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(Geotech)

Draft Report of Geotechnical Investigation

*Proposed El Segundo Segment
Norwalk - El Segundo Rail Transit Project*

Prepared for,

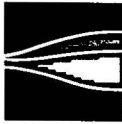
Transit Consultants of Southern California

LeRoy Crandall and Associates

Job No. ADE-88044

January 27, 1989

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January 27, 1989

Transit Consultants of Southern California
403 West 8th Street, Suite 1100
Los Angeles, California 90014

Attention: Mr. Deepak Shah
Manager, Structural Design

Subject: Draft Report - Geotechnical Investigation
Proposed El Segundo Segment
Norwalk-El Segundo Rail Transit Project
LC&A Job No. ADE-88044

Gentlemen:

This letter transmits ten copies of our draft report covering the geotechnical investigation performed for the El Segundo Segment of the Norwalk-El Segundo Rail Transit Project. The report has been issued initially in draft form for your review and comment prior to final submittal.

We look forward to discussing this report with you.

Respectfully submitted,

LeROY CRANDALL AND ASSOCIATES

Marshall Lew, Ph.D.
Project Manager
Vice President

WP20/sle

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M. J. Schiff and Associates

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Section 1
Executive Summary

SECTION 1

EXECUTIVE SUMMARY

This report presents the results of the geotechnical investigation performed for the proposed El Segundo Segment of the Norwalk-El Segundo Rail Transit Project.

The findings and conclusions developed during this investigation are presented herein. The first part of the report presents the text which includes data analyses, interpretative information, conclusions, and recommendations for design. The Appendices, which follow, contain the detailed results of field and laboratory programs, and provide information that supports the conclusions and recommendations presented in the main text.

We previously performed a preliminary geotechnical investigation in order to establish general conditions along the alignment. Information and data developed as a result of that study have been reviewed and considered in preparing this report, and the prior field exploration and laboratory test data have been incorporated herein. Also, applicable excerpts from that report have been included herein for easy reference. We also previously performed an environmental audit to evaluate the potential for subsurface soil or ground water contamination along the alignment. A summary of this environmental audit has been included for reference.

The proposed El Segundo Segment will extend from the Century Freeway near Aviation Boulevard to Compton Boulevard. This section is referred to as the Baseline Route, which is elevated for a large portion of its total length. There are five stations planned along the segment: Aviation Boulevard Station, Mariposa Avenue Station, El Segundo Boulevard Station, Douglas Street Station, and the Compton Boulevard Station. A yard and shops area is planned at the south end of the alignment.

A review of published literature indicates that no known active or potentially active faults cross the alignment. Accordingly, the possibility of surface rupture along the alignment due to faulting



is considered remote. The possibility of liquefaction occurring within the underlying deposits is also considered remote. Although the area could be subject to severe ground shaking in the event of a major earthquake, this hazard is common to Southern California and the effects of the shaking can be mitigated by proper structural design and proper construction.

Fill soils occur along part of the alignment; the fill soils are generally shallow, but local deep deposits could occur. Native materials generally consist of moderately firm but expansive clay, underlain by dense and firm sands and silty sand with clay and silt. The sand deposits have very little cohesion. Ground water is relatively deep beneath the alignment. Resistivity testing indicates that the soils along the alignment range from mildly corrosive to corrosive.

A portion of the alignment extends within the limits of the El Segundo Oil Field where there has been extensive oil production activities in the past. There may be some potential for encountering contaminated soils during construction. There is also a known environmental problem at the Kramer and Company site in El Segundo; explorations at this site have not been performed.

Foundation support for the aerial structures (rail guideways and elevated stations) and the Rosecrans Avenue/Aviation Boulevard Bridge may utilize drilled cast-in-place reinforced concrete piles. Some difficulties could be encountered in the construction of the piles due to caving. If the grading recommendations are followed, the proposed at-grade structures may be supported on spread footings. The footings should be underlain by at least three feet of properly compacted fill. The on-site soils, except for debris and clay, may be used as fill material.

The successful completion of the studies herein reported was made possible by the splendid cooperation of many individuals and organizations. We wish to extend our sincere thanks to all those who in any manner aided in the work. We are grateful to the staffs of the Los Angeles County Transportation Commission (LACTC) and the Transit Consultants of Southern California (TRANSCAL) for their assistance during the project. The counsel of Mr. Deepak Shah of TRANSCAL is especially appreciated.



Section 2
Introduction

SECTION 2

INTRODUCTION

2.1 PURPOSE OF INVESTIGATION

The purpose of this geotechnical investigation was to determine and evaluate the geotechnical conditions along the proposed El Segundo Segment with regard to their possible effects on the design and construction of the planned project.

2.2 SCOPE OF WORK

The scope of work for this investigation included the following major tasks:

- o Drilling and sampling
- o Laboratory testing
- o Resistivity studies
- o Geologic studies
- o Environmental audit
- o Engineering analyses
- o Seismic engineering studies
- o Preparation of geotechnical report
- o Management, progress reports, and meetings.

The scope of the investigation was planned in collaboration with Mr. Deepak Shah of Transit Consultants of Southern California.

2.3 EXPLORATION AND TESTING

Field exploration consisted of subsurface drilling, logging, and sampling. The purpose of the field investigation was to develop a comprehensive understanding of the subsurface conditions along the

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project route, and to establish the physical properties of the various soil types to be encountered. The results of the field explorations are presented in Appendix A.

Laboratory tests were performed on representative soil samples in order to define the engineering properties of the various earth materials encountered. The tests performed included: moisture and density determinations, direct shear tests, consolidation tests, compaction and California Bearing Ratio tests, Expansion Index tests, and mechanical analyses. The laboratory test results are presented in Appendix B .

Downhole seismic surveys were performed in two of the borings to determine the propagation velocities of compressional and shear waves through the subsurface soils. The results are presented in Appendix C. The seismicity of the region surrounding the El Segundo segment was determined from a computer search of a magnetic tape catalog of earthquakes. The computer scan is presented in Appendix D. Resistivity tests were performed to evaluate the corrosion potential of the soils. This task was performed by M. J. Schiff & Associates; the results are presented in Appendix E.

2.4 LIMITATIONS OF INVESTIGATION

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has been prepared for Transit Consultants of Southern California and their design consultants to be used solely in the design of the proposed rail transit project and related facilities. The report has not been prepared for use by other parties, and may not contain sufficient information for purposes of other parties or other uses.

As mentioned, our preliminary evaluation included an environmental audit to evaluate the potential for subsurface soil or ground water contamination. Specific chemical tests to determine the presence and concentrations of hydrocarbon or other forms of contamination were not performed on any of the soil samples with the exception of OVA monitoring.



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2.5 INSPECTION OF BORING SAMPLES

Soil samples recovered from the borings and remaining after laboratory testing are stored at the laboratory of the Los Angeles Office of LeRoy Crandall and Associates located at 900 Grand Central Avenue, Glendale, California 91201.

2.6 PREVIOUS INVESTIGATIONS

We previously performed a preliminary geotechnical investigation in order to establish general conditions along the alignment. The results were presented in our report dated November 29, 1988 (our Job No. ADE-88044). Information and data developed as a result of that study have been reviewed and considered in preparing this report. The prior field exploration and laboratory test data have been incorporated herein. Also, applicable excerpts from that report have been included herein for easy reference.

The results of an environmental audit of prior and current land use to determine the potential for soil contamination were presented in our report dated August 25, 1988; our Job No. F-88044-4.

Information regarding the adjacent Century Freeway (Interstate 105) project was furnished by the State of California Department of Transportation (CALTRANS).

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Section 3
Project Description

SECTION 3

PROJECT DESCRIPTION

3.1 GENERAL DESCRIPTION

The proposed El Segundo Segment of the Norwalk-El Segundo Rail Transit Project will run from the Century Freeway near Aviation Boulevard at the north end of the alignment to near Compton Boulevard at the south end of the alignment. The proposed alignment of the entire Norwalk-El Segundo Rail Transit Project is shown on Plate 3.1, System Map. The El Segundo Segment is shown in more detail on Plate 3.2, Map of El Segundo Segment. This section is referred to as the Baseline Route, which is elevated for a large portion of its total length.

There are five stations planned along this segment of the rail transit project: Aviation Boulevard Station, Mariposa Avenue Station, El Segundo Boulevard Station, Douglas Street Station, and Compton Boulevard Station. The stations will provide both pedestrian and handicapped access, fare collection, seating, shelter, and security. All stations will include shuttle bus stops and passenger drop-off areas. Three of the stations (Aviation Boulevard, Douglas Street, and Compton Boulevard) will provide small park-and-ride facilities. There is also a rail yard and shop area in Hawthorne at the south end of the segment.

3.2 EL SEGUNDO SEGMENT ALIGNMENT AND STATIONS

The rail transit alignment for El Segundo Segment diverges from the Century Freeway segment about 1,800 feet east of Aviation Boulevard. The elevated aerial alignment continues westward from the Century Freeway (Interstate 105) to the Aviation Boulevard Station, which is about 500 feet east of Aviation Boulevard. The Aviation Boulevard Station is an aerial station platform. The alignment continues west, past the station to the Aviation Wye, which will connect to the future Coast Line to the north.



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After leaving the Aviation Wye, the route continues westward on an aerial structure and turns southwesterly upon crossing Douglas Street. The alignment turns south after crossing Nash Street and proceeds above grade on the west side of Nash Street as it enters the Mariposa Avenue Station.

The Mariposa Avenue Station is an above-grade station located south of the intersection of Mariposa Avenue and Nash Street. The line continues south from the Mariposa Avenue Station and continues along the west side of Nash Street. After crossing Grand Avenue, the alignment diagonally crosses the intersection of El Segundo Boulevard and Nash Street to the El Segundo Boulevard Station.

The El Segundo Boulevard Station is an aerial station which overhangs both El Segundo Boulevard and the Hughes EDSG Facility parking lot. It includes an off-street shuttle van facility and a drop-off area. The line continues southward on an aerial structure from the El Segundo Boulevard Station along the eastern edge of the Hughes property and crosses the Southern Pacific Railroad freight rail spur and a vacant building on the H. Kramer and Company property. The alignment continues south on the aerial structure, running through the Southern California Edison Company right-of-way. The alignment turns southeasterly to pass over and run parallel to the south side of the Atchison Topeka and Santa Fe (ATSF) Railroad Los Angeles Harbor tracks before entering the Douglas Street Station.

The Douglas Street Station is an aerial station located in an area interrupted by the ATSF mainline tracks. Access to the station from the south is from a drop-off area at the end of the cul-de-sac using stairs and an elevator; access from the north is from a drop-off area under the Southern California Edison right-of-way using stairs. A small parking lot is planned on the Southern California Edison right-of-way. As the line leaves the aerial station, it continues southward on an aerial structure, parallel to the ATSF mainline.

The alignment will diagonally cross the intersection of Rosecrans Avenue and Aviation Boulevard on a new bridge structure west of the existing ATSF railroad truss bridge. The span length may be as long as 270 feet to accommodate future widening of the Rosecrans/Aviation intersection.

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About 300'

After crossing the intersection of Rosecrans Avenue and Aviation Boulevard, the alignment descends to grade and uses the ATSF right-of-way to the Compton Boulevard Station.

The Compton Boulevard Station will be at-grade with side platforms. A parking lot will be located either east of the railroad or on U.S. Air Force property east of the yard and shops site. South of the Compton Boulevard Station, the alignment turns west into the Hawthorne Yard and Shops area. The future Torrance mainline segment would continue to the south.

3.3 YARD AND SHOPS AREA

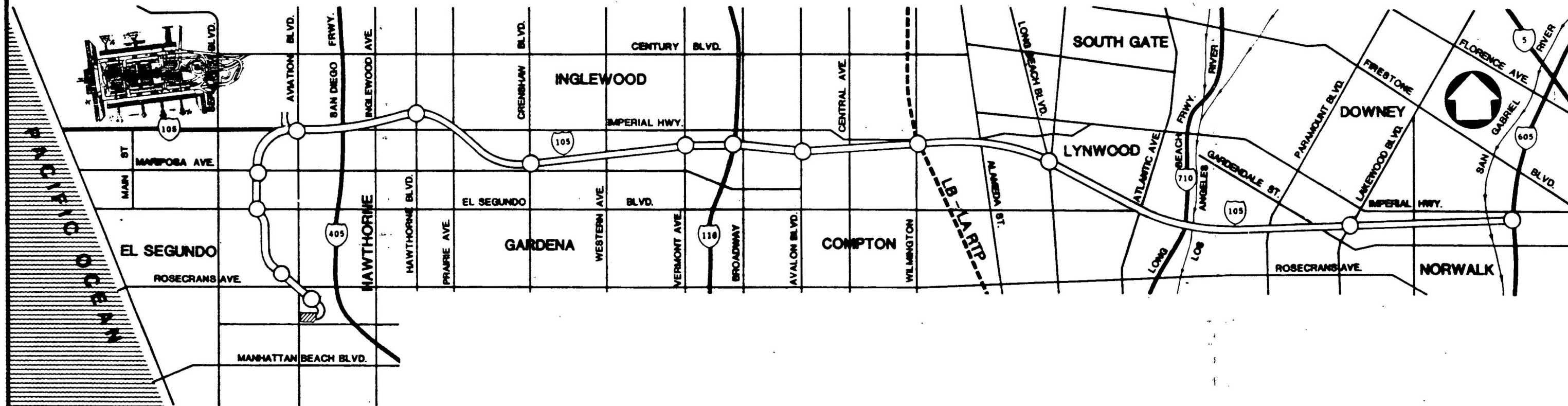
The Hawthorne Yard and Shops would serve the following operations: vehicle dispatch, storage, interior and exterior cleaning, running repair, daily and periodic inspection, testing, and blowdown. A vehicle maintenance building, operations building, and other facilities will be built to accommodate such operations.

The proposed Hawthorne Rail Yard would be on approximately 9.4 acres of land located at 14714 Aviation Boulevard that was owned by the State of California. The site, which is relatively level, is bordered by Aviation Boulevard on the west, U. S. Air Force property on the south and east, and a Southern California Edison utility right-of-way on the north. It would permit direct access from the Compton Boulevard Station on the north, with a possible future southern exit to the future Torrance mainline extension of the rail transit project.



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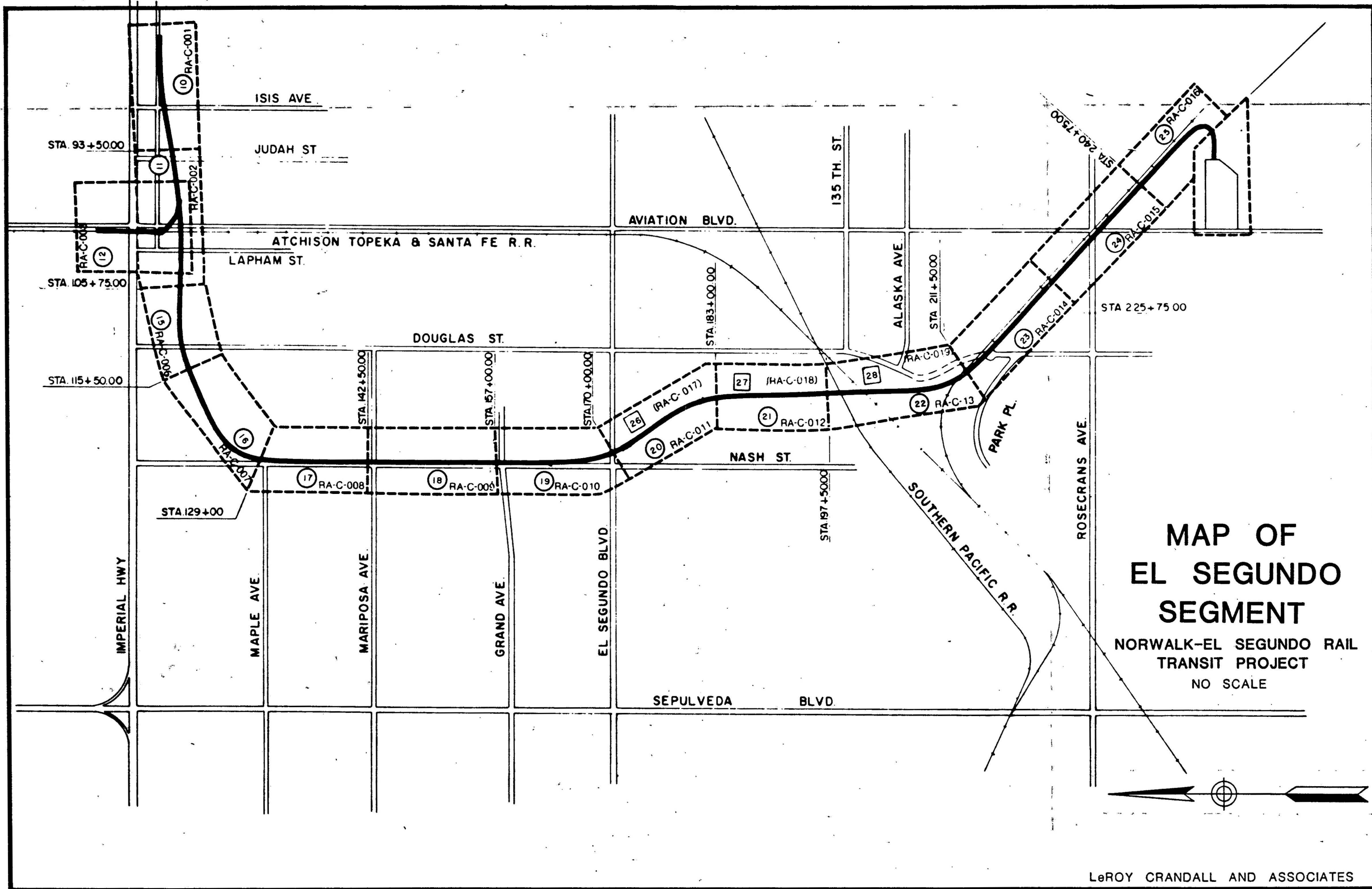
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SYSTEM MAP

NORWALK-EL SEGUNDO RAIL
TRANSIT PROJECT
NO SCALE

LeROY CRANDALL AND ASSOCIATES



MAP OF EL SEGUNDO SEGMENT

NORWALK-EL SEGUNDO RAIL
TRANSIT PROJECT
NO SCALE

Section 4
Geology

SECTION 4

GEOLOGY

4.1 PHYSICAL SETTING

The proposed El Segundo Segment of the Norwalk-El Segundo Rail Transit Project will be located within the Los Angeles Basin at the northerly end of the Peninsular Ranges geomorphic province. This geomorphic province trends northwest, reflecting the dominant trend of major fold belts and fault zones in the Southern California region.

The most prominent physiographic feature along the alignment, the El Segundo Sandhills, consists of a coastal belt of dunes and sandhills extending south from Ballona Gap to the Palos Verdes Hills (a distance of about 11½ miles) and inland, or eastward, from three to five miles (Poland et al., 1959). The sandhills are subdivided into two distinct elements. One element is adjacent to the coast and is comprised largely of active, or recent, dunes. The recent dunes are between one-third to one-half mile wide, with a maximum elevation of 185 feet above sea level.

The second element constitutes the main part of the sandhills, consisting of stabilized ancient, or older dunes. The older dune sand attains a maximum height of about 245 feet above sea level. Weathering and associated stabilizing processes have removed all but the gross features of dune topography in the older dune sand area (California Department of Water Resources, 1961).

The major geologic structural feature in the area is the Newport-Inglewood Fault Zone which is reflected at the surface by the nearby Baldwin Hills. At its closest point, the Newport-Inglewood Fault Zone is about 2.8 miles northeast of the alignment.

The relationship of the rail transit alignment to regional and local geologic features is shown on Plate 4.1, Regional Geology, and Plate 4.2, Local Geology, respectively. The alignment is shown in relation to major fault zones and earthquake epicenters on Plate 4.3, Regional Seismicity.



4.2 GEOLOGIC MATERIALS

The alignment will extend across areas partially mantled by late Pleistocene age (older) dune sands and by continental deposits of the late Pleistocene Lakewood Formation. Where present, the older dune sands directly overlie the Lakewood Formation. As observed in our exploratory borings, the older dune sand consists of fine to medium sand initially deposited as offshore bars and later reworked by wind and stream action (Poland et al., 1959). The older dune sand is estimated to attain a maximum depth of about 100 feet in the area.

The Lakewood Formation consists primarily of sand, with discontinuous lenses of silt and clay. These deposits extend to depths of about 200 feet beneath the alignment and unconformably overlie marine silt and clay of the early Pleistocene San Pedro Formation. The San Pedro Formation, attaining a maximum of thickness of 200 feet, is underlain by approximately 26,000 feet of Tertiary marine and non-marine sedimentary rocks. The Tertiary units, in turn, are underlain by basement rocks believed to be primarily Catalina Schist.

A thin cover of artificial fill materials is present along some of the alignment.

4.3 GROUND WATER

The proposed transit alignment is located within Township 3 South, Range 14 West, Sections 7, 18, and 20, within the West Coast Hydrologic Subarea of the Coastal Plain of Los Angeles County Hydrologic Subunit. Water level measurements by the Los Angeles County Flood Control District indicate that the ground water elevation in the area has historically been at or below sea level (this would correspond to a water level depth generally about 100 feet beneath the alignment). The highest recorded water level in the area over the past 50 years was about 14 feet above sea level in 1973, obtained in a well situated about one-half mile west of the south end of the alignment (near the intersection of Sepulveda Boulevard and Rosecrans Avenue).

Data compiled by the Los Angeles County Flood Control District in the fall of 1985 indicate the water level beneath the alignment had varied between five feet above sea level (at the northerly



end) to about five feet below sea level (at the southerly end). Accordingly, the depth to ground water ranged, at that time, from 95 feet to 85 feet, respectively.

Perched ground water, at a depth of about 50 feet below ground surface, has been reported for the area near the intersection of Rosecrans Avenue and Aviation Boulevard. Water was measured at a depth of 73 feet in one of the borings drilled near this intersection; details of the boring are discussed in Section 6.

4.4 GEOLOGIC HAZARDS

4.4.1 General

The geologic hazards along the alignment are essentially limited to those caused by earthquakes. The major cause of damage from earthquakes is the result of shaking from earthquake waves. Damage due to actual displacement or fault movement beneath a structure is much less frequent.

4.4.2 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 4.1. Table 4.2 presents a listing of active faults in Southern California with the anticipated magnitude of a maximum credible earthquake of each fault. Table 4.3 provides a similar listing for potentially active faults. No faults or fault associated features were observed in the vicinity of the alignment during our reconnaissance of the area.

No known active faults pass beneath the alignment nor does the alignment extend into or through an established Alquist-Priolo Special Studies Zone. In our opinion, there is little probability of surface fault rupture occurring beneath the El Segundo Segment alignment.

Nearby faults include the active Newport-Inglewood Fault Zone and the potentially active Charnock, Overland, and Palos Verdes Faults. Other significant faults include the active San Andreas and Malibu Coast Fault Zones.



TABLE 4.1

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 4.2)

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 4.3)

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.

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TABLE 4.2

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

Fault (in alphabetical order)	Date of Latest Major Activity	Maximum Credible Earthquake	Known Fault Length (f) (Miles)
Big Pine	1852	7.5 (b)	47
Coyote Creek	1968	7.2 (c)	50
Elsinore	1910	7.5 (b)	120
Garlock	(d)	7.75(b)	170
Malibu Coast	1973	7.0 (c)	30
Manix	1947	6.25(b)	15
More Ranch	(d)	7.5 (b)	34
Newport-Inglewood	1933	7.0 (b)	39
Raymond	(e)	6.6 (c)	15
San Andreas Zone	1857	8.25(b)	200+
San Cayetano	(e)	6.75(c)	32
San Fernando Zone	1971	6.5 (b)	8
San Gabriel	(e)	7.5 (c)	80
San Jacinto Zone	1968	7.5 (b)	112
Superstition Hills	1987	7.0 (b)	22
White Wolf	1952	7.75(b)	60
Whittier	1987(?)	7.1 (c)	30

(a) Historic movement (1769 present).

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

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

(d) Intermittent creep.

(e) Zoned by the State Geologist for the Alquist-Priolo Program.

(f) Based on Division of Mines and Geology "Fault Map of California,"
Map No. 1 (1975)

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TABLE 4.3

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

Fault (in alphabetical order)	Maximum Credible Earthquake	Fault Length (d) (Miles)
Calico-Newberry	7.25(b)	60
Charnock	6.6 (c)	13
*Chino	6.7 (c)	18
Cucamonga	6.5 (b)	20
*Duarte	6.3 (c)	60
Northridge Hills	6.5 (b)	12
Norwalk	6.4 (c)	20
Oakridge	7.5 (b)	35
*Overland	6.2 (c)	6
Ozena	7.3 (c)	47
Palos Verdes	7.0 (b)	30
Pinto Mountain	7.5 (b)	42
*San Jose	6.5 (c)	17
Santa Cruz Island	7.2 (c)	50
Santa Monica-Hollywood	6.8 (c)	17
Santa Susana	6.5 (b)	10
Santa Ynez	7.5 (b)	100
Sierra Madre	7.5 (b)	55
Sierra Nevada	8.25(b)	118
*Verdugo	6.8 (c)	12

(a) Pleistocene deposits disrupted.

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

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

(d) Based on Division of Mines and Geology "Fault Map of California," Map No. 1 (1975).

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



4.4.2.1 Newport-Inglewood Fault Zone

The closest known active fault is the Inglewood Fault of the Newport-Inglewood Fault Zone, located about 2.8 miles northeast of the alignment at its closest point. The fault zone, or uplift as it is sometimes called, is composed of a series of discontinuous northwest trending en echelon faults extending from the southern edge of the Santa Monica Mountains southeastward to the area offshore of Newport Beach.

The Newport-Inglewood uplift is reflected at the surface by a line of geomorphically young anticlinal hills and mesas formed by the folding and faulting of a thick sequence of Pleistocene and Tertiary sedimentary rocks (Barrows, 1974). The magnitude 6.3 Long Beach earthquake of 1933 occurred on the Newport-Inglewood Fault Zone. Other faults comprising the fault zone include the Potrero, Avalon-Compton, Cherry Hill, Pickler, Northeast Flank, and Reservoir Hill-Seal Beach Faults.

4.4.2.2 Malibu Coast Fault Zone

The Malibu Coast Fault Zone, located about 11 miles northwest of the rail transit project, is an east-west trending, north-dipping reverse fault extending westward from Santa Monica to offshore of Point Mugu. Although some seismologists and geologists attribute movement of the fault to the February 21, 1973 Point Mugu earthquake, Holocene activity on the fault had not been positively established until recently. Fault trenching conducted in 1985 and 1986 on South Winter Mesa in the Malibu area of Los Angeles County exposed several faults disrupting Tertiary and Pleistocene units, and one fault offsetting colluvial deposits estimated to be 6,000 years old (Fall et al., 1987). The observed faults, named the Winter Mesa Faults, are believed to be splays of the nearby Malibu Coast Fault; accordingly, the Holocene faulting on the Winter Mesa Faults is considered representative of active faulting along the Malibu Coast Fault Zone.

4.4.2.3 San Andreas Fault Zone

The active San Andreas Fault Zone is California's most prominent structural feature, trending in a general northwest direction for almost the entire length of the state. In Southern California, the



San Andreas Fault Zone extends from the Mexican border to the Transverse Mountain Ranges west of Tejon Pass, for a length of approximately 280 miles. At its closest point, the San Andreas Fault Zone is approximately 45 miles north-northeast of the alignment. Along this segment of the fault zone there is no single traceable fault line; rather, the fault is composed of several branches including the Banning Fault and the Mission Creek Fault. The July 8, 1986 North Palm Springs earthquake was believed to have occurred on the Banning Fault. Preliminary data indicate that this earthquake, occurring at 2:21 a.m., registered a magnitude of 5.9 on the Richter scale with the epicenter located approximately 12 miles northwest of Palm Springs.

4.4.2.4 Charnock Fault

The potentially active Charnock Fault is located 0.9 miles northeast of the alignment at its closest point. The Charnock Fault trends northwest-southeast, subparallel to the trend of the Newport-Inglewood Fault Zone and the Overland Fault. Differential water levels occur in the San Pedro Formation across the fault and therefore it is concluded that the fault has experienced some movement during early Pleistocene time (approximately 500,000 to 2 million years ago).

4.4.2.5 Overland Fault

The Overland Fault is located 3.7 miles north of the alignment. The Overland Fault trends northwest and lies between the Charnock and Newport-Inglewood Fault Zones. The fault extends from the northwest flank of the Baldwin Hills to Santa Monica Boulevard in the vicinity of Overland Avenue. Displacement on the fault is believed to be vertical, with an offset of about 30 feet. Water levels in the Pleistocene age sediments indicate that the fault is an effective barrier to ground water movement and that Pleistocene material has been offset.

4.4.2.6 Palos Verdes Fault

The potentially active Palos Verdes Fault is approximately 3.5 miles west-southwest, and offshore, of the alignment. This fault is traceable in the subsurface along the northern flank of the Palos Verdes Hills. Zielbaure et al. (1962) report that early Pleistocene age San Pedro Formation beds are sharply upward along the fault trace but, on land, the fault does not cut material younger than



middle Pleistocene. Offshore data, consisting of acoustic and reflection profiles, show offsets in the base of Holocene material, suggesting very youthful movement along the Palos Verdes Fault.

4.4.3 Seismicity

The seismicity of the region surrounding the El Segundo segment of the rail transit project was determined from a computer search of a magnetic tape catalog of earthquakes. The catalog of earthquakes included those with a Richter magnitude greater than 4.0, within a radius of 100 kilometers from the center of the El Segundo Segment, compiled by the California Institute of Technology for the period 1932 to 1987, 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 in Appendix D. The earthquake recurrence curve based on that information is presented on Plate 4.4, Recurrence Curve. The search indicates that 303 earthquakes of Richter Magnitude 4.0 and greater have been recorded within 100 kilometers (62 miles) from the center of the alignment during the period from 1932 to 1987.

The information listed for each earthquake found in the computer scan in Appendix D 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 explanation of the letter code for the quality factor of the data is presented on the first page of the scan.

The epicenter of the June 21, 1920 Inglewood earthquake was located about 2.7 miles north of the alignment. This earthquake, which occurred at 6:47 p.m., had an estimated Richter magnitude of 4.9 and the intensity, described as a very strong shock, was estimated as 8½ on the Rossi-Forel intensity scale. No evidence of surface rupture was found. Damage to structures was sustained in the vicinity of the Inglewood City Hall along Commercial Street (now called La Brea Avenue). At least 36 aftershocks between June 21 and July 16, 1920 followed the main shock.

The epicenter of the March 11, 1933 Long Beach earthquake, magnitude 6.3, was located about 31 miles southeast of the south end of the alignment. This earthquake, although of only moderate magnitude, ranks as one of the major disasters in the history of Southern California. The majority



of damage was suffered by structures now considered substandard construction and/or located on filled or saturated ground.

The epicenter of the February 9, 1971 San Fernando earthquake, with a magnitude of 6.5, was about 34 miles north of the alignment. Surface rupture occurred on the Sylmar and Tujunga Faults which are segments of the larger San Fernando Fault Zone.

The epicenter of the October 1, 1987 Whittier Narrows earthquake was situated about 20 miles east-northeast of the alignment. This earthquake registered a magnitude of 5.9 and was followed by numerous aftershocks including a magnitude 5.3 quake on October 4, 1987.

The location of the alignment in relation to known active and potentially active faults indicates that the alignment is not exposed to greater than normal seismic risk relative to other areas within the Coastal Plain of Los Angeles County.

4.4.4 Liquefaction and Seismically Induced Settlement

The evaluation of the liquefaction potential of the soils along the alignment involved an estimation of the potential loss of shear strength of the saturated cohesionless soils during earthquakes that may affect the project. Significant factors which may affect liquefaction include the soil types, particle size and gradation, water level, relative density, confining pressure, intensity of shaking, and duration of shaking. Studies indicate that the liquefaction potential is the greatest where the ground water level is shallow and loose fine sands occur within a depth of 40 to 50 feet. The liquefaction potential increases as the acceleration and duration of ground shaking increase.

Based on the available published data and our previous and current borings, both of which indicate a great depth to ground water, we see little or no potential for liquefaction occurring along the alignment.

Seismically induced differential settlement is also not considered a potential problem.



4.4.5 Stability

The alignment extends across relatively flat-lying ground with no potential for either landsliding or lurching (movement at right angles to a slope during strong earthquake shaking). Additionally, the alignment is not known to be on or in the path of any existing or potential landslides.

4.4.6 Flooding

The alignment does not extend across a flood hazard area as designated by the Federal Emergency Management Agency.

4.4.7 Tsunamis and Seiches

The alignment is at elevations of about 100 feet to 80 feet above mean sea level and located about two miles east-northeast of the Pacific Ocean. The risk of damage from earthquake generated sea waves, called tsunamis, need not be considered.

The alignment is not located downslope of any large bodies of water that could adversely affect the alignment in the event of earthquake induced failures or seiches (oscillations due to earthquake shaking).

4.4.8 Subsidence

Most of the alignment is situated over the El Segundo Oil Field and several oil wells have been drilled in close proximity to the proposed alignment. Subsidence associated with petroleum production has been identified in some of the oil fields in the Los Angeles Basin, including the nearby Playa Del Rey Oil Field located about 3.6 miles northwest of the alignment (Castle and Yerkes, 1976); however, subsidence has not been observed in the El Segundo Oil Field. In recent years, oil field subsidence has been mitigated by the injection of fluids. Consequently, the potential for future subsidence within the El Segundo Oil Field is considered low.

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4.4.9 Ground Shaking

Movements on any of the above described active and potentially active faults could cause ground shaking in the vicinity of the alignment. The relationship between the magnitude of an earthquake and the subsequent duration of strong shaking has been investigated by Bolt (1973). The relationship is presented in Table 4.4. 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 4.4

BRACKETED DURATION 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



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4.5 BIBLIOGRAPHY

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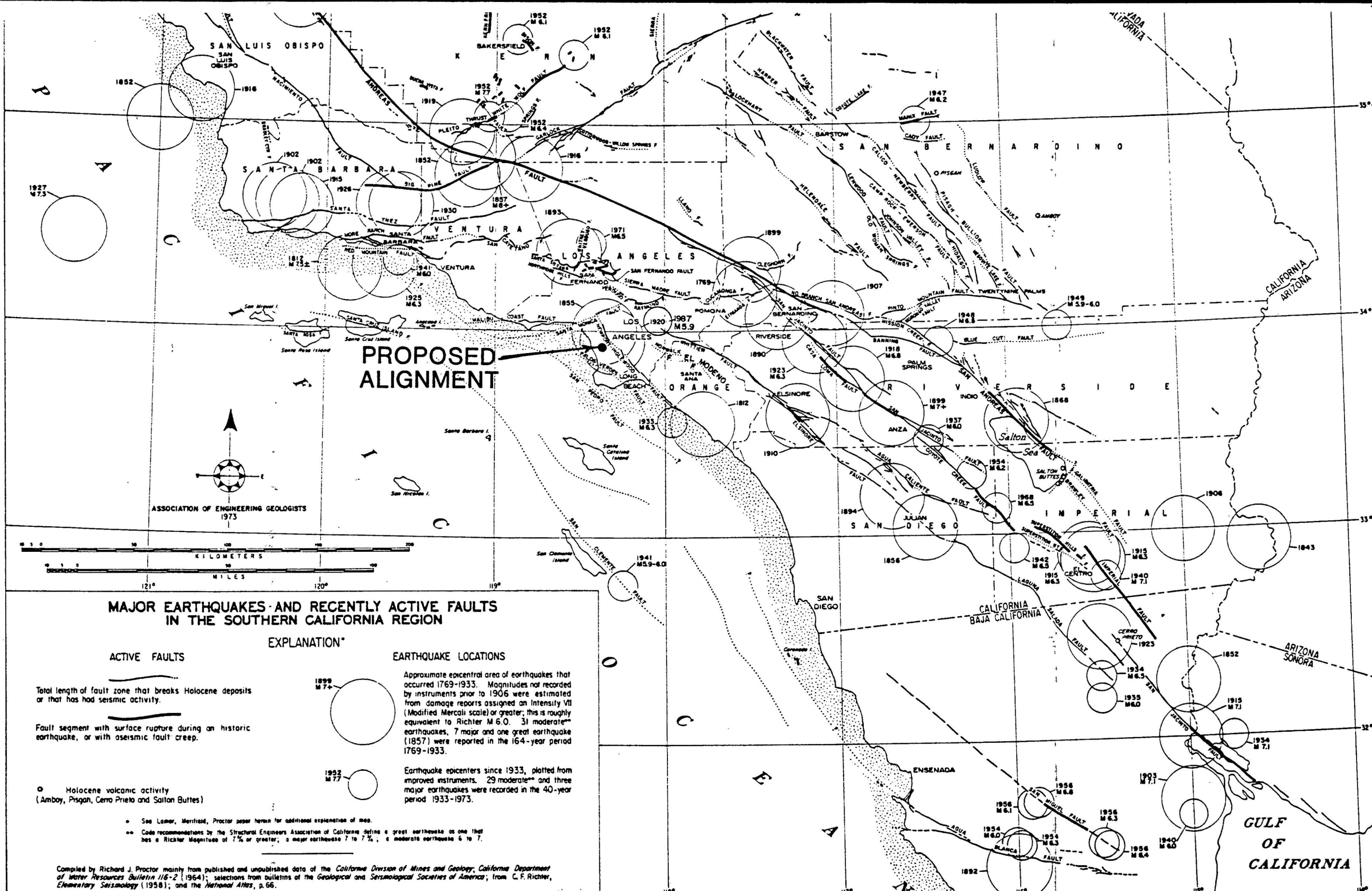
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MAJOR EARTHQUAKES AND RECENTLY ACTIVE FAULTS
IN THE SOUTHERN CALIFORNIA REGION

ACTIVE FAULTS

Total length of fault zone that breaks Holocene deposits or that has had seismic activity.

Fault segment with surface rupture during an historic earthquake, or with aseismic fault creep.

• Holocene volcanic activity
(Amboy, Pisgah, Cerro Prieto and Salton Buttes)

EXPLANATION*

EARTHQUAKE LOCATIONS

Approximate epicentral area of earthquakes that occurred 1769-1933. Magnitudes not recorded by instruments prior to 1906 were estimated from damage reports assigned an Intensity VII (Modified Mercalli scale) or greater; this is roughly equivalent to Richter M 6.0. 31 moderate earthquakes, 7 major and one great earthquake (1857) were reported in the 164-year period 1769-1933.

Earthquake epicenters since 1933, plotted from improved instruments. 29 moderate and three major earthquakes were recorded in the 40-year period 1933-1973.

* See Lamer, Merrifield, Proctor paper herein for additional explanation of map.
** Code recommendations by the Structural Engineers Association of California define a great earthquake as one that has a Richter Magnitude of 7% or greater; a major earthquake 7 to 7.4; a moderate earthquake 6 to 7.

Compiled by Richard J. Proctor mainly from published and unpublished data of the California Division of Mines and Geology; California Department of Water Resources Bulletin 116-2 (1964); selections from bulletins of the Geological and Seismological Societies of America; from C. F. Richter, Elementary Seismology (1958); and the National Atlas, p. 66.

REGIONAL SEISMICITY

LEROY CRANDALL AND ASSOCIATES



EXPLANATION:

- Qdo** PLEISTOCENE OLDER DUNE SAND
- Qlw** LAKEWOOD FORMATION
- GEOLOGIC CONTACT

REFERENCE:

BASE MAP FROM U.S.G.S. 7.5' VENICE QUADRANGLE 1964, (PHOTOREVISED 1981) AND INGLEWOOD QUADRANGLE 1964, (PHOTOREVISED 1981). GEOLOGY MODIFIED FROM DWR BULLETIN 104.

LOCAL GEOLOGY

SCALE 1" = 2000'

LeROY CRANDALL AND ASSOCIATES



LEGEND

SEDIMENTARY ROCKS

RECENT	Qol	ALLUVIUM GRAVEL, SAND, SILT, AND CLAY
	Qsr	ACTIVE DUNE SAND WHITE OR GREYISH, WELL SORTED SAND
UPPER	Qlw	OLDER DUNE SAND FINE TO MEDIUM SAND WITH SILT, AND GRAVEL LENSES
PLEISTOCENE	Qlw	LAKEWOOD FORMATION (INCLUDES "TERRACE DEPOSITS", "PALOS VERDES SAND", AND "UNNAMED UPPER PLEISTOCENE DEPOSITS") MARINE AND CONTINENTAL GRAVEL, SAND, SANDY SILT, SILT, AND CLAY WITH SHALE PEBBLES
LOWER	Qsp-Pp	SAN PEDRO FORMATION (INCLUDES "LA HABRA CONGLOMERATE" AND PART OF "SAUGUS FORMATION") MARINE AND CONTINENTAL GRAVEL, SAND, SANDY SILT, SILT, AND CLAY
	Pp	UNDIFFERENTIATED SAN PEDRO FORMATION AND/OR PICO FORMATION MARINE, PARTIALLY CONSOLIDATED GRAVEL, SAND, SILT, AND CLAY
PLIOCENE	Pp	PICO FORMATION MARINE SAND, SILT, AND CLAY INTERBEDDED WITH GRAVEL
	Re	REPETTO FORMATION MARINE SILTSTONE WITH LAYERS OF SANDSTONE AND CONGLOMERATE
		(SANTA MONICA MOUNTAINS) MODELO FORMATION MARINE CONGLOMERATIC SANDSTONE, SANDSTONE, AND SHALE TOPANGA FORMATION MARINE CONGLOMERATE, SANDSTONE, AND SHALE
MIocene	Mt	(PALOS VERDES HILLS) MONTEREY FORMATION MUDSTONE, DIATOMITE, AND SHALE (ELYSIAN HILLS, REPETTO HILLS, AND PUENTE HILLS) PUENTE FORMATION MARINE SILTSTONE, SANDSTONE, SHALE, CONGLOMERATE, LIMESTONE, AND TUFF
OLIGOCENE(?)		Vaqueros and Sespe Formations CONTINENTAL RED CONGLOMERATE AND SANDSTONE
EOCENE		MARTINEZ FORMATION MARINE CONGLOMERATE, SANDSTONE, SANDY SHALE, AND SHALE
PALEOCENE(?)	E-K	UNDIVIDED MARTINEZ AND CHICO FORMATIONS
UPPER	Ks	CHICO FORMATION UPPER MARINE MEMBER-HARD CONGLOMERATE, SANDSTONE, AND SHALE LOWER CONTINENTAL MEMBER-RED CONGLOMERATE AND SANDSTONE

IGNEOUS AND METAMORPHIC ROCKS

MIocene		MIDDLE MIOCENE VOLCANIC ROCKS VOLCANIC FLOWS, BRECCIAS, TUFFS, AND INTRUSIVES, CHIEFLY BASALTIC AND ANDESITIC WITH OCCASIONAL ACID ROCKS GENERALLY ASSOCIATED WITH TOPANGA, MODELO, OR PUENTE FORMATIONS
UPPER		(SANTA MONICA MOUNTAINS) INTRUSIVES OF GRANITE AND GRANODIORITE
		(PALOS VERDES HILLS) CATALINA SCHIST COMPARED WITH FRANCISCAN FORMATION OF THE COAST RANGES VARIED TYPES OF SCHISTOSE ROCKS
		SANTA MONICA SLATE GREY TO BLACK SLATE, SPOTTED SLATE, MICA SCHIST WITH QUARTZ VEINS

REFERENCE:
CALIFORNIA D.W.R.
BULLETIN 104, PLATE 3B
(1961)

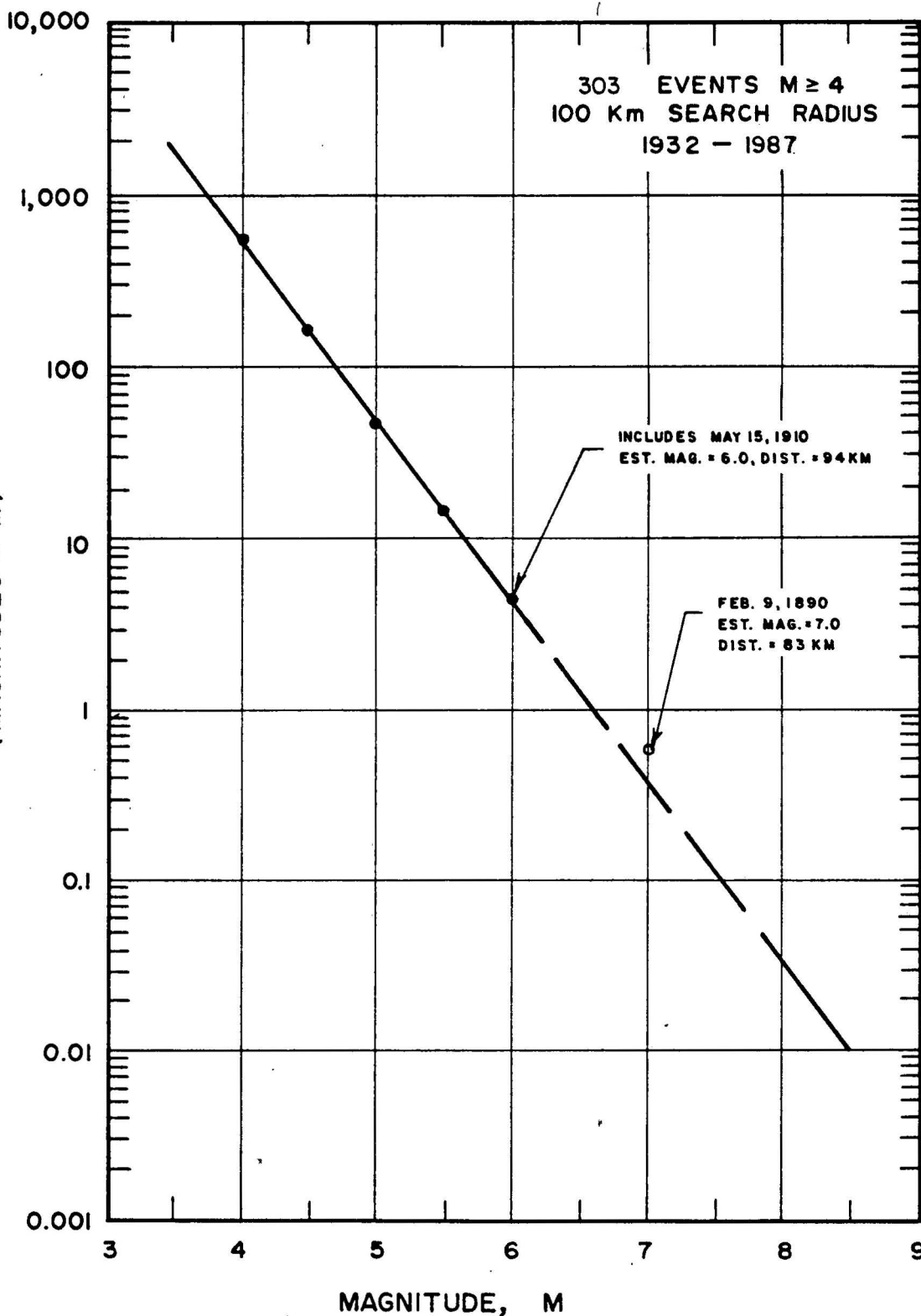
REGIONAL GEOLOGY

SCALE OF MILES



JOB ADE F-88044-7 DATE 10/18/88 DR. JOHN O.E. DM W.P. CHKD 3k

NUMBER OF EARTHQUAKES PER 100 YEARS
(MAGNITUDES $\geq M$)



RECURRENCE CURVE

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

LEROY CRANDALL AND ASSOCIATES

PLATE 4.4

Section 5
Summary of
Environmental Audit

SECTION 5

SUMMARY OF ENVIRONMENTAL AUDIT

5.1 PREVIOUS STUDY

An environmental audit of the El Segundo Segment was previously conducted to evaluate subsurface soil or ground water contamination along the alignment. The report of environmental audit was submitted on August 25, 1988. This section summarizes the findings of the environmental audit; for additional details, the August 25, 1988 report should be referred to.

5.2 EL SEGUNDO OIL FIELD

The proposed rail transit project traverses the El Segundo Oil Field between a point just south of Mariposa Avenue and a point north of where the alignment joins the ATSF mainline tracks. There are several abandoned oil and gas wells near the proposed alignment within the oil field limits. If wells are located on the alignment, the State of California Division of Oil and Gas should be notified prior to construction so they can make a determination if any of the abandoned wells would need to be reabandoned to meet current requirements. Permanent structures built over abandoned gas or oil wells may require a venting system be installed to reduce the potential for methane gas accumulation.

It should be anticipated that oil field products, such as oil saturated soil and drilling muds, could be encountered in the subsurface soil within the limits of the oil field. Naturally occurring petroleum in soils is generally not considered a hazardous waste; however, chemical testing of the soil may be required to verify chemical constituents and appropriate disposal.

5.3 LANDFILLS

Based on the information available from the County of Los Angeles Department of Health Services (DHS) regarding solid waste disposal sites near the alignment, the closest such site is located near the intersection of 156th Street and Inglewood Boulevard. The distance from this site to the



nearest point on the alignment is roughly three-quarters of a mile to the southeast. Accordingly, it is unlikely to have any environmental impact on the project.

Our site reconnaissance noted a trashy area within the Southern California Edison Company property near Isis Avenue and 146th Street. This area is immediately adjacent to a waste disposal transfer site. The DHS was also aware of a former solid waste transfer facility at the site of the existing fire station at El Segundo Boulevard and Nash Street. Within the fenced area of the present waste handling operator, there are drums of hydraulic oil, presumably for the disposal trucks. Both areas may encounter solid waste and/or oily soils beneath the subsurface due to possible past disposal practices.

5.4 COMMERCIAL AND INDUSTRIAL SOURCES

The proposed alignment will pass near several light to heavy industrial businesses, which probably constitute the greatest environmental concern to the project. Of immediate concern is the Kramer and Company ("Kramer") site, located at 1 Chapman Way in El Segundo, which has been identified by the United States Environmental Protection Agency (EPA) as constituting an endangerment to public health or welfare or the environment. The full impact of this site on the light rail project is currently unknown since the site has not yet been fully investigated. The EPA has issued an order on June 7, 1988 to Kramer that immediate removal action be taken to contain and prevent the release and potential release of hazardous substances, pollutants or contaminants from the facility. If the remediation measures are completed prior to construction of the rail transit project, it is likely that construction would not be significantly affected. However, documents from the EPA indicate that Kramer had filed a Petition for Reorganization under Chapter 11 of the Bankruptcy Code in December 1985. The reorganization of Kramer may delay the ordered remediation and, as of the writing of this report, that work has not commenced.

Another industrial concern is the Allied Chemical plant southwest of the Kramer property. It appears, based on conversations with the El Segundo Fire Department, that the Allied Chemical site may have significant subsurface contamination. The alignment is greater than 2,000 feet from the Allied Chemical Plant, however, and it appears unlikely that the alignment would be affected.



As our prior environmental audit report indicates, there are numerous businesses near the alignment that have underground fuel tanks and/or store hazardous materials on their respective premises. In each of these businesses, there is a possibility of future or past release of stored materials. If such a release occurred in these areas, then it is possible that the subsurface conditions beneath the alignment could be affected.

The proposed alignment will pass near several fuel pipelines. Some of these lines parallel the ATSF Los Angeles Harbor mainline tracks and there are many pipelines at the intersection of Aviation Boulevard and Rosecrans Avenue. There is some potential that one or several of these fuel lines have leaked in the past, which could require special soil handling and disposal during construction. These pipelines, as well as the other utility lines, will have to be accurately located prior to construction of the rail project.

Several known contaminated sites, as reported by various public safety agencies, are identified on the March 1988 State of California Office of Permit Assistance (OPA) list. These sites were approximately shown in the environmental audit report based on the address given for the OPA listing. Some of these listed sites may have been mitigated.

Other areas of environmental concern identified during the site reconnaissance and our in-house review include: 1) the Southern California Edison Company Power Generation Plant located near the south end of the alignment (possible PCBs), and 2) the Chevron property (known as Section 18) between Sepulveda Boulevard and the Hughes EDSG Facility (oily soil and chlorinated hydrocarbons in the ground water) and possible oil/tar stained soils near the intersection of Hughes Way and Sepulveda Boulevard.

Historical aerial photographs indicate a possible waste disposal operation in the vicinity of the present Hughes EDSG site. It is possible, although unlikely, that the subsurface soils beneath the alignment in the vicinity of the facility could have been affected by this operation. The historical aerial photographs also indicate that possible hazardous waste storage occurred at least through 1949 along the existing railroad tracks south of the current Hughes facility near Douglas Street.



The last item of environmental concern is the railroad right-of-way itself. It appears from the aerial photographs that the existing tracks have been present since at least 1946. The railroad tracks serve a highly industrial area, and there is a possibility that rail cars traveling along the line may have accidentally released hazardous substances. It should be noted that no widespread areas of stained soil along the alignment were noted during our walk-over or photo review, however, and this possibility seems remote.

Ground water contamination should not affect the proposed alignment. Ground water occurs at depths in excess of 70 feet in the area and should not be encountered during construction operations if limited to shallower depths.

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Section 6
Field Explorations
and Laboratory Testing

SECTION 6

FIELD EXPLORATION AND LABORATORY TESTING

6.1 FIELD EXPLORATION PROGRAM

The field exploration program was performed in accordance with the statement of work described in the limited notice to proceed from TRANSCAL dated May 31, 1988 and subsequent notice to proceed for the final geotechnical investigation dated October 27, 1988.

A detailed description of the drilling exploration program, boring logs, and downhole seismic surveys is presented in Appendices A through C.

6.1.1 Borings

A total of 67 borings were drilled at the locations shown on Plates 6.1 through 6.15. The locations and depths of borings were initially agreed upon by TRANSCAL and Crandall and were modified as necessary to avoid underground utilities and overhead power lines. The logs of the borings are presented in Appendix A.

The borings were drilled to depths of 5 to 100 feet, for a total of 3,360 lineal feet of drilling. The drilling was performed between August 8 and August 12, 1988 and between December 1, 1988 and January 19, 1989. A summary of the boring locations and depths is presented in Table 6-1.

The soils encountered were logged by our field representatives, and both undisturbed and bulk samples were obtained for laboratory inspection and testing. Undisturbed samples were obtained with the Crandall sampler at depth intervals of about five feet and at major changes in soil stratigraphy. Detailed descriptions of the field exploration procedures are presented in Appendix A.



TABLE 6.1
SUMMARY OF BORINGS

<u>Boring No.</u>	<u>Plate No.</u>	<u>Boring Depth</u>	<u>Drilling Equipment Type</u>	<u>Location</u>
1	A-1	75	Bucket/Rotary Wash	Nash St. South of Mariposa Ave.
2	A-2	75	Bucket	Hughes EDSG Facility
3	A-3	60	Bucket	Hughes EDSG Facility
4	A-4	100	Rotary Wash	Rosecrans Ave. & Aviation Blvd
5	A-5	100	Rotary Wash	Rosecrans Ave. & Aviation Blvd
6	A-6	30	Bucket	Yard and Shops Area
7	(Boring eliminated from drilling program)			
8	A-7	75	Bucket	CALTRANS I-105 Right of Way
9	(Boring eliminated from drilling program)			
10	A-8	60	Bucket	CALTRANS I-105 Right of Way
11	A-9	61	Rotary Wash	Between Aviation Blvd & Lapham St.
12	A-10	61	Rotary Wash	ATSF Right of Way
13	A-11	76	Rotary Wash	Aviation Blvd & Imperial Hwy
14	A-12	61	Rotary Wash	Aviation Blvd & Imperial Hwy
15	A-13	61	Rotary Wash	ATSF Right of Way
16	A-14	61	Rotary Wash	ATSF Right of Way
17	A-15	76	Rotary Wash	ATSF Right of Way
18	A-16	61	Rotary Wash	ATSF Right of Way
19	A-17	61	Rotary Wash	ATSF Right of Way
20	A-18	61	Rotary Wash	ATSF Right of Way
21	A-19	61	Rotary Wash	Rockwell Int'l
22	A-20	76	Rotary Wash	Rockwell Int'l
23	A-21	61	Rotary Wash	Nash St. & Maple St.
24	A-22	61	Rotary Wash	Nash St. Betwn Maple Ave. & Mariposa Ave.
25	A-23	61	Rotary Wash	Nash St. Betwn Maple Ave. & Mariposa Ave.
26	A-24	61	Rotary Wash	Nash St. Betwn Maple Ave. & Mariposa Ave.
27	A-25	60	Bucket	Nash St. Betwn Mariposa Ave. & Grand Ave.
28	A-26	61	Rotary Wash	Nash St. Betwn Mariposa Ave. & Grand Ave.
29	A-27	61	Rotary Wash	Nash St. Betwn Mariposa Ave. & Grand Ave.
30	A-28	76	Rotary Wash	Nash St. & Grand Ave.
31	A-29	61	Rotary Wash	Nash St. Betwn Grand Ave. & El Segundo Blvd
32	A-30	61	Rotary Wash	Nash St. Betwn Grand Ave. & El Segundo Blvd
33	A-31	76	Rotary Wash	Nash St. Betwn Grand Ave. & El Segundo Blvd
34	A-32	60	Bucket	Nash St. & El Segundo Blvd
35	A-33	70	Bucket	Hughes EDSG Facility
36	A-34	61	Rotary Wash	Hughes EDSG Facility
37	A-35	61	Rotary Wash	Hughes EDSG Facility



TABLE 6.1
SUMMARY OF BORINGS
(Continued)

<u>Boring No.</u>	<u>Plate No.</u>	<u>Boring Depth</u>	<u>Drilling Equipment Type</u>	<u>Location</u>
38	A-36	61	Rotary Wash	Hughes EDSG Facility
39	A-37	61	Rotary Wash	Hughes EDSG Facility
40	A-38	60	Bucket	SPTC Right of Way
41	(Kramer Property - status unknown)			
42	(Kramer Property - status unknown)			
43	A-39	61	Rotary Wash	ATSF Right of Way
44	A-40	61	Rotary Wash	ATSF Right of Way
45	A-41	61	Rotary Wash	ATSF Right of Way
46	A-42	61	Rotary Wash	ATSF Right of Way
47	A-43	76	Rotary Wash	ATSF Right of Way
48	A-44	61	Rotary Wash	ATSF Right of Way
49	A-45	5	Hand Auger	SCE East of Douglas St. & So. of Alaska Ave.
50	A-46	30	Bucket	SCE East of Douglas St. & So. of Alaska Ave.
51	A-47	5	Hand Auger	SCE East of Douglas St. & So. of Alaska Ave.
52	A-48	61	Rotary Wash	ATSF Right of Way
53	A-49	50	Bucket	Aviation Blvd & Rosecrans Ave.
54	A-50	40	Bucket	Aviation Blvd & Rosecrans Ave.
55	A-51	21	Bucket	ATSF Right of Way
56	A-52	20	Bucket	ATSF Right of Way
57	A-53	21	Bucket	ATSF Right of Way
58	A-54	20	Bucket	ATSF Right of Way
59	A-55	6	Bucket	SCE East of Isis St. & So. of 146 St.
60	A-56	6	Bucket	SCE East of Isis St. & So. of 146 St.
61	A-57	8	Hand Auger	SCE East of Isis St. & So. of 146 St.
62	A-58	30	Bucket	Yard and Shops Area
63	A-59	30	Bucket	Yard and Shops Area
64	A-60	30	Bucket	Yard and Shops Area
65	A-61	30	Bucket	Yard and Shops Area
66	A-62	30	Bucket	Yard and Shops Area
67	A-63	10	Bucket	Yard and Shops Area
68	A-64	10	Bucket	Yard and Shops Area
69	A-65	10	Bucket	Yard and Shops Area
70	A-66	10	Bucket	Yard and Shops Area
71	A-67	10	Bucket	Yard and Shops Area

D
R
A
F
T



6.1.2 Drilling Contractors and Equipment

The drilling was performed with rotary wash-type and bucket auger-type drilling equipment. The rotary wash borings were drilled by A&W Drilling Company utilizing a Mahew 1000 drilling rig operated by a two-man crew. The auger borings were drilled by the C&L Drilling Company, utilizing a bucket-type rig operated by a two-man crew. Three of the borings were drilled by hand auger-type drilling equipment with a two-man Crandall crew.

6.1.3 Soil Classification

The soils were classified using the Unified Soil Classification System. The field soil classifications were verified by visual inspection in the laboratory by staff engineers and further verified (as necessary) by laboratory tests.

6.2 DOWNHOLE SEISMIC SURVEYS

Downhole seismic surveys were performed at two locations (Borings 4 and 22) to determine the propagation velocities of the compression waves (P waves) and shear waves (S waves). The test procedures and results are presented in Appendix C.

6.3 LABORATORY TESTING PROGRAM

Each soil sample was first visually observed in the laboratory to verify the sample description and classification assigned by the field personnel. A laboratory testing program was then developed that would provide the soil parameters required in performing various engineering analyses. The various tests performed include the following:

- o Moisture Content/Dry Density
- o Direct Shear
- o Consolidation
- o Compaction
- o California Bearing Ratio
- o Expansion Index
- o Particle Size Distribution



The test procedures and results are presented in Appendix B. The field moisture content and dry density of the undisturbed soil samples are shown to the left of the boring logs presented in Appendix A.

6.4 SOIL CORROSIVITY TESTING

Field and laboratory tests to evaluate the soil corrosivity characteristics at selected locations along the rail transit project alignment. The soil corrosivity testing was performed by M. J. Schiff & Associates under a subcontract.

Field resistivity testing was performed at five locations along the alignment. The Wenner Four Pin method was utilized for various pin spacings. The electrical resistivity of selected soil samples was determined in the laboratory to provide additional data. The soils along the rail transit project range from mildly corrosive to corrosive. Specific details and recommendations regarding soil corrosivity are presented in Appendix E, Resistivity Testing.

D

R

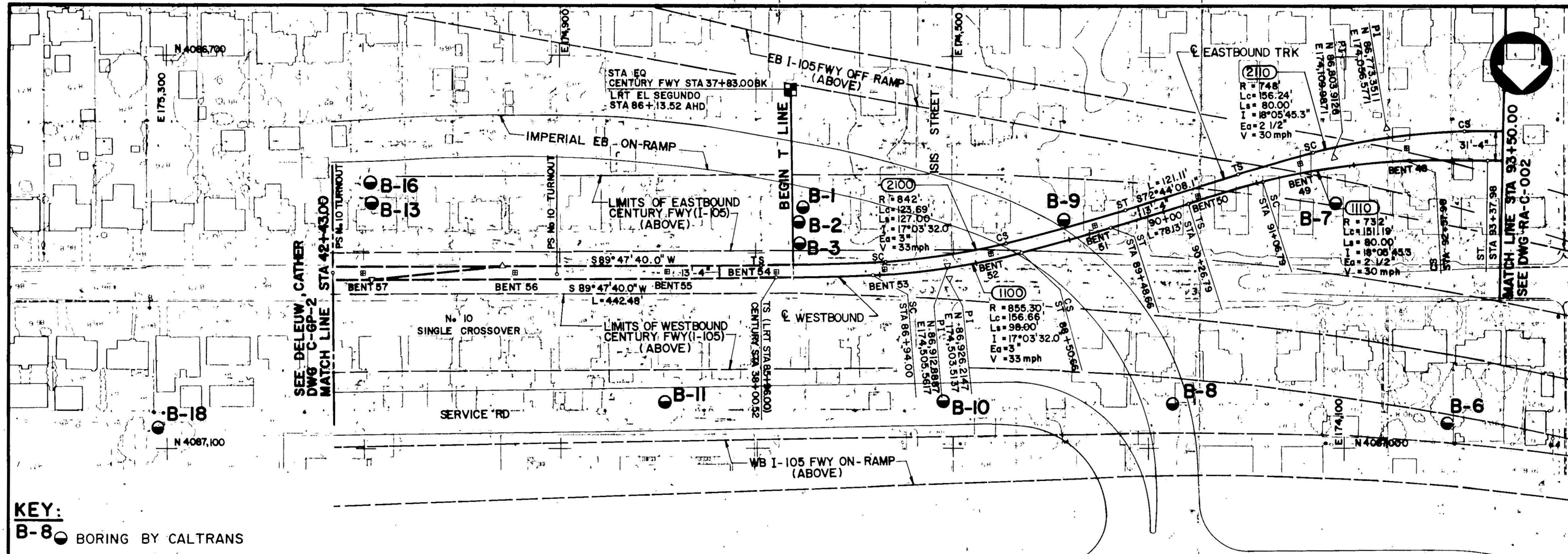
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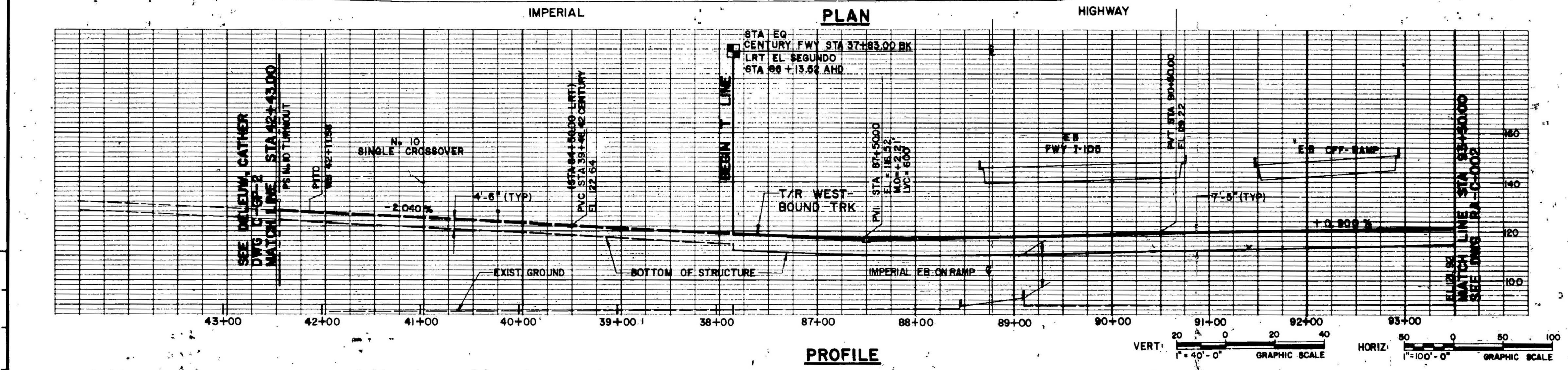
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JOB ADEP-88044-7 DATE 4-89 CHKD. L.D.P.



KEY:
B-8 BORING BY CALTRANS

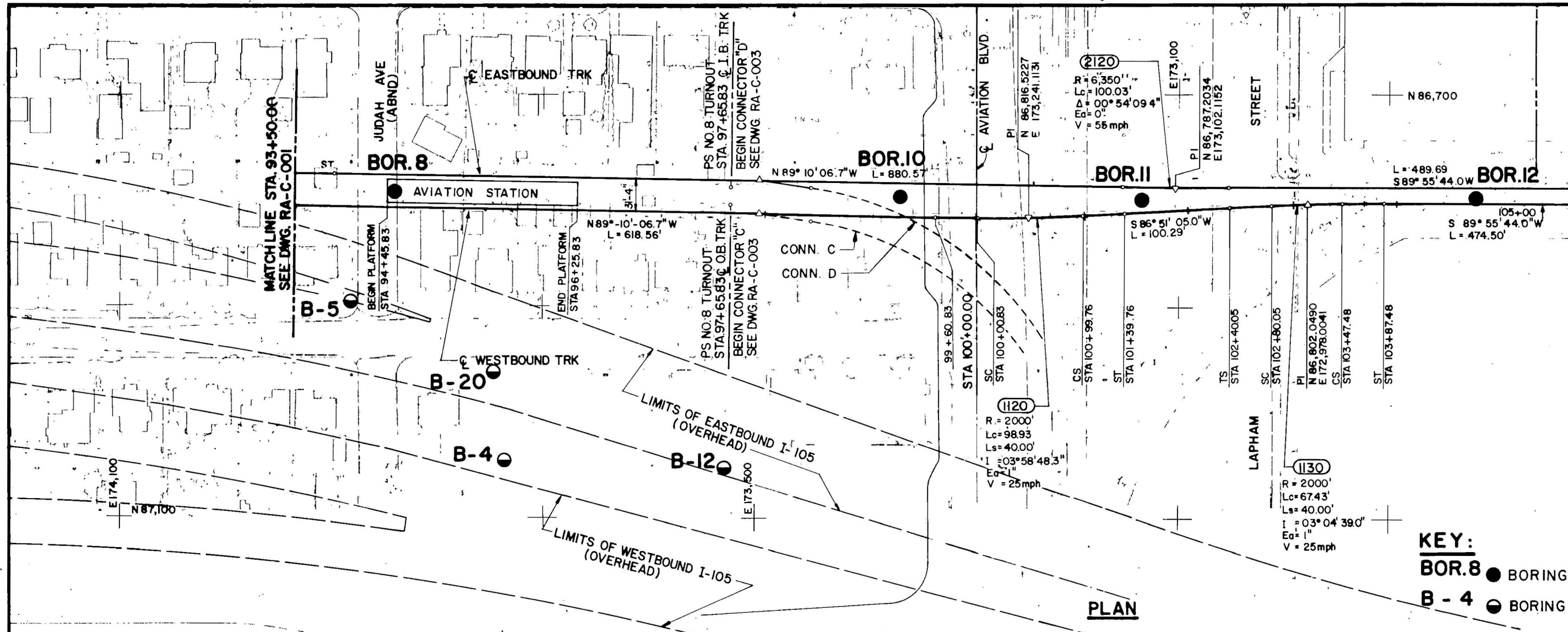


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DRAWN BY <i>[Signature]</i>	TRANSCAL Transit Consultants of Southern California	DRAWING NO. RA-C-001
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APPROVED BY <i>[Signature]</i>	TRANSCAL Transit Consultants of Southern California	SCALE AS NOTED
DATE 9/23/88	SUBMITTED: <i>[Signature]</i>	APPROVED: <i>[Signature]</i>

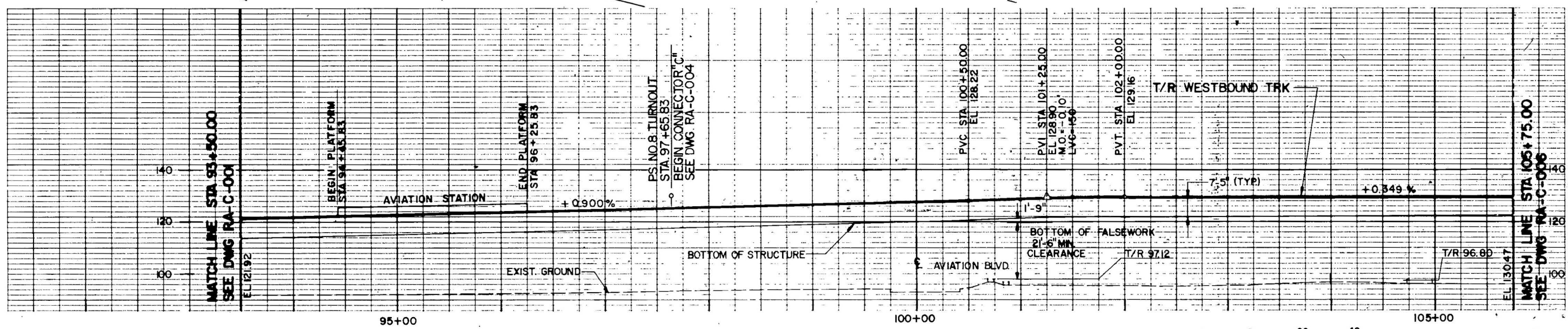
EL SEGUNDO SITE WORK
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BASELINE PLAN & PROFILE, 1 OF 15
STA 86+13.52 TO STA 93+50.00

OB DEF 04 7 0 E 8 HK 4 2 DM

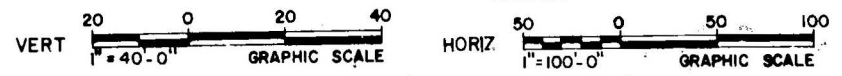


KEY:
BOR.8 ● BORING BY L.C. & A.
B - 4 ● BORING BY CALTRANS

PLAN



PROFILE



Project Number	Cost Element	Line Item	Contract Designator	Physical Entity	Work Element

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Norwalk - El Segundo Rail Transit Project

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PRELIMINARY ENGINEERING
BASELINE PLAN & PROFILE, 2 OF 15
STA 93+50.00 TO STA 105+75.00

CONTRACT NO.	RA-C-002
DRAWING NO.	13
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SHEET NO.	13
SCALE	AS NOTED

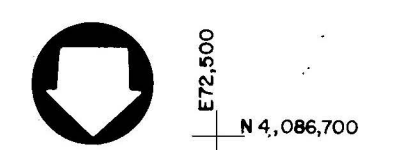
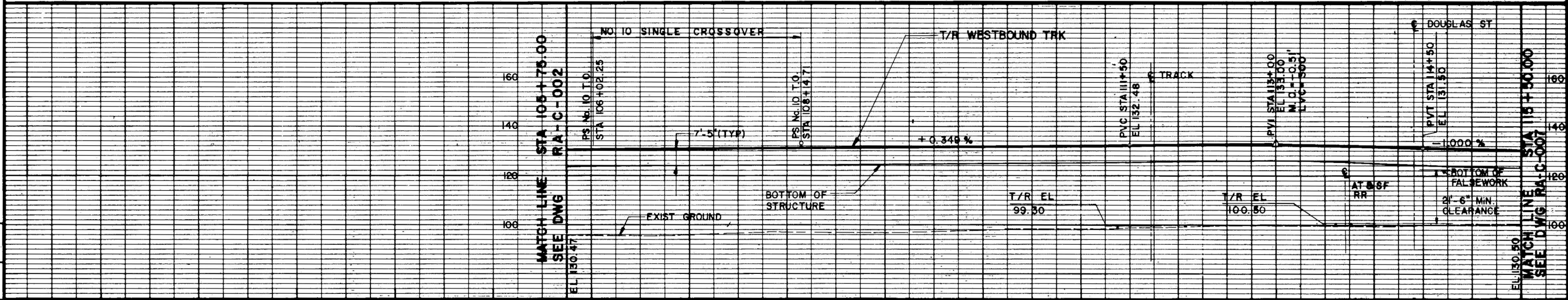
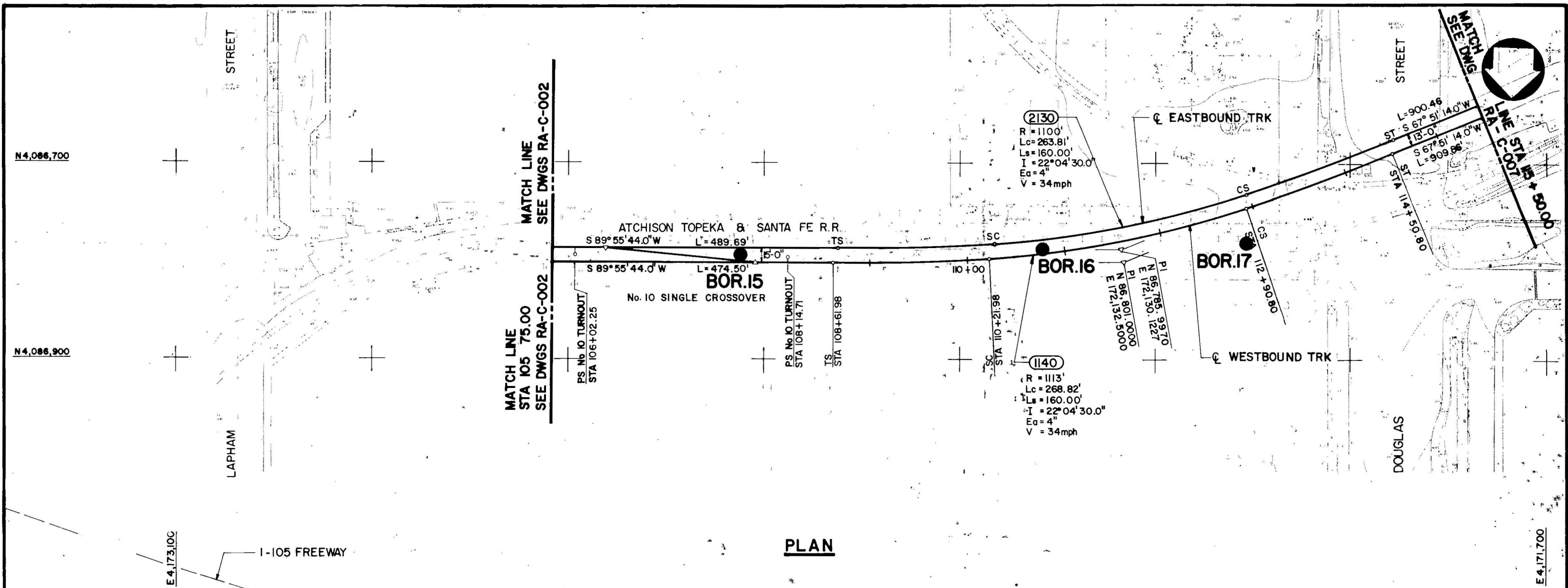


PLATE 63

JOB ADEF-8044-7 DATE 4-89 CHKD. 3/89 DM



Project Number	Line Item	Contract Designer	Physical Entity	Work Element

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DESIGNED BY: *Susan Brink*
DRAWN BY: *Chris Bogaljin*
CHECKED BY: *John Kelly*
APPROVED BY: *David Kray*
DATE: 9/23/88

LOS ANGELES COUNTY TRANSPORTATION COMMISSION
Norwalk - El Segundo Rail Transit Project

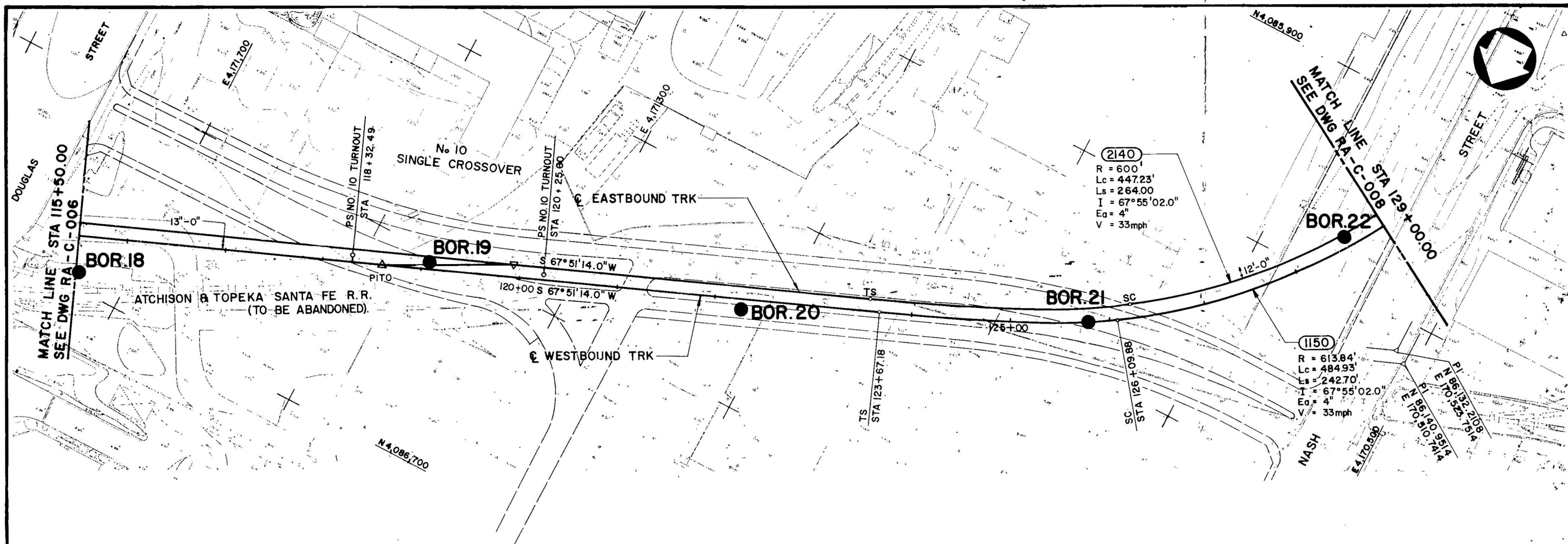
TRANSCAL
Transit Consultants of Southern California

SUBMITTED: *David Kray* APPROVED: *David Kray*

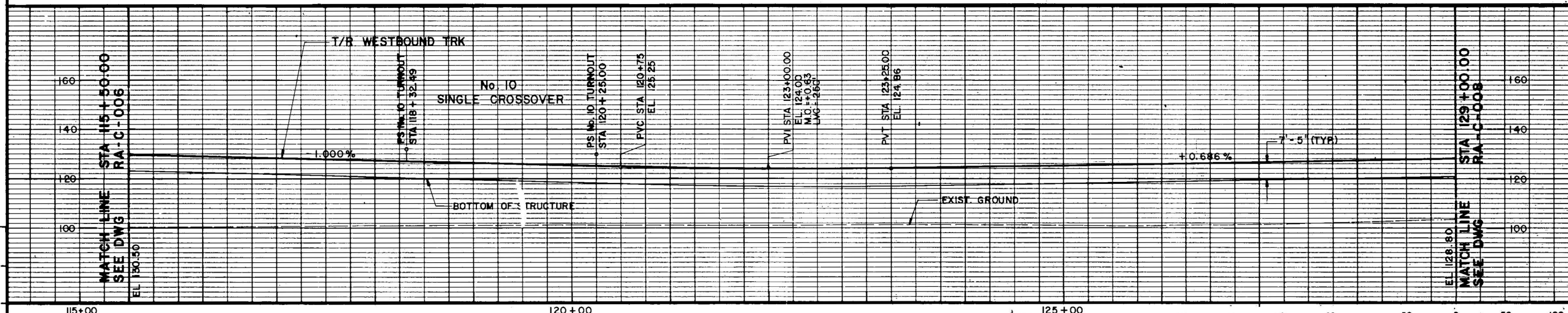
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CONTRACT NO. RA-C-006
DRAWING NO. 16
REV. SHEET NO. 16
SCALE AS NOTED

OB ADEF 880447 DATE 4 89 CHKD



PLAN



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APPROVED BY: *[Signature]*
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LOS ANGELES COUNTY TRANSPORTATION COMMISSION
Norwalk - El Segundo Rail Transit Project

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Transit Consultants of Southern California

SUBMITTED: *[Signature]*

TRANS
Transit Consultants of Southern California

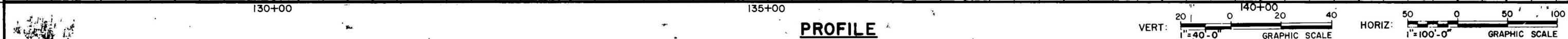
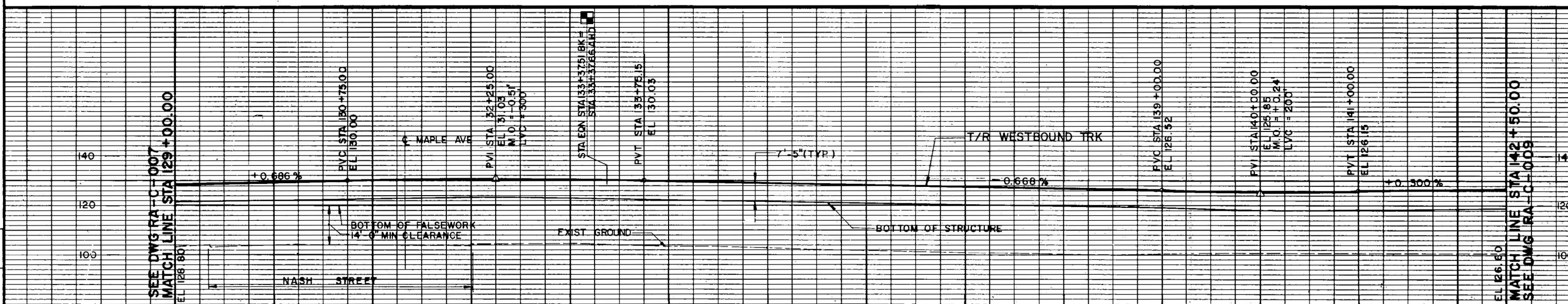
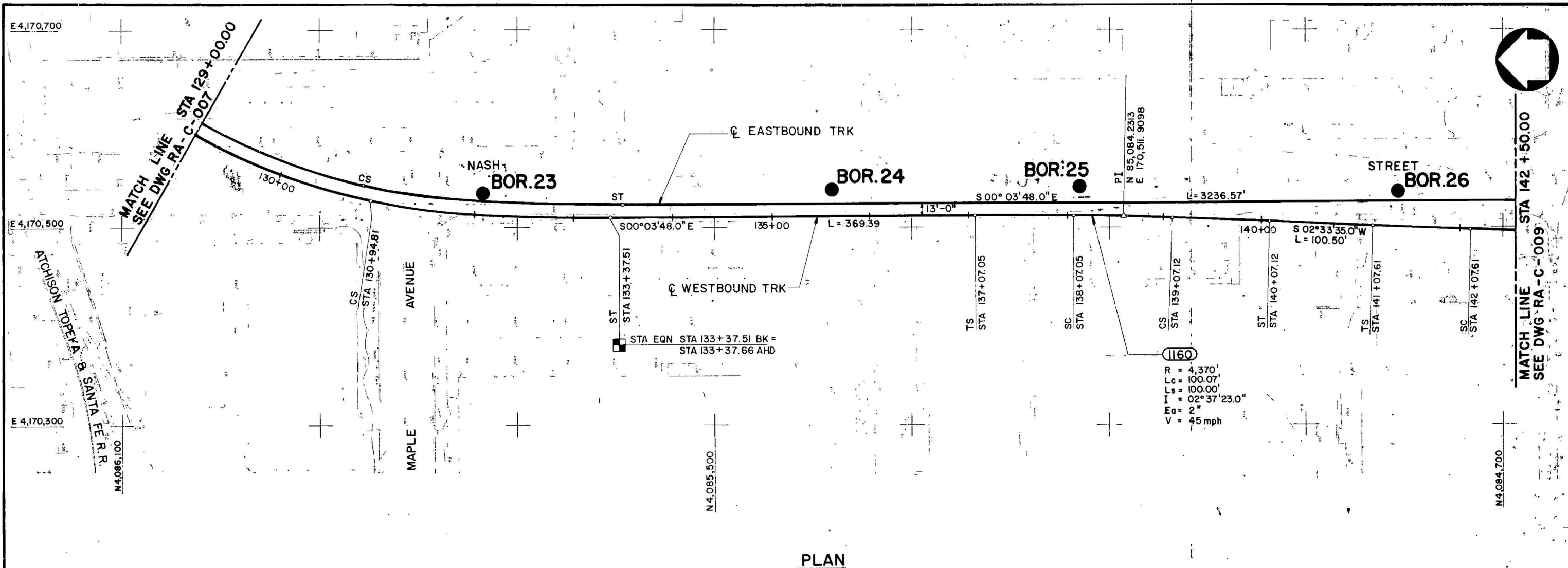
A Joint Venture of:
B Parsons Brinckerhoff Quade & Douglas, Inc.
B Daniel, Mann, Johnson & Mendenhall
B Skidmore, Engle & Associates (California) Corp.

APPROVED: *[Signature]*

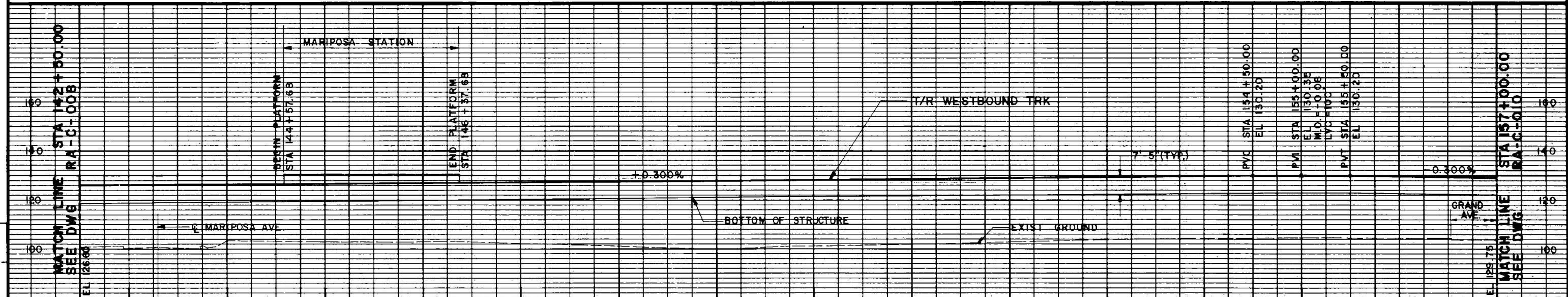
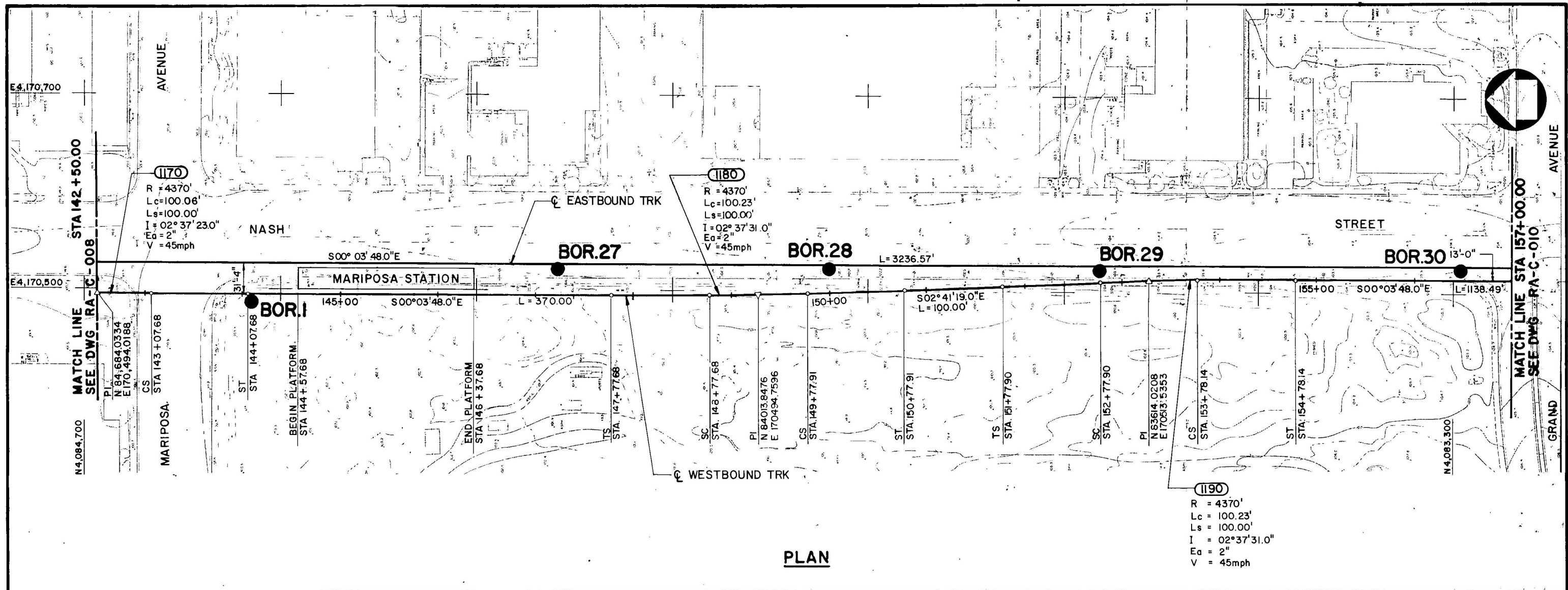
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SHEET NO.	
SCALE	AS NOTED

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LOS ANGELES COUNTY TRANSPORTATION COMMISSION Norwalk - El Segundo Rail Transit Project				TRANS Transit Consultants of Southern California				EL SEGUNDO SITE WORK PRELIMINARY ENGINEERING BASELINE PLAN & PROFILE, 7 OF 15 STA 129+00.00 TO STA 142+50.00	
CONTRACT NO. RA-C-008				DRAWING NO. RA-C-008				REVISION SHEET NO. 18	
SCALE AS NOTED				PLATE 6.6					



Project Number	Cost Element	Line Item	Contract Designer	Physical Entity	Work Element

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LOS ANGELES COUNTY TRANSPORTATION COMMISSION
 Norwalk - El Segundo Rail Transit Project

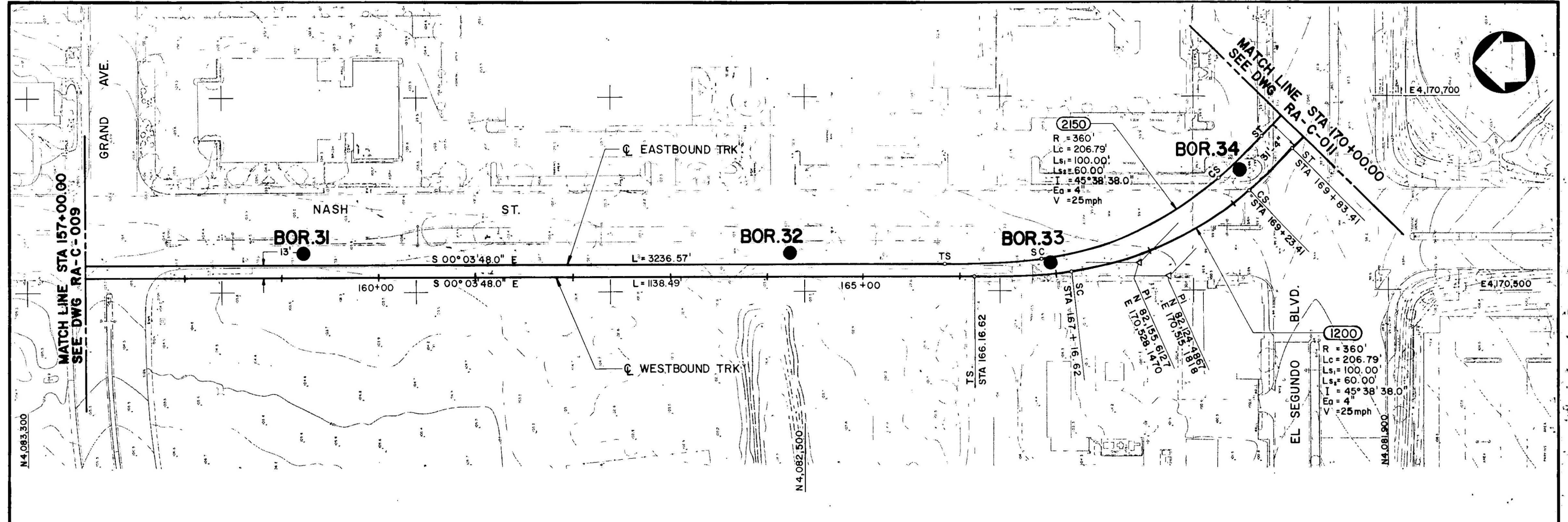
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 Transit Consultants of Southern California

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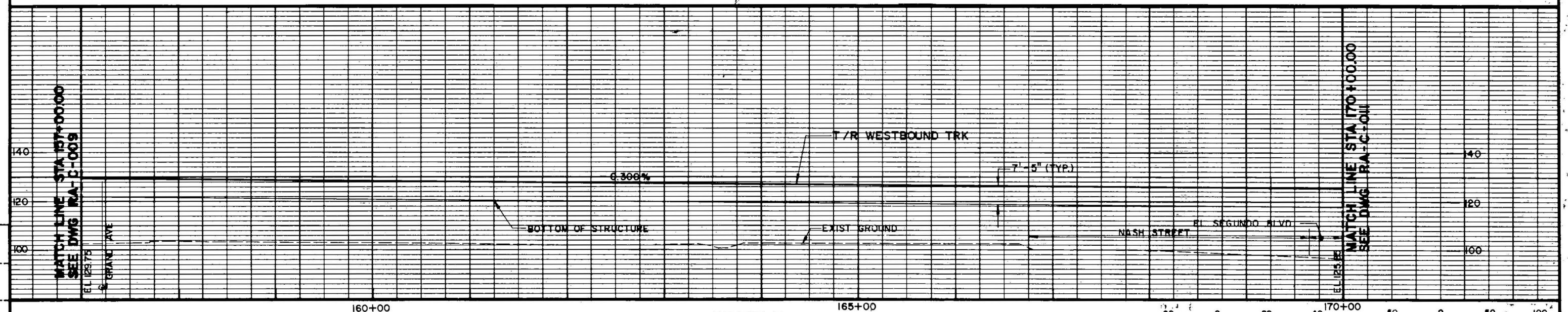
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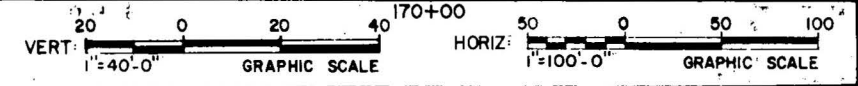
JOB ADEF-88044-7 DATE 1-4-89 CHKD. SK DM



PLAN



PROFILE



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CHECKED BY: *[Signature]*
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LOS ANGELES COUNTY TRANSPORTATION COMMISSION
Norwalk - El Segundo Rail Transit Project

TRANSCAL
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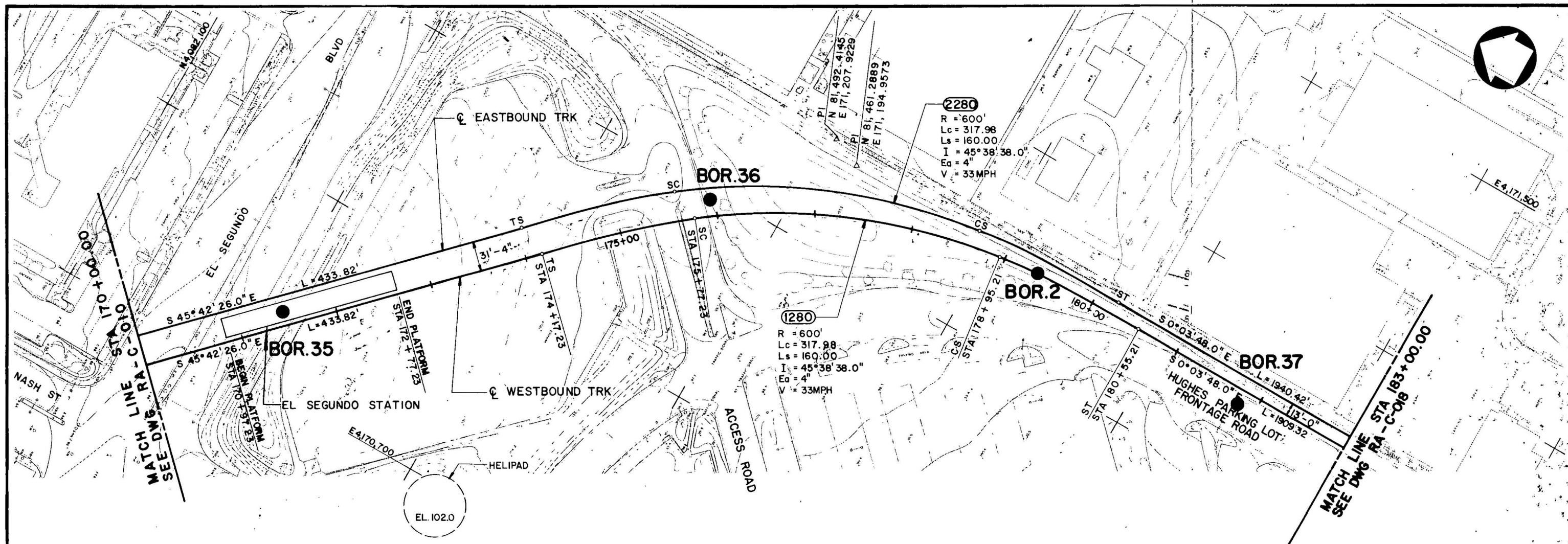
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B Daniel, Mann, Johnson & Mendenhall
B Kiewit Engineers (California) Corp.

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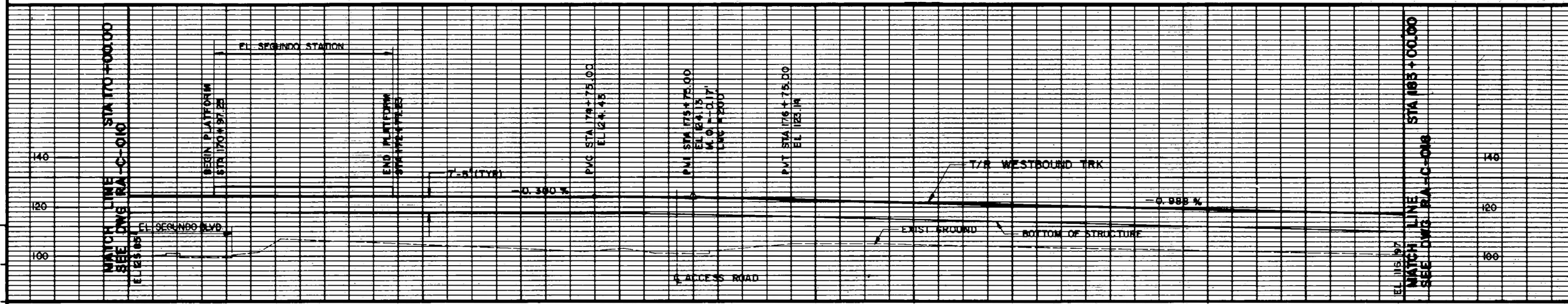
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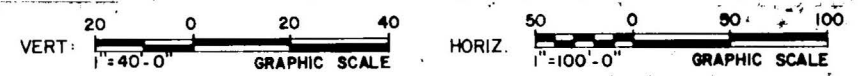
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PLAN



PROFILE



Project Number	
Contract Number	
Line Item	
Work Element	

REV.	DATE	DESCRIPTION	BY	APP.

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APPROVED BY: *[Signature]*
DATE: 9/23/88

LOS ANGELES COUNTY TRANSPORTATION COMMISSION
Norwalk - El Segundo Rail Transit Project

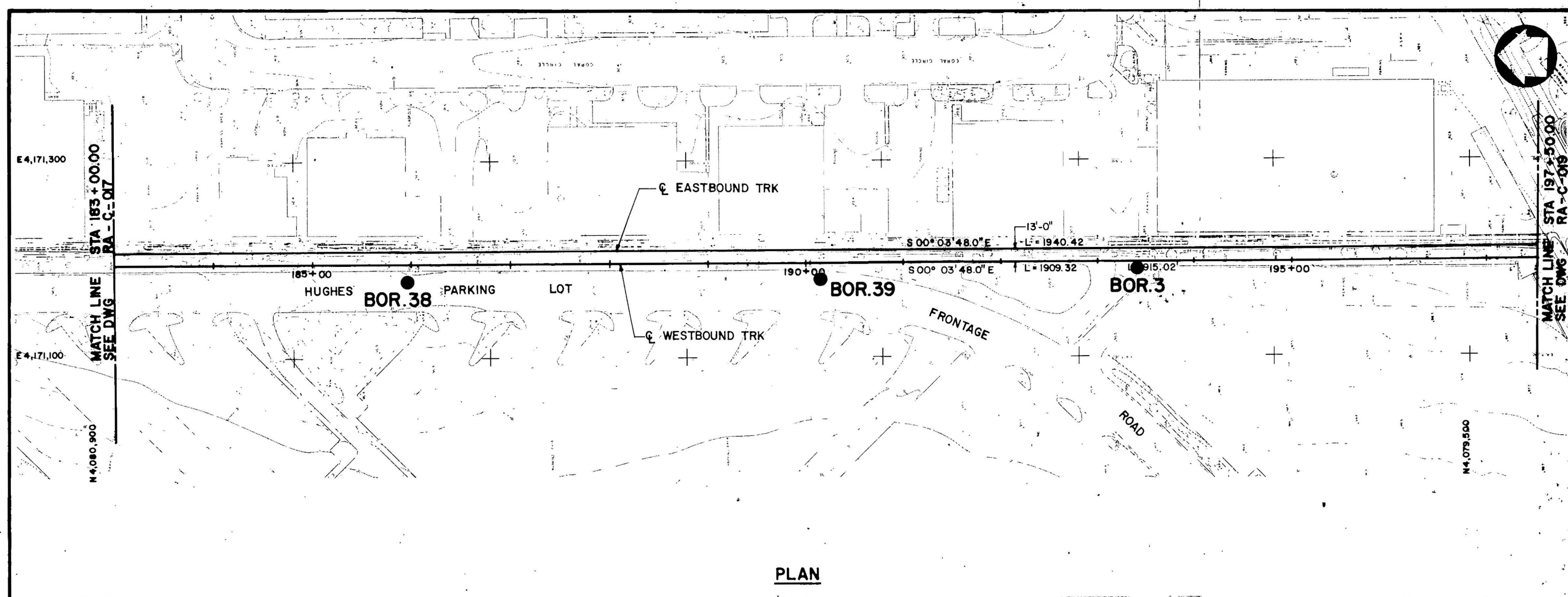
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Transit Consultants of Southern California

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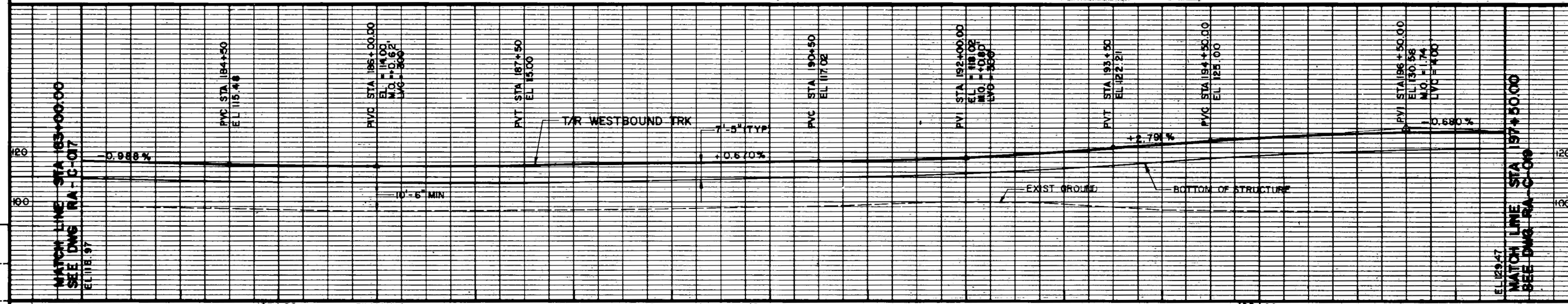
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PRELIMINARY ENGINEERING
ALT. PLAN & PROFILE, HUGHES, 1 OF 3
STA 170+00.00 TO STA 183+00.00

CONTRACT NO.
DRAWING NO. **RA-C-017**
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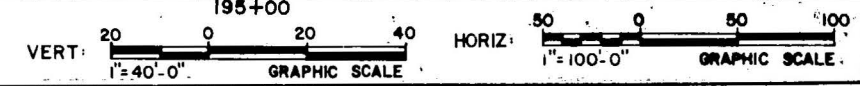
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PLAN



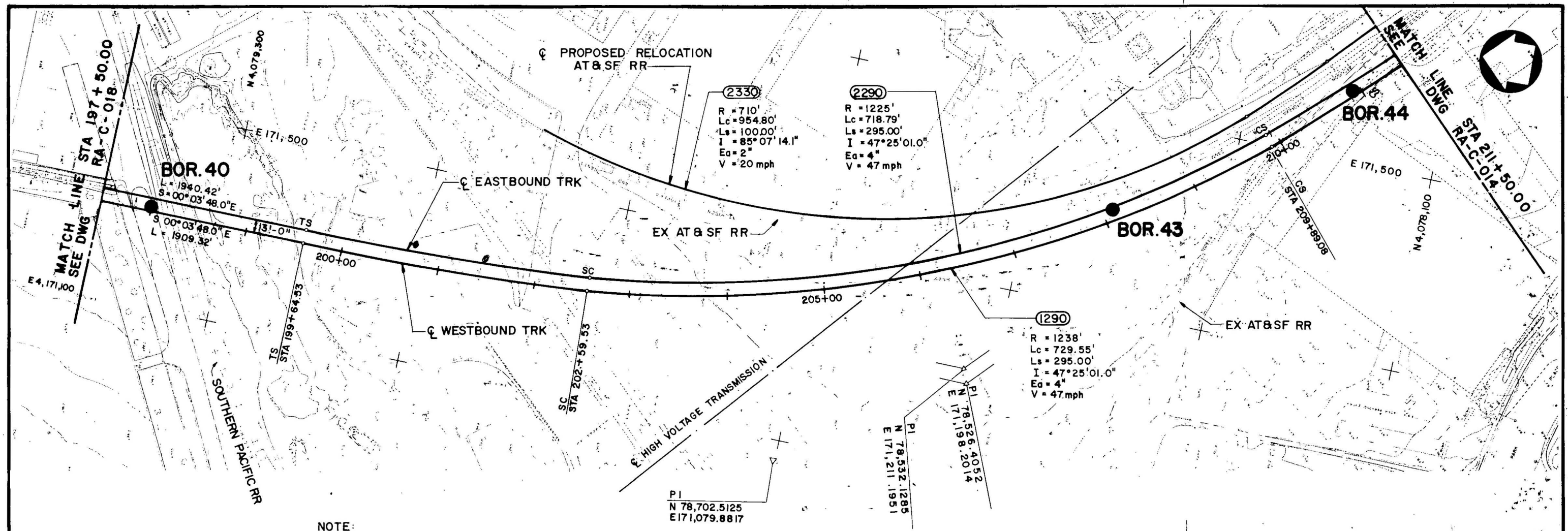
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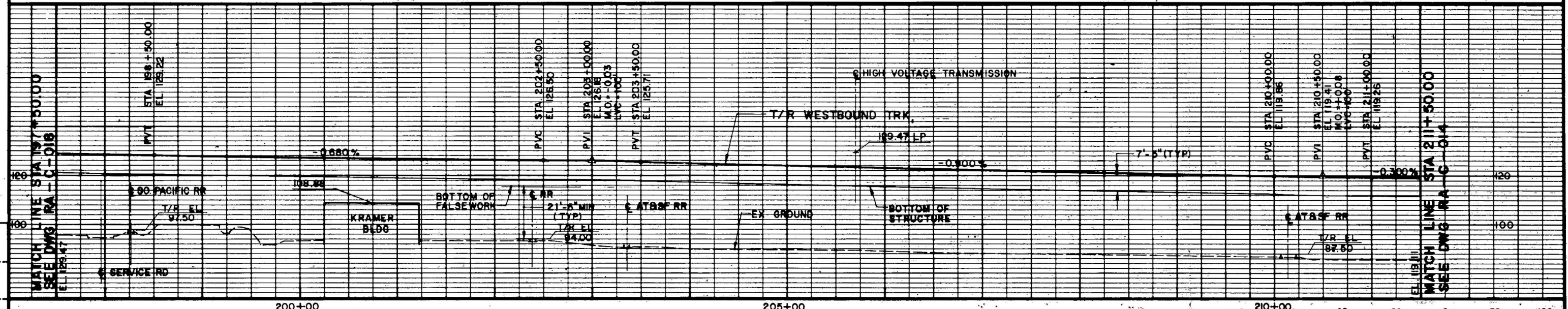
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CHECKED BY <i>[Signature]</i>			SHEET NO. 28
APPROVED BY <i>[Signature]</i>			SCALE AS NOTED
DATE 9/23/88			

JOB ADEF-88044-7 DATE 1-4-89 CHKD. *JK*

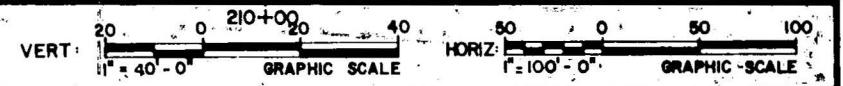


NOTE:
BORINGS 41 AND 42 ON KRAMER
PROPERTY COULD NOT BE DRILLED.

PLAN



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Amir
DRAWN BY
Amir
CHECKED BY
Amir
APPROVED BY
Amir
DATE 9/23/88

LOS ANGELES COUNTY TRANSPORTATION COMMISSION
Norwalk - El Segundo Rail Transit Project

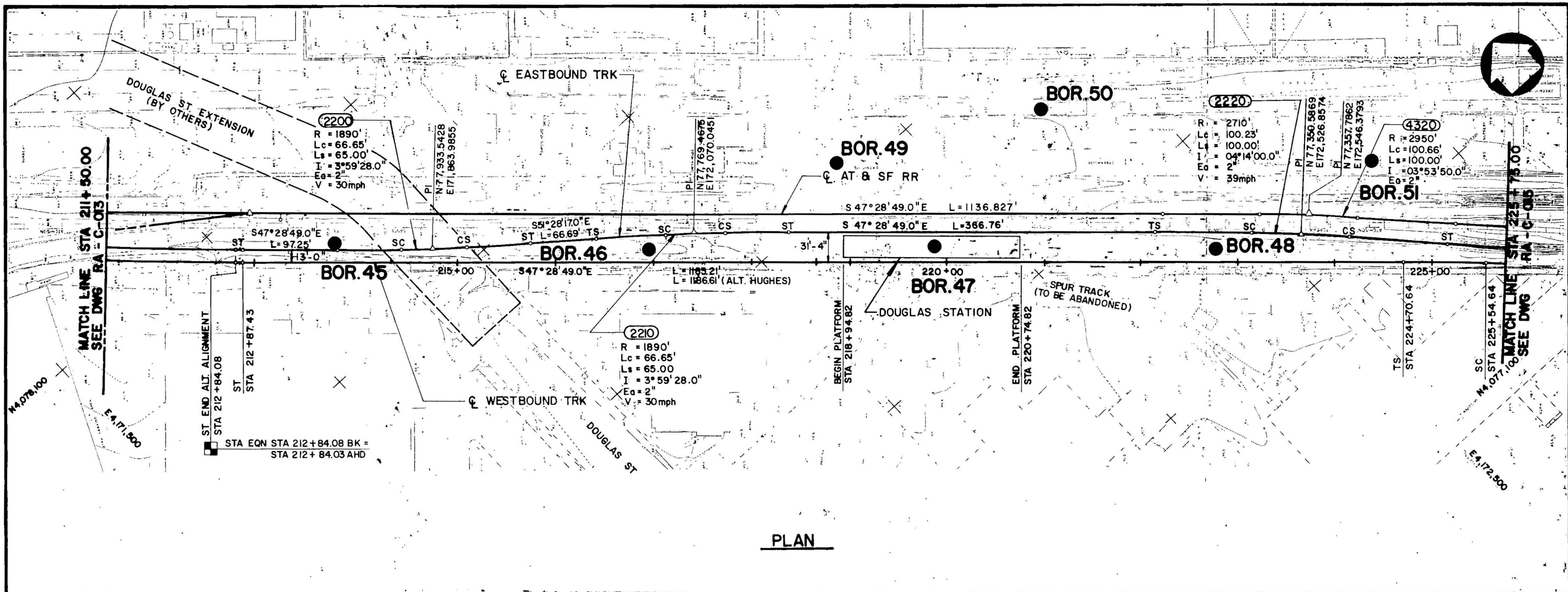
TRANSCAL
Transit Consultants of Southern California

APPROVED: *Amir*

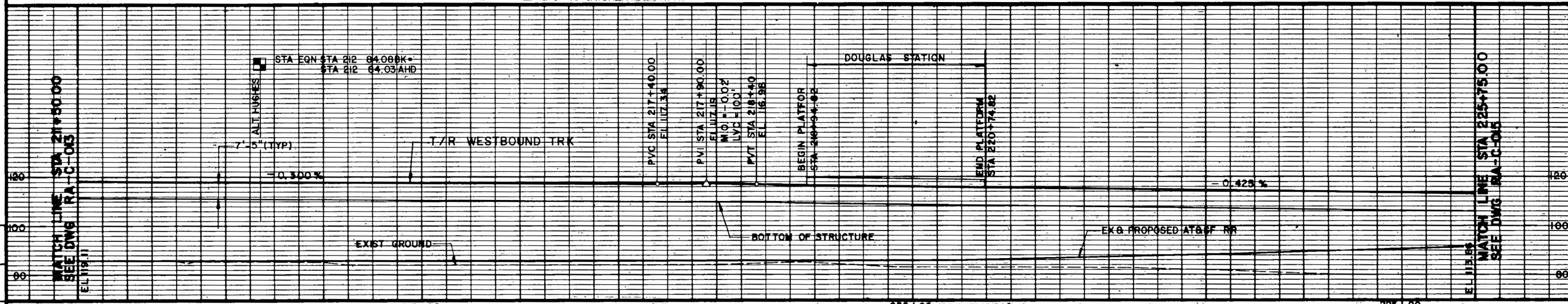
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ALT. PLAN & PROFILE, HUGHES, 3 OF 3
STA 197+50.00 TO STA 211+50.00

CONTRACT NO.	DRAWING NO.
RA - C-019	29
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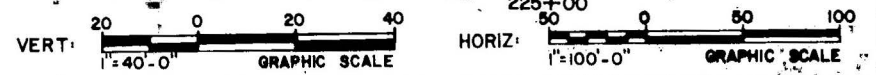
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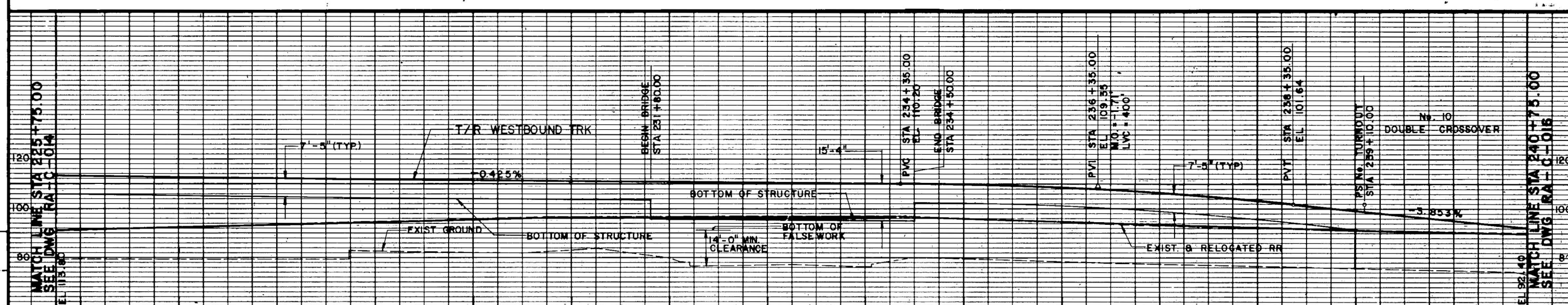
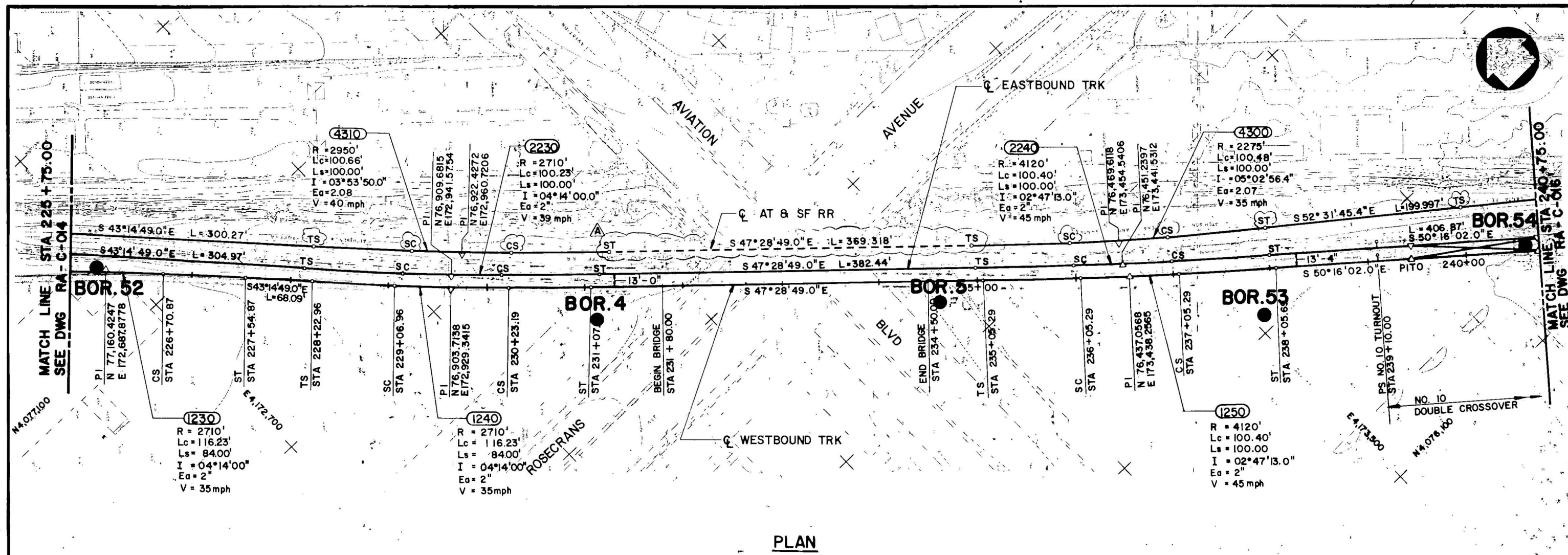
PROFILE



REV.	DATE	DESCRIPTION	BY	APP.

DESIGNED BY <i>[Signature]</i>	LOS ANGELES COUNTY TRANSPORTATION COMMISSION Norwalk - El Segundo Rail Transit Project	CONTRACT NO. RA-C-014
DRAWN BY <i>[Signature]</i>	TRANSAL Transit Consultants of Southern California	DRAWING NO. RA-C-014
CHECKED BY <i>[Signature]</i>	APPROVED BY <i>[Signature]</i>	REV. 24
DATE 9/23/88	SUBMITTED: <i>[Signature]</i>	SHEET NO. 24
		SCALE AS NOTED

JOE EF 04 89 CHK 3



Project Number	Contract Designer	Physical Entity	Work Element
A	10/14/88	TIE INTO EXISTING BRIDGE SHOWN	INITIAL ISSUE
REV.	DATE	DESCRIPTION	BY

DESIGNED BY: J. BALSHEM

CHECKED BY: [Signature]

APPROVED BY: [Signature]

DATE: 9/23/88

LOS ANGELES COUNTY TRANSPORTATION COMMISSION

Norwalk - El Segundo Rail Transit Project

TRANSIT CONSULTANTS OF SOUTHERN CALIFORNIA

APPROVED: [Signature]

EL SEGUNDO SITE WORK

PRELIMINARY ENGINEERING

BASELINE PLAN & PROFILE, 14 OF 15

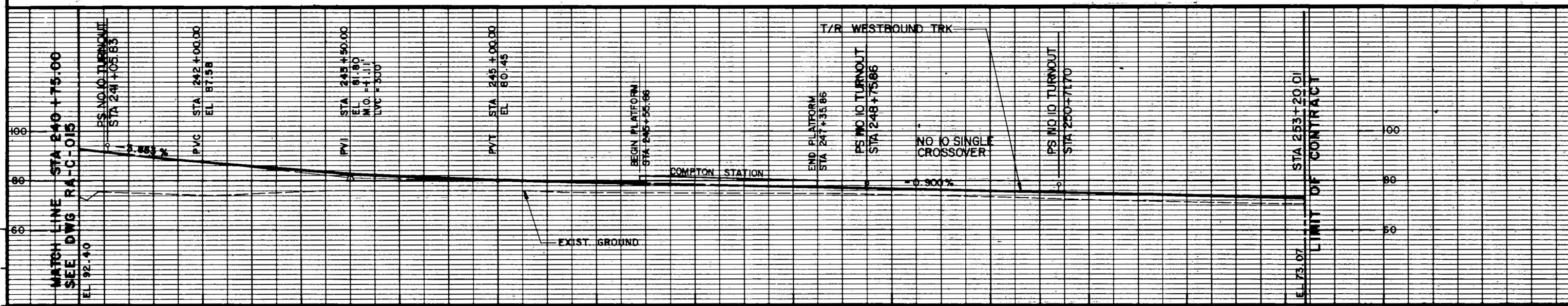
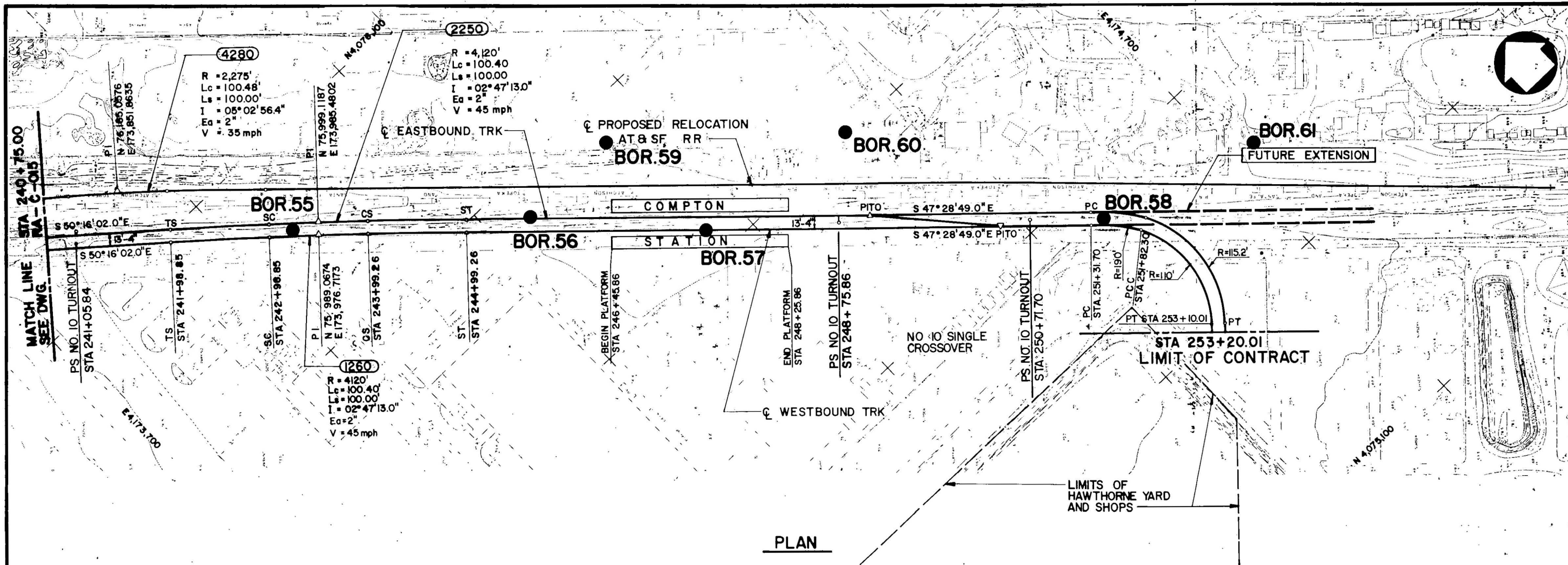
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CONTRACT NO. RA-C-015

DRAWING NO. 25

SCALE AS NOTED

JOB ADEP 80 7 DATE 89 CHKD 56 DM



REV.	DATE	DESCRIPTION	BY	APP.

DESIGNED BY <i>T. Balsheim</i>	LOS ANGELES COUNTY TRANSPORTATION COMMISSION Norwalk - El Segundo Rail Transit Project	CONTRACT NO. RA-C-016
DRAWN BY <i>T. Balsheim</i>	TRANS-CAL Transit Consultants of Southern California	DRAWING NO. 26
CHECKED BY <i>David Brackin</i>	APPROVED BY <i>David Brackin</i>	REV. AS NOTED
DATE 9/23/88	SUBMITTED BY <i>David Brackin</i>	SCALE AS NOTED

1. YARD CURVES ARE 100 FT. EXCEPT AS NOTED.
2. TURNOUTS ARE 190' LATERAL TURNOUTS EXCEPT AS NOTED.



TRANSCAL
Transcal Corporation
Transcal Corporation at Southern California

TRANS **Journal of Southern California**

CONTRACT NO.	
DRAWING NO. YS-C-002	
REV.	SHEET NO. 7
SCALE	

PLATE 6 15

Section 7
Subsurface Conditions

SECTION 7

SUBSURFACE CONDITIONS

7.1 SUBSURFACE INVESTIGATIONS

As described in Section 6, a total of 67 borings were drilled as part of the geotechnical investigation. Six of these borings were drilled as part of the preliminary geotechnical investigation for the rail transit project. In addition, a review of existing geotechnical data from 35 previous projects in the nearby vicinity of the rail transit project was performed as part of the preliminary geotechnical investigation.

Geotechnical information from the Century Freeway (Interstate 105) Project was also made available by the State of California Department of Transportation (CALTRANS). The pertinent data are for the eastern portion of the Airport Viaduct as identified by CALTRANS.

7.2 SUMMARY OF SOIL CONDITIONS

7.2.1 Fill Materials

Fill soils were encountered to depths of 1/2 to 15 feet in 44 of the 67 borings drilled. Typically, the thickness of the fill soils was generally shallow ranging up to about 5 feet. The materials found within the fill consisted of clay, silt, silty sand, and sand. Varying amounts of gravel and debris were found within the fill soils. Typically, the clay fill soils were encountered more within the northern portion of the rail alignment and the silty sand and sand soils were encountered more in the southern portion.

7.2.2 Natural Soils

As mentioned in Section 4, the rail transit alignment extends across areas mantled by deposits of late Pleistocene age dune sands and by continental deposits of the late Pleistocene Lakewood Formation.



The near surface natural soils were found to contain significant amounts of clay, especially in the northern portion of the alignment from the Century Segment terminus to the Hughes EDSG Facility and within the Hawthorne Yard and Shops Area. The clay soils ranged in consistency from moderately soft to moderately stiff. These clay soils would become weaker in strength with an increase in the moisture content. In addition, the clay soils exhibit a high potential for expansion and would tend to shrink or swell with changes in moisture content. Where the clays were not encountered near the surface, the upper soils generally consisted of silts and silty sands. Whereas these soils were generally moderately firm at present moisture content, some of the soils would become weaker in strength and more compressible with an increase in moisture content.

The deeper natural soils consisted primarily of sand and silty sand with some lesser amounts of silt, clayey sand, and clay. Silt, clayey sand, and clay soils were more pronounced in areas where the Lakewood Formation was encountered. The deeper natural soils were generally firm and dense.

7.2.3 Potential for Subsurface Contamination

7.2.3.1 Field Observations

The potential for subsurface contamination was discussed in the Report of Environmental Audit, dated August 25, 1988. A portion of the alignment traverses the El Segundo Oil Field and numerous oil and gas wells, both producing and abandoned, have been identified in the near vicinity. As such, hydrocarbon contamination of some of the soils should be expected along this portion of the alignment.

Hydrocarbon odors were noted during the drilling of the exploration borings. Obvious hydrocarbon odors were noticed in shallow soil samples obtained in seven of the borings (Borings 25, 26, 37, 38, 39, 43, and 52). Specific chemical tests to determine the presence and concentrations of hydrocarbon or other forms of contamination were not performed on any of the soil samples with the exception of OVA monitoring as described in the following section.



It should be noted that many of the exploration borings were drilled with rotary wash-type drilling equipment which utilized drilling mud in the drilling process. This type of drilling process would make it more difficult to detect hydrocarbon odors during drilling.

7.2.3.2 OVA Sample Monitoring

Soil samples from our borings were monitored for the possible presence of volatile organic constituents (VOCs). The samples were analyzed in our laboratory using either one of the following organic vapor analyzer (OVA) instruments: 1) a Photo Vac Tip II detector, 2) an HNu detector, and 3) a Foxboro Century 128 GC detector.

In general, the majority of the samples analyzed did not register any elevated levels of VOCs. There were, however, six borings which had one or two soils samples with VOCs in excess of 20 ppm. Two of these six borings had one or two samples with VOCs in excess of 100 ppm.

Low to moderate VOC readings were found in the samples obtained at 1½ feet (26 ppm) and at 3½ feet (24 ppm) from Boring 52; at 5½ feet (86 ppm) and at 34½ feet (22 ppm) from Boring 54; at 7½ feet (30 ppm) from Boring 62, and at 7½ feet (20 ppm) from Boring 64. Higher concentrations were found in Boring 38 at 2½ feet (550 ppm) and at 4½ feet (130 ppm), and in Boring 36 at 55½ feet (250 ppm).

The borings which were found to have soil samples with low to moderate VOC readings were generally located near the intersection of Rosecrans Avenue and Aviation Boulevard. The borings which had soil samples with higher concentrations of VOCs were located within the Hughes EDSG complex.

7.3 SUMMARY OF WATER CONDITIONS

The exploration borings were drilled with three types of equipment: bucket auger-type, rotary wash-type, and hand auger. Because drilling mud was used in the rotary wash drilling operations, it was more difficult to determine water conditions in the borings drilled with this type of equipment. Due to time restrictions for drilling and the need for timely backfilling of the borings,



water level determinations could not be made in many of the rotary wash borings. A piezometer was installed in Boring 5, however.

Water seepage was encountered in four of the borings drilled with bucket auger or hand auger equipment. Shallow water seepage was encountered at the Hughes EDSG Facility at depths of 3 to 9 feet in Boring 3, and at a depth of 13 feet in Boring 40; these seepages were probably due to irrigation of landscaped areas at the EDSG Facility. Deeper water seepage was encountered in Borings 8 and 10 at depths of 72 and 54 feet, respectively. Water was measured at a depth of 72½ feet in Boring 8, located at the Aviation Boulevard Station location. Water was also measured in Boring 35, located at the El Segundo Boulevard Station site, at a depth of 68 feet; the water appears to perched on top of a relatively impermeable layer.

Water was measured in the piezometer casing installed in Boring 5 at a depth of 73 feet. Boring 5 is located near the southeast corner of the intersection of Rosecrans Avenue and Aviation Boulevard.

Although the water level was not determined in most of the rotary wash borings, a review of the moisture contents of the soil samples strongly suggest that the true water table was not encountered. However, elevated moisture contents of the finer grained soils such as silts and clays do suggest the possibility of perched water within the coarser sands and silty sands on top of the less permeable silts and clays in a few of the borings, especially in the northern part of the alignment.

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Section 8
Recommendations
Aerial Structures

SECTION 8

RECOMMENDATIONS - AERIAL STRUCTURES

8.1 GENERAL

It is anticipated that aerial structures (rail guideways and elevated stations) will be supported spans typically about 100 feet in length and that a single column may be utilized. Consequently, loads are estimated to be on the order of 1,000 to perhaps 3,000 kips.

Although the deeper sands and silty sand are relatively dense and firm, the anticipated loads could result in significant settlement of the aerial structures. To provide foundation support with minimum settlement, drilled cast-in-place friction piling may be used. Friction piling would also provide resistance to seismic loads. This type of foundation system has been utilized for support of the CALTRANS-designed Century Freeway project and for the elevated roadway at the Los Angeles International Airport, as well as for support of some of the aerial structures of the Long Beach-Los Angeles Rail Transit Project.

8.2 DRILLED PILE DESIGN

8.2.1 General

Because of the soil conditions and general lack of water, drilled cast-in-place concrete piling may be used. Either groups of piles or single large diameter concrete piles may be used. For foundation design, the aerial structure alignment has been divided into the following five sections where the soil conditions are similar.

- | | |
|-------------------|--|
| <u>Section 1:</u> | Aviation Boulevard to Nash Street
Borings 8 and 10 through 21. |
| <u>Section 2:</u> | Along Nash Street to El Segundo Boulevard
Borings 1 and 22 through 32 |
| <u>Section 3:</u> | El Segundo Boulevard to Edge of Kramer Property
Borings 33 through 40 |



Section 4: South Edge of Kramer Property to Douglas Station
Borings 43 through 48

Section 5: Rosecrans and Aviation Bridge
Borings 4, 5, 52, 53, and 54

8.2.2 Section 1 Aviation Boulevard to Nash Street

8.2.2.1 Capacities

The downward and upward capacities of 4-, 6-, and 8-foot-diameter drilled piles are presented on Plate 8.1, Drilled Pile Capacities. Dead plus live load capacities are shown; a one-third increase may be used for wind or seismic loads. The dead plus live capacities are allowable capacities; a factor of safety of 2 was used to determine the allowable capacities. If piles in groups are required, the piles should be spaced not less than $2\frac{1}{2}$ diameters on centers so that group action need not be considered.

8.2.2.2 Lateral Loads

Lateral loads may be resisted by the piles. It may be assumed that the soils adjacent to a single 6-foot-diameter pile, at least 40 feet long, can resist horizontal loads imposed at the top of the pile of 120 kips. This capacity has been determined for an allowable lateral deflection of one-fourth inch at the top of the pile. For an allowable lateral deflection of one-half inch at the top of the pile, the lateral capacity may be increased to 240 kips. The lateral resistance of other sizes of piles may be assumed to be proportional to the diameter. The lateral modulus of subgrade reaction may be assumed to be 750 kips per cubic foot.

The passive resistance of the soils against the pile caps may be assumed to be equal to the pressure developed by a fluid with a density of 250 pounds per cubic foot.



8.2.2.3 Settlement

The estimated settlements of the proposed aerial structures, supported on drilled piling, are as follows:

<u>Imposed Load (kips)</u>	<u>Settlement (inches)</u>
1,000	1-1/4
2,000	1-3/4
3,000	2

8.2.3 Section 2 Along Nash Street to El Segundo Boulevard

8.2.3.1 Capacities

The downward and upward capacities of 4-, 6-, and 8-foot-diameter drilled piles are presented on Plate 8.2, Drilled Pile Capacities. Dead plus live load capacities are shown; a one-third increase may be used for wind or seismic loads. The dead plus live capacities are allowable capacities; a factor of safety of 2 was used to determine the allowable capacities. If piles in groups are required, the piles should be spaced not less than 2½ diameters on centers so that group action need not be considered.

8.2.3.2 Lateral Loads

Lateral loads may be resisted by the piles. It may be assumed that the soils adjacent to a single 6-foot-diameter pile, at least 40 feet long, can resist horizontal loads imposed at the top of the pile of 150 kips. This capacity has been determined for an allowable lateral deflection of one-fourth inch at the top of the pile. For an allowable lateral deflection of one-half inch at the top of the pile, the lateral capacity may be increased to 300 kips. The lateral resistance of other sizes of piles may be assumed to be proportional to the diameter. The lateral modulus of subgrade reaction may be assumed to be 1,000 kips per cubic foot.

The passive resistance of the soils against the pile caps may be assumed to be equal to the pressure developed by a fluid with a density of 250 pounds per cubic foot.



8.2.3.3 Settlement

The estimated settlements of the proposed aerial structures, supported on drilled piling, are as follows:

<u>Imposed Load (kips)</u>	<u>Settlement (inches)</u>
1,000	1
2,000	1-1/2
3,000	1-3/4

8.2.4 Section 3 El Segundo Boulevard to Edge of Kramer Property

8.2.4.1 Capacities

The downward and upward capacities of 4-, 6-, and 8-foot-diameter drilled piles are presented on Plate 8.3, Drilled Pile Capacities. Dead plus live load capacities are shown; a one-third increase may be used for wind or seismic loads. The dead plus live capacities are allowable capacities; a factor of safety of 2 was used to determine the allowable capacities. If piles in groups are required, the piles should be spaced not less than 2½ diameters on centers so that group action need not be considered.

8.2.4.2 Lateral Loads

Lateral loads may be resisted by the piles. It may be assumed that the soils adjacent to a single 6-foot-diameter pile, at least 40 feet long, can resist horizontal loads imposed at the top of the pile of 150 kips. This capacity has been determined for an allowable lateral deflection of one-fourth inch at the top of the pile. For an allowable lateral deflection of one-half inch at the top of the pile, the lateral capacity may be increased to 300 kips. The lateral resistance of other sizes of piles may be assumed to be proportional to the diameter. The lateral modulus of subgrade reaction may be assumed to be 1,000 kips per cubic foot.

The passive resistance of the soils against the pile caps may be assumed to be equal to the pressure developed by a fluid with a density of 250 pounds per cubic foot.



8.2.4.3 Settlement

The estimated settlements of the proposed aerial structures, supported on drilled piling, are as follows:

<u>Imposed Load (kips)</u>	<u>Settlement (inches)</u>
1,000	3/4
2,000	1-1/4
3,000	1-1/2

8.2.5 Section 4 South Edge of Kramer Property to Douglas Station

8.2.5.1 Capacities

The downward and upward capacities of 4-, 6-, and 8-foot-diameter drilled piles are presented on Plate 8.4, Drilled Pile Capacities. Dead plus live load capacities are shown; a one-third increase may be used for wind or seismic loads. The dead plus live capacities are allowable capacities; a factor of safety of 2 was used to determine the allowable capacities. If piles in groups are required, the piles should be spaced not less than 2½ diameters on centers so that group action need not be considered.

8.2.5.2 Lateral Loads

Lateral loads may be resisted by the piles. It may be assumed that the soils adjacent to a single 6-foot-diameter pile, at least 40 feet long, can resist horizontal loads imposed at the top of the pile of 150 kips. This capacity has been determined for an allowable lateral deflection of one-fourth inch at the top of the pile. For an allowable lateral deflection of one-half inch at the top of the pile, the lateral capacity may be increased to 300 kips. The lateral resistance of other sizes of piles may be assumed to be proportional to the diameter. The lateral modulus of subgrade reaction may be assumed to be 1,000 kips per cubic foot.

The passive resistance of the soils against the pile caps may be assumed to be equal to the pressure developed by a fluid with a density of 250 pounds per cubic foot.



8.2.5.3 Settlement

The estimated settlements of the proposed aerial structures, supported on drilled piling, are as follows:

<u>Imposed Load (kips)</u>	<u>Settlement (inches)</u>
1,000	3/4
2,000	1-1/4
3,000	1-1/2

8.2.6 Section 5 Rosecrans and Aviation Bridge

The proposed bridge will span the intersection of Rosecrans Avenue and Aviation Boulevard and will extend at least 270 feet over the intersection to allow for future widening. There are numerous utility lines in the area, including oil and gas pipelines.

8.2.6.1 Capacities

The downward and upward capacities of 4-, 6-, and 8-foot-diameter drilled piles are presented on Plate 8.5, Drilled Pile Capacities. Dead plus live load capacities are shown; a one-third increase may be used for wind or seismic loads. The dead plus live capacities are allowable capacities; a factor of safety of 2 was used to determine the allowable capacities. If piles in groups are required, the piles should be spaced not less than 2½ diameters on centers so that group action need not be considered.

8.2.6.2 Lateral Loads

Lateral loads may be resisted by the piles. It may be assumed that the soils adjacent to a single 6-foot-diameter pile, at least 40 feet long, can resist horizontal loads imposed at the top of the pile of 150 kips. This capacity has been determined for an allowable lateral deflection of one-fourth inch at the top of the pile. For an allowable lateral deflection of one-half inch at the top of the pile, the lateral capacity may be increased to 300 kips. The lateral resistance of other sizes of piles may be assumed to be proportional to the diameter. The lateral modulus of subgrade reaction may be assumed to be 1,000 kips per cubic foot.



The passive resistance of the soils against the pile caps may be assumed to be equal to the pressure developed by a fluid with a density of 250 pounds per cubic foot.

8.2.6.3 Settlement

The estimated settlements of the proposed bridge, supported on drilled piling, are as follows:

<u>Imposed Load (kips)</u>	<u>Settlement (inches)</u>
1,000	3/4
2,000	1-1/4
3,000	1-1/2
5,000	1-3/4

8.3 PILE INSTALLATION

The El Segundo Segment is located within areas mantled by older dune sand deposits and the Pleistocene Lakewood Formation. There are significant amounts of sandy soils within these two geologic formations. As a result of caving one of the borings drilled for this investigation with bucket auger-type drilling equipment was terminated. A significant percentage of prior borings drilled by our firm for other projects in the vicinity with bucket auger-type drilling equipment also experienced significant caving.

The bucket auger exploration borings were drilled typically with relatively small diameter equipment, ranging from 16 to 24 inches in diameter. It should be noted that the caving potential increases as the diameter of the excavation increases. The sandy soils are relatively cohesionless, and may be held together by small capillary tension forces. If allowed to dry, the soils would lose that capillary tension and would be more likely to cave. The use of high speed drilling equipment would also cause disturbance of the soils, increasing the likelihood of caving.

Ground water may be shallower towards the southern portion of the El Segundo segment; however, zones of perched water were encountered towards the northern portion and the possibility exists



that perched water could occur on top of less permeable soils. The presence of water would also increase the likelihood of caving.

It should be anticipated that significant caving and sloughing may occur during excavation of the large diameter drilled piles above the ground water table, and particularly below the water, unless positive steps are taken to support the sides of the hole. Special techniques will likely be needed to satisfactorily install the piles. The use of casing has been observed on the nearby Interstate 105 project to install large diameter piles.

Only competent drilling contractors with demonstrated experience in the installation of drilled cast-in-place large diameter piles using drilling mud and casing in similar circumstances should be considered for the pile work. The drilling system should be equipped to include the use of casing and drilling mud to prevent shaft caving during drilling and placing of concrete. The equipment should provide for the introduction of drilling mud of sufficient specific gravity to retain the shaft sides, and continuous pumping for retrieval of the mud concurrent with concrete placement. The pressure head of mud in the shaft should be sufficient to maintain a stable bottom during all construction operations.

The contractor should provide the equipment necessary to check the bearing, dimensions and alignment of each drilled shaft.

Drilling should be performed in a sequence such that no adjacent pile closer than five pile diameters on center is drilled sooner than eight hours after placement of the concrete.

Care should be exercised during placement of the reinforcement steel to minimize disturbance and caving of the sides of any uncased portions of the drilled shaft.

Concrete should be pumped through a tremie pipe extending to the bottom of the shaft with the pipe being at least eight feet below the surface of the concrete at all times during placement. The discharge end of the tremie should be constructed so that it is watertight against intrusion from the

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outside and so that it will readily discharge concrete. The tremie pipe should be supported so that it can be raised and lowered rapidly should it become necessary to cut off or retard the flow. Casing should be pulled as the concrete is placed; the bottom of the casing, however, should be maintained at least three feet below the surface of the concrete at all times. The discharge pipe should be kept full of concrete during the entire placing operation and should not be removed from the concrete until all of the concrete is placed and fresh concrete appears at the top of the pile. The volume of concrete pumped into the hole should be recorded and compared to the design volume.

8.4 BRIDGE RETAINING WALLS

For design of the bridge retaining walls, where the backfill is level or nearly level, it may be assumed that drained backfill soils will exert an active lateral earth pressure equal to that developed by a fluid with a density of 35 pounds per cubic foot. Where the earth slopes upward at 2:1, an equivalent fluid pressure of 53 pounds per cubic foot should be used.

The retaining wall structures may be supported on spread footings established in the undisturbed natural soils. The footings should be established at least five feet below the lowest adjacent grade and at least five feet below existing grade and may be designed to impose a maximum pressure of 6,000 pounds per square foot. A one-third increase may be used for wind and seismic loads.

A retained earth embankment with a maximum height of 27 feet will be built. The retained earth embankment is estimated to settle about three inches under the centerline of the embankment. The imposed load and the settlement caused by the retained earth embankment would impact underground utilities and structures underlying the embankment and could also impact nearby at-grade structures. The underlying soils are primarily granular; accordingly, the majority of settlement should occur as the embankment fill is placed.



8.5 SEISMIC CRITERIA

8.5.1 Input to CALTRANS Seismic Criteria for Bridges

The proposed bridge will be designed in accordance with the bridge design criteria of the State of California Department of Transportation (CALTRANS). The geotechnical information needed for the CALTRANS criteria is the depth to rock and the expected peak bedrock acceleration. Based on a review of the soils and geologic data (Section 4.2), the depth to rock is greater than 150 feet.

The expected peak bedrock acceleration is 0.7g, based on the proximity of the Charnock and Newport-Inglewood Faults.

8.5.2 Effect of Strong Ground Shaking on Pile Foundations

It should be anticipated that following a major earthquake some lateral movement of large diameter pile foundations at the ground surface will occur, especially if pile caps are not used. However, because of the rigidity and mass of the foundations, the lateral movement would not be expected to be great. As the soils are predominantly granular in nature, we do not believe that significant voids would develop between the soils and the piles ~~would develop~~ after an earthquake. Minor voids should not significantly affect the vertical or lateral load capacities of the foundations.

There is the possibility of some clay soils in the upper 10 feet below the ground surface in some areas and voids could develop in these soils with a resulting temporary loss of load carrying capacity in shear. This could reduce the vertical capacities of the piles; however, the lateral capacities should not be affected significantly. The contribution of the upper soils to the vertical pile capacities is relatively small compared to deeper depths; consequently, the overall capacities of the piles should not be significantly affected. We believe that in time, these voids would eventually close and the load carrying capacity of these soils would be restored. As a conservative estimate, the upper five feet of vertical pile capacity could be neglected for design purposes where clay soils are present in the upper soils.



After any major seismic event, it is recommended that an inspection of all pile foundations be made and if any voids in the upper soils are found, the voids should be filled by pressure grouting as soon as possible.

Lateral movement of the elevated structures would not only occur from earthquake excitation but also from repeated wind, temperature, and vehicle (centrifugal, acceleration, deceleration, and impact) loading. It is our opinion that the repeated lateral movements from these sources would be within the elastic range of the soil and that these effects need not be considered.

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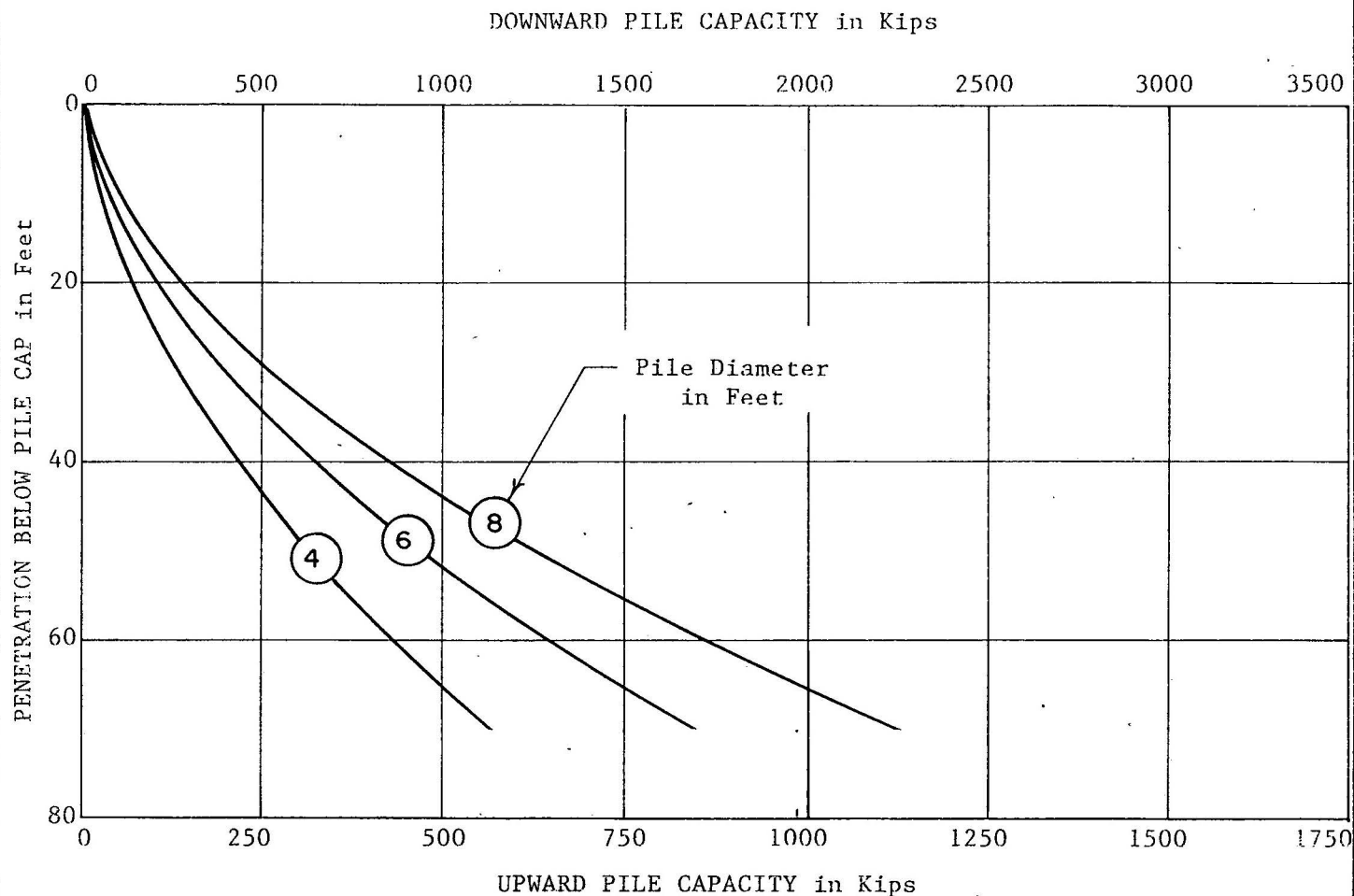
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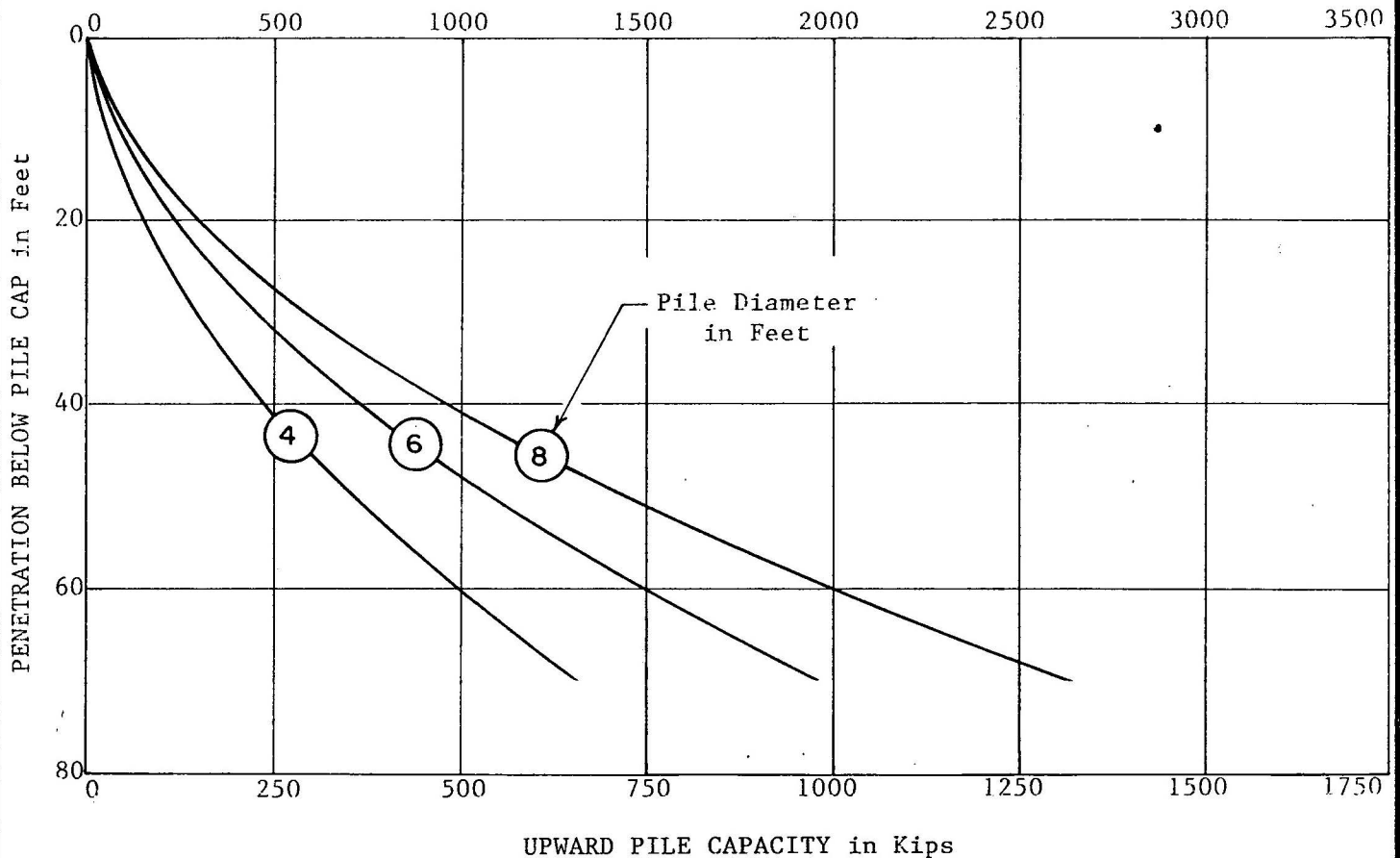
- (1) The indicated values refer to the total of dead plus live loads; a one-third increase may be used when considering wind or seismic loads.
- (2) Piles in groups should be spaced a minimum of $2\frac{1}{2}$ diameters on centers, and should be drilled and filled alternately with the concrete permitted to set at least 8 hours before drilling an adjacent hole.
- (3) The indicated values are based on the strength of the soils; the actual pile capacities may be limited to lesser values by the strength of the piles.

DRILLED PILE CAPACITIES

SECTION 1: AVIATION BOULEVARD TO NASH STREET
BORINGS 8 AND 10 THROUGH 21

LeROY CRANDALL AND ASSOCIATES

DOWNWARD PILE CAPACITY IN Kips



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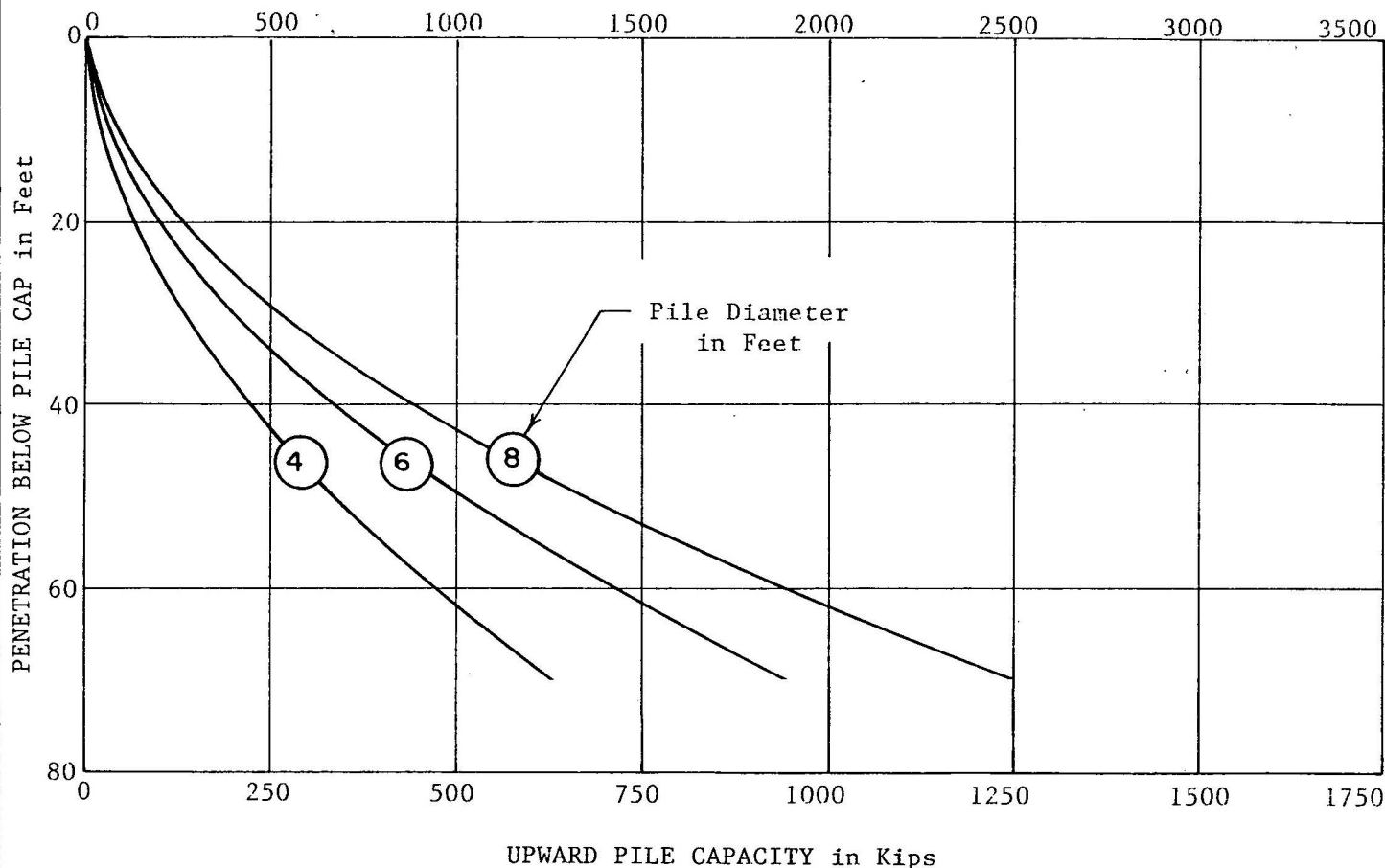
- (1) The indicated values refer to the total of dead plus live loads; a one-third increase may be used when considering wind or seismic loads.
- (2) Piles in groups should be spaced a minimum of $2\frac{1}{2}$ diameters on centers, and should be drilled and filled alternately with the concrete permitted to set at least 8 hours before drilling an adjacent hole.
- (3) The indicated values are based on the strength of the soils; the actual pile capacities may be limited to lesser values by the strength of the piles.

DRILLED PILE CAPACITIES

SECTION 2: ALONG NASH STREET TO EL SEGUNDO BOULEVARD
BORINGS 1 AND 22 THROUGH 32

LeROY CRANDALL AND ASSOCIATES

DOWNWARD PILE CAPACITY in Kips



NOTES:

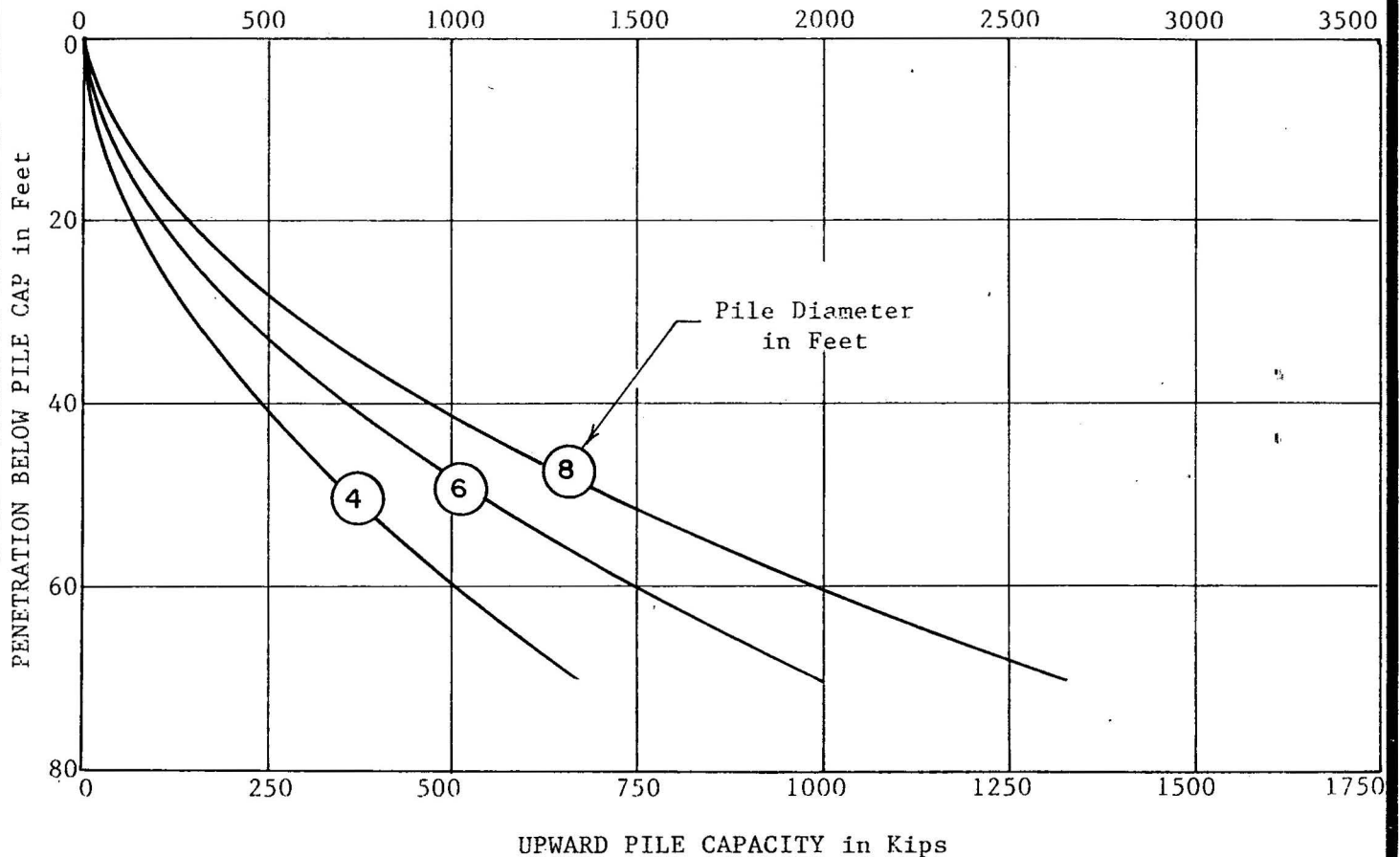
- (1) The indicated values refer to the total of dead plus live loads; a one-third increase may be used when considering wind or seismic loads.
- (2) Piles in groups should be spaced a minimum of $2\frac{1}{2}$ diameters on centers, and should be drilled and filled alternately with the concrete permitted to set at least 8 hours before drilling an adjacent hole.
- (3) The indicated values are based on the strength of the soils; the actual pile capacities may be limited to lesser values by the strength of the piles.

DRILLED PILE CAPACITIES

SECTION 3: EL SEGUNDO BOULEVARD TO EDGE OF KRAMER PROPERTY
BORINGS 33 THROUGH 40

LeROY CRANDALL AND ASSOCIATES

DOWNWARD PILE CAPACITY in Kips



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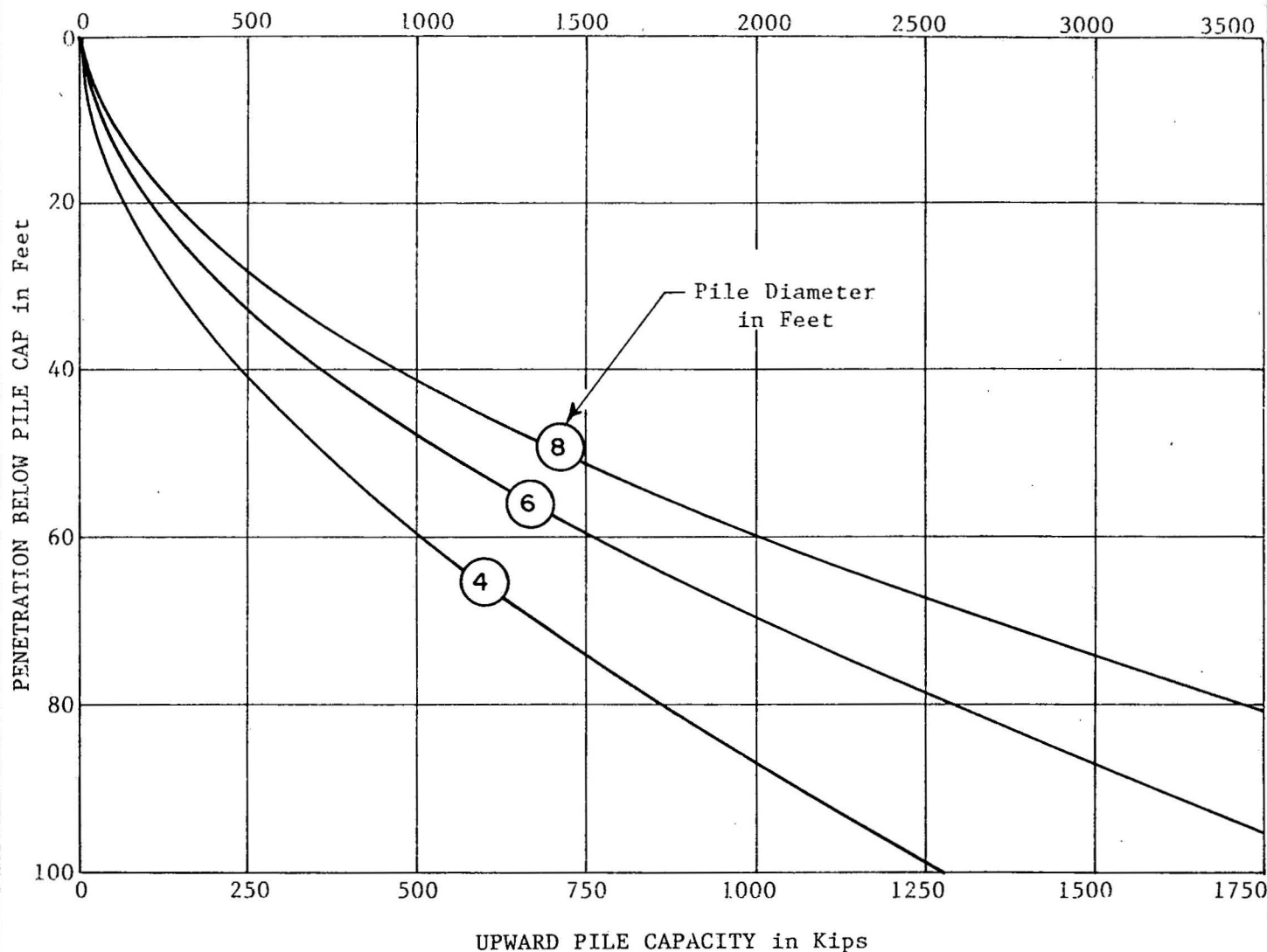
- (1) The indicated values refer to the total of dead plus live loads; a one-third increase may be used when considering wind or seismic loads.
- (2) Piles in groups should be spaced a minimum of $2\frac{1}{2}$ diameters on centers, and should be drilled and filled alternately with the concrete permitted to set at least 8 hours before drilling an adjacent hole.
- (3) The indicated values are based on the strength of the soils; the actual pile capacities may be limited to lesser values by the strength of the piles.

DRILLED PILE CAPACITIES

SECTION 4: SOUTH EDGE OF KRAMER PROPERTY TO DOUGLAS STATION
BORINGS 43 THROUGH 48

LeROY CRANDALL AND ASSOCIATES

DOWNWARD PILE CAPACITY in Kips



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- (1) The indicated values refer to the total of dead plus live loads; a one-third increase may be used when considering wind or seismic loads.
- (2) Piles in groups should be spaced a minimum of $2\frac{1}{2}$ diameters on centers, and should be drilled and filled alternately with the concrete permitted to set at least 8 hours before drilling an adjacent hole.
- (3) The indicated values are based on the strength of the soils; the actual pile capacities may be limited to lesser values by the strength of the piles.

DRILLED PILE CAPACITIES

SECTION 5: ROSECRANS AND AVIATION BRIDGE
BORINGS 4, 5, 52, 53, AND 54

LeROY CRANDALL AND ASSOCIATES

Section 9
Recommendations
At-Grade Trackbed and Structures

SECTION 9

RECOMMENDATIONS AT-GRADE TRACKBED AND STRUCTURES

9.1 COMPTON AVENUE STATION

9.1.1 Foundation Support

9.1.1.1 General

Borings 55 to 61 were drilled in the area of the Compton Avenue Station. Fill soils, $\frac{1}{2}$ and 7 feet in thickness, were encountered in two of the seven borings. Deeper fill deposits may exist between boring locations.

The upper natural soils consist of silt and clay, underlain by sand and silty sand. The upper natural soils are moderately firm but would become weaker when wet. The soils become firmer with depth.

We recommend that the existing fill soils and upper natural soils be excavated and replaced as properly compacted fill and that any required additional fill be properly compacted. If the grading recommendations are followed, the proposed station structure may be supported on spread footings established in properly compacted fill. Footings should be underlain by at least three feet of properly compacted fill.

9.1.1.2 Bearing Value

Spread footings established in properly compacted fill may be designed to impose an allowable pressure of 2,000 pounds per square foot. A one-third increase in the bearing value may be used for wind or seismic loads. Exterior footings should extend at least two feet below the adjacent exterior grade. Interior footings may be established at a depth of two feet below the top of the adjacent floor slab. Since the recommended bearing value is a net value, the weight of the concrete within the footings may be taken as 50 pounds per cubic foot, and the weight of soil backfill may be neglected when computing the imposed downward foundation loadings.

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If desired, loading dock walls, minor retaining walls, and free standing walls may be supported on shallower footings using a lesser bearing value. Footings for such light loads established in properly compacted fill and extending at least 1½ feet below the lowest adjacent grade may be designed to impose a pressure of 1,500 pounds per square foot.

9.1.1.3 Settlement

The settlement of the proposed station, supported on spread footings in the manner recommended, will depend on the magnitude of the structural loads, but should be within acceptable limits if the loads are not excessive. Settlement analyses should be performed prior to construction.

9.1.1.4 Lateral Loads

Lateral loads may be resisted by soil friction and by the passive resistance of the soils. A coefficient of friction of 0.4 may be used between footings or the floor slab and the supporting soils. The passive resistance of the properly compacted fill against footings may be assumed to be equal to the pressure developed by a fluid with a density of 250 pounds per cubic foot. A one-third increase in the passive value 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.

9.1.1.5 Footing Observation

To verify the presence of firm compacted fill soils at design elevations, all footing excavations should be observed by experienced personnel. Footing excavations should be cleaned of any loosened soils before placing steel or concrete.

9.1.2 GRADING

To provide improved support for spread footings, for concrete slabs, and for paving, the existing fill soils and disturbed natural soils should be excavated, the underlying natural soils should be reworked, and all required fill should be properly compacted. To provide support for spread footings, the upper natural soils beneath the footings should be excavated and replaced as properly compacted fill; footings should be underlain by at least three feet of compacted fill.

May be a problem
for the oil lines.



After clearing the site, all existing fill soils should be excavated from the building area and areas to be paved. The soils beneath footings should be excavated to a depth of at least three feet below the planned footing bottoms; these excavations should extend at least four feet beyond the footings in plan. The exposed soils should be carefully observed to verify the removal of all unsuitable soils.

Next, the upper six inches of exposed soils should be scarified to a depth of six inches and rolled with heavy compaction equipment. The upper six inches of exposed soils should be compacted to at least 90% of the maximum density obtainable by the ASTM Designation D1557-78 method of compaction.

All required fill should be placed in loose lifts not more than eight inches in thickness, and compacted to at least 90%. The moisture content of the soils at the time of compaction should vary no more than 2% above or below optimum moisture content.

The on-site soils, less any debris or organic matter within the existing fill deposits, may be used in required fills. Any required imported fill material should consist of relatively non-expansive soils. The expansion index of the import material should be less than 35. The material should contain sufficient fines (binder material) so as to result in a stable subgrade.

The excavation and reworking of the upper soils and the compaction of all required fill should be observed and tested by a competent geotechnical firm. Any required imported fill material should be approved for use prior to importing.

9.1.3 CONCRETE SLAB SUPPORT

If the subgrade is prepared as recommended, concrete slabs may be supported on grade. The required thickness and reinforcing of the slabs would depend on the imposed loadings as well as the structural characteristics of the concrete. For design of concrete slabs, a modulus of subgrade reaction (k) of 150 pounds per cubic inch may be used for the compacted subgrade. Joints in the slabs should be keyed or dowelled to prevent differential movements at the joints.



9.2 DOUGLAS STREET STATION UNDERPASS

9.2.1 Foundation Support

The proposed underpass structures may be supported on spread footings established in the natural soils. If the above grading recommendations are followed and if inspection of the footing excavations is performed, footings may be established in either properly compacted fill or the firm natural soils. Spread footings may be designed to impose an allowable bearing pressure of 2,000 pounds per square foot at a depth of at least two feet below the lowest adjacent grade.

The passive resistance of the soils may be assumed to be 250 pounds per cubic foot. A coefficient of friction of 0.4 may be used between the bottom of the footings and the supporting soils.

9.2.2 Walls Below Grade

For design of the underpass walls where the surface of the backfill is level, it may be assumed that the soils will exert a lateral pressure equal to that developed by a fluid with a density of 30 pounds per cubic foot.

Backfill adjacent to the walls should be mechanically compacted to at least 90% of the maximum density obtainable by the ASTM Designation D1557-78 method of compaction. The recommended lateral earth pressure is for properly drained backfill; weep holes or other means of drainage should be provided. Relatively non-expansive soils should be used for backfill adjacent to the walls.

9.3 TRACKS ON GRADE

9.3.1 Track Support

To provide uniform support for tracks on grade, the upper soils should be excavated so as to permit the placement of at least one foot of properly compacted subgrade fill beneath the sub-ballast.

If grading is performed as recommended herein, tracks on grade may be supported by the conventional system consisting of ties, ballast, and sub-ballast established on firm natural soils or properly compacted fill.

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The track may also be supported on concrete ties and reinforced concrete leveling course over an asphaltic concrete course and a subbase. There are other track support options that may be considered, if desired, such as in-place compaction of the subgrade soils, use of geotextile fabric, soil cement, and others.

The allowable bearing value of the compacted subgrade soils may be assumed to be 20 pounds per square inch.

9.3.2 Grading

After completion of excavation to permit placement of at least one foot of compacted subgrade fill beneath sub-ballast, the exposed soils should be proof-rolled with heavy compaction equipment to detect any soft subgrade areas which, if encountered, should be removed. The upper six inches of exposed soils should be scarified and then rolled with suitable compaction equipment. The upper six inches of exposed soils should be compacted to at least 90% of the maximum density obtainable by the ASTM Designation D1557-78 method of compaction. All required fill should be placed in loose lifts not more than eight inches in thickness and compacted to at least 90%.

The on-site soils, except for debris and clay, may be used as fill material. All imported fill should consist of relatively non-expansive soils with sufficient fines (binder) to be relatively impermeable when compacted and result in a stable subgrade. The expansion index of the select material should be less than 35.

9.4 PARK-AND-RIDE AREAS

9.4.1 Soil Properties for Pavement Design

California Bearing Ratio tests were performed on selected samples to provide data for pavement design. The results are summarized in Table 9.1, Summary of CBR Test Data.

*= 2880 #/sq ft
Why larger than
2000 #/sq ft for Fdn's?*



Table 9.1
Summary of CBR Test Data

<u>Station</u>	<u>Boring No. and Depth</u>	<u>Soil Type</u>	<u>CBR</u>	
			<u>90%*</u>	<u>95%*</u>
Aviation Blvd.	8 @ 1' - 4'	Silty Clay	-	-
El Segundo Blvd.	35 @ 2' - 5'	Fill - Clay and Silty Sand	1	2
Douglas Street	49 @ 2' - 4'	Silty and and Sandy Clay	1	2
	51 @ 0 - 2'	Fill - Silty Sand	20	38
Compton Blvd.	59 @ 1' - 3'	Sandy Silt	9	47
	61 @ 0 - 2'	Fill - Silty Sand	13	28

* Percent compaction based on ASTM Designation D1557-78 method of compaction.

9.4.2 Design Criteria

9.4.2.1 Grading

To provide support for paving, the subgrade soils should be properly prepared. Compaction of the subgrade to at least 90% of the maximum dry density obtainable, including trench backfills, will be important for paving support. The preparation of the subgrade should be done immediately prior to the placement of the base course. Proper drainage of the paved areas should be provided since this will reduce moisture infiltration into the subgrade and increase the life of the paving.

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Existing fill soils should be excavated to a depth of at least one foot below the planned subgrade level in areas to be paved with asphaltic paving. After excavating as recommended, the exposed soils should be proof-rolled to determine the presence of any unsuitable deposits, and additional excavation performed if necessary to remove all unsuitable deposits. Next, the upper six inches of exposed soils should be scarified to a depth of six inches and rolled with heavy compaction equipment. The upper six inches of exposed soils should be compacted to at least 90% of the maximum density obtainable by the ASTM Designation D1557-78 method of compaction.

All required fill should be placed in loose lifts not more than eight inches in thickness, and compacted to at least 90%. The moisture content of the soils at the time of compaction should vary no more than 2% above or below optimum moisture content.

The on-site soils, less any debris or organic matter within the existing fill deposits, may be used in required fills. Any required imported fill material should consist of relatively non-expansive soils. The expansion index of the import material should be less than 35. The material should contain sufficient fines (binder material) so as to result in a stable subgrade. Imported fill material to be used beneath asphaltic paving should have a CBR value of at least 15 when compacted to 90%.

The excavation and reworking of the upper soils and the compaction of all required fill should be observed and tested by a competent geotechnical firm. Any required imported fill material should be approved for use prior to importing.

9.4.2.2 Asphaltic Paving

To provide data for design of asphaltic paving, California Bearing Ratio tests were performed on samples of the upper soils. The results of the CBR tests are presented in Table 9.1.

The required paving thickness and base thickness will depend on the anticipated wheel loads and volume of traffic (Traffic Index). Assumed Traffic Indexes and the corresponding paving sections are presented in Table 9.2, Recommended Paving Sections.



Table 9.2
Recommended Paving Sections

<u>Station</u>	<u>Traffic Index</u>	<u>Thickness (In.)</u>	
		<u>Asphaltic Concrete</u>	<u>Base Course</u>
Aviation Blvd.	5	*	*
	6	*	*
	7	*	*
	8	*	*
El Segundo Blvd.	5	4	8
	6	5	11
	7	6	13
	8	7	15
Douglas Street	5	4	8
	6	5	11
	7	6	13
	8	7	15
Compton Blvd.	5	3	4
	6	4	5
	7	4	8
	8	5	9

Careful inspection is recommended to verify that the recommended thicknesses or greater are achieved and that proper construction procedures are used.

9.4.2.3 Base Course

The base course should meet the specifications for Class 2 Aggregate Base as defined in Section 26 of the State of California, Department of Transportation, Standard Specifications, dated January, 1981. The base course should be compacted to at least 95%.



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Section 10
Recommendations
Yard and Shops Area

SECTION 10

RECOMMENDATIONS YARD AND SHOPS AREA

10.1 FOUNDATION SUPPORT

10.1.1. General

There are existing fill soils present at the site and the demolition and removal of the existing facilities will result in disturbance of the upper soils. The upper natural soils consist primarily of clay with lesser amounts of silty sand and clayey sand. The deeper soils consist of sand. The upper natural soils are moderately firm but would become weaker when wet. The soils become firmer with depth. The clay soils are expansive and would swell and shrink with changes in the moisture content.

We recommend that the existing fill soils and upper natural soils be excavated and compacted and that any required additional fill be properly compacted. If the grading recommendations are followed, the proposed buildings may be supported on spread footings established in properly compacted fill. Footings should be underlain by at least three feet of properly compacted fill.

To provide uniform support for tracks on grade, the upper soils should be excavated so as to permit the placement of at least one foot of properly compacted subgrade fill beneath the sub-ballast. The recommendations for Tracks on Grade in Section 9 would be applicable to the tracks on grade in the Yard and Shops area.

10.1.2 Bearing Value

Spread footings established in properly compacted fill may be designed to impose an allowable pressure of 2,000 pounds per square foot. A one-third increase in the bearing value may be used for wind or seismic loads. Exterior footings should extend at least two feet below the adjacent

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exterior grade. Interior footings may be established at a depth of two feet below the top of the adjacent floor slab. Since the recommended bearing value is a net value, the weight of the concrete within the footings may be taken as 50 pounds per cubic foot, and the weight of soil backfill may be neglected when computing the imposed downward foundation loadings.

If desired, loading dock walls, minor retaining walls, and free standing walls may be supported on shallower footings using a lesser bearing value. Footings for such light loads established in properly compacted fill and extending at least 1½ feet below the lowest adjacent grade may be designed to impose a pressure of 1,500 pounds per square foot.

10.1.3 Settlement

The settlement of the proposed buildings, supported on spread footings in the manner recommended, will depend on the magnitude of the structural loads, but should be within acceptable limits if the loads are not excessive. Settlement analyses should be performed prior to construction.

10.1.4 Lateral Loads

Lateral loads may be resisted by soil friction and by the passive resistance of the soils. A coefficient of friction of 0.4 may be used between footings or the floor slabs and the supporting soils. The passive resistance of the properly compacted fill against footings may be assumed to be equal to the pressure developed by a fluid with a density of 250 pounds per cubic foot. A one-third increase in the passive value 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.

10.1.5 Footing Observation

To verify the presence of firm compacted fill soils at design elevations, all footing excavations should be observed by experienced personnel. Footing excavations should be cleaned of any loosened soils before placing steel or concrete.

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10.2 GRADING

To provide improved support for spread footings, for concrete slabs, and for paving, the existing fill soils and disturbed natural soils should be excavated, the underlying natural soils should be reworked, and all required fill should be properly compacted. To provide support for spread footings, the upper natural soils beneath the footings should be excavated and replaced as properly compacted fill; footings should be underlain by at least three feet of compacted fill. The upper clay soils are somewhat expansive; at least the upper one foot of compacted fill beneath the floor slabs and beneath any adjacent concrete walks and slabs should consist of relatively non-expansive soils.

After clearing the site, all existing fill soils should be excavated from the building areas and areas to be paved. Disturbed natural soils within the building areas should also be excavated. The upper soils should be excavated as necessary to allow the placement of at least one foot of relatively non-expansive material beneath the floor slab, beneath concrete paving, and beneath adjacent concrete walks and slabs. The soils beneath the footings should be excavated to a depth of at least three feet below the planned footing bottoms; these excavations should extend at least four feet beyond the footings in plan.

The soils should be carefully inspected to verify the removal of all unsuitable deposits. Next, the exposed natural soils should be scarified to a depth of at least six inches, brought to optimum moisture content, and rolled with heavy compaction equipment. The upper six inches of exposed natural soils should be compacted to at least 90% of the maximum density obtainable by the ASTM Designation D1557-78 method of compaction.

Depending on the moisture content, it may be necessary to allow the surface to dry slightly prior to compacting. If the exposed soils are too wet and soft to achieve the recommended compaction, it may be necessary to place a layer of coarse gravel or a geotextile fabric over the exposed soils to provide a base for the compaction of the required fill.



All required fill should be placed in loose lifts not more than eight inches in thickness and compacted to at least 90%. The moisture content of the on-site clayey soils at the time of compaction should be brought to between 2% and 4% over optimum moisture content. Relatively non-expansive soils should be compacted at a moisture content varying no more than 2% below or above optimum moisture content.

The on-site soils, less any debris or organic matter within the existing fill, may be used in required fills. Due to their expansive characteristics, however, the on-site clayey soils should not be placed within one foot of subgrade level in the building area or beneath adjacent concrete walks and slabs. Any required imported fill and at least the upper one foot of fill should consist of relatively non-expansive soils. The Expansion Index of any imported material should be less than 35. Imported fill should contain sufficient fines (binder material) so as to be relatively impermeable when compacted and result in a stable subgrade.

The excavation and reworking of the upper soils and the compaction of all required fill should be observed and tested by a competent geotechnical firm. Any required imported fill material should be approved for use prior to importing.

10.3 FLOOR SLAB SUPPORT

If the subgrade is prepared as recommended, floor slabs may be supported on grade. As previously recommended, at least the upper one foot of fill beneath the building floor slabs, beneath concrete paving, and beneath adjacent concrete slabs and walks should consist of relatively non-expansive and predominantly granular soils.

The required thickness and reinforcing of the slabs would depend on the imposed loadings as well as the structural characteristics of the concrete. For design of concrete slabs, a modulus of subgrade reaction (k) of 100 pounds per cubic inch may be used for the compacted subgrade. Joints in the slabs should be keyed or dowelled to prevent differential movements at the joints. Consideration should be given to including reinforcing steel in the concrete to control cracking due to changes in temperature and shrinkage of the concrete.



If a floor covering that would be critically affected by moisture, such as vinyl, is to be used in any area, the floor slabs in such areas should be supported on a four-inch-thick layer of gravel or on an impermeable membrane as a capillary break. A suggested gradation for the gravel layer would be as presented below:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4"	90 - 100
No. 4	0 - 10
No. 100	0 - 3

If a membrane is used, a low-slump concrete should be used to minimize possible curling of the slabs. The concrete slabs should be allowed to cure properly before placing vinyl or other moisture-sensitive floor covering.

10.4 WALLS BELOW GRADE

For design of the loading dock walls or retaining walls where the surface of the backfill is level, it may be assumed that the soils will exert a lateral pressure equal to that developed by a fluid with a density of 30 pounds per cubic foot.

Backfill adjacent to the walls should be mechanically compacted to at least 90% of the maximum density obtainable by the ASTM Designation D1557-78 method of compaction. The recommended lateral earth pressure is for properly drained backfill; weep holes or other means of drainage should be provided. Relatively non-expansive soils should be used for backfill adjacent to the walls.

10.5 PAVING

10.5.1 Soil Properties for Pavement Design

California Bearing Ratio tests were performed on selected samples to provide data for pavement design. The results are summarized in Table 10.1, Summary of CBR Test Data.



Table 10.1
Summary of CBR Test Data

<u>Boring No. and Depth</u>	<u>Soil Type</u>	<u>CBR</u>	
		<u>90%*</u>	<u>95%*</u>
63 @ 4' to 6'	Fill - Silty Clay	1	2
69 @ 1' to 3'	Fill - Silty Sand and Silty Clay	9	20

* Percent compaction based on ASTM Designation D1557-78 method of compaction.

10.5.2 Asphaltic Paving

The required paving thickness and base thickness will depend on the anticipated wheel loads and volume of traffic (Traffic Index). Assumed Traffic Indexes and the corresponding paving sections are presented in Table 10.2, Recommended Paving Sections. The paving sections are based on the Flexible Pavement Structural Section Design Guide for California Cities and Counties, Third Edition.

Table 10.2
Recommended Paving Sections

<u>Traffic Index</u>	<u>Thickness (In.)</u>	
	<u>Asphaltic Concrete</u>	<u>Base Course</u>
5	4	8
6	5	11
7	6	13
8	7	15

Careful inspection is recommended to verify that the recommended thicknesses or greater are achieved and that proper construction procedures are used.



10.5.3 Base Course

The base course should meet the specifications for Class 2 Aggregate Base as defined in Section 26 of the State of California, Department of Transportation, Standard Specifications, dated January, 1981. The base course should be compacted to at least 95%.

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Appendix A
Field Exploration Program

APPENDIX A

FIELD EXPLORATION PROGRAM

The field explorations consisted of subsurface drilling, sampling, and testing. Sixty-seven exploration borings were drilled to depths ranging from 5 to 100 feet below the existing grade. Of those borings, Borings 1 through 6 were drilled during the preliminary geotechnical investigation. Originally, seventy-one borings were planned. Borings 7 and 9 were deleted from the drilling program because of available information from the State of California Department of Transportation (CALTRANS) for the adjacent Century Freeway (Interstate 105) project. Borings 41 and 42, which were to be located on the H. Kramer and Company property, were not drilled due to the environmental conditions that exist on the site.

The majority of the borings were drilled using 16-, 17-, 18-, and 24-inch-diameter bucket-type drilling equipment and/or 5-inch-diameter rotary wash-type equipment. Raveling and caving of the bucket borings occurred during drilling, as indicated on the boring logs. Drilling mud was used with the rotary wash-type equipment to prevent caving. Casing was used in the upper four feet of Boring 14, to prevent caving within a gravel fill. Borings 49, 51, and 61 were drilled using 8-inch-diameter hand auger equipment.

After completion of Borings 4 and 22, PVC casings were installed in the borings to permit measurements of compressional and shear wave velocities by downhole seismic surveys. After completion of Boring 5, a PVC pipe with the lower portion perforated was installed in the boring to permit future measurement of the water level.

Each of the borings was backfilled upon completion of drilling. The borings were logged continuously during the drilling. Undisturbed samples were obtained with the Crandall sampler at depth intervals of about five feet and at major changes in soil stratigraphy. The Crandall sampler



is a brass ring-lined 3.188 inch (outside diameter) tube that is driven with a kelly bar. The inside diameter of the sampler is 2.625 inches. Bulk samples of the upper soils were obtained to permit the performance of laboratory compaction and other tests.

The logs of the borings are presented on Plates A-1 through A-67; the depths at which undisturbed samples were obtained are indicated to the left of the boring logs. The energy required to drive the Crandall sampler twelve inches is indicated on the logs. The energy is determined based on the following relationship:

$$E = \frac{WBS}{P}, \text{ where: } \begin{array}{l} W = \text{Driving Weight} = 400 \text{ to } 1950 \text{ pounds} \\ B = \text{Number of Blows of Driving Weight} \\ S = \text{Stroke of Driving Weight} = 1 \text{ to } 1\frac{1}{2} \text{ feet} \\ P = \text{Penetration of LC\&A Sampler} = 1 \text{ foot} \end{array}$$

The soils are classified in accordance with the Unified Soil Classification System described on Plate A-68.

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BORING 1

DATE DRILLED: August 9 & 12, 1988
 EQUIPMENT USED: 18" - Diameter Bucket (0' to 56")
 5" - Diameter Rotary Wash (to 75')
 ELEVATION 104 *

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.	
100	5	19.4	112	3		CL FILL - SANDY CLAY - some Silt, pieces of concrete and asphalt, mottled greyish brown
		11.8	115	5		CL Traces of organic matter SILTY CLAY - dark brown
		13.0	116	7		CL
95	10	11.8	103	7		SC CLAYEY SAND - fine, brown Lenses of Silty Sand
		13.9	105	7		SC
90	15	10.4	124	10		SM SILTY SAND - fine, some Clay, brown
		12.8	115	10		SC CLAYEY SAND - fine, brown
85	20	2.0	102	10		SP SAND - fine to medium, some Gravel, light brown
80	25	2.6	99	13		SP Fine
75	30	2.5	104	9		SP SAND and SILTY SAND - fine, light brown
70	35	6.2	100	13		SP SAND and SILTY SAND - fine, light brown
65	40	6.0	96	12		SP SAND and SILTY SAND - fine, light brown

* Elevations refer to datum of Plan and Profile drawings provided by TRANSCAL.

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 1 (Continued)

DATE DRILLED: August 9 & 12, 1988
 EQUIPMENT USED: 18" - Diameter Bucket (0' to 56')
 5" - Diameter Rotary Wash (to 75')

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.
60	45	4.7	101	10	
55	50	3.3	104	18	
50	55	2.7	112	14	
45	60	16.9	110	54	
40	65	37.8	84	9	
35	70	21.0	98	21	
30	75	24.4	93	12	

SP SAND - fine, light brown

Fine to medium, about 10% Gravel
 (TERMINATED BUCKET BORING DUE TO HEAVY CAVING.
 BORING CONTINUED WITH ROTARY WASH EQUIPMENT).

About 20% Gravel

CL SILTY CLAY - greyish brown

ML CLAYEY SILT - grey

ML SANDY SILT - grey
 Lenses of Clayey Silt

NOTE: Bucket Boring: Water not encountered. Heavy caving from 17' to 22' and below 47' (to 3' in diameter). Terminated boring due to heavy caving.

Rotary Wash Boring: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

BORING 2

DATE DRILLED: August 8, 1988
EQUIPMENT USED: 18" - Diameter Bucket

ELEVATION 101

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.		
100		10.1	114	5		SM	FILL - SILTY SAND - fine, some Clay, brown
	5	8.1	110	5			
95		11.4	116	5		SP SM	FILL - SAND and SILTY SAND - fine, brown
	10	12.1	112	5			
90		9.8	114	4		SM	SILTY SAND - fine, light brown
	15	14.3	107	5			
85							
	20	16.1	108	13			
80							
	25	15.8	104	12		SP SM	SAND and SILTY SAND - fine, light brown
75							
	30	9.9	101	14			Lenses of Sand
70							
	35	6.9	100	18		SP	SAND - fine, light brown
65							Few Cobbles
	40	11.7	96	12			Fine to medium

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 2.1

BORING 2 (Continued)

DATE DRILLED: August 8, 1988
EQUIPMENT USED: 18" - Diameter Bucket

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.	
60						
	45	6.7	98	15		
55						Some Gravel
	50	6.6	105	15		Fine
50						
	55	13.3	97	7	SM	SILTY SAND - fine, light brown
45						
	60	11.1	94	14	SP	SAND - fine, light brown
40						
	65	2.7	112	22		
35						
	70	5.7	107	7	CL	SILTY CLAY - greyish brown
30						Lenses of Silty Sand
	75	17.8	112	17	SM	SILTY SAND - fine, light brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 3

DATE DRILLED: August 8 & 9, 1988
EQUIPMENT USED: 18" - Diameter Bucket

ELEVATION 98

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.		
95	5	12.4	115	5		SP SM	FILL - SAND and SILTY SAND - fine, brown
		13.1	114	7			Traces of Clay, pieces of asphalt
90	10	13.1	119	4		CL	FILL - SANDY CLAY - pieces of asphalt, brown
		16.6	115	2		SM	FILL - SILTY SAND - fine, some Clay, brown
85	15	12.3	120	3		SC	CLAYEY SAND - fine, light greyish brown
		13.7	117	7			
80	20	5.9	101	7		SP SM	SAND and SILTY SAND - fine, light brown
75	25	6.0	103	8			
70	30	5.8	103	13			
65	35	5.9	100	19			
60		6.6	96	8		SP	SAND - fine and medium, light brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 3.1

CHKD *JK*

dmh

W.P.

DM

O.E.

dmh

DR.

AKH

F.T.

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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 (Continued)

DATE DRILLED: August 8 & 9, 1988
EQUIPMENT USED: 18" - Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
55						SM
	45	8.3	97	12		
50						SP
	50	9.0	91	13		SM
45						
	55	8.5	95	10		
40						
60		7.6	101	12		

SILTY SAND - fine, light brown

SAND and SILTY SAND - fine, few Gravel, light brown

Some Gravel

NOTE: Small amount of water seepage encountered at 3' to 9'.
Raveling from 8' to 9' and 18' to 30' (to 2' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 4

DATE DRILLED: August 12, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 80

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.	
		4.0	100	5		SM
		6.8	109	2		SM
75	5	10.0	117	7		
		5.0	127	9		
70	10	18.7	110	7		SC
65	15	17.4	110	12		
60	20					SP
55	25	13.3	109	49		SM
50	30	17.4	103	33		
45	35	14.3	98	43		
40	40	12.5	108	54		SP

FILL - SILTY SAND - fine, reddish brown

SILTY SAND - fine, brown

CLAYEY SAND - fine, few Gravel, brown

Fine to medium

SAND - fine, about 20% Gravel, some large Cobbles, light brown

SILTY SAND - fine, light brown

Layers of Sand

SAND - fine to medium, brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 4.1

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.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
35	45	12.3	99	43	
30	50	10.6	97	43	SM
25	55	18.5	110	77	SP
20	60	17.4	106	60	
15	65	16.5	100	60	SP SM
10	70	24.6	92	54	
5	75	22.3	98	43	
0	80	24.0	96	30	

DATE DRILLED:
EQUIPMENT USED:

August 12, 1988
5" - Diameter Rotary Wash

SM

SILTY SAND - fine, light brown

SP

SAND - fine to medium, light brown

SP
SM

SAND and SILTY SAND - fine, light brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-4.2

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
- 5	85		21.5	100	54	
- 10	90		24.4	97	43	
- 15	95		24.5	98	43	
- 20	100		22.9	104	43	

BORING 4 (Continued)

DATE DRILLED: August 12, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

Fine to medium

NOTE: Drilling mud used in drilling process. Mud removed after completion of drilling. Water level not established. Installed 100' of 2"-diameter PVC pipe for downhole seismic survey. Annular space backfilled with gravel.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 4.3

JOB ADEF-88044-7 DATE 8/23/88 F.T. AKH DR. dmh O.E. DM W.P. dmh CHKD 24

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 5	
							DATE DRILLED: August 11, 1988	
							EQUIPMENT USED: 5" - Diameter Rotary Wash	
							ELEVATION 80	
ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
75	5		7.5	113	7		SM	FILL - SILTY SAND - fine, some Gravel and Cobbles, reddish brown
			5.7	108	2		SM	SILTY SAND - fine, brown
			8.7	117	7			
70	10		11.1	120	9			
			15.6	116	10		CL	SANDY CLAY - brown
65	15		13.6	118	18		SM	SILTY SAND - fine, about 10% Gravel and Cobbles, brown
60	20		8.6	118	21		SP	SAND - medium, about 20% Gravel, light brown
55	25		14.1	113	18			Fine to medium, about 10% Gravel
			19.4	99	36			
			12.9	122	60			Medium
50	30							
							SP SM	SAND and SILTY SAND - fine, light brown
45	35		11.0	101	30			
40	40		10.4	101	27			

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES
 PLATE A - 5.1

BORING 5 (Continued)

DATE DRILLED: August 11, 1988
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.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
35	45		12.4	105	45	
30	50		17.7	97	33	
25	55		14.4	114	45	
20	60		16.6	101	30	
15	65		14.3	99	45	
10	70		22.7	92	40	
5	75		23.3	96	60	
0	80		22.5	97	60	

SP

SAND - fine to medium, light brown

SP
SM

SAND and SILTY SAND - fine, light brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-5.2

BORING 5 (Continued)

DATE DRILLED: August 11, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
-5	85		23.2	96	54	
-10	90		24.2	95	36	
-15	95		27.8	96	36	
-20	100		20.1	107	77	

NOTE: Drilling mud used in drilling process. Mud removed after completion of drilling. Installed 100' of 2" - diameter PVC pipe (bottom 50' perforated to permit future water level measurements). Water level measured at 73' on 8/23/88.

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 - 5.3

BORING 6

DATE DRILLED: August 10, 1988
EQUIPMENT USED: 18" - Diameter Bucket

ELEVATION 71

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
70		3.4	110	3	SP
		23.6	99	2	SM
65	5	24.1	101	1	CL
		30.1	91	3	
60	10	32.7	89	3	
		15.3	120	8	CL
55	15	2.9	109	15	SM
					SP
50	20	2.9	117	17	
45	25	4.8	106	24	
30		5.8	101	19	

6" Asphaltic Paving - 6" Base Course
FILL - SAND and SILTY SAND - fine, pieces of concrete,
few Gravel, light brown

SILTY CLAY - dark brown

Some Sand, brown

Greyish brown

SANDY CLAY - brown

SILTY SAND - fine, about 10% Gravel, brown

SAND - fine, about 10% Gravel, light brown

Lenses of Gravel

Few Gravel

NOTE: Water not encountered. Raveling from 16' to 24' (to 2' in diameter).

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 - 6

BORING 8

DATE DRILLED: January 19, 1989
 EQUIPMENT USED: 24" - Diameter Bucket 0 to 24'
 18" - Diameter Bucket 24' to 74'
 ELEVATION 93

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	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
90		20.6	108	6		CL SILTY CLAY - dark grey
	5	19.5	108	6		Greyish brown
		20.2	108	8		
85		18.4	104	4		ML CLAYEY SILT - greyish brown
	10	25.3	98	6		CL SILTY CLAY - greyish brown
		10.3	105	10		SM SILTY SAND - fine, light brown
80						
	15	13.6	98	16		CL SANDY CLAY - brown
75		18.7	109	12		
	20					SP SAND - fine, light brown
70		3.0	108	12		
	25					
65		2.7	99	16		
	30					
60		32.1	88	6		ML CLAYEY SILT - grey
	35					
55		26.5	99	12		ML SANDY SILT - brown
40						

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 7.1

BORING 8 (Continued)

DATE DRILLED: January 19, 1989
EQUIPMENT USED: 24" - Diameter Bucket 0 to 24'
18" - Diameter Bucket 24' to 74'

ELEVATION	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
50					ML
	45	49.0	71	4	CL
45					
	50	42.4	80	6	SM
40					SP
	55	9.5	102	27	
35					
	60	4.2	103	27	
30					
	65	18.9	105	28	CL
25					
	70	30.7	88	6	ML
20					SM
75		5.7	104	30	

CLAYEY SILT - light grey and brown

SILTY CLAY - greyish brown

SILTY SAND - fine, reddish brown

SAND - fine, light brown

Layer of Silty Clay

Fine to medium

Grey

SILTY CLAY - sulfur odor, few shells, grey

CLAYEY SILT - grey

SILTY SAND - fine, light greyish brown

NOTE: Water level measured at a depth of 72-1/2' 5 minutes after completion of drilling. Caving from 24' to 27' (to 3' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 7.2

JOB ADEF-88044-7 DATE 1/4/89 F.T. BG DR. Ip W.P. Ip CHKD DM

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: 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 10	
ELEVATION	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		DATE DRILLED: January 19, 1989	
							EQUIPMENT USED: 24" - Diameter Bucket 0 to 16'	
							18" - Diameter Bucket 16' to 60'	
							ELEVATION 94	
							Layers of Asphaltic Paving and Base Course	
							FILL - CLAY and SAND - dark brown	
							SILTY CLAY - black	
90	5	24.2	102	3		CL	Dark brown	
		21.7	105	6			Grey	
85	10	16.1	118	12				
		26.6	94	6				
80	15	15.0	101	4		ML	CLAYEY SILT - some Sand, brownish grey	
		20.4	109	10				
75	20	22.3	102	6		CL	SILTY CLAY - brown	
70	25	4.0	104	12		SP	SAND - fine, light brown	
65	30	3.1	103	16				
60	35	34.2	89	5		CL	SILTY CLAY - greyish brown	
55	40	29.1	94	12		SM	SILTY SAND - fine to medium, brown	

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

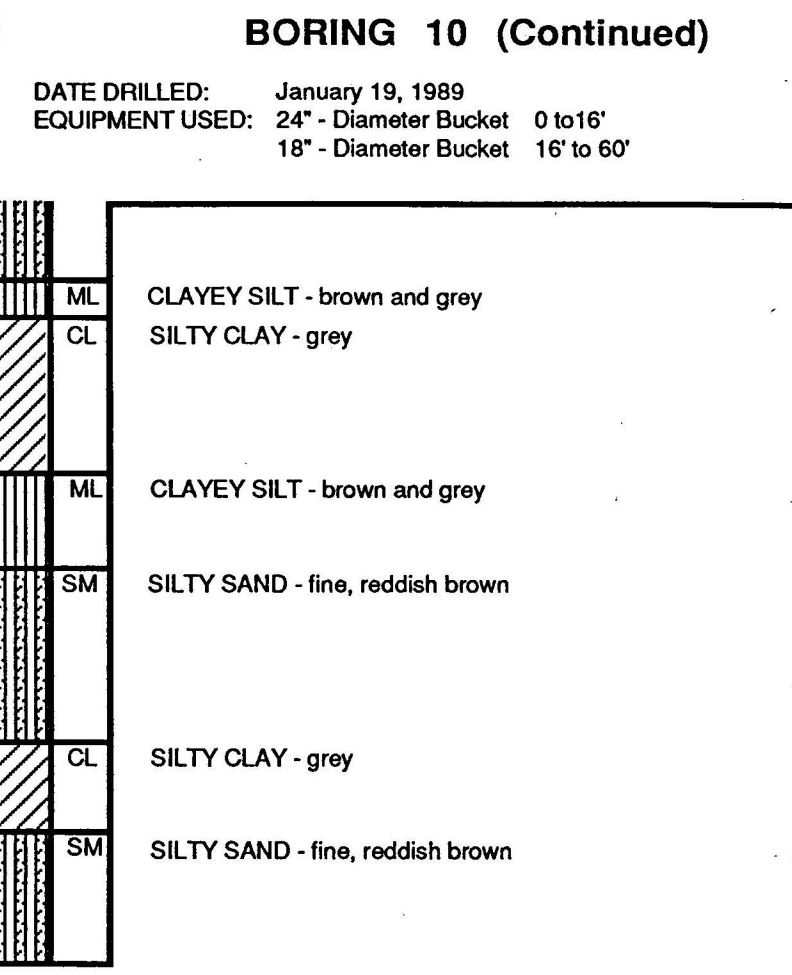
LeROY CRANDALL AND ASSOCIATES

PLATE A - 8.1

JOB ADEF-88044-7 DATE 1/4/89 F.T. BG DR. Ip O.E. SK W.P. Ip CHKD DM

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	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
50	45	48.5	74	5	
45	50	21.6	90	14	
40	55	45.4	75	6	
35	60	3.9	106	24	



NOTE: Water seepage encountered at a depth of 54'. No caving.

LOG OF BORING

BORING 11

DATE DRILLED: December 21, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash
ELEVATION 94

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.	
90	5		24.5	102	3		CL
			26.3	100	3		5" Asphaltic Paving - 6" Base Course SILTY CLAY - dark grey
							Brown and grey
			17.2	114	7		Some Sand, brown
85	10		25.5	98	5		
							ML
			20.4	103	5		SANDY SILT - some Clay, brown
80	15		16.5	113	10		CL
							SANDY CLAY - some Silt, brown
75	20						SP
			8.1	111	18		SAND - fine to medium, light brown
70	25		11.4	118	34		
65	30		19.2	106	29		CL
							SILTY CLAY - grey
60	35		33.6	89	8		Layers of Sand
55	40						

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-9.1

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
50	45		37.6	85	9	
			27.4	93	7	
45	50		12.7	91	54	
40	55		13.2	108	41	
35	60		13.1	104	54	
30	65					

DATE DRILLED: December 21, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash



SP

SAND - fine, light brown

Few shells

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 12

DATE DRILLED: December 21, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 95

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.	
						CL
		17.4	109	4		FILL - SILTY CLAY - some Sand, Gravel and Cobbles, black
90	5	23.4	98	2		CL
		27.1	98	4		SILTY CLAY - dark brownish grey
						ML
85	10	30.6	87	5		CLAYEY SILT - brown and grey
		24.9	98	4		
80	15	15.7	115	11		CL
						SP
75	20	12.9	111	27		SAND - fine, light brown
70	25	16.8	106	34		
65	30	18.1	106	41		Light greyish brown
60	35	38.4	80	10		CL
						SILTY CLAY - grey
55	40					ML
						SANDY SILT - brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 10.1

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
			29.4	92	11	
50	45		28.8	94	10	
45	50		10.7	106	40	
40	55		21.6	102	34	
35	60		16.8	106	47	
30	65					

DATE DRILLED: December 21, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ML CLAYEY SILT - greyish brown

SM SILTY SAND - fine, light brown

SP SAND - fine to medium, light brown

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 10.2

JOB ADEF-88044-7 DATE 1/3/89 F.T. BG DR. dmh O.E. SK ☒ W.P. dmh CHKD DM

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 13	
							DATE DRILLED: December 22, 1988	
							EQUIPMENT USED: 5" - Diameter Rotary Wash	
							ELEVATION 95	
ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
			6.9	104	3		SM	4" Asphaltic Paving
			25.2	99	3		CL	FILL - SILTY SAND - some Clay and Gravel, fine to medium, brown
90	5							SILTY CLAY - dark brown
			22.1	102	5			Light brown
85	10		17.2	112	7			
			29.2	86	3		ML	CLAYEY SILT - brown
80	15		13.3	113	8		ML	SANDY SILT - brown
75	20		27.3	97	9		CL	SILTY CLAY - brown
							SP	SAND - fine to medium, light brown
70	25		8.5	117	34			
65	30		16.9	108	47			
60	35		33.5	86	5		CL	SILTY CLAY - grey
55	40							

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB ADEF-88044-7 DATE 1/3/89 F.T. BG DR. dmh O.E. SK, J. W.P. dmh CHKD DM

BORING 13 (Continued)

DATE DRILLED: December 22, 1988
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.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
		30.4	91	6		ML SANDY SILT - grey
50	45	38.7	82	5		CL SILTY CLAY - grey
45	50	36.6	87	11		SM SILTY SAND - fine, brown
40	55	13.9	96	54		SP SM SAND and SILTY SAND - fine, light brown
35	60	10.1	103	34		
30	65	14.0	103	41		Fine to medium, grey
25	70	43.7	80	4		CL SILTY CLAY - grey
20	75	35.6	85	13		Layer of Silty Sand
15	80					

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB ADEF-88044-7 DATE 1/3/89 F.T. BG DR. dmh O.E. SK JL W.P. dmh CHKD DM

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 14							DATE DRILLED: December 29, 1988		EQUIPMENT USED: 5" - Diameter Rotary Wash		ELEVATION 94	
ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.						
							GP					FILL - SAND, SILT and CLAY - some Gravel, brown FILL - GRAVEL
							CL					SILTY CLAY - black Some Sand, light brown
90	5		22.8	104	4							
			16.4	117	8							
85	10		24.5	96	5							
			27.5	97	8		ML					SANDY SILT - brown Light brown
80	15		13.4	107	7							
							SP					SAND - fine to medium, light brown Brown
75	20		9.5	115	14							
			10.6	108	27							
70	25											
			11.6	116	27							
65	30											
			36.6	85	10		CL					SILTY CLAY - greyish brown
60	35											
55	40											

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

BORING 14 (Continued)

DATE DRILLED: December 29, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
50	45	35.7	86	4	
45	50	46.5	76	4	
40	55	39.0	84	6	
35	60	11.4	114	81	
30	65	13.2	96	47	



SAND and SILTY SAND - fine to medium, light brown

NOTE: Drilling mud used in drilling process. Casing used from 0' to 4' to prevent caving. Water level not established.

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

BORING 15

DATE DRILLED: December 29, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 92

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.		
90		14.2	118	6		ML	FILL - SANDY SILT - brown
						ML	Layer of Gravel
						CL	CLAYEY SILT - brown
							SILTY CLAY - dark brown
	5						Brown
85		13.5	121	14		SC	CLAYEY SAND - medium, some Silt, brown
						CL	SILTY CLAY - brown
80	10	25.3	99	7			
						ML	CLAYEY SILT - brown
	15	18.1	109	5		SM	SILTY SAND - fine, brown
75		10.9	112	11		SP	SAND - fine to medium, light brown
	20	9.4	108	34			
70							
	25	15.6	107	34			
65							
	30	16.2	106	34			Layer of Clay
60							
	35	21.4	105	24		CL	SILTY CLAY - greyish brown
55							
40							

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

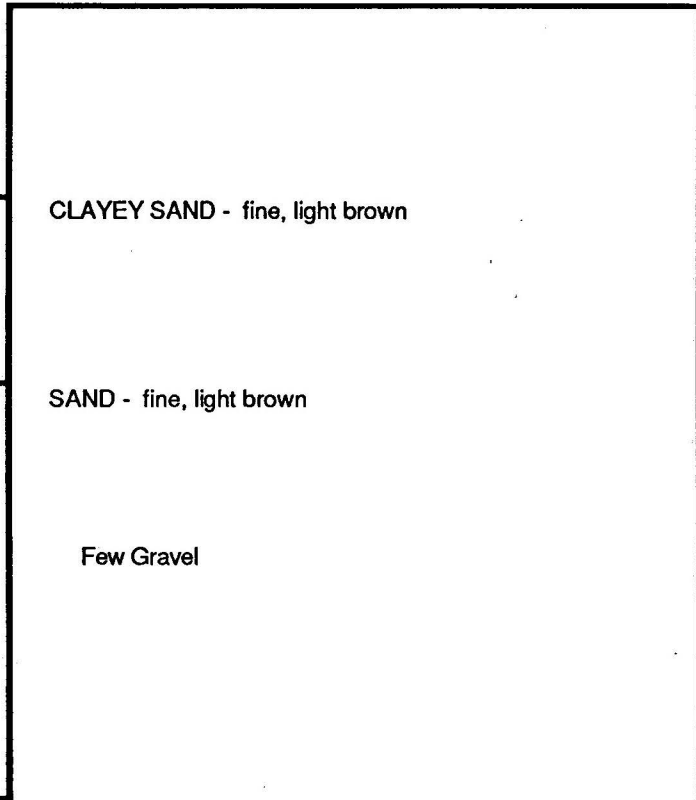
LeROY CRANDALL AND ASSOCIATES

PLATE A - 13.1

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.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
50		39.6	78	19	
45	45	16.6	109	11	SC
45					
50	50	10.8	113	41	SP
40					
55	55	19.6	104	41	
35					
60	60	15.0	107	47	
30					
65					

DATE DRILLED: December 29, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash



NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 13.2

BORING 16

DATE DRILLED: December 28, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 98

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	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
95		9.9	126	14		SM
	5	14.9	119	14		
90		12.1	123	41		
	10	7.2	109	14		
85		6.4	103	17		SP SM
	15	10.2	116	16		
80						
	20	6.9	106	20		
75						
	25	10.9	96	27		
70						
	30	18.3	103	34		SP
65						
	35	31.6	93	17		CL
60						
40						

SILTY SAND - fine, brown

SAND and SILTY SAND - fine, light brown

Some Clay

SAND - fine, light brown

SILTY CLAY - greyish brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 14.1

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.

ELEVATION	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55		38.7	86	9	
45		10.1	122	34	
50					
50		9.9	101	47	
45					
55		6.1	109	54	
40					
60		11.5	105	68	
35					
65					

BORING 16 (Continued)

DATE DRILLED: December 28, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash



Some Sand

SAND - fine, light brown

Layer of Silty Sand

Fine to medium

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

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 17	
							DATE DRILLED: December 28, 1988	
							EQUIPMENT USED: 5" - Diameter Rotary Wash	
							ELEVATION 98	
ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
95			13.2	119	7		SP ML CL	FILL - SAND, SILT and CLAY - some Gravel and Cobbles, pieces of wire, brown
	5		17.0	115	6		CL	SILTY CLAY - brown
			11.2	123	11		SM	SILTY SAND - fine, brown
90			12.1	119	10			
	10		15.6	113	10			
85			7.8	107	11			
	15		8.2	110	16			
80								
	20		16.4	108	18		SP	SAND - fine, light brown
75								
	25		14.0	104	32			Fine to medium
70								
	30							Fine
65								
	35						CL	SILTY CLAY - greyish brown
60								
40								

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 15.1

BORING 17 (Continued)

DATE DRILLED: December 28, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55		39.9	81	5	
45		18.9	100	25	
50					
50		20.1	97	34	
45					
55		14.2	106	34	
40					
60		14.7	114	44	
35					
65		31.8	89	5	
30					
70		32.8	90	14	
25					
75		39.7	83	16	
20					
80					

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

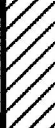
LeROY CRANDALL AND ASSOCIATES

PLATE A - 15.2

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.

JOB ADEF-88044-7 DATE 1/4/89 F.T. BG DR. Ip W.P. Ip CHKD DM

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 18	
ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DATE DRILLED: December 22, 1988 EQUIPMENT USED: 5" - Diameter Rotary Wash	
							ELEVATION 100	
95	5		18.9	109	7		CL	FILL - DEBRIS - Gravel, soil and pieces of concrete SILTY CLAY - black
			20.3	106	5			
90	10		15.2	116	7			Light brown Some Sand, brown
			20.5	104	5			
85	15		30.9	91	7			
			28.7	95	9			
80	20		26.9	95	11			
75	25		12.1	118	11		SP	SAND - fine to medium, some Clay, brown
70	30		17.2	104	34			
65	35		15.3	105	16			Reddish brown
60	40						CL	SILTY CLAY - greyish brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 16.1

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.

							BORING 19	
							DATE DRILLED: December 27, 1988	
							EQUIPMENT USED: 5" - Diameter Rotary Wash	
							ELEVATION 100	
ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
			15.1	117	7		ML	FILL - SANDY SILT - some Gravel, brown
			14.7	116	5		CL	SANDY SILT - brown
95	5		13.6	120	10		CL	SILTY CLAY - brown
			10.0	114	11		SP SM	SANDY CLAY - brown
90	10		7.6	103	7		SP	SAND and SILTY SAND - fine, brown
			7.7	104	10			SAND - fine, light brown
85	15							
			8.4	106	14			
80	20							
			13.8	98	34			
75	25							
70	30							
65	35		37.6	84	15		ML	SANDY SILT - light grey
							CL	SILTY CLAY - greyish brown
60	40							

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 17.1

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.

ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55	45		37.6	81	8	
			7.6	100	41	
50	50		12.0	93	34	
45	55		15.2	117	68	
40	60		14.5	107	47	
35	65					

DATE DRILLED: December 27, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

SP

SAND - fine to coarse, light brown

Fine

Fine to medium

Fine to coarse

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 17.2

BORING 20

DATE DRILLED: December 27, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 101

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	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOG.	
100		8.3	110	10		SP ML FILL - SAND and SILT - some Gravel, brown
	5	20.3	105	5		CL SILTY CLAY - black
95		17.5	111	5		Grey
	10	21.9	106	5		Brown
90		21.3	102	5		ML CLAYEY SILT - light brown
85	15	9.7	116	18		SC CLAYEY SAND - fine, light brown
80	20	13.6	110	16		SP SAND - fine, light brown
75	25	13.9	95	27		
70	30	16.6	101	41		
65	35	9.5	100	41		
40						Layer of Clay

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 18.1

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.

ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
60			20.9	—	34	
	45					
55			7.3	96	41	
	50					
50			18.8	111	34	
	55					
45			12.7	118	47	
	60					
40			16.0	105	54	
	65					

BORING 20 (Continued)

DATE DRILLED: December 27, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

Fine to medium

Fine to coarse

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 18.2

BORING 21

DATE DRILLED: January 4, 1989
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 102

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.	
100		22.5	101	3		CL SILTY CLAY - dark brown
	5	20.0	109	5		
95		23.9	103	3		Brown
	10	25.4	99	4		ML CLAYEY SILT - brown
90		14.7	118	10		SC CLAYEY SAND - fine, brown
	15	19.0	109	10		CL SANDY CLAY - light brown
85						SP SAND - fine, light brown
	20	11.7	102	17		
80						
	25	15.4	105	34		
75						
	30	16.7	105	27		Fine to medium
70						
	35	7.9	110	27		SM SILTY SAND - fine, light brown
65						
	40					SP SAND - fine to medium, light brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 19.1

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
60			16.9	102	41	
	45		40.6	80	3	
55						
	50		16.2	112	41	
50						
	55		16.9	110	54	
45						
	60		12.5	122	57	
40						
65						

DATE DRILLED: January 4, 1989
EQUIPMENT USED: 5" - Diameter Rotary Wash

Layers of Silt and Clay

Greyish brown
Few Gravel

Fine to coarse

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 19.2

JOB ADEF-88044-7 DATE 1/3/89 F.T. BG DR. dmh O.E. SK W.P. dmh CHKD DM

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 22	
							DATE DRILLED: January 4, 1989	
							EQUIPMENT USED: 5" - Diameter Rotary Wash	
							ELEVATION 103	
ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
100	5		7.0	118	30		SM	4 " Asphaltic Paving - 7" Base Course - 5" Asphaltic Paving
			10.7	124	20		ML	SILTY SAND - fine, brown
95	10		28.9	88	8			CLAYEY SILT - brown
			12.1	118	14		SP	Some Sand SAND - fine, some Silt, light brown
90	15		5.8	105	17			
			8.8	108	30		CL	SILTY CLAY - grey
85	20		19.1	110	8			
			8.4	116	21		SC	CLAYEY SAND - fine, brown
80	25						SP	SAND - fine, light brown
			19.6	104	27			
75	30							
			18.9	104	44			Fine to medium
70	35							
			15.1	106	44			
65	40							
								Fine to coarse, some Gravel and Cobbles

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

BORING 22 (Continued)

DATE DRILLED: January 4, 1989
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.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
60		12.7	121	41	
45		43.4	78	5	CL
55					SM
50		11.2	101	34	SP
50					
55		12.8	119	51	
45					
60		13.5	122	47	
40					
65		12.6	109	44	
35					
70		12.8	107	27	SM
30					
75		5.7	116	47	
25					
80					

SILTY CLAY - light brown

SILTY SAND - fine, brown

SAND - fine to medium, greyish brown

Few Gravel

Medium to coarse

Layer of Silty Clay

SILTY SAND - fine, brown

NOTE: Drilling mud used in drilling process. Mud removed to a depth of 75' after completion of drilling. Water level not established. Installed 2" PVC pipe for downhole survey.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 20.2

BORING 23

DATE DRILLED: December 13, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 104

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	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
100	5	6.9	122	16		13" Asphaltic Paving
		7.1	119	14		SILTY SAND - fine, brown
						Lenses of Clay
95	10	6.7	112	11		Light brown
		9.5	119	15		Reddish brown
90	15	8.6	112	16		
		22.4	105	12	CL	SILTY CLAY - greyish brown
85	20				SP	SAND - fine, greyish brown
		7.8	105	18		
80	25					
		21.6	99	47		
75	30					Grey
		17.7	110	44		
70	35				SP SM	SAND and SILTY SAND - fine to medium, grey
		13.4	114	61		
65						
40						

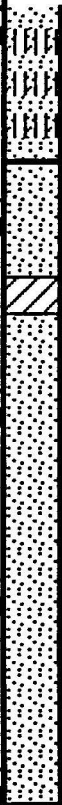
(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 21.1

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.

ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
60	45		17.3	110	54	
			16.8	108	54	
55	50		8.2	107	74	
50	55		18.8	98	68	
45	60		18.8	111	81	
40	65					

BORING 23 (Continued)

DATE DRILLED: December 13, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

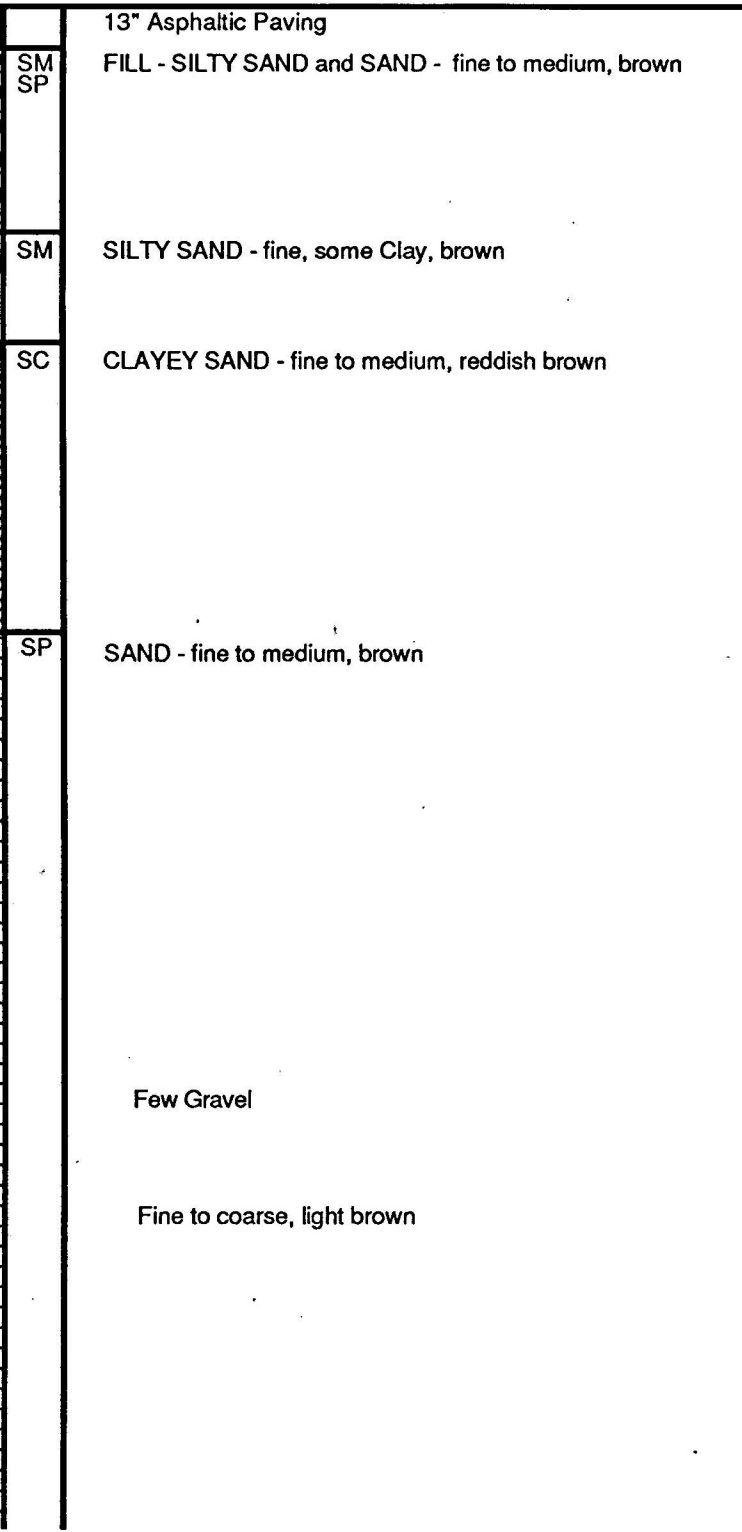
PLATE A - 21.2

BORING 24

DATE DRILLED: December 12 & 13, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 102

ELEVATION	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
100		7.1	126	13	
	5	7.1	114	14	
95		9.9	122	17	
	10	12.3	115	14	
90		12.7	119	17	
	15	12.7	112	16	
85					
	20	7.3	114	27	
80					
	25	19.4	102	47	
75					
	30	11.3	126	47	
70					
	35	16.9	106	74	
65					
	40				



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 - 22.1

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.

ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
60			12.8	118	61	
	45		17.9	108	54	
55						
	50		15.1	115	68	
50						
	55		18.3	108	51	
45						
	60		16.3	113	68	
40						
	65					



BORING 24 (Continued)

DATE DRILLED: December 12 & 13, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

Fine to medium

Some Silt

Few Gravel

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 22.2

BORING 25

DATE DRILLED: December 12, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 100

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	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
95	5		23.7	104	4		CL
			21.1	106	4		
			17.4	114	5		SC
90	10		12.5	111	7		
			13.5	117	14		
85	15		10.7	112	11		SP
80	20		9.0	111	34		
75	25		17.5	111	37		SW
70	30		9.2	124	41		
65	35						
60	40						SP

12" Asphaltic Paving

SILTY CLAY - dark grey

Slight hydrocarbon odor

Brown

CLAYEY SAND - fine to medium, brown

SAND - fine, light brown

Some Gravel

Fine to medium

Some Gravel and Cobbles

Medium to coarse

SAND - well graded, some Gravel and Cobbles, greyish brown

SAND - medium, light brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

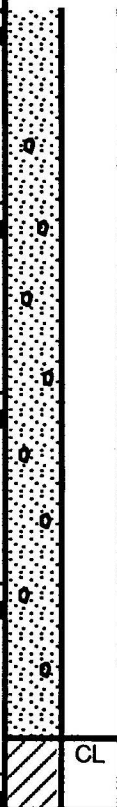
PLATE A - 23.1

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.

BORING 25 (Continued)

DATE DRILLED: December 12, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55	45	16.5	116	74	
		13.9	122	81	
50	50	18.7	103	61	
45	55	16.5	115	74	
40	60	38.9	82	12	
35	65				



Few Gravel

Medium to coarse

Medium

SILTY CLAY - grey and brown

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 23.2

BORING 26

DATE DRILLED: December 9, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 100

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.	
95	5	15.6	105	7		14" Asphaltic Paving Thin fabric material beneath asphaltic paving
		20.8	104	3		FILL - CLAYEY SAND - some Gravel, slight hydrocarbon odor, grey
		25.9	98	3		SILTY CLAY - dark grey Slight hydrocarbon odor
90	10	15.6	118	9		Brown and grey
		24.2	102	8		Layer of Sandy Clay, brown
85	15	5.2	108	13		SAND - fine to medium, some Gravel, brown
						Few Cobbles
80	20	19.3	107	37		
75	25	13.5	108	20		SAND and SILTY SAND - fine to coarse, brown
						Some Gravel and Cobbles
70	30	8.4	131	74		About 30% Gravel and Cobbles
65	35	12.7	120	81		
60	40					

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

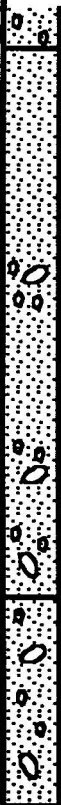
PLATE A - 24.1

BORING 26 (Continued)

DATE DRILLED: December 9, 1988
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.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55	45		12.1	103	>100	
			12.0	111	68	
50	50		13.7	107	81	
45	55		16.1	115	74	
40	60		9.6	116	81	
35	65					



SP

SAND - fine to medium, brown

Light brown

Layers of Gravel and Cobbles

SW

SAND - well graded, few Gravel and Cobbles, greyish brown

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 24.2

BORING 27

DATE DRILLED: December 8, 1988
EQUIPMENT USED: 17" - Diameter Bucket

ELEVATION 102

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.	
100						5" Asphaltic Paving - 8" Base Course
	5	12.4	116	5		FILL - SILTY CLAY - some Sand, dark greyish brown
95		19.7	107	2		(ABANDONED WATER PIPE ALONG SIDE OF BORING)
	10	7.0	104	5		SILTY CLAY - brown and grey
90		8.7	97	10		CLAYEY SAND - fine, light brown
	15	4.7	102	13		Layer of Silty Sand
85		2.4	123	14		Cemented pieces
	20	3.6	104	18		SAND - fine, light brown
80		4.0	110	10		Some Gravel
	25	3.2	110	9		About 10% Gravel (to 2" in size),
75		9.4	96	10		Greyish brown
	30					Few Gravel
70						Light brown
65						
40						

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 25.1

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
60	45		4.2	105	15	
55	50		4.8	98	14	
50	55		2.6	120	19	
45	60		1.8	102	23	



BORING 27 (Continued)
DATE DRILLED: December 8, 1988
EQUIPMENT USED: 17" - Diameter Bucket

Some Gravel

Fine to medium, brown

NOTE: Water not encountered. Raveling from 16' to 26' (to 2' in diameter).

LOG OF BORING

BORING 28

DATE DRILLED: December 8, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 101

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.	
100						4" Asphaltic Paving - 10" Base Course
		17.2	114	4		FILL - SILTY CLAY - grey and brown
						SILTY CLAY - dark grey
95	5	19.5	106	2		
		23.7	103	2		
						Brown
90	10	18.0	111	4		CLAYEY SAND - fine, brown
		14.4	117	8		Few Gravel
85	15	7.1	127	22		GRAVEL - well graded, Sand and Silty Sand matrix, grey and brown
80	20	7.6	131	51		
75	25	11.2	125	41		SAND - fine, light brown
70	30	13.8	96	54		Layers of Gravel
65	35	15.0	90	44		
40						

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 26.1

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
60 -	45		13.0	119	51	
55 -	50		10.0	101	29	
50 -	55		14.0	113	54	
45 -	60		16.5	106	74	
40 -	65		15.8	115	>100	

BORING 28 (Continued)

DATE DRILLED: December 8, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

Fine to medium, brown
Few Gravel

Some Gravel

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

BORING 29

DATE DRILLED: December 7, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 103

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.	
100		9.3	124	8		SC 4" Asphaltic Paving - 7" Base Course FILL - CLAYEY SAND - fine to medium, brown
	5	17.1	110	3		CL SILTY CLAY - dark grey
95		21.8	101	3		Light brown
	10	28.9	94	2		
90		10.3	118	8		SC CLAYEY SAND - fine to medium, brown
	15	15.2	118	11		Fine
85						
	20	8.2	111	16		SP SAND - fine to medium, light brown
80						GP GRAVEL - some Cobbles, Sand matrix, light brown
	25	21.9	103	34		
75						Some shells
	30	9.7	98	65		
70						
	35	18.7	93	65		SP SAND - fine to medium, few Gravel, brown
65						
40						

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 27.1

JOB ADEF-88044-7 DATE 12/18/88 F.T. FH DR. dmh W.P. dmh CHKD DM

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.
60			8.4	114	65	
	45		19.7	100	61	
55						
	50		9.7	110	81	
50						
	55		13.6	118	>100	
45						
	60		16.0	108	81	
40						
	65					

BORING 29 (Continued)
DATE DRILLED: December 7, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash



Layers of Gravel

Fine to coarse

Fine, some Silt

Fine to medium

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

BORING 30

DATE DRILLED: December 5, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 104

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.	
100	5	6.8	128	17		SP
		8.1	116	8		
95	10	17.8	107	3		CL
		14.8	115	6		
90	15	15.0	105	9		SM
85	20	12.9	108	14		
80	25	13.7	114	16		SP SM
75	30	11.6	109	45		
70	35	16.5	104	45		
65	40					

4" Asphaltic Paving - 9" Base Course

FILL - SAND - fine to medium, some Silt, pieces of wood, dark brown

Organic odor

SILTY CLAY - some Sand and rootlets, dark grey

Brown

SILTY SAND - fine, brown

Light reddish brown

SAND and SILTY SAND - fine, few Gravel, brown

Few Cobbles

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 28.1

BORING 30 (Continued)

DATE DRILLED: December 5, 1988
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.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
60	45		11.9	104	37		SP SAND - fine to medium, light brown
55	50		13.1	103	41		
50	55		9.2	97	32		Some Clay
45	60		15.7	107	45		Layers of Gravel
40	65		18.6	107	51		
35	70		39.7	82	9		CL SILTY CLAY - brown
30	75		25.5	99	18		Layers of Sandy Silt
25	80		34.9	87	14		

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 28.2

JOB ADEF-88044-7 DATE 12/18/88 F.T. FH DR. dmh W.P. dmh CHKD DM

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 31						
DATE DRILLED: December 6, 1988 EQUIPMENT USED: 5" - Diameter Rotary Wash						
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
100	5	8.2	121	5	SM	5" Asphaltic Paving - 7" Base Course FILL - SILTY SAND - fine to medium, dark brown
		14.1	121	3	SC	FILL - CLAYEY SAND - fine to medium, some rootlets, brown
95	10	18.9	111	6	CL	SILTY CLAY - brown
		12.3	120	8	SC	CLAYEY SAND - fine to medium, reddish brown
90	15	16.5	107	6	SP	SAND - fine to medium, light brown
		8.0	101	10	SM	SILTY SAND - fine, light brown
85	20	19.7	99	22		
		16.4	108	45		Few Gravel
80	25	18.8	98	37		
		16.2	108	37	SP SM	SAND and SILTY SAND - fine, light brown
75	30					Few Gravel
70	35					
65	40					

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

JOB ADEF-88044-7 DATE 12/18/88 F.T. FH DR. dmh O.E. SK W.P. dmh CHKD DM

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.
60			14.1	112	37	
45			9.9	106	61	
55						
50			15.8	96	41	
50						
55			11.0	103	41	
45						
60			21.5	105	61	
40						
65						

DATE DRILLED: December 6, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash



SP	SAND - fine to medium, light brown
	Some Gravel
SP SM	SAND and SILTY SAND - fine, light brown
	Layer of Gravel
	Few Cobbles

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

BORING 32

DATE DRILLED: December 2, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 102

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.	
100		8.7	113	5		4" Asphaltic Paving - 8" Base Course
	5	11.4	114	6		SILTY SAND - fine, reddish brown
						Fine to medium, reddish brown
95		8.5	109	7		
	10	10.6	114	11		Layer of Clay
90		11.2	119	18	SP	SAND - fine, brown
	15	12.1	108	15		
85					SM	SILTY SAND - fine, brown
	20	16.1	109	24		
80						
	25	16.9	107	34		Light brown
75						
	30	17.2	97	20		Fine
70						
	35	22.2	95	34		
65					SW	SAND - well graded, brown
40					SM	SILTY SAND - fine, brownish grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 30.1

BORING 32 (Continued)

DATE DRILLED: December 2, 1988
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.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
60		19.4	95	30	
45		13.7	106	49	
55					
50		11.0	95	27	
50					
55		12.0	102	41	
45					
60		15.1	103	>100	
40					
65					



Light brownish grey

SAND - well graded, some Gravel, brown

Light grey

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 30.2

BORING 33

DATE DRILLED: December 1, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 100

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
		6.7	127	16		SP
		7.0	116	8		
95	5					
		24.3	100	3		CL
		23.0	105	6		CL
90	10					
		23.6	102	5		
		28.7	94	5		CL
85	15					
		29.1	95	7		
80	20					
		20.8	104	9		
75	25					
		7.7	111	27		SP
70	30					
		15.0	97	28		SM
65	35					
60	40					

4" Asphaltic Paving - 8" Base Course

SAND - fine to medium, dark brown

Brown

Some Clay and Gravel

SILTY CLAY - some Sand, greenish grey

Light brown

SANDY CLAY - some Silt, brown

SILTY CLAY - some Sand, brown

SAND - fine to medium, light brown

SILTY SAND - fine, light brown

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 - 31.1

BORING 33 (Continued)

DATE DRILLED: December 1, 1988
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.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55	45		16.9	106	41	
			7.9	107	45	
50	50		9.5	98	34	
45	55		11.4	103	37	
40	60		23.4	97	34	
35	65					
30	70		23.6	101	10	
25	75		23.5	98	12	
20	80					



Grey

Light brown

Light brownish grey

SAND - fine to medium, brown

Some Gravel

Some Silt

Fine, grey

Layers of Clay

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 31.2

BORING 34

DATE DRILLED: December 1, 1988
EQUIPMENT USED: 17" - Diameter Bucket

ELEVATION 102

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.	
100		12.3	114	3		SM 2" Asphaltic Paving
	5	12.7	119	6		FILL - SILTY SAND - fine to medium, few Gravel, dark brown
95		16.0	118	8		CLAYEY SAND - medium, reddish brown
						Fine to medium
90	10	26.7	98	8		CL SANDY CLAY - light brown
		10.9	94	8		SC CLAYEY SAND - fine to medium, light brown
	15					SM SILTY SAND - fine, light brown
85		6.2	97	10		Light reddish-brown
	20	5.6	96	10		
80						
	25	3.4	99	13		
75						SP SAND - fine to medium, light brown
	30	5.7	100	11		
70						
	35	10.7	97	10		
65						
	40	3.6	108	12		SM SILTY SAND - fine, light brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 32.1

JOB ADEF-88044-7 DATE 12//8/88 F.T. FH DR. dmh O.E. SK. *SK* W.P. dmh CHKD DM

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.
60	45	7.6	95	14	
55	50	8.0	98	13	
50	55	11.7	92	13	
45	60	5.5	103	11	
					
SP					

SAND - fine to medium, grey

NOTE: Water not encountered. No caving.

DATE DRILLED: December 1, 1988
EQUIPMENT USED: 17" - Diameter Bucket

BORING 34 (Continued)

LOG OF BORING

LeROY GRANDALL AND ASSOCIATES

PLATE A-32.2

BORING 35

DATE DRILLED: December 1 & 2, 1988
EQUIPMENT USED: 17" - Diameter Bucket

ELEVATION 102

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.	
100		16.2	113	2		CL SM 2" Asphaltic Paving - 4" Base Course - 2" Asphaltic Paving FILL - CLAY and SILTY SAND - pieces of concrete, dark brown and grey Very Clayey
	5	21.9	107	2		Pieces of brick
95		18.1	110	3		
	10	21.3	104	1		Pieces of asphalt
90		26.7	97	1		
	15				CL	SILTY CLAY - grey
85		26.7	96	3		
	20	37.6	86	3		
80		33.0	90	5		
	25	32.9	91	8		Some Sand
75					SM	SILTY SAND - fine, light brown
	30	5.0	98	11		
70						
	35	5.9	92	10		
65						
	40	5.6	104	12		

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 33.1

BORING 35 (Continued)

DATE DRILLED: December 1 & 2, 1988
EQUIPMENT USED: 17" - Diameter Bucket

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.
60					
	45	2.9	108	11	
55					
	50	5.7	98	16	
50					
	55	5.9	98	18	
45					
	60	13.4	99	15	
40					
	65	2.8	108	18	
35					
	70	33.9	88	10	



Light grey

Some shells
SAND - fine to medium, grey

Few Gravel
CLAYEY SILT - grey

NOTE: Water measured at a depth of 68' (appears to be perched above the Clayey Silt). Caving below 67'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 36

DATE DRILLED: December 2, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 100

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.	
95	5	14.2	114	12		4" Asphaltic Paving - 10" Base Course
		8.4	113	9		SILTY SAND - fine to medium, brown
		11.4	121	10		
90	10	9.2	105	8		Reddish brown
		9.0	108	12		Some Clay
85	15	12.7	105	20		Fine
80	20	8.4	106	20		Fine to medium
75	25	7.6	115	27	SP SM	SAND and SILTY SAND - fine to coarse, brown
70	30	14.2	117	41		
65	35	19.9	102	30	SP	SAND - fine to medium, brown
60	40					

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 34.1

BORING 36 (Continued)

DATE DRILLED: December 2, 1988
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.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55	45	18.9	103	41	
		12.6	100	34	
50	50	11.5	106	37	
45	55	14.1	107	41	
40	60	16.1	106	>100	
35	65				



SP
SM

Medium to coarse

SAND and SILTY SAND - fine, brown

SAND - medium to coarse, brown
Some Gravel

Grey

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

BORING 37

DATE DRILLED: December 6, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 100

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.	
95	5	9.1	114	6		SM 4" Asphaltic Paving - 8" Base Course FILL - SILTY SAND - fine to medium, dark brown
		18.9	109	5		Some Clay
		18.4	109	4		SC CLAYEY SAND - fine to medium, dark brown
		14.9	114	3		Hydrocarbon odor
90	10					CL SILTY CLAY - brown
		20.1	107	3		Some Sand and streaks of caliche
		27.7	95	4		
85	15					SM SILTY SAND - fine to medium, light reddish brown
		9.9	97	3		
80	20					
		18.7	99	20		
75	25					
		19.3	90	34		SP SAND - fine to medium, light greyish brown
70	30					
		10.1	107	30		
65	35					SP SAND and SILTY SAND - fine, light brown
		20.7	88	25		SM
60	40					

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 35.1

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55	45		13.2	101	37	
			13.0	90	45	
50	50		11.4	100	45	
45	55		12.4	98	34	
40	60		16.2	105	37	
35	65					

DATE DRILLED: December 6, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

Few Gravel

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 35.2

BORING 38

DATE DRILLED: December 7, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 96

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.
95		11.8	118	8	
	5	10.3	119	8	
90		14.1	110	6	
	10	13.6	109	8	
85		16.3	112	10	
	15	15.7	109	11	
80					
	20	8.9	104	29	
75					
	25	14.7	92	34	
70					
	30	10.9	114	37	
65					
	35	12.2	101	27	
60					
	40				

SM

4" Asphaltic Paving - 7" Base Course
FILL - SILTY SAND - fine to medium, dark brown
Hydrocarbon odor

SM

SILTY SAND - fine to medium, brown

Some Clay, reddish brown

Light brown

Fine
Few Gravel

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 36.1

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55			20.7	100	41	
	45					
50			10.2	99	55	
	50					
45			9.6	108	55	
	55					
40			14.8	103	34	
	60					
35			14.7	106	>100	
	65					

BORING 38 (Continued)

DATE DRILLED: December 7, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

Some Gravel

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 36.2

BORING 39

DATE DRILLED: December 8, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 98

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.	
95		9.0	122	18		SP
	5	10.0	112	14		
90		10.6	116	7		SM
	10	8.8	108	5		
85		12.1	107	7		
	15	10.9	110	7		
80						
	20	15.0	111	18		
75						
	25	12.6	106	30		SP
70						
	30	12.0	103	34		
65						
	35	7.7	103	24		
60						
	40					SM

4" Asphaltic Paving - 8" Base Course

FILL - SAND - fine to medium, brown
Slight hydrocarbon odor

SILTY SAND - fine to medium, reddish brown

Fine

Fine to medium

Brown

SAND - fine to medium, light brown

SILTY SAND - fine, some Gravel, brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 37.1

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55			11.2	102	30	
	45		15.5	100	34	
50						
	50		11.6	112	55	
45						
	55		14.0	98	41	
40						
	60		13.3	103	47	
35						
	65					

DATE DRILLED: December 8, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 37.2

BORING 40

DATE DRILLED: December 5, 1988
EQUIPMENT USED: 17" - Diameter Bucket

ELEVATION 95

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.	
90	5	6.3	115	6		SM
		5.9	111	5		
85	10	7.5	106	3		SM
		9.4	109	6		
80	15	16.8	109	10		
		14.7	117	14		
75	20	15.8	107	8		
70	25	15.4	101	6		
65	30	18.5	100	10		
60	35	6.3	100	13		SP
55	40	8.2	97	10		

FILL - SILTY SAND - fine to medium, brown

Pieces of asphalt

SILTY SAND - fine to medium, dark brown

Brown

SAND - fine, some Silt, light brown

Few Gravel

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 38.1

BORING 40 (Continued)

DATE DRILLED: December 5, 1988
EQUIPMENT USED: 17" - Diameter Bucket

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.
50	45		6.7	97	14	
45	50		8.9	92	14	
40	55		11.9	92	12	
35	60		9.6	94	10	

SP
SM

SAND and SILTY SAND - fine, light brown

NOTE: Water seepage encountered at a depth of 13'. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 38.2

BORING 43

DATE DRILLED: December 14, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 88

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	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
85			6.1	109	10		SM 12" Base Course SILTY SAND - fine to medium, slight hydrocarbon odor, brown
	5		22.4	104	3		CL SILTY CLAY - brown
80			17.4	112	5		Some Sand
	10		7.6	101	12		SP SM SAND and SILTY SAND - fine, light brown
75			15.3	100	14		
	15		11.6	115	27		
70							SP SAND - fine to medium, brown
	20		11.3	107	35		
65							
	25		10.0	115	34		
60							
	30		7.5	100	30		SP SM SAND and SILTY SAND - fine to medium, light brown
55							
	35		13.5	108	34		
50							Some Gravel
40							

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 39.1

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.

ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
45			10.2	95	17	
45			11.2	107	34	
40						
50			12.0	95	27	
35						
55			11.9	108	41	
30						
60			9.6	97	27	
25						
65						

DATE DRILLED: December 14, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

SM

SILTY SAND - fine, light brown

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 39.2

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 44	
							DATE DRILLED:	December 15, 1988
							EQUIPMENT USED:	5" - Diameter Rotary Wash
							ELEVATION	85
ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
80	5		21.8	103	2		SP	FILL - SAND - fine, some Gravel, light brown
							SP	SAND - fine to medium, light brown
75	10		16.9	112	3		CL	SILTY CLAY - dark brown
								Some Sand Light brown
70	15		11.7	110	7		SC	CLAYEY SAND - fine, light brown
							SP SM	SAND and SILTY SAND - fine, light brown
65	20		8.3	98	3			
60	25		7.9	103	16			
55	30		8.7	105	24			
50	35		16.4	92	47		SP	SAND - fine to medium, brown
45	40		9.8	97	41			
							SM	SILTY SAND - fine, light brown
			10.0	95	34			Layer of Sand, fine to coarse
			12.5	107	34			

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

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	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
40	45		9.6	98	37	
			13.5	103	41	
35	50		12.7	95	41	
30	55		12.0	112	68	
25	60		12.4	97	47	
20	65					

BORING 44 (Continued)

DATE DRILLED: December 15, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

Few Gravel

Grey

Brown

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 40.2

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 45							DATE DRILLED: December 15, 1988		EQUIPMENT USED: 5" - Diameter Rotary Wash		ELEVATION 85	
ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.						
			4.6	122	17			SP	FILL - SAND - fine, some Silt and Gravel, brown			
			11.2	120	6			SM	SILTY SAND - fine, dark brown			
80	5		11.9	123	13				Some Clay Brown			
			15.2	111	11			SC	CLAYEY SAND - fine, reddish brown			
75	10		13.9	114	17							
			14.5	110	27			SP SM	SAND and SILTY SAND - fine, light brown			
70	15		12.2	116	34							
65	20		13.2	89	30							
60	25		10.1	106	30			SM	SILTY SAND - fine, light brown			
55	30		13.8	97	30							
50	35											
45	40											

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	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
40	45		19.2	100	41	
			10.3	98	37	
35	50		13.9	107	47	
30	55		13.1	101	41	
25	60		14.2	109	61	
20	65					

BORING 45 (Continued)

DATE DRILLED: December 15, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

Layers of Gravel

Light brown
Lens of Clay

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 41.2

BORING 46

DATE DRILLED: December 19, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 85

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.	
		7.8	114	11		SM
		8.1	122	9		SM
80	5	18.4	112	10		SC
75	10	14.3	115	16		
		13.4	107	20		SP
70	15	12.9	105	18		
65	20	13.8	97	34		
60	25	12.8	108	41		
55	30	14.6	96	30		
						SM
50	35	9.8	97	30		
45	40					

FILL - SILTY SAND - fine to medium, some Gravel, brown
6" Base Course
SILTY SAND - fine to medium, dark brown

CLAYEY SAND - fine, brown

SAND - fine, some Silt, brown

Light brown

SILTY SAND - fine, light brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 42.1

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.

ELEVATION (ft.)	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
40	45		10.4	109	41	
			11.9	101	34	
35	50		10.7	108	47	
30	55		14.0	106	34	
25	60		27.4	95	30	
20	65					

DATE DRILLED: December 19, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 42.2

BORING 46 (Continued)

BORING 47

DATE DRILLED: December 19, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 84

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.	
		11.8	116	8		SM- FILL - SILTY SAND - brown 16" Base Course
80	5	10.6	121	17		ML SANDY SILT - dark brown
		14.8	117	9		SC CLAYEY SAND - fine, brown
75	10	10.2	114	15		
		14.0	112	14		
70	15	14.1	115	25		SP SAND - fine, some Clay, light brown
		10.6	108	28		
65	20	9.9	109	34		
		20.0	98	34		
60	25					
55	30	14.1	107	41		Fine to medium, few Gravel
50	35	14.1	93	41		SM SILTY SAND - fine, brown
45						

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

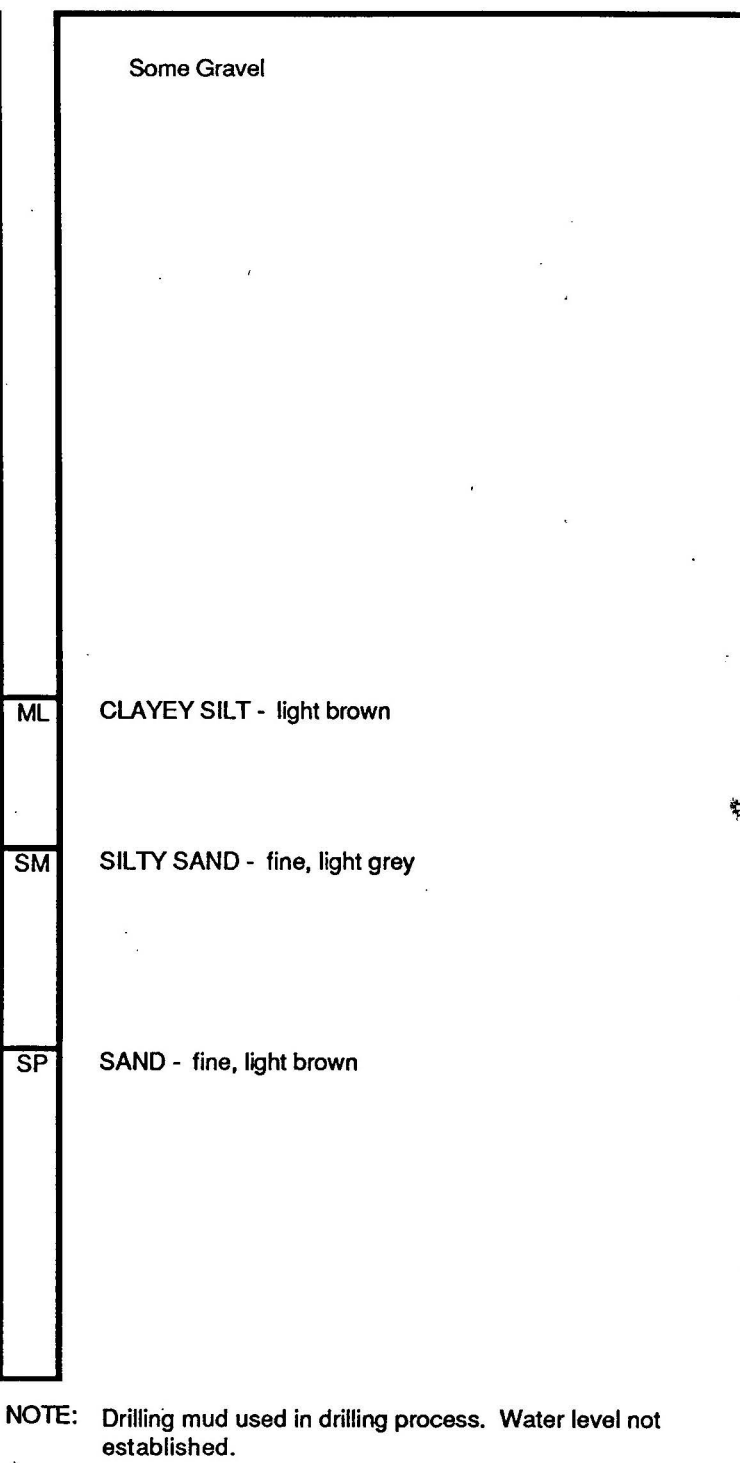
PLATE A - 43.1

BORING 47 (Continued)

DATE DRILLED: December 19, 1988
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.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
40	45	9.0	112	68	
		9.8	101	47	
35	50	13.0	109	41	
		17.6	105	27	
30	55				
		25.8	98	16	
25	60				
		9.1	97	61	
20	65				
		13.9	107	90	
15	70				
		20.3	100	61	
10	75				
5	80				



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 48	
							DATE DRILLED: December 20, 1988	
							EQUIPMENT USED: 5" - Diameter Rotary Wash	
							ELEVATION 82	
ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
80			6.0	109	11		SP	SAND - fine to medium, brown
	5		8.5	117	3		SM	Layer of Silt SILTY SAND - fine to medium, some Clay, dark brown
75			19.2	109	5			Layer of Clayey Sand, reddish brown
	10		16.3	111	3			
70			18.4	106	10			Brown
	15		18.4	105	19			
65								
	20		18.6	106	20			Few Gravel
60								
	25		11.9	107	20			Fine
55								
	30		11.5	101	27			
50								
	35		12.7	105	30			
45								
40								

(CONTINUED ON FOLLOWING PLATE)

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	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
40		12.6	102	34	
45		10.3	103	34	
50		12.7	100	37	
55		15.1	101	27	
60		14.7	106	>100	
65					

DATE DRILLED: December 20, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

SP SAND - fine, light brown

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 44.2

JOB ADEF-88044-7 DATE 12/16/88 F.T. BG DR. Ip O.E. SK SK W.P. Ip CHKD DM

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	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
80		13.3	110	< 1	
	5	26.9	96	1	
		13.5	113	4	
75					
	10				
70					
	15				

DATE DRILLED: December 14, 1988
EQUIPMENT USED: 8" - Diameter Hand Auger

ELEVATION 83



NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 45

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 50	
ELEVATION		DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DATE DRILLED: December 19, 1988 EQUIPMENT USED: 16" - Diameter Bucket
ELEVATION 85								
80	5			9.6	122	3	SM	6" Asphaltic Paving
				23.6	102	3	CL	FILL - SILTY SAND - fine, some Clay and Gravel, brown
				11.9	102	2	SM	SILTY CLAY - dark brown
				5.3	96	4	SM	SILTY SAND - fine, light brown
75	10			7.4	95	3	SP	SAND - fine, light brown
				6.5	95	6		
65	20			8.2	97	22		Light greyish brown
				9.8	94	22		Light brown
60	25							
55	30			9.2	103	23		

NOTE: Water not encountered. Slight raveling from 11' to 13'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB ADEF-88044-7 DATE 12/16/88 F.T. BG DR. lp O.E. SK SK W.P. lp CHKD DM

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	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
75			11.2	119	2	
	5		25.1	100	1	
			17.1	105	1	
70						
	10					
65						
	15					

DATE DRILLED: December 14, 1988
EQUIPMENT USED: 8" - Diameter Hand Auger

ELEVATION 78



FILL - SILTY SAND - fine, dark brown and grey

SILTY SAND - fine, dark brown

SILTY CLAY - dark brown

SANDY CLAY - brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 47

BORING 52

DATE DRILLED: December 20, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION 82

ELEVATION	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
80		8.0	113	11		SM FILL - SILTY SAND - fine to medium, some Gravel, dark brown Slight hydrocarbon odor
	5	7.2	124	8		
75		17.1	113	3		CL SILTY CLAY - dark brown
	10	15.4	114	13		Some Sand
70		16.8	109	16		SM SILTY SAND - fine, light brown
	15					
65						SP SAND - fine to medium, light greyish brown
	20	10.0	117	27		
60						
	25	9.2	99	90		Medium to coarse
55						
	30	8.5	106	27		SM SILTY SAND - fine, light brown
50						
	35	9.8	118	81		
45						Few Gravel
40						

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

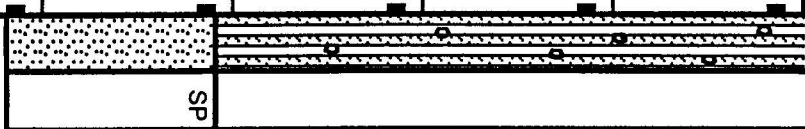
LeROY CRANDALL AND ASSOCIATES

PLATE A - 48.1

JOB ADEF-88044-7 DATE 12/29/88 F.T. BG DR. lp O.E. SK sk W.P. lp CHKD DM

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	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
40 -	45	11.6	101	47	
35 -	50	12.3	109	37	
30 -	55	16.7	104	30	
25 -	60	17.1	103	>100	
20 -	65	16.6	109	74	



NOTE: Drilling mud used in drilling process. Water level not established.

SAND - fine, light brown

BORING 52 (Continued)
DATE DRILLED: December 20, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES
PLATE A - 48.2

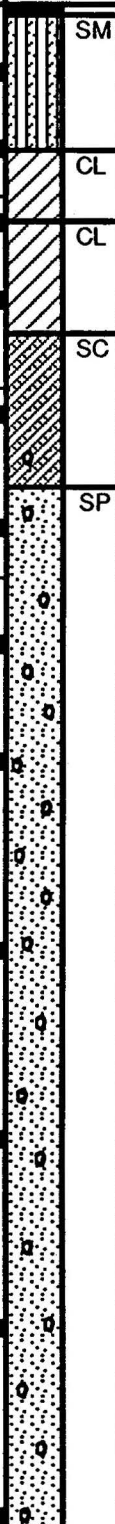
BORING 53

DATE DRILLED: December 5, 1988
EQUIPMENT USED: 17" - Diameter Bucket

ELEVATION 77

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.
75		8.2	103	2	
	5	21.9	104	3	
70		16.7	116	8	
		20.0	109	11	
65	10	5.8	110	11	
		3.6	109	16	
60	15	2.0	109	14	
		2.2	121	22	
55	20				
		5.0	102	11	
50	25				
		4.8	95	11	
45	30				
		5.1	96	11	
40	35				
		8.8	96	11	



3" Asphaltic Paving
SILTY SAND - fine to medium, dark brown

SILTY CLAY - some Sand, dark brown

SANDY CLAY - brown

CLAYEY SAND - fine to medium, brown

Some Gravel

SAND - fine to medium, about 10% Gravel, light brown

About 25% Gravel

Some Silt

Few Gravel

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 49.1

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.

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
35					
45		6.1	97	13	
30					
50		1.8	125	16	
25					
55					

DATE DRILLED: December 5, 1988
EQUIPMENT USED: 17" - Diameter Bucket

Fine

Medium to coarse, greyish brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 49.2

BORING 54

DATE DRILLED: December 2, 1988
EQUIPMENT USED: 17" - Diameter Bucket

ELEVATION 75

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.
70	5		8.6	112	3	SM
			13.1	107	2	CL
			16.0	116	8	
			19.3	113	5	CL
65	10					SC
			9.3	117	11	
60	15		4.0	108	16	SP
			3.6	107	16	
55	20		3.5	104	23	
50	25		3.9	105	23	
45	30		5.0	99	11	
40	35		4.7	100	10	
35	40		4.0	106	13	

3" Asphaltic Paving
FILL - SILTY SAND and CLAY - dark brown

Dark brownish grey
SILTY CLAY - grey

CLAYEY SAND - fine to medium, brown

SAND - fine to medium, light brown

Fine

Light grey

Light brown

Few Gravel (to 3" in size)

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 50

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 55	
							DATE DRILLED:	December 15, 1988
							EQUIPMENT USED:	16" - Diameter Bucket
							ELEVATION	79
ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
75	5		6.2	105	10		ML	SANDY SILT - some Clay, few Gravel and rootlets, dark brown
			8.6	126	22			
	10		8.7	116	11		CL	SILTY CLAY - dark brown
			4.5	102	13		CL	SANDY CLAY - light brown
70							SM	SILTY SAND - fine, light brown
			3.2	104	13		SP	SAND - fine to medium, some Silt, light brown
65	15		3.4	104	16			
60	20							
			4.1	103	22			
55	25							

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-51

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 56	
ELEVATION		DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DATE DRILLED: December 15, 1988 EQUIPMENT USED: 16" - Diameter Bucket	
ELEVATION 81								
80			5.7	101	8	ML	SANDY SILT - dark brown	
	5						Some Clay	
75			3.6	101	10	SM	SILTY SAND - fine, light brown	
			1.4	94	6	SP SM	SAND and SILTY SAND - fine, light brown	
70	10		2.6	98	8			
			2.7	106	18	SP	SAND - fine to medium, light grey	
65	15						Few Gravel	
			2.8	104	18		Light brown	
20								

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 52

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 57	
							DATE DRILLED: December 15, 1988	
							EQUIPMENT USED: 16" - Diameter Bucket	
							ELEVATION 75	
ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
70	5		10.3	106	5		ML	SANDY SILT - dark brown
			5.3	96	5		CL	SANDY CLAY - dark brown
			3.3	98	3		SM	SILTY SAND - fine, brown
			5.2	98	10			
65	10		2.6	97	13		SP	SAND- fine, light brown
60	15		4.2	99	14			
55	20		3.3	99	16			Fine to medium, light greyish brown
50	25							

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 53

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 58	
							DATE DRILLED: December 15, 1988	
							EQUIPMENT USED: 16" - Diameter Bucket	
							ELEVATION 72	
ELEVATION	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
70			6.9	104	6		ML	SANDY SILT - dark brown
	5		15.6	114	6		CL	SANDY CLAY - brown
65			13.3	116	5		SM	Dark brown SILTY SAND - fine to medium, light brown
	10		5.9	96	6		SP	SAND - fine, light brown
60			4.6	96	10			
	15		7.2	101	14			
55								
20			3.9	105	30			

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 54

JOB ADEF-88044-7 DATE 12/20/88 F.T. TC DR. Ip O.E. SK SL W.P. Ip CHKD DM

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	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
75			5.6	93	9	
	5		8.6	123	15	
			10.4	125	26	
70						
	10					
65						
	15					

DATE DRILLED: December 19, 1988
EQUIPMENT USED: 16" - Diameter Bucket

ELEVATION 79



FILL - SANDY SILT - pieces of asphalt, brown
SANDY SILT - dark brown

Some Clay

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 55

JOB ADEF-88044-7 DATE 12/20/88 F.T. TC DR. lp O.E. SK *sk* W.P. lp CHKD DM

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	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
65 -	15				
70 -	10				
75 -	5	8.6	103	1	
		9.1	108	4	
		10.9	119	10	

BORING 60
DATE DRILLED: December 19, 1988
EQUIPMENT USED: 16" - Diameter Bucket
ELEVATION 79

6" Asphaltic Paving
SM
SILTY SAND - fine, dark brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES
PLATE A-56

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	DEPTH (ft.)		MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
80	5		10.3	98	1	
			17.7	111	1	
			24.1	100	< 1	
			24.6	103	1	
75	10					
70	15					

DATE DRILLED: December 14, 1988
EQUIPMENT USED: 8" - Diameter Hand Auger

ELEVATION 85



FILL - SILTY SAND - some rootlets, dark brown

Some Clay

(ABANDONED PIPE)

SILTY CLAY - grey

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 57

BORING 62

DATE DRILLED: December 7, 1988
 EQUIPMENT USED: 24" - Diameter Bucket 0 to 10'
 17" - Diameter Bucket 10' to 30'
 ELEVATION 70

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
65	5	13.2	121	5	
		17.7	112	3	
		22.0	110	8	
		21.7	104	8	
60	10				
		8.9	116	11	
55	15	6.4	114	16	
50	20	2.0	110	18	
45	25	2.6	102	13	
40	30	4.9	100	14	

SC 2" Asphaltic Paving
 CLAYEY SAND - fine to medium, brown

CL SANDY CLAY - brown

SC CLAYEY SAND - fine, brown

SM SILTY SAND - fine, brown

SP SAND - fine, about 20% Gravel (to 1-1/2" in size), light brown

Some Gravel

About 30% Gravel
 Light grey

Some Silt, fine, light brown

NOTE: Water not encountered. Caving from 12 to 15' (to 2-1/2' in diameter)

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

BORING 63

DATE DRILLED: December 6, 1988
EQUIPMENT USED: 17" - Diameter Bucket

ELEVATION 71

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
70		21.9	106	2		2" Asphaltic Paving - 8" Base Course
		23.0	104	3		FILL - SILTY SAND - fine to medium, dark brown
	5	22.3	104	3		FILL - SILTY CLAY - black
65		29.6	90	2		Dark brown
		21.1	107	5		SILTY CLAY - dark brown
60	10	4.7	111	14		Brown
		4.8	101	16		SAND and CLAYEY SAND - fine to medium, brown
55	15	5.2	100	19		SAND - fine to medium, about 25% Gravel, light brown
		5.4	106	13		Few Gravel
50	20					
45	25					
30						

NOTE: Water not encountered. No caving.

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

BORING 64

DATE DRILLED: December 7, 1988
 EQUIPMENT USED: 24" - Diameter Bucket 0 to 10'
 17" - Diameter Bucket 10' to 30'
 ELEVATION 70

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
65	5	22.4	104	2	SM
		18.0	110	3	CL
		17.4	108	5	
		15.1	113	6	
60	10	6.9	107	8	SC
		2.4	129	14	SP
55	15				
		6.8	110	13	
50	20				
		6.5	99	16	
45	25				
		8.1	95	11	
40	30				

1-1/2" Asphaltic Paving
 FILL - SILTY SAND - dark brown
 SILTY CLAY - dark brown
 Some Sand
 CLAYEY SAND - fine, light brown
 SAND - fine, some Silt, light brown
 About 25% Gravel (to 1" in size)
 Few Gravel
 Fine to medium

NOTE: Water not encountered. Caving from 13' to 18' (to 2-1/2' in diameter).

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

BORING 65

DATE DRILLED: December 6, 1988
EQUIPMENT USED: 17" - Diameter Bucket

ELEVATION 70

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
65	5	24.2	100	< 1	SM
		21.0	104	2	CL
		17.3	117	5	
		12.8	119	13	CL
60	10	5.1	108	6	SP
		4.9	97	13	
55	15				
		4.8	102	14	
50	20				
		4.8	111	19	
45	25				
		5.8	95	13	
40	30				

4" Asphaltic Paving
FILL - SILTY SAND - fine, brown
SILTY CLAY - dark greyish brown

Some caliche
SANDY CLAY - brown

SAND - fine to medium, some Clay, light brown

Some Gravel

Brown

Fine

NOTE: Water not encountered. No caving.

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 - 61

BORING 66

DATE DRILLED: December 6, 1988
EQUIPMENT USED: 17" - Diameter Bucket

ELEVATION 70

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.
65	5	22.3	100	2	CL
		21.9	101	3	CL
		21.9	102	3	CL
		14.2	121	6	CL
60	10				SC
		10.5	111	6	SC
55	15	7.0	110	6	SP
					SW
50	20	1.0	123	18	SW
					SP
45	25	3.0	108	19	SP
					SP
40	30	2.4	105	14	SP

4" Asphaltic Paving - 4" Base Course
FILL - SILTY CLAY - some Sand, dark greyish brown

SILTY CLAY - brown

SANDY CLAY - brown

CLAYEY SAND - fine to medium, brown

SAND - fine to medium, light brown

SAND - well graded, about 25% Gravel, (to 1-1/2" in size),
greyish brown

Few Cobbles

About 15% Gravel

SAND - fine to medium, light brown

NOTE: Water not encountered. Caving from 13' to 24' (to 2-1/2' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 62

JOB ADEF-88044-7 DATE 12/14/88 F.T. FH DR. lp W.P. ip CHKD PM

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.
70	5		9.3	94	3	
			21.4	105	3	
65	10		17.6	111	6	
			7.5	107	8	
		6.4	104	6		
60	15					

BORING 67
DATE DRILLED: December 7, 1988
EQUIPMENT USED: 24" - Diameter Bucket
ELEVATION 73

	SM	3" Asphaltic Paving SILTY SAND - fine to medium, brown
	CL	SILTY CLAY - brown
	CL	SANDY CLAY - brown
	SC	CLAYEY SAND - fine to medium, reddish brown
	SM	SILTY SAND - fine to medium, reddish brown

NOTE: Water not encountered. No caving.

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.
70		20.9	102	3	
	5	19.3	109	5	
65		16.9	112	8	
		9.3	115	8	
60	10	5.1	104	10	
	15				

DATE DRILLED: December 7, 1988
EQUIPMENT USED: 24" - Diameter Bucket

ELEVATION 71

4" Asphaltic Paving
FILL - SILTY SAND - fine, brown
SILTY CLAY - dark brown
Some Sand
CLAYEY SAND - fine to medium, reddish brown
SAND - fine, light brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 64

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.
65	5	22.1	102	5	
		22.3	105	5	
		23.1	104	3	
		28.3	96	5	
60	10	22.8	105	6	
55	15				

DATE DRILLED: December 7, 1988
EQUIPMENT USED: 24" - Diameter Bucket

ELEVATION 70



2" Asphaltic Paving - 2" Base Course
FILL - SILTY SAND - fine, some Clay, brown
SILTY CLAY - dark brown

Brown
Grey

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 65

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.
70		9.7	95	2	
	5	15.1	105	6	
65		9.1	112	5	
		4.2	103	5	
60	10	4.8	101	5	
	15				

BORING 70

DATE DRILLED: December 7, 1988
EQUIPMENT USED: 24" - Diameter Bucket

ELEVATION 71



FILL - SILTY SAND - some Clay, dark greyish brown

SILTY CLAY - brown

SILTY SAND - fine to medium, reddish brown

Fine

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 66

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.
65	5	20.2	106	5	
		19.5	109	6	
		19.2	107	6	
		22.3	102	8	
60	10	21.5	105	8	
55	15				

DATE DRILLED: December 7, 1988
EQUIPMENT USED: 24" - Diameter Bucket
ELEVATION 70

2" Asphaltic Paving - 6" Base Course
SILTY SAND - fine, dark brown
SILTY CLAY - dark grey

Dark brown and grey

NOTE: Water not encountered. No caving.

LOG OF BORING

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	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. I, March, 1953. (Revised April, 1960)

LEROY CRANDALL & ASSOCIATES

Appendix B
Laboratory Data

APPENDIX B

LABORATORY TESTING

B.1 GENERAL

The laboratory program included testing of undisturbed samples, as well as tests on bulk materials. The undisturbed samples were placed in plastic bags and stored in sealed cans until ready for use, and the bulk samples were stored in plastic bags.

The first phase of the testing program consisted of determining the classification of the soils. The primary classifications were made by making a visual inspection. Representative samples were then selected for more specific studies to determine pertinent shear strength and consolidation parameters, as well as other soil properties.

B.2 MOISTURE CONTENT

Moisture contents of the soil samples were determined by first weighing the material at natural moisture content, drying it in an oven at a temperature of about 230°F, weighing the completely oven-dried sample, and calculating the moisture content. Natural water contents were determined on the undisturbed samples shortly after the samples arrived at the laboratory. The results of the tests are shown to the left of the boring logs presented in Appendix A.

B.3 DRY DENSITY

Dry density was determined by carefully measuring a ring sample of the soil with a known volume, weighing the sample after it had been oven-dried, and calculating the unit weight. Results of the dry density determinations are presented to the left of the boring logs.

D

R

A

F

T



B.4 DIRECT SHEAR TESTS

Direct shear tests were performed on selected undisturbed samples. The tests were performed at field and increased moisture contents and at surcharge pressures equal to the existing overburden pressures. Selected samples were tested at an increased surcharge pressure to provide more complete data. Remolded samples, compacted to 90% at optimum moisture content, were prepared for direct shear tests; these samples were tested at optimum and increased moisture contents and at different surcharge pressures. All of the samples were tested at a constant strain of 0.05 inches per minute. The yield-point values determined from the direct shear tests are presented on Plates B-1.1 through B-1.6, Direct Shear Test Data.

B.5 CONSOLIDATION TESTS

Undisturbed samples were tested in consolidometers to determine the consolidation characteristics of the soils. Vertical loads were instantaneously applied in increments, and the rate of vertical consolidation was measured for each increment. Each load was allowed to consolidate the sample for at least 12 hours before a new increment was added. Water was added to selected samples during the tests to illustrate the effect of moisture on the compressibility; the other samples were tested at field moisture content. Three remolded samples (compacted to 90% at optimum moisture content) were also tested. The results of the consolidation tests are presented on Plates B-2.1 through B-2.48, Consolidation Test Data.

B.6 COMPACTION AND C.B.R. TESTS

The optimum moisture content and maximum dry density of the soils were determined by performing compaction tests on 10 samples. The tests were performed in accordance with the ASTM Designation D1557-78 method of compaction. This method of compaction utilizes a 1/30 cubic-foot mold, in which each of five layers of soil is compacted by 25 blows of a 10-pound hammer falling 18 inches.

After completion of the compaction tests, California Bearing Ratio tests were performed on eight of the samples in accordance with the ASTM Designation D1883-73 method. The results of the compaction and California Bearing Ratio tests are presented on Plates B-3.1 through B-3.4, Compaction and C.B.R. Test Data.



D

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B.7 EXPANSION INDEX TEST DATA

The Expansion Index of the soils was determined by testing five samples in accordance with the Uniform Building Code Standard No. 29-2 method. The results of the tests are shown on Plates B-4.1 through B-4.2, Expansion Index Test Data.

B.8 MECHANICAL ANALYSES

To determine the particle size distribution of the soils and to aid in classifying the soils, mechanical analyses were performed on seventeen samples. The results of the mechanical analyses are presented on Plates B-5.1 through B-5.5, Particle Size Distribution.

D

R

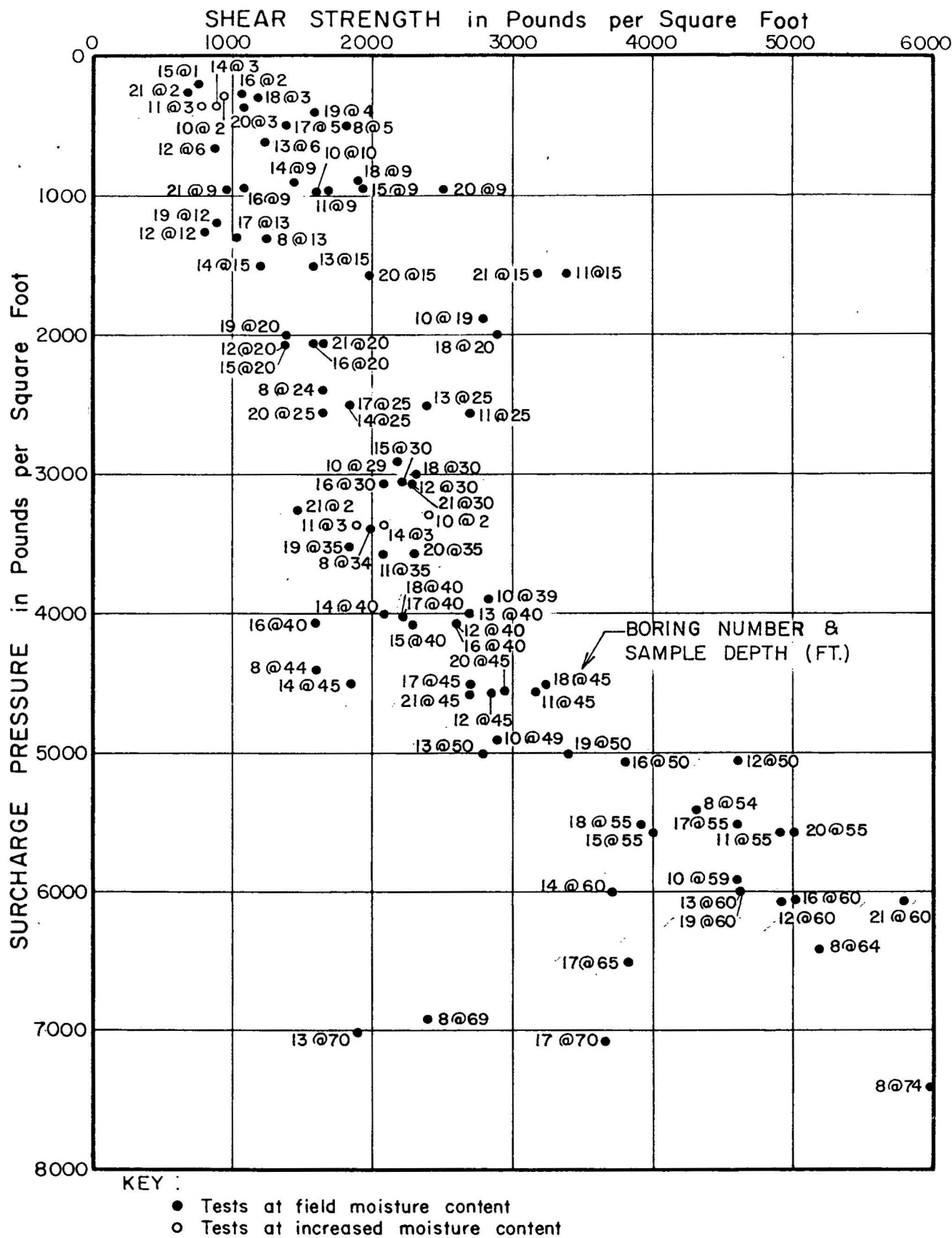
A

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T

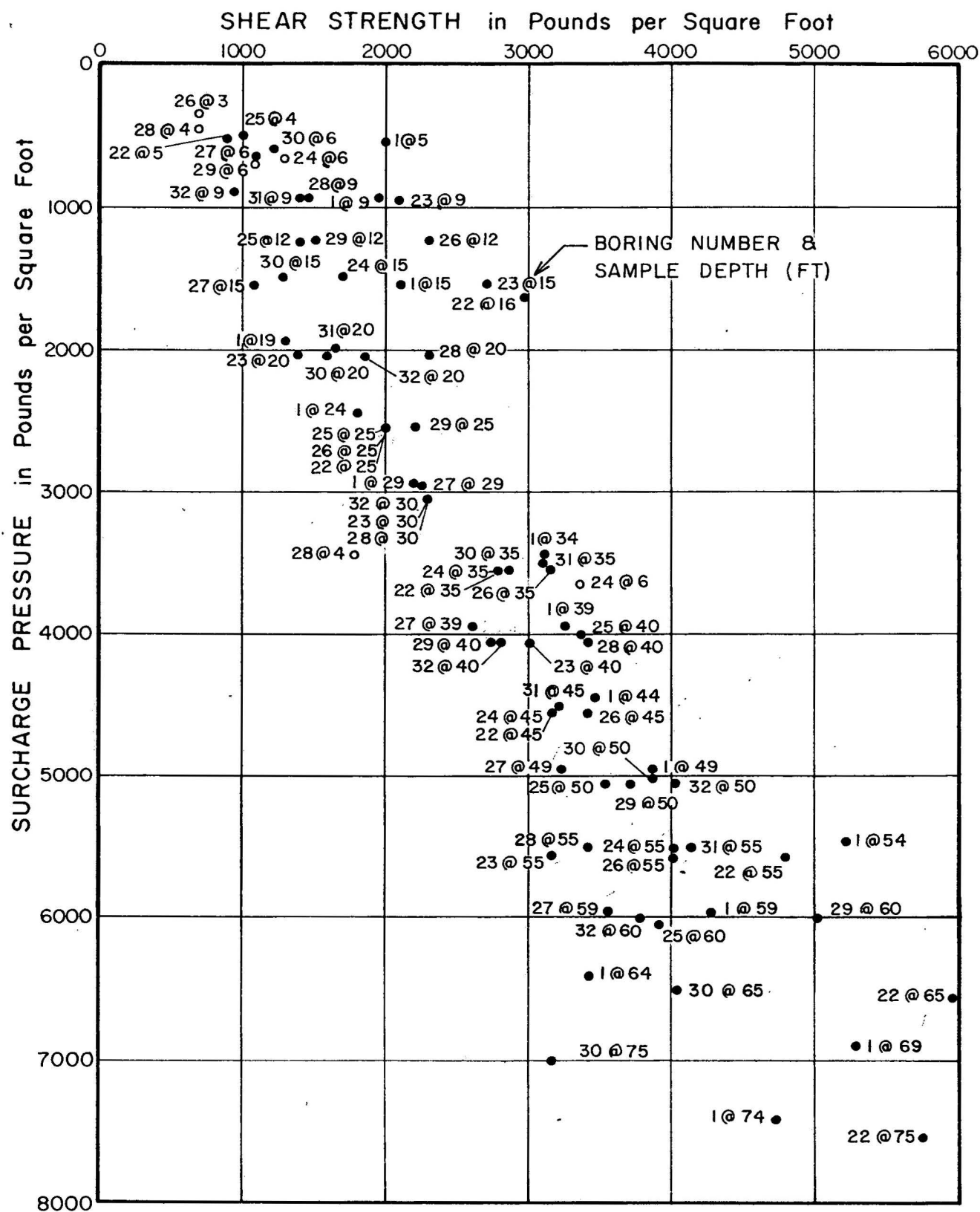


JOB ADEF-88044.7 DATE 1-17-88 DR. J. L. L. O.E. 54 CHKD. P. 44

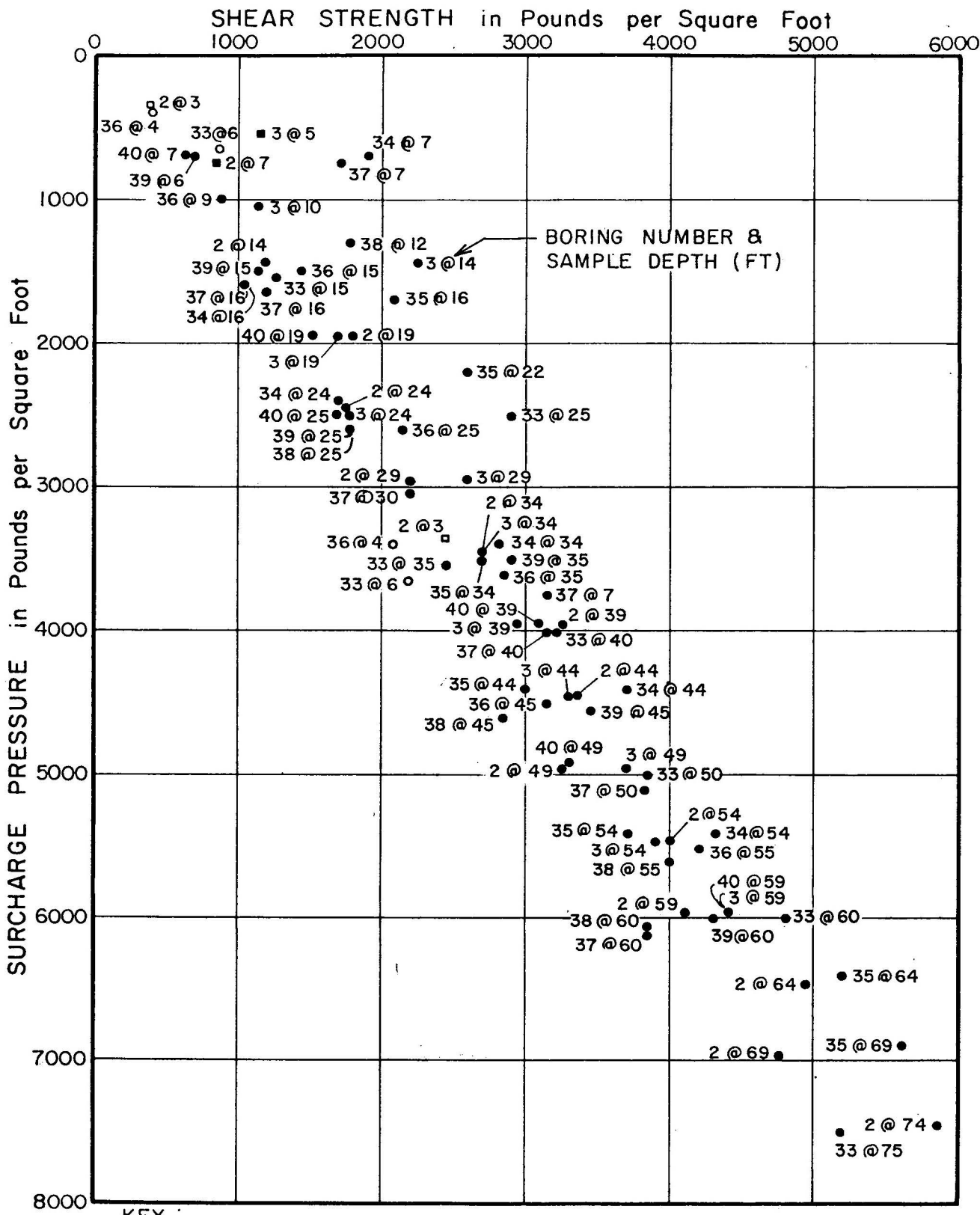


DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES



JOB ADEE-88044-7 DATE 1-4-89 DR. JULIANO O.E. DM. CHKD. *[Signature]*

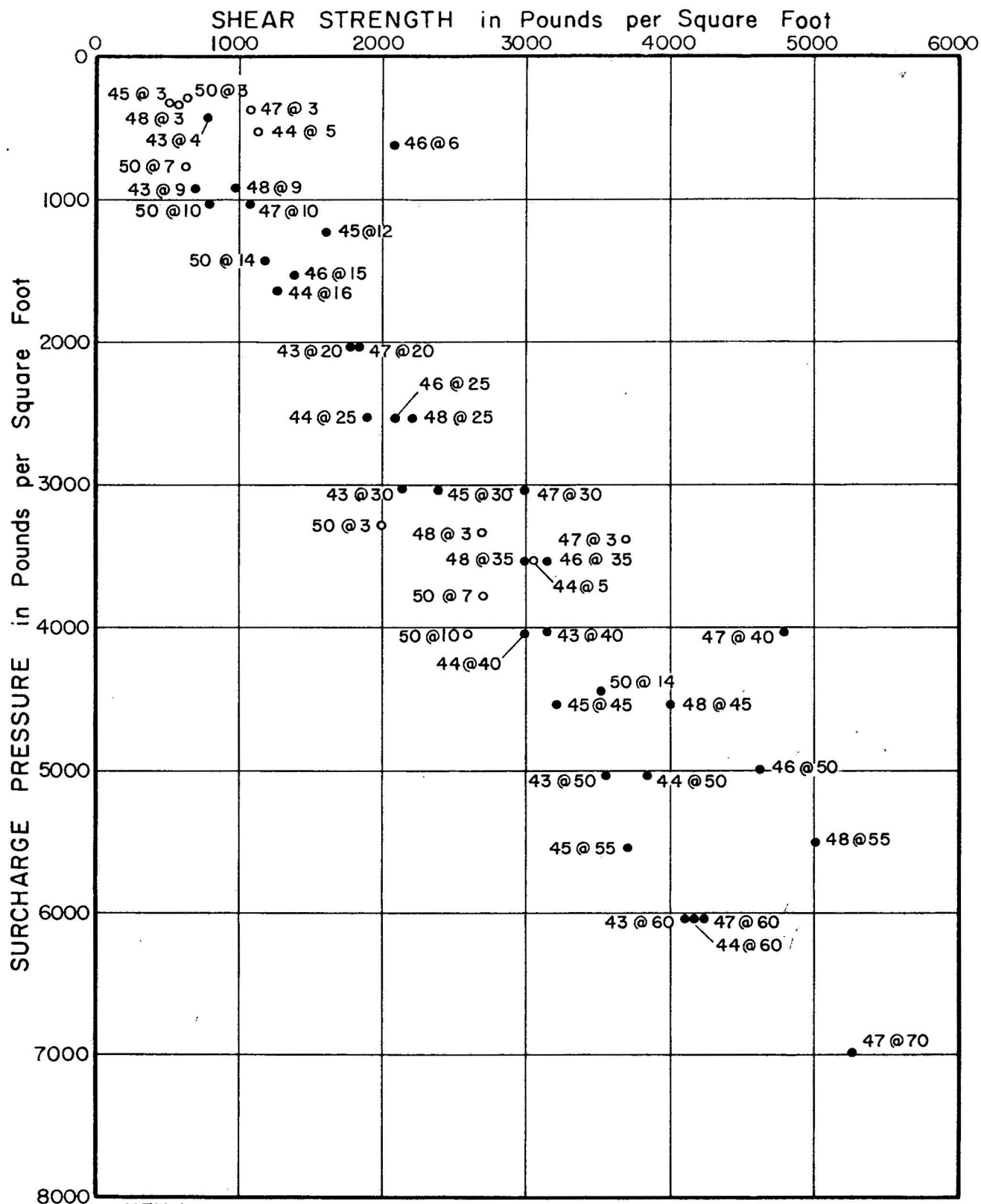


KEY :
● Tests at field moisture content
○ Tests at increased moisture content
— Natural soils
— Fill soils

DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES

CHKD. S/C
O.E. DM
DR. Juliana
1-6-88
DATE 1-6-88
JOB ADEF-88044-7

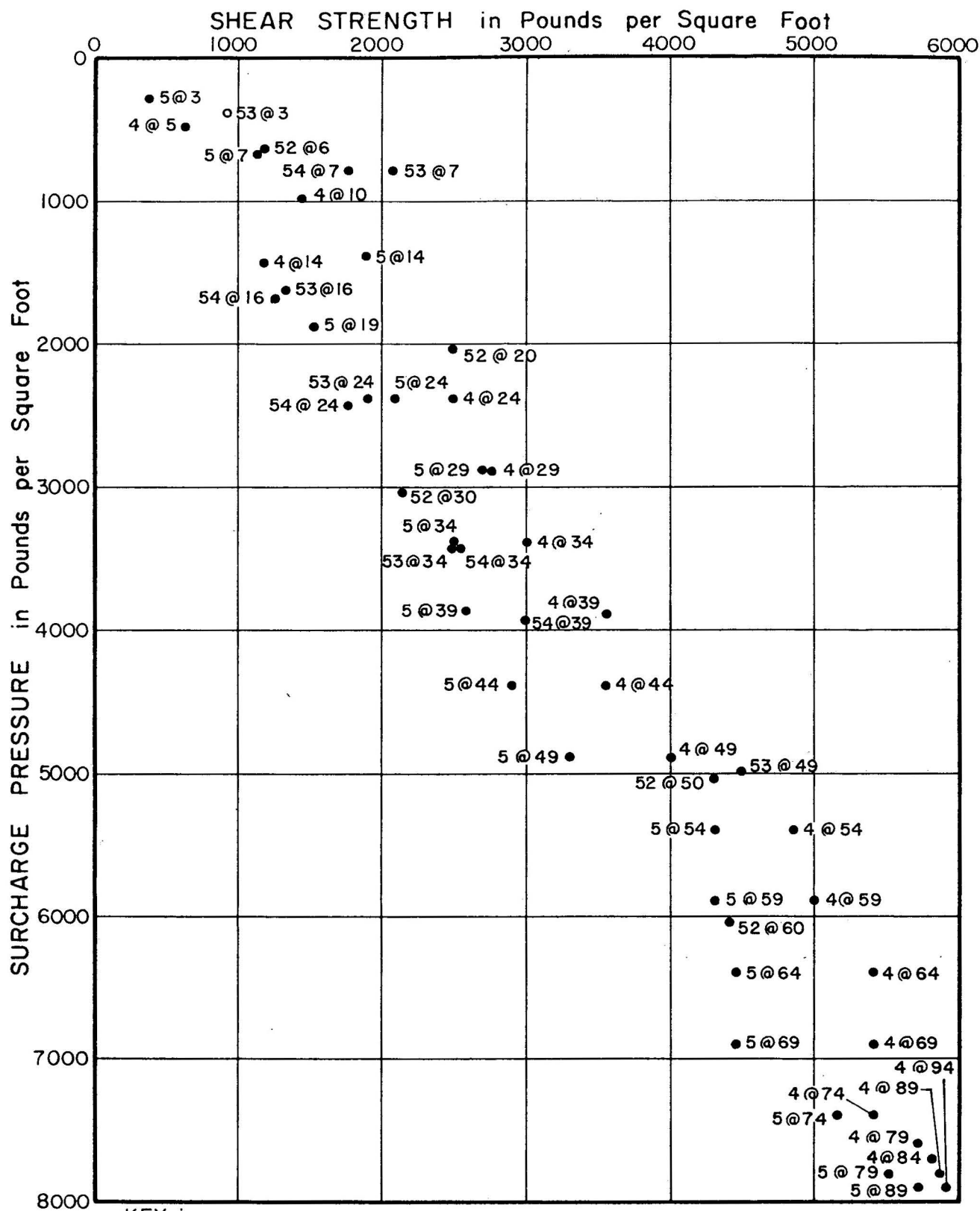


KEY :
● Tests at field moisture content
○ Tests at increased moisture content

DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES

JOB ADEF-88044-7 DATE 1-6-88 DR. Juliana O.E. PM
 CHKD. SK



DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES

SHEAR STRENGTH in Pounds per Square Foot

SURCHARGE PRESSURE in Pounds per Square Foot

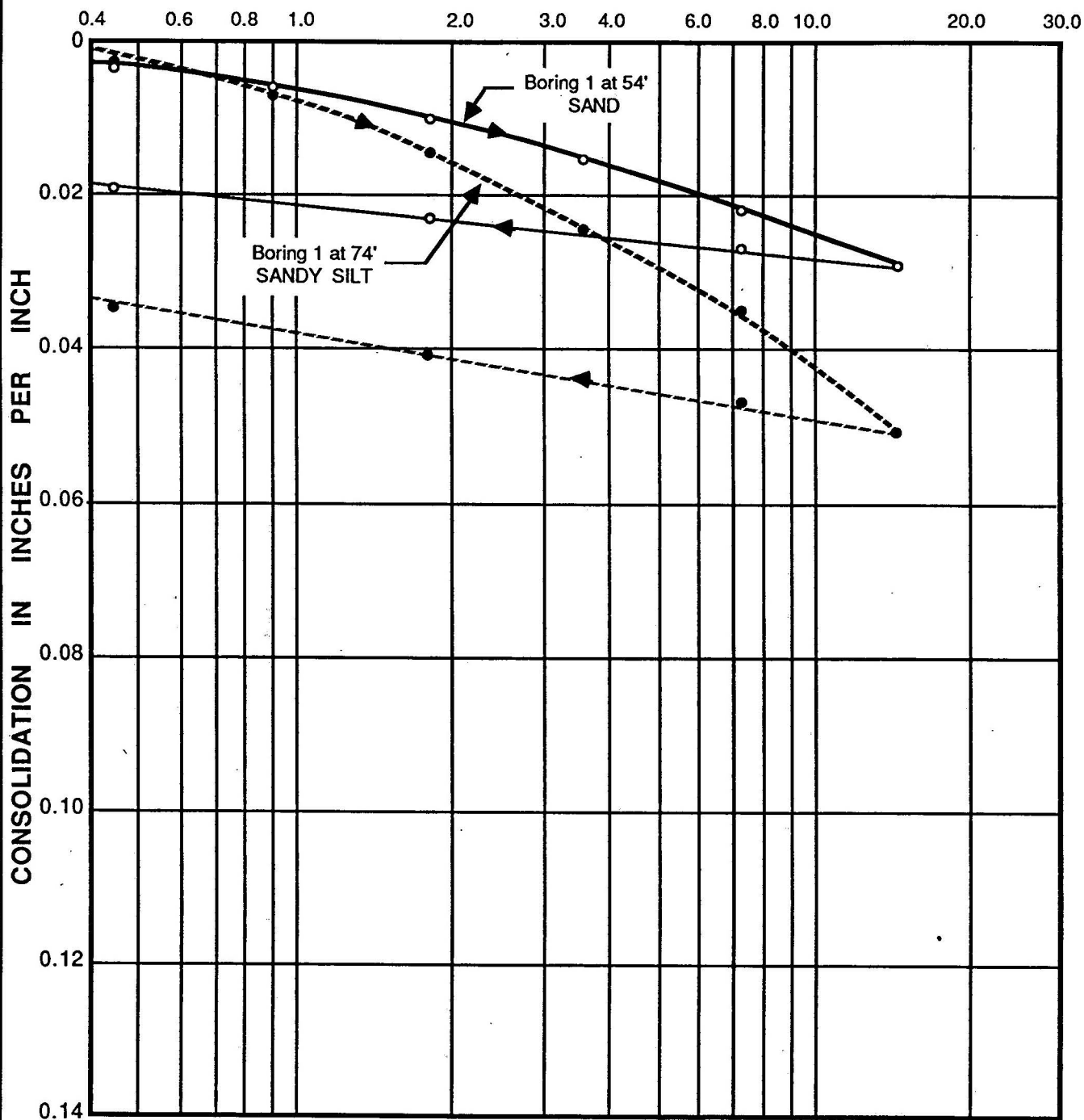
0 1000 2000 3000 4000 5000 6000

0 1000 2000 3000 4000 5000 6000 7000 8000

60@1, 57@2, 55@2, 68@1-3, 62@3, 64@3, 6@5, 56@3, 57@0-3, 57@4, 69@5, 66@6, 6@7, 63@4-6, 68@1-3, 70@3, 6@3, 57@6, 63@10, 68@1-3, 57@2, 6@1, 69@5, 64@3, 68@1-3, 62@3, 63@4-6, 66@6, 57@4, 57@6, 6@7, 56@7, 63@10, 63@4-6

JOB ADEF-88044-7 DATE 1/10/89 DR. _____ lp _____ W.P. _____ lp _____ O.E. SK _____ CHKD _____ DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

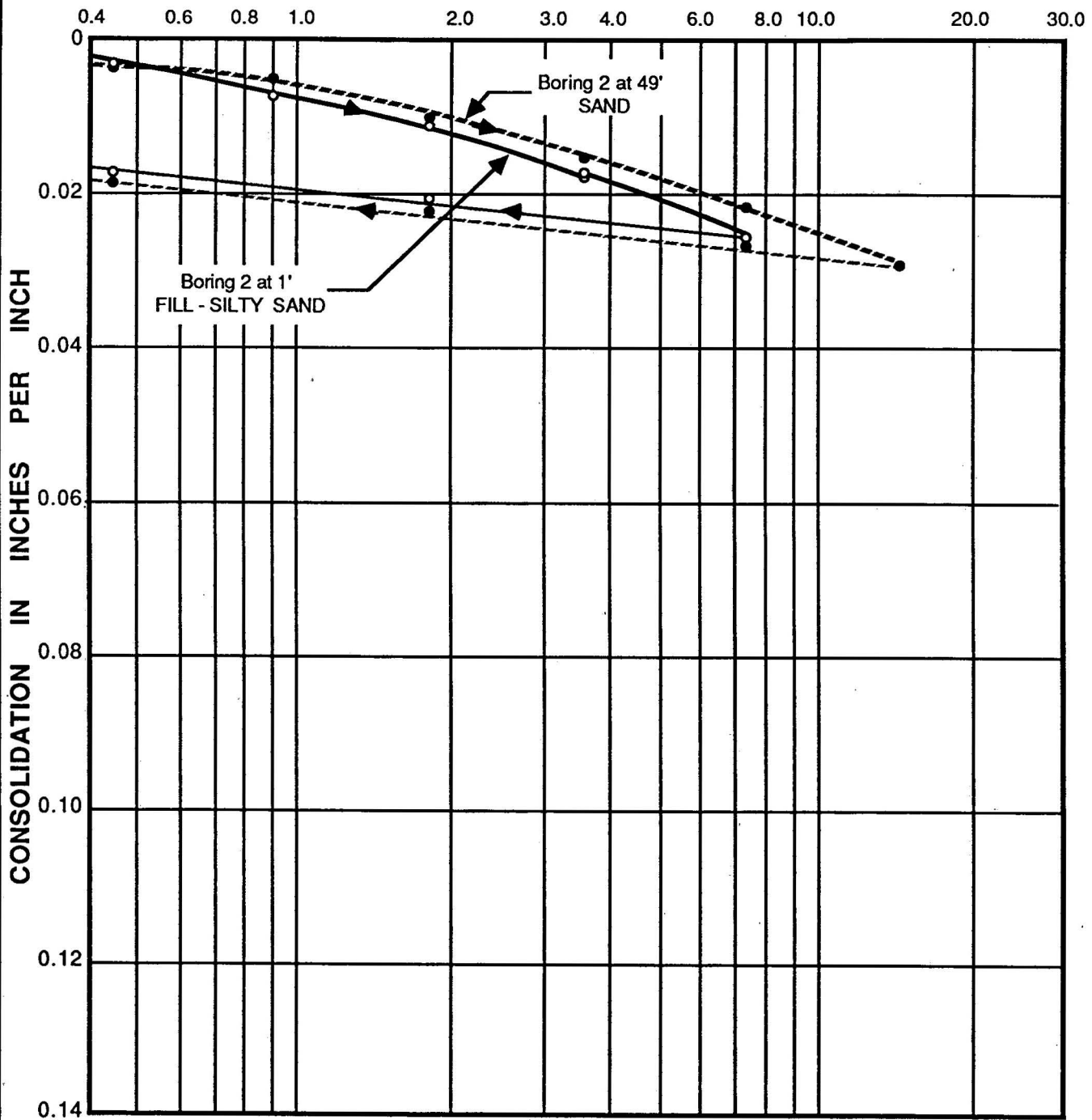
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.1

JOB ADEF-88044-7 DATE 1/10/89 DR. Jp W.P. Jp O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT

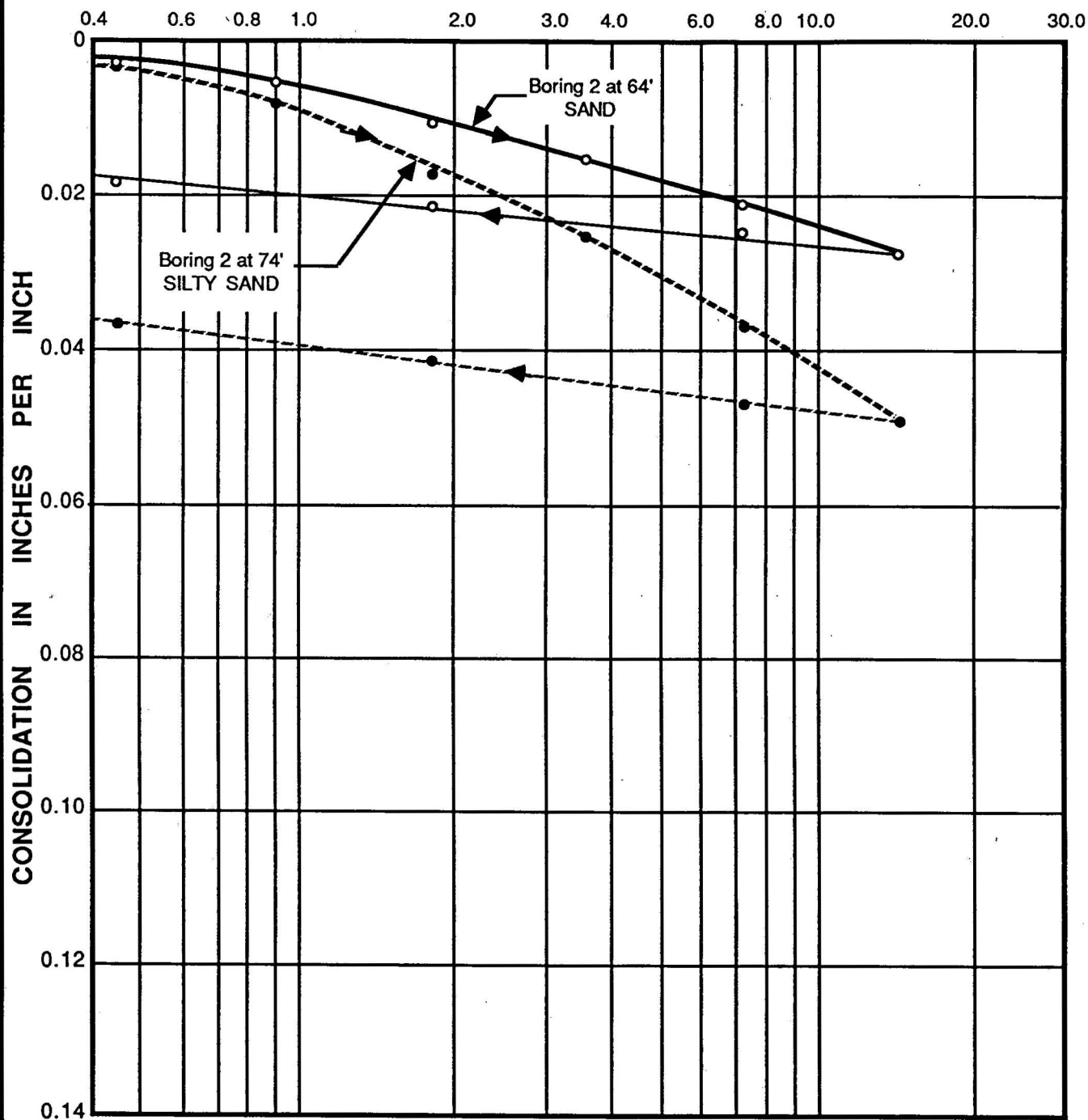


NOTE: Water added to sample from 1' after consolidation under a load of 3.6 kips per square foot.
The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

JOB ADEF-88044-7 DATE 1/10/89 DR. lp W.P. lp O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

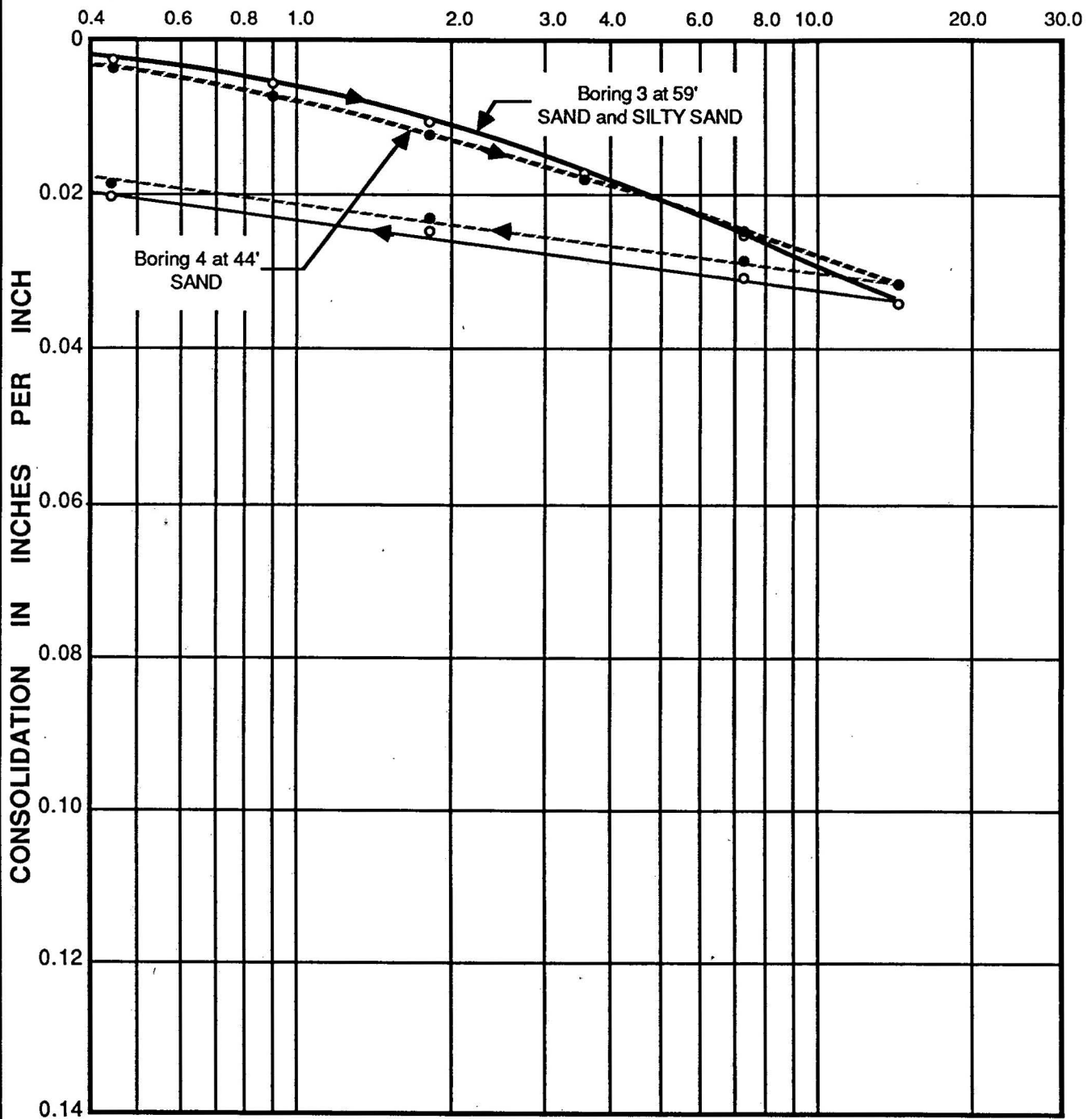
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.3

JOB ADEF-88044-7 DATE 1/10/89 DR. lp W.P. lp O.E. SK CHKD DAM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

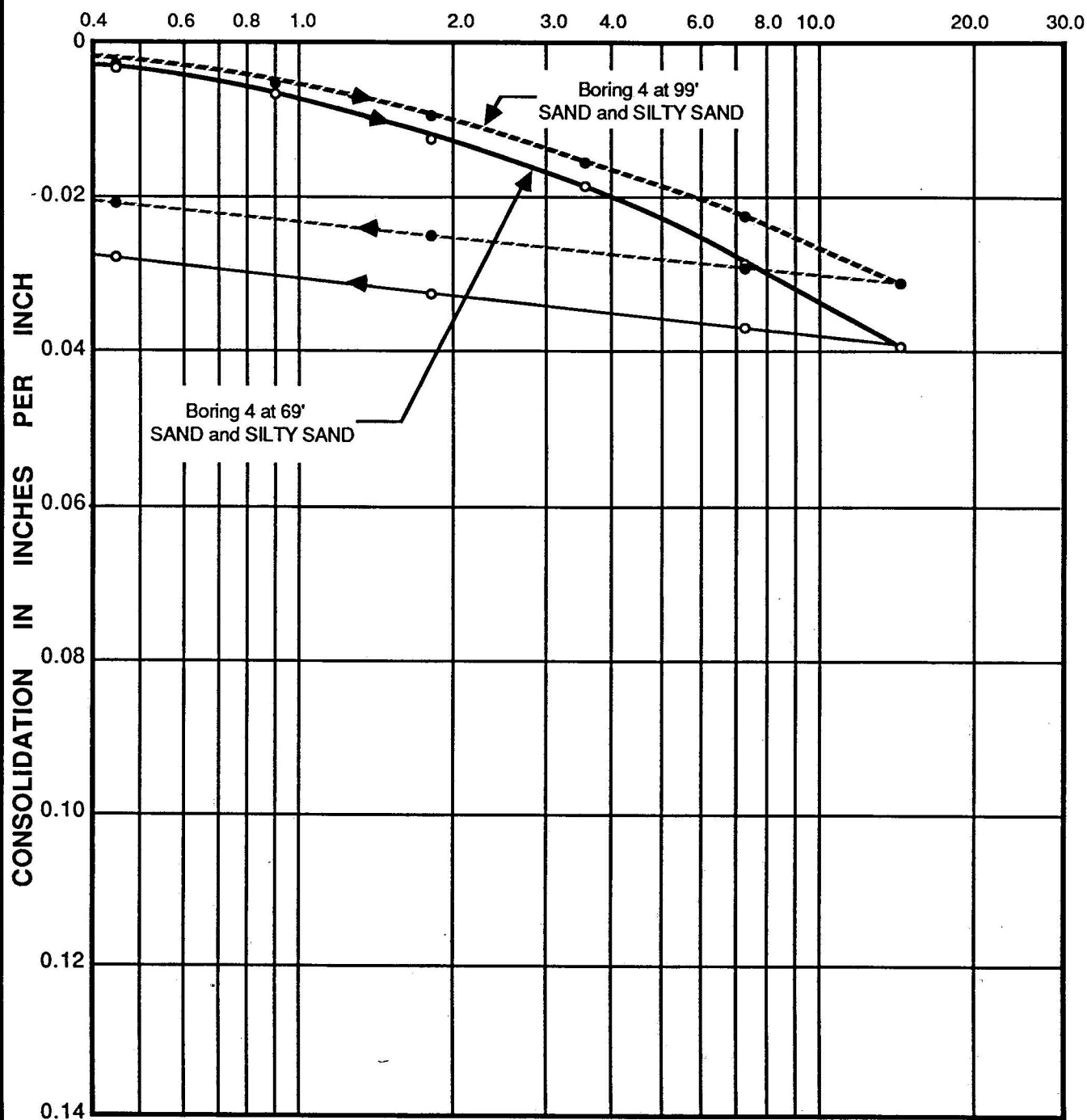
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.4

JOB ADEF-88044-7 DATE 1/10/89 DR. lp W.P. lp O.E. SK CHKD AKH

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

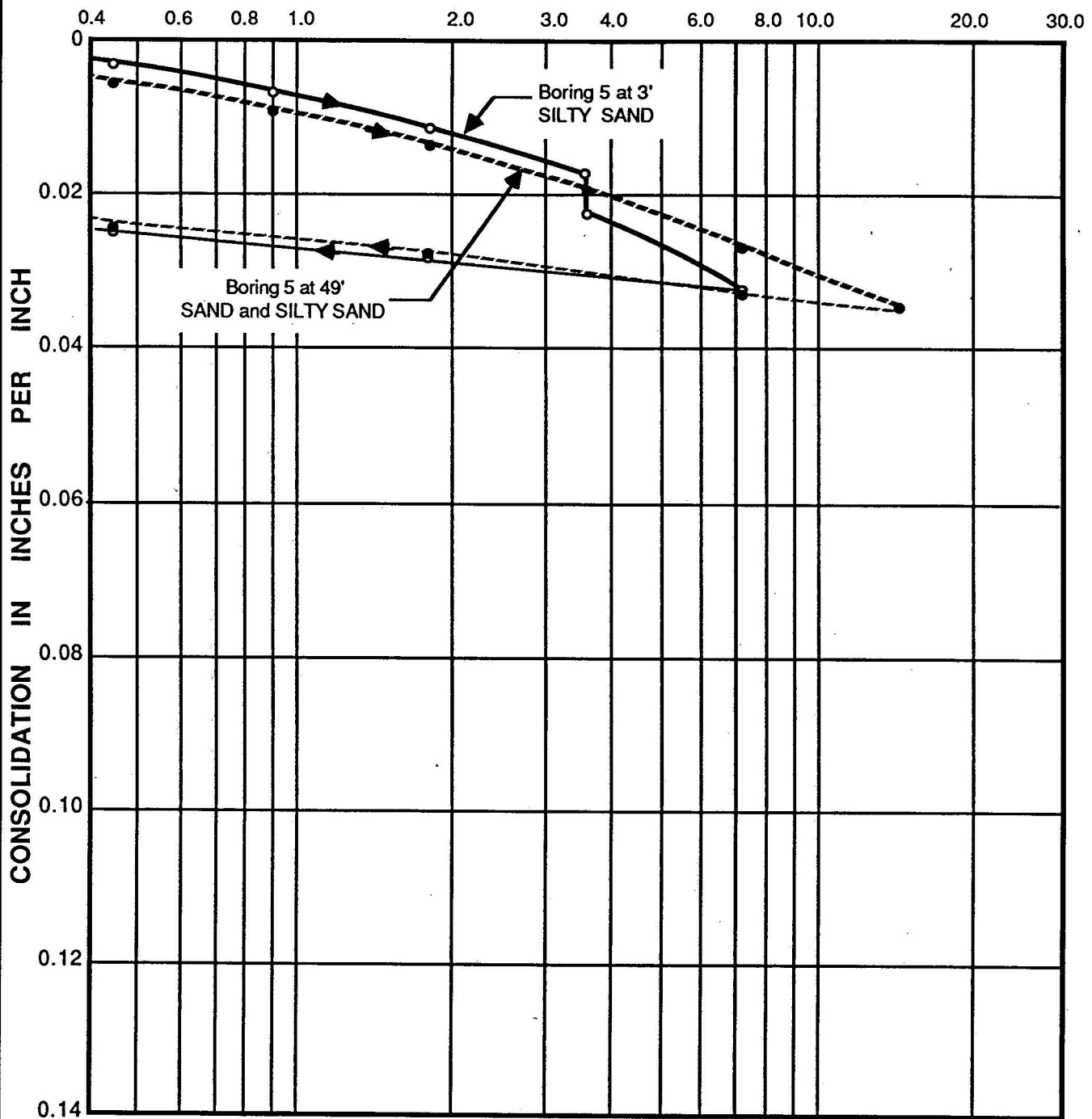
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.5

JOB ADEF-88044-7 DATE 1/10/89 DR. lp W.P. lp O.E. SK CHKD AKH

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample at 3' after consolidation under a load of 3.6 kips per square foot.
The other sample tested at field moisture content.

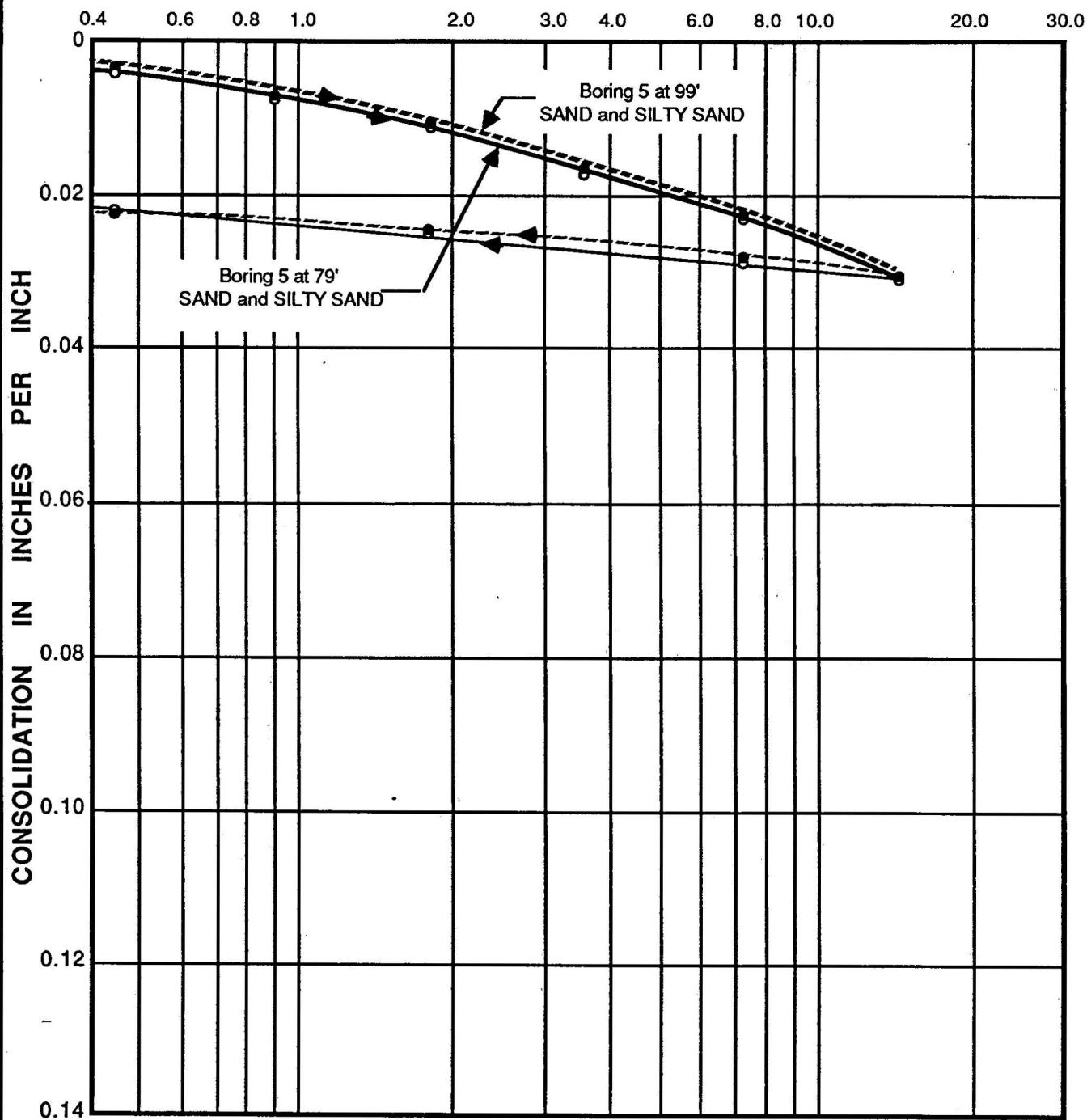
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.6

JOB ADEF-88044-7 DATE 1/10/89 DR. lp W.P. lp O.E. SK CHKD DMM

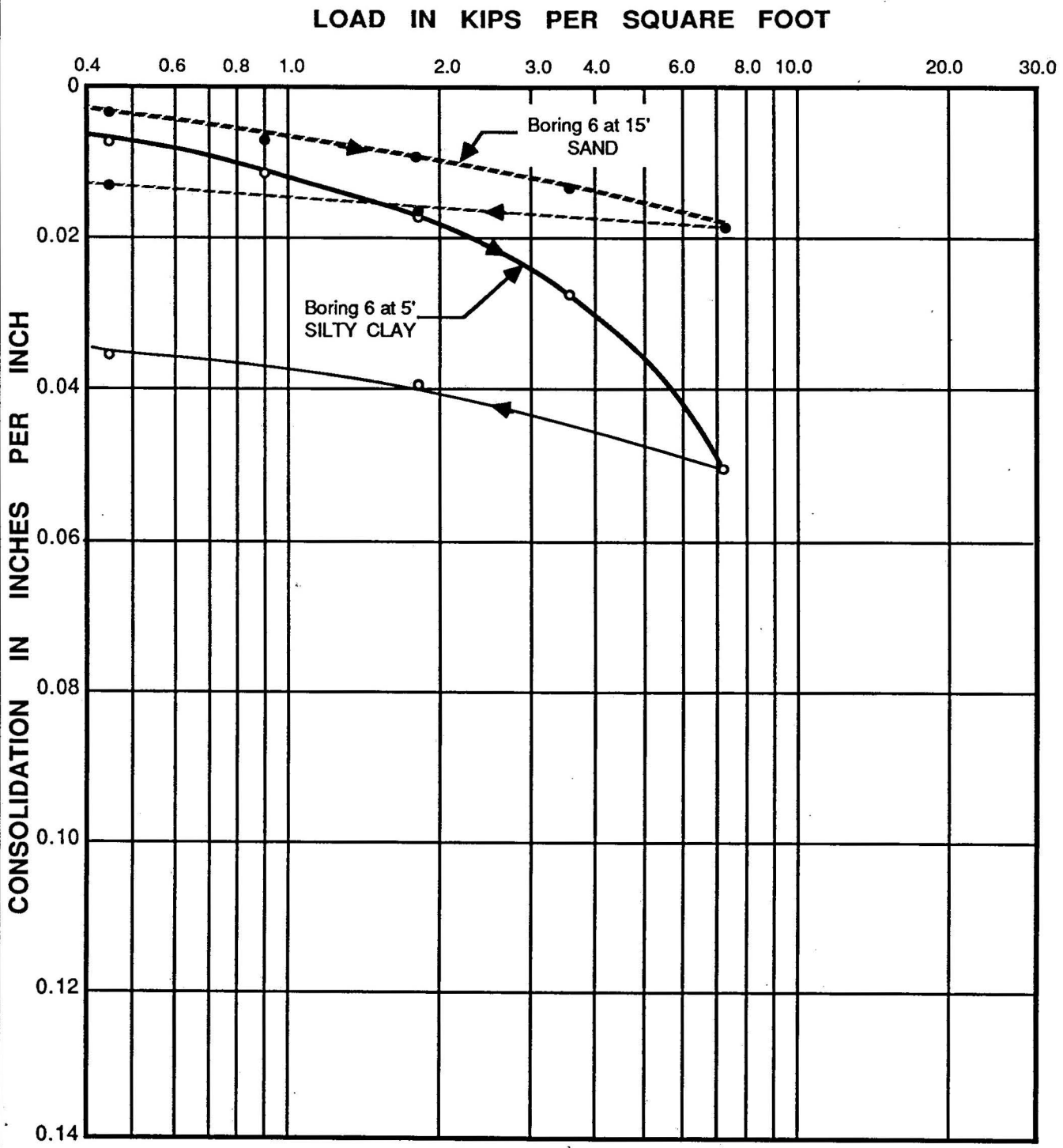
LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

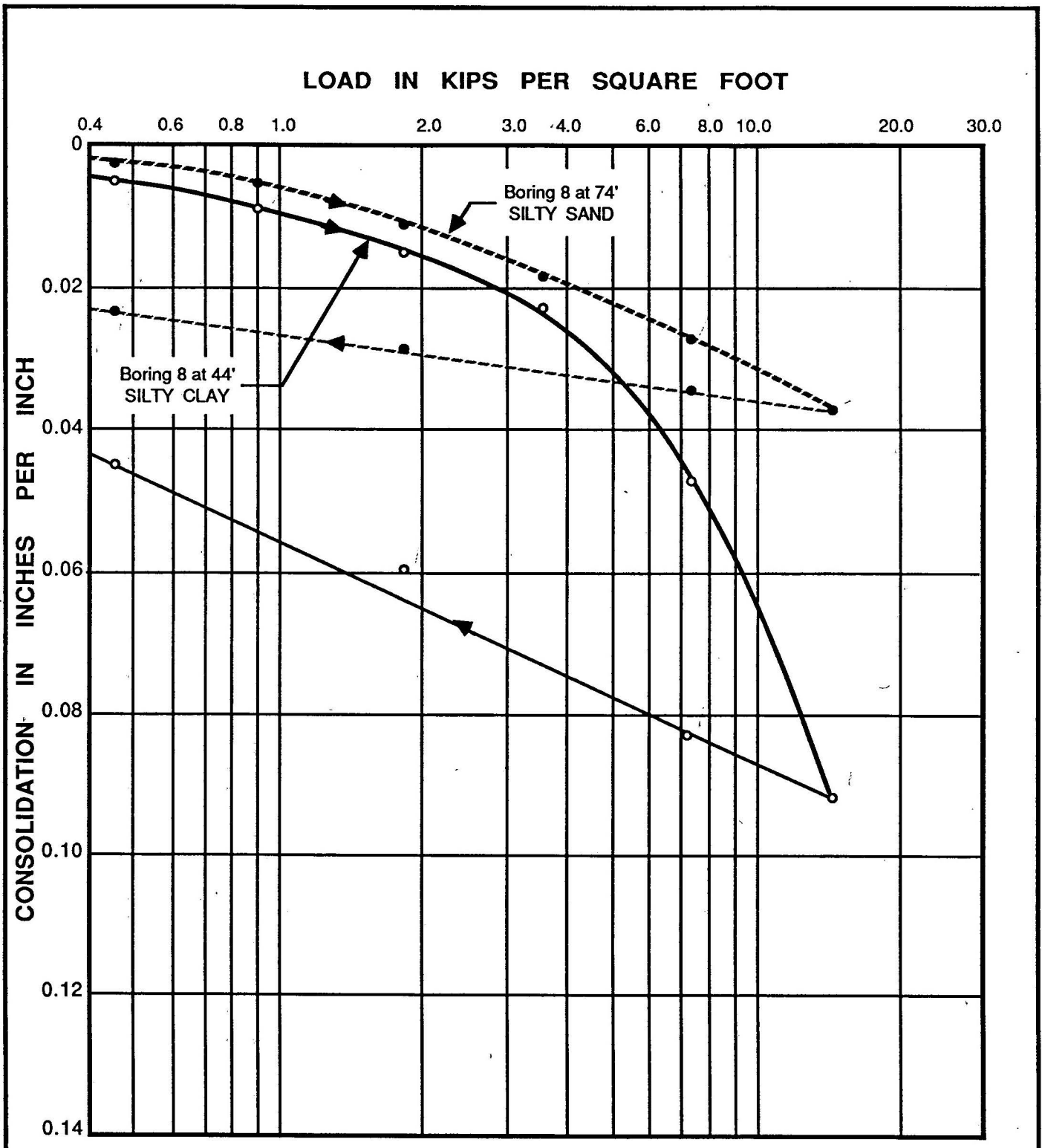
JOB ADEF-88044-7 DATE 1/10/89 DR. Ip W.P. Ip O.E. SK CHKD D/M



NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

JOB ADEF-88044-7 DATE 1/10/89 DR. Ip W.P. Ip O.E. SK $\frac{sk}{Ip}$ CHKD DM

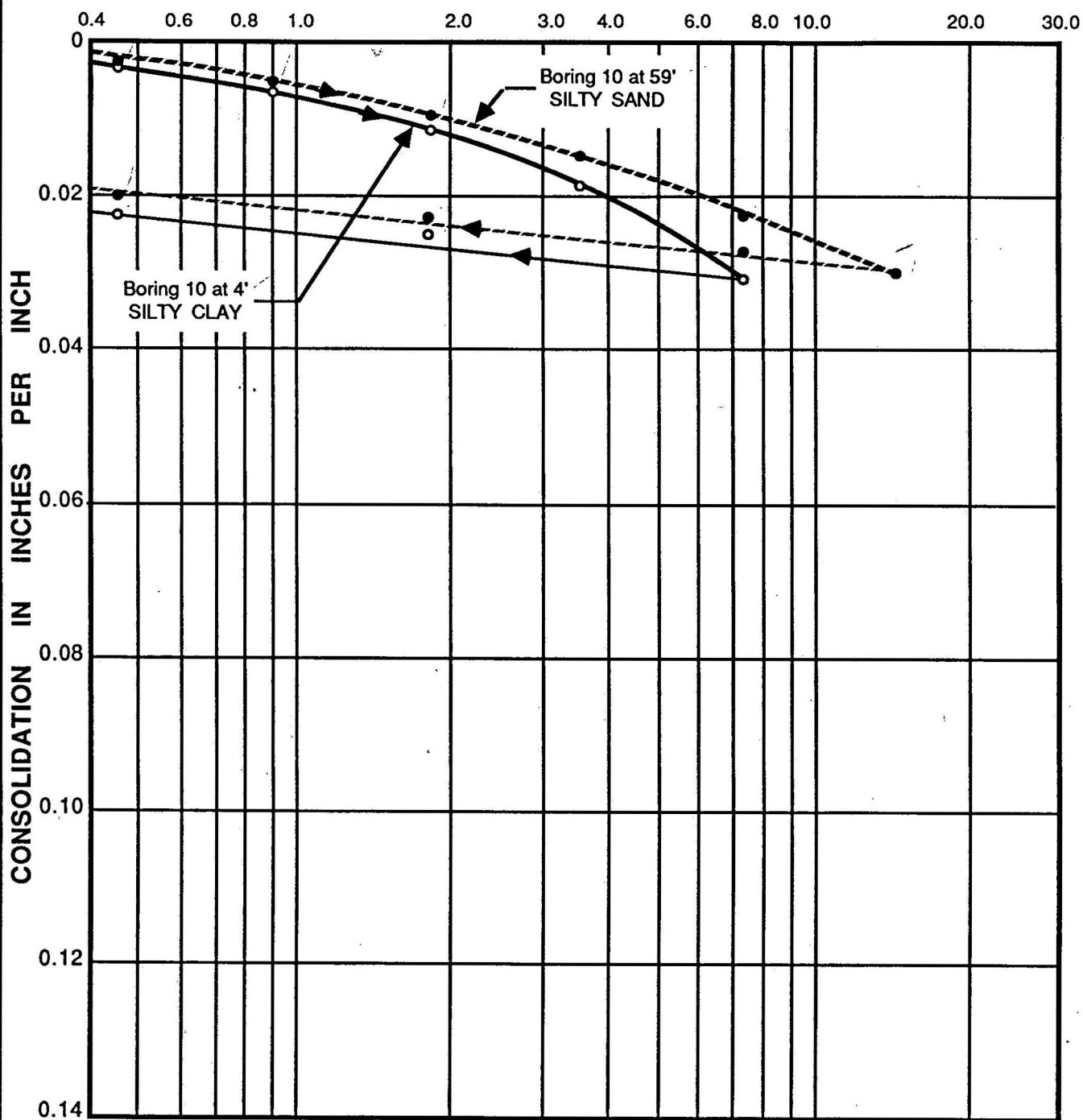


NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

JOB ADEF-88044-7 DATE 1/10/89 DR. lp W.P. lp O.E. SK SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

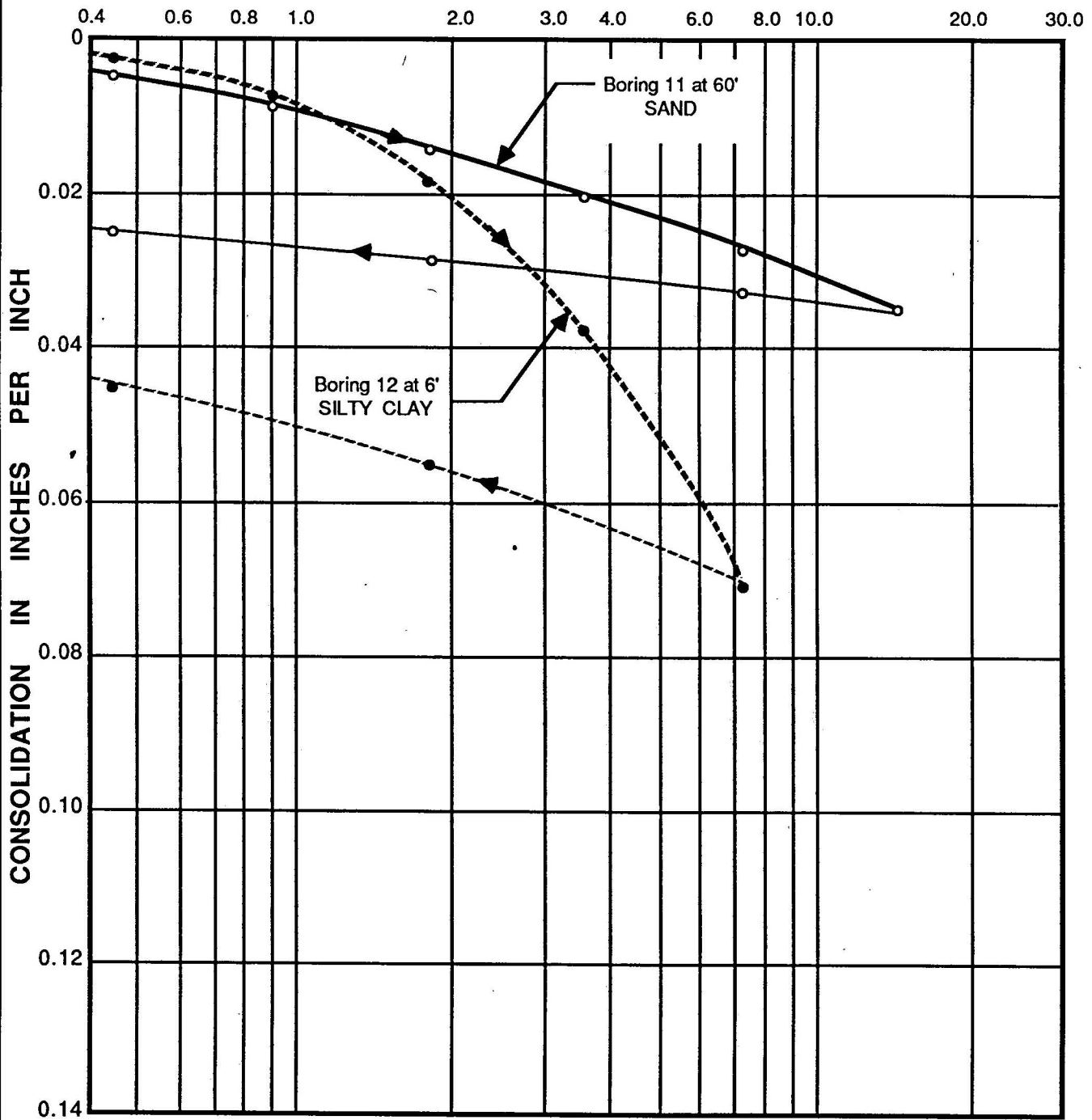
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B-2.10

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD AKH

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

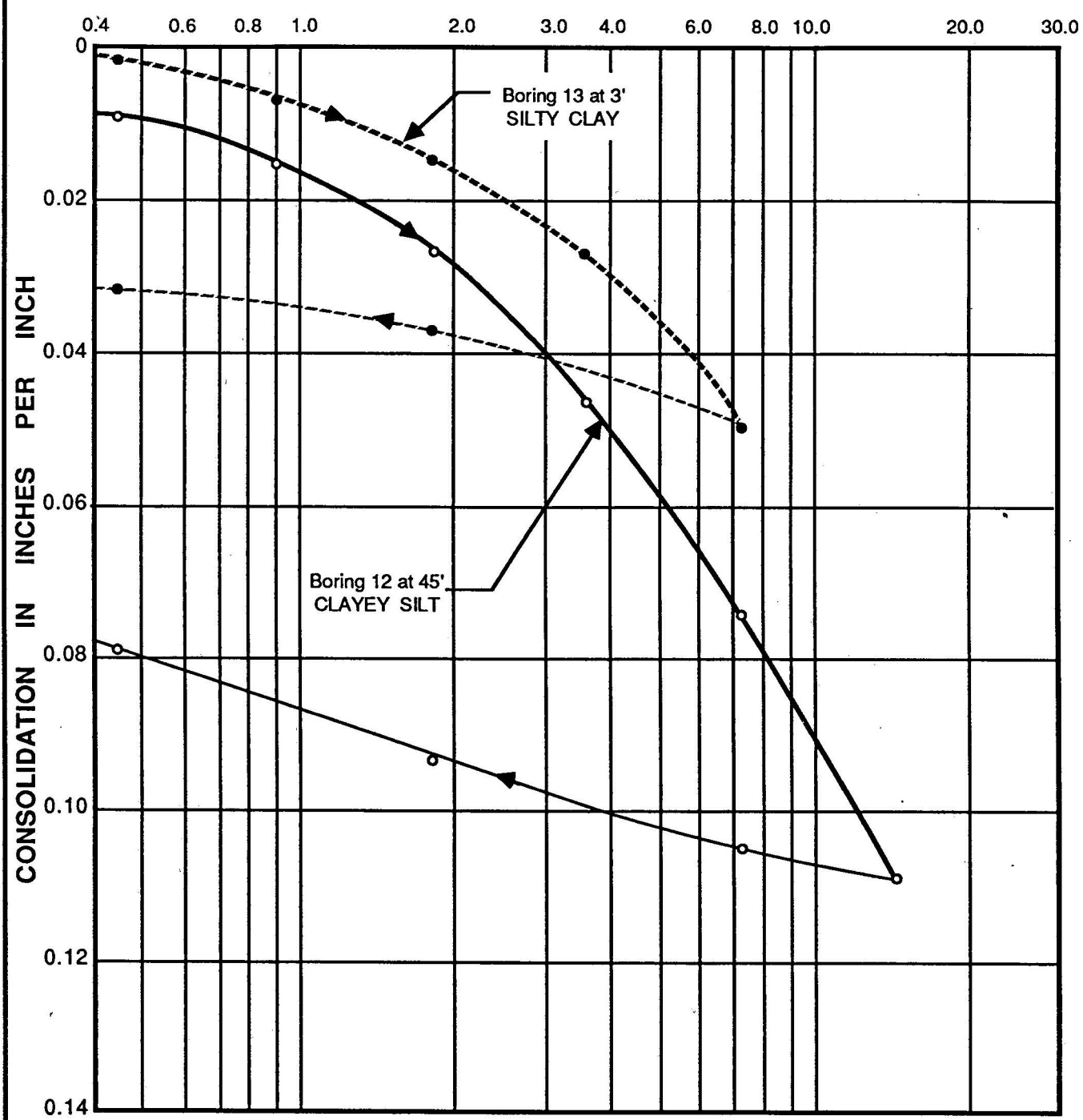
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.11

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD AKH

LOAD IN KIPS PER SQUARE FOOT

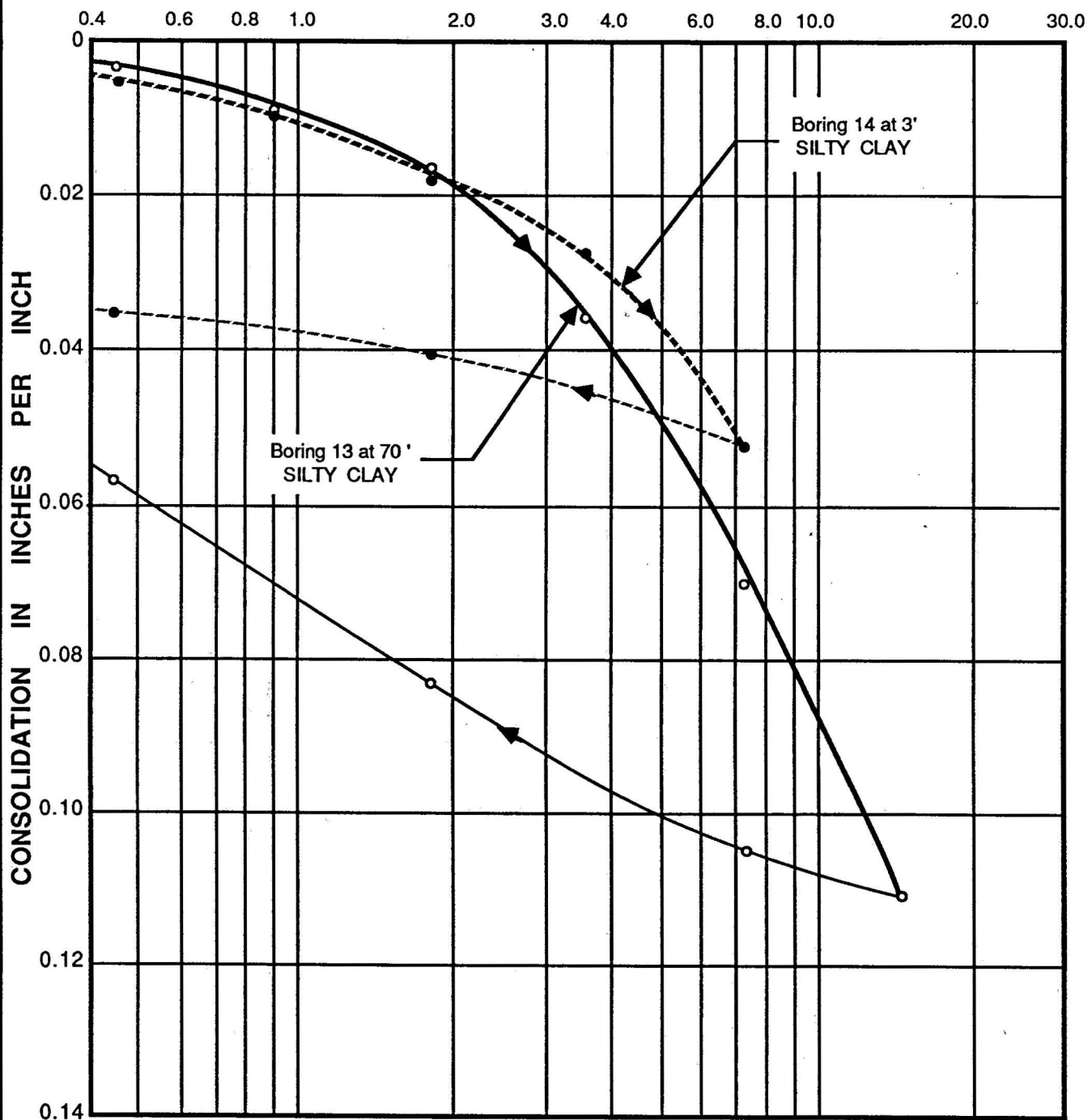


NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

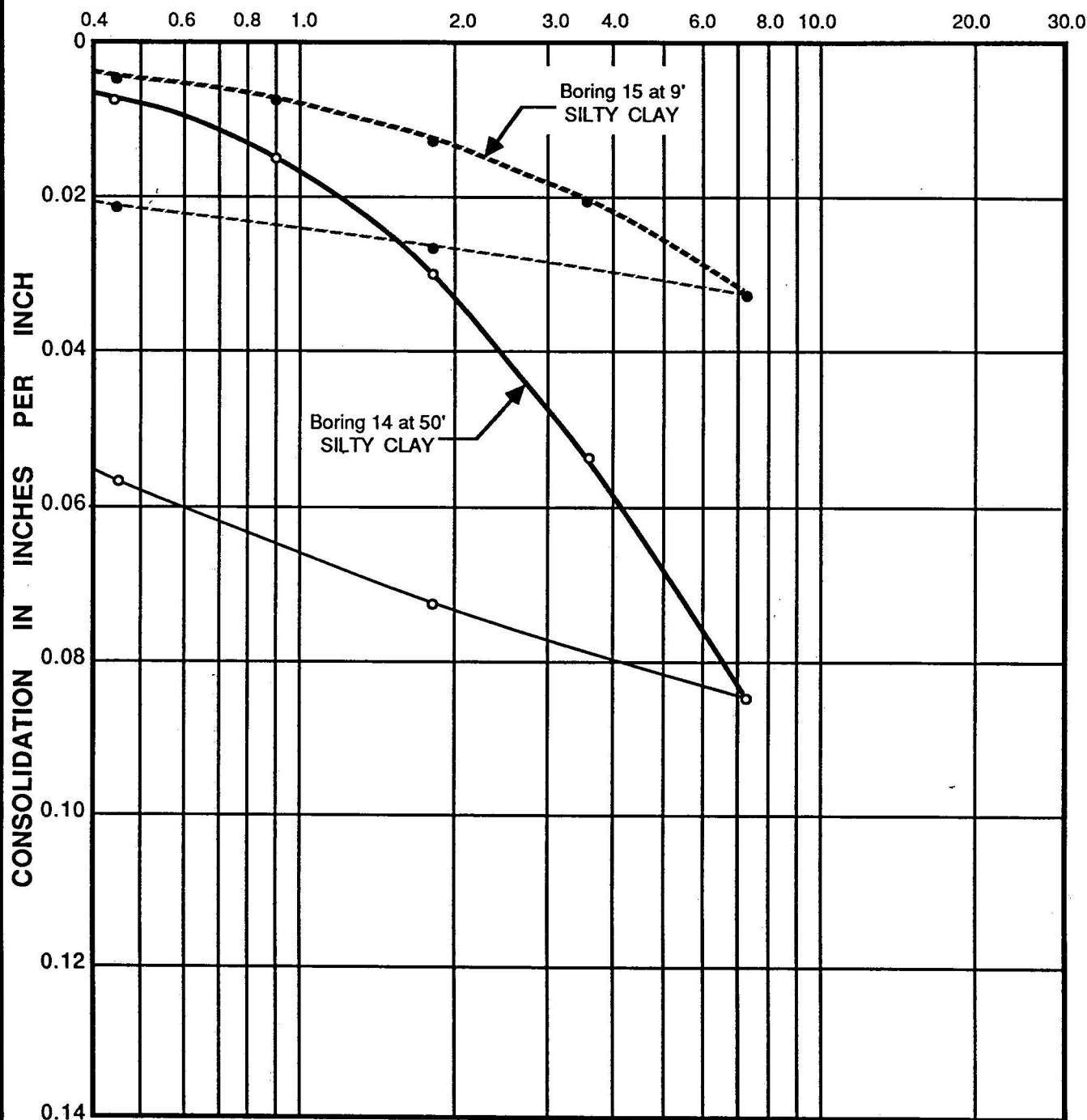
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.13

JOB ADEF-88044-7 DATE 1/11/89 DR. Ip W.P. Ip O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

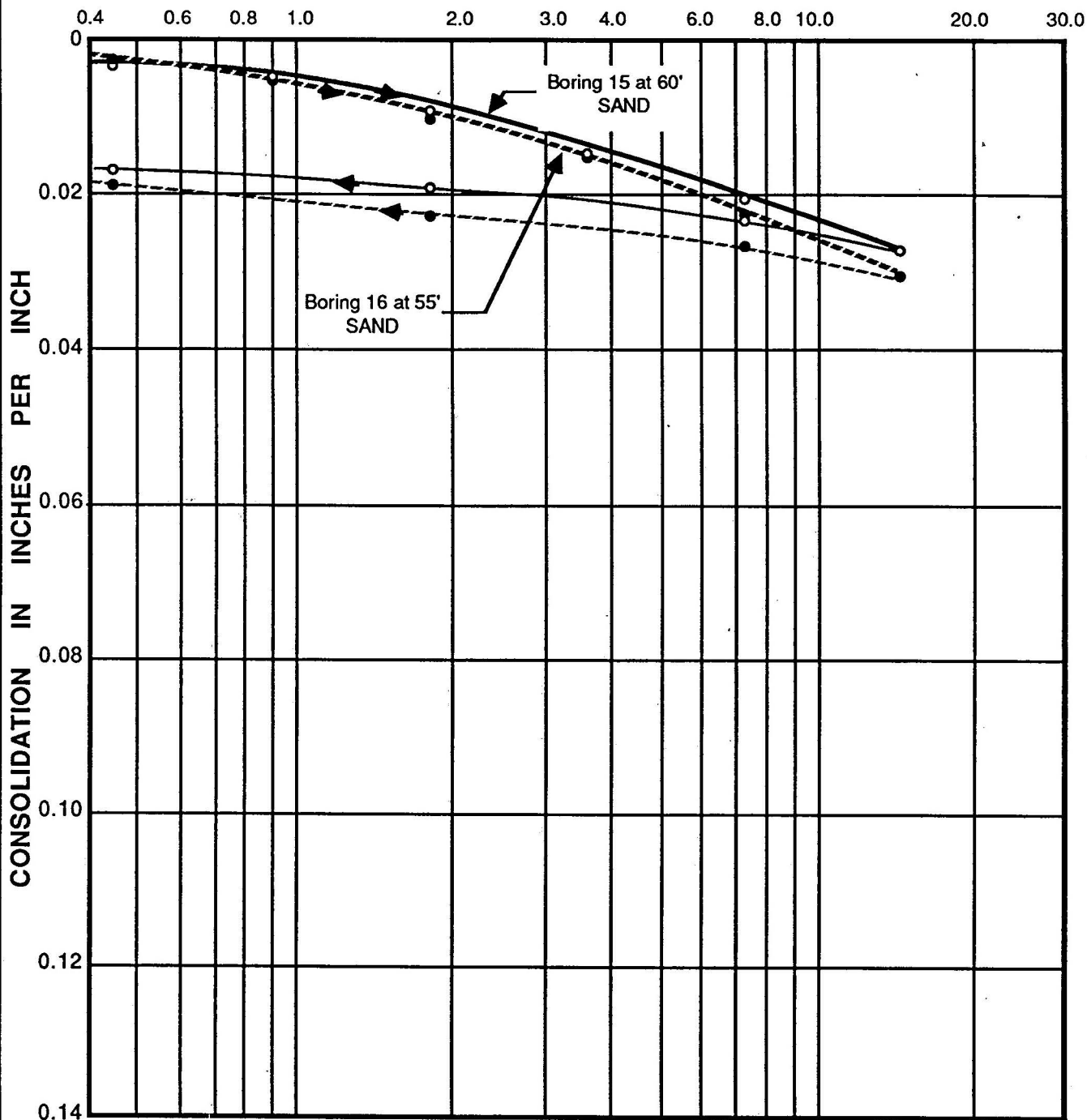
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.14

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



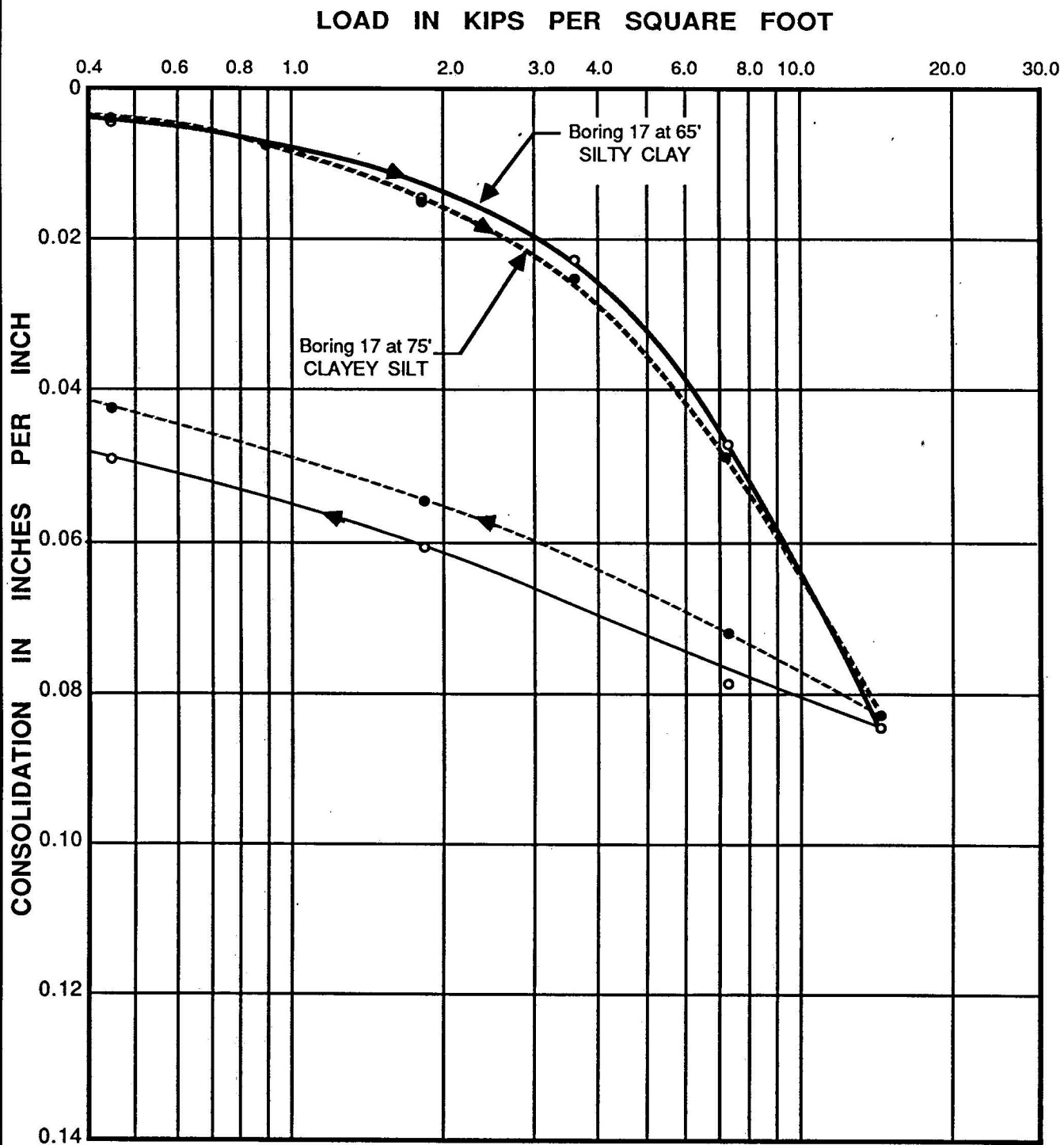
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.15

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD AKH



NOTE: Samples tested at field moisture content.

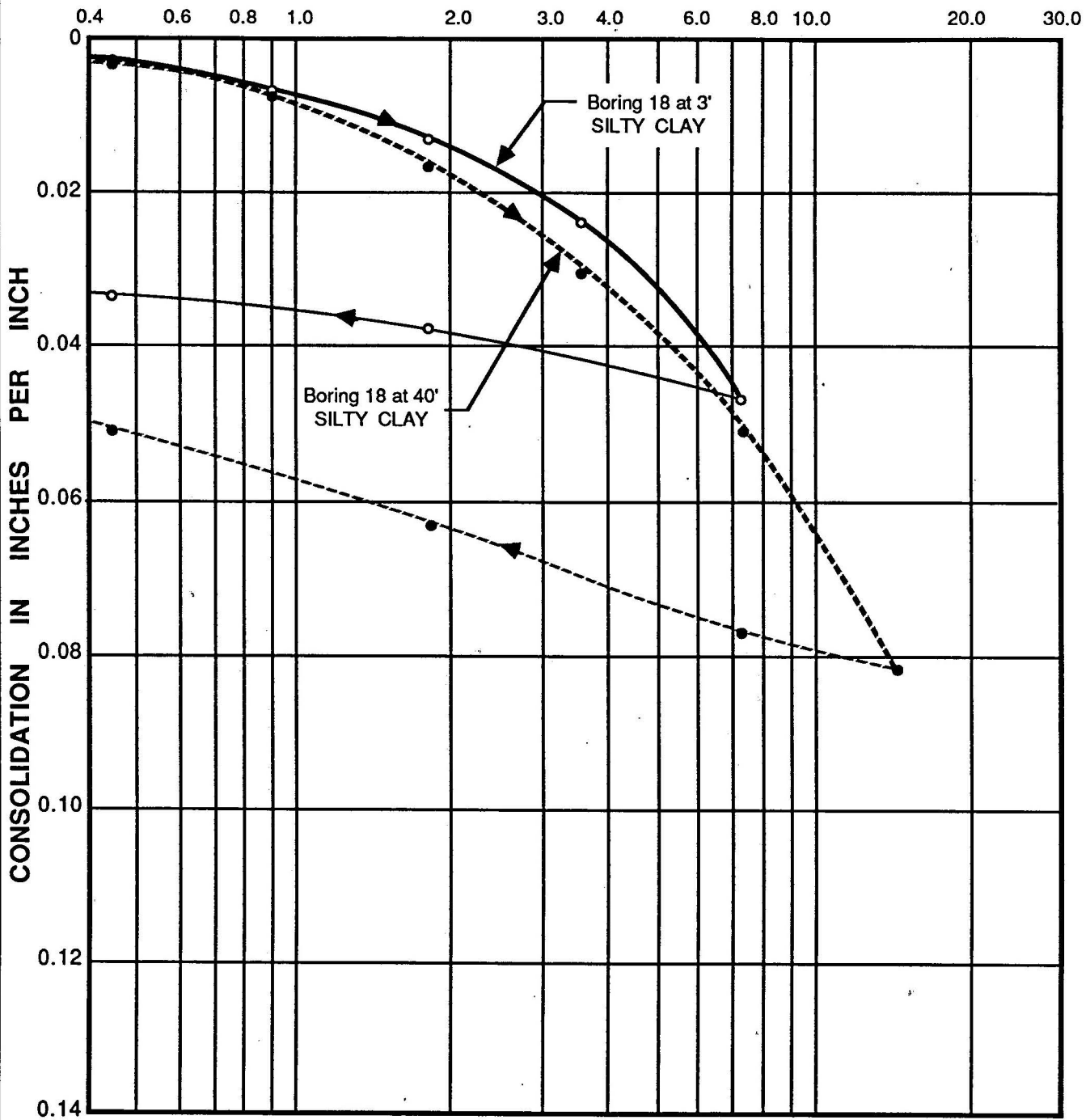
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.16

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD AKH

LOAD IN KIPS PER SQUARE FOOT



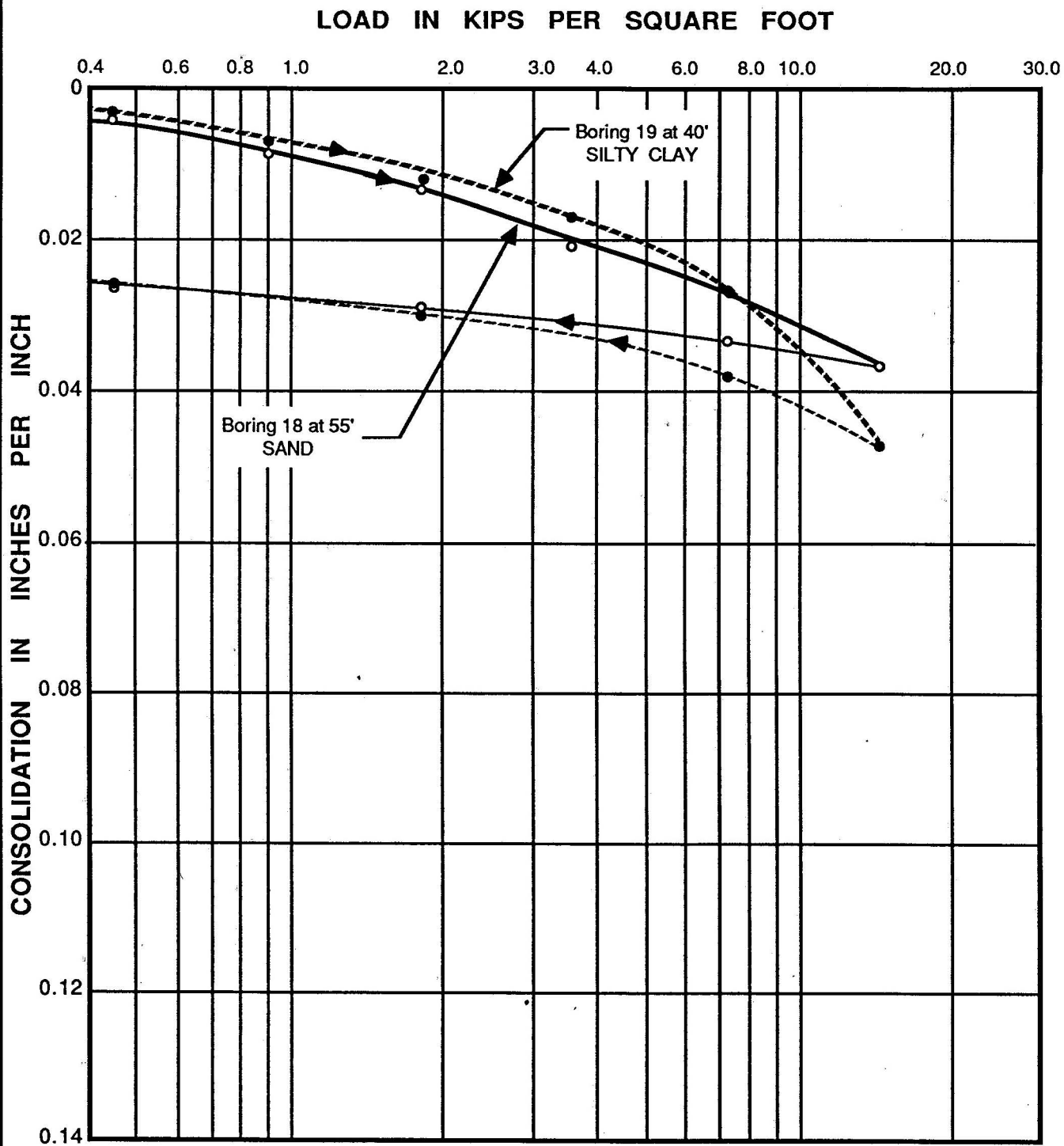
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.17

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD AKH



NOTE: Samples tested at field moisture content.

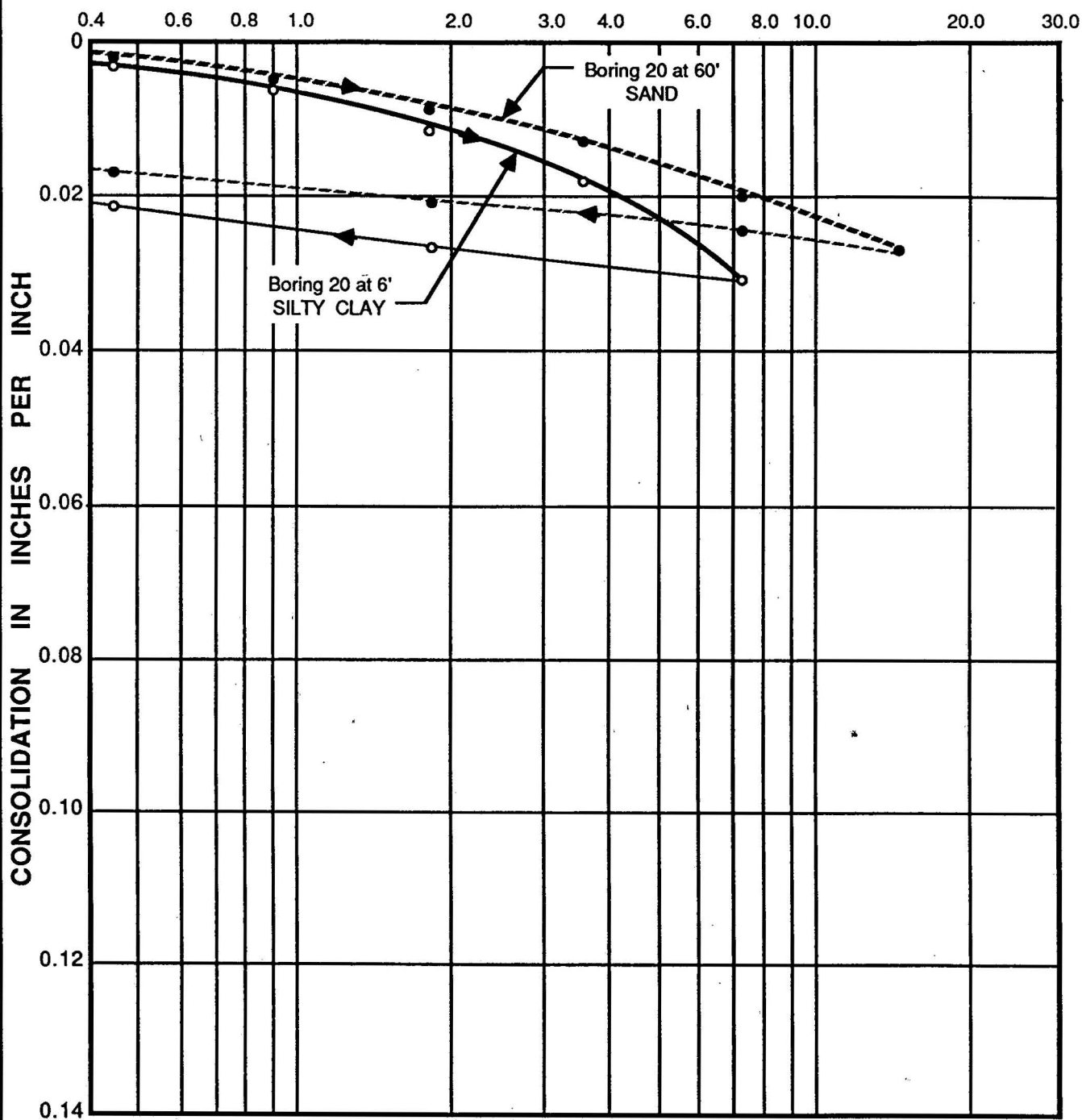
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.18

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

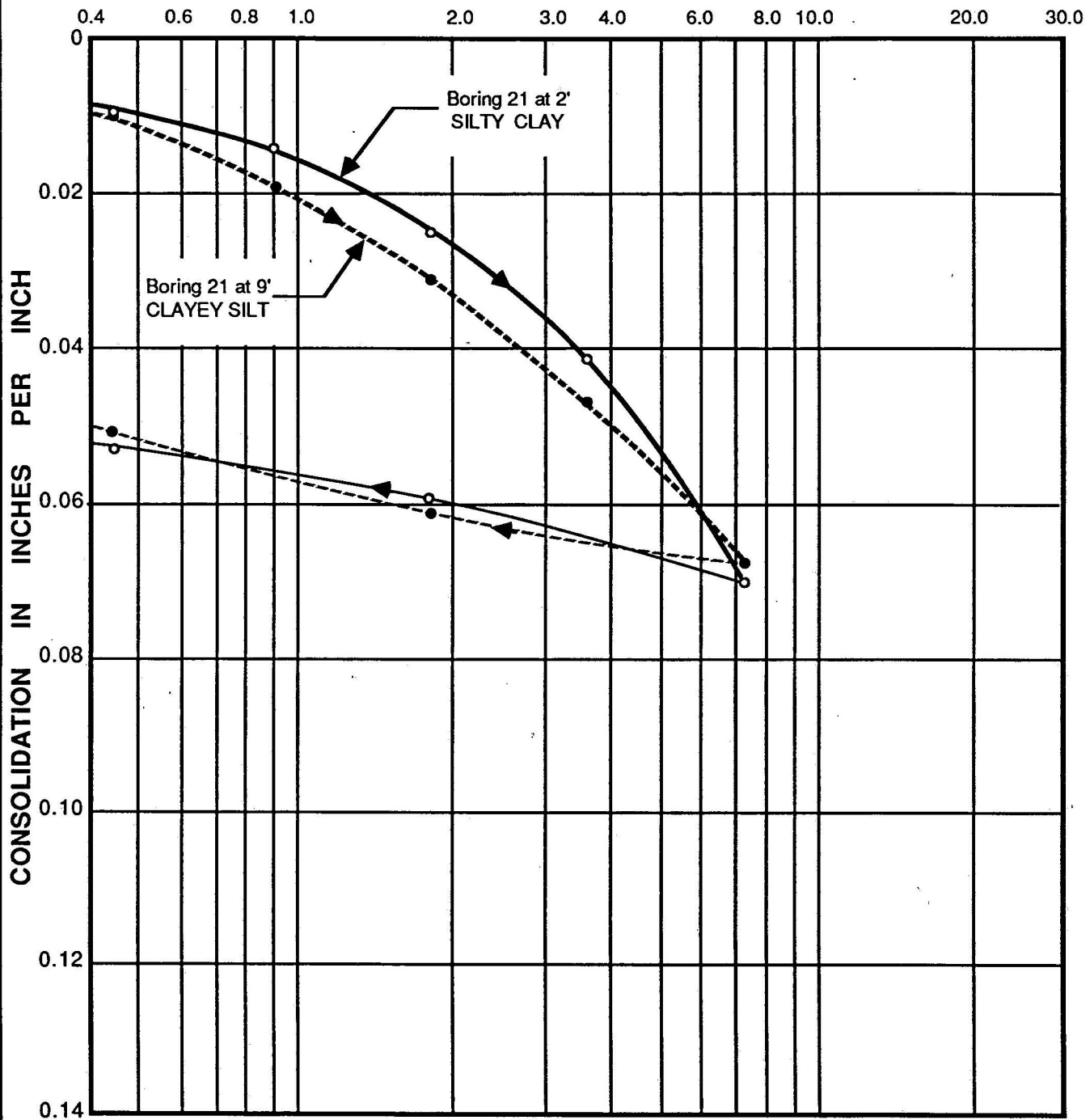
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.19

JOB ADEF-88044-7 DATE 1/11/89 DR. ip W.P. ip O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

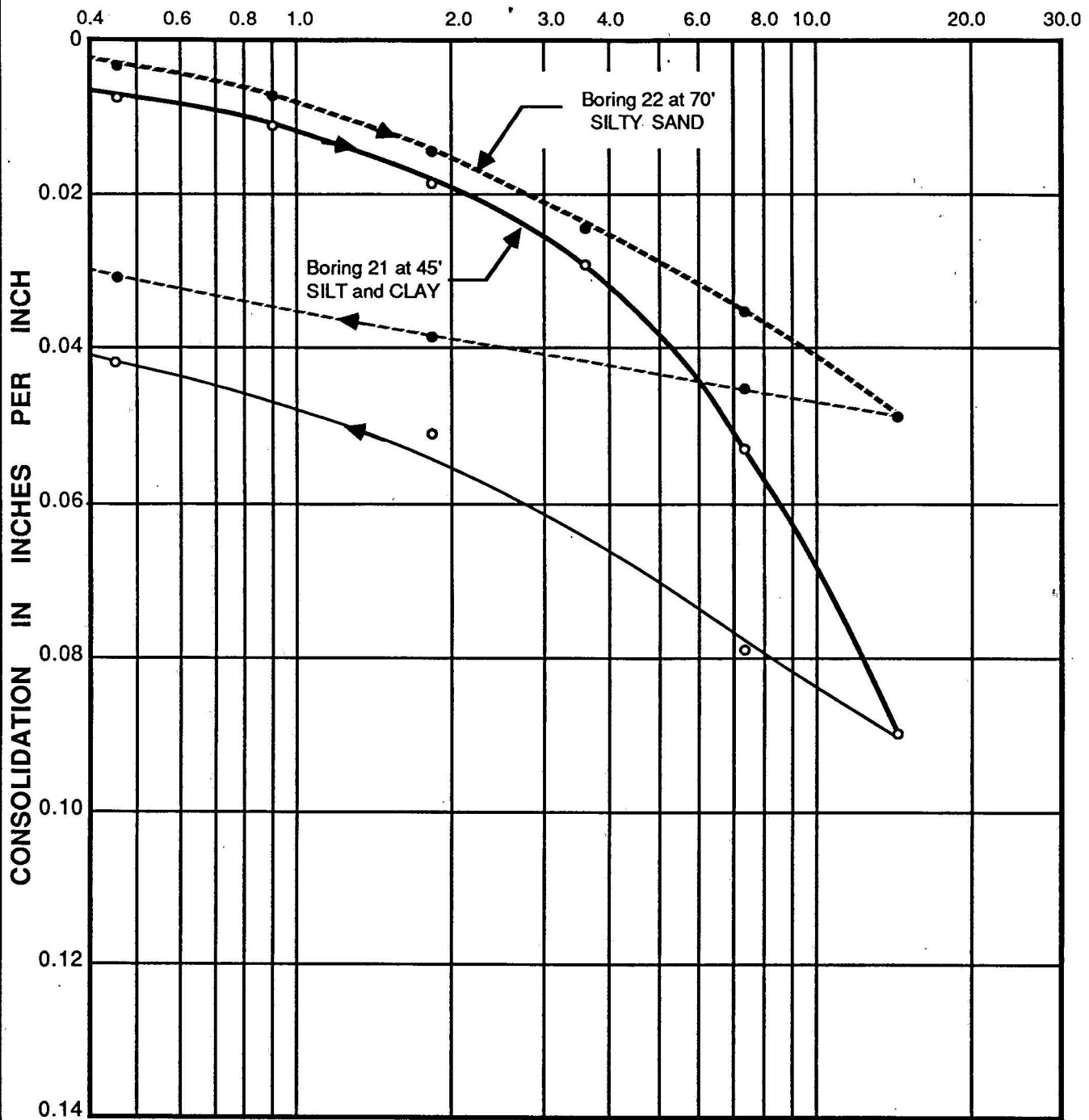
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.20

JOB ADEF-88044-7 DATE 1/11/89 DR. Jp W.P. Jp O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

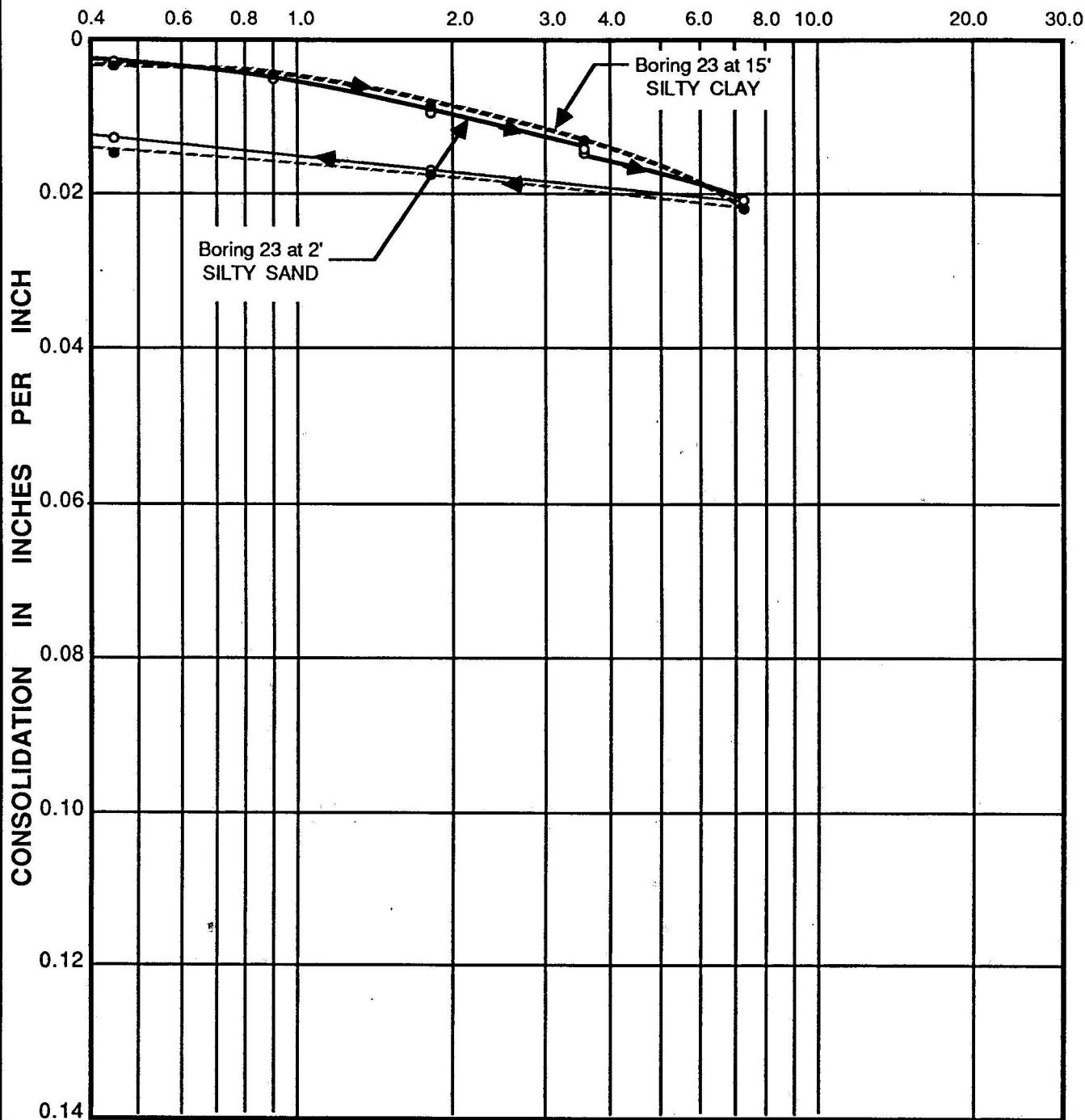
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.21

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample from 2' after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

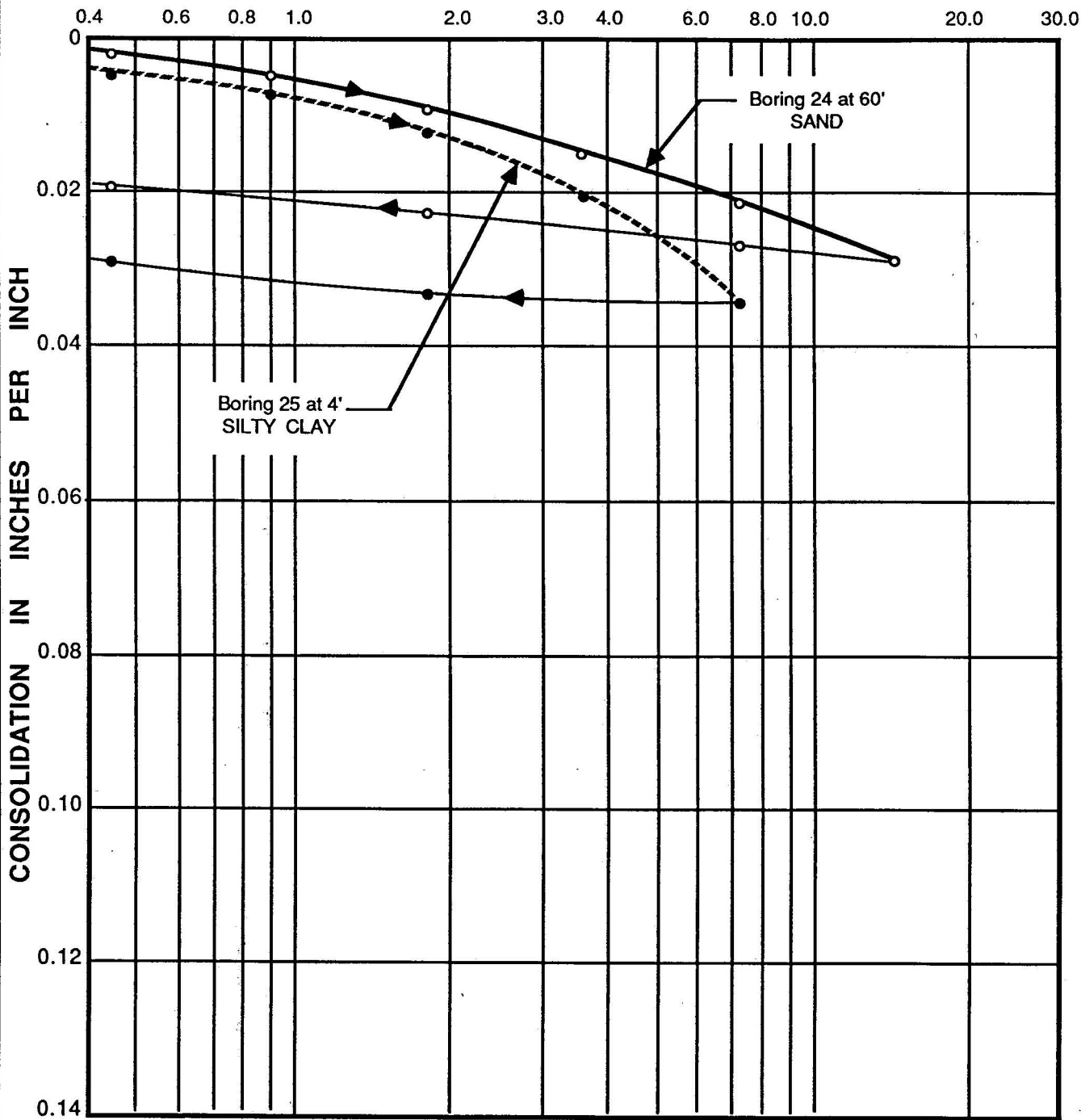
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.22

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

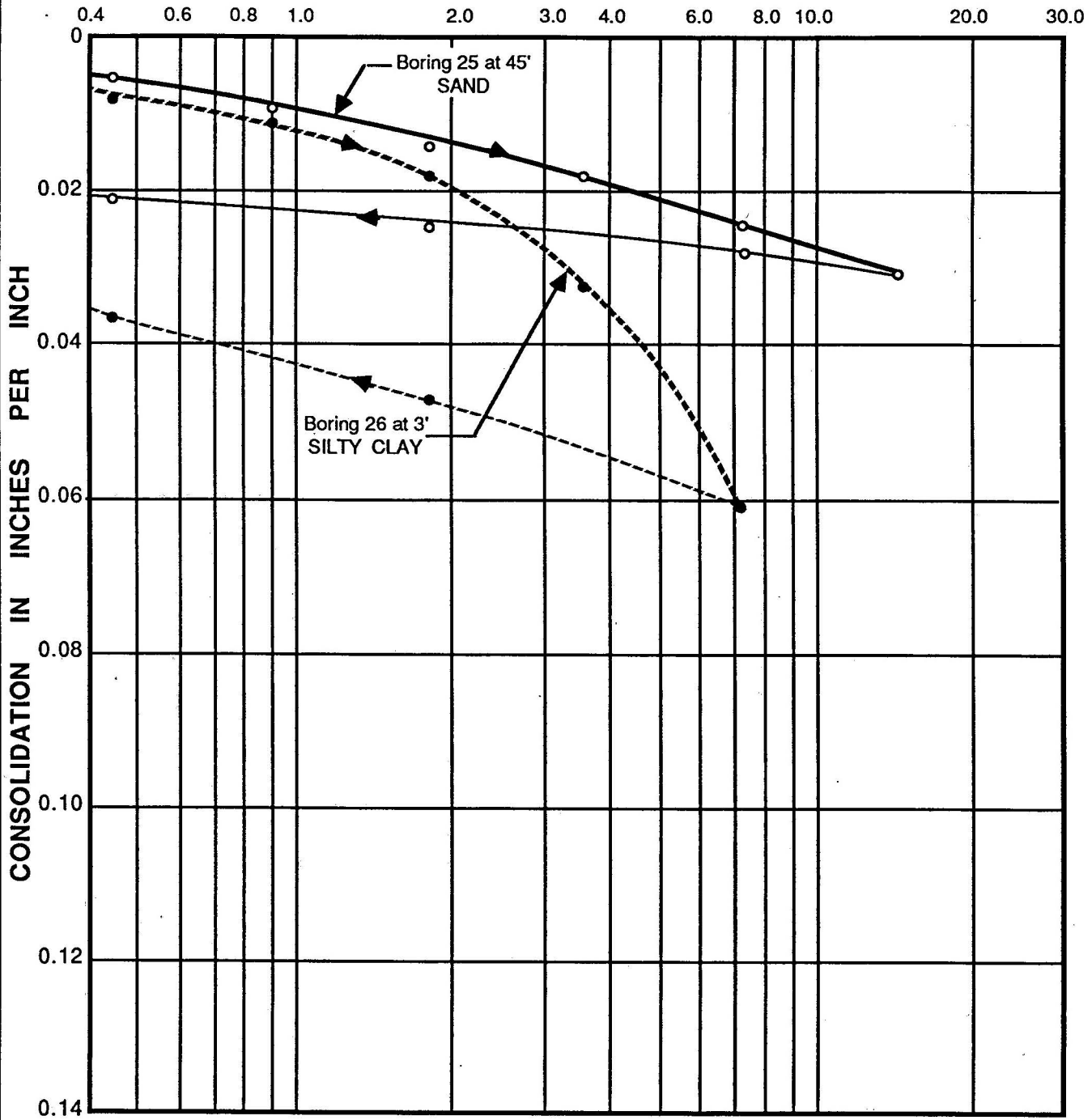
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.23

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample from Boring 26 after consolidation under a load of 3.6 kips per square foot.
The other sample tested at field moisture content.

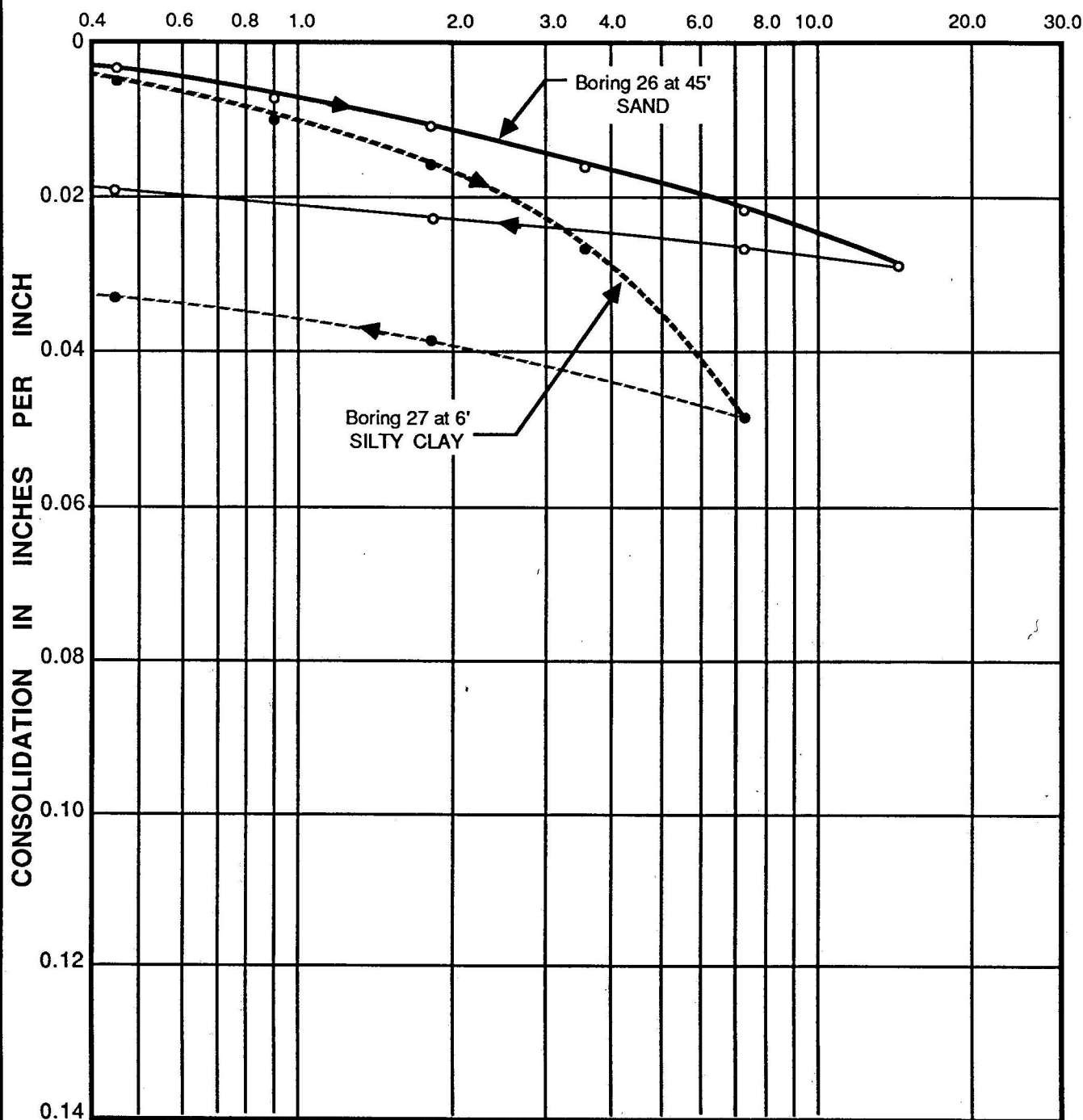
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.24

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

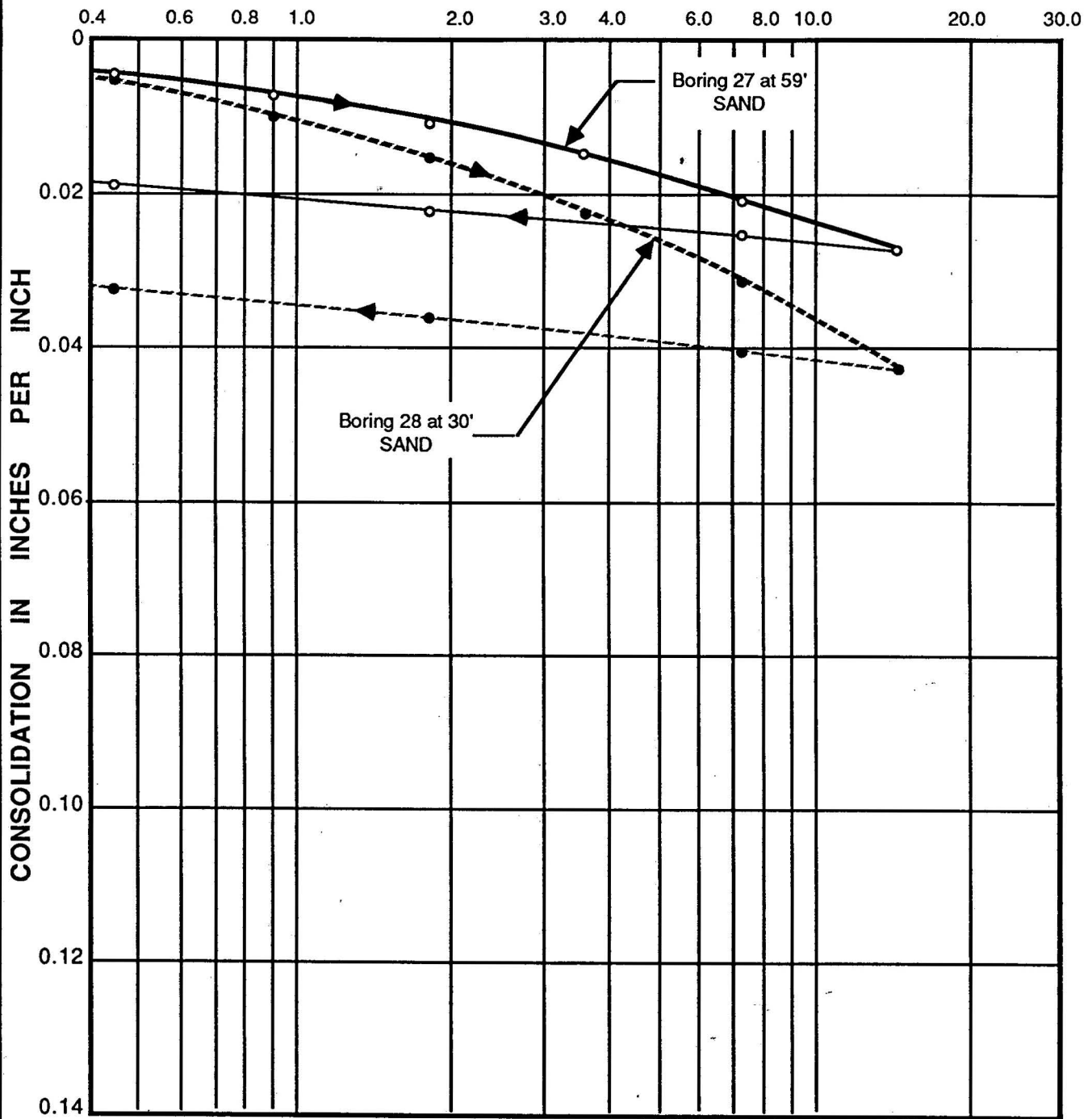
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.25

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

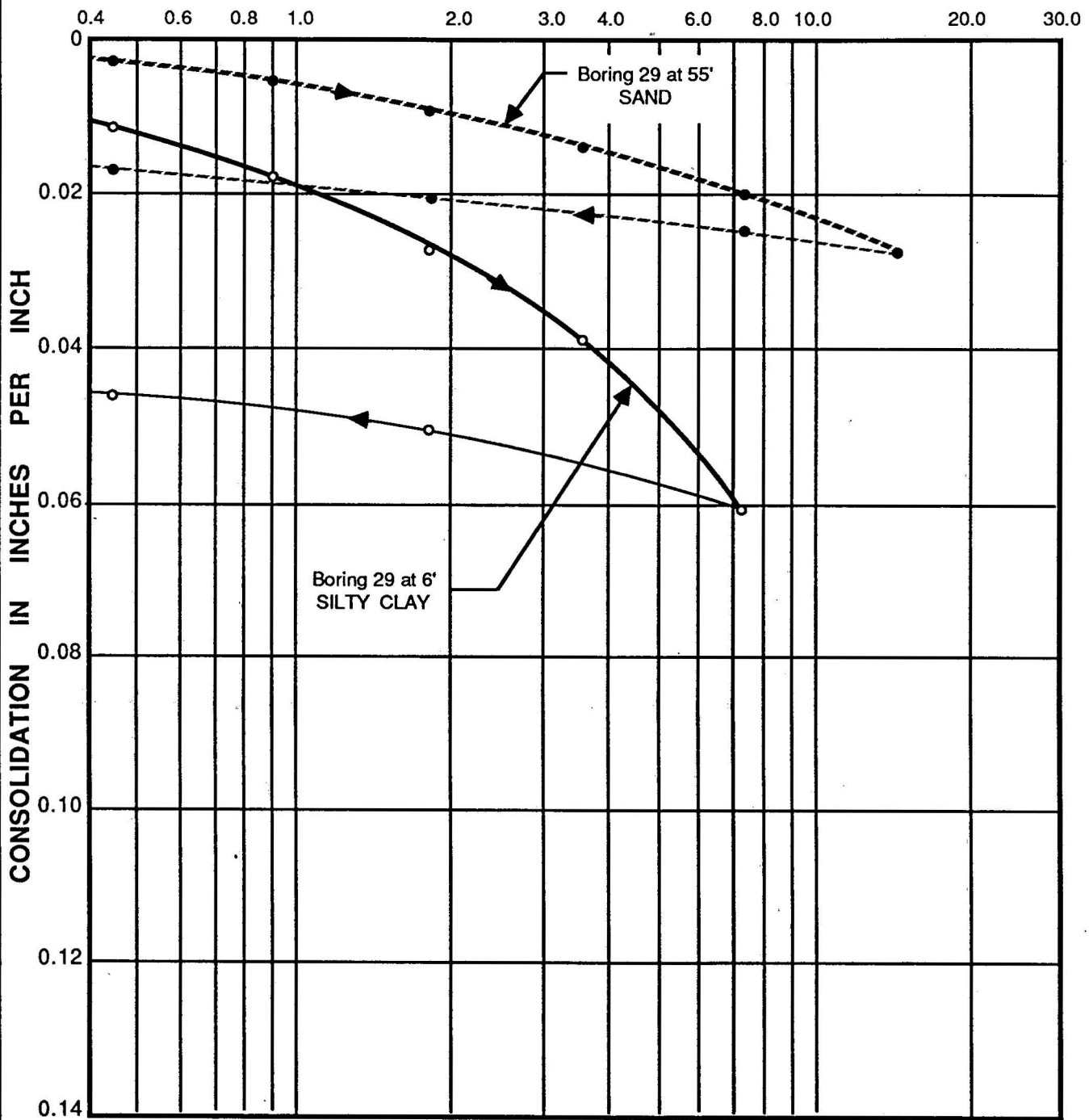
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.26

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD P/M

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

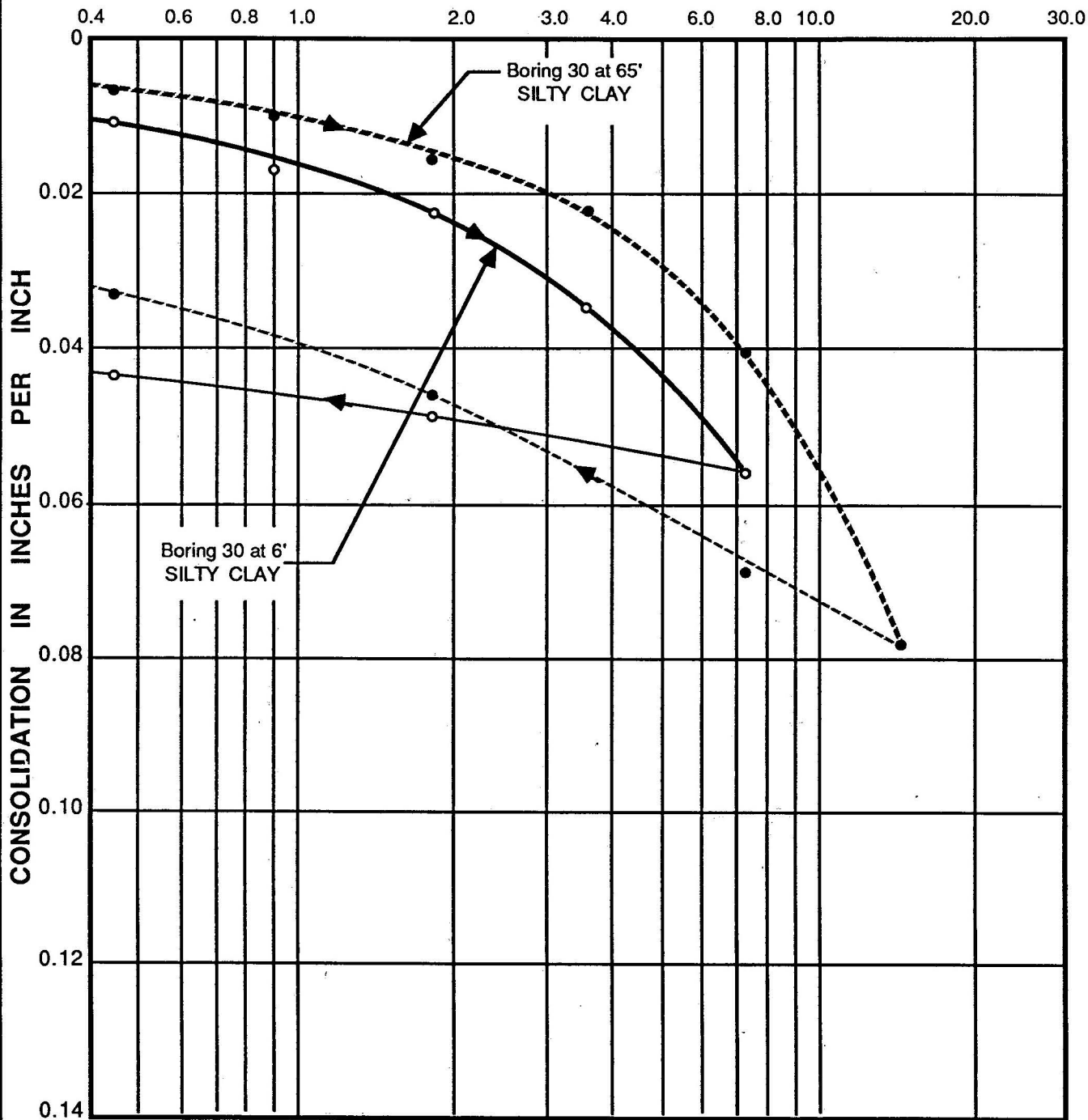
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.27

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD A.K.H.

LOAD IN KIPS PER SQUARE FOOT



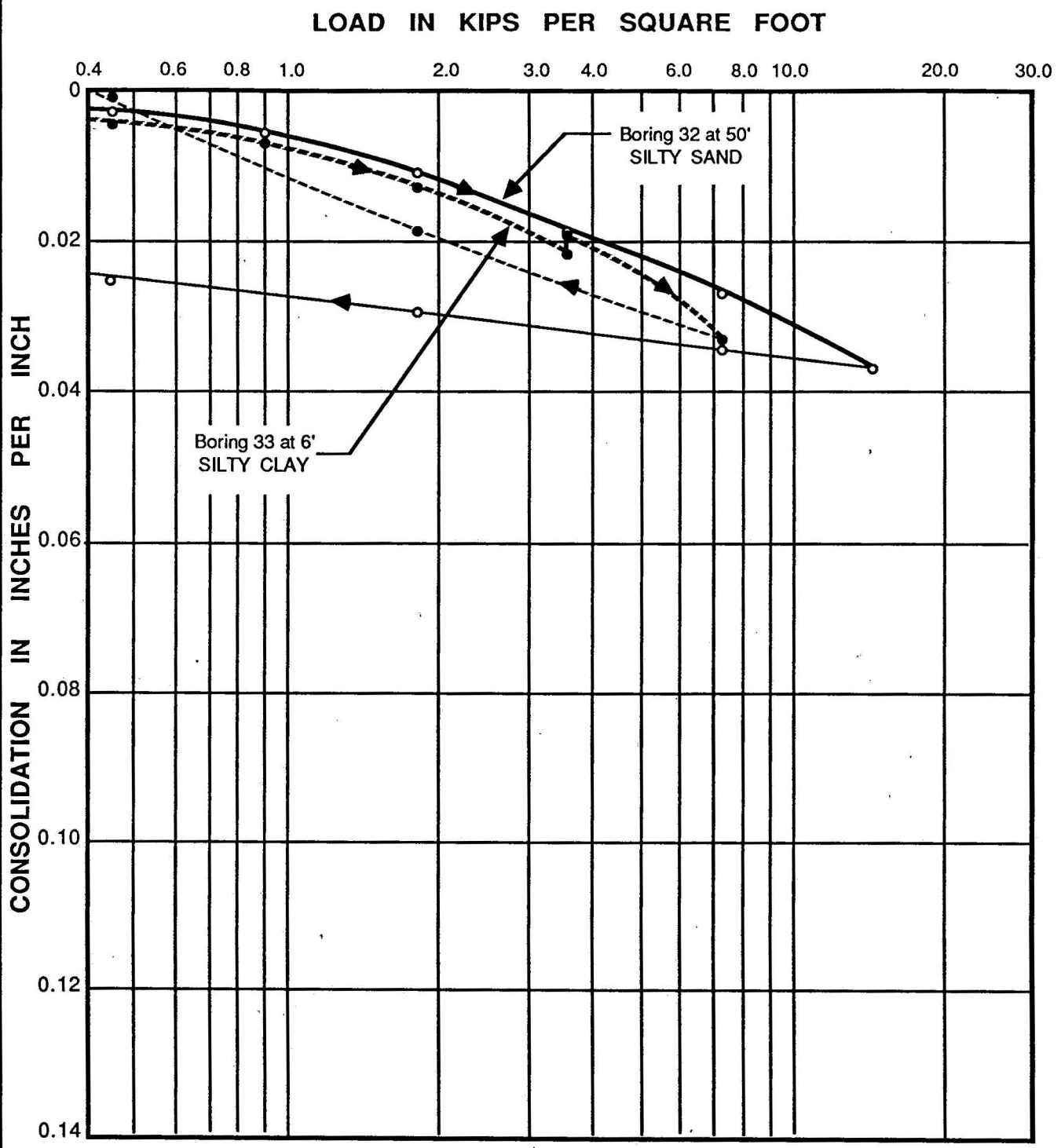
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.28

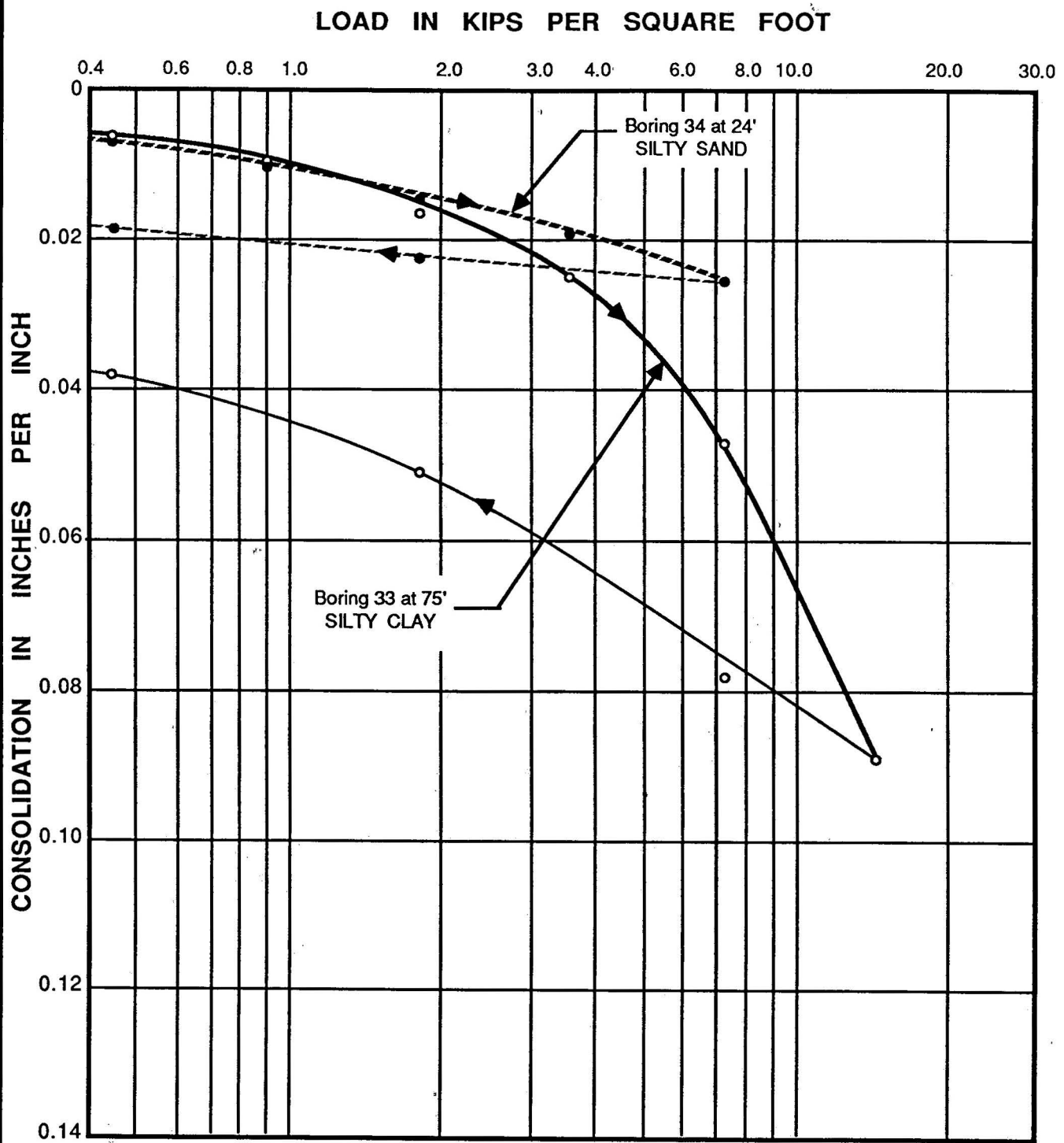
JOB ADEF-88044-7 DATE 12/28/88 DR dmm W.P. dmm O.E. SK CHKD AKH



NOTE: Water added to sample from Boring 33 after consolidation under a load of 3.6 kips per square foot.
The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

JOB - ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM



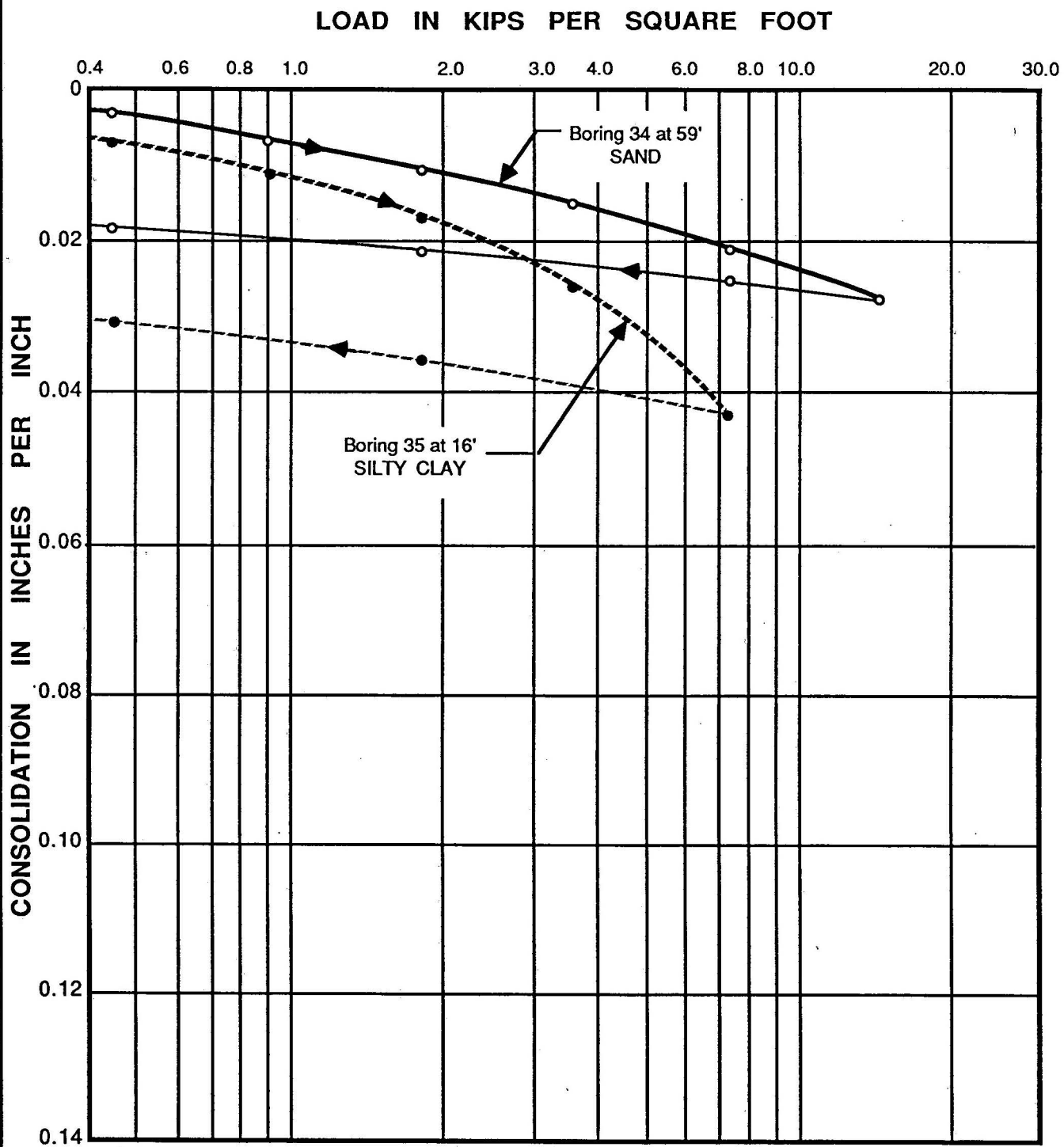
NOTE: Samples tested with field moisture content.

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

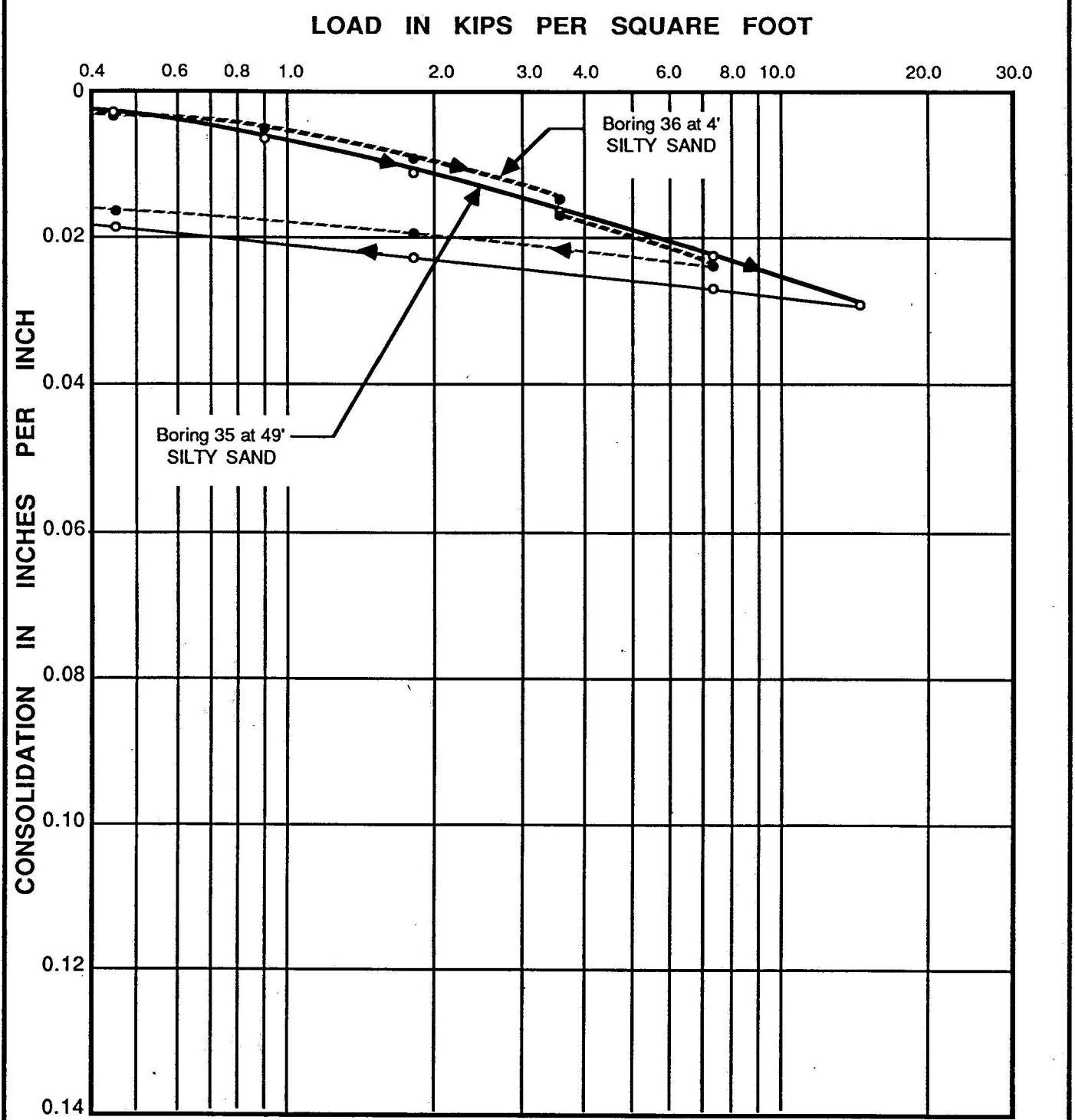
PLATE B - 2.30

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD AKH



NOTE: Samples tested at field moisture content.

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

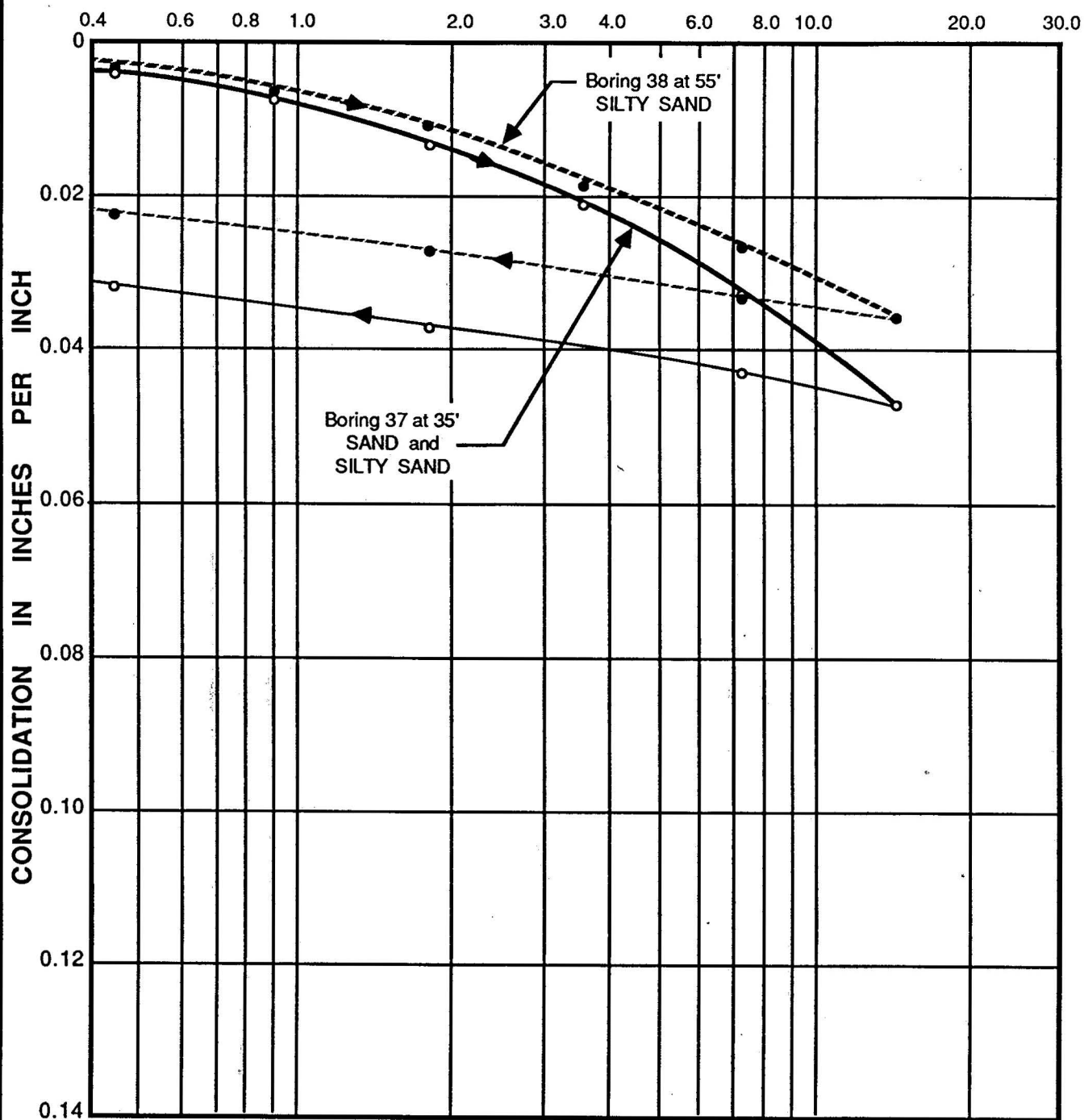


NOTE: Water added to sample from Boring 36 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD A.K.H.

LOAD IN KIPS PER SQUARE FOOT



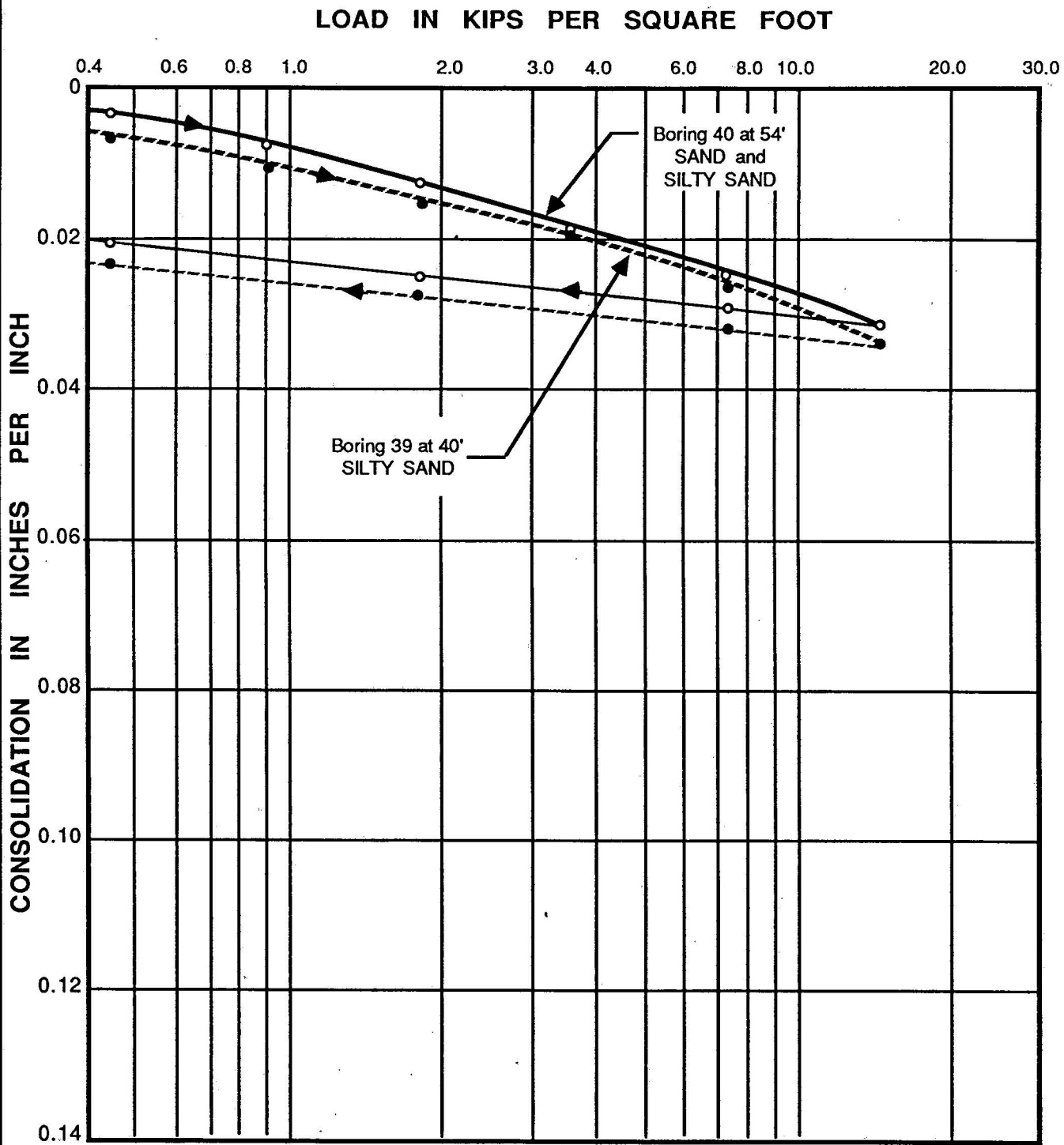
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

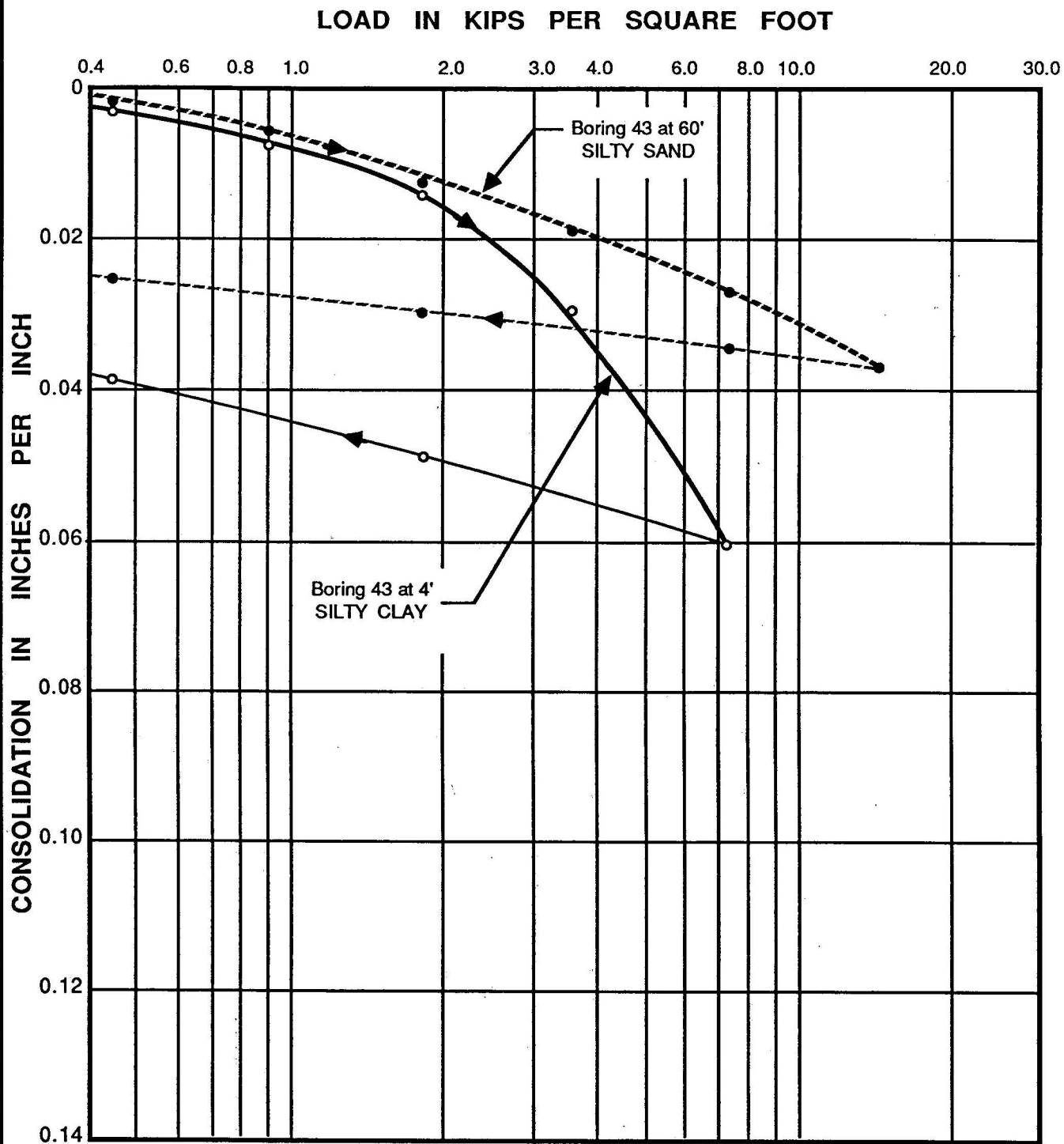
LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.33

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD A.K.H



JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM



NOTE: Samples tested at field moisture content.

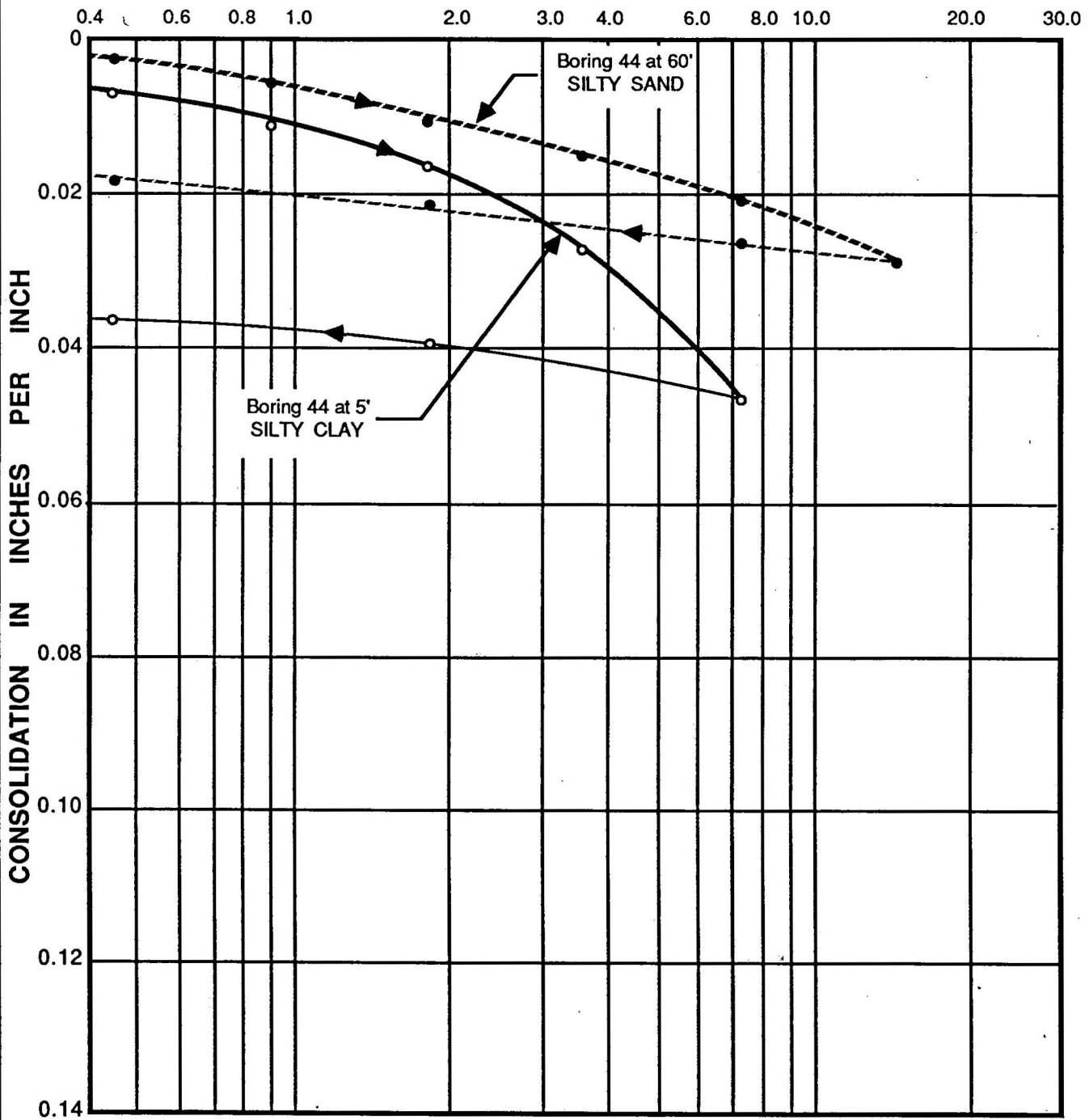
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.35

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD AKH

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

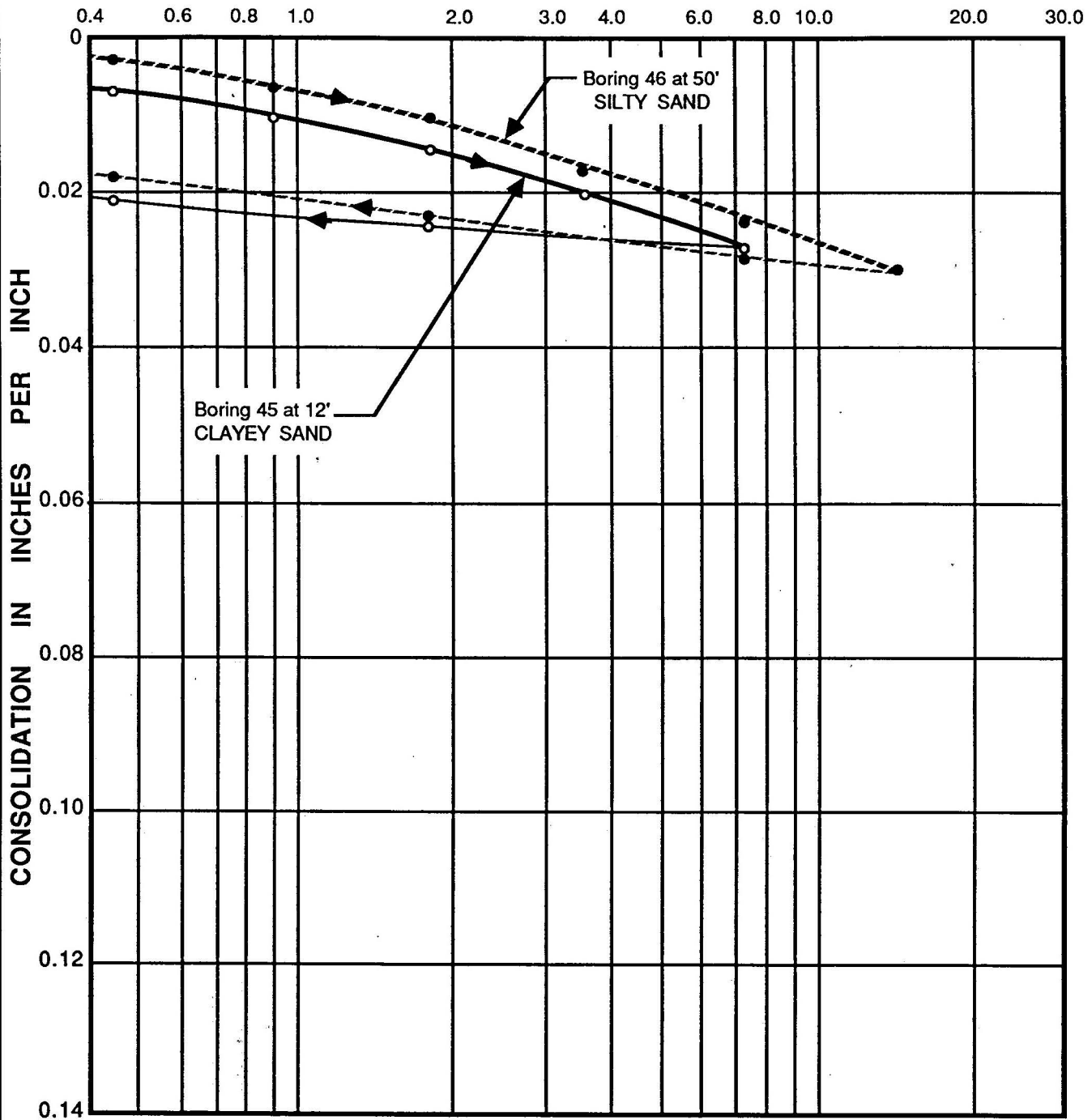
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.36

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

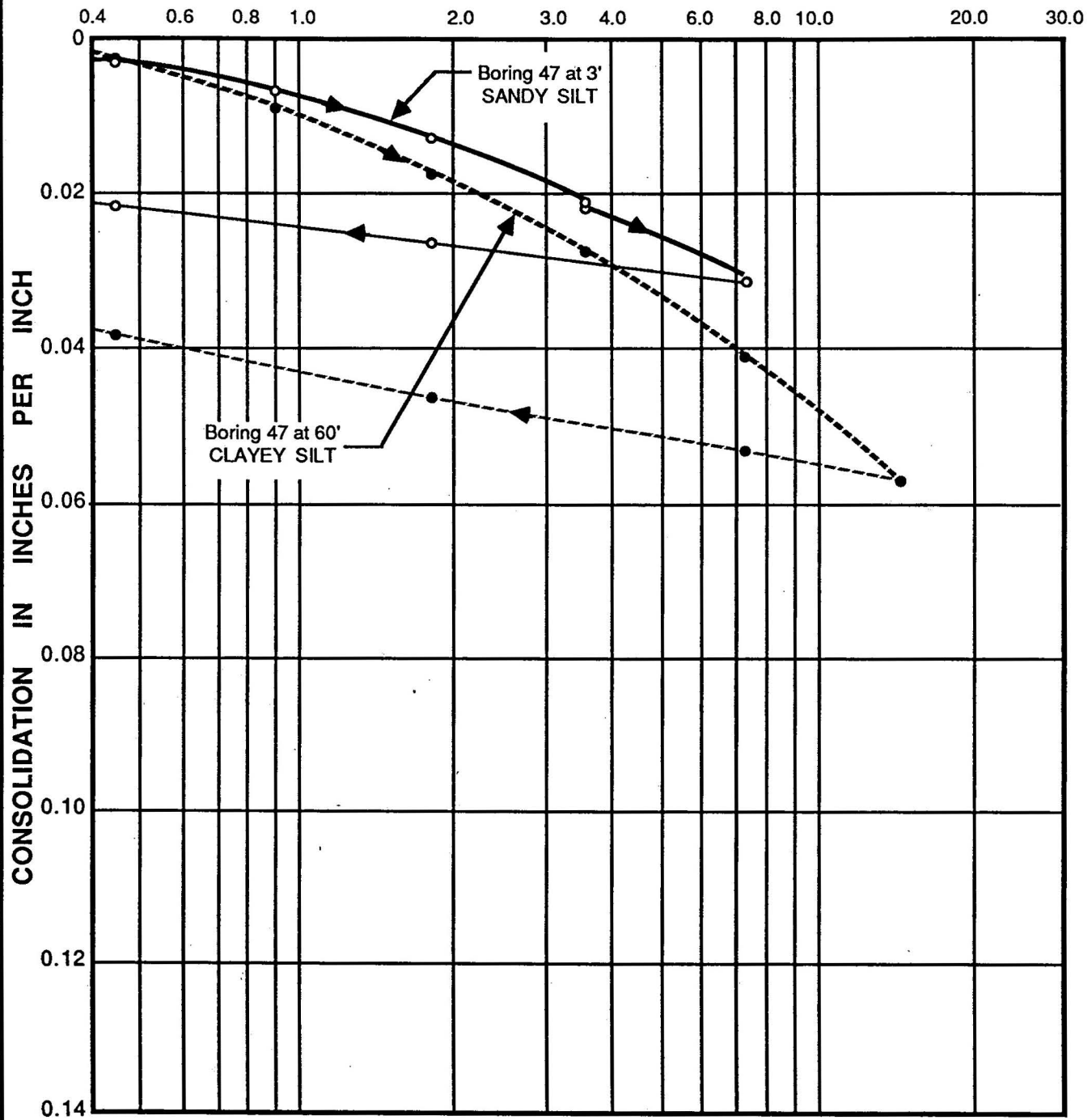
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.37

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM1

LOAD IN KIPS PER SQUARE FOOT



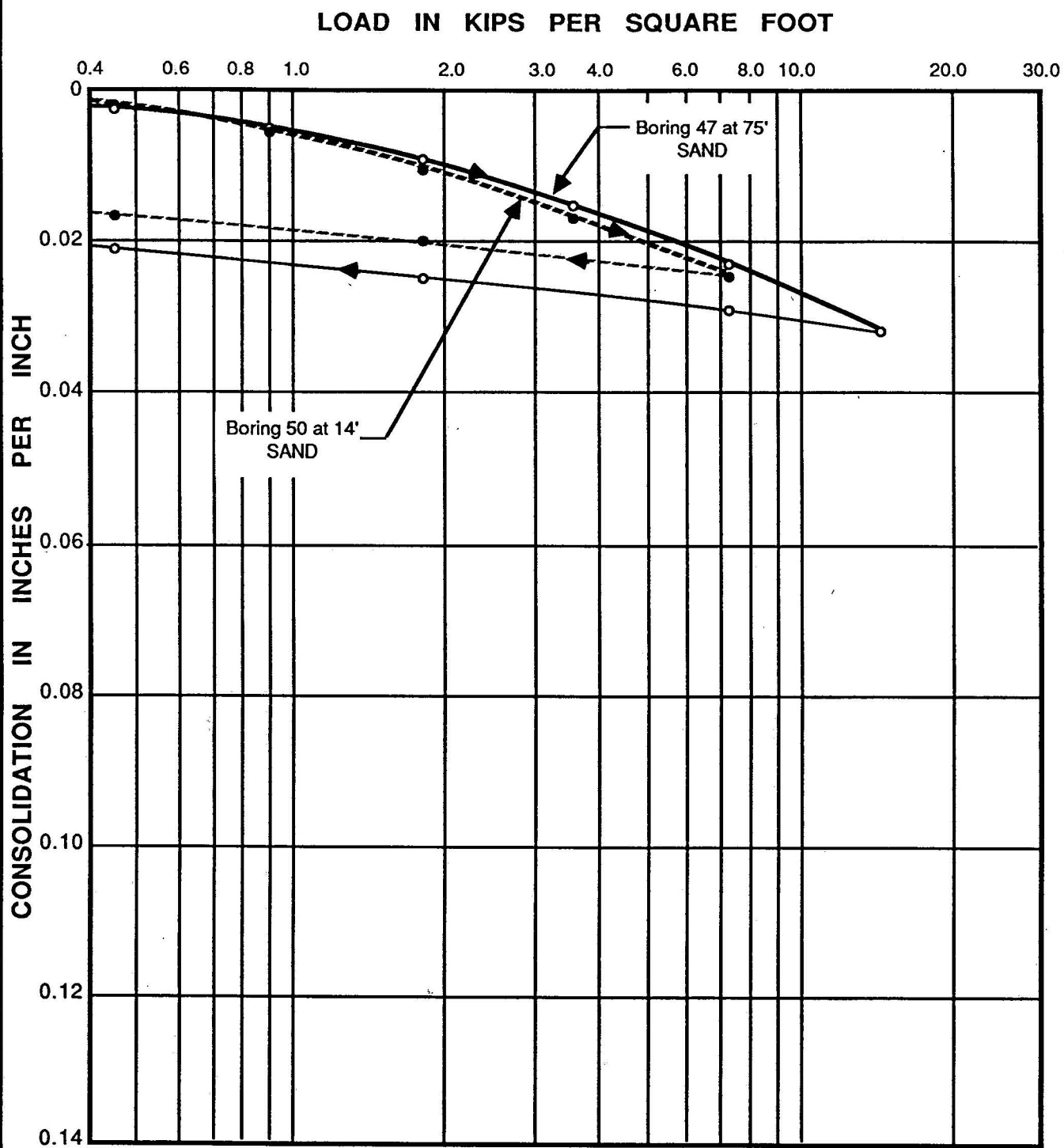
NOTE: Water added to sample from 3' after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.38

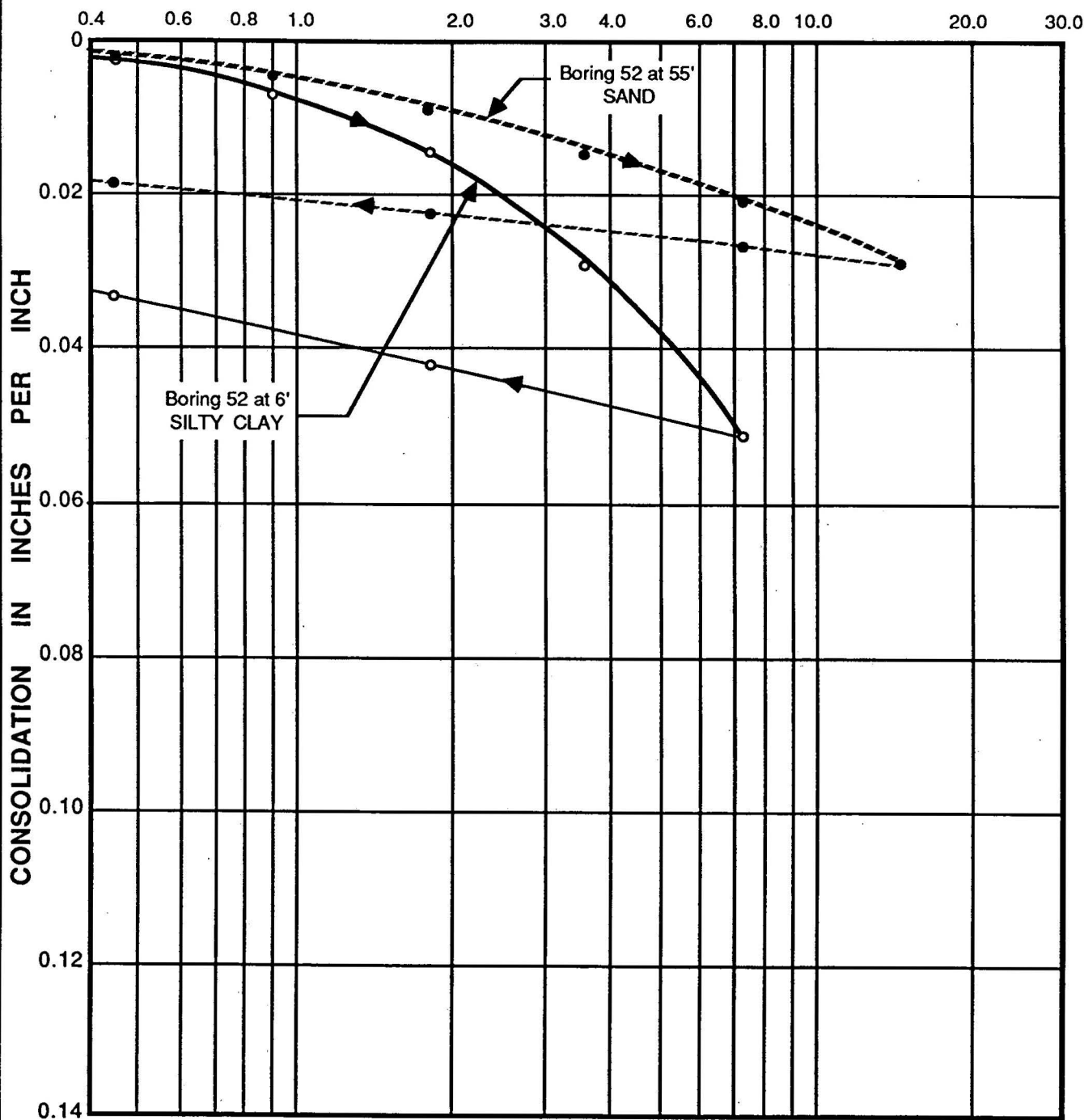
JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM



NOTE: Samples tested at field moisture content.

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



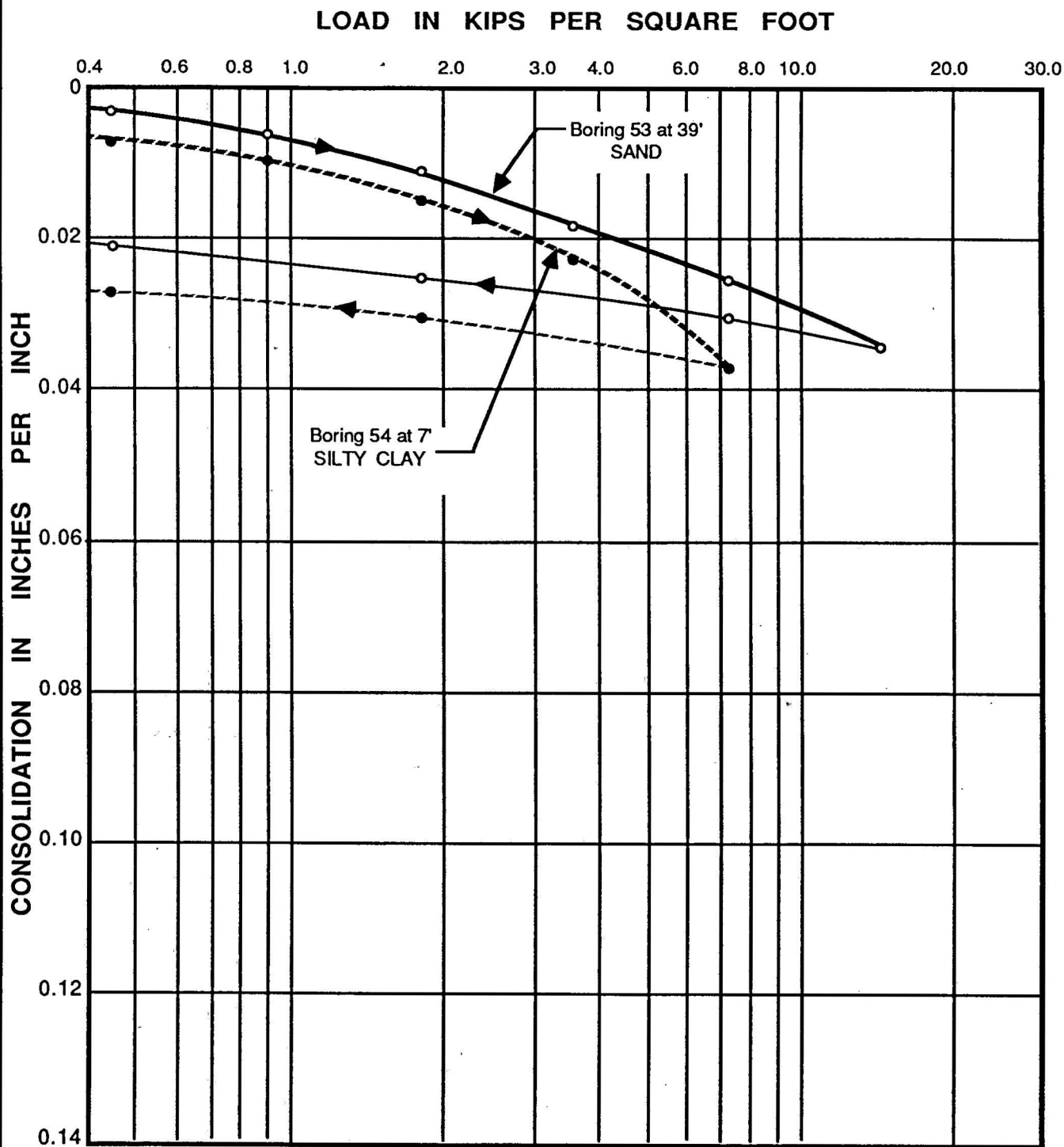
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.40

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD PM



NOTE: Samples tested at field moisture content.

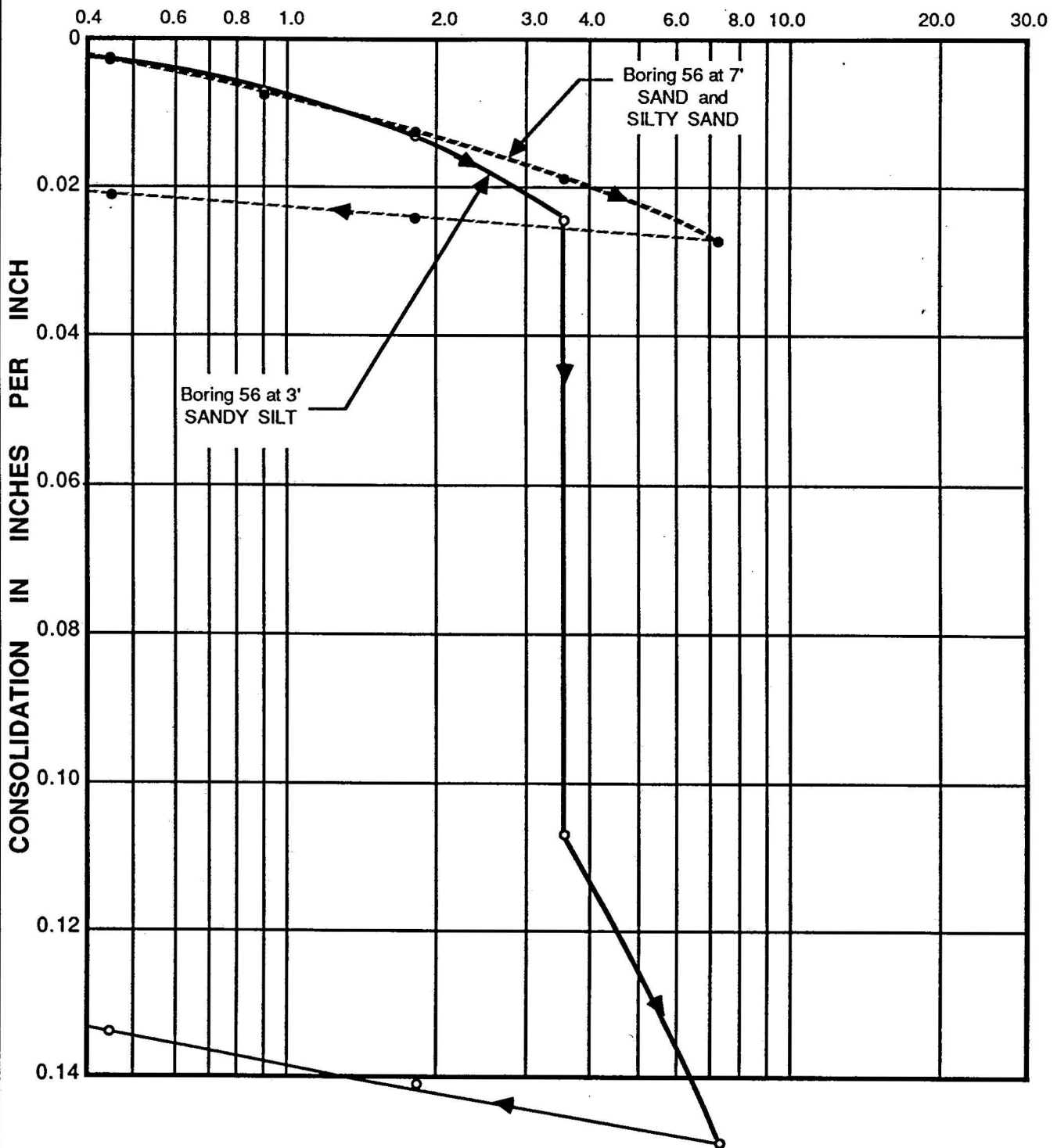
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.41

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample from 3' after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

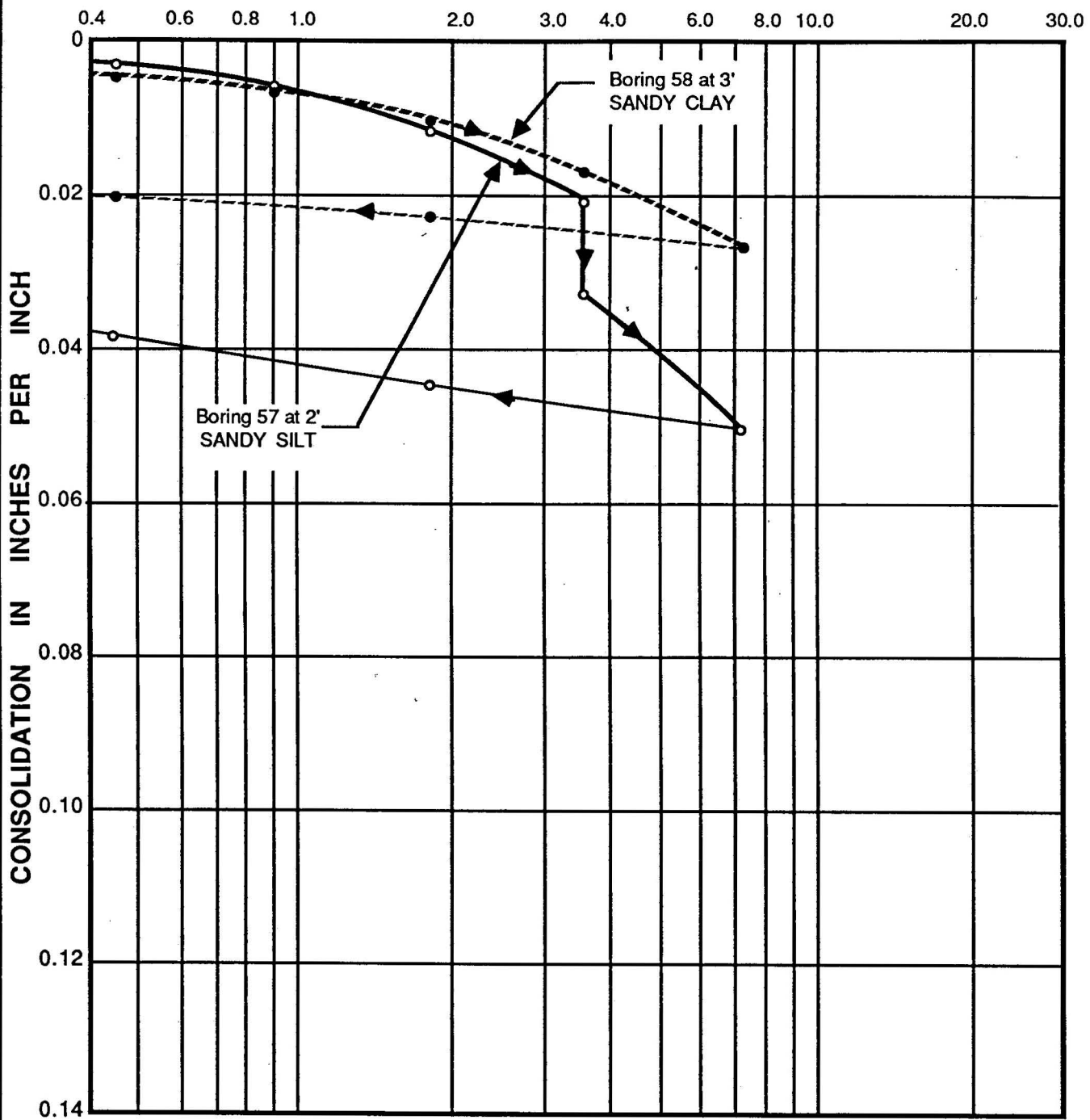
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.42

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample from Boring 57 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

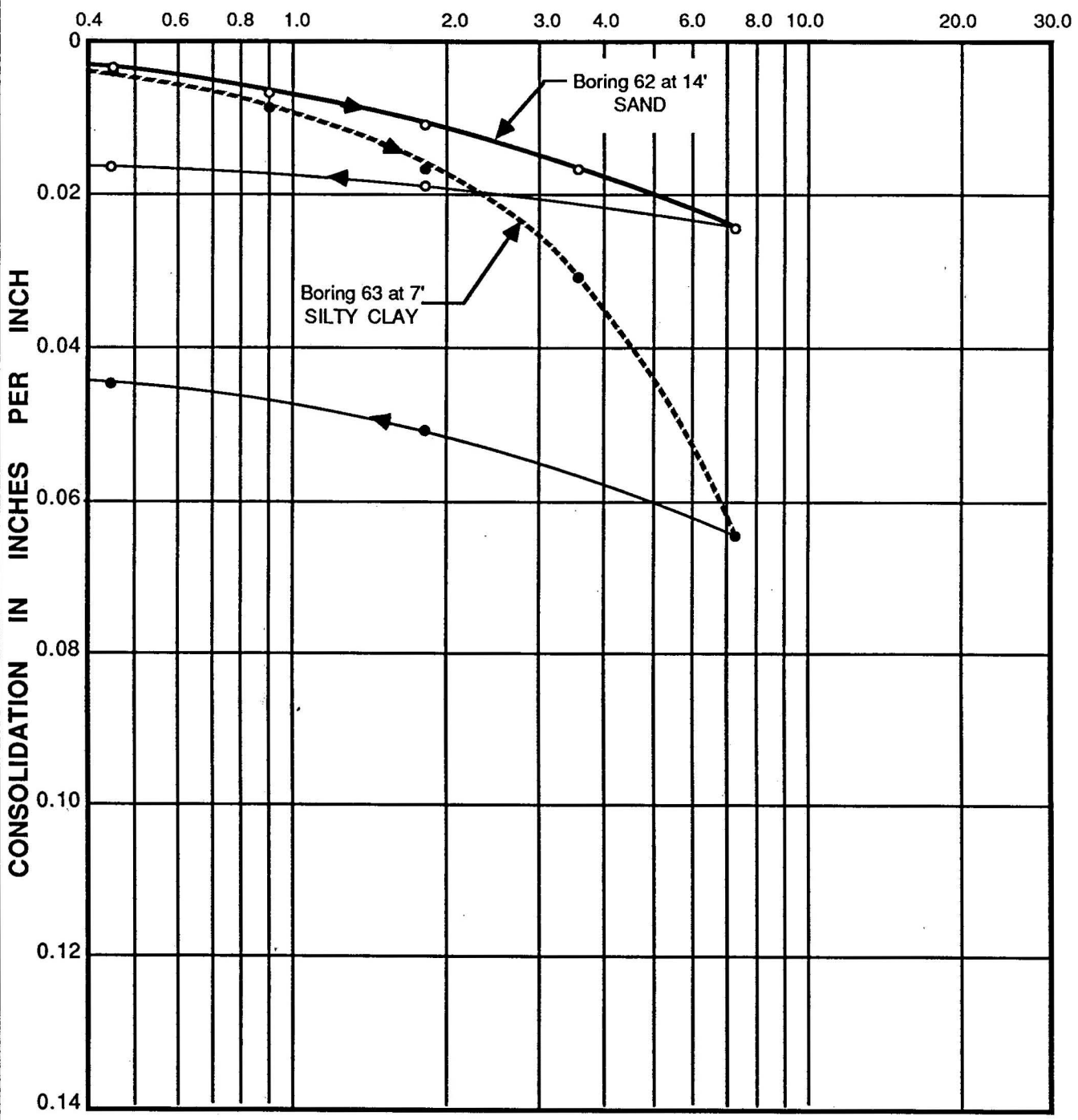
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.43

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

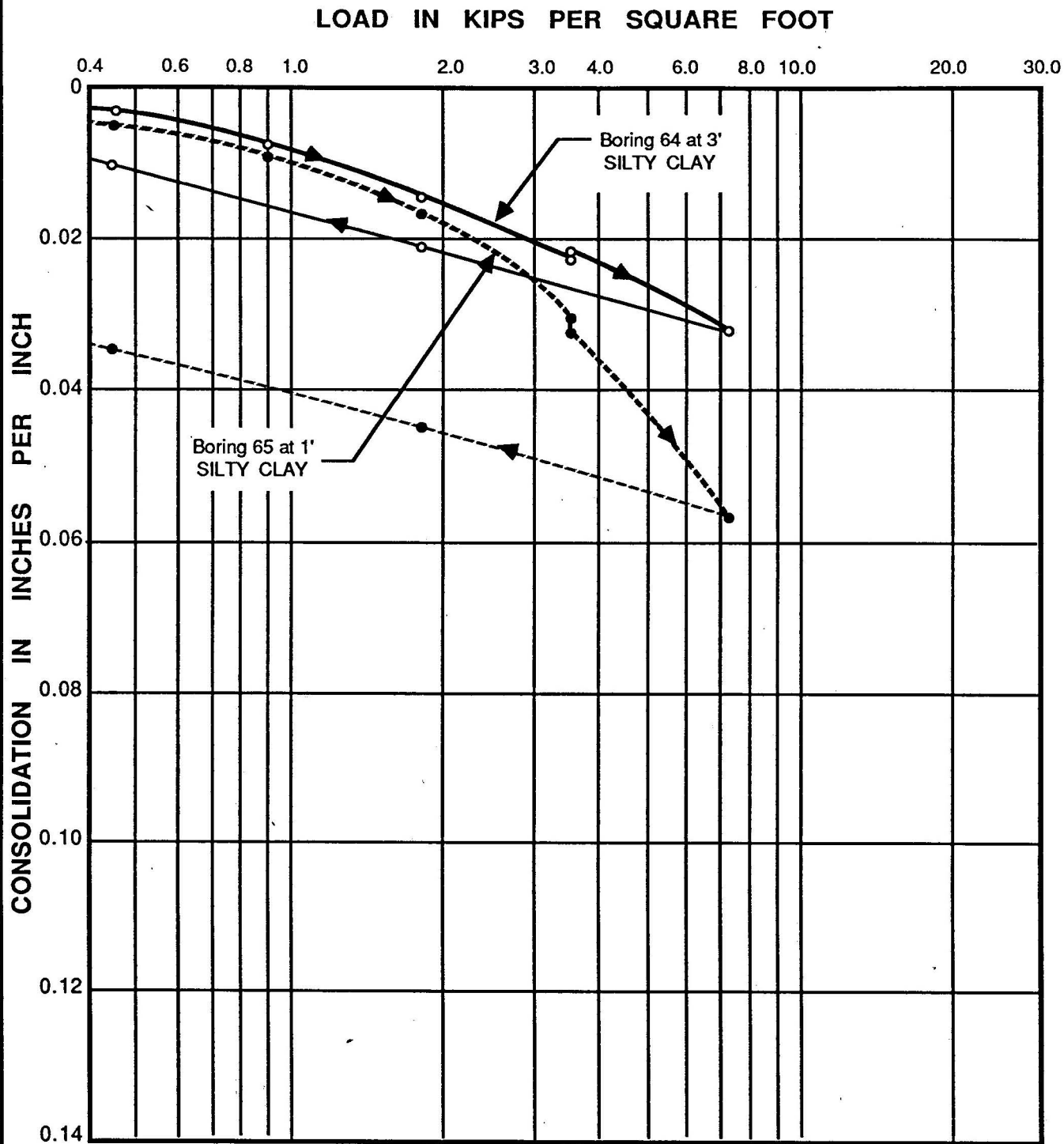
LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM



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

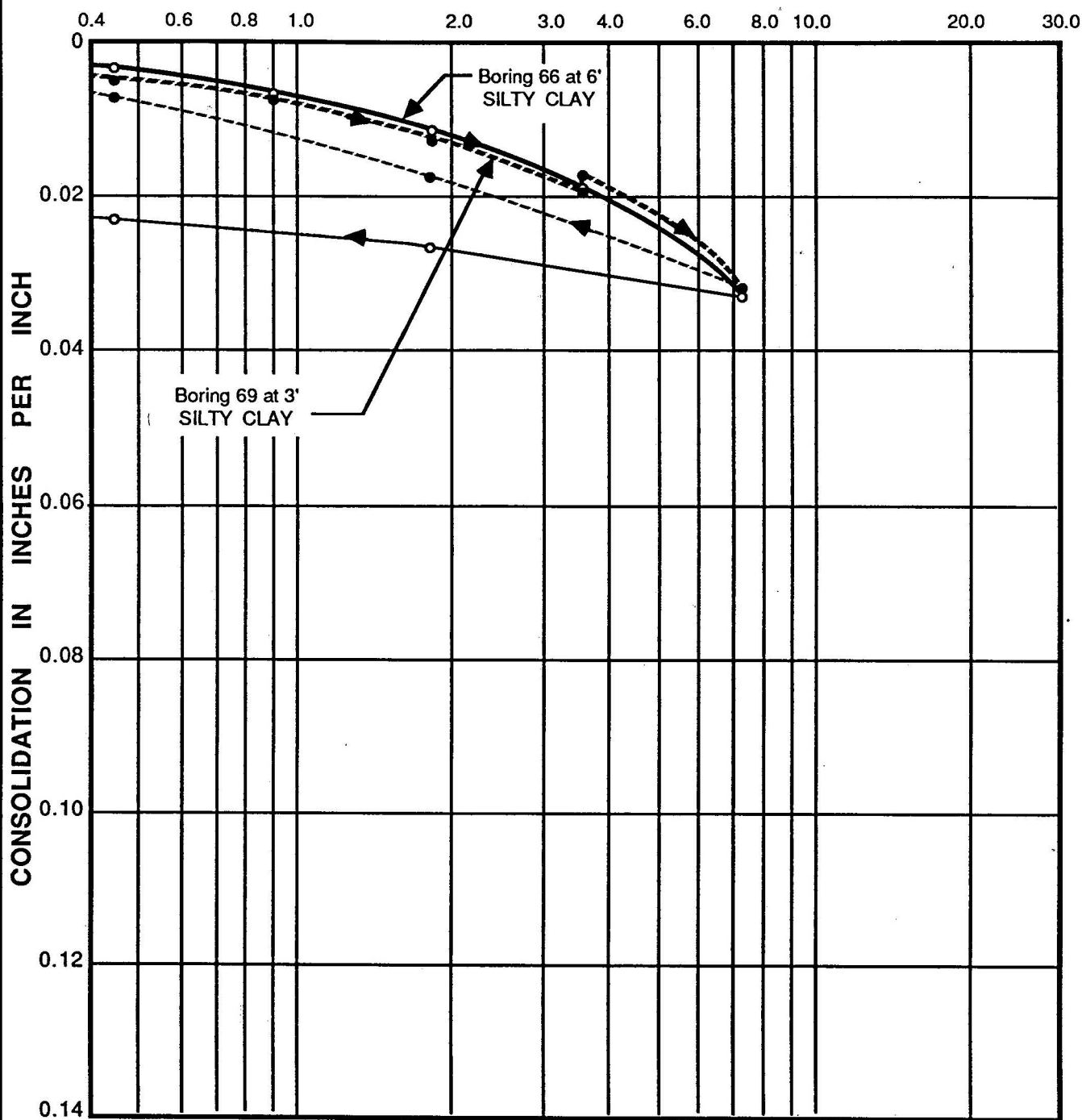
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.45

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample from Boring 69 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

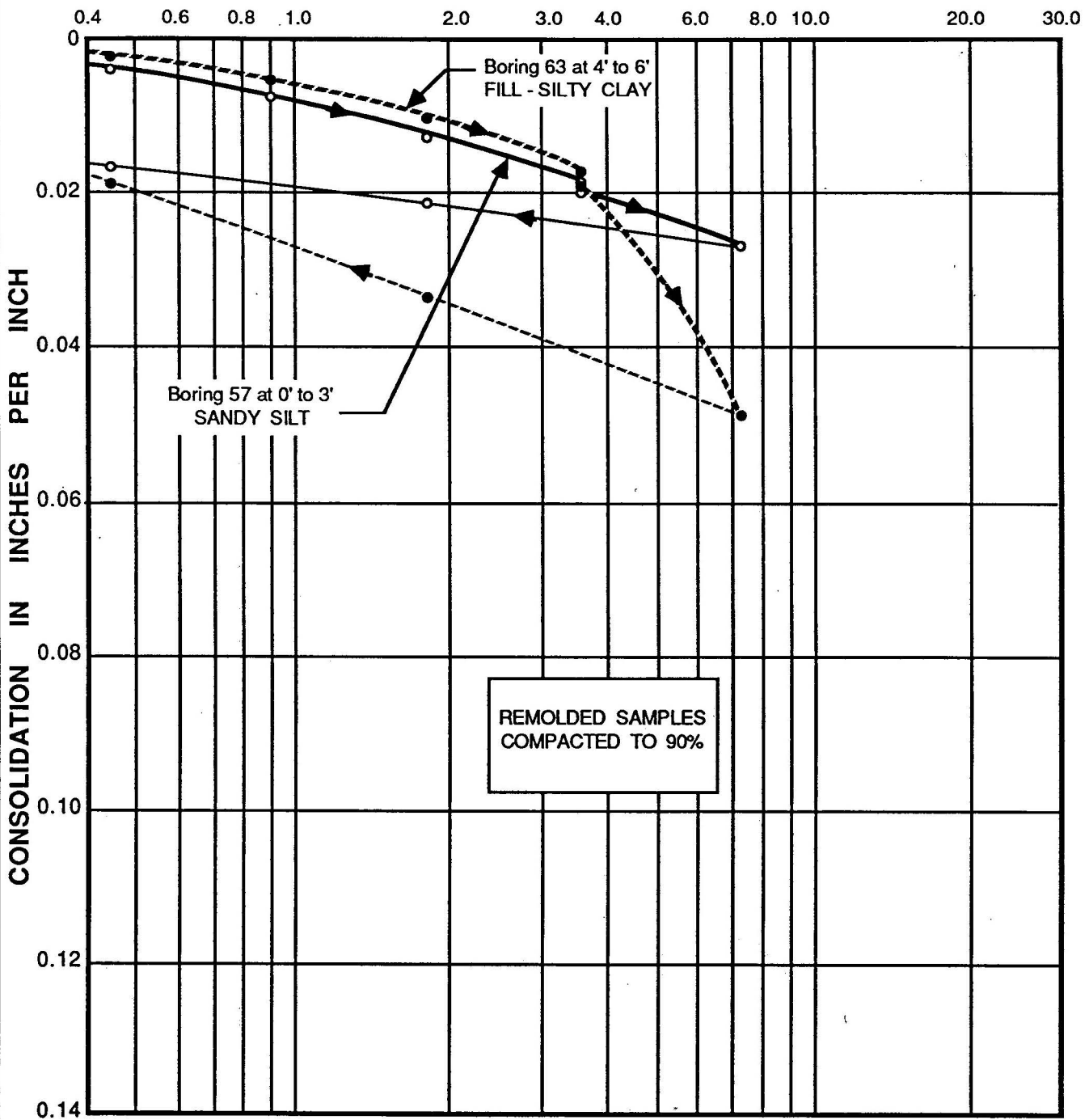
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.46

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



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

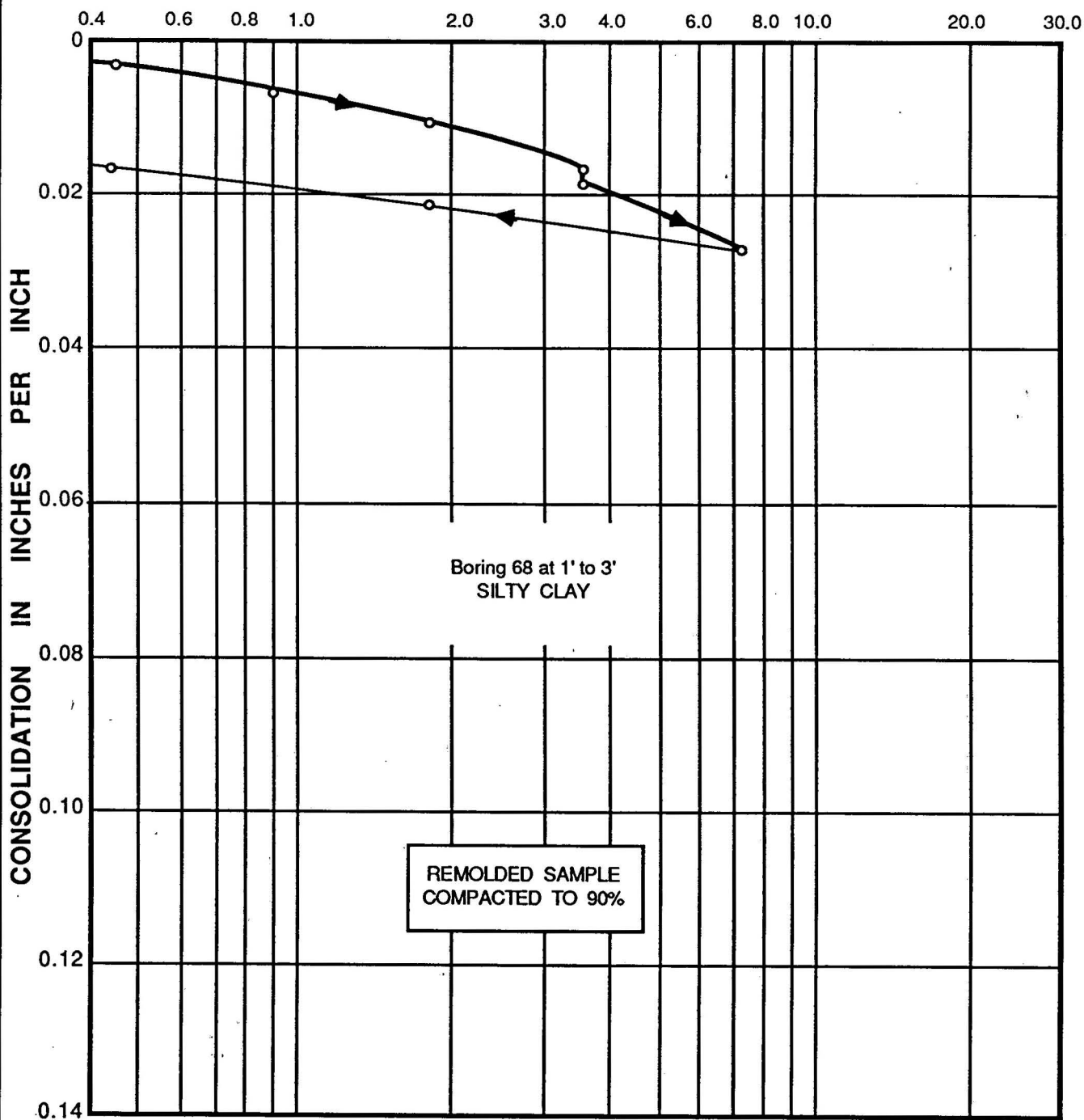
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.47

JOB ADEF-88044-7 DATE 12/28/88 DR. dmh W.P. dmh O.E. SK CHKD DM

LOAD IN KIPS PER SQUARE FOOT



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

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 2.48

BORING NUMBER
AND SAMPLE DEPTH:

6 at 1' to 3'

8 at 1' to 4'

SOIL TYPE:

FILL - SAND and
SILTY SAND

SILTY CLAY

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

125

OPTIMUM MOISTURE CONTENT*:
(% of dry wt.)

9

EXPANSION (%):
(From optimum to saturated
moisture content)

—

C. B. R. **
(% of standard)

AT 90% COMPACTION:

—

AT 95% COMPACTION:

—

*TEST METHOD: ASTM Designation D1557 - 78

**TEST METHOD: ASTM Designation D1883 - 73

COMPACTION AND C. B. R. TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 3.1

JOB ADEF-88044-7 DATE 1/11/89 W.P. lp O.E. SK CHKD DM

JOB ADEF-88044-7 DATE 1/11/89 W.P. _____ Ip _____ O.E. SK _____ CHKD DM _____

BORING NUMBER
AND SAMPLE DEPTH:

35 at 2' to 5'

49 at 2' to 4'

SOIL TYPE:

FILL - CLAY
and SILTY SAND

SILTY and
SANDY CLAY

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

120

119

OPTIMUM MOISTURE CONTENT*:
(% of dry wt.)

12

13

EXPANSION (%):
(From optimum to saturated
moisture content)

6.2

8.6

C. B. R. **
(% of standard)

AT 90% COMPACTION:

1

1

AT 95% COMPACTION:

2

2

*TEST METHOD: ASTM Designation D1557 - 78

**TEST METHOD: ASTM Designation D1883 - 73

COMPACTION AND C. B. R. TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 3.2

BORING NUMBER
AND SAMPLE DEPTH:

51 at 0' to 2'

57 at 0' to 3'

59 at 1' to 3'

SOIL TYPE:

FILL -
SILTY SAND

SANDY SILT

SANDY SILT

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

127

127

127

OPTIMUM MOISTURE CONTENT*:
(% of dry wt.)

9

9

9

EXPANSION (%):
(From optimum to saturated
moisture content)

1.8

—

2.5

C. B. R. **
(% of standard)

AT 90% COMPACTION:

20

—

9

AT 95% COMPACTION:

38

—

47

*TEST METHOD: ASTM Designation D1557 - 78

**TEST METHOD: ASTM Designation D1883 - 73

COMPACTION AND C. B. R. TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 3.3

JOB ADEF-88044-7 DATE 1/11/89 W.P. lp O.E. SK CHKD DM

BORING NUMBER
AND SAMPLE DEPTH:

61 at 0' to 2'

63 at 4' to 6'

68 at 1' to 3'

SOIL TYPE:

FILL -
SILTY SAND

FILL -
SILTY CLAY

FILL - SILTY SAND,
and SILTY CLAY

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

128

119

129

OPTIMUM MOISTURE CONTENT*:
(% of dry wt.)

10

15

9

EXPANSION (%):
(From optimum to saturated
moisture content)

1.2

10.5

1.1

C. B. R. **
(% of standard)

AT 90% COMPACTION:

13

1

9

AT 95% COMPACTION:

28

2

20

* TEST METHOD: ASTM Designation D1557 - 78

** TEST METHOD: ASTM Designation D1883 - 73

COMPACTION AND C. B. R. TEST DATA

LeROY CRANDALL AND ASSOCIATES

PLATE B - 3.4

JOB ADEF-88044-7 DATE 1/11/89 W.P. lp O.E. SK CHKD DM

JOB ADEF-88044-7 DATE 1/11/89 W.P. Ip O.E. SK CHKD DM

BORING NUMBER AND SAMPLE DEPTH :	1 at 5' to 7'	6 at 5' to 9'	63 at 4' to 6'
SOIL TYPE :	SILTY CLAY	SILTY CLAY	FILL - SILTY CLAY
CONFINING PRESSURE : (lbs./sq. ft.)	144	144	144
INITIAL MOISTURE CONTENT : (% of dry wt.)	11.3	13.5	12.5
FINAL MOISTURE CONTENT : (% of dry wt.)	29.7	34.0	27.0
DRY DENSITY : (lbs./cu. ft.)	104	98	100
EXPANSION INDEX :	99	127	60

TEST METHOD : Uniform Building Code Standard
No. 29 - 2, Expansion Index Test

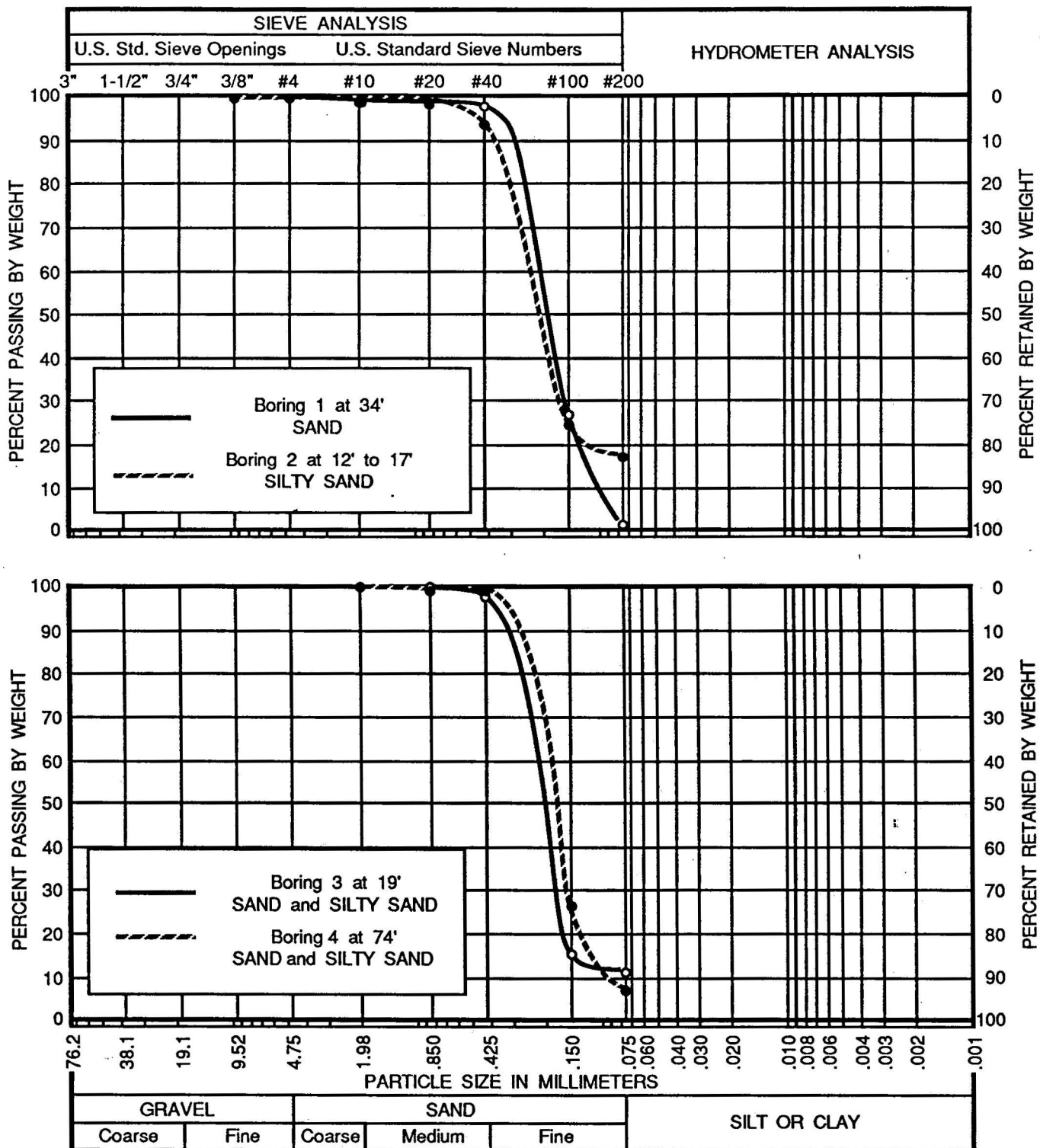
EXPANSION INDEX TEST DATA

JOB ADEF-88044-7 DATE 1/11/89 W.P. lp O.E. SK CHKD DM

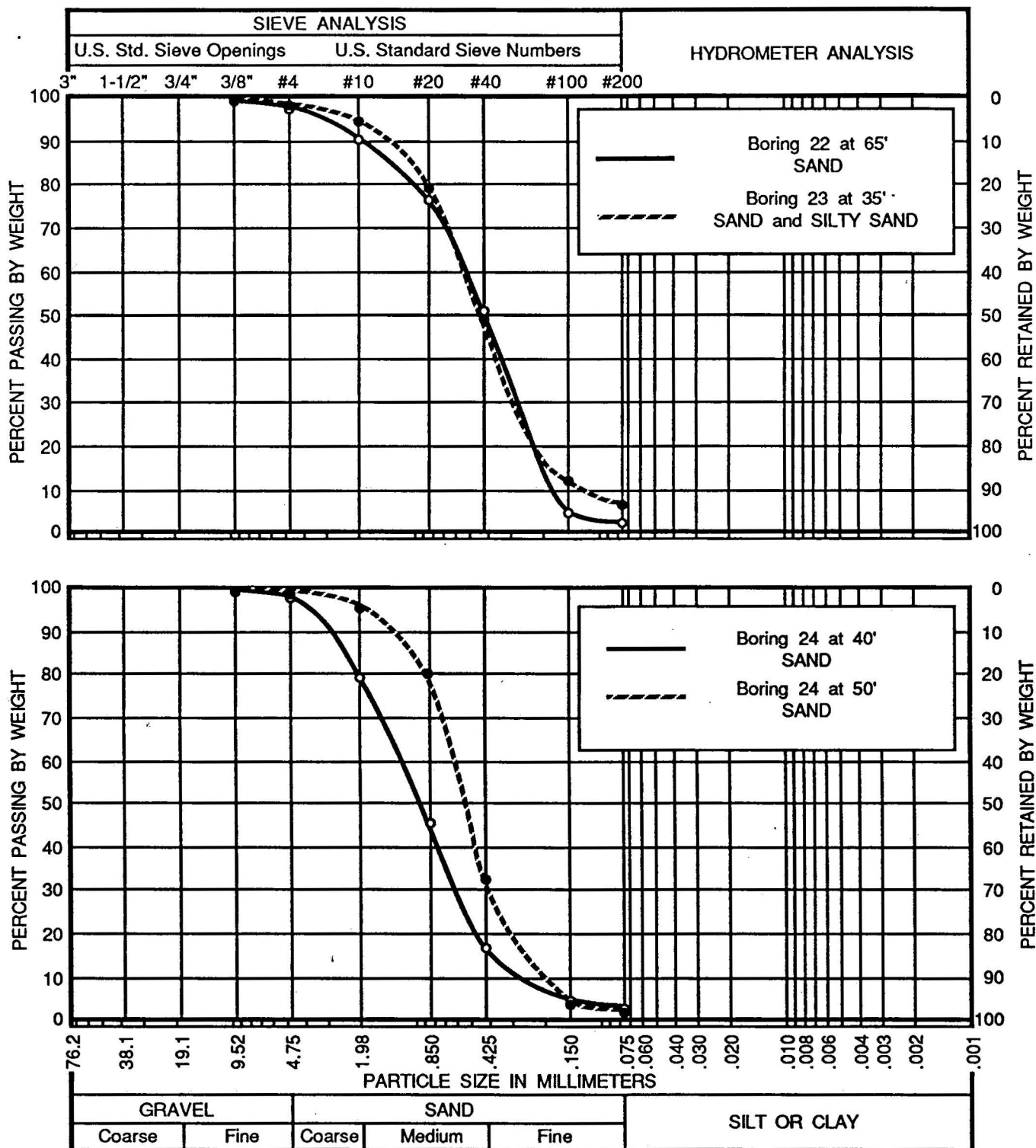
BORING NUMBER AND SAMPLE DEPTH :	68 at 1' to 3'	71 at 1-1/2' to 3'
SOIL TYPE :	FILL - SILTY SAND, and SILTY CLAY	SILTY CLAY
CONFINING PRESSURE : (lbs./sq. ft.)	144	144
INITIAL MOISTURE CONTENT : (% of dry wt.)	9.0	13.0
FINAL MOISTURE CONTENT : (% of dry wt.)	21.0	29.3
DRY DENSITY : (lbs./cu. ft.)	113	100
EXPANSION INDEX :	38	91

TEST METHOD : Uniform Building Code Standard
No. 29 - 2, Expansion Index Test

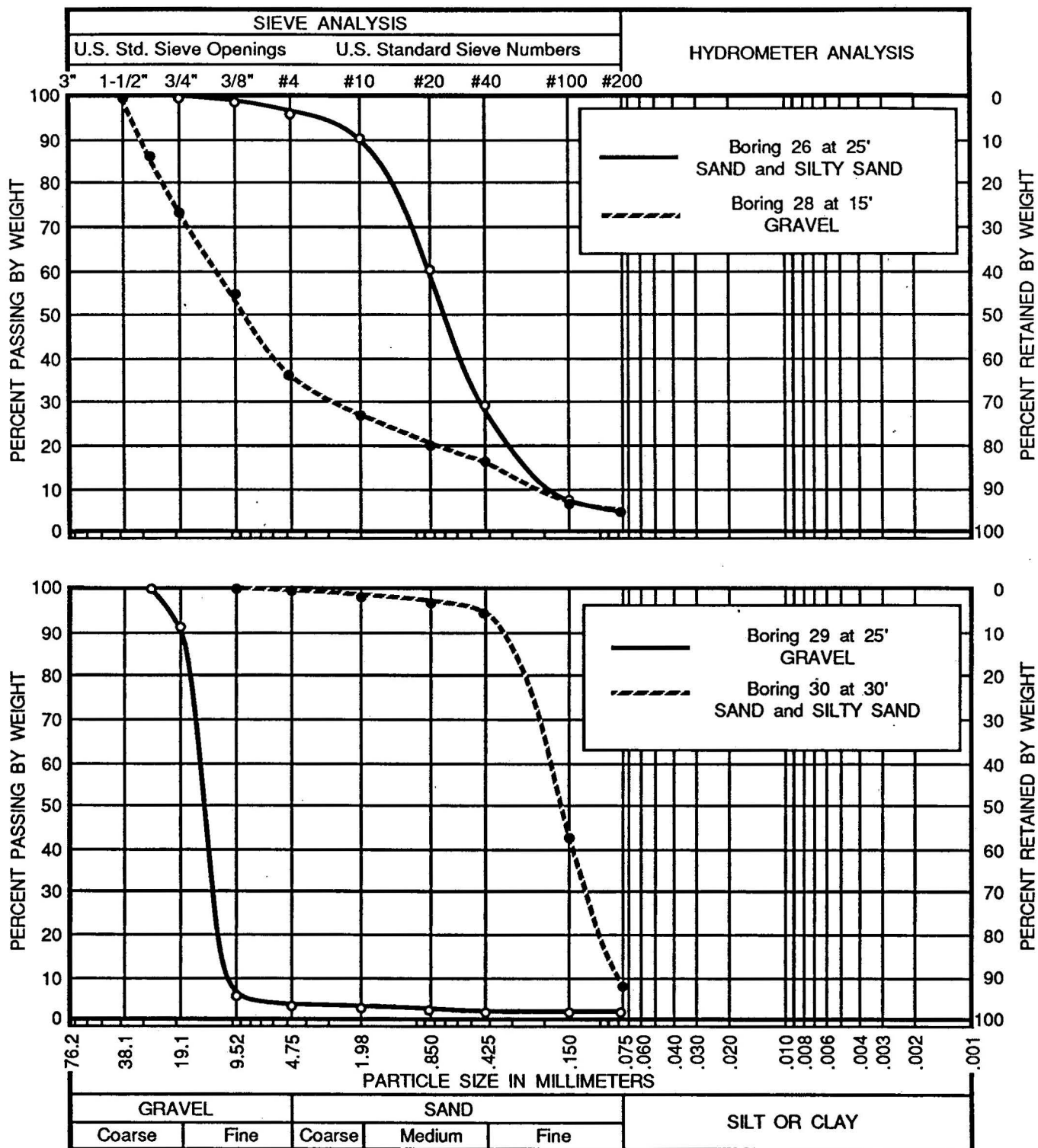
EXPANSION INDEX TEST DATA



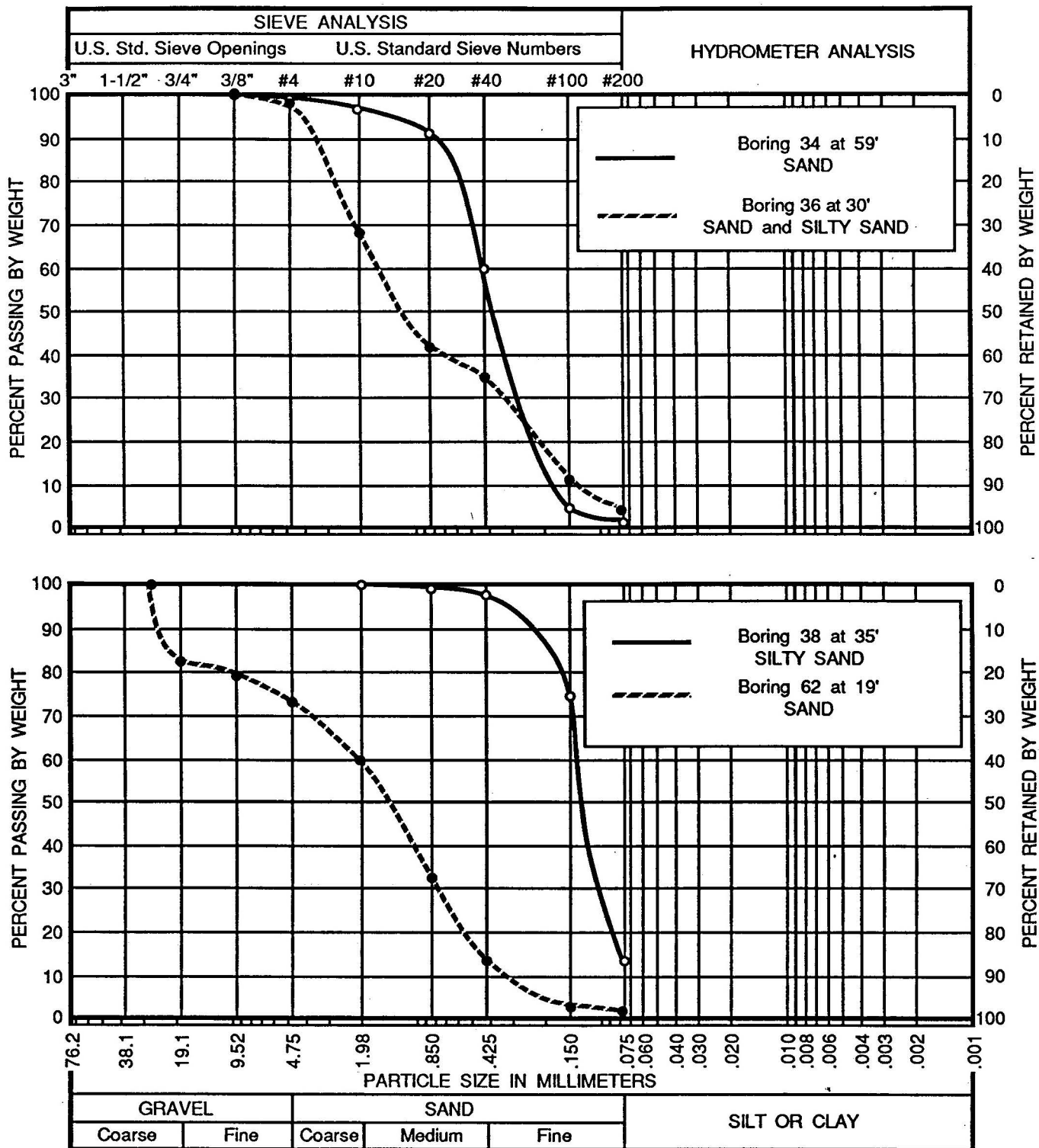
PARTICLE SIZE DISTRIBUTION



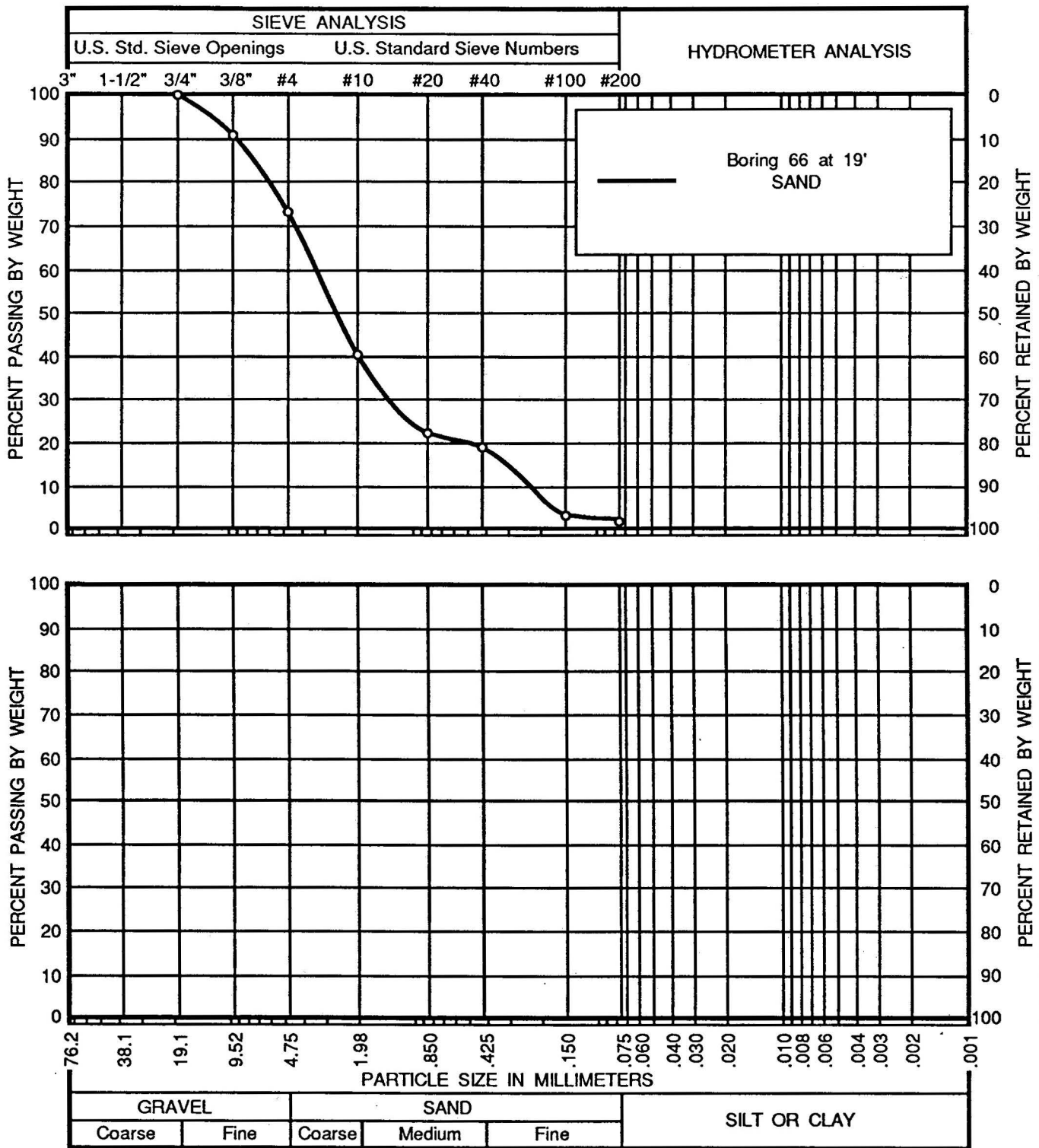
PARTICLE SIZE DISTRIBUTION



PARTICLE SIZE DISTRIBUTION



PARTICLE SIZE DISTRIBUTION



PARTICLE SIZE DISTRIBUTION

LeROY CRANDALL AND ASSOCIATES

PLATE B-5.5

Appendix C
Downhole Seismic Surveys

APPENDIX C

DOWNHOLE SEISMIC SURVEYS

C.1 SUMMARY

Downhole seismic surveys were performed in Borings 4 and 22 to determine the propagation velocity of compressional and shear waves through the subsurface soils. Measurements were made from the ground surface to depths of 76 and 100 feet in the borings.

C.2 PROCEDURE

After completion of the drilling of the borings, two-inch-diameter PVC pipes were installed in the borings, and pea gravel backfill was placed around the pipes. Downhole seismic surveys were then performed in the pipes to determine the propagation velocities of the compressional waves (P-waves) and shear waves (S-waves).

A borehole seismometer, connected with cable to an amplifier and recorder, was lowered to the bottom of the pipe. A wooden plank was placed adjacent to the boring and weighted down with the front wheels of a vehicle. The S-waves were generated by horizontally striking the end of the plank with a sledge hammer; the P-waves were generated by vertically striking the top of the plank. The S-waves and P-waves were detected by the three orthogonal geophones of the borehole seismometer. When the measurements were completed at a given depth, the seismometer was raised to a higher level and a new set of measurements was taken.

C.3 ANALYSIS

The times of first arrivals of the S-waves and P-waves were determined from the recordings and were plotted versus distance from the source on travel time curves which are presented on Plates C-1 and C-2, Downhole Seismic Survey. The propagation velocities were computed and are presented on Plates C-1 and C-2.

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C.4 SITE PERIOD CALCULATIONS

The evaluation of the characteristic site period, T_s , is necessary to determine the coefficient of site-structure resonance, S , in accordance with Section 2312 of the 1985 edition of the Uniform Building Code. The characteristic site periods were evaluated following the procedures suggested in SEAOC Standard No. 1, Recommended Lateral Force Requirements and Commentary, Seismology Committee, Structural Engineers Association of California, 1980.

The site period determination requires the knowledge of the shear wave velocities of the various deposits underlying the site. The shear wave velocity values were determined based on the results of downhole seismic surveys.

The average shear wave velocities that were utilized in the determination of the site periods are presented on Plates C-3 and C-4, Site Period Determination, for geotechnical profiles that are judged to reflect a possible range of depths below the ground surface at which the shear wave velocity is 2,500 feet per second or greater.



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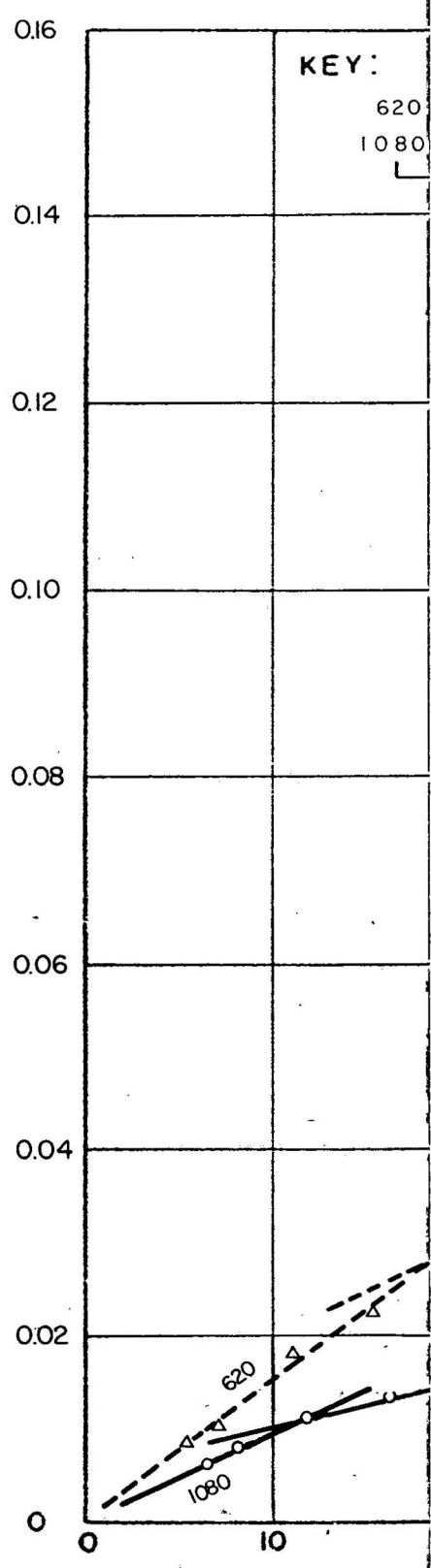
A

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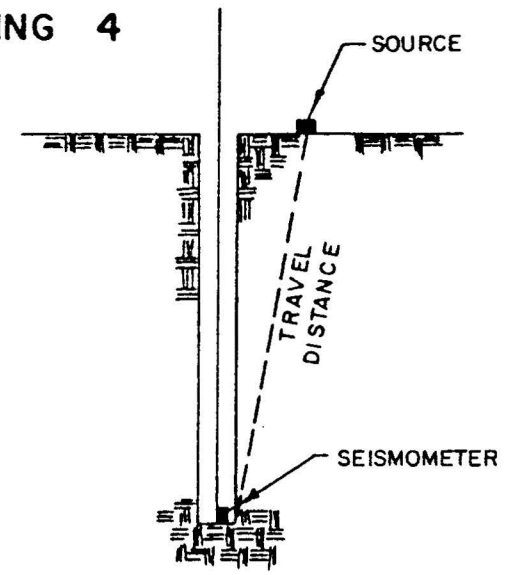
T

JOB A-88044-6 DATE 9-12-88 DR.  O.E. B.W. *BL* CHKD. D.M. *DM*

TRAVEL TIME IN SECONDS



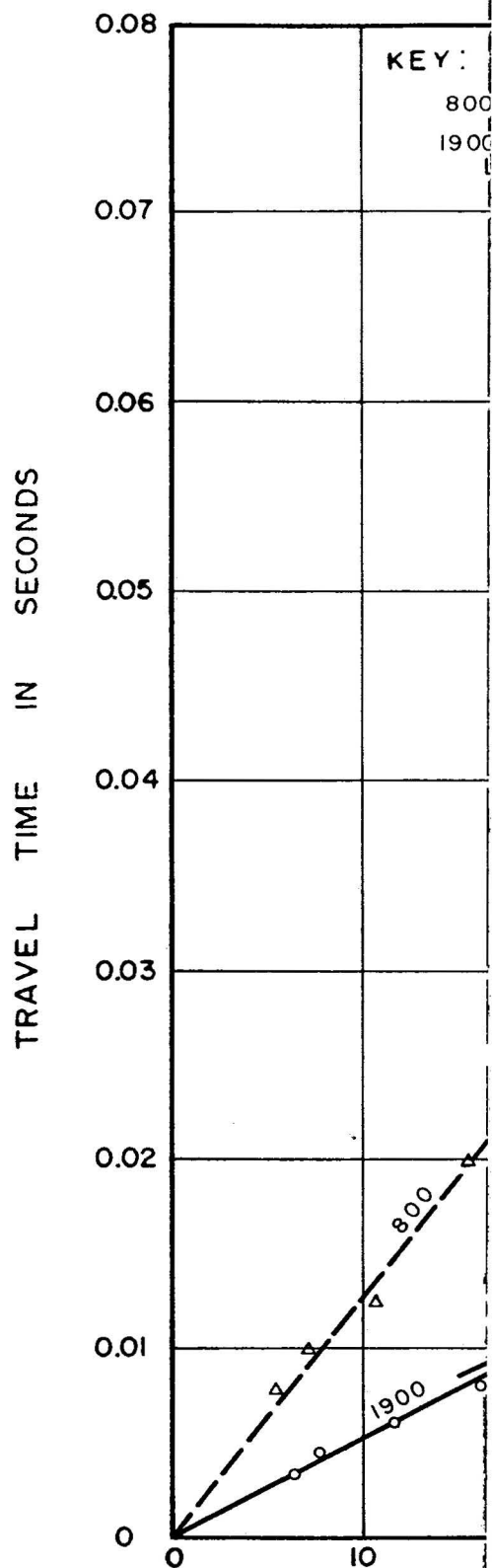
BORING 4



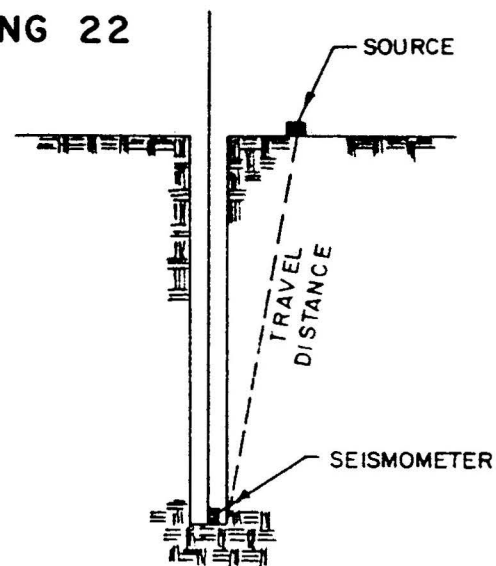
SECTION

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PLATE C - 1



BORING 22



SECTION

BORING NO. 4

LOCATION: Rosecans Avenue and
Aviation Boulevard**CHARACTERISTIC SITE PERIOD:**

(1) Postulated Geotechnical Profiles Below Ground Surface:

PROFILE A

DEPTH BELOW GROUND SURFACE (Feet)	LAYER THICKNESS (Feet)	SHEAR WAVE VELOCITY (Ft./Sec.)
0 - 18	18	620
18 - 67	49	1080
67 - 100	33	1700
100 - 150	50	1700 *
150 - 200	50	2000 *
200 +	—	2500 *

PROFILE B

DEPTH BELOW GROUND SURFACE (Feet)	LAYER THICKNESS (Feet)	SHEAR WAVE VELOCITY (Ft./Sec.)
0 - 18	18	620
18 - 67	49	1080
67 - 100	33	1700
100 - 200	100	1700 *
200 - 250	50	2000 *
250 +	—	2500 *

* Extrapolated below 100 feet below ground surface.

(2) Range of Characteristic Site Period:

Ts = 0.7 to 1.0 sec

SITE PERIOD DETERMINATION

LeROY CRANDALL AND ASSOCIATES

PLATE C-3

JOB ADEF-88044-7 DATE 1/18/89 W.P. lp O.E. DM DM CHKD

BORING NO. 22

LOCATION: Nash Street and
Maple Avenue**CHARACTERISTIC SITE PERIOD:**

(1) Postulated Geotechnical Profiles Below Ground Surface:

PROFILE A

DEPTH BELOW GROUND SURFACE (Feet)	LAYER THICKNESS (Feet)	SHEAR WAVE VELOCITY (Ft./Sec.)
0 - 24	24	800
24 - 75	51	1090
75 - 150	75	1700
150 - 200	50	2000 *
200 +	—	2500 *

PROFILE B

DEPTH BELOW GROUND SURFACE (Feet)	LAYER THICKNESS (Feet)	SHEAR WAVE VELOCITY (Ft./Sec.)
0 - 24	24	800
24 - 75	51	1090
75 - 200	125	1700
200 - 250	50	2000 *
250 +	—	2500 *

* Extrapolated below 75 feet below ground surface.

(2) Range of Characteristic Site Period:

 $T_s = 0.7 \text{ to } 1.0 \text{ sec}$ **SITE PERIOD DETERMINATION**

LeROY CRANDALL AND ASSOCIATES

PLATE C-4

JOB ADEF-88044-7 DATE 1/18/89 W.P. ip O.E. DM DM CHKD

Appendix D
Seismicity Data

APPENDIX D

SEISMICITY DATA

The seismicity of the region surrounding the El Segundo Segment of the rail transit project was determined from a computer search of a magnetic tape catalog of earthquakes. The catalog of earthquakes included those with a Richter magnitude greater than 4.0, within a radius of 100 kilometers of the site, compiled by the California Institute of Technology for the period 1932 to 1987, 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 in this Appendix.

The information listed for each earthquake found in the computer scan 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 explanation of the letter code for the quality factor of the data is presented on the first page of the scan.



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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	50	.0	6.3
03-11-1933	02:04:00	33.75 N	118.08 W	C	34	.0	4.9
03-11-1933	02:05:00	33.75 N	118.08 W	C	34	.0	4.3
03-11-1933	02:09:00	33.75 N	118.08 W	C	34	.0	5.0
03-11-1933	02:10:00	33.75 N	118.08 W	C	34	.0	4.6
03-11-1933	02:11:00	33.75 N	118.08 W	C	34	.0	4.4
03-11-1933	02:16:00	33.75 N	118.08 W	C	34	.0	4.8
03-11-1933	02:17:00	33.60 N	118.00 W	E	50	.0	4.5
03-11-1933	02:22:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	02:27:00	33.75 N	118.08 W	C	34	.0	4.6
03-11-1933	02:30:00	33.75 N	118.08 W	C	34	.0	5.1
03-11-1933	02:31:00	33.60 N	118.00 W	E	50	.0	4.4
03-11-1933	02:52:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	02:57:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	02:58:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	02:59:00	33.75 N	118.08 W	C	34	.0	4.6
03-11-1933	03:05:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	03:09:00	33.75 N	118.08 W	C	34	.0	4.4
03-11-1933	03:11:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	03:23:00	33.75 N	118.08 W	C	34	.0	5.0
03-11-1933	03:36:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	03:39:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	03:47:00	33.75 N	118.08 W	C	34	.0	4.1
03-11-1933	04:36:00	33.75 N	118.08 W	C	34	.0	4.6
03-11-1933	04:39:00	33.75 N	118.08 W	C	34	.0	4.9
03-11-1933	04:40:00	33.75 N	118.08 W	C	34	.0	4.7
03-11-1933	05:10:22	33.70 N	118.07 W	C	38	.0	5.1
03-11-1933	05:13:00	33.75 N	118.08 W	C	34	.0	4.7
03-11-1933	05:15:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	05:18:04	33.57 N	117.98 W	C	53	.0	5.2
03-11-1933	05:21:00	33.75 N	118.08 W	C	34	.0	4.4
03-11-1933	05:24:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	05:53:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	05:55:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	06:11:00	33.75 N	118.08 W	C	34	.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	Q	DIST	DEPTH	MAGNITUDE
03-11-1933	06:18:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	06:29:00	33.85 N	118.27 W	C	13	.0	4.4
03-11-1933	06:35:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	06:58:03	33.68 N	118.05 W	C	40	.0	5.5
03-11-1933	07:51:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	07:59:00	33.75 N	118.08 W	C	34	.0	4.1
03-11-1933	08:08:00	33.75 N	118.08 W	C	34	.0	4.5
03-11-1933	08:32:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	08:37:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	08:54:57	33.70 N	118.07 W	C	38	.0	5.1
03-11-1933	09:10:00	33.75 N	118.08 W	C	34	.0	5.1
03-11-1933	09:11:00	33.75 N	118.08 W	C	34	.0	4.4
03-11-1933	09:26:00	33.75 N	118.08 W	C	34	.0	4.1
03-11-1933	10:25:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	10:45:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	11:00:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	11:04:00	33.75 N	118.13 W	C	30	.0	4.6
03-11-1933	11:29:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	11:38:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	11:41:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	11:47:00	33.75 N	118.08 W	C	34	.0	4.4
03-11-1933	12:50:00	33.68 N	118.05 W	C	40	.0	4.4
03-11-1933	13:50:00	33.73 N	118.10 W	C	33	.0	4.4
03-11-1933	13:57:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	14:25:00	33.85 N	118.27 W	C	13	.0	5.0
03-11-1933	14:47:00	33.73 N	118.10 W	C	33	.0	4.4
03-11-1933	14:57:00	33.88 N	118.32 W	C	7	.0	4.9
03-11-1933	15:09:00	33.73 N	118.10 W	C	33	.0	4.4
03-11-1933	15:47:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	16:53:00	33.75 N	118.08 W	C	34	.0	4.8
03-11-1933	19:44:00	33.75 N	118.08 W	C	34	.0	4.0
03-11-1933	19:56:00	33.75 N	118.08 W	C	34	.0	4.2
03-11-1933	22:00:00	33.75 N	118.08 W	C	34	.0	4.4
03-11-1933	22:31:00	33.75 N	118.08 W	C	34	.0	4.4
03-11-1933	22:32:00	33.75 N	118.08 W	C	34	.0	4.1
03-11-1933	22:40:00	33.75 N	118.08 W	C	34	.0	4.4
03-11-1933	23:05:00	33.75 N	118.08 W	C	34	.0	4.2
03-12-1933	00:27:00	33.75 N	118.08 W	C	34	.0	4.4
03-12-1933	00:34:00	33.75 N	118.08 W	C	34	.0	4.0
03-12-1933	04:48:00	33.75 N	118.08 W	C	34	.0	4.0
03-12-1933	05:46:00	33.75 N	118.08 W	C	34	.0	4.4
03-12-1933	06:01:00	33.75 N	118.08 W	C	34	.0	4.2
03-12-1933	06:16:00	33.75 N	118.08 W	C	34	.0	4.6
03-12-1933	07:40:00	33.75 N	118.08 W	C	34	.0	4.2
03-12-1933	08:35:00	33.75 N	118.08 W	C	34	.0	4.2



DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
03-12-1933	15:02:00	33.75 N	118.08 W	C	34	.0	4.2
03-12-1933	16:51:00	33.75 N	118.08 W	C	34	.0	4.0
03-12-1933	17:38:00	33.75 N	118.08 W	C	34	.0	4.5
03-12-1933	18:25:00	33.75 N	118.08 W	C	34	.0	4.1
03-12-1933	21:28:00	33.75 N	118.08 W	C	34	.0	4.1
03-12-1933	23:54:00	33.75 N	118.08 W	C	34	.0	4.5
03-13-1933	03:43:00	33.75 N	118.08 W	C	34	.0	4.1
03-13-1933	04:32:00	33.75 N	118.08 W	C	34	.0	4.7
03-13-1933	06:17:00	33.75 N	118.08 W	C	34	.0	4.0
03-13-1933	13:18:28	33.75 N	118.08 W	C	34	.0	5.3
03-13-1933	15:32:00	33.75 N	118.08 W	C	34	.0	4.1
03-13-1933	19:29:00	33.75 N	118.08 W	C	34	.0	4.2
03-14-1933	00:36:00	33.75 N	118.08 W	C	34	.0	4.2
03-14-1933	12:19:00	33.75 N	118.08 W	C	34	.0	4.5
03-14-1933	19:01:50	33.62 N	118.02 W	C	47	.0	5.1
03-14-1933	22:42:00	33.75 N	118.08 W	C	34	.0	4.1
03-15-1933	02:08:00	33.75 N	118.08 W	C	34	.0	4.1
03-15-1933	04:32:00	33.75 N	118.08 W	C	34	.0	4.1
03-15-1933	05:40:00	33.75 N	118.08 W	C	34	.0	4.2
03-15-1933	11:13:32	33.62 N	118.02 W	C	47	.0	4.9
03-16-1933	14:56:00	33.75 N	118.08 W	C	34	.0	4.0
03-16-1933	15:29:00	33.75 N	118.08 W	C	34	.0	4.2
03-16-1933	15:30:00	33.75 N	118.08 W	C	34	.0	4.1
03-17-1933	16:51:00	33.75 N	118.08 W	C	34	.0	4.1
03-18-1933	20:52:00	33.75 N	118.08 W	C	34	.0	4.2
03-19-1933	21:23:00	33.75 N	118.08 W	C	34	.0	4.2
03-20-1933	13:58:00	33.75 N	118.08 W	C	34	.0	4.1
03-21-1933	03:26:00	33.75 N	118.08 W	C	34	.0	4.1
03-23-1933	08:40:00	33.75 N	118.08 W	C	34	.0	4.1
03-23-1933	18:31:00	33.75 N	118.08 W	C	34	.0	4.1
03-25-1933	13:46:00	33.75 N	118.08 W	C	34	.0	4.1
03-30-1933	12:25:00	33.75 N	118.08 W	C	34	.0	4.4
03-31-1933	10:49:00	33.75 N	118.08 W	C	34	.0	4.1
04-01-1933	06:42:00	33.75 N	118.08 W	C	34	.0	4.2
04-02-1933	08:00:00	33.75 N	118.08 W	C	34	.0	4.0
04-02-1933	15:36:00	33.75 N	118.08 W	C	34	.0	4.0
05-16-1933	20:58:55	33.75 N	118.17 W	C	27	.0	4.0
08-04-1933	04:17:48	33.75 N	118.18 W	C	26	.0	4.0
10-02-1933	09:10:18	33.78 N	118.13 W	A	28	.0	5.4
10-02-1933	13:26:01	33.62 N	118.02 W	C	47	.0	4.0
10-25-1933	07:00:46	33.95 N	118.13 W	C	24	.0	4.3
11-13-1933	21:28:00	33.87 N	118.20 W	C	18	.0	4.0
11-20-1933	10:32:00	33.78 N	118.13 W	B	28	.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	41	.0	4.5
04-17-1934	18:33:00	33.57 N	117.98 W	C	53	.0	4.0
10-17-1934	09:38:00	33.63 N	118.40 W	B	31	.0	4.0
11-16-1934	21:26:00	33.75 N	118.00 W	B	40	.0	4.0
06-19-1935	11:17:00	33.72 N	117.52 W	B	83	.0	4.0
07-13-1935	10:54:17	34.20 N	117.90 W	A	56	.0	4.7
09-03-1935	06:47:00	34.03 N	117.32 W	B	100	.0	4.5
12-25-1935	17:15:00	33.60 N	118.02 W	B	49	.0	4.5
08-22-1936	05:21:00	33.77 N	117.82 W	B	55	.0	4.0
10-29-1936	22:35:36	34.38 N	118.62 W	C	56	.0	4.0
01-15-1937	18:35:47	33.56 N	118.06 W	B	49	.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	53	.0	4.0
09-01-1937	13:48:08	34.21 N	117.53 W	A	86	.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	46	.0	4.0
05-31-1938	08:34:55	33.70 N	117.51 W	B	85	.0	5.5
07-05-1938	18:06:56	33.68 N	117.55 W	A	82	.0	4.5
08-06-1938	22:00:56	33.72 N	117.51 W	B	84	.0	4.0
08-31-1938	03:18:14	33.76 N	118.25 W	A	21	.0	4.5
11-29-1938	19:21:16	33.90 N	118.43 W	A	4	.0	4.0
12-07-1938	03:38:00	34.00 N	118.42 W	B	10	.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	29	.0	4.0
12-27-1939	19:28:49	33.78 N	118.20 W	A	23	.0	4.7
01-13-1940	07:49:07	33.78 N	118.13 W	B	28	.0	4.0
02-08-1940	16:56:17	33.70 N	118.07 W	B	38	.0	4.0
02-11-1940	19:24:10	33.98 N	118.30 W	B	11	.0	4.0
04-18-1940	18:43:44	34.03 N	117.35 W	A	97	.0	4.4
05-18-1940	09:15:12	34.60 N	118.90 W	C	90	.0	4.0
06-05-1940	08:27:27	33.83 N	117.40 W	B	92	.0	4.0
07-20-1940	04:01:13	33.70 N	118.07 W	B	38	.0	4.0
10-11-1940	05:57:12	33.77 N	118.45 W	A	16	.0	4.7
10-12-1940	00:24:00	33.78 N	118.42 W	B	15	.0	4.0
10-14-1940	20:51:11	33.78 N	118.42 W	B	15	.0	4.0
11-01-1940	07:25:03	33.78 N	118.42 W	B	15	.0	4.0
11-01-1940	20:00:46	33.63 N	118.20 W	B	36	.0	4.0
11-02-1940	02:58:26	33.78 N	118.42 W	B	15	.0	4.0
01-30-1941	01:34:47	33.97 N	118.05 W	A	32	.0	4.1
03-22-1941	08:22:40	33.52 N	118.10 W	B	51	.0	4.0
03-25-1941	23:43:41	34.22 N	117.47 W	B	92	.0	4.0
04-11-1941	01:20:24	33.95 N	117.58 W	B	75	.0	4.0
10-22-1941	06:57:19	33.82 N	118.22 W	A	19	.0	4.9
11-14-1941	08:41:36	33.78 N	118.25 W	A	19	.0	5.4
04-16-1942	07:28:33	33.37 N	118.15 W	C	64	.0	4.0



DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
09-03-1942	14:06:01	34.48 N	118.98 W	C	84	.0	4.5
09-04-1942	06:34:33	34.48 N	118.98 W	C	84	.0	4.5
10-24-1943	00:29:21	33.93 N	117.37 W	C	94	.0	4.0
06-19-1944	00:03:33	33.87 N	118.22 W	B	16	.0	4.5
06-19-1944	03:06:07	33.87 N	118.22 W	C	16	.0	4.4
02-24-1946	06:07:52	34.40 N	117.80 W	C	77	.0	4.1
06-01-1946	11:06:31	34.42 N	118.83 W	C	70	.0	4.1
03-01-1948	08:12:13	34.17 N	117.53 W	B	85	.0	4.7
04-16-1948	22:26:24	34.02 N	118.97 W	B	55	.0	4.7
10-03-1948	02:46:28	34.18 N	117.58 W	A	81	.0	4.0
01-11-1950	21:41:35	33.94 N	118.20 W	A	18	.0	4.1
01-24-1950	21:56:59	34.67 N	118.83 W	C	94	.0	4.0
08-22-1950	22:47:58	34.15 N	119.35 W	B	93	.0	4.2
09-22-1951	08:22:39	34.12 N	117.34 W	A	100	.0	4.3
02-10-1952	13:50:55	33.58 N	119.18 W	C	82	.0	4.0
08-23-1952	10:09:07	34.52 N	118.20 W	A	70	.0	5.0
10-26-1954	16:22:26	33.73 N	117.47 W	B	87	.0	4.1
11-17-1954	23:03:51	34.50 N	119.12 W	B	94	.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	63	.0	4.1
01-03-1956	00:25:49	33.72 N	117.50 W	B	85	.0	4.7
02-07-1956	02:16:57	34.53 N	118.64 W	B	73	.0	4.2
02-07-1956	03:16:39	34.59 N	118.61 W	A	78	.0	4.6
03-25-1956	03:32:02	33.60 N	119.10 W	A	74	.0	4.2
03-18-1957	18:56:28	34.12 N	119.22 W	B	80	.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	60	.0	4.1
10-20-1961	19:49:51	33.65 N	117.99 W	B	47	.0	4.3
10-20-1961	20:07:14	33.66 N	117.98 W	B	47	.0	4.0
10-20-1961	21:42:41	33.67 N	117.98 W	B	46	.0	4.0
10-20-1961	22:35:34	33.67 N	118.01 W	B	44	.0	4.1
11-20-1961	08:53:35	33.68 N	117.99 W	B	45	.0	4.0
09-14-1963	03:51:16	33.54 N	118.34 W	B	41	.0	4.2
08-30-1964	22:57:37	34.27 N	118.44 W	B	40	.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	64	.0	4.0
01-08-1967	07:37:30	33.63 N	118.47 W	B	32	.0	4.0
01-08-1967	07:38:05	33.66 N	118.41 W	C	28	.0	4.0
06-15-1967	04:58:06	34.00 N	117.97 W	B	40	.0	4.1
02-28-1969	04:56:12	34.57 N	118.11 W	A	78	.0	4.3
05-05-1969	16:02:10	34.30 N	117.57 W	B	87	.0	4.4
10-24-1969	20:26:43	33.34 N	119.10 W	B	91	.0	4.7
10-27-1969	13:16:02	33.55 N	117.81 W	B	67	.0	4.5
10-31-1969	10:39:29	33.43 N	119.10 W	B	85	.0	4.8



DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
09-12-1970	14:10:11	34.27 N	117.52 W	A	90	.0	4.1
09-12-1970	14:30:53	34.27 N	117.54 W	A	88	.0	5.4
09-13-1970	04:47:49	34.28 N	117.55 W	A	88	.0	4.4
02-09-1971	14:00:42	34.41 N	118.40 W	B	55	.0	6.4
02-09-1971	14:01:08	34.41 N	118.40 W	D	55	.0	5.8
02-09-1971	14:01:33	34.41 N	118.40 W	D	55	.0	4.2
02-09-1971	14:01:40	34.41 N	118.40 W	D	55	.0	4.1
02-09-1971	14:01:50	34.41 N	118.40 W	D	55	.0	4.5
02-09-1971	14:01:54	34.41 N	118.40 W	D	55	.0	4.2
02-09-1971	14:01:59	34.41 N	118.40 W	D	55	.0	4.1
02-09-1971	14:02:03	34.41 N	118.40 W	D	55	.0	4.1
02-09-1971	14:02:30	34.41 N	118.40 W	D	55	.0	4.3
02-09-1971	14:02:31	34.41 N	118.40 W	D	55	.0	4.7
02-09-1971	14:02:44	34.41 N	118.40 W	D	55	.0	5.8
02-09-1971	14:03:25	34.41 N	118.40 W	D	55	.0	4.4
02-09-1971	14:03:46	34.41 N	118.40 W	D	55	.0	4.1
02-09-1971	14:04:07	34.41 N	118.40 W	D	55	.0	4.1
02-09-1971	14:04:34	34.41 N	118.40 W	C	55	.0	4.2
02-09-1971	14:04:39	34.41 N	118.40 W	D	55	.0	4.1
02-09-1971	14:04:44	34.41 N	118.40 W	D	55	.0	4.1
02-09-1971	14:04:46	34.41 N	118.40 W	D	55	.0	4.2
02-09-1971	14:05:41	34.41 N	118.40 W	D	55	.0	4.1
02-09-1971	14:05:50	34.41 N	118.40 W	D	55	.0	4.1
02-09-1971	14:07:10	34.41 N	118.40 W	D	55	.0	4.0
02-09-1971	14:07:30	34.41 N	118.40 W	D	55	.0	4.0
02-09-1971	14:07:45	34.41 N	118.40 W	D	55	.0	4.5
02-09-1971	14:08:04	34.41 N	118.40 W	D	55	.0	4.0
02-09-1971	14:08:07	34.41 N	118.40 W	D	55	.0	4.2
02-09-1971	14:08:38	34.41 N	118.40 W	D	55	.0	4.5
02-09-1971	14:08:53	34.41 N	118.40 W	D	55	.0	4.6
02-09-1971	14:10:21	34.36 N	118.31 W	B	50	.0	4.7
02-09-1971	14:10:28	34.41 N	118.40 W	D	55	.0	5.3
02-09-1971	14:16:13	34.34 N	118.33 W	C	48	.0	4.1
02-09-1971	14:19:50	34.36 N	118.41 W	B	50	.0	4.0
02-09-1971	14:34:36	34.34 N	118.64 W	C	53	.0	4.9
02-09-1971	14:39:18	34.39 N	118.36 W	C	53	.0	4.0
02-09-1971	14:40:17	34.43 N	118.40 W	C	58	.0	4.1
02-09-1971	14:43:47	34.31 N	118.45 W	B	45	.0	5.2
02-09-1971	15:58:21	34.33 N	118.33 W	B	47	.0	4.8
02-09-1971	16:19:26	34.46 N	118.43 W	B	61	.0	4.2
02-10-1971	03:12:12	34.37 N	118.30 W	B	52	.0	4.0
02-10-1971	05:06:36	34.41 N	118.33 W	A	56	.0	4.3
02-10-1971	05:18:07	34.43 N	118.41 W	A	58	.0	4.5
02-10-1971	11:31:35	34.38 N	118.45 W	A	52	.0	4.2
02-10-1971	13:49:54	34.40 N	118.42 W	A	54	.0	4.3



DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
02-10-1971	14:35:27	34.36 N	118.49 W	A	51	.0	4.2
02-10-1971	17:38:55	34.40 N	118.37 W	A	54	.0	4.2
02-10-1971	18:54:42	34.45 N	118.44 W	A	60	.0	4.2
02-21-1971	05:50:53	34.40 N	118.44 W	A	55	.0	4.7
02-21-1971	07:15:12	34.39 N	118.43 W	A	53	.0	4.5
03-07-1971	01:33:41	34.35 N	118.46 W	A	49	.0	4.5
03-25-1971	22:54:10	34.36 N	118.47 W	A	50	.0	4.2
03-30-1971	08:54:43	34.30 N	118.46 W	A	44	.0	4.1
03-31-1971	14:52:23	34.29 N	118.51 W	A	44	.0	4.6
04-01-1971	15:03:04	34.43 N	118.41 W	A	58	.0	4.1
04-02-1971	05:40:25	34.28 N	118.53 W	A	43	.0	4.0
04-15-1971	11:14:32	34.26 N	118.58 W	B	43	.0	4.2
04-25-1971	14:48:07	34.37 N	118.31 W	B	52	.0	4.0
06-21-1971	16:01:08	34.27 N	118.53 W	B	42	.0	4.0
06-22-1971	10:41:19	33.75 N	117.48 W	B	86	.0	4.2
02-21-1973	14:45:57	34.06 N	119.03 W	B	61	.0	5.9
03-09-1974	00:54:32	34.40 N	118.47 W	C	55	.0	4.7
08-14-1974	14:45:55	34.43 N	118.37 W	A	58	.0	4.2
01-01-1976	17:20:13	33.96 N	117.89 W	A	47	.0	4.2
04-08-1976	15:21:38	34.35 N	118.66 W	A	55	.0	4.6
08-12-1977	02:19:26	34.38 N	118.46 W	B	53	.0	4.5
09-24-1977	21:28:24	34.46 N	118.41 W	C	61	.0	4.2
05-23-1978	09:16:51	33.91 N	119.17 W	C	72	.0	4.0
01-01-1979	23:14:39	33.94 N	118.68 W	B	27	.0	5.0
10-17-1979	20:52:37	33.93 N	118.67 W	C	26	.0	4.2
10-19-1979	12:22:38	34.21 N	117.53 W	B	86	.0	4.1
09-04-1981	15:50:50	33.67 N	119.11 W	C	72	5.0	5.3
10-23-1981	17:28:17	33.63 N	119.02 W	C	66	12.0	4.6
10-23-1981	19:15:52	33.64 N	119.06 W	C	69	6.2	4.6
04-13-1982	11:02:12	34.05 N	118.96 W	A	55	16.6	4.0
05-25-1982	13:44:30	33.54 N	118.21 W	A	44	13.7	4.1
01-08-1983	07:19:30	34.14 N	117.45 W	A	91	4.6	4.1
02-27-1984	10:18:15	33.47 N	118.06 W	C	58	6.0	4.0
06-12-1984	00:27:52	34.54 N	118.99 W	A	89	11.8	4.1
10-26-1984	17:20:43	34.02 N	118.99 W	A	57	13.3	4.6
04-03-1985	04:04:50	34.38 N	119.04 W	A	80	27.9	4.0
10-01-1987	14:42:20	34.06 N	118.08 W	A	33	9.5	5.9
10-01-1987	14:45:41	34.05 N	118.10 W	A	31	13.6	4.7
10-01-1987	14:48:03	34.08 N	118.09 W	A	34	11.7	4.1
10-01-1987	14:49:06	34.06 N	118.10 W	A	32	11.7	4.7
10-01-1987	15:12:32	34.05 N	118.09 W	A	32	10.8	4.7
10-01-1987	15:59:54	34.05 N	118.09 W	A	32	10.4	4.0
10-04-1987	10:59:38	34.07 N	118.10 W	A	32	8.2	5.3



S E A R C H O F E A R T H Q U A K E D A T A F I L E 1

SITE: ADEF-88044, El Segundo Segment, NES Rail Transit Project

COORDINATES OF SITE	.....	33.91 N	118.39 W
DISTANCE PER DEGREE	.....	110.9 KM-N	92.5 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	.....		303

L e R O Y C R A N D A L L A N D A S S O C I A T E S



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	94	.0	6.0

S E A R C H O F E A R T H Q U A K E D A T A F I L E 2

SITE: ADEF-88044, El Segundo Segment, NES Rail Transit Project

COORDINATES OF SITE	.....	33.91 N	118.39 W
DISTANCE PER DEGREE	.....	110.9 KM-N	92.5 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	

L e R O Y C R A N D A L L A N D A S S O C I A T E S



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	Q	DIST	DEPTH	MAGNITUDE
02-09-1890	04:06:00	34.00 N	117.50 W	D	83	.0	7.0

S E A R C H O F E A R T H Q U A K E D A T A F I L E 3

SITE: ADEF-88044, El Segundo Segment, NES Rail Transit Project

COORDINATES OF SITE	.....	33.91 N	118.39 W
DISTANCE PER DEGREE	.....	110.9 KM-N	92.5 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	

L e R O Y C R A N D A L L A N D A S S O C I A T E S



S U M M A R Y O F E A R T H Q U A K E S E A R C H

* * *

*What period of time?
1933 - 87 ~ 54 yrs.*

NUMBER OF HISTORIC EARTHQUAKES WITHIN 100 KM RADIUS OF SITE

MAGNITUDE RANGE	NUMBER
4.0 - 4.5	210
4.5 - 5.0	66
5.0 - 5.5	19
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

1890 c 7.0

* * *

L e R O Y C R A N D A L L A N D A S S O C I A T E S



COMPUTATION OF RECURRENCE CURVE

LOG N - A - B M

* * *

BIN	MAGNITUDE	RANGE	NO/YR (N)
1	4.00	4.00 - 8.50	5.42
2	4.50	4.50 - 8.50	1.67
3	5.00	5.00 - 8.50	.489
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 = 1.277 B = .5976 (NORMALIZED)
A = 4.952 B = 1.0526 SIGMA = .108E-01

* * *

L e R O Y C R A N D A L L A N D A S S O C I A T E S



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	7.51	7.65	7.76
.10	..	237	474	711	949	..	6.95	7.23	7.39	7.50
.20	..	112	224	336	448	..	6.65	6.93	7.09	7.21
.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	6.52
.90	..	10	21	32	43	..	5.69	5.97	6.14	6.26

MMIN = 4.00 MMAX = 8.50
MU = 5.52 BETA = 2.424

* * *

L e R O Y C R A N D A L L A N D A S S O C I A T E S



Appendix E
Resistivity Data

M. J. SCHIFF & ASSOCIATES

Consulting Corrosion Engineers

1291 NORTH INDIAN HILL BOULEVARD
CLAREMONT, CALIFORNIA 91711
714/626-0967
FAX 714/621-1419

January 24, 1989

LeROY CRANDALL & ASSOCIATES
900 Grand Central Avenue
Glendale, California 91201-3009

Attention: Mr. Do Mar

Re: Preliminary Results
Soil Corrosivity Tests
Norwalk El Segundo Rail Transit
Your #ADE-88044, MJS&A #88310

INTRODUCTION:

Field and laboratory tests have been conducted on soils along and from the route of the subject rail transit project in accordance with your verbal authorization of December 12, 1988; some of the laboratory tests are still underway and a final report will be submitted when the laboratory tests are completed. The conclusions in this report should be considered as preliminary and subject to review and change pending the results of the laboratory testing.

The purpose of these tests was to determine if the soils may have deleterious effects on underground utilities, tanks, hydraulic vehicle hoist cylinders, and concrete structures and foundations.

The proposed route runs from the Century Freeway near Aviation Boulevard to Compton Boulevard. The elevated section will be supported by 50 feet deep reinforced concrete piles, 6 feet in diameter. The Hawthorne Yard and Shops, near Compton Boulevard, will be constructed at grade and will consist of vehicle maintenance facilities, operations building, etc.

TEST PROCEDURES

The electrical resistivity of the soil was measured in the field using the Wenner Four Pin Method. This procedure gives the average resistivity to a depth equal to the spacing between the pins. Pin spacings of 2.5, 5, 7.5, 10, and 15 feet were used so that variations with depth could be evaluated. Strata resistivities were calculated from the data using the Barnes Procedure.

The electrical resistivity of each soil sample was measured in its as-received condition and again with distilled water added to create the standardized condition of saturation. Soil 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. Oxidation-reduction (redox) potentials and sulfides were also measured on samples from borings 26 and 34. Results are shown on Table 1.

SOIL CHARACTERISTICS

One of the most useful factors in determining soil corrosivity is electrical resistivity. The electrical resistivity of a soil is a measure of its resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. A soil's resistivity decreases and, therefore, its corrosivity increases primarily as its moisture and chemical contents increase.

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

<u>Resistivity in ohm-centimeters</u>	<u>Corrosivity Category</u>
0 to 1,000	severely corrosive
1,000 to 2,000	corrosive
2,000 to 10,000	moderaely corrosive
over 10,000	mildly corrosive

Field tests place the average soil resistivities in the mildly corrosive to severely corrosive categories.

Laboratory tests place the soils in mildly corrosive to severely corrosive categories both as-received and saturated.

The pH values ranged from 7.0 to 8.5 which is neutral to strongly alkaline. This is not significant in evaluating corrosivity in this case.

The chemical content of most of the samples was low. Samples from borings 13, 66 and 71 had a moderate chemical content. However, there was not a high enough concentration of any particular anion to be of special concern.

The chemical content of the fill sample from boring 35 was high. Sodium chloride was the predominant compound. Chloride ions are particularly corrosive to ferrous metals and in such high concentrations they can overcome the corrosion inhibiting effect of concrete on reinforcing steel.

Sulfides which are aggressive to copper, showed no reaction in a qualitative test. The high positive redox potentials indicate reducing conditions in which anaerobic, sulfide reducing bacteria are dormant.

Since most of these borings are widely separated along the route, each site will be discussed individually.

Mariposa Station: Field stratum resistivities were in the moderately corrosive and corrosive categories. Laboratory samples from borings 26 and 27 were in the moderately corrosive category as-received. When saturated the sample from boring 26 dropped into the corrosive category. pH was mildly and moderately alkaline. Chemical content was low.

El Segundo Station: Field stratum resistivities were in the moderately corrosive to corrosive categories. Laboratory samples from borings 34 and 35 were in the moderately corrosive and severely corrosive categories as-received. When saturated, the sample from boring 34 dropped into the corrosive category. pH was mildly and moderately alkaline. The chemical content was high with sodium chloride the predominant compound.

Douglas Station: Laboratory samples from borings 47 and 49 were in the moderately corrosive category as-received. When saturated, the sample from boring 49 dropped into the corrosive category. The pH was moderately alkaline, and chemical content was low.

Compton Boulevard Station: Field stratum resistivities were in the mildly corrosive to corrosive categories. Laboratory samples from borings 56 and 57 were in the mildly corrosive category as-received. When saturated, the sample from boring 56 dropped into the corrosive category. The pH was mildly and strongly alkaline and chemical content was low.

Hawthorne Yard and Shops: The field stratum resistivities were in the mildly corrosive to corrosive categories. The laboratory samples from borings 65, 66, 67, and 71 were in the mildly corrosive and corrosive categories as-received. When saturated, three dropped into the severely corrosive category. The pH ranged from 7.6 to 8.2 which is mildly to moderately alkaline. The chemical content of two of the samples was low and the other two was moderate.

RECOMMENDATIONS

Boring	Location	Steel	Iron	Copper	Concrete	Plastic & Asbestos-cement
	All sites	1,2,3,5,10			13	15
8,10	*Aviation Blvd Stn.					
26,27	Mariposa Stn.		7	8	11	
34,35	El Segundo Stn.		6	14	11,12	
47,49	Douglas Stn.		7	8	11	
56,57	Compton Blvd. Stn.		7	8	11	
65,66,	Hawthorne Yard	4,9	6	8	11	
67,71	& Shops					

* Recommendations to be made at a later date.

1. Underground steel utilities should be blasted and given a high quality protective coating such as 40 mil extruded polyethylene 20 mil plastic tape over primer or hot applied coal tar enamel or tape.
2. All underground steel should be electrically insulated from dissimilar metals, cement-mortar or concrete coated steel, and above ground steel. Underground steel pipe should be bonded for electrical continuity if rubber gasketed, mechanical, grooved end, or other nonconductive type joints are used.
3. Cathodic protection is recommended for underground steel.
4. Hydraulic vehicle hoist cylinders, buried air/oil tanks, and associated steel piping should be coated, insulated from other metals including reinforcing steel, and bonded as described above. In addition all buried steel parts should either be cathodically protected or encased in concrete. Underground steel fuel tanks should be protected in accordance with California Underground Storage Tank Regulations dated August 1985 (including 1987 amendments), issued by the State Water Resources Control Board.
5. 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.

6. Cast or ductile iron pipe, valves, and fittings should be encased in an 8 mil polyethylene tube or wrap per AWWA Standard C105/ANSI 21.5. As an alternate, iron piping not under pressure, such as sewers or drains, may be bedded and backfilled with cement slurry or alkalized sand (25 pounds hydrated lime mixed with each cubic yard of sand) at least 3 inches thick surrounding the pipe. Underground iron pipe should be electrically insulated from dissimilar metals, cement-mortar or concrete coated iron, and above ground iron.
7. Cast or ductile iron pipe, valves, and fittings do not require special protective measures such as plastic wrap. However, to avoid possibly creating corrosion problems iron should not be placed partially in contact with concrete. Coatings mentioned above for steel or polyethylene plastic sheets 8 mils thick may be used to prevent such contact. Underground iron pipe should also be electrically insulated from dissimilar metals, concrete or cement-mortar coated iron, and above ground iron.
8. No special precautions are required for copper, asbestos-cement or plastic utilities placed underground from a corrosion viewpoint.
9. Where metallic pipelines penetrate concrete structures such as building floors or walls, plastic sleeves, rubber seals, or other dielectric material should be used to prevent pipe contact with the concrete and reinforcing steel.
10. 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.
11. Standard construction practices and concrete mixes may be used for concrete in contact with these soils using type 1 or 2 cement.
12. Concrete cover over reinforcing steel in concrete contacting these soils should be at least 2 inches thick if placed against forms and 3 inches thick if placed against the earth. Also a water/cement ratio not exceeding 0.45 is recommended to reduce concrete permeability.
13. It is assumed that prestressed concrete piles will contain at least 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 1.5 inches thick over embedded steel from a corrosion viewpoint. If groundwater is present, 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 1.25 inches deep and the hole filled with epoxy.
14. Copper should be coated with plastic pipe wrapping tape.
15. No special precautions are required for asbestos-cement or plastic utilities placed underground from a corrosion viewpoint.

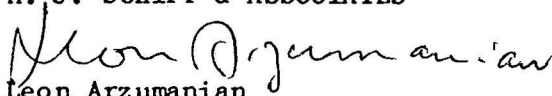
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LeROY CRANDALL & ASSOCIATES
MJS&A #88310

January 24, 1989
Page 6

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


Leon Arzumian

sm
Enc. Table 1
Field soil resistivity data
L27

Table 1 - LABORATORY TESTS ON SOIL SAMPLES

Page 1 of 2

Location and Depth	Soil Type	Soil Resistivity ohm-centimeters		pH	-----Chemical Analysis in mg/kg (ppm) of dry soil-----								Sulfide S	Redox MV
		As Rec'd	Sat'd		Calcium Ca	Magnesium Mg	Sodium Na	Bicarbonate HCO3	Chloride Cl	Sulfate SO4				
Mariposa														
B26 6'	clay	3,200	1,100	8.1	trace	trace	172	122	212	40	none	+200		
B27 12'	sand	6,700	2,900	7.7	trace	trace	69	122	71	trace				
El Segundo														
B34 10'	clay	4,000	1,300	7.9	trace	trace	58	trace	142	trace				
B35 13'	fill	570	390	7.6	trace	trace	702	122	1062	35	none	+210		
Douglas														
B47 35'	sand	6,900	2,600	8.0	trace	trace	58	trace	142	trace				
B49 4'	clay	4,400	1,100	8.4	trace	126	122	142	15					

Table 1 - LABORATORY TESTS ON SOIL SAMPLES

Page 2 of 2

Location and Depth			Soil Resistivity ohm-centimeters			-----Chemical Analysis in mg/kg (ppm) of dry soil-----					
Soil Type			As Rec'd	Sat'd	pH	Calcium Ca	Magnesium Mg	Sodium Na	Bicarbonate HCO3	Chloride Cl	Sulfate SO4
Compton											
B56	5'	sand	33,000	1,400	7.6	trace	trace	115	244	71	trace
B57	20'	sand	44,000	6,000	8.5	trace	trace	23	trace	trace	trace
Hawthorne											
B65	5'	clay	3,700	1,300	8.1	trace	trace	150	122	142	25
B66	4'	fill	1,400	630	7.8	40	trace	230	122	283	190
B67	3'	clay	2,100	950	7.6	trace	trace	115	122	212	20
B71	5'	clay	3,800	770	8.2	80	trace	253	122	354	130

Carbonates = 0 for all samples

Norwalk El Segundo Rail Transit
El Segundo, California
Your #ADE-88044, MJS&A #88310
F8

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Norwalk - El Segundo Rail Transit
El Segundo, California

SOIL RESISTIVITY - FIELD TESTS

LOCATON	DEPTH feet	RESISTANCE ohms	AVERAGE RESISTIVITY TO DEPTH ohm-cm	STRATUM RESISTIVITY ohm-cm
Aviation Blvd. station 94+50	2.50	2.70	1350	1350
	5.00	1.00	1000	794
	7.50	.40	600	333
	10.00	.25	500	333
	15.00	.20	600	1000
Aviation Blvd. station 95+00	2.50	4.50	2250	2250
	5.00	1.80	1800	1500
	7.50	1.00	1500	1125
	10.00	.50	1000	500
	15.00	.25	750	500

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Norwalk - El Segundo Rail Transit
El Segundo, California

SOIL RESISTIVITY - FIELD TESTS

LOCATON	DEPTH feet	RESISTANCE ohms	AVERAGE RESISTIVITY TO DEPTH ohm-cm	STRATUM RESISTIVITY ohm-cm
Near Mariposa Station 142+00	2.50	3.00	1500	1500
				1313
	5.00	1.40	1400	1750
	7.50	1.00	1500	4500
	10.00	.90	1800	3150
	15.00	.70	2100	
Near El Segundo Station 175+00	2.50	10.50	5250	5250
				4773
	5.00	5.00	5000	3750
	7.50	3.00	4500	3000
	10.00	2.00	4000	2000
	15.00	1.00	3000	

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Norwalk - El Segundo Rail Transit
El Segundo, California

SOIL RESISTIVITY - FIELD TESTS

LOCATION	DEPTH feet	RESISTANCE ohms	AVERAGE RESISTIVITY TO DEPTH ohm-cm	STRATUM RESISTIVITY ohm-cm
Compton Station 247+00	2.50	2.50	1250	1250
	5.00	1.50	1500	1875
	7.50	1.00	1500	1500
	10.00	.85	1700	2833
	15.00	.70	2100	3967
Hawthorne Yard & Shops 252+00	2.50	2.30	1150	1150
	5.00	1.30	1300	1495
	7.50	1.00	1500	2167
	10.00	.90	1800	4500
	15.00	.75	2250	4500

DD2

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 18 (Continued)

DATE DRILLED: December 28, 1988
EQUIPMENT USED: 5" - Diameter Rotary Wash

ELEVATION	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55	45	28.5	93	7	
		16.8	106	22	
50	50	12.4	109	30	
45	55	15.6	98	34	
40	60	13.1	117	61	
35	65				



Layer of Clayey Sand
SILTY SAND - fine, light brown

Brown

SAND - fine, light brown

NOTE: Drilling mud used in drilling process. Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A - 16.2