)	(lb./cu. ft.)	(ft.-lb./ft.)			
								ELEVATION 10
		8.4	117	10			SM	COMPACTED FILL - SILTY SAND and CLAYEY SAND - fine, light brown
5	5	15.7	114	7			CL	COMPACTED FILL - SANDY CLAY - some Gravel, brown
		19.0	109	9				Dark grey
0	10	37.4	82	2			CL	SILTY CLAY - dark grey
								WATER LEVEL 8/19/86
		33.2	90	2			ML	SANDY SILT - brownish grey
-5	15							Layers of Silty Sand with some shells
		37.1	85	2				Grey
-10	20						CL	SILTY CLAY - some shells, dark grey
		53.5	69	2				Lenses of coarse Sand and some Gravel from 23' to 29' (LL = 42%; PI = 20%)
-15	25							
-20	30	23.1	102	1				
		27.9	97	2				
-25	35						ML	SANDY SILT - dark grey
-30	40	26.7	99	3				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.7a

BORING 7 (CONTINUED)

DATE DRILLED: August 18, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOG.
-35	45	35.0	88	2			CL
-40	50	29.2	95	3			
-45	55	32.7	90	3			
-50	60	31.9	91	9			SP SM
-55	65						

SILTY CLAY - dark grey

SAND - fine, some Gravel, dark grey

SILTY SAND - fine, dark grey

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 10½' after removal of mud and at 10' 17 hours later; bottom of boring at 14'.

Drilled 8"-diameter auger boring 10' east of rotary wash boring to a depth of 12' for water level determination. Water level measured at 10½' 10 minutes after completion of drilling.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.7b

JOB L90328 AEO DATE 8/24/86 DR. J. CE.

Form 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

							BORING 8	
							DATE DRILLED:	August 19, 1986
							EQUIPMENT USED:	5"-Diameter Rotary Wash
ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	ELEVATION 11	
10		14.8	106	6			CL SP	COMPACTED FILL - CLAY and SAND - some hydrocarbons, petroleum odor, dark greyish brown
		15.4	115	6				
5	5	6.8	103	17			SM	COMPACTED FILL - SILTY SAND - fine, light brown
		17.8	101	18				
0	10	18.1	103	10				
							CL	SILTY CLAY - traces of organic matter, dark grey
-5	15	39.3	80	2				WATER LEVEL 8/19/86
							ML	CLAYEY SILT - lenses of fine Sand, layers of Clay, grey
-10	20	33.2	89	2				(LL = 37%; PI = 11%)
							CL	SILTY CLAY - traces of organic matter, lenses of Silty Sand, dark grey
-15	25	99.5	45	1				Lenses of coarse Sand and Gravel with shells
-20	30	30.4	89	1				
-25	35	19.5	113	2				Layer of Silty Sand
							SP	SAND - fine to medium, some fines, grey
40		19.5	109	18				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.8a

JOB L90328 AEODATE 8/24/90 DR. DE

FORM 124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-30							
	45		13.7	122	18		
-35							
	50		16.8	112	18		

BORING 8 (CONTINUED)

DATE DRILLED: August 19, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

SAND - well graded, some Gravel, dark grey

Layers of Silty Clay

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 25'. Water level measured at 14' after removal of mud; bottom of boring at 37'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.8b

100 190328AEO DATE 8/24/86 DR. CR. G.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

							BORING 9	
							DATE DRILLED: August 19, 1986	
							EQUIPMENT USED: 5"-Diameter Rotary Wash	
ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.	
							ELEVATION 12	
10							CL SC	COMPACTED FILL - SANDY CLAY and CLAYEY SAND - some hydrocarbons, dark brown
	5	17.2	106	6				Black
		16.6	118	6				Pieces of glass
	5	12.8	123	8				Greyish brown
							SM	COMPACTED FILL - SILTY SAND - fine, light brown
10		26.3	98	6				
0							CL	SILTY CLAY - traces of organic matter, dark grey
		31.1	91	3				Grey
15								Layers of Silty Sand from 13' to 17'
-5								WATER LEVEL 8/19/86
		48.4	71	1			ML	CLAYEY SILT - traces of organic matter, dark grey
20								
-10								
		71.6	57	1				(LL = 36%; PI = 10%)
25								Lenses of Sand
-15								
		48.8	76	8				Layers of Silty Sand from 27' to 30'
30								Lenses of Sand
-20								
		51.0	60	1				Layers of Peat
35								
-25							SP	SAND - fine, grey
40		21.4	104	16				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB L90328 AEO DATE 8/24/80 DR. RV DE

Form 124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30							
	45						
-35							
	50		39.5	83	3		

BORING 9 (CONTINUED)

DATE DRILLED: August 19, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

Some Gravel

SILTY CLAY - traces of organic matter, dark grey

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 25'. Water level measured at 16' after removal of mud and at 15½' 20 minutes later.

Drilled 8"-diameter auger boring 10' north of rotary wash boring to a depth of 16' for water level determination. Water level measured at 15½'. Boring squeezing in below 10'.

LOG OF BORING

L•ROY CRANDALL AND ASSOCIATES

JOB L20328AEO DATE 8/24/90 DR. ON DE

Form 124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
				(% of dry wt.)	(lb./cu. ft.)	(ft.-lbs./ft.)	
10		11.0	113	11			SH
5		23.1	103	4			ML
5		39.4	81	3			ML
10		54.9	68	1			CH
0		38.0	81	<1			
15							
-5		62.7	62	1			
20							
-10		26.4	98	3			SM
25							
-15		27.6	98	7			CL
30							
-20		15.1	117	13			SP
35							
-25		22.3	108	18			
40							

BORING 10

DATE DRILLED: August 19, 1986
EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 13

FILL - SILTY SAND - fine, light brown

FILL - SANDY SILT - grey
Dark grey
Some Clay, black

CLAY - traces of organic matter, black

Layers of Silty Sand from 10' to 11½'

WATER LEVEL 8/19/86

Lenses of Sand

SILTY SAND - fine, some shells, dark grey

SILTY CLAY - dark grey

SAND - fine to medium, layers of Silty Sand, some Gravel, grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 10 (CONTINUED)

DATE DRILLED: August 19, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30				16.9	119	19	
-45							
-35							
50				16.6	121	16	

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 11' after removal of mud and at 11' 30 minutes later.

Drilled 8"-diameter auger boring 10' south of rotary wash boring to a depth of 12' for water level determination. Water level measured at 11½'. Boring squeezing in between 7' and 8'.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.10b

VER 4-20-85, ALIQUOT DATE: 8/24/80 DE QU 0.5

JOB L90322BAE DATE 8/24/90 DR. BY O.E

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.	
								ELEVATION 14.4
		16.6	108	7			CL SN	COMPACTED FILL - SILTY CLAY and SILTY SAND - fine, brown and grey
10	5	16.7	121	5				Pieces of concrete and brick, some hydrocarbons, some Cobbles
		16.0	107	4				About 10% Gravel
5	10							Pieces of asphaltic paving
		11.0	118	6				
0	15	12.1	102	1			CL X SN	SILTY CLAY - black WATER LEVEL 4/6/87 SILTY SAND - fine, grey
		34.7	87	2				Layer of Sandy Silt
-5	20	45.2	79	2			NL	SANDY SILT - traces of organic matter, dark grey
-10		53.3	68	1			HI	ELASTIC SILT - traces of organic matter, shells, dark grey
-15	30	29.8	92	2			CL	SILTY CLAY - some shells, black (LL = 33%; PI = 15%)
-20	35	24.4	99	2			NL	SANDY SILT - dark grey
							SN	SILTY SAND - fine, grey
-25	40	21.1	154	11			SP SN	SAND - fine to coarse, few Gravel, some fines, grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB L20328 AED DATE 8/24/90 DR. ON 05

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOG
			(% of dry wt.)	(lb./cu. ft.)	(ft.-lb./ft.)		
-30	45	15.2	115	10			
-35	50	38.8	83	4			CL
-40	55	39.1	81	2			
-45	60	27.5	97	5			ML
-50	65	15.4	117	45			SW
-55	70	10.3	123	33			

BORING II (CONTINUED)
DATE DRILLED: February 12, 1987
EQUIPMENT USED: 5"-Diameter Rotary Wash

SILTY CLAY - dark grey

SANDY SILT - dark grey

GRAVELLY SAND - well graded, about 30% Gravel, grey
About 40% Gravel and Cobbles

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 35'. Water level measured at 15' 30 minutes after removal of mud and at 12-1/2' on 2/17/87.

Set 20' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 13' on 4/6/87 and on 9/19/90.

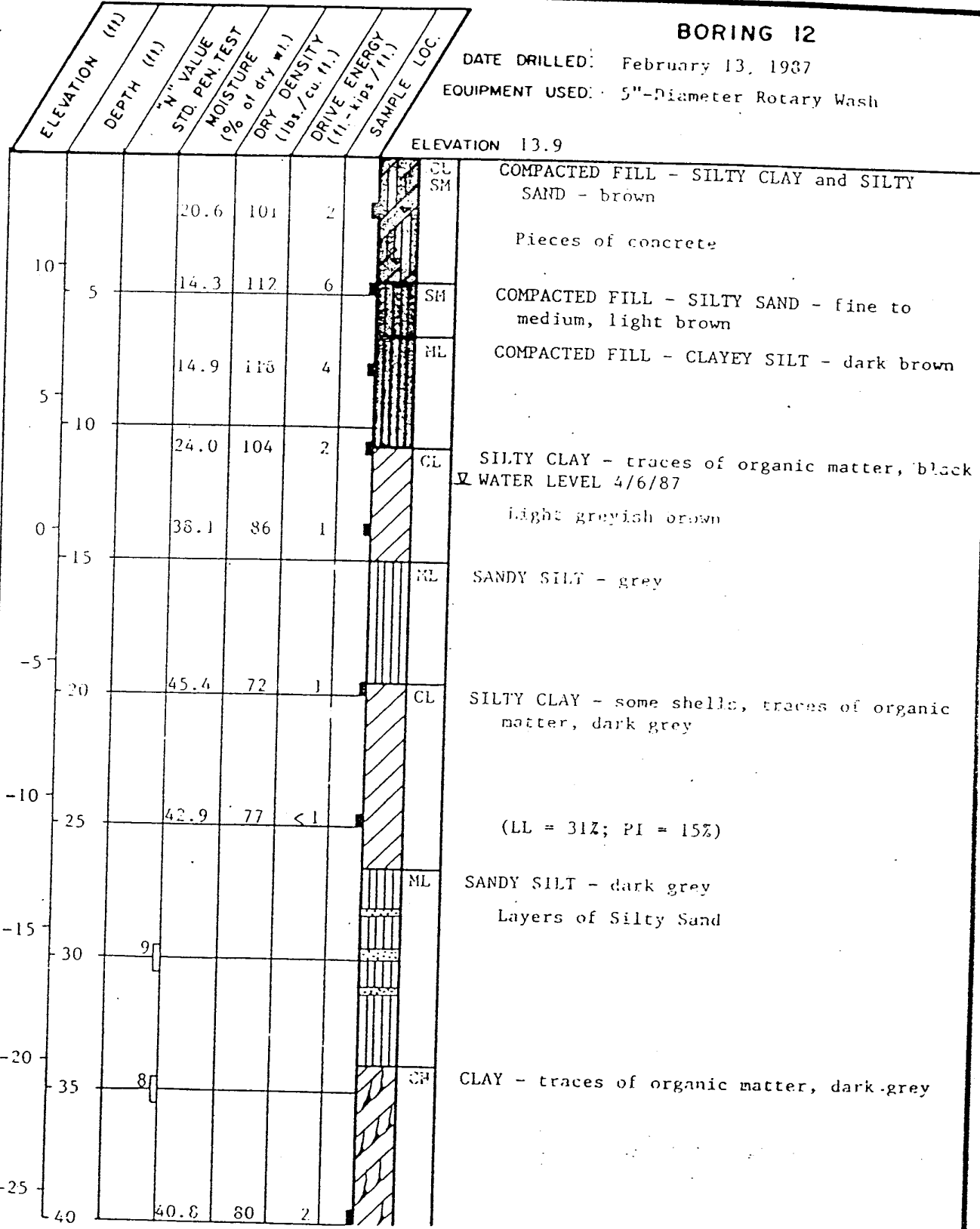
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB L90328AEQ DATE 8/24/90 DR. JUT. DE

Form 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB L 90328 AED DATE 8/24/90 DE OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
-30	45		49.4	76	2		
-35	50	24					ML
-40	55		28.9	96	4		
-45	60		11.9	124	36		SM
-50	65						
-55	70						

BORING 12 (CONTINUED)

DATE DRILLED: February 13, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SANDY SILT - dark grey

SILTY SAND - fine to coarse, about 30%
Gravel, some Cobbles, grey

Many Cobbles

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 12-1/2' on 2/14/87.

Set 19' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 12' on 4/6/87 and on 9/19/90. Water level measured at 12-1/2' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.12b

JOB L90328AED DATE 8/24/90 DE OE

Form 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
(ft.)	(ft.)		(% of dry wt.)	(lb./cu. ft.)	(ft.-kips/ft.)		
10		14.2	111	8			ML
5		10.9	124	11			SM CL
5		23.6	103	3			CL
10							CL
0		55.5	68	< 1			ML CH
15		37.5	86	2			ML
-5		51.2	72	1			CH
-20		60.7	65	1			
-10		22.5	107	1			CL
-25							
-30		30.3	96	2			
-20							
-35		28.2	98	5			ML
-25							
-40		30.8	91	3			

BORING 13

DATE DRILLED: February 13, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 12.9

COMPACTED FILL - SANDY SILT - pieces of concrete, greyish brown to dark brown

COMPACTED FILL - SILTY SAND and SILTY CLAY - dark brown

COMPACTED FILL - SILTY CLAY - pieces of brick, dark brown

WATER LEVEL 4/6/87

SILTY CLAY - black

CLAYEY SILT - greyish brown

CLAY - traces of organic matter, black

SANDY SILT - brownish grey

CLAY - layers of Sand, some cemented nodules, grey

Some shells

SILTY CLAY - traces of organic matter, black

Layers of Sandy Silt, some Gravel, dark brown
Dark grey

SANDY SILT - dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.13a

BORING 13 (CONTINUED)

DATE DRILLED: February 13, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-30							CH
	45	27.5	93	2			
-35							
	50	36.4	87	4			
-40							SW
	55	10.4	127	23			
-45							
	60	12.0	123	33			SW
-50							
	65						
-55							
	70						

CLAY - dark grey

SAND - well graded, about 10% Gravel, grey

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 11-1/2' 30 minutes after removal of mud and at 9-1/2' on 2/14/87.

Set 21-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 10' on 4/6/87. Water level measured at 10-1/2' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.13b

BORING 14

DATE DRILLED: February 17, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.	ELEVATION	DESCRIPTION
				(% of dry wt.)	(lb./cu. ft.)	(ft.-lbs./ft.)		11.3	
10		18.0	113	5			CL		COMPACTED FILL - SILTY CLAY - some Sand, some hydrocarbons, brown
	5						SP		COMPACTED FILL - SAND - fine, light brown
5		7.2	118	8			SM		COMPACTED FILL - SILTY SAND - fine, dark brown
	5						ML		COMPACTED FILL - CLAYEY SILT - some Gravel, grey
10		18.3	114	4					WATER LEVEL 4/6/87
0		40.4	80	1			CL		SILTY CLAY - dark grey
	15	35.3	88	1			ML		SANDY SILT - traces of organic matter, grey
-5		44.9	78	1			CL		SILTY CLAY - traces of organic matter, grey
									Layers of fine Sand, some shells
20		39.3	83	1			ML		SANDY SILT - some layers of Clay, grey
-10									
25		0							
-15							CL		SILTY CLAY - dark grey
30		55.2	70	1					
-20									Lenses of fine Sand
35		10							
-25									
40		25.7	95	4			SM		SILTY SAND - fine, dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.14a

BORING 14 (CONTINUED)

DATE DRILLED: February 17, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30							
45	24						
-35							SP
50	27						
-40							
55	23.4	105	7				
-45							
60	13.2	126	27				SW
-50							
65							
-55	11.8	129	36				
70							

SAND - fine to coarse, some Gravel, dark grey

Grey

Layers of Silt and Clay

Some organic matter

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 10-1/2' 30 minutes after removal of mud and at 9' on 2/18/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 9-1/2' on 4/6/87. Water level measured at 11' on 9/19/90.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.14b

JOB L70 KB AEU DATE 8/24/90 DR. DE

BORING 15

DATE DRILLED: February 17, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 14.7

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS, AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.	DESCRIPTION
				% of dry wt.	(lb./cu. ft.)	(ft.-lb./ft.)		
		12.5	113	6			CL	COMPACTED FILL - CLAY - some Silt and Sand, some hydrocarbons, petroleum odor, dark brown and grey
10	5	21.1	104	4			SP	COMPACTED FILL - SAND - fine, light brown
		15.8	109	13				
5	10	18.7	110	7			CL	COMPACTED FILL - SILTY CLAY and SANDY CLAY - brown
		38.0	82	2			CH	CLAY - black WATER LEVEL 4/6/87 (LL = 61%; PI = 31%) Grey
0	15	38.4	84	1				Layers of Silty Sand
-5	20	71.9	57	1			CL	SILTY CLAY - grey
-10	25	90.9	49	1				
-15	30	42.6	81	1			CH	CLAY - few shells, dark grey
-20	35	28.4	96	2				Layers of Silty Sand
-25	40	17.1	116	4			SH	SILTY SAND - fine, dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING.

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.15a

JOB L90328 AEO DATE 8/24/90 DR. DE

Form 12.

JOB L-90328AED DATE 8/24/90 DR. DE

FORM 124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30	45	20.9	105	11			SP
-35	50	15.6	111	12			SW SM
-40	55	18.8	115	21			
-45	60						SW
-50	65	10.4	136	24			

BORING 15 (CONTINUED)
 DATE DRILLED: February 17, 1987
 EQUIPMENT USED: 5"-Diameter Rotary Wash

SAND - fine, layers of Silt and Clay, grey

SAND - well graded, about 10% Gravel, some fines, grey

Layer of Sandy Silt

Layer of Sandy Silt

GRAVELLY SAND - well graded, about 40% Gravel, grey

Layer of Clayey Silt, dark grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 13' 15 minutes after removal of mud and at 12-1/2' on 2/18/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 13-1/2' on 4/6/87 and on 9/19/90.

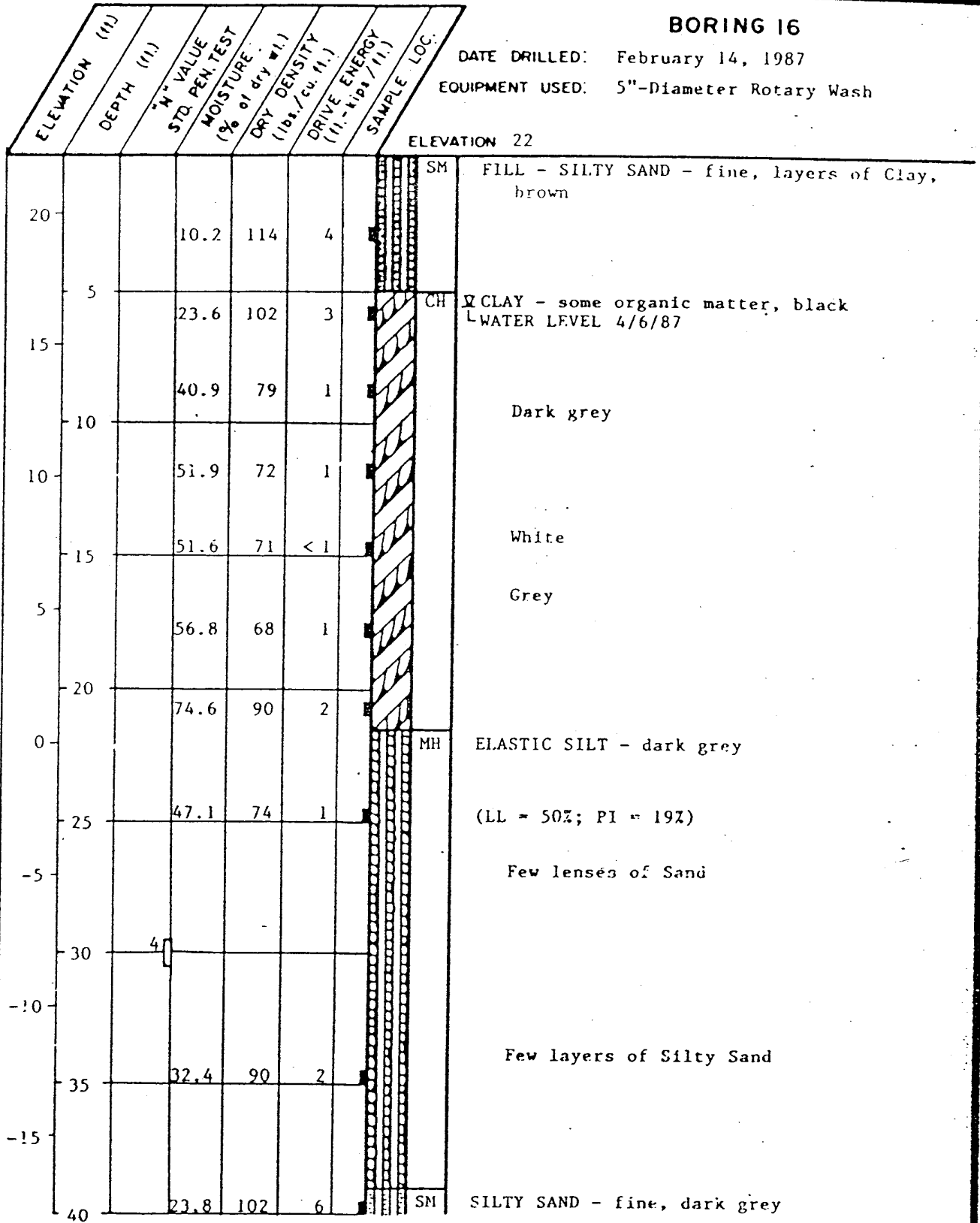
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.15b

JOB L90328 AEO DATE 8/24/90 PR. PE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

BORING 16

DATE DRILLED: February 14, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

LeROY CRANDALL AND ASSOCIATES

JOB 490328 AEO DATE 8/24/90 DR. CRG

Form 129

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
-20							
	45	50					
-25							SW
	50	28.4	97	22			SM
-30							SP SM
	55	55					
-35							
	60	16.2	110	21			SP
-40							
	65	23.8	98	14			SM
-45							
70		24.6	92	15			

Grey

SAND - well graded, about 10% Gravel, grey

SILTY SAND - fine, dark grey

SAND - fine, some fines, grey

SAND - fine to medium, few Gravel, light grey

SILTY SAND - fine, dark grey

Piece of wood, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 35'. Water level measured at 8' 30 minutes after removal of mud and at 5-1/2' on 2/17/87.

Set 18-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 5-1/2' on 4/6/87. Water level measured at 7' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.16t

BORING 17

DATE DRILLED: February 16, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 15.8

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
(ft.)	(ft.)			(% of dry wt.)	(lb./cu. ft.)	(ft.-lb./ft.)	
15				17.6	110	3	CL
10	5			7.7	111	15	SM
5	10			20.1	112	4	CL
0	15			23.0	102	5	CL
-5	20			33.7	86	2	ML
-10	25			38.2	85	1	CL
-15	30			49.8	73	1	CL
-20	35	24		41.3	81	1	SM
-25	40			24.9	104	4	ML
				32.0	92	1	

COMPACTED FILL - SILTY CLAY - some Silty Sand, some hydrocarbons, petroleum odor, greyish brown

COMPACTED FILL - SILTY SAND - fine, light brown

COMPACTED FILL - SILTY CLAY - some Sand, greyish brown

SILTY CLAY - traces of organic matter, black

WATER LEVEL 4/6/87
Some cemented nodules, grey

CLAYEY SILT - dark grey

SILTY CLAY - dark grey

Some layers of Silty Sand

SILTY SAND - fine, dark grey

CLAYEY SILT - some organic matter, dark grey

(LL = 34%; PI = 7%)

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.17a

Form L-1003B-AEQ DATE 8/24/90 DR DE

BORING 17 (CONTINUED)

DATE DRILLED: February 16, 1987
EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N° VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
-25							
	45	34.5	90	2			
-30							
	50	33.4	90	2			
-35							
	55	100 (9" pen)					SP
-40							SW SM
	60	10.1	130	51			
-45							
	65	13.0	129	36			
-50							
	70						

Streaks of Peat and organic matter

SAND - fine to medium, grey

GRAVELLY SAND - well graded, about 30% Gravel, some fines, grey
Large Cobbles

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 14' 30 minutes after removal of mud and at 12-1/2' on 2/17/87.

Set 19' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 13' on 4/6/87.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.171

BORING 18

DATE DRILLED: February 16, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 12.3

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
				(% of dry wt.)	(lbs./cu. ft.)	(ft.-kips/ft.)	
10		15.7	117	7			CL
5		7.2	101	11			SM
5		37.9	85	2			CL
10		40.3	81	1			CL
0		26.8	100	4			ML
15		41.2	80	1			CL
-5		62.9	63	1			MH
20		97.8	56	<1			MH
-10		70.3	58	1			MH
25		18.7	115	17			SP
-15		45.7	78	2			SW MH
30							SW MH
-20							SW MH
35							SW MH
-25							SW MH
40							SW MH

COMPACTED FILL - SILTY CLAY - some Silty Sand, some hydrocarbons, dark brown

Pieces of brick and concrete

COMPACTED FILL - SILTY SAND - fine, light brown

Patches of Clay

WATER LEVEL 4/6/87

SILTY CLAY - traces of organic matter, black

SANDY SILT - grey

Layers of Silty Clay

SILTY CLAY - traces of organic matter, grey

ELASTIC SILT - some organic matter, grey

(LL = 60%; PI = 29%)

SAND - fine to medium, grey

SAND and ELASTIC SILT - interlayered, dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LoROY CRANDALL AND ASSOCIATES

PLATE A-1.18a

JOB 190328 AEO DATE 8/24/90 DR

rum 12~

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-30							
	45		13.8	113	10		SW SM
-35							
	50		24.9	103	5		SW
-40							
	55						
-45							SP
	60		20.1	104	36		

BORING 18 (CONTINUED)

DATE DRILLED: February 16, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SAND - well graded, few Gravel, some fines, dark grey

Some layers of Silty Clay and Sandy Silt (from 48' to 50-1/2')

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, grey

SAND - fine, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 9-1/2' 60 minutes after removal of mud and at 9' on 2/17/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 8-1/2' on 4/6/87. Water level measured at 11-1/2' on 9/19/90.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.18b

JOB L20328AEQ DATE 8/24/90 DR. WILLIAM DE

FORM 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.	
								ELEVATION 9.4
		11.6	105	7			CL	COMPACTED FILL - SILTY CLAY - some Silty Sand, some hydrocarbons, brown
5	5						CL	SILTY CLAY - black
		33.4	89	2				
		54.7	69	1			ML	WATER LEVEL 4/6/87 CLAYEY SILT - dark grey
0	10							
		45.4	76	1			CL	SILTY CLAY - traces of organic matter, grey
-5	15	74.8	57	1				Dark grey
		34.7	83	< 1				Grey
-10	20	32.7	90	1				
		29.2	93	7			SM	SILTY SAND - fine, grey
-15	25						CL	SILTY CLAY - layers of Sand, dark grey
-20	30	7						
-25	35	36.4	87	1				(LL = 38%; PI = 14%)
-30	40	30.9	94	2				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.19a

JOB L-90328AED DATE 2/24/90 DR. DE

FORM 12.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN-TEST (% of dry wt.)	MOISTURE	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-35	45	28.4	95	7			ML
-40	50	58					SW
-45	55						SW
-50	60	9.7	134	45			

BORING 19 (CONTINUED)

DATE DRILLED: February 17, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SANDY SILT - dark grey

SAND - well graded, few Gravel, light grey

GRAVELLY SAND - well graded, about 30% Gravel and Cobbles, light grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 8' 30 minutes after removal of mud and at 7' on 2/18/87.

Set 18-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 7-1/2' on 4/6/87. Water level measured at 13-1/2' on 9/19/90.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.19b

BORING 20

DATE DRILLED: February 19 & 20, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.	
ELEVATION 13.5								
		14.3	100	4			CL SM	COMPACTED FILL - SILTY CLAY and SILTY SAND - pieces of asphaltic paving, petroleum odor, dark grey Some hydrocarbons
10	5	13.7	104	13			SM	COMPACTED FILL - SILTY SAND - fine, some Clayey layers, some hydrocarbons, greyish brown
5		12.7	105	5				WATER LEVEL 2/20/87
10		20.8	105	1			CL	SILTY CLAY - some organic matter, some Sandy layers, dark grey
0		40.4	82	1				
15							ML	SANDY SILT - some organic matter, dark grey
-5	1						MH	ELASTIC SILT - some organic matter, black
20		107.4	42	< 1				Lenses of Peat
-10		83.5	51	< 1				(LL = 68%; PI = 32%)
25								Few Sand layers
-15	2							
30		145.4	38	2				
-20							SP SM	SAND - fine to medium, some fines, traces of organic matter, dark grey
35	18							
-25		84.4	51	1			MH CH	ELASTIC SILT and CLAY - interlayered, some Peat, some Sand, dark grey, dark brown, and black
40								

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.20a

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30	45	13				SM
-35	50	25.3	100	23		SP
-40	55	13.6	126	30		GW
-45	60	11.2	130	40		

BORING 20 (CONTINUED)

DATE DRILLED: February 19 & 20, 1987.

EQUIPMENT USED: 5'-Diameter Rotary Wash

SILTY SAND - fine, some lenses of Sandy Silt with organic matter, few Gravel, dark grey

SAND - fine, light grey

GRAVELLY SAND - well graded, about 40% Gravel, light grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 11-1/2' 15 minutes' after removal of mud and at 8-1/2' 4-1/2 hours later.

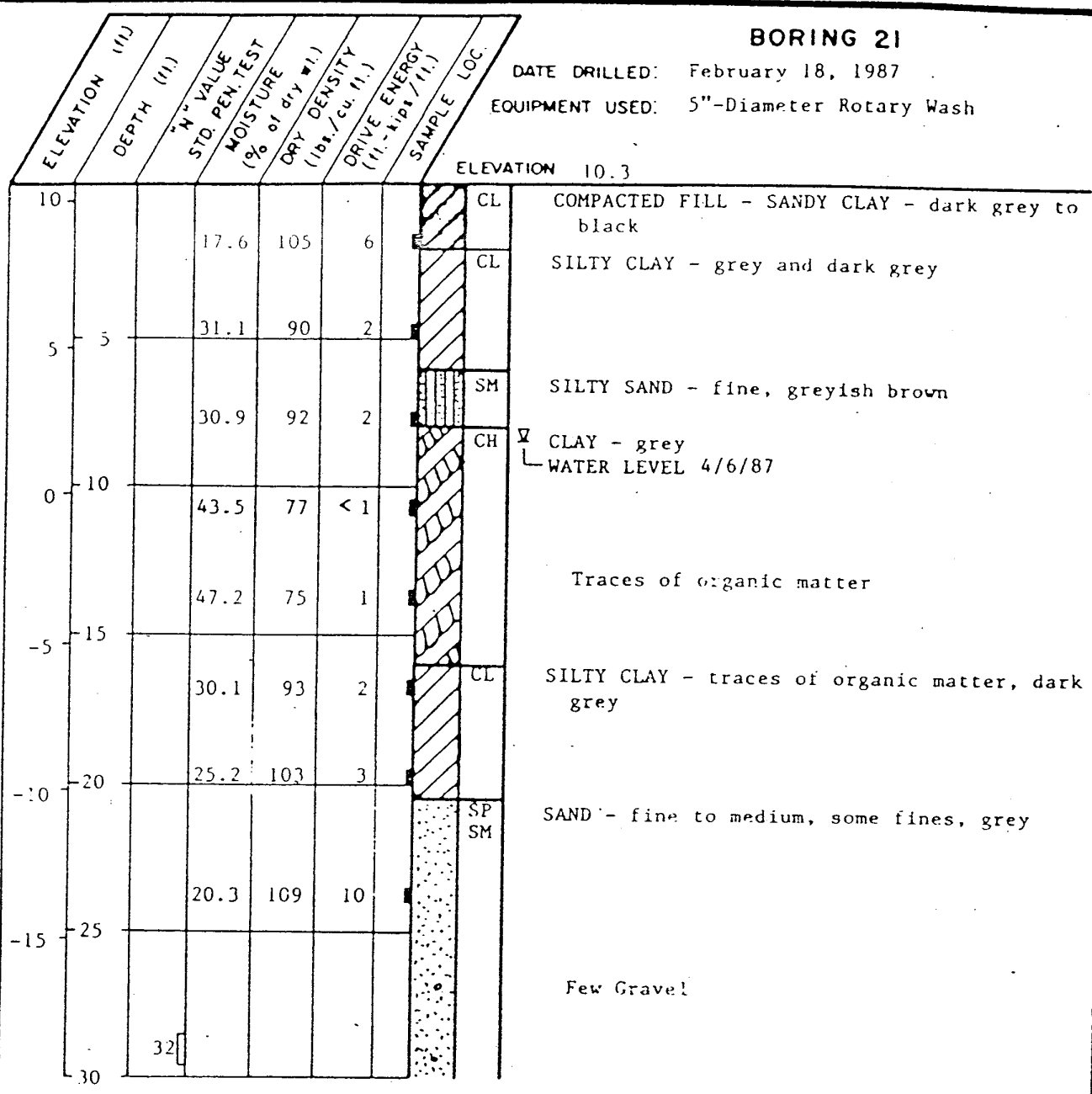
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.20b

Form 122
 JOB L-90-328A-0 DATE 8/24/90 DE CE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB 79038 DATE 8/24/90 DE OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-20							
		12.7	122	8			
-25	35						CL
							ML
		33.0	90	4			
-30	40						SP
							CL
							GP
							GM
		62					
-35	45						
-40	50						
		9.6	136	36			
-55							

BORING 21 (CONTINUED)

DATE DRILLED: February 18, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SILTY CLAY - dark grey

SILT - some organic matter, dark grey

SAND - fine, dark grey

SILTY CLAY - grey

SANDY GRAVEL - fine to coarse, about 40%
Sand, some fines, grey

Some Cobbles

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 9-1/2' 30 minutes after removal of mud and at 8-1/2' on 2/23/87.

Set 18-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 8-1/2' on 4/6/87.

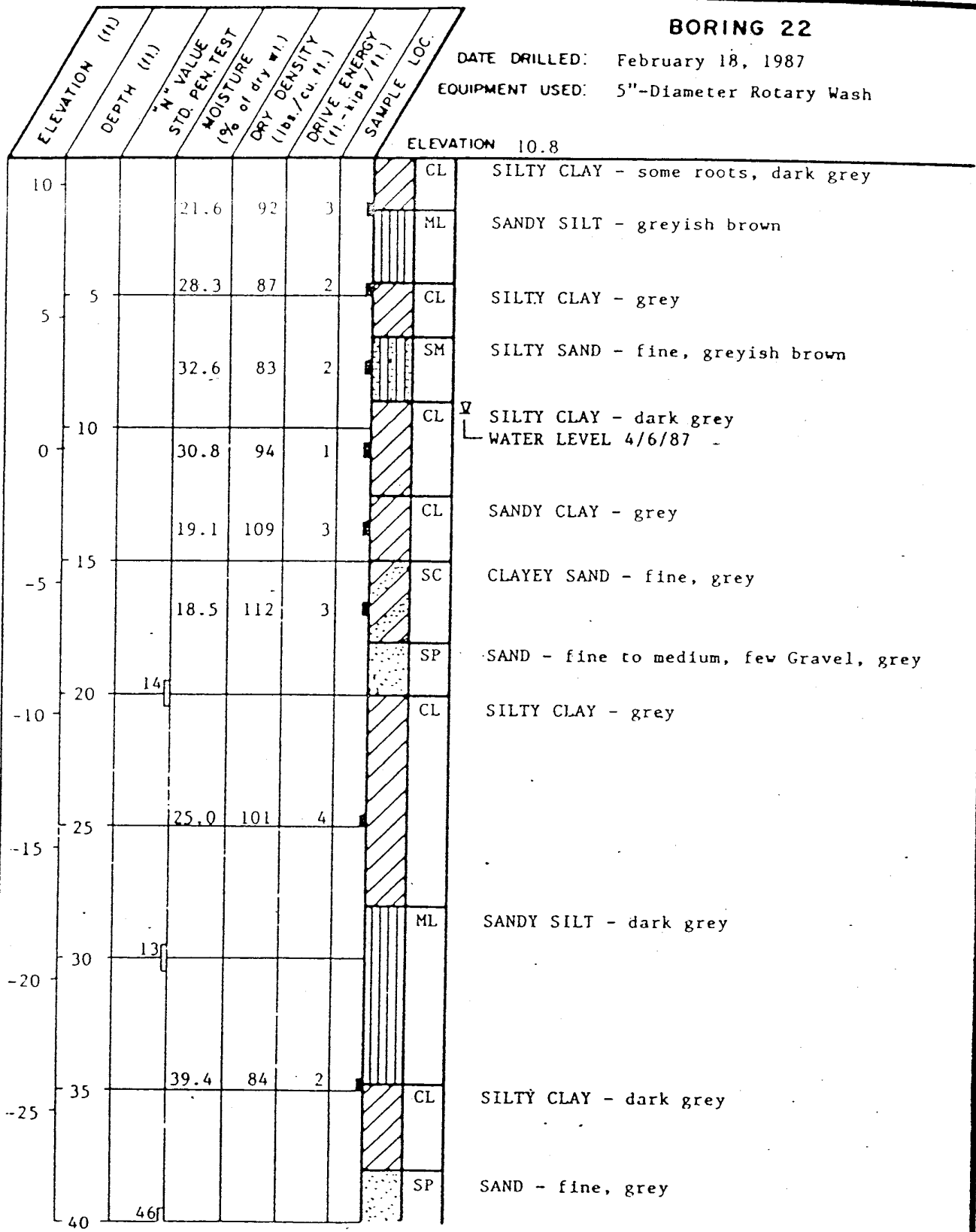
LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PI ATF A-1.21b

JOB 22032BAED DATE 8/24/90 DR. GE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LOROY CRANDALL AND ASSOCIATES

JOB LOG SHEET DATE 8/24/90 DR...

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREIN APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30							
	45		19.4	116	18		
-35							SW
	50		8.2	130	36		
-40							
55							

BORING 22 (CONTINUED)

DATE DRILLED: February 18, 1987
EQUIPMENT USED: 5"-Diameter Rotary Wash

Fine to medium Sand, few Gravel

GRAVELLY SAND - well graded, about 30% Gravel and Cobbles, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 9-1/2' 30 minutes after removal of mud and at 9-1/2' on 2/20/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 9-1/2' on 4/6/87. Water level measured at 10-1/2' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

BORING 23

DATE DRILLED: February 18, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 11.6

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
10		19.9	84	2			CL
							ML
5		34.0	83	1			CL
5		33.7	85	< 1			
10		18.4	112	4			CL
0		17.0	115	5			SC
15		25.6	99	2			CL
-5		27.2	98	2			SM
20		29.8	93	2			CL
-10		22.5	103	5			ML
25		26.9	96	5			SM
-15		4.2	123	11			SW SM
30							
-20							
35							
-25							
40							

SILTY CLAY - dark brown

SANDY SILT - light brown

SILTY CLAY - dark grey

SANDY CLAY - greyish brown

WATER LEVEL 4/6/87

CLAYEY SAND - fine to medium, grey

SILTY CLAY - grey

SILTY SAND - fine, grey

SILTY CLAY - layers of Silt and Silty Sand, dark grey

SANDY SILT - dark grey

Layers of Clay

SILTY SAND - fine, traces of organic matter, dark grey
Some Gravel

SAND - well graded, few Gravel, some fines, dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.23a

JOB 490328AEO DATE 8/24/90 DR

FORM 123

JOB L2032BAEO DATE 8/24/90 DR OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30						CL
	45					SW
-35						
	50					
-40		11.3	132	36		
	55					

BORING 23 (CONTINUED)

DATE DRILLED: February 18, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SILTY CLAY - dark grey

GRAVELLY SAND - well graded, about 30%
Gravel and Cobbles, some fines, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 11-1/2' on 2/20/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 11-1/2' on 4/6/87.

LOG OF BORING

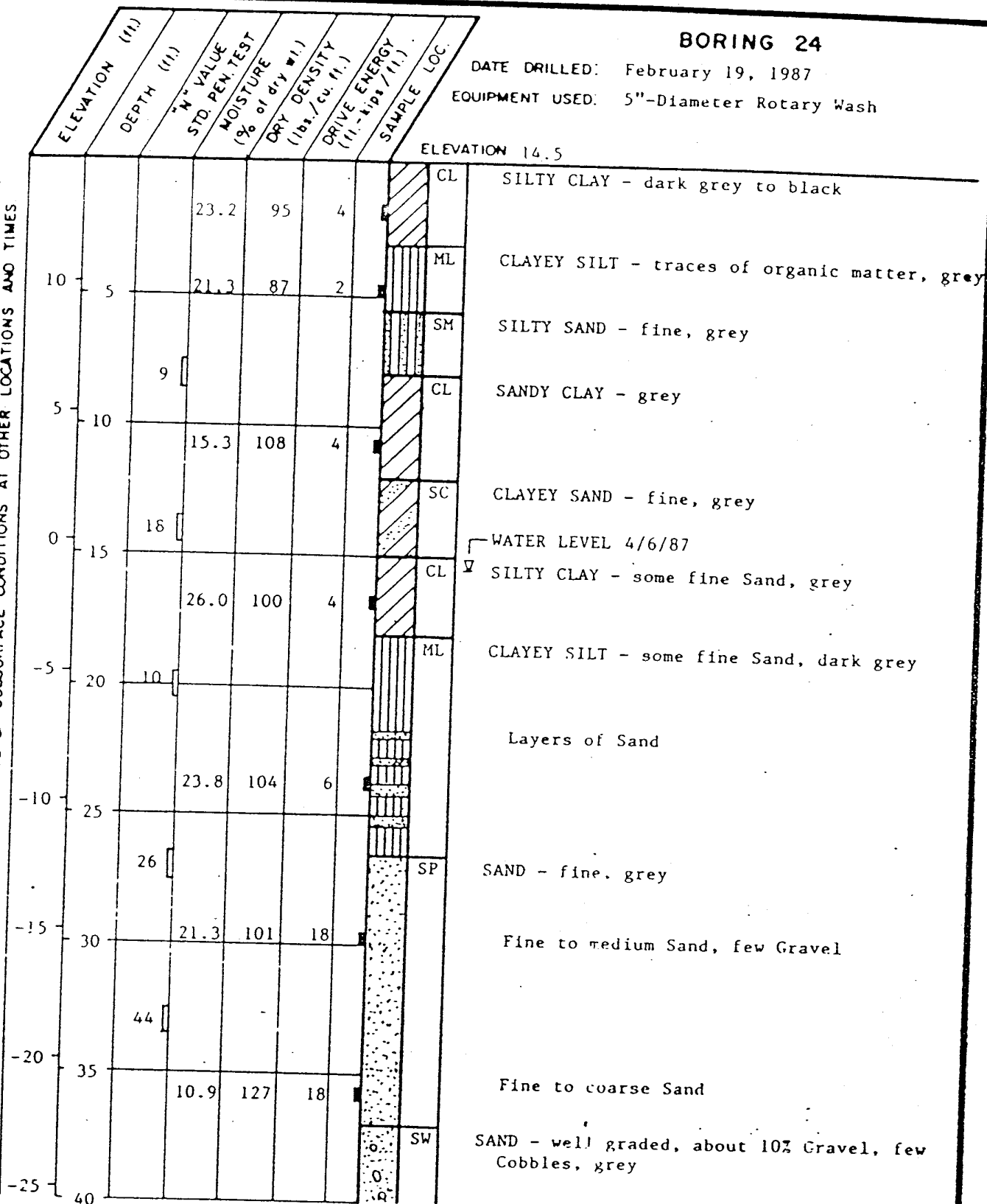
LORRY CRANDALL AND ASSOCIATES

PLATE A-1.231

WPS 190328AEQ DATE 8/24/90 DR

Form 1

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.24a

NOB 220200 AEA DATE 2/24/87 DR OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
	40						
-30	45		11.4	125	36		SW
-35	50						SP
-40	55		21.7	107	36		

BORING 24 (CONTINUED)

DATE DRILLED: February 19, 1987
EQUIPMENT USED: 5"-Diameter Rotary Wash

Few layers of fine Sand

GRAVELLY SAND - well graded, about 30% Gravel and Cobbles, grey

SAND - fine, few Gravel, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 21' 15 minutes after removal of mud and at 13-1/2' on 2/20/87.

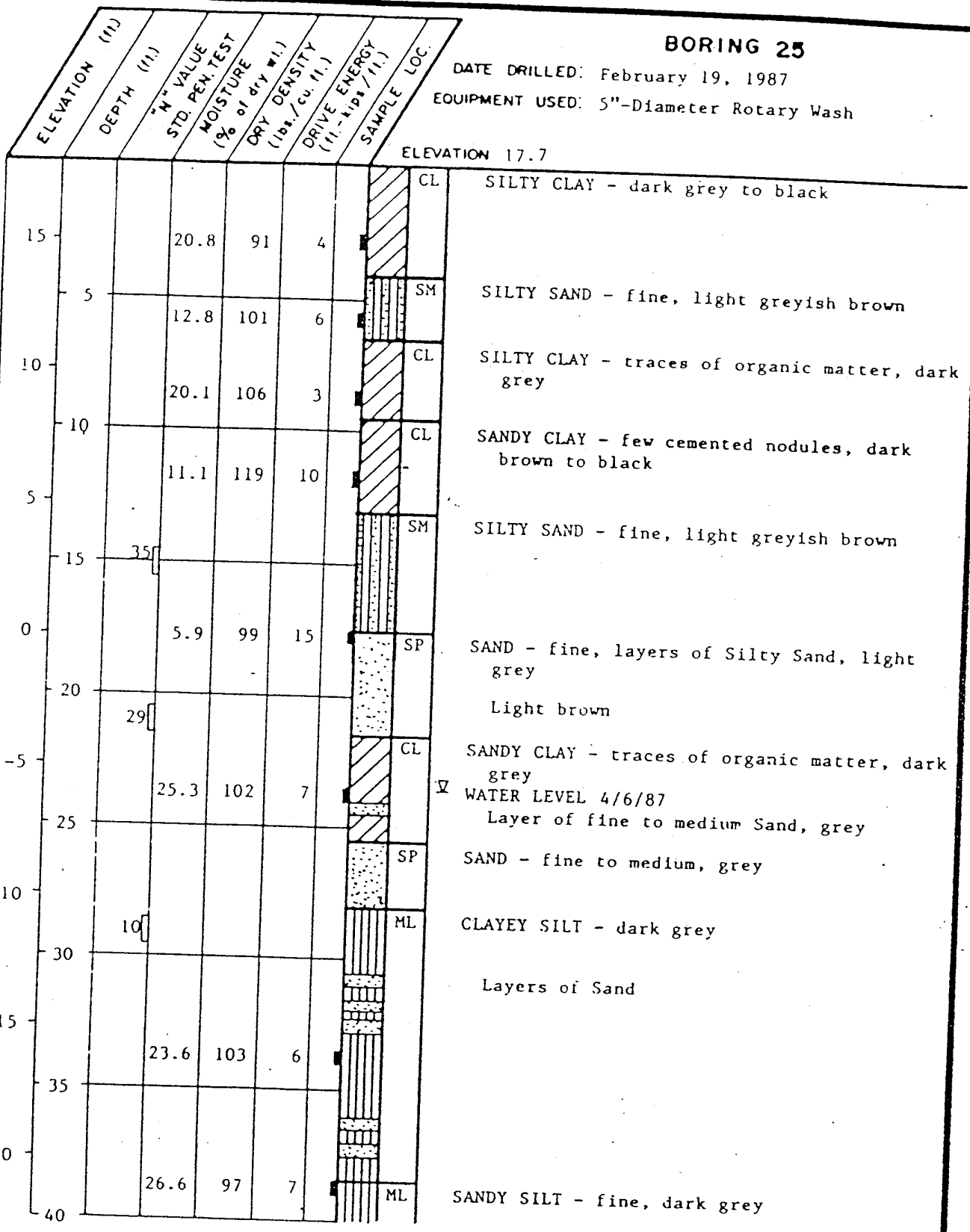
Set 15-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 15-1/2' on 4/6/87.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123, JOB 49032B AEO DATE 5/24/90 DR JUNIN O.E. 3 W.P. 13 CHKD L10

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

WIS 490305AEU DATE 01/29/90 DR DE

124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-25							SP
	45	61					SW
-30							
	50						
		9.3	132		36		
-35							
	55						

BORING 25 (CONTINUED)

DATE DRILLED: February 19, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SAND - fine, grey

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, some fines, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 24-1/2' 30 minutes after removal of mud and at 23' on 2/20/87.

Set 25' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 23-1/2' on 4/6/87. Water level measured at 24' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft)	DEPTH (ft)	N VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.	
(ft)	(ft)		(% of dry wt.)	(lb./cu. ft.)	(ft.-lb./ft.)			
							SM	1" Asphaltic Paving
		4.5	110	7				FILL - SILTY SAND - fine, brown
20	5	13.4	99	2			ML	SANDY SILT - dark brown
15	10	7.8	115	7			SM	SILTY SAND - fine, greyish brown
		15					ML	SANDY SILT - dark greyish brown
10	15	15.6	116	4				
		18					SM	SILTY SAND - fine to medium, greyish brown
5	20	8.5	112	18				Layer of Sandy Silt
		16						Fine Sand
0	25	8.4	102	30				Fine to medium Sand, some Gravel, light grey
-5	30	11						
-10	35	16.6	110	24			SP	SAND - fine to medium, grey
-15	40						SW	GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

BORING 26

DATE DRILLED: February 20, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 24.3

JOB L90328AEQ DATE 2/24/87 DR OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-20	45						
-25	50		24.1	92	36		

BORING 26 (CONTINUED)

DATE DRILLED: February 20, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 25'. Water level measured at 15' 15 minutes after removal of mud. Water not encountered on 2/23/87; mud at 29', bottom of boring at 35'.

Set 35-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water not encountered in 34' depth measured on 4/6/87.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.26b

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	 GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			 GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amt. of fines)	 GM	Silty gravels, gravel-sand-silt mixtures.
			 GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 sieve size)	CLEAN SANDS (Little or no fines)	 SW	Well graded sands, gravelly sands, little or no fines.
			 SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amt. of fines)	 SM	Silty sands, sand-silt mixtures.
			 SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (More than 50% of material is SMALLER than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit LESS than 50)		 ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			 CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			 OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (Liquid limit GREATER than 50)		 MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			 CH	Inorganic clays of high plasticity, fat clays.
			 OH	Organic clays of medium to high plasticity, organic silts.
		HIGHLY ORGANIC SOILS		Pt

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

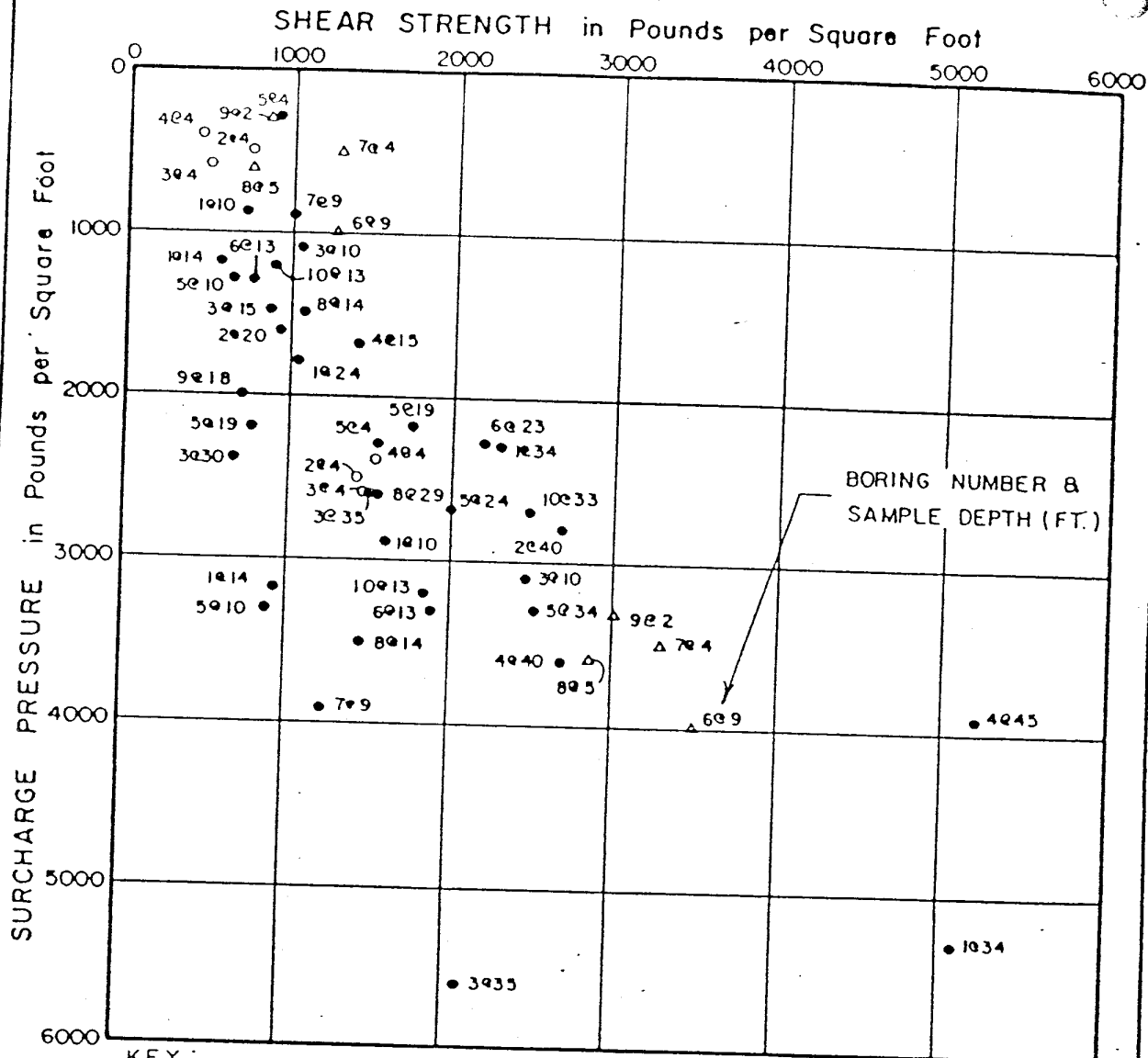
P A R T I C L E S I Z E L I M I T S						
SILT OR CLAY	SAND			GRAVEL		
	FINE	MEDIUM	COARSE	FINE	COARSE	
	NO. 200	NO. 40	NO. 10	NO. 4	3 in.	36 in.
	U. S. STANDARD SIEVE SIZE					

UNIFIED SOIL CLASSIFICATION SYSTEM

Reference:
The Unified Soil Classification System, Corps of Engineers, U. S. Army Technical Memorandum No 3-357, Vol. I, March, 1953. (Revised April, 1960)

LEROY CRANDALL & ASSOCIATES

JOB 690328AED DATE 8/24/90 DR G.E.



KEY:

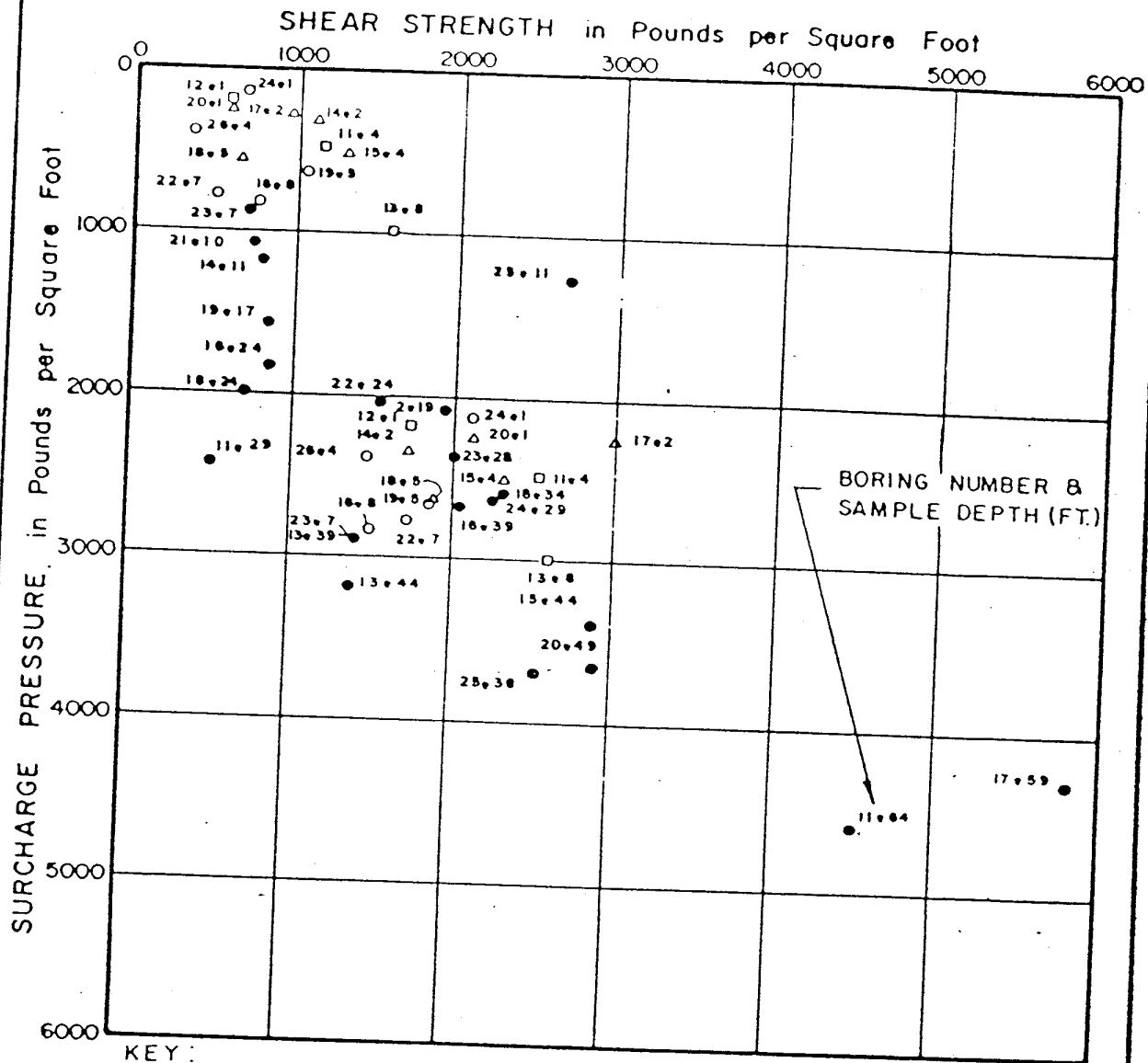
- Tests at field moisture content
- Tests at increased moisture content
- △ Tests at increased moisture content
- Compacted fill
- Natural soils

DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES

PLATE A 71

JOB L 20328AE DATE 8/24/90 PR. 05



KEY:

- Tests at field moisture content
- □ △ Tests at increased moisture content
- └─┐ Compacted fill
- └─┐ Uncertified fill
- └─┐ Natural soils

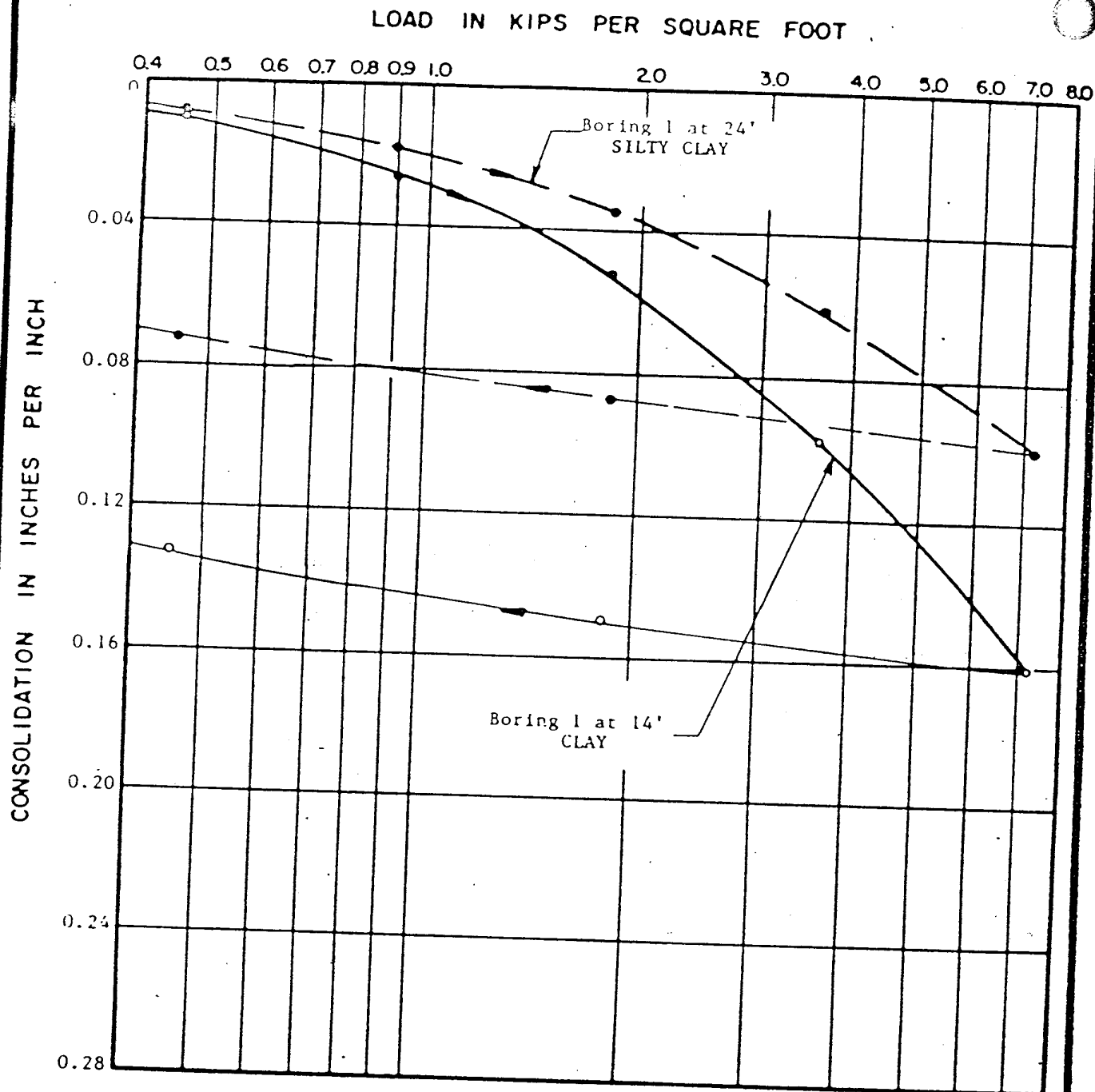
DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES

PLATE A-3.2

JOB L 20328AE0 DATE 2/24/90 BY CE

FORM 116

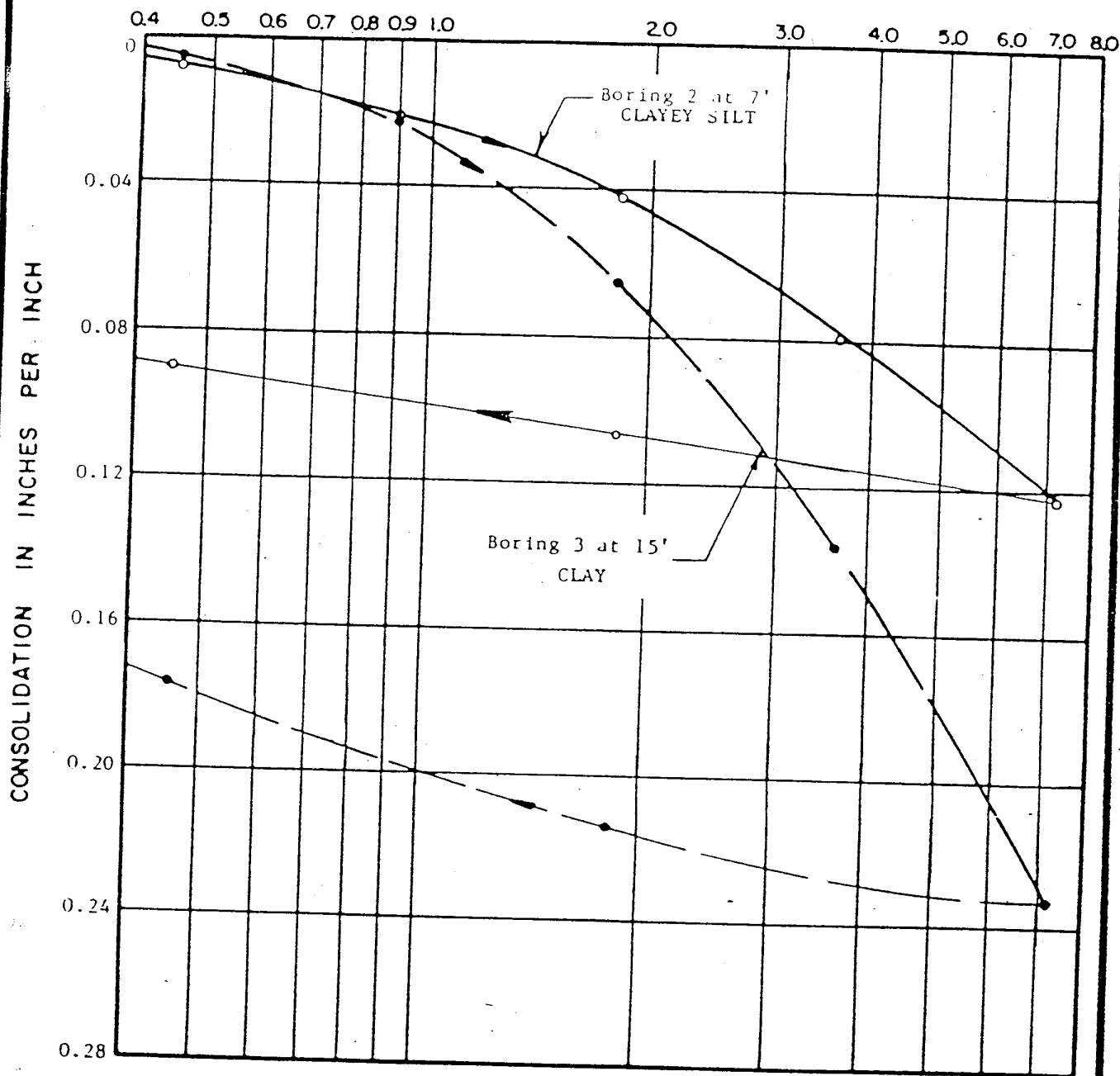


NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

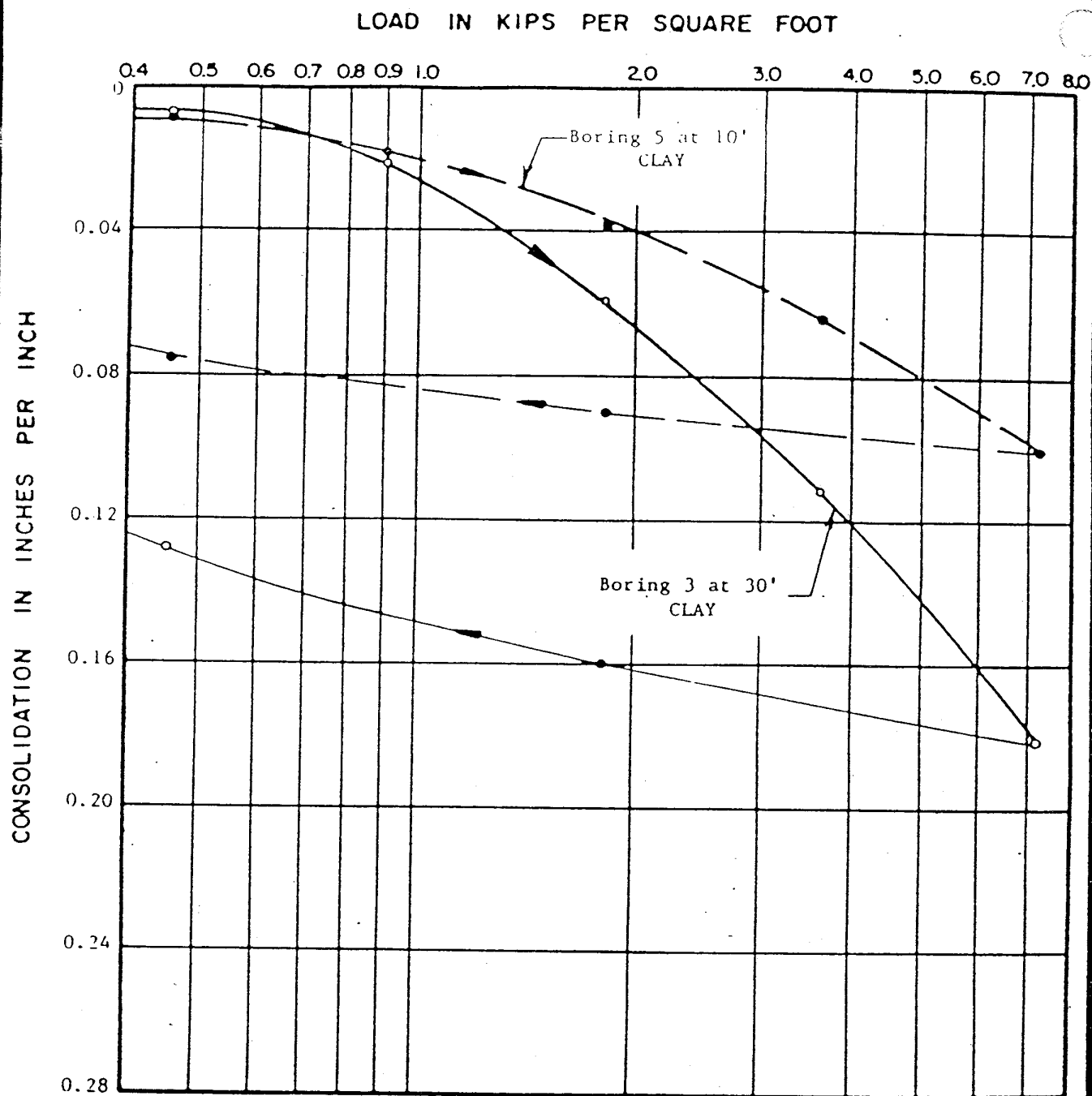
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.2

DB L90328AE0 DATE 8/24/90 PR 05

JOB L90328 AED DATE 8/24/90 DR



NOTE: Samples tested at field moisture content.

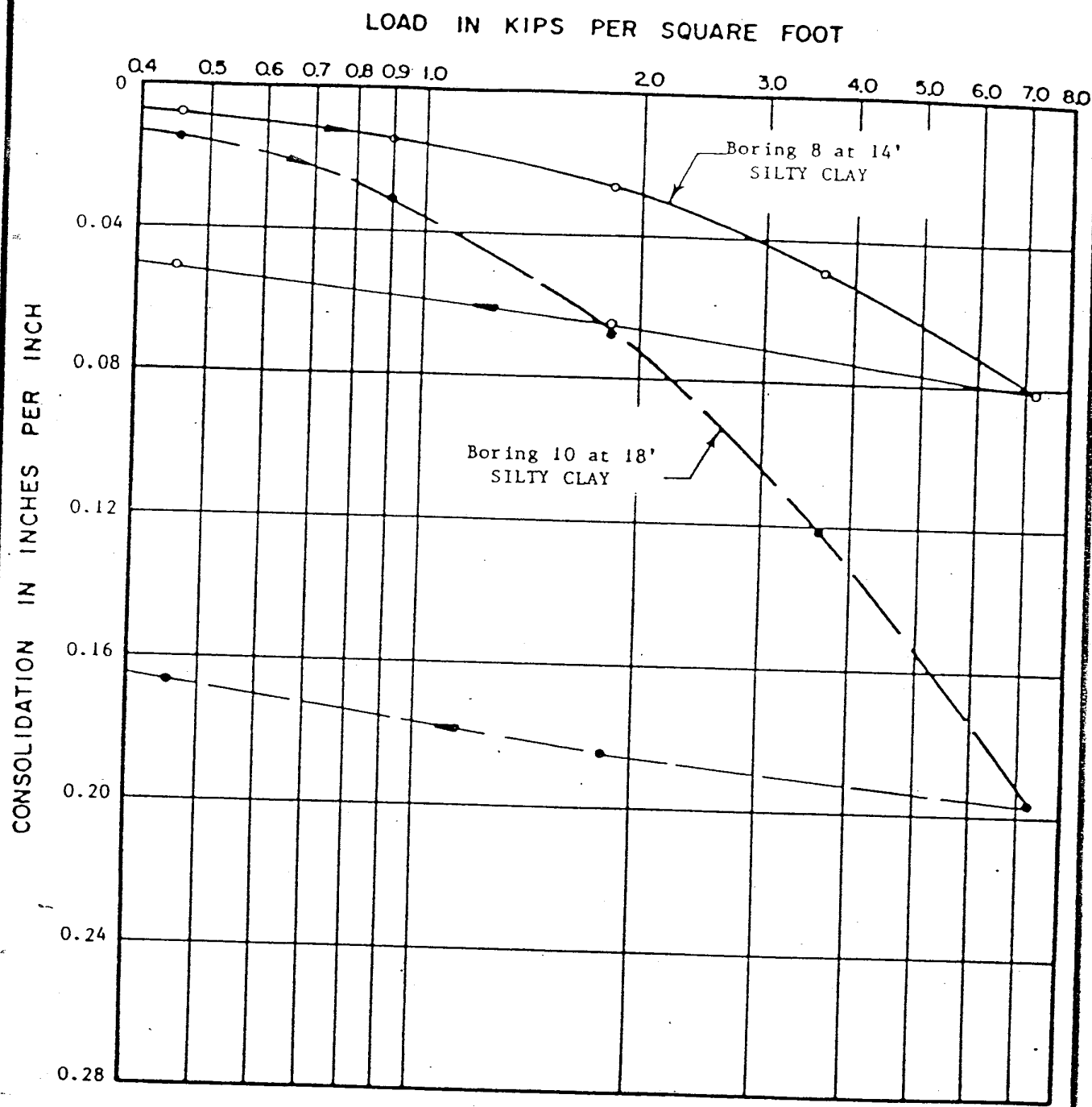
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.3

JOB 620328AED DATE 8/24/90 DR. DE

FORM III

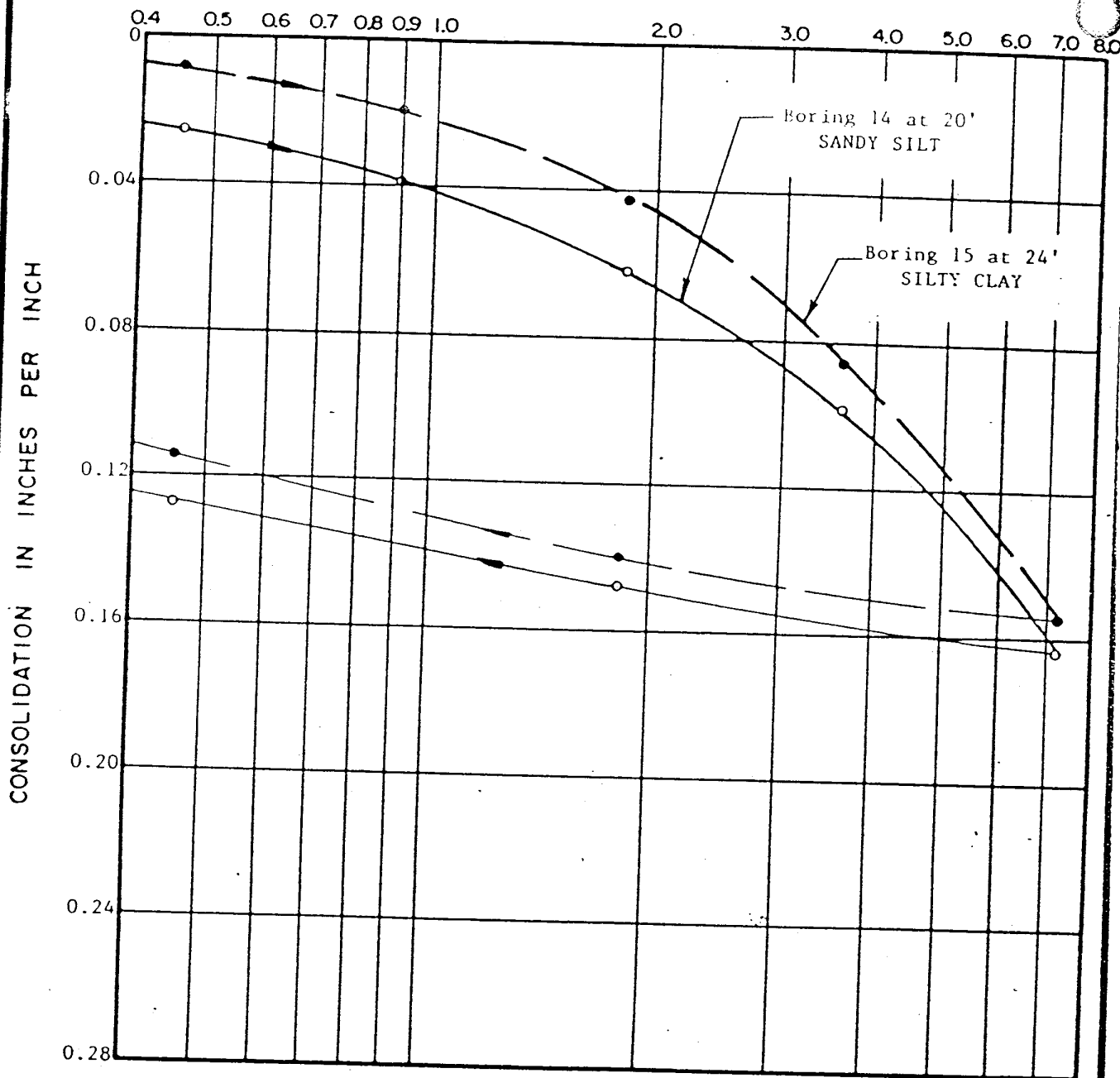


NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

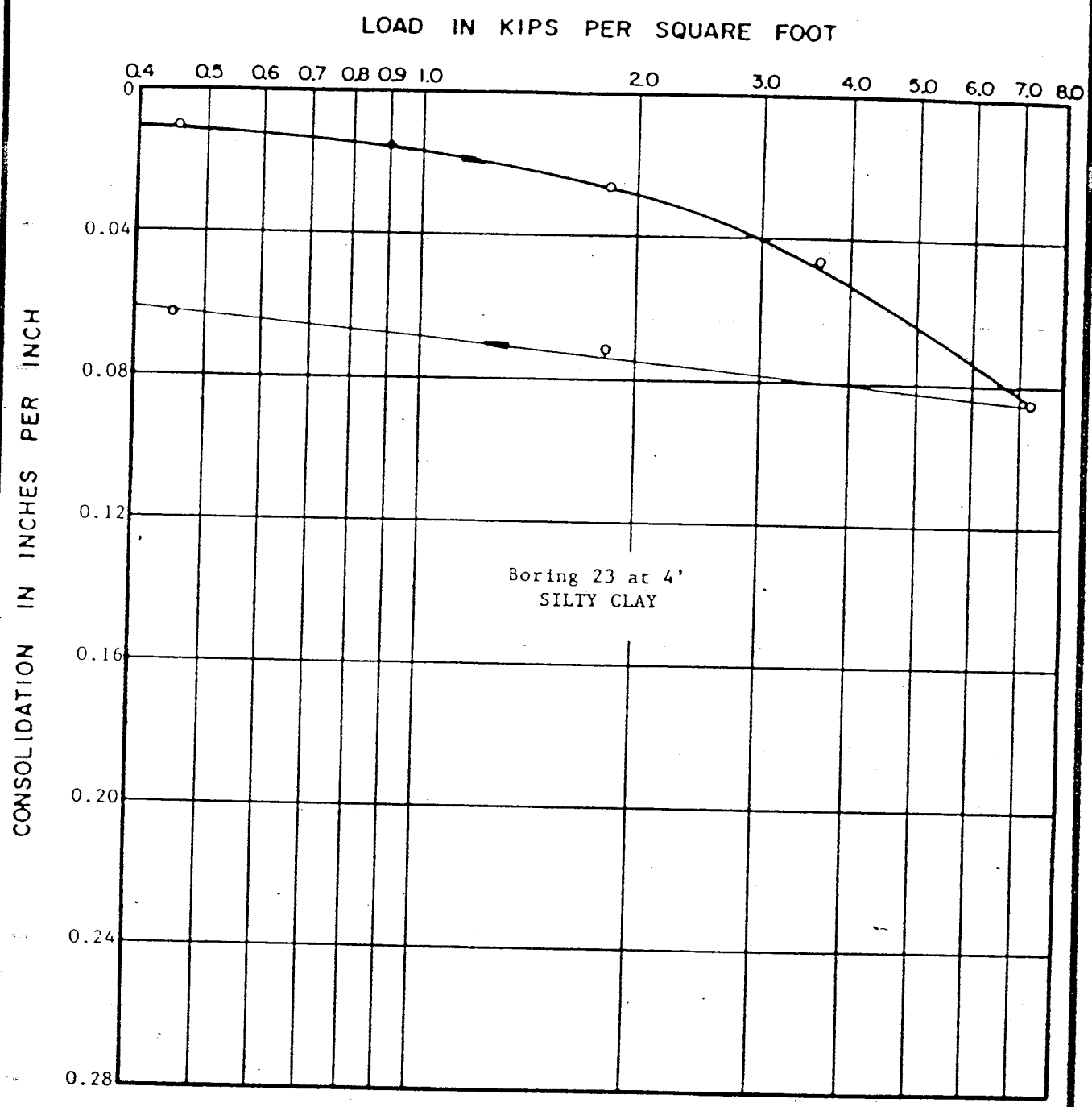
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.5

JOB 190320AEO DATE 8/24/90 DR *MS*

FORM 117

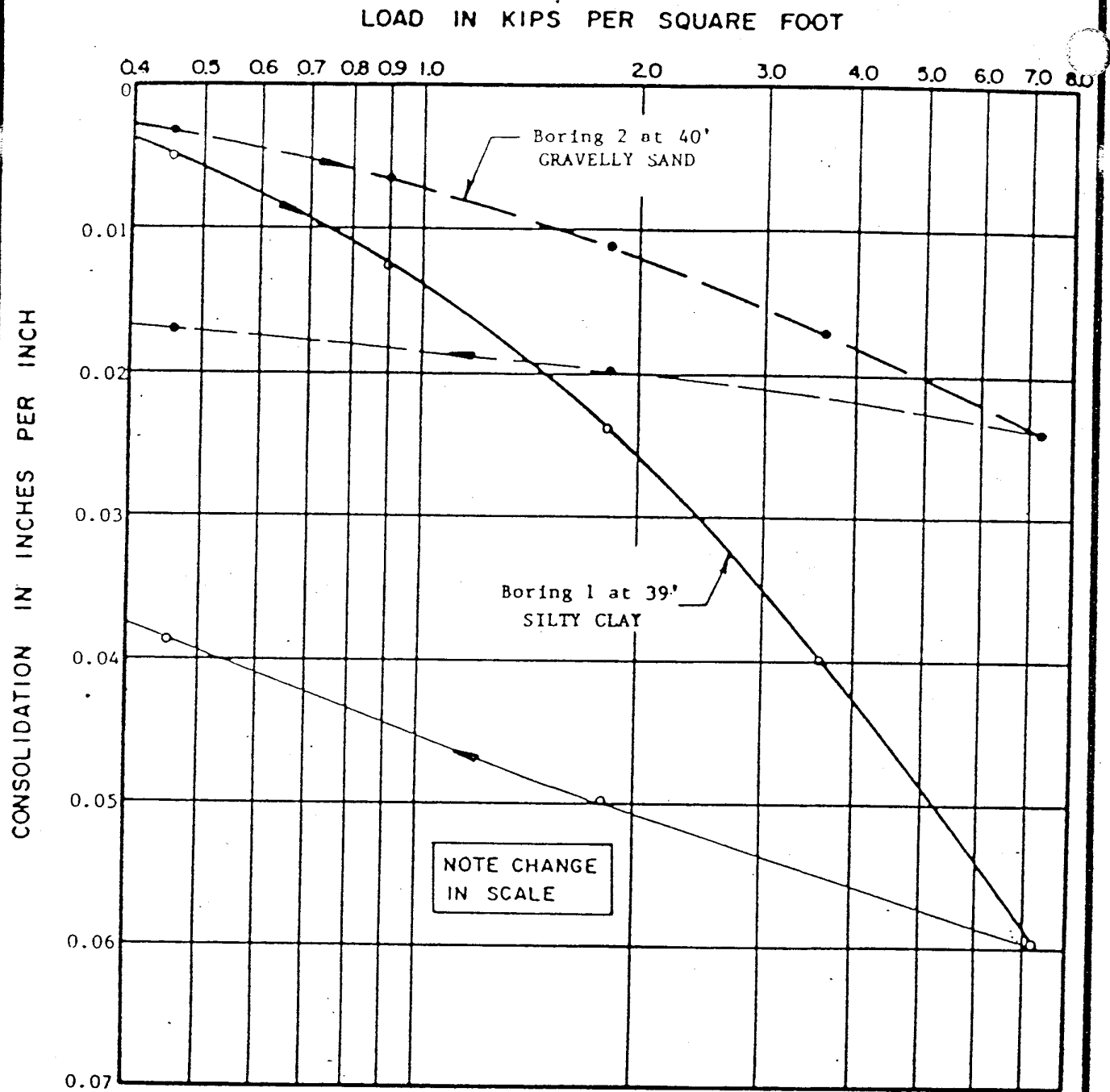


NOTE: Sample tested at field moisture content.

CONSOLIDATION TEST DATA

L. ROY CRANDALL AND ASSOCIATES

JOB 490328AEQ DATE 8/24/90 PM 06



NOTE: Samples tested at field moisture content.

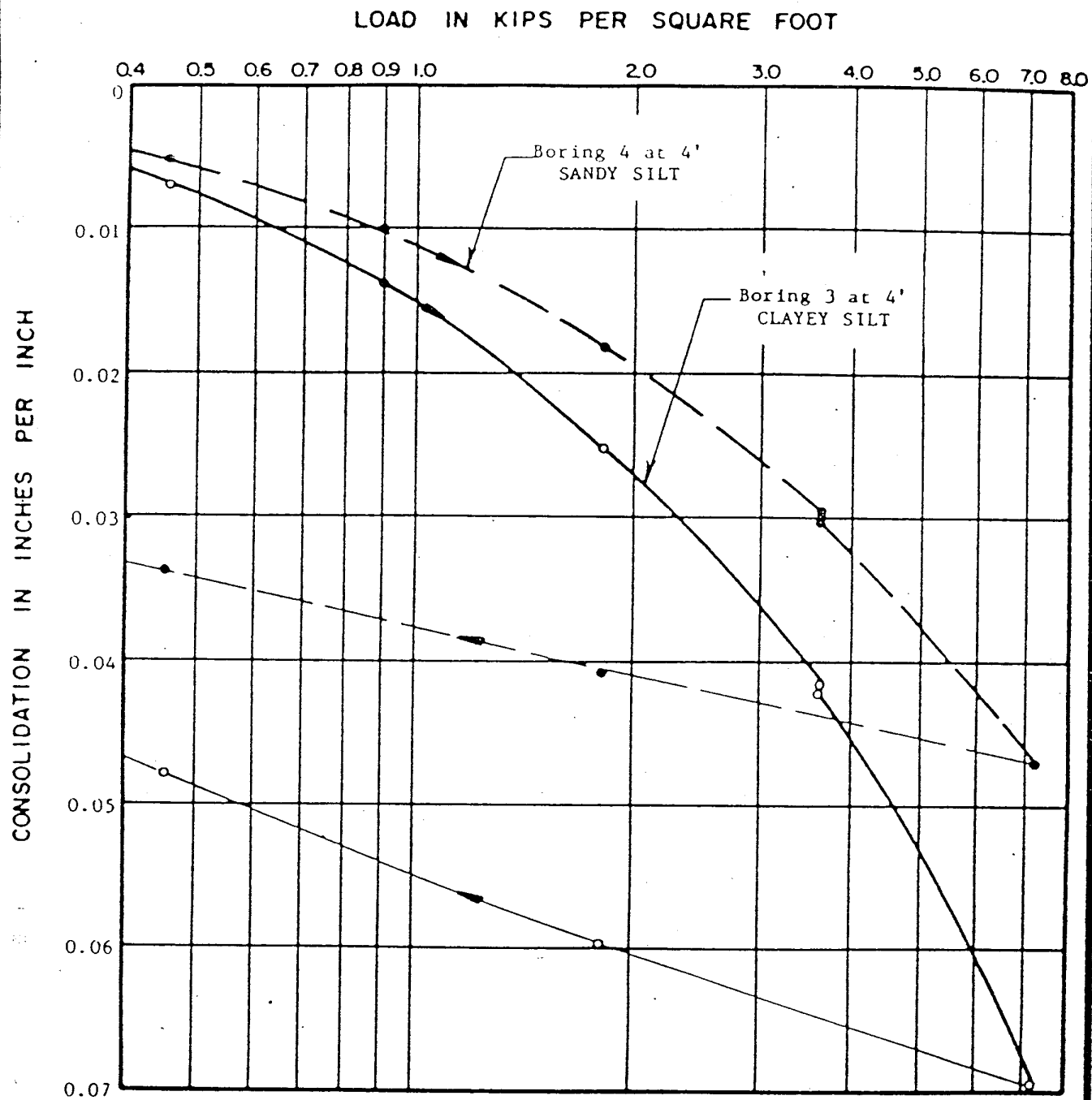
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.7

JOB L9032BAEQ DATE 8/24/2005 DR

FORM 111



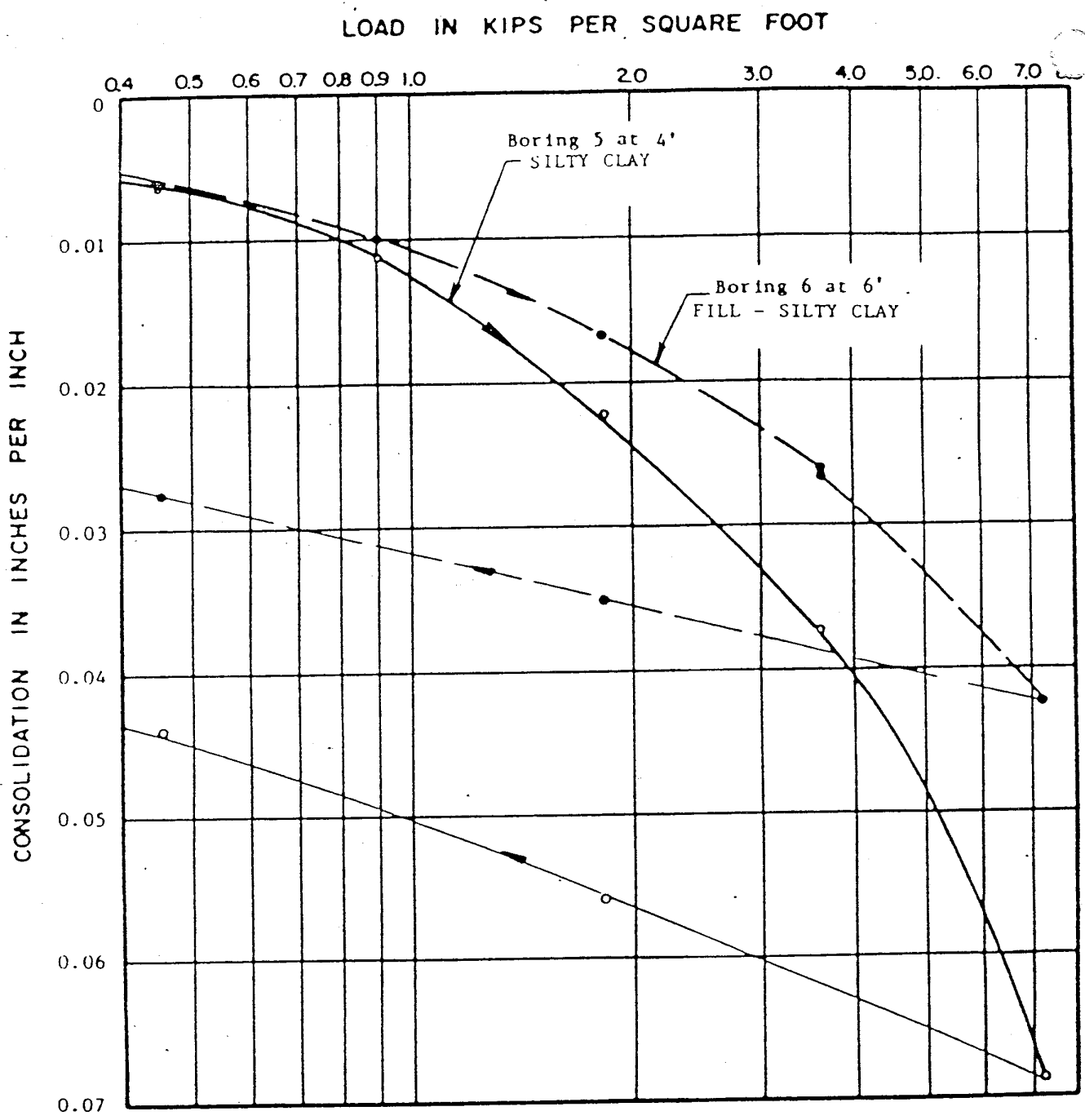
NOTE: Water added to samples after consolidation under a load of 3.6 kips per square foot.

CONSOLIDATION TEST DATA

LORRY CRANDALL AND ASSOCIATES

PLATE A-4.8

FORM 116 JOB L 90328 DATE 8/24/90 DR OE



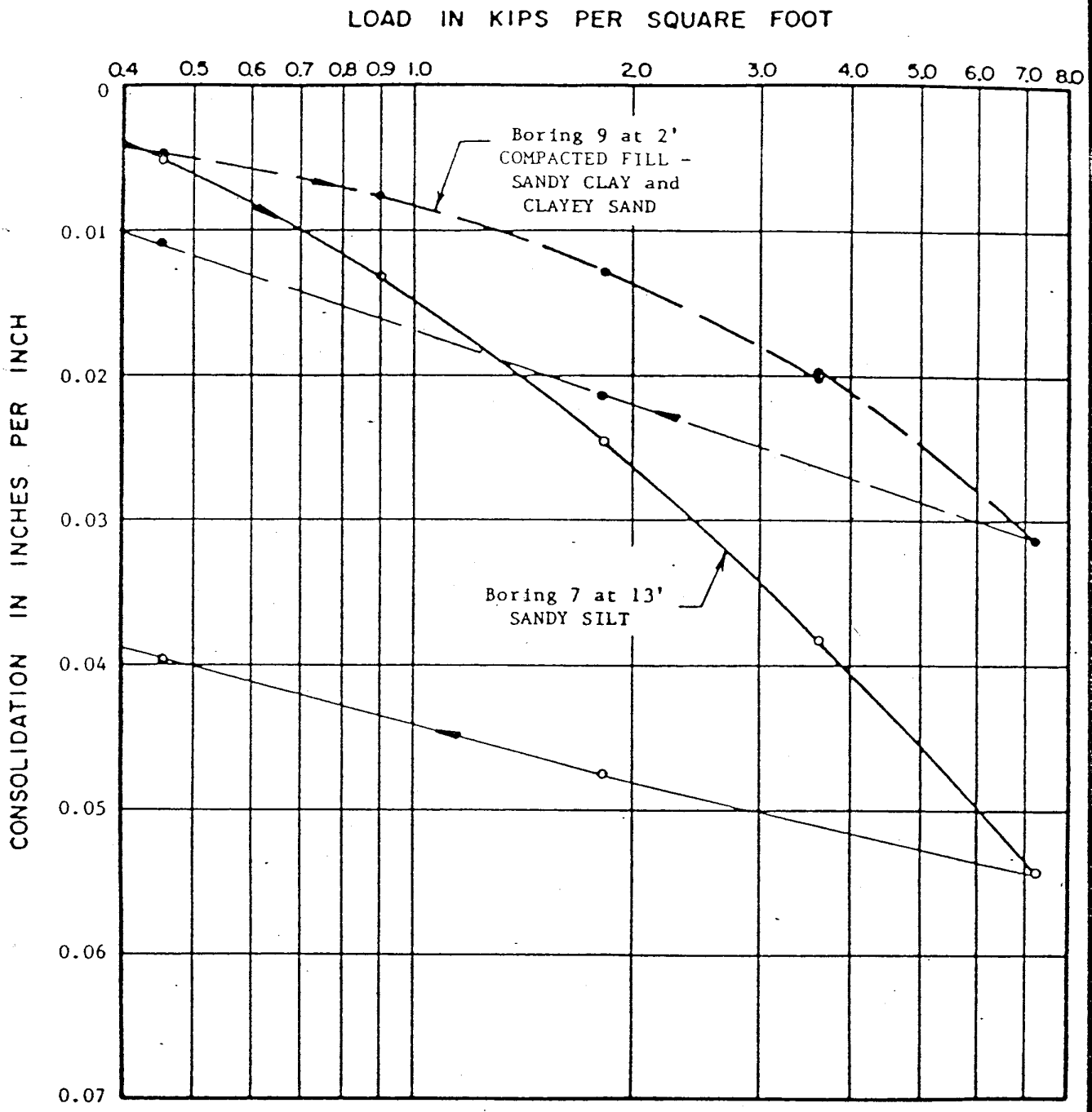
NOTE: Water added to sample from Boring 6 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB 29032BAEO DATE 8/24/90 DR OE

FORM II



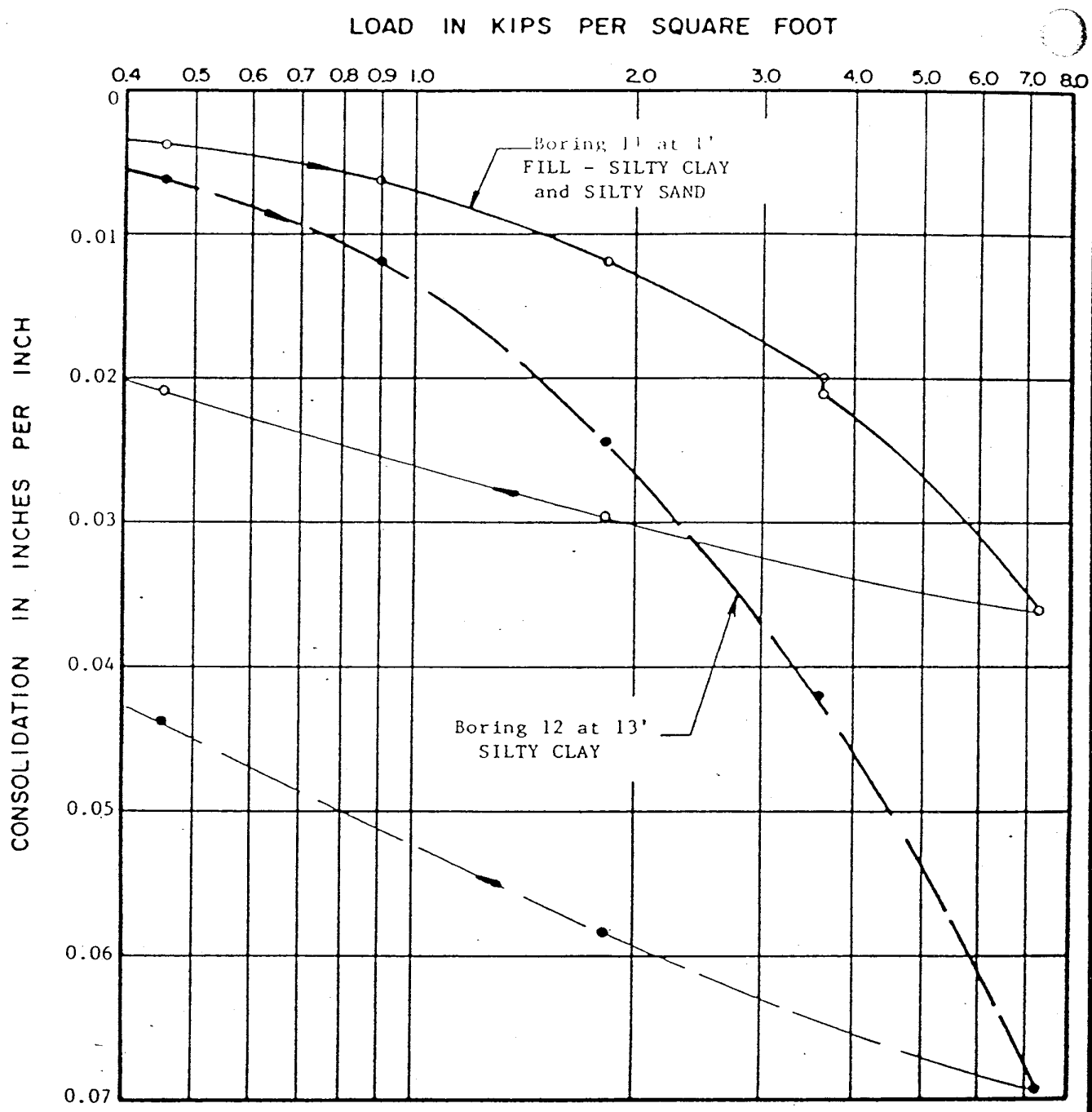
NOTE: Water added to sample from Boring 9 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

NOB 190328 AED DATE 8/24/90 DR CE 110

FORM 116



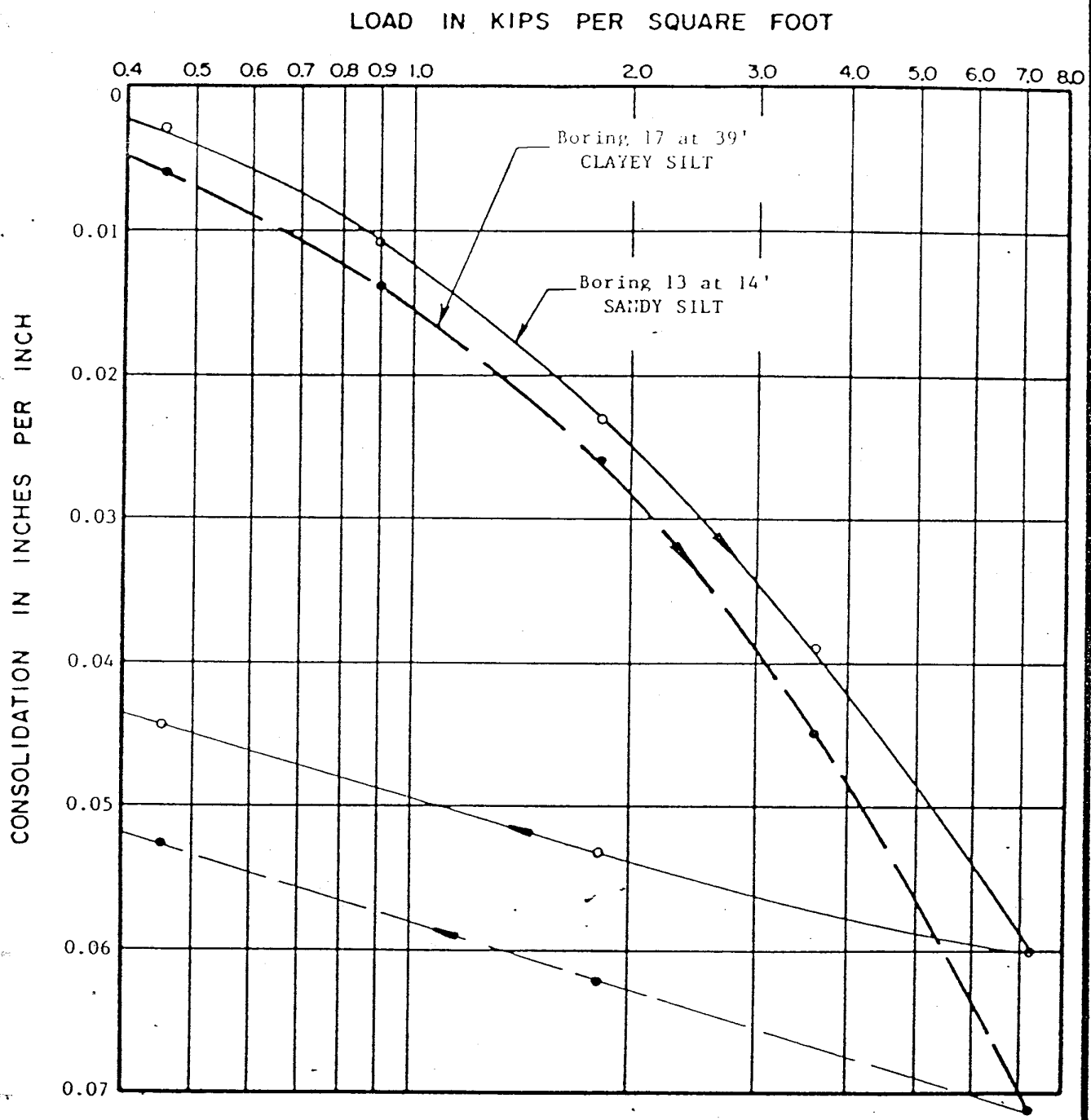
NOTE: Water added to sample from Boring 11 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB L90328 AEO DATE 4/24/90 PR 05
110

FORM 116



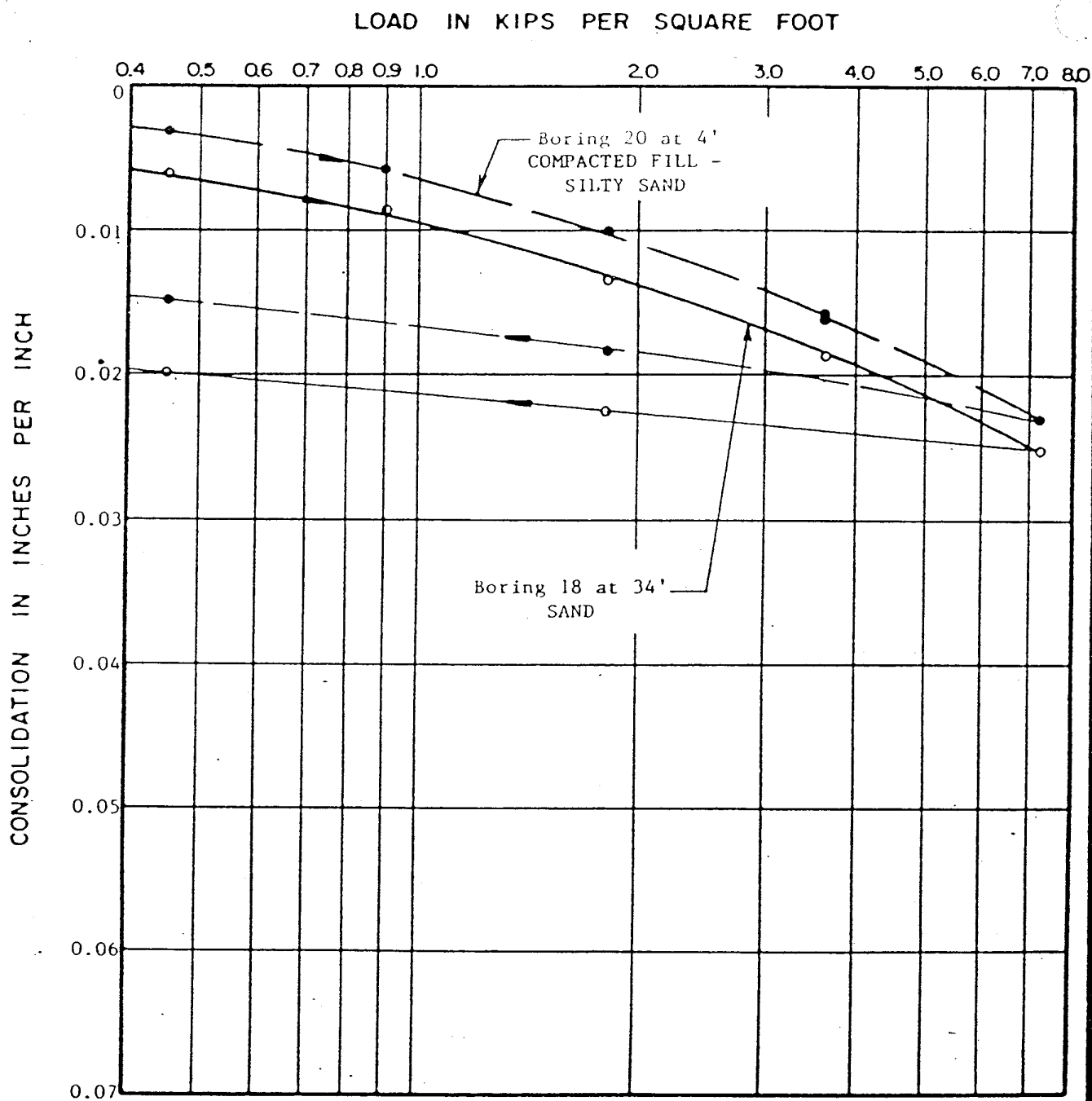
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB L90328AED DATE 8/24/90 DR. CE MB

FORM 116



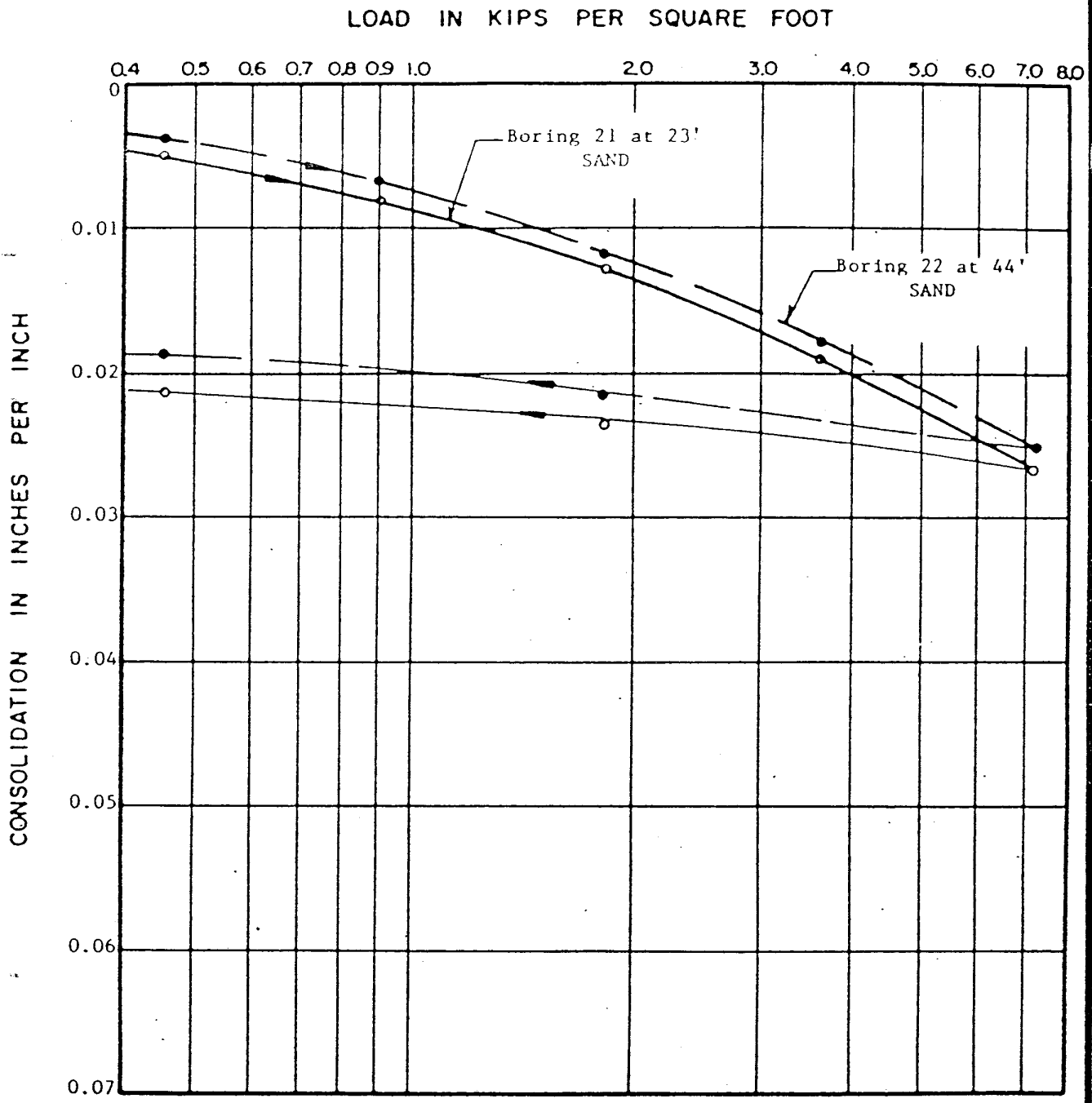
NOTE: Water added to sample from Boring 20 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.13

FORM IV
JOB: L90328 AED DATE 8/24/90 PR OE
AD



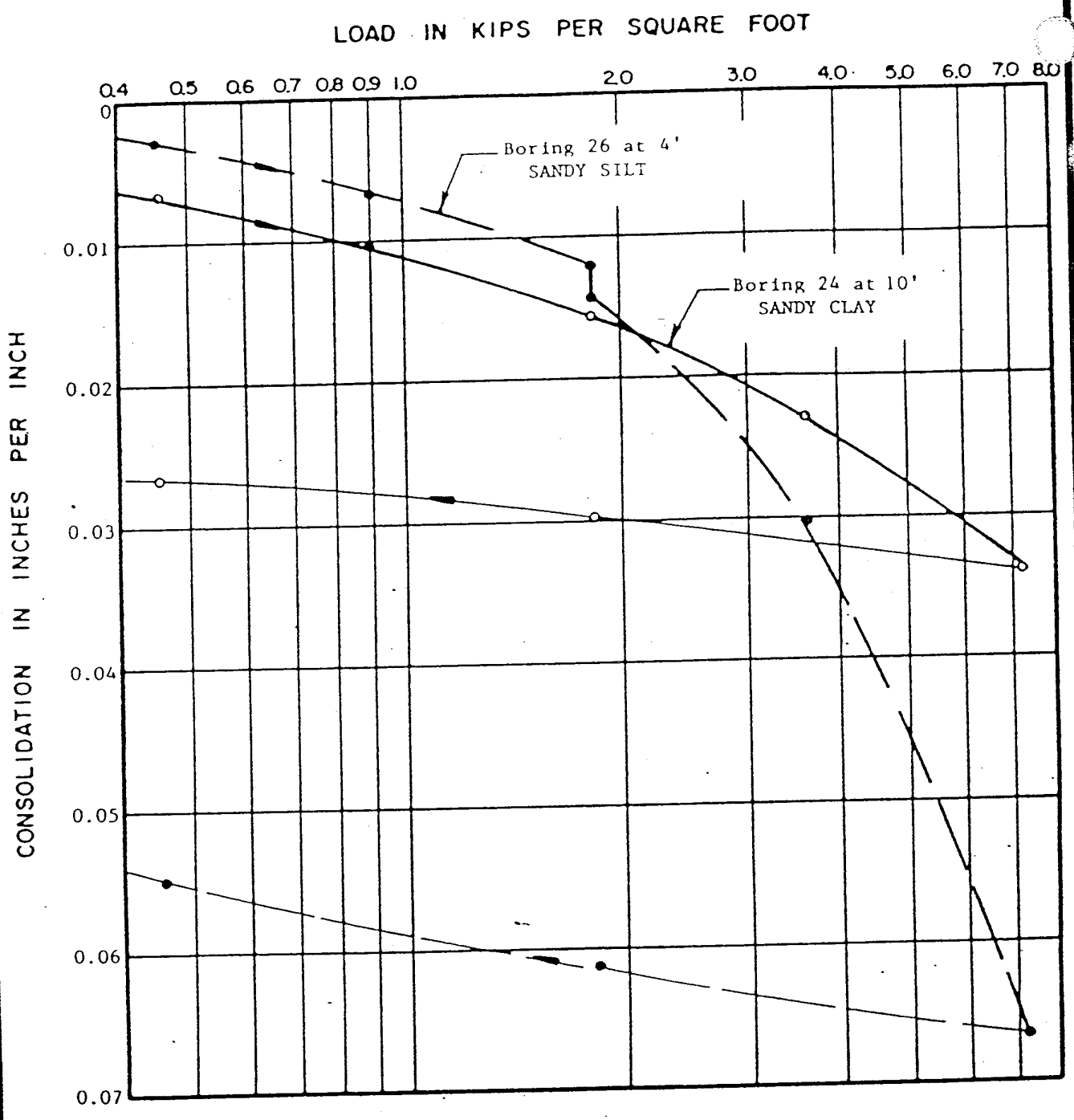
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB L90328 AEO DATE 8/24/90 DR OE MD

FORM 116



NOTE: Water added to sample from Boring 26 after consolidation under a load of 1.8 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB L90328.AEO DATE 8/24/90 W.P. dmh O.E. BK CHKD

BORING NUMBER AND SAMPLE DEPTH:	2 at 4'	4 at 1'	5 at 4'
SOIL TYPE:	CLAYEY SILT	SILTY CLAY	SILTY CLAY
CONFINING PRESSURE: (lbs./sq. ft.)	200	200	200
FIELD MOISTURE CONTENT: (% of dry wt.)	36.9	24.4	29.3
EXPANSION FROM FIELD TO SOAKED MOISTURE CONTENT: (%)	1.5	2.4	0.9
SOAKED MOISTURE CONTENT: (% of dry wt.)	39.1	28.0	31.1
SHRINKAGE FROM FIELD TO AIR-DRIED MOISTURE CONTENT: (%)	22.7	17.8	12.9
AIR-DRIED MOISTURE CONTENT: (% of dry wt.)	10.1	7.5	5.9
TOTAL VOLUME CHANGE: (%)	24.2	20.2	13.8

EXPANSION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE A - 5.1

JOB L90328.AEO DATE 8/24/90 W.P. BK O.E. dmh CHKD

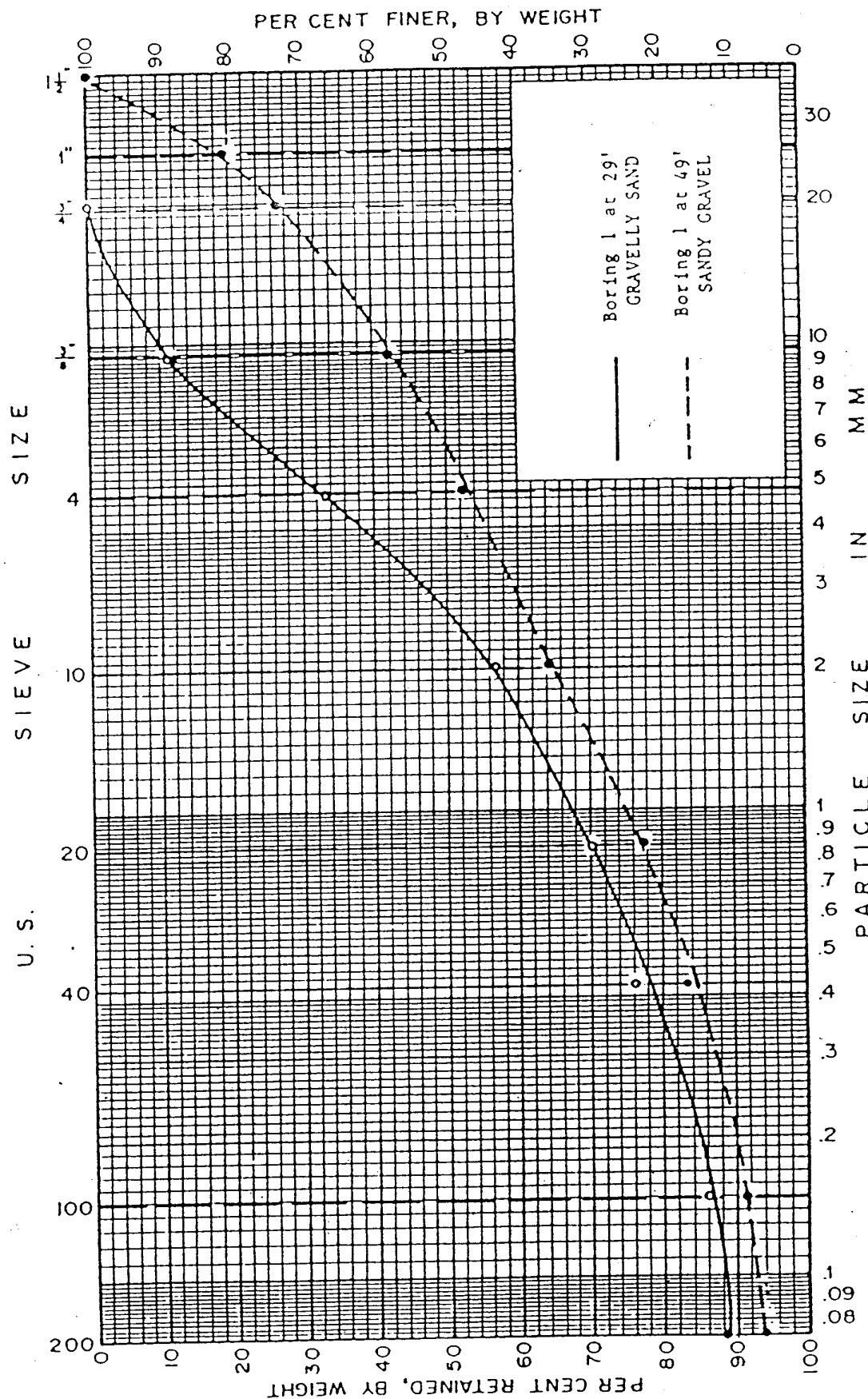
BORING NUMBER AND SAMPLE DEPTH :	12 at 1'	19 at 5'	24 at 1'
SOIL TYPE :	COMPACTED FILL -		
CONFINING PRESSURE : (lbs./sq. ft.)	200	200	200
FIELD MOISTURE CONTENT : (% of dry wt.)	20.6	33.4	23.2
EXPANSION FROM FIELD TO SOAKED MOISTURE CONTENT : (%)	0.2	3.5	5.1
SOAKED MOISTURE CONTENT : (% of dry wt.)	23.1	37.3	31.5
SHRINKAGE FROM FIELD TO AIR - DRIED MOISTURE CONTENT : (%)	7.7	12.9	9.7
AIR - DRIED MOISTURE CONTENT : (% of dry wt.)	4.4	9.0	9.5
TOTAL VOLUME CHANGE : (%)	7.9	16.4	14.8

EXPANSION TEST DATA

LeROY CRANDALL AND ASSOCIATES

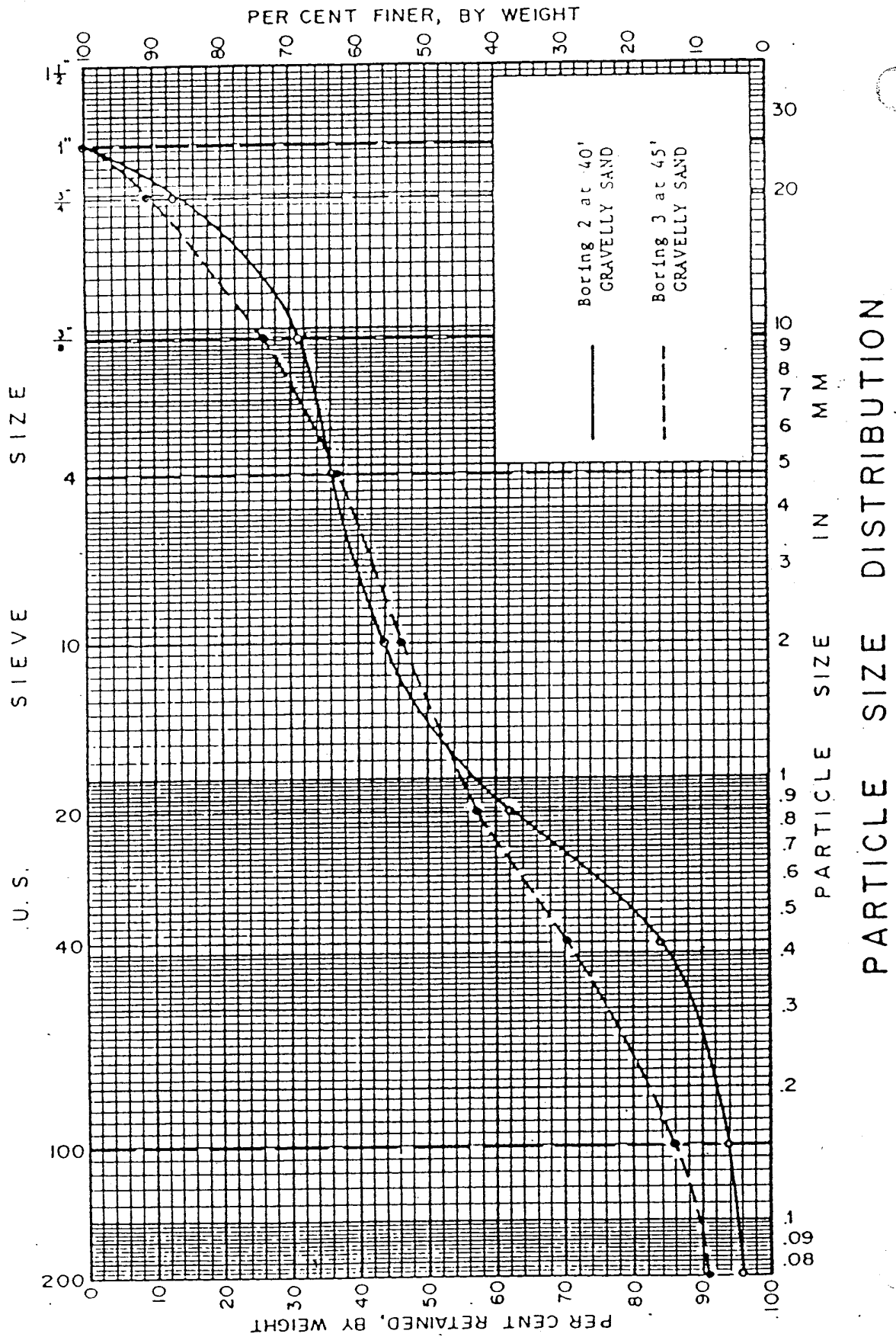
PLATE A - 5.2

FORM 121 JOB L90328AEO DATE 8/24/90 DE DR

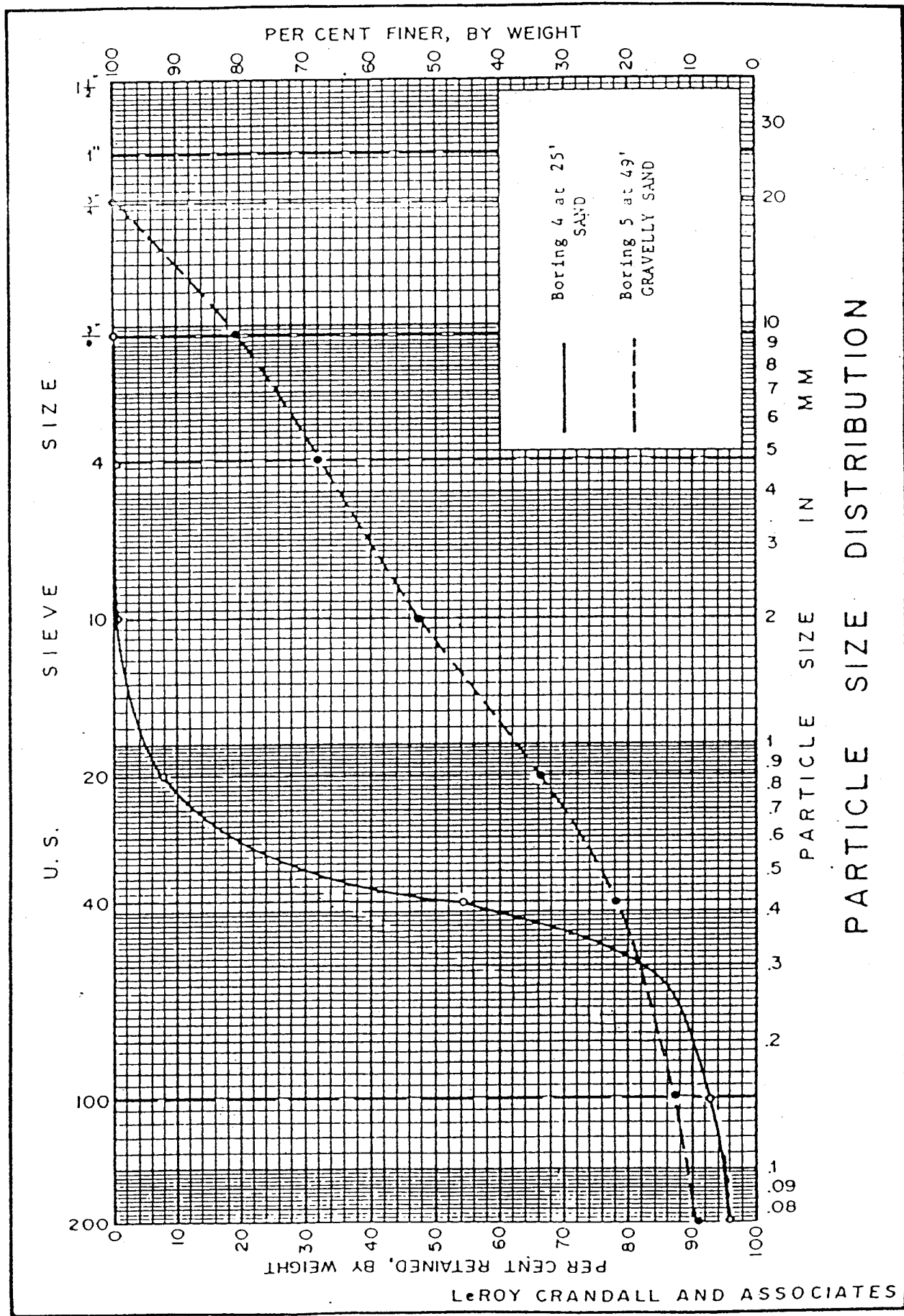


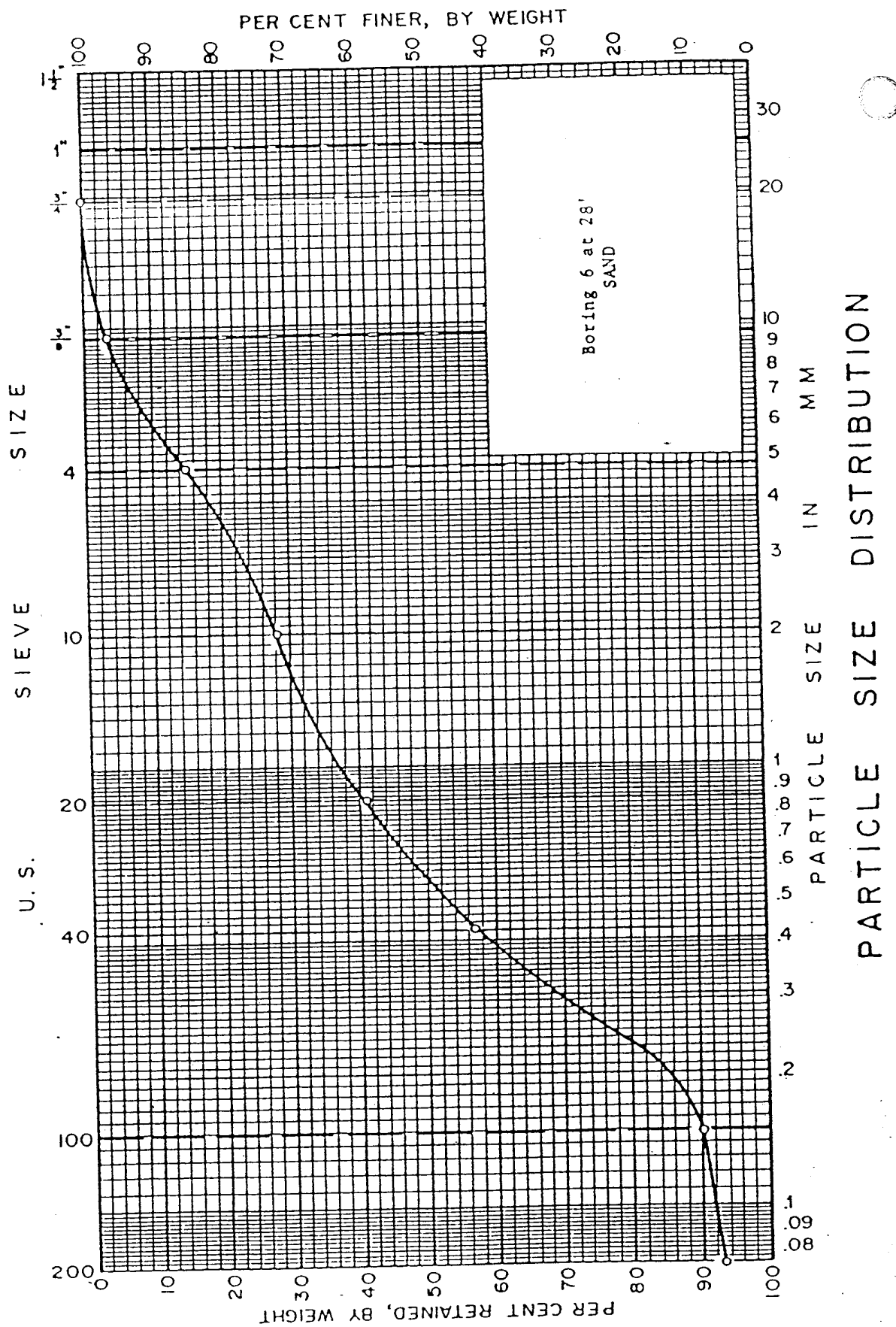
LEROY CRANDALL AND ASSOCIATES

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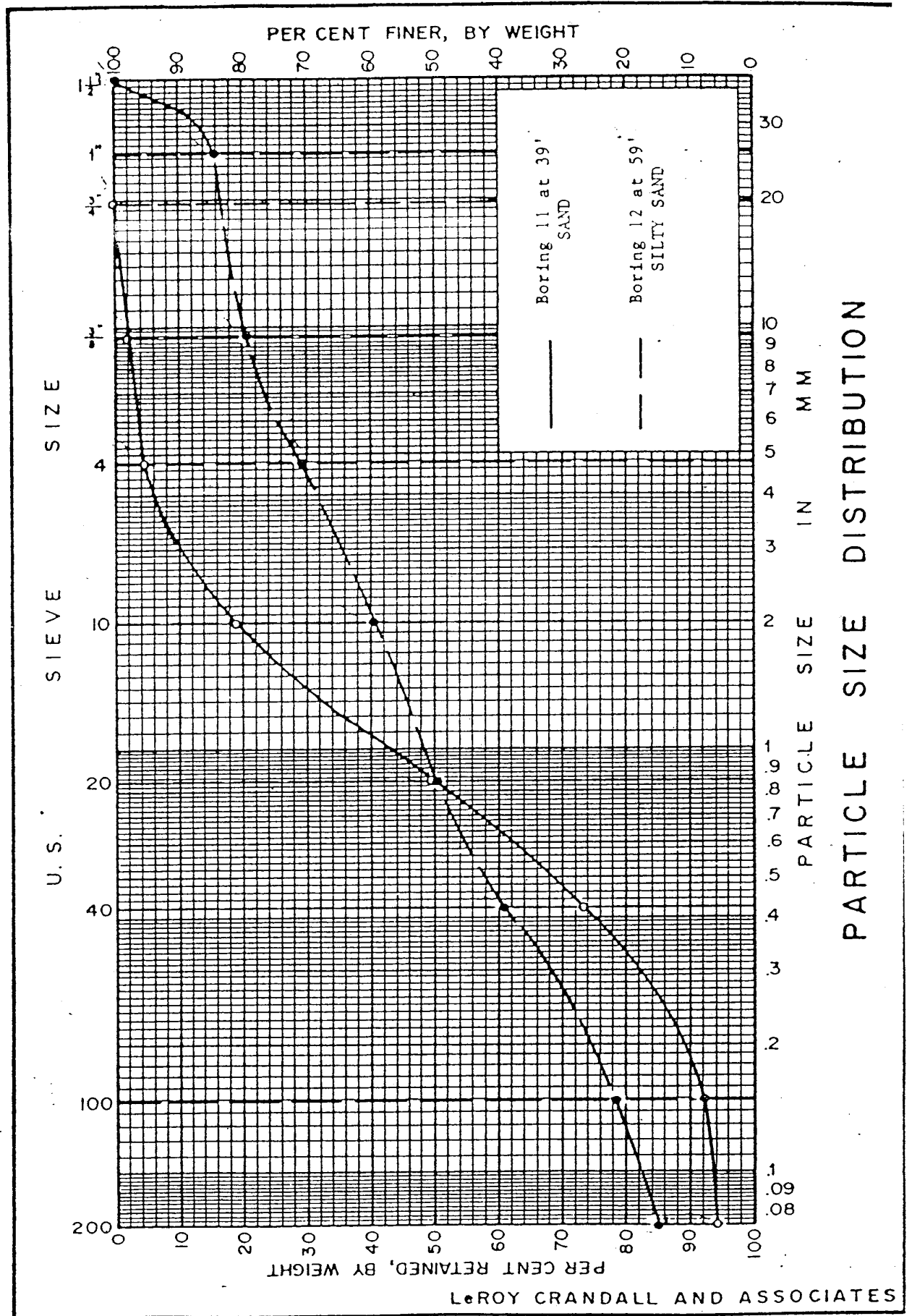
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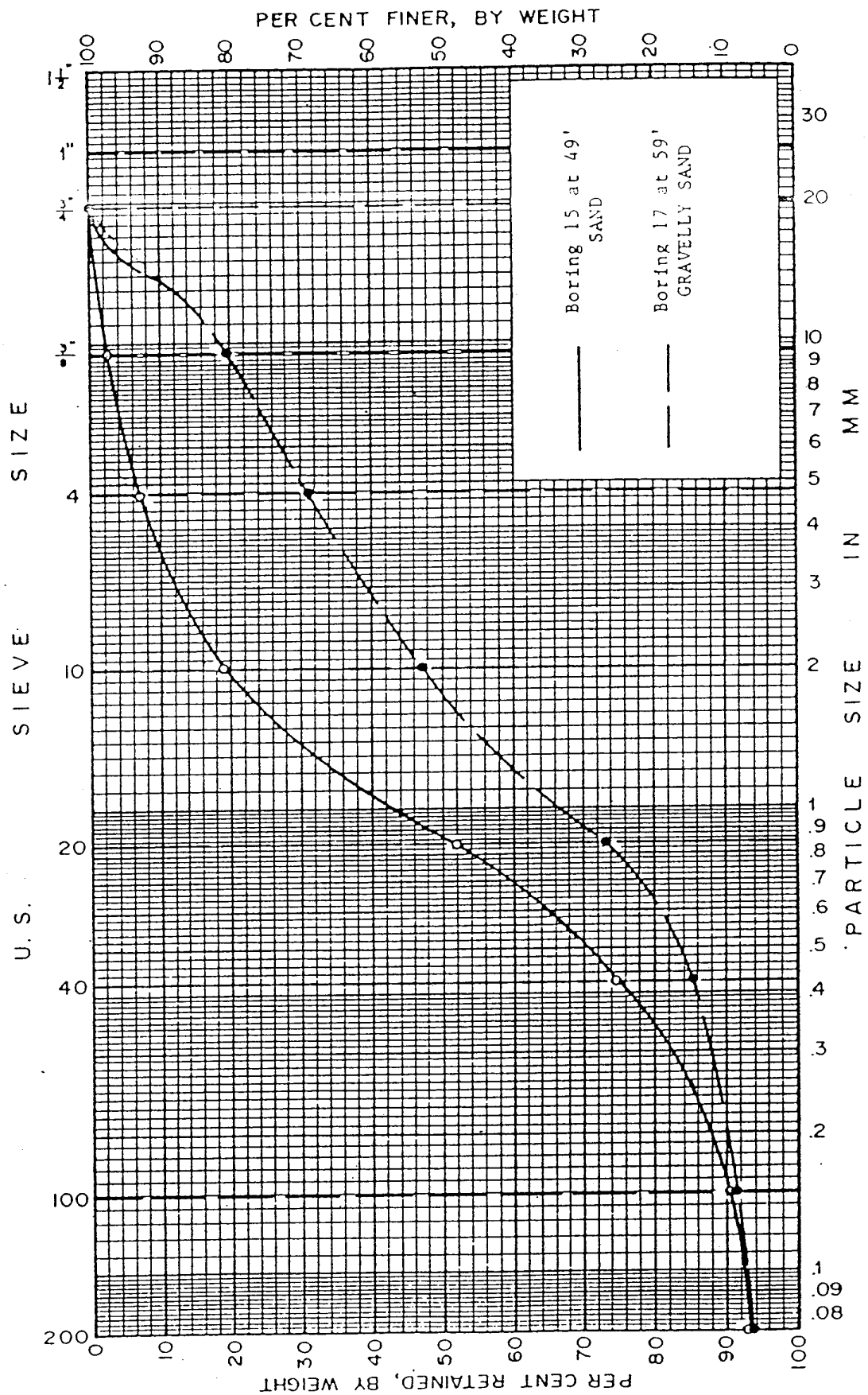




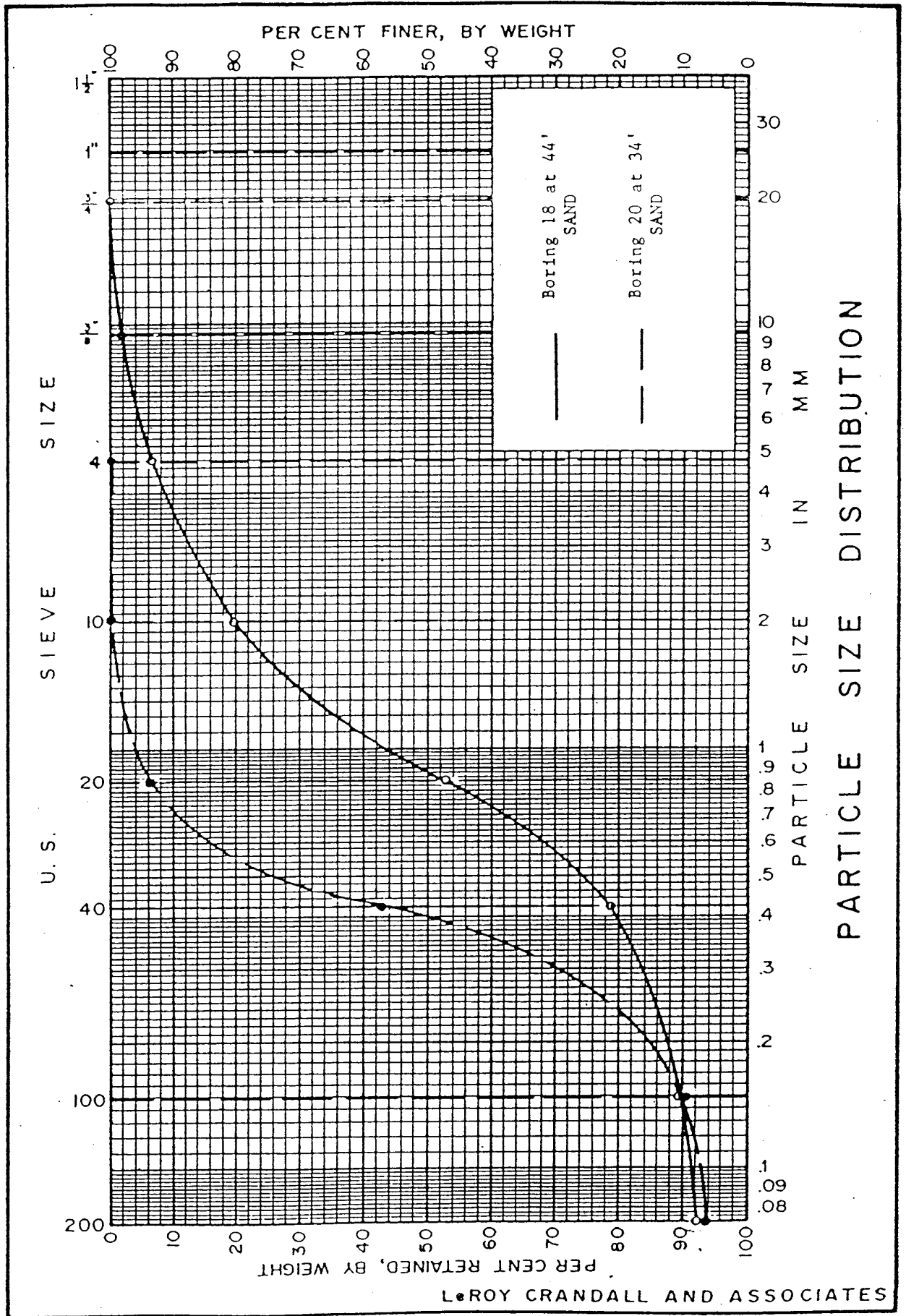
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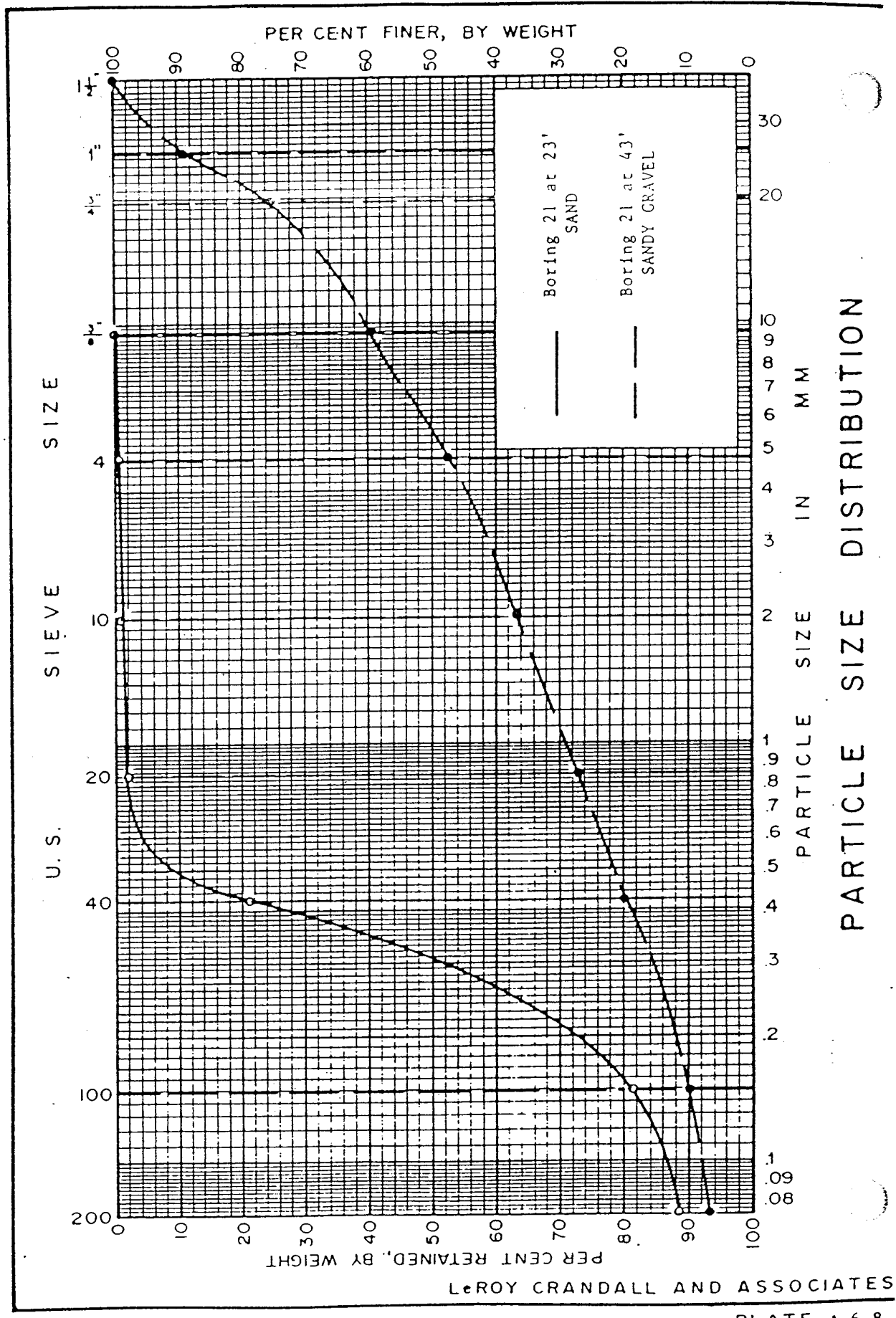
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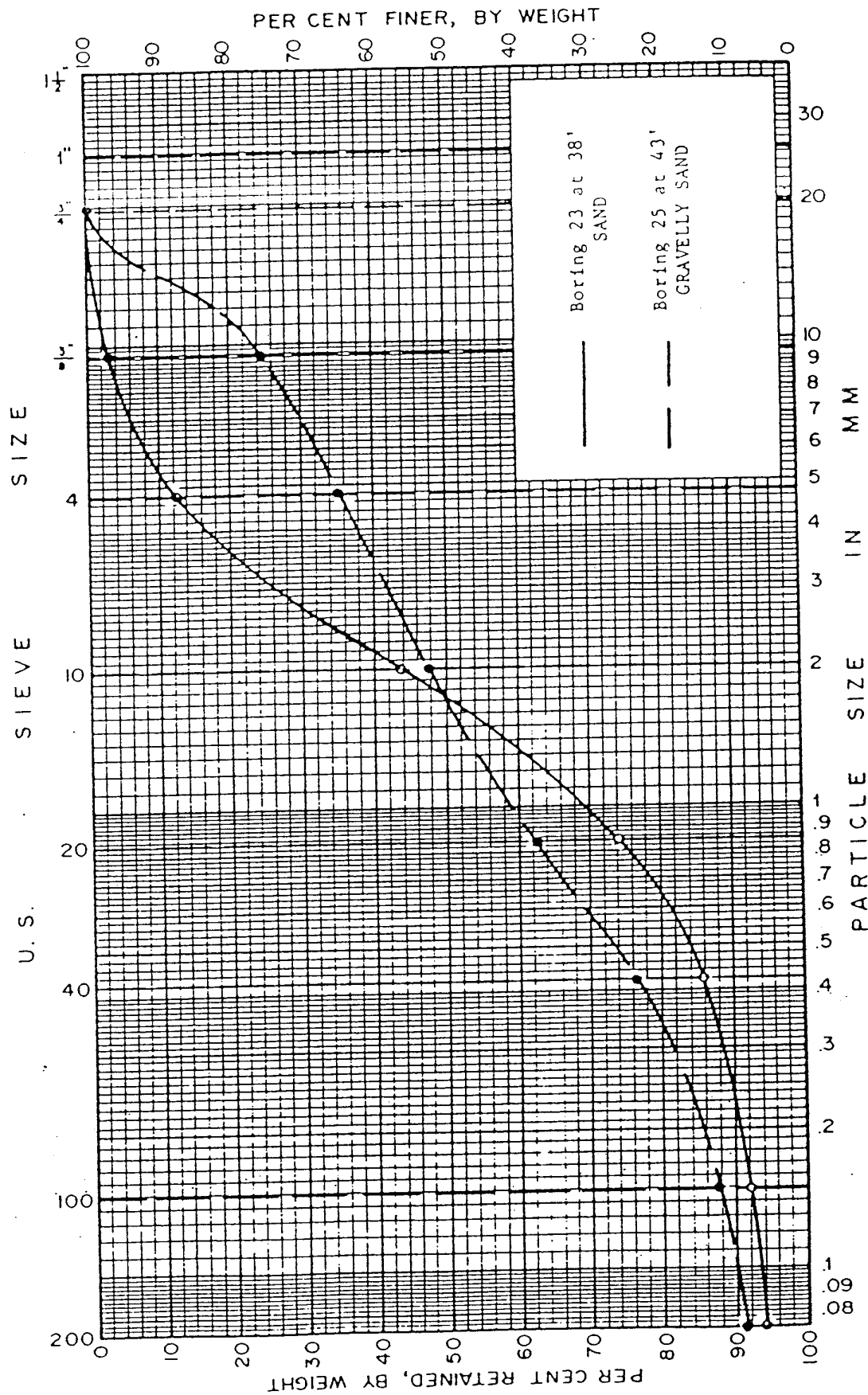
LeROY CRANDALL AND ASSOCIATES





LeROY CRANDALL AND ASSOCIATES

WB L90328AEO DATE 8/24/90 DE OE



M. J. SCHIFF & ASSOCIATES

Consulting Corrosion Engineers

1291 NORTH INDIAN HILL BOULEVARD
CLAREMONT, CALIFORNIA 91711
(714) 626-0967

March 19, 1987

LeRoy Crandall & Associates
900 Grand Central Avenue
Glendale, California 91201-3009

Attention: Mr. Boris Korin

Re: Soil Corrosivity Tests
Howard Hughes Properties
Los Angeles, California
Your #AE-86125-F, MJS&A #87024

Gentlemen:

Laboratory tests have been completed on fourteen soil samples we selected from your borings for the subject project on Jefferson Boulevard and Centinela Avenue. The purpose of these tests was to determine if the soils may have deleterious effects on underground utilities, hydraulic elevator cylinders, and concrete foundations.

The electrical resistivity of each sample was measured in its as-received condition and again with distilled water added to create the standardized condition of saturation. Resistivities are at about their lowest value when the soil is saturated. The samples were chemically analyzed for the major anions and cations, and pH was measured. Sulfides and oxidation-reduction (redox) potentials were also measured on the grey/black clay samples. Results are shown on Table 1.

Electrical resistivities of soils are a measure of their resistance to the flow of corrosion currents. Corrosion currents, following Ohm's Law, tend to be lower in high resistivity soils. The electrical resistivity of a soil varies primarily with its chemical and moisture contents.

A commonly accepted correlation between electrical resistivity and corrosivity toward ferrous metals is:

below	1,000 ohm-centimeters	severely corrosive
1,000 to	2,000 " "	corrosive
2,000 to	10,000 " "	moderately corrosive
over	10,000 " "	mildly corrosive

Electrical resistivities measured in the laboratory with as-received moisture content were in mildly to severely corrosive categories. When saturated, they were in moderately to very severely corrosive categories. The deeper soils were near their most corrosive moisture content as-received due to the high water table. The resistivities of other samples dropped considerably with added moisture indicating that they were quite dry as-received. The wide variations in soil resistivity can create concentration type corrosion cells that increase corrosivity beyond what would be expected from the soil resistivities alone.

CORROSION AND CATHODIC PROTECTION ENGINEERING SERVICES
SURVEYS • PLANS AND SPECIFICATIONS • INTERFERENCE PROBLEMS • SOIL TESTS • SUPERVISION INSPECTION AND ADJUSTMENT OF INSTALLATIONS

PLATE A-7.1

pH values varied from 7.1 to 8.1 which is neutral to moderately alkaline. This is not significant in evaluating corrosivity in this case.

The chemical content of most of the samples was moderate. Exceptions were high sodium chloride in borings 11 at 24 feet, 12 at 13 feet, and 15 at foot. Chloride ions are corrosive to ferrous metals.

Sulfides, which are aggressive to copper, showed a trace reaction in a qualitative test. The low positive redox potentials indicate mild oxidizing conditions in which anaerobic, sulfide producing bacteria function marginally.

We classify this site as severely corrosive to ferrous metals and mildly corrosive to copper. The following corrosion control measures are recommended.

Test any fill material that is placed at the site in the future. Some of the clay fill material is severely corrosive and requires strong corrosion control measures. Sandy fill would be less corrosive.

Underground steel utilities should be given a high quality protective coating such as 40 mil extruded polyethylene, 20 mil plastic tape over primer per AWWA Standard C209, or hot applied coal tar enamel or tape per AWWA Standard C203.

All underground steel should be electrically insulated from above ground steel, dissimilar metals, and cement-mortar or concrete coated steel. Underground steel pipe should be bonded for electrical continuity if rubber gasketed, mechanical, grooved end, or other nonconductive type joints are used.

In addition, cathodic protection is necessary for underground steel utilities.

The use of nonmetallic materials should be considered.

Hydraulic elevator cylinders should be well coated as described above. Each cylinder should be isolated from building metals by installing dielectric material between the piston platen and car and also in the oil line. The oil line should be placed above ground if possible but, if underground, should be protected as described above for steel utilities. Cathodic protection is recommended for hydraulic cylinders or, as an alternate, each cylinder may be placed in a plastic casing with a plastic watertight seal at the bottom.

Cast or ductile iron pipe, valves, and fittings should be encased in an 8 mil polyethylene tube or wrap per AWWA Standard C105 or ANSI 21.5. Iron placed in soils represented by samples from B11 at 24 feet and B12 at 13 feet should be bonded for electrical continuity and cathodically protected as well.

Copper should be bedded and backfilled in alkalized sand (25 pounds hydrated lime per cubic yard of sand) at least 3 inches thick surrounding the pipe.

No special precautions are required for asbestos-cement, or plastic utilities placed underground from a corrosion viewpoint. However, any iron valves or fittings should be protected as mentioned above.

Where metallic pipelines penetrate concrete structures, such as building floors or walls, plastic sleeves or other dielectric material should be used to prevent pipe contact with the concrete and reinforcing steel.

On any type of pipe, bare steel appurtenances such as bolts, joint harnesses, or flexible couplings should be coated with a coal tar or rubber based mastic after assembly.

Standard construction practices and concrete mixes may be used for concrete in contact with these soils using type 2 cement. However, concrete cover over reinforcing steel in concrete contacting these soils should be at least 2.5 inches thick if placed against forms and 3.5 inches thick if placed against earth. Also a water/cement ratio not exceeding 0.50 is recommended to reduce concrete permeability.

It is assumed that prestressed concrete piles will contain about 8 sacks of type 2 prestress cement per cubic yard of concrete and a water/cement ratio not exceeding 0.45. With such a mix, concrete cover should be at least 2 inches thick over embedded steel from a corrosion viewpoint. Solid steel lifting lugs are recommended to prevent groundwater from wicking into the pile interior. If wire rope lifting lugs are used they should be carefully drilled out 1.75 inches deep and the hole filled with epoxy.

The scope of this study was limited to a determination of soil corrosivity and its general effects on materials likely to be used for construction. If the architect and/or engineers desire more specific information, designs, specifications, or review of design, we will be happy to work with them as a separate phase of this project.

Respectfully submitted,
M. J. SCHIFF & ASSOCIATES

Paul Smith
ms

Paul R. Smith, P.E.

cb
Enc: Table 1 - Laboratory Tests on Soil Samples
WS12

Table 1 - LABORATORY TESTS ON SOIL SAMPLES

Boring and Depth	Soil Type	Soil Resistivity		pH	-----Chemical Analysis in mg/kg (ppm) of dry soil-----					Sulfide S	Redox MV
		As Rec'd	Sat'd		Ca	Mg	Na	HCO ₃	Chloride Cl	Sulfate SO ₄	
B11 7'	fill	12,000	1,600	7.5	80	trace	126	122	212	120	
B11 24'	clay	150	120	7.4	440	288	2737	488	4248	2000	trace +140
B12 13'	clay	340	200	8.0	80	trace	1748	732	1487	1150	trace +100
B13 2'	fill	20,000	920	7.4	80	trace	161	244	142	135	
B14 5'	fill	6,600	3,300	7.1	40	trace	12	122	71	50	
B15 1'	fill	7,100	450	7.7	120	24	598	488	779	250	trace +130
B16 5'	clay	2,300	1,200	7.4	80	24	104	244	142	200	
B18 24'	clay	640	520	7.6	280	72	483	488	566	900	trace +110
B20 4'	fill	18,000	6,400	7.9	40	trace	12	122	71	55	
B21 4'	clay	2,700	1,000	7.7	80	trace	161	122	283	85	
B23 4'	clay	2,300	2,200	7.7	80	24	138	244	142	190	
B24 16'	clay	1,700	720	8.1	120	48	161	366	212	275	
B25 2'	clay	7,400	840	8.0	120	trace	207	366	212	150	trace +110
B26 4'	silt	9,800	2,300	8.0	40	24	115	244	142	85	

Carbonate = 0 for all samples

Howard Hughes Properties
Los Angeles, California
HJS&A #87024
F3

APPENDIX B: GEOLOGIC AND SEISMIC DATA

B.1 GENERAL

The geologic-seismic studies included a field reconnaissance of the site as well and an office analysis of published and unpublished literature pertinent to the study area. The County of Los Angeles Seismic Safety Element, 1974, and the City of Los Angeles Seismic Safety Plan, 1974, were reviewed as part of our literature analysis.

This Appendix presents additional background information regarding faults, seismicity, and ground shaking.

B.2 FAULTS

The numerous faults in Southern California include active, potentially active, and inactive faults. The criteria for these major groups, as established by the Association of Engineering Geologists (1973), are presented in Table B-1. Table B-2 presents a listing of active faults in Southern California with the distance in miles between the site and the nearest point on the fault. Table B-3 provides a similar listing for potentially active faults. No faults or fault-associated features were observed on the site during the field reconnaissance.

B.2.1 Active Faults

The nearest active fault to the site is the Inglewood fault of the Newport-Inglewood fault zone located about 2 miles east-northeast from the northeast corner of site. The Newport-Inglewood structural zone is expressed at the surface by a northwesterly trending series of discontinuous faults and folds that extend across the Los Angeles Basin from Newport Beach to Beverly Hills (Barrows, 1974). The 1920 Inglewood and the 1933 Long Beach earthquakes have been attributed to this fault zone.

The active Malibu Coast fault is located 7 miles northwest of the site. The Malibu Coast fault has been considered active based on the 1973 Point Mugu earthquake, which was attributed to this fault.

TABLE B-1

CRITERIA FOR CLASSIFICATION OF FAULTS WITH
REGARD TO SEISMIC ACTIVITY(Modified from *Association of Engineering Geologists,
Geology and Earthquake Hazards, 1973*)A. Active Faults: (See Table B-2)

These faults have shown historical activity or have been included in the State of California's fault rupture studies zones as established by the California Division of Mines and Geology in accordance with the Alquist-Priolo Special Studies Zone Act of 1972. This category includes such faults as the San Andreas, San Jacinto, and Newport-Inglewood.

B. Potentially Active Faults: (See Table B-3)

These faults are those, based on available data, along which no known historical ground surface ruptures or earthquakes have occurred. These faults, however, show strong indications of geologically recent activity. Potentially active faults can be placed in two subgroups that are based on the boldness or sharpness of their topographic features and the estimates related to recency of activity. These subgroups are:

1. Subgroup One - High Potential

- a. Offsets affecting the Holocene deposits (age less than 10 - 11,000 years).
- b. A ground water barrier or anomaly occurring along the fault within the Holocene deposits.
- c. Earthquake epicenters (generally from small earthquakes occurring close to the fault).
- d. Strong geomorphic expression of fault origin features (e.g. faceted spurs, offset ridges or stream valleys or similar features, especially where Holocene topography appears to have been modified).

2. Subgroup Two - Low Potential

This subgroup is the same as 1-a, b, or d above, with the exception that the indications of fault movement can be only determined in Pleistocene deposits (less than 1,000,000 years ago).

C. Inactive Faults:

These faults are without recognized Holocene or Pleistocene offset or activity.

TABLE B-2

MAJOR NAMED FAULTS CONSIDERED TO BE ACTIVE (a)
IN SOUTHERN CALIFORNIA

Fault (in alphabetical order)	Date of Latest Major Activity	Maximum Credible Earthquake	Distance From Site (Miles)	Direction From Site
Big Pine	1852	7.5 (b)	65	NNW
Cucamonga	(e)	6.5 (b)	44	ENE
Elsinore	1910	7.5 (b)	65	ESE
Garlock	(d)	7.75 (b)	62	NNW
Helendale	(e)	7.5 (b)	72	NE
Malibu Coast	1973	7.0 (c)	7	NW
More Ranch	(d)	7.5 (b)	80	WNW
Newport-Inglewood	1933	7.0 (b)	2	ENE
Raymond	(e)	6.6 (c)	16	NE
San Andreas Zone	1857	8.25 (b)	43	NNE
San Cayetano	(e)	6.75 (c)	36	NW
San Fernando Zone	1971	6.5 (b)	22	N
San Gabriel	(e)	7.5 (c)	25	NNE
San Jacinto Zone	1968	7.5 (b)	63	ENE
White Wolf	1952	7.75 (b)	77	NNE
Whittier		7.1 (c)	23	E

- (a) Historic movement (1769 to present).
 (b) Greensfelder, C.D.M.G. Map Sheet 23, 1974.
 (c) Mark (1977) Length-Magnitude relationship.
 (d) Intermittent creep.
 (e) Movement within the last 11,000 years; zoned by the State Geologist for the Alquist-Priolo Program.

TABLE B-3

MAJOR NAMED FAULTS CONSIDERED TO BE POTENTIALLY ACTIVE (a)
IN SOUTHERN CALIFORNIA

Fault (in alphabetical order)	Maximum Credible Earthquake	Distance From Site (Miles)	Direction From Site
Charnock	6.6 (c)	0	NE
*Chino	6.7 (c)	39	E
*Duarte	6.3 (c)	28	ENE
Northridge Hills	6.5 (b)	19.5	N
Norwalk	6.4 (c)	23	ESE
Oakridge	7.5 (b)	35	NNW
*Overland	6.2 (c)	0.8	ENE
Ozena	7.3 (c)	71	NW
Palos Verdes	7.0 (b)	5	SSW
*San Jose	6.5 (c)	32	E
Santa Cruz Island	7.2 (c)	56	W
Santa Monica-Hollywood	6.8 (c)	5	NNW
Santa Susana	6.5 (b)	24	NNW
Santa Ynez	7.5 (b)	50	NW
Sierra Madre	7.5 (b)	23	NE
Sierra Nevada (Southern Branch)	8.25 (b)	94	NNE
*Verdugo	6.8 (c)	17	NNE

(a) Pleistocene deposits disrupted.

(b) Greensfelder, C.D.M.G. Map Sheet 23, 1974.

(c) Mark (1977) Length-Magnitude relationship.

* Low Potential per A.E.G. definition.

The active Raymond and San Fernando fault zones are situated approximately 16 miles northeast and 22 miles north of the site, respectively. The 1971 San Fernando earthquake produced surface ruptures along the Sylmar and Tujunga faults, which are segments of the larger San Fernando fault zone.

Other active faults in the vicinity of the Los Angeles Coastal Plain include the Whittier fault and San Gabriel fault zone located 23 miles east and 25 miles north-northeast of the site, respectively. The active San Andreas fault zone is located 43 miles north-northeast of the site.

B.2.2 Potentially Active Faults

The closest potentially active fault is the Charnock fault, which has been postulated as passing at depth beneath the eastern portion of the site. The results of our study regarding the presence of the Charnock fault beneath the site are presented in Appendix C.

The potentially active Overland fault and Santa Monica-Hollywood fault zone are located 0.8 mile east-northeast and 5 miles north-northwest of the site, respectively. The Overland fault trends northwest and lies approximately parallel to and a short distance northeast of the Charnock fault. The Santa Monica-Hollywood fault zone trends east-west to east-northeast and is typified by predominant reverse-oblique fault movement. Recent work by Hill, et al. (1979) and Weber, et al. (1980) consider the eastern portion of the Hollywood fault to be active in the vicinity of the Atwater area. The Santa Monica fault, which is known to act as a well defined ground water barrier in the Santa Monica area, is considered by Hill, et al. (1979) to be undergoing tectonic strain accumulation and release based on an analysis of micro-earthquake data for the area. The Santa Monica fault has been considered an active fault based on the assumption that it is an easterly landward extension of the active Malibu Coast fault. These data, however, are inconclusive, and in our opinion, the Santa Monica Fault is considered only potentially active.

Other nearby potentially active faults are listed in Table B-3.

B.2.3 Inactive Faults

The closest inactive faults to the site occur adjacent to the site in the Playa del Rey Oil Field (California Division of Oil and Gas, 1974). Six small faults are depicted as offsetting Miocene age oil-bearing strata, but do not displace Pliocene age sediments. The faults do not affect Pliocene age (5 million years before present) rocks, and are therefore considered inactive. The potential for surface rupture from these inactive faults is extremely low.

B.3 SEISMICITY

The seismicity of the region surrounding the site was determined from a computer search of a magnetic tape catalog of earthquakes. The catalog of earthquakes included those compiled by the California Institute of Technology for the period from 1932 to 1981, and those earthquakes for the period 1812 to 1931 compiled by Richter and the U.S. National Oceanic and Atmospheric Administration (NOAA). The computer printout of the earthquakes is presented as Table B-4 and follows the text of this appendix. The search indicates that 306 earthquakes of Richter magnitude 4.0 and greater have occurred within 100 kilometers (62 miles) of the site during the period 1932 to 1987. The earthquake data were plotted to develop the recurrence curve presented on Plate 2-5.

The information listed for each earthquake found in Table B-4 includes date and time in Greenwich Civil Time (GCT), location of the epicenter in latitude and longitude, quality of epicentral determination (Q), depth in kilometers, and magnitude. Where a depth of 0.0 is given, the solution was based on an assumed 16-kilometer focal depth. The letter code for the quality factor is presented on the first page of the table.

The epicenter of the March 11, 1933 Long Beach earthquake, magnitude 6.3, was located about 37 miles southeast of the site. This earthquake, although of only moderate magnitude, ranks as one of the major disasters in Southern California. The majority of damage was suffered by structures now considered substandard construction and/or were located on filled or saturated ground.

The epicenter of the February 9, 1971, San Fernando earthquake with a magnitude of 6.5 was about 33 miles north of the site. Surface rupture occurred on the Sylmar and Tujunga faults, which are segments of the larger San Fernando fault system. The data indicate the San Fernando earthquake generated horizontal ground motion greater than 0.5g (g = acceleration of gravity) within about 11 miles of the epicenter. Horizontal ground accelerations reportedly ranged from 0.11 to 0.19g in downtown Los Angeles, about 10 miles east-northeast of the site.

The location of the site in relation to known active and potentially active faults indicates the site is not exposed to greater than normal seismic risk than other areas in the Los Angeles region.

B.4 GROUND SHAKING

Movements on any of the above-described active and potentially active faults could cause ground shaking at the site. The relationship between the magnitude of an earthquake and the duration of strong shaking that results has been investigated by Bolt (1973). The relationship is set forth in Table B-5. The period of strong shaking is defined as that period of time when the acceleration of the ground due to seismic waves is in excess of 0.05g.

TABLE B-5

BRACKETED DURATION OF STRONG SHAKING AS A FUNCTION OF
MAGNITUDE AND DISTANCE TO SOURCE
(after Bolt, 1973)

Distance to Source (km)	Bracketed Duration (seconds)						
	Magnitude						
	5.5	6.0	6.5	7.0	7.5	8.0	8.5
10	8	12	19	26	31	34	35
25	4	9	15	24	28	30	32
50	2	3	10	22	26	28	29
75	1	1	5	10	14	16	17
100	0	0	1	4	5	6	7
125	0	0	1	2	2	3	3
150	0	0	0	1	2	2	3
175	0	0	0	0	1	2	2
200	0	0	0	0	0	1	2

B.5 BIBLIOGRAPHY

- Association of Engineering Geologists, 1973, "Geology and Earthquake Hazards, Planners Guide to the Seismic Safety Element," Special Publication.
- Association of Engineering Geologists, 1973, "Geology, Seismicity, and Environmental Impact," Special Publication.
- Barrows, A.G., 1974, "A Review of the Geology and Earthquake History of the Newport-Inglewood Structural Zone, Southern California," California Division of Mines and Geology, Special Report 114.
- Baumann, Paul, and Lavery, F.B., 1940, "Annual Report of Hydrologic Data, Season 1938 - 39," Los Angeles County Flood Control District.
- Bolt, B.A., 1973, "Duration of Strong Ground Motion," in Proceedings, Fifth World Conference on Earthquake Engineering.
- California Department of Water Resources, 1961, "Planned Utilization of the Ground Water Basins of the Coastal Plain of Los Angeles County," App. A, Ground Water Geology, Bulletin 104.
- California Department of Water Resources, 1964, "Crustal Strain and Fault Movement Investigation," Bulletin 116-2.
- California Department of Water Resources, 1975, "Sea Water Intrusion in California, Inventory of Coastal Basins," Bulletin 63-5.
- California Department of Water Resources, 1977, Hydrologic Data: 1975, Volume II, Southern California, Bulletin 130-75.
- California Department of Water Resources, Water Data Information Service.
- California Division of Mines and Geology, 1954, "Geology of Southern California," Bulletin 170.
- California Division of Mines and Geology, 1975, "Geologic Map of California Showing Locations of Faults, Volcanoes, Thermal Springs and Thermal Wells," Map No. 1.
- California Division of Oil and Gas, 1974, "California Oil and Gas Fields; Volume II, South, Central Coastal, and Offshore California," Report No. TR12.
- Converse, Ward, Davis, Dixon, 1981, "Geotechnical Investigation Report Volume 1 - SCRTD Metro Rail Project."

- Greensfelder, R.W., 1974, "Maximum Credible Rock Acceleration from Earthquakes in California," California Division of Mines and Geology, Map Sheet 23.
- Hill, R. L., Sprotte, E.C., Chapman, R.H., Chase, G.W., Bennett, J. H., Real, C.R., Borchardt, Glenn, and Weber, F.H., Jr., 1979, "Earthquake Hazards Associated With Faults in the Greater Los Angeles Metropolitan Area, Los Angeles County, California, Including Faults in the Santa Monica-Raymond, Verdugo-Eagle Rock and Benedict Canyon Fault Zones," California Division of Mines and Geology, Open File Report 79-16LA.
- Los Angeles, City of, 1974, "Seismic Safety Plan."
- Los Angeles County Department of Regional Planning, 1982, "Local Coastal Plan, Phase II - Land Use Plan, Marina del Rey/Ballona," Los Angeles County, California.
- Los Angeles, County of, 1974, "Seismic Safety Element, Los Angeles County General Plan."
- Los Angeles County Flood Control District, 1985, "Coastal Plain Ground Water Contours, Deep Aquifers," Fall 1985.
- Mark, R.K., 1977, "Application of Linear Statistical Models of Earthquake Magnitude Versus Fault Length in Estimating Maximum Expectable Earthquakes," *Geology*, Vol. 5, p. 464-466.
- Poland, J.F., Garrett, A.A., and Sinnott, Allen, 1959, "Geology, Hydrology, and Chemical Character of Ground Waters in the Torrance-Santa Monica Area, California," U.S. Geological Survey Water Supply Paper 1461.
- Smith, T.C., 1978, "Fault Evaluation Report," California Division of Mines and Geology, FER - 71.
- U.S. Geological Survey, 1965, "Venice 7.5-Minute Quadrangle Map," photorevised 1981.
- Weber, F.H., Bennett, J.H., Chapman, R.H., Chase, G.W., and Saul, R.B., 1980, "Earthquake Hazards Associated with the Verdugo-Eagle Rock and Benedict Canyon Fault Zones, Los Angeles County, California," California Division of Mines and Geology, Open File Report 80-10LA.
- Yerkes, R.F., McCulloh, Schoellhamer, J.E., and Vedder, J.G., 1965, "Geology of the Los Angeles Basin - An Introduction," U.S. Geological Survey, Professional Paper 420-A.
- Ziony, J. I., 1985, "Evaluating Earthquake Hazards in the Los Angeles Region - An Earth Science Perspective," U.S. Geological Survey, Professional Paper 1360.

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 4.0 OR
GREATER WITHIN 100 KM OF THE SITE
(CAL TECH DATA 1932-1987)

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
03-11-1933	01:54:08	33.62 N	117.97 W	A	57	.0	6.3
03-11-1933	02:04:00	33.75 N	118.08 W	C	40	.0	4.9
03-11-1933	02:05:00	33.75 N	118.08 W	C	40	.0	4.3
03-11-1933	02:09:00	33.75 N	118.08 W	C	40	.0	5.0
03-11-1933	02:10:00	33.75 N	118.08 W	C	40	.0	4.6
03-11-1933	02:11:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	02:16:00	33.75 N	118.08 W	C	40	.0	4.8
03-11-1933	02:17:00	33.60 N	118.00 W	E	57	.0	4.5
03-11-1933	02:22:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	02:27:00	33.75 N	118.08 W	C	40	.0	4.6
03-11-1933	02:30:00	33.75 N	118.08 W	C	40	.0	5.1
03-11-1933	02:31:00	33.60 N	118.00 W	E	57	.0	4.4
03-11-1933	02:52:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	02:57:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	02:58:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	02:59:00	33.75 N	118.08 W	C	40	.0	4.6
03-11-1933	03:05:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	03:09:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	03:11:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	03:23:00	33.75 N	118.08 W	C	40	.0	5.0
03-11-1933	03:36:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	03:39:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	03:47:00	33.75 N	118.08 W	C	40	.0	4.1
03-11-1933	04:36:00	33.75 N	118.08 W	C	40	.0	4.6
03-11-1933	04:39:00	33.75 N	118.08 W	C	40	.0	4.9
03-11-1933	04:40:00	33.75 N	118.08 W	C	40	.0	4.7
03-11-1933	05:10:22	33.70 N	118.07 W	C	44	.0	5.1
03-11-1933	05:13:00	33.75 N	118.08 W	C	40	.0	4.7
03-11-1933	05:15:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	05:18:04	33.57 N	117.98 W	C	60	.0	5.2
03-11-1933	05:21:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	05:24:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	05:53:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	05:55:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	06:11:00	33.75 N	118.08 W	C	40	.0	4.4

NOTE: Q IS A FACTOR RELATING THE QUALITY OF EPICENTRAL DETERMINATION

A = SPECIALLY INVESTIGATED

B = EPICENTER PROBABLY WITHIN 5 KM, ORIGIN TIME TO NEAREST SECOND

C = EPICENTER PROBABLY WITHIN 15 KM, ORIGIN TIME TO A FEW SECONDS

D = EPICENTER NOT KNOWN WITHIN 15 KM, ROUGH LOCATION

E = EPICENTER ROUGHLY LOCATED, ACCURACY LESS THAN "D"

P = PRELIMINARY

DATE	TIME	LATITUDE	LONGITUDE	O	DIST	DEPTH	MAGNITUDE
03-11-1933	06:18:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	06:29:00	33.85 N	118.27 W	C	19	.0	4.4
03-11-1933	06:35:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	06:58:03	33.68 N	118.05 W	C	47	.0	5.5
03-11-1933	07:51:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	07:59:00	33.75 N	118.08 W	C	40	.0	4.1
03-11-1933	08:08:00	33.75 N	118.08 W	C	40	.0	4.5
03-11-1933	08:32:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	08:37:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	08:54:57	33.70 N	118.07 W	C	44	.0	5.1
03-11-1933	09:10:00	33.75 N	118.08 W	C	40	.0	5.1
03-11-1933	09:11:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	09:26:00	33.75 N	118.08 W	C	40	.0	4.1
03-11-1933	10:25:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	10:45:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	11:00:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	11:04:00	33.75 N	118.13 W	C	36	.0	4.6
03-11-1933	11:29:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	11:38:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	11:41:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	11:47:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	12:50:00	33.68 N	118.05 W	C	47	.0	4.4
03-11-1933	13:50:00	33.73 N	118.10 W	C	40	.0	4.4
03-11-1933	13:57:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	14:25:00	33.85 N	118.27 W	C	19	.0	5.0
03-11-1933	14:47:00	33.73 N	118.10 W	C	40	.0	4.4
03-11-1933	14:57:00	33.88 N	118.32 W	C	14	.0	4.9
03-11-1933	15:09:00	33.73 N	118.10 W	C	40	.0	4.4
03-11-1933	15:47:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	16:53:00	33.75 N	118.08 W	C	40	.0	4.8
03-11-1933	19:44:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	19:56:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	22:00:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	22:31:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	22:32:00	33.75 N	118.08 W	C	40	.0	4.1
03-11-1933	22:40:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	23:05:00	33.75 N	118.08 W	C	40	.0	4.2
03-12-1933	00:27:00	33.75 N	118.08 W	C	40	.0	4.4
03-12-1933	00:34:00	33.75 N	118.08 W	C	40	.0	4.0
03-12-1933	04:48:00	33.75 N	118.08 W	C	40	.0	4.0
03-12-1933	05:46:00	33.75 N	118.08 W	C	40	.0	4.4
03-12-1933	06:01:00	33.75 N	118.08 W	C	40	.0	4.2
03-12-1933	06:16:00	33.75 N	118.08 W	C	40	.0	4.6
03-12-1933	07:40:00	33.75 N	118.08 W	C	40	.0	4.2
03-12-1933	08:35:00	33.75 N	118.08 W	C	40	.0	4.2

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
03-12-1933	15:02:00	33.75 N	118.08 W	C	40	.0	4.2
03-12-1933	16:51:00	33.75 N	118.08 W	C	40	.0	4.0
03-12-1933	17:38:00	33.75 N	118.08 W	C	40	.0	4.5
03-12-1933	18:25:00	33.75 N	118.08 W	C	40	.0	4.1
03-12-1933	21:28:00	33.75 N	118.08 W	C	40	.0	4.1
03-12-1933	23:54:00	33.75 N	118.08 W	C	40	.0	4.5
03-13-1933	03:43:00	33.75 N	118.08 W	C	40	.0	4.1
03-13-1933	04:32:00	33.75 N	118.08 W	C	40	.0	4.7
03-13-1933	06:17:00	33.75 N	118.08 W	C	40	.0	4.0
03-13-1933	13:18:28	33.75 N	118.08 W	C	40	.0	5.3
03-13-1933	15:32:00	33.75 N	118.08 W	C	40	.0	4.1
03-13-1933	19:29:00	33.75 N	118.08 W	C	40	.0	4.2
03-14-1933	00:36:00	33.75 N	118.08 W	C	40	.0	4.2
03-14-1933	12:19:00	33.75 N	118.08 W	C	40	.0	4.5
03-14-1933	19:01:50	33.62 N	118.02 W	C	54	.0	5.1
03-14-1933	22:42:00	33.75 N	118.08 W	C	40	.0	4.1
03-15-1933	02:08:00	33.75 N	118.08 W	C	40	.0	4.1
03-15-1933	04:32:00	33.75 N	118.08 W	C	40	.0	4.1
03-15-1933	05:40:00	33.75 N	118.08 W	C	40	.0	4.2
03-15-1933	11:13:32	33.62 N	118.02 W	C	54	.0	4.9
03-16-1933	14:56:00	33.75 N	118.08 W	C	40	.0	4.0
03-16-1933	15:29:00	33.75 N	118.08 W	C	40	.0	4.2
03-16-1933	15:30:00	33.75 N	118.08 W	C	40	.0	4.1
03-17-1933	16:51:00	33.75 N	118.08 W	C	40	.0	4.1
03-18-1933	20:52:00	33.75 N	118.08 W	C	40	.0	4.2
03-19-1933	21:23:00	33.75 N	118.08 W	C	40	.0	4.2
03-20-1933	13:58:00	33.75 N	118.08 W	C	40	.0	4.1
03-21-1933	03:26:00	33.75 N	118.08 W	C	40	.0	4.1
03-23-1933	08:40:00	33.75 N	118.08 W	C	40	.0	4.1
03-23-1933	18:31:00	33.75 N	118.08 W	C	40	.0	4.1
03-25-1933	13:46:00	33.75 N	118.08 W	C	40	.0	4.1
03-30-1933	12:25:00	33.75 N	118.08 W	C	40	.0	4.4
03-31-1933	10:49:00	33.75 N	118.08 W	C	40	.0	4.1
04-01-1933	06:42:00	33.75 N	118.08 W	C	40	.0	4.2
04-02-1933	08:00:00	33.75 N	118.08 W	C	40	.0	4.0
04-02-1933	15:36:00	33.75 N	118.08 W	C	40	.0	4.0
05-16-1933	20:58:55	33.75 N	118.17 W	C	34	.0	4.0
08-04-1933	04:17:48	33.75 N	118.18 W	C	33	.0	4.0
10-02-1933	09:10:18	33.78 N	118.13 W	A	34	.0	5.4
10-02-1933	13:26:01	33.62 N	118.02 W	C	54	.0	4.0
10-25-1933	07:00:46	33.95 N	118.13 W	C	26	.0	4.3
11-13-1933	21:28:00	33.87 N	118.20 W	C	23	.0	4.0
11-20-1933	10:32:00	33.78 N	118.13 W	B	34	.0	4.0
01-09-1934	14:10:00	34.10 N	117.68 W	A	69	.0	4.5
01-18-1934	02:14:00	34.10 N	117.68 W	A	69	.0	4.0

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
01-20-1934	21:17:00	33.62 N	118.12 W	B	48	.0	4.5
04-17-1934	18:33:00	33.57 N	117.98 W	C	60	.0	4.0
10-17-1934	09:38:00	33.63 N	118.40 W	B	39	.0	4.0
11-16-1934	21:26:00	33.75 N	118.00 W	B	46	.0	4.0
06-11-1935	18:10:00	34.72 N	118.97 W	B	97	.0	4.0
06-19-1935	11:17:00	33.72 N	117.52 W	B	87	.0	4.0
07-13-1935	10:54:17	34.20 N	117.90 W	A	53	.0	4.7
12-25-1935	17:15:00	33.60 N	118.02 W	B	55	.0	4.5
08-22-1936	05:21:00	33.77 N	117.82 W	B	59	.0	4.0
10-29-1936	22:35:36	34.38 N	118.62 W	C	48	.0	4.0
01-15-1937	18:35:47	33.56 N	118.06 W	B	57	.0	4.0
03-19-1937	01:23:38	34.11 N	117.43 W	A	92	.0	4.0
07-07-1937	11:12:00	33.57 N	117.98 W	B	60	.0	4.0
09-01-1937	13:48:08	34.21 N	117.53 W	A	85	.0	4.5
09-01-1937	16:35:34	34.18 N	117.55 W	A	83	.0	4.5
05-21-1938	09:44:00	33.62 N	118.03 W	B	53	.0	4.0
05-31-1938	08:34:55	33.70 N	117.51 W	B	89	.0	5.5
07-05-1938	18:06:56	33.68 N	117.55 W	A	86	.0	4.5
08-06-1938	22:00:56	33.72 N	117.51 W	B	88	.0	4.0
08-31-1938	03:18:14	33.76 N	118.25 W	A	29	.0	4.5
11-29-1938	19:21:16	33.90 N	118.43 W	A	9	.0	4.0
12-07-1938	03:38:00	34.00 N	118.42 W	B	2	.0	4.0
12-27-1938	10:09:29	34.13 N	117.52 W	B	84	.0	4.0
11-04-1939	21:41:00	33.77 N	118.12 W	B	36	.0	4.0
12-27-1939	19:28:49	33.78 N	118.20 W	A	29	.0	4.7
01-13-1940	07:49:07	33.78 N	118.13 W	B	34	.0	4.0
02-08-1940	16:56:17	33.70 N	118.07 W	B	44	.0	4.0
02-11-1940	19:24:10	33.98 N	118.30 W	B	10	.0	4.0
04-18-1940	18:43:44	34.03 N	117.35 W	A	98	.0	4.4
05-18-1940	09:15:12	34.60 N	118.90 W	C	82	.0	4.0
06-05-1940	08:27:27	33.83 N	117.40 W	B	95	.0	4.0
07-20-1940	04:01:13	33.70 N	118.07 W	B	44	.0	4.0
10-11-1940	05:57:12	33.77 N	118.45 W	A	24	.0	4.7
10-12-1940	00:24:00	33.78 N	118.42 W	B	22	.0	4.0
10-14-1940	20:51:11	33.78 N	118.42 W	B	22	.0	4.0
11-01-1940	07:25:03	33.78 N	118.42 W	B	22	.0	4.0
11-01-1940	20:00:46	33.63 N	118.20 W	B	43	.0	4.0
11-02-1940	02:58:26	33.78 N	118.42 W	B	22	.0	4.0
01-30-1941	01:34:47	33.97 N	118.05 W	A	33	.0	4.1
03-22-1941	08:22:40	33.52 N	118.10 W	B	59	.0	4.0
03-25-1941	23:43:41	34.22 N	117.47 W	B	91	.0	4.0
04-11-1941	01:20:24	33.95 N	117.58 W	B	77	.0	4.0
10-22-1941	06:57:19	33.82 N	118.22 W	A	25	.0	4.9
11-14-1941	08:41:36	33.78 N	118.25 W	A	27	.0	5.4
04-16-1942	07:28:33	33.37 N	118.15 W	C	72	.0	4.0

DATE	TIME	LATITUDE	LONGITUDE		Q	DIST	DEPTH	MAGNITUDE
09-03-1942	14:06:01	34.48 N	118.98 W	C	76	.0	4.5	
09-04-1942	06:34:33	34.48 N	118.98 W	C	76	.0	4.5	
04-06-1943	22:36:24	34.68 N	119.00 W	C	95	.0	4.0	
10-24-1943	00:29:21	33.93 N	117.37 W	C	96	.0	4.0	
06-19-1944	00:03:33	33.87 N	118.22 W	B	21	.0	4.5	
06-19-1944	03:06:07	33.87 N	118.22 W	C	21	.0	4.4	
02-24-1946	06:07:52	34.40 N	117.80 W	C	73	.0	4.1	
06-01-1946	11:06:31	34.42 N	118.83 W	C	62	.0	4.1	
03-01-1948	08:12:13	34.17 N	117.53 W	B	84	.0	4.7	
04-16-1948	22:26:24	34.02 N	118.97 W	B	52	.0	4.7	
10-03-1948	02:46:28	34.18 N	117.58 W	A	80	.0	4.0	
01-11-1950	21:41:35	33.94 N	118.20 W	A	20	.0	4.1	
01-24-1950	21:56:59	34.67 N	118.83 W	C	86	.0	4.0	
02-26-1950	00:06:22	34.62 N	119.08 W	C	94	.0	4.7	
08-22-1950	22:47:58	34.15 N	119.35 W	B	89	.0	4.2	
02-10-1952	13:50:55	33.58 N	119.18 W	C	84	.0	4.0	
08-23-1952	10:09:07	34.52 N	118.20 W	A	63	.0	5.0	
10-26-1954	16:22:26	33.73 N	117.47 W	B	91	.0	4.1	
11-17-1954	23:03:51	34.50 N	119.12 W	B	87	.0	4.4	
05-15-1955	17:03:26	34.12 N	117.48 W	A	87	.0	4.0	
05-29-1955	16:43:35	33.99 N	119.06 W	B	60	.0	4.1	
01-03-1956	00:25:49	33.72 N	117.50 W	B	89	.0	4.7	
02-07-1956	02:16:57	34.53 N	118.64 W	B	65	.0	4.2	
02-07-1956	03:16:39	34.59 N	118.61 W	A	70	.0	4.6	
03-25-1956	03:32:02	33.60 N	119.10 W	A	76	.0	4.2	
03-18-1957	18:56:28	34.12 N	119.22 W	B	76	.0	4.7	
06-28-1960	20:00:48	34.12 N	117.47 W	A	88	.0	4.1	
10-04-1961	02:21:32	33.85 N	117.75 W	B	63	.0	4.1	
10-20-1961	19:49:51	33.65 N	117.99 W	B	53	.0	4.3	
10-20-1961	20:07:14	33.66 N	117.98 W	B	53	.0	4.0	
10-20-1961	21:42:41	33.67 N	117.98 W	B	53	.0	4.0	
10-20-1961	22:35:34	33.67 N	118.01 W	B	50	.0	4.1	
11-20-1961	08:53:35	33.68 N	117.99 W	B	51	.0	4.0	
09-14-1963	03:51:16	33.54 N	118.34 W	B	49	.0	4.2	
08-30-1964	22:57:37	34.27 N	118.44 W	B	32	.0	4.0	
01-01-1965	08:04:18	34.14 N	117.52 W	B	84	.0	4.4	
04-15-1965	20:08:33	34.13 N	117.43 W	B	92	.0	4.5	
07-16-1965	07:46:22	34.48 N	118.52 W	B	56	.0	4.0	
01-08-1967	07:37:30	33.63 N	118.47 W	B	39	.0	4.0	
01-08-1967	07:38:05	33.66 N	118.41 W	C	35	.0	4.0	
06-15-1967	04:58:06	34.00 N	117.97 W	B	41	.0	4.1	
02-28-1969	04:56:12	34.57 N	118.11 W	A	71	.0	4.3	
05-05-1969	16:02:10	34.30 N	117.57 W	B	85	.0	4.4	
10-24-1969	20:26:43	33.34 N	119.10 W	B	95	.0	4.7	
10-27-1969	13:16:02	33.55 N	117.81 W	B	73	.0	4.5	

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
10-31-1969	10:39:29	33.43 N	119.10 W	B	88	.0	4.8
09-12-1970	14:10:11	34.27 N	117.52 W	A	88	.0	4.1
09-12-1970	14:30:53	34.27 N	117.54 W	A	87	.0	5.4
09-13-1970	04:47:49	34.28 N	117.55 W	A	86	.0	4.4
02-09-1971	14:00:42	34.41 N	118.40 W	B	48	.0	6.4
02-09-1971	14:01:08	34.41 N	118.40 W	D	48	.0	5.8
02-09-1971	14:01:33	34.41 N	118.40 W	D	48	.0	4.2
02-09-1971	14:01:40	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:01:50	34.41 N	118.40 W	D	48	.0	4.5
02-09-1971	14:01:54	34.41 N	118.40 W	D	48	.0	4.2
02-09-1971	14:01:59	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:02:03	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:02:30	34.41 N	118.40 W	D	48	.0	4.3
02-09-1971	14:02:31	34.41 N	118.40 W	D	48	.0	4.7
02-09-1971	14:02:44	34.41 N	118.40 W	D	48	.0	5.8
02-09-1971	14:03:25	34.41 N	118.40 W	D	48	.0	4.4
02-09-1971	14:03:46	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:04:07	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:04:34	34.41 N	118.40 W	C	48	.0	4.2
02-09-1971	14:04:39	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:04:44	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:04:46	34.41 N	118.40 W	D	48	.0	4.2
02-09-1971	14:05:41	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:05:50	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:07:10	34.41 N	118.40 W	D	48	.0	4.0
02-09-1971	14:07:30	34.41 N	118.40 W	D	48	.0	4.0
02-09-1971	14:07:45	34.41 N	118.40 W	D	48	.0	4.5
02-09-1971	14:08:04	34.41 N	118.40 W	D	48	.0	4.0
02-09-1971	14:08:07	34.41 N	118.40 W	D	48	.0	4.2
02-09-1971	14:08:38	34.41 N	118.40 W	D	48	.0	4.5
02-09-1971	14:08:53	34.41 N	118.40 W	D	48	.0	4.6
02-09-1971	14:10:21	34.36 N	118.31 W	B	43	.0	4.7
02-09-1971	14:10:28	34.41 N	118.40 W	D	48	.0	5.3
02-09-1971	14:16:13	34.34 N	118.33 W	C	41	.0	4.1
02-09-1971	14:19:50	34.36 N	118.41 W	B	42	.0	4.0
02-09-1971	14:34:36	34.34 N	118.64 W	C	45	.0	4.9
02-09-1971	14:39:18	34.39 N	118.36 W	C	46	.0	4.0
02-09-1971	14:40:17	34.43 N	118.40 W	C	50	.0	4.1
02-09-1971	14:43:47	34.31 N	118.45 W	B	37	.0	5.2
02-09-1971	15:58:21	34.33 N	118.33 W	B	40	.0	4.8
02-09-1971	16:19:26	34.46 N	118.43 W	B	53	.0	4.2
02-10-1971	03:12:12	34.37 N	118.30 W	B	44	.0	4.0
02-10-1971	05:06:36	34.41 N	118.33 W	A	48	.0	4.3
02-10-1971	05:18:07	34.43 N	118.41 W	A	50	.0	4.5
02-10-1971	11:31:35	34.38 N	118.45 W	A	45	.0	4.2

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
02-10-1971	13:49:54	34.40 N	118.42 W	A	47	.0	4.3
02-10-1971	14:35:27	34.36 N	118.49 W	A	43	.0	4.2
02-10-1971	17:38:55	34.40 N	118.37 W	A	47	.0	4.2
02-10-1971	18:54:42	34.45 N	118.44 W	A	52	.0	4.2
02-21-1971	05:50:53	34.40 N	118.44 W	A	47	.0	4.7
02-21-1971	07:15:12	34.39 N	118.43 W	A	46	.0	4.5
03-07-1971	01:33:41	34.35 N	118.46 W	A	41	.0	4.5
03-25-1971	22:54:10	34.36 N	118.47 W	A	43	.0	4.2
03-30-1971	08:54:43	34.30 N	118.46 W	A	36	.0	4.1
03-31-1971	14:52:23	34.29 N	118.51 W	A	36	.0	4.6
04-01-1971	15:03:04	34.43 N	118.41 W	A	50	.0	4.1
04-02-1971	05:40:25	34.28 N	118.53 W	A	35	.0	4.0
04-15-1971	11:14:32	34.26 N	118.58 W	B	35	.0	4.2
04-25-1971	14:48:07	34.37 N	118.31 W	B	44	.0	4.0
06-21-1971	16:01:08	34.27 N	118.53 W	B	34	.0	4.0
06-22-1971	10:41:19	33.75 N	117.48 W	B	90	.0	4.2
07-27-1972	00:31:17	34.78 N	118.90 W	A	100	.0	4.4
02-21-1973	14:45:57	34.06 N	119.03 W	B	58	.0	5.9
08-06-1973	23:29:17	33.99 N	119.48 W	A	99	.0	5.0
03-09-1974	00:54:32	34.40 N	118.47 W	C	47	.0	4.7
08-14-1974	14:45:55	34.43 N	118.37 W	A	50	.0	4.2
01-01-1976	17:20:13	33.96 N	117.89 W	A	48	.0	4.2
04-08-1976	15:21:38	34.35 N	118.66 W	A	47	.0	4.6
08-12-1977	02:19:26	34.38 N	118.46 W	B	45	.0	4.5
09-24-1977	21:28:24	34.46 N	118.41 W	C	53	.0	4.2
05-23-1978	09:16:51	33.91 N	119.17 W	C	71	.0	4.0
01-01-1979	23:14:39	33.94 N	118.68 W	B	25	.0	5.0
10-17-1979	20:52:37	33.93 N	118.67 W	C	25	.0	4.2
10-19-1979	12:22:38	34.21 N	117.53 W	B	85	.0	4.1
09-04-1981	15:50:50	33.67 N	119.11 W	C	73	5.0	5.3
10-23-1981	17:28:17	33.63 N	119.02 W	C	68	12.0	4.6
10-23-1981	19:15:52	33.64 N	119.06 W	C	71	6.2	4.6
04-13-1982	11:02:12	34.05 N	118.96 W	A	51	16.6	4.0
05-25-1982	13:44:30	33.54 N	118.21 W	A	52	13.7	4.1
01-08-1983	07:19:30	34.14 N	117.45 W	A	90	4.6	4.1
02-27-1984	10:18:15	33.47 N	118.06 W	C	65	6.0	4.0
06-12-1984	00:27:52	34.54 N	118.99 W	A	82	11.8	4.1
10-26-1984	17:20:43	34.02 N	118.99 W	A	54	13.3	4.6
04-03-1985	04:04:50	34.38 N	119.04 W	A	73	27.9	4.0
10-01-1987	14:42:20	34.06 N	118.08 W	A	32	9.5	5.9
10-01-1987	14:45:41	34.05 N	118.10 W	A	30	13.6	4.7
10-01-1987	14:48:03	34.08 N	118.09 W	A	32	11.7	4.1
10-01-1987	14:49:06	34.06 N	118.10 W	A	30	11.7	4.7
10-01-1987	15:12:32	34.05 N	118.09 W	A	31	10.8	4.7
10-01-1987	15:59:54	34.05 N	118.09 W	A	31	10.4	4.0

DATE TIME LATITUDE LONGITUDE Q DIST DEPTH MAGNITUDE

10-04-1987 10:59:38 34.07 N 118.10 W A 30 8.2 5.3

SEARCH OF EARTHQUAKE DATA FILE 1

SITE: Maguire Thomas Partners

COORDINATES OF SITE 33.98 N 118.41 W
DISTANCE PER DEGREE 110.9 KM-N 92.4 KM-W
MAGNITUDE LIMITS 4.0 - 8.5
TEMPORAL LIMITS 1932 - 1987
SEARCH RADIUS (KM) 100
NUMBER OF YEARS OF DATA 56
NUMBER OF EARTHQUAKES IN FILE 3079
NUMBER OF EARTHQUAKES IN AREA 306

LeROY CRANDALL AND ASSOCIATES

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 6.0 OR
GREATER WITHIN 100 KM OF THE SITE
(RICHTER DATA 1906-1931)

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
05-15-1910	15:47:00	33.70 N	117.40 W	D	98	.0	6.0

SEARCH OF EARTHQUAKE DATA FILE 2

SITE: Maguire Thomas Partners

COORDINATES OF SITE	33.98 N 118.41 W
DISTANCE PER DEGREE	110.9 KM-N 92.4 KM-W
MAGNITUDE LIMITS	6.0 - 8.5
TEMPORAL LIMITS	1906 - 1931
SEARCH RADIUS (KM)	100
NUMBER OF YEARS OF DATA	26
NUMBER OF EARTHQUAKES IN FILE	35
NUMBER OF EARTHQUAKES IN AREA	1

LeROY CRANDALL AND ASSOCIATES

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 7.0 OR
GREATER WITHIN 100 KM OF THE SITE
(NOAA/CDMG DATA 1812-1905)

DATE	TIME	LATITUDE	LONGITUDE	O	DIST	DEPTH	MAGNITUDE
02-09-1890	04:06:00	34.00 N	117.50 W	.D	84	.0	7.0

SEARCH OF EARTHQUAKE DATA FILE 3

SITE: Maguire Thomas Partners

COORDINATES OF SITE		33.98 N 118.41 W
DISTANCE PER DEGREE		110.9 KM-N 92.4 KM-W
MAGNITUDE LIMITS		7.0 - 8.5
TEMPORAL LIMITS		1812 - 1905
SEARCH RADIUS (KM)		100
NUMBER OF YEARS OF DATA		94
NUMBER OF EARTHQUAKES IN FILE		9
NUMBER OF EARTHQUAKES IN AREA		1

LEROY CRANDALL AND ASSOCIATES

SUMMARY OF EARTHQUAKE SEARCH

NUMBER OF HISTORIC EARTHQUAKES WITHIN 100 KM RADIUS OF SITE

MAGNITUDE RANGE	NUMBER
4.0 - 4.5	212
4.5 - 5.0	66
5.0 - 5.5	20
5.5 - 6.0	6
6.0 - 6.5	3
6.5 - 7.0	0
7.0 - 7.5	1
7.5 - 8.0	0
8.0 - 8.5	0

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COMPUTATION OF RECURRENCE CURVE

$$\text{LOG } N = A - B M$$

BIN	MAGNITUDE	RANGE	NO/YR (N)
1	4.00	4.00 - 8.50	5.47
2	4.50	4.50 - 8.50	1.69
3	5.00	5.00 - 8.50	.507
4	5.50	5.50 - 8.50	.149
5	6.00	6.00 - 8.50	.423E-01
6	6.50	6.50 - 8.50	.568E-02 NU
7	7.00	7.00 - 8.50	.568E-02 NU
8	7.50	7.50 - 8.50	.000
9	8.00	8.00 - 8.50	.000

A = 1.290 B = .5992 (NORMALIZED)
A = 4.970 B = 1.0553 SIGMA = .128E-01

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COMPUTATION OF DESIGN MAGNITUDE
CONSTANT AREA

* * *

TABLE OF DESIGN MAGNITUDES

RISK	RETURN PERIOD (YEARS)				DESIGN MAGNITUDE				
					DESIGN LIFE (YEARS)				
	25	50	75	100	25	50	75	100	
.01 ..	2487	4974	7462	9949	..	7.84	8.05	8.15	8.21
.05 ..	487	974	1462	1949	..	7.24	7.50	7.65	7.75
.10 ..	237	474	711	949	..	6.95	7.23	7.38	7.49
.20 ..	112	224	336	448	..	6.65	6.93	7.09	7.20
.30 ..	70	140	210	280	..	6.46	6.74	6.90	7.02
.50 ..	36	72	108	144	..	6.18	6.47	6.63	6.75
.70 ..	20	41	62	83	..	5.96	6.24	6.41	6.53
.90 ..	10	21	32	43	..	5.69	5.98	6.14	6.26

MMIN = 4.00 MMAX = 8.50
MU = 5.61 BETA = 2.430

* * *

LeROY CRANDALL AND ASSOCIATES

APPENDIX C: CHARNOCK FAULT HAZARD EVALUATION

C.1 GENERAL

The fault hazard evaluation was undertaken to ascertain the presence or absence of the Charnock fault beneath the site, and if possible, determine the recency of activity of the fault.

The geologic studies performed as part of this evaluation included stratigraphic correlation of subsurface materials (based on previously drilled exploratory borings) and a review of published and unpublished literature pertinent to the Charnock fault. Particular emphasis was given to U.S. Geological Survey Water Supply Paper 1461 (Poland et al., 1959) and California Division of Mines and Geology Fault Evaluation Report FER-71 (Smith, 1978). We have also reviewed ground water data developed by McLaren Environmental Engineering in the evaluation.

The following reports by Kovacs-Byer and Associates, Inc. were also reviewed:

Additional Geotechnical Exploration, Charnock Fault Evaluation, Tentative Tracts 43415 and 43416, Westchester, California, for Howard Hughes Realty, Inc., August 5, 1987, KB 7606-G and KB 7607-G.

Additional Geotechnical Exploration, Charnock Fault Evaluation, Tentative Tract 43416, Westchester, California, for Howard Hughes Realty, Inc., August 5, 1987, Revised October 19, 1987, KB 7606-G and KB 7607-G.

C.2 BACKGROUND

The Charnock fault was recognized as a ground water barrier as early as 1939 by the Los Angeles County Flood Control District (Baumann and Lavery, 1940). Poland et al. (1959) subsequently assigned the name "Charnock fault" to the barrier because it presumably passes west of the Charnock well fields in the City of Santa Monica. As described by Poland et al., the fault trends northwest-southeast from approximately the intersection of La Grange Avenue and Sawtelle Boulevard, in West Los Angeles, to south of Redondo Beach Boulevard in the vicinity of Gardena. The Charnock fault is sub-parallel to the

potentially active Overland Avenue fault and the active Newport-Inglewood fault zone, located 1 mile and 3 miles northeast of the Charnock fault, respectively. For the most part, the trace of the Charnock fault is concealed by Holocene (Recent) deposits. It is estimated that the base of the early Pleistocene age San Pedro Formation has been displaced approximately 140 feet, with the dropped block on the east side of the fault.

To date, there is no evidence of fault movement during the Holocene epoch (last 11,000 years). The fault is depicted as cutting late Pleistocene units; however, according to Poland et al. (1959) the "50-foot gravel," representing the base of the Holocene in Ballona Gap, is apparently unaffected by faulting. Additionally, no ground water barriers are known to exist in the Holocene materials blanketing the fault. The California Division of Mines and Geology (CDMG), in their fault evaluation report prepared for the Charnock fault, refer to the fault as "ill-defined" having been identified on the basis of subsurface data only. Furthermore, the CDMG concludes the fault is probably pre-Holocene and, therefore, does not meet the state's definition of an active fault. Based on these data, the Charnock fault is considered potentially active as opposed to active. The fault is not within an established Alquist-Priolo Special Studies Zone.

C.3 SUBSURFACE DATA

Subsurface data from 36 exploration borings on the level portion of Tentative Tract 44857 were reviewed as part of the fault hazard evaluation. In addition, we reviewed 20 borings drilled on the property west of Lincoln Boulevard for Tentative Tract No. 44880. The locations of the borings are shown on Plates C-1.1 and C-1.2, Geologic Map and Plot Plan. Six of the borings were drilled east of the Charnock fault's inferred trace; the remaining borings were drilled west of the fault trace. The borings extended to depths varying from 47 to 77 feet below the existing ground surface. The subsurface conditions in the borings are depicted on Plate C-2, Geologic Sections, and Plate C-3, Fence Diagram. Geologic Sections A-A' and B-B' were constructed to provide continuity between the two section lines. The Fence Diagram was constructed for the borings drilled in close proximity to the mapped fault trace.

The materials observed in the borings are flood plain deposits consisting of interlayered sand to silty sand, silty clay to clayey silt, and sand and gravel. The sand and gravel, representing the "50-foot gravel" of Poland et al. (1959), was encountered in the borings at depths of about 40 to 66 feet below ground surface. Underlying the "50-foot gravel" are silt and clay units of the early Pleistocene age San Pedro Formation. The San Pedro Formation was noted in three of the borings drilled for Tract 44880 (Boring 1 of AE-86415 and Boring 2 and 3 of AE-86416). An attempt was made to determine if similar units could be correlated between the various borings; the correlations are shown on Plate C-2. Although there is some variation as a result of interfingering units, there does appear to be fairly good correlation of the units across Tract 44880 (Section A-A') and Tract 44857 (Section B-B') as well as across the inferred fault trace shown on Plate C-2. In particular, the upper surface of the "50-foot gravel" is laterally continuous across both sites with no indication of offset or disruption of the unit. Although the data are limited, the "50-foot gravel"/San Pedro Formation contact beneath Tract 44880 appears to be unaffected by faulting.

Water levels were noted in the borings at elevations ranging from about 3.0 feet above mean sea level to 5.8 feet below sea level. The higher water levels were noted in the westernmost borings (drilled in Tract 44880) and the lower levels were observed in the easternmost borings (Tract 44857). Based on the various water levels, an overall easterly sloping gradient of approximately 0.0005 (1 foot of fall for a run of 2,000 feet) is indicated from west to east. No ground water anomaly, suggestive of a fault created ground water barrier, is observable.

C.4 CONCLUSIONS

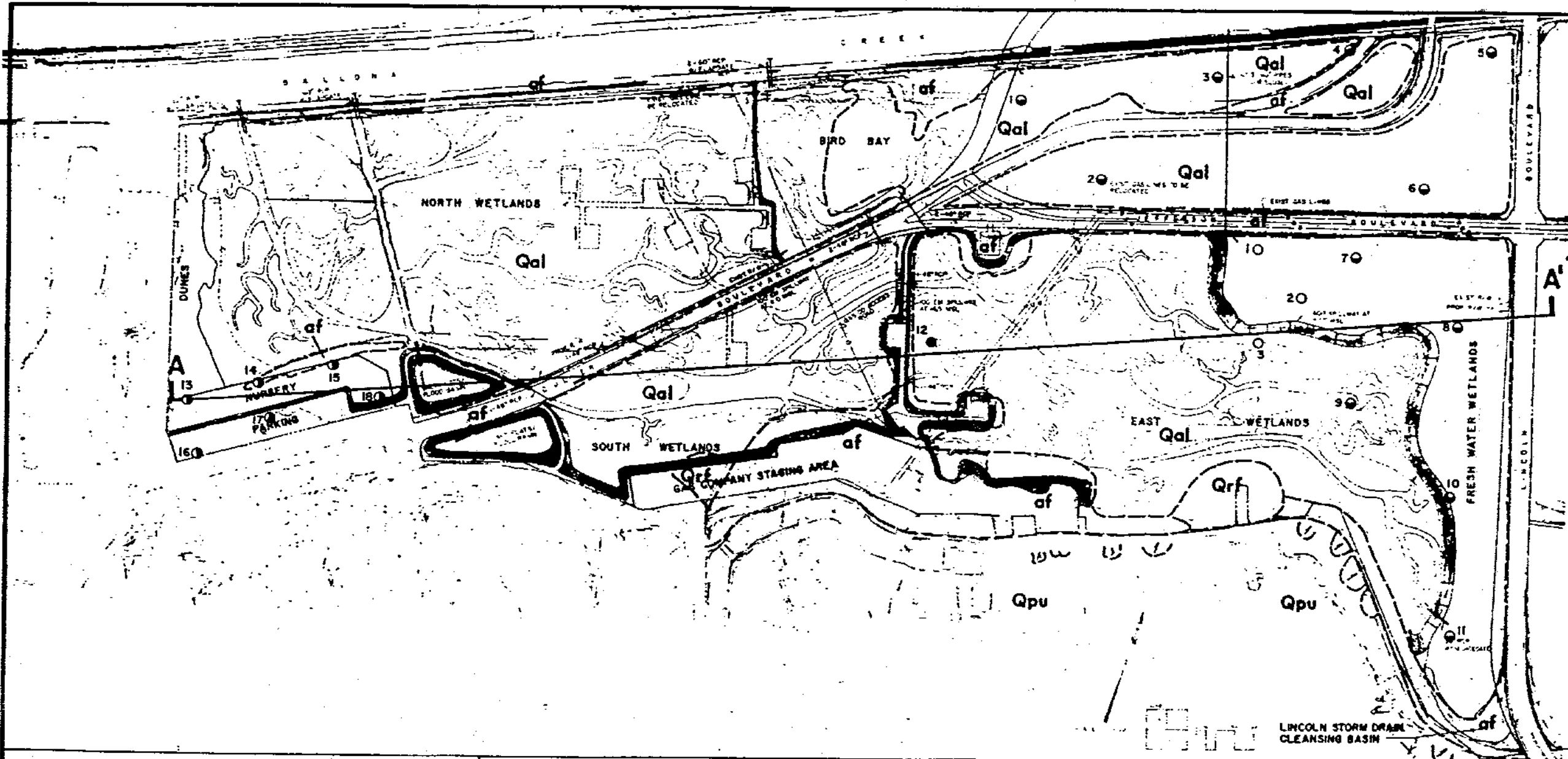
As previously stated, the Charnock fault has been identified on the basis of differing water levels on opposing sides of the fault. The most recent data presented by the Los Angeles County Flood Control District, for water levels obtained in fall of 1985, indicate a water level difference of about 10 feet adjacent to the inferred fault trace. According to the Flood Control District data, the water surface elevation would be near sea level west of the

fault and about 10 feet below sea level east of the fault trace. Although our borings detected a gradual drop in the water level going from west to east across the site, there were no abrupt changes in the water levels that typically characterize fault-related ground water barriers.

The upper surface of the "50-foot gravel," encountered in all of our borings, appears to be unaffected by faulting. This unit is considered the base of the Holocene in Ballona Gap; therefore, if faulting is present at depth, it is either confined to Pleistocene units (and by definition potentially active) or has not been active since early Holocene.

Recently, Kovacs-Byer and Associates conducted a fault investigation for the Charnock fault along the bluffs immediately upslope and southeast of the subject site. This investigation included the excavation of several trenches and sidehill cuts in an attempt to locate the fault trace. These various excavations were observed by personnel from our office. The materials exposed in the excavations consisted of an unfaulted section of late Pleistocene age ancient dune sand; the Charnock fault was not observed.

Based on the findings from our exploratory borings and the results of the Kovacs-Byer and Associates investigation, it appears that the Charnock fault either does not exist beneath the Playa Vista site or is buried by materials that are late Pleistocene age or older. These findings are consistent with the previous opinions presented by Poland et al. (1959) and Smith (1978). Therefore, it is concluded that the Charnock fault is not active and does not present a hazard to future development within the subject tracts. No further studies on the possible presence of the fault or its activity are considered necessary.



- EXPLANATION:**
- 12 ● PREVIOUS INVESTIGATION (AE-87133-B)
 - 11 ● PREVIOUS INVESTIGATION (AE-87133)
 - 18 ● PREVIOUS INVESTIGATION (AE-85415)
 - 3 ○ PREVIOUS INVESTIGATION (AE-85416)
 - BORING LOCATION AND NUMBER
 - af ARTIFICIAL FILL
 - Qrf RECENT ALLUVIUM FAN
 - Qal RECENT ALLUVIUM
 - Qpu UNDIFFERENTIATED UPPER PLEISTOCENE DEPOSITS
 - SHALLOW SLUMP
 - GEOLOGIC SECTION LINE
 - GEOLOGIC CONTACT

LeROY CRANDALL AND ASSOCIATES
 GEOTECHNICAL CONSULTANTS
 One of the Law Companies
 908 Grand Central Avenue, Glendale, California 91201-3009, (818) 243-4140

**GEOLOGIC MAP AND
SITE PLAN** PLATE C-1.1

JOB NO: L 90328 AEO	TO ACCOMPANY REPORT
DATE: 1-3-91	DATED: 1-3-91
SCALE: 1" = 400'	REVISIONS:
DRAWN BY: JULIANA	
CHECKED BY:	

RESTORATION OF WETLANDS / FULL TIDAL FLUSHING
(SCHEMATIC PLAN)

PSOMAS

PRELIMINARY

**BALLONA
WETLAND
PROJECT**

PV 360

APPENDIX D:**EXPLORATIONS AND LABORATORY TESTS
BLUFF STABILITY INVESTIGATION****D.1 EXPLORATIONS**

The bluff materials were investigated by drilling seven exploration borings (Borings B-1 through B-6) to depths of 19 to 60 feet. The locations of the borings are shown on Plates 3-1.1 and 3-1.2. The locations of borings from our nearby projects on the adjacent properties at the top of the bluff are also shown.

During the drilling of Boring B-5, a portion of the sewer liner was encountered at a depth of approximately 19 feet. Boring B-5 was subsequently abandoned and Boring B-5A was drilled approximately 280 feet west of Boring B-5. All of the borings were drilled using bucket-type drilling equipment. Caving of the boring walls occurred, and Borings 1 through 4 were terminated because of heavy caving when water was encountered at about Elevation +2.

The soils encountered were logged by our field technician, and undisturbed and loose samples were obtained for laboratory inspection and testing. The logs of the borings are presented on Plates D-1.1 through D-1.7; the depths at which undisturbed samples were obtained are indicated to the left of the boring logs. The energy required to drive the sampler 12 inches is indicated on the logs. The soils are classified in accordance with the Unified Soil Classification System described on Plate D-2.

D.2 LABORATORY TESTS

The field moisture content and dry density of the soils encountered were determined by performing tests on the undisturbed samples. The results of the tests are shown to the left of the boring logs.

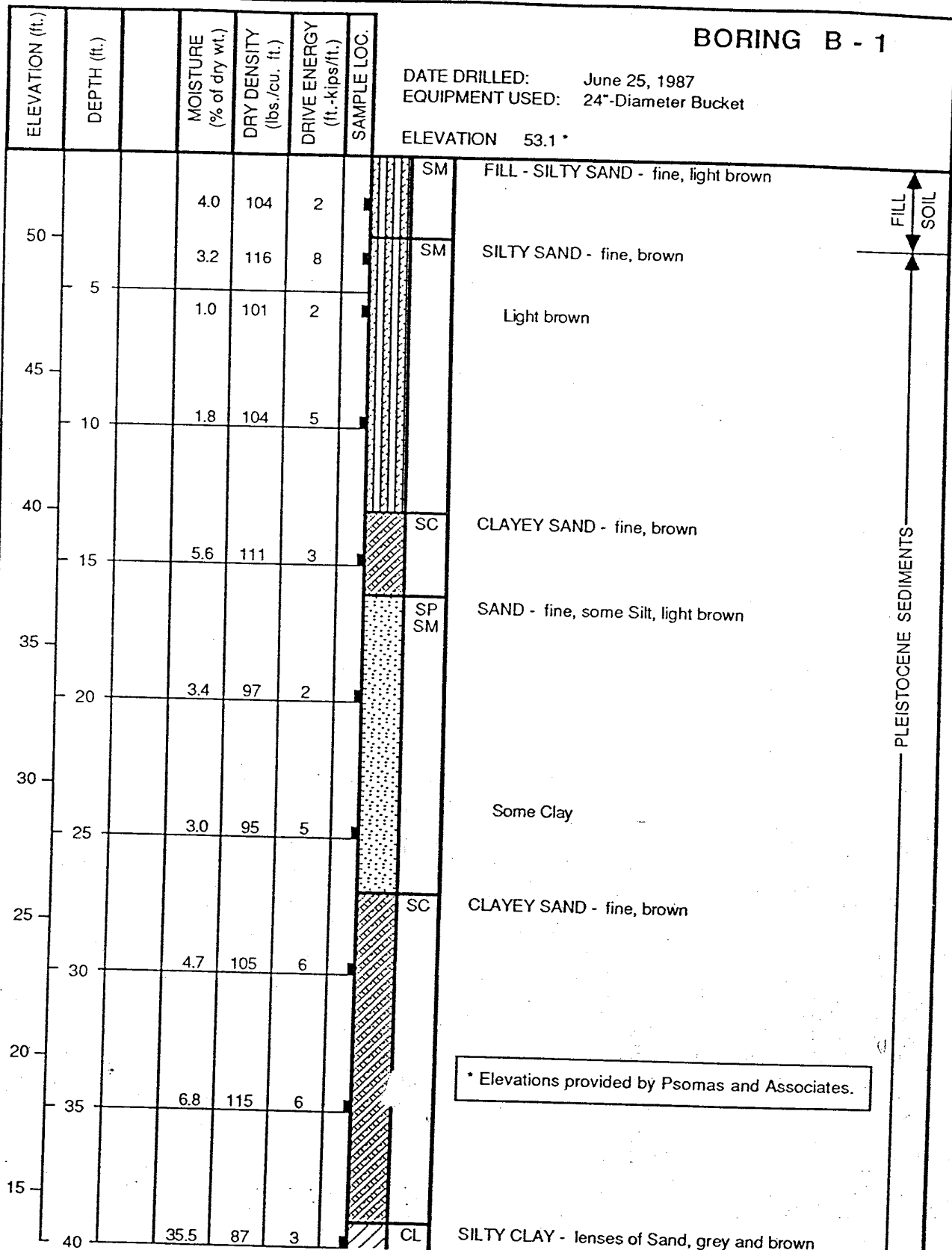
Direct shear tests were performed to determine the strength of the soils. The tests were performed on undisturbed samples and on remolded samples compacted to 90% of the maximum density obtainable by the ASTM Designation D1557-70 method of compaction. These samples were tested at field or optimum moisture content and at nearly saturated moisture contents after soaking for at least 24 hours. Each sample was tested at two different surcharge pressures. The shear values determined from the direct shear tests are presented on Plates D-3.1 through D-3.3, Direct Shear Test Data. In addition to testing the samples obtained during this investigation, direct shear test results were available from our prior investigations on the adjacent properties at the top of the bluff. The results of the prior shear tests on samples from nearby prior borings are presented on Plate D-3.4.

To assist in classification of the soils, the percent passing the No. 200 Sieve was determined on 22 samples. The tests were performed in accordance with the ASTM Designation D1140-54 test method. The results of those determinations are presented on Plate D-4, Sieve Data.

The optimum moisture content and maximum dry density of the existing fill soils were determined by performing compaction tests on two samples. The tests were performed in accordance with the ASTM Designation D1557-70 method of compaction. The results of the tests are presented on Plate D-5, Compaction Test Data.

OB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note : The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D-1.1a

JOB L90328.AEO

DATE 8/24/90

F.T.

LS

DR.

dmh

O.E.

AS

W.P.

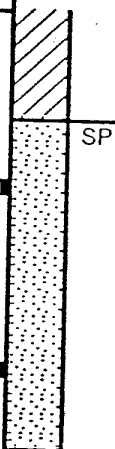
dmh

CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
10					
45		2.7	112	13	
5					
50		13.6	121	20	
0					
55					

DATE DRILLED: June 25, 1987
EQUIPMENT USED: 24"-Diameter Bucket



SAND - fine to medium, light brown

(BORING TERMINATED DUE TO CAVING)

NOTE: Water level measured at a depth of 51' at completion of drilling and at 50' 5 minutes later. Heavy caving below 51'.

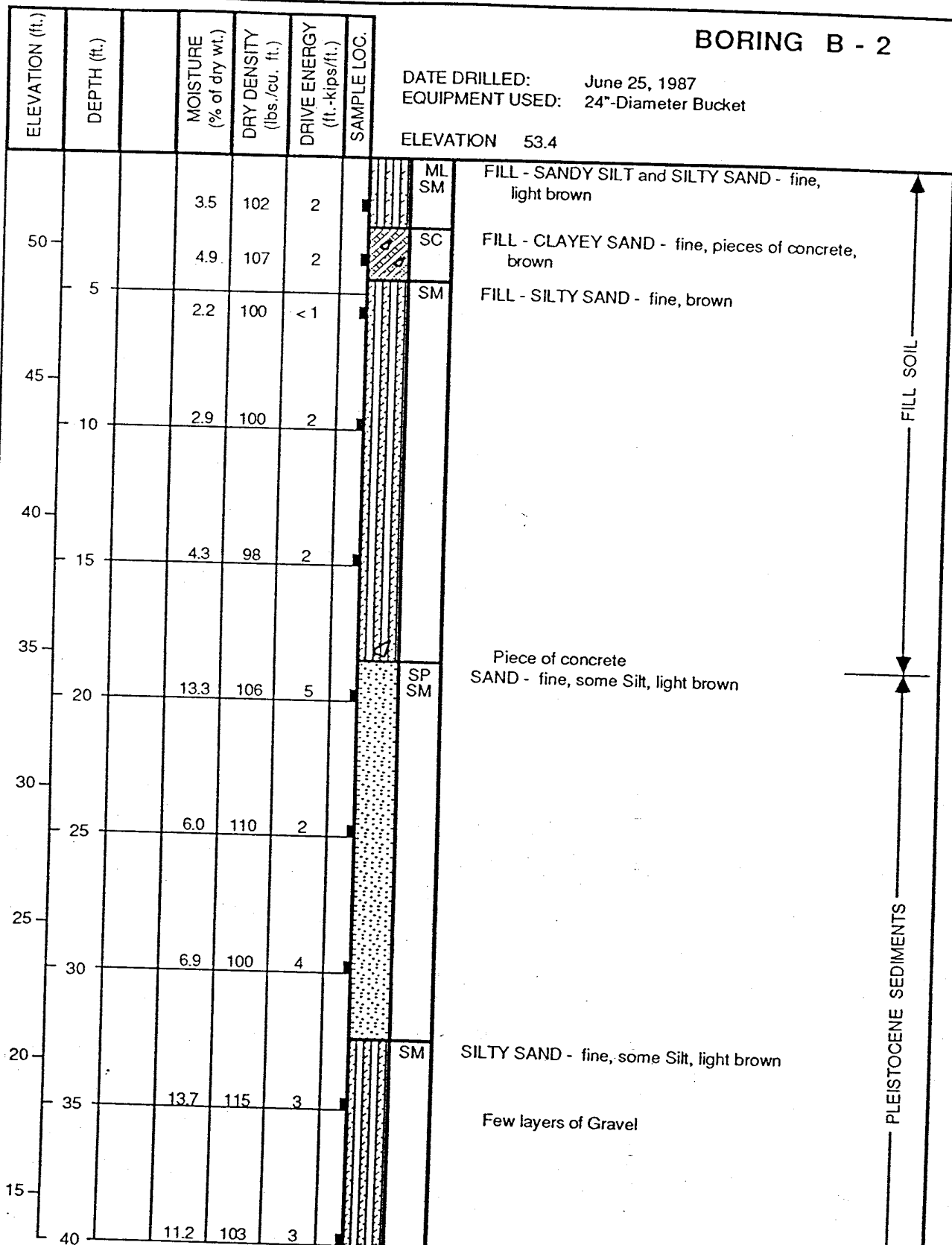
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.1b

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

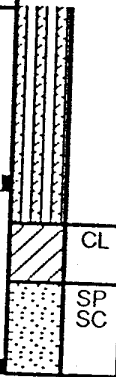
PLATE D - 1.2a

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh O.E. AS W.P. dmh CHKD dmh

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
10					
45		9.8	104	4	
5					
50		15.0	118	6	

DATE DRILLED: June 25, 1987
EQUIPMENT USED: 24"-Diameter Bucket



SILTY CLAY - lenses of Sand, grey and brown

SAND - fine, some Clay, light greyish brown

(BORING TERMINATED DUE TO CAVING)

NOTE: Water not encountered. Caving from 19' to 50' (to 3' in diameter).

↓ PLEISTOCENE SEDIMENTS

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.2b

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

							BORING B - 3	
							DATE DRILLED:	June 26, 1987
							EQUIPMENT USED:	24"-Diameter Bucket
							ELEVATION	53.9
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.			
50	5	6.4	111	2		ML SM	FILL - SANDY SILT and SILTY SAND - fine, some Clay, light brown	
		5.5	109	2			Light greyish brown	
45	10	11.5	94	2			Light brownish grey	
40	15	3.7	106	2		SM	SILTY SAND - fine, brown	
35	20	21.2	101	2		ML	SANDY SILT - layers of Clay, light grey	
30	25	31.1	90	<1			Layer of Clay, grey	
25	30	16.6	104	4			Layer of Silty Sand	
20	35	33.3	89	2		CL	SILTY CLAY - layers of Sandy Silt, grey	
15	40	39.2	85	9				

FILL SOIL

PLEISTOCENE SEDIMENTS

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.3a

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. AS CHKD dmh

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated.
It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
10	45	6.5	106	13	
5	50	19.0	108	40	
0	55				

BORING B - 3 (Continued)

DATE DRILLED: June 25, 1987
EQUIPMENT USED: 24"-Diameter Bucket

SP

SAND - medium, light brown

Some Clay, light grey

(BORING TERMINATED DUE TO CAVING)

NOTE: Water level measured at a depth of 51-1/2' at completion of drilling and at 51' 5 minutes later. Heavy caving from 51' to 52'.

PLEISTOCENE SEDIMENTS

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.3b

JOB L90328.AEO DATE 8/24/90 F.T. LS DR dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated.
It is not warranted to be representative of subsurface conditions at other locations and times.

							BORING B - 4	
							DATE DRILLED: June 26, 1987	
							EQUIPMENT USED: 24"-Diameter Bucket	
							ELEVATION 56.4	
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.			
55		4.9	109	3		SM ML	FILL - SILTY SAND and SANDY SILT - fine, some Clay, light brown	
50	5	4.5	103	2				
45	10	16.7	103	2				
40	15	8.0	100	2				
35	20	12.9	102	5		SP SM	Large piece of concrete SAND - fine, some Silt, light brownish grey	
30	25	11.9	122	8		SC	Layer of Silty Clay CLAYEY SAND - fine, brownish grey	
25	30	5.1	109	8		SP SC	SAND - fine, some Clay, light brown	
20	35	4.2	109	8		SP	SAND - medium, light brown	
15	40	4.6	111	12		SP SC	SAND - fine, some Clay, light brown	

FILL SOIL
PLEISTOCENE SEDIMENTS

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

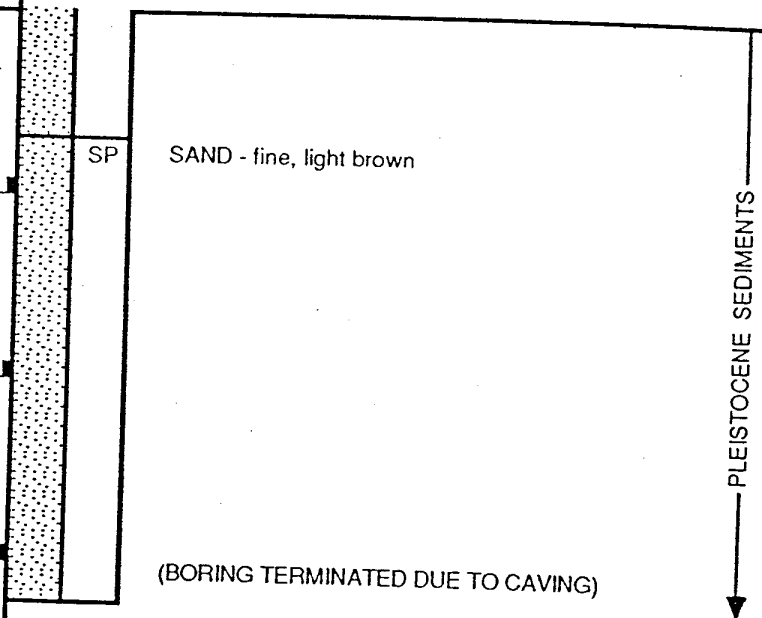
PLATE D - 1.4a

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh O.E. AS W.P. dmh CHKD dmh

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
15	45	4.2	111	14	
10	50	6.2	114	42	
5	55	17.7	113	36	
0	60				

DATE DRILLED: June 26, 1987
EQUIPMENT USED: 24"-Diameter Bucket



NOTE: Water level measured at a depth of 55-1/2' at completion of drilling and at 55' 5 minutes later. Heavy caving below 53'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES
PLATE D - 1.4b

OB L90328.AEO DATE 3/16/88 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

							BORING B - 5-A	
							DATE DRILLED: June 27, 1987	
							EQUIPMENT USED: 20"-Diameter Bucket	
							ELEVATION 56.3	
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.			
55		3.5	102	5		SM ML	FILL - SILTY SAND and SANDY SILT - fine, light brownish grey	FILL SOIL
50	5	1.6	105	2		SP SM	SAND - fine, some Silt, light brown	
						SP	SAND - fine to medium, few Gravel, light brown	
45	10	4.5	103	2				
						ML	SANDY SILT - some Clay, brown	
40	15	27.3	97	3				
						SP SM	SAND - fine, some Silt, greyish brown	
35	20	12.5	98	2		CL	SILTY CLAY - grey	
						ML	SANDY SILT - some Clay, brown	
30	25	14.5	118	5				
						SP	SAND - medium, light brown	
25	30	3.7	103	2				
						CL	SILTY CLAY - light brownish grey	
20	35	23.9	103	2		SC	CLAYEY SAND - fine to medium, grey	
						SP SM	SAND - fine, some Silt, light brown	
40	40	5.9	108	5				

PLEISTOCENE SEDIMENTS

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.5a

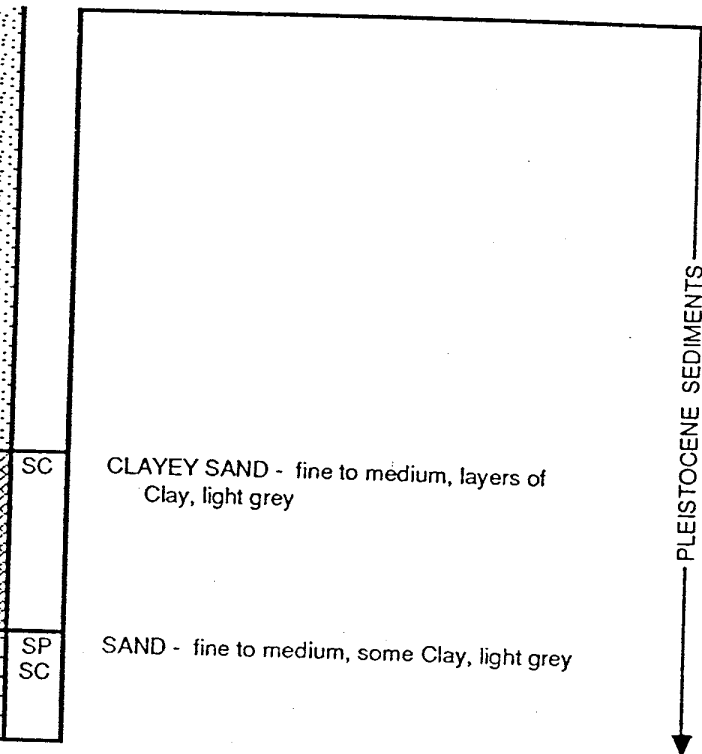
JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
15					
45		5.0	113	4	
10					
50		3.5	104	12	
5					
55		23.6	105	11	
0					
60		13.3	106	11	

BORING B - 5-A (Continued)

DATE DRILLED: June 27, 1987
EQUIPMENT USED: 20"-Diameter Bucket



NOTE: Water measured at a depth of 56' at completion of drilling and at 55' 5 minutes later. Heavy caving below 57'.

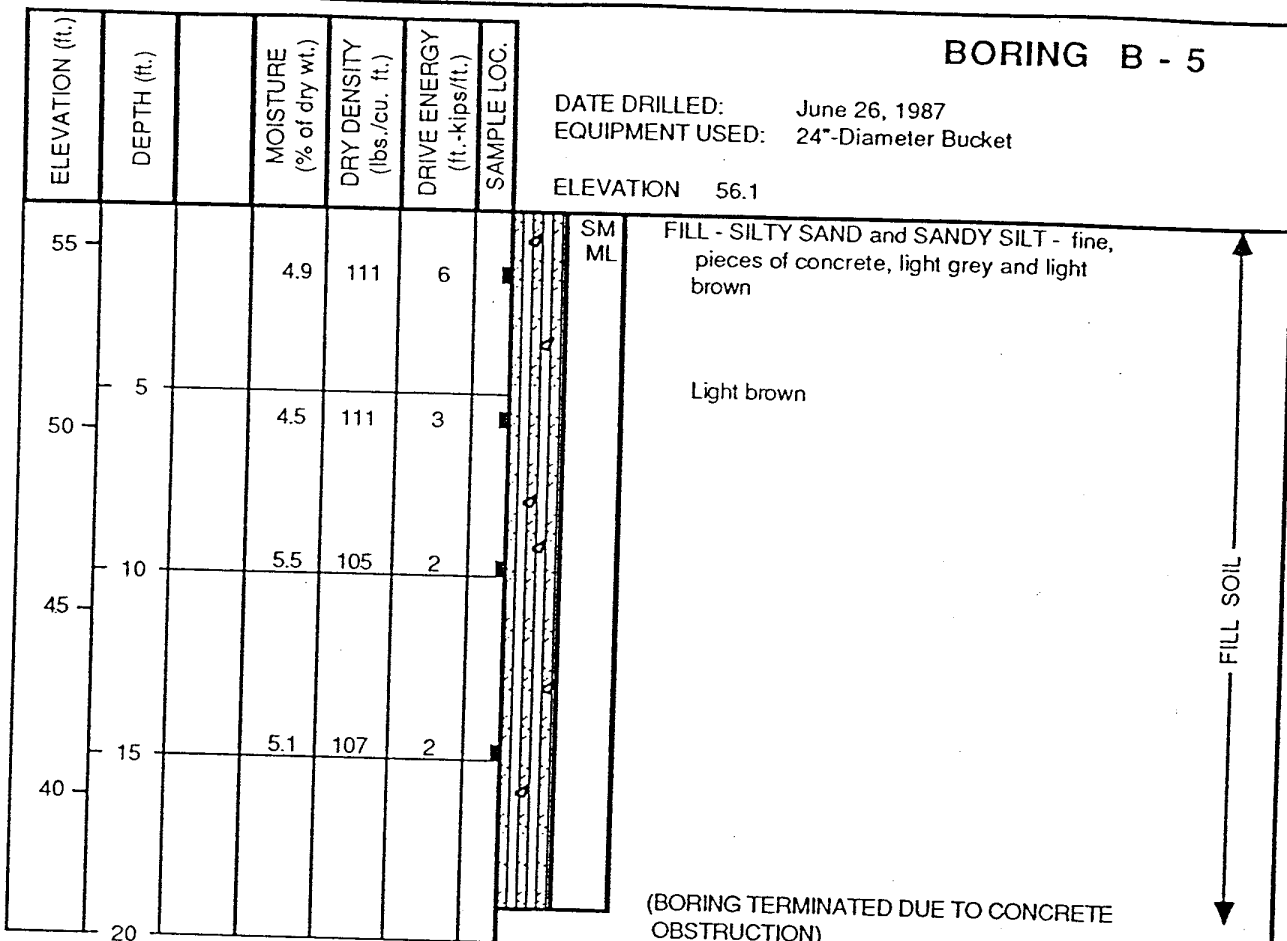
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.5b

DB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. AS O.E. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.



NOTE: Water not encountered. No caving.

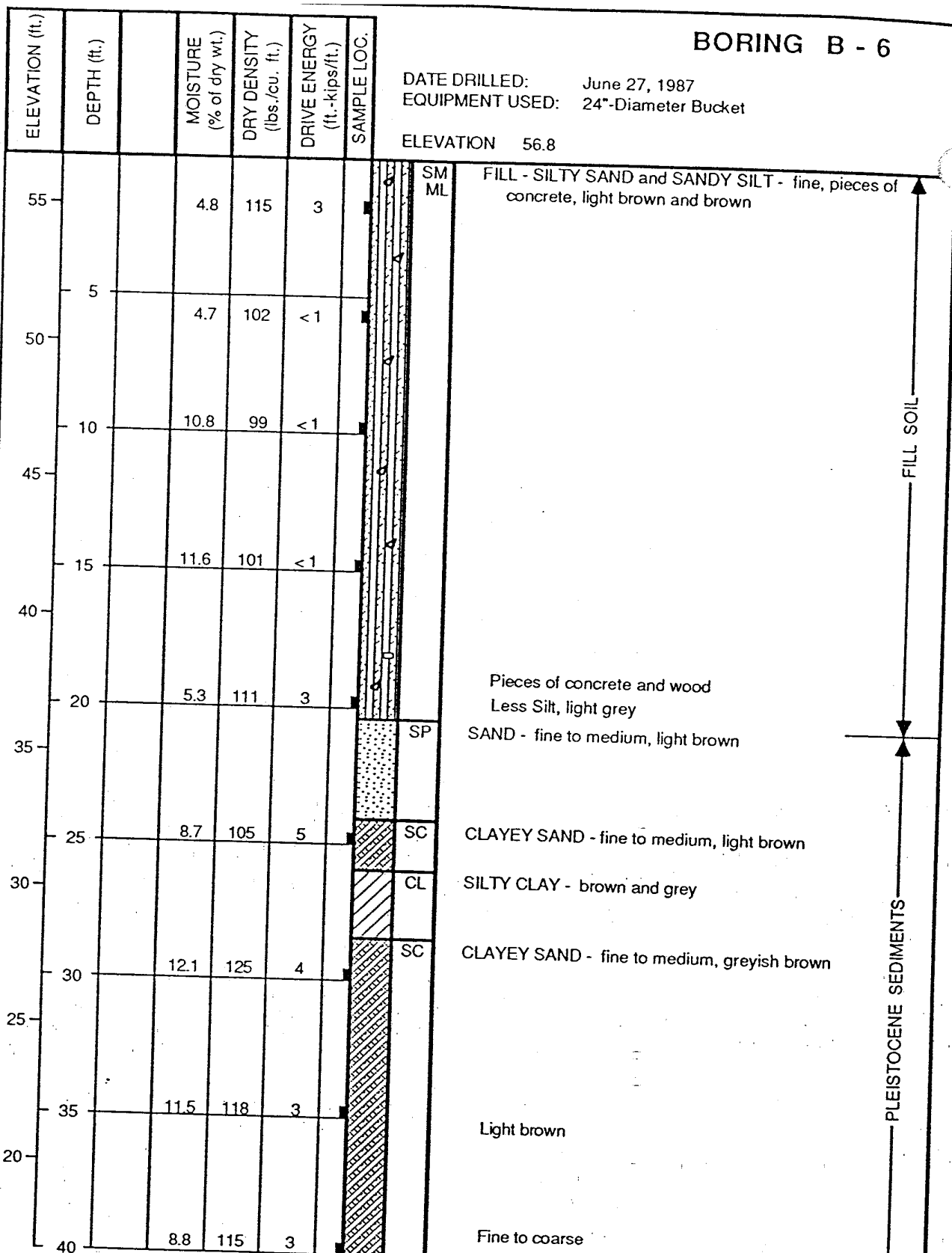
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D-1.6

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.7a

BORING B - 6 (Continued)

DATE DRILLED: June 27, 1987
EQUIPMENT USED: 24"-Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
15					
45		8.2	101	4	
10					
50		4.6	110	10	
5					
55		20.8	102	19	
0					
60		14.2	108	19.	

Fine to medium

Reddish brown

Light brown

PLEISTOCENE SEDIMENTS

NOTE: Water level measured at a depth of 56' at completion of drilling and at 55' 5 minutes later. Heavy caving below 57.

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.7b

JB L90328-AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh AS O.E. dmh CHKD

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	 GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			 GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amt. of fines)	 GM	Silty gravels, gravel-sand-silt mixtures.
			 GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 sieve size)	CLEAN SANDS (Little or no fines)	 SW	Well graded sands, gravelly sands, little or no fines.
			 SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amt. of fines)	 SM	Silty sands, sand-silt mixtures.
			 SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (More than 50% of material is SMALLER than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit LESS than 50)	 ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	
		 CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	
		 OL	Organic silts and organic silty clays of low plasticity.	
		SILTS AND CLAYS (Liquid limit GREATER than 50)	 MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
	 CH		Inorganic clays of high plasticity, fat clays.	
	 OH		Organic clays of medium to high plasticity, organic silts.	
	HIGHLY ORGANIC SOILS		 PI	Peat and other highly organic soils.

BOUNDARY CLASSIFICATIONS Soils possessing characteristics of two groups are designated by combinations of group symbols.

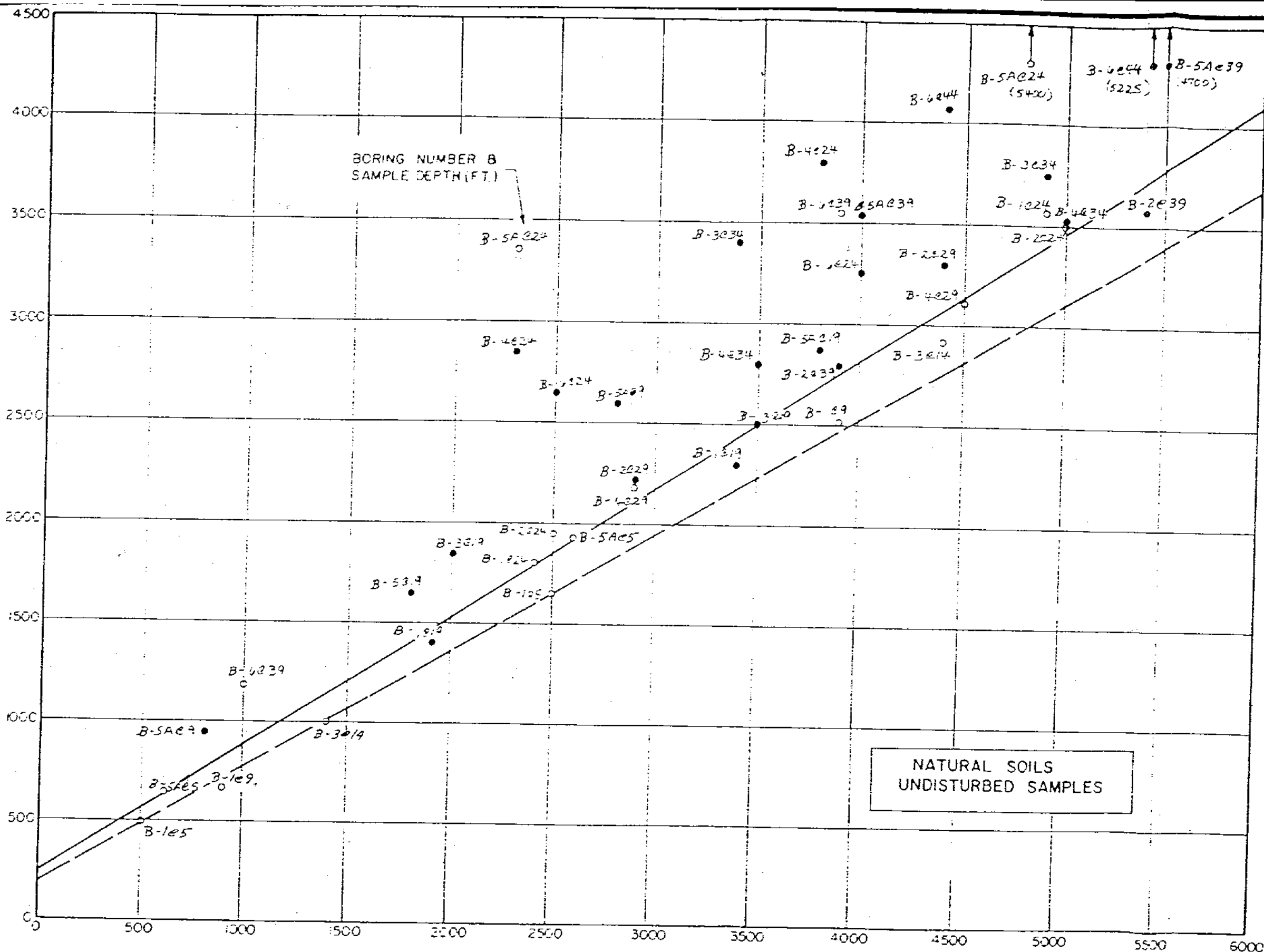
P A R T I C L E S I Z E L I M I T S						
SILT OR CLAY	SAND			GRAVEL		BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE	
	NO. 200	NO. 40	NO. 10	NO. 4	3/4 in.	3 in.
						12 in.
	U. S. STANDARD SIEVE SIZE					

UNIFIED SOIL CLASSIFICATION SYSTEM

Reference:
The Unified Soil Classification System, Corps of Engineers, U. S. Army Technical Memorandum No 3-357, Vol 1, March, 1953. (Revised April, 1960)

LEROY CRANDALL & ASSOCIATES

SHEAR STRENGTH in Pounds per Square Foot

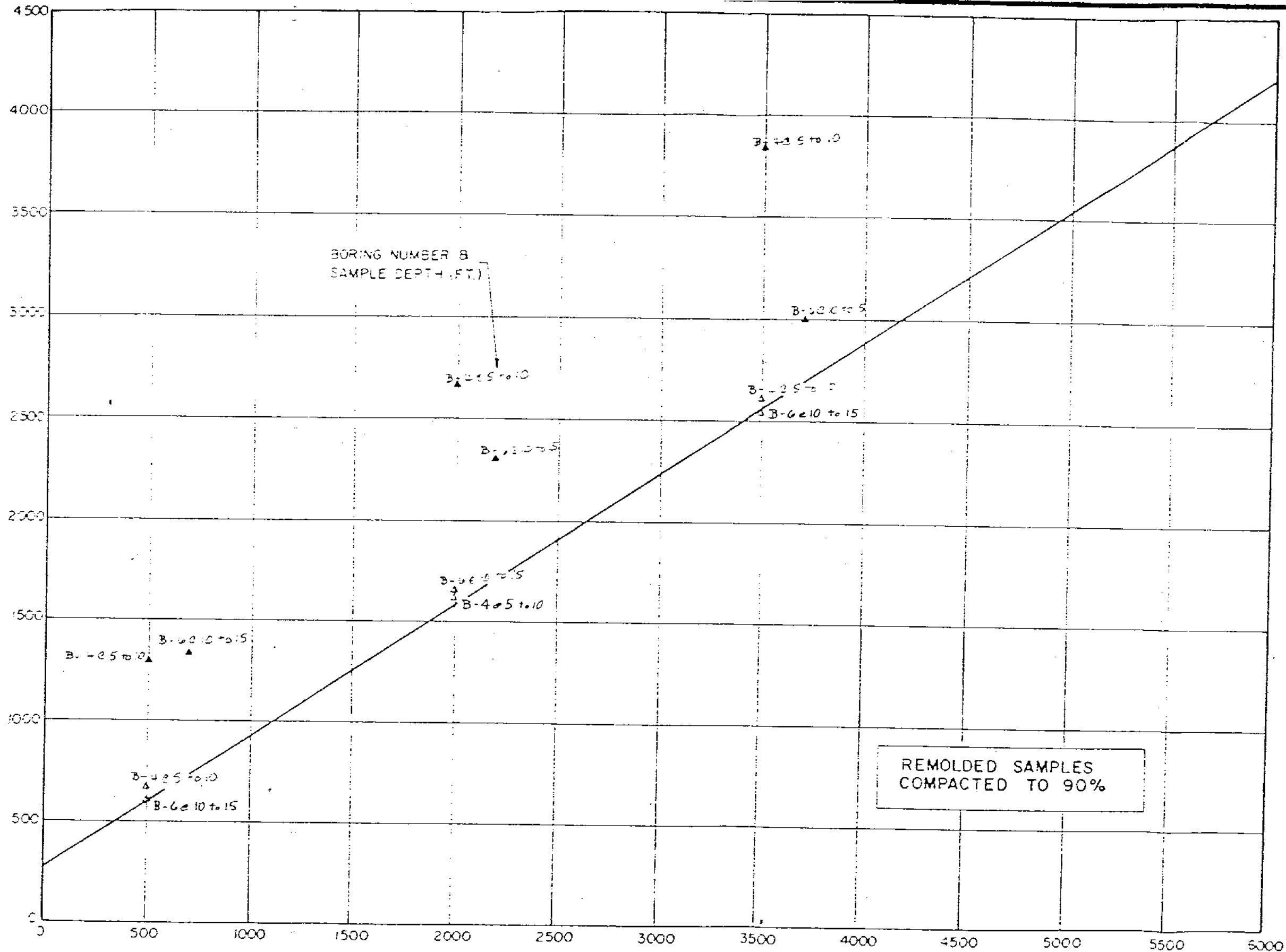


SURCHARGE PRESSURE in Pounds per Square Foot

DIRECT SHEAR TEST DATA

LeROY CRANDALL AND ASSOCIATES

SHEAR STRENGTH in Pounds per Square Foot

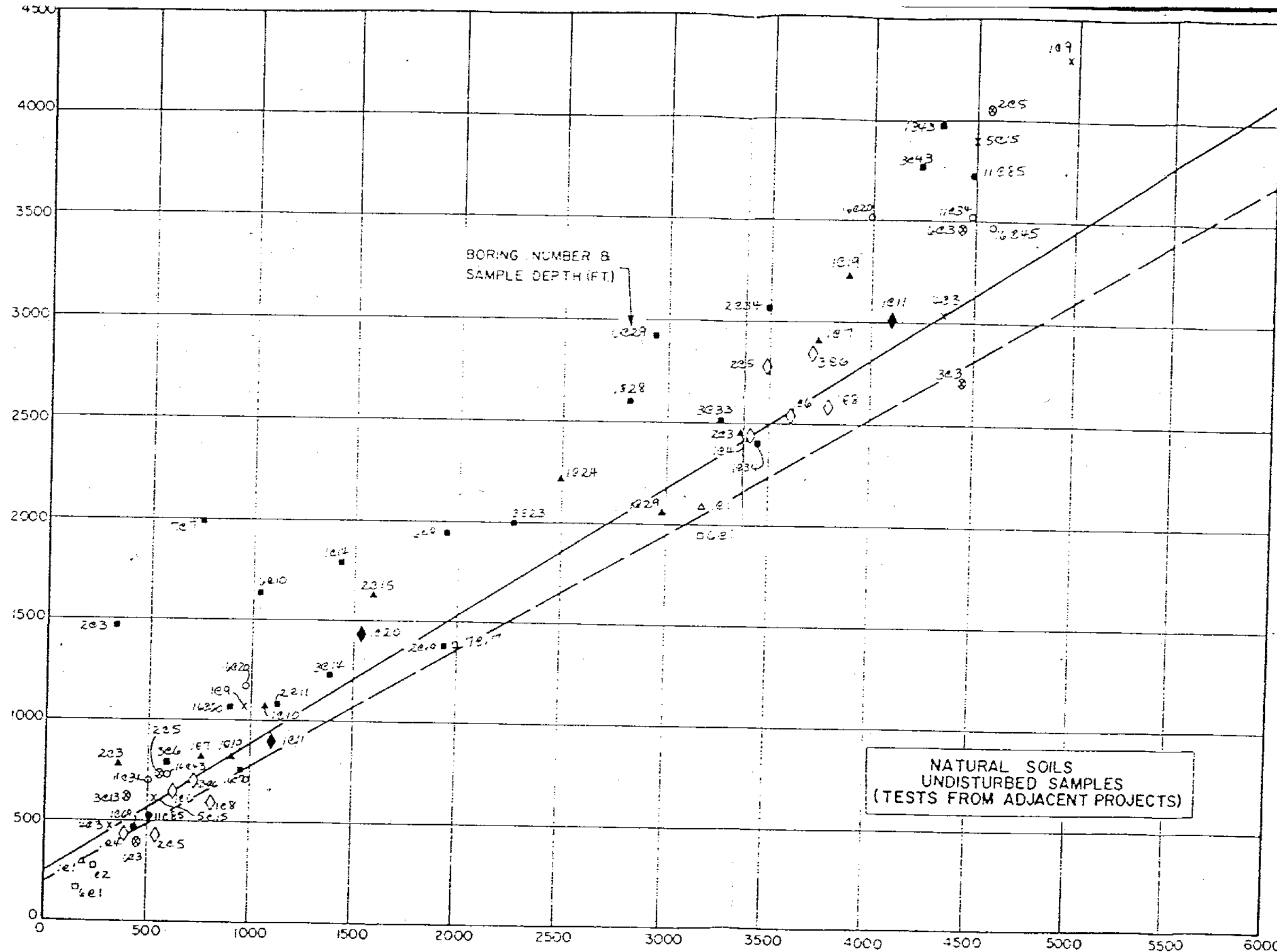


SURCHARGE PRESSURE in Pounds per Square Foot

DIRECT SHEAR TEST DATA

LEROY CRANDALL AND ASSOCIATES

SHEAR STRENGTH in Pounds per Square Foot



- KEY:
- ▲ A-84025
 - ADE-83049
 - A-82255
 - x ⊗ A-86139-8
 - ◆ A-86324
 - Tests of increased moisture content
 - - - Tests of field moisture content

VALUES USED IN ANALYSES

- GROSS STABILITY
- $C = 250 \text{ psf}$
- $\phi = 33^\circ$
- - - SURFICIAL STABILITY
- $C = 200 \text{ psf}$
- $\phi = 30^\circ$

SURCHARGE PRESSURE in Pounds per Square Foot

DIRECT SHEAR TEST DATA

LeROY CRANDALL AND ASSOCIATES

JOB L90328.AEO DATE 1/3/91 W.P. _____ Ip _____ O.E. _____ AS _____ CHKD _____

BORING NUMBER AND SAMPLE DEPTH	SOIL TYPE	% PASSING NO. 200 SIEVE
B - 1 at 5'	SILTY SAND	14
B - 1 at 19'	SAND (SP-SM)	7
B - 2 at 5'	FILL - SILTY SAND	17
B - 2 at 14'	FILL - SILTY SAND	13
B - 2 at 29'	SAND (SP-SM)	7
B - 2 at 39'	SILTY SAND	12
B - 3 at 3'	FILL - SILTY SAND	12
B - 3 at 9'	FILL - SANDY SILT	55
B - 3 at 19'	SILTY SAND	42
B - 4 at 14'	FILL - SILTY SAND	29
B - 4 at 24'	CLAYEY SAND	44
B - 4 at 34'	SAND	4
B - 4 at 39'	SAND	10
B - 5A at 5'	SAND (SP-SM)	6
B - 5A at 9'	SAND	4
B - 5A at 19'	SAND (SP-SM)	7
B - 5A at 39'	SAND (SP-SM)	7
B - 6 at 5'	FILL - SILTY SAND	17
B - 6 at 14'	FILL - SILTY SAND	22
B - 6 at 24'	CLAYEY SAND	12
B - 6 at 29'	CLAYEY SAND	36
B - 6 at 44'	CLAYEY SAND	16

Test Method: ASTM Designation D1140-54

SIEVE DATA

LeROY CRANDALL AND ASSOCIATES
PLATE D - 4

JOB L90328.AEO DATE 1/3/91 W.P. drh O.E. AS CHKD

BORING NUMBER
AND SAMPLE DEPTH :

B - 4 at 5' to 10'

B - 6 at 10' to 15'

SOIL TYPE :

FILL - SILTY SAND
and SANDY SILT

FILL - SILTY SAND
and SANDY SILT

MAXIMUM DRY DENSITY :
(lbs./cu. ft.)

133

126

OPTIMUM MOISTURE CONTENT :
(% of dry wt.)

8.5

9.5

TEST METHOD: ASTM Designation D1557 - 70

COMPACTION TEST DATA

APPENDIX E:

BLUFF PLANT LIST

A landscaping plant list has been developed by Campbell & Campbell, Landscape Architects for the bluff. A copy of that list has been provided to us by Sharon H. Lockhart and is presented as Plates E-1 and E-2.

-o0o-

Proposed Plantings Westchester and Playa del Rey Bluffs

Coastal Sage Scrub

Large Plant Cover

(plants listed in order of abundance with most abundant being first)

Artemisia californica	Coastal Sagebrush
Lupinus longifolius	Lupine
Baccharis pilularis consanguinea	Chaparral Broom
Isomeris arborea	Bladderpod
Rhus integrifolia	Lemonade Berry
Datura wrightii	
Encelia californica	Coast Sunflower
Salvia mellifera	Black Sage
Prunus virginiana	Western Chokeberry
Rhus laurina	Laurel Sumac
Heteromeles arbutifolia	Toyon

Coastal Sage Scrub

Subshrub Cover

(plants listed in order of abundance with most abundant being first)

Eschscholzia californica	California Poppy
Astragalus leucopsis	
Cirsium occidentale	Western Thistle
Calystegia macrostegia	Morning Glory
Senecio douglasii	Bush Groundsel
Solanum douglasii	Douglas Nightshade
Horkelia cuneata	

Perennial Grasses

(to be introduced as plugs)

Stipa pulchra/cernus	Purple Stipa
Melica imperfecta	Coast Range Melic
Elymus condensatus	Giant Wild Rye

Hydroseed Mix
(in alphabetical order)

Ambrosia psilostachya	Western Ragweed
Artemisia californica	Coastal Sagebrush
Baccharis pilularis consanguinea	Chaparral Broom
Corethrogyne filaginifolia	Curweed Aster
Croton californicus	
Cucurbita foetidissima	Calabazilla
Encelia californica	Coast Sunflower
Eriogonum gracile	
Eriogonum parvifolium	Coastal Buckwheat
Eschscholzia californica	California Poppy
Gnaphalium bicolor	Bicolor Cudweed
Gnaphalium microcephalum	White Everlasting
Haplopappus ericoides	Mock Heather
Haplopappus squarrosus	Sawtooth Goldenbush
Haplopappus venetus	Coastal Goldenbush
Heterotheca grandiflora	Telegraph Weed
Isomeris arborea	Bladderpod
Lasthenia glabrata	
Lotus scoparius	Deerweed
Lotus strigosus	Bishop's Lotus
Lupinus bicolor	Lupine
Lupinus succulentus	Succulent Lupine
Malcothamnus fasciculatus	Mesa Bushmallow
Marah macrocarpus	Wild Cucumber
Orthocarpus purpurascens	Owl's Clover
Phacelia ramosissima	
Salvia apiana	White Sage
Salvia mellifera	Black Sage
Senecio douglasii	Bush Groundsel
Stipa pulchra/cernus	Purple Stipa

SECTION 3.0: BLUFF STABILITY INVESTIGATION

3.1 SCOPE

This phase of the geotechnical studies involves the stability of the bluff adjacent to the southern boundary of the Playa Vista Project. The bluff is shown on Plate 3-1, Location Plan, and on Plates 3-2.1 through 3-2.4, Geologic Map. Although only a portion of the bluff is within the subject tract, the stability investigation was undertaken to determine any hazard the bluff presented to the subject tract and the effects of any planned grading on the bluff stability.

Our investigation was authorized to determine the static physical characteristics of the soils within the bluff to enable a determination of the bluff stability. The investigation included geologic mapping of the surface of the bluff to identify the general characteristics and distribution of the geologic units, and to locate areas of water seepage, erosion, slumps, and other indications of potential instability. The investigation also included exploring the soil conditions by drilling exploration borings and determining the strength of the materials by performing laboratory tests on the undisturbed samples. We also reviewed prior reports by our firm and by Kovacs-Byer and Associates as part of the investigation.

3.2 BLUFF DESCRIPTION

The bluff is a north-facing slope formed by erosion by the ancestral Los Angeles River. The top of the bluff varies from approximately Elevation 130 to 160 feet above sea level; the base of the bluff varies from approximately Elevation 10 to 25 feet. The average slope of the face of the bluff varies from about 1¾:1 to 2½:1 (horizontal to vertical).

The existing City of Los Angeles North Outfall Sewer is located within the bluff some 30 to 50 feet above the toe. The sewer is described in more detail in a following section.

The bluff is composed principally of late Pleistocene age dune sand. Although classified as "dune sand," these soils actually contain varying amounts of fines; much of the materials are classified as silty sand. These natural deposits are somewhat cemented and although bedding was observed in these materials, the bedding is relatively flat.

Fill soils were encountered over the sewer and on the portion of the slopes below the sewer.

3.3 PRIOR INVESTIGATIONS

We have performed several investigations on the adjacent properties at the top of the western portion of the bluff. Reports covering these prior investigations are:

Report of Preliminary Geotechnical Investigation, Proposed University Expansion, Fordham Road and 78th Street, Los Angeles, California, for the Loyola-Marymount University, dated October 27, 1982 (LCA AE-82255).

Report of Preliminary Foundation Investigation, Proposed Corporate Headquarters, Lincoln Boulevard South of Jefferson Boulevard, Los Angeles, California, for the Hughes Aircraft Company, dated February 9, 1983 (LCA A-82139-B).

Report of Geotechnical Investigation, Proposed Corporate Headquarters, Lincoln Boulevard South of Jefferson Boulevard, Los Angeles, California, for the Hughes Aircraft Company, dated April 19, 1983 (LCA ADE-83049).

The locations of our prior borings are shown on Plates 3-2.1 through 3-2.4.

Prior investigations near the eastern portion of the bluff have been performed by Kovacs-Byer and Associates. We were furnished copies of the following documents for our review:

Preliminary Geologic and Soils Engineering Exploration, 85-Lot Single Family Residential Subdivision, North of the Terminus of Dunbarton Avenue, Westchester, California, for Howard Hughes Realty, Inc., September 19, 1983, KG 7607-G.

Preliminary Geologic and Soils Engineering Exploration, 120-Lot Single Family Residential Subdivision, West of the Intersection of Kentwood Avenue and Riggs Place, Westchester, California, for Howard Hughes Realty, Inc., May 14, 1984, KG 7606-G.

Additional Geotechnical Exploration, Slope Stability Evaluation, Tentative Tracts 43415 and 43416, Westchester, California, for Howard Hughes Realty, Inc., August 5, 1987, KG 7606-G and KG 7607-G.

Additional Geotechnical Exploration, Slope Stability Evaluation, Tentative Tracts 43415 and 43416, Westchester, California, for Howard Hughes Realty, Inc., Revised August 31, 1987, August 5, 1987, KB 7607-G.

Additional Geotechnical Exploration, Slope Stability Evaluation, Tentative Tracts 43415 and 43416, Westchester, California, for Howard Hughes Realty, Inc., Revised October 9, 1987, August 5, 1987, KB 7606-G and KB 7607-G.

Updated Geologic and Soils Engineering Exploration, Tentative Tract 43415, 85-Lot Single Family Residential Subdivision, North of the Terminus of Dunbarton Avenue, Westchester, California, for Howard Hughes Realty, Inc., dated January 25, 1988, KG 7607-G.

Updated Geologic and Soils Engineering Exploration, Tentative Tract 43416, 120-Lot Single Family Residential Subdivision, West of the Intersection of Kentwood Avenue and Riggs Place, Westchester, California, for Howard Hughes Realty, Inc., dated January 25, 1988, KG 7606-G.

3.4 GEOLOGIC MAPPING

A detailed geologic map was prepared of the bluff surface. The geologic mapping was performed to ascertain the general characteristics and distribution of geologic units, and to locate areas of erosion, slumps, and other indications of potential instability. The mapping included observing areas of water seepage or evidence of water seepage, such as the presence of water-loving vegetation. The results of the geologic mapping are presented on Plates 3-2.1 through 3-2.4.

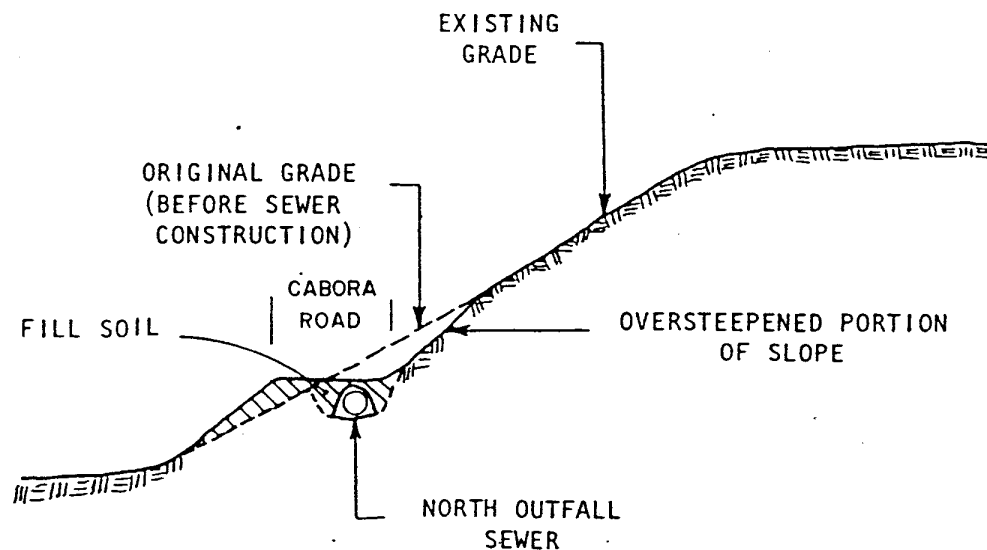
3.5 SITE CONDITIONS

3.5.1 Physiography

The bluff between Lincoln Boulevard and Centinela Avenue forms the approximate southern boundary of the Playa Vista Development over a length of about 10,000 feet. The bluff varies from approximately 120 to 140 feet in height; the average slope of the face of the bluff varies from $1\frac{3}{4}:1$ to $2\frac{1}{2}:1$ (horizontal to vertical).

3.5.2 North Outfall Sewer

The existing City of Los Angeles, North Outfall Sewer is located within the lower portion of the bluff. The sewer construction and maintenance road, known as Cabora Road, is located over the sewer some 30 to 50 feet above the toe of the bluff. Based on drawings furnished to us, the sewer was constructed in 1925 and is semi-elliptical in shape, 10½ feet high, and is constructed of cast-in-place concrete with a vitrified clay block lining. The sewer was designed to be bedded entirely within natural materials. Within most of the bluff, the sewer was constructed in an open excavation that was subsequently backfilled. The sewer is a tunnel along the easternmost 2,000 feet of the bluff. The exact location of the sewer within Cabora Road has not been defined on the survey drawings provided to us, but its general location can be established by the locations of manholes within the road. The location of the sewer on the bluff is shown in the following sketch; the approximate original grade is also shown.



Although the sewer trench was subsequently backfilled, the roadway was preserved and the oversteepened cut portion of the slope remained. The present height of the oversteepened portion of the slope, which is most evident east of Boring B-3, varies from about 25 feet to 40 feet. The slope of this oversteepened portion varies from about 1:1 to 1½:1 (horizontal to vertical).

3.5.3 Adjacent Properties

The south property line for a portion of the Playa Vista Development is located approximately along Cabora Road. The adjacent properties at the top of the bluff are occupied (from west to east) by the Hughes Aircraft Headquarters Facility, Loyola-Marymount University, and residential development. The locations of these properties are identified on Plate 3-1.

The Hughes Aircraft Headquarters Facility was constructed within the upper portion of the bluff, significantly reducing the total slope height in this area. The remnants of a secondary access road from Cabora Road to a former building are present on the slope below the planned Leavey Campus of Loyola-Marymount University. This secondary road has been breached by erosion.

Tentative Tracts 43415 and 43416 are shown on Plate 3-1. These tracts were investigated by Kovacs-Byer and Associates.

3.5.4 Vegetation

The existing vegetation adjacent to and below the Hughes Aircraft Headquarters Building and the Loyola-Marymount Leavey Campus is generally sparse, consisting of scattered grasses and weeds with some light brush. A relatively heavy growth of vegetation was observed immediately above Cabora Road south of the Leavey Campus. A portion of the slope above Cabora Road and immediately below the primary Loyola-Marymount campus and the residential development to the east of the campus has been planted with ice plant.

There are significant bare portions of the slope, principally below Cabora Road and on the easternmost portion of the bluff.

3.6 EXPLORATIONS AND TESTING

The bluff materials were investigated by drilling seven exploration borings (Borings B-1 through B-7) to depths of 19 to 60 feet. The locations of the borings are shown on Plates 3-2.1 and 3-2.2. The locations of borings from our nearby projects on the adjacent properties at the top of the bluff are also shown. The logs of the borings and the results of laboratory tests performed on representative samples are presented in Appendix D.

3.7 GEOLOGY

3.7.1 General

The bluff, known as the Ballona Escarpment, is an erosional feature formed by downcutting of the ancestral Los Angeles River, which has since been redirected to the south. The bluff is composed principally of late Pleistocene age dune sand, which has been generally interpreted as ancient offshore bars modified by wind and stream action since their emergence from the ocean (Poland et al., 1959). According to Poland et al., these deposits were probably formed during a high level of the sea immediately before the latest Pleistocene withdrawal, which instituted the cutting of the present escarpment. The dune sand is underlain by marine and continental deposits of the late Pleistocene age Lakewood and San Pedro Formations (Department of Water Resources, 1961).

The geologic materials exposed in the bluff and mapped during this investigation are identified on Plates 3-2.1 through 3-2.4. Other features mapped during the investigation, such as slumps, bedding attitudes, and a spring, are also shown.

3.7.2 Geologic Materials

General

Sections at each of the boring locations have been prepared and are presented on Plates 3-3.1 through 3-3.7, Geologic Section. The geologic conditions observed in this investigation and the topography of the existing bluff are shown on the sections.

Fill Soils

Up to 20 feet of fill was encountered in our exploration borings adjacent to the North Outfall Sewer. The fill consists primarily of silty sand and sandy silt and is backfill placed over the sewer, which was constructed in an open excavation in this area.

Additional fill deposits overlie the lower portions of the slope. These fill deposits are a result of prior sewer construction and maintenance of Cabora Road, where soil debris has accumulated on the road and has been cast over the side of the road, and construction of the Hughes Aircraft headquarters building.

Only minor deposits of fill (less than 1 foot thick) were observed on the adjacent properties at the top of the bluff.

Alluvium

The flood plain adjacent to the base of the bluff is underlain by approximately 100 feet of recent alluvium deposited by the ancestral Los Angeles River. The upper 20 to 30 feet of alluvium is composed primarily of soft silty clay and clay with layers of silt and sand. Underlying the soft surficial deposits is another 20- to 30-foot thickness of firmer silt and clay sediments. The lowermost 30 to 50 feet of sediments are composed of sand and gravel, and are described by Poland et al. (1959) as the "50-foot gravel," a ground water aquifer.

The alluvium was not encountered in our exploration borings, which were drilled in the bluff above the flood plain.

Dune Sand

The bluff above Cabora Road is capped by a variable thickness of late Pleistocene dune sands. These sands are well sorted and clean. Continuous bedding structure within the dune sand is generally poorly developed or absent. Cross-bedding, however, is common.

Lakewood Formation

Underlying the dune sands is the Lakewood Formation, which is described by Poland et al. (1959) as consisting of sand and gravel with some silty layers. The sediments are only slightly cemented and are high erodible. The Lakewood Formation in the bluff area is similar to the overlying Pleistocene sands, and the contact has not been identified on either the geologic map or the boring logs. The Lakewood Formation unconformably overlies the early Pleistocene age San Pedro Formation at depth.

3.8 GROUND WATER OCCURRENCE

3.8.1 Ground Water

Water was measured in five of our borings at depths of 50 to 55 feet, corresponding to an elevation of 1 to 3 feet above mean sea level (Elevation +1 to +3). This water level is at least 15 feet below the toe of the bluff and is consistent with water levels observed elsewhere within the Playa Vista development. As a result, ground water will not adversely impact the bluff stability.

3.8.2 Springs

Surface waters percolating through the dune sand occasionally resurface as springs in the bluff face, and may contribute to slope erosion. One spring was observed crossing Cabora Road approximately 260 feet west of Boring B-2 (see Plate 3-2.1, Geologic Map). Accelerated erosion does not appear to have resulted from the spring flow, although water-loving vegetation associated with the spring may mask or discourage erosion.

3.9 SLOPE STABILITY

3.9.1 General

The geologic mapping of the bluff did not reveal the presence of any deep-seated rotational or translational landslide failures. There was no indication of failure of the slopes below Cabora Road. Shallow slumps were observed in a secondary road cut made above Cabora Road. Deeply incised erosion gullies were found in areas where surface water runoff has been allowed to flow over the edge of the bluff.

3.9.2 Slumping and Slope Retreat

The bluff within the study area varies in height from approximately 120 to 140 feet. The upper portions of the slope are generally inclined from $1\frac{3}{4}$:1 to $2\frac{1}{2}$:1 (horizontal to vertical). The slope below Cabora Road has inclinations varying from $1\frac{3}{4}$:1 to 3:1. Localized erosion gullies are steeper.

The naturally weathered slopes do not contain any indications of deep-seated instability, and the layering within the sedimentary materials was observed to dip in a favorable direction into the slope. The bluff appears to have reached an essentially stable slope configuration prior to the construction of the sewer outfall. Cabora Road and the secondary access road were cut into the slightly cemented sands at inclinations of $\frac{1}{2}$:1 to 1:1 (horizontal to vertical). The oversteepened portions of the slopes have subsequently retreated by shallow slumping (mass wasting). The cut slopes are likely to continue slumping until a stable configuration is reestablished, probably when the slopes reach an inclination of $1\frac{1}{2}$:1 to 2:1. Many of the old road cuts appear to have already stabilized at inclinations of approximately $1\frac{1}{2}$:1.

3.9.3 Slope Erosion

Steeply incised erosion gullies have formed where surface water runoff has drained over the edge of the bluff. An example of this process has formed immediately to the north of the central depression in the Loyola-Marymount University proposed Leavey Campus site. Mass wasting occurred as rainwater accumulated in a depression at the top of the bluff and

drained over the edge. The runoff resulted in an erosion gully by direct scouring, and by secondary slumping of adjacent sediments into the widening chasm. A small access road on the bluff slope was completely breeched, and a 100-foot section of steel pipe was placed to carry surface water across the chasm. Secondary slumping into the gully is still continuing. The runoff from the top of the slope at this location has been directed westerly by placement of an earth berm and excavation of a diversion channel.

3.10 STABILITY ANALYSES

3.10.1 Shear Strength

Direct shear tests were performed to determine the shear strength of the bluff materials. The tests were performed on undisturbed samples of the fill and natural soils and on remolded samples of the on-site soils compacted to 90%. The shear tests are described in Appendix D.

Based on the direct shear tests, the following shear strength parameters were used in our analyses:

Gross Stability

Natural Soil:

Cohesion = 250 pounds per square foot
Angle of Internal Friction = 33 degrees

Existing Fill Soil:

Cohesion = 100 pounds per square foot
Angle of Internal Friction = 32 degrees

Compacted Fill Soil:

Cohesion = 300 pounds per square foot
Angle of Internal Friction = 33 degrees

Surficial StabilityNatural Soil:

Cohesion = 200 pounds per square foot
Angle of Internal Friction = 30 degrees

Existing Fill Soil:

Cohesion = 100 pounds per square foot
Angle of Internal Friction = 30 degrees

Compacted Fill Soil:

Cohesion = 300 pounds per square foot
Angle of Internal Friction = 33 degrees

The shear strength determinations are based on samples tested both at field and optimum moisture contents and on samples that were soaked prior to testing. The shear strengths used in our gross stability analyses are based on a low average of the weaker tests. However, the strengths used in the surficial analyses are based on the weakest of the wet samples tested. The weakest strengths are more appropriate to a surficial analysis than to a gross stability analysis.

It should be noted that some cohesion is used in all of the analyses. The cohesion is justified by the shear tests and is obvious when observing the materials in place in the bluff. In fact, recent trenching within the easterly portion of the bluff by Kovacs-Byer and Associates for a fault study showed that the materials will stand vertically for heights of more than 10 feet for extended periods of time. Cohesion is clearly present in the materials at field moisture content and we believe cohesion is also present when these materials become wet. (The cohesion value used in the analyses is deliberately relatively low.) The cohesion is a result of intergranular cementation between the soil particles by the mineral content and by the amount of fines in the soils (see Plate D-4 in Appendix D).

3.10.2 Gross Stability

Analyses were performed for various sections along the slope as presented on Plates 3-3.1 through 3-3.7. The most critical conditions occur along Section 4 where the slope is about 125 feet in height and the average inclination of the slope is about 1.8:1 (horizontal to vertical). The results of the gross stability analyses are summarized on Plate 3-4.1, Stability Analyses (Gross Stability), with the calculations presented on Plates 3-4.2 through 3-4.10.

As shown, the most critical potential failure circle is through the toe of the slope above Cabora Road where the slope was oversteepened by the sewer construction. For this case, the slope has a static factor of safety of 1.4 and a factor of safety of 1.1 when subjected to a 0.15g lateral seismic force. The slope has a factor of safety of 1.5 for a potential failure through the toe of the bluff at its full height.

These analyses are consistent with the observed performance of the slope, where the prior sewer excavation resulted in an oversteepened slope above Cabora Road.

The analyses by Kovacs-Byer and Associates for the slopes below and immediately adjacent to Tentative Tracts 43415 and 43416 show similar, but slightly lower, factors of safety because of their slightly greater slope height.

3.10.3 Surficial Stability

The surficial stability analyses are summarized on Plate 3-5.1, Stability Analyses (Surficial Stability), with the calculations presented on Plate 3-5.2. The analyses were performed to determine the steepest slope possible to achieve a factor of safety of 1.5 against surficial failure. The allowable slope inclinations (horizontal to vertical) for this factor of safety are:

Natural Slopes: 1¼:1

Existing Fill Slopes: 2½:1

Compacted Fill Slopes: 1¼:1

The analyses actually gave a factor of safety of 2.0 for a 1½:1 compacted fill slope, but we do not believe that steeper compacted fill slopes would be appropriate.

3.11 CONCLUSIONS

The natural materials encountered in the bluff are dense, slightly cemented, sandy deposits. The natural deposits do not contain adverse geologic structure that could create slope stability problems. Fill soils occur on the portion of the slope below the sewer, and are the result of both sewer construction and maintenance of the sewer access road.

The bluff is considered grossly stable (not potentially subject to deep seated sliding). However, construction of the North Outfall Sewer along the bluff has resulted in some oversteepened portions of the slope above the sewer with subsequent slumping of some portions of this slope. Such slumping will continue to occur until the portion of the slope above the sewer reaches a stable inclination.

The soils in the bluff are susceptible to erosion. Localized erosion has occurred where runoff drainage has been directed over the top of the bluff.

The potential hazard for development at the toe of the bluff is related to the accumulation of soil debris at the toe of the slope. Such debris is a result of shallow surficial slumping and erosion within the lower slope below the sewer. The sewer maintenance road is at least 30 feet wide and serves as an effective catchment for soil debris from the upper slope. There are several alternatives that can be used to reduce the slumping and erosion hazard at the toe of the slope. These include flattening the lower portion of the slope, removing the fill soils below Cabora Road, placing a compacted fill on the face of the slope below Cabora Road, or placing an erosion control matting on the face of the slope. We understand that the use of an erosion control matting is preferred. Recommendations for placement of this matting are discussed in a following section.

The potential hazard for development at the top of the bluff is the gradual retreat of the edge of the bluff as a result of both erosion and slumping at the oversteepened portions of the slope. In our opinion, there is little likelihood of the slumping ever reaching the top of the bluff, and therefore the bluff does not pose a hazard to the existing development at the top of the bluff.

It is currently planned to excavate the top of the bluff at Tentative Tract No. 43415 up to 12 feet and flatten the existing 1½:1 (horizontal to vertical) slope above the existing 10-foot wide haul road above the North Outfall Sewer to 2:1.

It is also planned to excavate the top of the bluff at Tentative Tract No. 43416 up to 10 feet. Remedial grading and placement of drainage devices only are planned for the bluff face above the sewer. Elsewhere, compacted fills with 2:1 slopes are planned.

It is our conclusion that the proposed grading on the subject tentative tracts will not have an adverse effect on the Playa Vista development. In fact, the planned lowering and flattening of the slope will actually improve the bluff stability.

3.12 RECOMMENDATIONS

3.12.1 General

If the recommendations provided below are followed, we believe the presence of the bluff will not adversely affect the Playa Vista development (Tentative Tract 49104).

Additional grading is not required above Cabora road; the 30-foot-wide easement for the maintenance road provides sufficient catchment area for soil debris. In effect, the road is a setback for the site from the upper slope.

To reduce the hazard of soil debris accumulation, the slope below Cabora Road could be regraded by either flattening the existing slope or by excavation and the placing of a stabilization fill. Alternatively, a building setback could be used at the toe of the slope in

lieu of remedial grading. However, personnel at the City of Los Angeles Grading Division have indicated that a building setback would not be an acceptable alternative to improve the slope. We recommend an erosion-resistant matting be placed over the slope to reduce the hazard of soil debris accumulation.

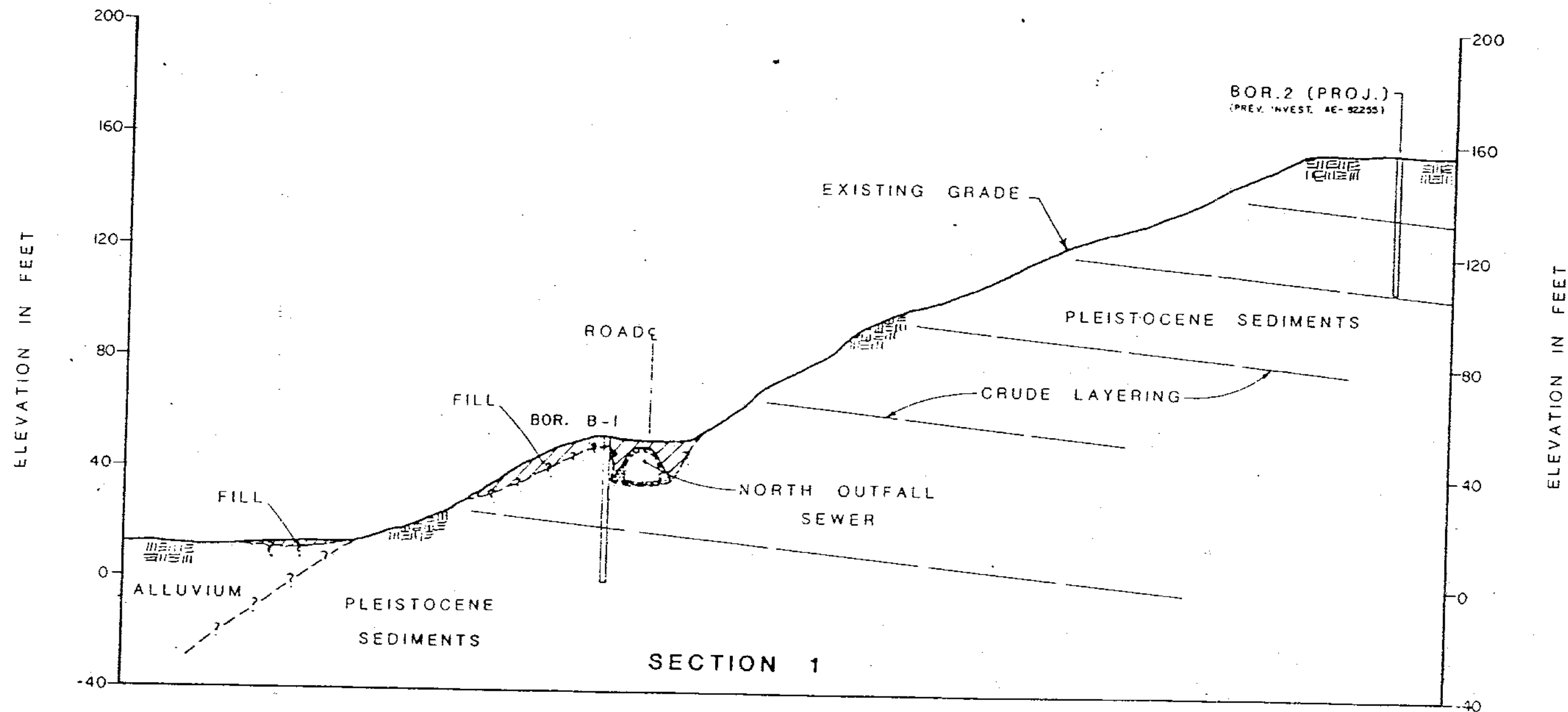
Excavation below Cabora Road could pose some hazard to the existing sewer, and aesthetics could dictate that the slope be left in its present condition without regrading.

If any areas are regraded, they will have to be replanted. A list of recommended planting material is presented in Appendix E.

3.12.2 Erosion-Resistant Matting

A soil erosion-resistant matting is recommended for the portion of the slope below Cabora Road to reduce the soil hazard potential to an acceptable level. A proprietary product, such as Miramat, Enkamat, Tensar Erosion Mat, Bon Terra Blankets, or similar products, could be used. We understand the vegetation on the slope will be removed and the slope replanted. To minimize disturbing the soils, we recommend the heavier brush and trees be cut at or near the ground surface and not pulled. The matting should be placed after removing the vegetation and prior to replanting. The vegetation should be selected from the list provided in Appendix E. The matting installation should be done in accordance with the manufacturer's instructions.

A planting scheme will need to be developed by a landscape architect for all slopes. This is particularly important for the slopes below Cabora Road where erosion is a potential problem.



NOTES:

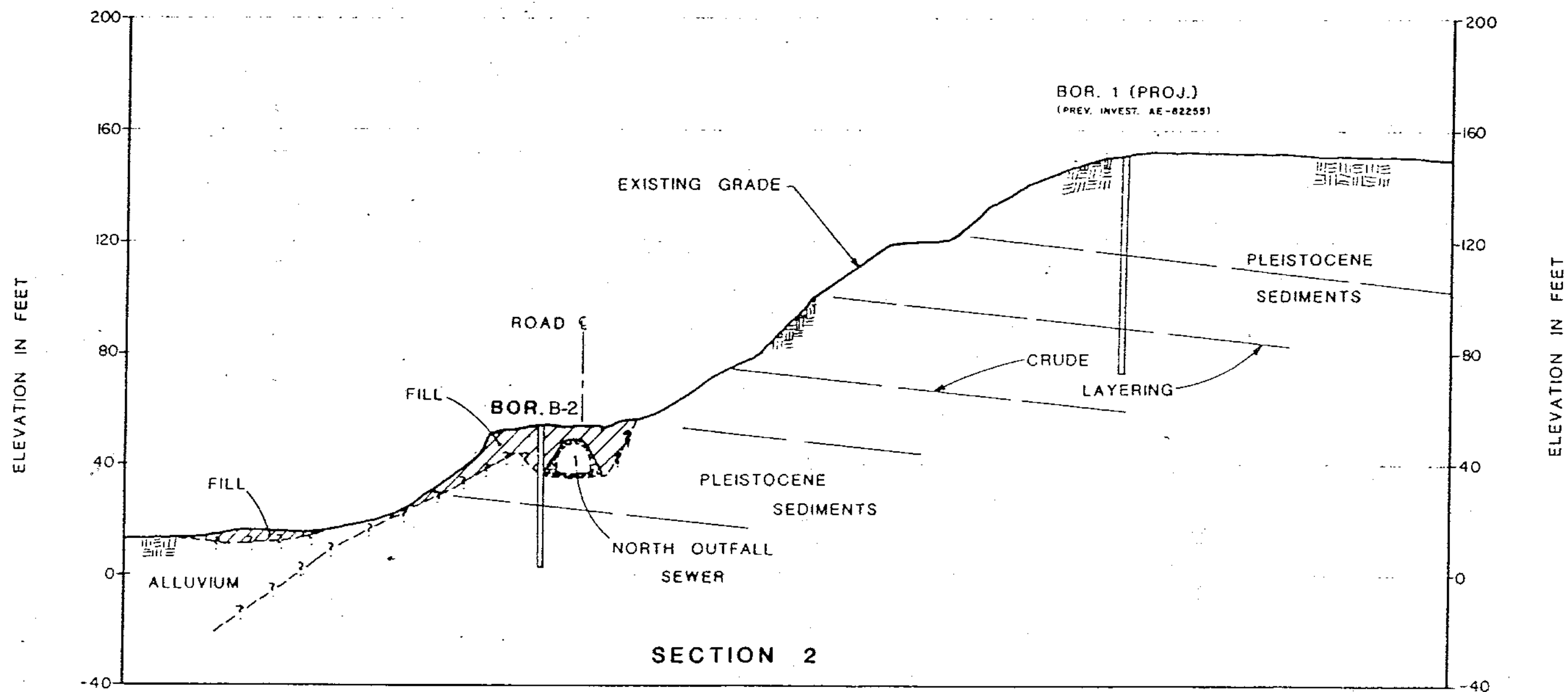
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- 2.) SEE PLATE 3-2.1 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES

PLATE 3.2.1



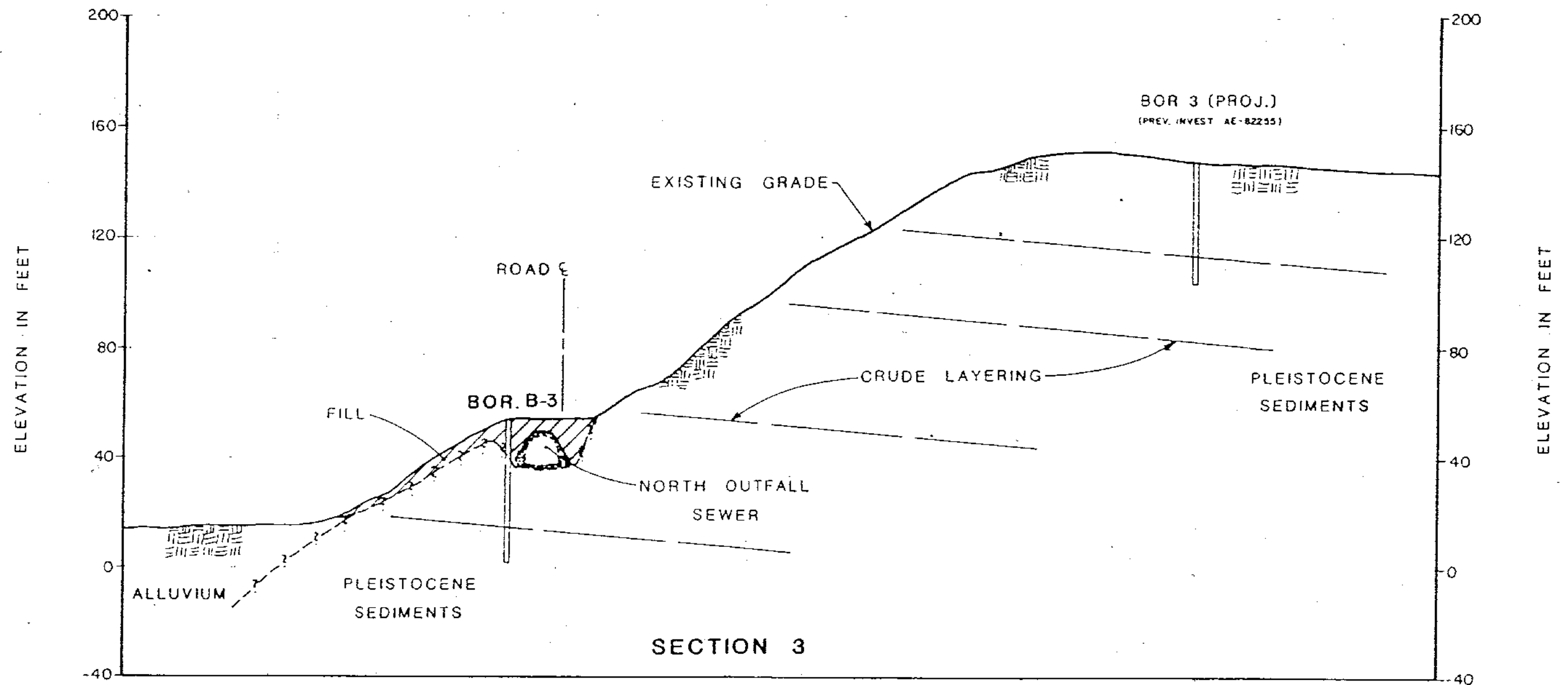
NOTES:

- 1.) THE SECTION IS BASED ON GEOLOGIC CONDITIONS AT BORING LOCATIONS AND AT SURFACE EXPOSURES MAPPED DURING THE INVESTIGATION. THE GEOLOGIC CONDITIONS BETWEEN SUCH LOCATIONS HAVE BEEN INTERPOLATED. LOCALIZED VARIATIONS COULD OCCUR. THE SECTION IS INTENDED FOR DESCRIPTIVE PURPOSES ONLY.
- 2.) SEE PLATE 3-2.1 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES



NOTES:

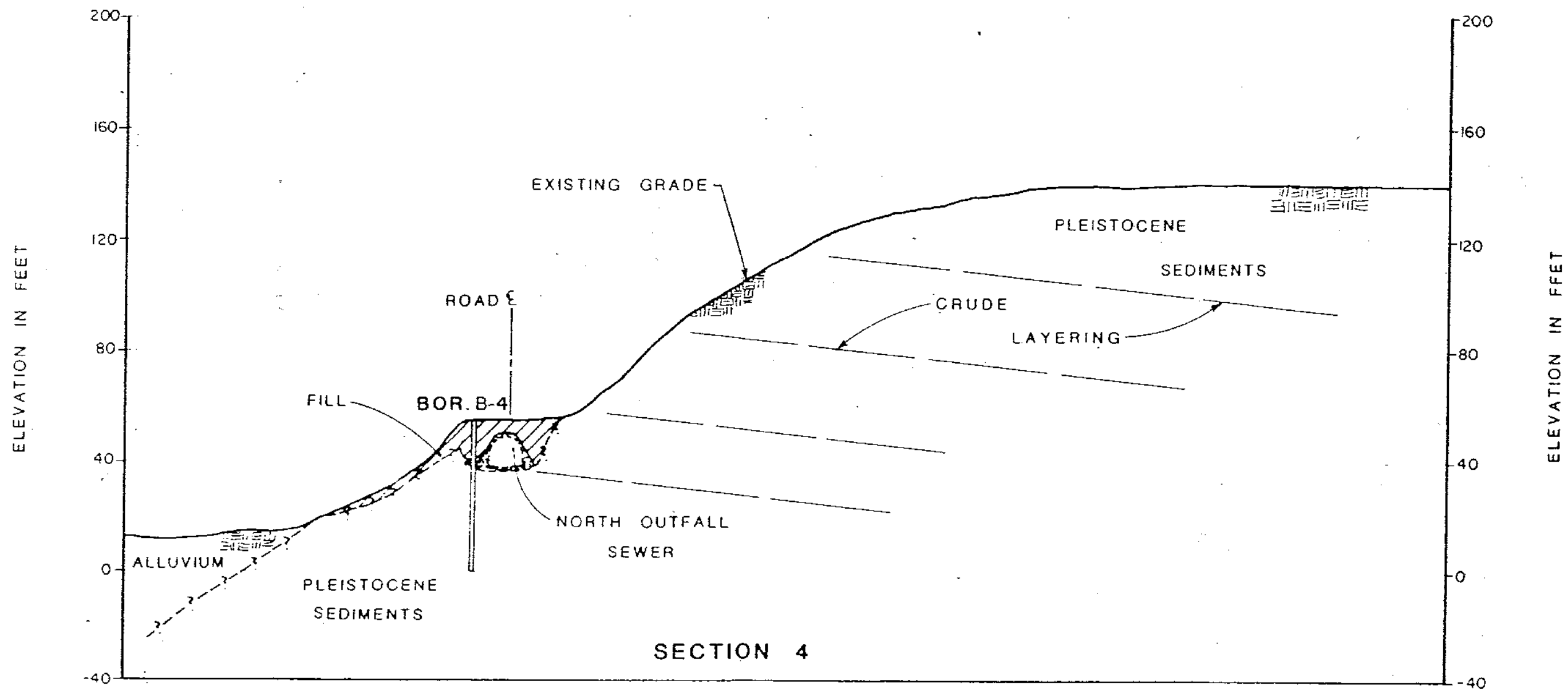
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- 2.) SEE PLATE 3-2.1 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES

PLATE 3-3.3



NOTES:

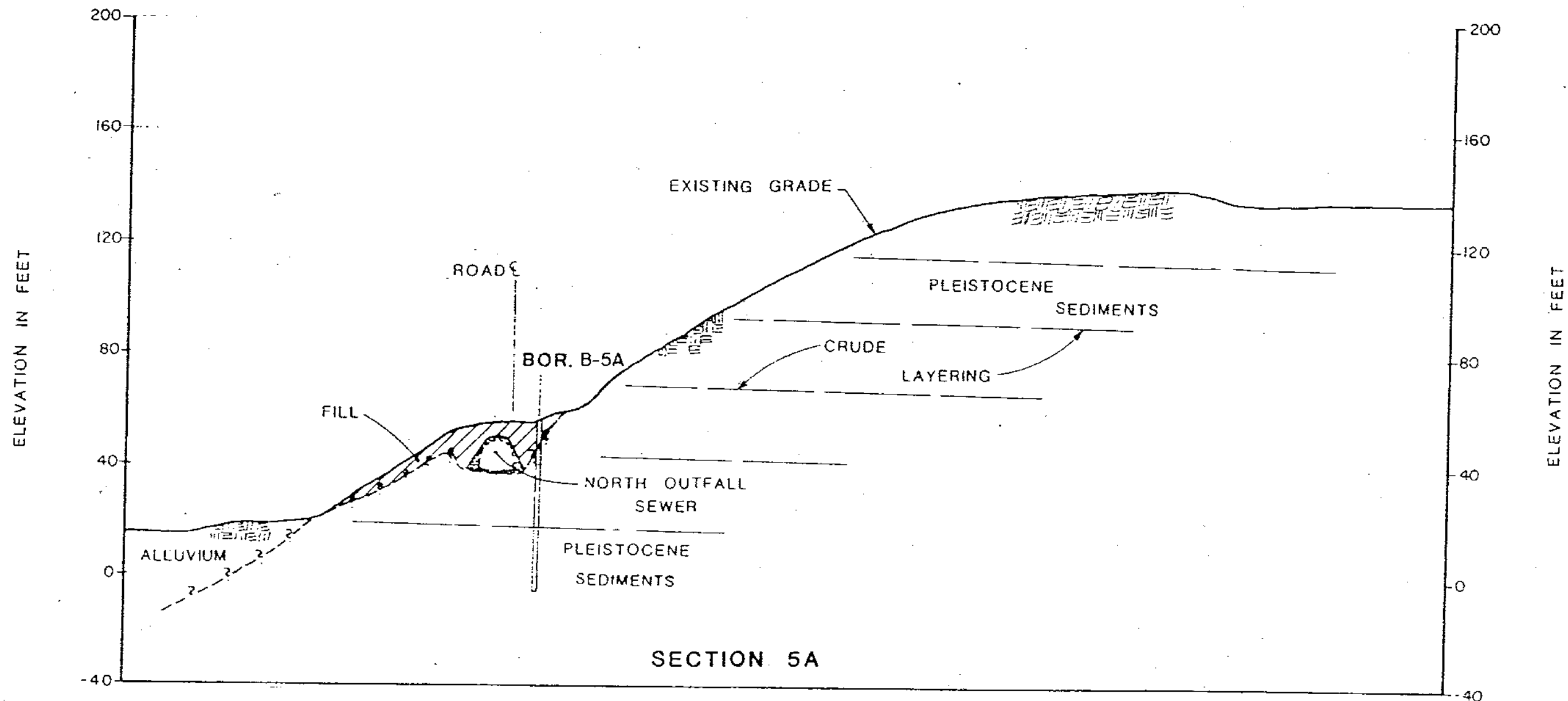
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- 2.) SEE PLATE 3-2.1 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES

PLATE 3-3.4



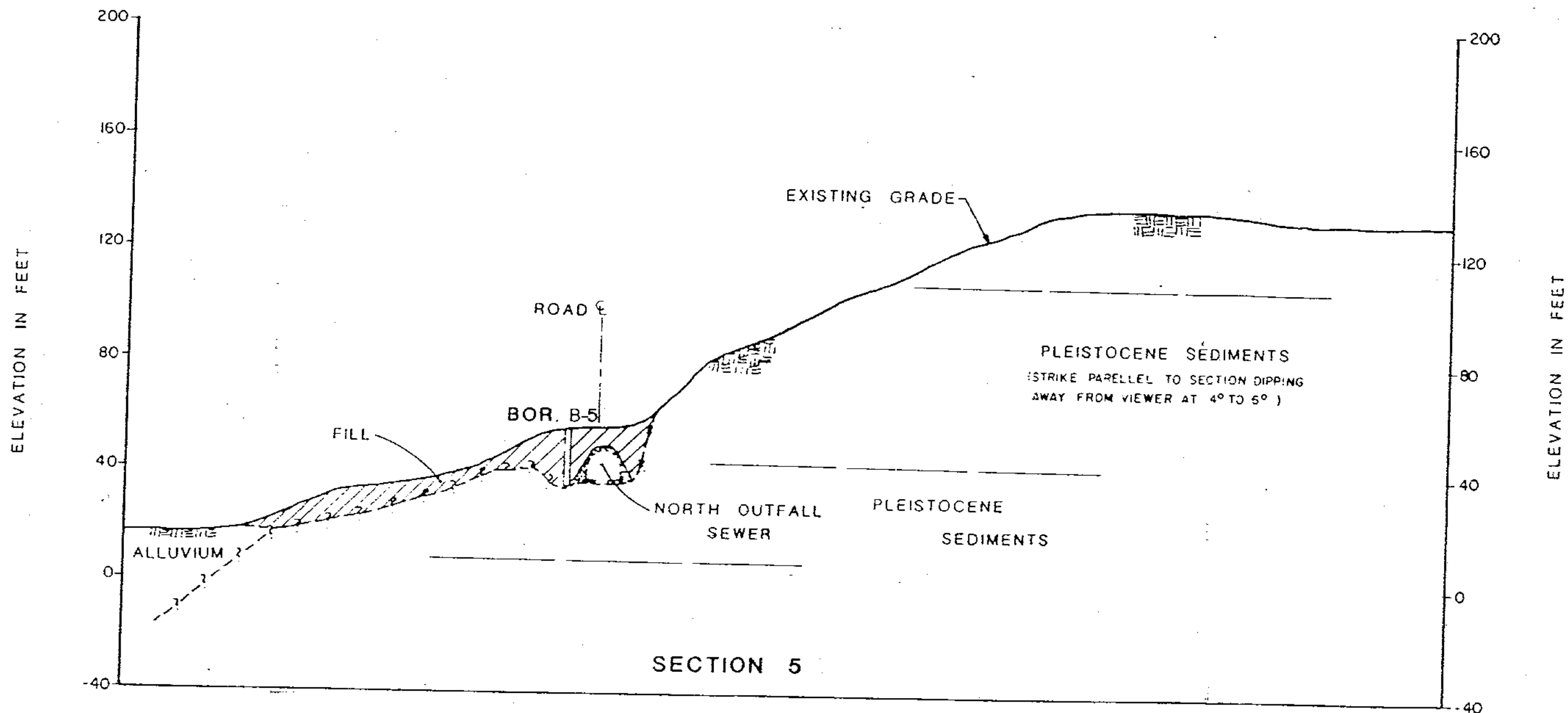
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- 1.) THE SECTION IS BASED ON GEOLOGIC CONDITIONS AT BORING LOCATIONS AND AT SURFACE EXPOSURES MAPPED DURING THE INVESTIGATION. THE GEOLOGIC CONDITIONS BETWEEN SUCH LOCATIONS HAVE BEEN INTERPOLATED. LOCALIZED VARIATIONS COULD OCCUR. THE SECTION IS INTENDED FOR DESCRIPTIVE PURPOSES ONLY.
- 2.) SEE PLATE 3-2.2 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LEROY CRANDALL AND ASSOCIATES



NOTES:

1.) THE SECTION IS BASED ON GEOLOGIC CONDITIONS AT BORING LOCATIONS AND AT SURFACE EXPOSURES MAPPED DURING THE INVESTIGATION. THE GEOLOGIC CONDITIONS BETWEEN SUCH LOCATIONS HAVE BEEN INTERPOLATED. LOCALIZED VARIATIONS COULD OCCUR. THE SECTION IS INTENDED FOR DESCRIPTIVE PURPOSES ONLY.

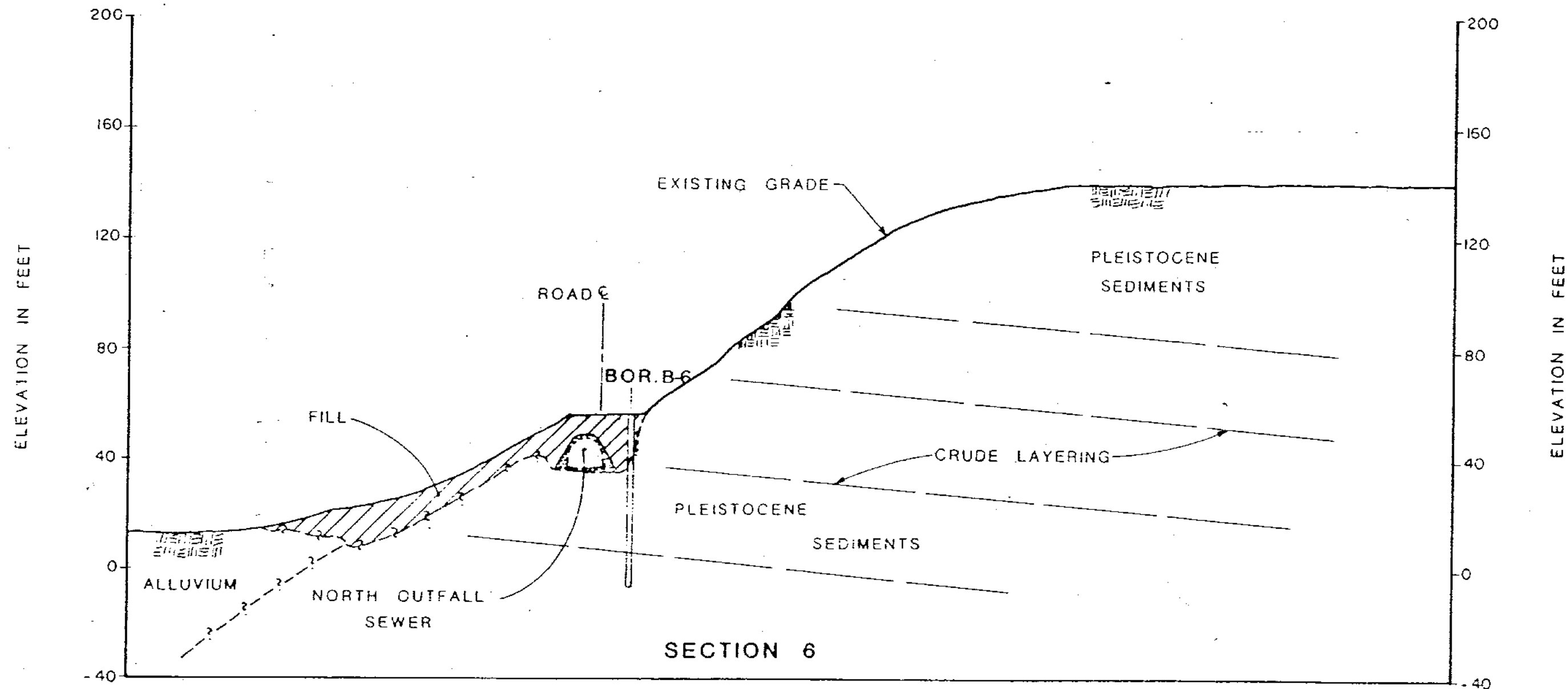
2.) SEE PLATE 3-2.2 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LEROY CRANFALL AND ASSOCIATES

PLATE 3-3.6



NOTES:

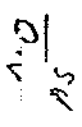
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- 2.) SEE PLATE 3-2.2 FOR LOCATION OF SECTION.

GEOLOGIC SECTION

SCALE 1" = 40'

LeROY CRANDALL AND ASSOCIATES

PLATE 3-3.7



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MATERIAL PROPERTIES

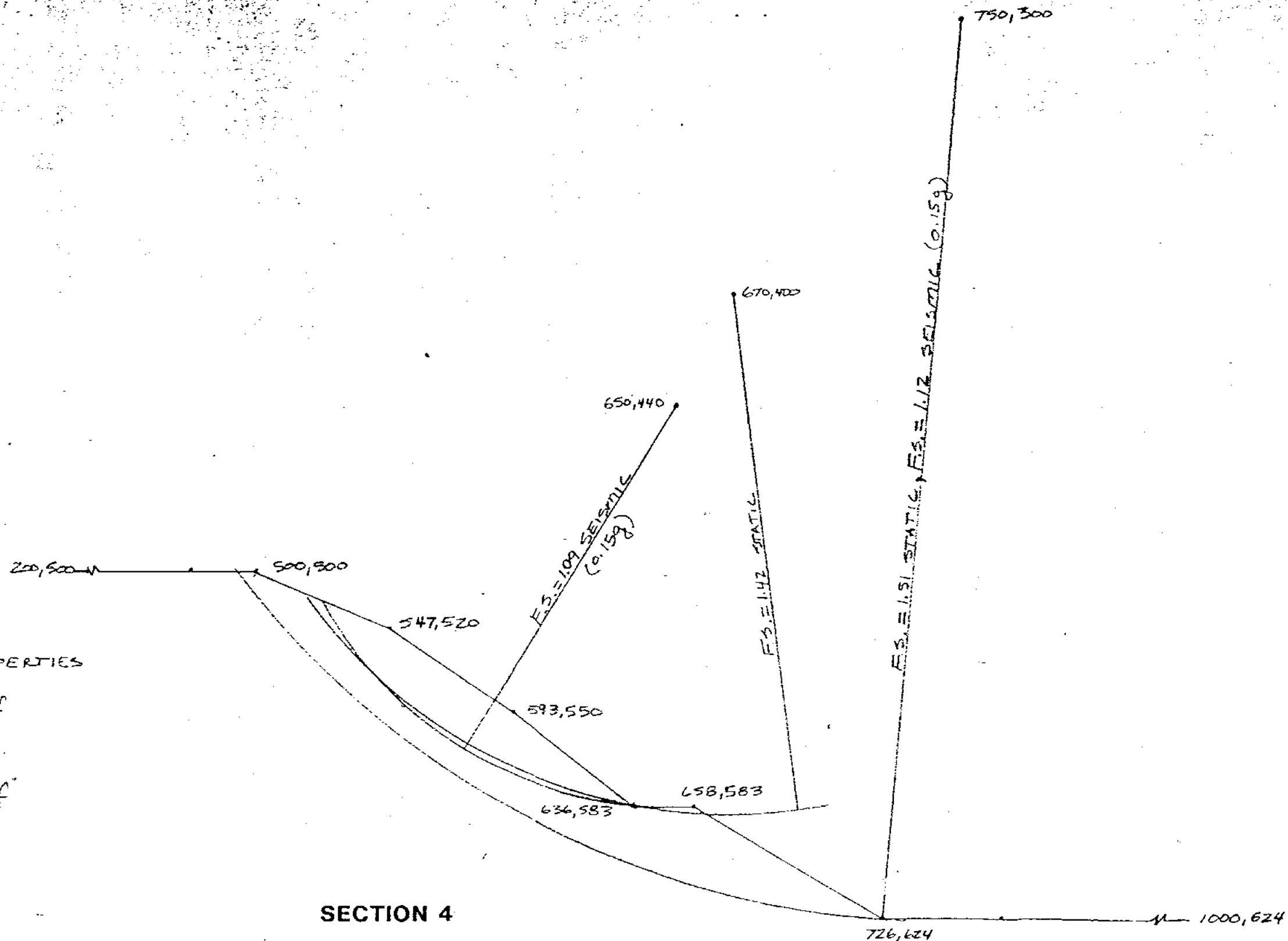
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$$\phi = 33^\circ$$

$$\gamma = 120 \text{ pcf}$$

SECTION 4

SCALE 1" = 40'



GROSS SLOPE STABILITY

Playa Vista Project

LeROY CRANDALL AND ASSOCIATES

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* * TSTAB slope stability analysis * *
* * Revision 2.52 - 01/06/86 * *
* * ----- * *
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* * copyright (c) 1983,84,85 TAGA * *
* * copyright (c) 1983,84,85 DPMS * *
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L90328.AEO - Section 4-4, Toe, Static
*****

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HBL ✓ BK

***** INPUT DATA FOR ANALYSIS BY BISHOP'S SIMPLIFIED METHOD

CONTROL DATA,

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AUTOMATIC SEARCH FOR CRITICAL CIRCLE
NUMBER OF DEPTH LIMITING TANGENTS      0
NUMBER OF VERTICAL SECTIONS            8
NUMBER OF SOIL LAYER BOUNDARIES        2
NUMBER OF POINTS DEFINING COHESION PROFILE 0
NUMBER OF CURVES DEFINING COHESION ANISOTROPY 0
NUMBER OF BOUNDARY LINE LOADS          0
NUMBER OF BOUNDARY PRESSURE LOADS      0

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SEISMIC COEFFICIENT      =      .000
ATMOSPHERIC PRESSURE     =      .000
UNIT WEIGHT OF WATER     =     62.400
UNIT WEIGHT OF WATER IN TENSION CRACK =     62.400

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SEARCH STARTS AT CENTER (650.0, 420.0),WITH FINAL GRID OF 20.0

ALL CIRCLES PASS THROUGH THE POINT (726.0, 624.0)

GEOMETRY

SECTIONS	200.00	500.00	547.00	593.00	636.00	658.00	726.00	1000.00
T. CRACKS	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
W IN CRACK	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 1	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 2	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	120.00	250.00	33.00	.00

 L90328.AEO - Section 4-4, Toe, Static

***** RESULTS

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
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2	654.7	234.7	610.0	420.0	2.507
3	635.6	255.6	650.0	380.0	1.979
4	627.2	207.2	690.0	420.0	1.630
5	640.8	180.8	650.0	460.0	1.965
6	626.6	246.6	690.0	380.0	1.637
7	624.0	204.0	730.0	420.0	1.660
8	627.9	167.9	690.0	460.0	1.695
9	631.5	211.5	670.0	420.0	1.748
10	626.9	226.9	690.0	400.0	1.624
11	624.6	204.6	710.0	420.0	1.590
12	627.5	187.5	690.0	440.0	1.654
13	624.6	224.6	710.0	400.0	1.566
14	624.0	204.0	730.0	420.0	1.660
15	624.7	184.7	710.0	440.0	1.637
16	626.9	226.9	690.0	400.0	1.624
17	624.5	244.5	710.0	380.0	1.555
18	624.0	224.0	730.0	400.0	1.588
19	626.6	246.6	690.0	380.0	1.637
20	624.5	264.5	710.0	360.0	1.559
21	624.0	244.0	730.0	380.0	1.548
22	624.0	264.0	730.0	360.0	1.529
23	625.2	245.2	750.0	380.0	1.650
24	624.0	224.0	730.0	400.0	1.588
25	624.5	264.5	710.0	360.0	1.559
26	624.0	284.0	730.0	340.0	1.520
27	625.1	265.1	750.0	360.0	1.574
28	624.5	284.5	710.0	340.0	1.578
29	624.0	304.0	730.0	320.0	1.527
30	625.0	285.0	750.0	340.0	1.534
31	624.4	304.4	710.0	320.0	1.605
32	624.9	304.9	750.0	320.0	1.515
33	625.1	265.1	750.0	360.0	1.574
34	624.5	264.5	710.0	360.0	1.559
35	624.9	324.9	750.0	300.0	1.506
36	627.2	307.2	770.0	320.0	1.577
37	624.0	324.0	730.0	300.0	1.547
38	624.8	344.8	750.0	280.0	1.513
39	627.0	327.0	770.0	300.0	1.535
40	624.0	344.0	730.0	280.0	1.574
41	626.8	346.8	770.0	280.0	1.514
42	627.2	307.2	770.0	320.0	1.577
43	624.0	304.0	730.0	320.0	1.527

F.S. MINIMUM= 1.506 FOR THE CIRCLE OF CENTER (750.0, 300.0)

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* * ----- *
* * TSTAB slope stability analysis *
* * Revision 2.52 - 01/06/86 *
* * ----- *
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* * copyright (c) 1983,84,85 DPMS *
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L90328.ARO - Section 4-4, Toe, Siesmic
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HB ✓ BK

**** INPUT DATA FOR ANALYSIS BY BISHOP'S SIMPLIFIED METHOD

CONTROL DATA,

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NUMBER OF SOIL LAYER BOUNDARIES        2
NUMBER OF POINTS DEFINING COHESION PROFILE 0
NUMBER OF CURVES DEFINING COHESION ANISOTROPY 0
NUMBER OF BOUNDARY LINE LOADS          0
NUMBER OF BOUNDARY PRESSURE LOADS      0

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SEISMIC COEFFICIENT      =      .150
ATMOSPHERIC PRESSURE     =      .000
UNIT WEIGHT OF WATER     =      62.400
UNIT WEIGHT OF WATER IN TENSION CRACK =      62.400

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SEARCH STARTS AT CENTER (650.0, 420.0), WITH FINAL GRID OF 20.0

ALL CIRCLES PASS THROUGH THE POINT (-726.0, 624.0)

GEOMETRY

SECTIONS	200.00	500.00	547.00	593.00	636.00	658.00	726.00	1000.00
T. CRACKS	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
W IN CRACK	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 1	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 2	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	120.00	250.00	33.00	.00

 L90328.AEO - Section 4-4, Toe, Seismic

***** RESULTS

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	637.7	217.7	650.0	420.0	1.431
2	654.7	234.7	610.0	420.0	1.781
3	635.6	255.6	650.0	380.0	1.430
4	627.2	207.2	690.0	420.0	1.218
5	640.8	180.8	650.0	460.0	1.476
6	626.6	246.6	690.0	380.0	1.212
7	624.0	204.0	730.0	420.0	1.230
8	627.9	167.9	690.0	460.0	1.271
9	630.3	250.3	670.0	380.0	1.307
10	626.4	266.4	690.0	360.0	1.221
11	624.5	244.5	710.0	380.0	1.156
12	626.9	226.9	690.0	400.0	1.209
13	624.5	264.5	710.0	360.0	1.155
14	624.0	244.0	730.0	380.0	1.152
15	624.6	224.6	710.0	400.0	1.167
16	624.0	264.0	730.0	360.0	1.136
17	625.2	245.2	750.0	380.0	1.223
18	624.0	224.0	730.0	400.0	1.181
19	624.5	264.5	710.0	360.0	1.155
20	624.0	284.0	730.0	340.0	1.127
21	625.1	265.1	750.0	360.0	1.170
22	624.5	284.5	710.0	340.0	1.163
23	624.0	304.0	730.0	320.0	1.129
24	625.0	285.0	750.0	340.0	1.140
25	624.4	304.4	710.0	320.0	1.177
26	624.9	304.9	750.0	320.0	1.124
27	625.1	265.1	750.0	360.0	1.170
28	624.5	264.5	710.0	360.0	1.155
29	624.9	324.9	750.0	300.0	1.115
30	627.2	307.2	770.0	320.0	1.172
31	624.0	324.0	730.0	300.0	1.138
32	624.8	344.8	750.0	280.0	1.116
33	627.0	327.0	770.0	300.0	1.140
34	624.0	344.0	730.0	280.0	1.152
35	626.8	346.8	770.0	280.0	1.122
36	627.2	307.2	770.0	320.0	1.172
37	624.0	304.0	730.0	320.0	1.129

F.S. MINIMUM= 1.115 FOR THE CIRCLE OF CENTER (750.0, 300.0)

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* * ----- * *
* * TSTAB slope stability analysis * *
* * Revision 2.52 - 01/06/86 * *
* * ----- * *
* *
* * copyright (c) 1983,84,85 TAGA * *
* * copyright (c) 1983,84,85 DPMS * *
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*****
L90328.AEO - Section 4-4, Bench, Static
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4.6L ✓ BK

***** INPUT DATA FOR ANALYSIS BY BISHOP'S SIMPLIFIED METHOD

CONTROL DATA,

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AUTOMATIC SEARCH FOR CRITICAL CIRCLE
NUMBER OF DEPTH LIMITING TANGENTS      0
NUMBER OF VERTICAL SECTIONS             8
NUMBER OF SOIL LAYER BOUNDARIES         2
NUMBER OF POINTS DEFINING COHESION PROFILE 0
NUMBER OF CURVES DEFINING COHESION ANISOTROPY 0
NUMBER OF BOUNDARY LINE LOADS           0
NUMBER OF BOUNDARY PRESSURE LOADS       0

```

```

SEISMIC COEFFICIENT      =      .000
ATMOSPHERIC PRESSURE     =      .000
UNIT WEIGHT OF WATER     =     62.400
UNIT WEIGHT OF WATER IN TENSION CRACK =     62.400

```

SEARCH STARTS AT CENTER (650.0, 420.0), WITH FINAL GRID OF 20.0

ALL CIRCLES PASS THROUGH THE POINT (636.0, 583.0)

GEOMETRY

SECTIONS	200.00	500.00	547.00	593.00	636.00	658.00	726.00	1000.00
T. CRACKS	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
W IN CRACK	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 1	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 2	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	120.00	250.00	33.00	.00

 L90328.AEO - Section-4-4, Bench, Static

***** RESULTS

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	583.6	163.6	650.0	420.0	1.445
2	585.1	165.1	610.0	420.0	1.763
3	583.5	203.5	650.0	380.0	1.506
4	591.7	171.7	690.0	420.0	1.577
5	583.8	123.8	650.0	460.0	1.431
6	583.1	123.1	630.0	460.0	1.498
7	583.7	143.7	650.0	440.0	1.428
8	587.6	127.6	670.0	460.0	1.577
9	583.9	103.9	650.0	480.0	1.481
10	583.1	143.1	630.0	440.0	1.517
11	583.6	163.6	650.0	420.0	1.445
12	587.0	147.0	670.0	440.0	1.473
13	583.1	163.1	630.0	420.0	1.548
14	586.5	166.5	670.0	420.0	1.426
15	587.6	127.6	670.0	460.0	1.577
16	583.1	123.1	630.0	460.0	1.498
17	586.1	186.1	670.0	400.0	1.424
18	591.7	171.7	690.0	420.0	1.577
19	583.5	183.5	650.0	400.0	1.468
20	585.8	205.8	670.0	380.0	1.439
21	590.8	190.8	690.0	400.0	1.473
22	583.5	203.5	650.0	380.0	1.506
23	590.1	210.1	690.0	380.0	1.439
24	591.7	171.7	690.0	420.0	1.577
25	583.6	163.6	650.0	420.0	1.445

F.S. MINIMUM= 1.424 FOR THE CIRCLE OF CENTER (670.0, 400.0)

```

*****
* *****
* *
* * ----- * *
* * TSTAB slope stability analysis * *
* * Revision 2.52 - 01/06/86 * *
* * ----- * *
* *
* * copyright (c) 1983,84,85 TAGA * *
* * copyright (c) 1983,84,85 DPMS * *
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*****
L90328.AEO - Section 4-4, Bench, Seismic
*****

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436 ✓ 68

***** INPUT DATA FOR ANALYSIS BY BISHOP'S SIMPLIFIED METHOD

CONTROL DATA.

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AUTOMATIC SEARCH FOR CRITICAL CIRCLE
NUMBER OF DEPTH LIMITING TANGENTS      0
NUMBER OF VERTICAL SECTIONS             8
NUMBER OF SOIL LAYER BOUNDARIES         2
NUMBER OF POINTS DEFINING COHESION PROFILE 0
NUMBER OF CURVES DEFINING COHESION ANISOTROPY 0
NUMBER OF BOUNDARY LINE LOADS           0
NUMBER OF BOUNDARY PRESSURE LOADS       0

```

```

SEISMIC COEFFICIENT      =      .150
ATMOSPHERIC PRESSURE     =      .000
UNIT WEIGHT OF WATER     =     62.400
UNIT WEIGHT OF WATER IN TENSION CRACK =     62.400

```

SEARCH STARTS AT CENTER (650.0, 420.0), WITH FINAL GRID OF 20.0

ALL CIRCLES PASS THROUGH THE POINT (636.0, 583.0)

GEOMETRY

SECTIONS	200.00	500.00	547.00	593.00	636.00	658.00	726.00	1000.00
T. CRACKS	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
W IN CRACK	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 1	500.00	500.00	520.00	550.00	583.00	583.00	624.00	624.00
BOUNDARY 2	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	120.00	250.00	33.00	.00

 L90328.AEO - Section 4-4, Bench, Seismic

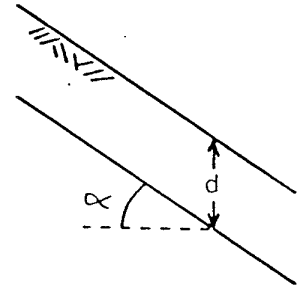
***** RESULTS

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	583.6	163.6	650.0	420.0	1.097
2	585.1	165.1	610.0	420.0	1.304
3	583.5	203.5	650.0	380.0	1.125
4	591.7	171.7	690.0	420.0	1.225
5	583.8	123.8	650.0	460.0	1.104
6	583.1	163.1	630.0	420.0	1.164
7	583.5	183.5	650.0	400.0	1.106
8	586.5	166.5	670.0	420.0	1.093
9	583.7	143.7	650.0	440.0	1.092
10	583.1	143.1	630.0	440.0	1.151
11	587.0	147.0	670.0	440.0	1.139
12	583.8	123.8	650.0	460.0	1.104
13	583.1	163.1	630.0	420.0	1.164
14	586.5	166.5	670.0	420.0	1.093
15	587.6	127.6	670.0	460.0	1.229
16	583.1	123.1	630.0	460.0	1.147

F.S. MINIMUM= 1.092 FOR THE CIRCLE OF CENTER (650.0, 440.0)

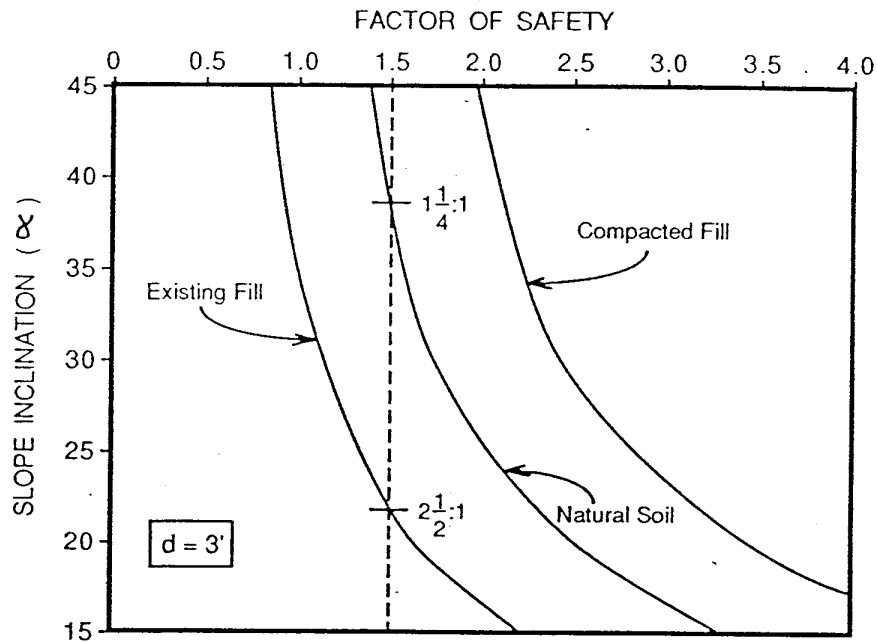
Surficial Stability

$$\text{Factor of Safety} = \frac{C + (\gamma_t - \gamma_w) \cdot d \cdot \cos^2 \alpha \tan \phi}{\gamma_t \cdot d \cdot \cos \alpha \sin \alpha}$$



Shear Strength

Natural Soil : C = 200 psf; $\phi = 30^\circ$
 Existing Fill : C = 100 psf; $\phi = 30^\circ$
 Compacted Fill : C = 300 psf; $\phi = 33^\circ$



STABILITY ANALYSES (SURFICIAL STABILITY)

LeROY CRANDALL AND ASSOCIATES

CLIENT : Maguire/Thomas Partners

JOB NO.: L90328.AEO

BY: bk

DATE: 09/19/90

TITLE : Analysis of Infinite Slope with Parallel Seepage

$$F.S. = \frac{C + (UNITWT - UNITWT \cdot WATER) \cdot H \cdot (\cos \alpha) + \frac{1}{2} \cdot \tan(\phi) \cdot H}{UNITWT \cdot H \cdot (\cos \alpha) + (\sin \alpha)}$$

Effective Cohesion PSF	Effective Friction Degrees	Total Unit Wt PCF	Vertical Depth Feet	Slope Angle Degrees	Slope Inclination (h:v)	Factor of Safety

Natural Soils

200.0	30.0	120.0	3.00	45.00	1.0:1	1.39
200.0	30.0	120.0	3.00	42.30	1.1:1	1.42
200.0	30.0	120.0	3.00	33.70	1.5:1	1.62
200.0	30.0	120.0	3.00	26.60	2.0:1	1.94
200.0	30.0	120.0	3.00	21.80	2.5:1	2.30
200.0	30.0	120.0	3.00	18.40	3.0:1	2.69
200.0	30.0	120.0	3.00	15.90	3.5:1	3.08
200.0	30.0	120.0	3.00	14.00	4.0:1	3.48

Existing Fill Soils

100.0	30.0	120.0	3.00	45.00	1.0:1	0.89
100.0	30.0	120.0	3.00	30.50	1.7:1	1.11
100.0	30.0	120.0	3.00	26.60	2.0:1	1.25
100.0	30.0	120.0	3.00	21.80	2.5:1	1.50
100.0	30.0	120.0	3.00	19.00	2.9:1	1.71
100.0	30.0	120.0	3.00	18.40	3.0:1	1.76
100.0	30.0	120.0	3.00	14.00	4.0:1	2.30

Compacted Fill Soils

300.0	33.0	120.0	3.00	45.00	1.0:1	1.98
300.0	33.0	120.0	3.00	33.70	1.5:1	2.27
300.0	33.0	120.0	3.00	26.60	2.0:1	2.70
300.0	33.0	120.0	3.00	18.40	3.0:1	3.72
300.0	33.0	120.0	3.00	14.00	4.0:1	4.80

SURFICIAL STABILITY

APPENDIX A:**EXPLORATIONS AND LABORATORY TESTS****A.1 EXPLORATIONS**

The soil conditions beneath the level portion of the site were explored by drilling 26 borings (Borings 1 through 26) at the locations shown on Plate 2-1. (Borings 1 through 10 were drilled in May and August of 1986; Borings 11 through 26 were drilled in February of 1987.) The borings were drilled to depths of 47 to 71 feet below the existing grade using 5-inch-diameter rotary wash-type drilling equipment. Drilling mud was used with the rotary wash-type equipment to prevent caving. Supplementary borings were drilled adjacent to Borings 4 and 5 using 20-inch-diameter bucket-type drilling equipment and adjacent to Borings 7, 9, and 10 using 8-inch-diameter auger-type equipment for additional water level information. About 15 to 20 feet of perforated PVC pipe was installed in Borings 11 through 19 and 21 through 26 to allow continued monitoring of water levels.

The soils encountered were logged by our field technician, and undisturbed samples were obtained for laboratory inspection and testing. The logs of the borings are presented on Plates A-1.1 through A-1.26; the depths at which undisturbed samples were obtained are indicated to the left of the boring logs. The energy required to drive the sampler 12 inches is indicated on the logs. The soils are classified in accordance with the Unified Soil Classification System described on Plate A-2.

A.2 LABORATORY TESTS

The field moisture content and dry density of the soils encountered were determined by performing tests on the undisturbed samples. The results of the tests are shown to the left of the boring logs.

To determine the liquid limit and plasticity index of the soils and to aid in classifying the soils, the Atterberg Limits were determined for selected samples. The results of the tests are presented on the boring logs.

Direct shear tests were performed on numerous undisturbed samples to determine the strength of the soils. The tests were performed at field and at nearly saturated moisture contents (after soaking for 24 hours) and at various surcharge pressures. The yield-point values determined from the direct shear tests are presented on Plates A-3.1 and A-3.2, Direct Shear Test Data.

Confined consolidation tests were performed on 29 undisturbed samples to determine the compressibility of the soils. Water was added to seven of the samples during the tests to illustrate the effect of moisture on the compressibility. The results of the tests are presented on Plates A-4.1 through A-4.15, Consolidation Test Data.

Expansion tests were performed on six undisturbed samples to determine volume change of the soils due to changes in the moisture content. The samples were confined under a nominal surcharge pressure, soaked, and the resulting expansion was measured. Next, the samples were allowed to air-dry and the resulting shrinkage was measured. The results of the expansion tests are presented on Plates A-5.1 and A-5.2, Expansion Test Data.

To determine the particle size distribution of the soils and to aid in classifying the soils, mechanical analyses were performed on 17 samples. The results of the mechanical analyses are presented on Plates A-6.1 through A-6.9, Particle Size Distribution.

Soil corrosivity studies were performed for us by M. J. Schiff & Associates. Schiff's report, dated March 19, 1987, is presented on Plates A-7.1 through A-7.4.

JOB L9032AED DATE 8/27/90 DR. O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN-TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbf./ft.)	SAMPLE LOC.
10		18.6	108	9			CL
							ML
5		44.8	76	2			CL
		29.6	94	6			SM
							ML
0		34.0	88	2			CH
		46.8	73	< 1			
-5							
		39.2	82	1			
-10							CL
		28.9	90	3			
-15							SP
		21.3	106	26			SM
-20							
		11.9	118	32			
-25							
		29.3	95	16			CL
-40							

BORING 1

DATE DRILLED: May 20, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 11*

COMPACTED FILL - SILTY CLAY - some Silt and Silty Sand, brown

COMPACTED FILL - SANDY SILT - mottled very dark grey and brown

SILTY CLAY - traces of organic matter, dark grey

WATER LEVEL 5/20/86

SILTY SAND - fine, dark grey

CLAYEY SILT - light brownish grey
Layers of Clay

CLAY - some organic matter, dark grey

(LL = 67%; PI = 38%)

More organic matter, black

SILTY CLAY - dark grey

GRAVELLY SAND - fine to coarse, about 30%
Gravel, some fines, dark grey

About 40% Gravel and Cobbles

*Elevations refer to datum of reference survey; see Plate 1.

Elevations of Borings 11 through 15 and 17 through 26 provided by Psomas & Assoc.
Layers of Silty Clay

SILTY CLAY - very dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.1a

JOB L-90328 AED DATE 8/27/90 DR. O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-30							
	45		13.4	119	58		
-35							
	50		8.9	133	74		
-40							
	55		10.5	130	74		
-45							
	60		11.8	125	84		

BORING 1 (CONTINUED)

DATE DRILLED: May 20, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

SANDY GRAVEL - well graded, about 50% Sand,
some fines, dark grey

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 6 1/2' 30 minutes after removal of mud; bottom of boring at 28'.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.1b

JOB L90328AEQ DATE 8/27/90 PR. O.E.

FORM 1-6

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
(ft.)	(ft.)		(% of dry wt.)	(lb./cu. ft.)	(ft.-lbs./ft.)		
10		5.9	116	7			SM ML
5		36.9	80	3			ML
5		35.6	84	2			ML
10		19.0	109	5			ML
0							ML
15		22.3	107	8			SM
-5							ML
20		24.8	99	3			GP
-10							ML
25							ML
-15							ML
30		34.5	88	3			ML
-20							ML
35		42.1	80	5			SW
-25							SW
40							SW

BORING 2

DATE DRILLED: May 20, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 12

FILL - SILTY SAND and CLAYEY SILT - brown and very dark grey

CLAYEY SILT - black

(LL = 58%; PI = 27%)

X WATER LEVEL 5/20/86

SILT - some Sand, dark grey

SANDY SILT - dark grey

SILTY SAND - fine, dark grey

CLAYEY SILT - cemented nodules, dark grey

SANDY GRAVEL - fine, grey

SANDY SILT - grey

CLAYEY SILT - some organic matter, some shells, very dark grey

(LL = 34%; PI = 9%)

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, light grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.2a

JOB 29050AEO DATE 8/27/90 DR OE

... 12.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 2 (CONTINUED)

DATE DRILLED: May 20, 1986
EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30			16.4	111	37		
	45						
-35			24.8	94	47		
	50						
-40			7.5	127	58		
	55						SP
-45			21.6	107	82		
	60						
-50			20.9	105	58		
	65						
-55			15.4	116	84		
	70						
-60			14.3	117	140		
	75						

Layers of fine Sand

SAND - fine to medium, few Gravel, light grey

Fine Sand

Fine to medium Sand

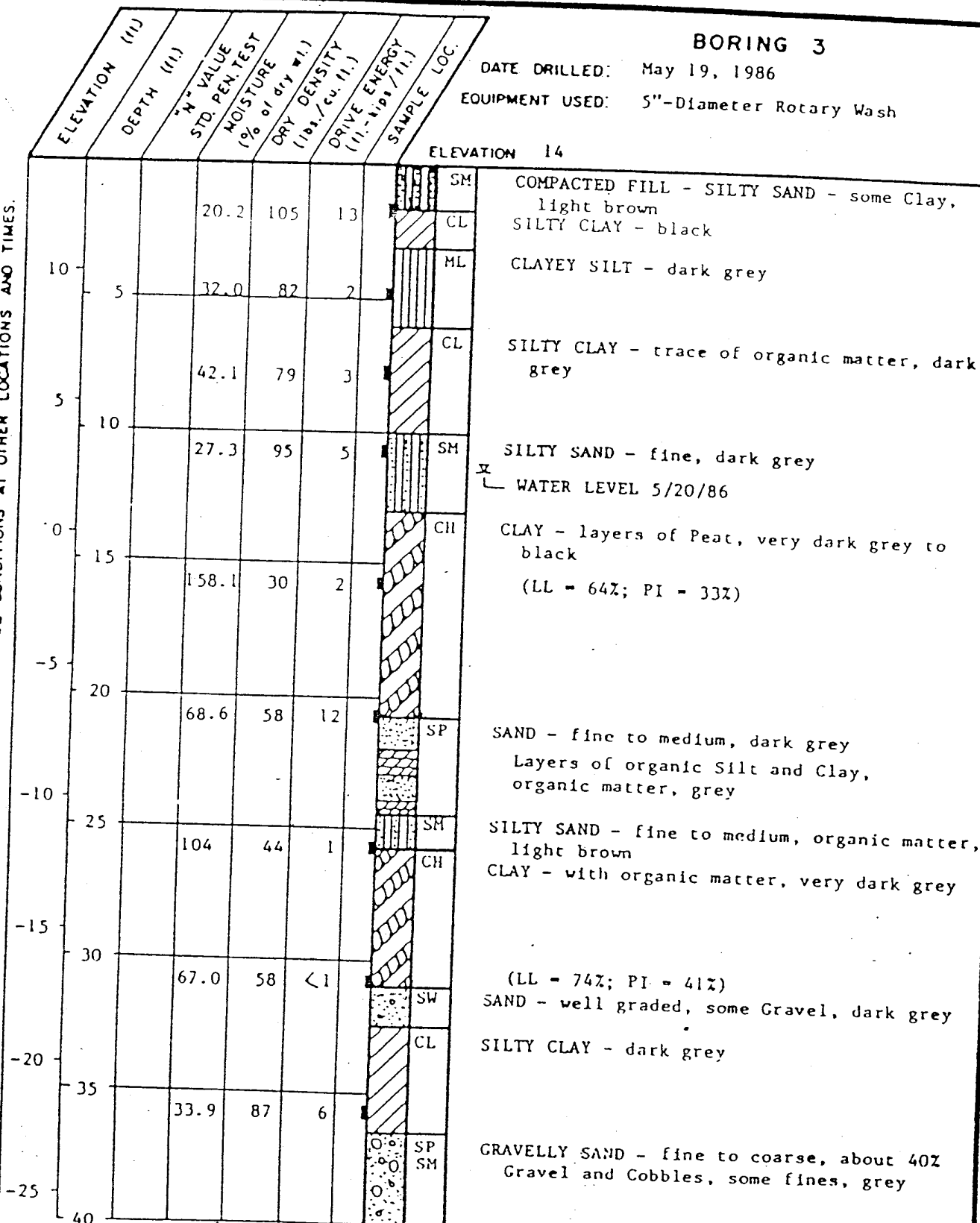
NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 8' 4 hours after removal of mud; bottom of boring at 39'.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB L20528AEO DATE 8/27/90 DR O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



BORING 3
DATE DRILLED: May 19, 1986
EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 14

WATER LEVEL 5/20/86

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB 440328 AED DATE 8/27/90 DR. O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30	45		8.3	134	58		
-35	50		13.2	124	84		
-40	55		1.3	142	70		
-45	60		8.5	136	105		
-50	65		8.7	130	126		

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 11 1/2' 16 hours after removal of mud; bottom of boring at 32'.

BORING 3 (CONTINUED)
DATE DRILLED: May 19, 1986
EQUIPMENT USED: 5"-Diameter Rotary Wash

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.3b

JOB 190328 AEO DATE 8/27/90 DR O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
15		24.4	95	7		CL
5		23.8	89	5		ML
10		37.4	82	3		CH
10		18.2	109	5		CL
5						
15		15.5	109	12		SH
0						
20		18.6	111	12		CL
-5						SP
25		17.1	113	26		
-10						
30		23.3	97.1	32		
-15						
35		17.0	105	26		
-20						
40						SW

BORING 4

DATE DRILLED: May 19, 1986
EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 18

SILTY CLAY - black

SANDY SILT - greyish brown

CLAY - traces of organic matter, dark grey
(LL = 65%; PI = 43%)

SILTY CLAY - very dark grey

SILTY SAND - fine, greyish brown
Some coarser Sand

SILTY CLAY - dark grey

SAND - fine to medium, light brown
WATER LEVEL 5/20/86

Grey

Layers of Silty Clay

SAND - well graded, about 40% Gravel and
Cobbles, grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.4a

BORING 4 (CONTINUED)

DATE DRILLED: May 19, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-25			18.8	108	42		
45			10.5	130	84		
-30							
50			7.8	128	180		
-35							
55							
-40							SP
60							

Dark grey

SAND - fine, grey

- NOTES: 1) Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 23' 17 hours after removal of mud; bottom of boring at 24'.
- 2) Drilled 20"-diameter bucket boring to 27' depth on July 29, 1986. Water seepage encountered at 23½'. Water level at 25½' 10 minutes after completion of drilling.

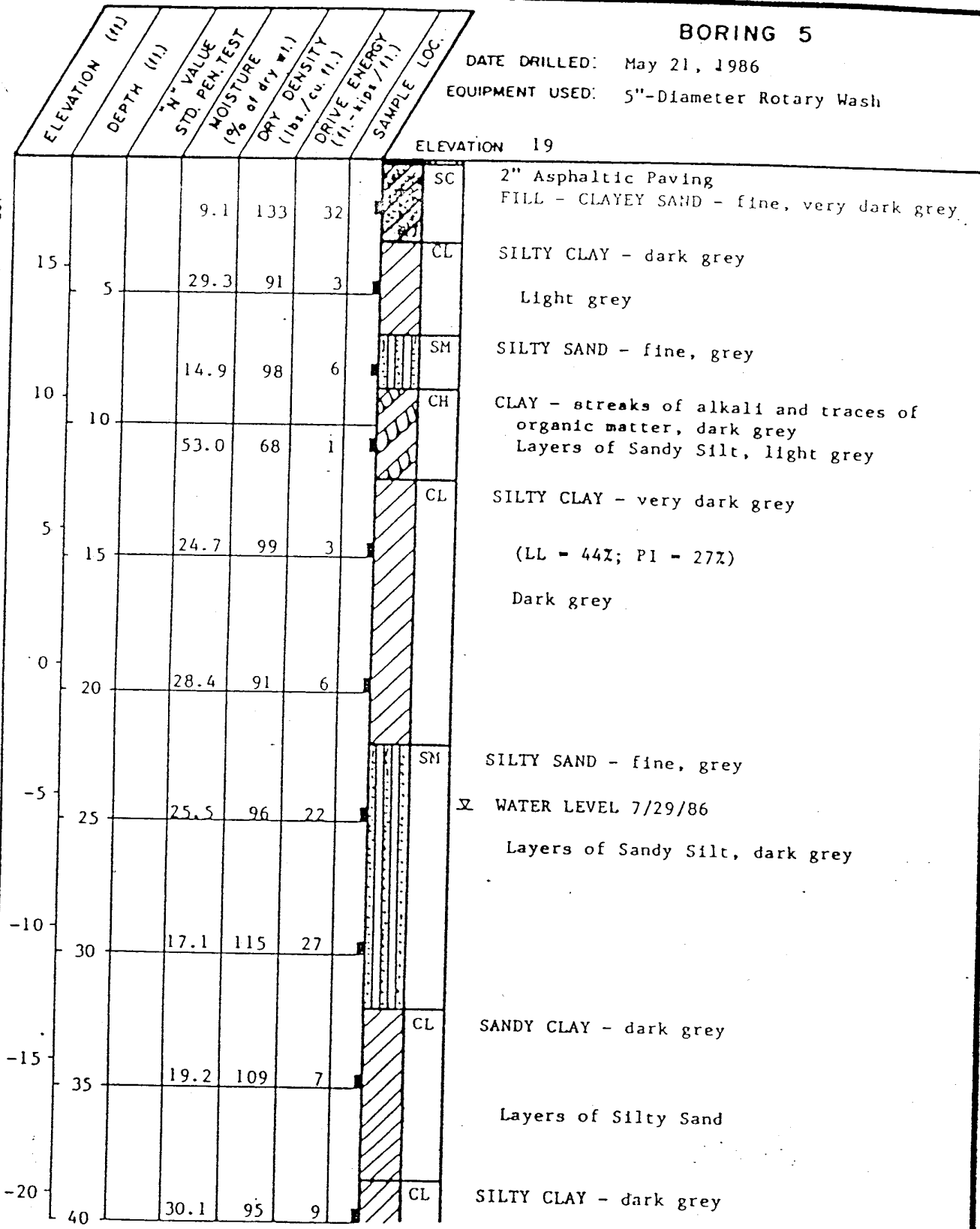
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.4b

DATE 2/27/90 DR UE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB L90323 AEO DATE 8/27/90 DR. RE

124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-25	45	8.2	136	82			SW SM
-30	50	8.7	135	58			
-35	55	7.1	133	84			
-40	60						SP

BORING 5 (CONTINUED)

DATE DRILLED: May 21, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

GRAVELLY SAND - well graded, about 30%
Gravel and Cobbles, some fines, grey

Boulder

SAND - fine, some fines, light grey

NOTES: 1) Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 35'. Water level measured at 25' 30 minutes after removal of mud; bottom of boring at 25'.

2) Drilled 20"-diameter bucket boring to 26 1/2' depth on July 29, 1986. Water seepage encountered at 26'. Water level at 24 1/2' 10 minutes after completion of drilling.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.5b

Form 125
 JOB 190328 AFO DATE 8/27/90 DR. OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

							BORING 6	
							DATE DRILLED:	August 18, 1986
							EQUIPMENT USED:	5"-Diameter Rotary Wash
ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.	
							ELEVATION 15	
10	5	13.9	123	7			SM	COMPACTED FILL - SILTY SAND and SILTY CLAY - some Cobbles, pieces of concrete dark brown
		10.4	123	6			CL	Layers of Gravel
		12.7	119	6			CL	COMPACTED FILL - SILTY CLAY - some Sand, dark grey
5	10							Some pieces of brick or asphaltic paving
		11.0	118	8			ML	COMPACTED FILL - SANDY SILT - some Silty Sand, some Gravel, dark greyish brown
0	15	35.1	84	2			ML	CLAYEY SILT - grey
							CL	SILTY CLAY - traces of organic matter, some Sandy lenses, dark grey
							ML	WATER LEVEL 8/18/86
-5	20	39.2	84	2			ML	CLAYEY SILT - traces of organic matter, grey
							ML	Lenses of Clay
-10	25	20.3	109	2			ML	SANDY SILT - some Gravel, dark grey
								Layers of coarse Sand with Gravel
-15	30	24.7	101	14			SP	SAND - fine to coarse, about 20% Gravel, dark grey
							ML	SANDY SILT - dark grey
-20	35	34.2	90	3			CH	CLAY - dark grey
								Lenses of Sand
-25	40	31.4	93	4				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB. 4-10342 A-1. DATE 8/14/86. VK. CUS.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
-30	45		37.3	85	3		
-35	50		29.6	96	6		
-40	55		30.5	93	6		
-45	60		6.6	133	38		SP

BORING 6 (CONTINUED)

DATE DRILLED: August 18, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

(LL = 53%; PI = 27%)

Layer of fine Sand

SAND - fine and medium, large amount of Gravel and Cobbles, grey

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 15' after removal of mud; bottom of boring at 17½'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.6b

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.	
(ft.)	(ft.)			(% of dry wt.)	(lb./cu. ft.)	(ft.-lb./ft.)		
								ELEVATION 10
		8.4	117	10			SM	COMPACTED FILL - SILTY SAND and CLAYEY SAND - fine, light brown
5	5	15.7	114	7			CL	COMPACTED FILL - SANDY CLAY - some Gravel, brown
		19.0	109	9				Dark grey
0	10	37.4	82	2			CL	SILTY CLAY - dark grey
								WATER LEVEL 8/19/86
		33.2	90	2			ML	SANDY SILT - brownish grey
-5	15							Layers of Silty Sand with some shells
		37.1	85	2				Grey
-10	20						CL	SILTY CLAY - some shells, dark grey
		53.5	69	2				Lenses of coarse Sand and some Gravel from 23' to 29' (LL = 42%; PI = 20%)
-15	25							
-20	30	23.1	102	1				
		27.9	97	2				
-25	35						ML	SANDY SILT - dark grey
-30	40	26.7	99	3				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.7a

BORING 7 (CONTINUED)

DATE DRILLED: August 18, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-35	45	35.0	88	2			CL
-40	50	29.2	95	3			
-45	55	32.7	90	3			
-50	60	31.9	91	9			SP SM
-55	65						

SILTY CLAY - dark grey

SAND - fine, some Gravel, dark grey

SILTY SAND - fine, dark grey

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 10½' after removal of mud and at 10' 17 hours later; bottom of boring at 14'.

Drilled 8"-diameter auger boring 10' east of rotary wash boring to a depth of 12' for water level determination. Water level measured at 10½' 10 minutes after completion of drilling.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.7b

JOB L90328 AEO DATE 8/24/86 DR. J. CE.

Form 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

							BORING 8	
							DATE DRILLED:	August 19, 1986
							EQUIPMENT USED:	5"-Diameter Rotary Wash
ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.	
ELEVATION 11								
10		14.8	106	6			CL SP	COMPACTED FILL - CLAY and SAND - some hydrocarbons, petroleum odor, dark greyish brown
		15.4	115	6				
5	5	6.8	103	17			SM	COMPACTED FILL - SILTY SAND - fine, light brown
		17.8	101	18				
0	10	18.1	103	10				
							CL	SILTY CLAY - traces of organic matter, dark grey
							x WATER LEVEL 8/19/86	
-5	15	39.3	80	2			ML	CLAYEY SILT - lenses of fine Sand, layers of Clay, grey
								(LL = 37%; PI = 11%)
-10	20	33.2	89	2			CL	SILTY CLAY - traces of organic matter, lenses of Silty Sand, dark grey
-15	25	99.5	45	1				Lenses of coarse Sand and Gravel with shells
-20	30	30.4	89	1				
-25	35	19.5	113	2				Layer of Silty Sand
							SP	SAND - fine to medium, some fines, grey
40		19.5	109	18				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.8a

JOB L90328 AEODATE 8/24/90 DR. DE

FORM 124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-30							
	45		13.7	122	18		
-35							
	50		16.8	112	18		

BORING 8 (CONTINUED)

DATE DRILLED: August 19, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

SAND - well graded, some Gravel, dark grey

Layers of Silty Clay

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 25'. Water level measured at 14' after removal of mud; bottom of boring at 37'.

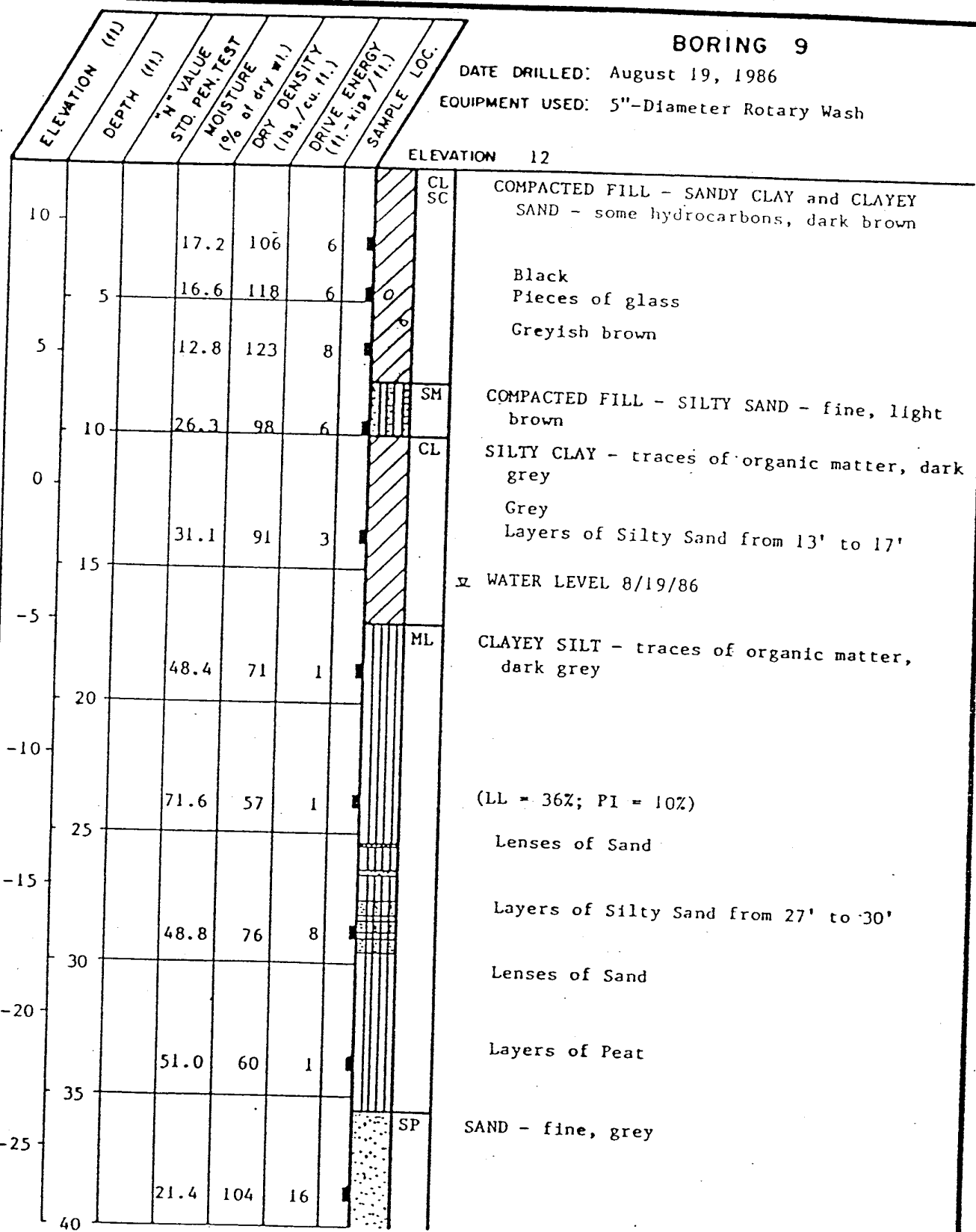
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.8b

100 190328AEO DATE 8/24/86 DR. CR. G.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB L90328 AEO DATE 8/24/80 DR. RV DE

Form 124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30							
	45						
-35							
	50		39.5	83	3		

BORING 9 (CONTINUED)

DATE DRILLED: August 19, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

Some Gravel

SILTY CLAY - traces of organic matter, dark grey

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 25'. Water level measured at 16' after removal of mud and at 15½' 20 minutes later.

Drilled 8"-diameter auger boring 10' north of rotary wash boring to a depth of 16' for water level determination. Water level measured at 15½'. Boring squeezing in below 10'.

LOG OF BORING

L•ROY CRANDALL AND ASSOCIATES

JOB L20328AEO DATE 8/24/90 DR. ON DE

Form 124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
				(% of dry wt.)	(lb./cu. ft.)	(ft.-lbs./ft.)	
10		11.0	113	11			SH
5		23.1	103	4			ML
5		39.4	81	3			ML
10		54.9	68	1			CH
0		38.0	81	<1			
15							
-5		62.7	62	1			
20							
-10		26.4	98	3			SM
25							
-15		27.6	98	7			CL
30							
-20		15.1	117	13			SP
35							
-25		22.3	108	18			
40							

BORING 10

DATE DRILLED: August 19, 1986
EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 13

FILL - SILTY SAND - fine, light brown

FILL - SANDY SILT - grey
Dark grey
Some Clay, black

CLAY - traces of organic matter, black

Layers of Silty Sand from 10' to 11½'

WATER LEVEL 8/19/86

Lenses of Sand

SILTY SAND - fine, some shells, dark grey

SILTY CLAY - dark grey

SAND - fine to medium, layers of Silty Sand, some Gravel, grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 10 (CONTINUED)

DATE DRILLED: August 19, 1986

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30				16.9	119	19	
-45							
-35							
50		16.6	121	16			

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling to a depth of about 30'. Water level measured at 11' after removal of mud and at 11' 30 minutes later.

Drilled 8"-diameter auger boring 10' south of rotary wash boring to a depth of 12' for water level determination. Water level measured at 11½'. Boring squeezing in between 7' and 8'.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.10b

VER. 4-20-85, ALIQUOT DATE: 8/24/80 DR. J. W. C. E.

JOB L90322BAE DATE 8/24/90 DR. OF O.E.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.	
								ELEVATION 14.4
		16.6	108	7			CL SN	COMPACTED FILL - SILTY CLAY and SILTY SAND - fine, brown and grey
10	5	16.7	121	5				Pieces of concrete and brick, some hydrocarbons, some Cobbles
		16.0	107	4				About 10% Gravel
5	10							Pieces of asphaltic paving
		11.0	118	6				
0	15	12.1	102	1			CL	SILTY CLAY - black
							SN	WATER LEVEL 4/6/87
								SILTY SAND - fine, grey
		34.7	87	2				Layer of Sandy Silt
-5	20	45.2	79	2			NL	SANDY SILT - traces of organic matter, dark grey
							HI	ELASTIC SILT - traces of organic matter, shells, dark grey
-10		53.3	68	1				
							CL	SILTY CLAY - some shells, black
-15	30	29.8	92	2				(LL = 33%; PI = 15%)
							NL	SANDY SILT - dark grey
-20	35	24.4	99	2			SN	SILTY SAND - fine, grey
							SP SN	SAND - fine to coarse, few Gravel, some fines, grey
-25	40	21.1	154	11				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOE L20328 AED DATE 8/24/90 DR. OV. 0.5

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOG
				(% of dry wt.)	(lbs./cu. ft.)	(ft.-lbf./ft.)	
-30	45	15.2	115	10			
-35	50	38.8	83	4			CL
-40	55	39.1	81	2			
-45	60	27.5	97	5			ML
-50	65	15.4	117	45			SW
-55	70	10.3	123	33			

BORING II (CONTINUED)
DATE DRILLED: February 12, 1987
EQUIPMENT USED: 5"-Diameter Rotary Wash

SILTY CLAY - dark grey

SANDY SILT - dark grey

GRAVELLY SAND - well graded, about 30% Gravel, grey
About 40% Gravel and Cobbles

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 35'. Water level measured at 15' 30 minutes after removal of mud and at 12-1/2' on 2/17/87.

Set 20' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 13' on 4/6/87 and on 9/19/90.

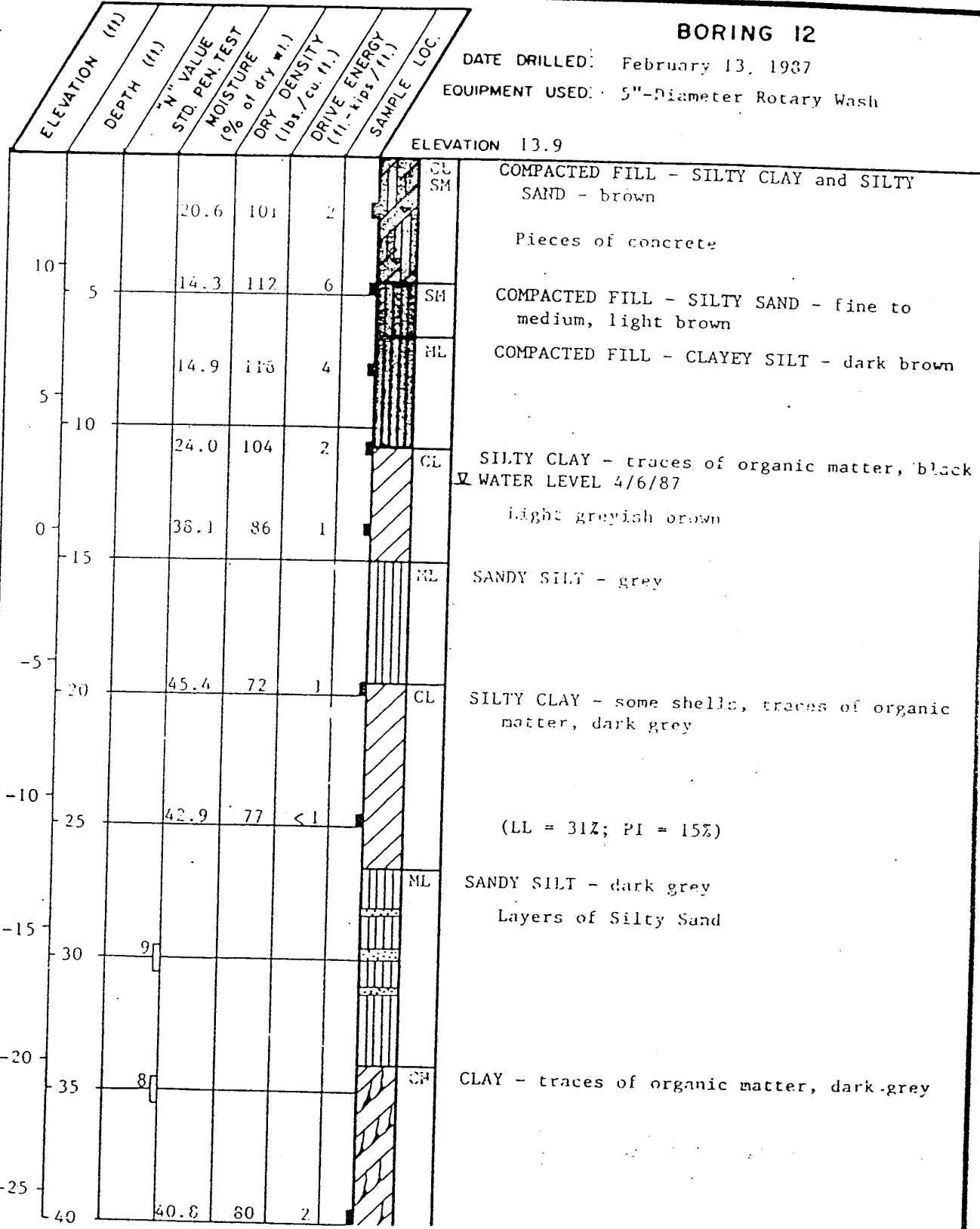
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB L90328AEQ DATE 8/24/90 DR. JUT. DE

Form 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB L 90328 AED DATE 8/24/90 DE OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft)	DEPTH (ft)	N-VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOG.
-30	45		49.4	76	2	
-35	50	24				ML
-40	55		28.9	96	4	
-45	60		11.9	124	36	SM
-50	65					
-55	70					

BORING 12 (CONTINUED)

DATE DRILLED: February 13, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SANDY SILT - dark grey

SILTY SAND - fine to coarse, about 30%
Gravel, some Cobbles, grey

Many Cobbles

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 12-1/2' on 2/14/87.

Set 19' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 12' on 4/6/87 and on 9/19/90. Water level measured at 12-1/2' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.12b

JOB L90328AED DATE 8/24/90 DE OE

Form 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
(ft.)	(ft.)		(% of dry wt.)	(lb./cu. ft.)	(ft.-kips/ft.)		
10		14.2	111	8			ML
5		10.9	124	11			SM CL
5		23.6	103	3			CL
10							CL
0		55.5	68	< 1			ML CH
15		37.5	86	2			ML
-5		51.2	72	1			CH
-20		60.7	65	1			
-10		22.5	107	1			CL
-25							
-30		30.3	96	2			
-20							
-35		28.2	98	5			ML
-25							
-40		30.8	91	3			

BORING 13

DATE DRILLED: February 13, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 12.9

COMPACTED FILL - SANDY SILT - pieces of concrete, greyish brown to dark brown

COMPACTED FILL - SILTY SAND and SILTY CLAY - dark brown

COMPACTED FILL - SILTY CLAY - pieces of brick, dark brown

WATER LEVEL 4/6/87

SILTY CLAY - black

CLAYEY SILT - greyish brown

CLAY - traces of organic matter, black

SANDY SILT - brownish grey

CLAY - layers of Sand, some cemented nodules, grey

Some shells

SILTY CLAY - traces of organic matter, black

Layers of Sandy Silt, some Gravel, dark brown
Dark grey

SANDY SILT - dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.13a

BORING 13 (CONTINUED)

DATE DRILLED: February 13, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-30							CH
	45	27.5	93	2			
-35							
	50	36.4	87	4			
-40							SW
	55	10.4	127	23			
-45							
	60	12.0	123	33			SW
-50							
	65						
-55							
70							

CLAY - dark grey

SAND - well graded, about 10% Gravel, grey

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 11-1/2' 30 minutes after removal of mud and at 9-1/2' on 2/14/87.

Set 21-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 10' on 4/6/87. Water level measured at 10-1/2' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.13b

BORING 14

DATE DRILLED: February 17, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.	ELEVATION	DESCRIPTION
				(% of dry wt.)	(lb./cu. ft.)	(ft.-lbs./ft.)		11.3	
10		18.0	113	5			CL		COMPACTED FILL - SILTY CLAY - some Sand, some hydrocarbons, brown
	5						SP		COMPACTED FILL - SAND - fine, light brown
5		7.2	118	8			SM		COMPACTED FILL - SILTY SAND - fine, dark brown
	5						ML		COMPACTED FILL - CLAYEY SILT - some Gravel, grey
10		18.3	114	4					WATER LEVEL 4/6/87
0		40.4	80	1			CL		SILTY CLAY - dark grey
	15	35.3	88	1			ML		SANDY SILT - traces of organic matter, grey
-5		44.9	78	1			CL		SILTY CLAY - traces of organic matter, grey
									Layers of fine Sand, some shells
20		39.3	83	1			ML		SANDY SILT - some layers of Clay, grey
-10									
25	0								
-15							CL		SILTY CLAY - dark grey
30		55.2	70	1					
-20									Lenses of fine Sand
35	10								
-25									
40		25.7	95	4			SM		SILTY SAND - fine, dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.14a

BORING 14 (CONTINUED)

DATE DRILLED: February 17, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
-30							
45	24						
-35							SP
50	27						
-40							
55	23.4	105	7				
-45							
60	13.2	126	27				SW
-50							
65							
-55	11.8	129	36				
70							

SAND - fine to coarse, some Gravel, dark grey

Grey

Layers of Silt and Clay

Some organic matter

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 10-1/2' 30 minutes after removal of mud and at 9' on 2/18/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 9-1/2' on 4/6/87. Water level measured at 11' on 9/19/90.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.14b

JOB L70 KB AEU DATE 8/24/90 DR. DE.

BORING 15

DATE DRILLED: February 17, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 14.7

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS, AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.	DESCRIPTION
				% of dry wt.	(lb./cu. ft.)	(ft.-lb./ft.)		
		12.5	113	6			CL	COMPACTED FILL - CLAY - some Silt and Sand, some hydrocarbons, petroleum odor, dark brown and grey
10	5	21.1	104	4			SP	COMPACTED FILL - SAND - fine, light brown
		15.8	109	13				
5	10	18.7	110	7			CL	COMPACTED FILL - SILTY CLAY and SANDY CLAY - brown
		38.0	82	2			CH	CLAY - black WATER LEVEL 4/6/87 (LL = 61%; PI = 31%) Grey
0	15	38.4	84	1				Layers of Silty Sand
-5	20	71.9	57	1			CL	SILTY CLAY - grey
-10	25	90.9	49	1				
-15	30	42.6	81	1			CH	CLAY - few shells, dark grey
-20	35	28.4	96	2				Layers of Silty Sand
-25	40	17.1	116	4			SH	SILTY SAND - fine, dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING.

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.15a

JOB L90328 AEO DATE 8/24/90 DR. DE

Form 12.

JOB L-90 328AED DATE 8/24/90 DR. DE

FORM 124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30	45	20.9	105	11			SP
-35	50	15.6	111	12			SW SM
-40	55	18.8	115	21			
-45	60						SW
-50	65	10.4	136	24			

BORING 15 (CONTINUED)
 DATE DRILLED: February 17, 1987
 EQUIPMENT USED: 5"-Diameter Rotary Wash

SAND - fine, layers of Silt and Clay, grey

SAND - well graded, about 10% Gravel, some fines, grey

Layer of Sandy Silt

Layer of Sandy Silt

GRAVELLY SAND - well graded, about 40% Gravel, grey

Layer of Clayey Silt, dark grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 13' 15 minutes after removal of mud and at 12-1/2' on 2/18/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 13-1/2' on 4/6/87 and on 9/19/90.

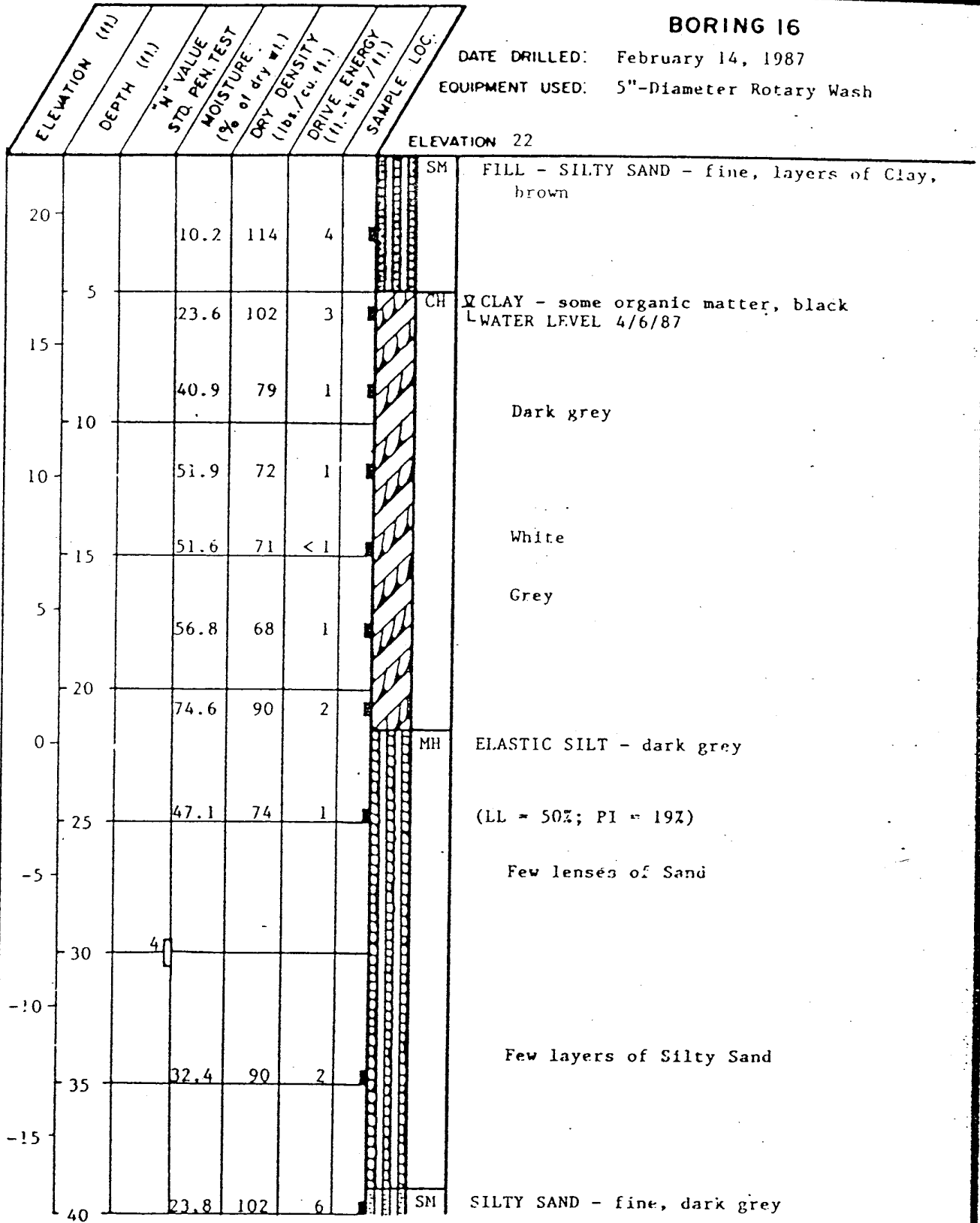
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.15b

JOB L90328 AEO DATE 8/24/90 PR. PE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB 490328 AEO DATE 8/24/90 DR. CRG

Form 129

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft)	DEPTH (ft)	N-VALUE	STD. PEN-TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-20						
45	50					
-25						SW
50		28.4	97	22		SM
-30						SP SM
55	55					
-35						
60		16.2	110	21		SP
-40						
65		23.8	98	14		SM
-45						
70		24.6	92	15		

Grey

SAND - well graded, about 10% Gravel, grey

SILTY SAND - fine, dark grey

SAND - fine, some fines, grey

SAND - fine to medium, few Gravel, light grey

SILTY SAND - fine, dark grey

Piece of wood, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 35'. Water level measured at 8' 30 minutes after removal of mud and at 5-1/2' on 2/17/87.

Set 18-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 5-1/2' on 4/6/87. Water level measured at 7' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.16t

BORING 16 (CONTINUED)

DATE DRILLED: February 14, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

BORING 17

DATE DRILLED: February 16, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 15.8

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
(ft.)	(ft.)			(% of dry wt.)	(lb./cu. ft.)	(ft.-lb./ft.)	
15				17.6	110	3	CL
10	5			7.7	111	15	SM
5	10			20.1	112	4	CL
0	15			23.0	102	5	CL
-5	20			33.7	86	2	ML
-10	25			38.2	85	1	CL
-15	30			49.8	73	1	CL
-20	35	24		41.3	81	1	SM
-25	40			24.9	104	4	ML
				32.0	92	1	

COMPACTED FILL - SILTY CLAY - some Silty Sand, some hydrocarbons, petroleum odor, greyish brown

COMPACTED FILL - SILTY SAND - fine, light brown

COMPACTED FILL - SILTY CLAY - some Sand, greyish brown

SILTY CLAY - traces of organic matter, black

WATER LEVEL 4/6/87
Some cemented nodules, grey

CLAYEY SILT - dark grey

SILTY CLAY - dark grey

Some layers of Silty Sand

SILTY SAND - fine, dark grey

CLAYEY SILT - some organic matter, dark grey

(LL = 34%; PI = 7%)

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.17a

Form L-1003B-AEQ-DATE 8/24/90 DR DE

BORING 17 (CONTINUED)

DATE DRILLED: February 16, 1987
EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N° VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
-25							
-30	45	34.5	90	2			
-35	50	33.4	90	2			
-40	55	100 (9" pen)					SP
-45	60	10.1	130	51			SW SM
-50	65	13.0	129	36			
-55	70						

Streaks of Peat and organic matter

SAND - fine to medium, grey

GRAVELLY SAND - well graded, about 30% Gravel, some fines, grey
Large Cobbles

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 14' 30 minutes after removal of mud and at 12-1/2' on 2/17/87.

Set 19' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 13' on 4/6/87.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.171

BORING 18

DATE DRILLED: February 16, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 12.3

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
			(% of dry wt.)	(lb./cu. ft.)	(ft.-kips/ft.)		
10		15.7	117	7			CL
5		7.2	101	11			SM
5		37.9	85	2			CL
10		40.3	81	1			CL
0		26.8	100	4			ML
15		41.2	80	1			CL
-5		62.9	63	1			MH
20		97.8	56	<1			MH
-10		70.3	58	1			MH
25		18.7	115	17			SP
-15		45.7	78	2			SW MH
30							SW MH
-20							SW MH
35							SW MH
-25							SW MH
40							SW MH

COMPACTED FILL - SILTY CLAY - some Silty Sand, some hydrocarbons, dark brown

Pieces of brick and concrete

COMPACTED FILL - SILTY SAND - fine, light brown

Patches of Clay

WATER LEVEL 4/6/87

SILTY CLAY - traces of organic matter, black

SANDY SILT - grey

Layers of Silty Clay

SILTY CLAY - traces of organic matter, grey

ELASTIC SILT - some organic matter, grey

(LL = 60%; PI = 29%)

SAND - fine to medium, grey

SAND and ELASTIC SILT - interlayered, dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LoROY CRANDALL AND ASSOCIATES

PLATE A-1.18a

JOB 190328 AEO DATE 8/24/90 DR

rum 12~

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-30							
	45		13.8	113	10		SW SM
-35							
	50		24.9	103	5		SW
-40							
	55						
-45							SP
	60		20.1	104	36		

BORING 18 (CONTINUED)

DATE DRILLED: February 16, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SAND - well graded, few Gravel, some fines, dark grey

Some layers of Silty Clay and Sandy Silt (from 48' to 50-1/2')

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, grey

SAND - fine, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 9-1/2' 60 minutes after removal of mud and at 9' on 2/17/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 8-1/2' on 4/6/87. Water level measured at 11-1/2' on 9/19/90.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.18b

JOB L20328AEQ DATE 8/24/90 DR. WILLIAM DE

FORM 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.	
								ELEVATION 9.4
		11.6	105	7			CL	COMPACTED FILL - SILTY CLAY - some Silty Sand, some hydrocarbons, brown
5	5						CL	SILTY CLAY - black
		33.4	89	2				
		54.7	69	1			ML	WATER LEVEL 4/6/87 CLAYEY SILT - dark grey
0	10							
		45.4	76	1			CL	SILTY CLAY - traces of organic matter, grey
-5	15	74.8	57	1				Dark grey
		34.7	83	< 1				Grey
-10	20	32.7	90	1				
		29.2	93	7			SM	SILTY SAND - fine, grey
-15	25						CL	SILTY CLAY - layers of Sand, dark grey
-20	30	7						
-25	35	36.4	87	1				(LL = 38%; PI = 14%)
-30	40	30.9	94	2				

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.19a

JOB L-90328AED DATE 2/24/90 DR. DE

FORM 12.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN-TEST (% of dry wt.)	MOISTURE	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
-35	45	28.4	95	7			ML
-40	50	58					SW
-45	55						SW
-50	60	9.7	134	45			

BORING 19 (CONTINUED)

DATE DRILLED: February 17, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SANDY SILT - dark grey

SAND - well graded, few Gravel, light grey

GRAVELLY SAND - well graded, about 30% Gravel and Cobbles, light grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 8' 30 minutes after removal of mud and at 7' on 2/18/87.

Set 18-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 7-1/2' on 4/6/87. Water level measured at 13-1/2' on 9/19/90.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.19b

BORING 20

DATE DRILLED: February 19 & 20, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
							ELEVATION 13.5
		14.3	100	4			CL SM
10	5	13.7	104	13			SM
5		12.7	105	5			
10		20.8	105	1			CL
0		40.4	82	1			
15							ML
-5							MH
20		107.4	42	< 1			
-10		83.5	51	< 1			
25							
-15							
30		145.4	38	2			
-20							SP SM
35							
-25							MH CH
40		84.4	51	1			

COMPACTED FILL - SILTY CLAY and SILTY SAND - pieces of asphaltic paving, petroleum odor, dark grey
Some hydrocarbons

COMPACTED FILL - SILTY SAND - fine, some Clayey layers, some hydrocarbons, greyish brown

WATER LEVEL 2/20/87

SILTY CLAY - some organic matter, some Sandy layers, dark grey

SANDY SILT - some organic matter, dark grey

ELASTIC SILT - some organic matter, black

Lenses of Peat

(LL = 68%; PI = 32%)

Few Sand layers

SAND - fine to medium, some fines, traces of organic matter, dark grey

ELASTIC SILT and CLAY - interlayered, some Peat, some Sand, dark grey, dark brown, and black

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.20a

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
(ft.)	(ft.)		(% of dry wt.)	(lb./cu. ft.)	(ft.-lbs./ft.)		
-30							SM
	45	13					
-35							SP
	50		25.3	100	23		
-40							GW
	55		13.6	126	30		
-45							
	60		11.2	130	40		

BORING 20 (CONTINUED)

DATE DRILLED: February 19 & 20, 1987.

EQUIPMENT USED: 5'-Diameter Rotary Wash

SILTY SAND - fine, some lenses of Sandy Silt with organic matter, few Gravel, dark grey

SAND - fine, light grey

GRAVELLY SAND - well graded, about 40% Gravel, light grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 11-1/2' 15 minutes' after removal of mud and at 8-1/2' 4-1/2 hours later.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.20b

Form 122
 JOB L-90-328AEO DATE 8/24/90 DE CE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.	
10							CL	COMPACTED FILL - SANDY CLAY - dark grey to black
		17.6	105	6			CL	SILTY CLAY - grey and dark grey
5	5	31.1	90	2				
		30.9	92	2			SM	SILTY SAND - fine, greyish brown
							CH	CLAY - grey
0	10	43.5	77	< 1				WATER LEVEL 4/6/87
		47.2	75	1				Traces of organic matter
-5	15	30.1	93	2			CL	SILTY CLAY - traces of organic matter, dark grey
-10	20	25.2	103	3				
							SP	SAND - fine to medium, some fines, grey
		20.3	109	10			SM	
-15	25							Few Gravel
		32						
-30	30							

BORING 21

DATE DRILLED: February 18, 1987
 EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 10.3

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB 79038 DATE 8/24/90 DE OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
-20							
		12.7	122		8		
-25	35						CL
							ML
		33.0	90		4		
-30	40						SP
							CL
							GP
							GM
		62					
-35	45						
-40	50						
		9.6	136		36		
-55							

BORING 21 (CONTINUED)

DATE DRILLED: February 18, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SILTY CLAY - dark grey

SILT - some organic matter, dark grey

SAND - fine, dark grey

SILTY CLAY - grey

SANDY GRAVEL - fine to coarse, about 40% Sand, some fines, grey

Some Cobbles

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 9-1/2' 30 minutes after removal of mud and at 8-1/2' on 2/23/87.

Set 18-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 8-1/2' on 4/6/87.

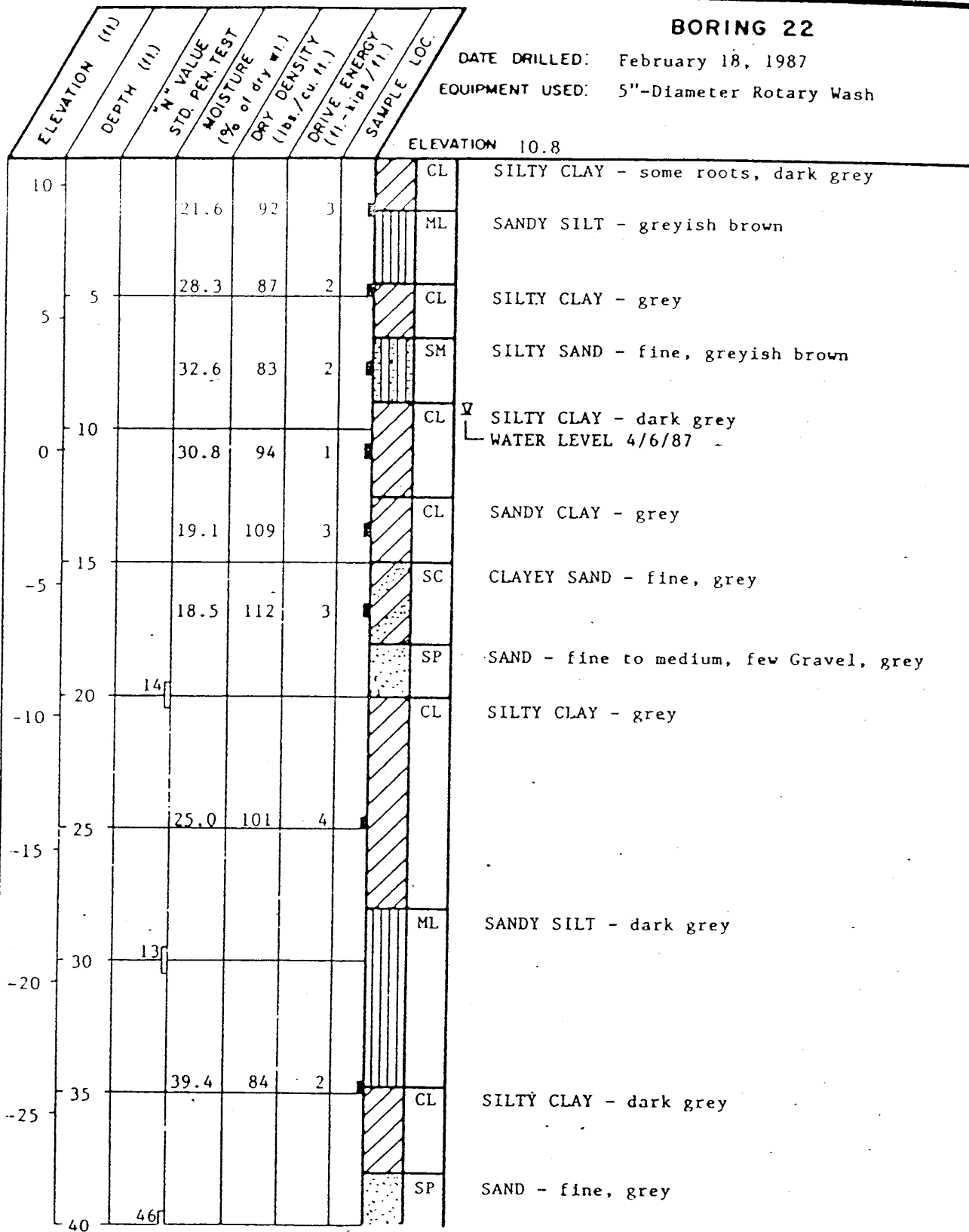
LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PI ATE A-1.21b

BORING 22
 DATE DRILLED: February 18, 1987
 EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB LOG SHEET DATE 8/24/90 DR...

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREIN APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30							
	45		19.4	116	18		
-35							SW
	50		8.2	130	36		
-40							
55							

BORING 22 (CONTINUED)

DATE DRILLED: February 18, 1987
EQUIPMENT USED: 5"-Diameter Rotary Wash

Fine to medium Sand, few Gravel

GRAVELLY SAND - well graded, about 30% Gravel and Cobbles, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 9-1/2' 30 minutes after removal of mud and at 9-1/2' on 2/20/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 9-1/2' on 4/6/87. Water level measured at 10-1/2' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

BORING 23

DATE DRILLED: February 18, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
				(% of dry wt.)	(lb./cu. ft.)	(ft.-lbs./ft.)	
10		19.9	84	2			CL
							ML
5		34.0	83	1			CL
5		33.7	85	< 1			
10		18.4	112	4			CL
0		17.0	115	5			SC
15		25.6	99	2			CL
-5		27.2	98	2			SM
20		29.8	93	2			CL
-10		22.5	103	5			ML
25		26.9	96	5			SM
-15		4.2	123	11			SW SM
30							
-20							
35							
-25							
40							

SILTY CLAY - dark brown

SANDY SILT - light brown

SILTY CLAY - dark grey

SANDY CLAY - greyish brown

WATER LEVEL 4/6/87

CLAYEY SAND - fine to medium, grey

SILTY CLAY - grey

SILTY SAND - fine, grey

SILTY CLAY - layers of Silt and Silty Sand, dark grey

SANDY SILT - dark grey

Layers of Clay

SILTY SAND - fine, traces of organic matter, dark grey
Some Gravel

SAND - well graded, few Gravel, some fines, dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.23a

JOB L2032BAEO DATE 8/24/90 DR OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-30						CL
	45					SW
-35						
	50					
-40		11.3	132	36		
	55					

BORING 23 (CONTINUED)

DATE DRILLED: February 18, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SILTY CLAY - dark grey

GRAVELLY SAND - well graded, about 30%
Gravel and Cobbles, some fines, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 11-1/2' on 2/20/87.

Set 19-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 11-1/2' on 4/6/87.

LOG OF BORING

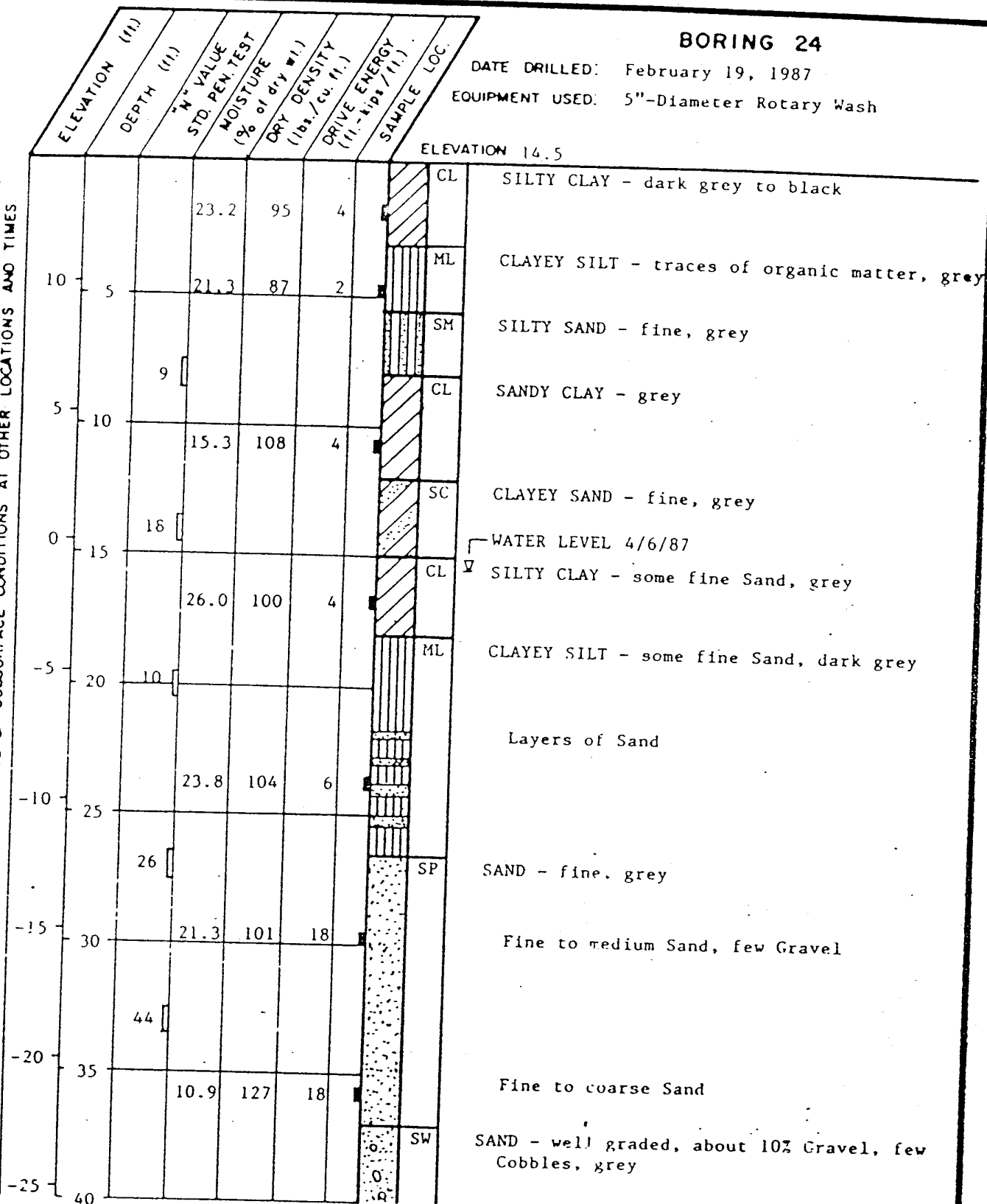
LORoy CRANDALL AND ASSOCIATES

PLATE A-1.231

WPS 190328AEQ DATE 8/24/90 DR

Form 1

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.24a

NOB 220200 AEA DATE 2/24/87 DR 06

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lb./ft.)	SAMPLE LOC.
	40						
-30	45		11.4	125	36		SW
-35	50						SP
-40	55		21.7	107	36		

BORING 24 (CONTINUED)

DATE DRILLED: February 19, 1987
EQUIPMENT USED: 5"-Diameter Rotary Wash

Few layers of fine Sand

GRAVELLY SAND - well graded, about 30% Gravel and Cobbles, grey

SAND - fine, few Gravel, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 21' 15 minutes after removal of mud and at 13-1/2' on 2/20/87.

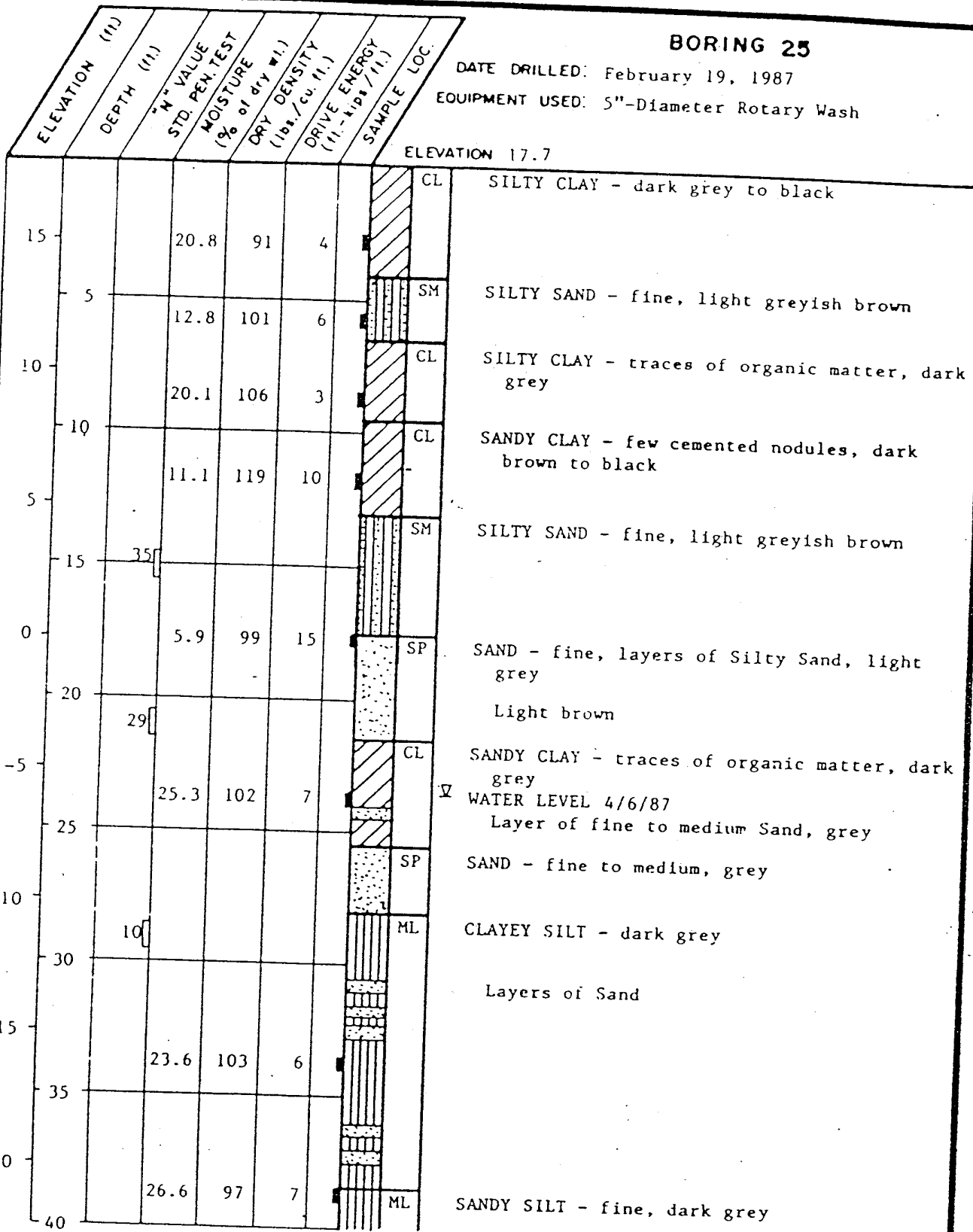
Set 15-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 15-1/2' on 4/6/87.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123, JOB 49032B AEO DATE 5/24/90 DR JUNIN O.E. 3 W.P. 13 CHKD L10

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.25a

WIS 490305AEU DATE 01/29/90 DR DE

124

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-25							SP
	45	61					SW
-30							
	50						
-35			9.3	132	36		
-55							

BORING 25 (CONTINUED)

DATE DRILLED: February 19, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

SAND - fine, grey

GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, some fines, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 30'. Water level measured at 24-1/2' 30 minutes after removal of mud and at 23' on 2/20/87.

Set 25' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water level measured at 23-1/2' on 4/6/87. Water level measured at 24' on 9/19/90.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

BORING 26						
DATE DRILLED: February 20, 1987						
EQUIPMENT USED: 5"-Diameter Rotary Wash						
ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)
SAMPLE LOC.						
ELEVATION 24.3						
		4.5	110	7		
20	5	13.4	99	2		
		7.8	115	7		
15	10					
		15				
10	15	15.6	116	4		
		18				
5	20	8.5	112	18		
0	25	16				
		8.4	102	30		
-5	30					
		11				
-10	35					
		16.6	110	24		
-15	40					

SM	1" Asphaltic Paving FILL - SILTY SAND - fine, brown
ML	SANDY SILT - dark brown
SM	SILTY SAND - fine, greyish brown
ML	SANDY SILT - dark greyish brown
SM	SILTY SAND - fine to medium, greyish brown
	Layer of Sandy Silt Fine Sand
	Fine to medium Sand, some Gravel, light grey
SP	SAND - fine to medium, grey
SW	GRAVELLY SAND - well graded, about 40% Gravel and Cobbles, grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB L90328AEQ DATE 2/24/87 DR OE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES

ELEVATION (ft.)	DEPTH (ft.)	N-VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-lbs./ft.)	SAMPLE LOC.
-20	45						
-25	50		24.1	92	36		

BORING 26 (CONTINUED)

DATE DRILLED: February 20, 1987

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: Drilling mud used in drilling process. Mud removed to a depth of about 25'. Water level measured at 15' 15 minutes after removal of mud. Water not encountered on 2/23/87; mud at 29', bottom of boring at 35'.

Set 35-1/2' of 2"-diameter PVC pipe for water level determination. Backfilled annular space with pea gravel. Water not encountered in 34' depth measured on 4/6/87.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-1.26b

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	 GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			 GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amt. of fines)	 GM	Silty gravels, gravel-sand-silt mixtures.
			 GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 sieve size)	CLEAN SANDS (Little or no fines)	 SW	Well graded sands, gravelly sands, little or no fines.
			 SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amt. of fines)	 SM	Silty sands, sand-silt mixtures.
			 SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (More than 50% of material is SMALLER than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit LESS than 50)		 ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			 CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			 OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (Liquid limit GREATER than 50)		 MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			 CH	Inorganic clays of high plasticity, fat clays.
			 OH	Organic clays of medium to high plasticity, organic silts.
		HIGHLY ORGANIC SOILS		 Pt

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

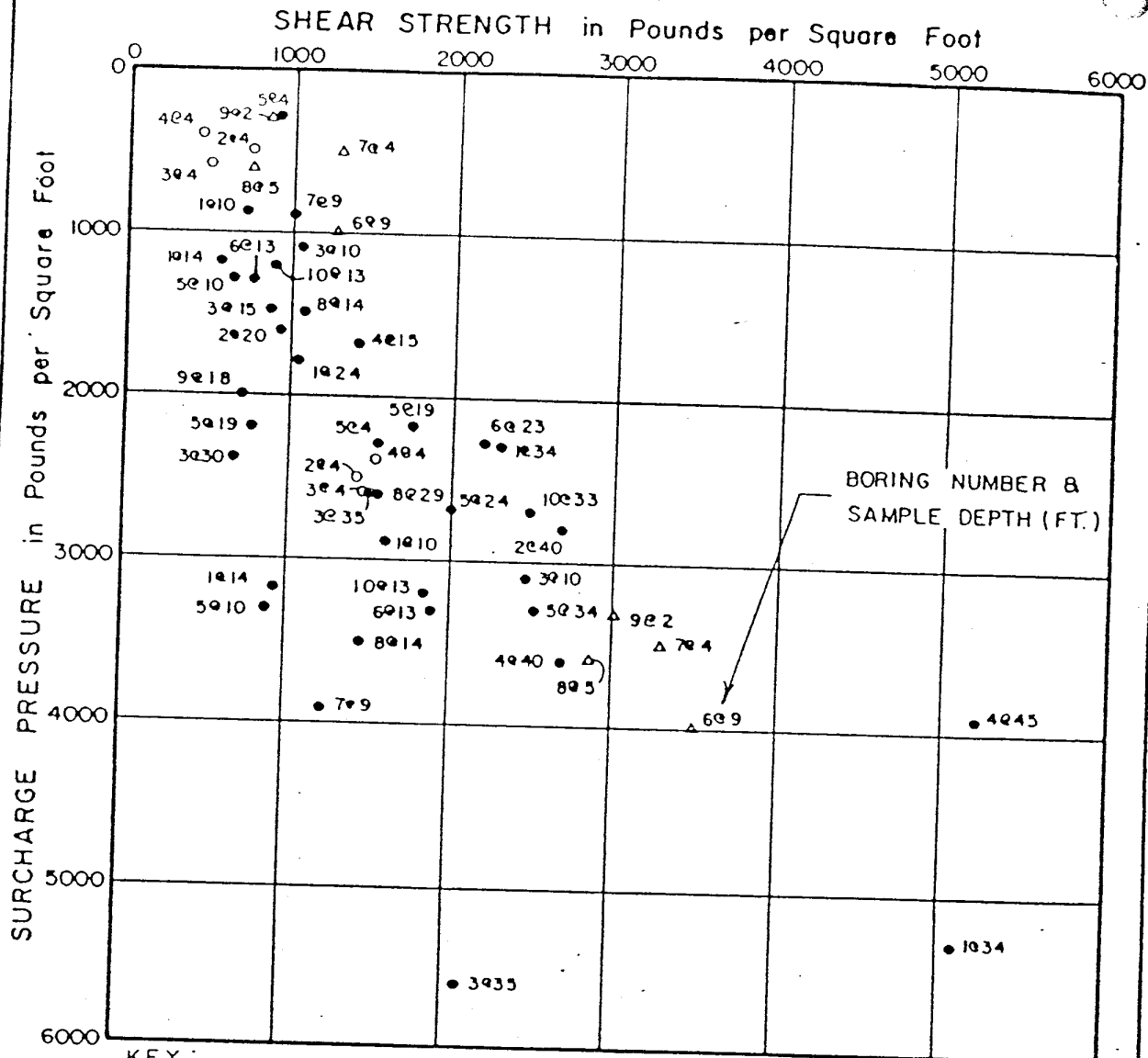
P A R T I C L E S I Z E L I M I T S						
SILT OR CLAY	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	
	NO. 200	NO. 40	NO. 10	NO. 4	3 in.	12 in.
	U. S. STANDARD SIEVE SIZE					

UNIFIED SOIL CLASSIFICATION SYSTEM

Reference:
The Unified Soil Classification System, Corps of Engineers, U. S. Army Technical Memorandum No 3-357, Vol. I, March, 1953. (Revised April, 1960)

LEROY CRANDALL & ASSOCIATES

JOB 690328AED DATE 8/24/90 DR G.E.



KEY:

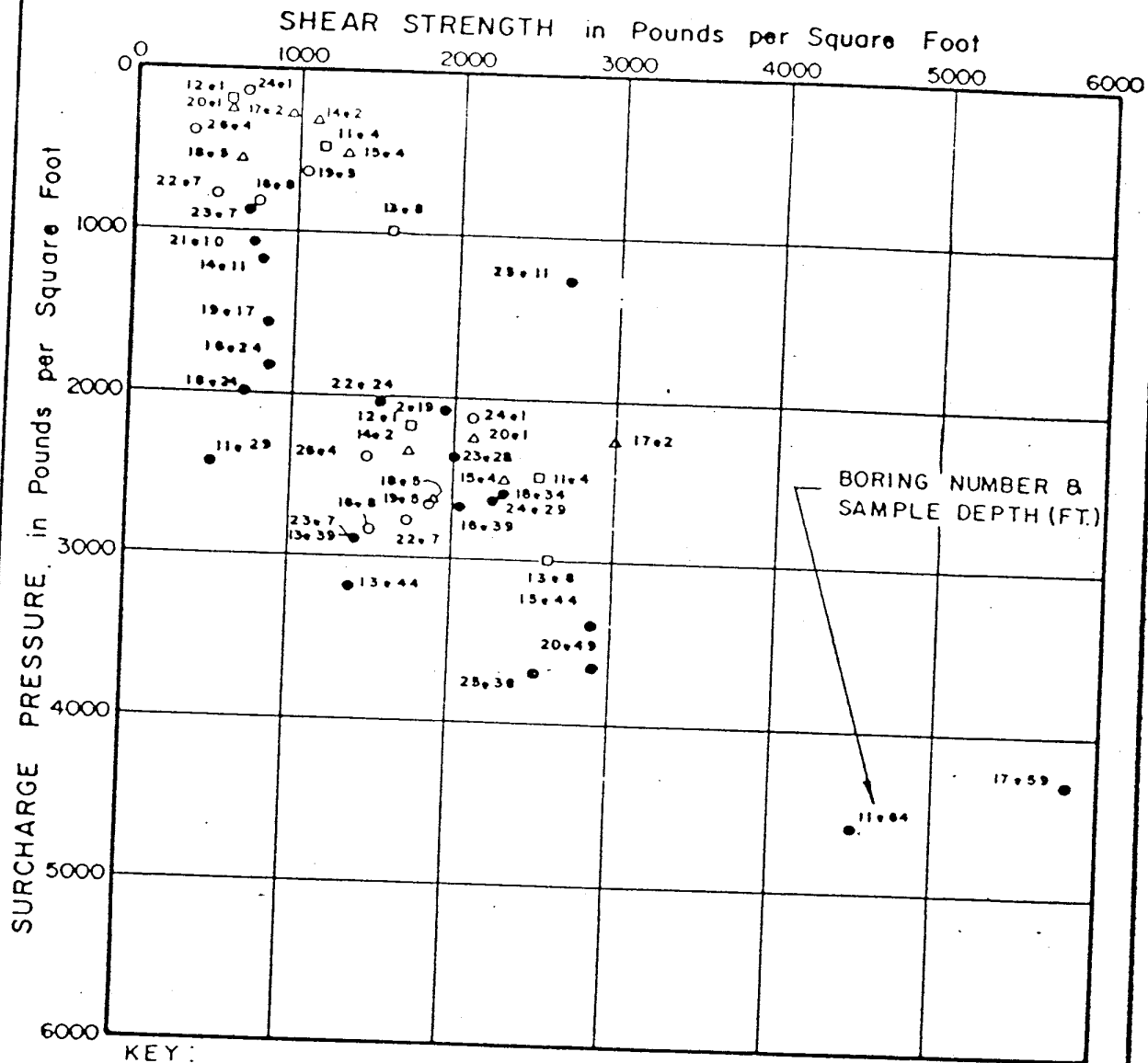
- Tests at field moisture content
- Tests at increased moisture content
- └ Compacted fill
- └ Natural soils

DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES

PLATE A 21

JOB L20328AE DATE 8/24/90 PR. 05



KEY:

- Tests at field moisture content
- □ △ Tests at increased moisture content
- └─┐ Compacted fill
- └─┐ Uncultivated fill
- └─┐ Natural soils

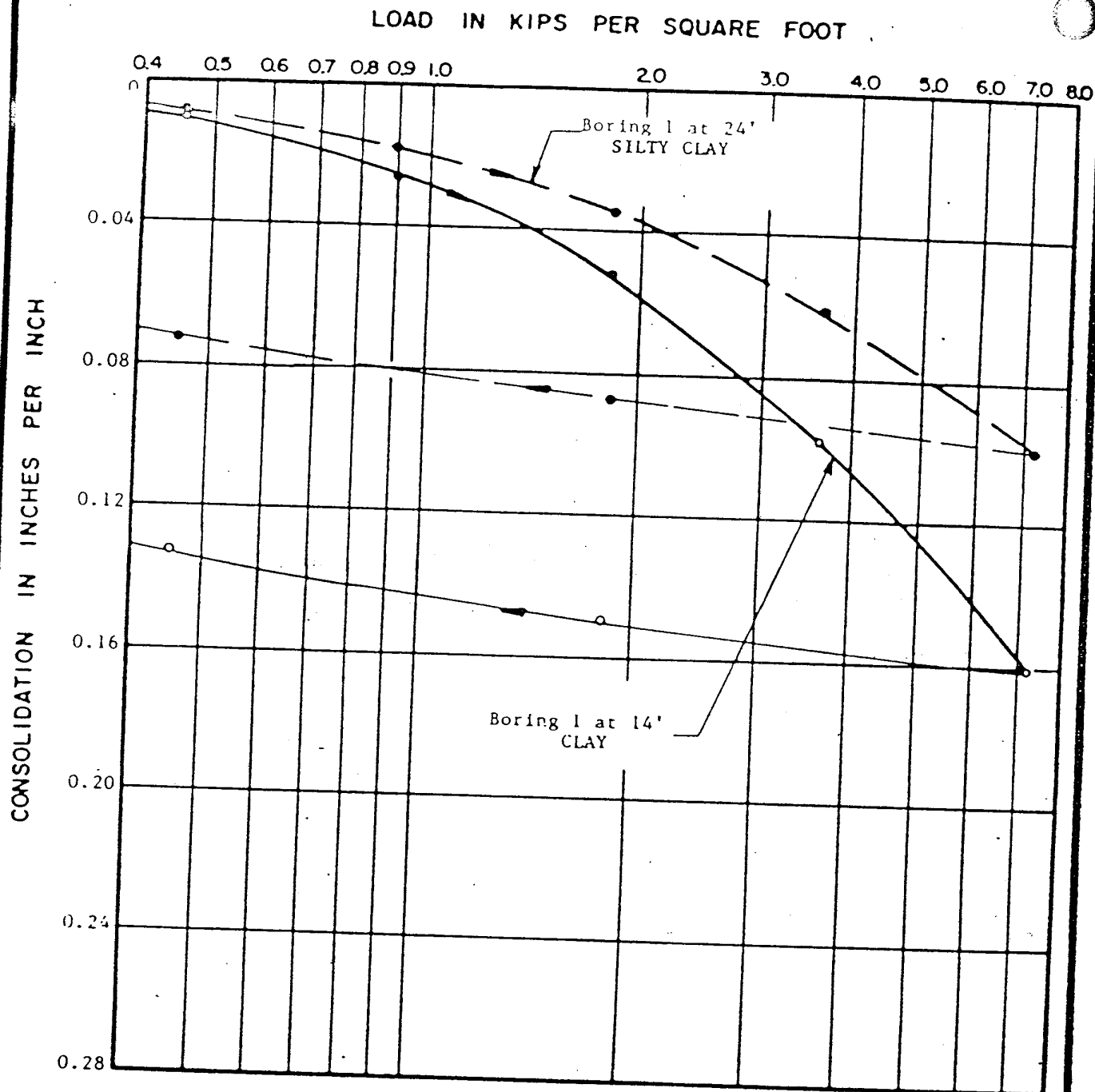
DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES

PLATE A-3.2

JOB L 20328AE0 DATE 2/24/90 BY CE

FORM 116

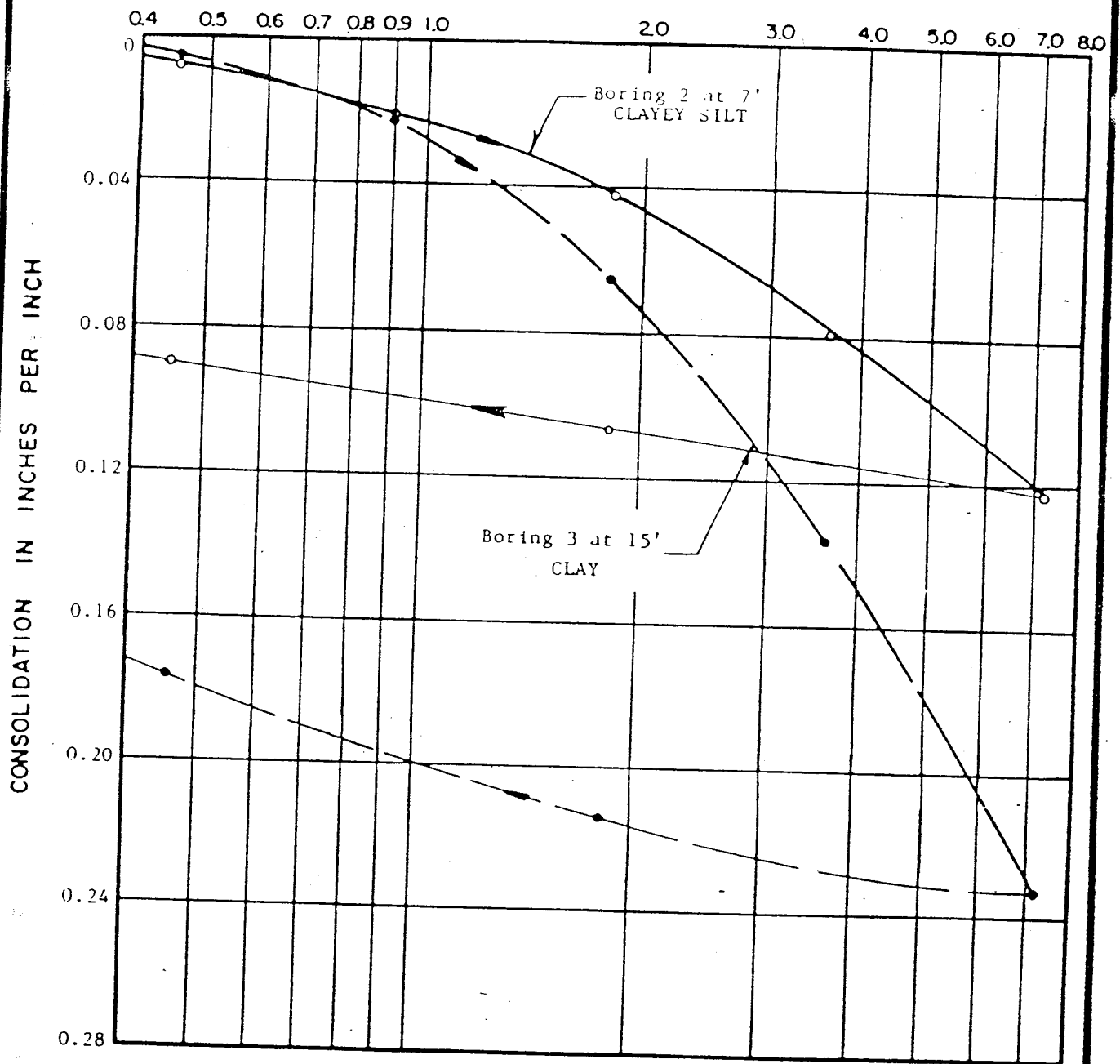


NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

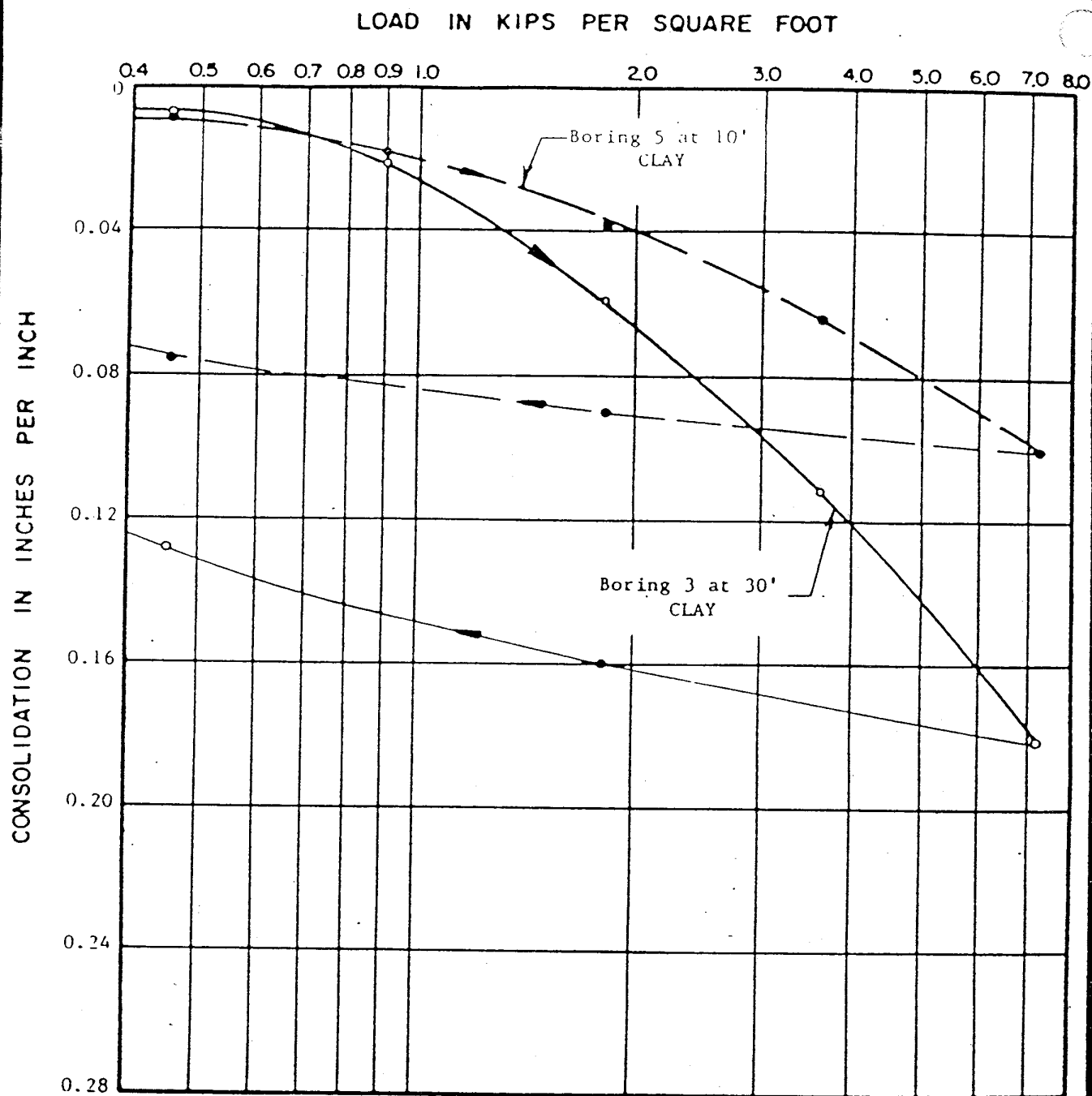
LEROY CRANDALL AND ASSOCIATES

PLATE A-4.2

DB L90328AE0 DATE 8/24/90 PR 05

FORM 116

JOB L90328 AED DATE 8/24/90 DR



NOTE: Samples tested at field moisture content.

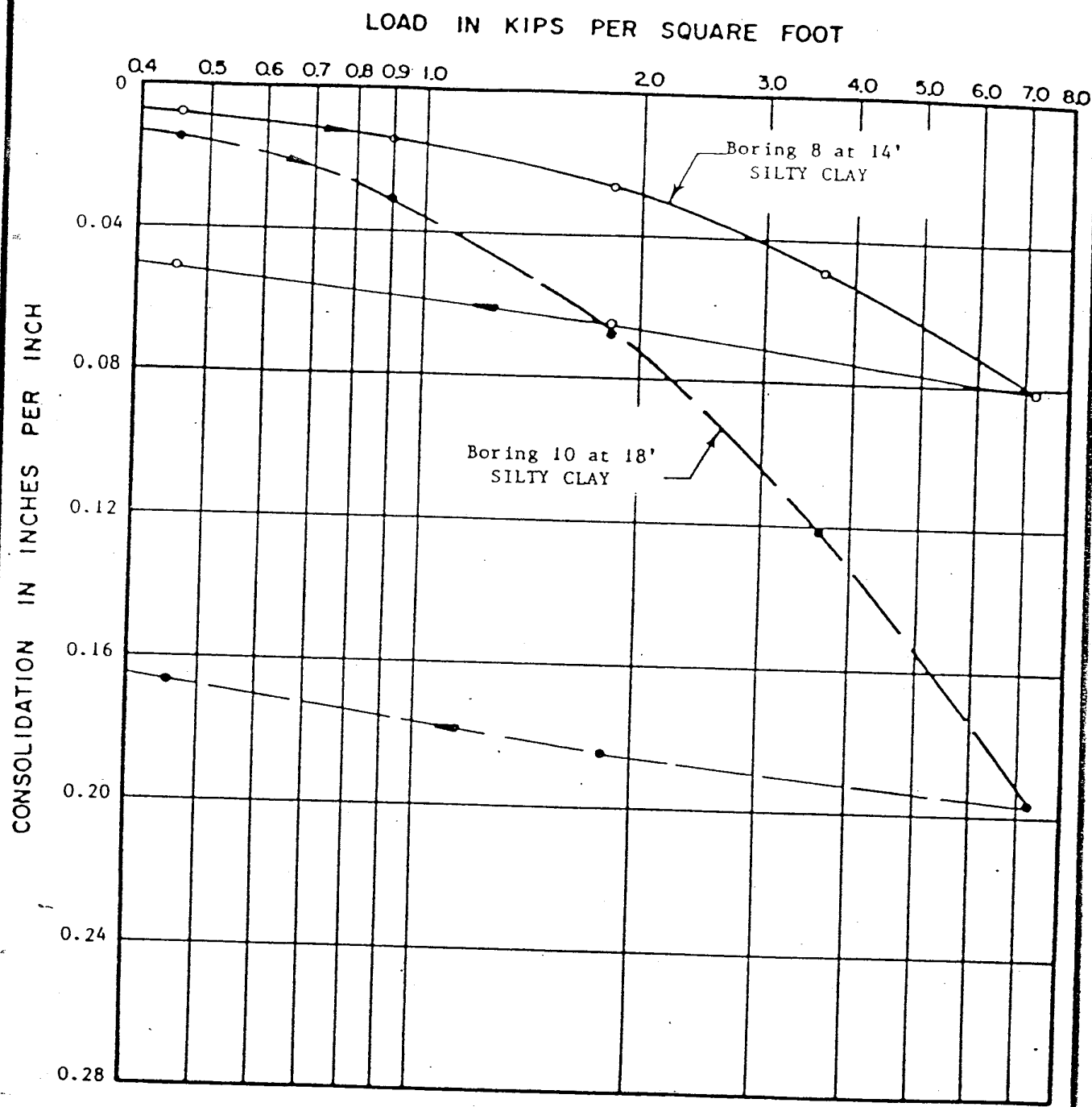
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.3

JOB 620328AED DATE 8/24/90 DR. DE

FORM III

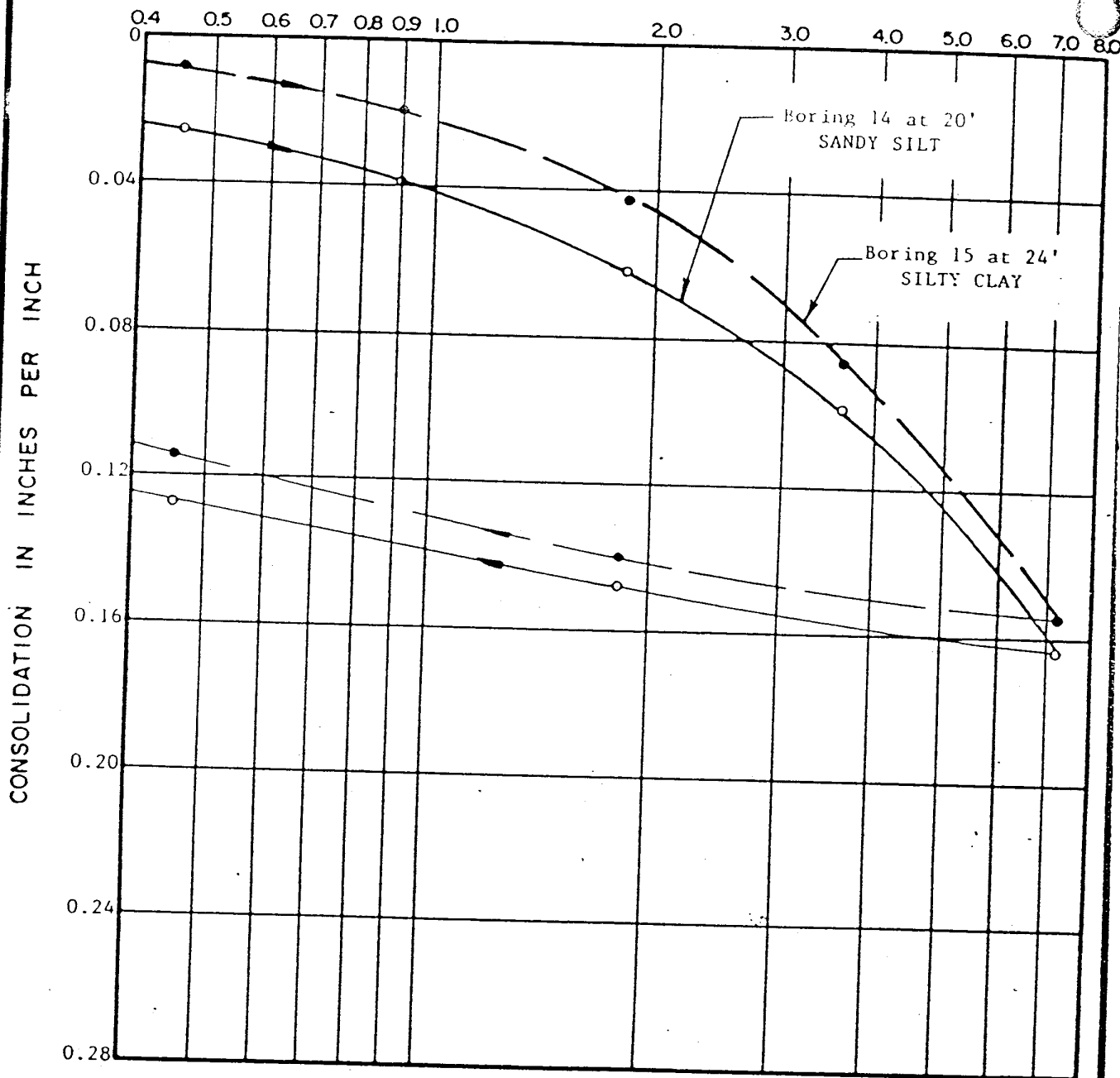


NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

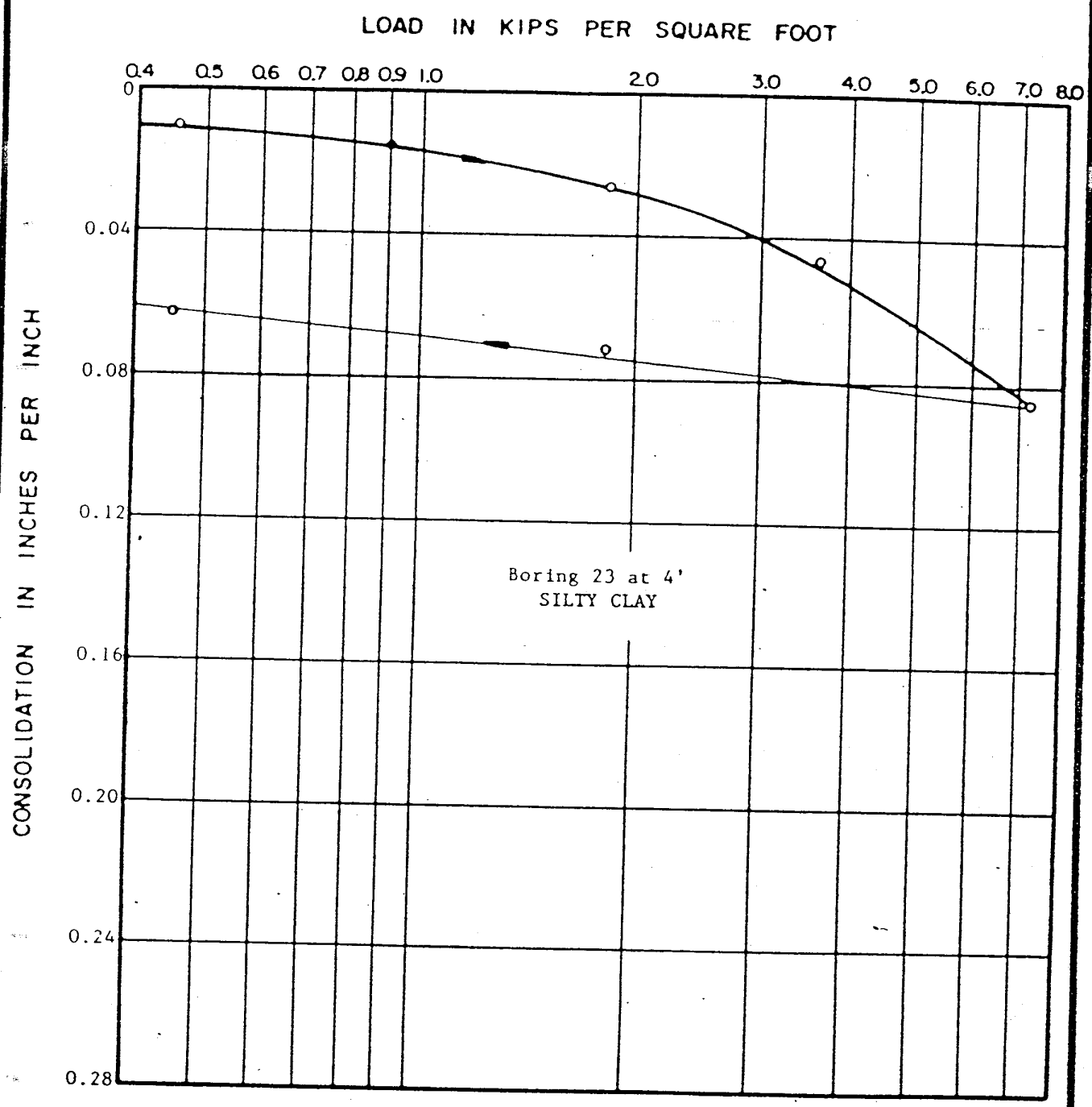
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.5

JOB 190320AEO DATE 8/24/90 DR *MS*

FORM 117

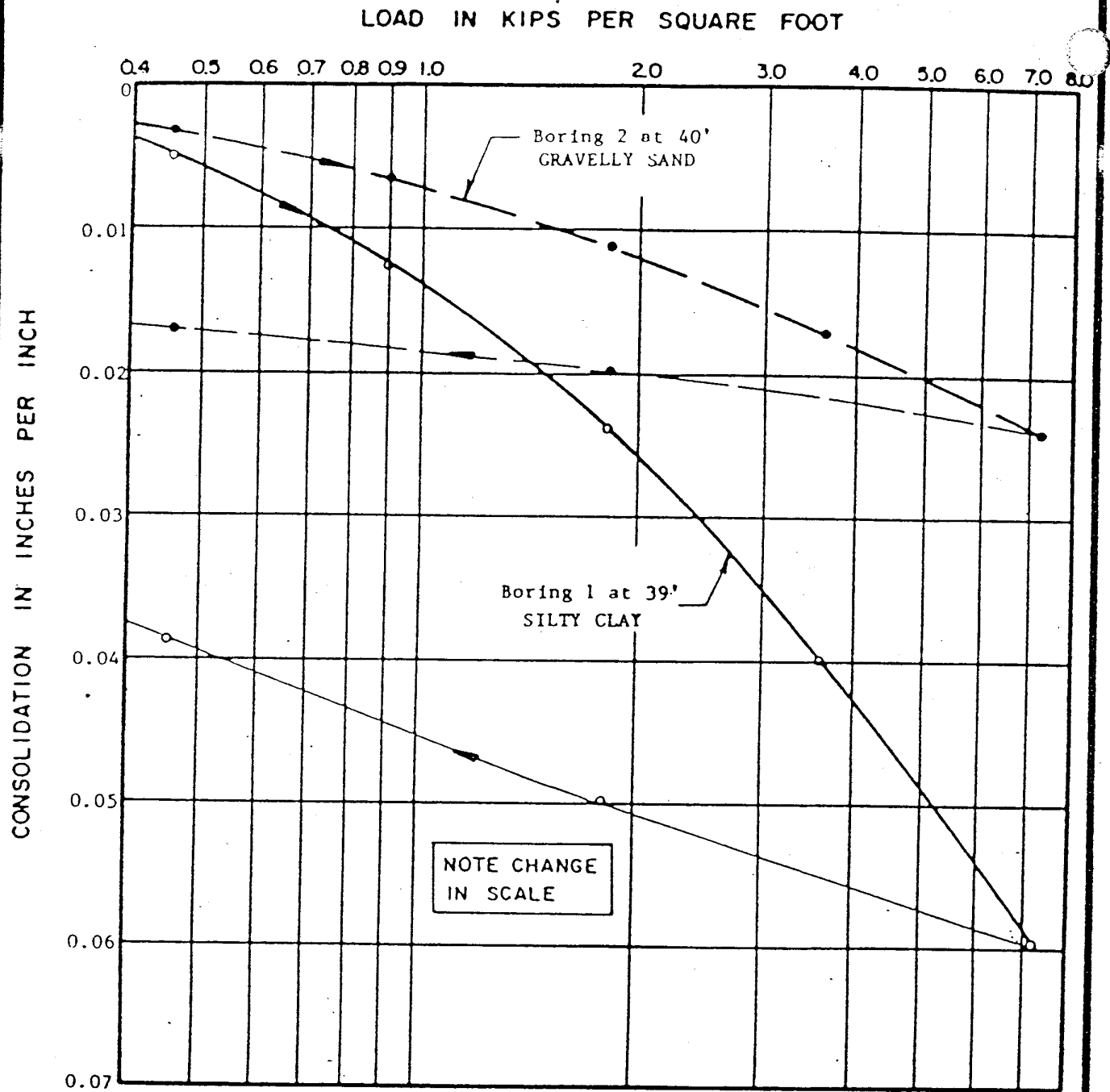


NOTE: Sample tested at field moisture content.

CONSOLIDATION TEST DATA

L. ROY CRANDALL AND ASSOCIATES

JOB L90328AEQ DATE 8/24/90 PM 06



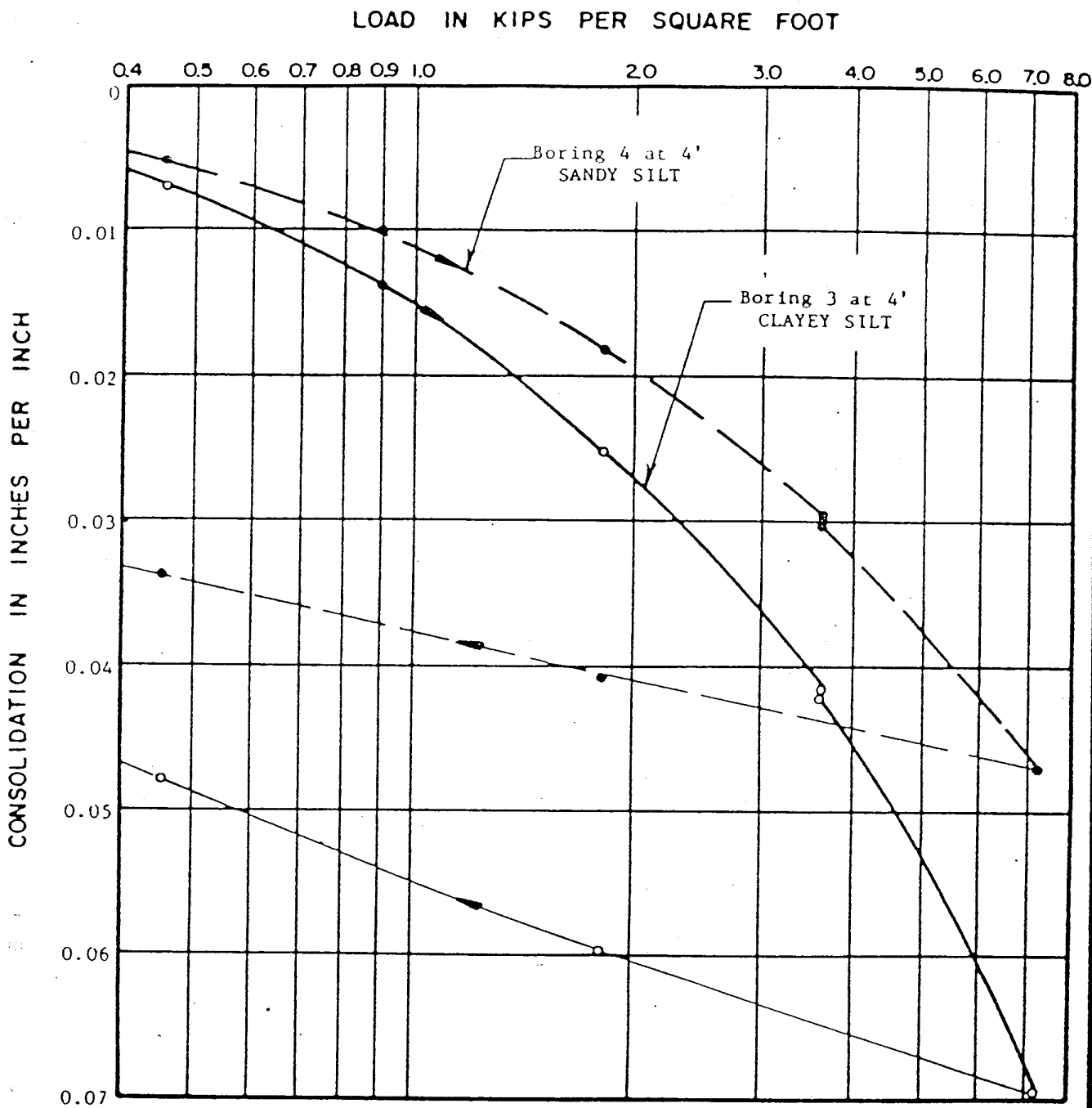
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.7

JOB L9032BAEQ DATE 8/24/2005 DR



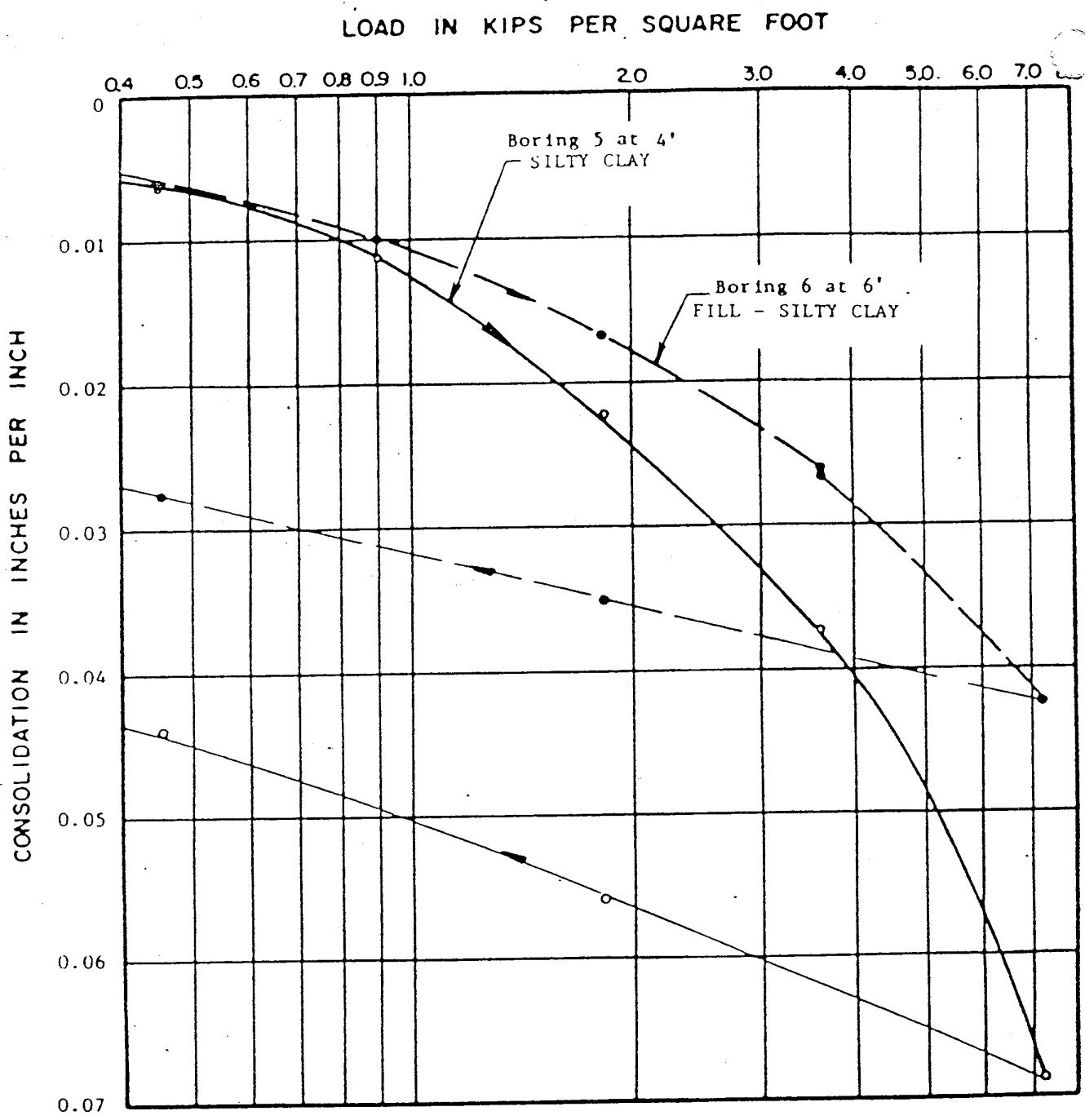
NOTE: Water added to samples after consolidation under a load of 3.6 kips per square foot.

CONSOLIDATION TEST DATA

LORRY CRANDALL AND ASSOCIATES

PLATE A-4.8

FORM 116 JOB L 90328 DATE 8/24/90 DR OE



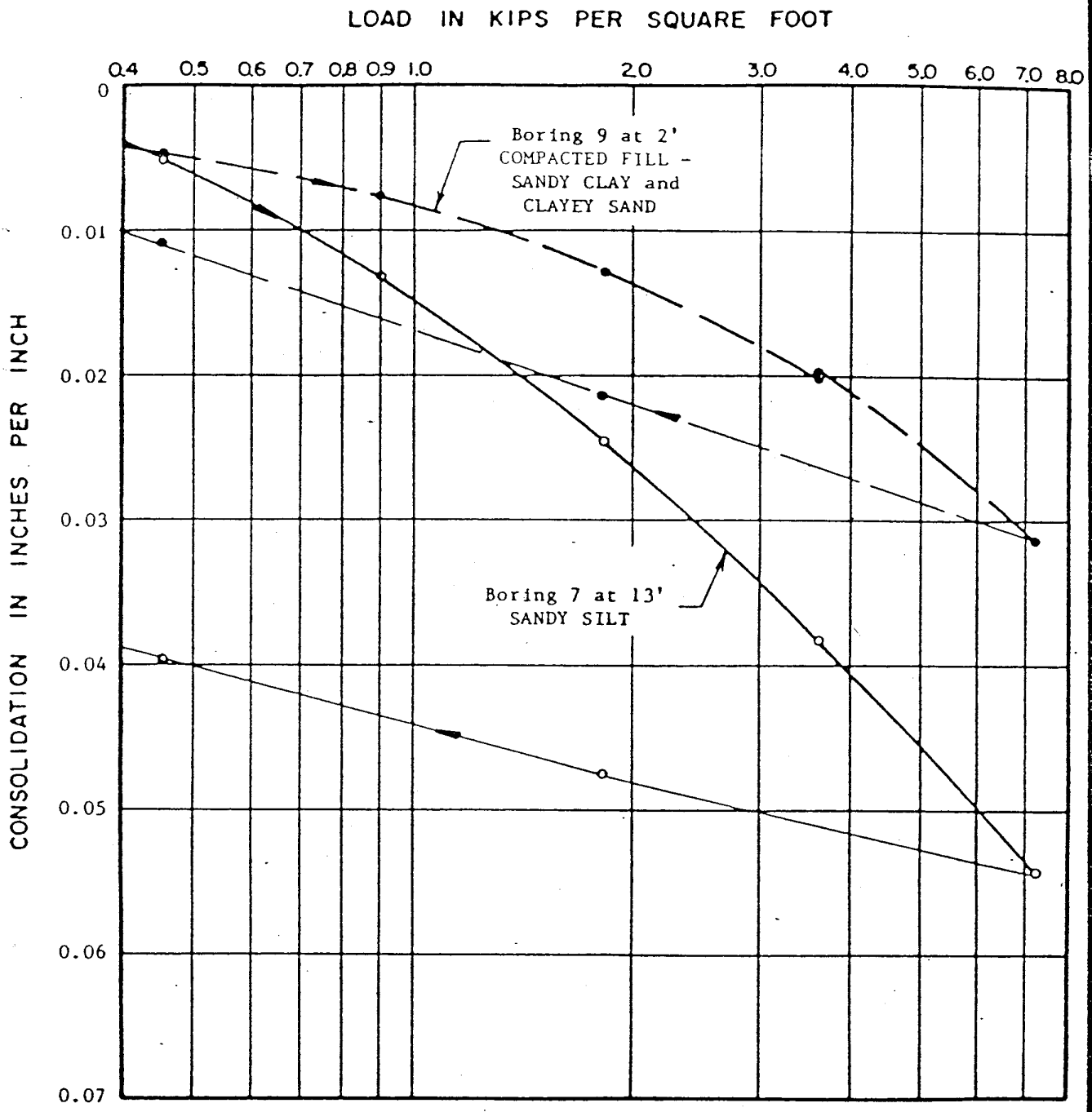
NOTE: Water added to sample from Boring 6 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB 29032BAEO DATE 8/24/90 DR OE

FORM II



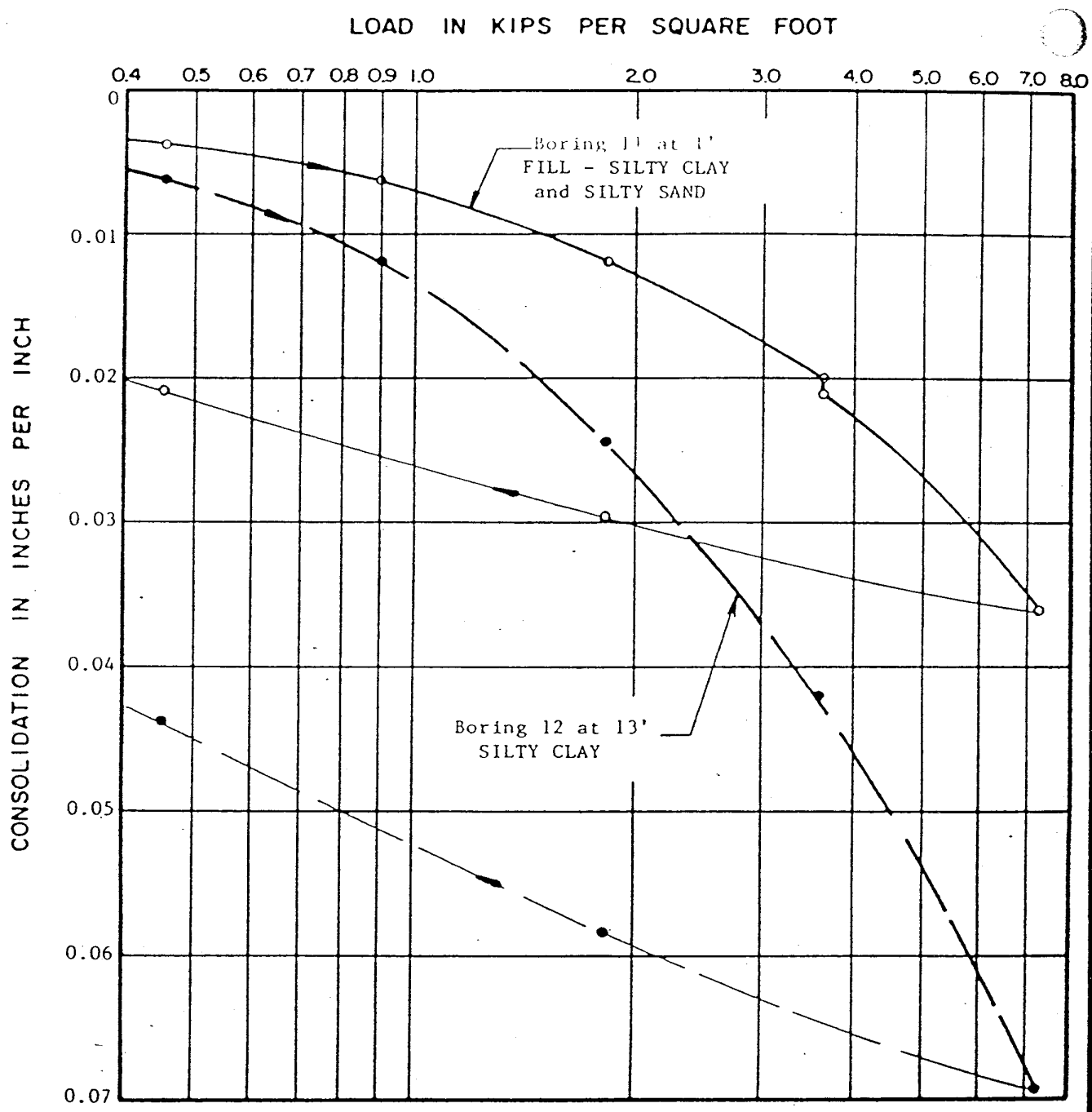
NOTE: Water added to sample from Boring 9 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

NOB L90328AED DATE 8/24/90 DR CE 110

FORM 116



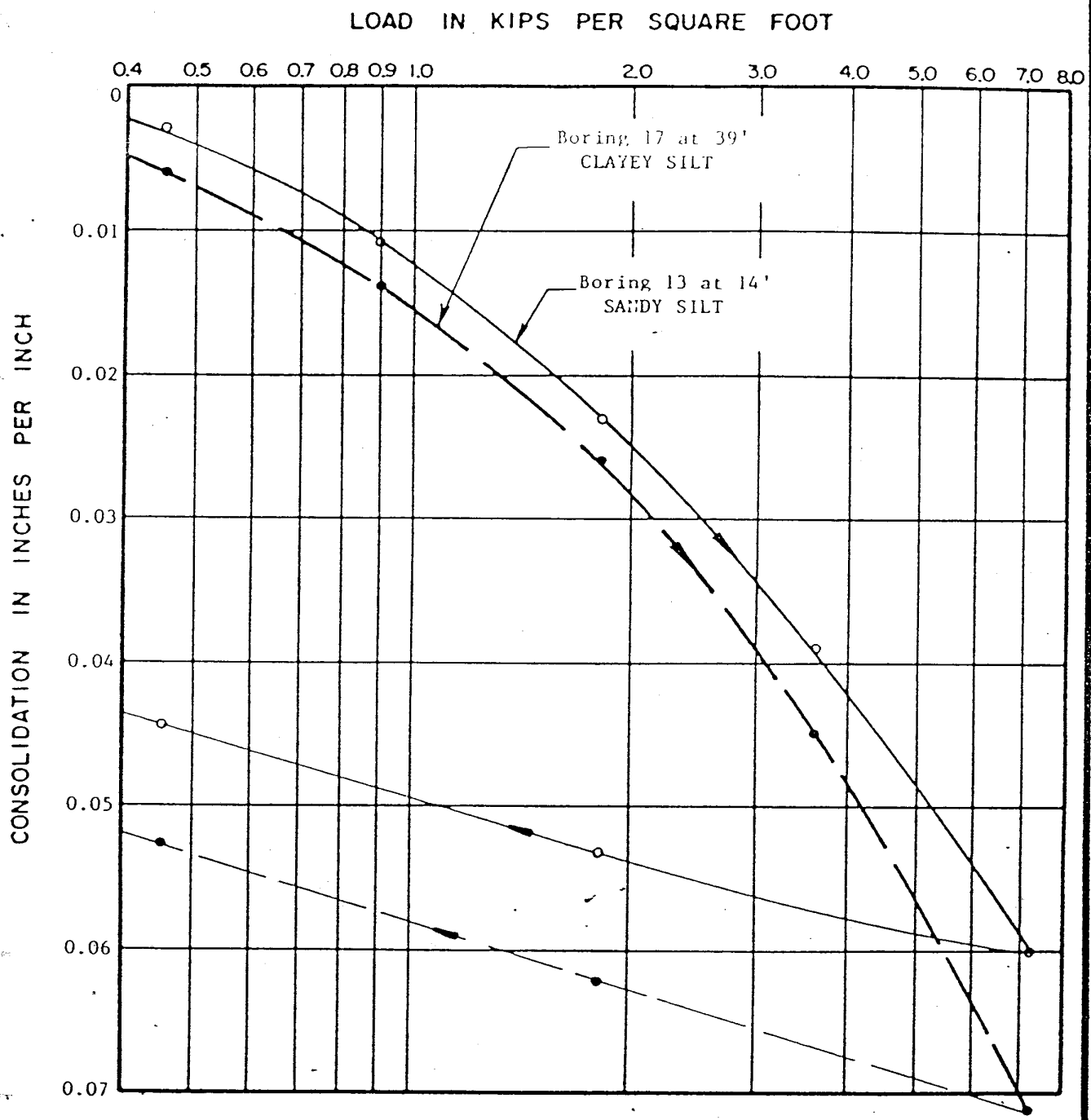
NOTE: Water added to sample from Boring 11 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB L90328 AEO DATE 4/24/90 PR 05
110

FORM 116



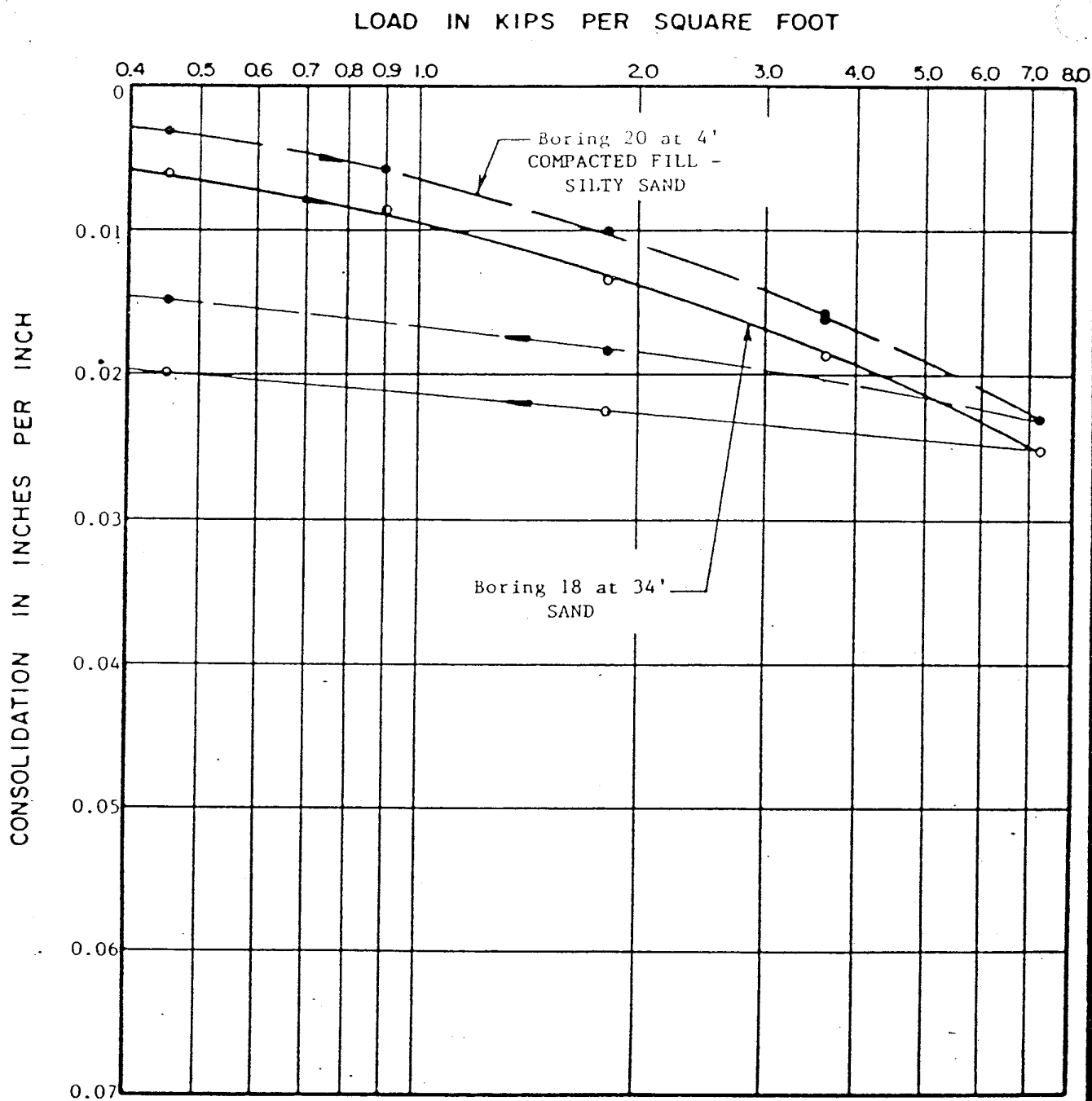
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB L90328AED DATE 8/24/90 DR. CE MB

FORM 116



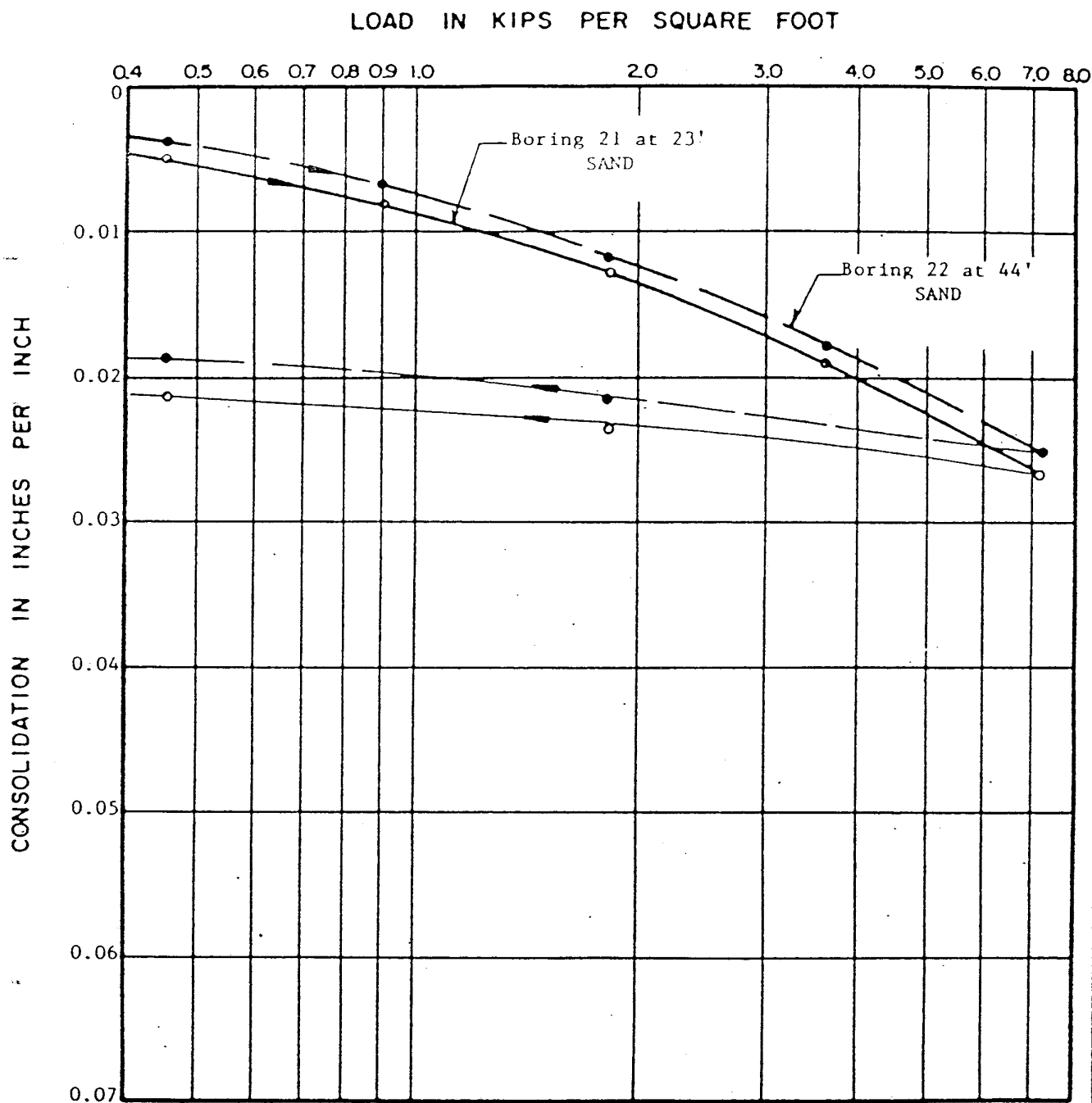
NOTE: Water added to sample from Boring 20 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.13

FORM IV
JOB: L90328 AED DATE 8/24/90 PR OE
AD



NOTE: Samples tested at field moisture content.

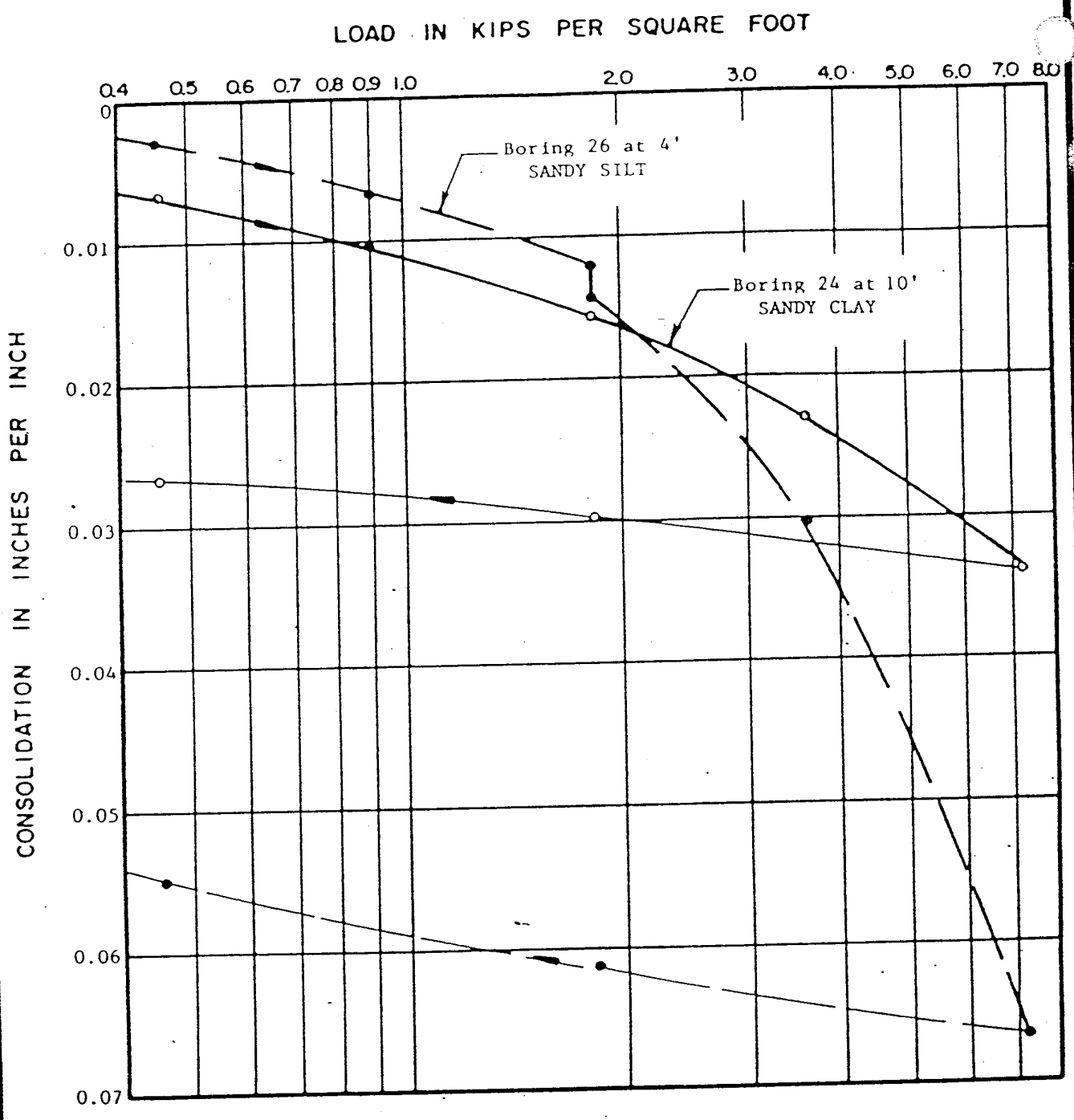
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

PLATE A-4.14

JOB L90328 AEO DATE 8/24/90 DR OE MD

FORM 116



NOTE: Water added to sample from Boring 26 after consolidation under a load of 1.8 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB L90328.AEO DATE 8/24/90 W.P. dmh O.E. BK CHKD

BORING NUMBER AND SAMPLE DEPTH:	2 at 4'	4 at 1'	5 at 4'
SOIL TYPE:	CLAYEY SILT	SILTY CLAY	SILTY CLAY
CONFINING PRESSURE: (lbs./sq. ft.)	200	200	200
FIELD MOISTURE CONTENT: (% of dry wt.)	36.9	24.4	29.3
EXPANSION FROM FIELD TO SOAKED MOISTURE CONTENT: (%)	1.5	2.4	0.9
SOAKED MOISTURE CONTENT: (% of dry wt.)	39.1	28.0	31.1
SHRINKAGE FROM FIELD TO AIR-DRIED MOISTURE CONTENT: (%)	22.7	17.8	12.9
AIR-DRIED MOISTURE CONTENT: (% of dry wt.)	10.1	7.5	5.9
TOTAL VOLUME CHANGE: (%)	24.2	20.2	13.8

EXPANSION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE A - 5.1

JOB L90328.AEO DATE 8/24/90 W.P. BK O.E. dmh CHKD

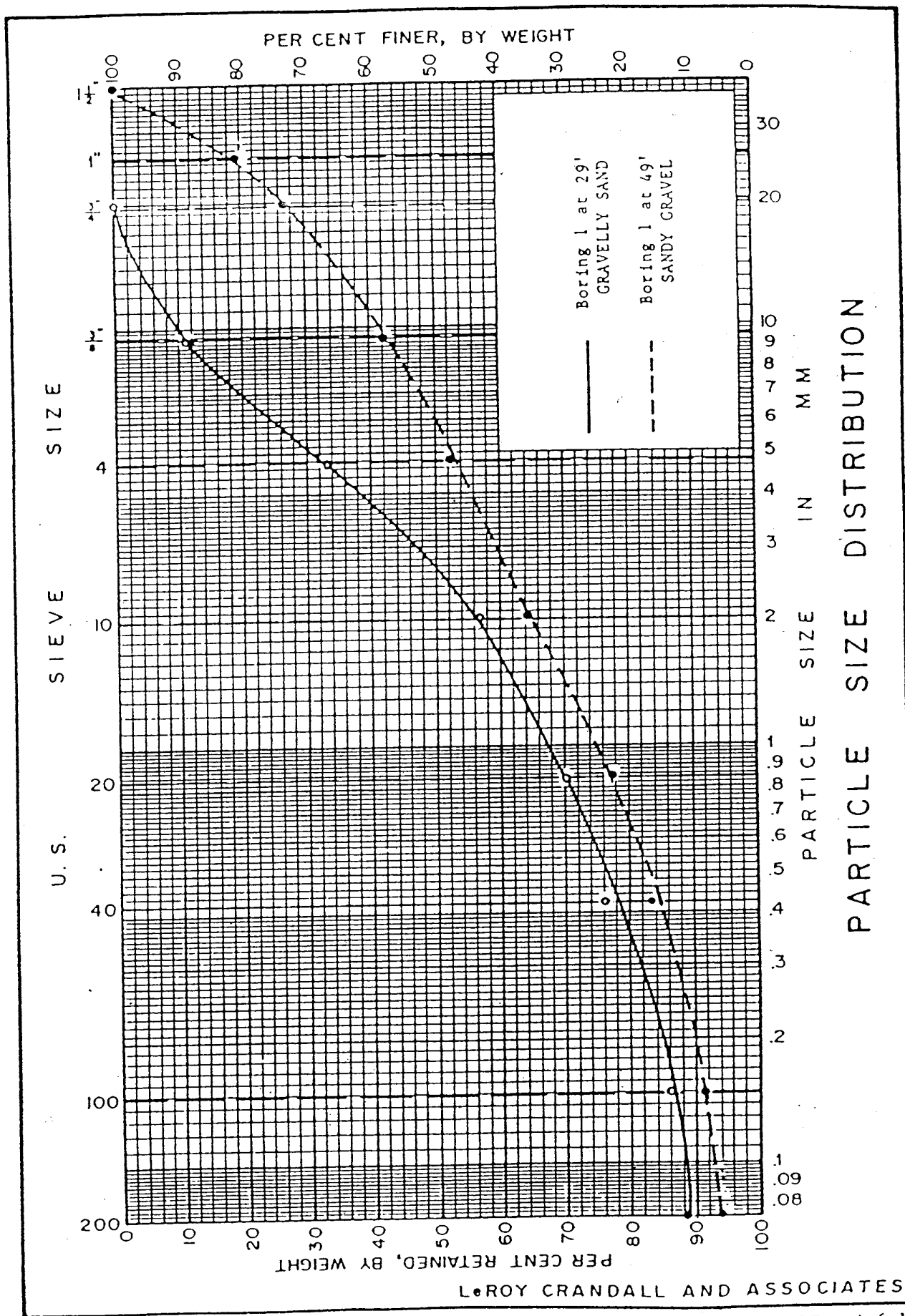
BORING NUMBER AND SAMPLE DEPTH :	12 at 1'	19 at 5'	24 at 1'
SOIL TYPE :	COMPACTED FILL -		
CONFINING PRESSURE : (lbs./sq. ft.)	200	200	200
FIELD MOISTURE CONTENT : (% of dry wt.)	20.6	33.4	23.2
EXPANSION FROM FIELD TO SOAKED MOISTURE CONTENT : (%)	0.2	3.5	5.1
SOAKED MOISTURE CONTENT : (% of dry wt.)	23.1	37.3	31.5
SHRINKAGE FROM FIELD TO AIR - DRIED MOISTURE CONTENT : (%)	7.7	12.9	9.7
AIR - DRIED MOISTURE CONTENT : (% of dry wt.)	4.4	9.0	9.5
TOTAL VOLUME CHANGE : (%)	7.9	16.4	14.8

EXPANSION TEST DATA

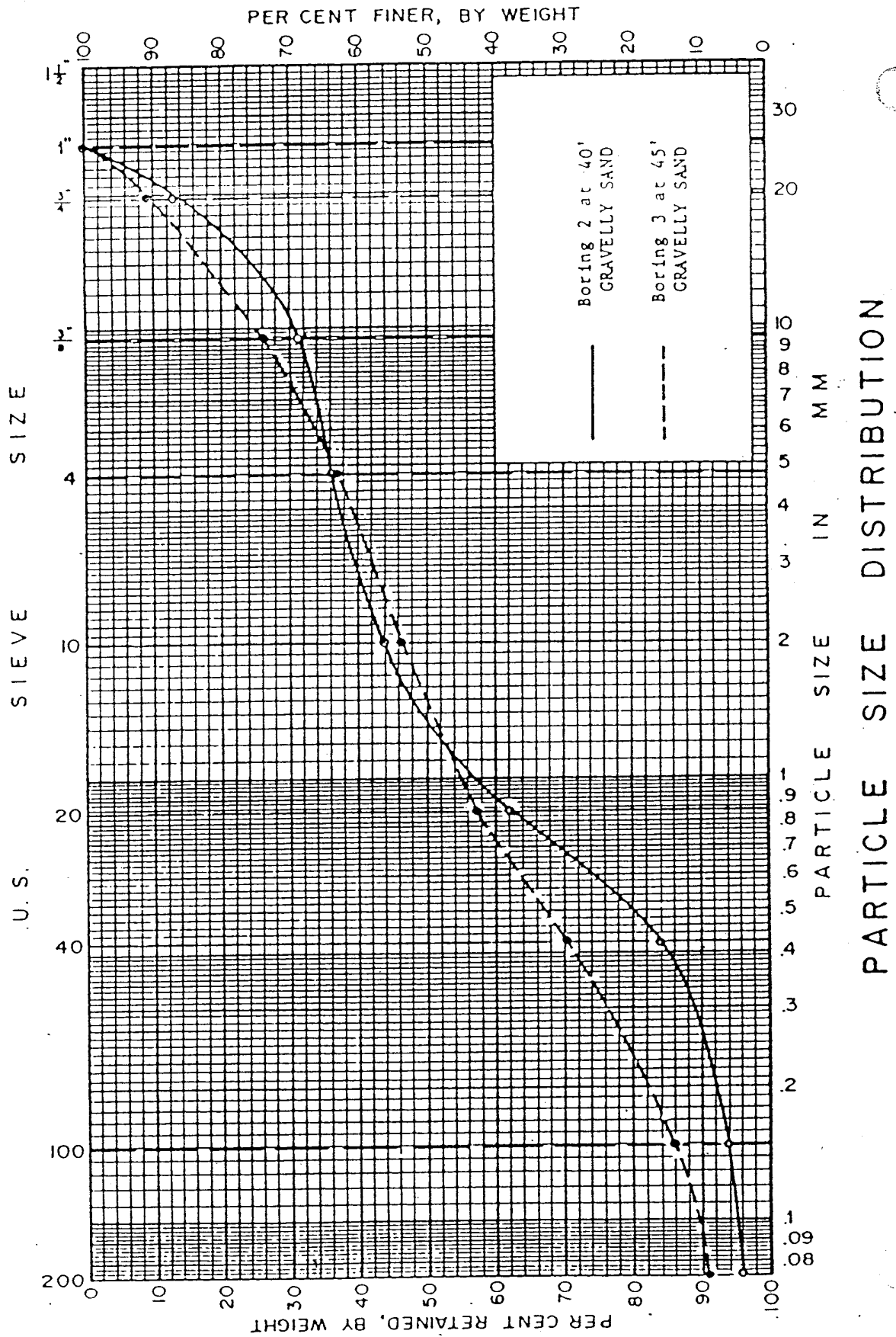
LeROY CRANDALL AND ASSOCIATES

PLATE A - 5.2

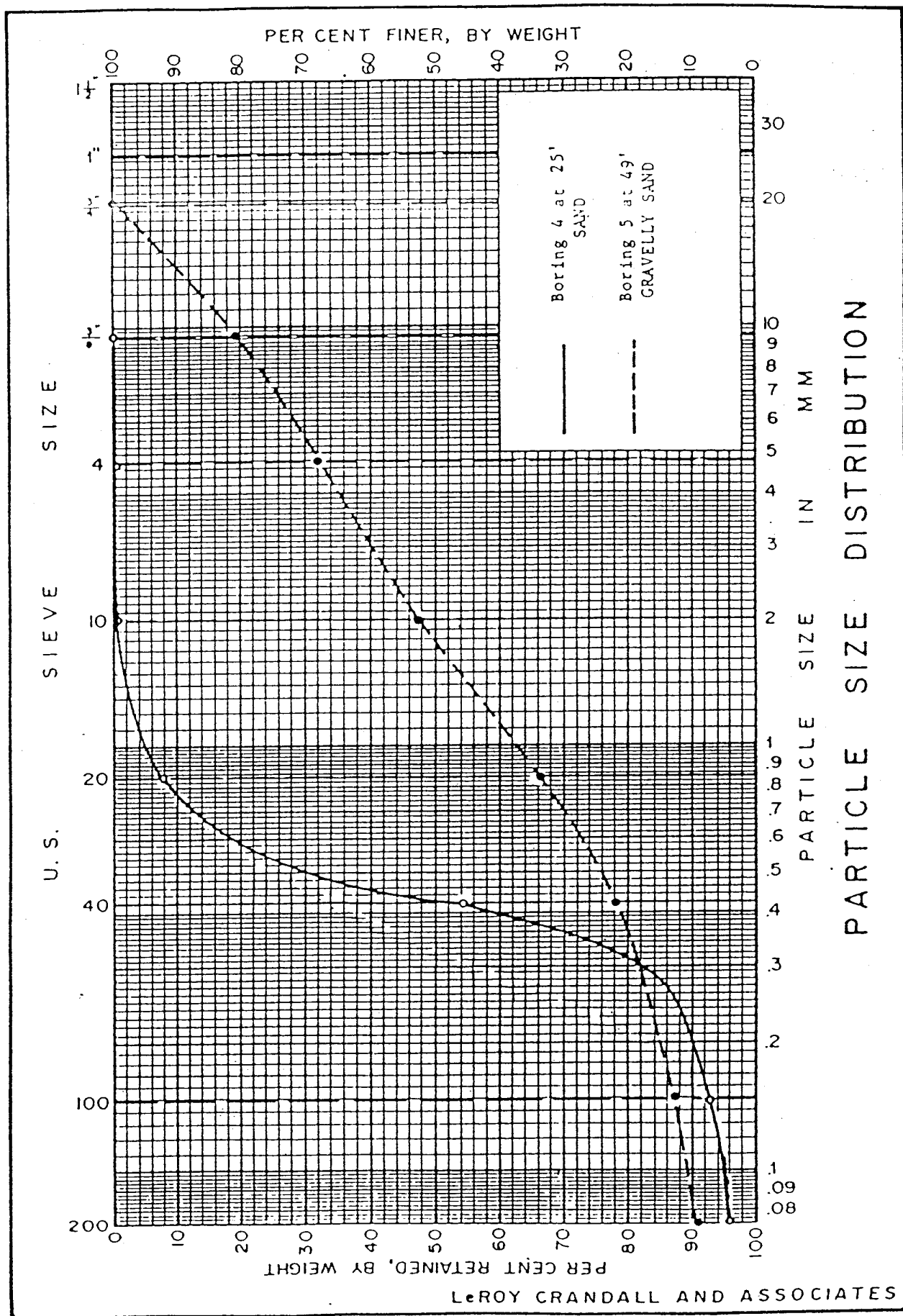
FORM 121 JOB L90328AEO DATE 8/24/90 DE DR

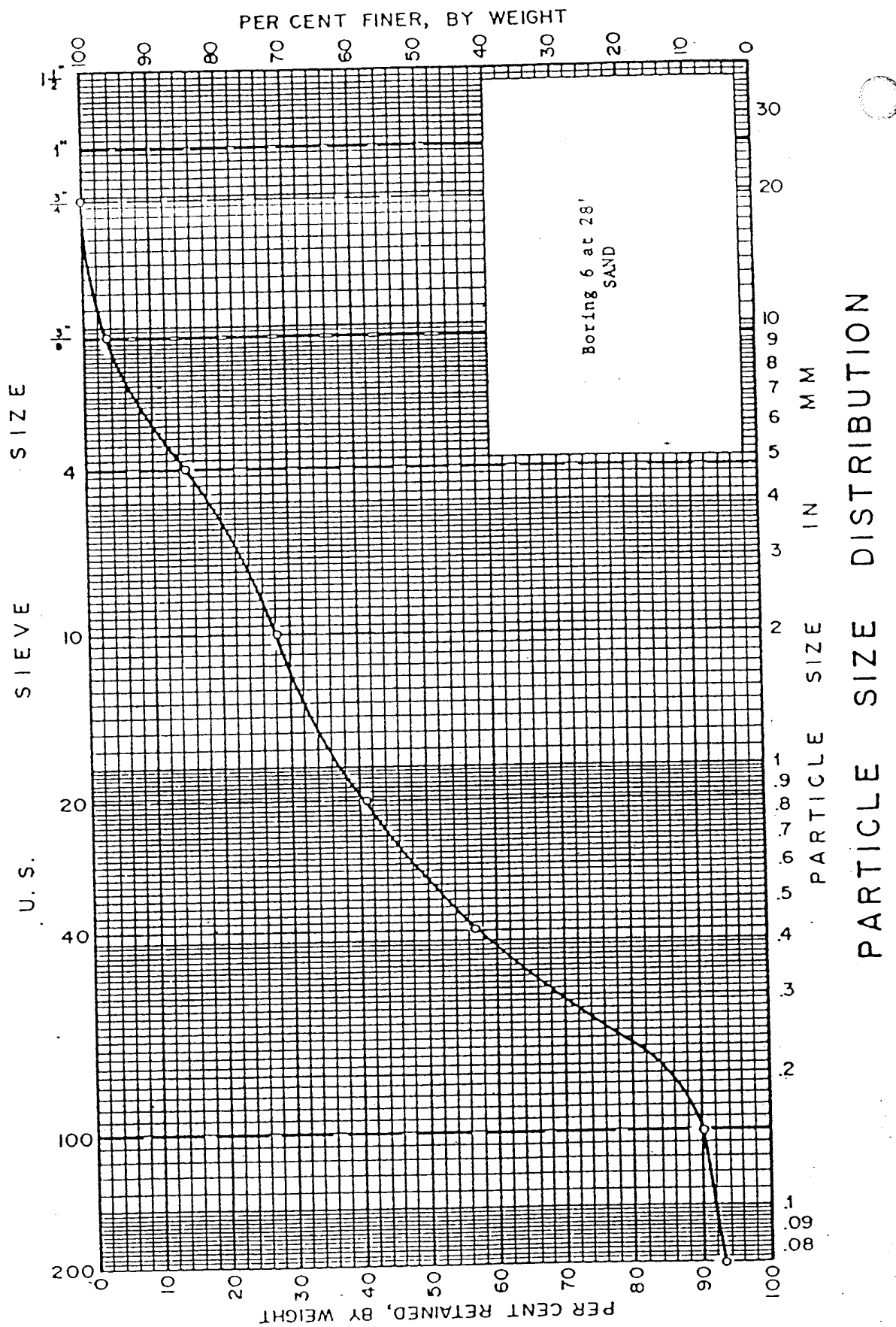


FORM 121 J. JOBS - 190328AED DATE 9/24/50 DR. DE

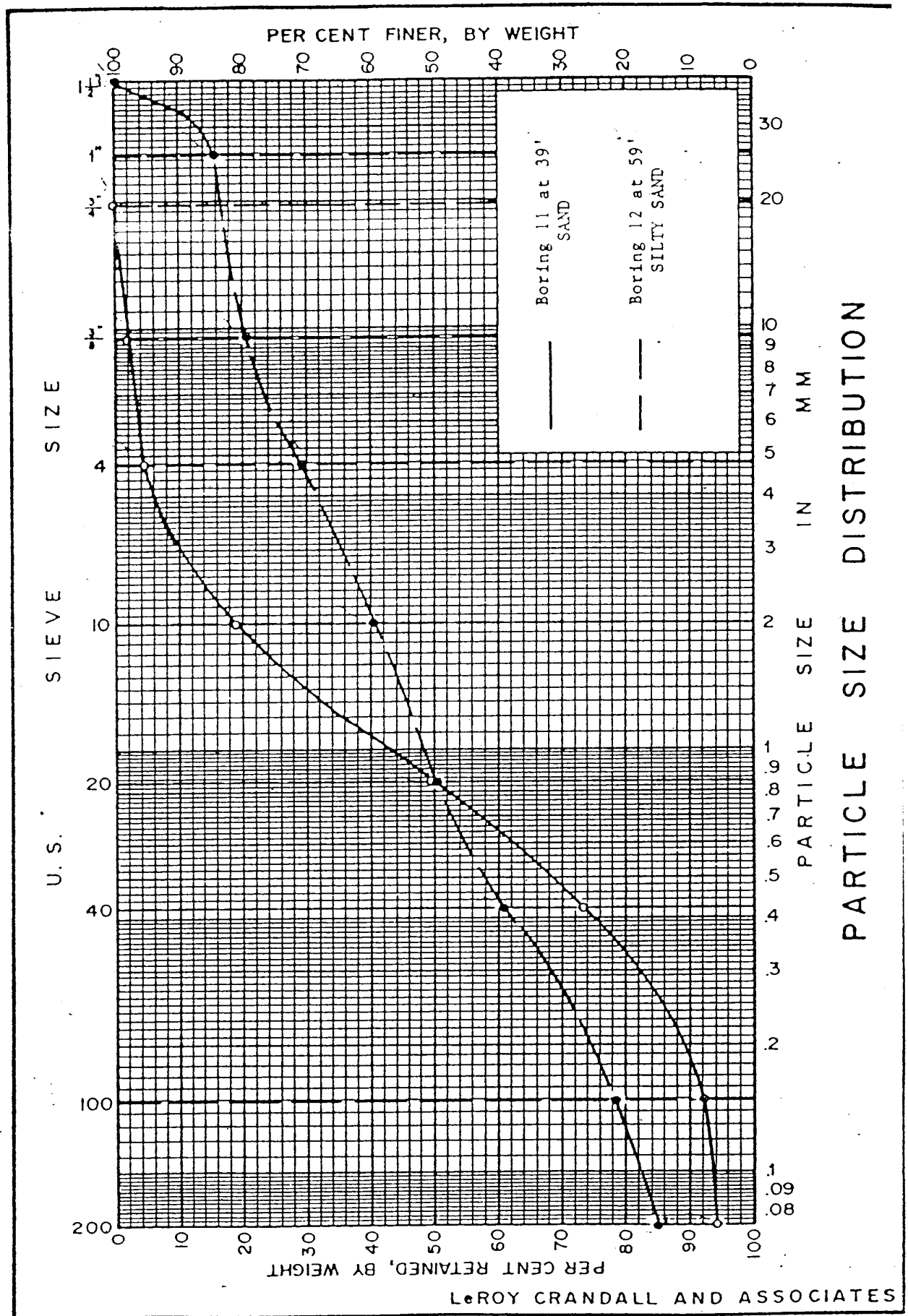


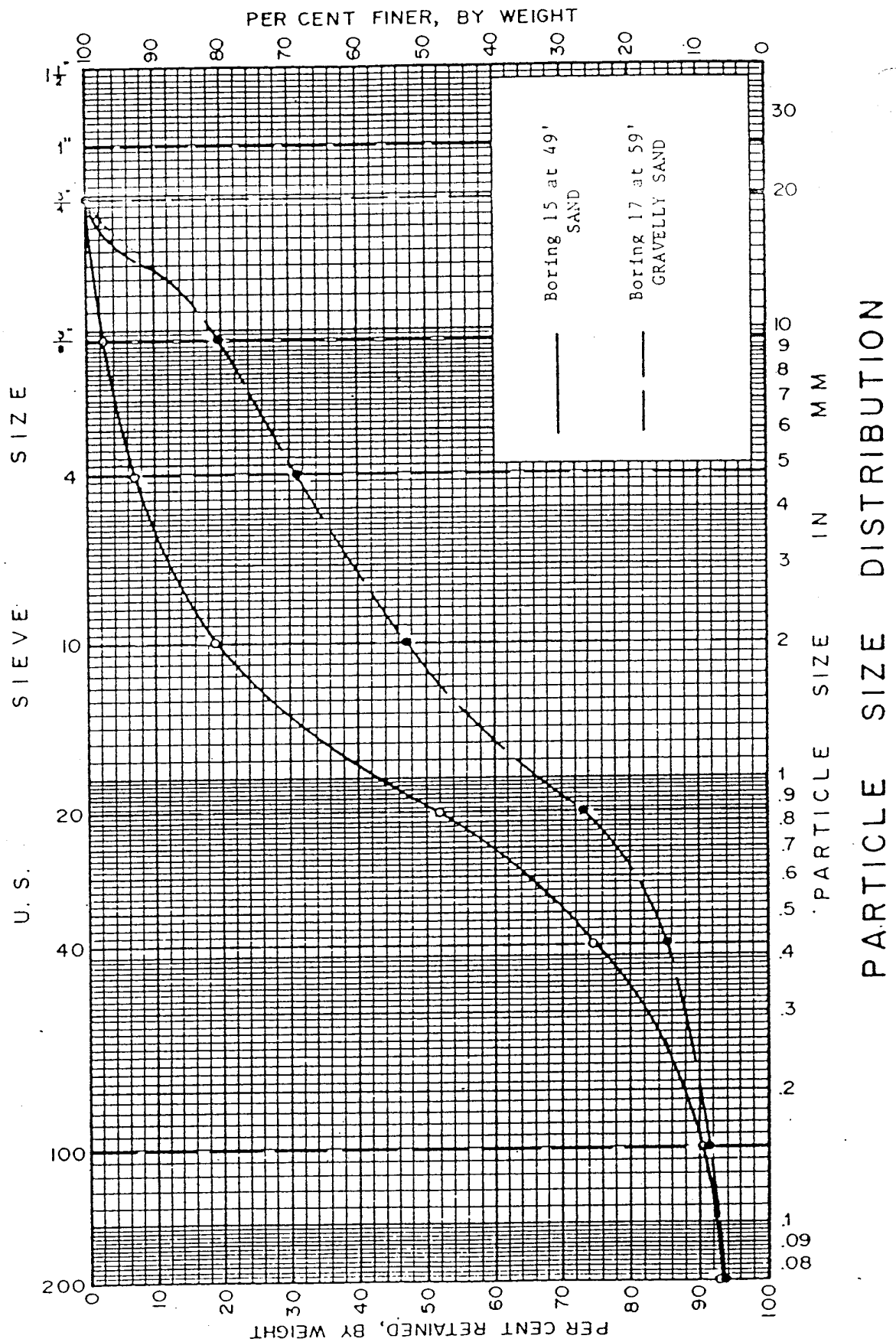
LeROY CRANDALL AND ASSOCIATES



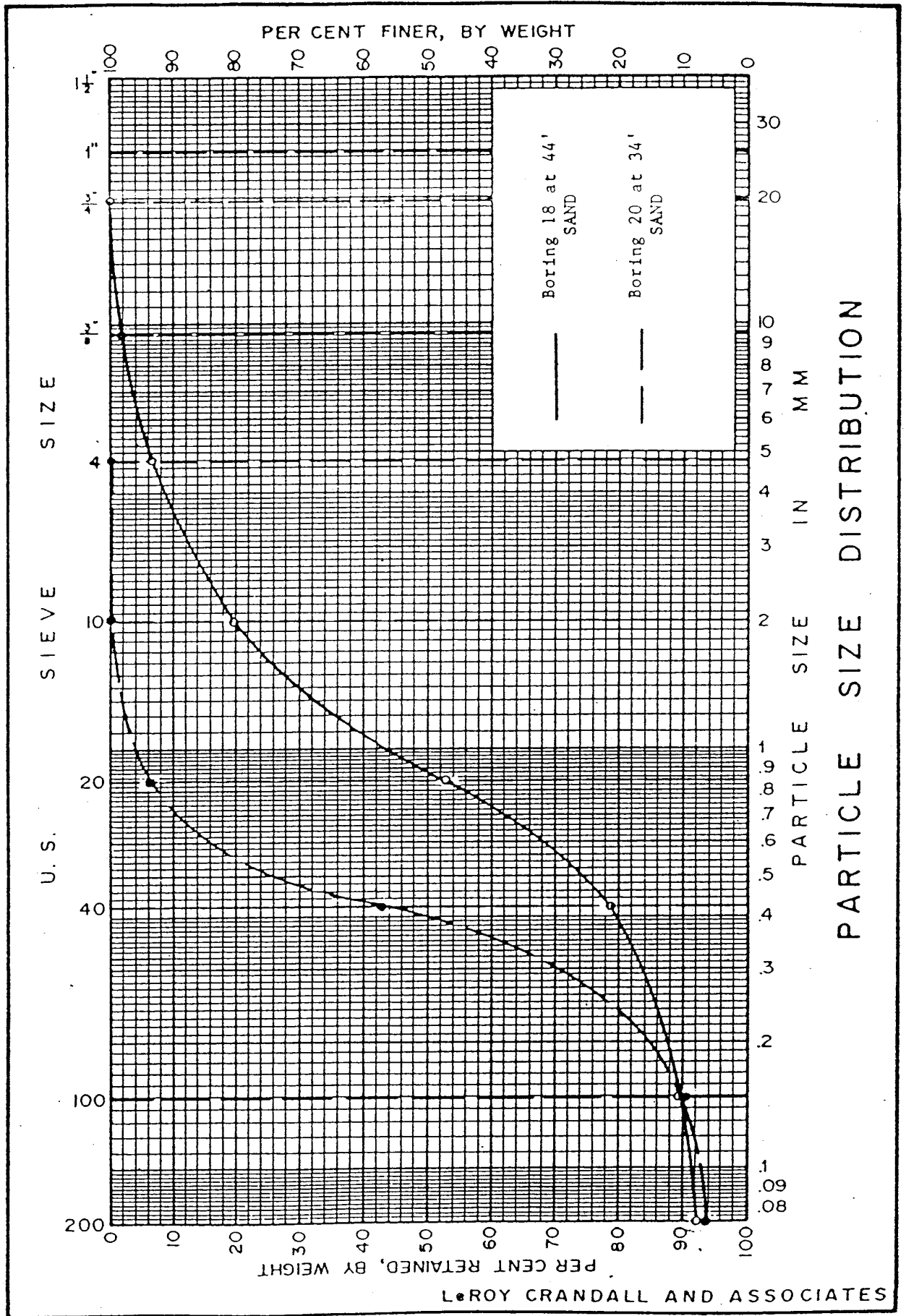


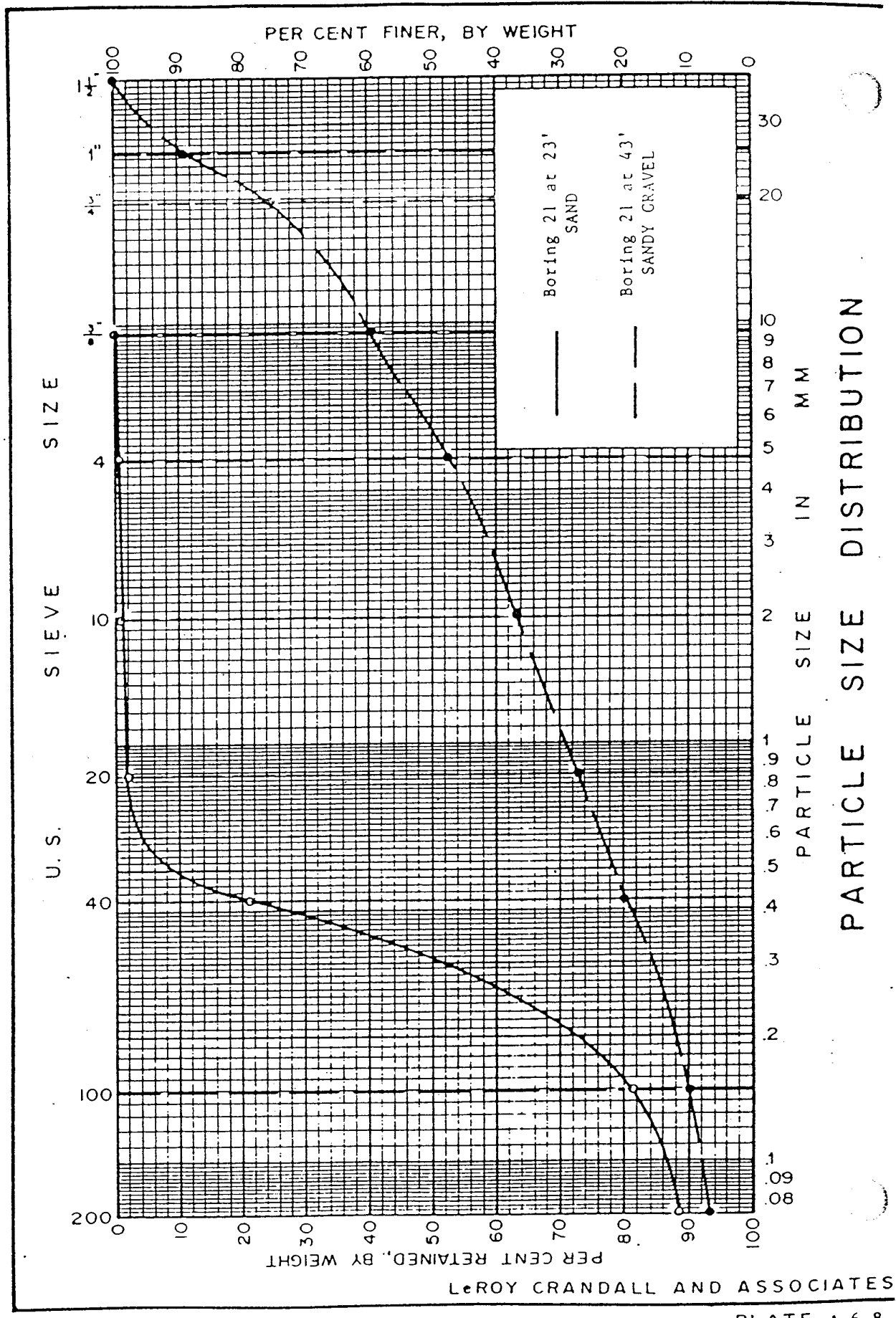
FORM





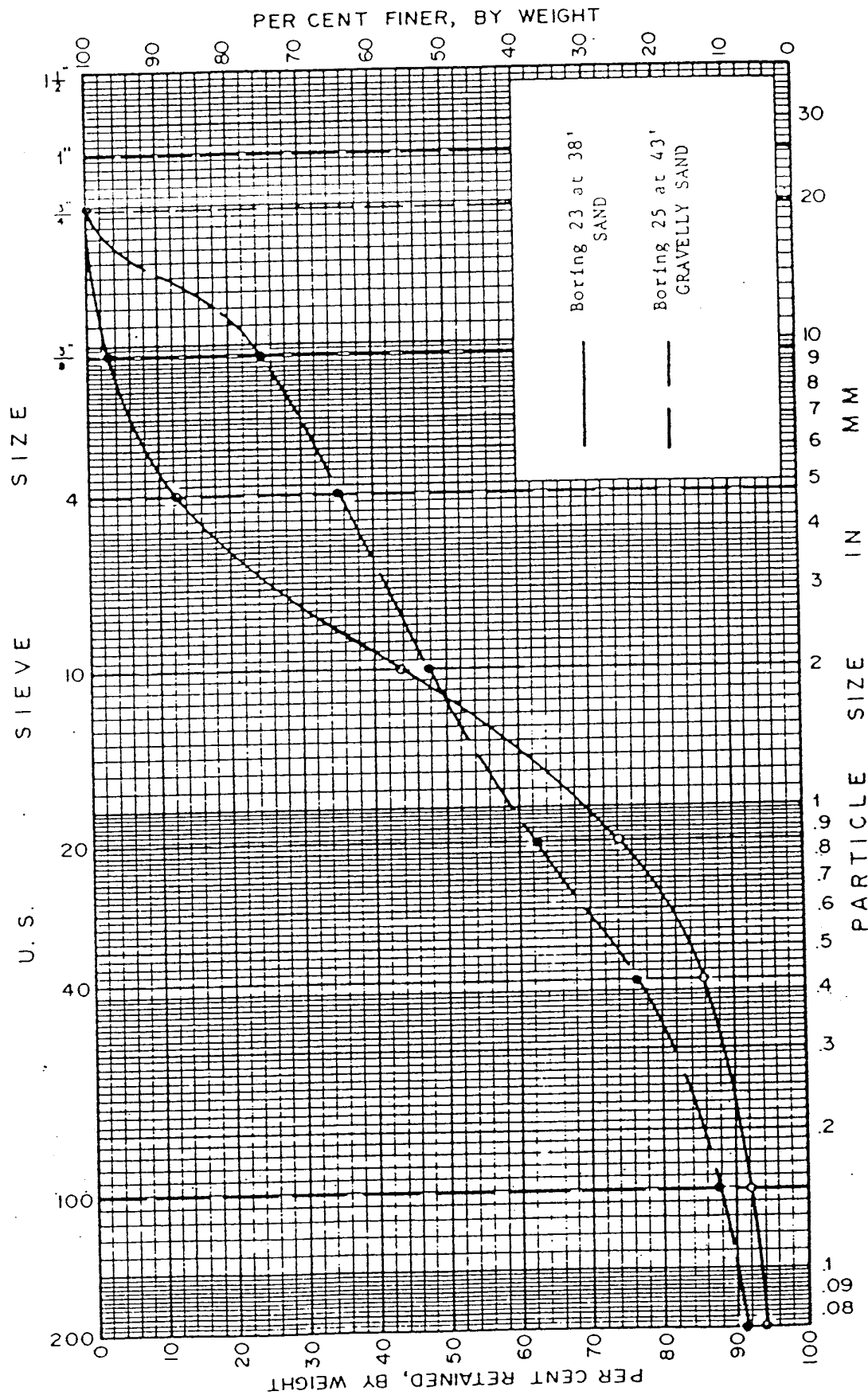
LeROY CRANDALL AND ASSOCIATES





LeROY CRANDALL AND ASSOCIATES

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M. J. SCHIFF & ASSOCIATES

Consulting Corrosion Engineers

1291 NORTH INDIAN HILL BOULEVARD
CLAREMONT, CALIFORNIA 91711
(714) 626-0967

March 19, 1987

LeRoy Crandall & Associates
900 Grand Central Avenue
Glendale, California 91201-3009

Attention: Mr. Boris Korin

Re: Soil Corrosivity Tests
Howard Hughes Properties
Los Angeles, California
Your #AE-86125-F, MJS&A #87024

Gentlemen:

Laboratory tests have been completed on fourteen soil samples we selected from your borings for the subject project on Jefferson Boulevard and Centinela Avenue. The purpose of these tests was to determine if the soils may have deleterious effects on underground utilities, hydraulic elevator cylinders, and concrete foundations.

The electrical resistivity of each sample was measured in its as-received condition and again with distilled water added to create the standardized condition of saturation. Resistivities are at about their lowest value when the soil is saturated. The samples were chemically analyzed for the major anions and cations, and pH was measured. Sulfides and oxidation-reduction (redox) potentials were also measured on the grey/black clay samples. Results are shown on Table 1.

Electrical resistivities of soils are a measure of their resistance to the flow of corrosion currents. Corrosion currents, following Ohm's Law, tend to be lower in high resistivity soils. The electrical resistivity of a soil varies primarily with its chemical and moisture contents.

A commonly accepted correlation between electrical resistivity and corrosivity toward ferrous metals is:

below	1,000 ohm-centimeters	severely corrosive
1,000 to	2,000 " "	corrosive
2,000 to	10,000 " "	moderately corrosive
over	10,000 " "	mildly corrosive

Electrical resistivities measured in the laboratory with as-received moisture content were in mildly to severely corrosive categories. When saturated, they were in moderately to very severely corrosive categories. The deeper soils were near their most corrosive moisture content as-received due to the high water table. The resistivities of other samples dropped considerably with added moisture indicating that they were quite dry as-received. The wide variations in soil resistivity can create concentration type corrosion cells that increase corrosivity beyond what would be expected from the soil resistivities alone.

CORROSION AND CATHODIC PROTECTION ENGINEERING SERVICES
SURVEYS • PLANS AND SPECIFICATIONS • INTERFERENCE PROBLEMS • SOIL TESTS • SUPERVISION INSPECTION AND ADJUSTMENT OF INSTALLATIONS

PLATE A-7.1

pH values varied from 7.1 to 8.1 which is neutral to moderately alkaline. This is not significant in evaluating corrosivity in this case.

The chemical content of most of the samples was moderate. Exceptions were high sodium chloride in borings 11 at 24 feet, 12 at 13 feet, and 15 at foot. Chloride ions are corrosive to ferrous metals.

Sulfides, which are aggressive to copper, showed a trace reaction in a qualitative test. The low positive redox potentials indicate mild oxidizing conditions in which anaerobic, sulfide producing bacteria function marginally.

We classify this site as severely corrosive to ferrous metals and mildly corrosive to copper. The following corrosion control measures are recommended.

Test any fill material that is placed at the site in the future. Some of the clay fill material is severely corrosive and requires strong corrosion control measures. Sandy fill would be less corrosive.

Underground steel utilities should be given a high quality protective coating such as 40 mil extruded polyethylene, 20 mil plastic tape over primer per AWWA Standard C209, or hot applied coal tar enamel or tape per AWWA Standard C203.

All underground steel should be electrically insulated from above ground steel, dissimilar metals, and cement-mortar or concrete coated steel. Underground steel pipe should be bonded for electrical continuity if rubber gasketed, mechanical, grooved end, or other nonconductive type joints are used.

In addition, cathodic protection is necessary for underground steel utilities.

The use of nonmetallic materials should be considered.

Hydraulic elevator cylinders should be well coated as described above. Each cylinder should be isolated from building metals by installing dielectric material between the piston platen and car and also in the oil line. The oil line should be placed above ground if possible but, if underground, should be protected as described above for steel utilities. Cathodic protection is recommended for hydraulic cylinders or, as an alternate, each cylinder may be placed in a plastic casing with a plastic watertight seal at the bottom.

Cast or ductile iron pipe, valves, and fittings should be encased in an 8 mil polyethylene tube or wrap per AWWA Standard C105 or ANSI 21.5. Iron placed in soils represented by samples from B11 at 24 feet and B12 at 13 feet should be bonded for electrical continuity and cathodically protected as well.

Copper should be bedded and backfilled in alkalized sand (25 pounds hydrated lime per cubic yard of sand) at least 3 inches thick surrounding the pipe.

No special precautions are required for asbestos-cement, or plastic utilities placed underground from a corrosion viewpoint. However, any iron valves or fittings should be protected as mentioned above.

Where metallic pipelines penetrate concrete structures, such as building floors or walls, plastic sleeves or other dielectric material should be used to prevent pipe contact with the concrete and reinforcing steel.

On any type of pipe, bare steel appurtenances such as bolts, joint harnesses, or flexible couplings should be coated with a coal tar or rubber based mastic after assembly.

Standard construction practices and concrete mixes may be used for concrete in contact with these soils using type 2 cement. However, concrete cover over reinforcing steel in concrete contacting these soils should be at least 2.5 inches thick if placed against forms and 3.5 inches thick if placed against earth. Also a water/cement ratio not exceeding 0.50 is recommended to reduce concrete permeability.

It is assumed that prestressed concrete piles will contain about 8 sacks of type 2 prestress cement per cubic yard of concrete and a water/cement ratio not exceeding 0.45. With such a mix, concrete cover should be at least 2 inches thick over embedded steel from a corrosion viewpoint. Solid steel lifting lugs are recommended to prevent groundwater from wicking into the pile interior. If wire rope lifting lugs are used they should be carefully drilled out 1.75 inches deep and the hole filled with epoxy.

The scope of this study was limited to a determination of soil corrosivity and its general effects on materials likely to be used for construction. If the architect and/or engineers desire more specific information, designs, specifications, or review of design, we will be happy to work with them as a separate phase of this project.

Respectfully submitted,
M. J. SCHIFF & ASSOCIATES

Paul Smith
ms

Paul R. Smith, P.E.

cb
Enc: Table 1 - Laboratory Tests on Soil Samples
WS12

Table 1 - LABORATORY TESTS ON SOIL SAMPLES

Boring and Depth	Soil Type	Soil Resistivity		pH		-----Chemical Analysis in mg/kg (ppm) of dry soil-----										Sulfide S	Redox MV
		As Rec'd	Sat'd			Ca	Mg	Na	HCO3	Chloride	Sulfate						
B11 7'	fill	12,000	1,600	7.5		80	trace	126	122	212	120						
B11 24'	clay	150	120	7.4		440	288	2737	488	4248	2000					trace	+140
B12 13'	clay	340	200	8.0		80	trace	1748	732	1487	1150					trace	+100
B13 2'	fill	20,000	920	7.4		80	trace	161	244	142	135						
B14 5'	fill	6,600	3,300	7.1		40	trace	12	122	71	50						
B15 1'	fill	7,100	450	7.7		120	24	598	488	779	250					trace	+130
B16 5'	clay	2,300	1,200	7.4		80	24	104	244	142	200						
B18 24'	clay	640	520	7.6		280	72	483	488	566	900					trace	+110
B20 4'	fill	18,000	6,400	7.9		40	trace	12	122	71	55						
B21 4'	clay	2,700	1,000	7.7		80	trace	161	122	283	85						
B23 4'	clay	2,300	2,200	7.7		80	24	138	244	142	190						
B24 16'	clay	1,700	720	8.1		120	48	161	366	212	275						
B25 2'	clay	7,400	840	8.0		120	trace	207	366	212	150					trace	+110
B26 4'	silt	9,800	2,300	8.0		40	24	115	244	142	85						

Carbonate = 0 for all samples

Howard Hughes Properties
Los Angeles, California
HJS&A #87024
F3

APPENDIX B: GEOLOGIC AND SEISMIC DATA

B.1 GENERAL

The geologic-seismic studies included a field reconnaissance of the site as well and an office analysis of published and unpublished literature pertinent to the study area. The County of Los Angeles Seismic Safety Element, 1974, and the City of Los Angeles Seismic Safety Plan, 1974, were reviewed as part of our literature analysis.

This Appendix presents additional background information regarding faults, seismicity, and ground shaking.

B.2 FAULTS

The numerous faults in Southern California include active, potentially active, and inactive faults. The criteria for these major groups, as established by the Association of Engineering Geologists (1973), are presented in Table B-1. Table B-2 presents a listing of active faults in Southern California with the distance in miles between the site and the nearest point on the fault. Table B-3 provides a similar listing for potentially active faults. No faults or fault-associated features were observed on the site during the field reconnaissance.

B.2.1 Active Faults

The nearest active fault to the site is the Inglewood fault of the Newport-Inglewood fault zone located about 2 miles east-northeast from the northeast corner of site. The Newport-Inglewood structural zone is expressed at the surface by a northwesterly trending series of discontinuous faults and folds that extend across the Los Angeles Basin from Newport Beach to Beverly Hills (Barrows, 1974). The 1920 Inglewood and the 1933 Long Beach earthquakes have been attributed to this fault zone.

The active Malibu Coast fault is located 7 miles northwest of the site. The Malibu Coast fault has been considered active based on the 1973 Point Mugu earthquake, which was attributed to this fault.

TABLE B-1

CRITERIA FOR CLASSIFICATION OF FAULTS WITH
REGARD TO SEISMIC ACTIVITY(Modified from *Association of Engineering Geologists,
Geology and Earthquake Hazards, 1973*)A. Active Faults: (See Table B-2)

These faults have shown historical activity or have been included in the State of California's fault rupture studies zones as established by the California Division of Mines and Geology in accordance with the Alquist-Priolo Special Studies Zone Act of 1972. This category includes such faults as the San Andreas, San Jacinto, and Newport-Inglewood.

B. Potentially Active Faults: (See Table B-3)

These faults are those, based on available data, along which no known historical ground surface ruptures or earthquakes have occurred. These faults, however, show strong indications of geologically recent activity. Potentially active faults can be placed in two subgroups that are based on the boldness or sharpness of their topographic features and the estimates related to recency of activity. These subgroups are:

1. Subgroup One - High Potential

- a. Offsets affecting the Holocene deposits (age less than 10 - 11,000 years).
- b. A ground water barrier or anomaly occurring along the fault within the Holocene deposits.
- c. Earthquake epicenters (generally from small earthquakes occurring close to the fault).
- d. Strong geomorphic expression of fault origin features (e.g. faceted spurs, offset ridges or stream valleys or similar features, especially where Holocene topography appears to have been modified).

2. Subgroup Two - Low Potential

This subgroup is the same as 1-a, b, or d above, with the exception that the indications of fault movement can be only determined in Pleistocene deposits (less than 1,000,000 years ago).

C. Inactive Faults:

These faults are without recognized Holocene or Pleistocene offset or activity.

TABLE B-2

MAJOR NAMED FAULTS CONSIDERED TO BE ACTIVE (a)
IN SOUTHERN CALIFORNIA

Fault (in alphabetical order)	Date of Latest Major Activity	Maximum Credible Earthquake	Distance From Site (Miles)	Direction From Site
Big Pine	1852	7.5 (b)	65	NNW
Cucamonga	(e)	6.5 (b)	44	ENE
Elsinore	1910	7.5 (b)	65	ESE
Garlock	(d)	7.75 (b)	62	NNW
Helendale	(e)	7.5 (b)	72	NE
Malibu Coast	1973	7.0 (c)	7	NW
More Ranch	(d)	7.5 (b)	80	WNW
Newport-Inglewood	1933	7.0 (b)	2	ENE
Raymond	(e)	6.6 (c)	16	NE
San Andreas Zone	1857	8.25 (b)	43	NNE
San Cayetano	(e)	6.75 (c)	36	NW
San Fernando Zone	1971	6.5 (b)	22	N
San Gabriel	(e)	7.5 (c)	25	NNE
San Jacinto Zone	1968	7.5 (b)	63	ENE
White Wolf	1952	7.75 (b)	77	NNE
Whittier		7.1 (c)	23	E

- (a) Historic movement (1769 to present).
 (b) Greensfelder, C.D.M.G. Map Sheet 23, 1974.
 (c) Mark (1977) Length-Magnitude relationship.
 (d) Intermittent creep.
 (e) Movement within the last 11,000 years; zoned by the State Geologist for the Alquist-Priolo Program.

TABLE B-3

MAJOR NAMED FAULTS CONSIDERED TO BE POTENTIALLY ACTIVE (a)
IN SOUTHERN CALIFORNIA

Fault (in alphabetical order)	Maximum Credible Earthquake	Distance From Site (Miles)	Direction From Site
Charnock	6.6 (c)	0	NE
*Chino	6.7 (c)	39	E
*Duarte	6.3 (c)	28	ENE
Northridge Hills	6.5 (b)	19.5	N
Norwalk	6.4 (c)	23	ESE
Oakridge	7.5 (b)	35	NNW
*Overland	6.2 (c)	0.8	ENE
Ozena	7.3 (c)	71	NW
Palos Verdes	7.0 (b)	5	SSW
*San Jose	6.5 (c)	32	E
Santa Cruz Island	7.2 (c)	56	W
Santa Monica-Hollywood	6.8 (c)	5	NNW
Santa Susana	6.5 (b)	24	NNW
Santa Ynez	7.5 (b)	50	NW
Sierra Madre	7.5 (b)	23	NE
Sierra Nevada (Southern Branch)	8.25 (b)	94	NNE
*Verdugo	6.8 (c)	17	NNE

(a) Pleistocene deposits disrupted.

(b) Greensfelder, C.D.M.G. Map Sheet 23, 1974.

(c) Mark (1977) Length-Magnitude relationship.

* Low Potential per A.E.G. definition.

The active Raymond and San Fernando fault zones are situated approximately 16 miles northeast and 22 miles north of the site, respectively. The 1971 San Fernando earthquake produced surface ruptures along the Sylmar and Tujunga faults, which are segments of the larger San Fernando fault zone.

Other active faults in the vicinity of the Los Angeles Coastal Plain include the Whittier fault and San Gabriel fault zone located 23 miles east and 25 miles north-northeast of the site, respectively. The active San Andreas fault zone is located 43 miles north-northeast of the site.

B.2.2 Potentially Active Faults

The closest potentially active fault is the Charnock fault, which has been postulated as passing at depth beneath the eastern portion of the site. The results of our study regarding the presence of the Charnock fault beneath the site are presented in Appendix C.

The potentially active Overland fault and Santa Monica-Hollywood fault zone are located 0.8 mile east-northeast and 5 miles north-northwest of the site, respectively. The Overland fault trends northwest and lies approximately parallel to and a short distance northeast of the Charnock fault. The Santa Monica-Hollywood fault zone trends east-west to east-northeast and is typified by predominant reverse-oblique fault movement. Recent work by Hill, et al. (1979) and Weber, et al. (1980) consider the eastern portion of the Hollywood fault to be active in the vicinity of the Atwater area. The Santa Monica fault, which is known to act as a well defined ground water barrier in the Santa Monica area, is considered by Hill, et al. (1979) to be undergoing tectonic strain accumulation and release based on an analysis of micro-earthquake data for the area. The Santa Monica fault has been considered an active fault based on the assumption that it is an easterly landward extension of the active Malibu Coast fault. These data, however, are inconclusive, and in our opinion, the Santa Monica Fault is considered only potentially active.

Other nearby potentially active faults are listed in Table B-3.

B.2.3 Inactive Faults

The closest inactive faults to the site occur adjacent to the site in the Playa del Rey Oil Field (California Division of Oil and Gas, 1974). Six small faults are depicted as offsetting Miocene age oil-bearing strata, but do not displace Pliocene age sediments. The faults do not affect Pliocene age (5 million years before present) rocks, and are therefore considered inactive. The potential for surface rupture from these inactive faults is extremely low.

B.3 SEISMICITY

The seismicity of the region surrounding the site was determined from a computer search of a magnetic tape catalog of earthquakes. The catalog of earthquakes included those compiled by the California Institute of Technology for the period from 1932 to 1981, and those earthquakes for the period 1812 to 1931 compiled by Richter and the U.S. National Oceanic and Atmospheric Administration (NOAA). The computer printout of the earthquakes is presented as Table B-4 and follows the text of this appendix. The search indicates that 306 earthquakes of Richter magnitude 4.0 and greater have occurred within 100 kilometers (62 miles) of the site during the period 1932 to 1987. The earthquake data were plotted to develop the recurrence curve presented on Plate 2-5.

The information listed for each earthquake found in Table B-4 includes date and time in Greenwich Civil Time (GCT), location of the epicenter in latitude and longitude, quality of epicentral determination (Q), depth in kilometers, and magnitude. Where a depth of 0.0 is given, the solution was based on an assumed 16-kilometer focal depth. The letter code for the quality factor is presented on the first page of the table.

The epicenter of the March 11, 1933 Long Beach earthquake, magnitude 6.3, was located about 37 miles southeast of the site. This earthquake, although of only moderate magnitude, ranks as one of the major disasters in Southern California. The majority of damage was suffered by structures now considered substandard construction and/or were located on filled or saturated ground.

The epicenter of the February 9, 1971, San Fernando earthquake with a magnitude of 6.5 was about 33 miles north of the site. Surface rupture occurred on the Sylmar and Tujunga faults, which are segments of the larger San Fernando fault system. The data indicate the San Fernando earthquake generated horizontal ground motion greater than 0.5g (g = acceleration of gravity) within about 11 miles of the epicenter. Horizontal ground accelerations reportedly ranged from 0.11 to 0.19g in downtown Los Angeles, about 10 miles east-northeast of the site.

The location of the site in relation to known active and potentially active faults indicates the site is not exposed to greater than normal seismic risk than other areas in the Los Angeles region.

B.4 GROUND SHAKING

Movements on any of the above-described active and potentially active faults could cause ground shaking at the site. The relationship between the magnitude of an earthquake and the duration of strong shaking that results has been investigated by Bolt (1973). The relationship is set forth in Table B-5. The period of strong shaking is defined as that period of time when the acceleration of the ground due to seismic waves is in excess of 0.05g.

TABLE B-5

BRACKETED DURATION OF STRONG SHAKING AS A FUNCTION OF
MAGNITUDE AND DISTANCE TO SOURCE
(after Bolt, 1973)

Distance to Source (km)	Bracketed Duration (seconds)						
	Magnitude						
	5.5	6.0	6.5	7.0	7.5	8.0	8.5
10	8	12	19	26	31	34	35
25	4	9	15	24	28	30	32
50	2	3	10	22	26	28	29
75	1	1	5	10	14	16	17
100	0	0	1	4	5	6	7
125	0	0	1	2	2	3	3
150	0	0	0	1	2	2	3
175	0	0	0	0	1	2	2
200	0	0	0	0	0	1	2

B.5 BIBLIOGRAPHY

- Association of Engineering Geologists, 1973, "Geology and Earthquake Hazards, Planners Guide to the Seismic Safety Element," Special Publication.
- Association of Engineering Geologists, 1973, "Geology, Seismicity, and Environmental Impact," Special Publication.
- Barrows, A.G., 1974, "A Review of the Geology and Earthquake History of the Newport-Inglewood Structural Zone, Southern California," California Division of Mines and Geology, Special Report 114.
- Baumann, Paul, and Laverty, F.B., 1940, "Annual Report of Hydrologic Data, Season 1938 - 39," Los Angeles County Flood Control District.
- Bolt, B.A., 1973, "Duration of Strong Ground Motion," in Proceedings, Fifth World Conference on Earthquake Engineering.
- California Department of Water Resources, 1961, "Planned Utilization of the Ground Water Basins of the Coastal Plain of Los Angeles County," App. A, Ground Water Geology, Bulletin 104.
- California Department of Water Resources, 1964, "Crustal Strain and Fault Movement Investigation," Bulletin 116-2.
- California Department of Water Resources, 1975, "Sea Water Intrusion in California, Inventory of Coastal Basins," Bulletin 63-5.
- California Department of Water Resources, 1977, Hydrologic Data: 1975, Volume II, Southern California, Bulletin 130-75.
- California Department of Water Resources, Water Data Information Service.
- California Division of Mines and Geology, 1954, "Geology of Southern California," Bulletin 170.
- California Division of Mines and Geology, 1975, "Geologic Map of California Showing Locations of Faults, Volcanoes, Thermal Springs and Thermal Wells," Map No. 1.
- California Division of Oil and Gas, 1974, "California Oil and Gas Fields; Volume II, South, Central Coastal, and Offshore California," Report No. TR12.
- Converse, Ward, Davis, Dixon, 1981, "Geotechnical Investigation Report Volume 1 - SCRTD Metro Rail Project."

- Greensfelder, R.W., 1974, "Maximum Credible Rock Acceleration from Earthquakes in California," California Division of Mines and Geology, Map Sheet 23.
- Hill, R. L., Sprotte, E.C., Chapman, R.H., Chase, G.W., Bennett, J. H., Real, C.R., Borchardt, Glenn, and Weber, F.H., Jr., 1979, "Earthquake Hazards Associated With Faults in the Greater Los Angeles Metropolitan Area, Los Angeles County, California, Including Faults in the Santa Monica-Raymond, Verdugo-Eagle Rock and Benedict Canyon Fault Zones," California Division of Mines and Geology, Open File Report 79-16LA.
- Los Angeles, City of, 1974, "Seismic Safety Plan."
- Los Angeles County Department of Regional Planning, 1982, "Local Coastal Plan, Phase II - Land Use Plan, Marina del Rey/Ballona," Los Angeles County, California.
- Los Angeles, County of, 1974, "Seismic Safety Element, Los Angeles County General Plan."
- Los Angeles County Flood Control District, 1985, "Coastal Plain Ground Water Contours, Deep Aquifers," Fall 1985.
- Mark, R.K., 1977, "Application of Linear Statistical Models of Earthquake Magnitude Versus Fault Length in Estimating Maximum Expectable Earthquakes," *Geology*, Vol. 5, p. 464-466.
- Poland, J.F., Garrett, A.A., and Sinnott, Allen, 1959, "Geology, Hydrology, and Chemical Character of Ground Waters in the Torrance-Santa Monica Area, California," U.S. Geological Survey Water Supply Paper 1461.
- Smith, T.C., 1978, "Fault Evaluation Report," California Division of Mines and Geology, FER - 71.
- U.S. Geological Survey, 1965, "Venice 7.5-Minute Quadrangle Map," photorevised 1981.
- Weber, F.H., Bennett, J.H., Chapman, R.H., Chase, G.W., and Saul, R.B., 1980, "Earthquake Hazards Associated with the Verdugo-Eagle Rock and Benedict Canyon Fault Zones, Los Angeles County, California," California Division of Mines and Geology, Open File Report 80-10LA.
- Yerkes, R.F., McCulloh, Schoellhamer, J.E., and Vedder, J.G., 1965, "Geology of the Los Angeles Basin - An Introduction," U.S. Geological Survey, Professional Paper 420-A.
- Ziony, J. I., 1985, "Evaluating Earthquake Hazards in the Los Angeles Region - An Earth Science Perspective," U.S. Geological Survey, Professional Paper 1360.

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 4.0 OR
GREATER WITHIN 100 KM OF THE SITE
(CAL TECH DATA 1932-1987)

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
03-11-1933	01:54:08	33.62 N	117.97 W	A	57	.0	6.3
03-11-1933	02:04:00	33.75 N	118.08 W	C	40	.0	4.9
03-11-1933	02:05:00	33.75 N	118.08 W	C	40	.0	4.3
03-11-1933	02:09:00	33.75 N	118.08 W	C	40	.0	5.0
03-11-1933	02:10:00	33.75 N	118.08 W	C	40	.0	4.6
03-11-1933	02:11:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	02:16:00	33.75 N	118.08 W	C	40	.0	4.8
03-11-1933	02:17:00	33.60 N	118.00 W	E	57	.0	4.5
03-11-1933	02:22:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	02:27:00	33.75 N	118.08 W	C	40	.0	4.6
03-11-1933	02:30:00	33.75 N	118.08 W	C	40	.0	5.1
03-11-1933	02:31:00	33.60 N	118.00 W	E	57	.0	4.4
03-11-1933	02:52:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	02:57:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	02:58:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	02:59:00	33.75 N	118.08 W	C	40	.0	4.6
03-11-1933	03:05:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	03:09:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	03:11:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	03:23:00	33.75 N	118.08 W	C	40	.0	5.0
03-11-1933	03:36:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	03:39:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	03:47:00	33.75 N	118.08 W	C	40	.0	4.1
03-11-1933	04:36:00	33.75 N	118.08 W	C	40	.0	4.6
03-11-1933	04:39:00	33.75 N	118.08 W	C	40	.0	4.9
03-11-1933	04:40:00	33.75 N	118.08 W	C	40	.0	4.7
03-11-1933	05:10:22	33.70 N	118.07 W	C	44	.0	5.1
03-11-1933	05:13:00	33.75 N	118.08 W	C	40	.0	4.7
03-11-1933	05:15:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	05:18:04	33.57 N	117.98 W	C	60	.0	5.2
03-11-1933	05:21:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	05:24:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	05:53:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	05:55:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	06:11:00	33.75 N	118.08 W	C	40	.0	4.4

NOTE: Q IS A FACTOR RELATING THE QUALITY OF EPICENTRAL DETERMINATION

A = SPECIALLY INVESTIGATED

B = EPICENTER PROBABLY WITHIN 5 KM, ORIGIN TIME TO NEAREST SECOND

C = EPICENTER PROBABLY WITHIN 15 KM, ORIGIN TIME TO A FEW SECONDS

D = EPICENTER NOT KNOWN WITHIN 15 KM, ROUGH LOCATION

E = EPICENTER ROUGHLY LOCATED, ACCURACY LESS THAN "D"

P = PRELIMINARY

DATE	TIME	LATITUDE	LONGITUDE	O	DIST	DEPTH	MAGNITUDE
03-11-1933	06:18:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	06:29:00	33.85 N	118.27 W	C	19	.0	4.4
03-11-1933	06:35:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	06:58:03	33.68 N	118.05 W	C	47	.0	5.5
03-11-1933	07:51:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	07:59:00	33.75 N	118.08 W	C	40	.0	4.1
03-11-1933	08:08:00	33.75 N	118.08 W	C	40	.0	4.5
03-11-1933	08:32:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	08:37:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	08:54:57	33.70 N	118.07 W	C	44	.0	5.1
03-11-1933	09:10:00	33.75 N	118.08 W	C	40	.0	5.1
03-11-1933	09:11:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	09:26:00	33.75 N	118.08 W	C	40	.0	4.1
03-11-1933	10:25:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	10:45:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	11:00:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	11:04:00	33.75 N	118.13 W	C	36	.0	4.6
03-11-1933	11:29:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	11:38:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	11:41:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	11:47:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	12:50:00	33.68 N	118.05 W	C	47	.0	4.4
03-11-1933	13:50:00	33.73 N	118.10 W	C	40	.0	4.4
03-11-1933	13:57:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	14:25:00	33.85 N	118.27 W	C	19	.0	5.0
03-11-1933	14:47:00	33.73 N	118.10 W	C	40	.0	4.4
03-11-1933	14:57:00	33.88 N	118.32 W	C	14	.0	4.9
03-11-1933	15:09:00	33.73 N	118.10 W	C	40	.0	4.4
03-11-1933	15:47:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	16:53:00	33.75 N	118.08 W	C	40	.0	4.8
03-11-1933	19:44:00	33.75 N	118.08 W	C	40	.0	4.0
03-11-1933	19:56:00	33.75 N	118.08 W	C	40	.0	4.2
03-11-1933	22:00:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	22:31:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	22:32:00	33.75 N	118.08 W	C	40	.0	4.1
03-11-1933	22:40:00	33.75 N	118.08 W	C	40	.0	4.4
03-11-1933	23:05:00	33.75 N	118.08 W	C	40	.0	4.2
03-12-1933	00:27:00	33.75 N	118.08 W	C	40	.0	4.4
03-12-1933	00:34:00	33.75 N	118.08 W	C	40	.0	4.0
03-12-1933	04:48:00	33.75 N	118.08 W	C	40	.0	4.0
03-12-1933	05:46:00	33.75 N	118.08 W	C	40	.0	4.4
03-12-1933	06:01:00	33.75 N	118.08 W	C	40	.0	4.2
03-12-1933	06:16:00	33.75 N	118.08 W	C	40	.0	4.6
03-12-1933	07:40:00	33.75 N	118.08 W	C	40	.0	4.2
03-12-1933	08:35:00	33.75 N	118.08 W	C	40	.0	4.2

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
03-12-1933	15:02:00	33.75 N	118.08 W	C	40	.0	4.2
03-12-1933	16:51:00	33.75 N	118.08 W	C	40	.0	4.0
03-12-1933	17:38:00	33.75 N	118.08 W	C	40	.0	4.5
03-12-1933	18:25:00	33.75 N	118.08 W	C	40	.0	4.1
03-12-1933	21:28:00	33.75 N	118.08 W	C	40	.0	4.1
03-12-1933	23:54:00	33.75 N	118.08 W	C	40	.0	4.5
03-13-1933	03:43:00	33.75 N	118.08 W	C	40	.0	4.1
03-13-1933	04:32:00	33.75 N	118.08 W	C	40	.0	4.7
03-13-1933	06:17:00	33.75 N	118.08 W	C	40	.0	4.0
03-13-1933	13:18:28	33.75 N	118.08 W	C	40	.0	5.3
03-13-1933	15:32:00	33.75 N	118.08 W	C	40	.0	4.1
03-13-1933	19:29:00	33.75 N	118.08 W	C	40	.0	4.2
03-14-1933	00:36:00	33.75 N	118.08 W	C	40	.0	4.2
03-14-1933	12:19:00	33.75 N	118.08 W	C	40	.0	4.5
03-14-1933	19:01:50	33.62 N	118.02 W	C	54	.0	5.1
03-14-1933	22:42:00	33.75 N	118.08 W	C	40	.0	4.1
03-15-1933	02:08:00	33.75 N	118.08 W	C	40	.0	4.1
03-15-1933	04:32:00	33.75 N	118.08 W	C	40	.0	4.1
03-15-1933	05:40:00	33.75 N	118.08 W	C	40	.0	4.2
03-15-1933	11:13:32	33.62 N	118.02 W	C	54	.0	4.9
03-16-1933	14:56:00	33.75 N	118.08 W	C	40	.0	4.0
03-16-1933	15:29:00	33.75 N	118.08 W	C	40	.0	4.2
03-16-1933	15:30:00	33.75 N	118.08 W	C	40	.0	4.1
03-17-1933	16:51:00	33.75 N	118.08 W	C	40	.0	4.1
03-18-1933	20:52:00	33.75 N	118.08 W	C	40	.0	4.2
03-19-1933	21:23:00	33.75 N	118.08 W	C	40	.0	4.2
03-20-1933	13:58:00	33.75 N	118.08 W	C	40	.0	4.1
03-21-1933	03:26:00	33.75 N	118.08 W	C	40	.0	4.1
03-23-1933	08:40:00	33.75 N	118.08 W	C	40	.0	4.1
03-23-1933	18:31:00	33.75 N	118.08 W	C	40	.0	4.1
03-25-1933	13:46:00	33.75 N	118.08 W	C	40	.0	4.1
03-30-1933	12:25:00	33.75 N	118.08 W	C	40	.0	4.4
03-31-1933	10:49:00	33.75 N	118.08 W	C	40	.0	4.1
04-01-1933	06:42:00	33.75 N	118.08 W	C	40	.0	4.2
04-02-1933	08:00:00	33.75 N	118.08 W	C	40	.0	4.0
04-02-1933	15:36:00	33.75 N	118.08 W	C	40	.0	4.0
05-16-1933	20:58:55	33.75 N	118.17 W	C	34	.0	4.0
08-04-1933	04:17:48	33.75 N	118.18 W	C	33	.0	4.0
10-02-1933	09:10:18	33.78 N	118.13 W	A	34	.0	5.4
10-02-1933	13:26:01	33.62 N	118.02 W	C	54	.0	4.0
10-25-1933	07:00:46	33.95 N	118.13 W	C	26	.0	4.3
11-13-1933	21:28:00	33.87 N	118.20 W	C	23	.0	4.0
11-20-1933	10:32:00	33.78 N	118.13 W	B	34	.0	4.0
01-09-1934	14:10:00	34.10 N	117.68 W	A	69	.0	4.5
01-18-1934	02:14:00	34.10 N	117.68 W	A	69	.0	4.0

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
01-20-1934	21:17:00	33.62 N	118.12 W	B	48	.0	4.5
04-17-1934	18:33:00	33.57 N	117.98 W	C	60	.0	4.0
10-17-1934	09:38:00	33.63 N	118.40 W	B	39	.0	4.0
11-16-1934	21:26:00	33.75 N	118.00 W	B	46	.0	4.0
06-11-1935	18:10:00	34.72 N	118.97 W	B	97	.0	4.0
06-19-1935	11:17:00	33.72 N	117.52 W	B	87	.0	4.0
07-13-1935	10:54:17	34.20 N	117.90 W	A	53	.0	4.7
12-25-1935	17:15:00	33.60 N	118.02 W	B	55	.0	4.5
08-22-1936	05:21:00	33.77 N	117.82 W	B	59	.0	4.0
10-29-1936	22:35:36	34.38 N	118.62 W	C	48	.0	4.0
01-15-1937	18:35:47	33.56 N	118.06 W	B	57	.0	4.0
03-19-1937	01:23:38	34.11 N	117.43 W	A	92	.0	4.0
07-07-1937	11:12:00	33.57 N	117.98 W	B	60	.0	4.0
09-01-1937	13:48:08	34.21 N	117.53 W	A	85	.0	4.5
09-01-1937	16:35:34	34.18 N	117.55 W	A	83	.0	4.5
05-21-1938	09:44:00	33.62 N	118.03 W	B	53	.0	4.0
05-31-1938	08:34:55	33.70 N	117.51 W	B	89	.0	5.5
07-05-1938	18:06:56	33.68 N	117.55 W	A	86	.0	4.5
08-06-1938	22:00:56	33.72 N	117.51 W	B	88	.0	4.0
08-31-1938	03:18:14	33.76 N	118.25 W	A	29	.0	4.5
11-29-1938	19:21:16	33.90 N	118.43 W	A	9	.0	4.0
12-07-1938	03:38:00	34.00 N	118.42 W	B	2	.0	4.0
12-27-1938	10:09:29	34.13 N	117.52 W	B	84	.0	4.0
11-04-1939	21:41:00	33.77 N	118.12 W	B	36	.0	4.0
12-27-1939	19:28:49	33.78 N	118.20 W	A	29	.0	4.7
01-13-1940	07:49:07	33.78 N	118.13 W	B	34	.0	4.0
02-08-1940	16:56:17	33.70 N	118.07 W	B	44	.0	4.0
02-11-1940	19:24:10	33.98 N	118.30 W	B	10	.0	4.0
04-18-1940	18:43:44	34.03 N	117.35 W	A	98	.0	4.4
05-18-1940	09:15:12	34.60 N	118.90 W	C	82	.0	4.0
06-05-1940	08:27:27	33.83 N	117.40 W	B	95	.0	4.0
07-20-1940	04:01:13	33.70 N	118.07 W	B	44	.0	4.0
10-11-1940	05:57:12	33.77 N	118.45 W	A	24	.0	4.7
10-12-1940	00:24:00	33.78 N	118.42 W	B	22	.0	4.0
10-14-1940	20:51:11	33.78 N	118.42 W	B	22	.0	4.0
11-01-1940	07:25:03	33.78 N	118.42 W	B	22	.0	4.0
11-01-1940	20:00:46	33.63 N	118.20 W	B	43	.0	4.0
11-02-1940	02:58:26	33.78 N	118.42 W	B	22	.0	4.0
01-30-1941	01:34:47	33.97 N	118.05 W	A	33	.0	4.1
03-22-1941	08:22:40	33.52 N	118.10 W	B	59	.0	4.0
03-25-1941	23:43:41	34.22 N	117.47 W	B	91	.0	4.0
04-11-1941	01:20:24	33.95 N	117.58 W	B	77	.0	4.0
10-22-1941	06:57:19	33.82 N	118.22 W	A	25	.0	4.9
11-14-1941	08:41:36	33.78 N	118.25 W	A	27	.0	5.4
04-16-1942	07:28:33	33.37 N	118.15 W	C	72	.0	4.0

DATE	TIME	LATITUDE	LONGITUDE		Q	DIST	DEPTH	MAGNITUDE
09-03-1942	14:06:01	34.48 N	118.98 W	C	76	.0	4.5	
09-04-1942	06:34:33	34.48 N	118.98 W	C	76	.0	4.5	
04-06-1943	22:36:24	34.68 N	119.00 W	C	95	.0	4.0	
10-24-1943	00:29:21	33.93 N	117.37 W	C	96	.0	4.0	
06-19-1944	00:03:33	33.87 N	118.22 W	B	21	.0	4.5	
06-19-1944	03:06:07	33.87 N	118.22 W	C	21	.0	4.4	
02-24-1946	06:07:52	34.40 N	117.80 W	C	73	.0	4.1	
06-01-1946	11:06:31	34.42 N	118.83 W	C	62	.0	4.1	
03-01-1948	08:12:13	34.17 N	117.53 W	B	84	.0	4.7	
04-16-1948	22:26:24	34.02 N	118.97 W	B	52	.0	4.7	
10-03-1948	02:46:28	34.18 N	117.58 W	A	80	.0	4.0	
01-11-1950	21:41:35	33.94 N	118.20 W	A	20	.0	4.1	
01-24-1950	21:56:59	34.67 N	118.83 W	C	86	.0	4.0	
02-26-1950	00:06:22	34.62 N	119.08 W	C	94	.0	4.7	
08-22-1950	22:47:58	34.15 N	119.35 W	B	89	.0	4.2	
02-10-1952	13:50:55	33.58 N	119.18 W	C	84	.0	4.0	
08-23-1952	10:09:07	34.52 N	118.20 W	A	63	.0	5.0	
10-26-1954	16:22:26	33.73 N	117.47 W	B	91	.0	4.1	
11-17-1954	23:03:51	34.50 N	119.12 W	B	87	.0	4.4	
05-15-1955	17:03:26	34.12 N	117.48 W	A	87	.0	4.0	
05-29-1955	16:43:35	33.99 N	119.06 W	B	60	.0	4.1	
01-03-1956	00:25:49	33.72 N	117.50 W	B	89	.0	4.7	
02-07-1956	02:16:57	34.53 N	118.64 W	B	65	.0	4.2	
02-07-1956	03:16:39	34.59 N	118.61 W	A	70	.0	4.6	
03-25-1956	03:32:02	33.60 N	119.10 W	A	76	.0	4.2	
03-18-1957	18:56:28	34.12 N	119.22 W	B	76	.0	4.7	
06-28-1960	20:00:48	34.12 N	117.47 W	A	88	.0	4.1	
10-04-1961	02:21:32	33.85 N	117.75 W	B	63	.0	4.1	
10-20-1961	19:49:51	33.65 N	117.99 W	B	53	.0	4.3	
10-20-1961	20:07:14	33.66 N	117.98 W	B	53	.0	4.0	
10-20-1961	21:42:41	33.67 N	117.98 W	B	53	.0	4.0	
10-20-1961	22:35:34	33.67 N	118.01 W	B	50	.0	4.1	
11-20-1961	08:53:35	33.68 N	117.99 W	B	51	.0	4.0	
09-14-1963	03:51:16	33.54 N	118.34 W	B	49	.0	4.2	
08-30-1964	22:57:37	34.27 N	118.44 W	B	32	.0	4.0	
01-01-1965	08:04:18	34.14 N	117.52 W	B	84	.0	4.4	
04-15-1965	20:08:33	34.13 N	117.43 W	B	92	.0	4.5	
07-16-1965	07:46:22	34.48 N	118.52 W	B	56	.0	4.0	
01-08-1967	07:37:30	33.63 N	118.47 W	B	39	.0	4.0	
01-08-1967	07:38:05	33.66 N	118.41 W	C	35	.0	4.0	
06-15-1967	04:58:06	34.00 N	117.97 W	B	41	.0	4.1	
02-28-1969	04:56:12	34.57 N	118.11 W	A	71	.0	4.3	
05-05-1969	16:02:10	34.30 N	117.57 W	B	85	.0	4.4	
10-24-1969	20:26:43	33.34 N	119.10 W	B	95	.0	4.7	
10-27-1969	13:16:02	33.55 N	117.81 W	B	73	.0	4.5	

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
10-31-1969	10:39:29	33.43 N	119.10 W	B	88	.0	4.8
09-12-1970	14:10:11	34.27 N	117.52 W	A	88	.0	4.1
09-12-1970	14:30:53	34.27 N	117.54 W	A	87	.0	5.4
09-13-1970	04:47:49	34.28 N	117.55 W	A	86	.0	4.4
02-09-1971	14:00:42	34.41 N	118.40 W	B	48	.0	6.4
02-09-1971	14:01:08	34.41 N	118.40 W	D	48	.0	5.8
02-09-1971	14:01:33	34.41 N	118.40 W	D	48	.0	4.2
02-09-1971	14:01:40	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:01:50	34.41 N	118.40 W	D	48	.0	4.5
02-09-1971	14:01:54	34.41 N	118.40 W	D	48	.0	4.2
02-09-1971	14:01:59	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:02:03	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:02:30	34.41 N	118.40 W	D	48	.0	4.3
02-09-1971	14:02:31	34.41 N	118.40 W	D	48	.0	4.7
02-09-1971	14:02:44	34.41 N	118.40 W	D	48	.0	5.8
02-09-1971	14:03:25	34.41 N	118.40 W	D	48	.0	4.4
02-09-1971	14:03:46	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:04:07	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:04:34	34.41 N	118.40 W	C	48	.0	4.2
02-09-1971	14:04:39	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:04:44	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:04:46	34.41 N	118.40 W	D	48	.0	4.2
02-09-1971	14:05:41	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:05:50	34.41 N	118.40 W	D	48	.0	4.1
02-09-1971	14:07:10	34.41 N	118.40 W	D	48	.0	4.0
02-09-1971	14:07:30	34.41 N	118.40 W	D	48	.0	4.0
02-09-1971	14:07:45	34.41 N	118.40 W	D	48	.0	4.5
02-09-1971	14:08:04	34.41 N	118.40 W	D	48	.0	4.0
02-09-1971	14:08:07	34.41 N	118.40 W	D	48	.0	4.2
02-09-1971	14:08:38	34.41 N	118.40 W	D	48	.0	4.5
02-09-1971	14:08:53	34.41 N	118.40 W	D	48	.0	4.6
02-09-1971	14:10:21	34.36 N	118.31 W	B	43	.0	4.7
02-09-1971	14:10:28	34.41 N	118.40 W	D	48	.0	5.3
02-09-1971	14:16:13	34.34 N	118.33 W	C	41	.0	4.1
02-09-1971	14:19:50	34.36 N	118.41 W	B	42	.0	4.0
02-09-1971	14:34:36	34.34 N	118.64 W	C	45	.0	4.9
02-09-1971	14:39:18	34.39 N	118.36 W	C	46	.0	4.0
02-09-1971	14:40:17	34.43 N	118.40 W	C	50	.0	4.1
02-09-1971	14:43:47	34.31 N	118.45 W	B	37	.0	5.2
02-09-1971	15:58:21	34.33 N	118.33 W	B	40	.0	4.8
02-09-1971	16:19:26	34.46 N	118.43 W	B	53	.0	4.2
02-10-1971	03:12:12	34.37 N	118.30 W	B	44	.0	4.0
02-10-1971	05:06:36	34.41 N	118.33 W	A	48	.0	4.3
02-10-1971	05:18:07	34.43 N	118.41 W	A	50	.0	4.5
02-10-1971	11:31:35	34.38 N	118.45 W	A	45	.0	4.2

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
02-10-1971	13:49:54	34.40 N	118.42 W	A	47	.0	4.3
02-10-1971	14:35:27	34.36 N	118.49 W	A	43	.0	4.2
02-10-1971	17:38:55	34.40 N	118.37 W	A	47	.0	4.2
02-10-1971	18:54:42	34.45 N	118.44 W	A	52	.0	4.2
02-21-1971	05:50:53	34.40 N	118.44 W	A	47	.0	4.7
02-21-1971	07:15:12	34.39 N	118.43 W	A	46	.0	4.5
03-07-1971	01:33:41	34.35 N	118.46 W	A	41	.0	4.5
03-25-1971	22:54:10	34.36 N	118.47 W	A	43	.0	4.2
03-30-1971	08:54:43	34.30 N	118.46 W	A	36	.0	4.1
03-31-1971	14:52:23	34.29 N	118.51 W	A	36	.0	4.6
04-01-1971	15:03:04	34.43 N	118.41 W	A	50	.0	4.1
04-02-1971	05:40:25	34.28 N	118.53 W	A	35	.0	4.0
04-15-1971	11:14:32	34.26 N	118.58 W	B	35	.0	4.2
04-25-1971	14:48:07	34.37 N	118.31 W	B	44	.0	4.0
06-21-1971	16:01:08	34.27 N	118.53 W	B	34	.0	4.0
06-22-1971	10:41:19	33.75 N	117.48 W	B	90	.0	4.2
07-27-1972	00:31:17	34.78 N	118.90 W	A	100	.0	4.4
02-21-1973	14:45:57	34.06 N	119.03 W	B	58	.0	5.9
08-06-1973	23:29:17	33.99 N	119.48 W	A	99	.0	5.0
03-09-1974	00:54:32	34.40 N	118.47 W	C	47	.0	4.7
08-14-1974	14:45:55	34.43 N	118.37 W	A	50	.0	4.2
01-01-1976	17:20:13	33.96 N	117.89 W	A	48	.0	4.2
04-08-1976	15:21:38	34.35 N	118.66 W	A	47	.0	4.6
08-12-1977	02:19:26	34.38 N	118.46 W	B	45	.0	4.5
09-24-1977	21:28:24	34.46 N	118.41 W	C	53	.0	4.2
05-23-1978	09:16:51	33.91 N	119.17 W	C	71	.0	4.0
01-01-1979	23:14:39	33.94 N	118.68 W	B	25	.0	5.0
10-17-1979	20:52:37	33.93 N	118.67 W	C	25	.0	4.2
10-19-1979	12:22:38	34.21 N	117.53 W	B	85	.0	4.1
09-04-1981	15:50:50	33.67 N	119.11 W	C	73	5.0	5.3
10-23-1981	17:28:17	33.63 N	119.02 W	C	68	12.0	4.6
10-23-1981	19:15:52	33.64 N	119.06 W	C	71	6.2	4.6
04-13-1982	11:02:12	34.05 N	118.96 W	A	51	16.6	4.0
05-25-1982	13:44:30	33.54 N	118.21 W	A	52	13.7	4.1
01-08-1983	07:19:30	34.14 N	117.45 W	A	90	4.6	4.1
02-27-1984	10:18:15	33.47 N	118.06 W	C	65	6.0	4.0
06-12-1984	00:27:52	34.54 N	118.99 W	A	82	11.8	4.1
10-26-1984	17:20:43	34.02 N	118.99 W	A	54	13.3	4.6
04-03-1985	04:04:50	34.38 N	119.04 W	A	73	27.9	4.0
10-01-1987	14:42:20	34.06 N	118.08 W	A	32	9.5	5.9
10-01-1987	14:45:41	34.05 N	118.10 W	A	30	13.6	4.7
10-01-1987	14:48:03	34.08 N	118.09 W	A	32	11.7	4.1
10-01-1987	14:49:06	34.06 N	118.10 W	A	30	11.7	4.7
10-01-1987	15:12:32	34.05 N	118.09 W	A	31	10.8	4.7
10-01-1987	15:59:54	34.05 N	118.09 W	A	31	10.4	4.0

DATE TIME LATITUDE LONGITUDE Q DIST DEPTH MAGNITUDE

10-04-1987 10:59:38 34.07 N 118.10 W A 30 8.2 5.3

SEARCH OF EARTHQUAKE DATA FILE 1

SITE: Maguire Thomas Partners

COORDINATES OF SITE 33.98 N 118.41 W
DISTANCE PER DEGREE 110.9 KM-N 92.4 KM-W
MAGNITUDE LIMITS 4.0 - 8.5
TEMPORAL LIMITS 1932 - 1987
SEARCH RADIUS (KM) 100
NUMBER OF YEARS OF DATA 56
NUMBER OF EARTHQUAKES IN FILE 3079
NUMBER OF EARTHQUAKES IN AREA 306

LeROY CRANDALL AND ASSOCIATES

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 6.0 OR
GREATER WITHIN 100 KM OF THE SITE
(RICHTER DATA 1906-1931)

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
05-15-1910	15:47:00	33.70 N	117.40 W	D	98	.0	6.0

SEARCH OF EARTHQUAKE DATA FILE 2

SITE: Maguire Thomas Partners

COORDINATES OF SITE	33.98 N 118.41 W
DISTANCE PER DEGREE	110.9 KM-N 92.4 KM-W
MAGNITUDE LIMITS	6.0 - 8.5
TEMPORAL LIMITS	1906 - 1931
SEARCH RADIUS (KM)	100
NUMBER OF YEARS OF DATA	26
NUMBER OF EARTHQUAKES IN FILE	35
NUMBER OF EARTHQUAKES IN AREA	1

LeROY CRANDALL AND ASSOCIATES

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 7.0 OR
GREATER WITHIN 100 KM OF THE SITE
(NOAA/CDMG DATA 1812-1905)

DATE	TIME	LATITUDE	LONGITUDE	O	DIST	DEPTH	MAGNITUDE
02-09-1890	04:06:00	34.00 N	117.50 W	.D	84	.0	7.0

SEARCH OF EARTHQUAKE DATA FILE 3

SITE: Maguire Thomas Partners

COORDINATES OF SITE	33.98 N 118.41 W
DISTANCE PER DEGREE	110.9 KM-N 92.4 KM-W
MAGNITUDE LIMITS	7.0 - 8.5
TEMPORAL LIMITS	1812 - 1905
SEARCH RADIUS (KM)	100
NUMBER OF YEARS OF DATA	94
NUMBER OF EARTHQUAKES IN FILE	9
NUMBER OF EARTHQUAKES IN AREA	1

LEROY CRANDALL AND ASSOCIATES

SUMMARY OF EARTHQUAKE SEARCH

NUMBER OF HISTORIC EARTHQUAKES WITHIN 100 KM RADIUS OF SITE

MAGNITUDE RANGE	NUMBER
4.0 - 4.5	212
4.5 - 5.0	66
5.0 - 5.5	20
5.5 - 6.0	6
6.0 - 6.5	3
6.5 - 7.0	0
7.0 - 7.5	1
7.5 - 8.0	0
8.0 - 8.5	0

LEROY CRANDALL AND ASSOCIATES

COMPUTATION OF RECURRENCE CURVE

$$\text{LOG } N = A - B M$$

BIN	MAGNITUDE	RANGE	NO/YR (N)
1	4.00	4.00 - 8.50	5.47
2	4.50	4.50 - 8.50	1.69
3	5.00	5.00 - 8.50	.507
4	5.50	5.50 - 8.50	.149
5	6.00	6.00 - 8.50	.423E-01
6	6.50	6.50 - 8.50	.568E-02 NU
7	7.00	7.00 - 8.50	.568E-02 NU
8	7.50	7.50 - 8.50	.000
9	8.00	8.00 - 8.50	.000

A = 1.290 B = .5992 (NORMALIZED)
 A = 4.970 B = 1.0553 SIGMA = .128E-01

LEROY CRANDALL AND ASSOCIATES

COMPUTATION OF DESIGN MAGNITUDE
CONSTANT AREA

* * *

TABLE OF DESIGN MAGNITUDES

RISK	RETURN PERIOD (YEARS)				DESIGN MAGNITUDE				
	DESIGN LIFE (YEARS)								
	25	50	75	100	25	50	75	100	
.01 ..	2487	4974	7462	9949	..	7.84	8.05	8.15	8.21
.05 ..	487	974	1462	1949	..	7.24	7.50	7.65	7.75
.10 ..	237	474	711	949	..	6.95	7.23	7.38	7.49
.20 ..	112	224	336	448	..	6.65	6.93	7.09	7.20
.30 ..	70	140	210	280	..	6.46	6.74	6.90	7.02
.50 ..	36	72	108	144	..	6.18	6.47	6.63	6.75
.70 ..	20	41	62	83	..	5.96	6.24	6.41	6.53
.90 ..	10	21	32	43	..	5.69	5.98	6.14	6.26

MMIN = 4.00 MMAX = 8.50
MU = 5.61 BETA = 2.430

* * *

LeROY CRANDALL AND ASSOCIATES

APPENDIX C: CHARNOCK FAULT HAZARD EVALUATION

C.1 GENERAL

The fault hazard evaluation was undertaken to ascertain the presence or absence of the Charnock fault beneath the site, and if possible, determine the recency of activity of the fault.

The geologic studies performed as part of this evaluation included stratigraphic correlation of subsurface materials (based on previously drilled exploratory borings) and a review of published and unpublished literature pertinent to the Charnock fault. Particular emphasis was given to U.S. Geological Survey Water Supply Paper 1461 (Poland et al., 1959) and California Division of Mines and Geology Fault Evaluation Report FER-71 (Smith, 1978). We have also reviewed ground water data developed by McLaren Environmental Engineering in the evaluation.

The following reports by Kovacs-Byer and Associates, Inc. were also reviewed:

Additional Geotechnical Exploration, Charnock Fault Evaluation, Tentative Tracts 43415 and 43416, Westchester, California, for Howard Hughes Realty, Inc., August 5, 1987, KB 7606-G and KB 7607-G.

Additional Geotechnical Exploration, Charnock Fault Evaluation, Tentative Tract 43416, Westchester, California, for Howard Hughes Realty, Inc., August 5, 1987, Revised October 19, 1987, KB 7606-G and KB 7607-G.

C.2 BACKGROUND

The Charnock fault was recognized as a ground water barrier as early as 1939 by the Los Angeles County Flood Control District (Baumann and Lavery, 1940). Poland et al. (1959) subsequently assigned the name "Charnock fault" to the barrier because it presumably passes west of the Charnock well fields in the City of Santa Monica. As described by Poland et al., the fault trends northwest-southeast from approximately the intersection of La Grange Avenue and Sawtelle Boulevard, in West Los Angeles, to south of Redondo Beach Boulevard in the vicinity of Gardena. The Charnock fault is sub-parallel to the

potentially active Overland Avenue fault and the active Newport-Inglewood fault zone, located 1 mile and 3 miles northeast of the Charnock fault, respectively. For the most part, the trace of the Charnock fault is concealed by Holocene (Recent) deposits. It is estimated that the base of the early Pleistocene age San Pedro Formation has been displaced approximately 140 feet, with the dropped block on the east side of the fault.

To date, there is no evidence of fault movement during the Holocene epoch (last 11,000 years). The fault is depicted as cutting late Pleistocene units; however, according to Poland et al. (1959) the "50-foot gravel," representing the base of the Holocene in Ballona Gap, is apparently unaffected by faulting. Additionally, no ground water barriers are known to exist in the Holocene materials blanketing the fault. The California Division of Mines and Geology (CDMG), in their fault evaluation report prepared for the Charnock fault, refer to the fault as "ill-defined" having been identified on the basis of subsurface data only. Furthermore, the CDMG concludes the fault is probably pre-Holocene and, therefore, does not meet the state's definition of an active fault. Based on these data, the Charnock fault is considered potentially active as opposed to active. The fault is not within an established Alquist-Priolo Special Studies Zone.

C.3 SUBSURFACE DATA

Subsurface data from 36 exploration borings on the level portion of Tentative Tract 44857 were reviewed as part of the fault hazard evaluation. In addition, we reviewed 20 borings drilled on the property west of Lincoln Boulevard for Tentative Tract No. 44880. The locations of the borings are shown on Plates C-1.1 and C-1.2, Geologic Map and Plot Plan. Six of the borings were drilled east of the Charnock fault's inferred trace; the remaining borings were drilled west of the fault trace. The borings extended to depths varying from 47 to 77 feet below the existing ground surface. The subsurface conditions in the borings are depicted on Plate C-2, Geologic Sections, and Plate C-3, Fence Diagram. Geologic Sections A-A' and B-B' were constructed to provide continuity between the two section lines. The Fence Diagram was constructed for the borings drilled in close proximity to the mapped fault trace.

The materials observed in the borings are flood plain deposits consisting of interlayered sand to silty sand, silty clay to clayey silt, and sand and gravel. The sand and gravel, representing the "50-foot gravel" of Poland et al. (1959), was encountered in the borings at depths of about 40 to 66 feet below ground surface. Underlying the "50-foot gravel" are silt and clay units of the early Pleistocene age San Pedro Formation. The San Pedro Formation was noted in three of the borings drilled for Tract 44880 (Boring 1 of AE-86415 and Boring 2 and 3 of AE-86416). An attempt was made to determine if similar units could be correlated between the various borings; the correlations are shown on Plate C-2. Although there is some variation as a result of interfingering units, there does appear to be fairly good correlation of the units across Tract 44880 (Section A-A') and Tract 44857 (Section B-B') as well as across the inferred fault trace shown on Plate C-2. In particular, the upper surface of the "50-foot gravel" is laterally continuous across both sites with no indication of offset or disruption of the unit. Although the data are limited, the "50-foot gravel"/San Pedro Formation contact beneath Tract 44880 appears to be unaffected by faulting.

Water levels were noted in the borings at elevations ranging from about 3.0 feet above mean sea level to 5.8 feet below sea level. The higher water levels were noted in the westernmost borings (drilled in Tract 44880) and the lower levels were observed in the easternmost borings (Tract 44857). Based on the various water levels, an overall easterly sloping gradient of approximately 0.0005 (1 foot of fall for a run of 2,000 feet) is indicated from west to east. No ground water anomaly, suggestive of a fault created ground water barrier, is observable.

C.4 CONCLUSIONS

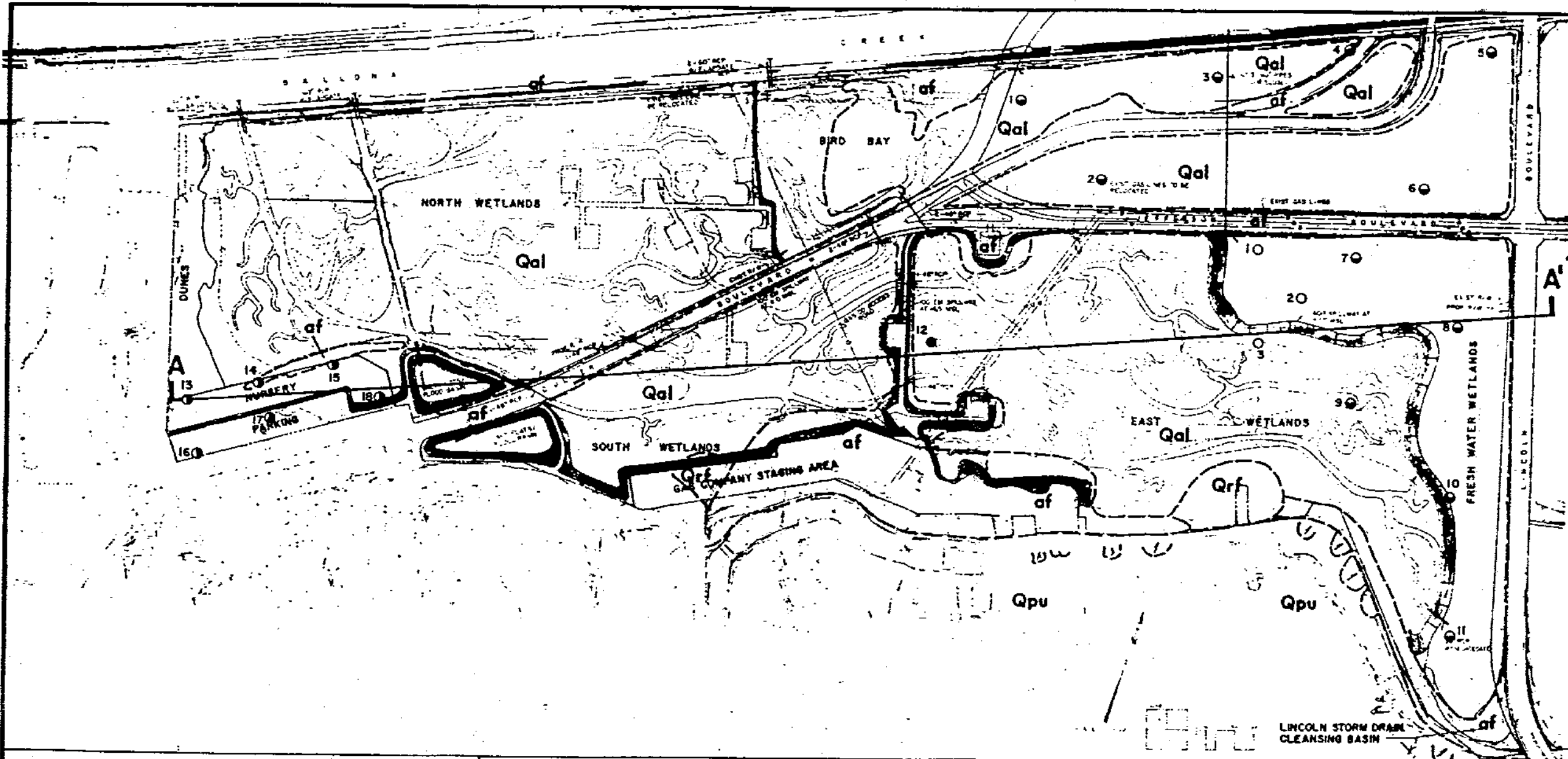
As previously stated, the Charnock fault has been identified on the basis of differing water levels on opposing sides of the fault. The most recent data presented by the Los Angeles County Flood Control District, for water levels obtained in fall of 1985, indicate a water level difference of about 10 feet adjacent to the inferred fault trace. According to the Flood Control District data, the water surface elevation would be near sea level west of the

fault and about 10 feet below sea level east of the fault trace. Although our borings detected a gradual drop in the water level going from west to east across the site, there were no abrupt changes in the water levels that typically characterize fault-related ground water barriers.

The upper surface of the "50-foot gravel," encountered in all of our borings, appears to be unaffected by faulting. This unit is considered the base of the Holocene in Ballona Gap; therefore, if faulting is present at depth, it is either confined to Pleistocene units (and by definition potentially active) or has not been active since early Holocene.

Recently, Kovacs-Byer and Associates conducted a fault investigation for the Charnock fault along the bluffs immediately upslope and southeast of the subject site. This investigation included the excavation of several trenches and sidehill cuts in an attempt to locate the fault trace. These various excavations were observed by personnel from our office. The materials exposed in the excavations consisted of an unfaulted section of late Pleistocene age ancient dune sand; the Charnock fault was not observed.

Based on the findings from our exploratory borings and the results of the Kovacs-Byer and Associates investigation, it appears that the Charnock fault either does not exist beneath the Playa Vista site or is buried by materials that are late Pleistocene age or older. These findings are consistent with the previous opinions presented by Poland et al. (1959) and Smith (1978). Therefore, it is concluded that the Charnock fault is not active and does not present a hazard to future development within the subject tracts. No further studies on the possible presence of the fault or its activity are considered necessary.



- EXPLANATION:**
- 12 ● PREVIOUS INVESTIGATION (AE-87133-B)
 - 11 ● PREVIOUS INVESTIGATION (AE-87133)
 - 18 ● PREVIOUS INVESTIGATION (AE-85415)
 - 3 ○ PREVIOUS INVESTIGATION (AE-85416)
 - BORING LOCATION AND NUMBER
 - af ARTIFICIAL FILL
 - Qrf RECENT ALLUVIUM FAN
 - Qal RECENT ALLUVIUM
 - Qpu UNDIFFERENTIATED UPPER PLEISTOCENE DEPOSITS
 - SHALLOW SLUMP
 - GEOLOGIC SECTION LINE
 - GEOLOGIC CONTACT

LeROY CRANDALL AND ASSOCIATES
 GEOTECHNICAL CONSULTANTS
 One of the Law Companies
 908 Grand Central Avenue, Glendale, California 91201-3009, (818) 243-4140

**GEOLOGIC MAP AND
SITE PLAN** PLATE C-1.1

JOB NO: L 90328 AEO	TO ACCOMPANY REPORT
DATE: 1-3-91	DATED: 1-3-91
SCALE: 1" = 400'	REVISIONS:
DRAWN BY: JULIANA	
CHECKED BY:	

RESTORATION OF WETLANDS / FULL TIDAL FLUSHING
(SCHEMATIC PLAN)

PSOMAS

DATE: 1-3-91
PRELIMINARY

BALLONA
WETLAND
PROJECT

PV 360

APPENDIX D:**EXPLORATIONS AND LABORATORY TESTS
BLUFF STABILITY INVESTIGATION****D.1 EXPLORATIONS**

The bluff materials were investigated by drilling seven exploration borings (Borings B-1 through B-6) to depths of 19 to 60 feet. The locations of the borings are shown on Plates 3-1.1 and 3-1.2. The locations of borings from our nearby projects on the adjacent properties at the top of the bluff are also shown.

During the drilling of Boring B-5, a portion of the sewer liner was encountered at a depth of approximately 19 feet. Boring B-5 was subsequently abandoned and Boring B-5A was drilled approximately 280 feet west of Boring B-5. All of the borings were drilled using bucket-type drilling equipment. Caving of the boring walls occurred, and Borings 1 through 4 were terminated because of heavy caving when water was encountered at about Elevation +2.

The soils encountered were logged by our field technician, and undisturbed and loose samples were obtained for laboratory inspection and testing. The logs of the borings are presented on Plates D-1.1 through D-1.7; the depths at which undisturbed samples were obtained are indicated to the left of the boring logs. The energy required to drive the sampler 12 inches is indicated on the logs. The soils are classified in accordance with the Unified Soil Classification System described on Plate D-2.

D.2 LABORATORY TESTS

The field moisture content and dry density of the soils encountered were determined by performing tests on the undisturbed samples. The results of the tests are shown to the left of the boring logs.

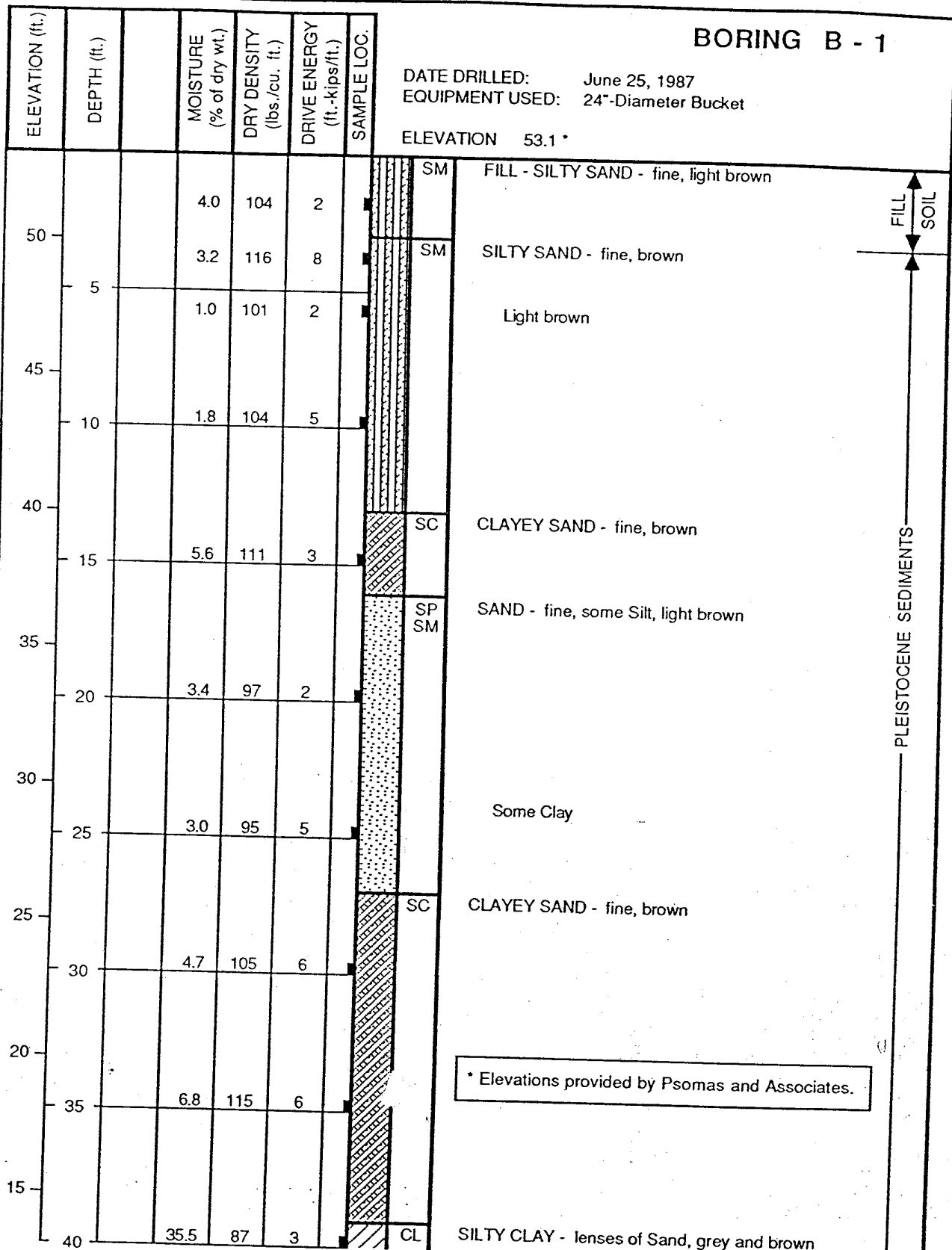
Direct shear tests were performed to determine the strength of the soils. The tests were performed on undisturbed samples and on remolded samples compacted to 90% of the maximum density obtainable by the ASTM Designation D1557-70 method of compaction. These samples were tested at field or optimum moisture content and at nearly saturated moisture contents after soaking for at least 24 hours. Each sample was tested at two different surcharge pressures. The shear values determined from the direct shear tests are presented on Plates D-3.1 through D-3.3, Direct Shear Test Data. In addition to testing the samples obtained during this investigation, direct shear test results were available from our prior investigations on the adjacent properties at the top of the bluff. The results of the prior shear tests on samples from nearby prior borings are presented on Plate D-3.4.

To assist in classification of the soils, the percent passing the No. 200 Sieve was determined on 22 samples. The tests were performed in accordance with the ASTM Designation D1140-54 test method. The results of those determinations are presented on Plate D-4, Sieve Data.

The optimum moisture content and maximum dry density of the existing fill soils were determined by performing compaction tests on two samples. The tests were performed in accordance with the ASTM Designation D1557-70 method of compaction. The results of the tests are presented on Plate D-5, Compaction Test Data.

OB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note : The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D-1.1a

JOB L90328.AEO

DATE 8/24/90

F.T. LS

DR. dmh

O.E. AS

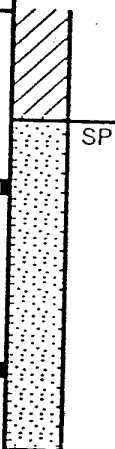
W.P. dmh

CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
10					
45		2.7	112	13	
5					
50		13.6	121	20	
0					
55					

DATE DRILLED: June 25, 1987
EQUIPMENT USED: 24"-Diameter Bucket



SAND - fine to medium, light brown

(BORING TERMINATED DUE TO CAVING)

NOTE: Water level measured at a depth of 51' at completion of drilling and at 50' 5 minutes later. Heavy caving below 51'.

PLEISTOCENE SEDIMENTS

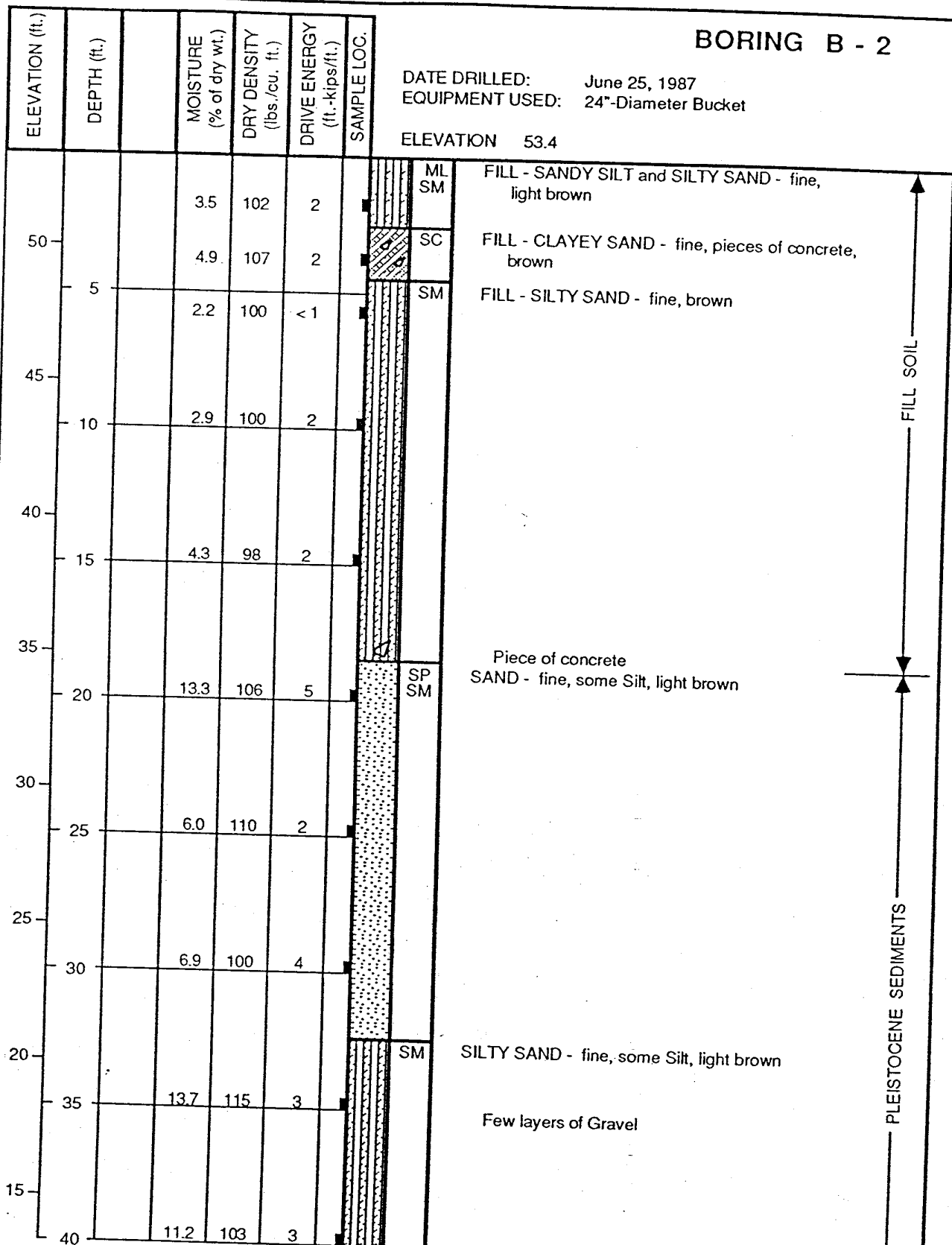
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.1b

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

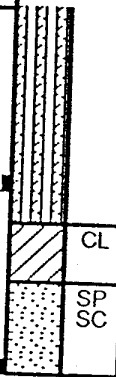
PLATE D - 1.2a

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh O.E. AS W.P. dmh CHKD dmh

Note : The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated.
It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
10					
45		9.8	104	4	
5					
50		15.0	118	6	

DATE DRILLED: June 25, 1987
EQUIPMENT USED: 24"-Diameter Bucket



SILTY CLAY - lenses of Sand, grey and brown

SAND - fine, some Clay, light greyish brown

(BORING TERMINATED DUE TO CAVING)

NOTE: Water not encountered. Caving from 19' to 50' (to 3' in diameter).

↓ PLEISTOCENE SEDIMENTS

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.2b

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

							BORING B - 3	
							DATE DRILLED:	June 26, 1987
							EQUIPMENT USED:	24"-Diameter Bucket
							ELEVATION	53.9
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.			
50	5	6.4	111	2		ML SM	FILL - SANDY SILT and SILTY SAND - fine, some Clay, light brown	
		5.5	109	2			Light greyish brown	
45	10	11.5	94	2			Light brownish grey	
40	15	3.7	106	2		SM	SILTY SAND - fine, brown	
35	20	21.2	101	2		ML	SANDY SILT - layers of Clay, light grey	
30	25	31.1	90	<1			Layer of Clay, grey	
25	30	16.6	104	4			Layer of Silty Sand	
20	35	33.3	89	2		CL	SILTY CLAY - layers of Sandy Silt, grey	
15	40	39.2	85	9				

FILL SOIL

PLEISTOCENE SEDIMENTS

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.3a

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. AS CHKD dmh

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated.
It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
10					
45		6.5	106	13	
5					
50		19.0	108	40	
0					
55					

BORING B - 3 (Continued)

DATE DRILLED: June 25, 1987
EQUIPMENT USED: 24"-Diameter Bucket

SP

SAND - medium, light brown

Some Clay, light grey

(BORING TERMINATED DUE TO CAVING)

NOTE: Water level measured at a depth of 51-1/2' at completion of drilling and at 51' 5 minutes later. Heavy caving from 51' to 52'.

PLEISTOCENE SEDIMENTS

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.3b

JOB L90328.AEO DATE 8/24/90 F.T. LS DR dmh O.E. AS W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated.
 It is not warranted to be representative of subsurface conditions at other locations and times.

							BORING B - 4	
							DATE DRILLED: June 26, 1987 EQUIPMENT USED: 24"-Diameter Bucket	
							ELEVATION 56.4	
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.			
55		4.9	109	3			SM ML	FILL - SILTY SAND and SANDY SILT - fine, some Clay, light brown
50	5	4.5	103	2				
45	10	16.7	103	2				
40	15	8.0	100	2				
35	20	12.9	102	5			SP SM	Large piece of concrete SAND - fine, some Silt, light brownish grey
30	25	11.9	122	8			SC	Layer of Silty Clay CLAYEY SAND - fine, brownish grey
25	30	5.1	109	8			SP SC	SAND - fine, some Clay, light brown
20	35	4.2	109	8			SP	SAND - medium, light brown
15	40	4.6	111	12			SP SC	SAND - fine, some Clay, light brown

FILL SOIL
 PLEISTOCENE SEDIMENTS

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

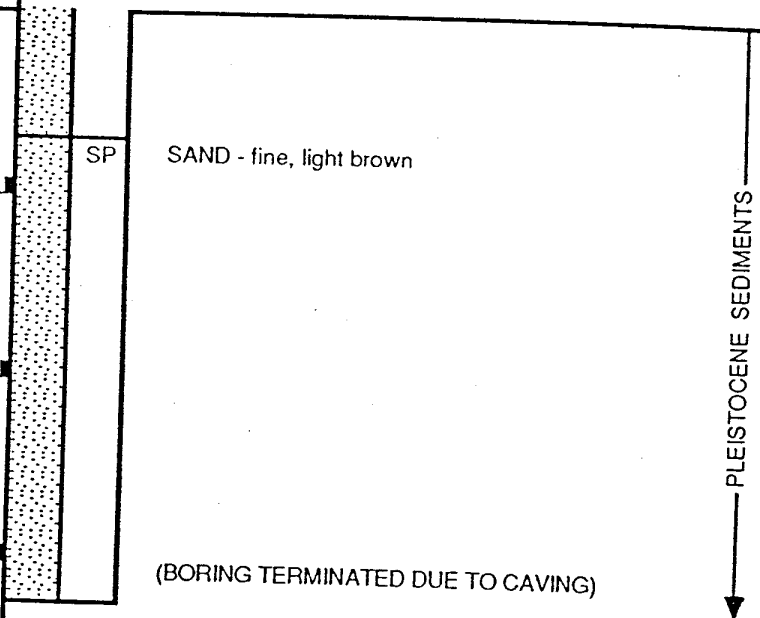
PLATE D - 1.4a

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh O.E. AS W.P. dmh CHKD dmh

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
15	45	4.2	111	14	
10	50	6.2	114	42	
5	55	17.7	113	36	
0	60				

DATE DRILLED: June 26, 1987
EQUIPMENT USED: 24"-Diameter Bucket



NOTE: Water level measured at a depth of 55-1/2' at completion of drilling and at 55' 5 minutes later. Heavy caving below 53'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES
PLATE D - 1.4b

OB L90328.AEO DATE 3/16/88 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

							BORING B - 5-A	
							DATE DRILLED: June 27, 1987	
							EQUIPMENT USED: 20"-Diameter Bucket	
							ELEVATION 56.3	
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.			
55		3.5	102	5		SM ML	FILL - SILTY SAND and SANDY SILT - fine, light brownish grey	
	5							
50		1.6	105	2		SP SM	SAND - fine, some Silt, light brown	
						SP	SAND - fine to medium, few Gravel, light brown	
	10	4.5	103	2				
45								
						ML	SANDY SILT - some Clay, brown	
40	15	27.3	97	3				
						SP SM	SAND - fine, some Silt, greyish brown	
35	20	12.5	98	2				
						CL	SILTY CLAY - grey	
	25	14.5	118	5		ML	SANDY SILT - some Clay, brown	
30								
	30	3.7	103	2		SP	SAND - medium, light brown	
25								
	35	23.9	103	2		CL	SILTY CLAY - light brownish grey	
20						SC	CLAYEY SAND - fine to medium, grey	
						SP SM	SAND - fine, some Silt, light brown	
40		5.9	108	5				

FILL
SOIL

PLEISTOCENE SEDIMENTS

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.5a

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
15					
45		5.0	113	4	
10					
50		3.5	104	12	
5					
55		23.6	105	11	
0					
60		13.3	106	11	

DATE DRILLED: June 27, 1987
EQUIPMENT USED: 20"-Diameter Bucket

NOTE: Water measured at a depth of 56' at completion of drilling and at 55' 5 minutes later. Heavy caving below 57'.

CLAYEY SAND - fine to medium, layers of Clay, light grey

SAND - fine to medium, some Clay, light grey

PLEISTOCENE SEDIMENTS

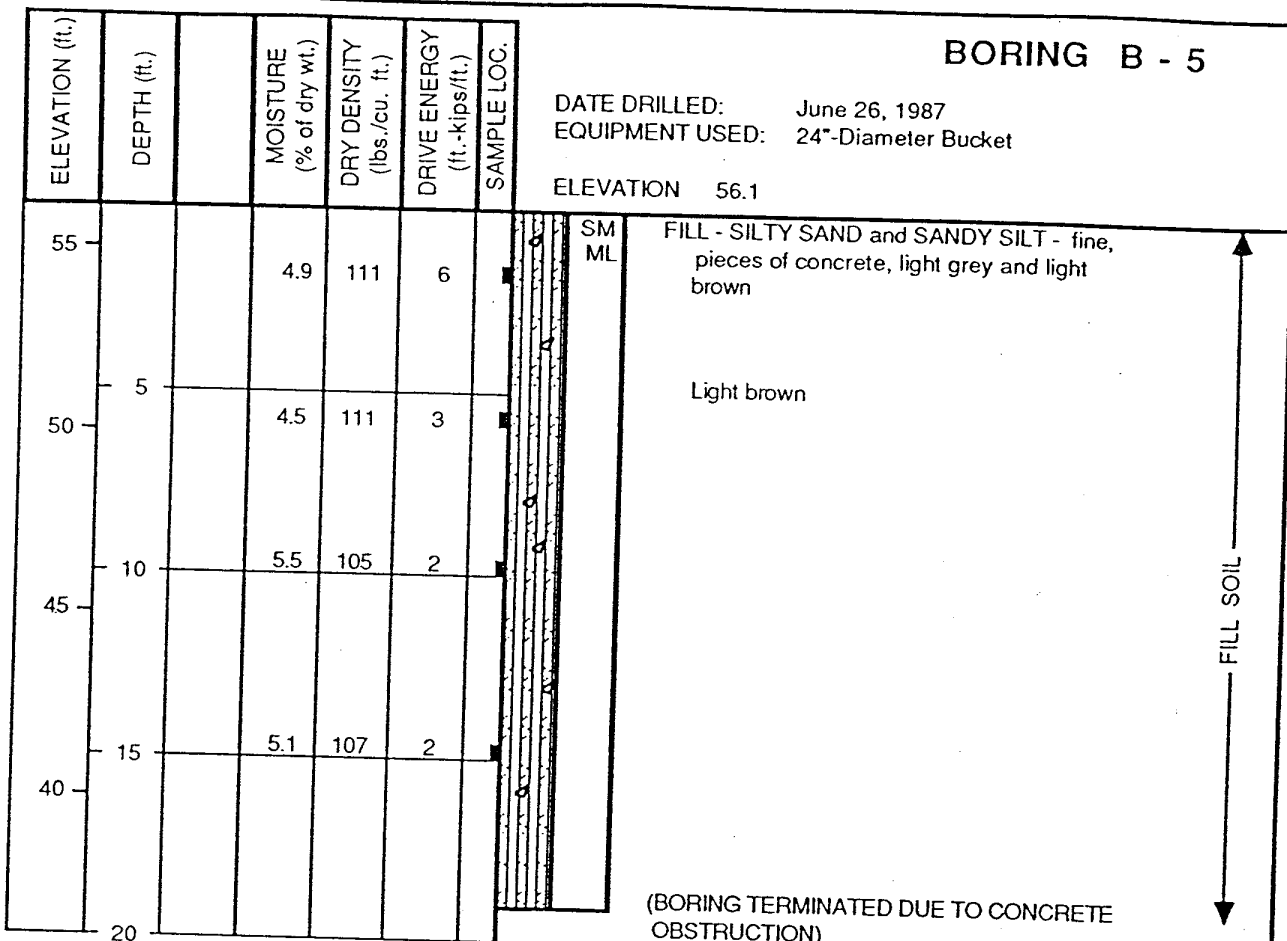
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.5b

DB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. AS O.E. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.



NOTE: Water not encountered. No caving.

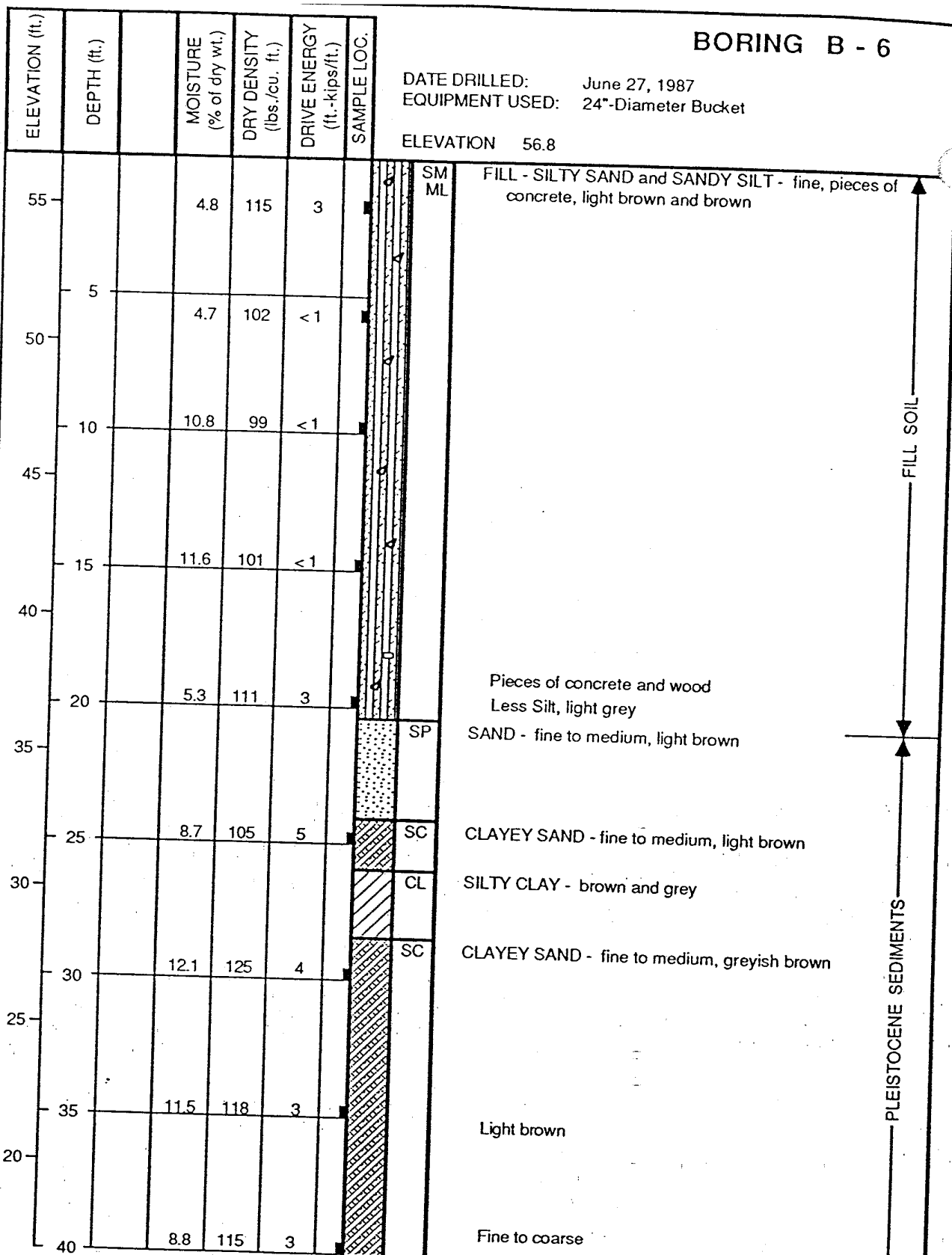
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D-1.6

JOB L90328.AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.7a

BORING B - 6 (Continued)

DATE DRILLED: June 27, 1987
EQUIPMENT USED: 24"-Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
15					
45		8.2	101	4	
10					
50		4.6	110	10	
5					
55		20.8	102	19	
0					
60		14.2	108	19.	

Fine to medium

Reddish brown

Light brown

PLEISTOCENE SEDIMENTS

NOTE: Water level measured at a depth of 56' at completion of drilling and at 55' 5 minutes later. Heavy caving below 57.

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE D - 1.7b

JB L90328-AEO DATE 8/24/90 F.T. LS DR. dmh W.P. dmh AS O.E. dmh CHKD

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	 GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			 GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amt. of fines)	 GM	Silty gravels, gravel-sand-silt mixtures.
			 GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 sieve size)	CLEAN SANDS (Little or no fines)	 SW	Well graded sands, gravelly sands, little or no fines.
			 SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amt. of fines)	 SM	Silty sands, sand-silt mixtures.
			 SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (More than 50% of material is SMALLER than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit LESS than 50)	 ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	
		 CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	
		 OL	Organic silts and organic silty clays of low plasticity.	
		SILTS AND CLAYS (Liquid limit GREATER than 50)	 MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
	 CH		Inorganic clays of high plasticity, fat clays.	
	 OH		Organic clays of medium to high plasticity, organic silts.	
	HIGHLY ORGANIC SOILS		 PI	Peat and other highly organic soils.

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

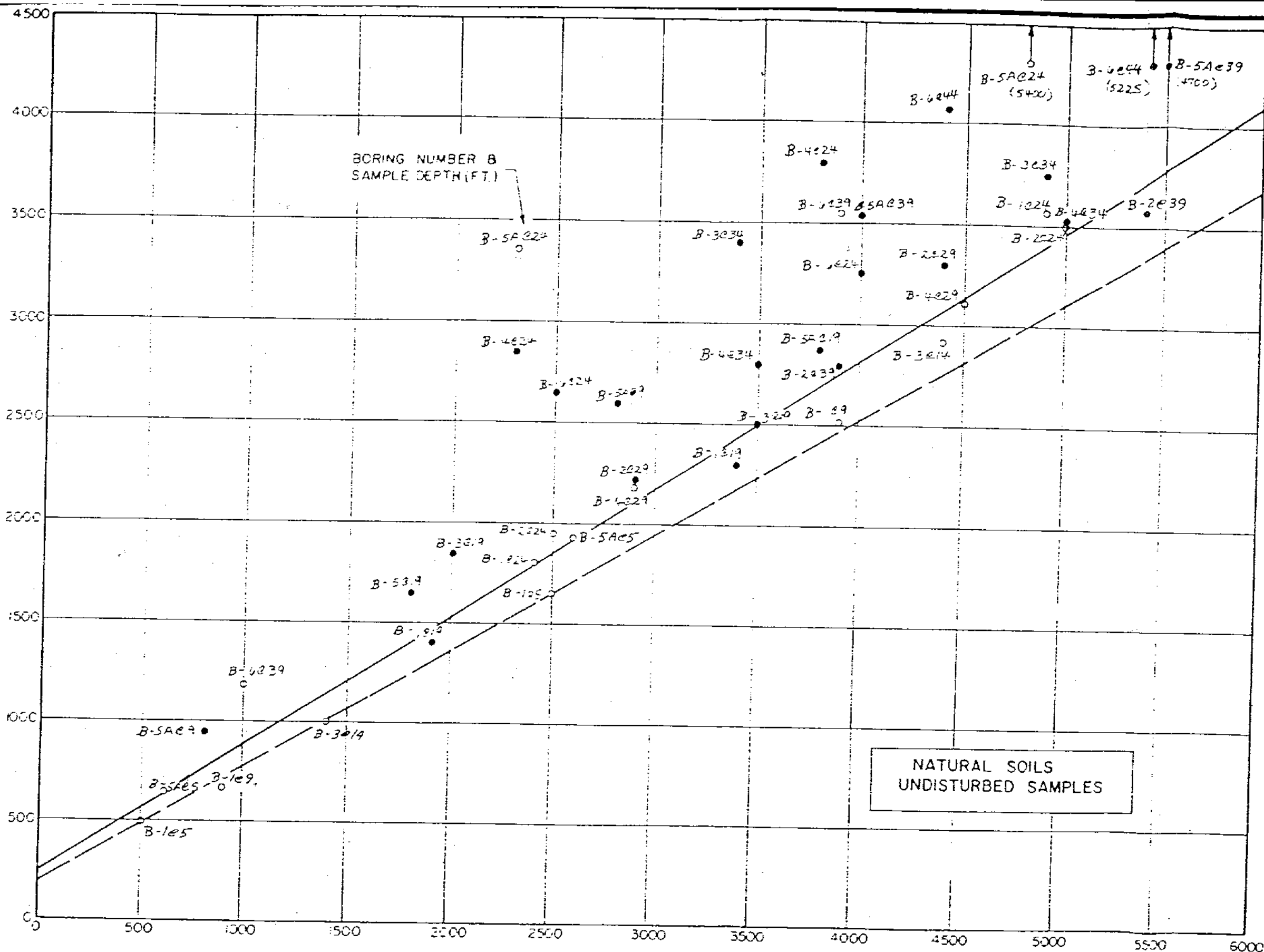
P A R T I C L E S I Z E L I M I T S						
SILT OR CLAY	SAND			GRAVEL		BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE	
	NO. 200	NO. 40	NO. 10	NO. 4	3/4 in.	3 in.
	U. S. STANDARD SIEVE SIZE					12 in.

UNIFIED SOIL CLASSIFICATION SYSTEM

Reference:
The Unified Soil Classification System, Corps of Engineers, U. S. Army Technical Memorandum No 3-357, Vol I, March, 1953. (Revised April, 1960)

LEROY CRANDALL & ASSOCIATES

SHEAR STRENGTH in Pounds per Square Foot

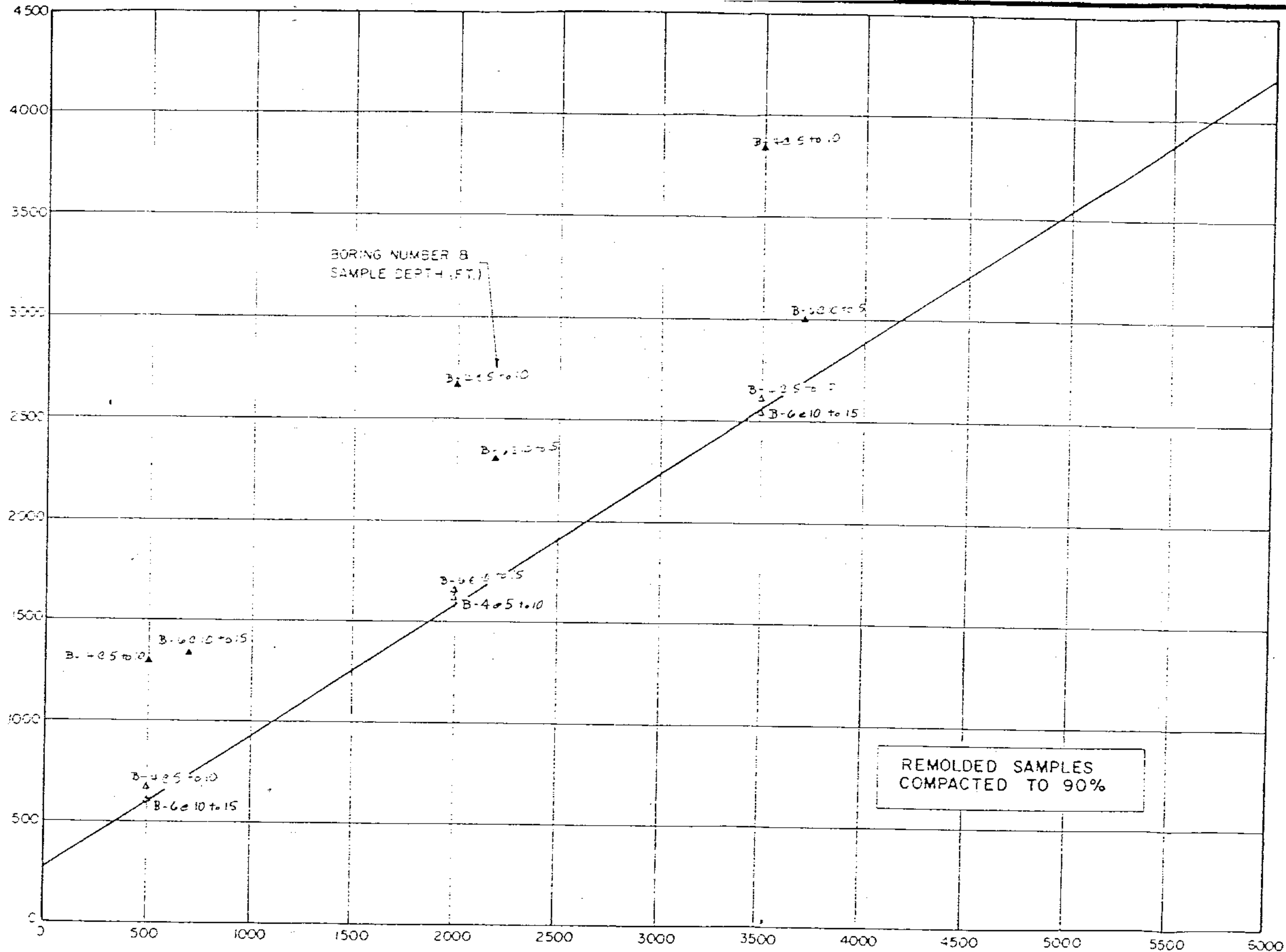


SURCHARGE PRESSURE in Pounds per Square Foot

DIRECT SHEAR TEST DATA

LeROY CRANDALL AND ASSOCIATES

SHEAR STRENGTH in Pounds per Square Foot

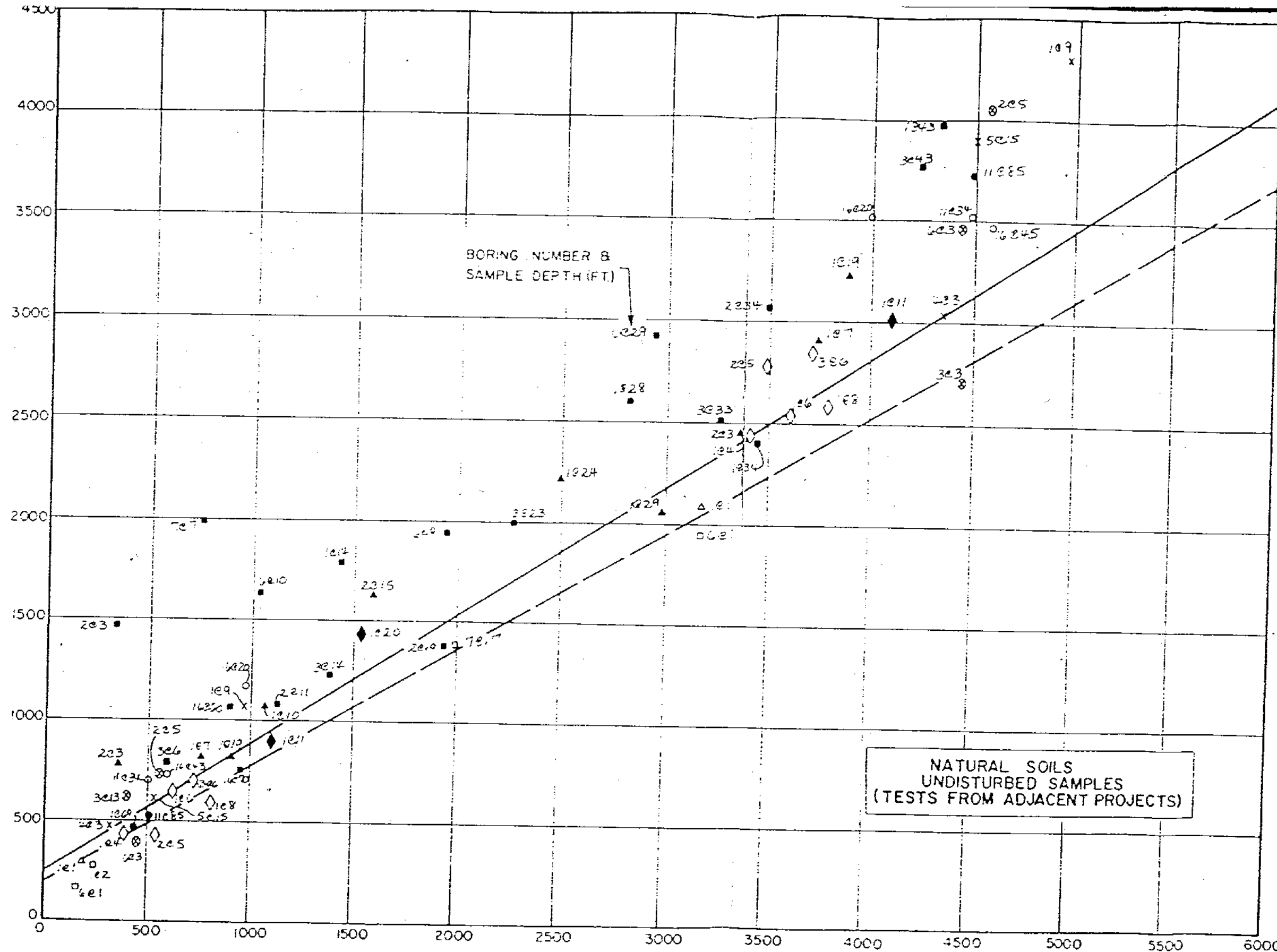


SURCHARGE PRESSURE in Pounds per Square Foot

DIRECT SHEAR TEST DATA

LEROY CRANDALL AND ASSOCIATES

SHEAR STRENGTH in Pounds per Square Foot



SURCHARGE PRESSURE in Pounds per Square Foot

DIRECT SHEAR TEST DATA

LeROY CRANDALL AND ASSOCIATES

JOB L90328.AEO DATE 1/3/91 W.P. _____ Ip _____ O.E. _____ AS _____ CHKD _____

BORING NUMBER AND SAMPLE DEPTH	SOIL TYPE	% PASSING NO. 200 SIEVE
B - 1 at 5'	SILTY SAND	14
B - 1 at 19'	SAND (SP-SM)	7
B - 2 at 5'	FILL - SILTY SAND	17
B - 2 at 14'	FILL - SILTY SAND	13
B - 2 at 29'	SAND (SP-SM)	7
B - 2 at 39'	SILTY SAND	12
B - 3 at 3'	FILL - SILTY SAND	12
B - 3 at 9'	FILL - SANDY SILT	55
B - 3 at 19'	SILTY SAND	42
B - 4 at 14'	FILL - SILTY SAND	29
B - 4 at 24'	CLAYEY SAND	44
B - 4 at 34'	SAND	4
B - 4 at 39'	SAND	10
B - 5A at 5'	SAND (SP-SM)	6
B - 5A at 9'	SAND	4
B - 5A at 19'	SAND (SP-SM)	7
B - 5A at 39'	SAND (SP-SM)	7
B - 6 at 5'	FILL - SILTY SAND	17
B - 6 at 14'	FILL - SILTY SAND	22
B - 6 at 24'	CLAYEY SAND	12
B - 6 at 29'	CLAYEY SAND	36
B - 6 at 44'	CLAYEY SAND	16

Test Method: ASTM Designation D1140-54

SIEVE DATA

LeROY CRANDALL AND ASSOCIATES
PLATE D - 4

JOB L90328.AEO DATE 1/3/91 W.P. drh O.E. AS CHKD

BORING NUMBER
AND SAMPLE DEPTH :

B - 4 at 5' to 10'

B - 6 at 10' to 15'

SOIL TYPE :

FILL - SILTY SAND
and SANDY SILT

FILL - SILTY SAND
and SANDY SILT

MAXIMUM DRY DENSITY :
(lbs./cu. ft.)

133

126

OPTIMUM MOISTURE CONTENT :
(% of dry wt.)

8.5

9.5

TEST METHOD: ASTM Designation D1557 - 70

COMPACTION TEST DATA

APPENDIX E:

BLUFF PLANT LIST

A landscaping plant list has been developed by Campbell & Campbell, Landscape Architects for the bluff. A copy of that list has been provided to us by Sharon H. Lockhart and is presented as Plates E-1 and E-2.

-o0o-

Proposed Plantings Westchester and Playa del Rey Bluffs

Coastal Sage Scrub

Large Plant Cover

(plants listed in order of abundance with most abundant being first)

Artemisia californica	Coastal Sagebrush
Lupinus longifolius	Lupine
Baccharis pilularis consanguinea	Chaparral Broom
Isomeris arborea	Bladderpod
Rhus integrifolia	Lemonade Berry
Datura wrightii	
Encelia californica	Coast Sunflower
Salvia mellifera	Black Sage
Prunus virginiana	Western Chokeberry
Rhus laurina	Laurel Sumac
Heteromeles arbutifolia	Toyon

Coastal Sage Scrub

Subshrub Cover

(plants listed in order of abundance with most abundant being first)

Eschscholzia californica	California Poppy
Astragalus leucopsis	
Cirsium occidentale	Western Thistle
Calystegia macrostegia	Morning Glory
Senecio douglasii	Bush Groundsel
Solanum douglasii	Douglas Nightshade
Horkelia cuneata	

Perennial Grasses

(to be introduced as plugs)

Stipa pulchra/cernus	Purple Stipa
Melica imperfecta	Coast Range Melic
Elymus condensatus	Giant Wild Rye

Hydroseed Mix
(in alphabetical order)

Ambrosia psilostachya	Western Ragweed
Artemisia californica	Coastal Sagebrush
Baccharis pilularis consanguinea	Chaparral Broom
Corethrogyne filaginifolia	Curweed Aster
Croton californicus	
Cucurbita foetidissima	Calabazilla
Encelia californica	Coast Sunflower
Eriogonum gracile	
Eriogonum parvifolium	Coastal Buckwheat
Eschscholzia californica	California Poppy
Gnaphalium bicolor	Bicolor Cudweed
Gnaphalium microcephalum	White Everlasting
Haplopappus ericoides	Mock Heather
Haplopappus squarrosus	Sawtooth Goldenbush
Haplopappus venetus	Coastal Goldenbush
Heterotheca grandiflora	Telegraph Weed
Isomeris arborea	Bladderpod
Lasthenia glabrata	
Lotus scoparius	Deerweed
Lotus strigosus	Bishop's Lotus
Lupinus bicolor	Lupine
Lupinus succulentus	Succulent Lupine
Malcothamnus fasciculatus	Mesa Bushmallow
Marah macrocarpus	Wild Cucumber
Orthocarpus purpurascens	Owl's Clover
Phacelia ramosissima	
Salvia aplana	White Sage
Salvia mellifera	Black Sage
Senecio douglasii	Bush Groundsel
Stipa pulchra/cernus	Purple Stipa