LAW Crandall
LAWGIBB Group Member

REPORT OF SUPPLEMENTAL EXPLORATION BORINGS

PASADENA BLUE LINE
DEL MAR TO MEMORIAL PARK LINE SEGMENT
PASADENA, CALIFORNIA

Prepared for:

ENGINEERING MANAGEMENT CONSULTANT

Los Angeles, California

March 25, 1998

Project No. 70131-2-0672.0029

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REPORT OF SUPPLEMENTAL EXPLORATION BORINGS
PROPOSED PASADENA BLUE LINE
PASADENA, CALIFORNIA
CONTRACT C6450
DEL MAR TO MEMORIAL PARK LINE SEGMENT
PASADENA BLUE LINE RAIL TRANSIT PROJECT
LAW/CRANDALL PROJECT 70131-2-0672.0029

March 25, 1998

INTRODUCTION

This report presents the results of our supplemental exploration borings for the Del Mar to Memorial Park Line Segment of the proposed Pasadena Blue Line Rail Transit Project. Law/Crandall performed the geotechnical investigation for the proposed Pasadena Blue Line Rail Transit Project and the geotechnical report was submitted on June 9, 1993 (our Project No. L92045.AE4).

Our services for this study were authorized on November 25, 1997, under Contract No. 2055, MTA CWO #0039, Work Order No. 28, WBS # R051340, by Mr. Robert L. Allman, Engineering Management Consultant Project Manager, Pasadena Blue Line.

The professional opinions presented in this supplementary report have been developed 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.

SCOPE OF SERVICES

Law/Crandall's services consisted of:

- Supplementary subsurface explorations to further determine the nature and stratigraphy of the subsurface soils, and to obtain soil samples for laboratory observation and testing.
- Laboratory testing of soils samples for determination of the static and dynamic physical soil properties.
- Preparation of a written report presenting the results of the supplementary explorations and laboratory testing.

PROJECT DESCRIPTION

A portion of the Del Mar to Memorial Park Line Segment of the proposed Pasadena Blue Line is planned to be below grade in a cut and cover tunnel. The alignment is within the former right-of-way of the Atchison, Topeka and Santa Fe (ATSF) Railroad between Del Mar Avenue (at the south) and Memorial Park (at the north) in the city of Pasadena. The Line Segment runs within the north-south oriented right-of-way located halfway between Arroyo Seco Parkway on the east and Raymond Avenue on the west. From the south end of the Line Segment (at Station NB 582.00) to Station NB 596+90, the alignment is planned to transition from at-grade to an open trench. From Station NB 596+90 to Station NB 608+58, the alignment is planned to be in a cut and cover box structure. From Station NB 608+58 to the north end of the Line Segment (at Station NB 618+00), the alignment is planned to transition from an open trench to at-grade.

At the time of our 1993 geotechnical investigation for the Pasadena Blue Line, the railroad was still in operation, and only a limited number of borings could be drilled in or near the ATSF Railroad right-of-way. Also, drilling in the public streets was not permitted by the City of Pasadena. Consequently, there were no borings drilled in the section where the cut and cover tunnel will be the deepest near Green Street and Colorado Boulevard. The right-of-way was abandoned by the railroad after being purchased by the Los Angeles County Metropolitan Transportation Authority (MTA). The tracks have been removed, and the alignment is now currently leased out as surface parking paved in asphaltic concrete. The earlier borings in the vicinity found sandy soils with significant amounts of gravel and cobble; these soils are also subject to raveling and caving. The cut and cover tunnel passes through "Old Pasadena," and many of the adjacent buildings along this portion of the alignment are historically significant structures. The structures are generally very old and most or all are of unreinforced masonry construction.

SUPPLEMENTARY FIELD EXPLORATIONS AND LABORATORY TESTS

FIELD EXPLORATIONS

The soil conditions along this portion of the alignment were further explored by drilling four additional borings at the locations shown in Figures 1.1 and 1.2, Boring Locations. The borings were drilled to depths of about 40 feet below the existing grade using 8-inch-diameter hollow stem auger-type drilling equipment. Originally, we had planned to drill the borings with 24-inch-diameter bucket auger drilling equipment and to use the soil cuttings as backfill. As the result of the review of the boring locations by the Real Estate Environmental Group of the Metropolitan Transportation Authority (MTA), we were informed by Mr. Al Ruppel of MTA that their records indicated that the proposed new boring locations were not in areas of known contamination. However, Mr. Ruppel said that it was a requirement that the borings be backfilled with grout and that cuttings derived from the drilling of the soil borings be placed in DOT-approved drums pending soil characterization for disposal purposes. A copy of a memorandum documenting the boring requirements is attached. The drilling of large diameter bucket auger borings as originally planned would produce a very large amount of soil cuttings. To minimize the amount of soil cuttings and backfilling of the borings, the borings were drilled with an 8-inch-diameter hollow stem auger instead of a 24-inch bucket auger. The cuttings were stored in DOT-approved drums and transported to the MTA Storage Yard near Downtown Los Angeles.

The soils encountered were logged by a Certified Engineering Geologist, and "California-type" ring samples, and bulk samples were obtained for laboratory inspection and testing. The "California-type" ring samples were obtained with the Crandall sampler which is a brass ring-lined 3.188-inch (outside diameter) tube driven with a kelly bar; the inside diameter of the sampler is 2.625 inches. The logs of the borings are presented in Figures 2.1 through 2.4; the depths at which "California-type" ring samples were obtained are indicated to the left of the boring logs. The number of blows required to drive the Crandall sampler 12 inches and the hammer weight and drop are indicated on the logs. In addition to obtaining the ring samples, standard penetration tests (SPT) were performed in Borings 203 and 204; the results of the tests are indicated on the logs. The weights and stroke for both Crandall sampler and SPTs are defined in Figure 3.1, Key to Logs of Borings. The soils are classified in accordance with the Unified Soil Classification System described in Figure 3.2.

SPT sampling was not performed in Borings 201 and 202. However, we calculated equivalent "N" values from the blows required to drive the Crandall sampler 12-inches based on an empirical formula; the equivalent "N" are indicated on the logs. The empirical correlation used indicates that 1 blow of the Crandall sampler is equivalent to about 0.52 SPT blows. The empirical formula is:

$$SPT = \frac{\text{(L/C Drive wt) (L/C Stroke)}}{\text{(SPT Drive wt) (SPT Stroke)}} \times \frac{A_{spt}}{A_{L/C}}$$

$$\times \frac{\text{(Efficiency of L/C Sampler)}}{\text{(Efficiency of SPT Sampler)}} \times \text{(L/C Blow Count)}$$

$$SPT = \frac{\text{(140 lb) (1.5 ft)}}{\text{(140 lb) (2.5 ft.)}} \times \frac{1.66\ in^2}{2.57\ in^2} \times \frac{80\%}{60\%} \times \text{(L/C Blow Count)}$$

$$SPT = 0.52 \times \text{(L/C Blow count)}$$

MONITORING FOR VOLATILE ORGANIC COMPOUNDS

The samples were monitored during our field explorations for volatile organic compounds using a Gastechtor Model 1238, a type of organic vapor analyzer (OVA). The OVA readings are indicated on the boring logs.

LABORATORY TESTS

Laboratory tests were performed on selected samples obtained from the borings to aid in the classification of the soils and to determine their engineering properties. The results of the laboratory tests are presented, as discussed below. In addition to the current laboratory tests, the results from the laboratory testing from samples obtained in the previous borings performed from Station NB 593+00 to Station NB 618+00 are also included in this report.

The field moisture content and dry density of the soils encountered in-the current borings were determined by performing tests on the "California-type" ring samples. The results of the current tests are shown to the left of the boring logs.

Direct shear tests were performed on selected samples to determine the strength of the soils. The tests were performed at field moisture content at various surcharge pressures. The yield-point values determined from the current direct shear tests are presented in Figure 4.1, Direct Shear Test Data. The yield-point values determined from the previous direct shear tests are presented in Figure 4.2, Direct Shear Test Data.

Confined consolidation tests were performed on 5 samples from the previous borings to determine the compressibility of the soils. The results of the tests are presented in Figures 5.1 through 5.3, Consolidation Test Data.

To determine the particle size distribution of the soils and to aid in classifying the soils, mechanical analyses were performed on six samples from the current borings. The results of the mechanical analyses are presented in Figures 6.1 and 6.2, Particle Size Distribution. The results of the mechanical analyses performed on samples from the previous borings are presented in Figure 6.3, Particle Size Distribution. Atterberg Limits tests were performed on the sample from Boring 202 at a depth of 30½ feet and Boring 204 at a depth of 35 feet; the plasticity tests could not be performed, indicating non-plastic soil.

FINDINGS

The soils encountered in Borings 201 through 204 consist of shallow artificial fill which is a remnant of the railroad; the fill consists of 18 to 24 inches of rock ballast over silty sand or sandy silt to a depth of about 3 to 5 feet below the existing grade. Below the fill, natural soils of Holocene age consisting of silty sand, sandy silt, and sand were encountered to the maximum depth of 40 feet in the borings. The sands and silty sands contain varying amounts of gravel; some cobbles were also encountered below 30 feet. The standard penetration blow counts indicate that the natural soils are dense.

Groundwater was not encountered in any of the borings. The OVA readings did not indicate the presence of detectable volatile organic compounds.

The soil conditions encountered in the new Borings 201 through 204 are similar to those previously encountered in Borings 27 through 29 and 89 through 92 in this Line Segment. The laboratory testing from the new soil samples give similar results as those previously obtained.

The following soil properties, previously recommended as the soil properties for Design Group 3 structures, may be used for design:

Cohesion	100 psf
Void Ratio Granular Soils	0.45
Modulus of Subgrade Reaction Granular Soils	200 pci
Angle of Internal Friction	39 degrees
Moist Unit Weight of Soil	120 pcf

In addition, lateral earth pressures may be taken as discussed in the following section, Conclusions and Recommendations.

Raveling of the sandy soils occurred in our prior borings in the upper 10 feet as well as at depths of 20 to 26 feet and below 40 feet. Observations of raveling or caving of the soils were not possible in the current borings because of the hollow-stem auger drilling equipment used. However, the direct shear tests indicate that the sands and silty sands do not have significant cohesion, thus confirming that these soils would have a tendency to ravel or cave when excavated.

CONCLUSIONS AND RECOMMENDATIONS

Based on the supplementary field explorations and laboratory test results, the soils encountered in this portion of the rail alignment are similar to those encountered in the previous investigation. Therefore, the recommendations contained in our June 9, 1993, geotechnical report are still applicable; however, for your information and convenience, our prior recommendations for this segment of alignment are presented in the following sections.

The proposed below-grade cut and cover tunnel may be designed using the recommendations in Section 11.0 of the June 9, 1993, report. The recommendations for shoring, slopes, and excavation are still considered applicable. The recommendations for underpinning and lateral surcharge pressures on lateral support systems are also still considered applicable.

Difficulties due to caving, gravel and cobbles should be anticipated and special precautions should be taken during excavation, installation of soldier piles, and installation of underpinning.

RECOMMENDATIONS—BELOW-GRADE CONSTRUCTION EXCERPTED FROM REPORT DATED JUNE 9, 1993

Fill soils, 1 to 6 feet deep, were encountered in the borings drilled within this area. The fill soils, which are not uniformly well compacted, consist of silt and silty sand and contain some debris. The underlying natural soils consist of sandy silt, silty sand, sand, and gravel with considerable amounts of cobbles. Water was not encountered within the 60-foot depth explored.

The right-of-way within this portion of the alignment is as narrow as 30 feet wide, and the proposed excavation for the depressed and tunnel areas will extend close to the various structures adjacent to the alignment. Underpinning of some of the existing footings that are close to the depressed and tunnel areas may be necessary. As an alternative, the shoring and walls below grade could be designed to support the loads imposed by the adjacent existing foundations.

Retaining walls and tunnel walls for this portion of the alignment may be supported on spread footings.

FOUNDATIONS

Bearing Values

Spread footings for this portion of the alignment may impose bearing pressures up to 8,000 pounds per square foot in the dense sand and gravel.

Footings should extend at least 1 foot into the supporting material and should be established at least 3 feet below the lowest adjacent final grade. A one-third increase in the recommended values may be used for wind or seismic loads. The recommended bearing values are net values. The weight of concrete in the footings may be assumed to be 50 pounds per cubic foot, and the weight of soil backfill may be neglected when determining the downward load on the footings.

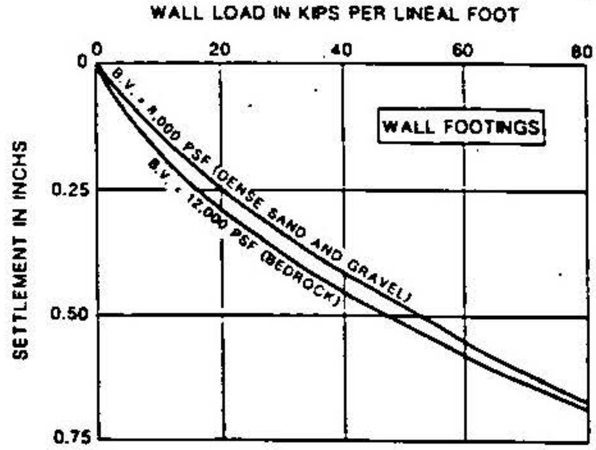
Lateral Loads

Lateral loads may be resisted by soil friction and by the passive resistance of the soils. A coefficient of friction of 0.5 may be used between footings and the supporting materials. A passive value of 300 pounds per square foot per foot of depth may be used.

A one-third increase in the passive values may be used for wind or seismic loads. The frictional resistance and the passive resistance of the soils may be combined without reduction in determining the total lateral resistance.

Settlement

The settlement of spread footings established in the dense sand and gravel may be determined using the following graph:



Footing Observation

The footing excavations should be carefully observed to verify the presence of satisfactory materials at footing design elevations. Footings should be deepened if necessary to extend into satisfactory supporting material.

The foundations should be left slightly uneven if necessary, rather than filling in overexcavated areas with loose or compacted soils. Where it is necessary to deepen a footing below the design depth, the overexcavated portion should be backfilled with concrete.

EXCAVATION AND SLOPES

Where space is not available for sloped cuts, shoring will be required. Shallow excavations are planned at the beginning and at the end of the below-grade construction. Where space is available at these locations, temporary unsurcharged excavations could be sloped back at 1:1. Preliminary data for shoring design are presented in the following section. All applicable safety requirements, including OSHA requirements, should be met.

Where sloped embankments are used, the tops of the slopes should be barricaded to prevent vehicles and storage loads within 5 feet of the tops of the slopes. A greater setback may be necessary when considering heavy vehicles, such as concrete trucks and cranes. If the temporary construction embankments are to be maintained during the rainy season, berms are suggested along the tops of the slopes, where necessary, to prevent runoff water from entering the excavation and eroding the slope faces. The soils exposed in the cut slopes should be inspected during excavation so that modifications of the slopes can be made if variations in the soil conditions occur, or if adverse seepage conditions develop.

SHORING

General

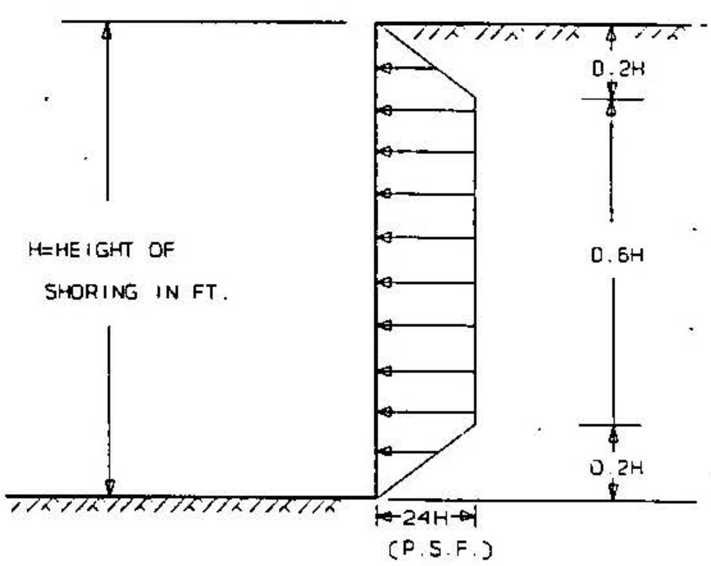
Where there is not sufficient space for sloped embankments, shoring will be required. One method of shoring would consist of steel soldier piles place in drilled holes, backfilled with concrete, and tied back with drilled-in friction anchors. However, because of space limitations and the granular nature of the subsurface soils, it would be very difficult to install tie-back anchors, and the installation of cantilevered, cross-braced, or internally braced shoring would be more practical. Another method of shoring being considered consists of tangent or secant piles that are cantilevered or cross braced.

Lateral Pressures

For design of cantilevered shoring, a triangular distribution of lateral earth pressure may be used. It may be assumed that the retained soils with level surface behind the cantilevered shoring will exert an active lateral pressure equal to that developed by a fluid with a density of 33 pounds per cubic foot.

When considering at rest earth pressure on cantilevered shoring, it may be assumed that the retained soils with level surface behind the shoring will exert a lateral pressure equal to that developed by a fluid with a density of 52 pounds per cubic foot.

For design of cross-braced or internally braced shoring, we recommend the use of a trapezoidal distribution of active earth pressure. The recommended pressure distribution, for the case where the grade is level behind the shoring, is illustrated below with the maximum pressure equal to 24H in pounds per square foot, where H is the height of the shoring in feet.



When considering "at rest" earth pressure on cross-braced or internally braced shoring, the lateral earth pressure would be similar to that presented above, except that the maximum earth pressure would be 37H pounds per square foot.

In addition to the recommended earth pressure, the upper 10 feet of shoring adjacent to the streets and traffic areas should be designed to resist a uniform lateral pressure of 100 pounds per square foot, which is a result of an assumed 300 pounds per square foot surcharge behind the shoring due to normal street traffic. If the traffic is kept back at least 10 feet from the shoring, the traffic surcharge may be neglected.

Surcharge Imposed by Existing Structures

In addition, the shoring (and walls below grade) should be designed to resist the lateral surcharge pressures imposed by the foundations of the adjacent existing structures. The foundation load information for some of the existing structures located adjacent to this portion of the alignment was provided to us on February 3,1993, by Mr. Guy Morrow of Degenkolb, Structural Engineers.

The recommended surcharge loads for the individual structures were presented in our report of June 9, 1993, and are still considered applicable.

This report supplements the geotechnical report of June 9, 1993.

Respectfully Submitted,

LAW/CRANDALL

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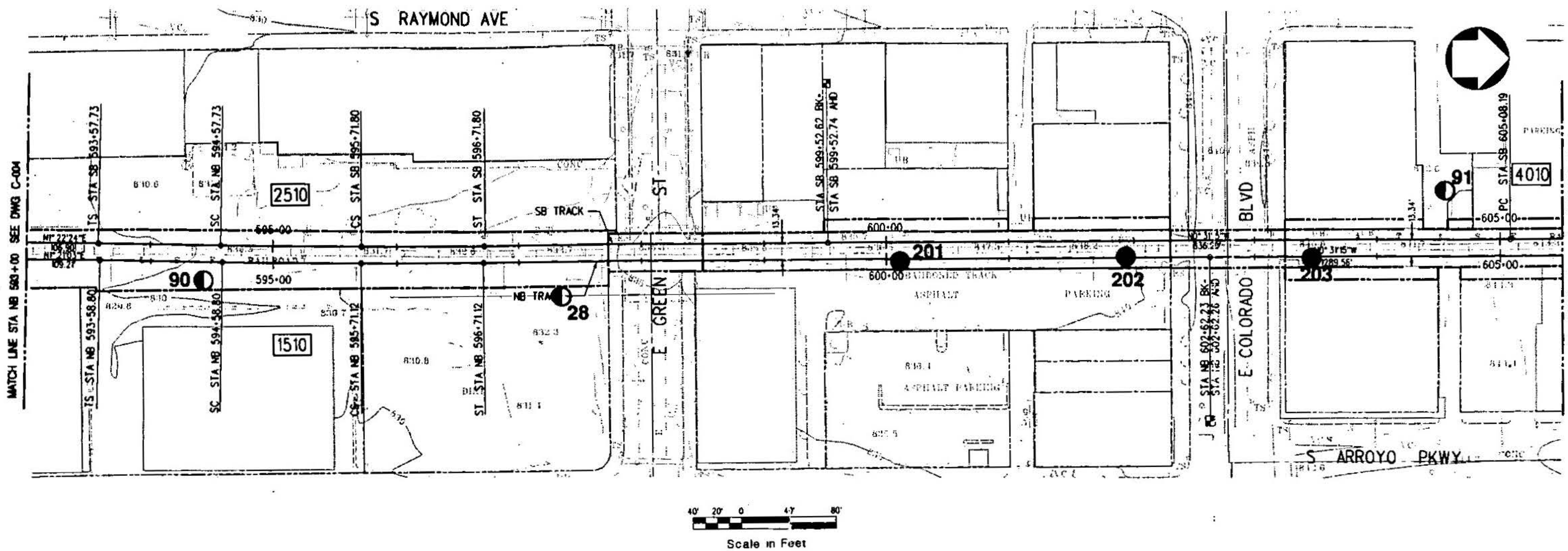


REFERENCE:
LAUPT TO PASADENA DEL MAR TO MEMORIAL PARK LINE SEGMENT PLAN AND PROFILE STA NB 593+00 TO STA 605+50 SHEET 2 OF 3 (DATED NOVEMBER 14, 1997), BY EMC.

LEGEND:

204 ● CURRENT INVESTIGATION (70131-2-0672.0029)

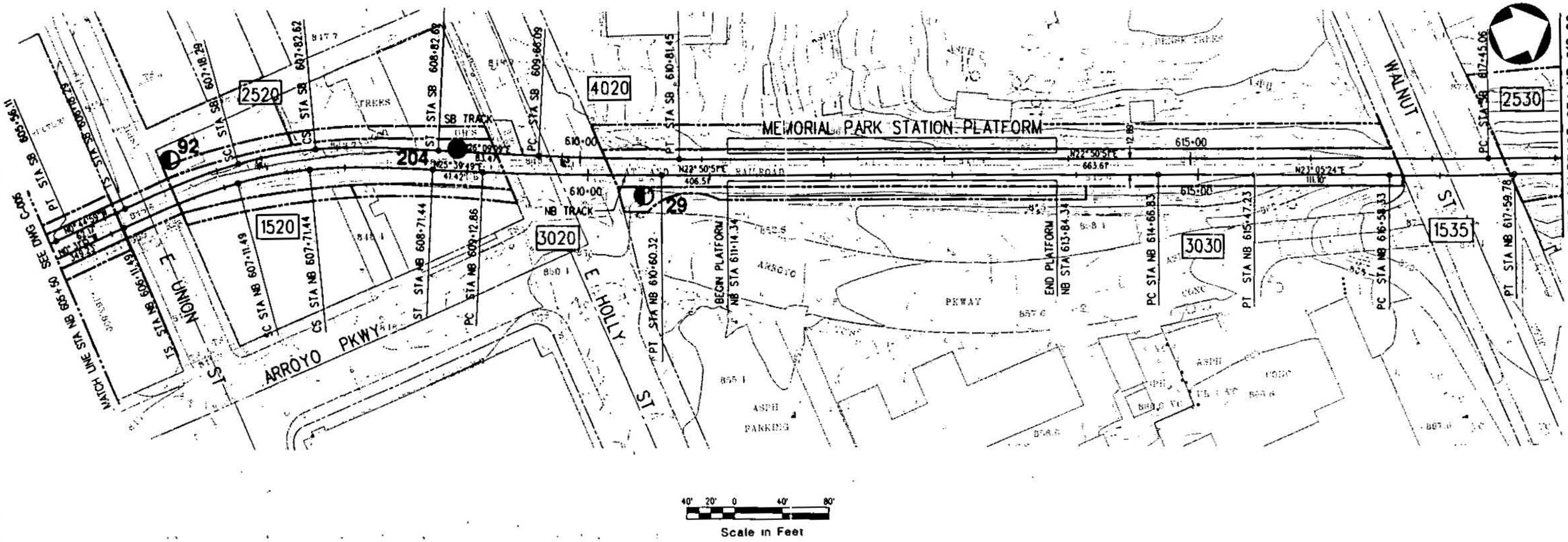
92 ◐ PREVIOUS INVESTIGATION (L92045.AE4)

└ BORING LOCATION AND NUMBER

BORING LOCATIONS

LAW/CRANDALL

FIGURE 1.1



REFERENCE:
LAUPT TO PASADENA DEL MAR TO MEMORIAL PARK LINE SEGMENT PLAN AND PROFILE STA NB 605+50 TO STA 618+00 SHEET 3 OF 3 (DATED NOVEMBER 14, 1997), BY EMC.

LEGEND:

204 ● CURRENT INVESTIGATION (70131-2-0672.0029)

92 ◐ PREVIOUS INVESTIGATION (L92045.AE4)

BORING LOCATION AND NUMBER

BORING LOCATIONS

LAW/CRANDALL

FIGURE 1.2

JOB 70131-2-0672.0029 DATE 3/5/1998 P.T. SMC DR.JB O.E. MWH CHKD mc

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-201

DATE DRILLED: January 12, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 837

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	O.V.A.** (ppm)	"N" VALUE STD.PEN.TEST	BLOW COUNT* (blows/ft.)	SAMPLE LOC.	USCS	DESCRIPTION
835	0–5							SM	ARTIFICIAL FILL (af) 24" Rock Ballast; SILTY SAND - fine, some Gravel, dark brown
830	5	5.0	108	<5		100 for 7"	■	SM	ALLUVIUM (Qal) SILTY SAND - fine to medium, about 20% Gravel, brown and grey
		5.6	112	<5		100	■		Fine, greyish brown
825	10	9.7	109	<5		80 for 11"	■		
820	15	13.6	112	<5		95	■		Mottled dark grey and brown
815	20	7.9	110	<5		96 for 11"	■		Brown
810	25	5.1	108	<5		63	■	SP-SM	SAND and SILTY SAND - fine, brown (10% Passing No. 200 Sieve)
								ML	SANDY SILT - few Gravel, reddish brown
805	30	14.8	121	<5		102 for 8"	■		*, **, *** see Figure 3.1, Key To Logs Of Borings
800	35					100 for 6"	□		Sample not recovered***
						100 for 7"			NOTE: Water not encountered. Sample not recovered
	40								END OF BORING AT 40'.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.1

JOB 70131-2-0672.0029 DATE 3/20/1998 F.T. SMC DR.JB O.E. MWH 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-202

DATE DRILLED: January 12, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 838

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	O.V.A.** (ppm)	EQUIVALENT "N" VALUE	BLOW COUNT* (blows/ft.)	SAMPLE LOC.		DESCRIPTION
									ARTIFICIAL FILL (af) 24" Rock Ballast
835								SM	SILTY SAND - fine, about 15% Gravel, dark brown
	5							SM	ALLUVIUM (Qal) SILTY SAND - fine to medium, about 20% Gravel, brown to greenish brown
					52	100	□		Sample not recovered
830					52	100	□		Sample not recovered
	10								
					52	100	□		Sample not recovered
825								ML	SANDY SILT - few Gravel, some Clay, brown
	15	18.7	103	<5	30	57	■		
820									
	20	12.5	105	<5	65	114	■		
815									
	25	8.5	98	<5	29	56	■	SM	SILTY SAND - fine, brown (23% Passing No. 200 Sieve)
810									
	30	16.3	115	<5	30	57	■	ML	SANDY SILT - some Clay, greyish brown (64% Passing No. 200 Sieve - Non-plastic fines)
805								SM	SILTY SAND - fine to medium, about 20% Gravel, brown
	35	4.7	110	<5	52	100	■		NOTE: Water not encountered.
800					57	110	□		Sample not recovered
	40								END OF BORING AT 40'.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.2

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-203

DATE DRILLED: January 13, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 841

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	O.V.A.** (ppm)	"N" VALUE STD.PEN.TEST	BLOW COUNT* (blows/ft.)
840						
		13.8	102	<5		50
	5					
835		9.9			50	
		3.9	112	<5		166
	10					
830		7.4			44	
		14.8	102	<5		56
	15					
825		7.0			52	
				<5		123
		8.5	117	<5		88
	20					
820		18.6			49	
		6.7	112	<5		108
	25					
815		5.6			83	
		12.3	100			61
	30					
810		13.8			49	
		6.7	113	<5		200 for 9"
	35					
805					50 for 6"	
		5.8	114	<5		200 for 7"
	40					

ARTIFICIAL FILL (af)
18" Rock Ballast

ML — SANDY SILT - about 20% Gravel, dark to reddish brown

ALLUVIUM (Qal)

SM — SILTY SAND - fine, about 20% Gravel, reddish brown to greyish brown

SP-SM — SAND and SILTY SAND - fine, some Gravel, reddish brown (9% Passing No. 200 Sieve)

Some Clay

SP — SAND - well graded, reddish brown

SM — SILTY SAND - fine, few Gravel, brown

About 30% Gravel

Some Gravel and Cobbles

NOTE: Water not encountered.

END OF BORING AT 40'.

LOG OF BORING

LAW/CRANDALL

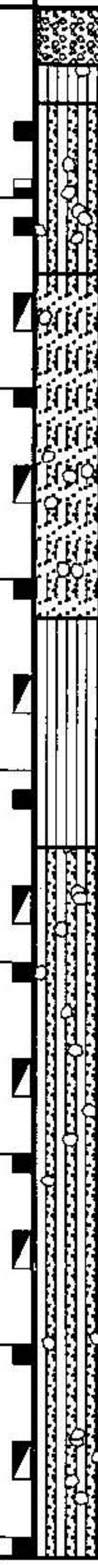
FIGURE 2.3

BORING B-204

DATE DRILLED: January 13, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 847

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	O.V.A.** (ppm)	"N" VALUE STD.PEN.TEST	BLOW COUNT* (blows/ft.)
845						
		8.0	104	<5		61
	5	5.6		<5		28
		5.2	106	<5		89
840		2.9			41	
	10	3.1	109	<5		200 for 11"
835		20.5			29	
	15	16.8	105	<5		47
830		26.2			17	
	20	17.8	106	<5		42
825		8.6			60	
	25	5.5	110	<5		73
820		6.4			65	
	30	4.3	117	<5		113
815		5.2			50 for 5"	
	35	5.9	113	<5		140 for 9"
810		5.8			50 for 5"	
	40			<5		200

SAMPLE LOC.



ARTIFICIAL FILL (af)
18" Rock Ballast

ML — SANDY SILT - dark brown

ALLUVIUM (Qal)

SM — SILTY SAND - fine, about 30% Gravel, brown
Disturbed sample

SP-SM — SAND and SILTY SAND - fine to coarse, some Gravel, light brown
(8% Passing No. 200 Sieve)

Brown

Some Clay

ML — SANDY SILT - reddish brown

SM — SILTY SAND - fine to coarse, about 20% Gravel, brown

(31% Passing No. 200 Sieve - Non-plastic fines)

NOTE: Water not encountered.

Few Cobbles

END OF BORING AT 40½'.

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.

JOB 70131-2-0672.0029 DATE 3/20/1998 F.T. SMc DR. JB O.E. MWH CHKD MWH for MWH

LOG OF BORING

LAW/CRANDALL

FIGURE 2.4

LAW/CRANDALL DRIVE SAMPLER:

6 ■ Indicates depth at which "California type" Ring sample obtained.

12 □ Indicates depth at which sampler was driven but no recovery.

17 ◘ Indicates depth at which disturbed sample obtained.

44 ◪ Indicates depth at which standard penetration test was performed.

* Number of blows required to drive the Crandall sampler 12 inches using a 140 pound hammer falling 18 inches.

** **O.V.A.:**
Gastechtor Model No. 1238 used.

*** Sand-trap used to retain sample, but in Borings B-201 and P-202, disturbed samples retained by Sand-trap were not transported to the laboratory in bags.

DATUM:

Elevations refer to datum of plan drawings provided by Engineering Management Consultant (EMC).

SOIL CLASSIFICATION:

Soils are classified according to the Unified Soil Classification System. (Shown on Figure 3.2)

KEY TO LOGS OF BORINGS

JOB 70131.20672.0029 DATE 2/26/98 DR. nh O.E. MWH CHKD

LAW/CRANDALL, INC.

FIGURE 3.1

JOB 70131-20672.0029 DATE 2/26/98 DR. nh O.E. MWH CHKD

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of material is LARGER than the 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 amount 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 amount 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 the 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	Peat and other highly organic soils

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

PARTICLE SIZE LIMITS

SILT OR CLAY	SAND			GRAVEL		COBBLES	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).

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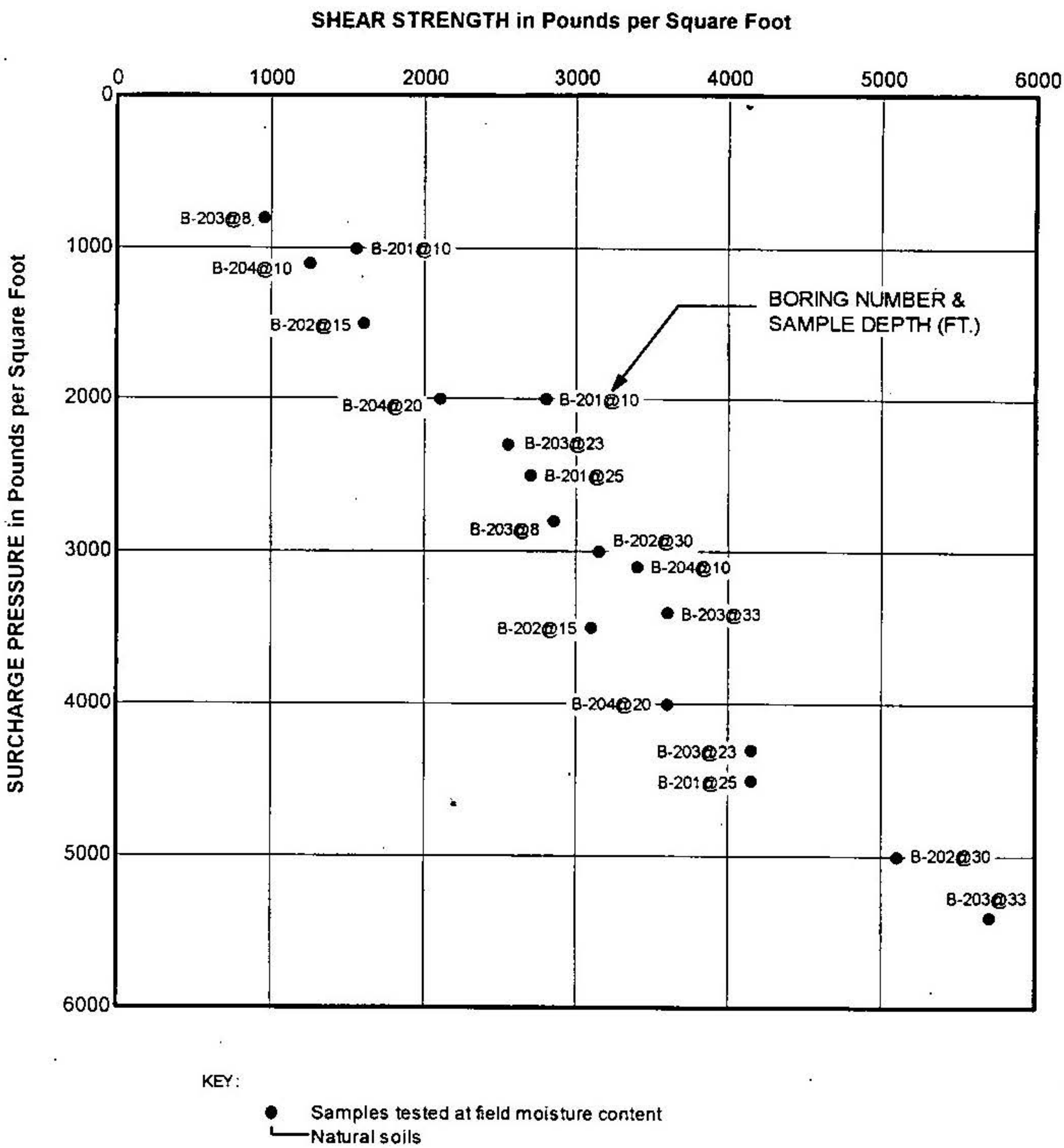
FIGURE 3.2



DIRECT SHEAR TEST DATA

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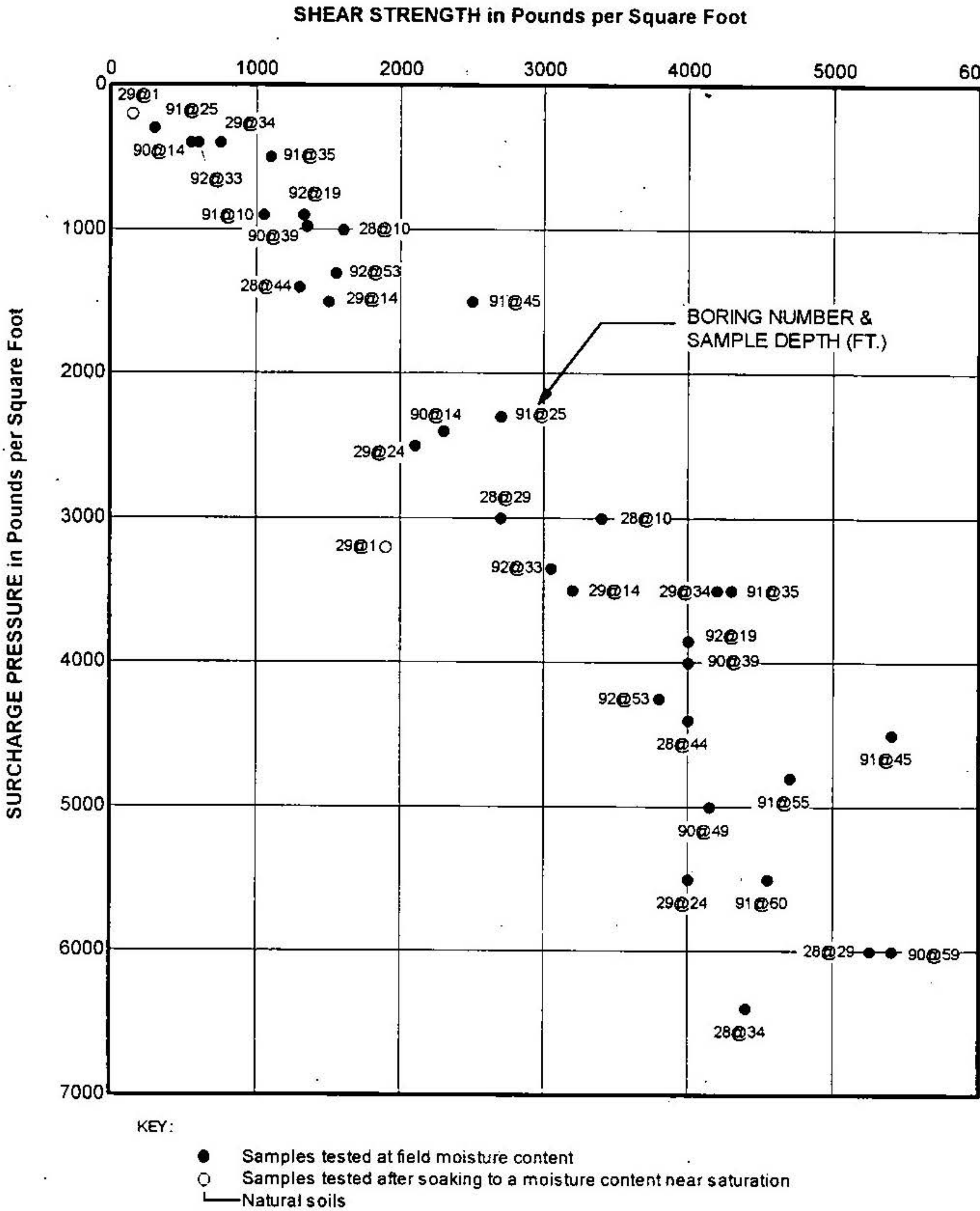
FIGURE 4.1

JOB 70131.20672.0029 DATE 1/16/98 DR JB OE MWH CHKD



DIRECT SHEAR TEST DATA

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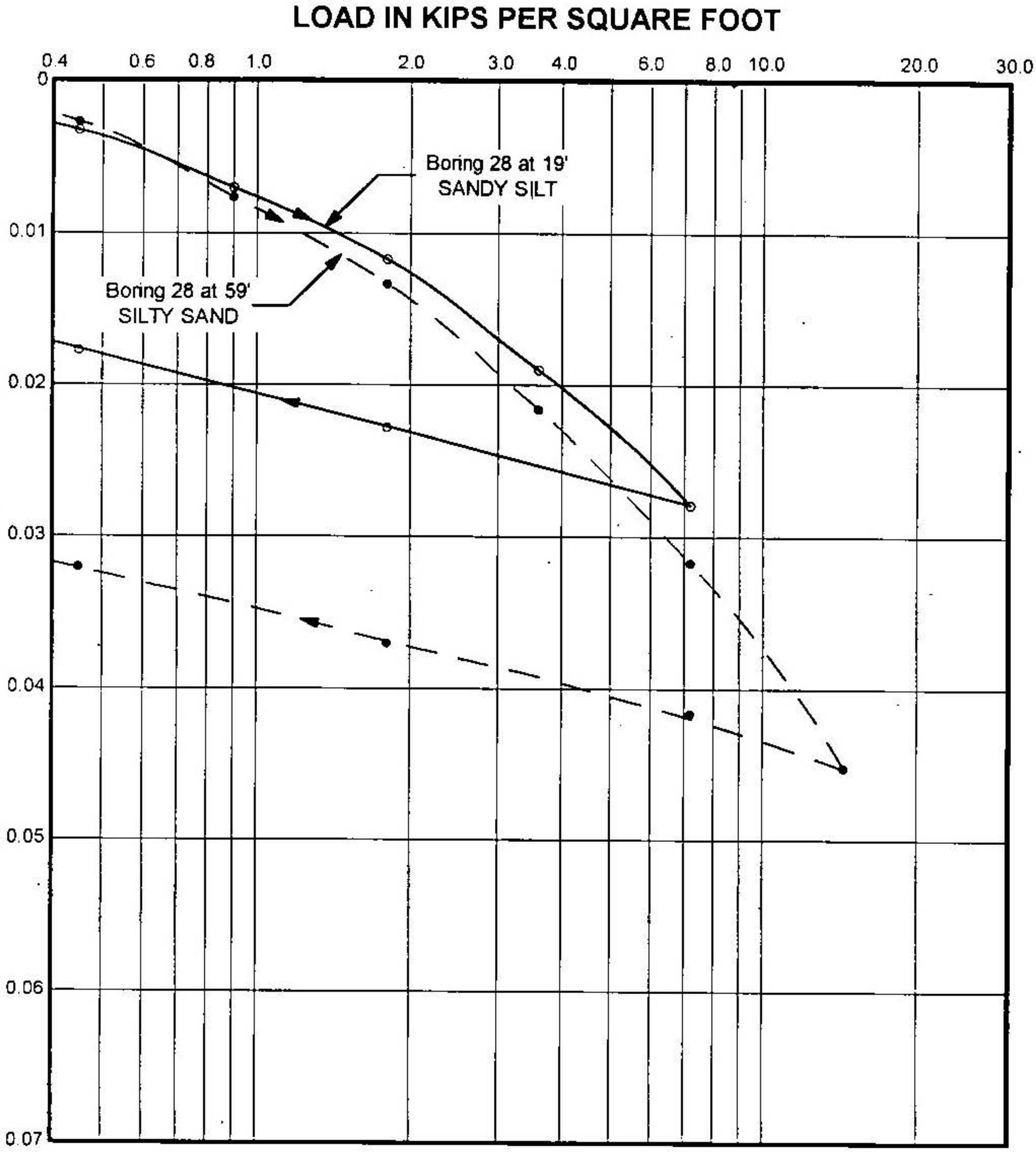
FIGURE 4.2

JOB 70131-2-0672.0029 DATE 3/4/98 DR MWH OE MWH CHKD



NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

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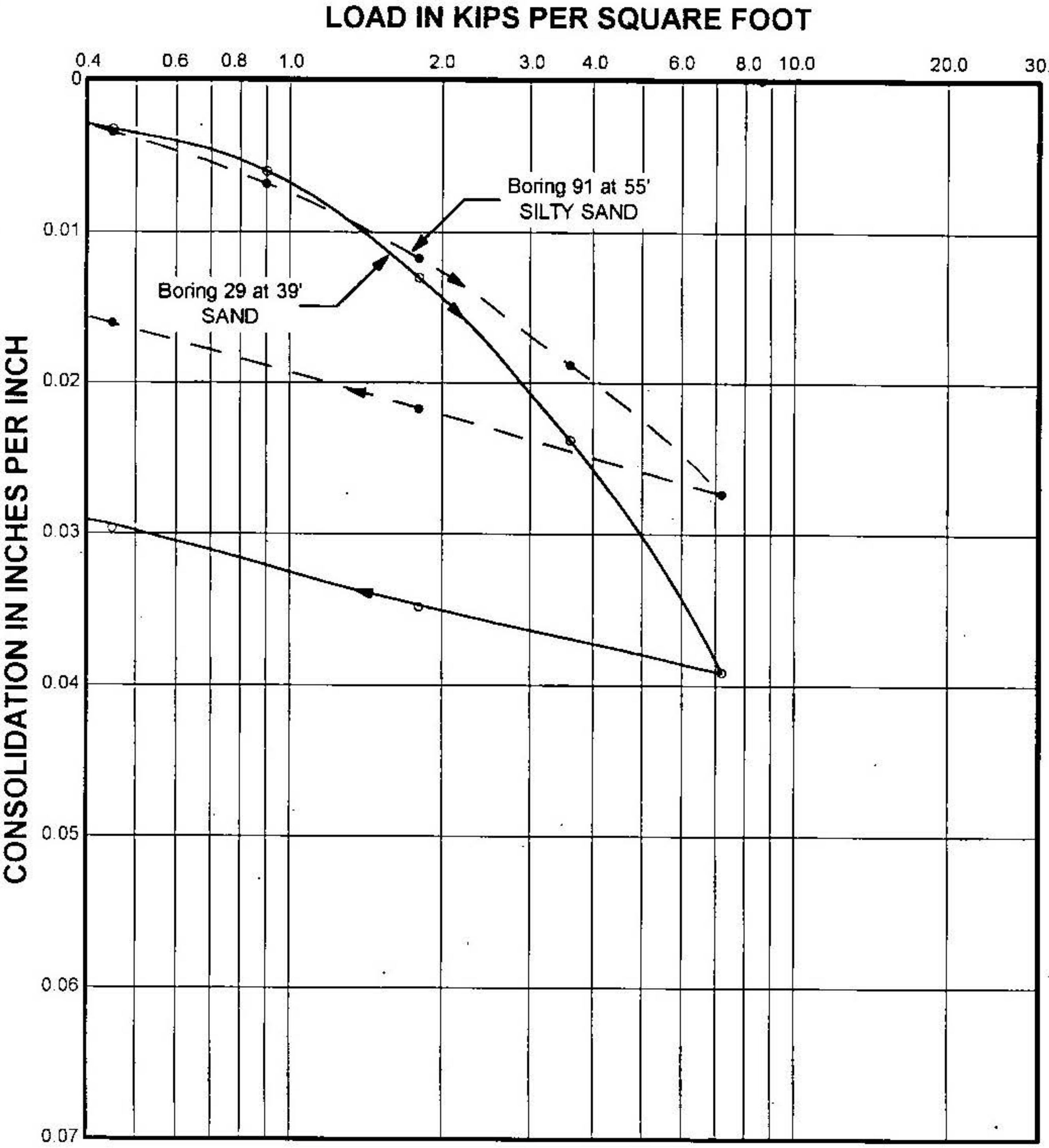
FIGURE 5.1

JOB 70131-2-0672.0029 DATE 3/4/98 DR JB OE MWH CHKD



NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

JOB 70131-2-0672.0029 DATE 3/4/98 DR JB OE MWH CHKD

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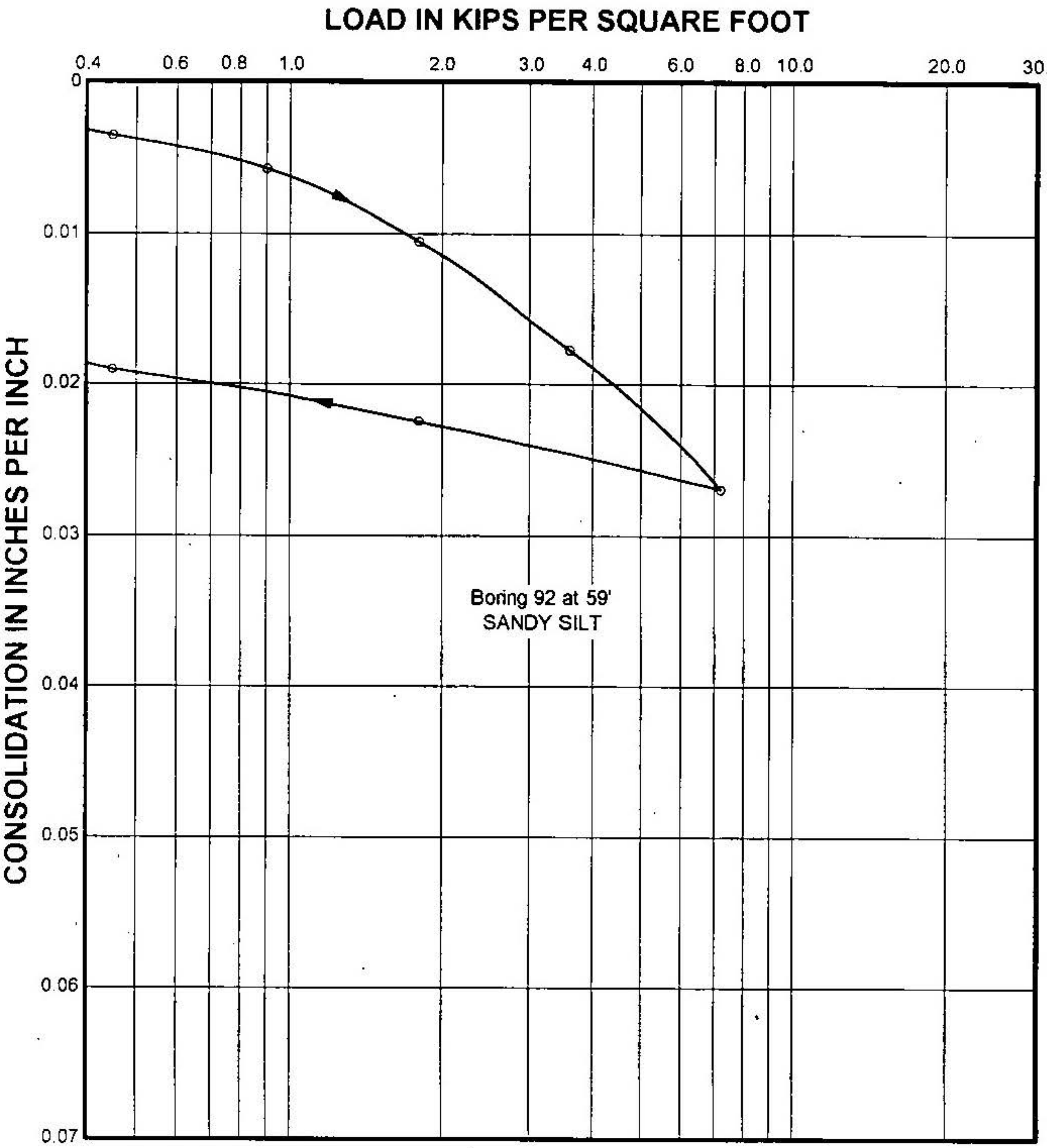
FIGURE 5.2



NOTE: Sample tested at field moisture content.

CONSOLIDATION TEST DATA

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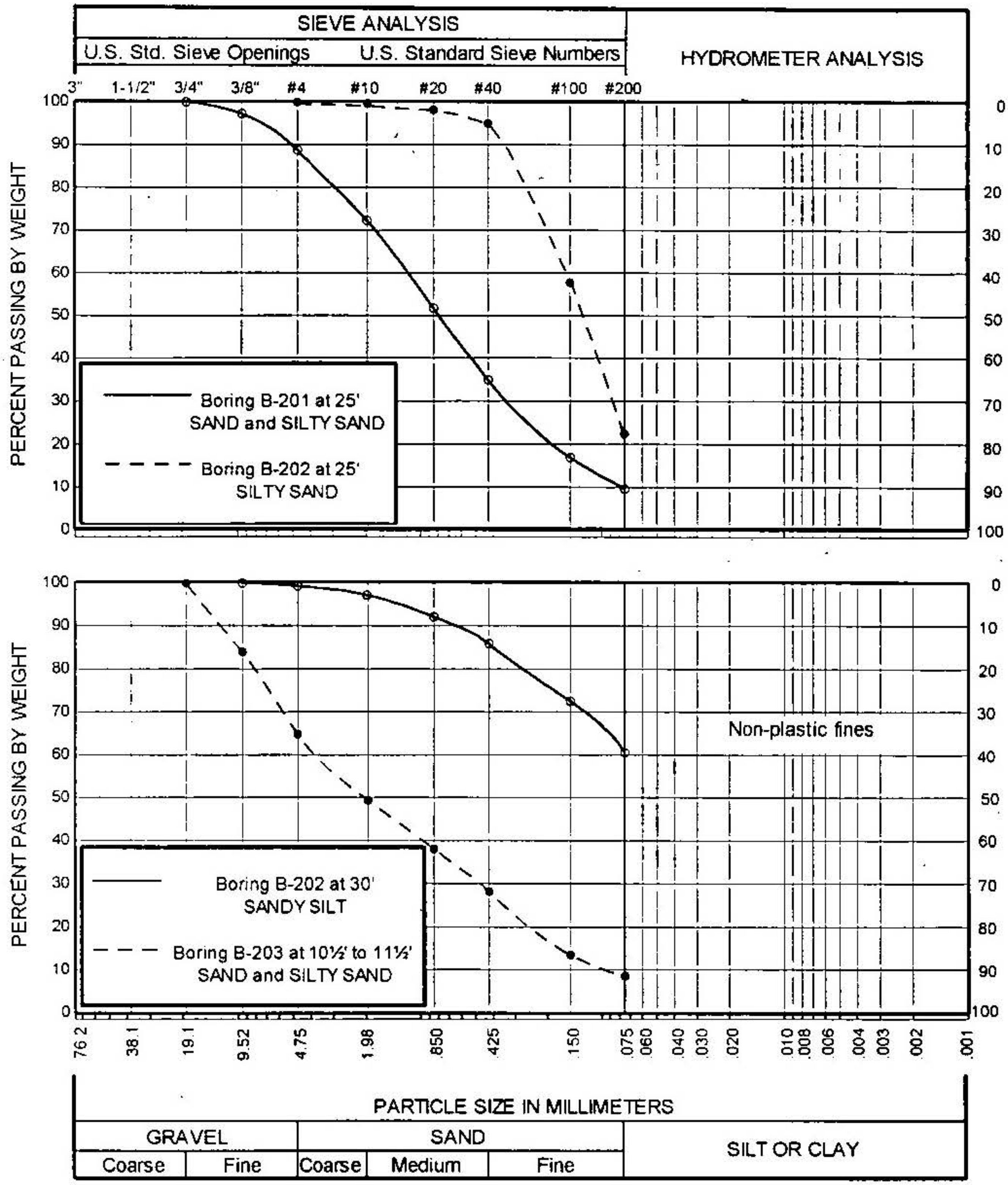
FIGURE 5.3

JOB 70131-2-0672.0029 DATE 3/4/98 DR JB OE MWH CHKD [signature]



JOB 70131.20672.0029 DATE 1/16/98 DR JB OE MWH CHKD

PARTICLE SIZE DISTRIBUTION

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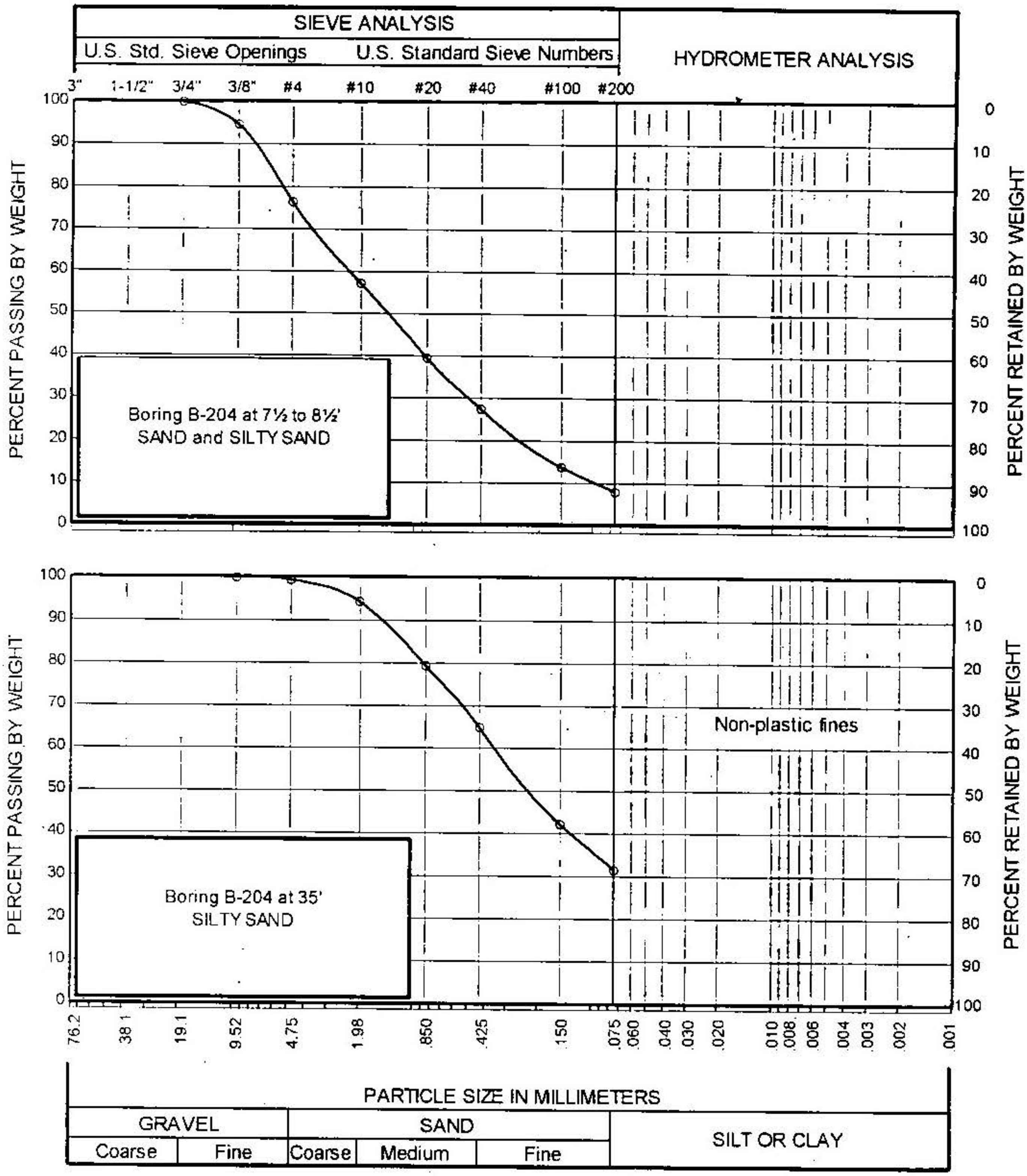
FIGURE 6.1

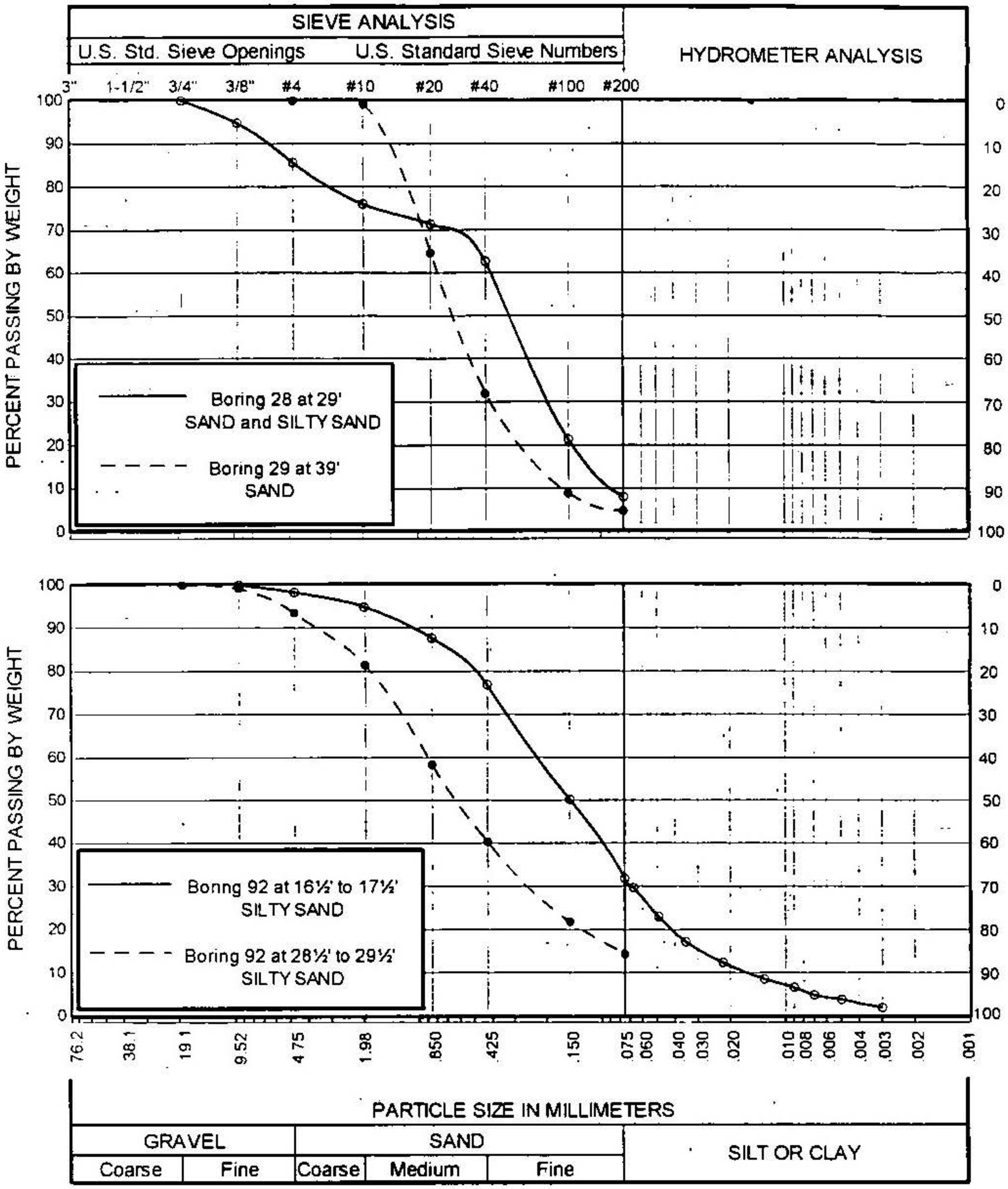
JOB 70131.2.0072.0029 DATE 1/16/98 DR JB OE MWH CHKD



PARTICLE SIZE DISTRIBUTION

LAW/CRANDALL

FIGURE 6.2



PARTICLE SIZE DISTRIBUTION

LAW/CRANDALL

FIGURE 6.3

LAW/CRANDALL
A DIVISION OF
LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

200 Citadel Drive Los Angeles, CA 90040 (213) 889-5300 FAX (213) 889-5398

Memorandum

Date: 03/25/98 Job. No.: 70131-2-0672.0029

To: Job File

From: Martin B. Hudson

Subject: Requirements for Drilling Borings

Prior to the start of our exploratory borings, on December 22, 1997, Messrs. Wil Stelts and Martin Hudson met with Messrs. K. S. Chandra and Bomi Ghadiali (part-time) of EMC, and with Mr. Ed Richardson of the MTA at the offices of EMC. We were directed at that meeting to plan the explorations through MTA Property Management since the MTA owns the Right of Way. Mr. Wil Stelts was told by Mr. Richardson to discuss the MTA's requirements with Mr. Al Ruppel of MTA Property Management. Mr. Stelts called Mr. Ruppel on December 29, 1997, and Mr. Ruppel outlined the requirements of the MTA, including the necessity of drumming the cuttings and testing the cuttings for disposal by the MTA, and backfilling the borings with slurry. Therefore, the boring types were changed to hollow stem auger borings to significantly reduce the amount of cuttings generated, and reduce the amount of slurry backfill required in the borings.