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GEOTECHNICAL ENGINEERING INVESTIGATION

on

Roosevelt Irrigation District
System Improvements

in

Phoenix, Arizona

for

Simons, Li & Associates
120 W. Broadway Suite 170
Tucson, Arizona 85701

SLA Project No. AZ-MC-08

524 N. 6th Ave.
Tucson, Arizona
85705
(602) 623-7774

DESERT EARTH ENGINEERING

October 23, 1984
84-210

Registered Professional Engineer (Civil)
CERTIFICATE NO.
10296
ROBERT L.
SOGGE
Date Signed 10/23/84
ARIZONA, U.S.A.

consulting geotechnical engineers

October 23, 1984
84-210

Simons, Li & Associates
120 W. Broadway, Suite 170
Tucson, Arizona 85702

ATTN: John Lynch

RE: Geotechnical Engineering Investigation for Roosevelt Irrigation District System Improvements, Phoenix, Arizona
SLA Project No. AZ-MC-08

Gentlemen:

Desert Earth Engineering is pleased to submit this preliminary report covering design recommendations relating to foundation aspects on the above-captioned project. Our field investigation was conducted on September 19 and 20, 1984. Field testing results on selected samples obtained during the field investigation provide the basis for our engineering evaluation and our conclusions and recommendations.

A final report for this project is pending completion of the field investigation. However, an adequate number of boreholes has already been accomplished to provide preliminary design information. In particular, boreholes have been made at the locations of the siphon transition structures and the conveyor belt for the sand and gravel company.

Also, one borehole was made 40 feet into fill material in a gravel yard waste pit. This fill is a very fine sand with a silt content ranging from 20 to 60 %. Special measures will be necessary to ensure stability of the embanked channel where it passes over this fill material. These measures are discussed in this report.

Our firm should be consulted if conditions encountered in the field are substantially different from those described in this report. This office, as part of our design function, should be engaged to observe soil conditions as they are uncovered during foundation and substructure installation in order to

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524 North Sixth Avenue
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insure that the construction procedure is in accordance with the design recommendations. Such services are particularly necessary for monitoring the placement of engineered fill where required.

We wish to thank you for the pleasure of being associated with you on this project. If we can be of any further assistance, please call us.

Prepared and reviewed by:

Registered Professional Engineer (Civil)
CERTIFICATE NO.
10296
ROBERT L.
SOGGE
Date Signed 10/25/
ARIZONA, U.S.A.

R.L. Sogge, P.E.
Ralph Pattison

RLS/ajt
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Ft. Collins, Colorado 80522

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SITE DESCRIPTION

Project Location: The project is located along about .75 miles of the Roosevelt Irrigation District Flume where it crosses the Agua Fria River in Phoenix, Arizona. The Flume runs east-west between and parallel to Indian School Road and Thomas Road. The Agua Fria River runs north-south between and parallel to 107th Avenue and Dysart Avenue.

Topography: The topography is generally flat except the river channel which, when channelized, will be about 1000 feet wide and 15-20 feet lower than the surrounding grade.

Water Drainage: The Agua Fria River flows south. Flume water flows west.

Vegetation Coverage: The majority of the channel traverse is free of vegetation, other than small scrub. An exception is the area of the gravel yard waste pits which is overgrown with tall reeds. There are also a few small trees along the alignment.

PROPOSED DEVELOPMENT

Structure: An embanked channel is to replace a metal elevated flume. Channel water will be siphoned under the Agua Fria River. A portion of the channel will pass over gravel yard waste pits. Bearing capacities will be given for these areas, siphon transition structures and a culvert spanning a gravel yard conveyor belt.

Loads: Embarked material will impose maximum loads of 2000 pounds per square foot for 15 feet of embankment. Footings for the conveyor culvert will support loads of 15 kips per lineal foot.

SCOPE OF WORK

The purpose of our work on this project is to conduct a field investigation and perform laboratory testing on the sampled soils in order to provide recommendations in report form for design of the foundation system. The report includes a discussion of the most suitable foundation type, depth of foundation embedment, allowable soil bearing pressures, estimated settlement, collapse or expansion potentials, and recommendations on earthwork. Also included are discussions on site and foundation preparation and on surface and groundwater control.

FIELD INVESTIGATION

No. of Completed Test Borings: 7

Location: See Site Plan, Figure 1

Date Drilled: September 19 and 20, 1984

A subsurface field investigation was conducted at the site using a Central Mining Equipment Model 55 drill rig, equipped with 6 5/8 inch OD, 3 1/4 inch ID hollow stem augers, to drill the bore holes. Soil sampling was achieved using a 2 inch OD, Split Spoon (SS) sampler, a 3 inch OD ring sampler, or bagged samples of auger cuttings.

The driving of the split spoon provides a measure of a soil´s strength through Standard Penetration Test (SPT) blow count (N) values expressed in blows/ft. The disturbed samples provided can be used for moisture and soil property determinations. The ring sampler also yields penetration resistance data and provides "undisturbed" samples of cohesive fine grained soils for expansion or collapse tests. When blow counts are determined by the ring sampler using the same SPT driving energy as for the split spoon, penetration resistances greater than the N-values will result due to its larger area. A penetrometer consisting of a 2 inch OD bull-nose sampler is also used to determine in-situ soil density. Penetration values from this device, expressed in blows/ft, also approximately correspond to split-spoon N values. The particular correspondence can be seen where both values were determined on the same soil strata. A blow count chart with density-consistency relations is presented in Appendix A.

Boring logs containing descriptions of the materials encountered in the subsurface investigation of the site are presented in Appendix A. A presentation of the penetration resistance values is also included on the boring logs. A soil profile for the project site is presented in Figure 2. This soil profile is a generalization of the subsurface soils found at each bore hole. It assumes that the overall soil conditions do not vary appreciably from those found at specific bore locations.

LABORATORY TESTING RESULTS

Grain Size Determination - Results in Appendix B.

Summary of Gradation and Plastic Index Tests

Boring No.	Depth (ft)	% Passing #200 Sieve	Liquid Limit	Plastic Index	USCS Symbol
B-3	4.5-6	8	NP	NP	SW
B-3	9.5-11	5	NP	NP	SP
B-4	14-15.5	4	NP	NP	SP
B-6	9.5-11	6	NP	NP	GP-GM
B-7	9.5-11	5	NP	NP	SP
B-10	10-11.5	20	NP	NP	SM
B-10	30-31.5	61	NP	NP	ML
Waste pit surface material	0-1	100	93	65	CH

CONCLUSIONS AND RECOMMENDATIONS

General Conclusions

Testing from seven boreholes along the alignment of the embarked channel indicates that no special problems in bearing

capacity will be encountered. An exception is the area of the gravel yard waste pit which will be discussed in a separate section below. Load-supporting soils along the rest of the alignment are sands with little or some silt. These sands are medium dense to dense, and any settlement that is induced by loading will occur during construction.

Footings for siphon transition structures can be designed for a bearing capacity of 2500 pounds per square foot when founded at least eighteen inches below the surface. Footings for a culvert over the conveyor belt on the east side of the river can be designed for a bearing capacity of 4000 pounds per foot when founded at the approximate elevation of the conveyor belt. At the edge of eccentrically loaded footings this bearing capacity can be increased to 5000 pounds per square foot. This eccentricity would result from the soil overburden existing on one side of a footing only.

Gravel-yard Waste Pit

One borehole was accomplished on a pad constructed into the partly filled waste pit. Information from gravel-yard officials indicates that this pit was originally 60 to 70 feet deep. At the time of our investigation this pit was filled to within five feet of native grade. Our borehole, to a depth of 40 feet, shows the fill in this pit to be mostly very fine sand with a silt content varying from 20 to 60 percent. Although no significant amounts of clay were encountered during the boring, examination of the edge of the built-up drilling pad shows evidence of a

layer of very plastic clay. The reject material used to construct the drilling pad had apparently pushed this clay up around the edges. The layer is at most a few feet deep and should be removed from the surface in any areas that will support the embanked channel.

The area of the original pit extends from approximately Station 11+80 to Station 20+60 on the embanked channel alignment. A dike perpendicular to the alignment at about Station 18+00 now divides the pit. West of this dike the pit is full to Elevation 1003 and overgrown with reeds. East of the dike the pit is not yet full and contains standing water to depths ranging from 2 to 8 feet and more. Water level is approximately Elevation 1001. These two separate areas will require different treatment to achieve stability of the embanked channel.

Either one of two general approaches to stabilization may be selected. One requires placement of geotextile fabric over the waste pond fill material before construction of the embarked channel begins. This fabric must extend from five feet south of the waste pond´s southern limit to a point ten feet beyond the toe of the embanked channel.

The second approach is to densify waste-pond fill material. This densification must be achieved by deep-vibration of the fill material after the embanked channel is in place. This densification would be subject to verification through field measurement of Standard Penetration Test blow counts. Monitoring of settlement during densification is also recommended.

The use of geotextile fabric presents a particularly good solution for the area west of the dike. Fill here is to an

elevation of 1003 ft. This area must be cleared of vegetation before covering it with the fabric. The fabric must extend to ten feet beyond the intersection of the slope line but does not need to go below the slope threshold. A cross-section of this area is shown in Figure 3.

The area east of the dike must be dewatered before the geotextile fabric can be placed. If construction-area dewatering only is desired, a dike should be placed parallel to the alignment of the channel and at least eighty feet from the head of the slope. This distance is necessary to ensure that the required area of fabric coverage is achieved.

Side slopes for the embanked channel may be constructed at an inclination of 2:1 (horizontal to vertical). Thresholds will also be necessary to stabilize these slopes. In the area west of the dike, Stations 18+00 to 20+60, this threshold should be constructed to Elevation 1007 and extend at least twenty-two feet beyond the toe of the slope. (See Figure 3)

East of the dike the threshold should be to Elevation 1004 and also must extend to at least twenty-two feet beyond the toe of the slope. Side slopes of this threshold should be constructed at an inclination of 3:1 (horizontal to vertical). Any material beyond this distance may be kept in place as it serves to further stabilize the embanked channel. For a cross-section of this portion of the alignment, Stations 11+80 to 18+00, see Figure 4.

Construction specifications for work in the area of the waste pits are as follows. Material used to construct the slope

thresholds should meet the specifications given in Appendix C and be compacted to 95% of Standard Proctor Optimum Density (ASTM D 698). A material that does not meet these specifications, such as gravel-pit reject rock, may be used if compaction is monitored by a qualified soils engineer.

If geotextile fabric is used as discussed above, no vibratory densification of waste-pit fill material will be required. However, if this fabric is not used, the material must be deep-vibrated after embankment loads are in place. This vibration must be performed to achieve minimum Standard Penetrometer blow counts of ten per foot in this stratum from the surface to depths of thirty feet. A recommended technique for achieving this vibratory densification is the use of casing-driving equipment. Spacing should be at six-foot intervals throughout the area that is to support embanked channel loads.

It is our understanding that the embanked channel is to be constructed of materials obtained from the Agua Fria riverbed. This soil is primarily well-graded sand with trace gravel; an embankment composed of this material can be designed with slopes of 2 horizontal to 1 vertical if the material is compacted to 95% of Proctor Maximum Dry Density. Any slopes within one foot of water level in the area of the undrained pond should be formed at an inclination of 3 horizontal to 1 vertical

Foundation

Spread footings are recommended for support of siphon transition structures and for the culvert over the conveyor belt. Supporting Foundations Soil - The embanked channel, the siphon

transition structures and the conveyor belt culvert will be supported by medium dense to dense fine sands with trace silt; an exception is that portion of the channel passing over the gravel-yard waste pit which will be supported by loose fill. The invert below the river will be supported by dense well-graded sands and dense sand-gravel-cobble layers.

Allowable Bearing Capacity - Footings for the conveyor culvert may be designed for a bearing capacity of 4000 pounds per square foot. The bearing capacity can be increased to 5000 psf at the edge of eccentrically-loaded footings. Footings for siphon transition structures may be designed for a bearing capacity of 2500 pounds per square foot for footings embedded at least eighteen inches into native soils. The footing depth is measured from the top of the lowest adjacent grade to the bottom of the footing.

The allowable soil-bearing values specified may be increased one-third when considering wind or seismic forces either acting alone or when combined with vertical loads. The allowable bearing capacity may be increased one-fourth below the toes of retaining walls.

Approximate Total Settlement - Total settlement of structure footings will be less than one inch, except in the waste-pit area. Here, immediate settlement as high as two-feet may occur during construction. However, post construction settlement will be less than two inches.

Approximate Differential Settlement - Differential settlement will be less than half of total settlement.

Collapse Potential - Collapse potential is negligible.

Swell Potential - Swell potential is negligible.

Lateral Foundation Pressures -

Active Sliding Pressure	35 pcf E.F.P.
Passive Resistance Pressure	300 pcf E.F.P.
Base Friction Coefficient (poured on grade)	$\tan 20^{o}$
Foundation Toe Pressures	Allowable x 1.25

E.F.P. = Equivalent Fluid Pressure

The pressure distribution behind a retaining wall depends on the deformation pattern of the wall. If wall movement is restrained near the top, pressures greater than the active condition, approaching K_o conditions, or 60 pcf E. F. P. are possible.

Passive and base friction resistance can be combined to resist sliding. A factor of safety of 1.5 should be used for sliding.

Site and Foundation Preparation

Embankment Materials - Embankment materials will be well-graded sands with trace gravel.

Required Fill Height - Embankment height will not exceed twenty feet.

Fill Material Source- Fill materials will be obtained in the bed of the Agua Fria River.

In view of the soils encountered, the following general procedure is recommended for preparation of the building site for support of foundation elements and interior or exterior slabs-on-grade.

- Prepare the surface by stripping and removing all existing debris, vegetation, etc. from the project site.
- Any soil disturbed during site cleaning must be replaced and recompacted.
- Engineered fill shall be placed in lifts no

greater than 8 inches loose and compacted to 95% of Standard Proctor Density.

- Native material supporting footings should be compacted from the surface.

- Recommended compaction equipment for fill is either conventional vibratory, sheepfoot or rubber-tired rollers. The backfill around footings and foundation wall must be compacted. Jumping jacks or vibrating turtles can be used in tight areas such as foundation trenches and adjacent walls.
- Engineered fill or native soil beneath all peripheral structures such as pipelines, sidewalks, exterior slabs and pavements, shall be compacted to 90% of the Standard Proctor density.
- Engineered fill not supporting a structure, such as that placed above a footing, shall be compacted to 90% of Standard Proctor density.
- In no case shall compaction be attempted using water settling.
- All structures should be set back a distance of approximately 8 ft from the edge of slopes. This requirement insures a stable foundation in areas such as the face of slopes where compaction is difficult to achieve.

- The top material should have sufficient binder to prevent erosion by wind, water, or traffic.

Summary of Compaction Requirements

Use	Min % Compaction*
Beneath foundation components and slabs-on-grade	
exposed in-situ subgrade soil	95%
engineered fill	95%
ABC (aggregate base course)	95%
Fill above footing bottom	90%
Beneath roadways	95%
Beneath exterior slabs, pavements and pipelines	
exposed in-situ subgrade soil	90%
engineered fill	90%
ABC	95%

* These percentages are of Standard Proctor (ASTM D 698)

Surface Water and Groundwater Control

The material at this site is such that it will not be affected by surface and subsurface groundwater. Nevertheless, it is greatly recommended that surface water runoff be controlled to

prevent ponding and infiltration into the foundation soil. The grade of the surface shall be sloped away from structures as soon as backfill around the walls and footings are in place.

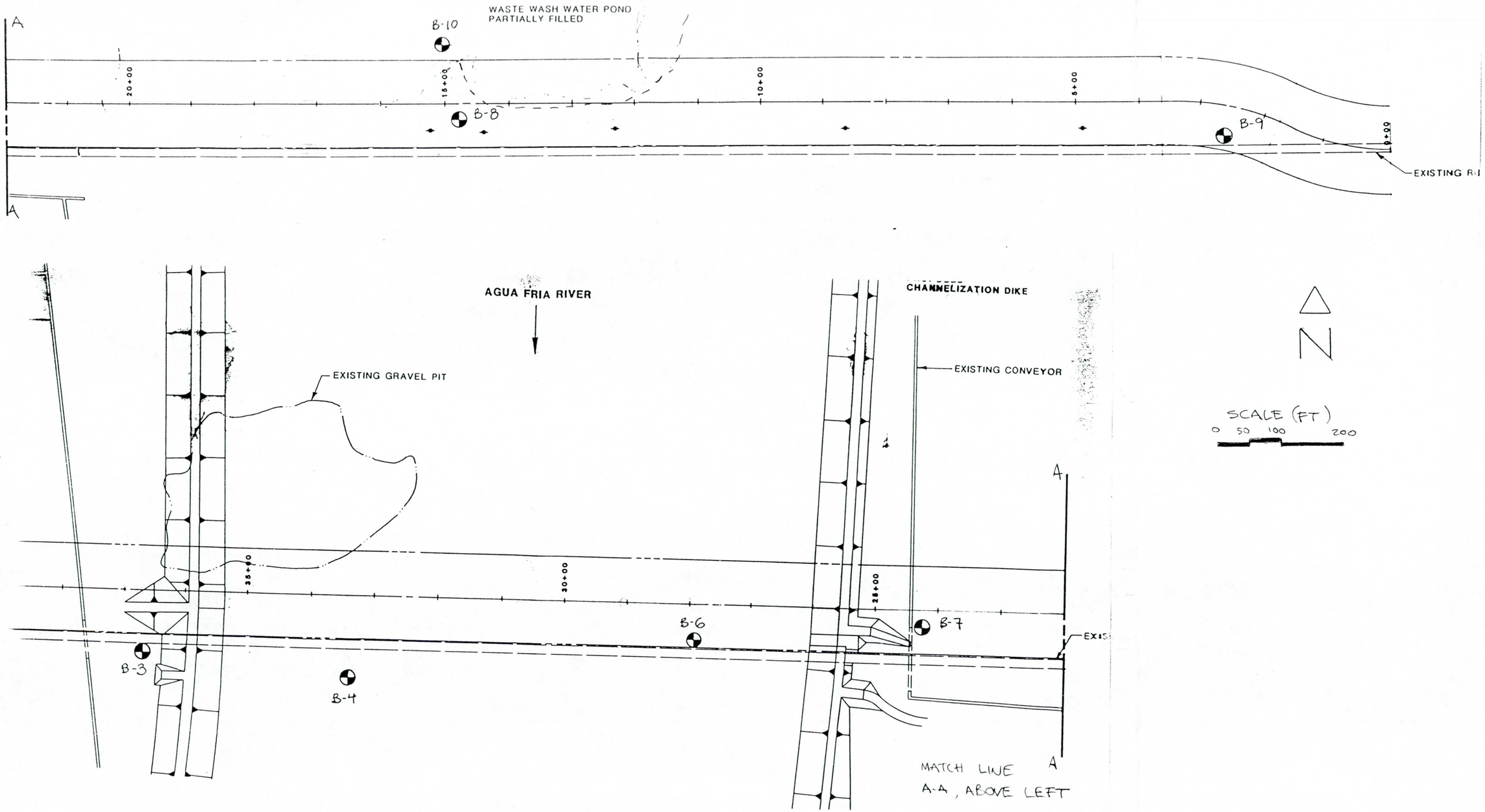
During the construction period water should not be allowed to enter any trenches for footings or other locations which will support structural components. If water softening of the soil occurs the softened soil should be removed.

LIMITATIONS

The field and laboratory testing relevant to this report was performed, unless otherwise noted, by Desert Earth Engineering. This work was performed in accordance with generally accepted engineering principles and practices.

This report assumes the subsurface conditions are as found in the test bore holes. If any conditions other than those assumed are encountered when making excavations, the owner or his representative should notify the Soil Engineer immediately so that supplementary recommendations can be made.

This report is issued with the understanding that it is the responsibility of the owner or his representative to ensure that the applicable provisions of the recommendations contained herein are called to the attention of the Structural Engineers and incorporated into the plans. Also, it is assumed that the necessary steps are taken to see that the contractor and subcontractors carry out such provisions in the field.

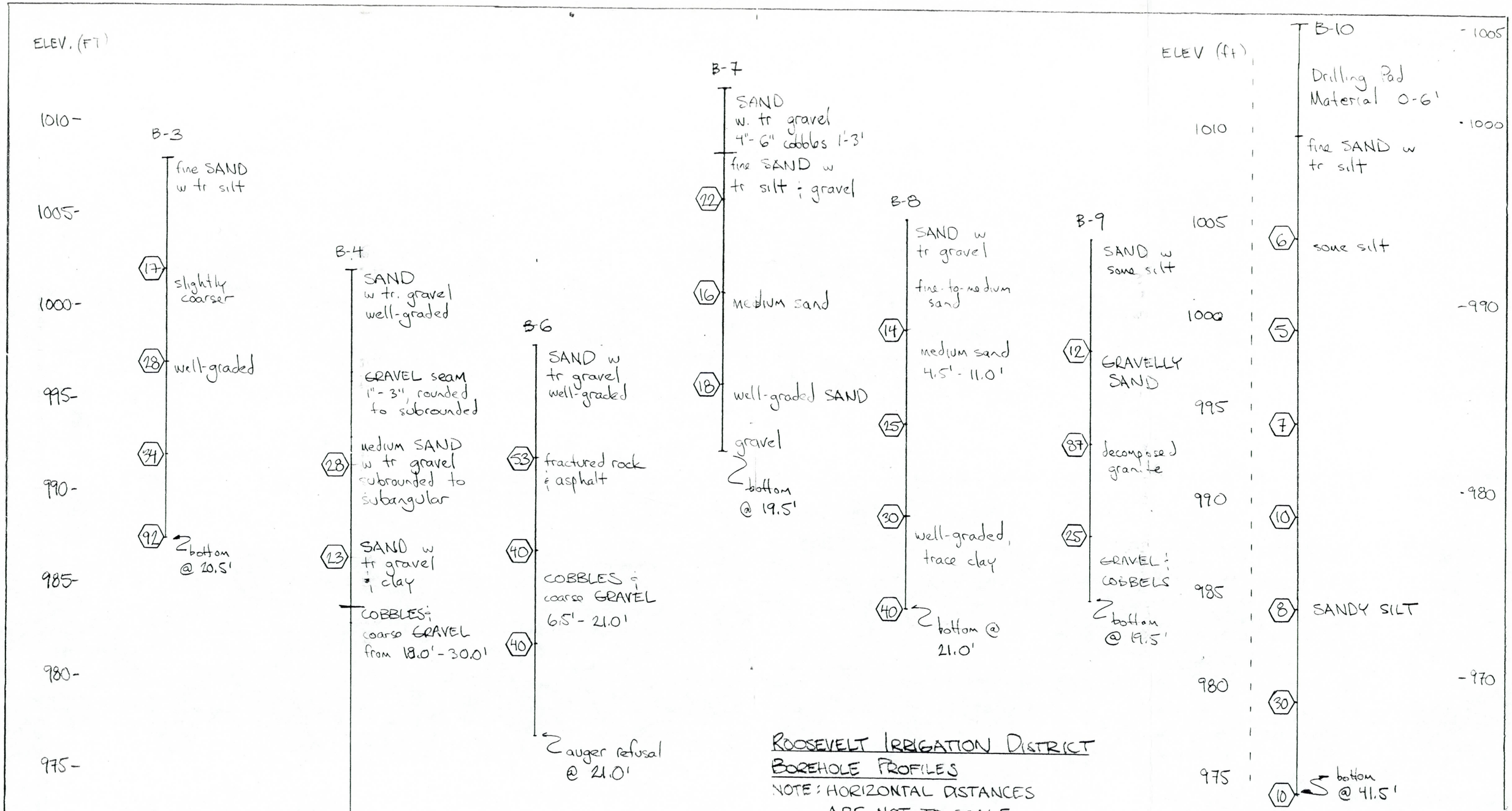


ROOSEVELT IRRIGATION DISTRICT SYSTEM IMPROVEMENTS

BOREHOLE LOCATIONS, DRILLED SEPT 19 & 20, 1984

Desert Earth Engineering
consulting geotechnical engineers

Drawn by:	Date	Checked by:	Date
RMP	1 OCT 84	R-1	10/17/84
Sheet of		Job No. 84-210	Figure No. 1

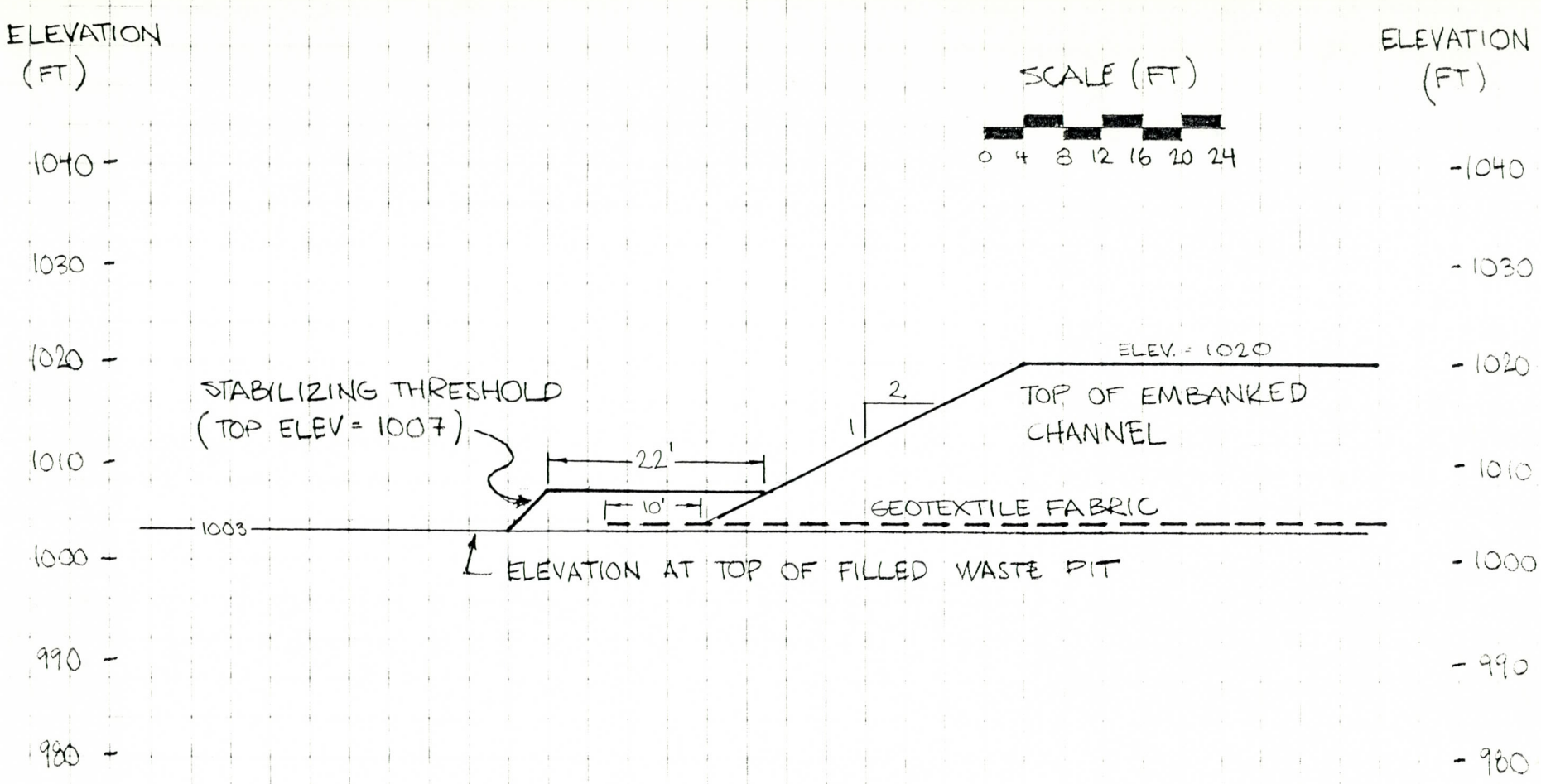


ROOSEVELT IRRIGATION DISTRICT
BOREHOLE PROFILES
NOTE: HORIZONTAL DISTANCES ARE NOT TO SCALE

(30) STANDARD SPLIT-SPOON PENETROMETER BLOWS/FT

Desert Earth Engineering
consulting geotechnical engineers

Drawn by: RMP	Date 1 Oct 84	Checked by:	Date
Sheet of	Job No. 84-210	Figure No. 2	



CROSS SECTION OF EMBANKMENT OVER FILLED WASTE PIT

Desert Earth Engineering consulting geotechnical engineers		
Drawn by: RMP Date 23 OCT 84	Checked by: KJ Date 10/23/84	
Sheet of	Job No. 84-210	Figure No. 3

APPENDIX A

Soil Boring Logs

DRILLING, SAMPLING, AND FIELD TESTING EQUIPMENT

DRILLING: The drilling is performed using a Central Mining Equipment CME-55 drill rig capable of auger drilling, rotary wash drilling, and rock coring. Auger drilling is performed using 6 5/8" OD x 3 1/4" ID hollow-stem augers with carbide-tipped teeth. Rotary wash drilling employs a tricone gear bit and core drilling a diamond bit. These latter methods use high pressure water as a drilling fluid.

SAMPLING: Disturbed samples are achieved using a standard 2" OD x 1 3/8" ID split spoon sampler. The ID dimension is that of the inner brass liner. "Undisturbed" samples of cohesive fine-grained soils are obtained using a ring sampler of 3" OD x 2.416" ID. The series of 1" long, 2.416" ID brass rings in the sampler have a 2.5" OD and therefore readily fit into laboratory direct-shear and consolidation equipment.

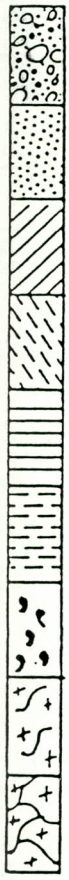
In very soft cohesive soils, thin-walled Shelby tube samples can be taken. Rock cores are obtained from diamond-core drilling.

FIELD TESTING: An approximation of the soil´s density and consistency, from which strength estimates can be made, is obtained using the penetration resistance to driving of the samplers. The Standard Penetration Test (SPT) N-value is the number of blows to drive a standard 2" OD x 1 3/8" ID split spoon sampler 1 ft. using a 140-pound weight dropping 30". Where driving resistance is difficult, blows/inches-driven values are presented.

A 3" OD ring sampler will generally have a larger blow count than will the split spoon sampler if the same driving energy is used for both.

Continuous-penetration resistance can be obtained using a 2" OD bull-nose penetrometer. When using the SPT driving energy the blow counts on a bull-nosed penetrometer are approximately equal to or greater than the N-value (blows/ft) resistance obtained.

METHOD OF SOIL CLASSIFICATION



GRAVEL (GP,GW)

SAND, SANDY (SP,SW,S)

SILT (ML,MH)

SILTY (M)

CLAY (CL,CH)

CLAYEY (C)

ORGANIC MATERIAL (OL,OH,PT)

WEATHERED TO DECOMPOSED BEDROCK

BEDROCK

CLASSIFICATION	U.S. Standard Sieve Size
BOULDERS	Above 12"
COBBLES	12" to 3"
GRAVEL Coarse Fine	3" to No.4 3"to3/4" 3/4"toNo.4
SAND Coarse Medium Fine	No.4toNo.200 No.4toNo.10 No.10toNo.40 No.40toNo.200
SILT & CLAY	Below No.200

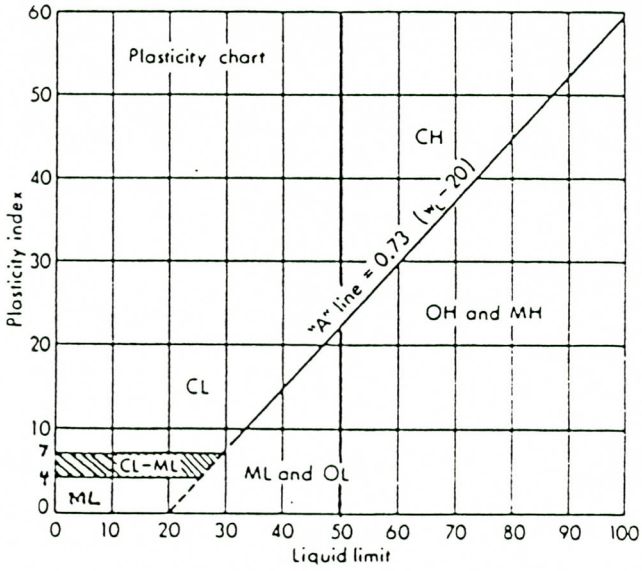
GRAIN SIZE CHART

Coarse Grained Scale
(50% retained on #200 sieve)

Adjective	%
with trace	1-12
with some	12-30
add "y" (ey)	> 30

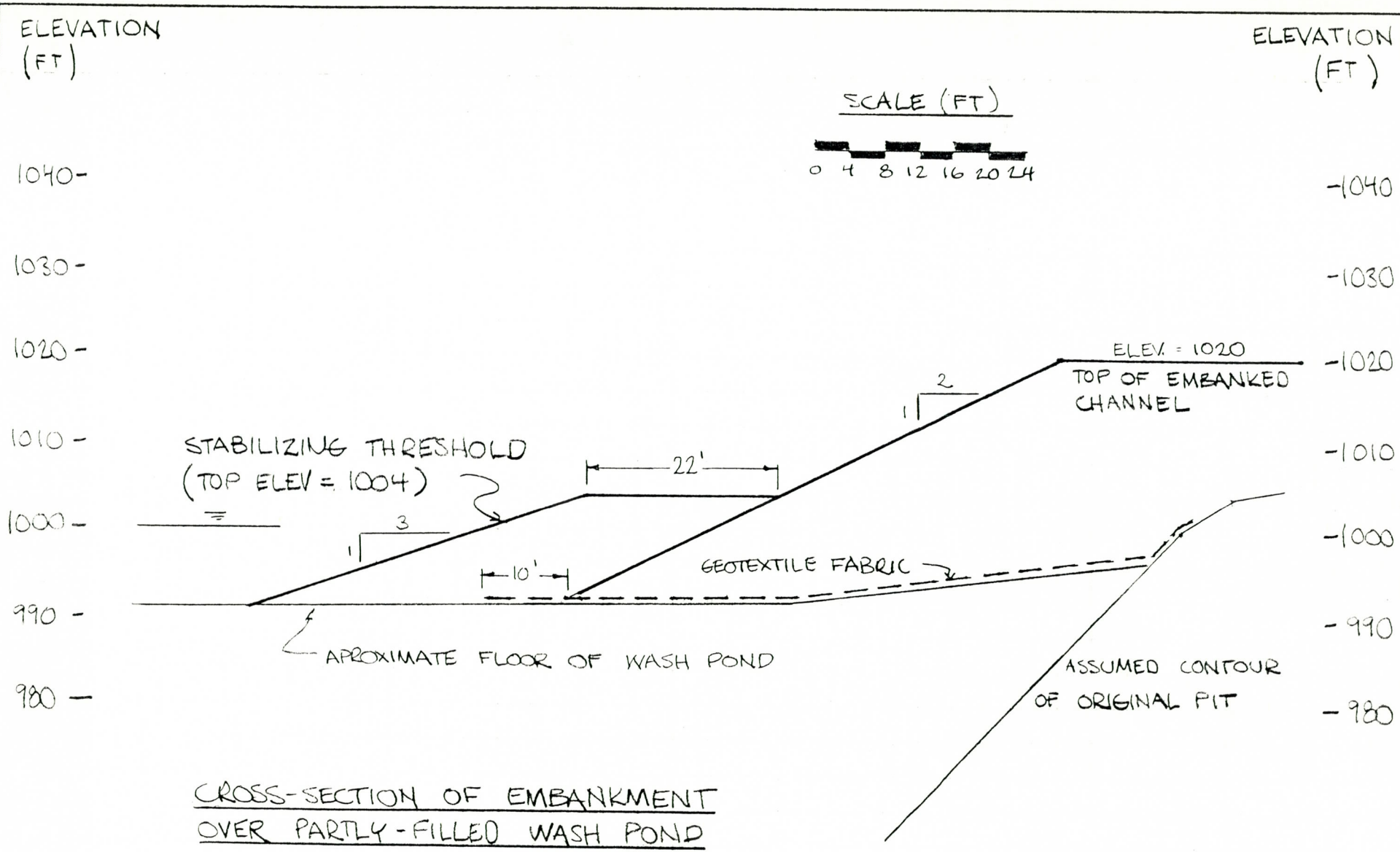
P = poorly graded
W = well graded

Fine Grained Soils
(50% passing #200 sieve)



L = low compressibility
H = high compressibility

P.I.	Adjective	Silt (ML & MH)	Clay (CL & CH)	Organics (OL & OH)
< 1	non-plastic	--	--	--
1-10	slightly plastic	--	silty	--
10-20	medium plastic	clayey	silty to no adj.	silty
20-40	plastic	clayey	--	clayey
> 40	very plastic	clayey	--	--



CROSS-SECTION OF EMBANKMENT OVER PARTLY-FILLED WASH POND

Desert Earth Engineering consulting geotechnical engineers		
Drawn by: RMP Date 23 OCT 84	Checked by: RJ Date 10/23/84	
Sheet of	Job No. 84-210	Figure No. 4

BLOW COUNT - DENSITY RELATIONS

Cohesionless coarse-grained soils

Density	Nspt *
very loose	< 4
loose	4 - 10
medium dense	10 - 30
dense	30 - 50
very dense	> 50

Cohesive fine-grained soils

For cohesive fine-grained soils, design is usually governed by the moisture content, plasticity, consolidation, compressibility, or swell properties. Therefore, field penetrometer readings giving an indication of strength as characterized by the consistency or cohesion of a soil can be misleading and are not presented here.

The blows to drive a 3" OD x 2.42" I.D. ring sampler 1 ft will be greater than for a split spoon sampler if the same driving energy is used for both.

* Nspt is the Standard Penetration Test (SPT) blows/ft resistance using a 2" OD x 1 3/8 I.D. sampler (ASTM D1586).

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JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING: Sta. 36+60

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

SAMPLING METHOD: Split-spoon Penetrometer

CASING DEPTH:

BORING NO.: B-3

SHEET: 1 OF 1

ENGINEER: R.M.P.

TIME: 1:10

DATE: 9/19/84

DATUM: ELEVATION 1008

SURFACE CONDITIONS: Flume maintenance road

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	
			0			(SP) brown fine SAND w/trace silt; dry
			1			
			2			
			3			
			4			
SS	18/16	9/8/9	5			
			6			slightly coarser, trace gravel
			7			gravel or small cobbles
			8			
			9			
S	18/15	10/17/11	10			(SW) sand well-graded, fractured quartz in sampler
			11			
			12			
			13			
			14			
S	18/18	25/15/19	15			
			16			
			17			
			18			
			19			bottom @ 20.5 feet
SS	12/2	42/50	20			fractured rock in sampler

desert earth engineering

JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING: Sta. 33+40

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

SAMPLING METHOD: Split-spoon Penetrometer

CASING DEPTH:

BORING NO.: B-4

SHEET: 1 of 2

ENGINEER: R.M.P.

TIME: 12:00

DATE: 9/19/84

DATUM

ELEVATION 1002

SURFACE CONDITIONS: River bed

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	
			0			(SW) brown SAND w/trace of gravel; moist loose, well graded
			1			
			2			
			3			
			4			
			5			
			6			gravel seam (1in.-3in.); rounded to subrounded
			7			
			8			
			9			(SP-SW) medium SAND w/trace gravel; moist subrounded to subangular
SS	18/18	8/14/14	10			
			11			
			12			
			13			
			14			(SW) brown-red SAND w/trace gravel and clay; moist, subangular, nonplastic
SS	18/12	23/14/9	15			rock at 14.0 ft in sampler
			16			cobble and coarse gravel seam; rounded to subrounded
			17			
			18			
			19			split-spoon refusal at 19.0 ft, cobble and gravel layer
SS	0		20			

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JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

SAMPLING METHOD: Split-spoon Penetrometer

CASING DEPTH:

BORING NO. B-4

SHEET 2 OF 2

ENGINEER R.M.P.

TIME 12:00 to 1:00

DATE 9-19-84

DATUM

ELEVATION

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	SURFACE CONDITIONS
			20			cobbles and coarse gravel; subrounded to subangular
			21			
			22			very rocky drilling from 19.0 to 30.0 ft
			23			
			24			
			25			very slow drilling
			26			large cobbles
			27			
			28			
			29			
			30			
			1			auger refusal at 30.0 ft, boulder
			2			
			3			
			4			
			5			
			6			
			7			
			8			
			9			
			0			

desert earth engineering

JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING: Sta. 27+90

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

SAMPLING METHOD: Split-spoon Penetrometer

CASING DEPTH:

BORING NO.: B-6

SHEET: 1 OF 2

ENGINEER: R.M.P.

TIME: 6:20

DATE: 9-20-84

DATUM

ELEVATION 998

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	SURFACE CONDITIONS
						Riverbed
			0			(SW) brown SAND w/trace gravel; moist, loose well-graded, subangular to subrounded.
			1			
			2			
			3			
			4			
SS	18/10	27/24/29	5			fractured rock and asphalt in sampler
			6			coarse gravel and small cobbles; rounded to subrounded
			7			
			8			
			9			cobbles
SS	18/12	23/18/22	10			trace clay, fractured rock in sampler
			11			
			12			rocky drilling; cobbles and gravel
			13			
			14			
SS	18/12	19/17/23	15			rocks in sampler
			16			slow drilling, gravel and cobbles
			17			
			18			
			19			very rocky
			20			

desert earth engineering

JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

BORING NO.: B-6

SHEET: 2 OF 2

ENGINEER: R.M.P.

SAMPLING METHOD: Split-spoon Penetrometer

TIME:

DATE: 9-20-84

CASING DEPTH:

DATUM

ELEVATION

SURFACE CONDITIONS

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	
			20			no sample taken, rocky drilling
			21			
			22			Auger refusal at 21.0 ft. boulder
			3			
			4			
			5			
			6			
			7			
			8			
			9			
			0			
			1			
			2			
			3			
			4			
			5			
			6			
			7			
			8			
			9			
			0			

desert earth engineering

JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING: Sta. 24+40

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

SAMPLING METHOD: Split-spoon Penetrometer

CASING DEPTH:

BORING NO.: B-7

SHEET: 1 OF 1

ENGINEER: R.M.P.

TIME: 7:30

DATE: 9-20-84

DATUM:

ELEVATION: 1012

SURFACE CONDITIONS: Flume maintenance road

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	
			0			brown SAND w/trace gravel
			1			many 4-6in. cobbles 1ft-3ft
			2			
			3			more gravel
			4			(SP) brown fine SAND w/trace silt and trace gravel; medium density, moist, nonplastic
SS	18/18	11/11/11	5			
			6			
			7			
			8			
			9			
SS	18/18	8/8/8	10			(SP) brown medium SAND; moist, medium dense
			11			
			12			
			13			
			14			
SS	18/18	9/9/9	15			(SW) brown SAND w/trace gravel; moist well-graded, subrounded to subangular, medium dense
			16			
			17			
			18			
			19			slightly gravelly split spoon refusal @ 19.5ft.
			20			bottom at 19.5 ft

desert earth engineering

JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING: Sta. 14+70

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

SAMPLING METHOD: Split-spoon Penetrometer

CASING DEPTH:

BORING NO.: B-8

SHEET: OF

ENGINEER: R.M.P.

TIME:

DATE: 9-20-84

DATUM: ELEVATION 1005

SURFACE CONDITIONS: Flume maintenance road

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	
			0			(SW) brown SAND w/trace gravel and silt; dry loose
			1			
			2			less well-graded, slightly moist
			3			(SP) brown F-M SAND; dry, medium dense
			4			
SS	18/18	4/6/8	5			medium sand
			6			
			7			
			8			
			9			
SS	18/18	12/12/13	10			medium sand
			11			
			12			
			13			
			14			
SS	18/18	11/12/18	15			(SW) well-graded; trace clay
			16			
			17			
			18			
			19			
SS	18/18	10/13/27	20			bottom at 21.0 ft

desert earth engineering

JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING: Sta. 2+70

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

SAMPLING METHOD: Split-spoon Penetrometer

CASING DEPTH:

BORING NO.: B-9

SHEET: OF

ENGINEER: R.M.P.

TIME: 9:00

DATE: 9/20/84

DATUM: ELEVATION 1004

SURFACE CONDITIONS: Flume maintenance road

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	
			0			(SM) brown SAND w/some silt; moist, slightly plastic
			1			
			2			
			3			
			4			
SS	18/18	3/4/8	5			
			6			(SW-SC) brown GRAVELLY SAND w/trace clay; moist, slightly plastic, rock fragments in sampler
			7			
			8			slightly more clay
			9			
SS	18/18	28/44/43	10			purple decomposed granite (10ft - 13ft)
			11			
			12			
			13			(SW) brown SAND w/trace gravel; moist medium dense, subrounded to subangular
			14			
			15			
SS	18/14	7/10/15	16			rocky drilling - gravel
			17			
			18			coarse gravel and cobbles - subrounded to subangular
			19			
			20			bottom at 19.5, no sample taken - too rocky

desert earth engineering

JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING: Sta. 15+00, 160N of Flume

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

SAMPLING METHOD: Split-spoon Penetrometer

CASING DEPTH:

BORING NO.: B-10

SHEET: 1 OF 2

ENGINEER: R.M.P.

TIME: 11:30

DATE: 9/20/84

DATUM

ELEVATION 1005

SURFACE CONDITIONS: Pad constructed of gravel yard reject material

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	
			0			COBBLES and coarse GRAVEL: loose, subrounded to rounded
			1			
			2			
			3			
			4			CLAY matrix; saturated, plastic
			5			
			6			top of deposition layer:fine SAND w/trace silt, occasional boulders; saturated, loose
			7			
			8			
			9			
			10			(SM) brown fine SAND w/some SILT and trace clay; loose saturated
SS	18/18	3/3/3	11			
			12			
			13			
			14			
			15			(SM) brown fine SAND 1/some silt, some varved clay; loose, saturated
SS	18/18	2/2/3	16			
			17			
			18			
			19			
			20			

desert earth engineering

JOB NO.	CLIENT	LOCATION
84-210	Simons, Li	RID

LOCATION OF BORING

DRILLING METHOD & EQUIPMENT: CME-55 Drill Rig equipped with 6 5/8" OD 3 1/4" ID hollow-stem continuous flight augers

SAMPLING METHOD: Split-spoon Penetrometer

CASING DEPTH:

BORING NO. B-10

SHEET 2 OF 2

ENGINEER R.M.P.

TIME:

DATE 9/20/84

DATUM: ELEVATION:

SURFACE CONDITIONS:

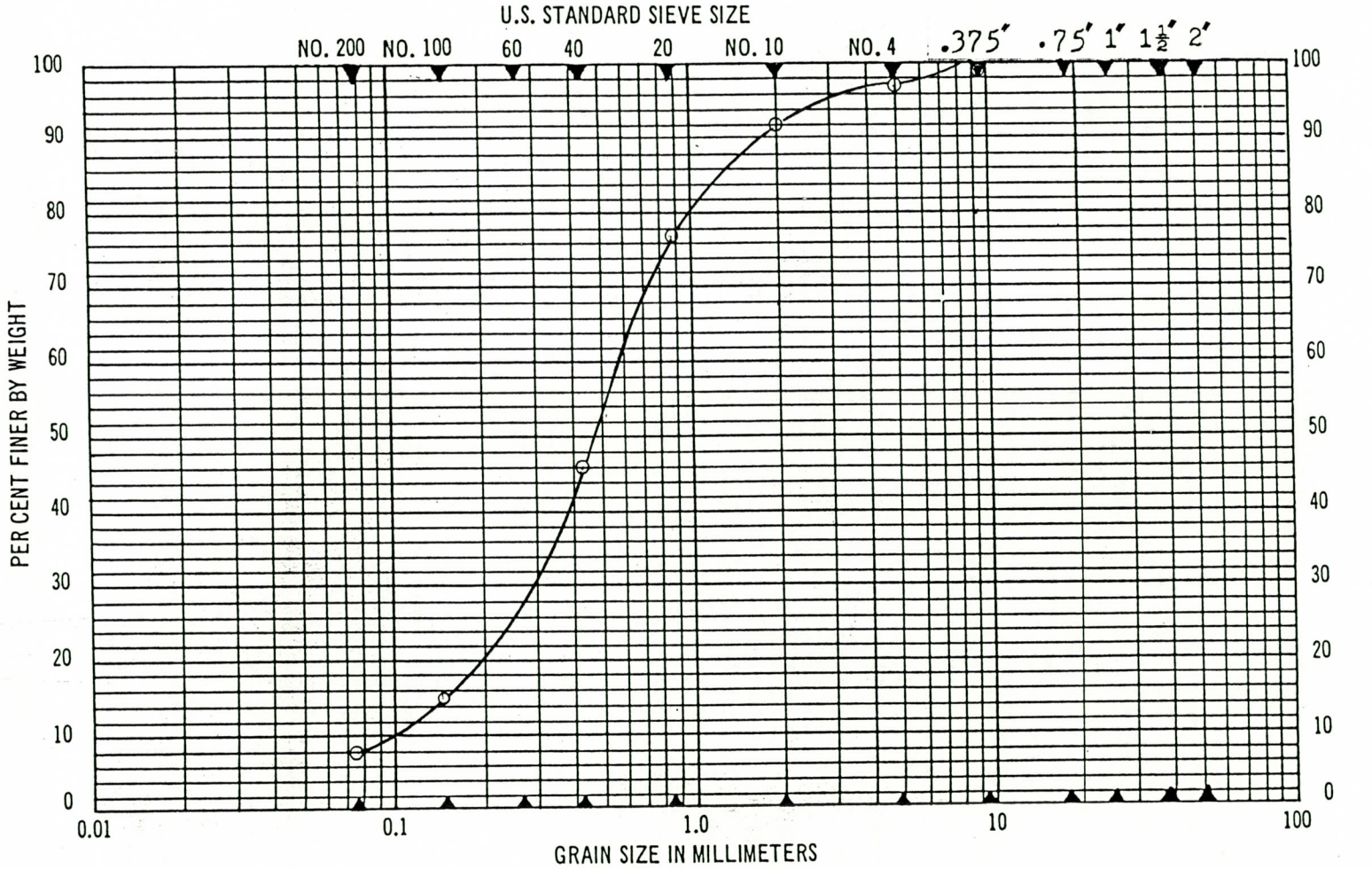
SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	BLOWS/6" SAMPLER	DEPTH IN FEET	BULL-NOSE BLOWS/FT	SOIL GRAPH	
			20			(SM) very fine SAND w/some silt saturated, loose
SS	18/18	3/4/3	21			
			22			
			23			
			24			
			25			
SS	18/18	3/5/5	26			
			27			
			28			
			29			(ML) fine SANDY SILT w/trace clay; moist loose saturated
			30			
SS	18/18	3/3/5	31			
			32			
			33			
			34			
			35			(SW) fine SAND w/some silt, dense, moist but not saturated
SS	18/18	10/12/18	36			
			37			
			38			
			39			bottom at 41.5ft split spoon sample 40-41.5ft
SS	18/18	2/4/6	40			(SP) fine SAND w/some silt, moist, loose

APPENDIX B

Laboratory Results

JOB NO. 84-210 BY RMP DATE 27 Sep 84

KEY	BORING	DEPTH	ELEV.	SOIL CLASSIFICATION
	B-3	4.5-6		(SP) fine-to-medium SAND with trace clay



SILT OR CLAY	SAND			GRAVEL		*
	FINE	MEDIUM	COARSE	FINE	COARSE	

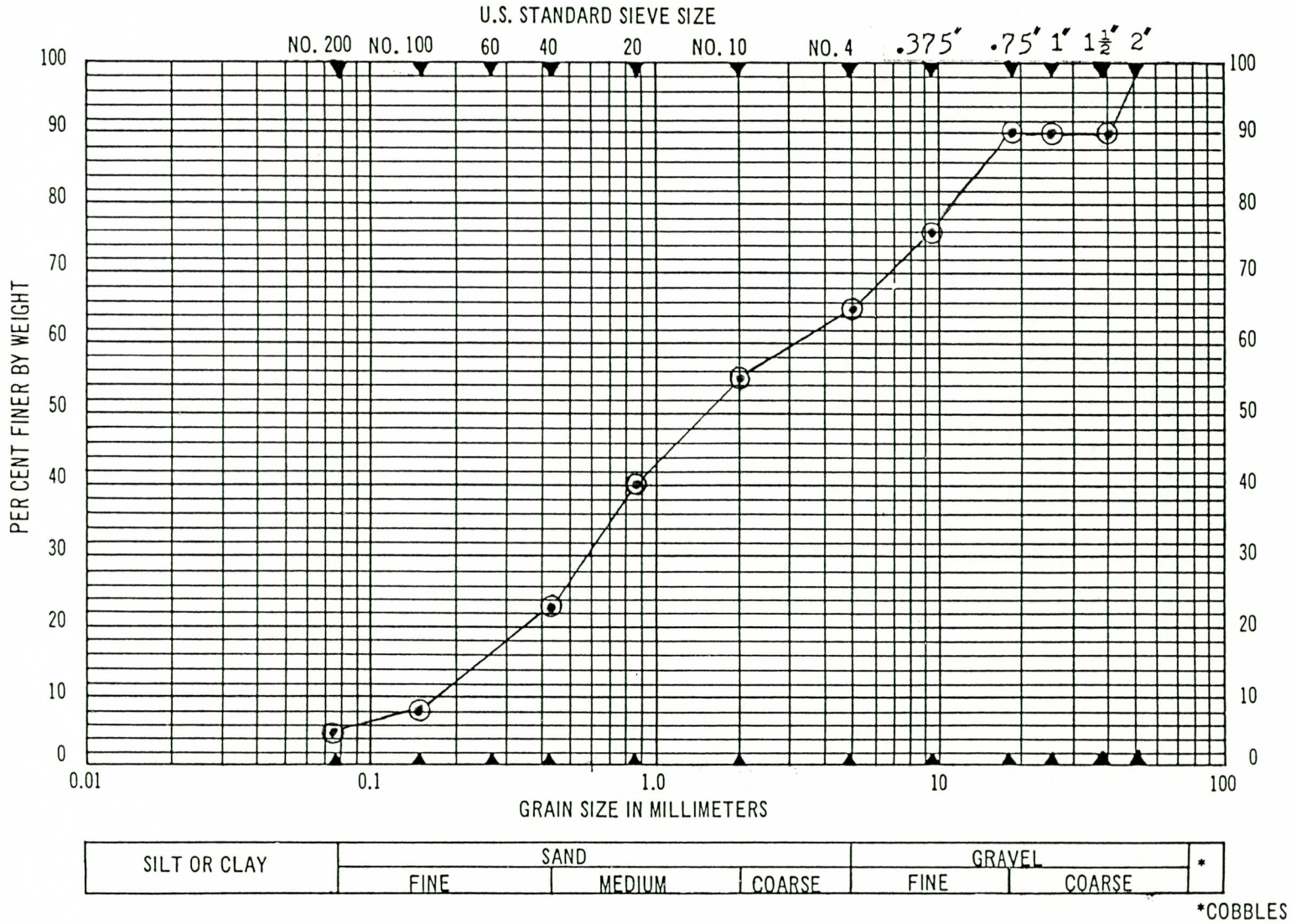
*COBBLES

GRAIN-SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION SYSTEM)

desert earth engineering

JOB NO. 84-210 BY RT DATE 15 Oct 84

KEY	BORING	DEPTH	ELEV.	SOIL CLASSIFICATION
	B-3	9.5-11		(SP) GRAVELLY SAND w/trace silt

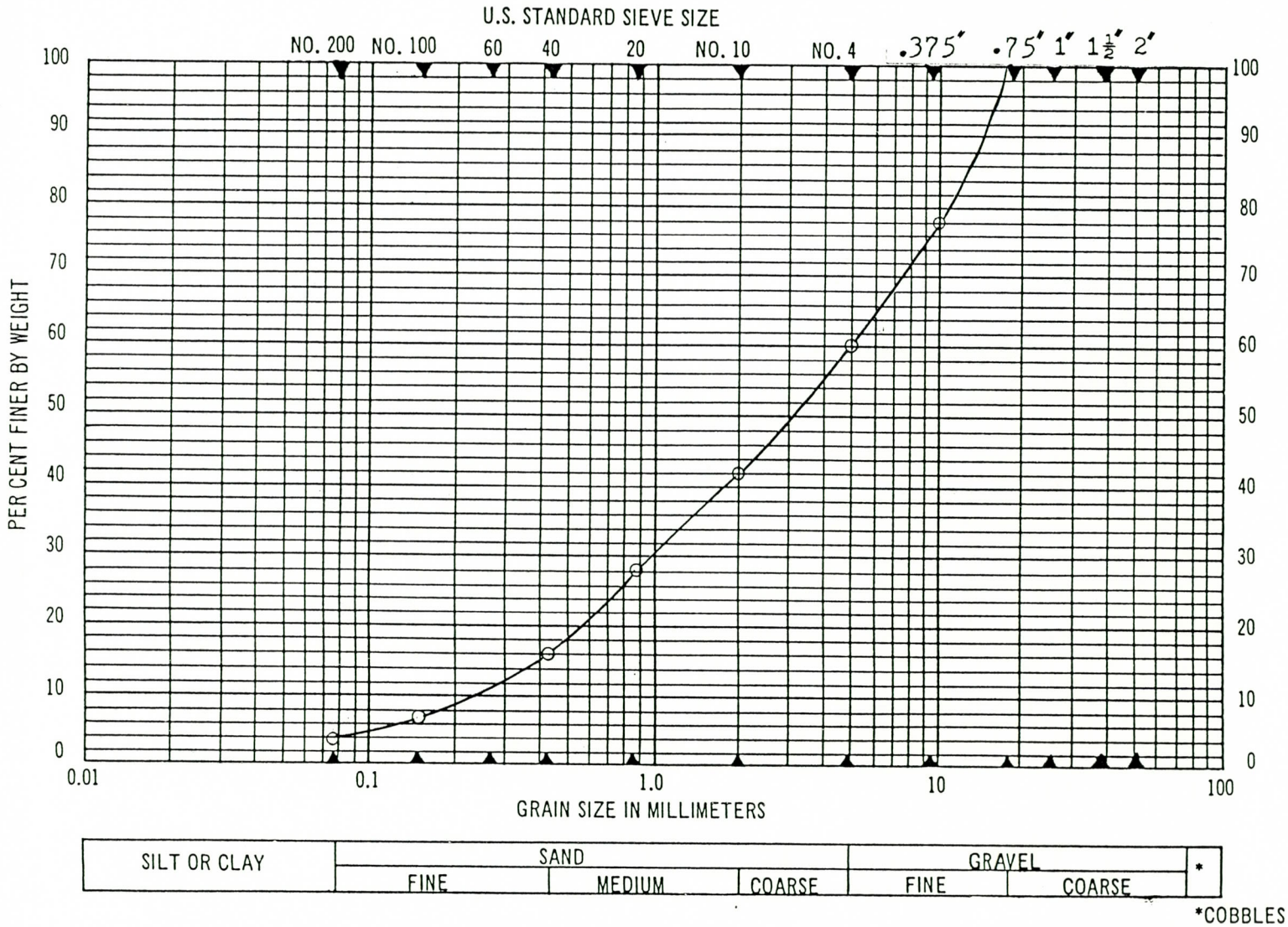


GRAIN-SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION SYSTEM)

desert earth engineering

JOB NO. 84-210 BY RMP DATE 27 Sep 84

KEY	BORING	DEPTH	ELEV.	SOIL CLASSIFICATION
	B-4	14-15.5		(SP) medium-to-coarse GRAVELLY SAND



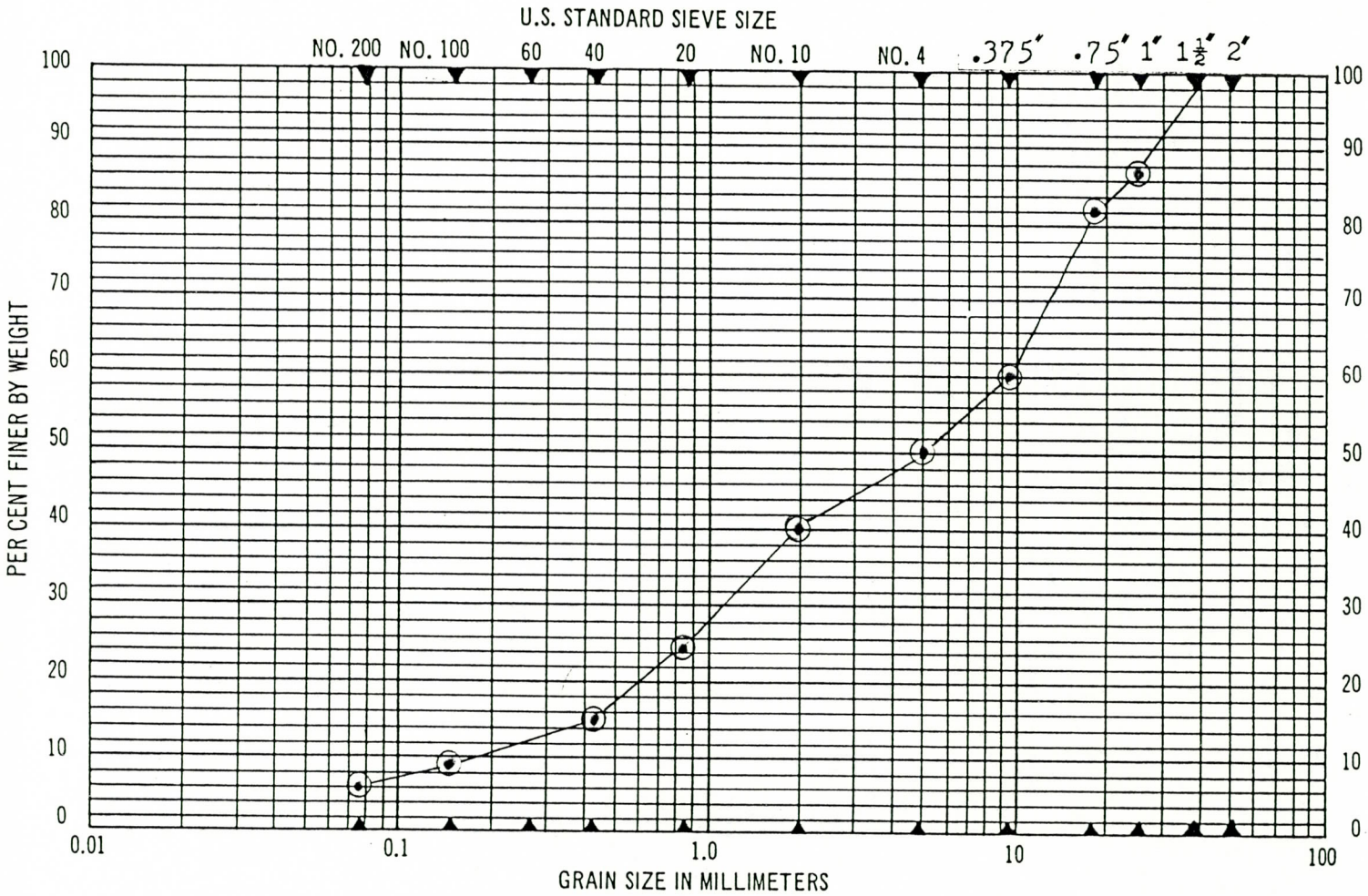
*COBBLES

GRAIN-SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION SYSTEM)

desert earth engineering

JOB NO. 84-210 BY RT DATE 15 Oct 84

KEY	BORING	DEPTH	ELEV.	SOIL CLASSIFICATION
	B-6	9.5-11		(GP-GM) M-C SANDY GRAVEL w/trace silt



SILT OR CLAY	SAND			GRAVEL		*
	FINE	MEDIUM	COARSE	FINE	COARSE	

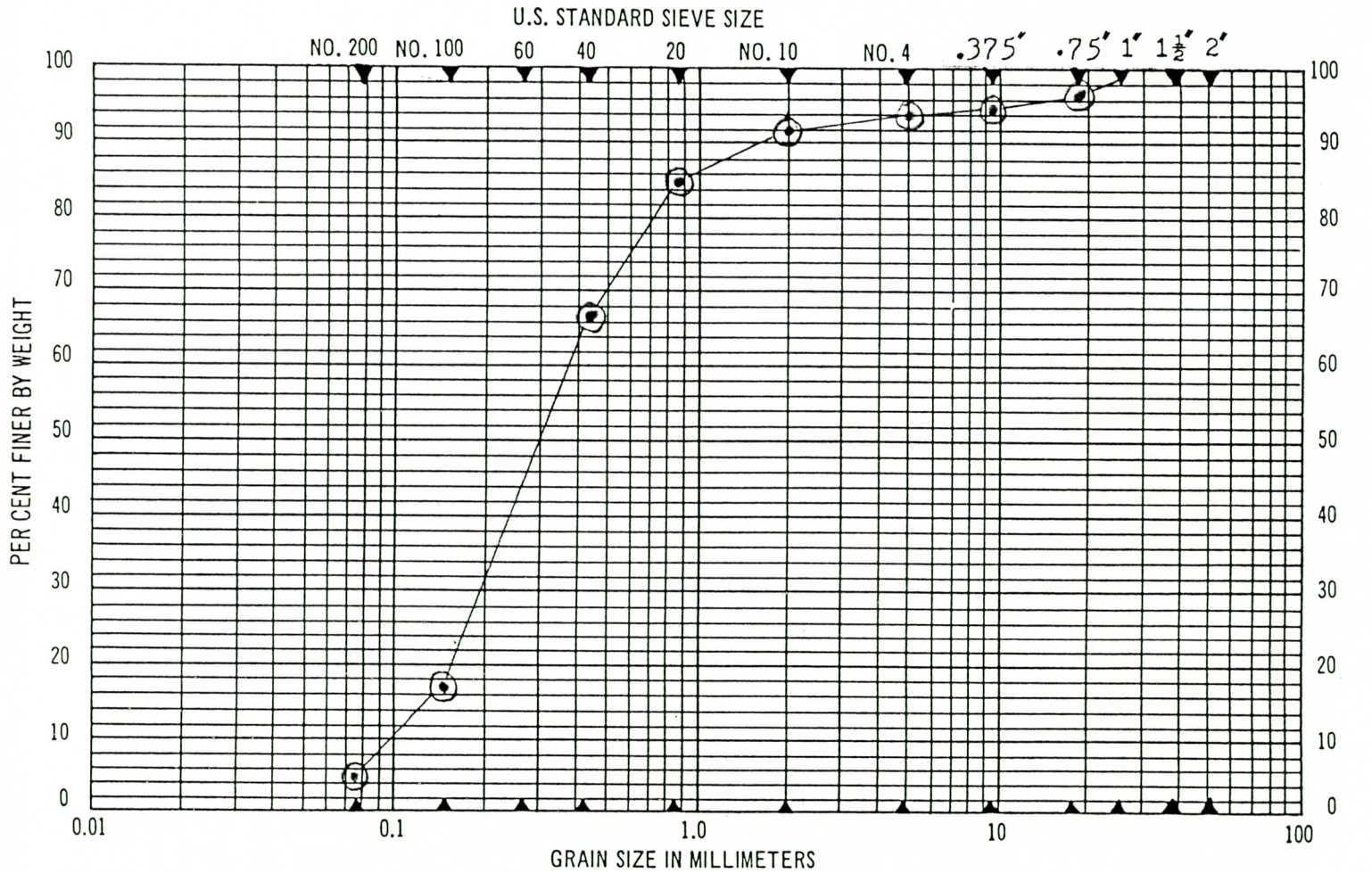
*COBBLES

GRAIN-SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION SYSTEM)

desert earth engineering

JOB NO. 84-210 BY RT DATE 15 Oct 84

KEY	BORING	DEPTH	ELEV.	SOIL CLASSIFICATION
	B-7	9.5-11.0		(SP) F-M SAND w/trace gravel and silt



SILT OR CLAY	SAND			GRAVEL		*
	FINE	MEDIUM	COARSE	FINE	COARSE	

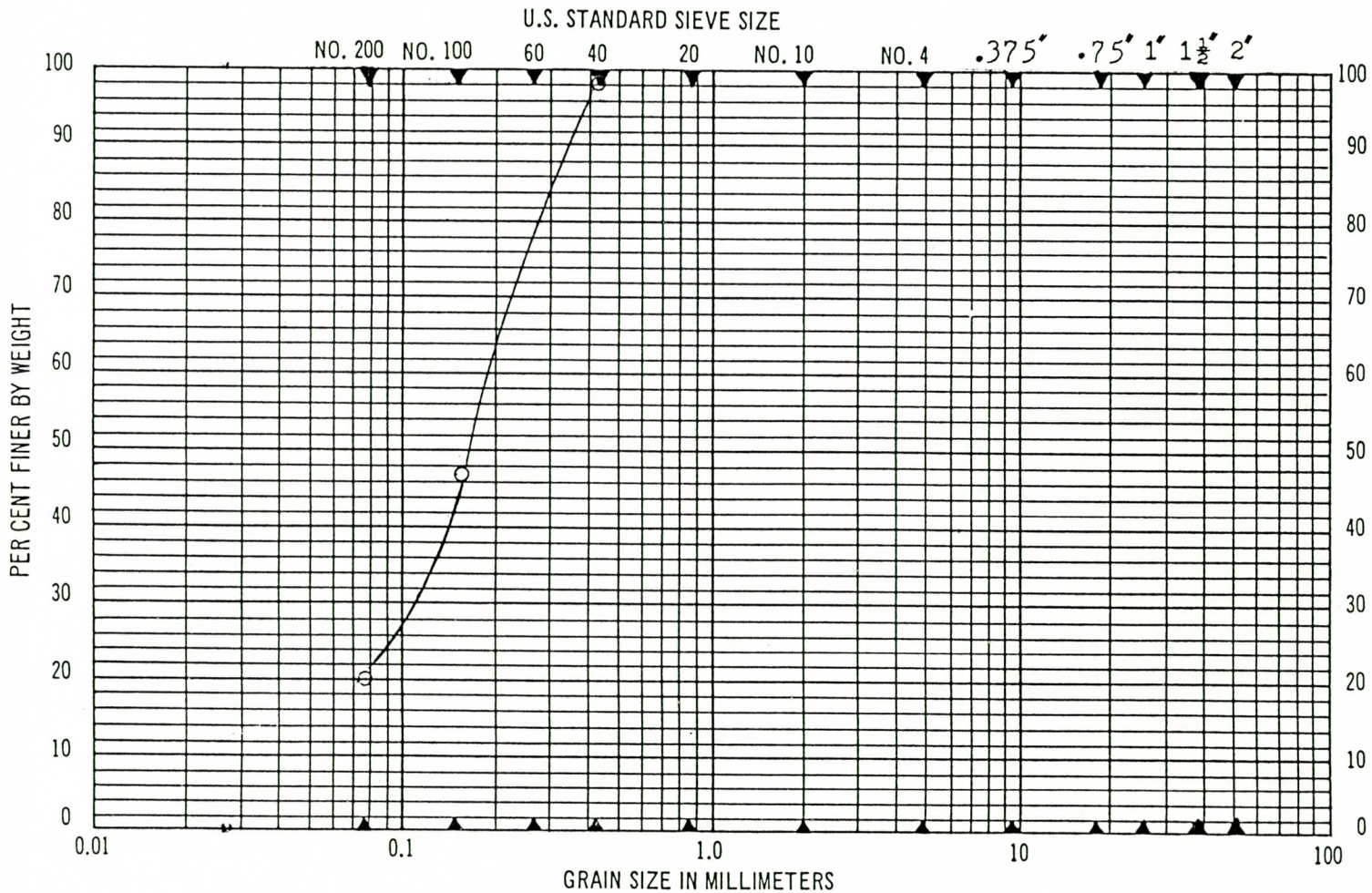
*COBBLES

GRAIN-SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION SYSTEM)

desert earth engineering

JOB NO. 84-210 BY RMP DATE 28 Sept 84

KEY	BORING	DEPTH	ELEV.	SOIL CLASSIFICATION
	B-10	10-11.5		(SP) fine SAND with some silt



SILT OR CLAY	SAND			GRAVEL		*
	FINE	MEDIUM	COARSE	FINE	COARSE	

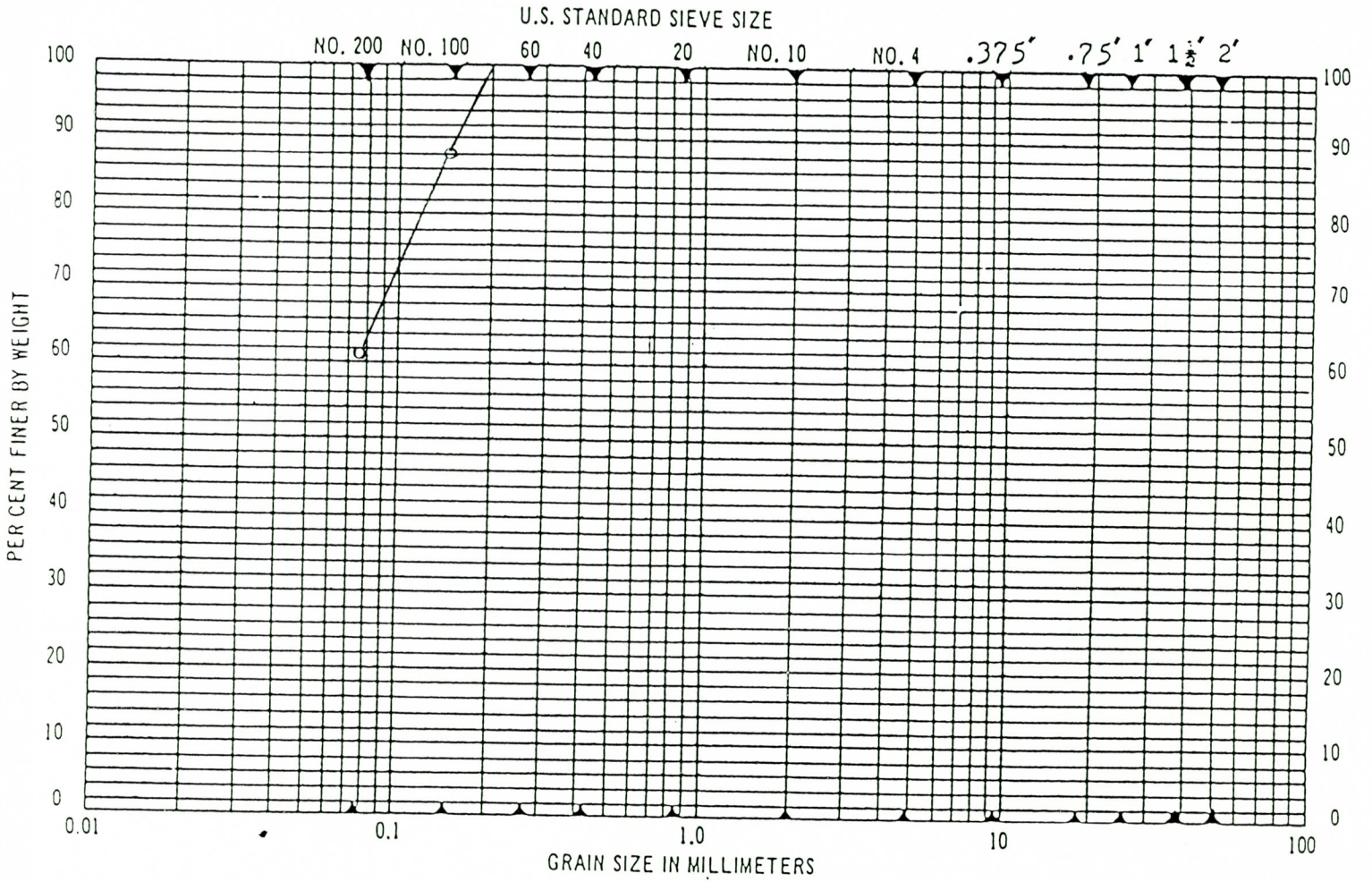
*COBBLES

GRAIN-SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION SYSTEM)

desert earth engineering

JOB NO. 84-210 BY RMP DATE 1 Oct 84

KEY	BORING	DEPTH	ELEV.	SOIL CLASSIFICATION
	B-10	30-31.5		(ML) SANDY SILT



SILT OR CLAY	SAND			GRAVEL		*
	FINE	MEDIUM	COARSE	FINE	COARSE	

*COBBLES

GRAIN-SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION SYSTEM)

desert earth engineering

APPENDIX C

Fill Specification

ENGINEERED FILL SPECIFICATION

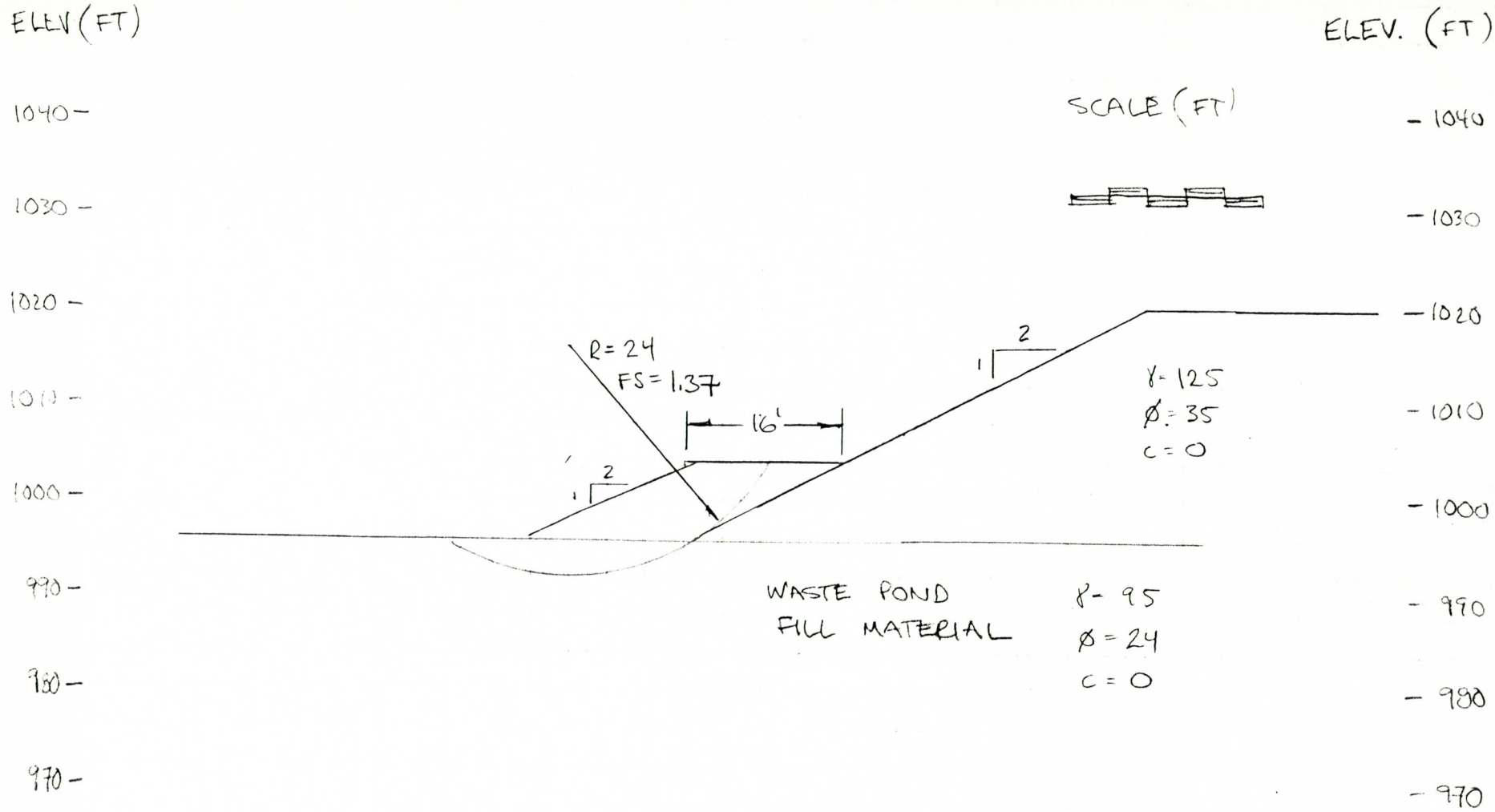
The engineered fill material or aggregate base course (ABC) material composing such a fill should be thoroughly mixed for uniform consistency, be completely free of vegetation, roots, rubble, debris or other deleterious matter, and shall conform to the following specifications.

Gradation (ASTM D422) Sieve Size	% Passing by Weight Fill	ABC
6"	100	--
1 1/2"	--	100
#4	--	45-90
#200	50 Max	0-12
Plastic Index (ASTM D424)	12 Max	5 Max
Percent Expansion	1.0 Max	0.0
Abrasion	--	50 Max
Soluble Sulfates (%)	0.10 Max	0.10 Max

*Expansion shall be measured during saturation of a remolded sample compacted to 95% of Standard Proctor (ASTM D698) density at optimum moisture content which is subject to a load intensity of 1 PSI.

APPENDIX D

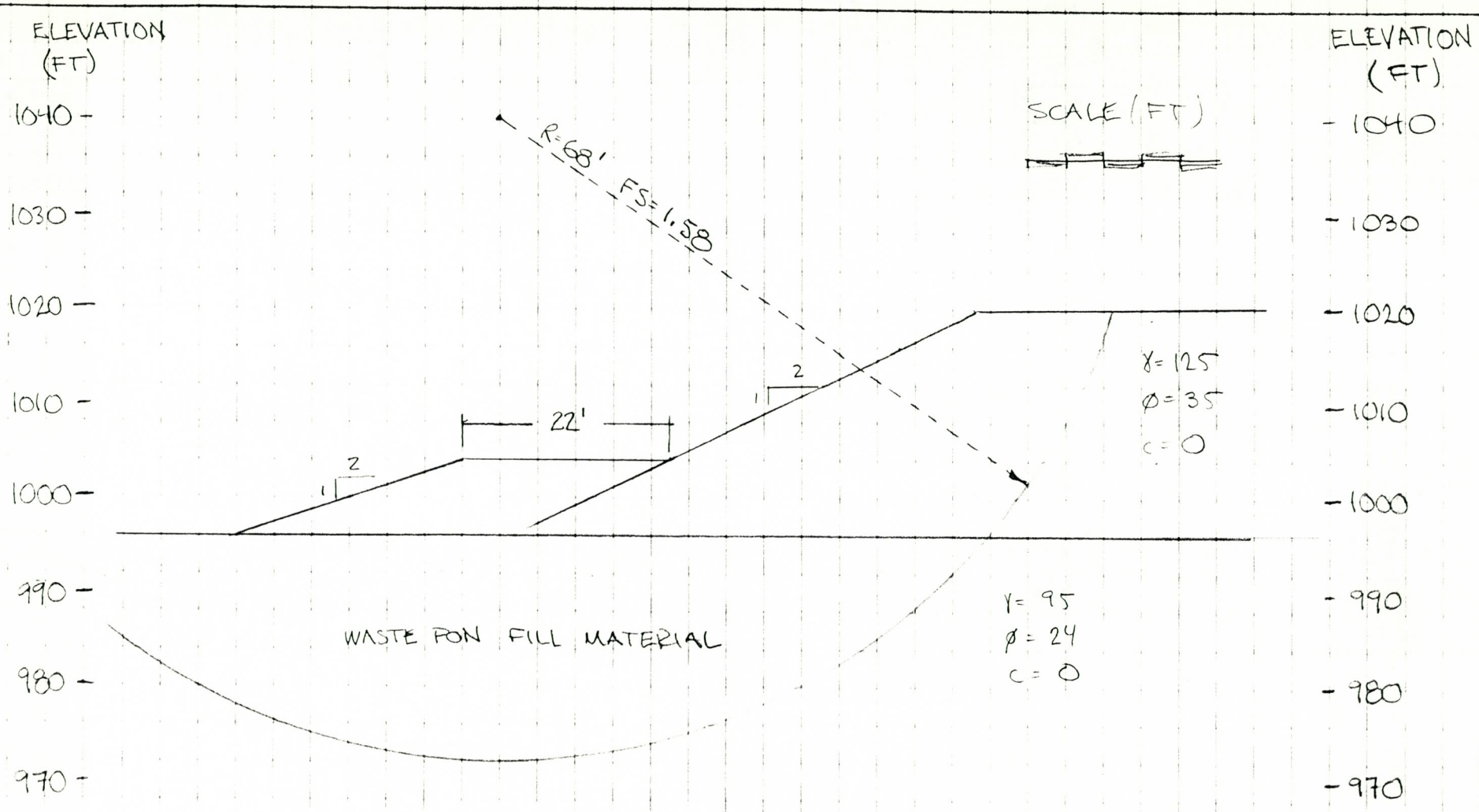
Slope Analyses



UNSTABLE SLOPE CONFIGURATION

SHOWING FAILURE CIRCLE

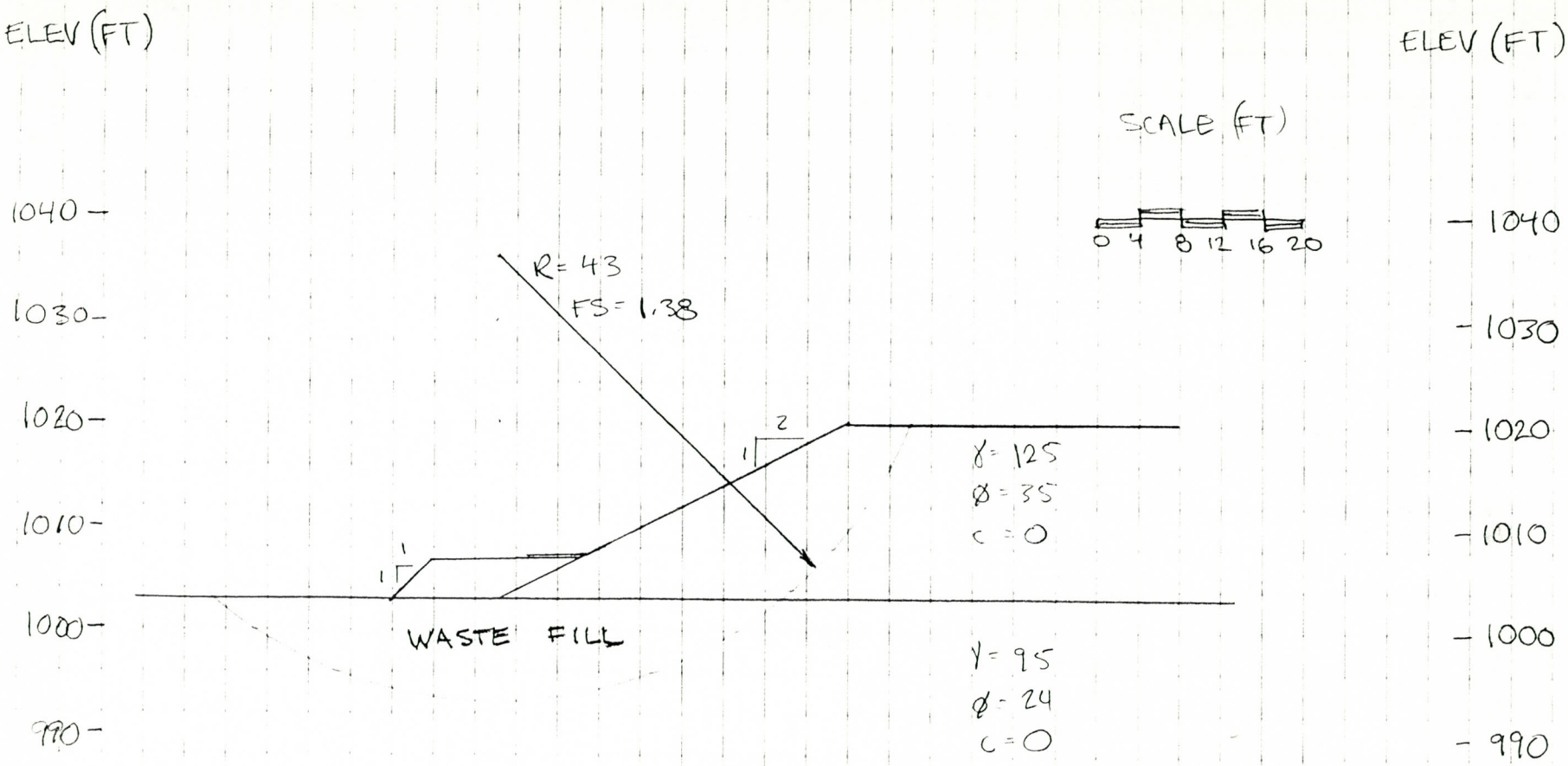
EMBANKED CHANNEL OVER WASTE POND



STABLE SLOPE CONFIGURATION

SHOWING CRITICAL STRESS CIRCLE

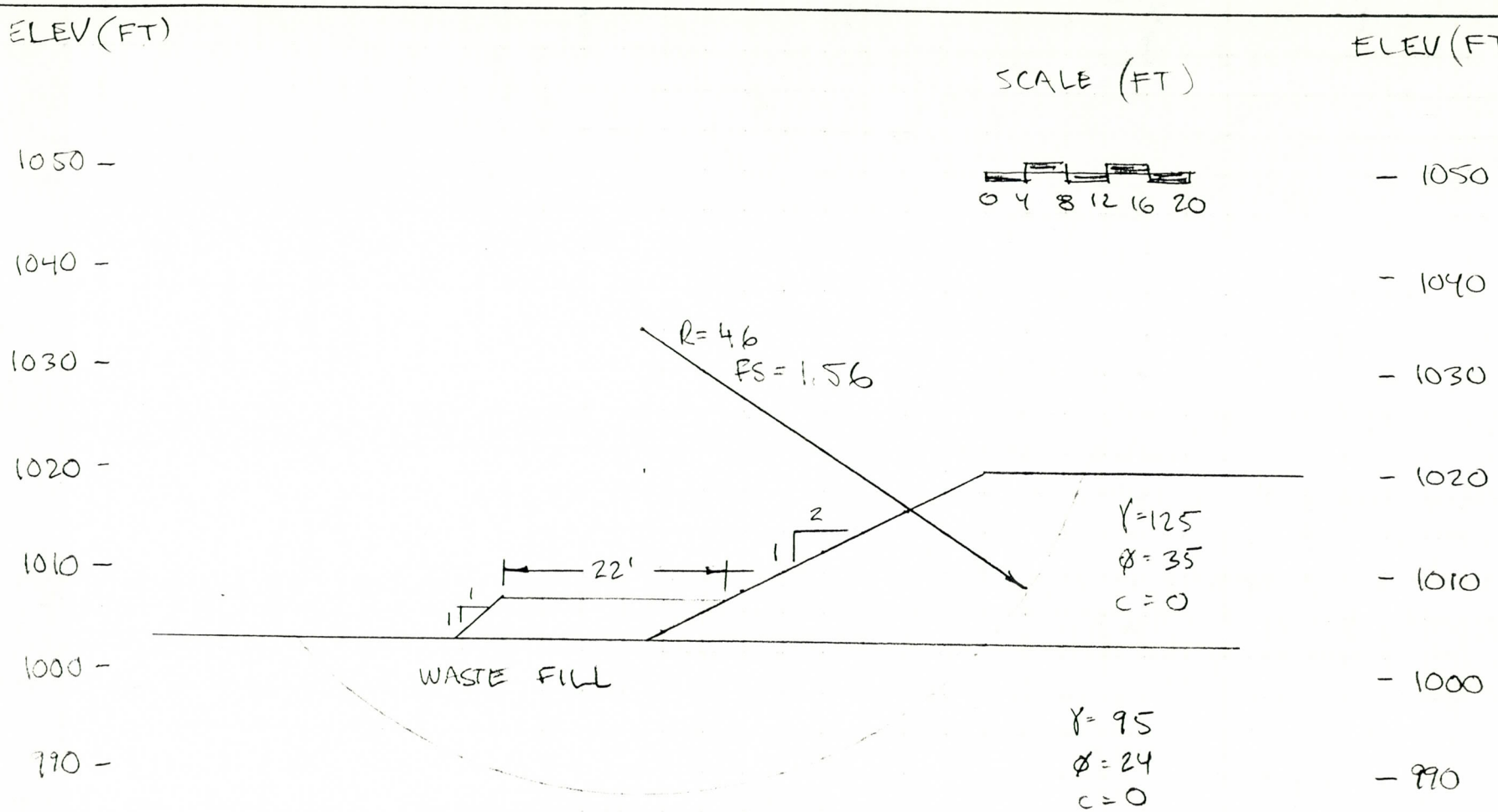
EMBANKED CHANNEL OVER WASTE POND



UNSTABLE SLOPE CONFIGURATION

SHOWING FAILURE CIRCLE

EMBANKED CHANNEL OVER FILLED WASTE PIT



STABLE SLOPE CONFIGURATION

SHOWING CRITICAL STRESS CIRCLE

EMBANKED CHANNEL OVER FILLED WASTE PIT