SPEEDIE
AND ASSOCIATES
GEOTECHNICAL/ENVIRONMENTAL/MATERIAL ENGINEERS
11029 N. 24th AVE., SUITE 805 • PHOENIX, ARIZONA 85029 • (602) 997-6391

REPORT ON GEOTECHNICAL INVESTIGATION

DESIGNATION: Campo Bello Lateral

LOCATION: 16th Street North of Bell Rd.
Phoenix, Arizona

CLIENT: Maricopa County

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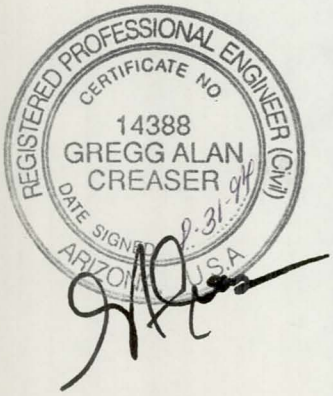
REPORT ON GEOTECHNICAL INVESTIGATION



DESIGNATION: Campo Bello Lateral

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Phoenix, Arizona

CLIENT: Maricopa County
Flood Control District

PROJECT NO: 940284SA

DATE: August 31, 1994

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INTRODUCTION

This report presents the results of a subsoil investigation carried out along the route of the proposed Campo Bello Drive Lateral construction located near 16th Street north of Bell Road in Phoenix, Arizona.

Preliminary information calls for the construction of a storm drain lateral to be located from 12th Street to 16th Street along Grovers Avenue and south along 12th Street to Campo Bello Drive. The depth of the lateral ranges from 15 to 22 feet.

GENERAL SITE AND SOIL CONDITIONS

Route Conditions - The alignment of the proposed storm drain lateral is within the right-of-way of 12th Street to 16th Street along Grovers Avenue and extends south along 12th Street to Campo Bello Drive. The roadway is paved with asphaltic concrete for its entire length. Surrounding land usage is generally residential in nature with some commercial located primarily at the major intersection crossings (i.e. Bell Road and 16th Street).

General Subsurface Conditions - Subsoil conditions along the route are somewhat consistent. The subsoils generally consist of medium dense to very dense clayey sand and silty sand and hard sandy clay deposits interbedded with varying amounts of gravels and cobbles (generally increasing with depth) and varying amounts of calcareous cementation. Possible fill material was encountered at Boring No. B-2, extending to a depth of 4 feet below ground surface. Auger refusal was encountered in Boring Nos. B-3 and B-4 at depths of 16.0 and 14.5 feet, respectfully, on possible bedrock or highly cemented materials. This, however, was not confirmed by coring.

All borings were dry upon completion and prior to backfilling. Groundwater levels are reported to be on the order of 225 feet deep in the general vicinity.

Natural water contents of samples tested range from 3.0 to 6.0 percent and dry densities from 96 to 116 pcf. Plasticity indices vary from 6 to 21 percent. The strata exhibited Standard Penetration Resistance (SPT) values of 32 to 50+ blows per foot. Swell tests indicate that the upper soils have a relatively low potential for volume increase (0.65 percent) due to wetting when compacted to moistures and densities expected during construction. The soils exhibit a pH of 8.0 and resistivities of 2808 to 4213 ohm-cm indicating a moderate degree of corrosion.

ANALYSIS AND RECOMMENDATIONS

Analysis of the field and laboratory data indicates that excavation operations should be relatively straight-forward using conventional equipment. However, the presence of cobbles and boulders at depth should be accounted for as their presence may affect the rate of progress. Depending on size and concentration, heavier excavation equipment may be required. Also in the area of Grovers Avenue, deeper excavations may encounter rock or rock like materials that will require heavy ripping and/or rock removal techniques.

Excavation to the design invert levels will likely terminate within the clayey sand well above the water table, hence, ground water should not be a factor in the design or installation of the storm drain lateral. Due to the nature of the coarser-grained deposits, significant disturbance due to gravel and cobbles may make neat trenches difficult to achieve. For this reason, cast-in-place concrete pipe may not be feasible. Trench walls may also experience some sloughing, particularly in the coarser grained soils. For trenches greater than shoulder height, precautions must be taken to protect workmen in accordance with all current governmental regulations. No special recommendations are made if precast reinforced concrete pipe is used except that pipe bedding will be required to prevent point loads due to possible presence of cobbles.

Boring and jacking operations should proceed problem-free. However, as with trench excavation, the presence of cobbles and boulders may affect progress and deeper trenches may encounter rock conditions depending on location.

Soil Corrosion - Resistivity test values were found to be 2808 to 4213 ohm-cm indicating a moderate degree of corrosiveness. Special protection to buried metal pipe should be considered for long term performance.

Utilities Installation - Trench excavations, backfilling and compaction should be carried out under M.A.G. Specification, Section 601. Backfill of trenches may be carried out using the site-excavated materials provided that oversized material is removed in the bedding zone. This material should be moisture-conditioned, placed in 8 inch lifts and mechanically compacted. Compaction requirements as set forth in M.A.G. Specification, Section 601 should be referred to.

GENERAL

The scope of this investigation and report does not include regional considerations such as seismic activity and ground fissures resulting from subsidence due to groundwater withdrawal, nor any considerations of hazardous releases or toxic contamination of any type.

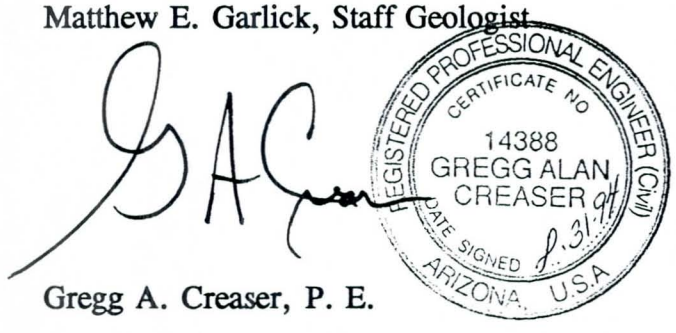
Our analysis of data and the recommendations presented herein are based on the assumption that soil conditions do not vary significantly from those found at specific sample locations. Our work has been performed in accordance with generally accepted engineering principles and practice; this warranty is in lieu of all other warranties expressed or implied.

We recommend that a Soils Engineer monitor the earthwork portions of this project to ensure compliance to project specifications and the field applicability of subsurface conditions which are the basis of the recommendations presented in this report. If any significant changes are made in the scope of work or type of construction that was assumed in this report, we must review such revised conditions to confirm our findings if the conclusions and recommendations presented herein are to apply.

Respectfully submitted,

SPEEDIE & ASSOCIATES

Matthew E. Garlick, Staff Geologist



Gregg A. Creaser, P. E.

August 31, 1994

APPENDIX

FIELD AND LABORATORY INVESTIGATION

SOIL BORING SITE PLAN

SOIL LEGEND

LOG OF TEST BORINGS

TABULATION OF TEST DATA

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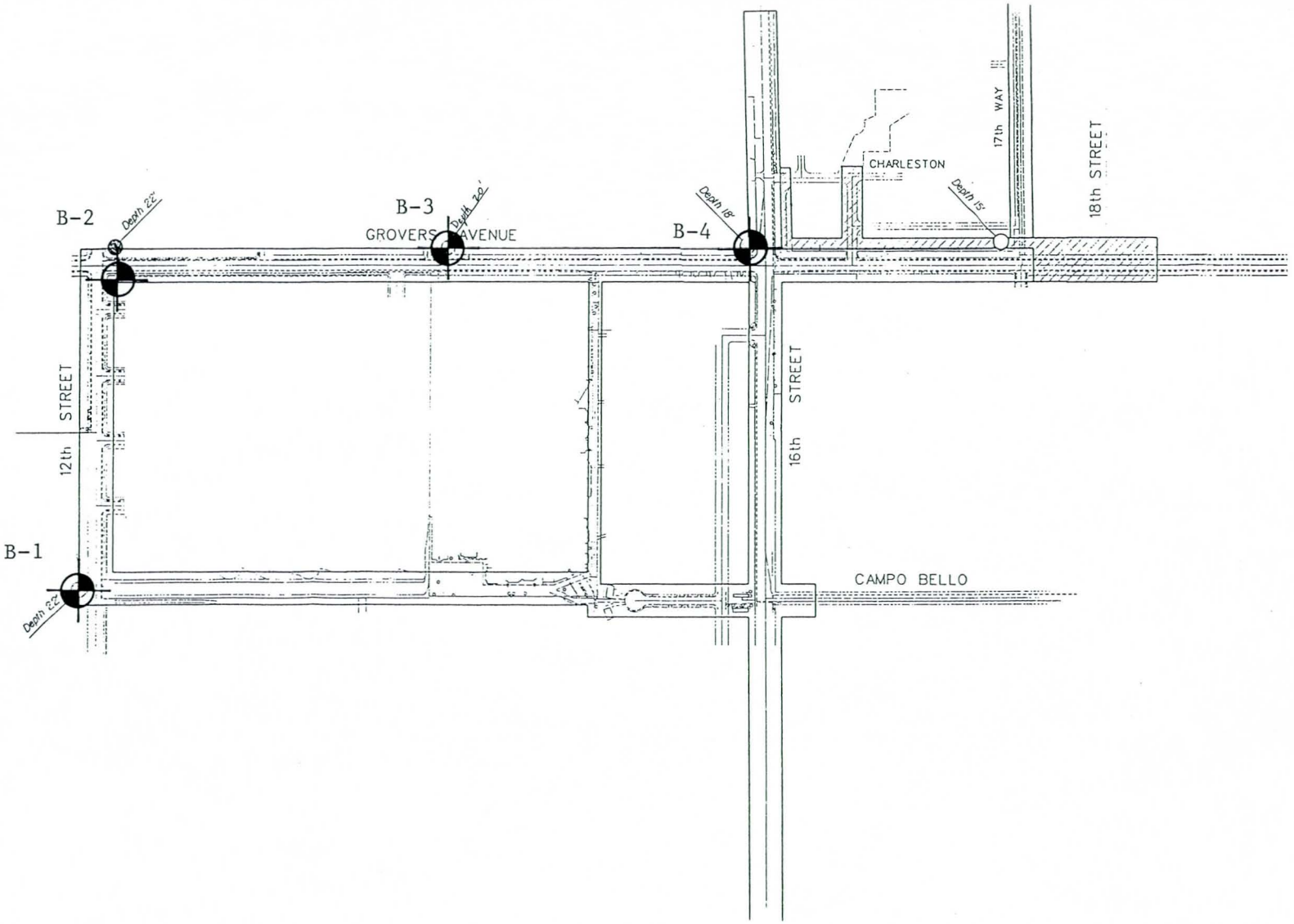
SWELL TEST DATA

pH & RESISTIVITY TEST DATA

FIELD AND LABORATORY INVESTIGATION

On August 17, 1994, four (4) soil test borings were drilled at the approximate locations shown on the attached Soil Boring Location Plan. All exploration work was carried out under the full-time supervision of our senior technician, who recorded subsurface conditions and obtained samples for laboratory testing. The soil borings were advanced with a truck-mounted CME-55 drill rig utilizing 7-inch diameter hollow stem flight augers. Detailed information regarding the borings and samples obtained can be found on and individual Log of Test Boring prepared for each drilling location.

Laboratory testing consisted of moisture content, dry density, grain-size distribution and plasticity (Atterberg Limits) tests for classification and pavement design parameters. Compression tests were performed on a selected ring sample in order to estimate settlements and determine effects of inundation. Remolded swell tests were performed on samples compacted to densities and moisture contents expected during construction. All field and laboratory data is presented in this appendix.



Approximate Boring Locations

Soil Boring Site Plan		
Campo Bello Lateral Near 16th St. N. of Bell Rd. Phoenix, Arizona		SPEEDIE AND ASSOCIATES GEOTECHNICAL/MATERIALS/SITE ENGINEERS
Drawn By: MAS	Date: 08-18-94	Project No. 940284SA

SOIL LEGEND

SAMPLE DESIGNATION	DESCRIPTION	
AS	Auger Sample-	A grab sample taken directly from auger flights
BS	Large Bulk Sample-	A grab sample taken directly from auger flights
S	Spoon Sample-	Standard Penetration Test (ASTM D-1586) Driving a 2.0 inch outside diameter split spoon sampler into undisturbed soil for three successive 6-inch increments by means of a 140 lb. weight free falling through a distance of 30 inches. The cumulative number of blows for the final 12 inches of penetration is the Standard Penetration Resistance (N).
RS	Ring Sample-	Driving a 3.0 inch outside diameter spoon equipped with a series of 2.42 inch inside diameter, 1 inch long brass rings, into undisturbed soil for one 12 inch increment by the same means of the Spoon Sample. The blows required for the 12 inches of penetration are recorded.
LS	Liner Sample-	Standard Penetration Test driving a 2.0 inch outside diameter split spoon equipped with two 3 inch long, 1¾ inch inside diameter brass liners, separated by a 1 inch long spacer, into undisturbed soil by the same means of the spoon sample.
ST	Shelby Tube-	A 3.0 inch outside diameter thin-walled tube continuously pushed into undisturbed soil by a rapid motion, without impact or twisting (ASTM D-1587).
–	Continuous Penetration Resistance-	Driving a 2.0 inch outside diameter "Bullnose Penetrometer" continuously into undisturbed soil by the same means of the spoon sample. The blows for each successive 12 inch increment are recorded.

CONSISTENCY			RELATIVE DENSITY	
Clays & Silts	Blows/Foot *	Strength †	Sands and Gravels	Blows/Foot *
Very Soft	0-2	0-¼	Very Loose	0-4
Soft	2-4	¼-½	Loose	5-10
Firm	5-8	½-1	Medium Dense	11-30
Stiff	9-15	1-2	Dense	31-50
Very Stiff	16-30	2-4	Very Dense	> 50
Hard	> 30	> 4		

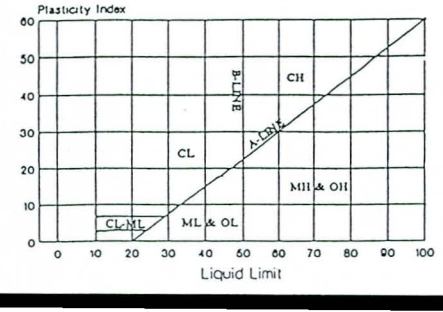
* Number of blows of a 140 lb hammer free falling 30 inches to drive a 2 inch O.D. split spoon sampler (ASTM D-1588)

† Unconfined compressive strength in tons/sq ft. Read from a pocket penetrometer

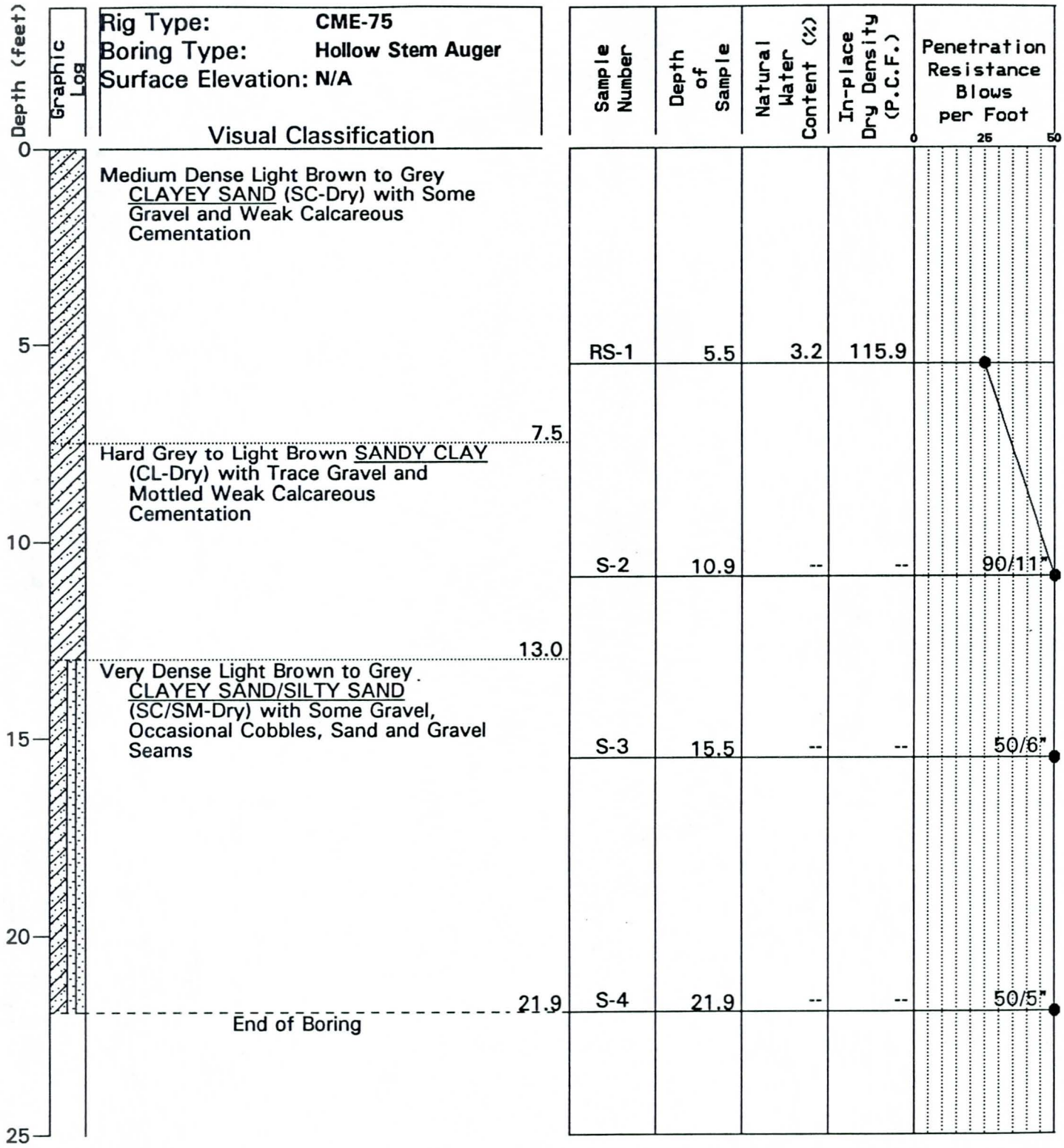
MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
Coarse Grained Soils More than 50% of material is larger than #200 sieve size	Gravel and Gravelly Soils 50% Coarse Fraction is > #4 Sieve Size	Clean Gravels		GW	Well Graded Gravels
				GP	Poorly Graded Gravels
		Gravels w/Fines		GM	Silty Gravels
				GC	Clayey Gravels
	Sand and Sandy Soils 50% Coarse Fraction is < #4 Sieve Size	Clean Sands		SW	Well Graded Sands
				SP	Poorly Graded Sands
		Sands w/Fines		SM	Silty Sand
				SC	Clayey Sand
Fine Grained Soils More than 50% of material is smaller than #200 sieve size	Silts and Clays Liquid limit is less than 50%			ML	Inorganic Silts, Low Plasticity
				CL	Inorganic Clays, Low Plasticity
				OL	Organic Silts, High Plasticity
	Silts and Clays Liquid limit is greater than 50%			MH	Inorganic Silts, High Plasticity
				CH	Inorganic Clays, High Plasticity
				OH	Organic Clays, High Plasticity
Highly Organic Soils				PT	Peat and Humus, Highly Organic

MATERIAL SIZE	PARTICLE SIZE			
	Lower Limit		Upper Limit	
	mm	Sieve Size †	mm	Sieve Size †
Sands				
Fine	.075	#200	0.42	#40
Medium	0.42	#40	2.00	#10
Coarse	2.00	#10	4.76	#4
Gravels				
Fine	4.76	#4	191	¾" °
Coarse	191	¾" °	762	3" °
Cobbles	762	3" °	304.8	12" °
Boulders	304.8	12" °	914.4	36" °

†U.S. Standard °Clear Square Openings



Rig Type: CME-75
Boring Type: Hollow Stem Auger
Surface Elevation: N/A



Boring Date: 8-17-94
Field Engineer/Technician: M. Vanhook
Driller: P. Mills
Contractor: Heber Mining

Water Level

Depth	Hour	Date
Dry	On Comp.	8-17-94

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: B- 1

Campo Bello Lateral

Near 16th Street & North of Bell Road

Phoenix, Arizona

Project No.: 940284SA

Rig Type: CME-75
Boring Type: Hollow Stem Auger
Surface Elevation: N/A

Depth (feet)	Visual Classification	Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot
0	POSSIBLE FILL: Light Brown to Grey SANDY CLAY (CLS-Dry) with Trace Gravel					
4.0						
5	Hard Light Brown to Grey SANDY CLAY (CLS-Dry) with a Trace of Gravel and Mottled Weak Calcareous Cementation	S-1	6.0	--	--	
8.0						
10	Dense Light Brown to Grey SILTY SAND (SM-Dry) with Trace Gravel and Heavy Weak to Mild Calcareous Cementation	RS-2	10.5	6.8	98.9	
		S-3	14.9	--	--	50/5"
15						
17.5						
20	Very Dense Light Brown to Grey CLAYEY SAND (SC-Dry) with Trace Gravel and Weak to Mild Calcareous Cementation					
22.0	End of Boring	S-4	22.0	--	--	56/12"
25						

Boring Date: 8-17-94
Field Engineer/Technician: M. Vanhook
Driller: P. Mills
Contractor: Heber Mining

Water Level

Depth	Hour	Date
Dry	On Comp.	8-17-94

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: B- 2

Campo Bello Lateral

Near 16th Street & North of Bell Road

Phoenix, Arizona

Project No.: 940284SA

Rig Type: CME-75
Boring Type: Hollow Stem Auger
Surface Elevation: N/A

Depth (feet)	Graphic Log	Visual Classification	Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0 – 25 – 50)
0		Hard Light Brown to Grey SANDY CLAY (CLS-Dry) with Trace Gravel Heavy Mild to Hard Calcareous Cementation					
			S-1	4.8	--	--	50/4"
5							
		8.0					
		Very Dense Brownish Grey SILTY SAND (SM-Dry) with Trace Gravel and Weak to Mild Calcareous Cementation					
			S-2	10.0	--	--	50/6"
10							
			AS-3	14.6	--	--	50/1"
15		16.0					
		Auger Refusal on Possible Bedrock					
20							
25							

Boring Date: 8-17-94
Field Engineer/Technician: M. Vanhook
Driller: P. Mills
Contractor: Heber Mining

Water Level

Depth	Hour	Date
Dry	On Comp.	8-17-94

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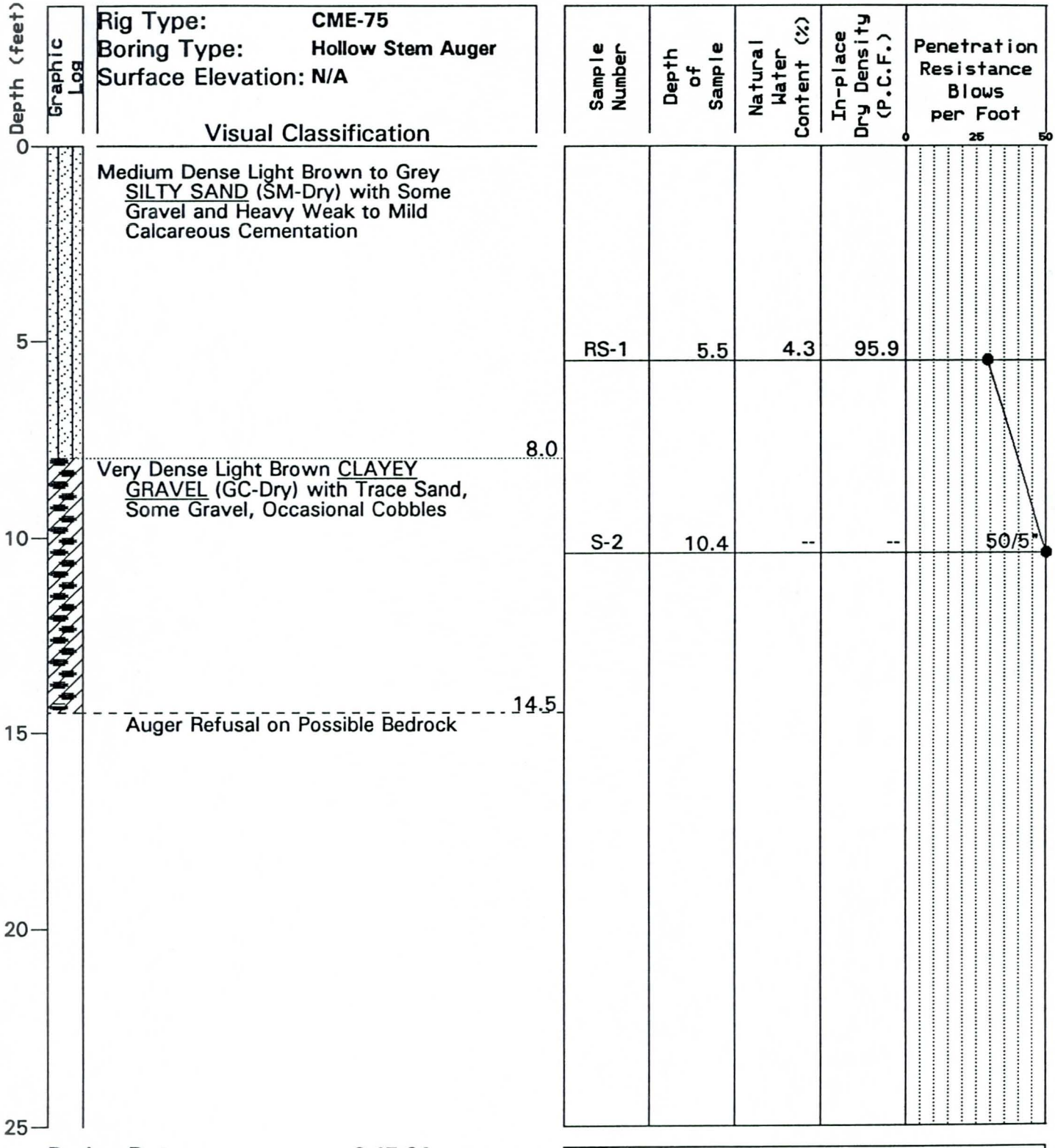
Log of Test Boring Number: B- 3

Campo Bello Lateral

Near 16th Street & North of Bell Road

Phoenix, Arizona

Project No.: 940284SA



Boring Date: 8-17-94
Field Engineer/Technician: M. Vanhook
Driller: P. Mills
Contractor: Heber Mining

Water Level

Depth	Hour	Date
Dry	On Comp.	8-17-94

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Log of Test Boring Number: B- 4

Campo Bello Lateral

Near 16th Street & North of Bell Road

Phoenix, Arizona

Project No.: 940284SA

TABULATION OF TEST DATA

PROJECT: Campo Bello Lateral - Near 16th Street & North of Bell Road
NUMBER: 940284SA

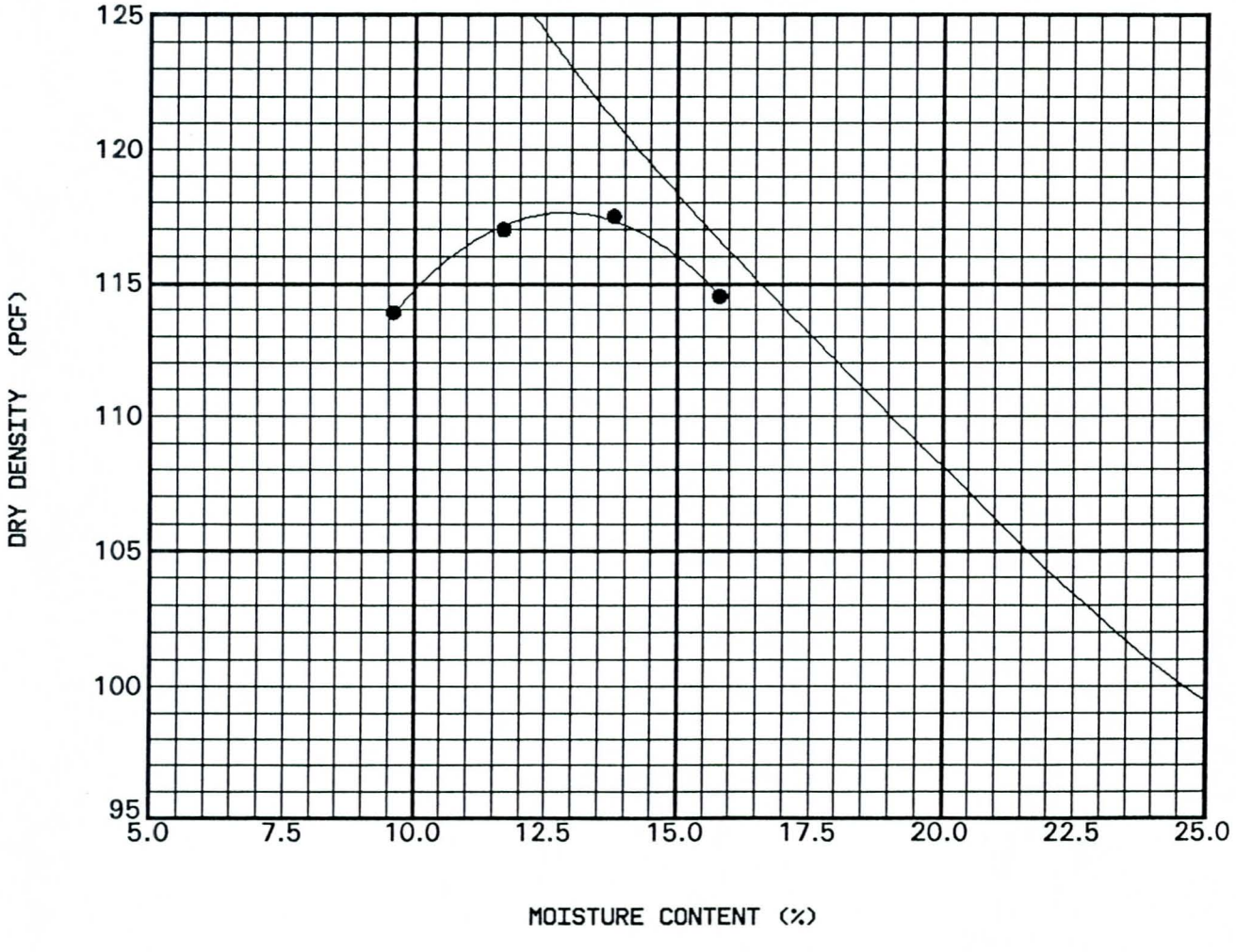
Test Boring Number	Sample Depth (feet)	Water Content %	Dry Density (pcf)	<#200 Sieve %	<#40 Sieve %	<#10 Sieve %	<#4 Sieve %	<3" Sieve %	Liquid Limit %	Plastic Limit %	Plasticity Index %	ASTM Classification
B- 1	5.5	3.2	115.9	17	32	58	79	100	35	22	13	SC
B- 1	19.5			33	48	62	74	100	25	19	6	SC-SM
B- 2	10.5	6.8	98.9	38	61	83	96	100	45	31	14	SM
B- 2	19.5								25	18	7	
B- 2	22.0	--	--	41	62	92	98	100	54	26	27	SC
B- 3	10.0	--	--	25	43	78	94	100	32	26	6	SM
B- 4	5.5	4.3	95.9	23	40	58	75	100	36	28	8	SM

Note: Sieve analysis results do not include material greater than 3". Refer to actual boring logs for the possibility of cobble and boulder sized materials.

MOISTURE-DENSITY RELATIONS

PROJECT:	Campo Bello Lateral	**PROJECT NO.:**	940284SA	**DATE:**	8/17/94
LOCATION:	Near 16th Street & North of Bell Road				
BORING NO.:	B- 1	**SAMPLE NO.:**		**SAMPLE DEPTH:**	19.50
METHOD OF COMPACTION:	ASTM D698A				
LIQUID LIMIT:	25	**PLASTIC LIMIT:**	19	**PLASTICITY INDEX:**	6
CLASSIFICATION:	SC-SM	**ASTM SOIL DESCRIPTION:**	SILTY, CLAYEY SAND with GRAVEL		

MAXIMUM DRY DENSITY: 117.5 PCF **OPTIMUM MOISTURE CONTENT:** 13.5 %



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SWELL TEST DATA

Boring/ Pit No.	Sample Depth, ft.	Remolded Dry Density (pcf)	Initial Moisture Content (%)	% Compaction	Initial Degree of Saturation (%)	Final Degree of Saturation (%)	Total Swell (%)
B-1	19.5	111.3	12.0	94.7*	66	70	0.6

*Based on a maximum dry density of 117.5 pcf at 13.5 percent optimum moisture

Campo Bello Lateral
Near 16th St. N of Bell Rd.
Phoenix, Arizona

SPEEDIE AND ASSOCIATES

Project No. 940284SA

Project: Campo Bello Lateral
Near 16th St. N of Bell Rd.

Project No.: 940284SA

pH & RESISTIVITY DATA

BORING NO.	DEPTH, ft.	pH	RESISTIVITY (ohm-cm)
B-1	19.5	8.0	1,334