

Geotechnical Report For

MATERIAL RESOURCE EVALUATION

near Skunk Creek
Maricopa County, Arizona

30 December 1981



**ENGINEERS TESTING
LABORATORIES, INC.**

A  WESTERN TECHNOLOGIES COMPANY

A400.906

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MATERIAL RESOURCE EVALUATION
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LABORATORIES, INC.**

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Flood Control District
of Maricopa County
3335 West Durango
Phoenix, Arizona 85009

30 December 1981

Attention: Mr. John Rodriguez, P.E.

Project: Material Resource Evaluation
near Skunk Creek
Maricopa County, Arizona

ETL No. 2121J266
(Inv. No. 21200914)

In accordance with your request, our firm has made an evaluation of the sand and gravel deposits located in the west 800 feet of the north 660 feet of the northeast quarter of Section 2 of T4N, R2E, in Maricopa County, Arizona. An assessment of the quality of these deposits was made based upon field exploration and classification and laboratory testing of representative samples. Estimates of the total quantity of economically usable sand and gravel were also made.

Field Exploration

Fourteen backhoe pits were excavated at the site. The original exploration program was to have included 20 pits; however, the scope of the project was reduced at the request of the District.

Ten of the backhoe pits were excavated to an average depth of 12 feet; four of the backhoe pits were deepened to greater than 20 feet. Locations of the test pits are shown on Figure 1. During test pit excavation, encountered materials were continuously examined and visually classified and, where applicable, sampled by a geotechnical engineer from our office. The results of the field exploration program are appended to this report.

Laboratory Testing

Representative material samples obtained during field exploration were subjected to the following laboratory analyses:

<u>Test</u>	<u>Purpose</u>
Percent Passing No. 200 Sieve	Classification
Atterberg Limits	Classification
Soluble Salts	Evaluation of corrosive potential of aggregate

The results of the laboratory analyses are presented herein.

Soil Conditions

As indicated by the field exploration and laboratory testing programs, the subsurface profiles of the area examined are relatively uniform. Below a depth of approximately six feet, a reddish brown stratum is encountered usually consisting of gravelly sand with cobbles and boulders and some silty clay.

In the depth interval of zero to six feet, the soil conditions are somewhat variable and depend upon the location of the test pits. Where test pits are located in a stream bed (i.e. 5, 10 on Figure 1), the soil is relatively clean and granular and is classified as a sand and gravel with cobbles and some boulders and traces of silt. Where test pits are located on the flood plain (i.e. 1, 2, 3, and 4 on Figure 1), the fine soil percentage increases significantly; a typical test pit on the flood plain encountered fine silty sand surface soils with traces of gravel and cobbles.

Site Evaluation Criteria

The materials encountered at the site have been classified as acceptable or unacceptable based upon the following criteria:

- o percentage of fines

- o extent and degree of cementation in the deposit

Materials having a high percentage of fines or having a high degree of cementation are uneconomical to process to conform to standardized mineral aggregate criteria. Acceptable soils may have a high percentage of waste due to the amount of boulders and cobbles greater than six inches which must be removed prior to utilization. In addition, laboratory testing revealed that acceptable soils may have a high soluble salts content and these may require washing prior to use.

Quantity of Acceptable Material

Assuming excavation to a depth of 24 feet is economical, and ignoring the effects of irregular topography, a total computed volume of 470,000 cubic yards of material is available. However, material deemed unusable due to the percentage of fines content was located at the surface of the northwest and southeast corner and formed a thin veneer over the site. The volume of material unusable due to the existence of a high percentage of fines is approximately 28,000 cubic yards. The percentage of the total volume to be wasted due to material size greater than six inches is approximately 15 percent. The percentage of deposit estimated to have such a high degree of cementation as to be uneconomical to process is approximately ten percent.

Conclusions

Using the above assumptions and acknowledging the limitations of the exploration program, the total volume of usable mineral aggregate is estimated to be about 325,000 cubic yards or

Material Resource Evaluation
ETL No. 2121J266

approximately 550,000 tons. A royalty of \$0.25 per ton is presently paid to the State of Arizona for mineral aggregate removed from nearby gravel pits; thus, royalty payments might be about \$140,000. Other economic factors are to be assessed by the District.

Should you have any questions concerning the results of our exploration program or if we may be of further assistance, please contact us.

Sincerely yours,
ENGINEERS TESTING LABORATORIES, INC.
Geotechnical Services

By: 
Glen K. Copeland P.E.

Reviewed by: 
Donald D. Treadwell, Ph.D., P.E.

/jm
copies to Addressee (5)



DEFINITION OF TERMINOLOGY

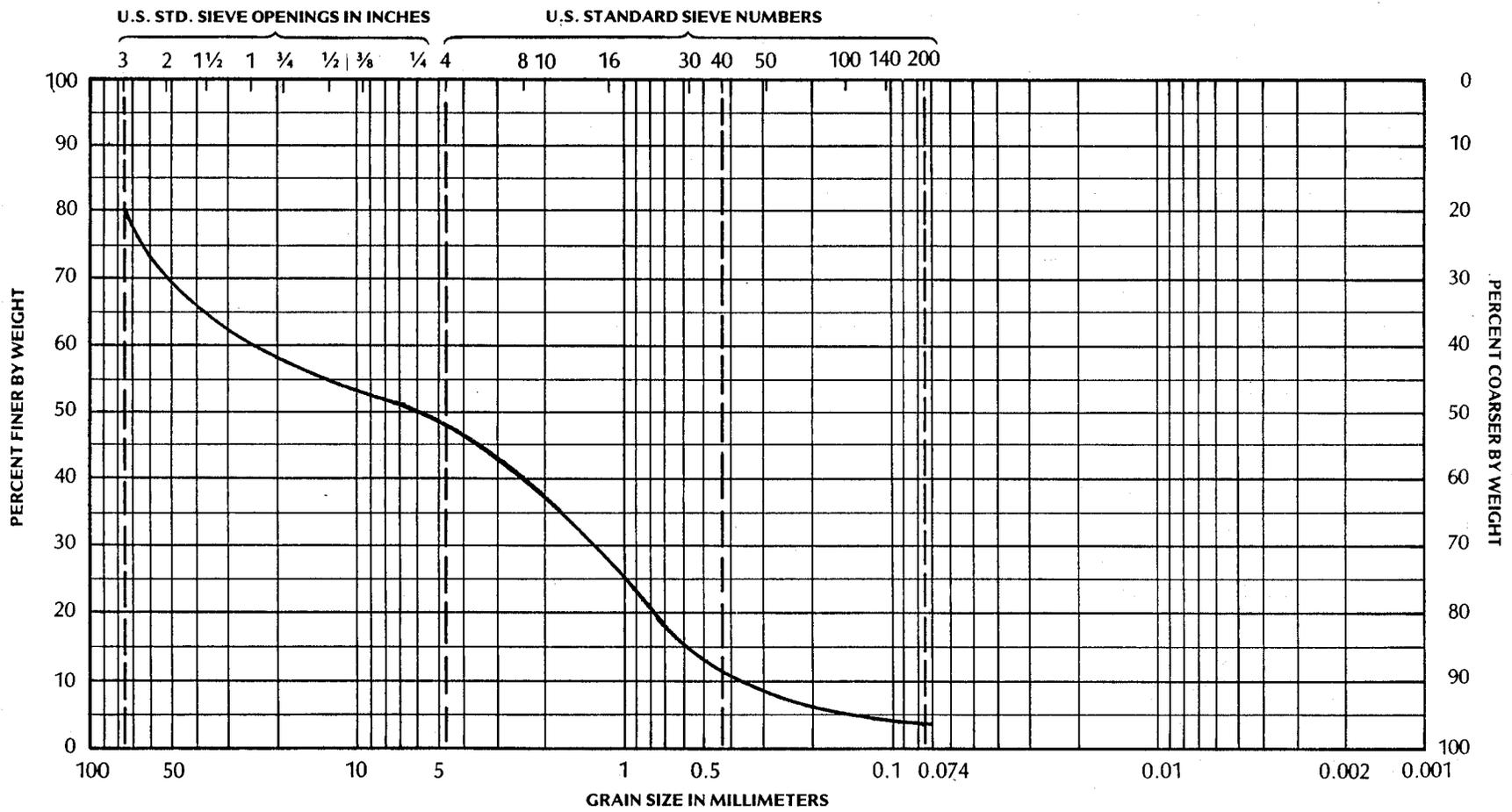
ALLOWABLE SOIL BEARING CAPACITY ALLOWABLE FOUNDATION PRESSURE	The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.
BACKFILL	A specified material placed and compacted in a confined area.
BASE COURSE	A layer of specified material placed on a subgrade or subbase.
BASE COURSE GRADE	Top of base course.
BENCH	A horizontal surface in a sloped deposit.
CAISSON	A concrete foundation element cast in a circular excavation which may have an enlarged base. Sometimes referred to as a cast-in-place pier.
CONCRETE SLABS-ON-GRADE	A concrete surface layer cast directly upon a base, subbase or subgrade.
CRUSHED ROCK BASE COURSE	A base course composed of crushed rock of a specified gradation.
DIFFERENTIAL SETTLEMENT	Unequal settlement between or within foundation elements of a structure.
ENGINEERED FILL	Specified material placed and compacted to specified density and/or moisture conditions under observation of a representative of a soil engineer.
EXISTING FILL	Materials deposited through the action of man prior to exploration of the site.
EXISTING GRADE	The ground surface at the time of field exploration.
EXPANSIVE POTENTIAL	The potential of a soil to expand (increase in volume) due to the absorption of moisture.
FILL	Materials deposited by the action of man.
FINISHED GRADE	The final grade created as a part of the project.
GRAVEL BASE COURSE	A base course composed of naturally occurring gravel with a specified gradation.
HEAVE	Upward movement.
NATIVE GRADE	The naturally occurring ground surface.
NATIVE SOIL	Naturally occurring on-site soil.
ROCK	A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.
SAND AND GRAVEL BASE	A base course of sand and gravel of a specified gradation.
SAND BASE COURSE	A base course composed primarily of sand of a specified gradation.
SCARIFY	To mechanically loosen soil or break down existing soil structure.
SETTLEMENT	Downward movement.
SOIL	Any unconsolidated material composed of discrete solid particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water.
STRIP	To remove from present location.
SUBBASE	A layer of specified material placed to form a layer between the subgrade and base course.
SUBBASE GRADE	Top of subbase.
SUBGRADE	Prepared native soil surface.

Type of Material Sand with gravel and cobbles, some boulders and silt Job No. 2121J266

Source of Material Test Pit #6 Depth = 4-5' Lab/Inv. No. 2121W266-2

Test Procedure ASTM D422 Tested/Calc. By HB Date 12-7-81

Reviewed By MD Date 12-15-81



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PARTICLE SIZE DISTRIBUTION CHART

Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

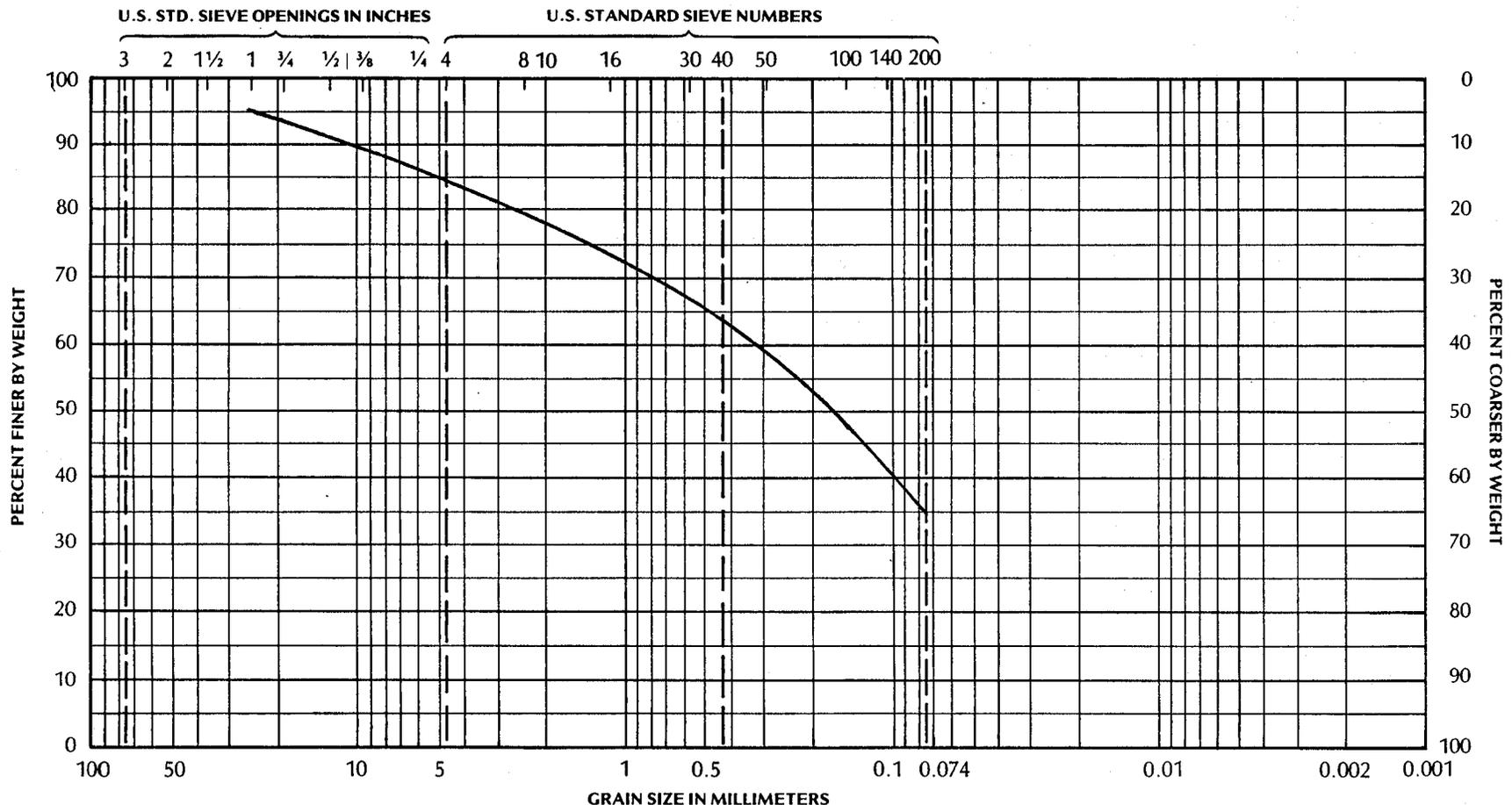
Particle Size, Percent Passing										Atterberg Limits				
2"	69	1"	60	½"	55	#10	37	#30	14	#100	5	0.05 mm	Liquid Limit	P.I.
1½"	65	¾"	57.5	#4	48	#16	27	#50	8	#200	3	0.002 mm	Plastic Limit	Sp. Gr.

Type of Material Silty sand with some gravel, trace cobbles Job No. 2121J266

Source of Material Test Pit #2 Depth = 0-2' Lab/Inv. No. 2121W266-2

Test Procedure ASTM D422 Tested/Calc. By HB Date 12-7-81

Reviewed By MD Date 12-15-81



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PARTICLE SIZE DISTRIBUTION CHART

Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

Particle Size, Percent Passing										Atterberg Limits			
2"	1"	95	1/2"	91	#10	78	#30	67	#100	47	0.05 mm	Liquid Limit	P.I.
1 1/2"	3/4"	93	#4	84	#16	73	#50	58	#200	35	0.002 mm	Plastic Limit	Sp. Gr.



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**LABORATORY
REPORT**

SOIL ANALYSIS CHEMICAL

Client Material Resource Evaluation
Maricopa County Flood Control District
3335 West Durango
Phoenix, Arizona 85009

Job No. 2121J266
Lab./Invoice No. 2121W266-2
Date of Report 12/17/81

Project Soluble Salts Analysis
Type of Samples Bagged Soil Sampled By _____ Date _____
Source of Samples _____ Submitted By _____ Date _____
Test Procedure Arizona Method 237 Authorized By _____ Date _____

DETERMINATION	SOC. O. AG. STD. METHODS	RESULTS			
		4 (10-11)	9 (7-8)		
Sample Identification					
pH	922				
Buffer pH (Acid Soils Only)	921				
Total Soluble Salts, ppm	AZ 237	575.	353.		
Nitrate NO ₃ - N, ppm	1219				
Phosphate PO ₄ - P, ppm	1044				
Potassium K, % Sat./ppm	844				
Magnesium Mg, % Sat./ppm	860				
Calcium Ca, % Sat./ppm	860				
Sodium Na, % Sat./ppm	1032				
Hydrogen H, % Sat./ppm	922				
Cation Exchange Capacity	900				
Sulfate SO ₄ - S, ppm	1111				
Chloride Cl, ppm	947				
Boron B, ppm	1062				
Iron Fe, ppm	963				
Zinc Zn, ppm	1098				
Manganese Mn, ppm	1013				
Copper Cu, ppm	1087				

Copies to Addressee (1)

Respectfully submitted,

ENGINEERS TESTING LABORATORIES, INC.

Robert V. Woods, Chemist

SOIL CLASSIFICATION AND LEGEND

COARSE-GRAINED SOIL

MORE THAN 50% LARGER THAN 200 SIEVE SIZE

Symbol	Letter	DESCRIPTION	MAJOR DIVISIONS
	GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% - 200 FINES	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size.
	GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% - 200 FINES	
	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, MORE THAN 12% - 200 FINES	
	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, MORE THAN 12% - 200 FINES	
	SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% - 200 FINES	SANDS More than half of coarse fraction is smaller than No. 4 sieve size.
	SP	POORLY-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% - 200 FINES	
	SM	SILTY SANDS, SAND-SILT MIXTURES MORE THAN 12% - 200 FINES	
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES MORE THAN 12% - 200 FINES	

FINE-GRAINED SOIL

MORE THAN 50% SMALLER THAN 200 SIEVE SIZE

Symbol	Letter	DESCRIPTION	MAJOR DIVISIONS
	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	SILTS AND CLAYS Liquid limit less than 50
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
	OL	ORGANIC SILTS AND ORGANIC SILT-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	
	PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	

NOTE — Soils with 5 to 12 percent minus 200 fines should be classified with dual symbols

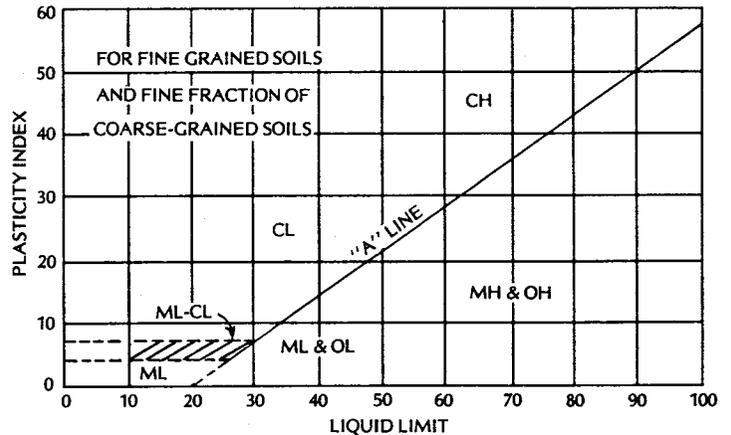
SOIL FRACTIONS

Component	Size Range
Boulders	Above 12 in.
Cobbles	3 in. to 12 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

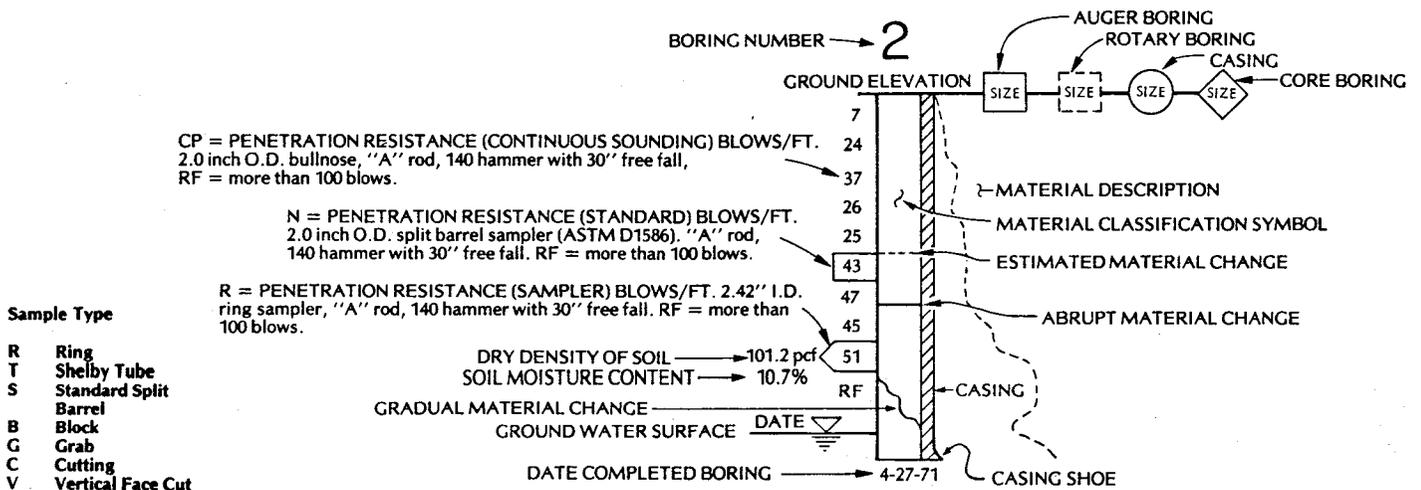
Soil Classification: ASTM D2487

Classification is visual unless accompanied by mechanical analysis and Atterberg limits. Percentage shown on log denotes visual approximation ± 5%.

PLASTICITY CHART



LEGEND OF BORING OPERATIONS



E**SOIL BORING DATA**

Location of Boring Material Resource Evaluation No. P1 Job No. 2121J266
 Elev. Top of Hole --- Datum Not established Prepared By MD Date 11-23-81
 Type/Size of Boring Backhoe Date 11-23-81 Driller M.C.F.C.D. Reviewed By GKC Date 12-18-81

Depth Ft.	Penetration Resistance Blows/Ft.		Sample Type	Dry Density pcf	Moisture Content	Graphical Log	Description	Soil Classification	Max. Size. In.	Particle Size Distribution %					Gradation Well Med. Poor	Grain Shape Angular Subangular Rounded Subrounded	Relative Density Low Med High	Dry Strength			Plasticity None Low Medium High	Consistency None Soft Firm Stiff Very Stiff Very Hard	Cementation None Light Moderate Heavy
	C	N								Boulders	Cobbles	Gravel	Sand	Silt & Clay				Very Low	Low	High			
1					Damp		SAND AND GRAVEL; gray to brown, some cobbles and occasional boulder	SW-SP	24"	TR	10	30	55	TR	xxx	x	x	x	x		x		
2										10	20	40	65	5									
3																							
4																							
5																							
6																							
7					Damp		SILTY GRAVELLY SAND; reddish-brown some cobbles and occasional boulders. Some zones exhibit moderate cementation	SP-SM	24"	5	10	20	30	5	xxx	x	x	xxx	xxx		xxx		
8										15	15	30	45	10									
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30							Stopped @ 24'. No groundwater table encountered.																

NOTE: THE DATA PRESENTED ON THESE BORING LOGS REPRESENTS SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC TEST LOCATIONS AND AT THE TIME DESIGNATED. THIS DATA MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND/OR TIMES. THIS BORING DATA WAS COMPILED PRIMARILY FOR DESIGN PURPOSES. THIS DATA SHOULD NOT BE CONSTRUED AS PART OF THE PLANS GOVERNING CONSTRUCTION OR AS DEFINING CONSTRUCTION TECHNIQUES.

E**SOIL BORING DATA**

Location of Boring Materials Resource Evaluation No. P4 Job No. 2121J266
 Elev. Top of Hole 1454' Datum _____ Prepared By MD Date 11-25-81
 Type/Size of Boring Backhoe Date 11-25-81 Driller M.C.F.C.D. Reviewed By GKC Date 12-18-81

Depth Ft.	Penetration Resistance Blows/Ft.		Sample Type	Dry Density pcf	Moisture Content	Graphical Log	Description	Soil Classification	Max. Size, In.	Particle Size Distribution %					Grada-tion Well Med. Poor	Grain Shape		Relative Density					Dry Strength			Plas-ticity		Consis-tency		Cemen-tation								
	C	N								Boulders	Cobbles	Gravel	Sand	Silt & Clay		Angular Subangular Rounded Subrounded	Low Med High None	Very Low Low Medium High Very High	None Low Medium High Soft Firm Stiff Very Stiff Hard	None Light Moderate Heavy																		
1					Sl. Damp		<u>SILTY GRAVELLY SAND; light brown</u>	<u>SM</u>	<u>12"</u>		<u>TR</u>	<u>20</u>	<u>50</u>	<u>20</u>	<u>x</u>	<u>x</u>	<u>x</u>	<u>x</u>																				
2											<u>10</u>	<u>30</u>	<u>60</u>	<u>30</u>																								
3																																						
4																																						
5																																						
6					Damp		<u>GRAVELLY SAND; reddish-brown</u>	<u>SM</u>			<u>TR</u>	<u>25</u>	<u>50</u>	<u>5</u>	<u>x</u>	<u>x</u>	<u>x</u>	<u>xxx</u>																				
7											<u>5</u>	<u>35</u>	<u>60</u>	<u>20</u>																								
8							<u>Occasional boulders.</u>																															
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21							<u>Stopped @ 21'. No groundwater table encountered.</u>																															
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SOIL BORING DATA

Location of Boring Material Resource Evaluation No. 3 Job No. 2121J266
 Elev. Top of Hole 1456' Datum Prepared By MD Date 11-17-81
 Type/Size of Boring Backhoe Date 11-17-81 Driller M.C.F.C.D. Reviewed By GKC Date 12-18-81

Depth Ft.	Penetration Resistance Blows/Ft.		Sample Type	Dry Density pcf	Moisture Content	Graphical Log	Description	Soil Classification	Max. Size. In.	Particle Size Distribution %					Grada-tion	Grain Shape	Relative Density	Dry Strength	Plasticity	Consistency	Cementation
	C	N								Boulders	Cobbles	Gravel	Sand	Silt & Clay							
1					Sl.	Damp	SILTY GRAVELLY SAND; reddish-brown	SP-SM	24"	5	10	20	30	5	xxx	x x	xxx		xx		xx
2							some cobbles and occasional boulders. Some zones exhibit moderate			15	15	30	45	10							
3							cementation.														
4																					
5					Sl.	Damp	SILTY SAND; light brown	SM	#10				60	25	xx	x x	x xx		xx		
6													75	40							
7					Sl.	Damp to Damp	SILTY GRAVELLY SAND; reddish-brown	SP-SM	24"	5	10	20	30	5	xxx	x x	xxx		xx		xx
8							some cobbles and occasional boulders. Some zones exhibit moderate			15	15	30	45	10							
9							cementation.														
10																					
11																					
12							Stopped @ 12'. No groundwater														
13							table encountered.														
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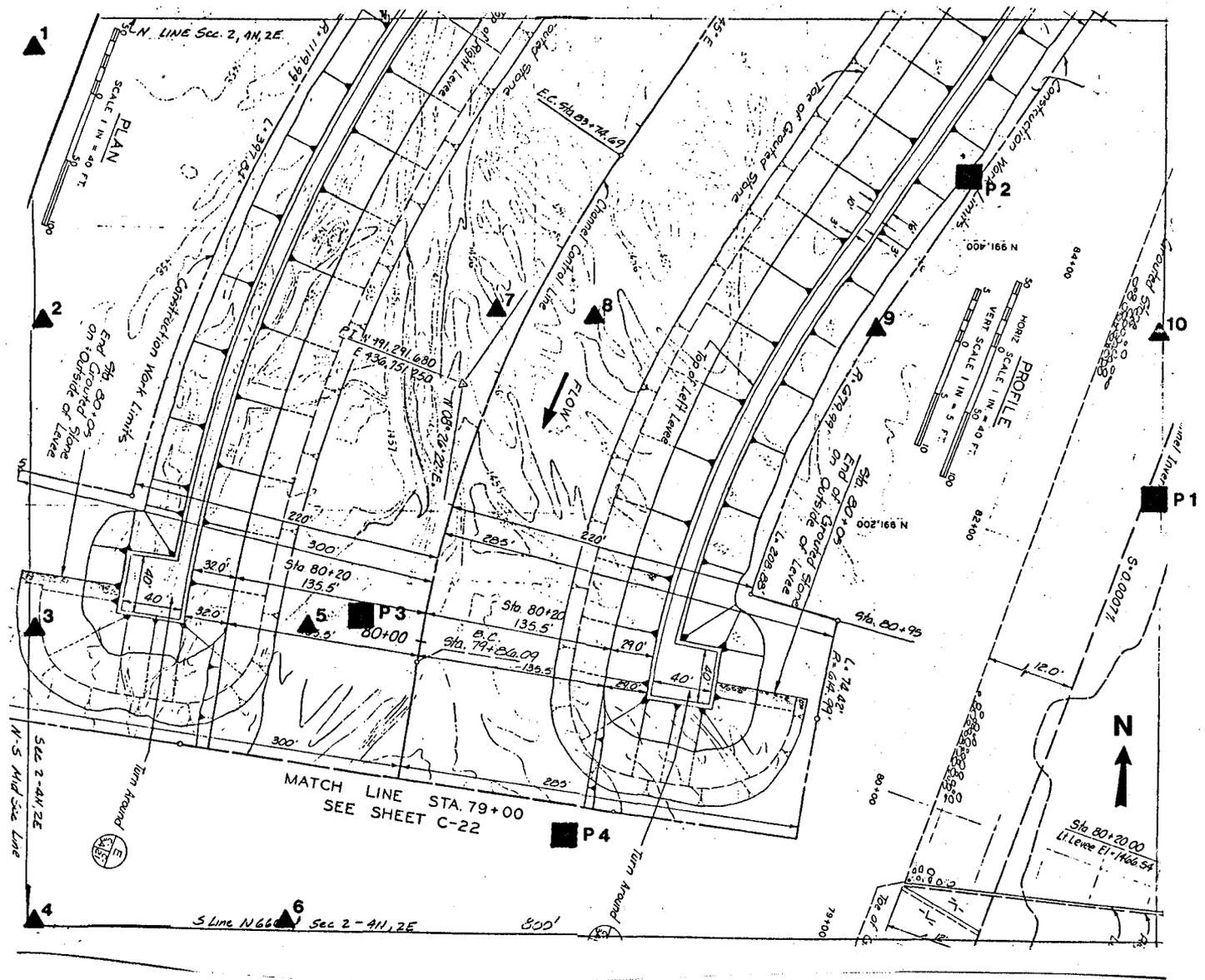
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E**SOIL BORING DATA**

Location of Boring Material Resource Evaluation No. 5 Job No. 2121J266
 Elev. Top of Hole 1453' Datum Prepared By MD Date 11-17-81
 Type/Size of Boring Backhoe Date 11-17-81 Driller M.C.F.C.D. Reviewed By GKC Date 12-18-81

Depth Ft.	Penetration Resistance Blows/Ft.		Sample Type	Dry Density pcf	Moisture Content	Graphical Log	Description	Soil Classification	Max. Size. In.	Particle Size Distribution %					Grada-tion	Grain Shape	Relative Density	Dry Strength			Plasticity	Consistency	Cementation	
	C	N								Boulders	Cobbles	Gravel	Sand	Silt & Clay				Well Med. Poor	Angular Subangular Rounded Subrounded	Low Med High				None
1					Sl.	Damp	SAND AND GRAVEL; gray to brown, some cobbles and occasional boulders	SW-SP	24"	TR	10	30	55	TR	xx	xx	x	x					x	
2										10	20	40	65	5										
3																								
4					Sl.	Damp	SAND AND GRAVEL; brown	SW	3"			30	60	TR	x	x	xxx	x						x
5												40	70	5										
6					Sl.	Damp	SILTY GRAVELLY SAND; reddish-brown some cobbles and occasional boulders. Some zones exhibit moderate cementation.	SP-SM	24"	5	10	20	30	5	xx	x	x	xxx			xx			xx
7										15	15	30	45	10										
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13							Stopped @ 12'. No groundwater table encountered.																	
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LEGEND

- ▲ Depth = 7-15'
- Depth = 21-24'

FIGURE 1 TEST PIT LOCATIONS