Adobe Dam Basin Fill & Channel

GEOTECHNICAL INVESTIGAITON REPORT

Adobe Dam Basin Fill & Channel

47th Avenue & Pinnacle Peak Road

Phoenix, Arizona

Registered Professional Engineer
CERTIFICATE
12176
NORMAN HAROLD
WETZ
Date Signed 12/7/93
ARIZONA, U.S.A.

SHB Job No. E93-299

SHB AGRA, INC.
Engineering & Environmental Services

AGRA
Earth & Environmental Group

A360.910

SHB AGRA, INC.
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December 9, 1993

Maricopa County
Flood Control District
2801 Durango Street
Phoenix, Arizona 85009

SHB Job No. E93-299

Attention: Warren F. Rosebraugh, P.E.

Re: Adobe Dam Basin Fill & Channel
47th Avenue & Pinnacle Peak Road
Phoenix, Arizona

Gentlemen:

Our Geotechnical Investigation Report on the referenced project is herewith submitted. The report includes the results of test drilling and laboratory analysis, and presents recommendations for slope configuration and site grading.

Should any questions arise concerning this report, please do not hesitate to contact us.

Respectfully submitted,
SHB AGRA, Inc.

By _____
Jonathan A. Crystal, P.E.

Reviewed by _____
Norman H. Wetz, P.E.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
12176
NORMAN HAROLD
WETZ
Date Signed 12/9/93
ARIZONA U.S.A.

Copies: Addressee (3)
ld/J93-1/12-09-93

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1. INTRODUCTION

This report is submitted pursuant to a geotechnical investigation made by this firm of the site of a storm water retention pond to be located on the south side of Pinnacle Peak Road near its intersection with 47th Avenue in Phoenix, Arizona. The object of the investigation was to evaluate the physical properties of the soils underlying the site to provide recommendations for slope design and site grading.

2. PROJECT DESCRIPTION

It is understood that a storm water retention pond is to be constructed at the existing Adobe Dam Recreation Area golf course. The excavated material is to be used for engineered fill on a project located immediately north of the site. The basin is to be sized with regard to the permeability of the underlying soils.

Should details involved in final design vary significantly from those given above, this firm should be notified for review and possible revision of recommendations presented in this report.

3. INVESTIGATION

3.1 Subsurface Exploration

Three exploratory borings were drilled to depths of about 15 feet below existing grade utilizing 6 5/8-inch O.D. hollow stem auger. Standard penetration testing and open-end drive sampling were performed at selected intervals in the borings. The results of the field investigation are presented in Appendix A, which includes a brief description of drilling and sampling equipment and procedures, a site plan showing the boring locations and logs of the test borings.

An open well piezometer was installed in Boring No.1 to perform an in-place permeability test. The interval between 8 and 10 feet was screened and isolated. The test was performed in general accordance with the Bureau of Reclamation E-19 method.

The field investigation was supervised by Aaron J. Glass, E.I.T, staff engineer of this firm.

3.2 Laboratory Analysis

The moisture content of selected samples recovered were determined. The results of these tests are shown on the boring logs. Grain-size analysis and Atterberg limits tests were performed on selected samples to aid in classification. In addition, two moisture-density (Standard Proctor) tests were performed on a bulk sample recovered. The results of these tests are presented in Appendix B.

4. SITE CONDITIONS & GEOTECHNICAL PROFILE

4.1 Site Conditions

The site is located south of Pinnacle Peak Road, between 47th and 51st Avenues, in Phoenix, Arizona. The site is relatively flat with a moderate slope downward to the northeast. Vegetative cover consists of a sparse to moderate cover of native grasses and shrubs.

A golf course is located adjacent to the south of the site. The access road and a parking lot for the golf course provides the eastern boundary of the site.

4.2 Geotechnical Profile

As indicated by the exploratory borings, the soils underlying the site generally consist of high plasticity sandy silt which extended to the depths of the borings. The soils are weakly to moderately lime cemented and are very firm to hard with occasional surficial moderately firm and firm zones.

4.3 Groundwater & Soil Moisture Conditions

No free groundwater was encountered in the borings and moisture contents were relatively low, being well below the plastic limits of the soils encountered.

5. DISCUSSION & RECOMMENDATIONS

5.1 Borrow Material

The soils encountered at the site are considered moderately expansive and capable of excessive movement upon significant moisture increases. Use of the material as structural fill will require careful consideration regarding its potential expansion. Careful attention to site drainage and moisture protection will be necessary to minimize future expansion related problems. Even so, significant risk remains if the material is used for fill below structures, particularly residential and other lightly loaded structures.

5.2 Slopes

Slope stability analysis using methods presented by Singh (1970)* indicate that excavated slopes of 1.5:1 (horizontal to vertical) have a factor of safety of at least 2.5. This considers in situ conditions similar to those encountered with estimated parameters of 30° angle of internal friction (0), 200 psf cohesion (c), 100 pcf unit weight (γ), and 10 feet maximum slope height (H). Extremely long holding times allowing saturation of the slopes by steady-state seepage will necessitate flatter slopes.

Slopes probably will undergo long-term erosion if not protected. Vegetating the slopes or armoring them with riprap will provide suitable protection. The use of riprap will require the use of filter media between the riprap and the soil slope.

5.3 Permeability

Results of the field permeability test indicate a permeability of 1.42×10^{-8} cm/sec at a depth of about 10 feet. This value is considered to be quite low for a retention basin. It is our opinion that provisions for alternate methods of draining the basin should be considered.

Siltation of the pond bottoms will occur over time. Provisions for cleaning the bottoms periodically should be implemented. This should include monitoring the basins at least annually for siltation.

*Singh, A., "Shear Strength of Man-Made Slopes," Journal of Soil Mechanics and Foundations Division, ASCE, Vol. 96, No. SM6, Proc. Paper 7652, November 1970, pp. 1879-1892.

TEST DRILLING EQUIPMENT & PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8" O.D., 3 1/4" I.D. hollow stem auger or 4 1/2" solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-55 or CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Ford industrial engines capable of delivering about 7,000 to 8,400 foot-pounds torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 16,000 to 20,000 pounds downward force.

Generally, refusal to penetration of the auger is adopted as top of the SGC or river-run material, which normally requires other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42" diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Hammer Drill Drilling with the Hammer drill is accomplished with a Drill Systems AP1000 drill rig advancing a double-walled drive casing with a link-belt 180 diesel pile driving hammer, having a rated energy of 8,100 foot-pounds per blow. Where noted on the boring log, the hammer is equipped with a supercharger which can boost the energy to approximately 12,000 foot-pounds per blow. The supercharger is used only in portions of the boring where blow counts are relatively high. Cuttings are removed with compressed air by a reverse circulation process, and are collected in a cyclone from which grab samples are obtained. The drive casing is either 9" O.D. by 6" I.D. or 6 5/8" O.D. by 4" I.D. and employs an expendable bit of slightly larger diameter than the O.D. of the casing. Hammer blows required to advance the drive casing are recorded in 1' increments, as noted on the boring logs. Standard penetration tests or 2.42" diameter ring samples taken are noted on the boring logs.

Odex System The Odex (overburden drilling with the eccentric method) system, also referred to as the DTH (down-the-hole hammer) system, consists of a pneumatic-rotary percussion down-the-hole hammer operating at the bottom being drilled through a 5" diameter steel casing. The eccentric button percussion bit overreams the boreholes and allows advancement of the casing. The same compressed air or air-detergent (foam) mixture that operates the hammer also serves to expel the cuttings from the borehole, where they can be collected as grab samples. Retraction of the eccentric drill bit allows removal of the hammer from the center of the casing to facilitate standard penetration testing (ASTM D1586) where noted on the boring logs.

Schramm Rotadrill The Schramm T64H truck-mounted drill rig is a top drive rotary rig capable of up to 85,500 inches/pounds of torque with a pulldown capacity of 35,000 lbs. Drilling is performed with either 4", or larger, diameter Tricone roller bits or 4" to 6" diameter down-the-hole hammer. Cutting removal is facilitated by compressed air or air/water mixtures and collected in a cyclone. Where noted on the boring logs, grab samples of the cuttings were collected. When casing is required to stabilize the borehole, an Aardvark drill through casing hammer is utilized, permitting simultaneous drilling and driving of the casing. Casing penetration is recorded on the boring logs in feet per minute. Standard penetration, 2.42" diameter ring samples, Shelby tubes, pitcher tube or Denison samples taken are noted on the boring logs.

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2" O.D., 1 3/8" I.D. samplers are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3" O.D. samplers lined with 2.42" I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samplers in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares the boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the boring logs.

elj/M1-92/02-14-92

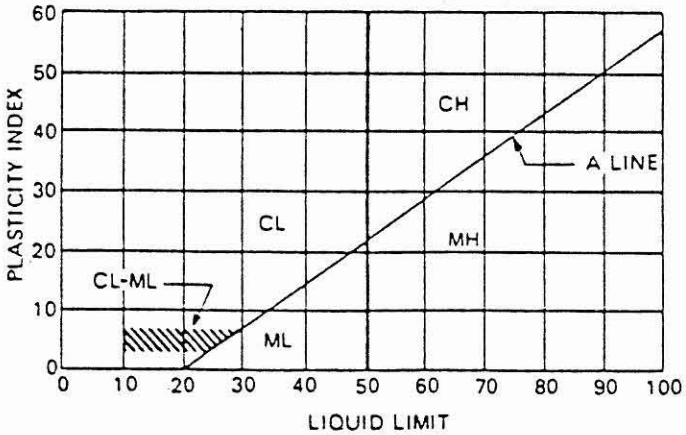
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the Unified Soil Classification system on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" Corp of Engineers, US Army Technical Memorandum No. 3-357 (Revised April 1960) or ASTM Designation: D2487-66T.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
					GP	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 seive)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (LIMITS PLOT BELOW "A" LINE & HATCHED ZONE ON PLASTICITY CHART)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CLAYS (LIMITS PLOT ABOVE "A" LINE & HATCHED ZONE ON PLASTICITY CHART)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

NOTE: Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone on the plasticity chart to have double symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 in.
Gravel	3 in. to No. 4 sieve
Coarse gravel	3 in. to ¾ in.
Fine gravel	¾ in. to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

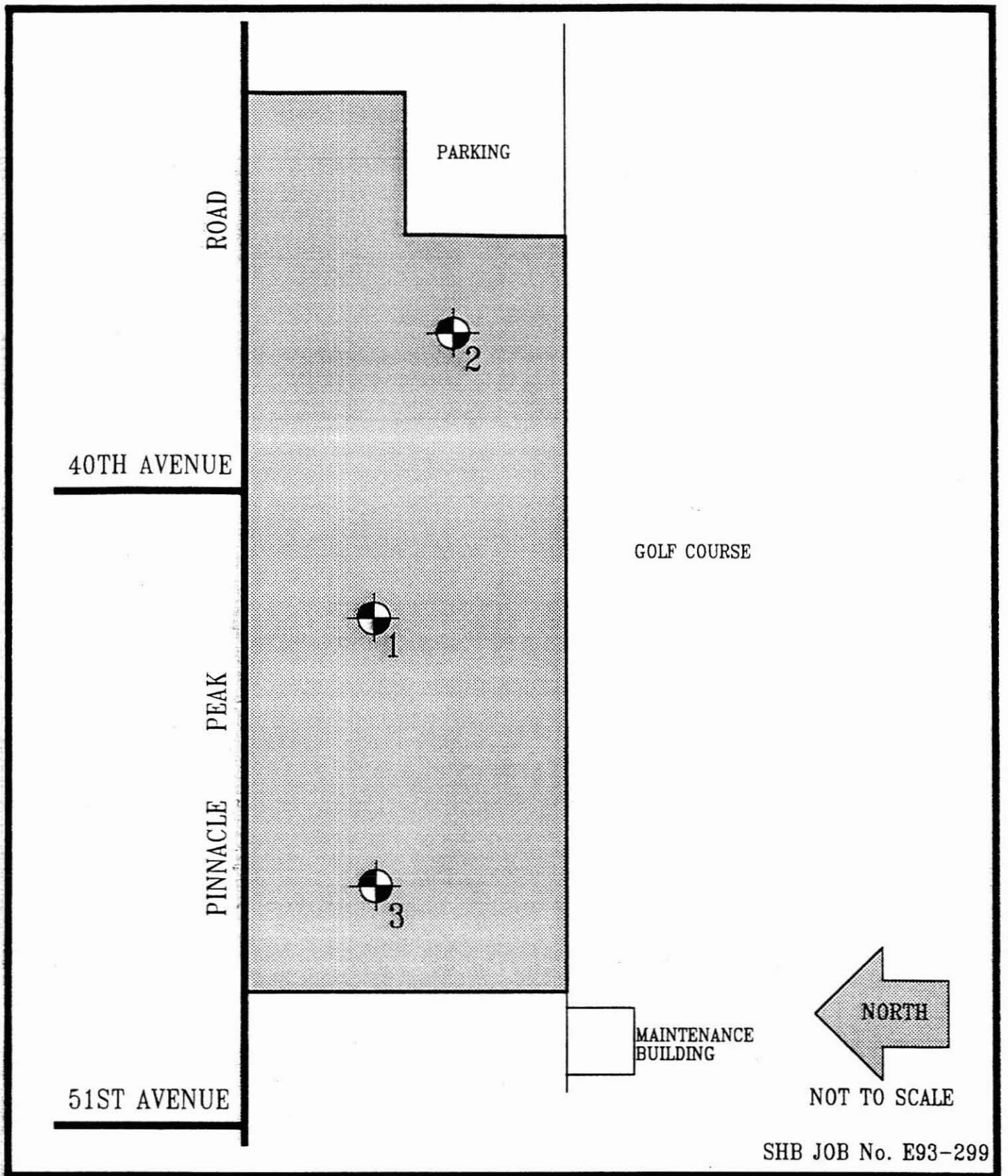
2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. Relative Firmness. Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

clj/M1-92/02-14-92


PARKING
ROAD
2
40TH AVENUE
GOLF COURSE
1
PEAK
PINNACLE
3
MAINTENANCE
BUILDING
NORTH
51ST AVENUE
NOT TO SCALE
SHB JOB No. E93-299

SITE PLAN

PROJECT Adobe Dam Basin Fill & Channel

LOG OF TEST BORING NO. 1

JOB NO. E93-299 DATE 11-18-93

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A					slightly moist	SANDY SILT, considerable clay, predominantly fine grained sand, strongly lime cemented, high plasticity, light brown
				S	16-28-43				hard	
				S	31-39-39					note: trace of fine grained angular gravel below 5'
										note: increase in medium to coarse grained subangular sand from 9' to 12'
5				S	17-50/6"			MH		
				A						
							21			
10				S	24-50/5"					
15				S	31-35-50/4 1/2"					
										Stopped Auger at 15' Sampler refused at 16'4 1/2"
20										
25										

GROUNDWATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.

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SALT LAKE CITY · LAKEWOOD/DENVER

PROJECT Adobe Dam Basin Fill & Channel

LOG OF TEST BORING NO. 2

JOB NO. E93-299 DATE 11-18-93

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A					slightly moist	**CLAYEY SILT**, some fine grained sand, trace of coarse grained sand, some strongly lime cemented, medium plasticity, light brown
				S	1-2-8			ML	soft	
				S	36-50/ 4 1/2"				slightly moist	**SANDY SILT**, considerable clay, predominantly fine to medium grained sand, trace of fine grained gravel, strongly lime cemented, high plasticity, light brown
5				S	50/4"				hard	
				A				MH		note: increase in fine grained gravel from 10' to 15'
							10			
10				S	50/3"					
15				S	50/4"					
										Stopped Auger at 15' Sampler refused at 15'4"
20										
25										

GROUNDWATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.

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PROJECT Adobe Dam Basin Fill & Channel

LOG OF TEST BORING NO. 3

JOB NO. E93-299 DATE 11-17-93

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				ML	slightly moist	**CLAYEY SILT**, trace of fine to medium grained sand, strongly lime cemented, medium plasticity, light brown
				S	4-6-17				firm	
				S	48-50/6"			MH	slightly moist	**SANDY SILT**, some clay, fine to medium grained sand, some fine grained subangular gravel, moderately to strongly lime cemented, nonplastic, light brown
5				S	50/5 1/2"				hard	note: increase in lime cement with depth within silty sand
							13		slightly moist	**SANDY SILT**, considerable clay, predominantly fine grained sand, strongly lime cemented, high plasticity, light brown
10				S	18-50/6"			MH		
15				S	38-50/4"					
										Stopped Auger at 15' Sampler refused at 15'10"
20										
25										

GROUNDWATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.

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PROJECT:	ADOBE DAM BASIN FILL AND CHANNEL	PROJECT NO:	E93-299
		W O NO:	1
LOCATION:	#1 @ 2.5'-4.0'	LAB NO:	4
		DATE:	12/29/93

MECHANICAL SIEVE ANALYSIS (ASTM C136)

SIEVE SIZE	% PASSING
2 IN	100
1 1/2 IN	100
1 IN	100
3/4 IN	100
1/2 IN	100
3/8 IN	100
1/4 IN	100
#4	99
#8	94
#10	93
#16	88
#30	83
#40	80
#50	78
#100	71
#200	58.2

L.L. = 60

P.I. = 23

MOISTURE CONTENT = 20.5%

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PROJECT:	ADOBE DAM BASIN FILL AND CHANNEL	PROJECT NO:	E93-299
		W O NO:	1
LOCATION:	#2 @ 5.0'-5'4"	LAB NO:	12
		DATE:	12/29/93

MECHANICAL SIEVE ANALYSIS (ASTM C136)

SIEVE SIZE	% PASSING
2 IN	100
1 1/2 IN	100
1 IN	100
3/4 IN	100
1/2 IN	100
3/8 IN	100
1/4 IN	100
#4	99
#8	91
#10	89
#16	83
#30	77
#40	75
#50	73
#100	68
#200	59.7

L.L. = 63

P.I. = 23

MOISTURE CONTENT = 9.9%

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PROJECT:	ADOBE DAM BASIN FILL AND CHANNEL	PROJECT NO:	E93-299
		W O NO:	1
LOCATION:	#3 @ 5.0'-10.0'	LAB NO:	16
		DATE:	12/29/93

MECHANICAL SIEVE ANALYSIS (ASTM C136)

SIEVE SIZE	% PASSING
2 IN	100
1 1/2 IN	100
1 IN	100
3/4 IN	100
1/2 IN	100
3/8 IN	100
1/4 IN	100
#4	97
#8	94
#10	93
#16	87
#30	81
#40	78
#50	76
#100	70
#200	59.4

L.L. = 63

P.I. = 30

MOISTURE CONTENT = 13.1%

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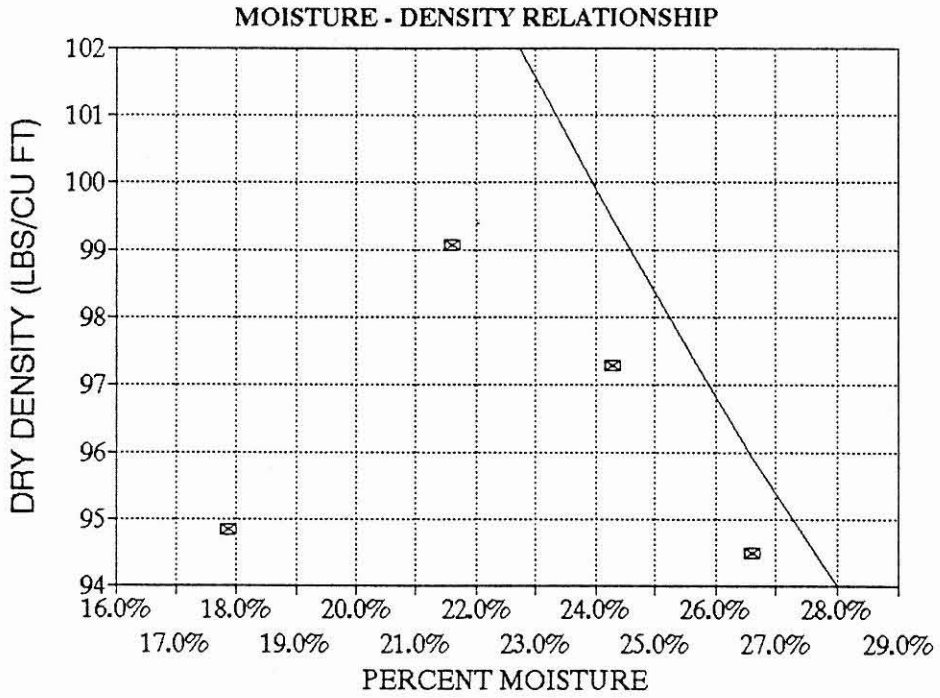
PROJECT:	ADOBE DAM BASIN FILL AND CHANNEL	**DATE**	12/29/93
LOCATION:	#1 @ 0.0'-5.0'	**JOB NO.**	E93-299
		W.O.NO.	1
		LAB NO.	1

ASTM D698

MAXIMUM DRY DENSITY	99.4 PCF	METHOD	A
OPTIMUM MOISTURE CONTENT	22.1%	CURVE	A



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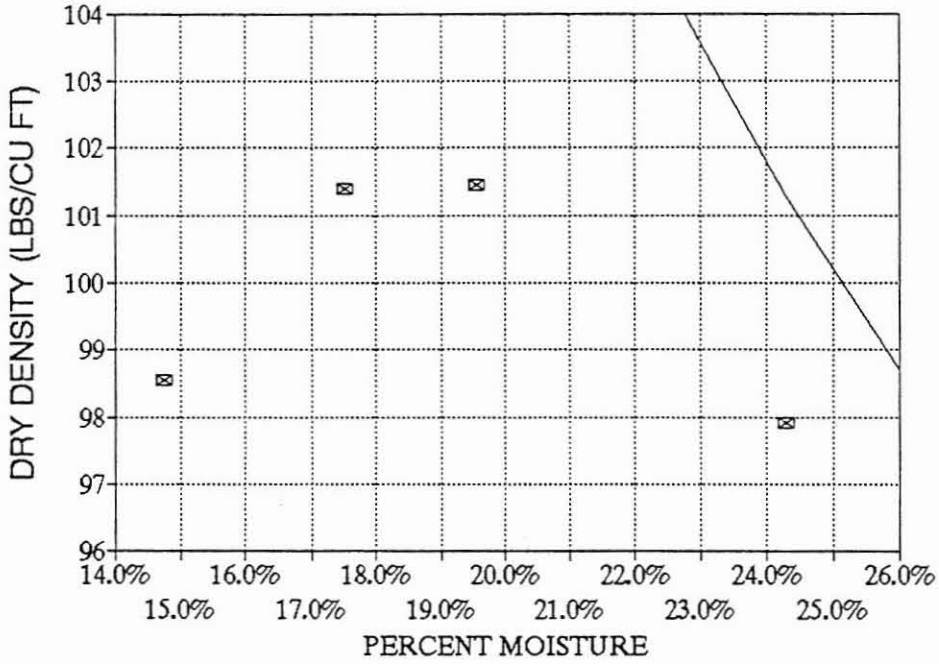
PROJECT:	ADOBE DAM BASIN FILL AND CHANNEL	**DATE**	12/29/93
LOCATION:	#3 @ 5.0'-10.0'	**JOB NO.**	E93-299
		W.O.NO.	1
		LAB NO.	16

ASTM D698

MAXIMUM DRY DENSITY	101.8 PCF	METHOD	A
OPTIMUM MOISTURE CONTENT	18.4%	CURVE	A

MOISTURE - DENSITY RELATIONSHIP



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Phoenix, Arizona 85009
Phone: 602-272-6848
Fax: 602-272-7239

January 28, 1994

Maricopa County Flood Control District
2801 West Durango Street
Phoenix, Arizona 85009

SHB Job No. E93-299
Addendum No. 1

Attention: Warren F. Rosebraugh, P.E.

Re: **Adobe Dam Basin Fill & Channel**
47th Avenue & Pinnacle Peak Road
Phoenix, Arizona

Gentlemen:

We have performed an additional investigation at the referenced project to evaluate earthwork factors of the excavated soils and the swell potential of native soils in the disposal area and the compacted fill soils. In conjunction, we have reviewed the results of our previous investigation for the project.

The additional investigation included drilling two borings at the basin site and four borings at the disposal, or fill, site immediately north of the basin site on the opposite side of Pinnacle Peak Road. The borings were drilled to depths of 10 feet using a CME-55 drill rig equipped with 6 5/8-inch O.D. auger. Relatively undisturbed 2.42-inch I.D. drive samples were recovered at selected intervals in the borings. Bulk samples of the major material types from the drill cuttings also were recovered. Results of the field investigation are attached, including a site plan showing the boring locations and logs of the test borings.

The density of the drive samples determined, the results of which are shown on the boring logs, gradations and Atterberg limits tests were performed on selected samples to aid in classification. Further, expansion (swell)

tests were performed on selected samples from both sites. The results of these tests are attached.

The test results indicate that the in-place density of the soils in the stormwater retention basin ranges from about 91 to 99 pounds per cubic foot (pcf) with an average of about 96 pcf. If the soils are to be compacted to at least 95 percent of maximum density and at optimum moisture content, the range of compaction would be 95 to 100 percent, probably averaging about 97 percent at optimum moisture content. Since the maximum density of the excavated soils appears to be on the order of 101 pcf, calculations would indicate that a volume reduction, or shrinkage, of at least 2 percent but not over 10 percent should be considered. If consideration for spillage and wind erosion is included in this value, the value of 10 percent should then be used and is recommended.

Ground loss during site grading for compaction of the native soils in the fill areas is estimated to be 1 inch. This value is based on the upper 12 inches of soils being compacted during site preparation and the effect of the additional weight of fill and earthwork equipment traffic during fill placement. No consideration is given to loss due to clearing and grubbing.

It should be noted that the above values are estimated based on the data available at the time of our analysis as well as our experience with the soils in the area of the project. Some judgment should continue to be used by others when using these values.

The swell tests performed on the native soils in the fill area indicate a low swell potential of less than 1 percent. The results of the swell tests on the fill soils indicate their swell potential ranges from about 8 to 15 percent, or from medium to high when considering Uniform Building Code

standards. It is our opinion that, even if the fill soils are placed correctly, additional risk will be imposed by this construction. In addition, significant drying of the fill soils will further increase the expansive potential. The estimated heave of various thicknesses of the fill soils are presented in Table 1 which is attached, the estimates are based on Van Der Merwe's Method (1964).

The fill should be placed in lifts not more than 8 inches in loose thickness and compacted to at least 93 percent, but not more than 98 percent, of maximum density as determined by ASTM D698. The moisture content during placement should be between optimum moisture content and 3 percent above, as determined by ASTM D698.

This addendum should be attached to the original report and be made a part thereof. Should any questions arise regarding this addendum, we would be pleased to discuss them with you.

SHB AGRA, Inc.

Respectfully submitted,

By _____
Jonathan A. Crystal, P.E.

Reviewed By _____
B. Dwaine Sergent, P.E.

Copies: Addressee (3)
mcb/J94-1/1-24-93

TABLE 1

Estimated Heave of Various Thicknesses of Expansive Fill from Adobe Dam Basin*

Thickness of Fill	ΣF_D	P.E. (in/ft)	Estimated Heave (inch)
1	.94	1/2	0.47
2	1.79	1/2	0.99
3	2.54	1/2	1.27
4	3.20	1/2	1.60
5	3.80	1/2	1.90

*Van Der Merwe, D.H., "The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction of Soils", The Civil Engineer in South Africa, Volume 6, No. 6, June 1964.

TEST DRILLING EQUIPMENT & PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8" O.D., 3 1/4" I.D. hollow stem auger or 4 1/2" solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-55 or CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Ford industrial engines capable of delivering about 7,000 to 8,400 foot-pounds torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 16,000 to 20,000 pounds downward force.

Generally, refusal to penetration of the auger is adopted as top of the SGC or river-run material, which normally requires other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42" diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Hammer Drill Drilling with the Hammer drill is accomplished with a Drill Systems AP1000 drill rig advancing a double-walled drive casing with a link-belt 180 diesel pile driving hammer, having a rated energy of 8,100 foot-pounds per blow. Where noted on the boring log, the hammer is equipped with a supercharger which can boost the energy to approximately 12,000 foot-pounds per blow. The supercharger is used only in portions of the boring where blow counts are relatively high. Cuttings are removed with compressed air by a reverse circulation process, and are collected in a cyclone from which grab samples are obtained. The drive casing is either 9" O.D. by 6" I.D. or 6 5/8" O.D. by 4" I.D. and employs an expendable bit of slightly larger diameter than the O.D. of the casing. Hammer blows required to advance the drive casing are recorded in 1' increments, as noted on the boring logs. Standard penetration tests or 2.42" diameter ring samples taken are noted on the boring logs.

Odex System The Odex (overburden drilling with the eccentric method) system, also referred to as the DTH (down-the-hole hammer) system, consists of a pneumatic-rotary percussion down-the-hole hammer operating at the bottom being drilled through a 5" diameter steel casing. The eccentric button percussion bit overreams the boreholes and allows advancement of the casing. The same compressed air or air-detergent (foam) mixture that operates the hammer also serves to expel the cuttings from the borehole, where they can be collected as grab samples. Retraction of the eccentric drill bit allows removal of the hammer from the center of the casing to facilitate standard penetration testing (ASTM D1586) where noted on the boring logs.

TEST DRILLING EQUIPMENT & PROCEDURES (CONT.)

Schramm Rotadrill The Schramm T64H truck-mounted drill rig is a top drive rotary rig capable of up to 85,500 inches/pounds of torque with a pulldown capacity of 35,000 lbs. Drilling is performed with either 4", or larger, diameter Tricone roller bits or 4" to 6" diameter down-the-hole hammer. Cutting removal is facilitated by compressed air or air/water mixtures and collected in a cyclone. Where noted on the boring logs, grab samples of the cuttings were collected. When casing is required to stabilize the borehole, an Aardvark drill through casing hammer is utilized, permitting simultaneous drilling and driving of the casing. Casing penetration is recorded on the boring logs in feet per minute. Standard penetration, 2.42" diameter ring samples, Shelby tubes, pitcher tube or Denison samples taken are noted on the boring logs.

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2" O.D., 1 3/8" I.D. samplers are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3" O.D. samplers lined with 2.42" I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samplers in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares the boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the boring logs.

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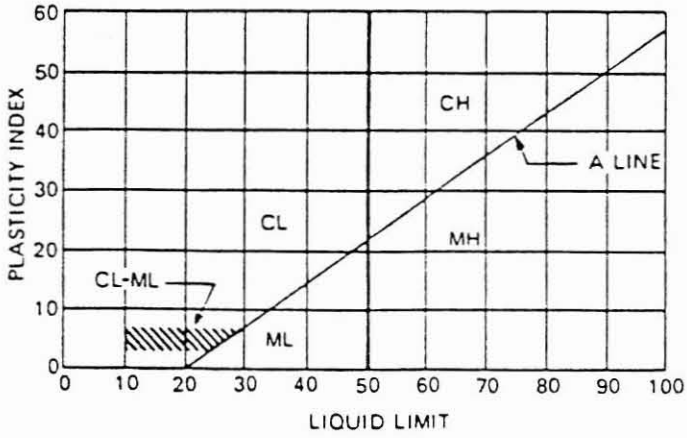
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the Unified Soil Classification system on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" Corp of Engineers, US Army Technical Memorandum No. 3-357 (Revised April 1960) or ASTM Designation: D2487-66T.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
					GP	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 seive)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (LIMITS PLOT BELOW "A" LINE & HATCHED ZONE ON PLASTICITY CHART)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CLAYS (LIMITS PLOT ABOVE "A" LINE & HATCHED ZONE ON PLASTICITY CHART)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

NOTE: Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone on the plasticity chart to have double symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 in.
Gravel	3 in. to No. 4 sieve
Coarse gravel	3 in. to ¾ in.
Fine gravel	¾ in. to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

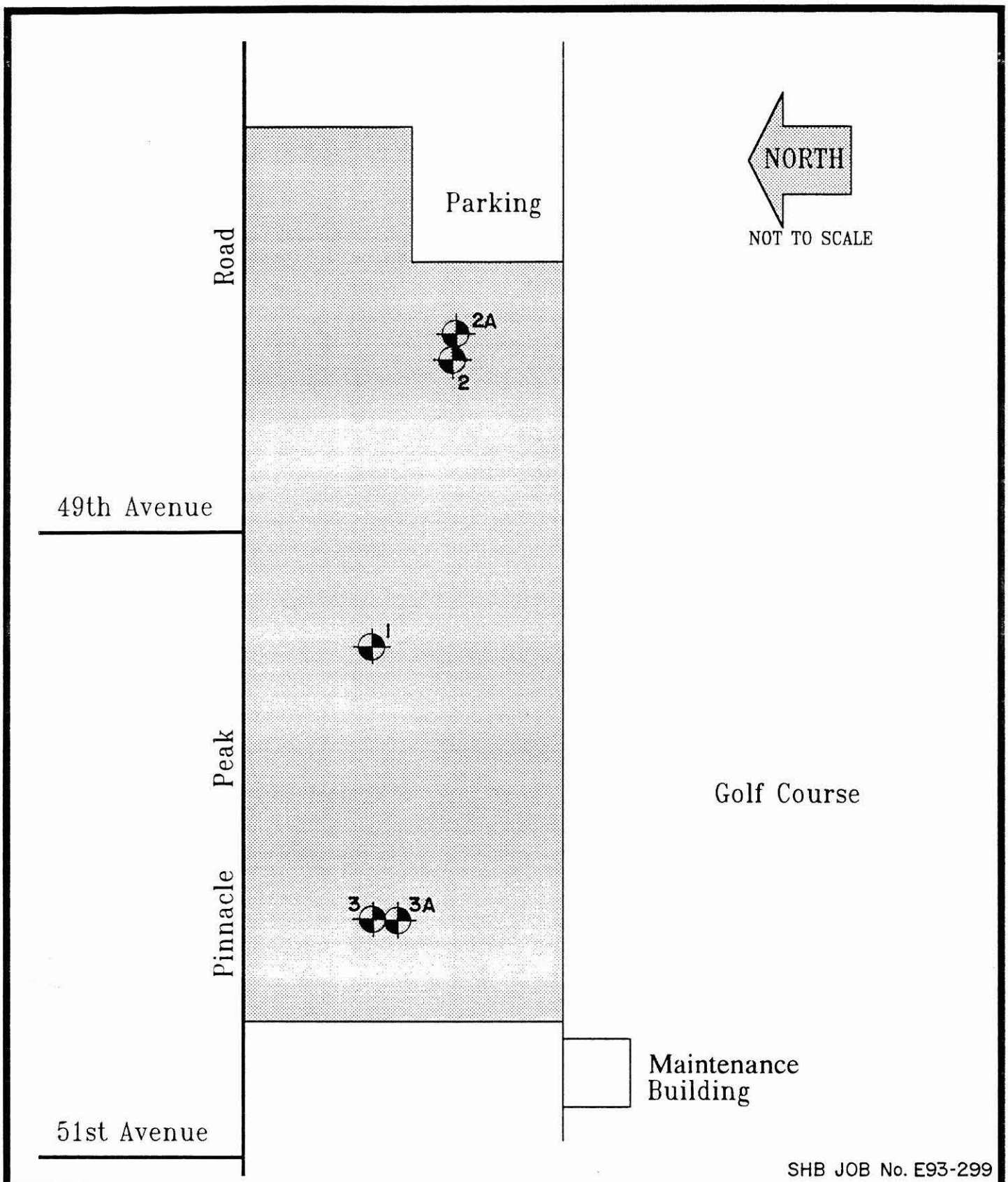
2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

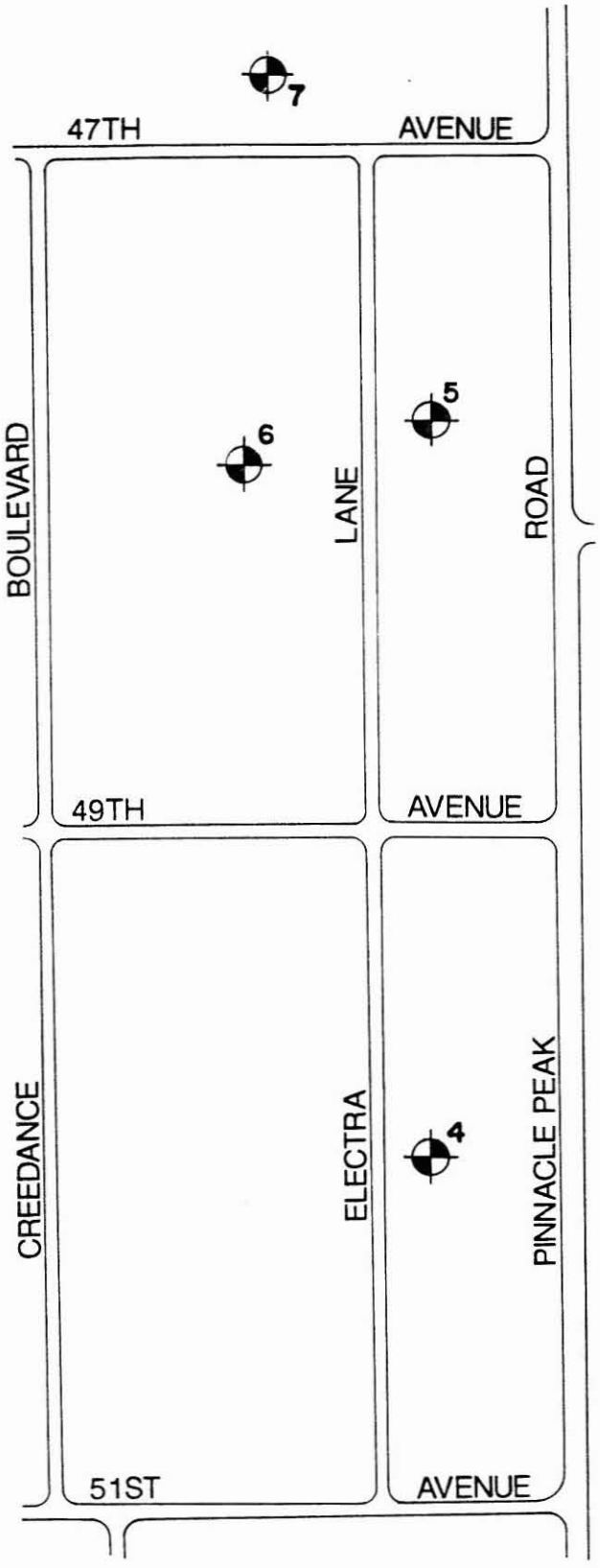
3. Relative Firmness. Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

clj/M1-92/02-14-92


NORTH
NOT TO SCALE
Parking
Road
2A
2
49th Avenue
1
Peak
Golf Course
Pinnacle
3
3A
Maintenance
Building
51st Avenue
SHB JOB No. E93-299

SITE PLAN



NOT TO SCALE

SHB JOB No. E93-299

SITE PLAN

PROJECT Adobe Dam Basin Fill & Channel

LOG OF TEST BORING NO. 2 A

JOB NO. E93-299 DATE 12-21-93

RIG TYPE CME-55
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist firm to hard	**CLAYEY SILT**, considerable medium to fine grained sand, trace of fine grained gravel, weakly lime cemented, high plasticity, light brown note: moderately to strongly lime cemented below 3'
								MH		
5				U	100/11"	91	9			
				S	100/3"					
10										Stopped Auger at 9'6" Sampler refused at 9'9"
15										
20										
25										

GROUNDWATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.

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PROJECT Adobe Dam Basin Fill & Channel

LOG OF TEST BORING NO. 3 A

JOB NO. E93-299 DATE 12-21-93

RIG TYPE CME-55
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist firm to hard	**CLAYEY SILT**, considerable medium to fine grained sand, weakly to moderately lime cemented, high plasticity, light brown note: moderately to strongly lime cemented below 4'
								MH		
5				U	100/7"	97	14			
10				S	100/8"	99	11			
										Stopped Auger at 9'6" Sampler refused at 10'2"
15										
20										
25										

GROUNDWATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.

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LOG OF TEST BORING NO. 4

JOB NO. E93-299 DATE 12-21-93

RIG TYPE CME-55
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist	**SANDY CLAY**, weakly lime cemented, medium plasticity, brown
				S	8-7-8				moderately firm to hard	note: moderately to strongly lime cemented below 3'
				U	32	93	10			
								CL		
5				S	15-28-34					
					50/3"					
				S	NR					
10										Stopped Auger at 9'6" Sampler refused at 9'9"
15										
20										
25										

GROUNDWATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.

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PROJECT Adobe Dam Basin Fill & Channel

LOG OF TEST BORING NO. 5

JOB NO. E93-299 DATE 12-21-93

RIG TYPE CME-55
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	6-4-8			SC/ CL	moist moderately firm	**SANDY CLAY**, considerable silt, weakly lime cemented, medium plasticity, brown
				S	11-15-27				slightly moist	**SILTY SAND**, considerable clay, moderately to strongly lime cemented, high plasticity, light brown
5				U	100/8"	84	13	SM	very firm to hard	
				S	50/4"					
10										Stopped Auger at 9'6" Sampler refused at 9'10"
15										
20										
25										

GROUNDWATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.

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PROJECT Adobe Dam Basin Fill & Channel

LOG OF TEST BORING NO. 6

JOB NO. E93-299 DATE 12-21-93

RIG TYPE CME-55
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	7-6-11			CL	moist firm	**SANDY CLAY**, considerable fine to medium grained sand, weakly lime cemented, medium plasticity, brown
				U	36	90	8		moist	**SANDY CLAY**, moderately to strongly lime cemented, medium plasticity, light brown
5				S	13-22-31			CL	very firm to hard	
				S	50/3"					
10										Stopped Auger at 9'6" Sampler refused at 9'9"
15										
20										
25										

GROUNDWATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.

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PROJECT Adobe Dam Basin Fill & Channel

LOG OF TEST BORING NO. 7

JOB NO. E93-299 DATE 12-21-93

RIG TYPE CME-55
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	14-11-9			CL	moist, firm	**SANDY CLAY**, weakly lime cemented, low plasticity, brown
				U	59	114	9	SC	moist, hard	**CLAYEY SAND**, considerable silt & some fine grained gravel, poorly graded, subangular to angular, weakly to moderately lime cemented, medium plasticity, reddish brown
5				S	13-34-45					
								CL	moist, hard	**SILTY CLAY**, considerable medium to fine grained sand, moderately to strongly lime cemented, low plasticity, light brown
				S	50/3"					
10										Stopped Auger at 9'6" Sampler refused at 9'9"
15										
20										
25										

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

SAMPLE TYPE

A - Drill cuttings.
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.

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LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive 1 inch high 2.5 inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated curve due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control of approximately 0.05 inch per minute. The machine is designed to receive one of the 1 inch high 2.42 inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

clj/M1-92/03-03-92

SERGENT, HAUSKINS & BECKWITH

TABULATION OF TEST RESULTS

Job No. E93-299
W/O 3

HOLE NO	DEPTH	UNIFIED CLASS	L.L	P.I	SIEVE ANALYSIS-ACCUM % PASSING #200 .75"	#100 1"	#50 1.5"	#40 2"	#30 2.5"	#16 3"	#10 3.5"	#8 4"	#4 6"	.25" 8"	.375" 10"	.5" 12"	LAB NO
2A	4'6"-5'5"	MH	52	18	52	62	69	72	75	82	88	89	96	98	99	100	3-299-24
3A	4'6"-5'1"	MH	54	23	55 100	63	66	69	71	76	80	81	87	90	94	95	3-299-26
4	2'6"-3'6"	CL	44	19	64 100	73	77	78	80	84	88	89	95	97	99	99	3-299-29
5	4'6"-5'2"	SM	59	18	30 100	38	44	47	51	60	68	72	86	91	98	99	3-299-33
6	2'6"-3'6"	CL	43	18	72	80	84	85	87	90	93	94	98	99	100		3-299-36
7	2'6"-3'6"	SC	41	19	26 100	29	33	35	38	44	52	56	81	90	97	98	3-299-40

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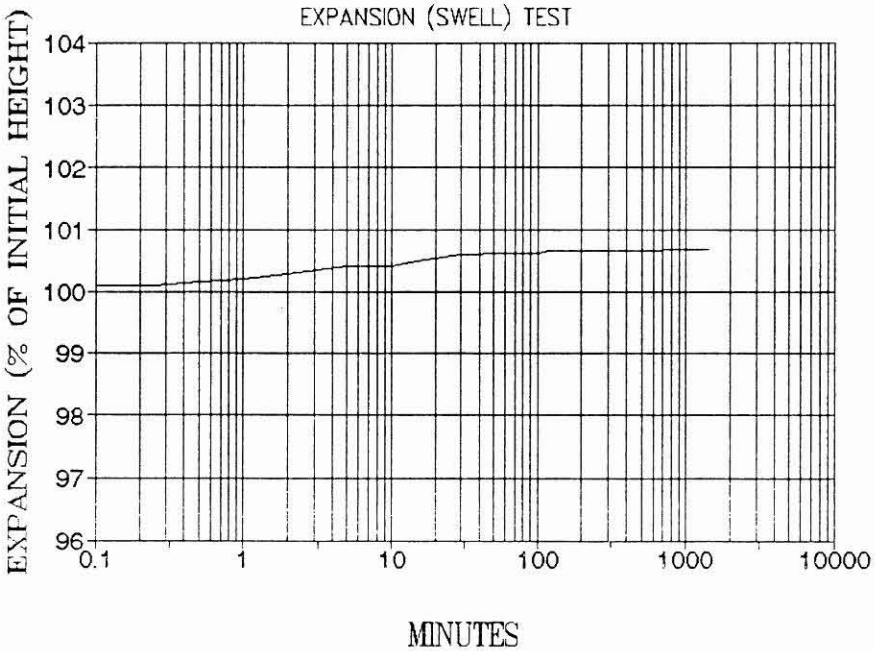
PROJECT:	ADOBE DAM BASIN	**JOB NO.**	E93-299
SAMPLE:	#4 @ 2'6" TO 3'6"	**W.O. NO.**	3
		LAB NO.	29
		DATE	1/10/94
METHOD :	B		
LOAD:	1 psi / INSITU		

ONE DIMENSIONAL SWELL OR SETTLEMENT OF SOILS (ASTM D-4546)

INITIAL DRY DENSITY	92.85 pcf
FINAL DRY DENSITY	92.22 pcf
INITIAL MOISTURE CONTENT	9.5%
FINAL MOISTURE CONTENT	31.6%
MOIST. PICK-UP (% DRY WT.)	22.1%
MOIST. PICK-UP (% IN. VOL.)	32.8%
SWELL (% INITAL HT.)	0.68%



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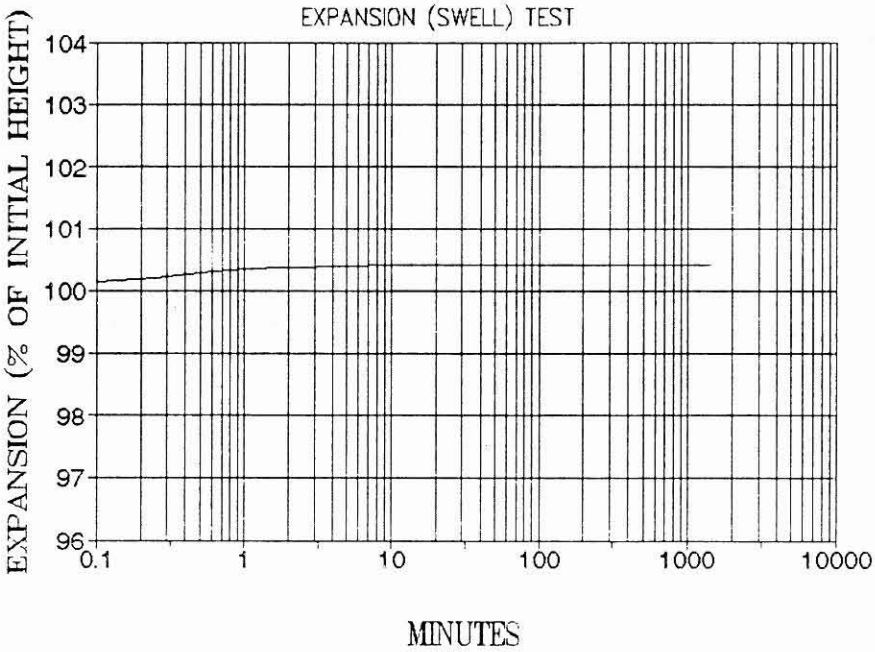
PROJECT:	ADOBE DAM BASIN	**JOB NO.**	E93-299
SAMPLE:	#6 @ 2'6" TO 3'6"	**W.O. NO.**	3
		LAB NO.	36
		DATE	1/10/94
METHOD :	B		
LOAD:	1 psi / INSITU		

ONE DIMENSIONAL SWELL OR SETTLEMENT OF SOILS (ASTM D-4546)

INITIAL DRY DENSITY	89.97 pcf
FINAL DRY DENSITY	89.60 pcf
INITIAL MOISTURE CONTENT	8.4%
FINAL MOISTURE CONTENT	29.9%
MOIST. PICK-UP (% DRY WT.)	21.4%
MOIST. PICK-UP (% IN. VOL.)	30.9%
SWELL (% INITAL HT.)	0.42%



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BORING NO./SAMPLE NO.	E93-299-1			E93-299-3											
DESCRIPTION	Red brown SILTY CLAY			Red brown SILTY CLAY											
UNIFIED SOIL CLASSIFICATION															
DIRECT SHEAR TEST (type)															
Initial Moisture Content %															
Test Moisture Content %															
Normal Stress (lbs./sq.ft.)															
Peak Shear Stress (lbs./sq.ft.)															
Ultimate Shear Stress (lbs./sq.ft.)															
Angle of Internal Friction (degrees)															
Cohesion (lbs./sq.ft.)															
EXPANSION TEST	UBC-29-2			UBC-29-2											
Initial Dry Density (lbs./cu.ft.)	95.9			95.0											
Initial Moisture %	14.0			14.5											
Final Moisture %	33.6			28.6											
Pressure (lbs./sq.ft.)	144			144											
Expansion Index Swell %	153	15.3		78	7.8										
CORROSIVITY TEST															
Resistivity (ohm-cm)															
pH															
CHEMICAL TEST															
Soluble Sulphate %															

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