GEOTECHNICAL INVESTIGATION REPORT
Channelization - Agua Fria River
Thomas Road & I-10
Maricopa County, Arizona

SHB Job No. E82-49

Consulting Geotechnical Engineers
PHOENIX • ALBUQUERQUE

SERGENT, HAUSKINS & BECKWITH CONSULTING GEOTECHNICAL ENGINEERS

APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING

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June 8, 1982

Dibble & Associates
Consulting Engineers
3625 North 16th Street
Phoenix, Arizona 85016

SHB Job No. E82-49

Attention: Kent M. Dibble, P.E.

Re: Channelization -
Agua Fria River
Thomas Road & I-10
Maricopa County, Arizona

Gentlemen,

Our Geotechnical Investigation Report on the referenced project is herewith submitted. The report includes results of test drilling, laboratory analysis and recommended criteria for channel embankment design and earthwork elements of the project.

Should any questions arise concerning this report, we would be pleased to discuss them with you.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By Norman H. Wetz
Norman H. Wetz, P.E.

Reviewed by George H. Beckwith
George H. Beckwith, P.E.

Registered Professional Engineer (Civil) CERTIFICATE NO. 5638 GEORGE HENRY BECKWITH Date Signed 6-8-82 ARIZONA, U.S.A.

Copies: Addressee (5)

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1. INTRODUCTION

This report is submitted pursuant to a geotechnical investigation made by this firm of the site of the proposed channelization of the Agua Fria River between Thomas Road and I-10 located in Maricopa County, Arizona. The object of this investigation was to evaluate the physical properties of the subsoils underlying the site to provide recommendations for the design of channel embankments and other earthwork elements of the project.

2. PROJECT DESCRIPTION

Preliminary details of the proposed construction were provided by Kent M. Dibble, P.E., of Dibble & Associates Consulting Engineers.

The proposed channel will have a bottom width of approximately 1,100 feet and a depth of 12 feet. The inside slopes of the proposed embankment are anticipated to be approximately 3:1 (horizontal to vertical) and outside slopes of 2:1 on the west bank and 6:1 on the east bank. The anticipated crest width of the embankments will be 16 feet. It is understood that cuts of 3 to 9 feet will be involved below existing grade. It is anticipated that erosion protection measures will be needed to resist water velocities of approximately 8 to 9 feet per second.

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

3. INVESTIGATION

3.1 Subsurface Exploration

Fourteen exploratory borings were drilled to depths of 7½ to 26 feet below existing grade. 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. The field investigation was supervised by Michael R. Hulpke, staff engineering geologist, of this firm.

3.2 Laboratory Analysis

Moisture content determinations were made on selected tube samples recovered, while dry densities were determined for selected 2.42 inch diameter open-end drive samples. The results of these tests are shown on the boring logs.

Grain-size analysis, Atterberg Limits, direct shear, moisture-density relationship and permeability tests

were performed on selected samples. The results of these tests are presented in Appendix B, along with a brief description of testing procedures.

4. SITE CONDITIONS & GEOTECHNICAL PROFILE

4.1 Site Conditions

The proposed channel will extend through the Agua Fria channel with the center portion being located in cultivated fields that have a grain crop. A majority of the existing river channel is void of vegetative cover.

4.2 Geotechnical Profile

Sandy silts and silty sands extend from the surface to depths of about 1½ to 8 feet below existing grade. These soils are generally moderately firm to firm. This stratum is not present in the borings in the existing Agua Fria River channel, including borings 1, 9, 10 and 14. Relatively clean sands with varying amounts of silt and gravel underlie the surface stratum and extended the full depths of the borings. The relative density of these soils varies from loose to dense with the majority being medium dense.

4.3 Soil Moisture & Groundwater Conditions

No free groundwater was encountered in the borings and soil moisture contents were relatively low throughout their extent.

5. DISCUSSION & RECOMMENDATIONS

5.1 Analysis of Results

With the present alignment and proposed cut grades, it appears that the majority of the soils in both the cut areas and embankments will consist of relatively clean sands with varying fractions of silt and gravel. The recommendations and analysis were based on the use of on-site materials being utilized in the fill slopes and the exposure of native soils in the bottom of the channel. Recommendations for embankment slopes, erosion protection measures, and guide specifications for site grading are given in the following sections of this report.

5.2 Embankment Slopes

The stability of embankments were analyzed utilizing methods outlined by Hoek and Bray (1)*. Two cases were analyzed, one where the slopes would be entirely dry, which would apply to the slopes a majority of the time, and the case during high flows when embankments would be partially saturated.

Factors of safety of approximately 1.6 for dry conditions and 0.84 for partially saturated conditions were

*Numbers in parentheses correspond to references listed at end of report.

calculated for 2:1 slopes. Factors of safety of 2.5 for dry conditions and 1.2 for saturated conditions were calculated for 3:1 slopes. Thus, it is recommended that slopes be no steeper than 3:1 for both interior and exterior slopes of the embankment constructed of native materials. If soil-cement is chosen as an erosion protection measure, the treated slopes could be steepened. This is discussed in Section 5.3.

5.3 Erosion Protection

Two alternatives for erosion protection, riprap or soil-cement, are recommended for consideration in the following sections.

5.3.1 Riprap

In order to stabilize the inside slopes of the channel, rock lining was analyzed utilizing methods outlined by Stephenson (2). Assuming an average flow velocity of 8 to 9 feet per second, a rock lining consisting of 6 inch diameter rock with a thickness of 12 inches was determined. Where higher flows occur, it may be necessary to increase the size of the rock and the thickness. The rock lining could be placed loose or be placed in wire baskets in the form of Gabion or Reno mattresses. For estimation purposes, it should be assumed that an 18 inch thickness would be necessary for rock lining and a 12 inch thickness would be necessary for the hand-placed Gabion or Reno

mattresses. The use of the Reno mattresses improves the stability of the rock-fill against scouring or rolling down the banks, thus, reducing maintenance. Filter fabric is recommended to be placed between the embankment soils and the rock riprap.

5.3.2 Soil-Cement

Soil-cement is recommended as an alternative for erosion protection on the inside slopes of the channel. Two types of construction could be utilized for lining the channel slope. The embankments could be built of native material and the upper 12 inches of soil on the inside slopes would be soil-cement. This would require a slope of 4:1, or flatter, to facilitate proper construction of soil-cement. The other method would consist of constructing an embankment in 6 to 8 inch lifts with the inside width of 6 feet consisting of soil-cement. Inside slopes for this type of construction could be steepened to 1:1. The soil-cement would greatly enhance the engineering properties of the native soils and would allow a safe slope at 1:1.

For estimation purposes, the cement content of soil-cement should be 12 percent. Exact cement content should be determined in accordance with ASTM D558, D559 and D560 from the on-site soils to be used for soil-cement treatment. Shrinkage cracks and some maintenance should be expected with the use of soil-cement.

5.4 Site Grading & Earthwork Recommendations

5.4.1 Surface Preparation

All vegetation, debris and any existing man-made fill should be removed from the areas to receive structural fill.

The upper 6 inches of exposed native soils beneath cut surfaces in the areas where structural fill is to be placed should be scarified, brought to within 2 percent of the optimum moisture content and compacted to at least 95 percent of maximum dry density as determined by ASTM D698.

5.4.2 Structural Fill

All structural fill required to bring the embankments to required elevations should be free of excessive vegetation, debris and deleterious material, and contain no particles larger than 6 inches in diameter. This material should contain at least 50 percent or more sand and gravel by weight (no more than 50 percent by weight should pass the no. 200 sieve). It should have a plasticity index of no more than 6 when tested by ASTM D423 and D424.

All structural fill should be compacted to a minimum of 95 percent of maximum dry density determined in accordance with ASTM D698. This would apply for

soil-cement as well as the structural fill. Moisture content during compaction shall be maintained within the limits of 1 percent below to 3 percent above optimum moisture content.

REFERENCES

1. Hoek E. and Bray, J.W., "Rock Slope Engineering", The Gresham Press, London, U.K., Revised 3rd Edition, 1981.

2. Stephenson, David, "Rockfill In Hydraulic Engineering", Developments In Geotechnical Engineering, Volume 27, Elsevier Scientific Publishing Co., 1979.

APPENDIX A

TEST DRILLING EQUIPMENT & PROCEDURES

Drilling Equipment Truck-mounted CME-55 drill rigs powered with 4 or 6 cylinder Ford industrial engines are used in advancing test borings. The 4 cylinder and 6 cylinder engines are capable of delivering about 4,350 and 6,500 foot/pounds torque to the drill spindle, respectively. The spindle is advanced with twin hydraulic rams capable of exerting 12,000 pounds downward force. Drilling through soil or softer rock is performed with 6 1/2 O.D., 3 1/4 I.D. hollow stem auger or 4 1/2 inch continuous flight auger. Carbide insert teeth are normally used on the auger bits so they can often penetrate rock or very strongly cemented soils which require blasting or very heavy equipment for excavation. Where refusal is experienced in auger drilling, the holes are sometimes advanced with tricone gear bits and NX rods using water or air as a drilling fluid.

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 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 foot on the logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587). Where samples of rock are required, they are obtained by NX 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.

Continuous Penetration Tests Continuous penetration tests are performed by driving a 2" O.D. blunt nosed penetrometer adjacent to or in the bottom of borings. The penetrometer is attached to 1 5/8" O.D. drill rods to provide clearance to minimize side friction so that penetration values are as nearly as possible a measure of end resistance. Penetration values are recorded as the number of blows of a 140 pound 30 inch free fall drop hammer required to advance the penetrometer in one foot increments or less.

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

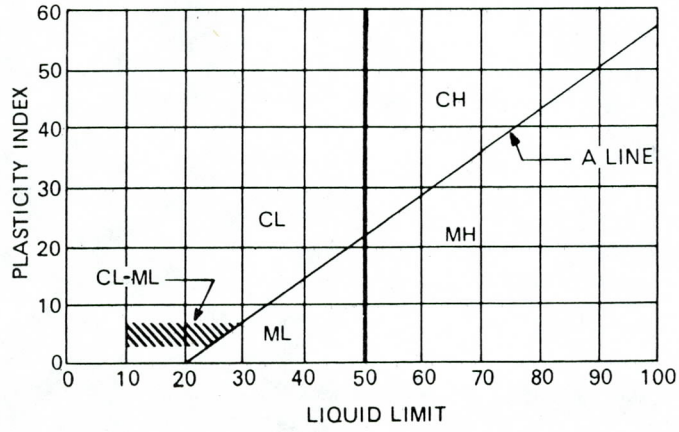
UNIFIED SOIL CLASSIFICATION SYSTEM

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.

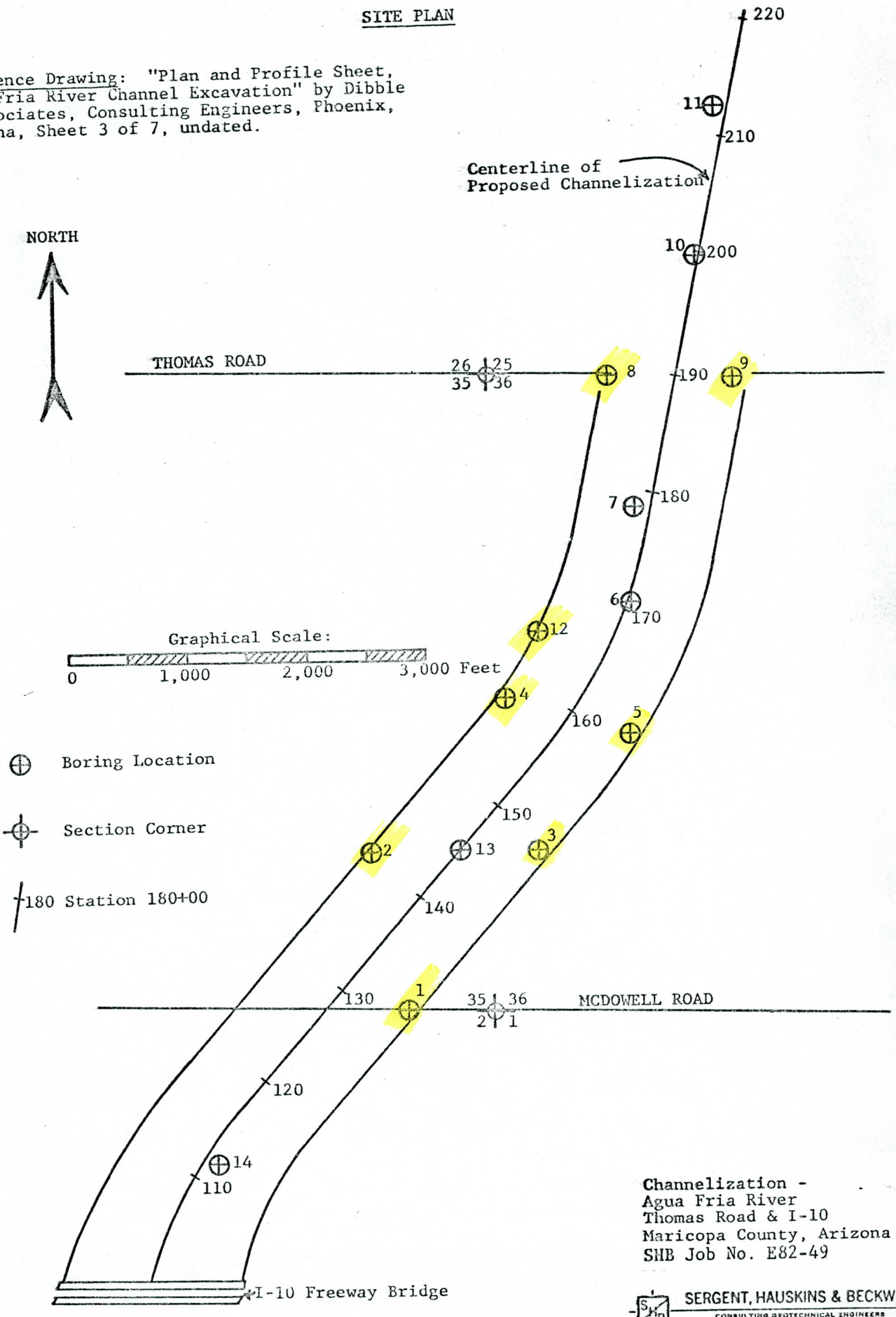
N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.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

SITE PLAN

Reference Drawing: "Plan and Profile Sheet, Agua Fria River Channel Excavation" by Dibble & Associates, Consulting Engineers, Phoenix, Arizona, Sheet 3 of 7, undated.



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PROJECT Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-30-82

LOG OF TEST BORING NO. 1

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

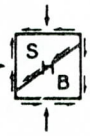
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	14				moist medium dense to loose	SAND, some silt & gravel, predominantly fine to medium, nonplastic, brown
			X	S	9			SP-SM		
5			X	S	19					
			X	S	17			SM	slightly moist to moist medium dense	SILTY SAND, some gravel, traces of clay, nonplastic to low plasticity, brown
10										
			X	S	42			SW-SM	moist dense	SAND, some silt & gravel, well graded, nonplastic, brown
15										
										Stopped auger at 14'6" Stopped sampler at 16'
20										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-29-82

LOG OF TEST BORING NO. 2

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

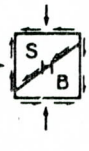
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	13			ML	moist moderately firm	SANDY SILT, low plasticity to nonplastic, brown
			X	S	18					
5			X	S	15				moist medium dense to very dense	SAND, some silt, trace of gravel, predominantly fine to medium, nonplastic, brown to light brown
								SP		
10			X	S	17					
15			X	U	100/8" (no recovery)					Stopped auger at 14'6" Sampler refused at 15'2"
20										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-29-82

LOG OF TEST BORING NO. 3

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

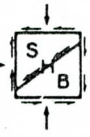
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	12			SM	moist	SILTY SAND, predominantly fine, nonplastic, brown
			X	U	31	93	9		medium dense	
5			X	S	9				moist	SAND, some silt & gravel, predominantly fine to medium, nonplastic, brown
								SP	dense to loose	
10			X	S	23					
								SW-SM	moist	SAND, some silt & gravel, nonplastic, brown to reddish-brown
15			X	S	27				medium dense	
										Stopped auger at 14'6" Stopped sampler at 16'
20										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-29-82

LOG OF TEST BORING NO. 4

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

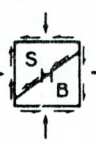
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	16			ML	moist firm	SANDY SILT, low plasticity to nonplastic, brown
			X	S	11			SP-SM	moist medium dense	SAND, some silt, predominantly fine to medium, nonplastic, brown
5			X	S	14					
								SW-SM	moist medium dense	SAND, considerable gravel, some silt, well graded, nonplastic, brown
10			X	S	12		6			
								SP-SM	moist medium dense	SAND, some silt & gravel, predominantly fine to medium, nonplastic, reddish-brown to brown
15			X	S	23		7			
20										Stopped auger at 14'6" Stopped sampler at 16'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-29-82

LOG OF TEST BORING NO. 5

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

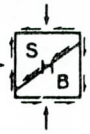
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	14			ML	dry	SANDY SILT, low plasticity to nonplastic, light brown to tan
			X	S	23(no recovery)				moderately firm	
5			X	S	25			SP-SM	slightly moist to moist	SAND, some to considerable silt, predominantly fine, nonplastic, light brown to tan
									medium dense	
10			X	S	26				moist	SAND, some silt & gravel, well graded, nonplastic, brown
								SW-SM	medium dense to dense	
15			X	S	34					
20										Stopped auger at 14'6" Stopped sampler at 16'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-29-82

LOG OF TEST BORING NO. 6

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

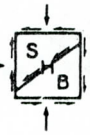
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	14		13	ML	moist moderately firm	SANDY SILT, nonplastic, dark brown
			X	S	40			SM		
5			X	S	21		6	SP-SM	moist very firm	SILTY SAND, trace of gravel, predominantly fine, low plasticity to nonplastic, brown to dark brown note: some thin sandy silt lenses
10			X	S	13			SW		
15			X	S	14			SC	moist medium dense	SAND, considerable silt, predominantly fine, nonplastic, brown to light brown
20									moist medium dense	SAND, some silt & gravel, well graded, nonplastic, brown to light brown
									moist moderately firm	CLAYEY SAND, trace of gravel, predominantly medium, low plasticity to nonplastic, reddish-brown
										Stopped auger at 14'6" Stopped sampler at 16'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-29-82

LOG OF TEST BORING NO. 7

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	17			SM	dry to moist firm	SILTY SAND, predominantly fine, nonplastic, brown
			X	S	46			ML	moist very firm	SANDY SILT, low plasticity to nonplastic, brown
5			X	S	20			SP	moist medium dense	SAND, some silt, trace of gravel, predominantly fine to medium, nonplastic, light brown
10			X	S	31			SW	moist to very moist dense	SAND, some silt & gravel, well graded, nonplastic, light brown
15			X	S	34					
20										Stopped auger at 14'6" Stopped sampler at 16'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-29-82

LOG OF TEST BORING NO. 8

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

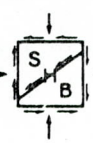
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	24			SM	moist firm	SILTY SAND, predominantly fine, nonplastic, brown
			X	S	21		13	ML	moist firm to hard	SANDY SILT, low plasticity to nonplastic, brown
5			X	U	77 (no recovery)					
								SP-SM	moist medium dense	SAND, some silt & gravel, predominantly fine to medium, nonplastic, light brown to brown
10			X	S	19					
								SM-SW	moist very dense	SAND, considerable silt, some gravel, well graded, nonplastic, light brown
15			X	S	40					
20										Stopped auger at 14'6" Stopped sampler at 16'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-30-82

LOG OF TEST BORING NO. 9

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	14			SP	slightly moist medium dense to loose	SAND, some silt & gravel, predominantly fine to medium, nonplastic, brown
			X	S	9					
5			X	S	8			SW	slightly moist loose to very dense	SAND, some silt & gravel, well graded, nonplastic, brown note: trace of cobbles below 7'
				S	50/0"					
10										Auger refused at 7'6" Sampler refused at 7'6"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-30-82

LOG OF TEST BORING NO. 10

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

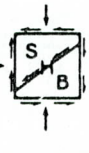
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	4				dry to moist	SAND, some fine gravel, trace of silt, predominantly fine to medium, nonplastic, light brown
			X	S	9			SP	very loose to medium dense	
5			X	S	18		3			
									moist to very moist	SAND, considerable silt & gravel, some cobbles, well graded, nonplastic, brown
10			X	S	50/2"			SW-SM	very dense	
15			X	S	50/2"					
										Stopped auger at 14'6" Sampler refused at 15'2"
20										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-30-82

LOG OF TEST BORING NO. 11

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	26				slightly moist firm to very firm	SILTY SAND, predominantly fine, nonplastic, brown
			X	S	12			SM		
5			X	U	48		8			
									moist medium dense to dense	SAND, some silt & gravel, predominantly fine to medium, nonplastic, brown
10			X	S	20					
								SP		
15			X	S	35					
									moist very firm to hard	SILTY SAND, considerable gravel, trace of clay, well graded, nonplastic to low plasticity, brown
20			X	S	37					
								SM		
25			X	S	72					
										Stopped auger at 24'6" Stopped sampler at 26'
30										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-29-82

LOG OF TEST BORING NO. 12

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

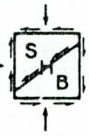
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	12			ML	moist moderately firm	SANDY SILT, low plasticity to nonplastic, brown
			X	U	32	102	8			
5			X	S	12			SP	moist medium dense	SAND, some silt, trace of gravel, predominantly fine, nonplastic, light brown
10			X	S	18			SW	moist medium dense	SAND, some silt & gravel, well graded, nonplastic, brown to light brown
15			X	S	50/5½"			SW-SM	moist very dense	SAND, considerable gravel, some silt, well graded, nonplastic to low plasticity, brown
										Stopped auger at 14'6" Sampler refused at 14'11½"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-29-82

LOG OF TEST BORING NO. 13

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

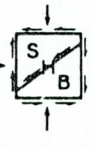
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	16		12	ML	moist to saturated	SANDY SILT, nonplastic, brown
			X	S	7		30		firm	
5			X	S	10		5	SP	very moist to moist loose	SAND, some silt & gravel, predominantly fine to medium, nonplastic, brown to light brown
10			X	S	7		4			
15			X	S	19			SW	moist medium dense	SAND, some gravel, trace of clay, well graded, nonplastic to low plasticity, brown
20										Stopped auger at 14'6" Stopped sampler at 16'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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 Channelization - Agua Fria River

JOB NO. E82-49 DATE 4-30-82

LOG OF TEST BORING NO. 14

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV.

DATUM

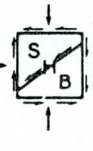
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	7				dry to moist loose to medium dense	SAND, some silt, predominantly fine to medium, nonplastic, light brown
			X	S	7		21	SP-SM		
5			X	S	14					
									very moist very firm	SILTY SAND, some gravel, trace of clay, predominantly fine to medium, nonplastic to low plasticity, dark brown
10			X	S	46			SM		
15			X	S	41					
										Stopped auger at 14'6" Stopped sampler at 16'
20										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
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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APPENDIX B

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 one 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 inches per minute. The machine is designed to receive one of the one 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.

TABULATION OF TEST RESULTS

Job No. E82-49
W/O 1

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	SIEVE ANALYSIS-ACCUM % PASSING #200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
4	9.5′-11′	SW-SM	-	NP	6	8	21	54	65	73	74	77	84	87	100		2-49-18
4	14.5′-16′	SP-SM	-	NP	7	8	23	53	64	81	86	92	100				2-49-19
6	0.5′-2′		-	NP													2-49-24
6	4.5′-6′		NA	-	9	19	79	97	98	100							2-49-26
8	2.5′-4′	ML	-	NP	61	79	94	99	99	100							2-49-35
10	4.5′-6′	SP	-	NP	2	4	22	68	84	96	98	100					2-49-43
11	4.5′-5.5′	SM	-	NP	48	65	92	98	99	99	100						2-49-48
13	0.5′-2′	ML	-	NP	56	79	97	99	100								2-49-58
14	2.5′-4′	SP-SM	-	NP	6	13	57	97	99	99	100						2-49-64

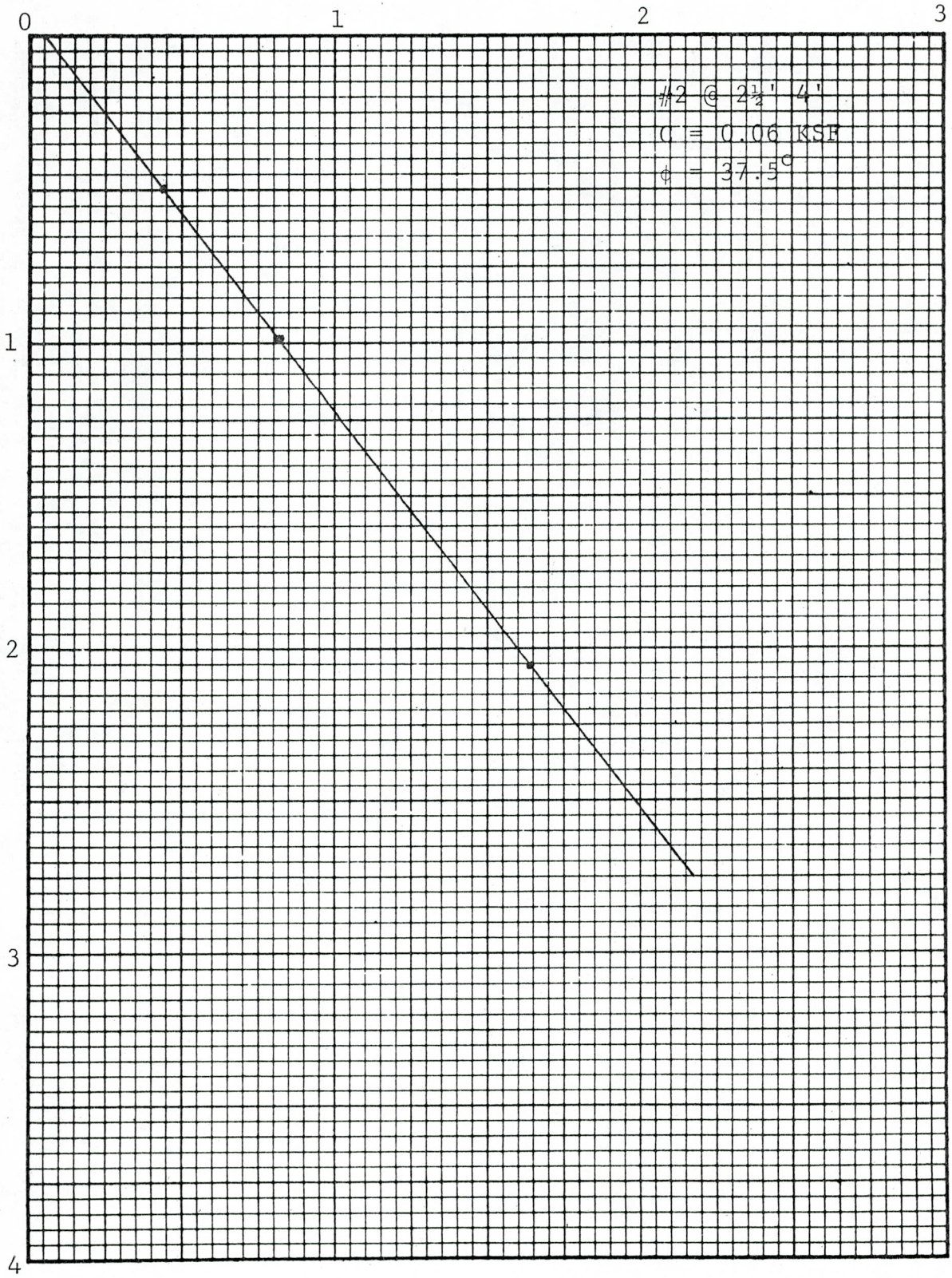
TABULATION OF TEST RESULTS

Job No. E82-49
W/O 2

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	SIEVE ANALYSIS-ACCUM % PASSING #200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
4	1'-2'	SM	-	NP	47	67	88	95	96	97	97	97	97	100			2-49-68
9	1'-2'	SP-SM	-	NP	5	9	36	64	72	81	83	86	92	95	99	100	2-49-69

SUMMARY OF DIRECT SHEAR TESTS

PROJECT Channelization - Agua Fria River **JOB NO.** E82-49-7



SOIL MOISTURE CONDITION

○ – INSITU
● – SUBMERGED

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT Channelization - Agua Fria River JOB NO. E82-49

LOCATION Thomas Road & I-10, Maricopa County, AZ LAB NO. 2-49-7

SAMPLE #2 @ 2½'-4'

DIRECT SHEAR TESTS

In Situ - Point No. 1 (= ± 0.50 KSF)

Initial Moisture Content	4.3 %
Dry Density (PCF)	100.6
Submerged	
Final Moisture Content	19.7 %
Maximum Vertical Deformation @ T max.	(+).007 inches
Shearing Stress, T max.	0.44 KSF

In Situ - Point No. 2 (= ± 1.00KSF)

Initial Moisture Content	3.8 %
Dry Density (PCF)	101.9
Submerged	
Final Moisture Content	18.9 %
Maximum Vertical Deformation @ T max.	(+).008 inches
Shearing Stress, T max.	0.81 KSF

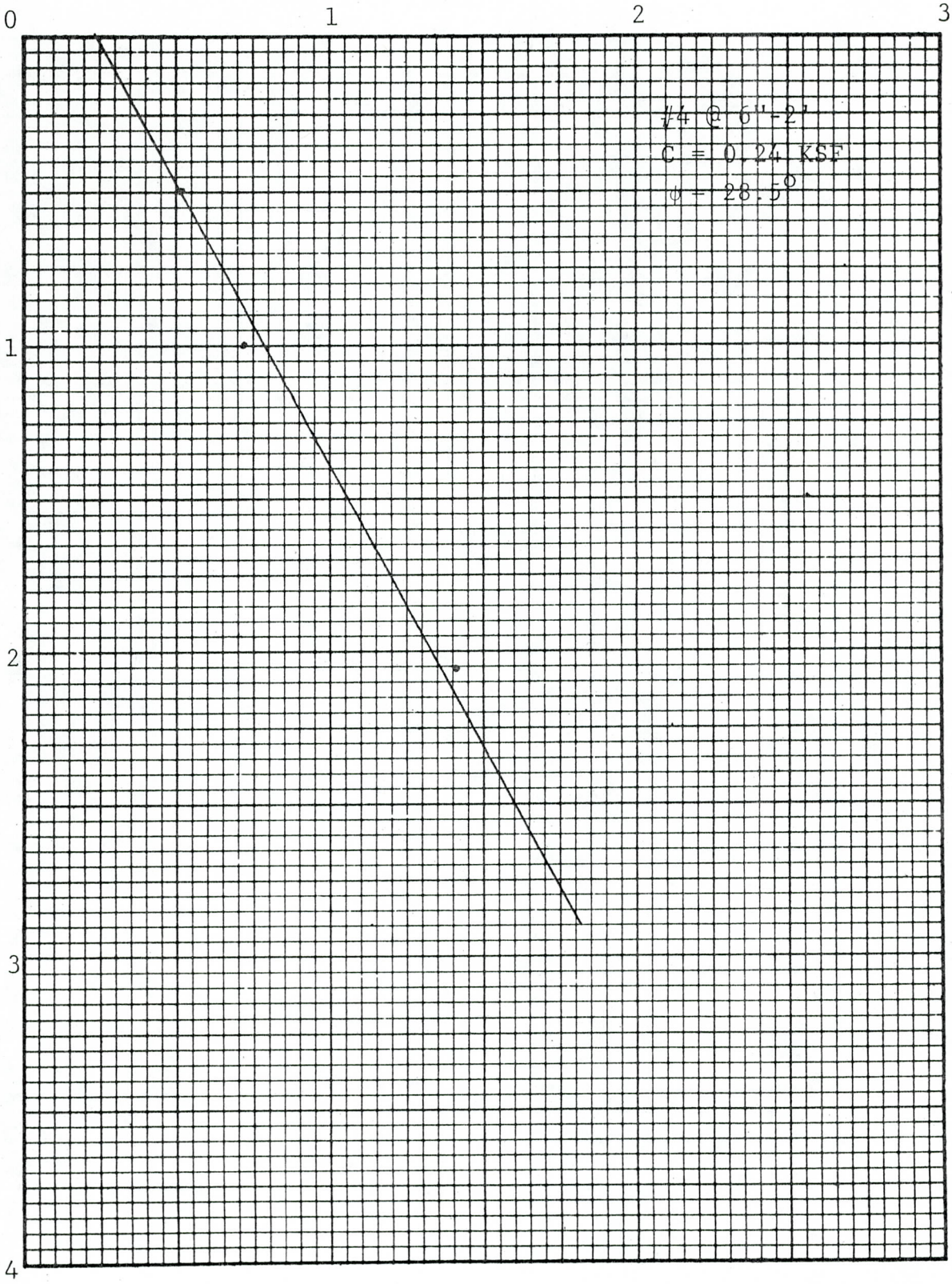
In Situ - Point No. 3 (= ± 2.06 KSF)

Inital Moisture Content	3.6 %
Dry Density (PCF)	101.7
Submerged	
Final Moisture Content	19.4 %
Maximum Vertical Deformation @ T max.	(+).003 inches
Shearing Stress, T max.	1.64 KSF

REMOLDED TO Est. 95 % OF Max. γ Dry

SUMMARY OF DIRECT SHEAR TESTS

PROJECT Channelization - Agua Fria River **JOB NO.** E82-49-15



SOIL MOISTURE CONDITION

○ – INSITU
● – SUBMERGED

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT Channelization - Agua Fria River JOB NO. E82-49

LOCATION Thomas Road & I-10, Maricopa County, AZ LAB NO. 2-49-15

SAMPLE #4 @ 6"-2' W/O No. 1

DIRECT SHEAR TESTS

IN SITU - POINT NO. 1 (= ± 0.50 KSF)

INITIAL MOISTURE CONTENT	8.2 %
DRY DENSITY (PCF)	110.6
SUBMERGED	
FINAL MOISTURE CONTENT	17.9 %
MAXIMUM VERTICAL DEFORMATION @ T MAX.	(+).001 INCHES
SHEARING STRESS, T MAX.	0.51 KSF

IN SITU - POINT NO. 2 (= ± 1.00 KSF)

INITIAL MOISTURE CONTENT	7.8 %
DRY DENSITY (PCF)	108.5
SUBMERGED	
FINAL MOISTURE CONTENT	17.5 %
MAXIMUM VERTICAL DEFORMATION @ T MAX.	( ).000 INCHES
SHEARING STRESS, T MAX.	0.72 KSF

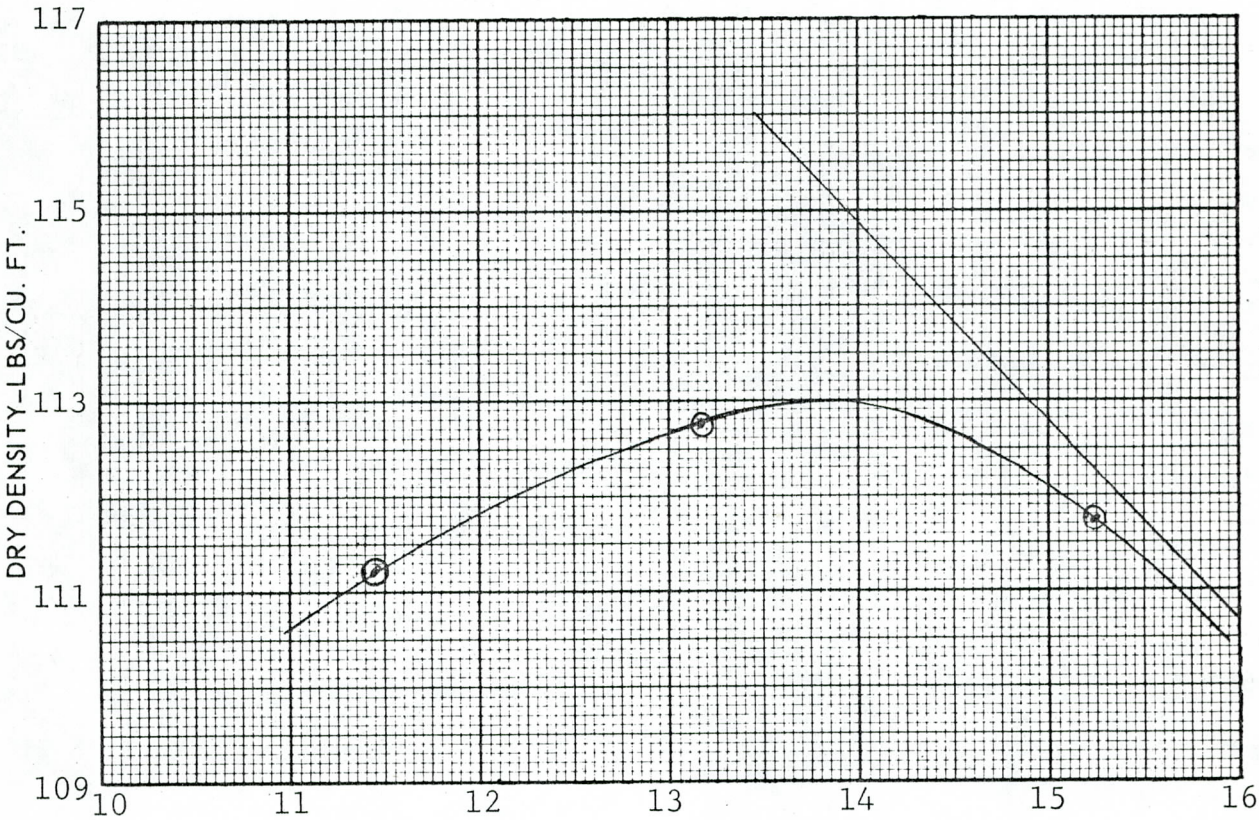
IN SITU - POINT NO. 3 (= ± 2.06 KSF)

INITAL MOISTURE CONTENT	7.8 %
DRY DENSITY (PCF)	110.5
SUBMERGED	
FINAL MOISTURE CONTENT	17.3 %
MAXIMUM VERTICAL DEFORMATION @ T MAX.	( ).000 INCHES
SHEARING STRESS, T MAX.	1.41 KSF

REMOLDED TO Est. 95 % OF Max. γ Dry

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Channelization - Agua Fria River **JOB NO.** E82-49



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
A	Boring #4 @ 1'-2'	13.8	113.0	D698	A	2-49-68

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4''	4.58''	3	25	5.5 LBS.	12''	12,375
B	-#4	6''	4.58''	3	56	5.5 LBS.	12''	12,317
C	-3/4	4''	4.58''	3	25	5.5 LBS.	12''	12,375
D	-3/4	6''	4.58''	3	56	5.5 LBS.	12''	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4''	4.58''	5	25	10.0 LBS.	18''	56,250
B	-#4	6''	4.58''	5	56	10.0 LBS.	18''	55,986
C	-3/4	4''	4.58''	5	25	10.0 LBS.	18''	56,250
D	-3/4	6''	4.58''	5	56	10.0 LBS.	18''	55,986

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Channelization - Agua Fria River **JOB NO.** E82-49

CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
B	Boring #9 @ 1'-2'	14.8	113.0	D698	A	2-49-69

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4''	4.58''	3	25	5.5 LBS.	12''	12,375
B	-#4	6''	4.58''	3	56	5.5 LBS.	12''	12,317
C	-3/4	4''	4.58''	3	25	5.5 LBS.	12''	12,375
D	-3/4	6''	4.58''	3	56	5.5 LBS.	12''	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4''	4.58''	5	25	10.0 LBS.	18''	56,250
B	-#4	6''	4.58''	5	56	10.0 LBS.	18''	55,986
C	-3/4	4''	4.58''	5	25	10.0 LBS.	18''	56,250
D	-3/4	6''	4.58''	5	56	10.0 LBS.	18''	55,986

REPORT ON LABORATORY TESTS

DATE _____

PROJECT Channelization - Agua Fria River JOB NO. E82-49

LOCATION Thomas Road & I-10; Maricopa County, AZ LAB NO. 2-49-68

PERMEABILITY TEST
(Pressurized Permeameter)

Sample Boring #4 @ 1'-2'

Remolded to Density of 109.4 PCF at 13.0 %

Diameter 4.920 cm Length 5.08 cm Area 19.01 cm^2 Vol. 96.62 cc

W_s 169.4 grms. w_o 13.0 % w_f 16.9 % G_s _____ V_s _____ cc

Void Ratio _____ Dry Density _____ PCF Trials _____ days

Pressure (PSI)	Head (inches)	Q (cc)	Time (min.)	K (cm/sec)	K (ft/yr)	Remarks
F.H.	48.8	52	1080	1.7×10^{-6}	2	Input "Q"
		10	1080	3.3×10^{-7}	0.3	Output "Q"
	47.8	94	2916	1.2×10^{-6}	1.2	Input "Q"
		16	2916	3.3×10^{-7}	0.3	Output "Q"
	46.5	147	6918	8.0×10^{-7}	0.8	Input "Q"
5	185.9	113	1650	6.4×10^{-7}	0.7	Input "Q"
		73	1650	4.2×10^{-7}	0.4	Output "Q"
5	185.7	71	1463	4.6×10^{-7}	0.5	Input "Q"
		46	1463	3.0×10^{-7}	0.3	Output "Q"
5	182.6	56	1474	3.6×10^{-7}	04	Input "Q"
		33	1474	2.0×10^{-7}	0.2	Output "Q"

REPORT ON LABORATORY TESTS

DATE _____

PROJECT Channelization - Agua Fria River JOB NO. E82-49

LOCATION Thomas Road & I-10; Maricopa County, AZ LAB NO. 2-49-69

PERMEABILITY TEST
(Pressurized Permeameter)

Sample Boring #9 @ 1'-2'

Remolded to Density of 108.5 PCF at 14.9 %

Diameter 4.92 cm Length 5.08 cm Area 19.01 cm^2 Vol. 96.62 cc

W_s 168.0 grms. w_o 14.9 % w_f 18.0 % G_s _____ V_s _____ cc

Void Ratio _____ Dry Density _____ PCF Trials _____ days

Pressure (PSI)	Head (inches)	Q (cc)	Time (min.)	K (cm/sec)	K (ft/yr)	Remarks
F.H.	42.5	195	8	1.0×10^{-3}	1040	Input ≠ Output
	42.3	290	26	4.6×10^{-4}	479	
	42.9	265	41	2.6×10^{-4}	273	
	40.1	380	132	1.3×10^{-4}	130	
	43.5	240	135	7.2×10^{-5}	74	
	43.4	280	311	3.6×10^{-5}	38	
	40.6	400	383	4.5×10^{-5}	47	
Constant =	66.0	920	1213	2.0×10^{-5}	21	
	66.0	760	1463	1.4×10^{-5}	15	