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January 14, 1988
Job No. 219-65

Placer County Water Agency
Power Systems Division
P.O. Box 667
Foresthill, California 95631
Attn: Steven Jones

Subject: Exploration of Reservoir Sediments
Ralston Afterbay
Placer and El Dorado Counties

Dear Mr. Jones:

INTRODUCTION

This report transmits the results of our exploration of reservoir sediments that have built up behind Ralston Dam. Ralston Reservoir is located at the confluence of the Middle Fork of the American River and Rubicon River as shown on the Location Map, Plate 1. The reservoir at this location is partially in Placer County and partially in El Dorado County.

Ralston Afterbay Dam (crest elevation 1189 ft.) is located approximately 89 feet above the original stream bed. The reservoir has a design gross storage of 2782 acre feet (4.5 million c.y.). A recent topographic survey (Herman & Peters Land Surveyor and Civil Engineer) as compared to the original topography indicates that the reservoir contains sediments on the order of 1 million cubic yards; nearly one quarter of the design gross storage capacity.

We understand that future sediment removal is anticipated to be on a periodic basis in the dry (i.e. excavation and truck haul) during annual outages. Sediment removal areas were outlined by you and are shown on the Site Plan, Plate 2. The purpose of this exploration is to evaluate the nature of the sediments while taking advantage of the 1987 fall reservoir outage. Most of the water had been drained from the reservoir (to elevation 1152 ft.).

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EXPLORATION DETAILS

We explored near-surface sediment conditions at the site on October 22, 1987 by excavating 10 backhoe test pits from 3 1/2 to 6 1/2 feet deep and obtaining bulk surface samples from areas inaccessible to exploration equipment. The test pit locations (shown on the Site Plan, Plate 2) were estimated from topographic and shoreline features.

We logged the test pits and obtained bulk samples for laboratory testing. Due to the loose and saturated nature of the sediments, exploration depths were limited by caving-in of the test pit sidewalls. Logs of test pits showing soil descriptions are presented on Plates 3 through 5. Soils are classified in accordance with the Unified Soil Classification System explained on Plate 6.

We performed field density tests to evaluate the moisture contents representative of the sediments after the reservoir was drained and to determine representative unit weights of sediments. Field density testing was performed in accordance with ASTM Test Designation D2992-71 (Density of Soil and Soil Aggregate by Nuclear Methods). The results of the field density tests appear in the attached Plate 7.

LABORATORY TESTING

Samples obtained during the field exploration were delivered to our laboratory where they were classified and tested. Laboratory test results including particle size analysis, specific gravity, and shear strength test results are presented on Plates 7 through 9.

Representative samples of the sediments were tested in the laboratory to determine the following engineering and physical properties:

These Included:	To Determine:
Grain-Size Distribution	Size and distribution of soil particles, i.e, clay, silt, sand, and gravel.
Direct Shear	Soil shearing strength under varying loads; for future use in slope stability evaluations and to determine dumping angles.
Specific Gravity	The specific gravity is useful in correlating the weight of soil solids with material types and other physical properties.

DISCUSSION

Reservoir Sediments and Sedimentation Patterns

The textural properties of sediments deposited in lakes and reservoirs generally follow predictable patterns governed predominantly by water velocity. The changes in water velocity within a reservoir are, in turn, a function of bottom morphology, tributaries, shoreline irregularity and sinuosity, and several other minor factors. Generally, coarser-grained sediments are deposited near the mouth of a river(s) and the finer-grained sediments are deposited at points on the reservoir farthest from the river(s). Finer-grained deposits are also commonly deposited in the leeward (more sheltered) sides of shoreline irregularities and/or sinuous meanders.

This simple model of reservoir sedimentation is more complicated for hydroelectric reservoirs such as Ralston which experience variations in water velocity due to the outflow of water for energy generation and outages due to maintenance. Because of the periodic fluctuations in water velocity, hydroelectric reservoirs contain features characteristic of both lakes (reservoirs) and rivers. Hydroelectric reservoirs commonly have a thalweg (i.e., a scour channel) which leads toward the tunnel inlets and sand and gravel bars (located on the leeward side of shoreline irregularities and sinuous meanders). Erosion is predominant in the thalweg and deposition is predominant in the sand bar areas. The locations of the thalweg and the sand

and gravel bars are governed by the occurrence of pressure eddies (areas of high water velocity) and suction eddies (areas of lower water velocity).

Ralston Afterbay contains sediments, up to 30+ feet thick, that have accumulated over the last 20± years since dam construction. The sediments near the dam were not accessible during this exploration. Those starting at about station 10+00 consist primarily of very loose to loose, fine-grained, silty sand with decaying organics and some interbeds of silt (primarily in the downstream portion of the Afterbay). Gas probably from decaying organics was noted escaping from the sediments at lower portions of the Afterbay. The sediments make a transition upstream at station 31+50 where recent flood gravels blanket older sand sediments, with increasing cobbles and boulders further upstream, just below the Ralston Powerhouse.

The influence of the convergence of the Middle Fork of the American and the Rubicon River is significant from a sedimentation standpoint, in that during flood stage, thick layers of coarse gravels overlie normal winter sand deposits, creating heterogeneous layering downstream.

CONCLUSIONS

We believe that, generally, the gravels and some of the sands would make excellent engineered fill material. The silty sands will require moisture-conditioning (drying) and compaction if they are to be used in a structural fill. The sediments that contain abundant organics would require a cement/lime additive if they were to be used as structural fill. Proposed excavation areas "A" through "F" will encounter primarily gravels with various amounts of sand. Area "G" contains primarily sand with some interbeds of silt and organics.

Earthwork Balance

Based on nuclear density tests performed at the surface of the drained reservoir and our past experience with sediments at other reservoirs, we

anticipate the following volume changes in materials when they are excavated and replaced as compacted (90 percent) fill:

General Description	Approximate Location	Estimated Shrinkage
Sand w/organics & silt	0 + 00 to 20 + 00	45 - 55%
Sand	20 + 00 to 31 + 50	25 - 35%
Gravel w/sand	31 + 50 to 67 + 00	10 - 15%

It should be understood that these values are not based on deep subsurface exploration and should be considered accurate only to the degree implied by the method used.

LIMITATIONS

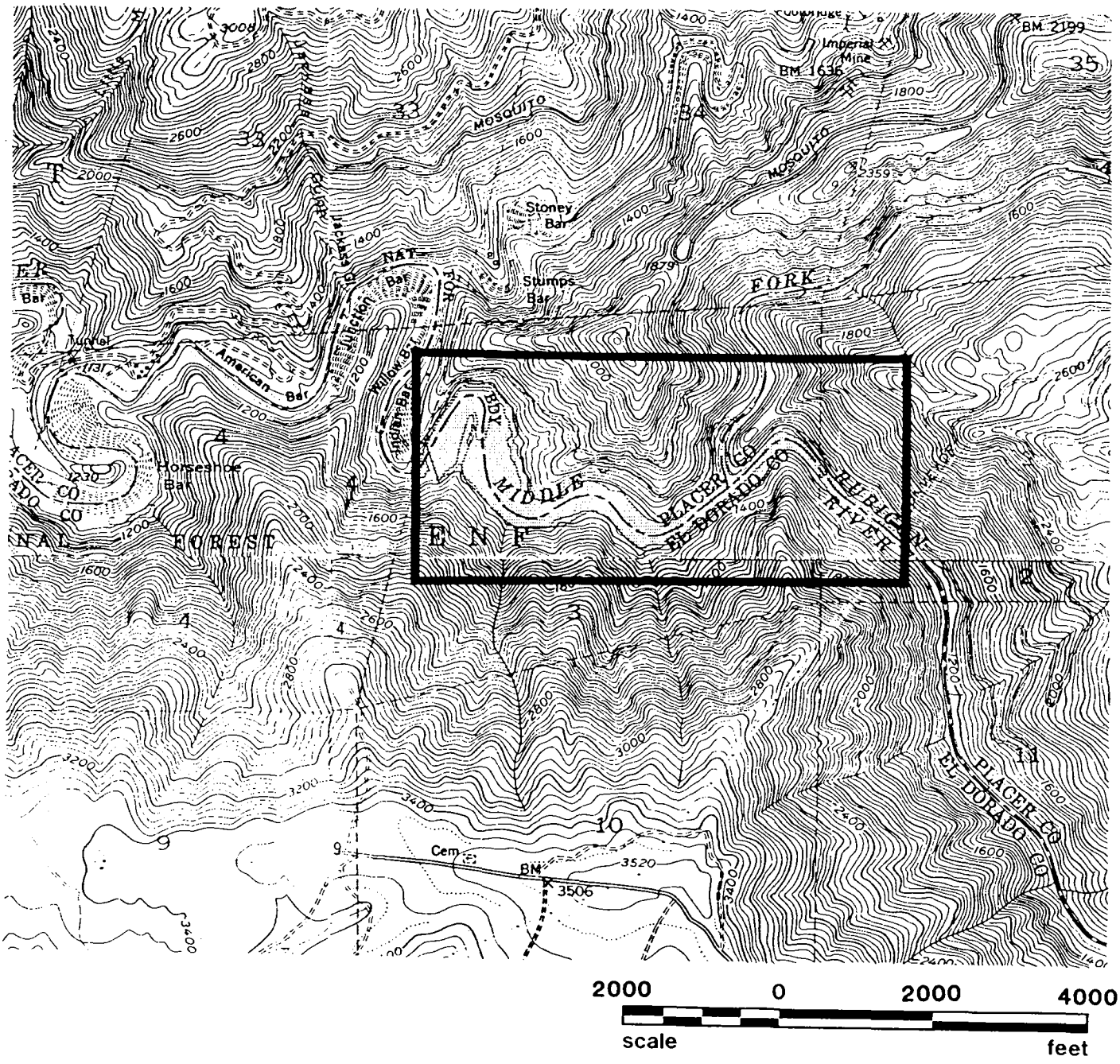
Our limited exploration is based on a surface reconnaissance, subsurface exploration, and engineering studies. The materials encountered in the test pits are believed to be representative of the sediments; however, the soils may vary in character between observation points. In the event that earthwork balance factors and distribution of sediments become critical to the design and construction of a disposal site, additional exploration using deep drilling methods would be necessary. The conclusions and recommendations contained herein are professional opinions derived in accordance with current standards of professional practice; no other warranty is expressed or implied.

Respectfully submitted,

ALPHA GEOTECHNICAL CONSULTANTS, INC.

Lenard D. Long
Geotechnical Engineer 537

LDL/rg



LOCATION MAP

Ralston Afterbay
Middle Fork American River
Placer and El Dorado Couties
California

BASE: Portions of U.S.G.S. Forest Hill, Georgetown, Tunnel Hill and Michigan Bluff Quadrangles, 7.5 minute topographic maps, dated 1942, 1942, 1950 and 1952 respectively, all photorevised in 1973, scale 1:24,000.

Plate 1

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-1	0 - 4 1/2	POORLY-GRADED GRAVEL WITH SAND (GP), gray, wet, about 75% gravel, well-rounded.
		Water at 3 1/2', total depth 4 1/2'.
TP-2	0 - 3 1/2	WELL-GRADED GRAVEL (GW), gray, wet, gravel to about 2' across, rounded, 6" common well-rounded.
		Water at 1 1/2', total depth 3 1/2'.
TP-3	0 - 4 1/2	WELL-GRADED GRAVEL (GW), gray, wet, well-rounded, becomes sandier at about 3'.
		Water encountered at about 2', total depth 4 1/2'.
TP-4	0 - 2 3/4	POORLY-GRADED SAND WITH SILT (SP), gray, wet, fine-grained.
	2 3/4 - 4	POORLY-GRADED GRAVEL (GP), gray, 2" common, about 5" across, well-rounded.
		No free ground water. Total depth 4'.
TP-5	0 - 4 1/2	WELL-GRADED GRAVEL WITH SAND (GW), gray, wet, gravel 2"-8" across common, up to 1 1/4' across, well-rounded.
		Water encountered at 1 1/2', total depth 4 1/2'.

TP-6	0 - 4 1/2	WELL-GRADED SANDY GRAVEL (GW), gray, wet, gravel about 3" across common, up to 10" across, well-rounded, (2 large boulders at 3', 2 1/2' across).
		Water encountered at 2 1/2', total depth 4 1/2'.
TP-7	0 - 4	WELL-GRADED GRAVEL WITH SAND (GW), gray, wet, 2"-7" across common, up to 1 1/2' across well-rounded.
		Water encountered at 1 1/2', total depth 4'.
TP-8	0 - 2 1/2	WELL-GRADED SANDY GRAVEL (GW), gray, wet, loose 2"-5" common, up to 1 1/4' across, well-rounded.
	2 1/2 - 5 1/2	WELL-GRADED GRAVELLY SAND (SW), gray, wet, loose fine to coarse-grained, sand, gravel from 1/4" to 8" across, 1" across common.
		Total depth 5 1/2'.
TP-9	0 - 4 3/4	WELL-GRADED GRAVEL (GW), gray, wet, loose, approximately 85-90% gravels, 4"-6" across common, up to 1 1/2'across.
		Water encountered at 3 3/4', total depth 4 3/4'.
TP-10	0 - 3	POORLY-GRADED SAND WITH SILT (SP), brown, loose, fine to medium-grained, saturated.
	3 - 3 1/2	SILTY SAND (SM), medium gray, loose, wet with organics (twigs, leaves, etc.) fine to medium-grained.
	3 1/2 - 4	POORLY-GRADED SAND (SP), fine to medium-grained, medium brown, micaceous, about 20 percent organics.

4 - 4 1/4	WELL-GRADED GRAVEL WITH SAND (GW), gray, loose, gravel to 8" across, 3" across common, well-rounded.
4 1/4 - 5	ORGANIC SILT (ML), medium brown, wet, soft, micaceous.
5 - 6 1/2	POORLY-GRADED SILTY SAND (SP), medium gray, loose, fine to medium-grained.
	Water encountered at 4 1/2', total depth 6 1/2.

UNIFIED SOIL CLASSIFICATION SYSTEM

ASTM D 2487–85

MAJOR DIVISIONS				SOIL CLASSIFICATION	
				GROUP SYMBOL	GROUP NAME
COARSE–GRAINED SOILS (MORE THAN 50 % RETAINED ON NO. 200 SIEVE)	GRAVELS (MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE)	CLEAN GRAVELS (LESS THAN 5% FINES)	$Cu \geq 4$ AND $1 \leq Cc \leq 3$	GW	WELL–GRADED GRAVEL
			$Cu < 4$ AND/OR $1 > Cc > 3$	GP	POORLY–GRADED GRAVEL
		GRAVELS WITH FINES (MORE THAN 12% FINES)	FINES CLASSIFY AS ML OR MH	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS (50% OR MORE OF COARSE FRACTION PASSES NO. 4 SIEVE)	CLEAN SANDS (LESS THAN 5% FINES)	$Cu \geq 6$ AND $1 \leq Cc \leq 3$	SW	WELL–GRADED SAND
			$Cu < 6$ AND OR $1 > Cc > 3$	SP	POORLY–GRADED SAND
		SANDS WITH FINES (MORE THAN 12% FINES)	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE–GRAINED SOILS (50% OR MORE PASSED THE NO. 200 SIEVE)	SILTS & CLAYS (LIQUID LIMIT LESS THAN 50%)	INORGANIC	PI > 7 AND PLOTS ON OR ABOVE "A" LINE	CL	LEAN CLAY
			PI < 4 OR PLOTS BELOW "A" LINE	ML	SILT
		ORGANIC	$\frac{\text{LIQUID LIMIT – OVEN DRIED}}{\text{LIQUID LIMIT – NOT DRIED}} < 0.75$	OL	ORGANIC CLAY ORGANIC SILT
	SILTS & CLAYS (LIQUID LIMIT 50% OR MORE)	INORGANIC	PI PLOTS ON OR ABOVE "A" LINE	CH	FAT CLAY
			PI PLOTS BELOW "A" LINE	MH	ELASTIC SILT
		ORGANIC	$\frac{\text{LIQUID LIMIT – OVEN DRIED}}{\text{LIQUID LIMIT – NOT DRIED}} < 0.75$	OH	ORGANIC CLAY ORGANIC SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT

SUMMARY OF TEST RESULTS

IN-PLACE MOISTURE/DENSITY TEST RESULTS

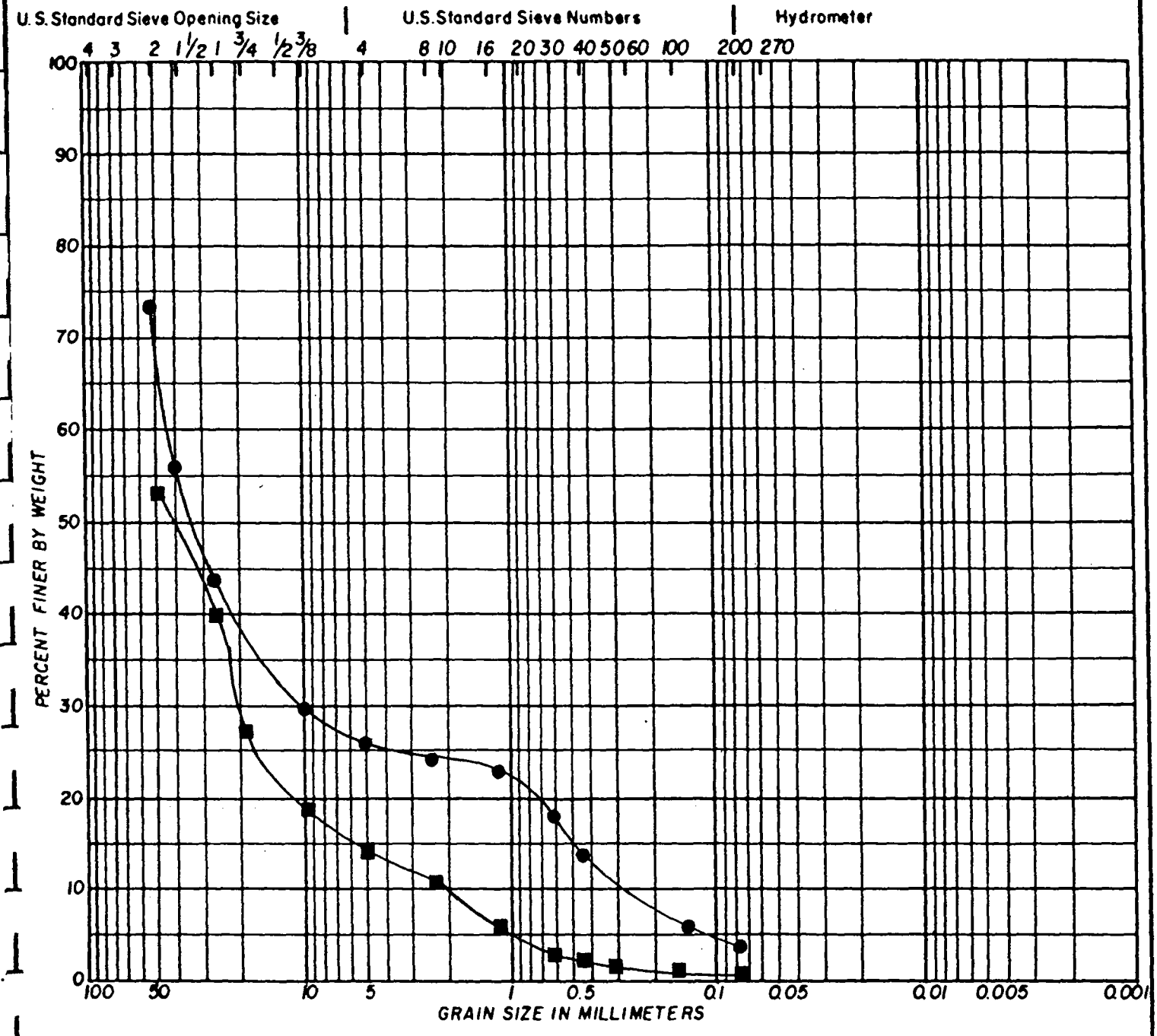
Station	Moisture Content	Dry Density	Soil Type
18 + 00	1.8%	87 pcf	silty sand
21 + 00	2.0	90 pcf	silty sand
23 + 00	42.0 %	65.0 pcf	silt
26 + 00	1.7%	92.0 pcf	silty sand
28 + 00	1.6%	91.4 pcf	silty sand
28 + 00	2.0%	92.0 pcf	silty sand
31 + 00	10.5%	81 pcf	silty sand
31 + 50	4.1%	95.0 pcf	gravel
37 + 50	2.6%	111.3 pcf	gravel

Specific Gravity of Soil Solids

Location	Specific Gravity
Bulk Sample #1 @ 0 - 1/2'	2.74
TP-3 @ 0 - 1'	2.74
TP-10 @ 3 1/2' - 4'	2.72

Direct Shear Test Results

Location	Normal Load	Shear Stress
Bulk Sample #1 @ 0 - 1'	4.8 psi	3.4 psi
	23.8	10.8
	95.1	47.1
Bulk Sample #2 @ 0 - 1/2'	4.8 psi	3.7 psi
	23.8 psi	13.3 psi
	95.1 psi	51.2 psi



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
●	TP-1 0 - 1 ft	Poorly-Graded Gravel with Sand (GP)
■	TP-2 0 - 1 ft	Well-Graded Gravel (GW)

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PARTICLE SIZE ANALYSIS

Ralston Afterbay
Placer County, California

PLATE

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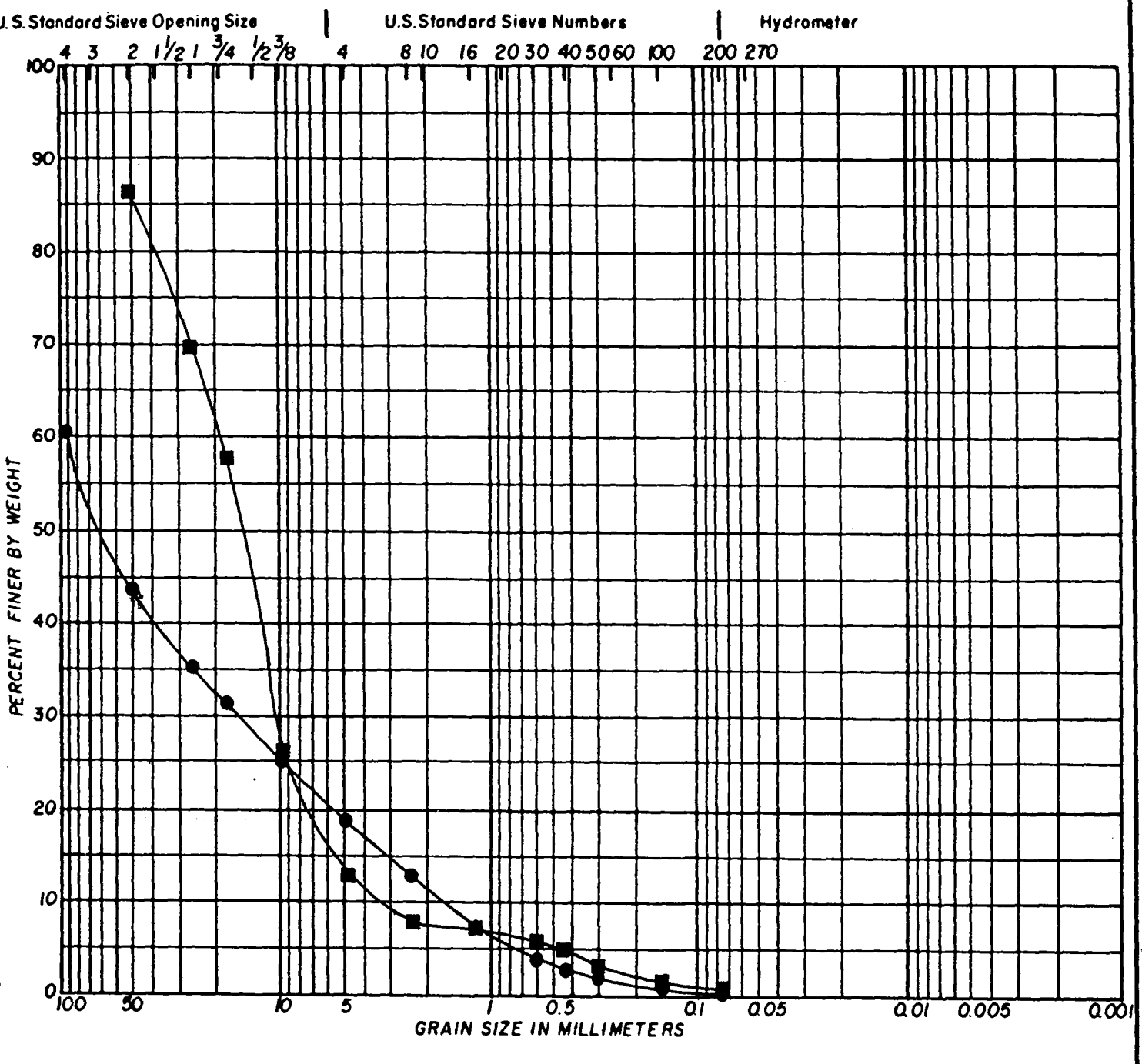

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
●	TP-3 @ 0 - 1 ft	Well-Graded Gravel (GW)
■	TP-4 @ 3 ft	Poorly-Graded Gravel (GP)

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PARTICLE SIZE ANALYSIS

Ralston Afterbay
Placer County, California

PLATE

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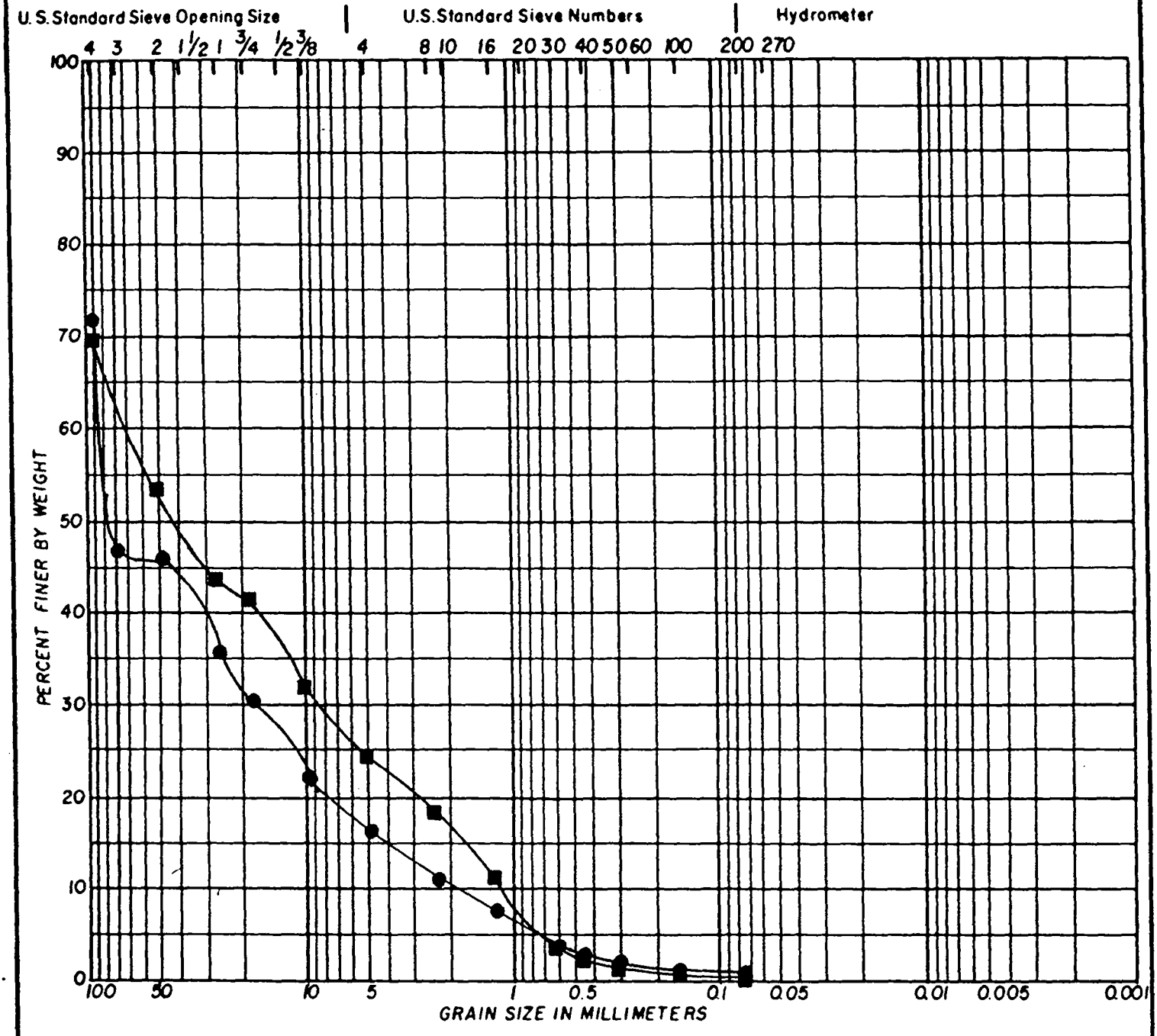

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
●	TP-5 @ 0 - 1 ft	Well-Graded Gravel with Sand (GW)
■	TP-7 @ 3 ft	Well-Graded Gravel with Sand (GW)

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PARTICLE SIZE ANALYSIS

Ralston Afterbay
Placer County, California

PLATE

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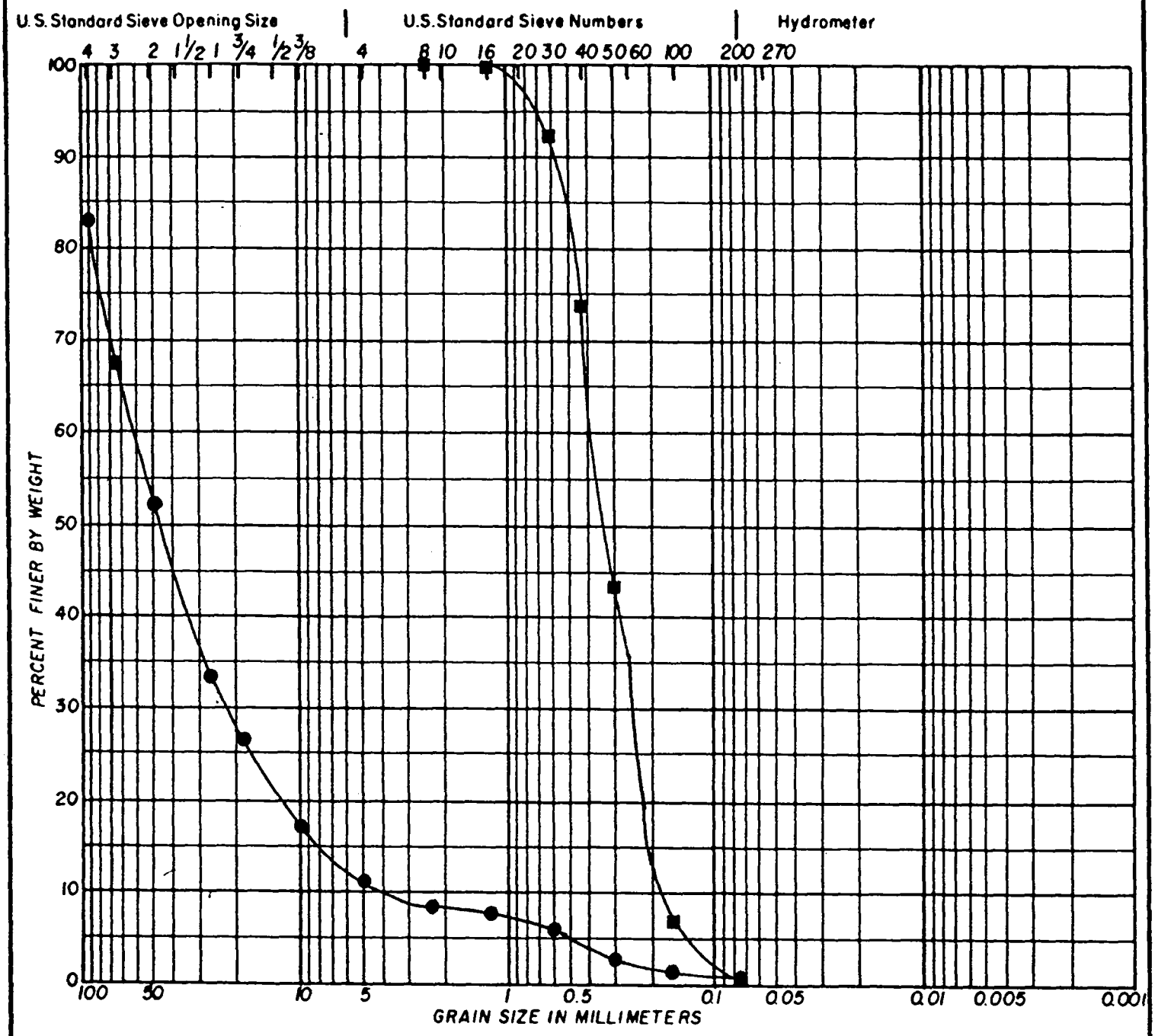

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
●	TP-9 @ 2 ft	Well-Graded Gravel (GW)
■	TP-10 @ 3½ - 4 ft	Poorly-Graded Sand (SP)

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PARTICLE SIZE ANALYSIS

Ralston Afterbay
Placer County, California

PLATE

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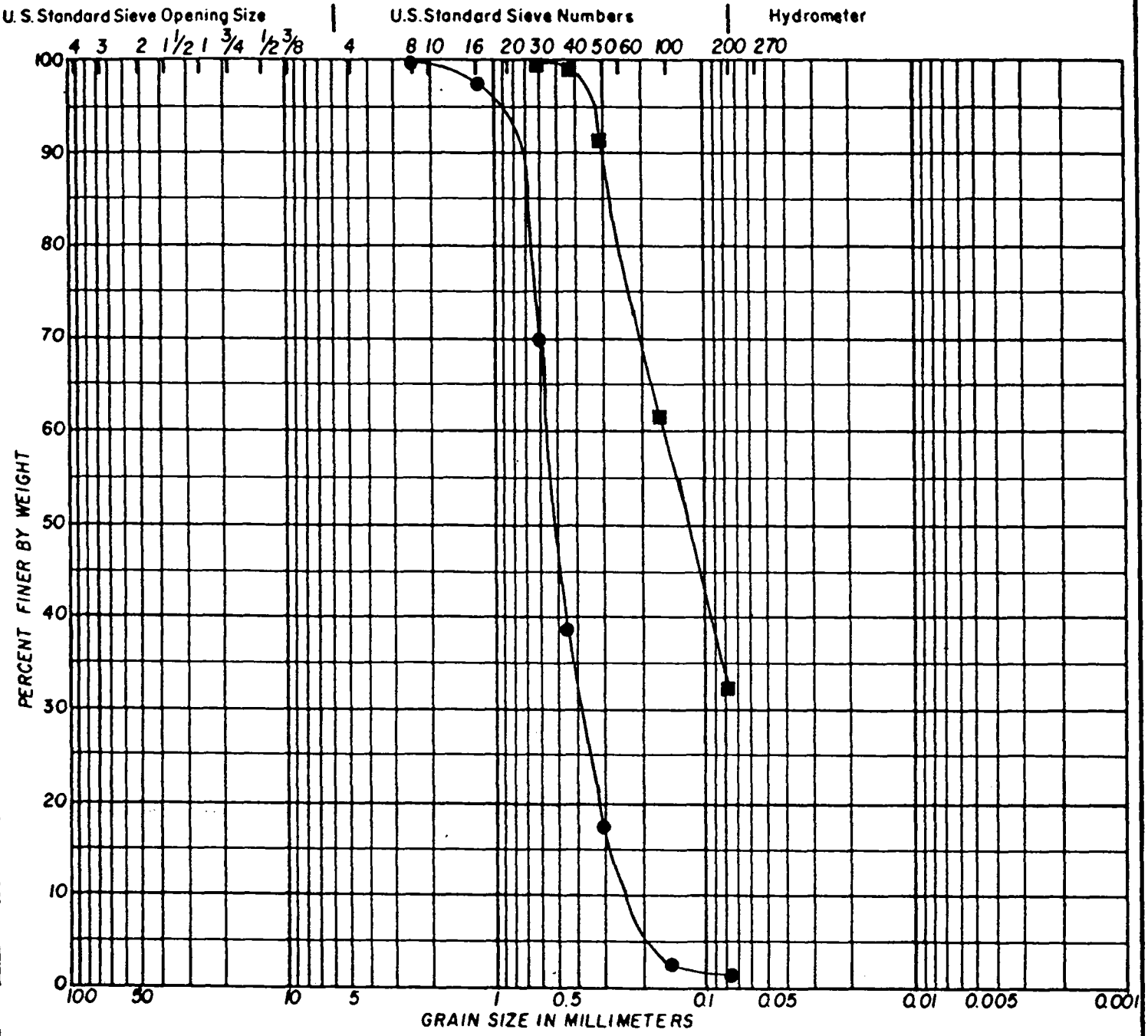

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
●	Bulk Sample #1 0 - ½ ft	Poorly-Graded Sand (SP)
■	Bulk Sample #2 0 - ½ ft	Clayey Sand (SC)

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PARTICLE SIZE ANALYSIS

Ralston Afterbay
Placer County, California

PLATE

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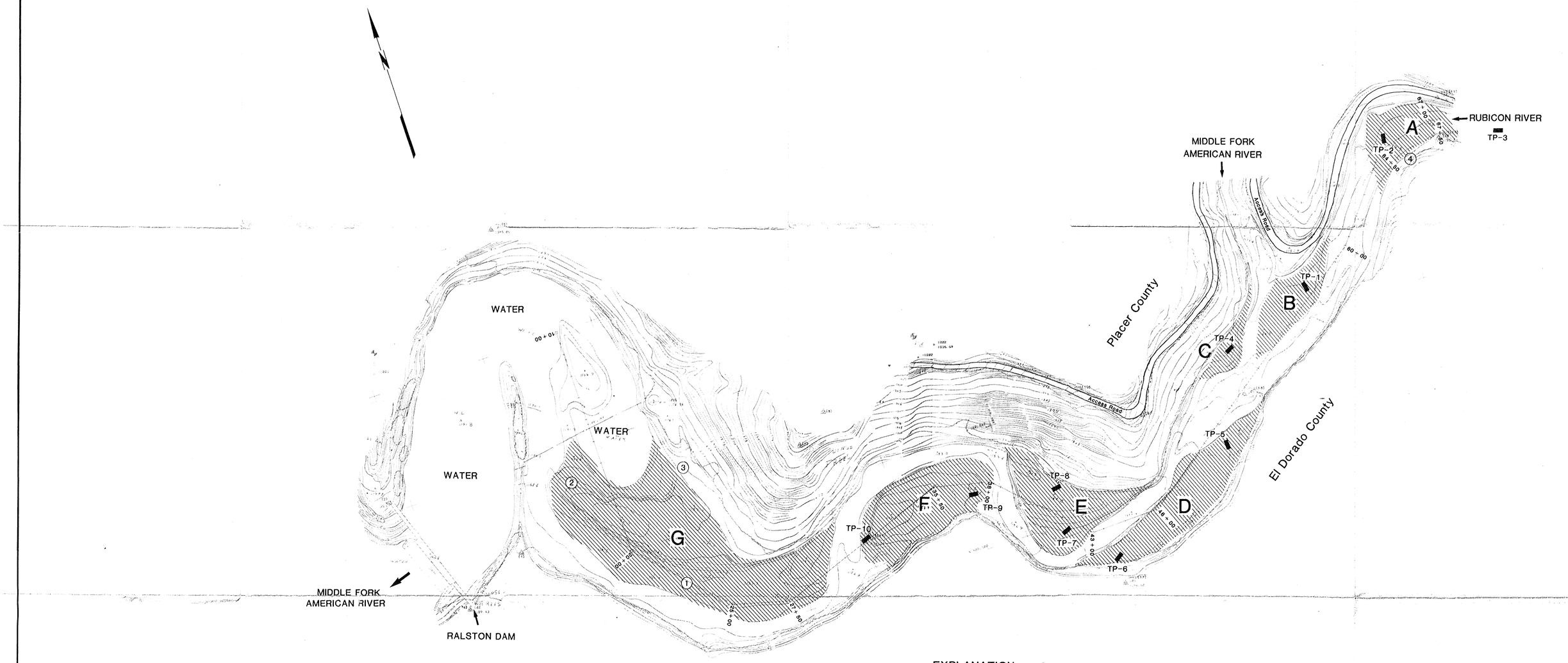

EXPLANATION

TP-10	Exploratory Test Pit
④	Bulk Surface Sample
67 + 60	Survey Station Number
G	Proposed Excavation Areas

200 0 200 400
scale feet

SITE PLAN

Scale: 1"=200'	Approved by:	Drawn by JL	
Date: 1/88		Revised	

Ralston Afterbay
Placer and El Dorado Counties
California

Alpha Geotechnical Consultants, Inc.

Job number 219-65

Base: Topographic map prepared by Radman Aerial Surveys and Herman & Peters, 10-25-87, contour interval of 5', and scale 1"=100'.

Plate 2