WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

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

June 16, 1986

Attn: Nick Karan, P.E.
Chief, Engineering Division

Re: Shrinkage Testing
Spookhill Flood Retention Structure
Maricopa County, Arizona

Job No. 2125J296

According to your request, we have completed the field sampling and laboratory testing services for the existing Spookhill Flood Retention Structure. These services were performed in accordance with your contract FCD 85-45 dated January 20, 1986.

The purpose of this investigation was to obtain disturbed and relatively undisturbed soil samples from various depths in the existing embankment for shrinkage limits testing. The subsurface exploration and sampling were performed at Station 265+00 and Station 280+00 along the Spookhill Flood Retention Structure. The shrinkage limits tests were run according to the procedures provided by the Soil Conservation Service. A copy of these procedures is included in the Appendix.

Subsurface exploration at the site was accomplished with a backhoe and an auger drill rig. The backhoe was used for the shallower exploration where block samples were taken, and the auger drill rig was used for the deeper exploration where Dennison samples were

obtained. The block samples were approximately 1 foot to a side, and the Dennison samples were approximately 2 feet long and 6-1/2 inches in diameter.

The predominant embankment material encountered was silty sand with varying amounts of gravel. Clayey sand with low plasticity was encountered in Boring 1 from a depth of 2 feet to a depth of 15 feet. This clayey sand was underlain by silty sand. The surface soils at both sites were sand and gravel to a depth of 2 feet. Logs of Borings are included in the Appendix.

Shrinkage limits tests as described by the SCS procedures could be performed with the remolded samples, but they could not be performed with the undisturbed samples. The lack of cohesion and the gravel size particles in the undisturbed samples did not allow the samples to be trimmed to regular shapes that could be measured for volume calculations. Attempts were made to seal the undisturbed samples in cellophane and paraffin to obtain submersed volume measurements. This method did not produce acceptably accurate results because the cellophane and paraffin could not be made to conform well enough to the shape of a trimmed sample.

The remolded samples were prepared in accordance with the design specifications for the fill. This data was provided by the Maricopa County Flood Control district and is reproduced in the Appendix (Construction Monitoring Test Results) along with the specific gravity determinations (Physical Properties). The remolded shrinkage limits tests were run with material passing the #4 sieve. The results of these tests are presented in the following table.

Station	Depth (ft)	Initial Dry Density (pcf)	Initial Moisture Content (%)	Volume Change[1] After Drying (%)
265+00	6.6-7.6	112.5	7.4	+2.7
265+00	9.2-10.2	120.2	8.5	+1.4
265+00	16.2-18.2	121.0	8.0	-0.4
265+00	18.3-20.3	115.7	9.6	-0.4
265+00	20.3-22.3	124.5	8.4	+0.5
280+00	5.5-6.5	118.2	8.6	+3.0
280+00	12.0-13.0	125.3	10.1	+0.5
280+00	16.0-18.0	119.9	9.7	+0.2
280+00	18.0-20.0	119.3	11.0	+0.4
280+00	20.5-22.5	123.6	11.0	+0.6

[1] + indicates volume increase, - indicates volumes decrease.

The volume changes indicate that the soils have a tendency to increase in volume, not shrink upon drying. Irregularities in the samples and measuring techniques are probably responsible for the apparent increase in volume upon drying. A variance of 0.01 inch in the length and diameter measurements would change the volume by 0.7 percent, and a variance of 0.02 inch would affect the volume by 1.4 percent. The individual measurements for each sample varied within ranges from 0.01 inch to 0.05 inch. Accordingly, volume determinations can be expected to vary approximately one percent or slightly more. With this in mind, only two samples exhibited any significant change in volume upon drying. These samples showed volume increases of 2.7 and 3.0 percent. A combination of measurement errors and sample irregularities may be responsible for the apparent volume increase of these two samples.

The sampling and testing program of the Spookhill Flood Retention Structure embankment material indicates that the silty sands and clayey sands used for construction have very low if any remolded

shrinkage potential. Shrinkage limits tests on undisturbed samples were not possible but do not seem necessary in light of the test results on the remolded samples.

We have enjoyed providing these services for you and are prepared to assist in other aspects of this project as needed. If you have any question concerning this report, or if we may be of any additional service, please call us.

Sincerely,
WESTERN TECHNOLOGIES INC.

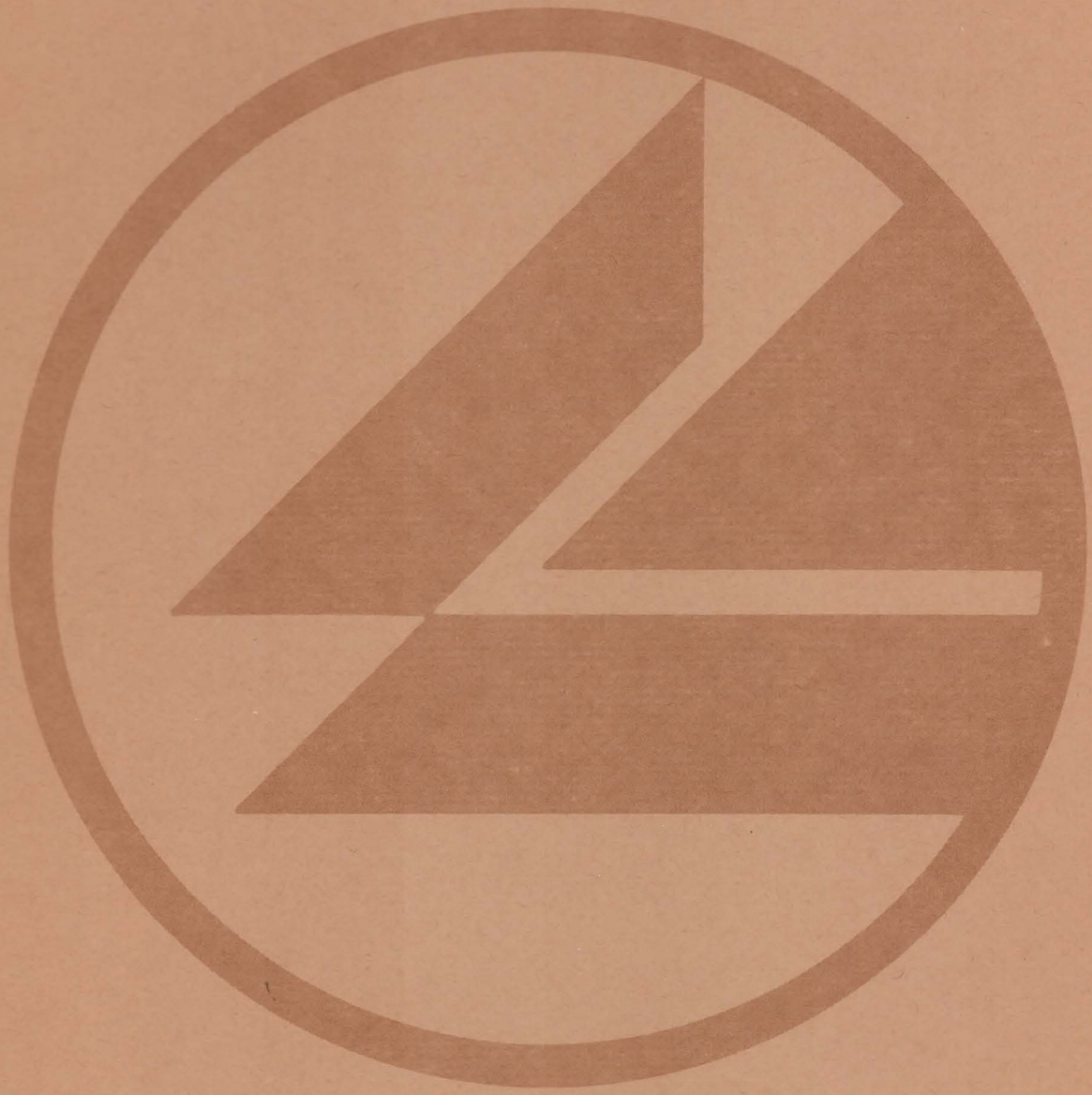
Registered Professional Engineer
CERTIFICATE NO.
1936
FRANK
COSTELLO
Signed
ARIZONA, U.S.A.

Frank Costello 6/8/06

Frank Costello, P.E. Reviewed by: Kenneth L. Ricker, P.E.

jh

Copies to: Addressee (5)



APPENDIX

Maricopa County Flood Control District
Job No. 2125J296

BORING LOG NOTES

The number shown in "LOG OF BORING NO." refers to the approximate location of the same number indicated on the "Site Plan" as positioned in the field by the client.

"STA" refers to the approximate stationing of the boring along the embankment.

"TYPE/SIZE BORING" refers to the exploratory equipment used in the boring wherein HSA = hollow-stem auger and 16" bucket = backhoe pit.

"Sample Type" refers to the form of sample recovery, in which B = Block sample and D = Dennison sample.

"Dry Density, pcf" refers to the laboratory-determined dry density in pounds per cubic foot. The symbol "NR" indicates that no sample was recovered. The symbol "*" indicates that determination of dry density was not possible.

"Unified Classification" refers to the soil type as defined by "Method of Soil Classification". The soils were classified visually in the field and, where appropriate, classifications were modified by visual examination of samples in the laboratory and/or by appropriate tests.

These notes and boring logs are intended for use in conjunction with the purposes of our services defined in the text. Boring log data should not be construed as part of the construction plans nor as defining construction conditions.

Boring logs depict our interpretations of subsurface conditions at the locations and on the date(s) noted. Variations in subsurface conditions and soil characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

In general, terms and symbols on the boring logs conform with "Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics" (ASTM D653).

LOG OF BORING NO. 1 Sta. 265+00

Project Geotechnical Services - Spookhill Dam Job No. 2125J296

Elevation Not Determined Datum Crest of the Embankment

Type/Size Boring 16" Bucket/7" HSA Rig Type John Deere 510/CME 75

Groundwater Conditions None Encountered Date /18/86; 3/18/86

Depth, feet	Sample Interval (ft) Top	Sample Interval (ft) Bottom	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
						SP-GP	SAND AND GRAVEL FILL; some cobbles, trace silt and clay, greenish gray, medium dense, damp
5						SC	CLAYEY SAND FILL; with silt, some gravel, brown, dense to very dense, damp to slightly damp
							Finer gravel
	6.6	7.6	B	*	7.2		
10	9.2	10.2	B	*	6.6		Light brown, slightly higher moisture content
							Brown, slightly more clay
15							Grades into silty sand and gravel
	16.2	18.2	D	*	7.8	SM	SILTY SAND AND GRAVEL FILL; grayish green, very dense, slightly damp
							Some cobbles (granitic composition)
20	18.3	20.3	D	*	9.2		
	20.3	22.2	D	*	8.4		
	22.2	23.0	D	NR			
25							Sampler refusal @ 23 feet on large cobbles
30							

LOG OF BORING NO. 2 Sta. 280+00

Project Geotechnical Services - Spookhill Dam Job No. 2125J296

Elevation Not Determined Datum Crest of the Embankment

Type/Size Boring 16" Bucket/7" HSA Rig Type John Deere 510/CME 75

Groundwater Conditions None Encountered Date 2/18/86; 3/20/86

Depth, feet	Sample Interval (ft) Top	Sample Interval (ft) Bottom	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
						SP-GP	SAND AND GRAVEL FILL; trace cobbles, trace silt and clay, greenish gray, medium dense, damp
5	5.5	6.5	B	*	5.8	SM	SILTY SAND FILL; with gravel, trace clay, brown, dense to very dense, damp to slightly damp
10	12.0	13.0	B	*	5.9		Grayish green color, no plasticity
15	16.0	18.0	D	*	7.9		
	18.0	20.0	D	*	8.6		
20	20.5	22.5	D	*	9.1		
	22.5	23.0	D	NR		SM	GRAVELLY SAND; with silt, tan to off white, very dense, slightly damp, very heavy cementation encountered at 22.0 feet
25							Sampler refusal @ 23.0 feet on heavily cemented gravelly sands
30							

United States Department of Agriculture

Soil Conservation Service

West National Technical Center
511 N. W. Broadway, Room 547
Portland, Oregon 97209-3489

Subject: ENG - Soil Mechanics - Shrinkage Limits

Date: February 26, 1985

To: Ralph Arrington, State Conservation Engineer,
SCS, Phoenix, Arizona

File Code:

Attached is a letter from the Lincoln Laboratory indicating the procedure for making shrinkage limits on compacted soils. The letter does not give the instructions I was hoping for but should be sufficient with the following additions:

1. Prepare a compacted specimen using soil from the same area of the fill an undisturbed sample was obtained. Prepare the sample in accordance with the ASTM Standard test procedure used for design of the fill. The dry density and moisture content shall be in accordance with the design specifications for the fill.

2. Extrude the specimen and dry according to the instructions in the attached letter. Determine G_s and moisture content of the soil.

3. Determine the volume of the mold in accordance with section 3.1.3 ASTM D698.

4. After the specimen has been dried, determine the average diameter, height and volume. The average of the diameter, height and volume shall be calculated from at least six diameter and three height measurements made to the nearest 0.001 in. (0.02 mn).

5. Make shrinkage calculations in accordance with attached letter.

6. Obtain an undisturbed sample of the fill. Determine G_s and moisture content for the sample.

7. Determine the average diameter, height and volume using measurement procedures similar to item 4.

8. Dry the undisturbed sample according to the attached letter.

9. Determine the average diameter, height and volume using measurement procedures similar to item 4.

10. Make shrinkage calculations in accordance with attached letter.

11. Plot the moisture contents and shrinkage limits percent vs. the dry density values for the remolded and undisturbed samples.

12. Calculate the theoretical minimum volume possible for the soil by using the following equation:

$$V_{min} = \frac{(W_s)\ (SL)}{\gamma\omega} + \frac{W_s}{G_s\gamma\omega}$$

where W_s = W+ of solids
SL = Shrinkage limit at Placement density in decimal.

13. Calculate volume associated with the in place density and assume one for the placement density volume.

14. Evaluate the volumetric shrinkage to determine the amount completed since construction and what is left yet to reach m minimum volume.

15. Following is an example set of calculations and comparison:

a. Placement density = 1.83 gm/cc

b. Present in place density = 1.87 gm/cc

c. $G_s = 2.949$ and SL = 19%

d.
$$V_{min} = \frac{(1.83)(.19)}{1} + \frac{1.83}{(2.949)} = 0.9683$$

e.
$$\gamma_{d_{max}} = \frac{W_s}{V_{min.}} = \frac{1.83}{.9683} = 1.89 \text{ gm/cc}$$

f.
$$\gamma = \frac{W_s}{V} \qquad V = \frac{W_s}{\gamma} = \frac{1.83}{1.87} = 0.9786 \text{ ft}^3$$

g.

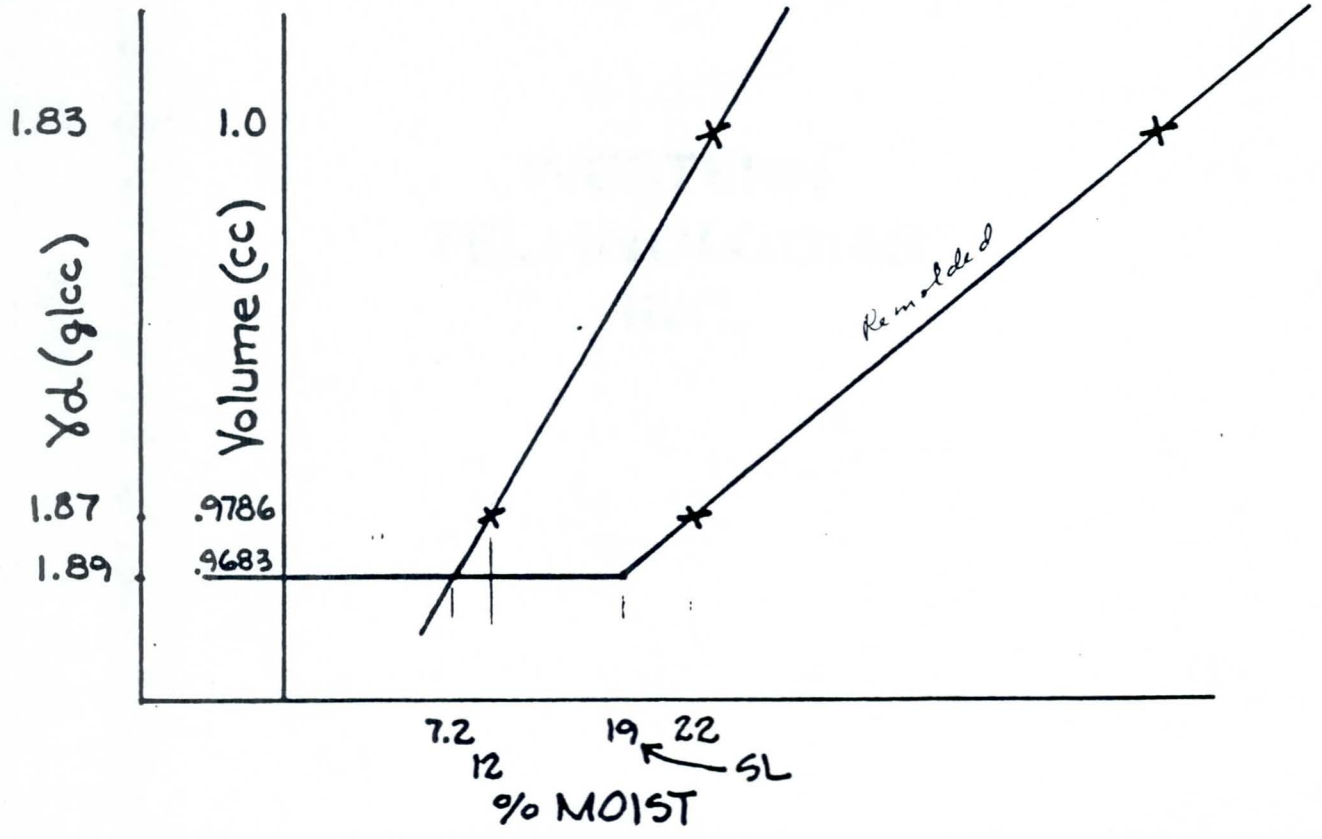
Condition	γ_d	W_s	Vol.	* Min. Vol. Sh.
Constructed	1.83	1.83	1.000	
Present	1.87	1.83	0.9786	
Min. Vol.	1.89	1.83	0.9683	7.2%

* $\frac{1.0 - .9683}{1.0 - .9786} = \frac{x}{22-12}$ $x = 14.8$ $A = 22-14.8 = 7.2$

h.

$\% C = \frac{1.0 - .9786}{1.0 - .9683} \times 100 = 67.5\%$ = Amount of Vol. Shrinkage that has occurred to date.

i. Plot of data and resulting calculations.



If I can be of further assistance please let me know.

C. E. Deal for

CLIFTON E. DEAL
Soil Mechanics Engineer

Attachment

cc:
Susanne Leckband, Design Engineer,
SCS, Phoenix, Arizona
Verne Bathurst, State Conservationist,
SCS, Phoenix, Arizona
Jack C. Stevenson, Head, Engineering Staff, WNTC

United States Department of Agriculture

Soil Conservation Service

Midwest National Technical Center
Soil Mechanics Laboratory
512 South 7th Street
Lincoln, NE 68508-2919

Subject: ENG - Soil Mechanics - Shrinkage Limits, Volumetric Shrinkage and Lineal Shrinkage

Date: February 12, 1985

To: Clifton E. Deal
Soil Mechanics Engineer
WNTC, SCS, Portland, OR

File Code: 210-22

Shrinkage limits, volumetric shrinkage and lineal shrinkage on puddled soils using the procedure of ASTM D427 are highly dependent on how much moisture the soil contains at the start and have little direct application for determining the shrinkage characteristics of a compacted soil. Better predictions can be made for compacted soil by compacting the soil at the proposed placement moisture and making direct volume and density measurements before and after drying to a constant volume.

The soil must be dried slowly and carefully to avoid drying cracks from forming that will affect the actual volume of the dried specimen. A moist-room can be used for the initial drying to prevent cracking. Usually, several days are required in the moist room. An alternate method of drying is to place the newly compacted specimens in sealed plastic bags and open the plastic bags for a few minutes at a time several times a day until the bags can be left open to dry at room temperature without cracking. Final drying in a standard oven should continue until no further moisture loss is obtained.

The following relationships are used to calculate the shrinkage properties.

$$V_{SH} = \frac{V_i - V_f}{V_f} \times 100$$

$$L.S. = \left(1 - \sqrt[3]{\frac{100}{V_{SH} + 100}}\right) \times 100$$

$$S.L. = w_{sat} = \frac{G_S - \gamma d_f}{G_S \times \gamma d_f} \times 100$$

Where:

V_{SH} = Volumetric shrinkage

V_i = Initial volume

V_f = Final volume

L.S. = Lineal shrinkage

S.L. = Shrinkage limit

γd_f = Final dry density

G_S = Specific gravity of soil

For soil specimens with shapes that are not conducive to accurate measurements with a ruler, the relationships can be determined using densities determined by displacement methods such as coating the soil with wax and determining volume by the difference of the weights of the soil in air and in water.

The volumetric shrinkage relationship and the density relationships are derived as follows:

Volume shrinkage is defined as the change in volume divided by the final volume.

$$V_{SH} = \frac{V_i - V_f}{V_f} \times 100 \quad (\div V_i) \quad = 100 \left[\frac{\frac{V_i - V_f}{V_i}}{\frac{V_f}{V_i}} \right] \quad \text{Regroup} \quad = 100 \left[\frac{\frac{V_i - V_f}{V_i}}{\frac{1}{V_i}} \right] \quad = \quad \text{Rearrange Terms}$$

$$= 100 \left[\frac{\frac{1}{V_f} - \frac{1}{V_i}}{\frac{1}{V_i}} \right] \quad (\times W_{fd}) \quad = 100 \left[\frac{\frac{W_{fd}}{V_f} - \frac{W_{fd}}{V_i}}{\frac{W_{fd}}{V_i}} \right] \quad (\text{sub. } \gamma d) \quad = 100 \left[\frac{\gamma d_f - \gamma d_i}{\gamma d_i} \right]$$

$$= 100 \left[\frac{\gamma d_f}{\gamma d_i} - 1 \right]$$

Where:

V_{SH} = Percent volumetric change

V_i = Initial volume

V_f = Final volume

γd_f = Final dry density

γd_i = Initial dry density

W_{fd} = Final dry weight of soil

See attachment No. 1 for an example of the calculated values.

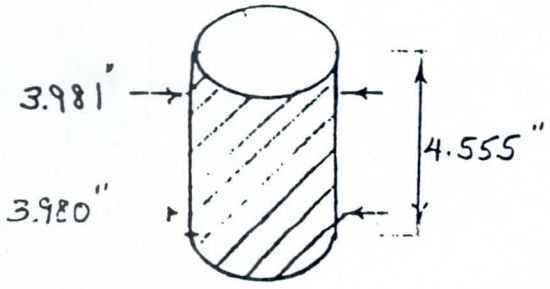
Lorn P. Dunnigan

LORN P. DUNNIGAN
Head, Soil Mechanics Laboratory

Attachment

Volumetric Calculations

82W 1157 - $G_s = 2.69$; $W_{fd} = 3.70$ #



$V_i = 1/30\ ft^3 = 0.0333\ ft^3$

$\gamma_{di} = \frac{W_d}{V_i} = \frac{3.7}{1/30} = 111.0\ pcf$
$= 1.779$

$$V_f = \frac{\pi D^2 h}{4} = \frac{\pi (3.9805)^2 \times (4.555)}{4 \times 1728} = 0.0328\ ft^3$$

$$\gamma_{df} = \frac{W_d}{V_f} = \frac{3.70\#}{0.0328 ft^3} = 112.8\ pcf = 1.808\ gm/cc$$

$$S.L. = w_{sat} = \frac{G_s - \gamma_{df}}{G_s \times \gamma_{df}} = \frac{2.69 - 1.808}{2.69 \times 1.808} \times 100 = 18.15\ \%$$

$$V_{SH} = \frac{V_i - V_f}{V_f} = \frac{0.0333 - 0.0328}{0.0328} \times 100 = 1.6\ \%$$

or

$$V_{SH} = \left(\frac{\gamma_{pg}}{\gamma_{di}} - 1\right) \times 100 = \left(\frac{1.808}{1.779} - 1\right) 100 = 1.6\%$$

$$L.S. = \left(1 - \sqrt[3]{\frac{100}{V_{SH}+100}}\right) \times 100 = \left(1 - \sqrt[3]{\frac{100}{1.6+100}}\right) \times 100 = .53\%$$

PHYSICAL PROPERTIES

Job No. 2125J296

Boring No.	Depth, ft.	Soil Class.	Particle Size Distribution, % Passing by wt.					Atterberg Limits		Moisture - Density Rel.			Specific Gravity	Permeability		'R' Value	Remarks
			3"	#4	#10	#40	#200	LL	PI	Dry Density pcf	Optimum Moisture %	Meth.		Dry Density pcf	K Cm/Sec	Corrected 'R'	
1	6.6-7.6	SC											2.67				1, 7
1	9.2-10.2	SC											2.69				1, 7
1	16.2-18.2	SM											2.71				1, 7
1	18.3-20.3	SM											2.68				1, 7
1	20.3-22.2	SM											2.72				1, 7
2	5.5-6.5	SM											2.70				1, 7
2	12.0-13.0	SM											2.64				1, 7
2	16.0-18.0	SM											2.72				1, 7
2	18.0-20.0	SM											2.70				1, 7
2	20.5-22.5	SM											2.69				1, 7

Boring No.	Depth, ft.	Comments

REMARKS

Classification/Particle Size
1. Visual
2. Laboratory Tested
3. Minus #200 Only

Moisture Density Relationship
4. Tested ASTM D-689/AASHTO T-99
5. Tested ASTM D-1557/AASHTO T-180
6. Other_____

Specific Gravity
7. Minus #4
8. Plus #4

Permeability
9. Constant Head
10. Falling Head

'R' Value
11. Expansion Pressure_____psf
12. Exudation Pressure_____psi

Note: NP = nonplastic

CONSTRUCTION MONITORING TEST RESULTS[1]

Station	Depth[2] (ft)	Corrected[3] Moisture Content (%)	Dry Density[4] (pcf)	Optimum Moisture Content (%)	Maximum Dry Density (pcf)	Percent Compaction	Percent Fines
265+00	6.2	7.4	125.0	8.7	130.7	95.6	19.3
265+00	9.2	8.5	122.7	9.6	128.1	95.8	16.1
265+00	16.2	8.0	121.9	8.7	128.8	94.6	27.4
265+00	18.3	9.6	128.9	11.4	124.8	103.3	18.7
265+00	22.5	8.4	122.8	10.0	129.3	95.0	26.4
280+00	5.5	8.6	123.8	9.6	126.8	97.6	33.8
280+00	12.0	10.1	118.3	10.6	124.7	94.9	30.2
280+00	16.0	9.7	120.5	11.0	124.9	96.5	22.4
280+00	20.5	11.0	120.7	10.7	126.6	95.3	24.0
280+00	27.0	10.2	123.1	10.6	123.5	99.6	29.4

[1]Test results provided by Mr. Nick Karan (Chief, Engineering Division Maricopa County Flood Control District)

[2]Depth below crest of embankment

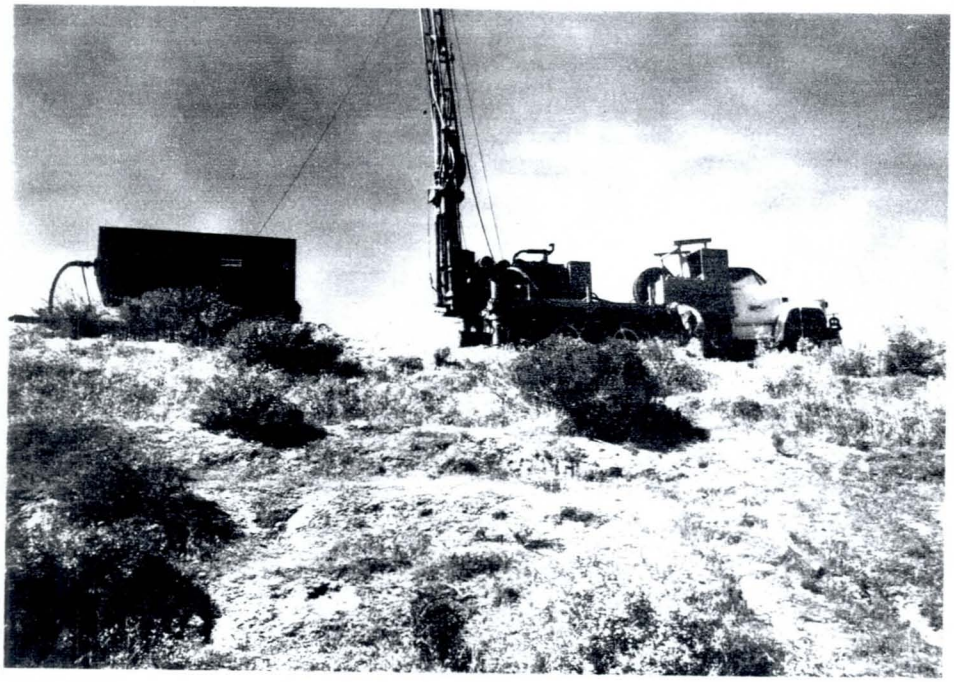
[3]Moisture content of material passing #4 sieve

[4]Dry density of material passing #4 sieve

JOB NO. 2126J296
SPOOKHILL DAM

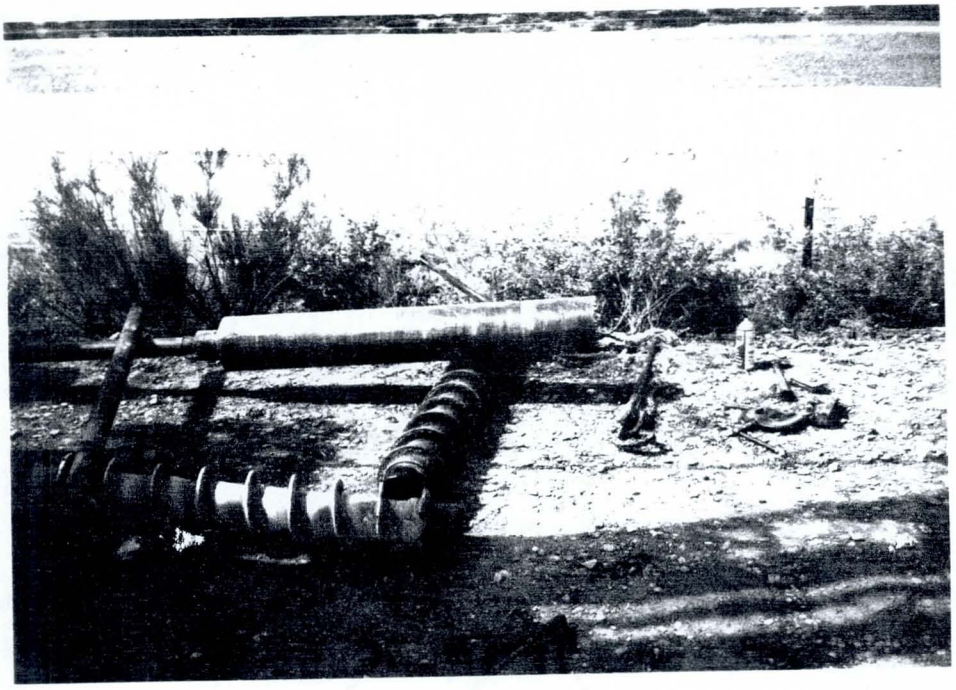
Prepared By s.f. Date 6/16/86 Checked By KEN RICKER Date 6/16/86

STA. 265+00

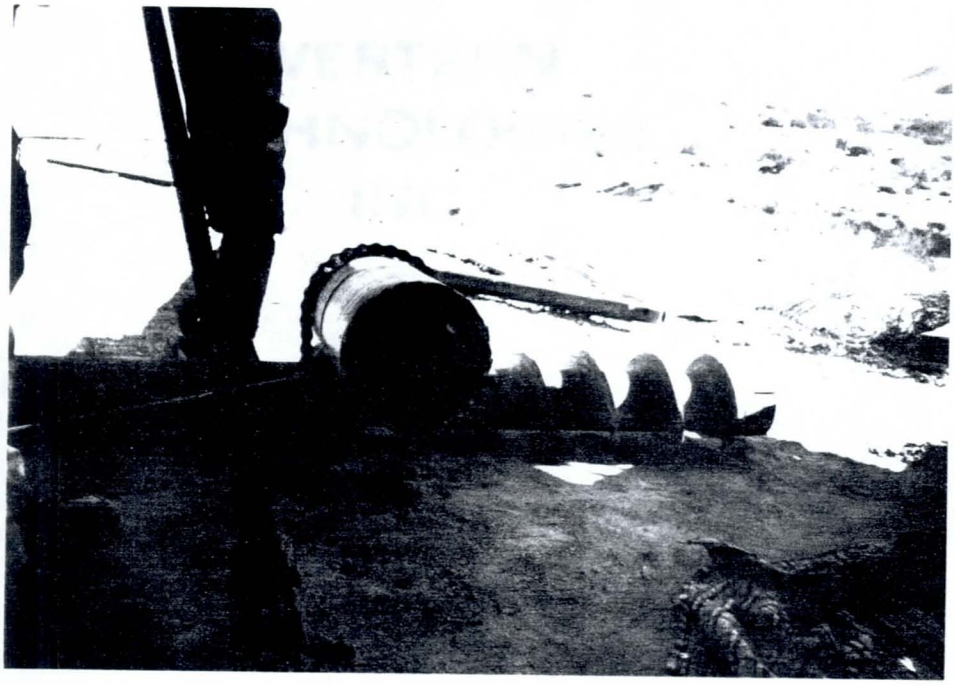


STA. 280+00

JOB NO. 2126J296
SPOOKHILL DAM



DENNISON SAMPLER

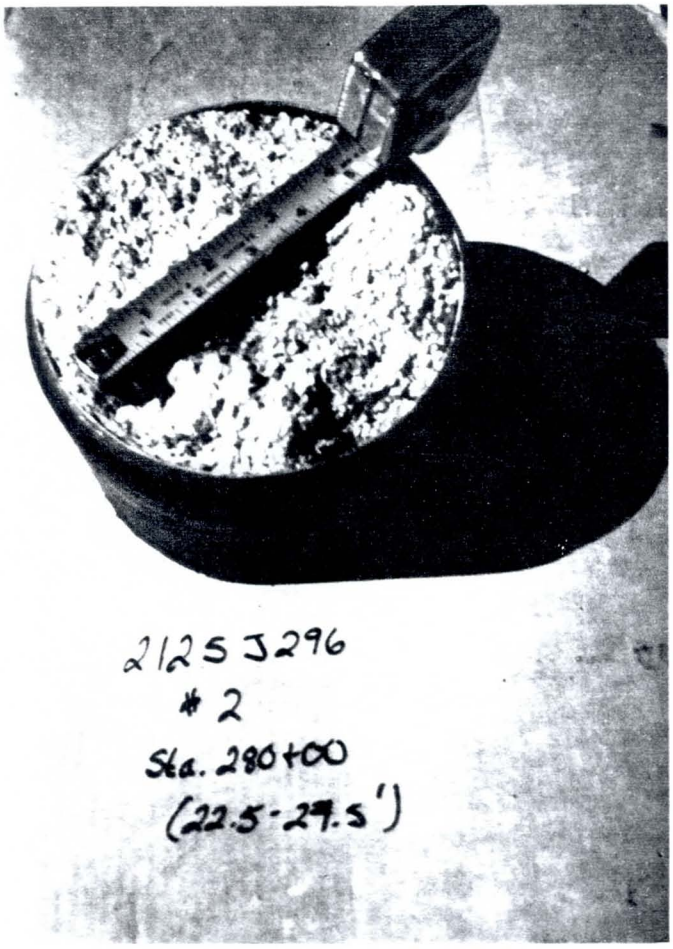


PREPARING DENNISON
SAMPLE FOR EXTRUSION

Prepared By s.f. Date 6/16/86 Checked By KEN RICKER Date 6/16/86

JOB NO. 2126J296
SPOOKHILL DAM

Prepared By s.f. Date 6/16/86 Checked By KEN RICKER Date 6/16/86



WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

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

October 11, 1984

Attn: Mr. Nick Karan, P.E.

Re: Shrinkage Limit Tests
Spook Hill Dam

Job No. 2184J017

Shrinkage limit tests were conducted according to ASTM Designation D427-83 which states that the initial water content for the test should be equal or slightly greater than the liquid limit. Using this procedure often results in shrinkage limit values greater than the plastic limit for sandy and silty clays (Holtz and Kovacs).

The soils tested were silty or clayey sands with 20.5% to 35.3% passing the 200 mesh sieve. High shrinkage limit values could be expected for soils that are predominately sands. The grain to grain contact would occur primarily between sand particles and the size of capillaries that produce tension upon drying would be relatively large in diameter. Capillary tension and resulting shrinkage would be low; therefore, little shrinkage would occur and the shrinkage limit would be high.

Shrinkage limit test results are meaningful only for clays and published interpretations may be applied only to clay soils. For clays, Holtz and Gibbs present the following information for arid region soils: A shrinkage limit greater than 12 has little volume change potential. Bowles says that it is not possible to quantify the term "little volume change potential".

References:

Holtz and Kovacs, "An Introduction to Geotechnical Engineering", 1981, Prentice-Hall, pages 178-185

Bowles, "Physical and Geotechnical Properties of Soils", 1979, McGraw-Hill, pages 223-225.

We hope this information assist you in the interpretation of the attached test results. If we may be of further service please don't hesitate to contact us.

Respectfully submitted,
WESTERN TECHNOLOGIES INC.

John C. Rosner

John C. Rosner, Ph.D., P.E.

nj

Attachments

Copies to: Addressee (3)

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam
Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84
Type of Material: -- — Submitted By: WTI — Date: 8/29/84
Source of Material: Station 265-6.6 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	35.3	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 7.4

Shrinkage Limit, % ASTM D427 12.6

Copies to: Client (3)

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 265-9.2 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	30.4	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 — 7.8

Shrinkage Limit, % ASTM D427 — 22.7

Copies to: Client (3)

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(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date
Reviewed By

Project: Spook Hill Dam
Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84
Type of Material: -- — Submitted By: WTI — Date: 8/29/84
Source of Material: Station 265-16.2 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	28.9	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- — LL = ____ PI = ____

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method ____ — Maximum Dry Density, pcf ____ Optimum Moisture, % ____

Specific Gravity of Soils (minus No. 4 material) ASTM D854- — Specific Gravity ____

Resistance 'R' Value of Compacted Soils ASTM D2844- — 'R' Value ____

Other:

Moisture Content, % ASTM D2216 — 7.8

Shrinkage Limit, % ASTM D427 — 25.7

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(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 265-18.3 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	20.5	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = ____ PI = ____

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method ____ Maximum Dry Density, pcf ____ Optimum Moisture, % ____

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity ____

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value ____

Other:

Moisture Content, % ASTM D2216 8.3

Shrinkage Limit, % ASTM D427 22.7

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 265-22.5 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	21.0	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL= PI=

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:
Moisture Content, % ASTM D2216 7.1

Shrinkage Limit, % ASTM D427 25.5

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Phoenix, Arizona 85036
(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-5.5 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	20.9	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = ____ PI = ____

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method ____ Maximum Dry Density, pcf ____ Optimum Moisture, % ____

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity ____

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value ____

Other:

Moisture Content, % ASTM D2216 5.8

Shrinkage Limit, % ASTM D427 21.3

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam
Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84
Type of Material: -- — Submitted By: WTI — Date: 8/29/84
Source of Material: Station 280-12.0 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	21.7	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = ____ PI = ____

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method ____ Maximum Dry Density, pcf ____ Optimum Moisture, % ____

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity ____

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value ____

Other:

Moisture Content, % ASTM D2216: 5.4

Shrinkage Limit, % ASTM D427: 18.6

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-16.0 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	24.5	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 8.5

Shrinkage Limit, % ASTM D427 19.9

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Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-20.5 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	32.6	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 9.7

Shrinkage Limit, % ASTM D427 26.1

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WESTERN TECHNOLOGIES INC.

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Phoenix, Arizona 85036
(602) 437-3737

LETTER OF TRANSMITTAL

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

Date 8/1/86
Job No. 2125J296
Lab./Invoice No.
Ref. No.

Attn. Mr. Nick Karan, P.E.; Chief Engineering Division

Project/Subject Shrinkage Testing
Spookhill Flood Retention Structure
Maricopa County, Arizona

Please be informed that we are:

x	Enclosing	Engineering Reports
	Forwarding Separately	Laboratory Reports
	Per Your Request	Field Reports
3	No. of Copies	Proposals
x	Other	

More fully described as follows: Shrinkage limits tests data sheets for remolded samples. On these sheets a negative volumetric change, % signifies an increase in volume.

For your:

x	Use	Information
	Approval	Action
	Files	Other

Material forwarded by:

	Our Messenger	Express Mail
	Your Messenger	Air Priority
x	First Class Mail	United Parcel Service
	Priority Mail	Motor Freight
	Certified Mail	Air Freight
	Special Delivery	City Delivery
	Other	

FLOOD CONTROL DISTRICT
RECEIVED
AUG 4'86

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	ASST		LMgt
	ADMIN		SUSP
	C & O		FILE
	ENGR		DESTROY
	FINANCE		

REMARKS

By Frank Costello

Frank Costello

145

SHRINKAGE LIMITS

Sample ID. STA 265+00 (6.6-7.6) Job No. 2125J296

Placement Density,pcf	125		Undisturbed
Placement Moisture,%	7.4		Remolded *
Present Density,gm/cc	1.802	Initial Measurements,in.	
Present Moisture,%	7.4	Height	Width
Soil Sp.Gr.,gm/cc	2.666	4.642	3.985
		4.601	3.971
Max. Dry Density,gm/cc	1.743	4.612	3.975
Minimum Volume,cu.ft.	1.1496	4.632	3.989
Wt. of Solids,lbs.	4.02		3.979
			3.984
Initial Volume,cu.ft.	0.0333		
Int. Dry Density,gm/cc	1.802	4.622	3.981
		Avg.	Avg.
Final Volume,cu.ft.	0.0342		
Final Dry Density,gm/cc	1.743	Final Measurements,in.	
		Height	Width
Shrinkage Limit,%	19.88	4.691	4.011
Volumetric Shrinkage,%	-2.7	4.694	4.009
Linear Shrinkage,%		4.655	4.010
		4.653	4.013
Volumetric Change,%	-2.7		4.021
Wt. After Drying,Lbs.	3.72		4.016
		4.673	4.013
		Avg.	Avg.

SHRINKAGE LIMITS

Sample ID. STA 265+00 (9.2-10.2) Job No. 2125J296

Placement Density,pcf	122.7		Undisturbed
Placement Moisture,%	8.5		Remolded *
Present Density,gm/cc	1.926	Initial Measurements,in.	
Present Moisture,%	8.5	Height	Width
Soil Sp.Gr.,gm/cc	2.693	4.496	3.936
		4.476	3.935
Max. Dry Density,gm/cc	1.931	4.500	3.927
Minimum Volume,cu.ft.	1.0185	4.506	3.935
Wt. of Solids,lbs.	4.12		3.926
			3.936
Initial Volume,cu.ft.	0.0316		
Int. Dry Density,gm/cc	1.926	4.495	3.933
		Avg.	Avg.
Final Volume,cu.ft.	0.0320		
Final Dry Density,gm/cc	1.931	Final Measurements,in.	
		Height	Width
Shrinkage Limit,%	14.66	4.458	3.977
Volumetric Shrinkage,%	-1.4	4.459	3.974
Linear Shrinkage,%		4.454	3.979
		4.452	3.978
Volumetric Change,%	-1.4		3.981
Wt. After Drying,Lbs.	3.86		3.976
		4.456	3.978
		Avg.	Avg.

station 265+00

SHRINKAGE LIMITS

Sample ID. 16-2-18.2

Job No. 2125-296

Undisturbed *

Remolded

Placement Density,pcf	121.9
Placement Moisture,%	8.0
Present Density,gm/cc	1.938
Present Moisture,%	8.0
Soil Sp.Gr.,gm/cc	2.710
Max. Dry Density,gm/cc	1.956
Minimum Volume,cu.ft.	0.9990
Wt. of Solids,lbs.	4.2
Initial Volume,cu.ft.	0.0322
Int. Dry Density,gm/cc	1.938
Final Volume,cu.ft.	0.0320
Final Dry Density,gm/cc	1.956
Shrinkage Limit,%	14.24
Volumetric Shrinkage,%	0.4
Linear Shrinkage,%	
Volumetric Change,%	0.4
Wt. After Drying,Lbs.	3.91

Initial Measurements,in.

Height	Width
4.469	3.983
4.466	3.982
4.471	3.977
4.466	3.982
	3.975
	3.979
4.468	3.980
Avg.	Avg.

Final Measurements,in.

Height	Width
4.412	3.984
4.475	3.982
4.414	3.987
4.470	3.982
	3.980
	3.986
4.443	3.984
Avg.	Avg.

SHRINKAGE LIMITS

Sample ID. STA 265+00 (18.3-20.3) Job No. 2125J296

Placement Density,pcf	128.9		Undisturbed _____
Placement Moisture,%	9.6		Remolded *
Present Density,gm/cc	1.853	Initial Measurements,in.	
Present Moisture,%	9.6	Height	Width
Soil Sp.Gr.,gm/cc	2.679	4.608	3.977
		4.607	3.981
Max. Dry Density,gm/cc	1.859	4.592	3.979
Minimum Volume,cu.ft.	1.1112	4.584	3.966
Wt. of Solids,lbs.	4.19		3.975
			3.989
Initial Volume,cu.ft.	0.0331		
Int. Dry Density,gm/cc	1.853	4.598	3.978
		Avg.	Avg.
Final Volume,cu.ft.	0.0329		
Final Dry Density,gm/cc	1.859	Final Measurements,in.	
		Height	Width
Shrinkage Limit,%	16.47	4.603	3.962
Volumetric Shrinkage,%	0.4	4.600	3.967
Linear Shrinkage,%	_____	4.571	3.976
		4.602	3.971
Volumetric Change,%	0.4		3.975
Wt. After Drying,Lbs.	3.82		3.977
		4.594	3.971
		Avg.	Avg.

SHRINKAGE LIMITS

Sample ID. STA 265+00 (20.2 - 22.2) Job No. 21251296

Placement Density,pcf	122.8		Undisturbed
Placement Moisture,%	8.4		Remolded *
Present Density,gm/cc	1.995	Initial Measurements,in.	
Present Moisture,%	8.4	Height	Width
Soil Sp.Gr.,gm/cc	2.716	4.2667	3.957
		4.259	3.960
Max. Dry Density,gm/cc	1.988	4.277	3.965
Minimum Volume,cu.ft.	0.9897	4.273	3.953
Wt. of Solids,lbs.	4.11		3.965
			3.973
Initial Volume,cu.ft.	0.0305		
Int. Dry Density,gm/cc	1.995	4.269	3.962
		Avg.	Avg.
Final Volume,cu.ft.	0.0306		
Final Dry Density,gm/cc	1.988	Final Measurements,in.	
		Height	Width
Shrinkage Limit,%	13.47	4.266	3.975
Volumetric Shrinkage,%	-0.5	4.241	3.969
Linear Shrinkage,%	_____	4.252	3.983
		4.287	3.977
Volumetric Change,%	-0.5		3.974
Wt. After Drying,Lbs.	3.8		3.980
		4.262	3.976
		Avg.	Avg.

SHRINKAGE LIMITS

Sample ID. STA 280+00 (5.5-6.5) Job No. 2125J296

Placement Density,pcf	123.8
Placement Moisture,%	8.6
Present Density,gm/cc	1.894
Present Moisture,%	8.5
Soil Sp.Gr.,gm/cc	2.695
Max. Dry Density,gm/cc	1.898
Minimum Volume,cu.ft.	1.0452
Wt. of Solids,lbs.	3.99
Initial Volume,cu.ft.	0.0311
Int. Dry Density,gm/cc	1.894
Final Volume,cu.ft.	0.0321
Final Dry Density,gm/cc	1.898
Shrinkage Limit,%	15.58
Volumetric Shrinkage,%	-3.0
Linear Shrinkage,%	_____
Volumetric Change,%	-3.0
Wt. After Drying,Lbs.	3.8

Undisturbed _____
Remolded *

Initial Measurements,in. Height	Width
4.437	3.934
4.43	3.935
4.426	3.927
4.426	3.925
	3.927
	3.937
4.430 Avg.	3.931 Avg.

Final Measurements,in. Height	Width
4.442	3.981
4.471	3.982
4.443	3.981
4.447	3.981
	3.990
	3.979
4.451 Avg.	3.982 Avg.

SHRINKAGE LIMITS

Sample ID. STA 280+00 (12.0-13.0) Job No. 21251296

Placement Density,pcf	118.3		Undisturbed
Placement Moisture,%	10.1		Remolded *
Present Density,gm/cc	2.007	Initial Measurements,in.	
Present Moisture,%	10.1	Height	Width
Soil Sp.Gr.,gm/cc	2.643	4.108	3.932
		4.111	3.94
Max. Dry Density,gm/cc	1.997	4.206	3.936
Minimum Volume,cu.ft.	0.9496	4.217	3.926
Wt. of Solids,lbs.	4.03		3.929
			3.926
Initial Volume,cu.ft.	0.0292		
Int. Dry Density,gm/cc	2.007	4.161	3.932
		Avg.	Avg.
Final Volume,cu.ft.	0.0294		
Final Dry Density,gm/cc	1.997	Final Measurements,in.	
		Height	Width
Shrinkage Limit,%	12.25	4.154	3.926
Volumetric Shrinkage,%	-0.5	4.146	3.924
Linear Shrinkage,%		4.231	3.928
		4.233	3.921
Volumetric Change,%	-0.5		3.931
Wt. After Drying,Lbs.	3.66		3.933
		4.191	3.927
		Avg.	Avg.

SHRINKAGE LIMITS

Sample ID. STA 280+00 (16.0-18.0) Job No. 2125J296

Placement Density,pcf	120.5		Undisturbed
Placement Moisture,%	9.7		Remolded *
Present Density,gm/cc	1.921	Initial Measurements,in.	
Present Moisture,%	9.7	Height	Width
Soil Sp.Gr.,gm/cc	2.717	4.582	3.985
		4.618	3.982
Max. Dry Density,gm/cc	1.924	4.622	3.973
Minimum Volume,cu.ft.	1.0036	4.600	3.982
Wt. of Solids,lbs.	4.36		3.972
			3.987
Initial Volume,cu.ft.	0.0332		
Int. Dry Density,gm/cc	1.921	4.606	3.980
		Avg.	Avg.
Final Volume,cu.ft.	0.0332		
Final Dry Density,gm/cc	1.924	Final Measurements,in.	
		Height	Width
Shrinkage Limit,%	15.17	4.612	3.981
Volumetric Shrinkage,%	-0.2	4.619	3.981
Linear Shrinkage,%		4.607	3.980
		4.617	3.983
Volumetric Change,%	-0.2		3.980
Wt. After Drying,Lbs.	3.99		3.980
		4.614	3.981
		Avg.	Avg.

SHRINKAGE LIMITS

Sample ID. STA 280+00 (18.0-20.0) Job No. 2125J296

Placement Density,pcf	120.7		Undisturbed
Placement Moisture,%	11.0		Remolded *
Present Density,gm/cc	1.911	Initial Measurements,in.	
Present Moisture,%	11.1	Height	Width
Soil Sp.Gr.,gm/cc	2.695	4.545	3.979
		4.542	3.979
Max. Dry Density,gm/cc	1.924	4.547	3.978
Minimum Volume,cu.ft.	1.0051	4.500	3.972
Wt. of Solids,lbs.	4.32		3.980
			3.982
Initial Volume,cu.ft.	0.0326		
Int. Dry Density,gm/cc	1.911	4.534	3.978
		Avg.	Avg.
Final Volume,cu.ft.	0.0327		
Final Dry Density,gm/cc	1.924	Final Measurements,in.	
		Height	Width
Shrinkage Limit,%	14.86	4.571	3.980
Volumetric Shrinkage,%	-0.4	4.572	3.982
Linear Shrinkage,%		4.548	3.978
		4.501	3.978
Volumetric Change,%	-0.4		3.981
Wt. After Drying,Lbs.	3.93		3.975
		4.548	3.979
		Avg.	Avg.

SHRINKAGE LIMITS

Sample ID. STA 280+00 (20.5-22.5) Job No. 2125J296

Placement Density,pcf	120.7		Undisturbed
Placement Moisture,%	11.0		Remolded *
Present Density,gm/cc	1.980	Initial Measurements,in.	
Present Moisture,%	11.0	Height	Width
Soil Sp.Gr.,gm/cc	2.690	4.213	3.976
		4.282	3.976
Max. Dry Density,gm/cc	1.964	4.226	3.972
Minimum Volume,cu.ft.	0.9850	4.214	3.966
Wt. of Solids,lbs.	4.16		3.965
			3.969
Initial Volume,cu.ft.	0.0303		
Int. Dry Density,gm/cc	1.980	4.234	3.971
		Avg.	Avg.
Final Volume,cu.ft.	0.0305		
Final Dry Density,gm/cc	1.964	Final Measurements,in.	
		Height	Width
Shrinkage Limit,%	13.75	4.206	3.974
Volumetric Shrinkage,%	-0.6	4.23	3.976
Linear Shrinkage,%		4.25	3.976
		4.289	3.98
Volumetric Change,%	-0.6		3.980
Wt. After Drying,Lbs.	3.74		3.981
		4.244	3.978
		Avg.	Avg.

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

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

June 27, 1985

Superceded

Attn: Mr. Nick Karan, P.E.
Chief, Engineering Division

Re: Geotechnical Services
Spookhill FRS

Ref. No. 2125A128
Revision No. 1

We are pleased to present this proposal to perform some geotechnical sampling and testing services for the existing Spookhill Flood Retention Structure. This proposal presents a recommended plan of operations and fees for the services described.

Based on our discussions, it is our understanding that undisturbed and disturbed samples are required for shrinkage testing from various elevations at two locations on the existing embankment. The following sample locations are required:

Station	Depth (ft)
265+00	6.6
	9.2
	16.2
	18.3
	22.2
280+00	5.5
	12.0
	16.0
	20.5
	27.0

Drilling and sampling are to be performed from the crest of the embankment, and the depths shown are below crest elevation.

PLAN OF OPERATIONS

The following procedures would be utilized in an attempt to obtain relatively undisturbed samples of existing embankment material at the locations and depths specified:

1. The four relatively shallow samples (6.6, 9.2 and 5.5, 12.0) would be taken in backhoe test pits by block sampling using SCS recommended methods. Excavation and subsequent backfilling of the test pits would be performed by Maricopa County personnel.

2. The deeper samples at each location would be taken with a drill rig using one of the following methods (listed in order of attempt):

   a. Shelby Tube
   b. Dennison Sampler (7-inch diameter)
   c. Soils Core Barrel

3. Disturbed samples would be taken at each location corresponding to an undisturbed sample.

It should be noted that due to the reported granular nature of the embankment fill material, we may be unable to obtain a representative undisturbed sample using any of these methods.

Shrinkage testing (shrinkage limit, volumetric shrinkage, lineal shrinkage) would be performed on both the disturbed and undisturbed samples from each location in accordance with the SCS procedures included in your transmittal.

FEE SCHEDULE

The following fees would apply to the services previously described. The initial attempt would include an experienced field engineer to perform block sampling on the four shallow samples. The fee for this phase would be $250.00 per block sample attempt. It is understodd that the backhoe and operator would be provided by others.

If we are unable to obtain shallow block samples due to the granular nature of the fill material, it is highly unlikely that suitable deeper undisturbed samples could be obtained by drilling methods. At this point we would recommend that the exploration program be terminated.

If we are successful at obtaining shallow block samples, the next phase of the exploration would include the following:

Mobilization/Demobilization		$ 650.00
Drilling (est. 3 days)		$3730.00*
	Subtotal	$4380.00

During the drilling operation we would attempt to obtain undisturbed samples at the depths requested utilizing one of the following methods (listed in order of attempt):

Shelby Tube (per sample attempt)	$ 35.00
Dennison Sampler (per sample attempt)	$ 165.00
Soil Core Barrel (per sample attempt)	$ 120.00

*Based on $40.40 per foot

- includes all footage
- includes field engineer
- does not include sample attempts

Laboratory testing would be performed in accordance with the SCS procedures included in your transmittal at the following rates:

Disturbed Sample (per each)	$ 147.50
Undisturbed Sample (per each)	$ 177.50

Based on these fees, the anticipated work would be performed for a total fee not to exceed $9750.00. Any additional work which might be indicated by the discovery of unanticipated conditions in the field will be performed, upon your authorization, in accordance with our current fee schedule. This proposal is intended to remain valid until July 31, 1985, at which time it would require review and possible revision. This revision should replace our original proposal dated June 19, 1985.

Respectfully submitted,

WESTERN TECHNOLOGIES INC.
Geotechnical Services

Craig P. Wiedeman

Craig P. Wiedeman, P.E.

jh

Copies to: Addressee (2)

FLOOD CONTROL DISTRICT
of
MARICOPA COUNTY
1959

FLOOD CONTROL DISTRICT
of
Maricopa County

3335 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 262-1501

D. E. Sagramoso, P.E., Chief Engineer and General Manager

May 22, 1985

Mr. John C. Rosner, Ph.D., P.E.
Western Technologies, Inc.
3737 East Broadway Road
Phoenix, AZ 85036

Dear John:

Enclosed please find a copy of the information from SCS outlining procedures for additonal testing to be performed at the Spook Hill FRS.

After you have a chance to review this information, please give me a call so that we may further discuss this matter.

Sincerely,

Nick Karan, P.E.
Chief, Engineering Division

Enclosure

NPK/jet FILE: INFO: CGF
SLS
DES

United States
Department of
Agriculture

Soil
Conservation
Service

201 E. Indianola Ave.
Suite 200
Phoenix, Arizona 85012

March 12, 1985

Dan Sagramoso
Chief Engineer and General Manager
Flood Control District of Maricopa County
3335 West Virginia Street
Phoenix, Arizona 85009

Dear Dan:

We have received the attached laboratory procedure for determining shrinkage, limits volumetric shrinkage and lineal shrinkage from our Portland Office. This is a follow-up to your report on abandonment of the Spookhill FRS Irrigation System. We had agreed to obtain procedure whereby undisturbed test data could be used for comparative shrinkage analysis.

After you review please contact this office for a meeting to discuss the subject further.

Sincerely,

Verne M. Bathurst
State Conservationist

Enclosure

United States Department of Agriculture

Soil Conservation Service

West National Technical Center
511 N. W. Broadway, Room 547
Portland, Oregon 97209-3489

Subject: ENG - Soil Mechanics - Shrinkage Limits

Date: February 26, 1985

To: Ralph Arrington, State Conservation Engineer,
SCS, Phoenix, Arizona

File Code:

Attached is a letter from the Lincoln Laboratory indicating the procedure for making shrinkage limits on compacted soils. The letter does not give the instructions I was hoping for but should be sufficient with the following additions:

1. Prepare a compacted specimen using soil from the same area of the fill an undisturbed sample was obtained. Prepare the sample in accordance with the ASTM Standard test procedure used for design of the fill. The dry density and moisture content shall be in accordance with the design specifications for the fill.

2. Extrude the specimen and dry according to the instructions in the attached letter. Determine G_s and moisture content of the soil.

3. Determine the volume of the mold in accordance with section 3.1.3 ASTM D698.

4. After the specimen has been dried, determine the average diameter, height and volume. The average of the diameter, height and volume shall be calculated from at least six diameter and three height measurements made to the nearest 0.001 in. (0.02 mn).

5. Make shrinkage calculations in accordance with attached letter.

6. Obtain an undisturbed sample of the fill. Determine G_s and moisture content for the sample.

7. Determine the average diameter, height and volume using measurement procedures similar to item 4.

8. Dry the undisturbed sample according to the attached letter.

9. Determine the average diameter, height and volume using measurement procedures similar to item 4.

10. Make shrinkage calculations in accordance with attached letter.

11. Plot the moisture contents and shrinkage limits percent vs. the dry density values for the remolded and undisturbed samples.

12. Calculate the theoretical minimum volume possible for the soil by using the following equation:

$$V_{min} = \frac{(W_s)\ (SL)}{\gamma\omega} + \frac{W_s}{G_s\gamma\omega}$$

where W_s = W+ of solids
SL = Shrinkage limit at Placement density in decimal.

13. Calculate volume associated with the in place density and assume one for the placement density volume.

14. Evaluate the volumetric shrinkage to determine the amount completed since construction and what is left yet to reach m minimum volume.

15. Following is an example set of calculations and comparison:

a. Placement density = 1.83 gm/cc

b. Present in place density = 1.87 gm/cc

c. G_s = 2.949 and SL = 19%

d.
$$V_{min} = \frac{(1.83)(.19)}{1} + \frac{1.83}{(2.949)} = 0.9683$$

e.
$$\gamma_{d_{max}} = \frac{W_s}{V_{min.}} = \frac{1.83}{.9683} = 1.89 \text{ gm/cc}$$

f.
$$\gamma = \frac{W_s}{V} \qquad V = \frac{W_s}{\gamma} = \frac{1.83}{1.87} = 0.9786 \text{ ft}^3$$

g.

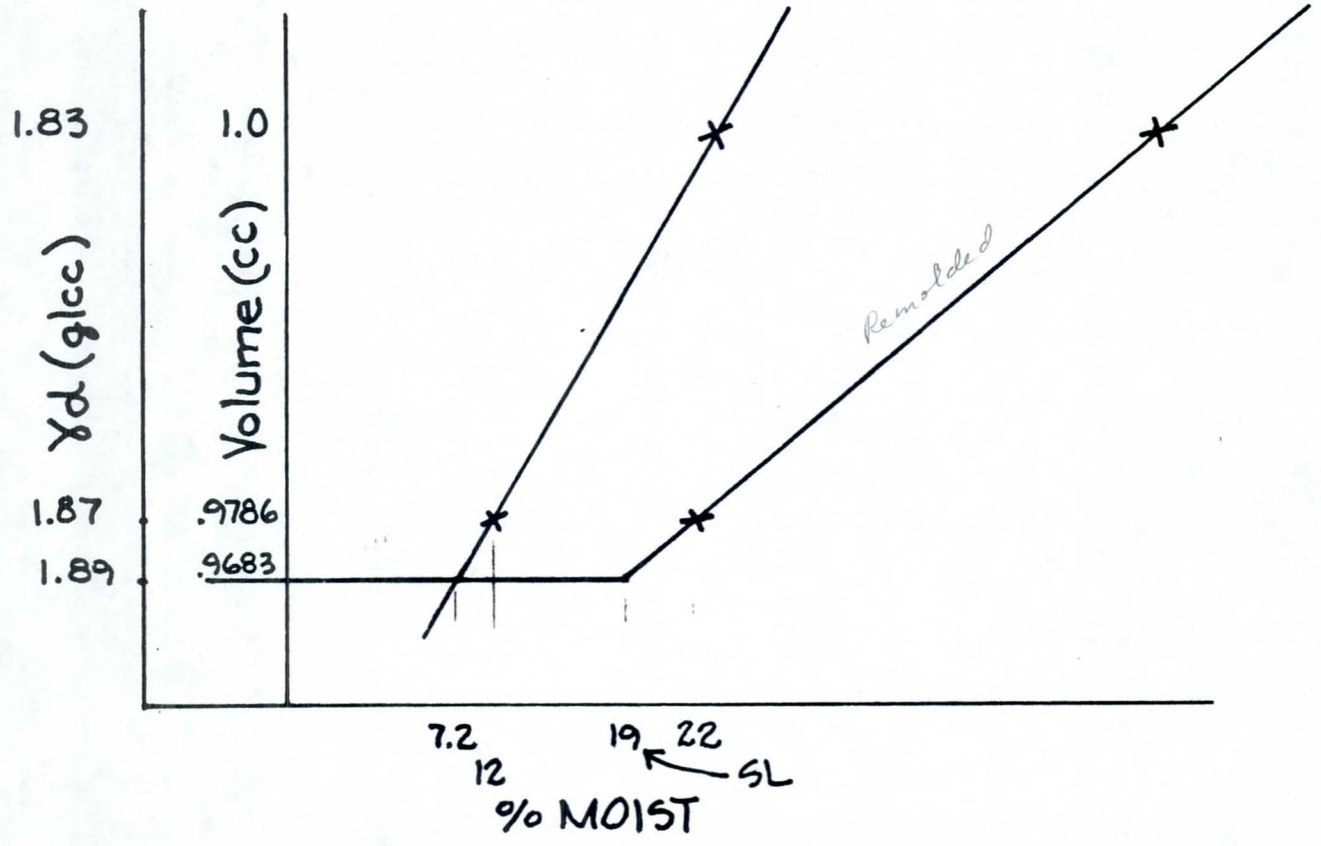
Condition	γ_d	W_s	Vol.	* Min. Vol. Sh.
Constructed	1.83	1.83	1.000	
Present	1.87	1.83	0.9786	
Min. Vol.	1.89	1.83	0.9683	7.2%

* $\frac{1.0 - .9683}{1.0 - .9786} = \frac{x}{22-12}$ $x = 14.8$ $A = 22-14.8 = 7.2$

h.

$\% C = \frac{1.0 - .9786}{1.0 - .9683} \times 100 = 67.5\%$ = Amount of Vol. Shrinkage that has occurred to date.

i. Plot of data and resulting calculations.



If I can be of further assistance please let me know.

C. E. Deal for

CLIFTON E. DEAL
Soil Mechanics Engineer

Attachment

cc:
Susanne Leckband, Design Engineer,
SCS, Phoenix, Arizona
Verne Bathurst, State Conservationist,
SCS, Phoenix, Arizona
Jack C. Stevenson, Head, Engineering Staff, WNTC

United States Department of Agriculture

Soil Conservation Service

Midwest National Technical Center
Soil Mechanics Laboratory
512 South 7th Street
Lincoln, NE 68508-2919

Subject: ENG - Soil Mechanics - Shrinkage Limits, Volumetric Shrinkage and Lineal Shrinkage

Date: February 12, 1985

To: Clifton E. Deal
Soil Mechanics Engineer
WNTC, SCS, Portland, OR

File Code: 210-22

Shrinkage limits, volumetric shrinkage and lineal shrinkage on puddled soils using the procedure of ASTM D427 are highly dependent on how much moisture the soil contains at the start and have little direct application for determining the shrinkage characteristics of a compacted soil. Better predictions can be made for compacted soil by compacting the soil at the proposed placement moisture and making direct volume and density measurements before and after drying to a constant volume.

The soil must be dried slowly and carefully to avoid drying cracks from forming that will affect the actual volume of the dried specimen. A moist-room can be used for the initial drying to prevent cracking. Usually, several days are required in the moist room. An alternate method of drying is to place the newly compacted specimens in sealed plastic bags and open the plastic bags for a few minutes at a time several times a day until the bags can be left open to dry at room temperature without cracking. Final drying in a standard oven should continue until no further moisture loss is obtained.

The following relationships are used to calculate the shrinkage properties.

$$V_{SH} = \frac{V_i - V_f}{V_f} \times 100$$

$$L.S. = \left(1 - \sqrt[3]{\frac{100}{V_{SH} + 100}}\right) \times 100$$

$$S.L. = w_{sat} = \frac{G_S - \gamma d_f}{G_S \times \gamma d_f} \times 100$$

Where:

V_{SH} = Volumetric shrinkage

V_i = Initial volume

V_f = Final volume

L.S. = Lineal shrinkage

S.L. = Shrinkage limit

γd_f = Final dry density

G_S = Specific gravity of soil

For soil specimens with shapes that are not conducive to accurate measurements with a ruler, the relationships can be determined using densities determined by displacement methods such as coating the soil with wax and determining volume by the difference of the weights of the soil in air and in water.

The volumetric shrinkage relationship and the density relationships are derived as follows:

Volume shrinkage is defined as the change in volume divided by the final volume.

$$V_{SH} = \frac{V_i - V_f}{V_f} \times 100 \quad (\div V_i) \quad = 100 \left[\frac{\frac{V_i - V_f}{V_i}}{\frac{V_f}{V_i}} \right] \quad \text{Regroup} \quad = 100 \left[\frac{\frac{V_i - V_f}{V_i}}{\frac{1}{V_i}} \right] \quad = \quad \text{Rearrange Terms}$$

$$= 100 \left[\frac{\frac{1}{V_f} - \frac{1}{V_i}}{\frac{1}{V_i}} \right] \quad (\times W_{fd}) \quad = 100 \left[\frac{\frac{W_{fd}}{V_f} - \frac{W_{fd}}{V_i}}{\frac{W_{fd}}{V_i}} \right] \quad (\text{sub. } \gamma d) \quad = 100 \left[\frac{\gamma d_f - \gamma d_i}{\gamma d_i} \right]$$

$$= 100 \left[\frac{\gamma d_f}{\gamma d_i} - 1 \right]$$

Where:

V_{SH} = Percent volumetric change

V_i = Initial volume

V_f = Final volume

γd_f = Final dry density

γd_i = Initial dry density

W_{fd} = Final dry weight of soil

See attachment No. 1 for an example of the calculated values.

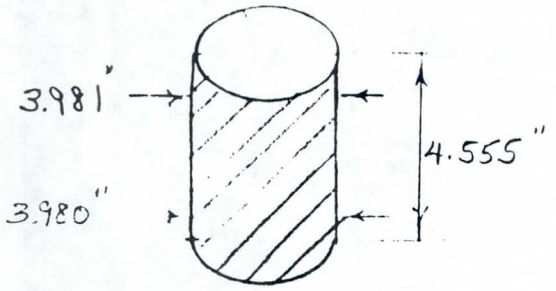
Lorn P. Dunnigan

LORN P. DUNNIGAN
Head, Soil Mechanics Laboratory

Attachment

Volumetric Calculations

82W 1157 - $G_s = 2.69$; $W_{fd} = 3.70$ #



$V_i = 1/30\ ft^3 = 0.0333\ ft^3$

$\gamma_{di} = \frac{W_{fd}}{V_i} = \frac{3.7}{1/30} = 111.0\ pcf$
$= 1.779$

$$V_f = \frac{\pi D^2 h}{4} = \frac{\pi (3.9805)^2 \times (4.555)}{4 \times 1728} = 0.0328\ ft^3$$

$$\gamma_{df} = \frac{W_{fd}}{V_f} = \frac{3.70\#}{0.0328 ft^3} = 112.8\ pcf = 1.808\ gm/cc$$

$$S.L. = w_{sat} = \frac{G_s - \gamma_{df}}{G_s \times \gamma_{df}} = \frac{2.69 - 1.808}{2.69 \times 1.808} \times 100 = 18.15\ \%$$

$$V_{SH} = \frac{V_i - V_f}{V_f} = \frac{0.0333 - 0.0328}{0.0328} \times 100 = 1.6\ \%$$

or

$$V_{SH} = \left(\frac{\gamma_{df}}{\gamma_{di}} - 1\right) \times 100 = \left(\frac{1.808}{1.779} - 1\right) 100 = 1.6\%$$

$$L.S. = \left(1 - \sqrt[3]{\frac{100}{V_{SH}+100}}\right) \times 100 = \left(1 - \sqrt[3]{\frac{100}{1.6+100}}\right) \times 100 = .53\%$$

United States Department of Agriculture

Soil Conservation Service

Suite 200, 201 East Indianola
Phoenix, Arizona 85012

January 3, 1985

Mr. Dan Sagramoso, P.E.
Chief Engineer and General Manager
Flood Control District of Maricopa Co.
3335 West Durango Street
Phoenix, Arizona 85009

Dear Dan:

We have reviewed your "Report on Abandonment of Spook Hill FRS Irrigation System." We desire to address the one issue regarding the shrinkage test data presented.

> The shrinkage test conducted under the procedure of ASTM D427 is made on saturated, disturbed samples. The embankment fill materials are placed at a moisture content below saturation. In-place stresses are imparted to the fill that may change the shrinkage limit values.
>
> Laboratory tests have been made on undisturbed samples taken from existing dams with the relationship as shown on the attached shrinkage limit diagram.
>
> Without comparative shrinkage analysis on undisturbed samples from the existing structure, it is not possible to determine whether cracking due to desiccation has reached a steady state.

Undisturbed tests were conducted on the Rittenhouse FRS by the FCD and the results showed additional shrinkage was expected for that structure.

My staff will discuss this topic at the next coordination meeting.

Sincerely,

Don R. Phillips Acting For

Verne M. Bathurst
State Conservationist

Attachment

FLOOD CONTROL DISTRICT
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JAN 04 '85

5	CH ENG	HYDRO
4	ASST	LMgt
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1	MP	FILE
2	ENGR	DESTROY
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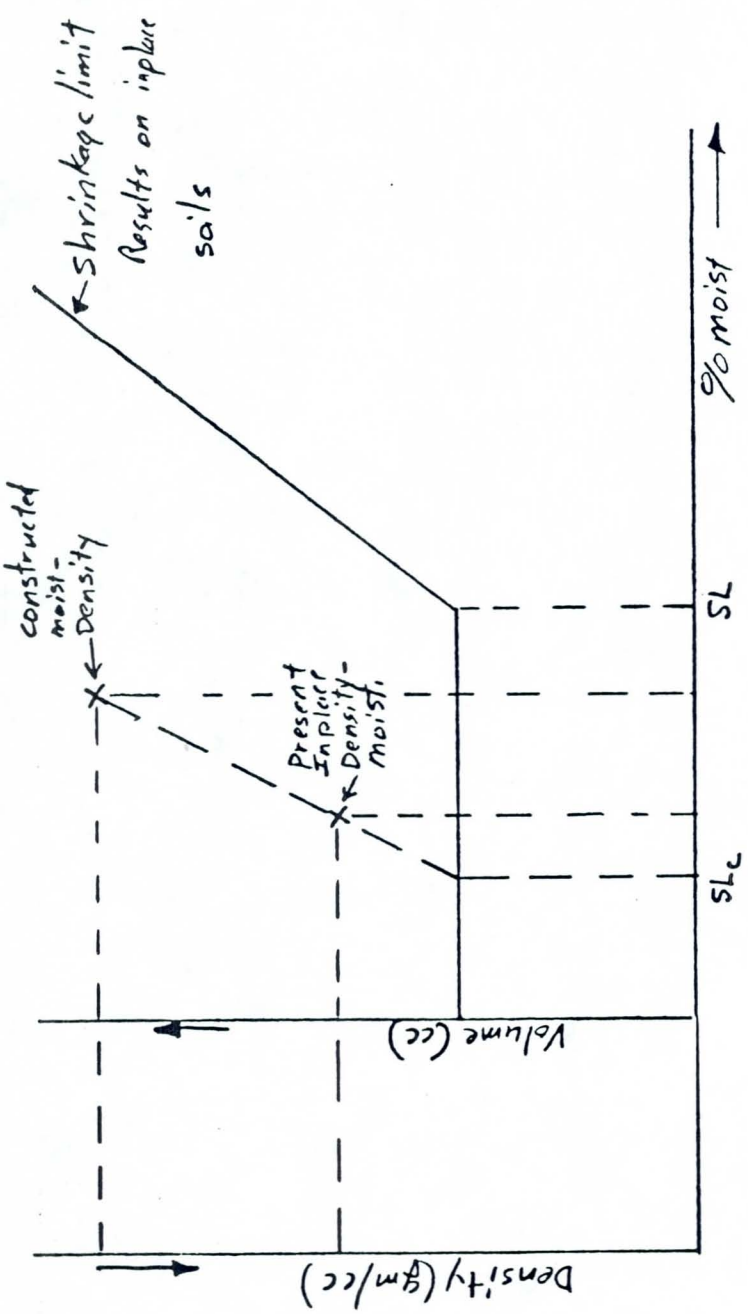
REMARKS 6 C+O

Shrinkage Limit Diagram CED 11/84



FLOOD CONTROL DISTRICT of Maricopa County

Interoffice Memorandum

CMT. NO.	SUBJECT: Spook Hill FRS Sprinklers	☒ FILE ☐ DESTROY

TO: CWM via RCP FROM: NPK DATE: 10-31-84

Please add the following to your Report on Spook Hill FRS:

At the request of our O & M Division, Western Technologies, Inc. in May 1983 performed in situ moisture tests on 20 samples obtained at sta ~~280+90~~ 280+00 and 22 samples at sta 286+90. A tabulation of the in situ moisture contents is ~~hereby~~ attached. In all the cases the in situ moisture contents are considerably lower than those at the time of construction.

Additional tests were performed by Western Technologies ~~Inc~~ in September 1984 at the request of our Engineering Division. These tests ~~investigated~~ included

FLOOD CONTROL DISTRICT of Maricopa County

Interoffice Memorandum

CMT. NO.	SUBJECT:	☐ FILE ☐ DESTROY

TO: FROM: DATE:

~~The~~ in situ moisture content, Shrinkage Limit and percent passing the #200 sieve.

~~Six~~ Five such tests were performed on samples from Sta 265+00 and four on samples from Sta 280+00 ~~In all of the tests samples the~~

The percent passing the #200 sieve ~~was~~ ranged between 35.3% and 20.5% indicating coarse grained materials.

~~In all the tests samples~~ In all the samples tested, the in situ moisture content was lower than the Shrinkage Limit. Copies of the lab test results are attached.

In coarse grained soils the cappilary forces causing surface tension are low thereby resulting in low amounts of shrinkage. ~~Furthermore the fact that the present in situ moisture~~

FLOOD CONTROL DISTRICT of Maricopa County

Interoffice Memorandum

CMT. NO.	SUBJECT:	☐ FILE _____ ☐ DESTROY

TO: FROM: DATE:

As moisture ~~evaporates~~ is lost, shrinkage occurs, with the resulting dessication cracking, untill the moisture content reaches that of the Shrinkage Limit. Further ~~evaporation~~ loss of moisture below the Shrinkage Limit will not result in additional shrinkage or ~~&~~ cracking. The fact that the moisture content in all the samples taken is lower than the Shrinkage Limit indicates that no further shrinkage or dessication cracking should be expected. Therefore attempts to prevent further moisture loss by ~~excessive watering~~ continuing to keep the surface of the stucture moist are not, in our opinion, justified.

Nick

6900-003
11/78

IRRIGATED AND NONIRRIGATED AREAS.

Station 286+90 "A"

NONIRRIGATED *

DEPTH IN FT	MOISTURE CONTENT %
1.0	3.4
2.5	3.7
5.0	4.2
7.5	4.9
10.0	5.8
12.5	3.0
15.0	1.2

#1

side slope of dam

1.0	1.9
2.5	2.6
5.0	4.1
7.5	4.0
10.0	3.5
12.5	3.6

#2

toe of dam

1.0	5.3
2.5	4.3
5.0	3.1
7.5	5.4
10.0	5.7
12.5	3.8
15.0	3.9
17.5	4.2
20.0	5.7

#3

Station 280+00 "B"

IRRIGATED **

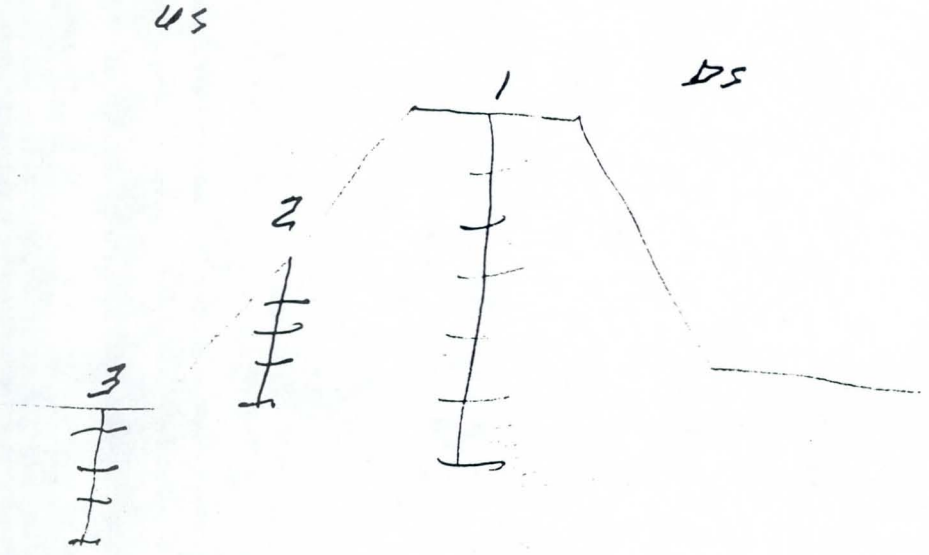
DEPTH IN FT	MOISTURE CONTENT %
2.5-3.5	5.7
5.0-6.0	7.6
7.5-8.5	3.6
10.0-11.0	7.5
12.5-13.5	9.9
15.0-16.0	7.7
17.5-18.5	10.0
20.0-21.0	8.8

0.0-1.5	5.5
5.0-6.0	9.6
7.5-8.5	8.9
10.0-11.0	7.3
12.5-13.5	8.9
15.0-16.0	7.0
17.5-18.5	8.6
20.0-21.0	7.6

2.5-4.0	6.4
5.0-6.0	8.3
7.5-8.5	8.2
10.0-11.0	8.9

* Core boring and moisture determinations by Maricopa County Highway Soils Lab using an Auger drill method.

** Core boring and moisture determinations by Western Technologies using methods similar to the above (as observed by FCD personnel).



WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

LETTER OF TRANSMITTAL

To AZ Flood Control Dist
3335 W. Durango St.
Phoe AZ 85009

Date 9-18-84

Job No. 2184J017

Lab./Invoice No.

Ref. No.

Attn. MR. Nick Karran

Project/Subject Spook Hill DAM Laboratory Test results

Please be informed that we are:

- ✓ Enclosing
- Forwarding Separately
- Per Your Request
- No. of Copies
- Other

- Engineering Reports
- ✓ Laboratory Reports
- Field Reports
- Proposals

~~More fully described as follows~~: Nick, Im encloseing The results on all The Samples ecept Sample # 280-27.0 Feet. The Lab was UNable To run Tests ON Sample provided So we Will have To go and get aNother ONe. I Will Coordinate W/ Bob Paet.

For your:

- ✓ Use
- Approval
- Files

- Information
- Action
- Other

Material forwarded by:

- Our Messenger
- Your Messenger
- First Class Mail
- Priority Mail
- Certified Mail
- Special Delivery
- Other

- ✓ Express Mail
- Air Priority
- United Parcel Service
- Motor Freight
- Air Freight
- City Delivery

FLOOD CONTROL DISTRICT
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SEP 19 '84

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	ADMIN		SUSP
	C & O		FILE
	ENGR		DESTROY
	FINANCE		
REMARKS			

By Gabriel R. Escamilla 9/1
Kelly Black

145

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karren

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam
Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84
Type of Material: -- — Submitted By: WTI — Date: 8/29/84
Source of Material: Station 265-22.5 — Authorized By: FCD/Karren — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	21.0	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = ____ PI = ____

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method ____ Maximum Dry Density, pcf ____ Optimum Moisture, % ____

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity ____

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value ____

Other:
Moisture Content, % ASTM D2216 7.1

Shrinkage Limit, ml ASTM D427 25.5

Copies to: Client (3)

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karren

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam
Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84
Type of Material: -- — Submitted By: WTI — Date: 8/29/84
Source of Material: Station 265-18.3 — Authorized By: FCD/Karren — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	20.5	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 8.3

Shrinkage Limit, ml ASTM D427 22.7

Copies to: Client (3)

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karren

Job No. 2184J017
Lab/Invoice No. 2184W017
Date
Reviewed By

Project: Spook Hill Dam
Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84
Type of Material: -- — Submitted By: WTI — Date: 8/29/84
Source of Material: Station 265-16.2 — Authorized By: FCD/Karren — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	28.9	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 7.8

Shrinkage Limit, ml ASTM D427 25.7

Copies to: Client (3)

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karren

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84
Type of Material: -- — Submitted By: WTI — Date: 8/29/84
Source of Material: Station 265-9.2 — Authorized By: FCD/Karren — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	30.4	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = ____ PI = ____

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method ____ Maximum Dry Density, pcf ____ Optimum Moisture, % ____

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity ____

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value ____

Other:

Moisture Content, % ASTM D2216 7.8

Shrinkage Limit, ml ASTM D427 22.7

Copies to: Client (3)

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karren

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 265-6.6 — Authorized By: FCD/Karren — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	35.3	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 7.4

Shrinkage Limit ml ASTM D427 12.6

Copies to: Client (3)

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karren

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-20.5 — Authorized By: FCD/Karren — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	32.6	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = ____ PI = ____

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method ____ Maximum Dry Density, pcf ____ Optimum Moisture, % ____

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity ____

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value ____

Other:

Moisture Content, % ASTM D2216 9.7

Shrinkage Limit, ml ASTM D427 26.1

Copies to: Client (3)

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-16.0 — Authorized By: FCD/Karren — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	24.5	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils
ASTM D424- LL = PI =

Moisture - Density Relations
☐ ASTM D698- ; ☐ ASTM D1557- ; Method
Maximum Dry Density, pcf
Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material)
ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils
ASTM D2844- 'R' Value

Other:

Moisture Content, %
ASTM D2216 8.5

Shrinkage Limit, ml
ASTM D427 19.9

Copies to: Client (3)

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karren

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-12.0 — Authorized By: FCD/Karren — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	21.7	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils
ASTM D424- LL = PI =

Moisture - Density Relations
☐ ASTM D698- ; ☐ ASTM D1557- ; Method
Maximum Dry Density, pcf
Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material)
ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils
ASTM D2844- 'R' Value

Other:
Moisture Content, %
ASTM D2216 5.4

Shrinkage Limit, ml
ASTM D427 18.6

Copies to: Client (3)

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karren

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-5.5 — Authorized By: FCD/Karren — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	20.9	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils
ASTM D424- LL = PI =

Moisture - Density Relations
☐ ASTM D698- ; ☐ ASTM D1557- ; Method
Maximum Dry Density, pcf
Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material)
ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils
ASTM D2844- 'R' Value

Other:

Moisture Content, %
ASTM D2216 5.8

Shrinkage Limit, ml
ASTM D427 21.3

Copies to: Client (3)

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FLOOD CONTROL DISTRICT
of
Maricopa County

3335 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 262-1501

D. E. Sagramoso, P.E., Chief Engineer and General Manager

AUG 21 1984

Mr. Gabriel R. Escamillo, Jr.
Manager, Geotechnical Exploration
Western Technologies Inc.
3737 East Broadway Road
Phoenix, Arizona 85036

Re: Soils Investigation at Spook Hill Dam

Dear Mr. Escamillo:

You are hereby authorized to proceed with the soil sampling and laboratory testing for this project in accordance with your proposal dated July 26, 1984 and your subsequent discussions with Nick Karan of my staff.

Soil samples are to be taken at the following locations and depths below the top of dam:

Station 265 + 00	Station 280 + 00
6.6 Feet	5.5 Feet
9.2 Feet	12.0 Feet
16.2 Feet	16.0 Feet
18.3 Feet	20.5 Feet
22.5 Feet	27.0 Feet

The depths given above correspond to the top of the sample. The maximum height of the sample shall be eight (8) inches.

The following tests are to be conducted on all the samples obtained:

1. In situ moisture content.
2. Shrinkage Limit.
3. Percent finer than the #200 sieve.

It is requested that a twenty-four hour notice be given to Bob Payette of my staff so that a representative of the Flood Control District be present at the job site in order to unlock gates, point out the two locations where drilling is to be done and verify the depths before the sampling operations are conducted.

We request that the sampling operations be conducted on a day other than Friday.

It is our understanding that the sampling and testing operations will be described in a letter that will accompany the lab results.

It is further understood that the total cost for this project will not exceed the sum of $1,800.

We are returning herewith a copy of your July 26, 1984 proposal with the General Conditions page properly signed for your files.

Sincerely,

D. E. Sagramoso, P. E.

Enclosure

NPK/ho

COORD: SLS 8/20 INFO: RCP ~~CGF~~ ~~RWS~~

File: Coord: M.C.

United States Department of Agriculture

Soil Conservation Service

Room 3008 Federal Building
230 North First Avenue
Phoenix, Arizona 85025

Subject: ENG-Meeting on the need for Continue Irrigation on Spookhill FRS for Vegetation & Cracking

Date: June 28, 1984

To: Files

File Code: 210

The meeting was called to order at 2:00 p.m. Tuesday June 25, 1984 by Bob Payette in the Flood Control Districts' Conference Room. The participants were as follows:

Ralph Arrington	SCS
Bill Payne	SCS
Stan Smith	FCD
Nick Karan	FCD
Catesby Moore	FCD
Bob Payette	FCD
Dan Lawrence	ADWR

Copies of the vegetation report and the construction records for moisture contents were distributed and discussed.

The report indicates the enhancement of vegetation by irrigation is no longer needed. No shrinkage limits were found in the construction records but it is concluded that the embankment shrinkage limit has been exceeded since the present embankment moisture is approximately 3-4% below the constructed moisture in the irrigated reaches and approximately 6-7% below the constructed moisture in the non-irrigated reach.

Bill Payne placed the tentative results of the subsidence survey on the blackboard. The survey showed the approximate settlement of the top of dam monuments to be 0.03 feet between station 110+00 and station 210+00. As soon as the subsidence survey is checked, copies will be sent to FCD and ADWR. The conclusion made is that since subsidence has not occurred it should not be a future problem on Spookhill. Therefore it is likely not to be a cause of cracking if cracking occurs.

The results of the discussions reduced to three positions which are:

ADWR-They have no objection to stopping the irrigation at this time, however, in the future the damage must be assessed for the need to repair.

June 28, 1984

Meeting on the need to Continue Irrigation on Spookhill FRS

To the Files

FCD-They desire to stop the irrigation since it is not needed for the vegetation and will reduce the large operation and maintenance expenses they are incurring.

SCS-Although continuing the irrigation is not a guarantee against embankment cracking, some benefits are decernible, and if the irrigation is stopped cracking must be expected. If repairs are needed, sponsors must share in the cost liability.

The FCD will prepare a report of findings and conclusions from the present data and send copies to ADWR and SCS. A meeting will be scheduled after the FCD report has been received and reviewed.

Ralph M. Arrington
State Conservation Engineer

cc: FCD
ADWR
Joe Knisley
Steve Revie
Jack Stevenson

United States Department of Agriculture

Soil Conservation Service

Room 3008 - Federal Building
230 North First Avenue
Phoenix, Arizona 85025

Subject: PROJ DEV MAINT - Watershed Protection
Evaluation of Vegetation on
Spook Hill Structure - 4/12/84

Date: May 23, 1984

To: Robert B. Crawford
State Resource Conservationist
Soil Conservation Service
Phoenix, Arizona

File Code: 390-11-21

Ralph Arrington, State Engineer, requested an evaluation on vegetative measures for determining what the impact of discontinuation of irrigation on the structure would have on present vegetative cover. Members participating in the evaluation were:

Catesby Moore, Landscape Architect, Maricopa Flood Control District
Carl Pachek, Agronomist, Soil Conservation Service, Phoenix
Jake Garrison, Plant Materials Specialist, SCS, Phoenix
Steve Revie, District Conservationist, SCS, Chandler

Starting on the southeast end, the vegetation is good to fair. A better stand is found on northeast exposures. All of the plants are in good vigor. Quailbush and desert broom are the dominant plants. The furrows have accumulated irrigation water, broke and left large rills on the slopes The borrow area east of the dike looks about the same as it did in 1981. Bursage and annuals have volunteered. Annuals still grow in the ripper marks, generally.

A good stand of quailbush was found along the top of the dike about 1/4 mile south of Brown Road. Plants growing vigorously on the slope were quailbush, desert broom, triangleleaf bursage and desert saltbush; Australian saltbush is present but plants were severely grazed. The erosion on this section is worse than at other locations. Catesby indicated that this area receives more irrigation water.

The reach north of McKellips Road has only fair cover of triangleleaf bursage, wild buckwheat and desert broom with a good litter of annuals, and erosion is not as severe. Blue, foothill and mexican palo verde were planted along the toe slopes on both sides of the dike. All of the plants are still growing on the downstream side. Plants on the upstream toe are vigorous except those located below the high water line. Blue and foothill palo verde located below the high water line are dead. Mexican palo verde was not affected by floodwater or standing water.

Saguaro and barrel cactus located on the dike near McDowell Road do not look vigorous. Most of the barrel cactus are dead. This is partly due to sprinkle irrigation and damage done by rodents near the base of the plants. The area north of McDowell Road was aerial seeded and not irrigated. The area has an excellent litter cover from annuals. Little erosion was evident.

The survival of palo verde trees on the north and east sides of the entire dike structure, as counted in the field, was 391 found alive and 113 found dead. This indicates a survival rate of 78%. The dead trees were 5 to 10 feet tall and had been flooded. The blue and foothill were affected by standing water but mexican was not affected. The lanscape plan included a total of 547 palo verdes planted, which indicates a survival rate of 72%. The latter is the official survival rate. The south and west sides were not checked - some lost in installation of CAP.

There would be several impacts if irrigation water is removed. They are:

1. Saguaro and barrel cactus will benefit.

2. After the water is removed from the fill there will be a reduction of quailbush and fourwing saltbush. This will be significant within five years.

3. The irrigation water provided on the site has encouraged annuals and a large supply of seed will continue to be available to provide cover with green plants in winter and litter cover in summer.

4. Areas on the dam that have bursage probably will not be affected by removal of irrigation water.

5. The dike has been irrigated long enough that a few riparian plants such as Yerba de pasimo and lotebush have established on the dike. These plants will die when irrigation is discontinued.

6. The erosion rate on the dike will be slowed to a minimum because of less concentration of water and annuals will provide better ground cover than the shrub canopy.

7. The irrigation system has been shut down for two-week time periods or longer and the vegetation was not eliminated.

8. These observations do not evaluate the moisture content of soil material in the dike.

Recommendations:

Discontinue irrigation and allow native plants to adjust to natural rainfall conditions. An acceptable number of plants should survive indefinitely with plants such as saguaro and barrel cactus benefiting. Less erosion will occur, at least on the southeast two miles of fill structure. The entire structure should look similar to the area north of McDowell, as a minimum, as less irrigation water has been available there. This recommendation relates to vegetative cover and erosion only. It does not include impacts on the change in moisture condition of the material in the dike.

Jacob C. Garrison, PMS

Carl E. Pachek, Agronomist

cc: Ralph Arrington, State Engineer, SCS
Catesby Moore, Maricopa Flood Cont. Dist.

all species planted Total 547 from plans. —

AZ

SPOOKHILL DAM - BUCKHORN MESA PROJECT

Attended by Jake & Carl 4/12/84

Evaluation of vegetation ~~(and Effect probable of when water is stopped.)~~

① SE. END OF STRUCTURE TO BROWN ROAD - North & East slopes ONLY.

	alive No.	dead No.	
			Palo Verde
Jake count	96 ✓	48 ✓	— dead trees are Blue + Foothill Palo Verde caused by flooding. (are from 5 to 8' high)
Carl	46 ✓		— 80 of the alive were Mexican P.V rest were Blue or Foothill
"	+ 3 ✓ (recently planted)	13 ✓	
"	19 ✓	1 ✓	
Total	164	62	Total dead & alive = 164 + 62 = 226

② McKELLIPS TO BROWN ROADS

	alive	dead	
Jake count	58	0	
Carl "	1	11	(dead were all flooded - Blue & Foothill
Total	59	11	1 alive = Parkinsonia also flooded

③ McDOWELL to McKELLIPS ROADS

	alive	dead	
Jake Count	75	29	(12 alive are Mexican P.V)
Carl Count	54	2	(4 " " ")
Total	129	31	

④ McDOWELL Road North to EMERGENCY SPILLWAY —

	alive	dead	
Jake count	35	6	(4 alive are Mex. P.V.)
Carl "	4	3	
	39	9	

Evaluation Grand Total

		alive	dead	Total
①	South Pecan Road	164	62	226
②		59	11	70
③		129	31	160
④		39	9	48
Total		391	113	504 ✓

SURVIVAL

% Alive - (trees found) = $\frac{391}{504}$ = 78%

% Alive - (trees planted) = $\frac{391}{547}$ = 72%

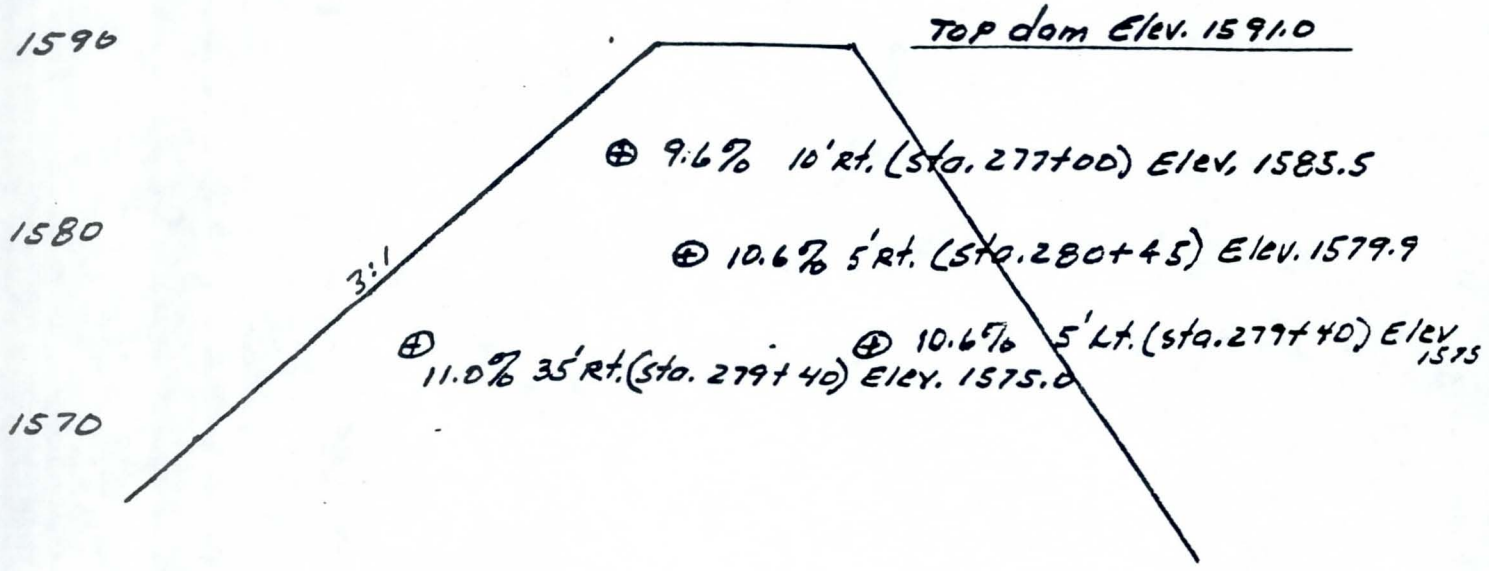
Az.

BJL 4-10-84

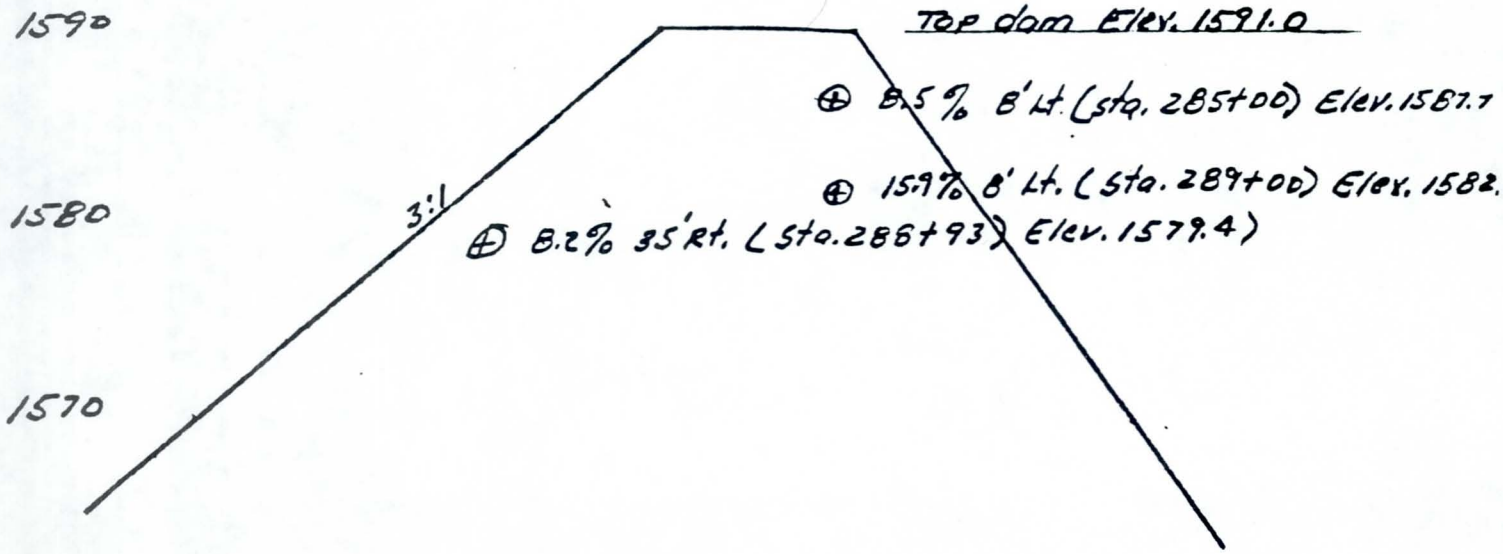
Buck Horn - Mesa. Spook Hill FRS

% Moisture Near Sta. 280+00 / / Sta. 286+90

Sta. 280+00



Sta. 286+90



SCS-ENG-532
Rev. 9-70
File Code ENG-13

Joe V.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
1- DAM

WEEKLY SUMMARY OF DENSITY DETERMINATIONS

Location MESA, ARIZONA - SPOOKHILL FRS
Owner MARICOPA FLOOD CONTROL DISTRICT Submitted By: J. VALENZUELA Date 22 JULY 19 78
Watershed BUCKHORN MESA Sub-watershed Site No.
Contractor MARDIAN CONSTRUCTION Co. Contract No. FCD-77-2-1 Report period: From 7 JULY 1978 to 27 JULY 19 78

Test No.	Date of Test	Location of Sample: From (Dam, Core, etc.)	Sta. No.	Distance Rt. or Lt. of ℄	Elev.	Particle Control Size	Corr. % Moist.	Dry Density Lbs/C.F.	Opt. Moist. %	Max. Dry Density Lbs/C.F.	% Comp.	% FINES	Instructions to Contractor	Tested By
34-1	7 JULY	DAM	277+00	10 LT ℄	1578.0	13	12.2	109.7	14.1	115.7	95.0	16.8		JV
35-1	11 JUL	DAM	279+40	35 LT ℄	1575.0	16	8.6	129.6	11.0	124.9	103.8	22.4	ADD MORE MOISTURE	JV
36-1	11 JUL	DAM	279+40	35 LT ℄	1575.0	16	9.7	120.5	11.0	124.9	96.5	22.4		JV
37-1	12 JUL	DAM	274+25	7 LT ℄	1582.9	8.1	11.4	113.6	13.1	118.7	95.7	18.0		JV
38-1	12 JUL	DAM	280+25	10 LT ℄	1577.1	13.9	11.0	111.9	13.3	118.2	95.0	20.5		JV
39-1	13 JUL	DAM	263+00	20 RT ℄	1568.5	22.5	8.4	122.8	10.0	129.3	95.0	26.4		JV
40-1	14 JUL	DAM	280+45	5 RT ℄	1579.9	12	10.1	118.3	10.6	124.9	95.0	30.2		JV
41-1	17 JUL	DAM	277+00	10 RT ℄	1585.5	5.5	8.6	123.8	9.6	126.8	97.6	33.8		JV
42-1	19 JUL	DAM	270+00	12 LT ℄	1581.8	9.2	8.5	122.7	9.6	128.1	95.8	16.1		JV
43-1	18 JUL	DAM	285+00	13 LT ℄	1584.8	6.2	11.3	117.3	10.9	123.4	95.1	20.2		JV
44-1	12 JUL	DAM	266+65	11 RT ℄	1584.4	6.6	7.4	125.0	8.7	130.7	95.6	19.3		JV
45-1	20 JUL	DAM	263+00	15 RT ℄	1572.7	18.3	9.6	128.9	11.4	124.8	103.3	18.7		JV
46-1	24 JUL	DAM	285+00	7 LT ℄	1587.7	3.3	8.5	122.3	10.5	128.8	95.0	16.4		JV
47-1	25 JUL	DAM	257+95	15 RT ℄	1572.2	19.0	8.5	118.2	10.3	124.8	95.0	25.5		JV
48-1	25 JUL	DAM	254+65	20 RT ℄	1572.9	18.1	6.2	104.2	10.0	127.9	81.5	24.0	RECOMPACT & ADD MOISTURE	JV
49-1	26 JUL	DAM	254+65	20 RT ℄	1572.9	18.1	9.6	121.2	10.0	127.9	95.0	24	RETEST OF TEST 48-1	JV
50-1	26 JUL	DAM	252+15	25 RT ℄	1572.8	18.8	12.0	118.1	10.8	125.0	95.0	24.7		JV
51-1	27 JUL	DAM	275+00	℄	1590 ±	10	8.0	132.7	10.0	125.7	105.6	30.5		JV

SCS-ENG-532
Rev. 9-70
File Code ENG-13

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WEEKLY SUMMARY OF DENSITY DETERMINATIONS

Location MESA, ARIZONA – SPOOKHILL FRS Owner MARICOPA FLOOD CONTROL DISTRICT Submitted By: J. VALENZUELA Date JULY 7 19 78

Watershed BUCKHORN MESA Sub-watershed Site No. 1

Contractor MARBIAN CONSTRUCTION CO. Contract No. FCD-77-2-1 Report period: From 19 JUNE 19 78 to 6 JULY 19 78

Test No.	Date of Test	Location of Sample: From (Dam, Core, etc.)	Sta. No.	Distance Rt. or Lt. of ℄	Elev.	Particle Control Size	Corr. % Moist.	Dry Density Lbs/C.F.	Opt. Moist. %	Max. Dry Density Lbs/C.F.	% Comp.	% Comp. Spec.	% Fines	Instructions to Contractor	Tested By
21-1	6/20/78	DAM	279+10	10 LT ℄ 31.3	1559.7	#4	7.6	129.5	9.5	128.9	100.5		28.0		JV
22-1	6/20/78	DAM	279+75	℄ 29	1562.1	#4	10.7	115.4	12.5	120.9	95.5		20.9		JV
23-1	6/21/78	DAM	279+25	25 RT ℄ 27	1564.0	#4	10.2	123.1	10.6	123.5	99.6		28.6		JV
24-1	6/23/78	DAM	278+00	15 RT ℄ 20.5	1570.3	#4	11.0	120.7	10.7	126.6	95.3		24.0		JV
25-1	6/26/78	DAM	275+00	32 RT ℄ 15.	1576.0	#4	8.1	124.1	10.1	126.9	97.8		33.1		JV
26-1	6/27/78	DAM	276+00	30 LT ℄ 17.3	1573.7	#4	11.0	104.5	14.1	116.9	89.4		29.5	RECOMPACT & ADD MOISTURE	JV
27-1	6/27/78	DAM	276+00	30 LT ℄	1573.7	#4	12.1	113.55	14.1	116.9	97.1		29.5	RETEST OF 26-1	JV
28-1	6/27/78	DAM	276 276+40	40 LT ℄ 16.5	1574.5	#4	8.0	123.6	11.0	126.6	97.6		30.7		JV
29-1	6/29/78	DAM	264 268+65	30 RT ℄	1562.6	#4	11.1	118.2	11.5	124.8	95.0		27.1		JV
30-1	6/30/78	DAM	279+35	29 RT ℄ 17.1	1573.9	#4	11.0	118.8	13.0	119.0	99.8		24.8		JV
31-1	7/6/78	DAM	267+00	35 RT ℄	1574.8	#4	6.5	119.3	8.7	128.9	92.6		27.6	RECOMPACT & ADD MOISTURE	JV
32-1	7/6/78	DAM	264 268+00	35 RT ℄	1574.3	#4	7.6	125.9	9.2	127.8	98.5		31.6		JV
33-1	7/6/78	DAM	267 267+00	35 RT ℄	1574.8	#4	8.0	121.9	8.7	128.9	99.0		27.6	RETEST OF 31-1	JV

SCS-ENG-532
Rev. 9-70
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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WEEKLY SUMMARY OF DENSITY DETERMINATIONS

Location SPOOK HILL FRS
Owner MARICOPA FLOOD CONTROL DISTRICT Submitted By: J. VALDEZUELA
Date JUNE 16 19 78
Watershed SOIL CONSERVATION SERVICE
Sub-watershed
Site No. 1 & 3
Contractor RAMPLAN
Contract No. FCD-77-3-1
Report period: From 2 JUNE 19 78 to 16 JUNE 19 78

Test No.	Date of Test	Location of Sample: From (Dam, Core, etc.)	Sta. No.	Distance Rt. or Lt. of ℄	Elev.	Particle Control Size	Corr. % Moist.	Dry Density Lbs/C.F.	Opt. Moist. %	Max. Dry Density Lbs/C.F.	% Comp.	% Comp. Spec.		Instructions to Contractor	Tested By
16-1	6/2/78	Dam	283+00	10' RT ℄	1574.9		10.2	120.6	10.7	127.1	95.0		22.1	RETEST OF 14-1	JV
17-1	6/2/78	Dam	288+00	8 LT ℄	1582.0		15.9	106.1	15.3	110.7	95.9		23.4		JV
18-1	6/6/78	Dam	290+00	20 LT ℄	1580.0		11.0	119.2	11.0	123.4	95.0		29.3		J V
19-1	6/8/78	Dam	284+00	15 LT ℄	1581.0		9.8	125.5	9.6	124.3	100.9		30.6		JV
1-3	6/9/78	RAMP	14+80	40 LT ℄	1570.6		14.2	110.9	13.7	113.6	97.6		24.4		JV
2-3	6/12/78	RAMP	17+95	47 RT ℄	1570.9		11.2	122.9	10.2	120.1	99.9		29.0		JV
3-3	6/12/78	RAMP	14+95	28 LT ℄	1574.2		9.1	127.2	11.1	122.0	104.3		27.7		JV
4-3	6/13/78	RAMP	14+40	25 RT ℄	1573.9		12.2	117.1	11.9	121.8	96.1		32.2		JV
5-3	6/13/78	RAMP	15+17	5 RT ℄	1576.4		13.8	124.3	16.8	111.1	111.9		21.5	ADD MOISTURE	JV
6-3	6/13/78	RAMP	15+82	25 LT ℄	1576.8		12.0	122.2	9.9	120.2	95.3		28.8		JV
7-3	6/13/78	RAMP	14+00	20 LT ℄	1575.3		9.9	135.1	11.5	123.5	109.4		32.0		JV
8-3	6/13/78	RAMP	13+20	℄	1574.4		12.6	118.1	14.9	116.0	101.8		29.6		JV
9-3	6/14/78	RAMP	15+17	5 RT ℄	1576.4		15.2	114.6	16.8	111.1	103.1		21.5	RETEST OF 5-3	JV
20-1	6/14/78	Dam	181+00	℄	1580.0		13.2	119.9	11.3	123.6	97.0		28.0		JV
10-1	6/15/78	RAMP	14+80	℄	1576.8		13.5	104	13.5	117.7	88.4		22.9	RECOMPACT	JV
11-1	6/15/78	RAMP	16+17	20 LT ℄	1581.7		9.7	112.9	10.5	126.3	89.4		22.4	RECOMPACT	JV
12-1	6/15/78	RAMP	14+80	℄	1576.8		12.7	117.9	13.5	117.7	100.2		22.5		JV
13-1	6/15/78	RAMP	16+17	20 LT ℄	1581.7		12.5	120.4	10.5	126.3	95.3		22.6		JV

United States Department of Agriculture

Soil Conservation Service

Room 3008 Federal Building
230 North First Avenue
Phoenix, Arizona 85025

Subject: ENG-Meeting on the need to Continue Irrigation Spookhill FRS for Vegetation and Cracking

Date: March 20, 1984

To: Files

File Code: 210

The meeting was called to order at 9:00 a.m. Tuesday March 20, 1984 by Bob Payette in the Flood Control District's small conference room. The list of participants is attached.

Bob Payette stated the aim of the meeting was to determine the need for future irrigation of the Spookhill FRS to maintain the vegetation and prevent cracking.

The Flood Control District has drilled some auger holes at station 286+90 (non-irrigated) and at station 280+00 (irrigated). The holes were drilled at three locations at each station and samples were taken at 2.5 foot depths. Moisture contents were run on all samples. The data is attached. The amount of water used for irrigation from 1980 to the present time with costs was listed and is attached.

Catesby Moore stated the vegetation south of McDowell Road was very lush, green and of the perennial variety due to the soil type (loamy sand) and the irrigation. Annual varieties of plants are almost non-existant. The vegetation north of McDowell Road is not as lush and has more annual plants and less perennial varieties due to the soil type (sandy loam) and the irrigation. In the non-irrigated area the vegetation is predominately annuals.

The slope erosion measured an average of 30% loss in the irrigated areas and an average of 2% loss in the non-irrigated. The erosion was caused by normal rainfall.

Subsidence surveys need to be rerun by the SCS as soon as possible. Ralph would see if SCS could pay the FCD to run the surveys due to SCS work load at present time.

SCS would check testing records for construction moisture contents and shrinkage limits. If more drilling and testing need be done then guidelines of location, depth, moisture content, shrinkage limit, etc. will have to be given to acquire the needed information required.

A report will be written of findings and conclusions after all data gathering has been completed.

The renovation of the pumphouse will be delayed to determine the need if any.

Dan Lawrence ADWR agreed to review the design features of Spookhill to determine these items positive and negative that may be of concern in determining the irrigation of the dam.

Ralph M. Arrington
State Conservation Engineer

cc: Jack Stevenson
Wayne Killgore
Steve Revie
Joe Knisley

MEETING ATTENDANCE ROSTER

Meeting: Spook Hill FRS & Floodway Location: FCD

Date: March 20, 1984

Name	Title	Organization	Phone
Cora Fernandez	Project Engineer	FCD	262-1501
Nick Karan	Chief, Eng. Div.	✓	✓
Gatesby Moore	Revegetation Ecologist	FCD	262-1501
Paul [illegible]	[illegible]	FCD	[illegible]
Stan Smith	Deputy Chief Engr	FCD	"
Bob Payette	Chief [illegible] Div.	FCD	"
Bill Payne	Design Engr.	SCS	261-6711
Ralph Arrington	Eng	SCS	261-6711
Dan Lawrence	Chief SOD	ADWR	255-1541

RESULTS OF TWO SEPARATE SETS OF MOISTURE CORE BORINGS AT SPOOKHILL IN IRRIGATED AND NONIRRIGATED AREAS.

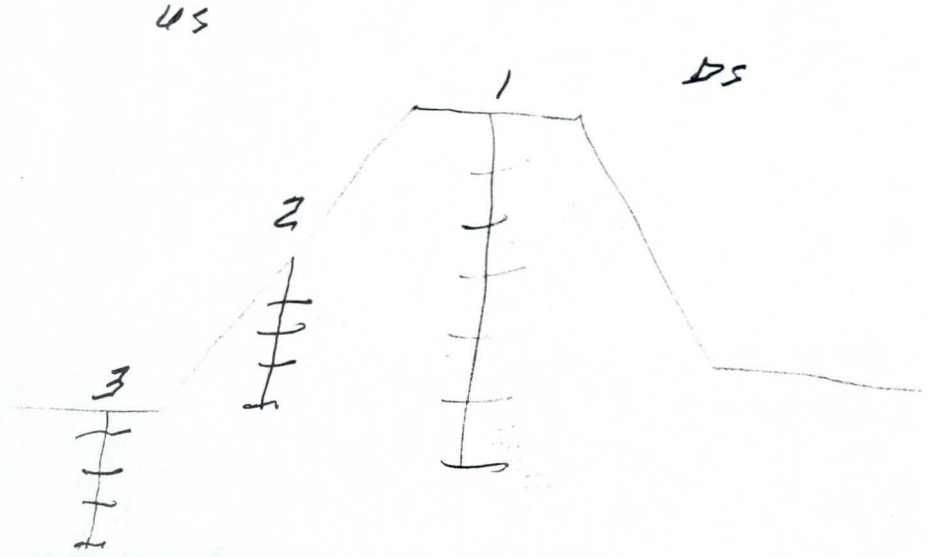
Station 286+90 "A" — Station 280+00 "B"

NONIRRIGATED * DEPTH IN FT	MOISTURE CONTENT %	IRRIGATED ** DEPTH IN FT	MOISTURE CONTENT %
1.0	3.4	2.5-3.5	5.7
2.5	3.7	5.0-6.0	7.6
5.0	4.2	7.5-8.5	3.6
7.5	4.9	10.0-11.0	7.5
10.0	5.8	12.5-13.5	9.9
12.5	3.0	15.0-16.0	7.7
15.0	1.2	17.5-18.5	10.0
		20.0-21.0	8.8
side slope of dam			
1.0	1.9	0.0-1.5	5.5
2.5	2.6		
5.0	4.1	5.0-6.0	9.6
7.5	4.0	7.5-8.5	8.9
10.0	3.5	10.0-11.0	7.3
12.5	3.6	12.5-13.5	8.9
		15.0-16.0	7.0
		17.5-18.5	8.6
		20.0-21.0	7.6
toe of dam			
1.0	5.3		
2.5	4.3	2.5-4.0	6.4
5.0	3.1	5.0-6.0	8.3
7.5	5.4	7.5-8.5	8.2
10.0	5.7	10.0-11.0	8.9
12.5	3.8		
15.0	3.9		
17.5	4.2		
20.0	5.7		

#1 #2 #3

* Core boring and moisture determinations by Maricopa County Highway Soils Lab using an Auger drill method.

** Core boring and moisture determinations by Western Technologies using methods similar to the above (as observed by FCD personnel).



SPOOKHILL WATER BILLS

Meter read date	amount water (in 1,000 of gallons)	Cost
12/28/83	1,165	663.28
11/29/83	983	564.86
10/29/83	1,014	581.62
9/30/83	1,099	627.59
8/30/83	768	448,58
8/ 03/83	125	86.64
7/29/83	1,408	794.70
7/14/83	166	109.02
Fiscal 83-84 Totals	7,.827	4,503,88
6/29/83	1,167	613.02
6/23/83	9	11.51
5/26/83	1,769	913.53
4/27/83	1	39.42
3/30/83	-	39.42
2/23/83	-	37.90
1/26/83	12	37.90
12/29/82	8	37.90
11/24/82	286	169.26
10/27/82	450	247.50
9/30/82	557	299.34
8/31/82	606	325.82
7/30/82	726	380.46
Fiscal 82-83 Totals	5,591	3,152.98
6/28/82	1,092	524.70
5/28/82	1,818	851.40
4/27/82	1,114	534.60
3/29/82	972	470.70
2/24/82	1,117	535.92
1/25/82	1,265	602.55
12/23/81	1,143	547.65
11/23/81	624	314.10
10/21/81	727	360.45
9/22/81	2,032	947.70
8/21/81	2,256	1,048.50
7/28/81	2,038	950.40
6/23/81	1,492	641.88
Fiscal year 81-82 Totals	17,690	8,330.55
5/27/81	2,176	922.32
4/23/81	1,047	459.43
3/27/81	1,154	503.30
2/24/81	417	201.13
1/29/81	909	402.85
12/23/80	652	297.48
11/25/80	1,182	514.78
1 /27/80	2,376	1,004.32
9/29/80	1,653	1,182.26
8/22/80	480	226.96
7/24/80	748	336.84
Fiscal year 80-81 Totals	12,794	6,051.67

Sta 280+00

~~Sta 265+00~~

SCS-ENG-532
Rev. 9-70
File Code ENG-13

Joe V.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
1- DAM

WEEKLY SUMMARY OF DENSITY DETERMINATIONS

Location MESA, ARIZONA - SPOOKHILL FRS | Owner MARICOPA FLOOD CONTROL DISTRICT | Submitted By: J. VALENZUELA | Date 22 JULY 19 78

Watershed BUCKHORN MESA | Sub-watershed | Site No.

Contractor MARDIAN CONSTRUCTION Co. | Contract No. FCD-77-2-1 | Report period: From 7 JULY 1978 to 27 JULY 19 78

Test No.	Date of Test	Location of Sample: From (Dam, Core, etc.)	Sta. No.	Distance Rt. or Lt. of ℄	Elev.	Particle Control Size	Corr. % Moist.	Dry Density Lbs/C.F.	Opt. Moist. %	Max. Dry Density Lbs/C.F.	% Comp.	% FINES	Instructions to Contractor	Tested By
34-1	7 JULY	DAM	277+00	10 LT ℄	1578.0	13	12.2	109.7	14.1	115.7	95.0	16.8		JV
35-1	11 JUL	DAM	279+40	35 LT ℄	1575.0	16	8.6	129.6	11.0	124.9	103.8	22.4	ADD MORE MOISTURE	JV
36-1	11 JUL	DAM	279+40	35 LT ℄	1575.0	16	9.7	120.5	11.0	124.9	96.5	22.4		JV
37-1	12 JUL	DAM	274+25	7 LT ℄	1582.9	8.1	11.4	113.6	13.1	118.7	95.7	18.0		JV
38-1	12 JUL	DAM	280+25	10 LT ℄	1577.1	13.9	11.0	111.9	13.3	118.2	95.0	20.5		JV
39-1	13 JUL	DAM	263+00	20 RT ℄	1568.5	22.5	8.4	122.8	10.0	129.3	95.0	26.4		JV
40-1	14 JUL	DAM	280+15	5 RT ℄	1579.9	12	10.1	118.3	10.6	124.9	95.0	30.2		JV
41-1	17 JUL	DAM	277+00	10 RT ℄	1585.5	5.5	8.6	123.8	9.6	126.8	97.6	33.8		JV
42-1	19 JUL	DAM	270+00	12 LT ℄	1581.8	9.2	8.5	122.7	9.6	128.1	95.8	16.1		JV
43-1	18 JUL	DAM	285+00	13 LT ℄	1584.8	6.2	11.3	117.3	10.9	123.4	95.1	20.2		JV
44-1	12 JUL	DAM	266+65	11 RT ℄	1584.4	6.6	7.4	125.0	8.7	130.7	95.6	19.3		JV
45-1	20 JUL	DAM	263+00	15 RT ℄	1572.7	18.3	9.6	128.9	11.4	124.8	103.3	18.7		JV
46-1	24 JUL	DAM	285+00	7 LT ℄	1587.7	3.3	8.5	122.3	10.5	128.8	95.0	16.4		JV
47-1	25 JUL	DAM	257+95	15 RT ℄	1572.2	11.0	8.5	118.2	10.3	124.8	95.0	25.5		JV
48-1	25 JUL	DAM	254+65	20 RT ℄	1572.9	1.1	6.2	104.2	10.0	127.9	81.5	24.0	RECOMPACT & ADD MOISTURE	JV
49-1	26 JUL	DAM	254+65	20 RT ℄	1572.9	18.1	9.6	121.2	10.0	127.9	95.0	24	RETEST OF TEST 48-1	JV
50-1	26 JUL	DAM	252+15	25 RT ℄	1572.8	18.8	12.0	118.1	10.8	125.0	95.0	24.7		JV
51-1	27 JUL	DAM	275+00	℄	1590 ±	1.0	8.9	132.7	10.0	125.7	105.6	30.5		JV

SCS-ENG-332
Rev. 9-70
File Code ENG-13

Sta 280+00
Sta 265+00

SOIL CONSERVATION SERVICE

WEEKLY SUMMARY OF DENSITY DETERMINATIONS

Location MESA, ARIZONA – SPOOKHILL FRS
Owner MARICOPA FLOOD CONTROL DISTRICT Submitted By: J. VALENZUELA Date JULY 7 19 78
Watershed BUCKHORN MESA Sub-watershed Site No. 1
Contractor RARBIAN CONSTRUCTION Co. Contract No. FCD-77-3-1 Report period: From 19 JUNE 19 78 to 6 JULY 19 78

Test No.	Date of Test	Location of Sample: From (Dam, Core, etc.)	Location of Sample: Sta. No.	Location of Sample: Distance Rt. or Lt. of ℄	Location of Sample: Elev.	Particle Control Size	Corr. % Moist.	Dry Density Lbs/C.F.	Opt. Moist. %	Max. Dry Density Lbs/C.F.	% Comp.	% Comp. Spec.	% Fines	Instructions to Contractor	Tested By
21-1	6/20/78	DAM	279+10	10 LT ℄ 21.3	1559.7	#4	7.6	129.5	9.5	128.9	100.5		28.0		JV
22-1	6/20/78	DAM	279+75	℄ 29	1562.1	#4	10.7	115.4	12.5	120.9	95.5		20.9		JV
23-1	6/21/78	DAM ✓	279+25	25 RT ℄ 27	1564.0	#4	10.2	123.1	10.6	123.5	99.6		29.6		JV
24-1	6/23/78	DAM ✓	279+00	15 RT ℄ 20.5	1570.3	#4	11.0	120.7	10.7	126.6	95.3		24.0		JV
25-1	6/26/78	DAM ✓	275+00	32 RT ℄ 15.0	1576.0	#4	8.1	124.1	10.1	126.9	97.8		33.1		JV
26-1	6/27/78	DAM ✓	276+00	30 LT ℄ 17.3	1573.7	#4	11.0	104.5	14.1	116.9	89.4		29.5	INCOMPACT & ADD MOISTURE	JV
27-1	6/27/78	DAM ✓	276+00	30 LT ℄ 17.3	1573.7	#4	12.1	113.55	14.1	116.9	97.1		29.5	RETEST OF 26-1	JV
28-1	6/27/78	DAM ✓	276+40	40 LT ℄ 16.5	1574.3	#4	8.0	123.6	11.0	126.6	97.6		30.7		JV
29-1	6/29/78	DAM	268+65	30 RT ℄	1562.6	#4	11.1	118.2	11.5	124.8	95.0		27.1		JV
30-1	6/30/78	DAM	279+35	25 RT ℄ 17.1	1573.9	#4	11.0	118.8	13.0	119.0	99.8		24.8		JV
31-1	7/6/78	DAM	267+00	35 RT ℄ 16.9	1574.8	#4	6.5	119.3	8.7	128.8	92.6		27.6	INCOMPACT & ADD MOISTURE	JV
32-1	7/6/78	DAM	268+00	35 RT ℄	1574.3	#4	7.6	125.9	9.2	127.8	98.5		31.6		JV
33-1	7/6/78	DAM	267+00	35 RT ℄ 16.2	1574.8	#4	8.0	121.9	8.7	128.8	95.0		27.6	RETEST OF 31-1	JV

Sta 280 +00

Sta 285 +00

SCS-ENG-532
Rev. 9-70
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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WEEKLY SUMMARY OF DENSITY DETERMINATIONS

Location SPOOK HILL FRS | Owner MARICOPA FLOOD CONTROL DISTRICT | Submitted By: J. VALENZUELA | Date JUNE 16 19 78

Watershed SOIL CONSERVATION SERVICE | Sub-watershed | Site No. 1 & 3

Contractor MANGUM | Contract No. FCD-77-3-1 | Report period: From 2 JUNE 19 78 to 16 JUNE 19 78

Test No.	Date of Test	Location of Sample: From (Dam, Core, etc.)	Sta. No.	Distance Rt. or Lt. of ℄	Elev.	Particle Control Size	Corr. % Moist.	Dry Density Lbs/C.F.	Opt. Moist. %	Max. Dry Density Lbs/C.F.	% Comp.	% Comp. Spec.		Instructions to Contractor	Tested By
16-1	6/2/78	DAM	283+00	10' RT ℄	1574.3		10.2	120.6	10.7	127.1	95.0		22.1	RETEST OF 14-1	JV
17-1	6/2/78	DAM	288+00	8 LT ℄	1582.0		13.9	106.1	15.3	110.7	95.9		23.4		JV
18-1	6/6/78	DAM	290+00	20 LT ℄	1580.0		11.0	119.2	11.0	125.4	95.0		29.3		JV
19-1	6/8/78	DAM	284+00	15 LT ℄	1581.0		9.8	125.5	9.6	124.3	100.9		30.6		JV
1-3	6/9/78	RAMP	14+80	40 LT ℄	1570.6		14.2	110.9	15.7	113.6	97.6		24.4		JV
2-3	6/12/78	RAMP	17+95	47 RT ℄	1570.5		11.2	122.9	10.2	120.1	95.9		29.0		JV
3-3	6/12/78	RAMP	14+95	28 LT ℄	1574.2		9.1	127.2	11.1	122.0	104.3		27.7		JV
4-3	6/13/78	RAMP	14+60	25 RT ℄	1579.9		12.2	117.1	11.9	121.8	96.1		32.2		JV
5-3	6/13/78	RAMP	15+17	5 RT ℄	1576.4		13.8	124.3	16.8	111.1	111.9		21.5	ADD MOISTURE	JV
6-3	6/13/78	RAMP	15+82	25 LT ℄	1576.8		12.0	122.2	9.9	120.2	95.3		28.8		JV
7-3	6/13/78	RAMP	14+00	20 LT ℄	1575.3		9.9	135.1	11.5	123.5	109.4		32.0		JV
8-3	6/13/78	RAMP	13+20	℄	1574.4		12.6	118.1	14.5	116.0	101.8		25.6		JV
9-3	6/14/78	RAMP	15+17	5 RT ℄	1576.4		15.2	114.6	16.8	111.1	103.1		21.5	RETEST OF 5-3	JV
20-1	6/14/78	DAM	181+00	℄	1590.0		13.2	119.9	11.3	123.6	97.0		28.0		JV
10-1	6/15/78	RAMP	14+80	℄	1576.8		13.5	104	13.5	117.7	88.4		22.5	RECOMPACT	JV
11-1	6/15/78	RAMP	16+17	20 LT ℄	1581.7		9.7	112.9	10.5	126.3	89.4		22.4	RECOMPACT	JV
12-1	6/15/78	RAMP	14+80	℄	1576.8		12.7	117.9	13.5	117.7	100.2		22.5		JV
13-1	6/15/78	RAMP	16+17	20 LT ℄	1581.7		12.5	120.4	10.5	126.3	95.3		22.4		JV

RESULTS OF TWO SEPARATE SETS OF MOISTURE CORE BORINGS AT SPOOKHILL IN IRRIGATED AND NONIRRIGATED AREAS.

NONIRRIGATED * Sta 286+90		IRRIGATED ** Sta 280+00	
DEPTH IN FT	MOISTURE CONTENT %	DEPTH IN FT	MOISTURE CONTENT %
1.0	3.4	2.5-3.5	5.7
2.5	3.7	5.0-6.0	7.6
5.0	4.2	7.5-8.5	3.6
7.5	4.9	10.0-11.0	7.5
10.0	5.8	12.5-13.5	9.9
12.5	3.0	15.0-16.0	7.7
15.0	1.2	17.5-18.5	10.0
		20.0-21.0	8.8
side slope of dam			
1.0	1.9	0.0-1.5	5.5
2.5	2.6		
5.0	4.1	5.0-6.0	9.6
7.5	4.0	7.5-8.5	8.9
10.0	3.5	10.0-11.0	7.3
12.5	3.6	12.5-13.5	8.9
		15.0-16.0	7.0
		17.5-18.5	8.6
		20.0-21.0	7.6
toe of dam			
1.0	5.3		
2.5	4.3	2.5-4.0	6.4
5.0	3.1	5.0-6.0	8.3
7.5	5.4	7.5-8.5	8.2
10.0	5.7	10.0-11.0	8.9
12.5	3.8		
15.0	3.9		
17.5	4.2		
20.0	5.7		

* Core boring and moisture determinations by Maricopa County Highway Soils Lab using an Auger drill method.

** Core boring and moisture determinations by Western Technologies using methods similar to the above (as observed by FCD personnel).

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

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

May 19, 1983

Attn: Mr. Robert Payette

Re: Spook Hill Dam

Job No. 2183J011

Dear Mr. Payette,

Thank you for your patience on this project and we look forward to working for you again. The last time that the driller went out he took samples of the other three borings and if you require moisture content testing on those samples please contact me.

Respectfully submitted,

WESTERN TECHNOLOGIES, INC.

Gabriel R Escamillo gj

Gabriel Escamillo

mb

Attachment

Copies to: Addressee (1)

SPOOK HILL DAM

JOB NO. 2183J011

drill at 280+00

TEST BORING NUMBER	DEPTH (FEET)	MOISTURE CONTENT %
1	2½ - 3½	5.7
1	5 - 6	7.6
1	7½ - 8½	3.6
1	10 - 11	7.5
1	12½ - 13½	9.9
1	15 - 16	7.7
1	17½ - 18½	10.0
1	20 - 21	8.8
2	0 - 1½	5.5
2	5 - 6	9.6
2	7½ - 8½	8.9
2	10 - 11	7.3
2	12½ - 13½	8.9
2	15 - 16	7.0
2	17½ - 18½	8.6
2	20 - 21	7.6
3	2½ - 4	6.4
3	5 - 6	8.3
3	7½ - 8½	8.2
3	10 - 11	8.9

SPOOKHILL WATER BILLS

Meter read date	amount water (in 1,000 of gallons)	Cost
12/28/83	1,165	663.28
11/29/83	983	564.86
10/29/83	1,014	581.62
9/30/83	1,099	627.59
8/30/83	768	448,58
8/ 03/83	125	86.64
7/29/83	1,408	794.70
7/14/83	166	109.02
Fiscal 83-84 Totals	7,827	4,503,88
6/29/83	1,167	613.02
6/23/83	9	11.51
5/26/83	1,769	913.53
4/27/83	1	39.42
3/30/83	-	39.42
2/23/83	-	37.90
1/26/83	12	37.90
12/29/82	8	37.90
11/24/82	286	169.26
10/27/82	450	247.50
9/30/82	557	299.34
8/31/82	606	325.82
7/30/82	726	380.46
Fiscal 82-83 Totals	5,591	3,152.98
6/28/82	1,092	524.70
5/28/82	1,818	851.40
4/27/82	1,114	534.60
3/29/82	972	470.70
2/24/82	1,117	535.92
1/25/82	1,265	602.55
12/23/81	1,143	547.65
11/23/81	624	314.10
10/21/81	727	360.45
9/22/81	2,032	947.70
8/21/81	2,256	1,048.50
7/28/81	2,038	950.40
6/23/81	1,492	641.88
Fiscal year 81-82 Totals	17,690	8,330.55
5/27/81	2,176	922.32
4/23/81	1,047	459.43
3/27/81	1,154	503.30
2/24/81	417	201.13
1/29/81	909	402.85
12/23/80	652	297.48
11/25/80	1,182	514.78
1 /27/80	2,376	1,004.32
9/29/80	1,653	1,182.26
8/22/80	480	226.96
7/24/80	748	336.84
Fiscal year 80-81 Totals	12,794	6,051.67

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
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Phoenix, Arizona 85036
(602) 437-3737

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

October 11, 1984

Attn: Mr. Nick Karan, P.E.

Re: Shrinkage Limit Tests
Spook Hill Dam

Job No. 2184J017

Shrinkage limit tests were conducted according to ASTM Designation D427-83 which states that the initial water content for the test should be equal or slightly greater than the liquid limit. Using this procedure often results in shrinkage limit values greater than the plastic limit for sandy and silty clays (Holtz and Kovacs).

The soils tested were silty or clayey sands with 20.5% to 35.3% passing the 200 mesh sieve. High shrinkage limit values could be expected for soils that are predominately sands. The grain to grain contact would occur primarily between sand particles and the size of capillaries that produce tension upon drying would be relatively large in diameter. Capillary tension and resulting shrinkage would be low; therefore, little shrinkage would occur and the shrinkage limit would be high.

Shrinkage limit test results are meaningful only for clays and published interpretations may be applied only to clay soils. For clays, Holtz and Gibbs present the following information for arid region soils: A shrinkage limit greater than 12 has little volume change potential. Bowles says that it is not possible to quantify the term "little volume change potential".

References:

Holtz and Kovacs, "An Introduction to Geotechnical Engineering", 1981, Prentice-Hall, pages 178-185

Bowles, "Physical and Geotechnical Properties of Soils", 1979, McGraw-Hill, pages 223-225.

We hope this information assist you in the interpretation of the attached test results. If we may be of further service please don't hesitate to contact us.

Respectfully submitted,
WESTERN TECHNOLOGIES INC.

John C. Rosner

John C. Rosner, Ph.D., P.E.

nj

Attachments

Copies to: Addressee (3)

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 265-6.6 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	35.3	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 — 7.4

Shrinkage Limit, % ASTM D427 — 12.6

Copies to: Client (3)

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Phoenix, Arizona 85036
(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84
Type of Material: -- — Submitted By: WTI — Date: 8/29/84
Source of Material: Station 265-9.2 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	30.4	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 7.8

Shrinkage Limit, % ASTM D427 22.7

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 265-16.2 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	28.9	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 7.8

Shrinkage Limit, % ASTM D427 25.7

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 265-18.3 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	20.5	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = ____ PI = ____

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method ____ Maximum Dry Density, pcf ____ Optimum Moisture, % ____

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity ____

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value ____

Other:

Moisture Content, % ASTM D2216 8.3

Shrinkage Limit, % ASTM D427 22.7

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 265-22.5 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	21.0	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils
ASTM D424- LL = PI =

Moisture - Density Relations
☐ ASTM D698- ; ☐ ASTM D1557- ; Method
Maximum Dry Density, pcf
Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material)
ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils
ASTM D2844- 'R' Value

Other:
Moisture Content, %
ASTM D2216 7.1

Shrinkage Limit, %
ASTM D427 25.5

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(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-5.5 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	20.9	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = ____ PI = ____

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method ____ Maximum Dry Density, pcf ____ Optimum Moisture, % ____

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity ____

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value ____

Other:

Moisture Content, % ASTM D2216 5.8

Shrinkage Limit, % ASTM D427 21.3

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LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-12.0 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	21.7	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils
ASTM D424- LL = PI =

Moisture - Density Relations
☐ ASTM D698- ; ☐ ASTM D1557- ; Method
Maximum Dry Density, pcf
Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material)
ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils
ASTM D2844- 'R' Value

Other:
Moisture Content, %
ASTM D2216 5.4

Shrinkage Limit, %
ASTM D427 18.6

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WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-16.0 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	24.5	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 8.5

Shrinkage Limit, % ASTM D427 19.9

Copies to: Client (3)

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WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

LABORATORY REPORT

PHYSICAL PROPERTIES OF SOILS

Client: Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009
Attn: Mr. Nick Karan

Job No. 2184J017
Lab/Invoice No. 2184W017
Date 9/11/84
Reviewed By

Project: Spook Hill Dam

Location: Mesa, Arizona — Sampled By: WTI — Date: 8/28/84

Type of Material: -- — Submitted By: WTI — Date: 8/29/84

Source of Material: Station 280-20.5 — Authorized By: FCD/Karan — Date: 8/28/84

Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification
3''		
2½''		
2''		
1½''		
1''		
¾''		
½''		
⅜''		
¼''		
No. 4		
8		
10		
16		
30		
40		
50		
100		
200	32.6	
Finer than 200 ASTM D1140-		

Soil Classification

Liquid Limit and Plasticity of Soils ASTM D424- LL = PI =

Moisture - Density Relations ☐ ASTM D698- ; ☐ ASTM D1557- ; Method Maximum Dry Density, pcf Optimum Moisture, %

Specific Gravity of Soils (minus No. 4 material) ASTM D854- Specific Gravity

Resistance 'R' Value of Compacted Soils ASTM D2844- 'R' Value

Other:

Moisture Content, % ASTM D2216 9.7

Shrinkage Limit, % ASTM D427 26.1

Copies to: Client (3)

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