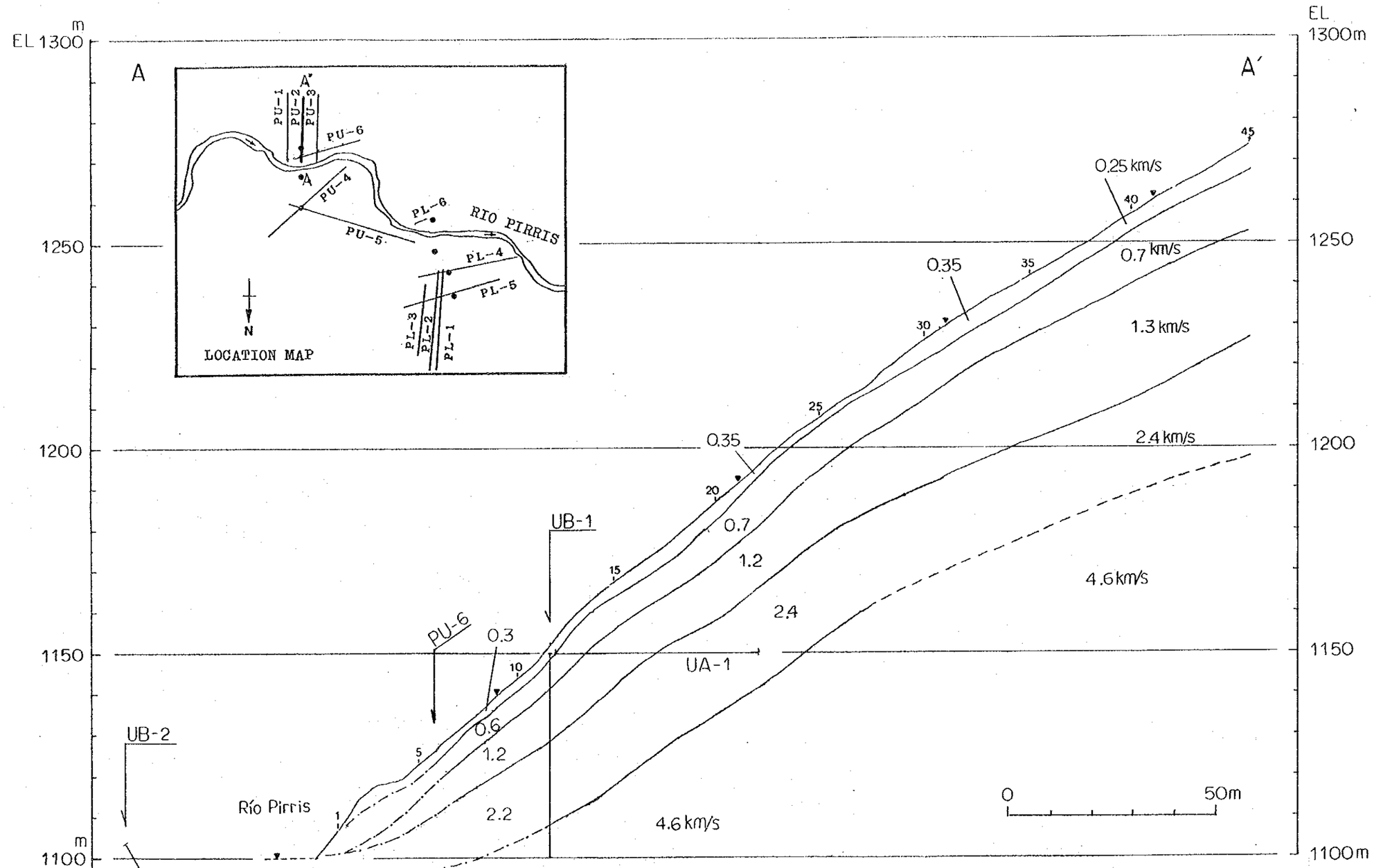
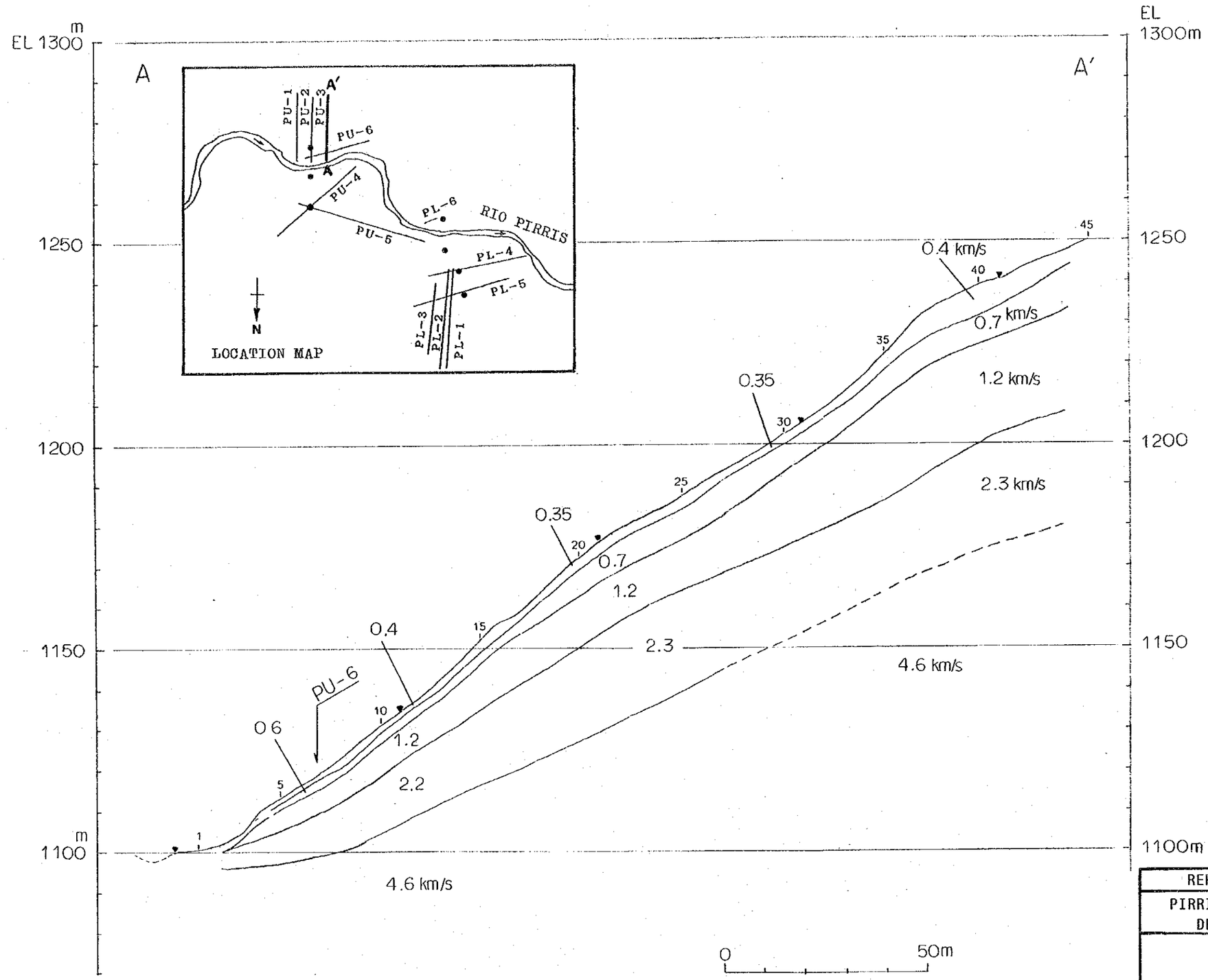


REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

SEISMIC PROFILE
PU-2
(UPPER DAM SITE)

A-5-4-(2)

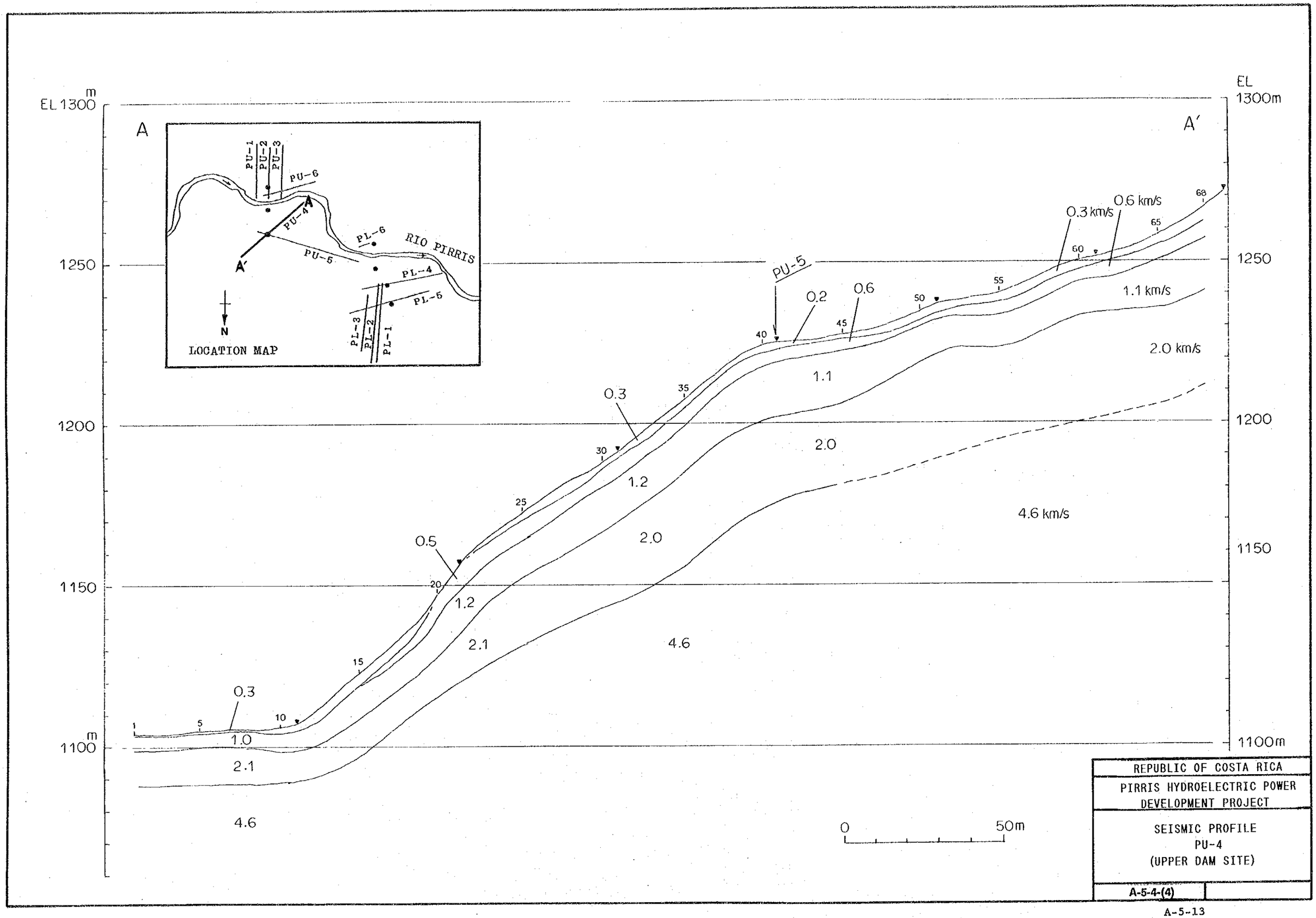


REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

SEISMIC PROFILE
PU-3
(UPPER DAM SITE)

A-5-4-(3)

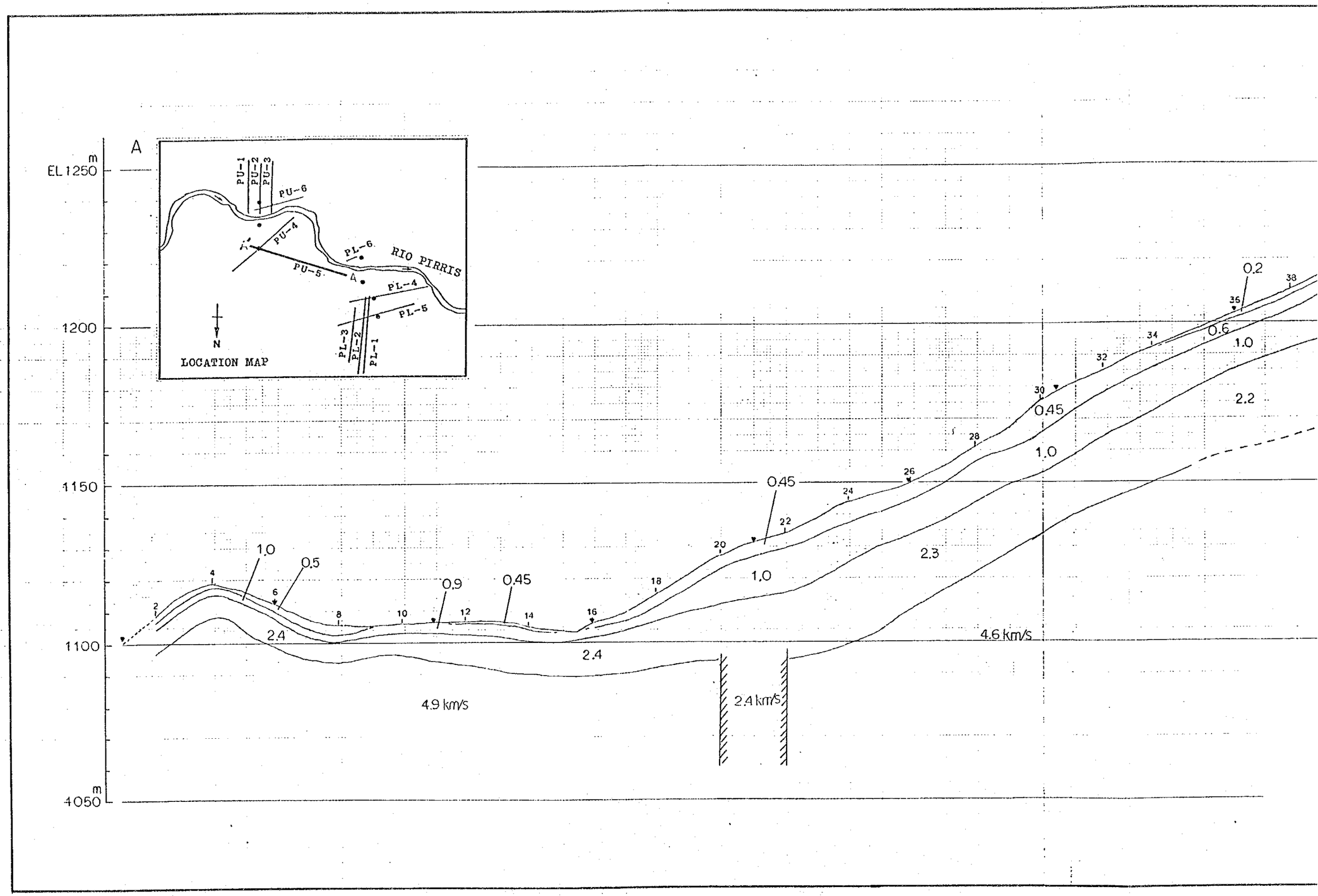


REPUBLIC OF COSTA RICA

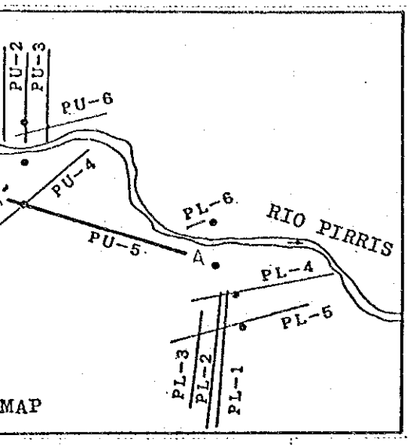
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

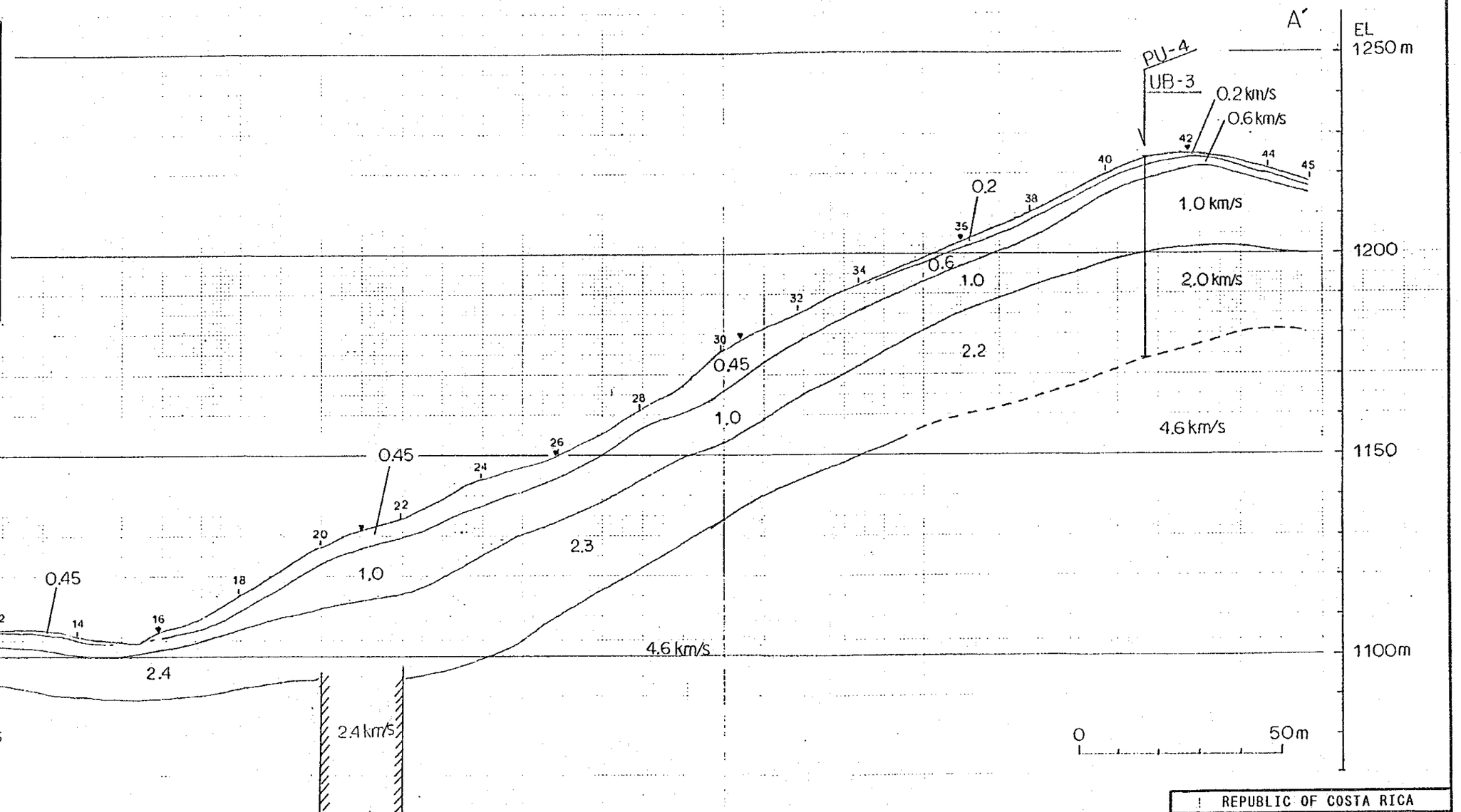
SEISMIC PROFILE
PU-4
(UPPER DAM SITE)

A-5-4-(4)


A
m
EL 1250
1200
1150
1100
4050
m
LOCATION MAP
N
PU-1
PU-2
PU-3
PU-4
PU-5
PU-6
PL-1
PL-2
PL-3
PL-4
PL-5
PL-6
RIO PIRRIS
A'
A
1.0
0.5
0.9
0.45
0.45
0.45
0.2
0.6
1.0
2.2
2.3
1.0
2.4
2.4
4.9 km/s
2.4 km/s
4.6 km/s
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38

APPENDIX



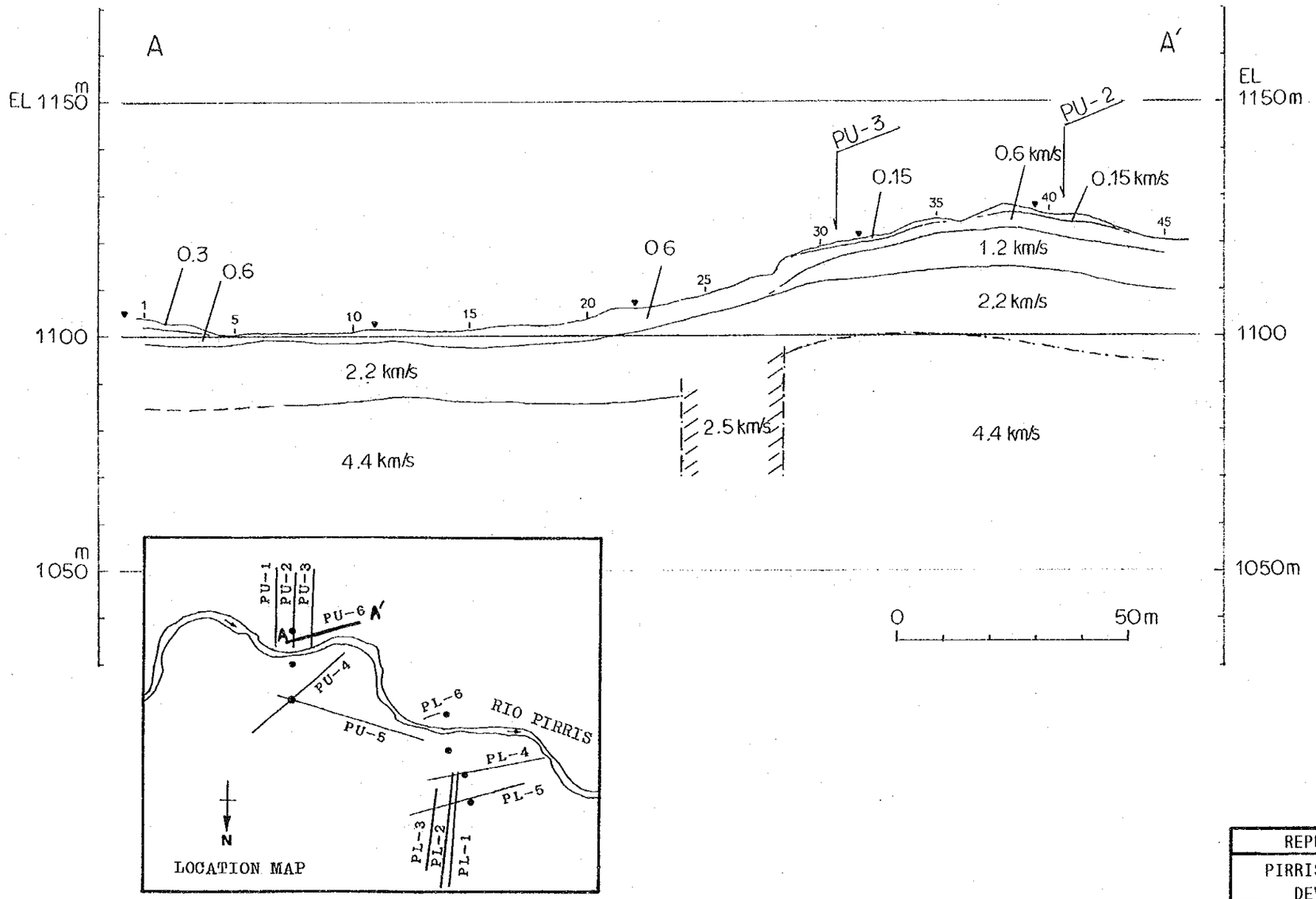


REPUBLIC OF COSTA RICA

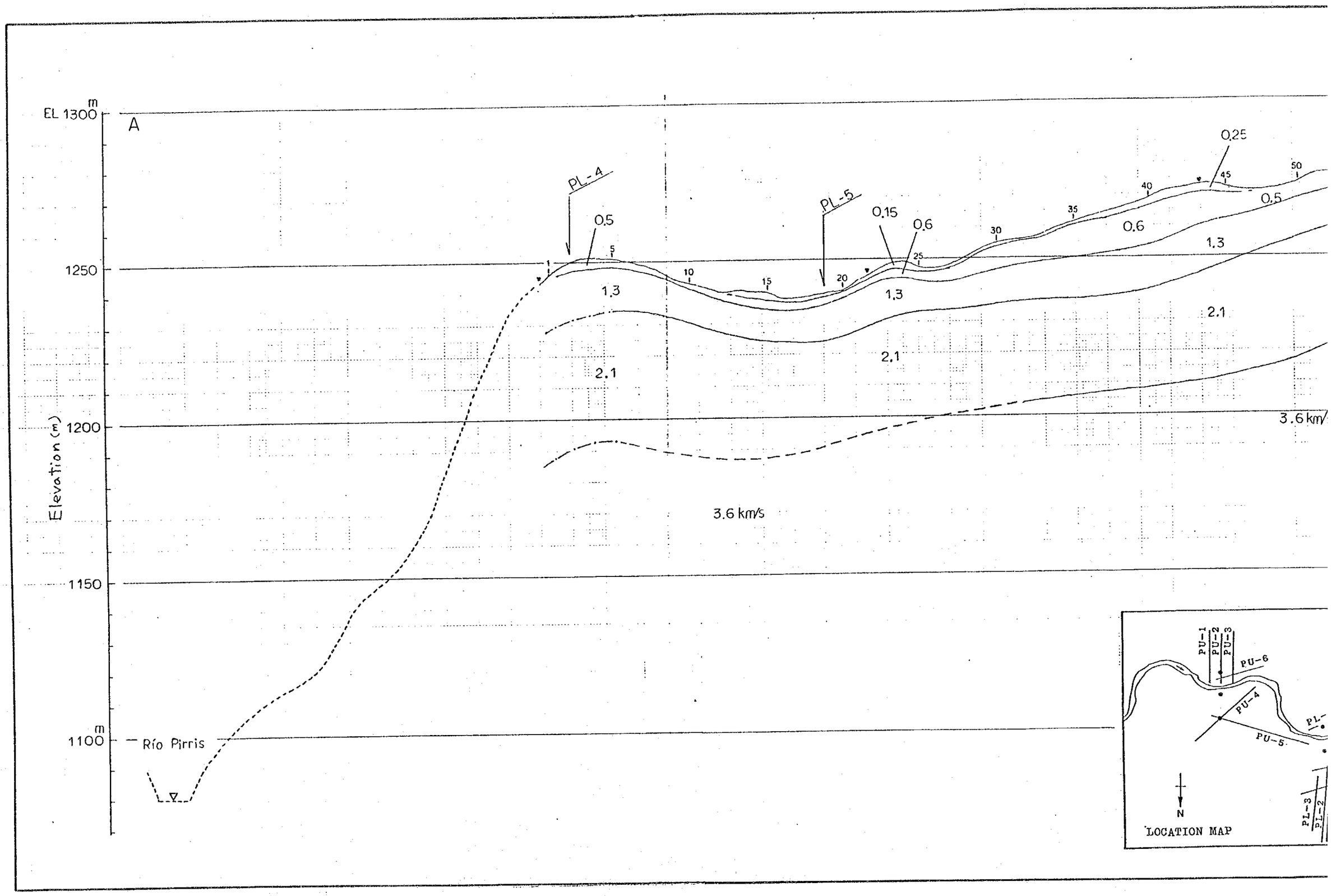
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

SEISMIC PROFILE
PU-5
(UPPER DAM SITE)

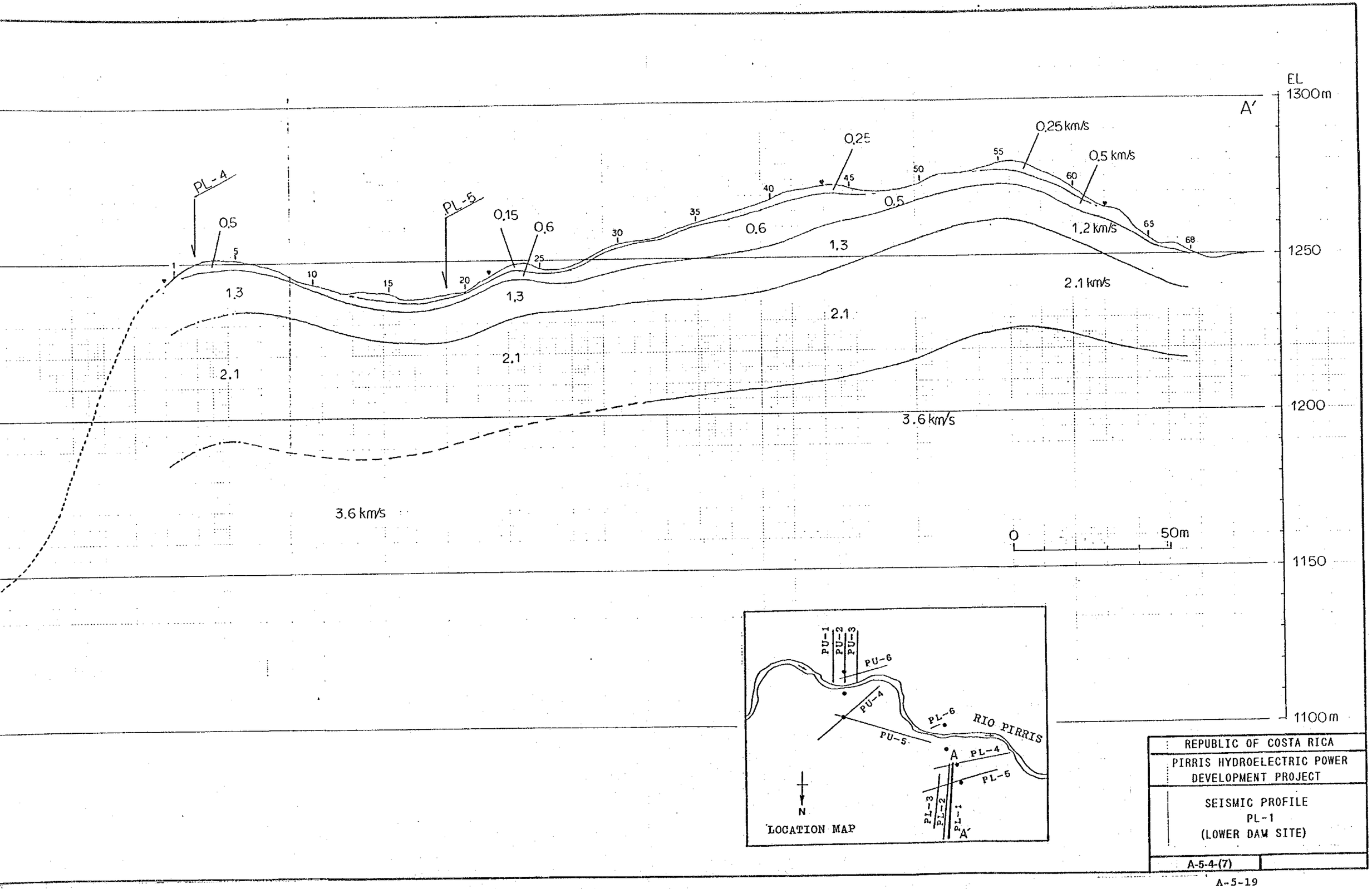
A-5-4-(5)

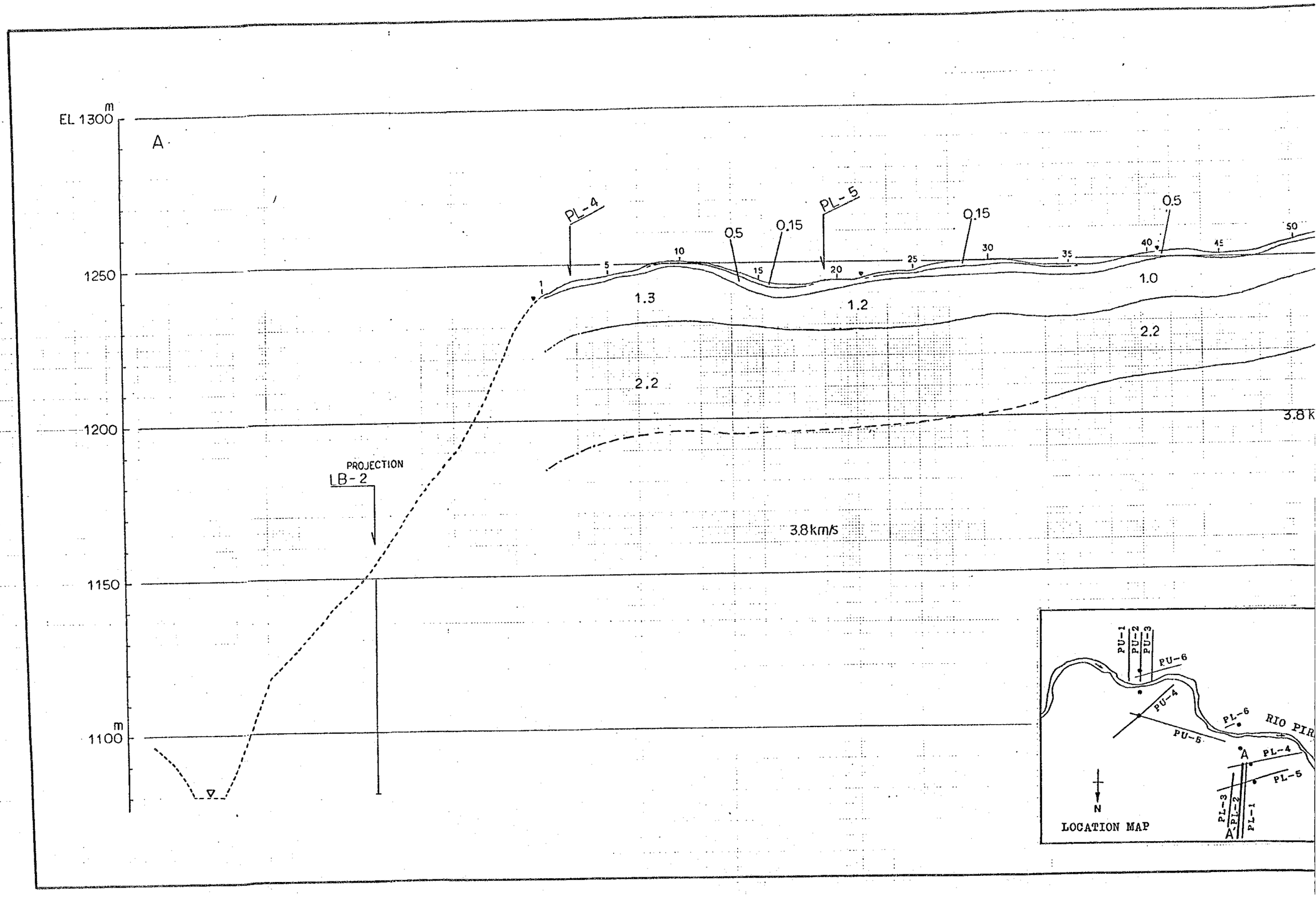


REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
SEISMIC PROFILE PU-6 (UPPER DAM SITE)
A-5-4-(6)

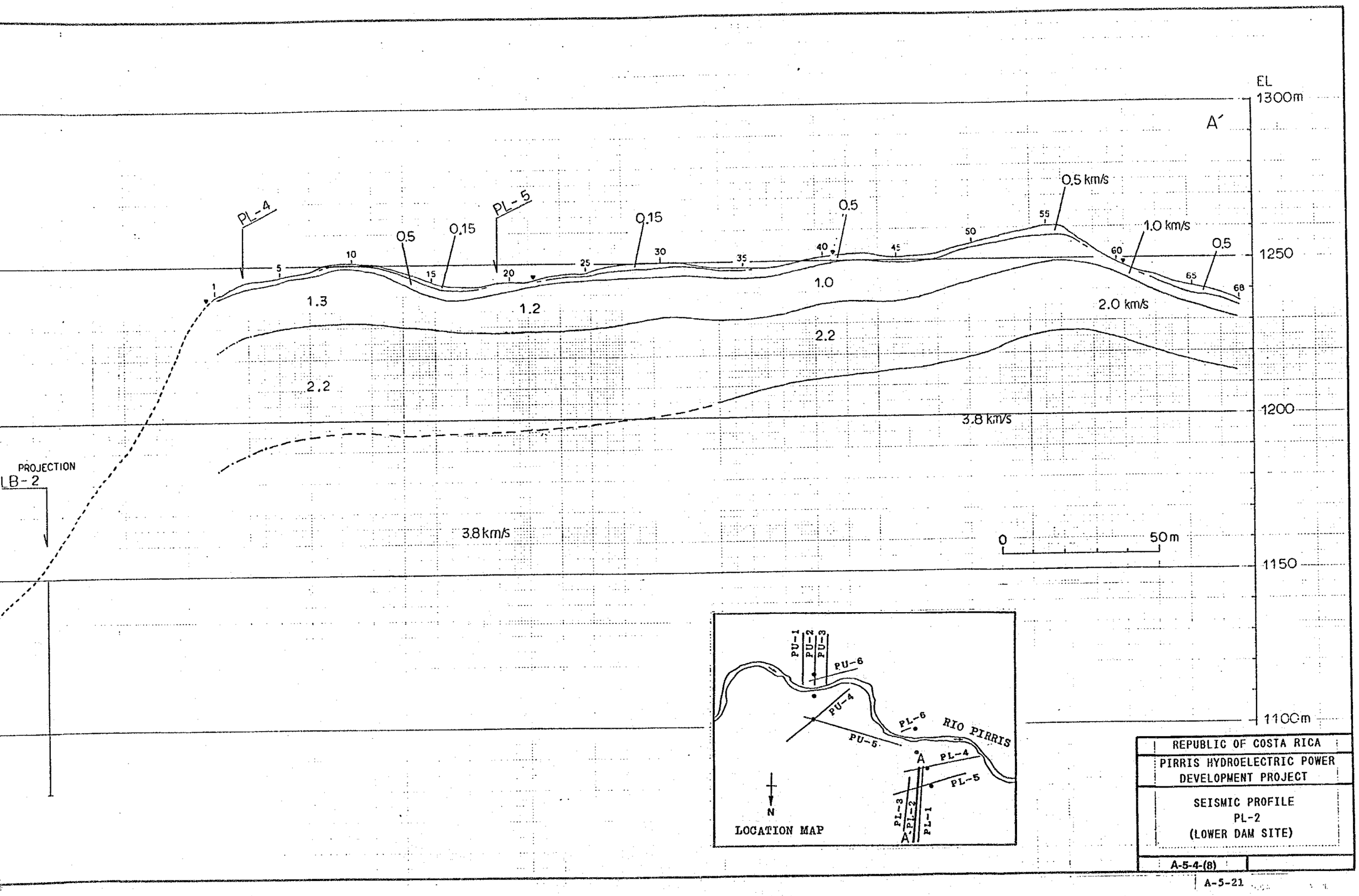

A
EL 1300 m
1250
1200
1150
1100 m
Elevation (m)
Río Pirris
PL-4
PL-5
0.5
1.3
2.1
3.6 km/s
0.15
0.6
0.25
0.5
1.3
2.1
3.6 km/s
0.6
1.3
2.1
5
10
15
20
25
30
35
40
45
50
PU-1
PU-2
PU-3
PU-6
PU-4
PU-5
PL-1
PL-3
PL-2
N
LOCATION MAP

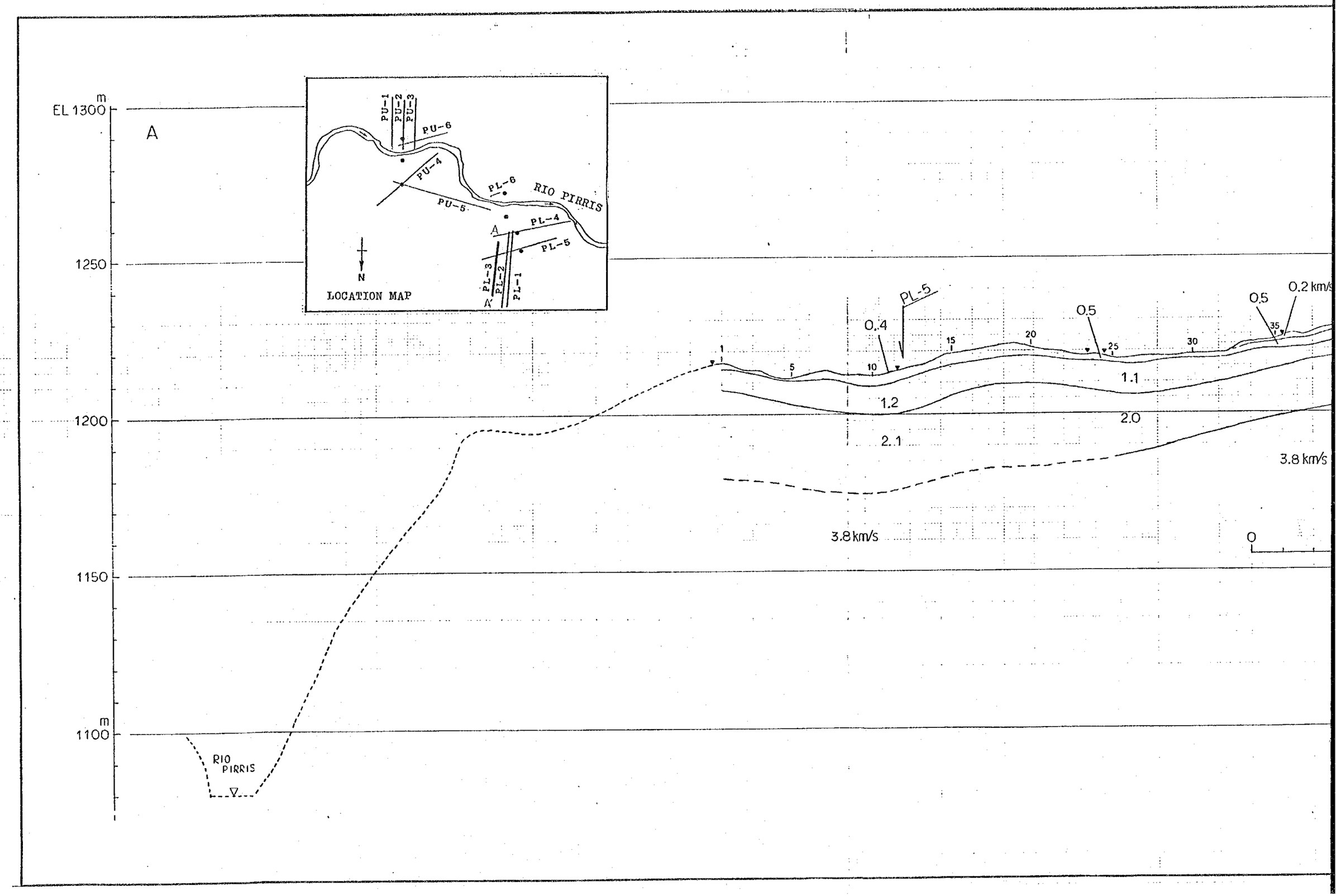
APPENDIX

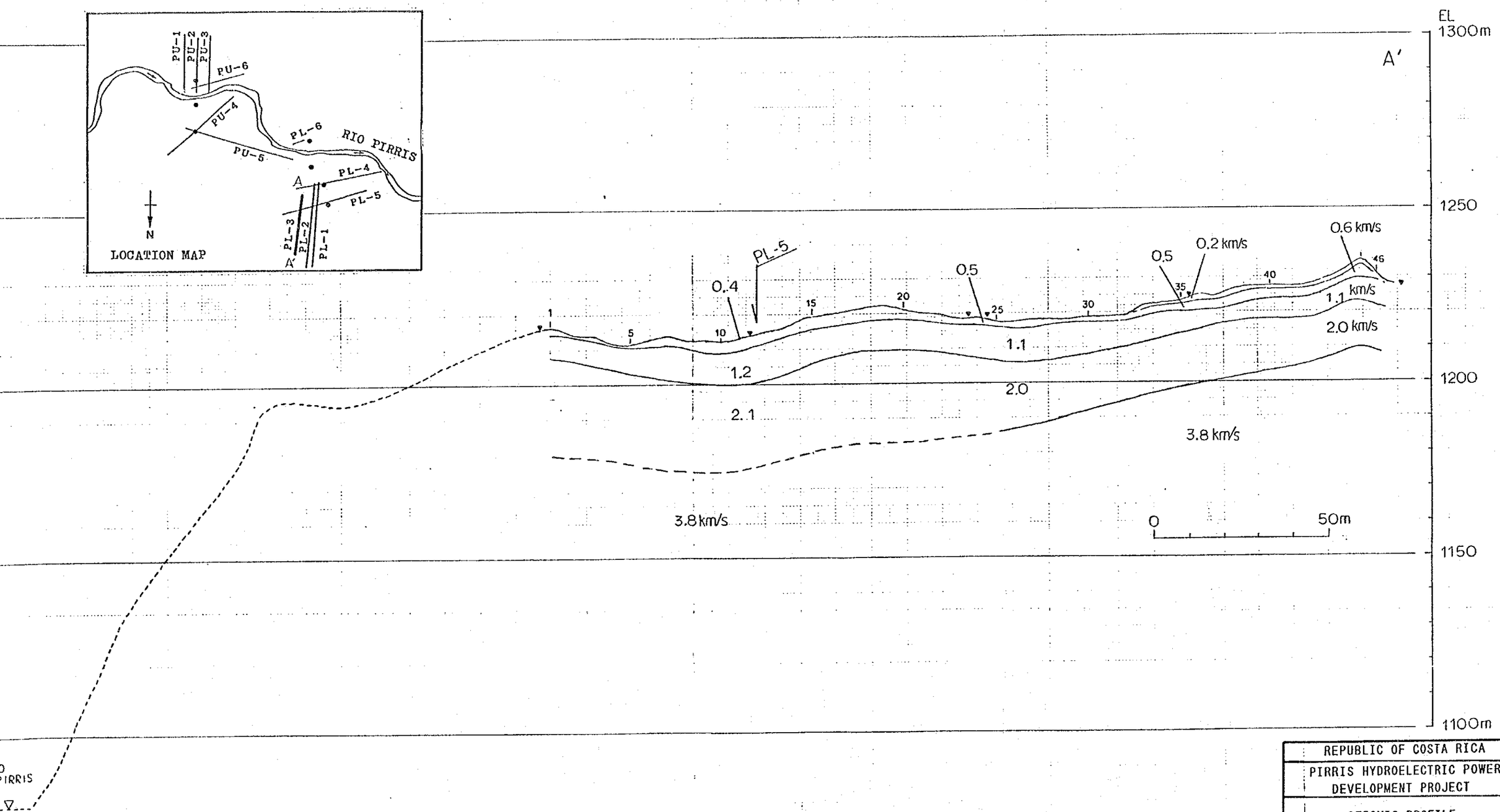

EL
1300m
1250
1200
1150
1100m
A'
PL-4
PL-5
0.5
0.15
0.6
0.25
0.5
0.6
1.3
1.2 km/s
0.25 km/s
0.5 km/s
1.3
1.3
2.1
2.1
2.1
2.1 km/s
3.6 km/s
3.6 km/s
0
50m
PU-1
PU-2
PU-3
PU-6
PU-4
PU-5
PL-6
RIO PIRRIS
A
PL-4
PL-5
PL-3
PL-2
PL-1
A'
N
LOCATION MAP
REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
SEISMIC PROFILE
PL-1
(LOWER DAM SITE)
A-5-4-(7)


m
EL 1300
1250
1200
1150
m
1100
A
PL-4
PL-5
0.5
0.15
0.15
0.5
1
5
10
15
20
25
30
35
40
45
50
1.3
1.2
1.0
2.2
2.2
3.8 k
3.8 km/s
PROJECTION
LB-2
PU-1
PU-2
PU-3
PU-6
PU-4
PU-5
PL-6
RIO PIR
PL-4
PL-5
PL-3
PL-2
PL-1
A
A
N
LOCATION MAP

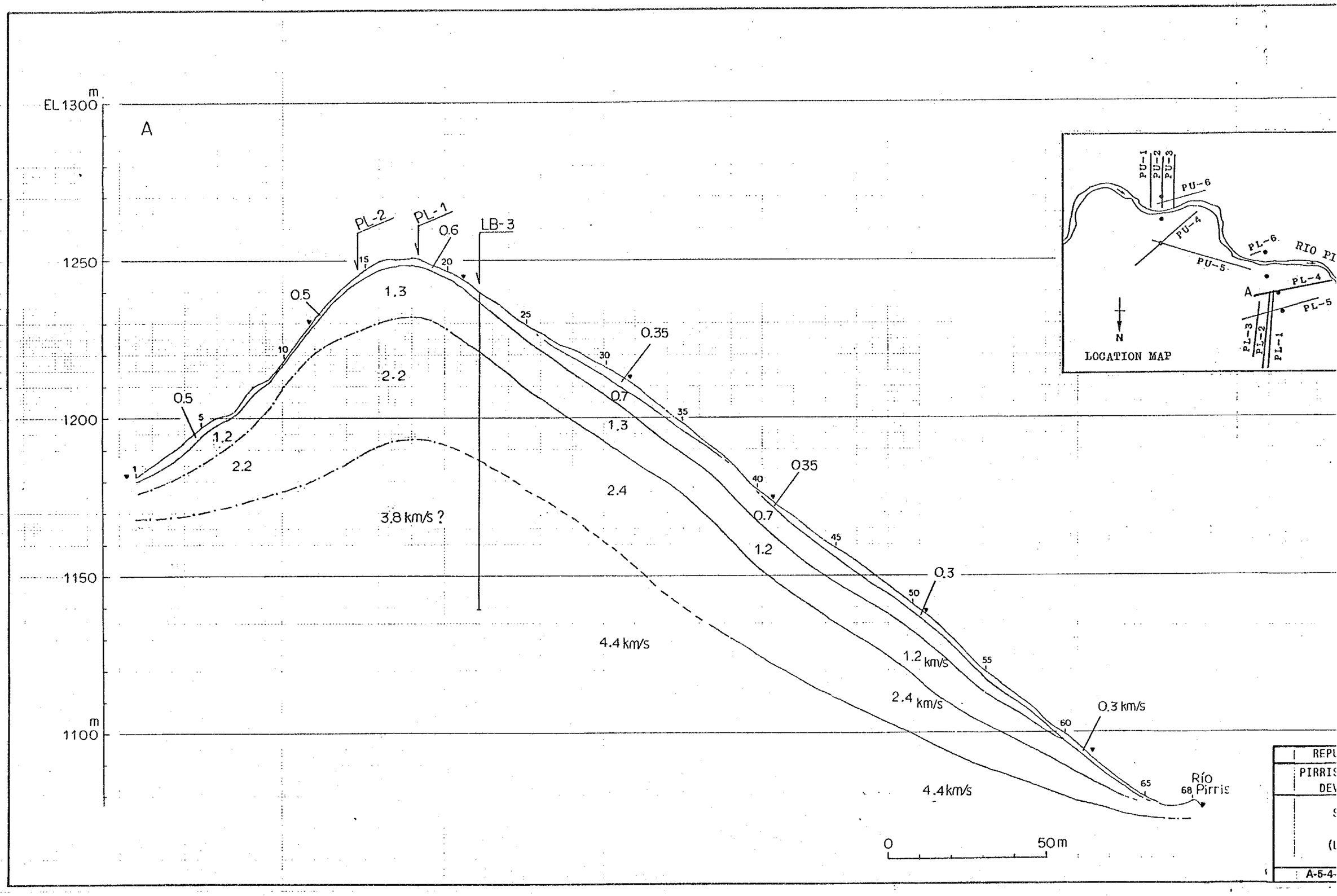
APPENDIX


EL
1300m
1250
1200
1150
1100m
A'
PL-4
PL-5
PROJECTION
LB-2
0.5
0.15
0.15
0.5
0.5 km/s
1.0 km/s
0.5
1.3
1.2
1.0
2.0 km/s
2.2
2.2
3.8 km/s
3.8 km/s
0
50m
PU-1
PU-2
PU-3
PU-6
PU-4
PU-5
PL-6
RIO PIRRIS
PL-4
PL-5
PL-3
PL-2
PL-1
A
A'
N
LOCATION MAP
REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
SEISMIC PROFILE
PL-2
(LOWER DAM SITE)
A-5-4-(8)

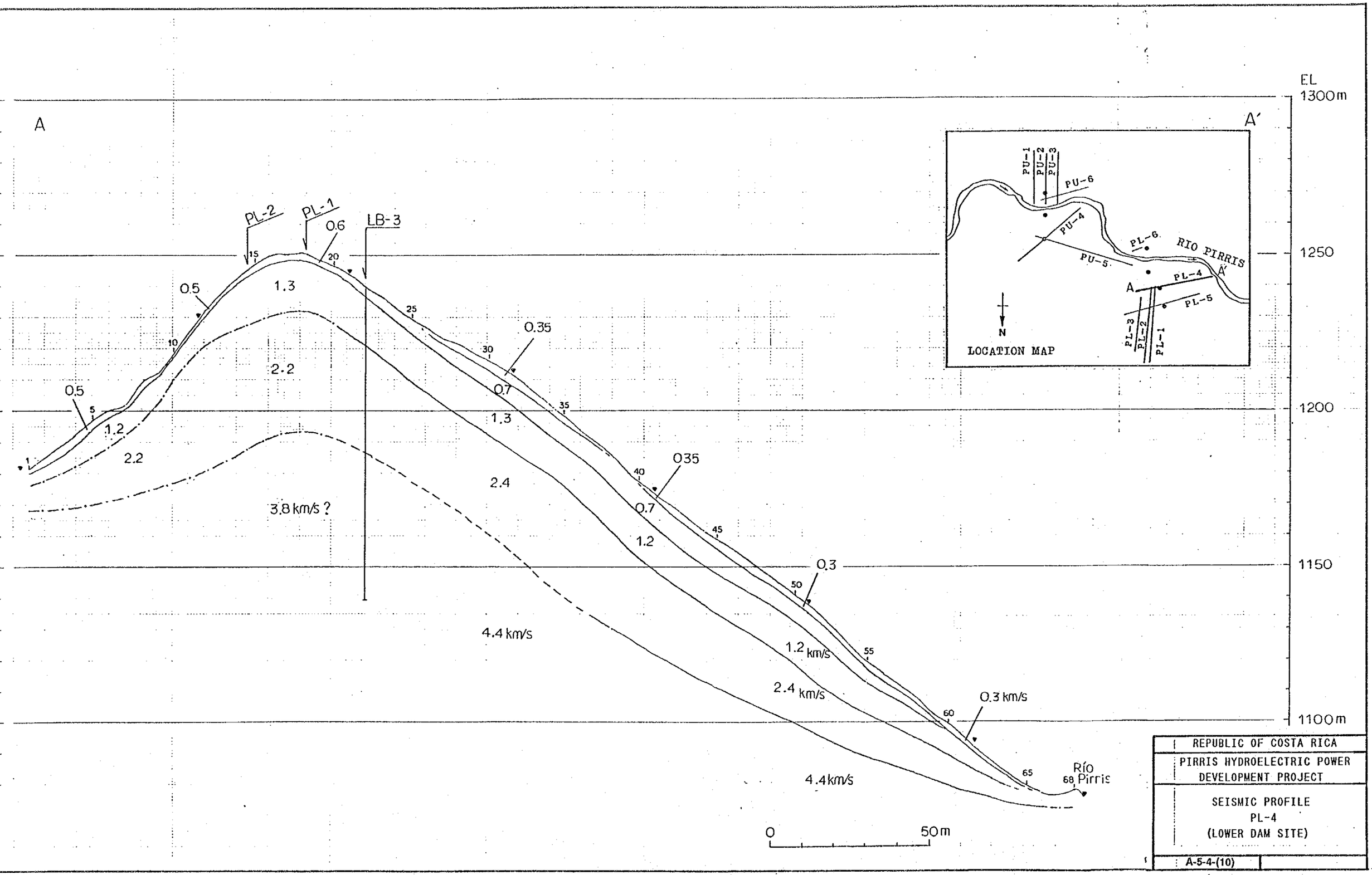

A
EL 1300 m
1250
1200
1150
1100 m
LOCATION MAP
N
PU-1
PU-2
PU-3
PU-4
PU-5
PU-6
PL-1
PL-2
PL-3
PL-4
PL-5
PL-6
RIO PIRRIS
A
A'
PL-5
0.4
0.5
0.5
0.2 km/s
1.1
1.2
2.0
2.1
3.8 km/s
3.8 km/s
0
RIO PIRRIS



REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
SEISMIC PROFILE PL-3 (LOWER DAM SITE)
A-5-4-(9)


m
EL 1300
1250
1200
1150
m
1100
A
PL-2
PL-1
LB-3
0.6
0.5
1.3
2.2
0.5
1.2
2.2
3.8 km/s ?
0.35
0.7
1.3
2.4
035
0.7
1.2
0.3
4.4 km/s
1.2 km/s
2.4 km/s
0.3 km/s
4.4 km/s
Río Pirris
0
50 m
PU-1
PU-2
PU-3
PU-6
PU-4
PU-5
PL-6
RIO PI
PL-4
PL-5
A
PL-3
PL-2
PL-1
N
LOCATION MAP
REPU
PIRRIS
DEV
A-6-4-

APPENDIX



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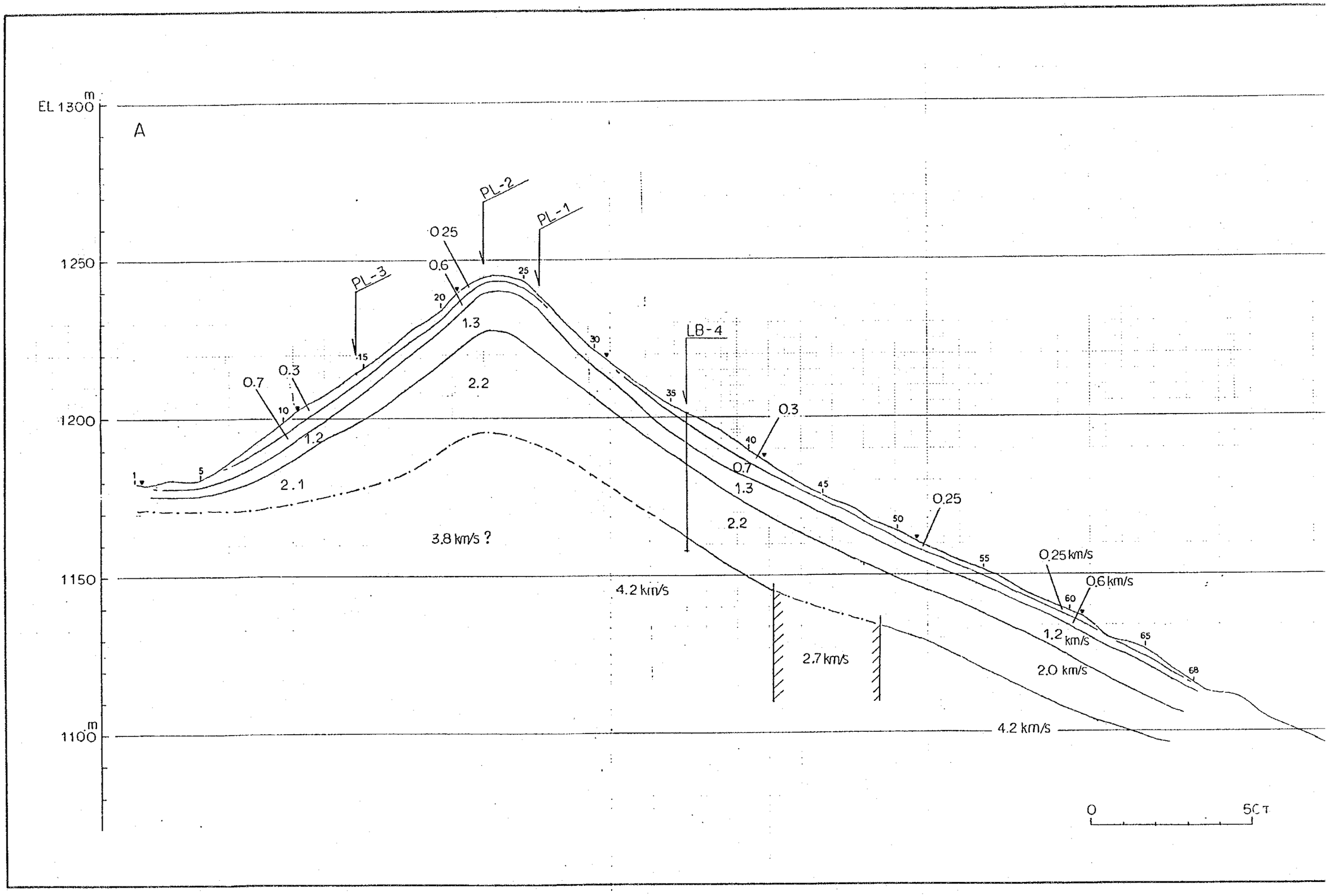
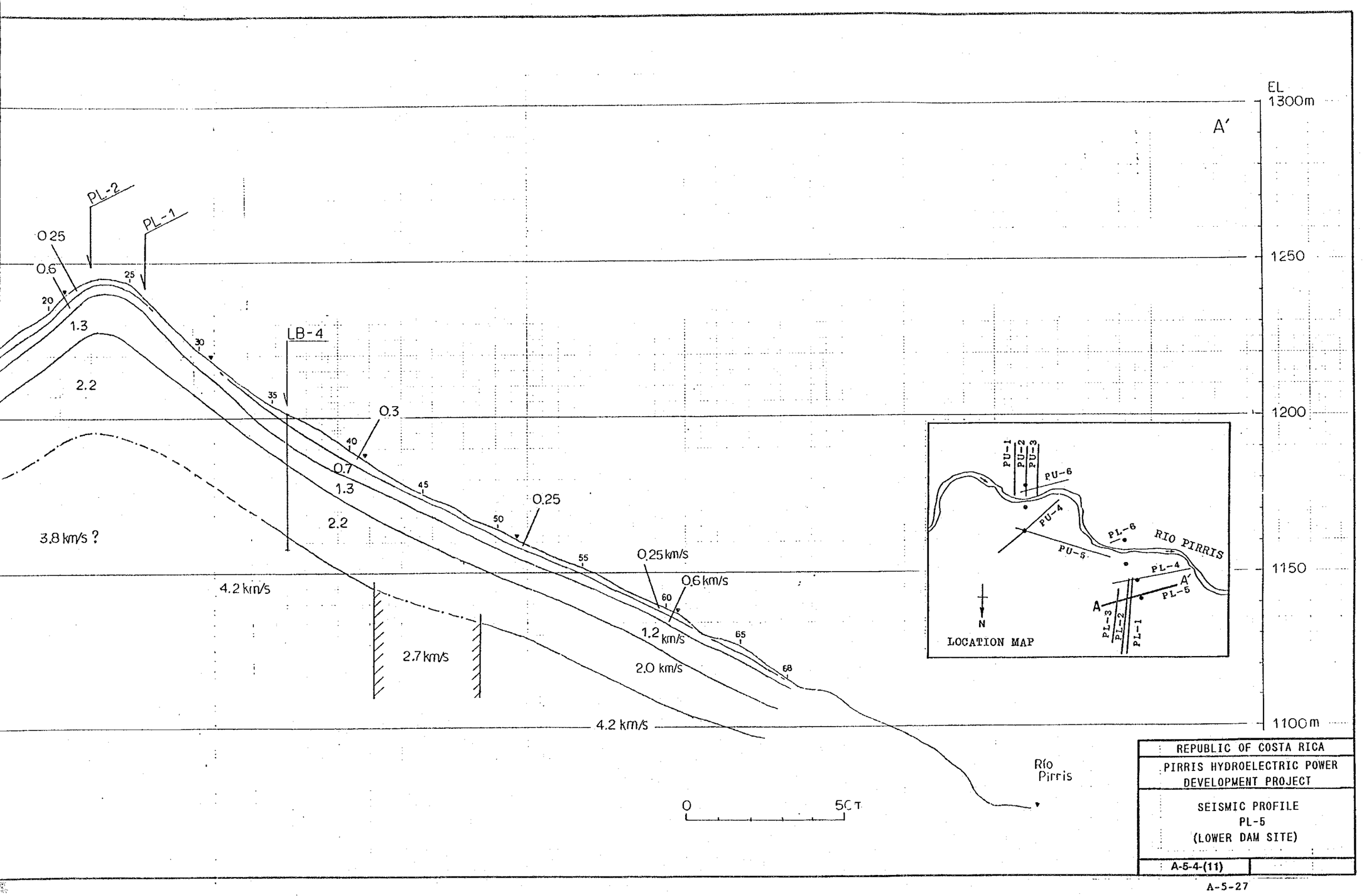
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

SEISMIC PROFILE
PL-4
(LOWER DAM SITE)

A-5-4-(10)


EL 1300 m
1250
1200
1150
1100 m
A
PL-3
PL-2
PL-1
LB-4
0.25
0.6
0.3
0.7
1.3
2.2
1.2
2.1
3.8 km/s ?
4.2 km/s
2.7 km/s
0.3
0.7
1.3
2.2
0.25
0.25 km/s
0.6 km/s
1.2 km/s
2.0 km/s
4.2 km/s
1
5
10
15
20
25
30
35
40
45
50
55
60
65
68
0
50 m

APPENDIX

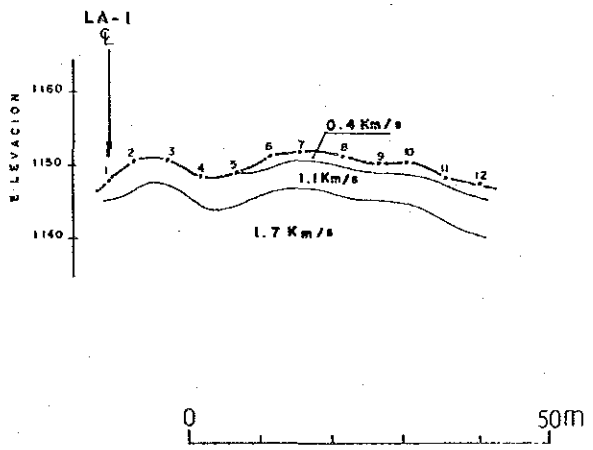


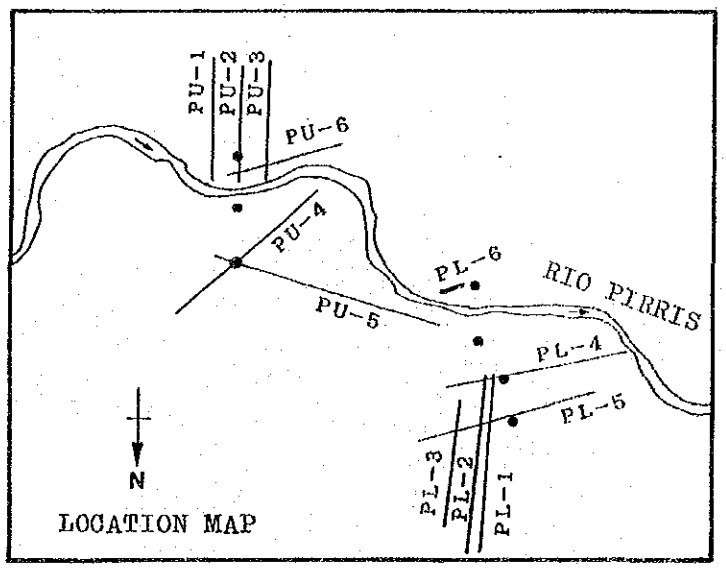
REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

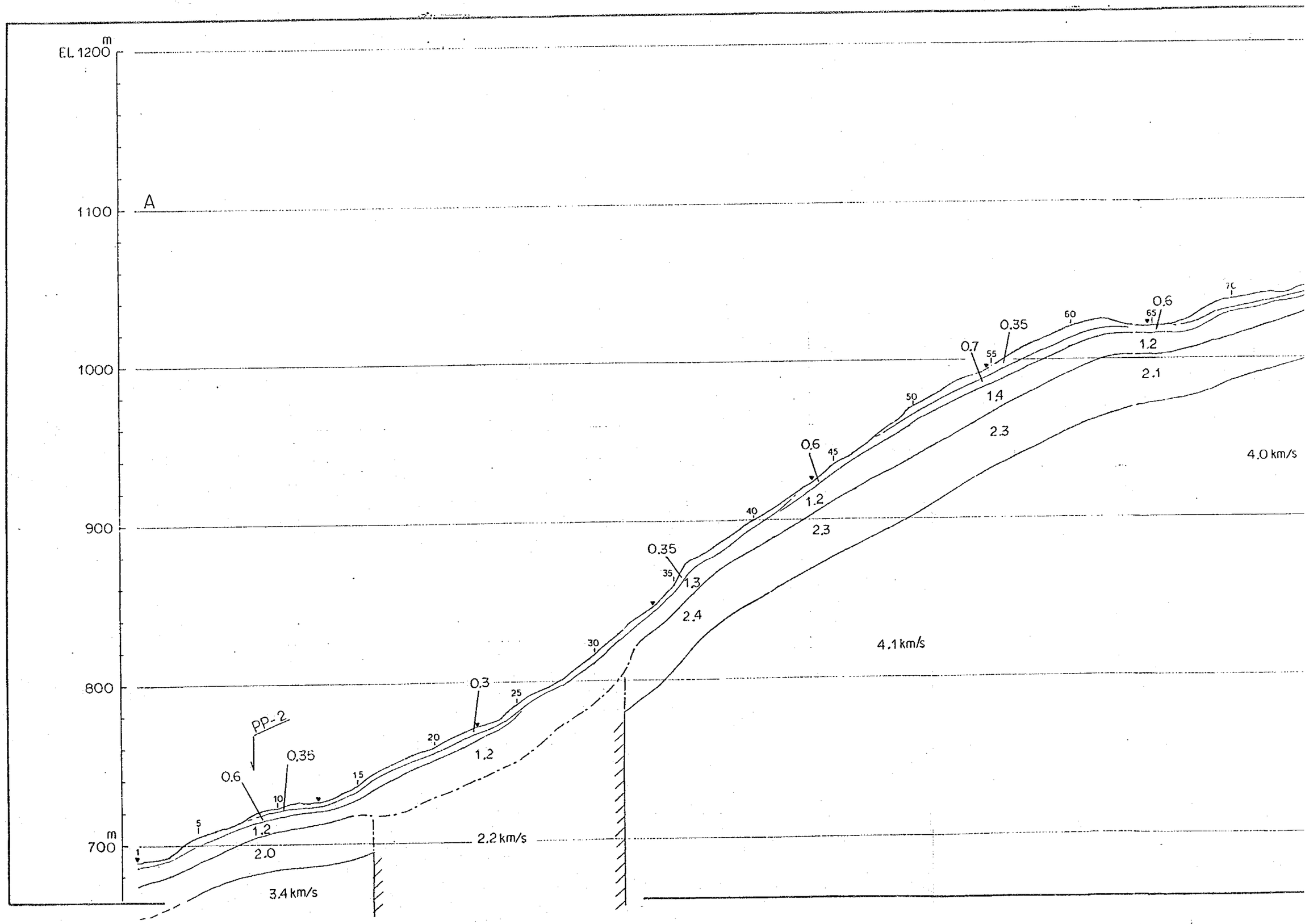
SEISMIC PROFILE
PL-5
(LOWER DAM SITE)

A-5-4-(11)

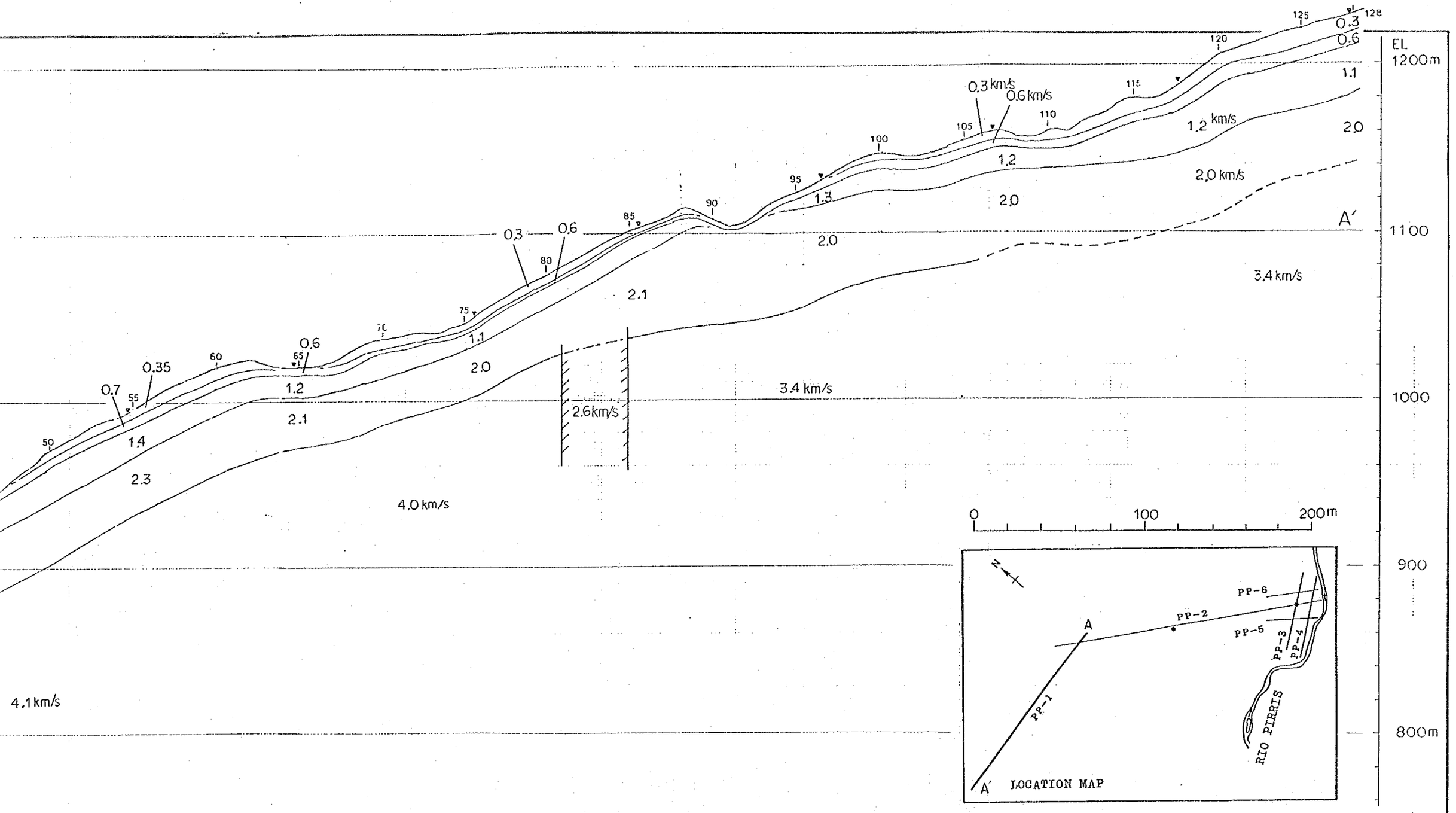




REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
SEISMIC PROFILE PL-6 (LOWER DAM SITE)
A-5-4-(12)


m
EL 1200
1100
1000
900
800
m
700
A
PP-2
0.6
0.35
0.3
1.2
2.0
3.4 km/s
2.2 km/s
0.35
1.3
2.4
4.1 km/s
0.6
1.2
2.3
0.7
1.4
2.3
0.35
0.6
1.2
2.1
4.0 km/s
1
5
10
15
20
25
30
35
40
45
50
55
60
65
70

A/ペ-ジ

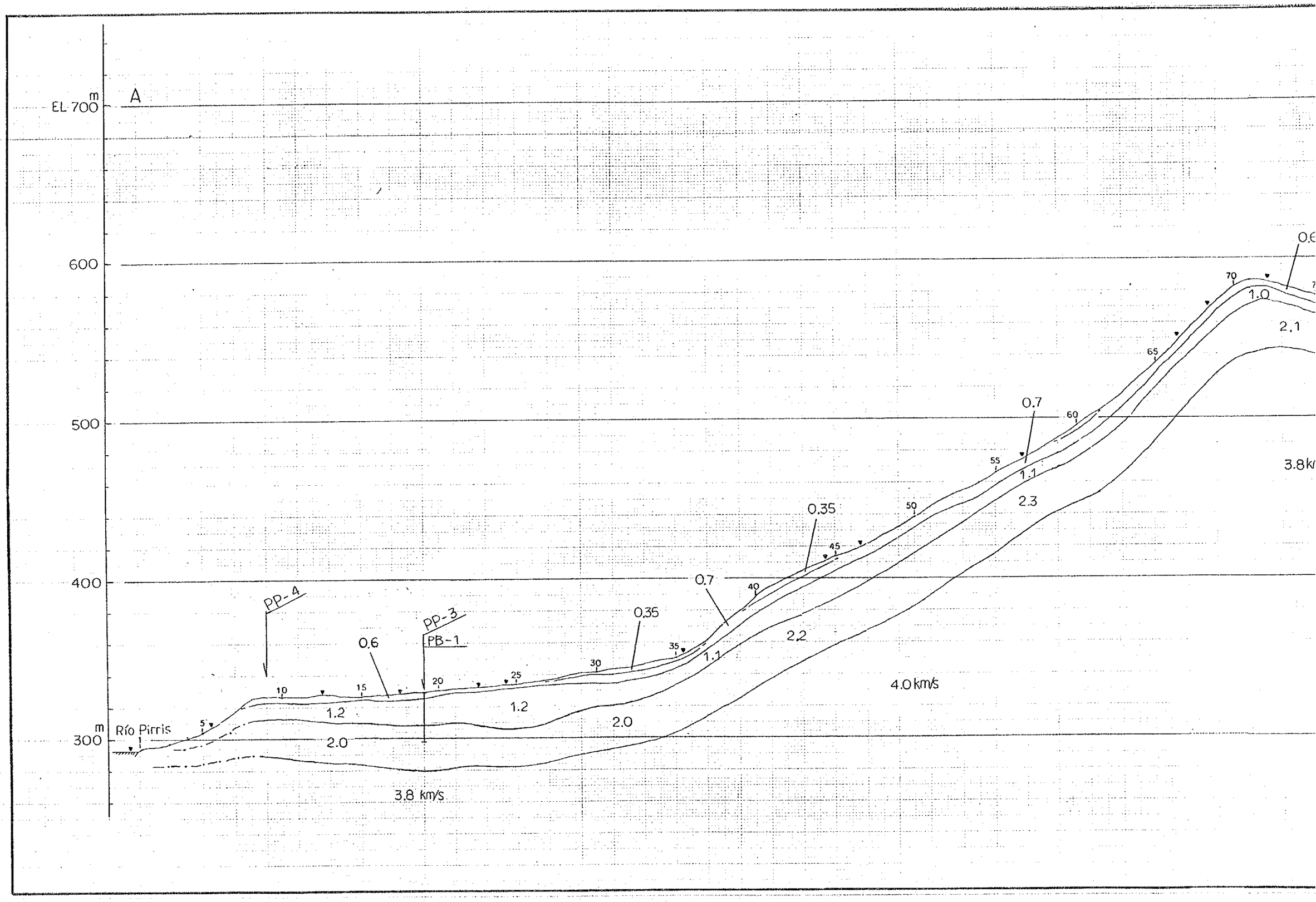


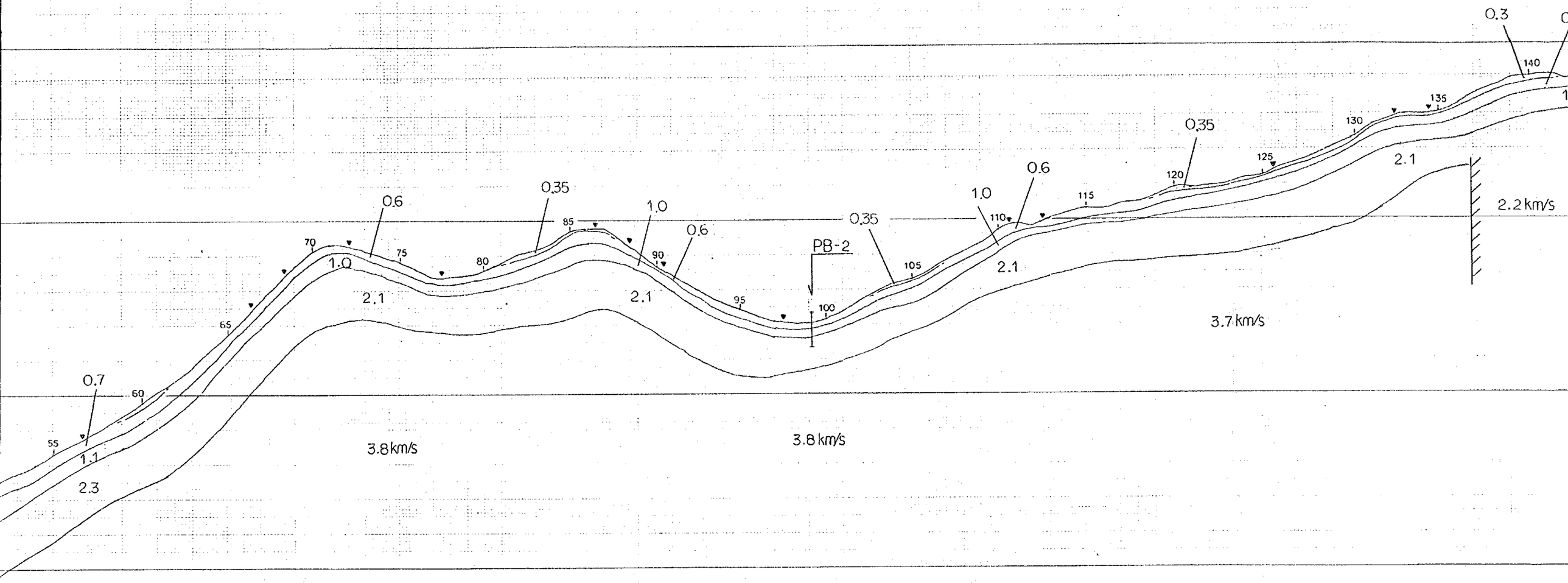
REPUBLIC OF COSTA RICA

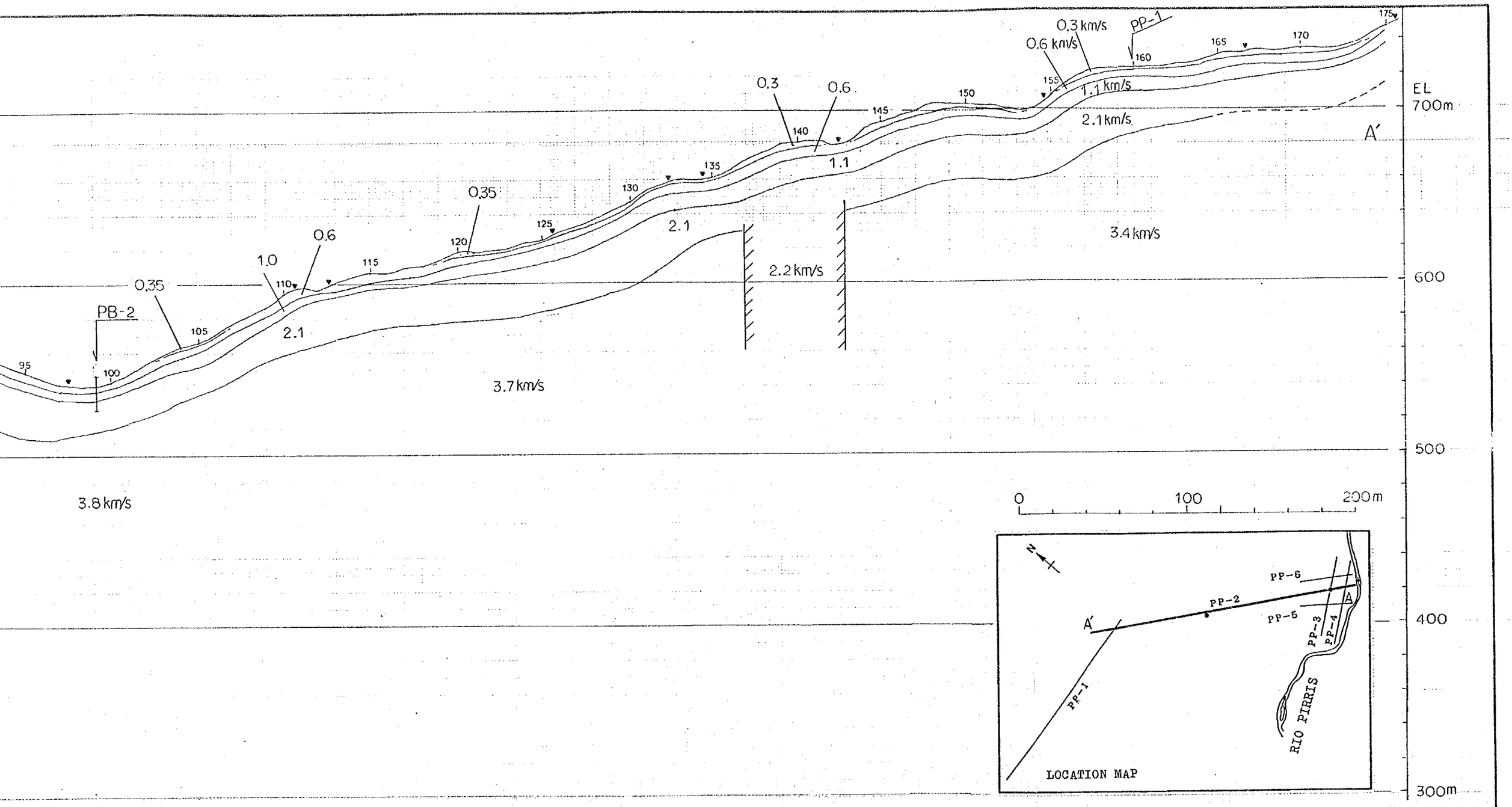
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

SEISMIC PROFILE
PP-1
(PENSTOCK AND POWER PLANT SITE)

A-5-4-(13)


A
EL 700 m
600
500
400
300 m
Río Pirris
PP-4
PP-3
PB-1
0.6
0.7
0.35
0.7
0.35
0.6
1.0
2.1
1.1
2.3
1.1
2.2
1.2
1.2
2.0
2.0
3.8 km/s
4.0 km/s
3.8 km/s
5
10
15
20
25
30
35
40
45
50
55
60
65
70


0.3
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
0.35
0.6
1.0
0.7
1.1
2.3
2.1
3.8 km/s
3.7 km/s
2.2 km/s
PB-2

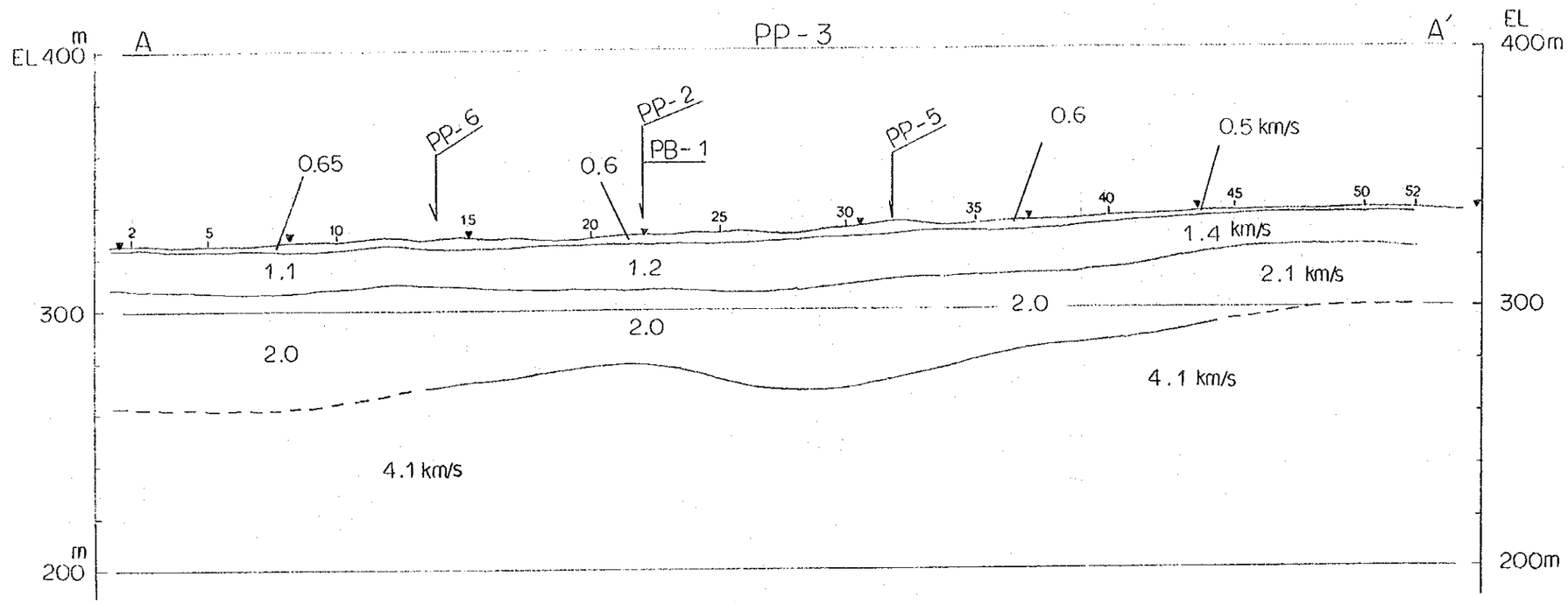


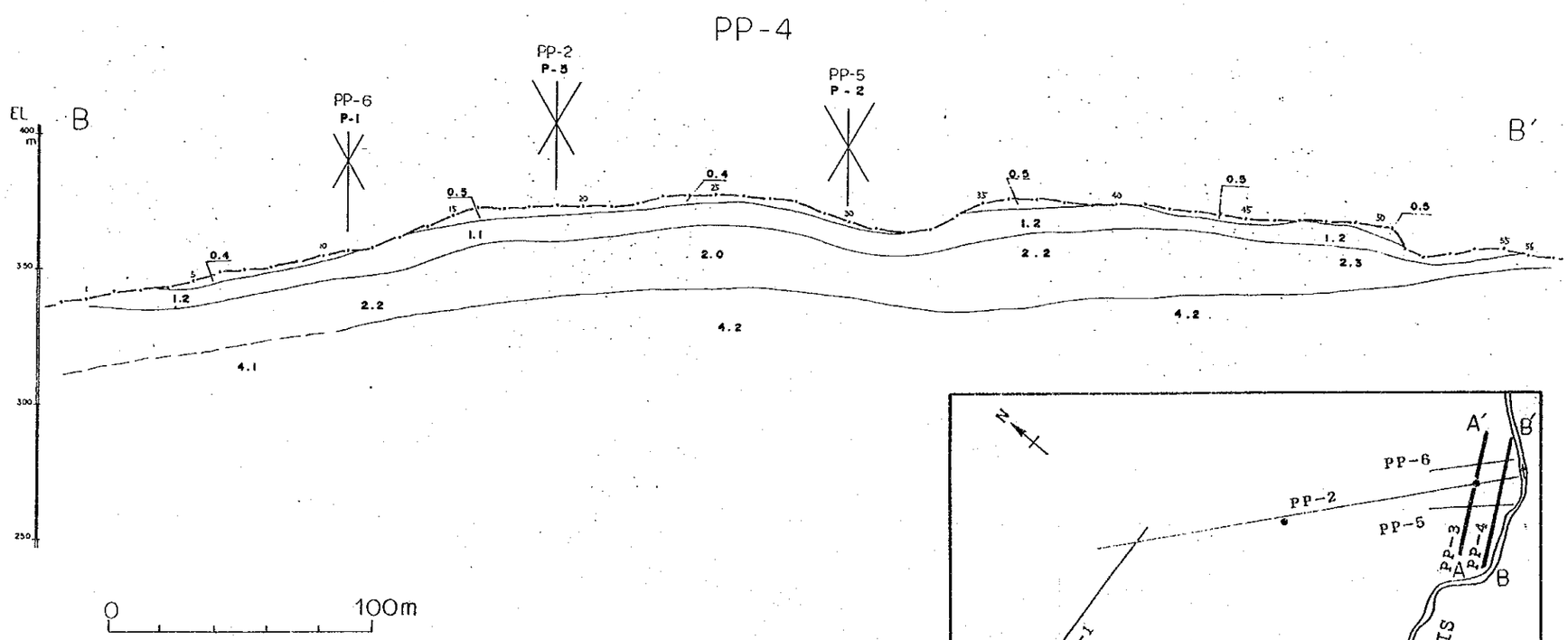
REPUBLIC OF COSTA RICA

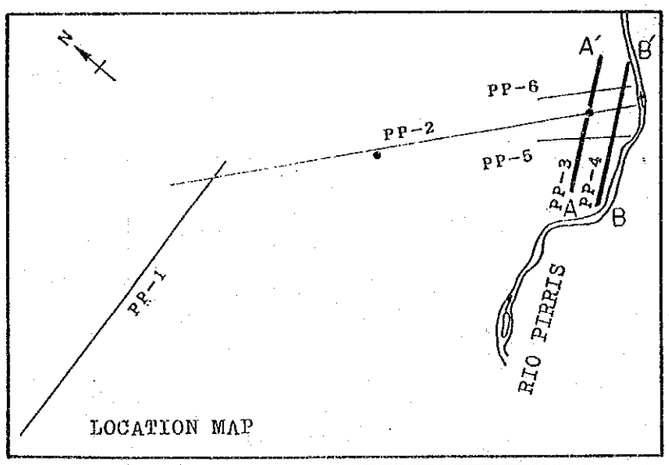
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

SEISMIC PROFILE
PP-2
(PENSTOCK AND POWER PLANT SITE)

A-5-4-(14)







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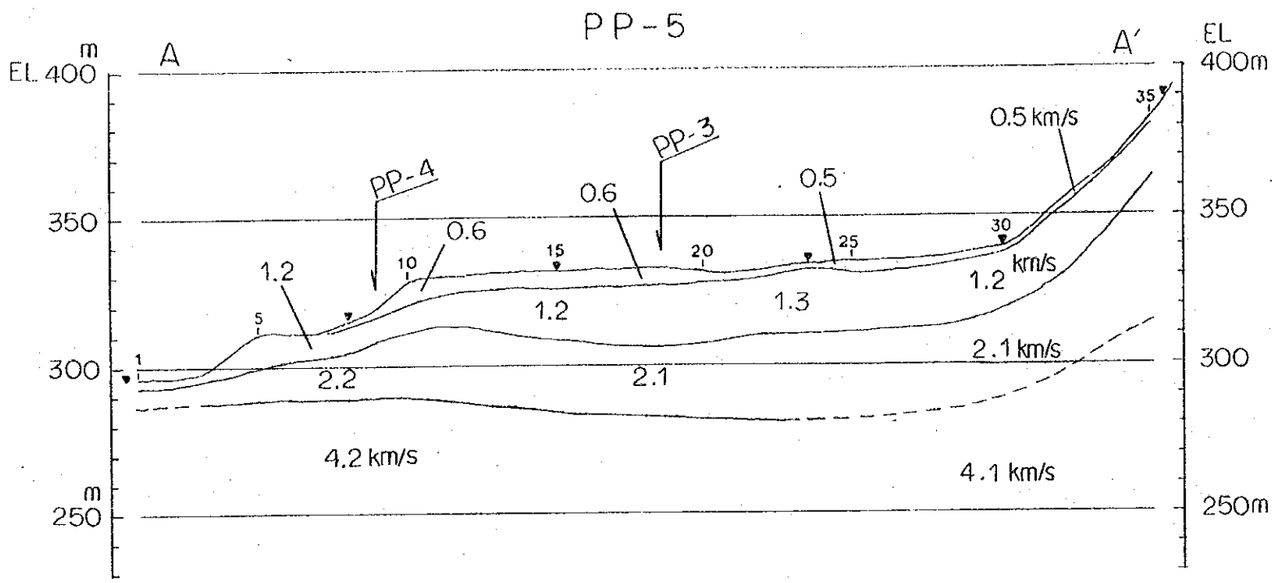
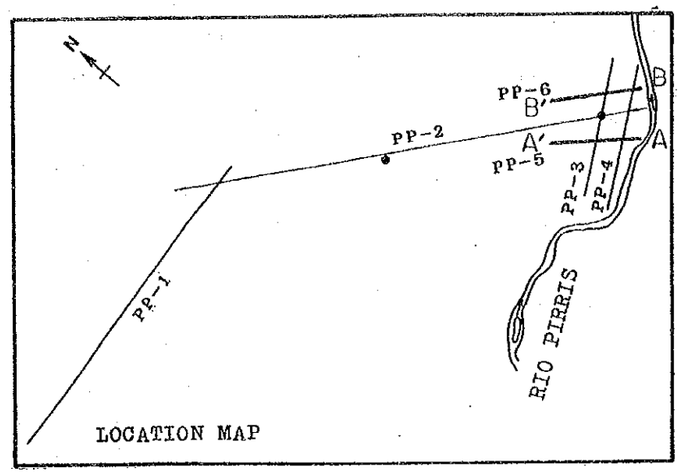
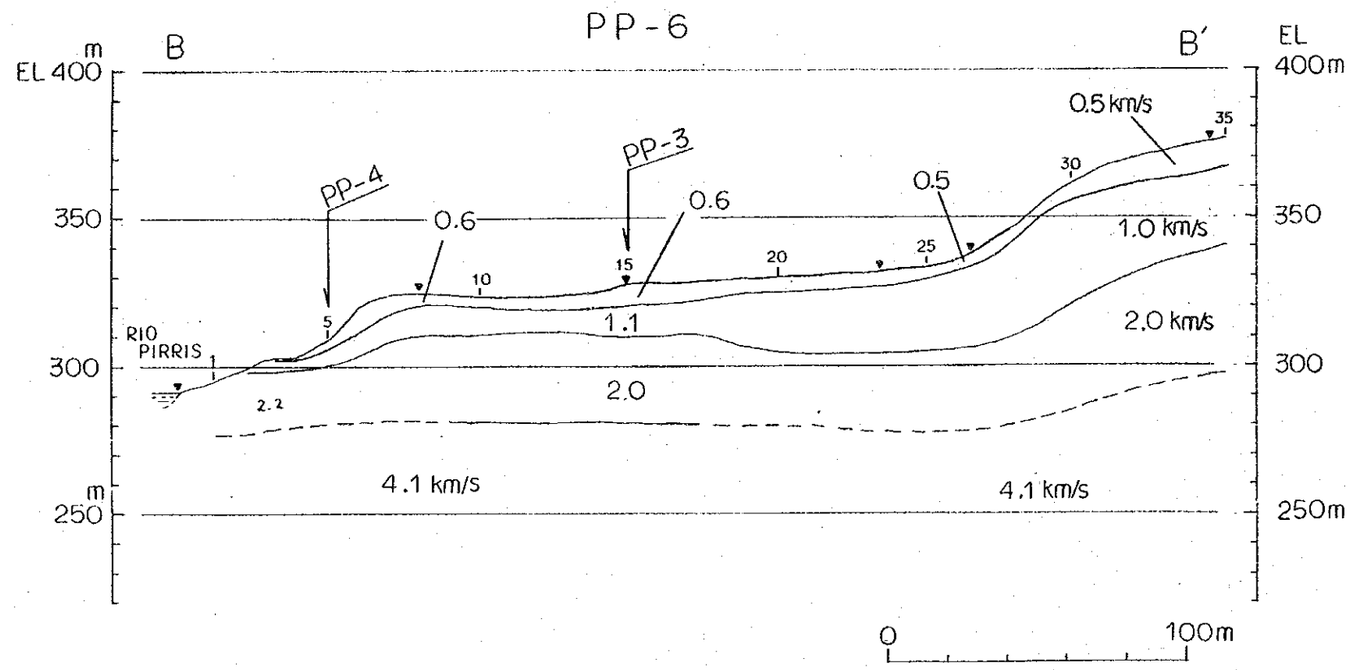
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

SEISMIC PROFILE
PP-3, PP-4
(PENSTOCK AND POWER PLANT SITE)

A-5-4-(15)







REPUBLIC OF COSTA RICA

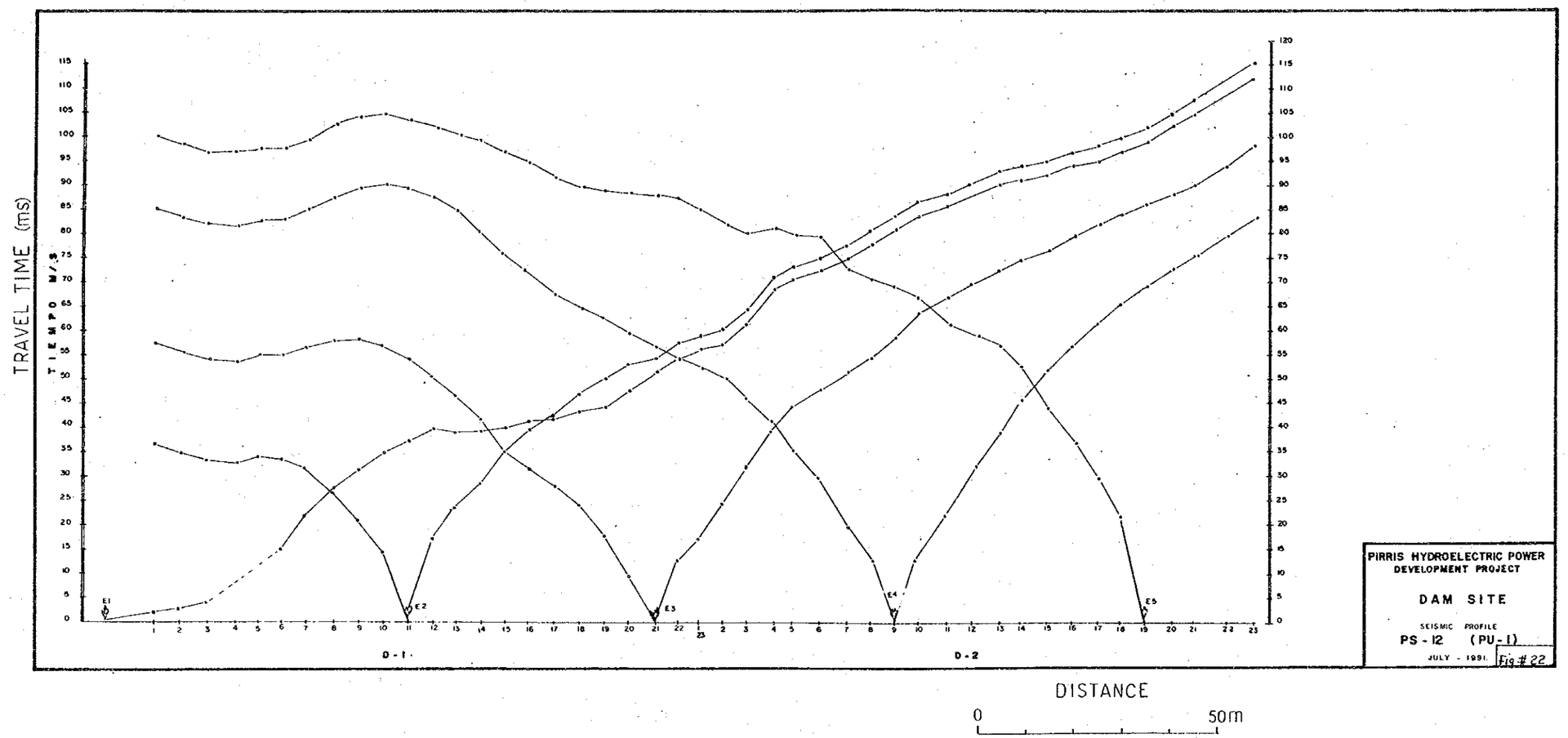
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

SEISMIC PROFILE
PP-5, PP-6
(PENSTOCK AND POWER PLANT SITE)

A-5-4-(16)

A-5-5 Time-Distance Plot (Sheet No. 1 ~ No. 14)

A-5-5-(1)	Time-Distance Plot	PU-1
A-5-5-(2)	Time-Distance Plot	PU-2
A-5-5-(3)	Time-Distance Plot	PU-3
A-5-5-(4)	Time-Distance Plot	PU-4
A-5-5-(5)	Time-Distance Plot	PU-5
A-5-5-(6)	Time-Distance Plot	PU-6
A-5-5-(7)	Time-Distance Plot	PL-1
A-5-5-(8)	Time-Distance Plot	PL-2
A-5-5-(9)	Time-Distance Plot	PL-3
A-5-5-(10)	Time-Distance Plot	PL-4
A-5-5-(11)	Time-Distance Plot	PL-5, PL-6
A-5-5-(12)	Time-Distance Plot	PP-1, PP-2
A-5-5-(13)	Time-Distance Plot	PP-3, PP-4
A-5-5-(14)	Time-Distance Plot	PP-5, PP-6



PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

DAM SITE

SEISMIC PROFILE

PS - 12 (PU-1)

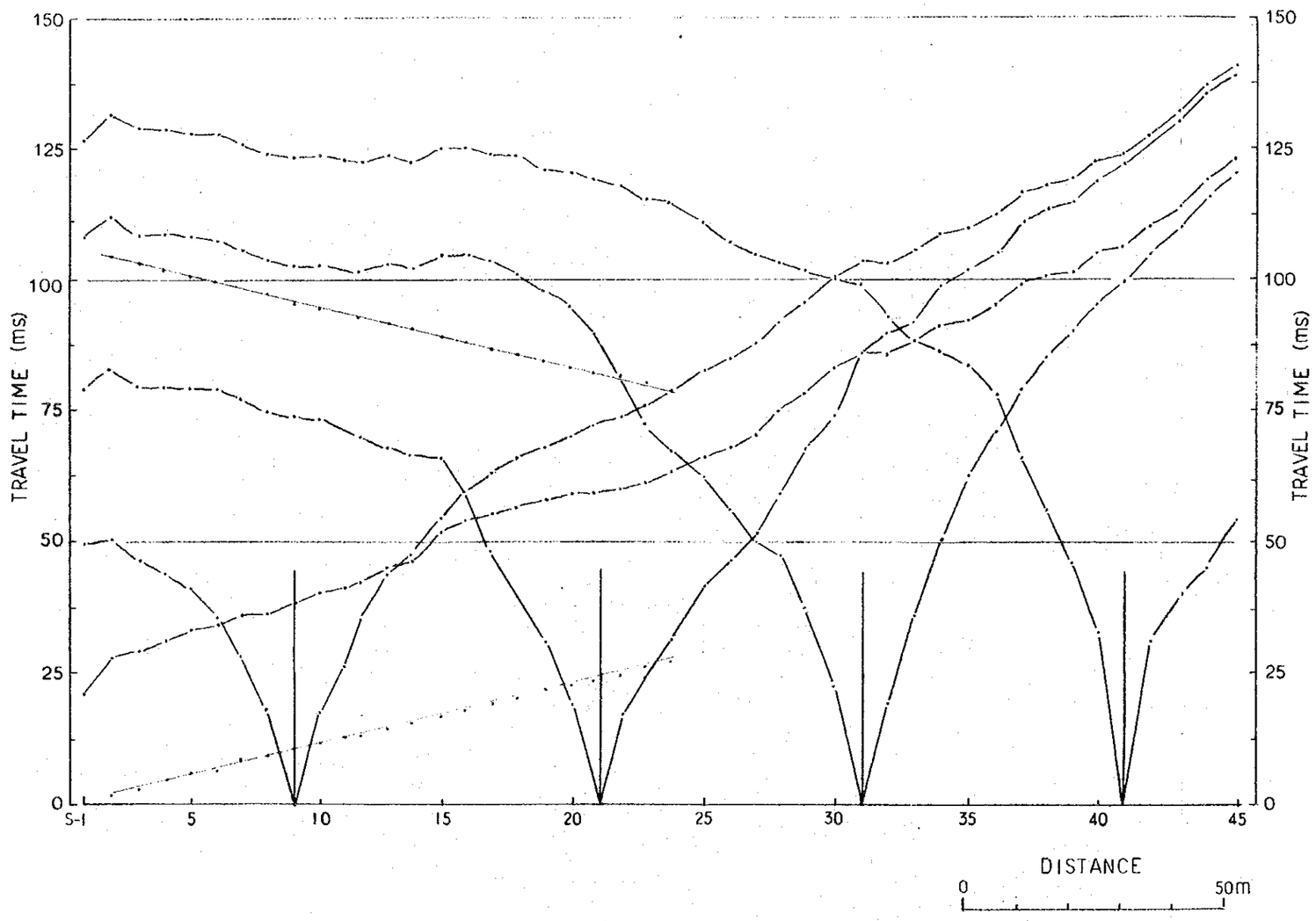
JULY - 1991. Fig # 22

REPUBLIC OF COSTA RICA

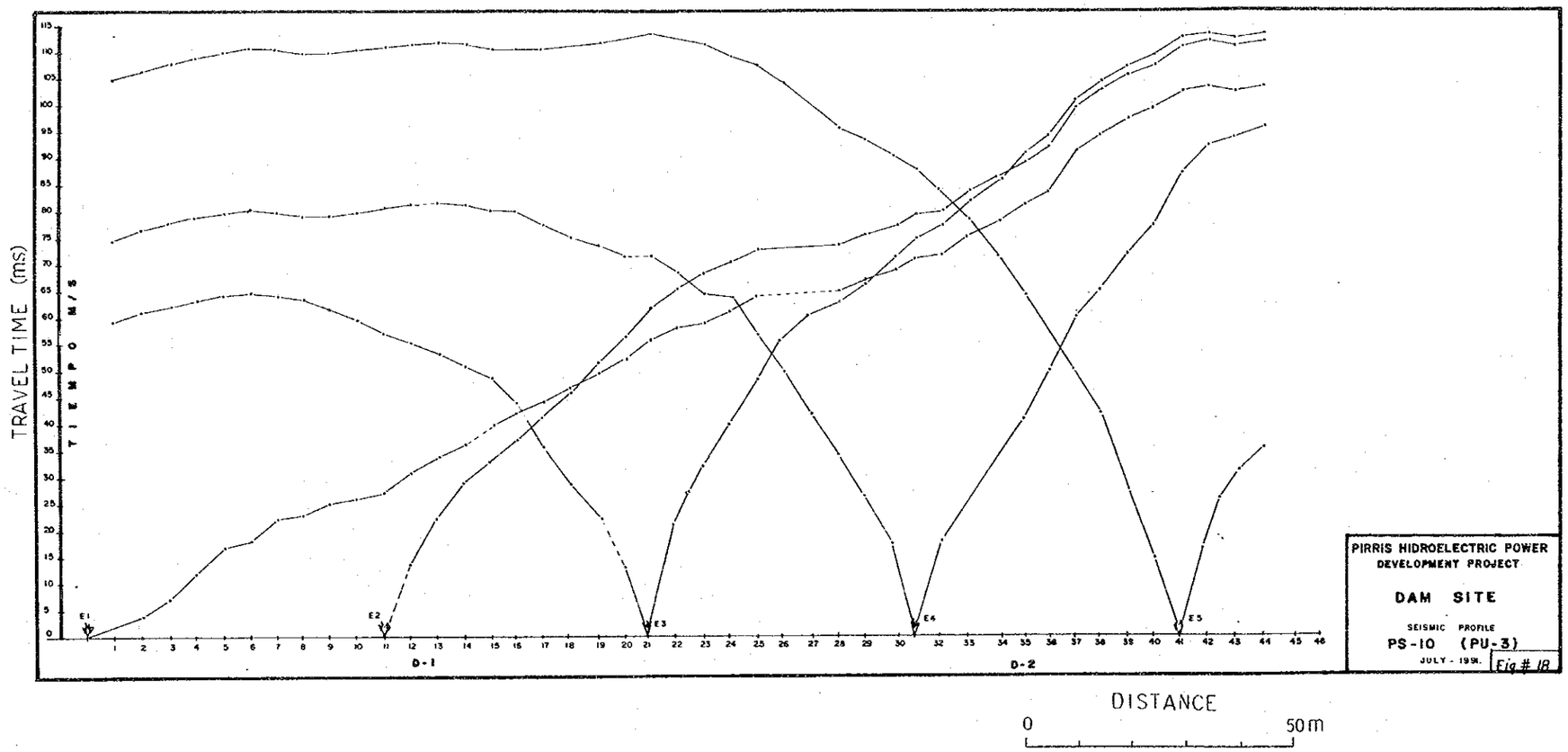
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

TIME-DISTANCE PLOT
PU-1
(UPPER DAM SITE)

A-5-5-(1)



REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
TIME-DISTANCE PLOT PU-2 (UPPER DAM SITE)
A-5-5-(2)

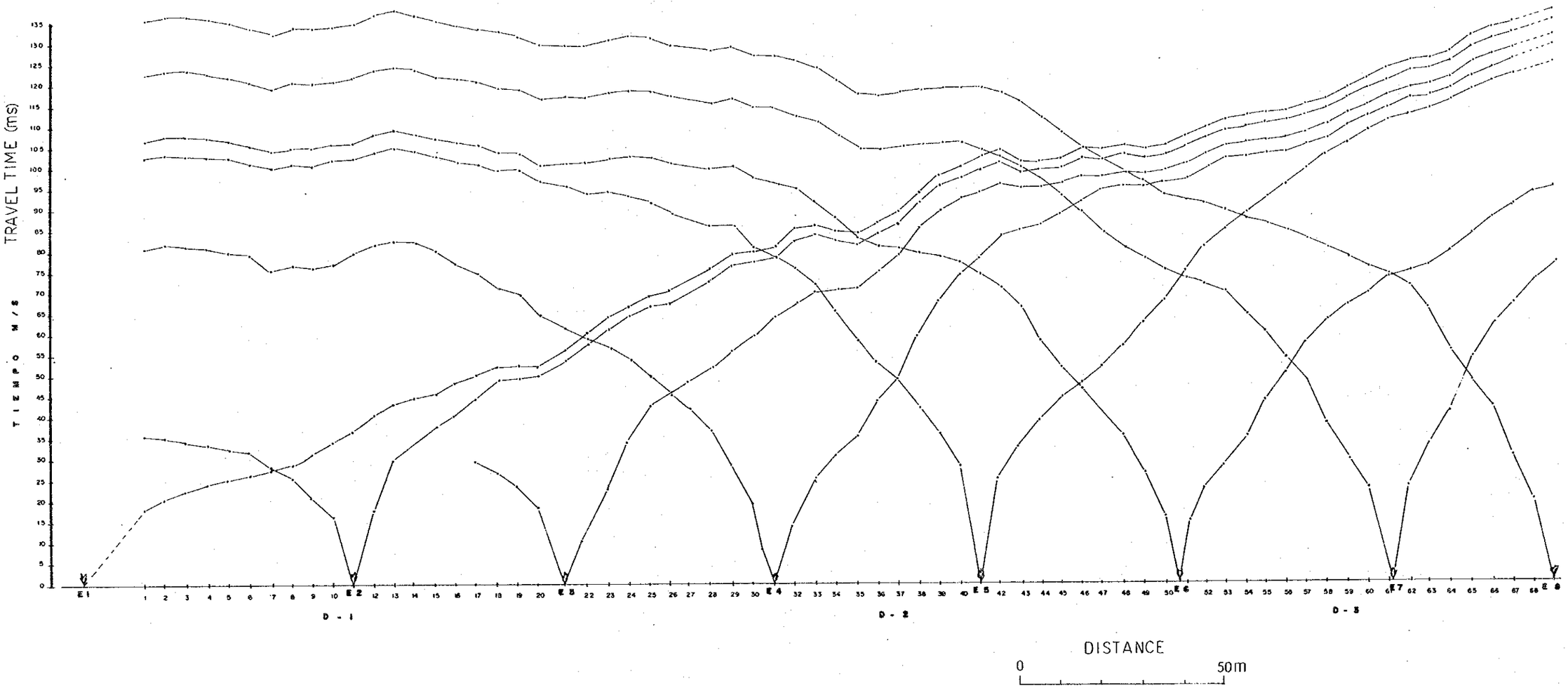


REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

TIME-DISTANCE PLOT
PU-3
(UPPER DAM SITE)

A-5-5-(3)

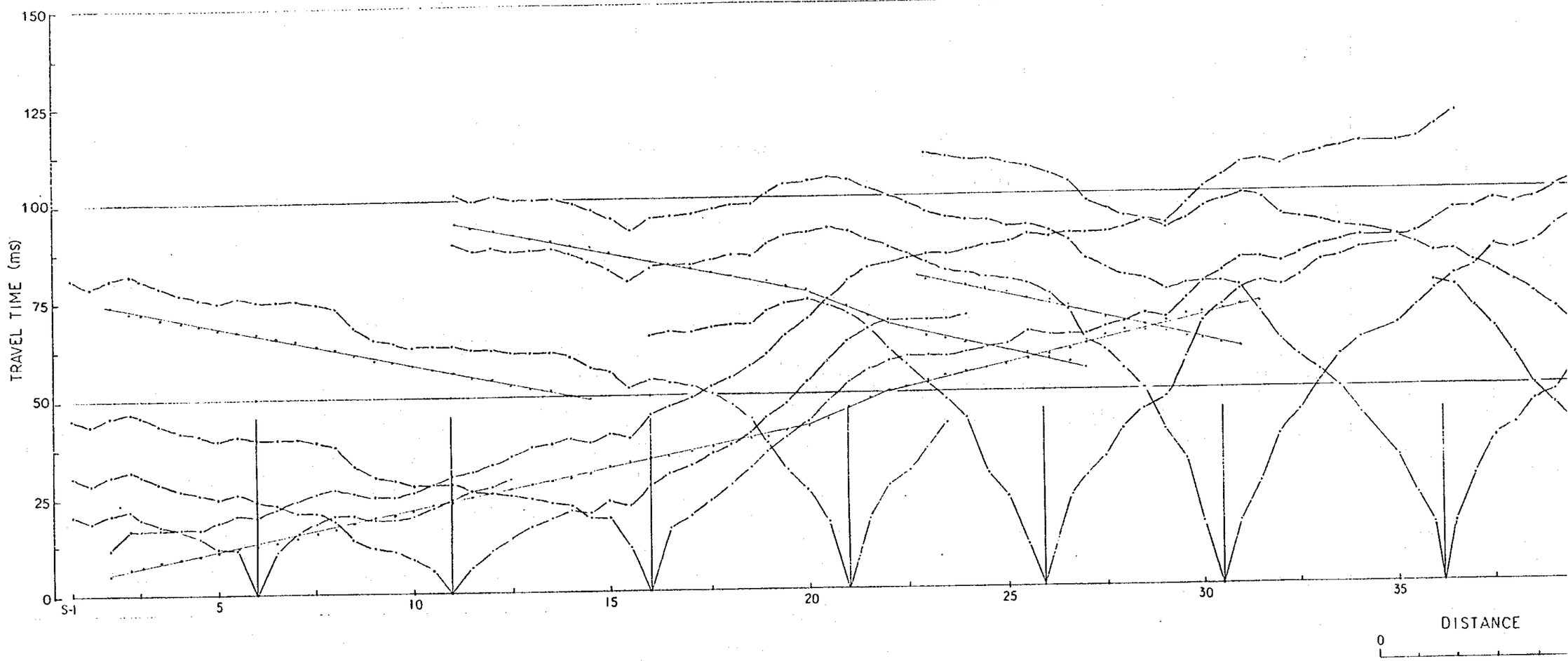


REPUBLIC OF COSTA RICA

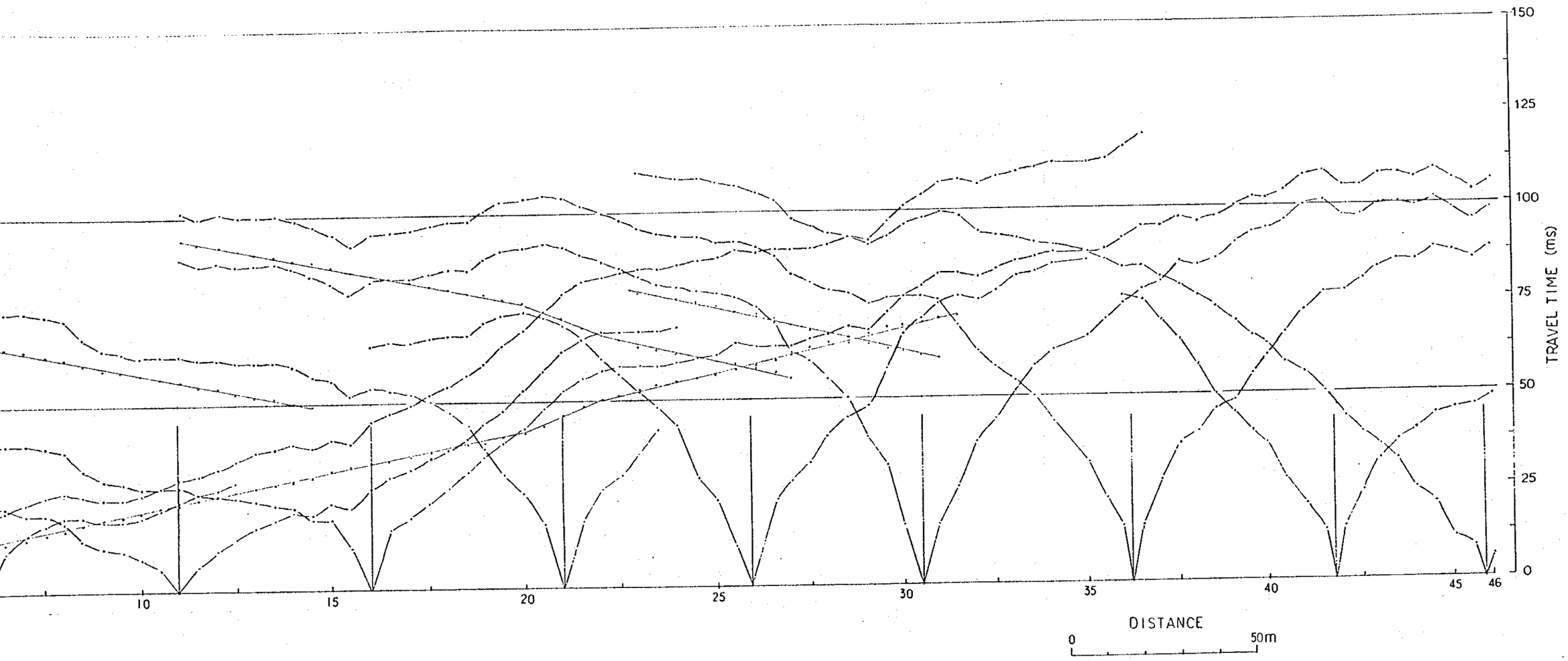
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

TIME-DISTANCE PLOT
PU-4
(UPPER DAM SITE)

A-5-5-(4)


150
125
100
75
50
25
0
TRAVEL TIME (ms)
S-1
5
10
15
20
25
30
35
DISTANCE
0

APPENDIX

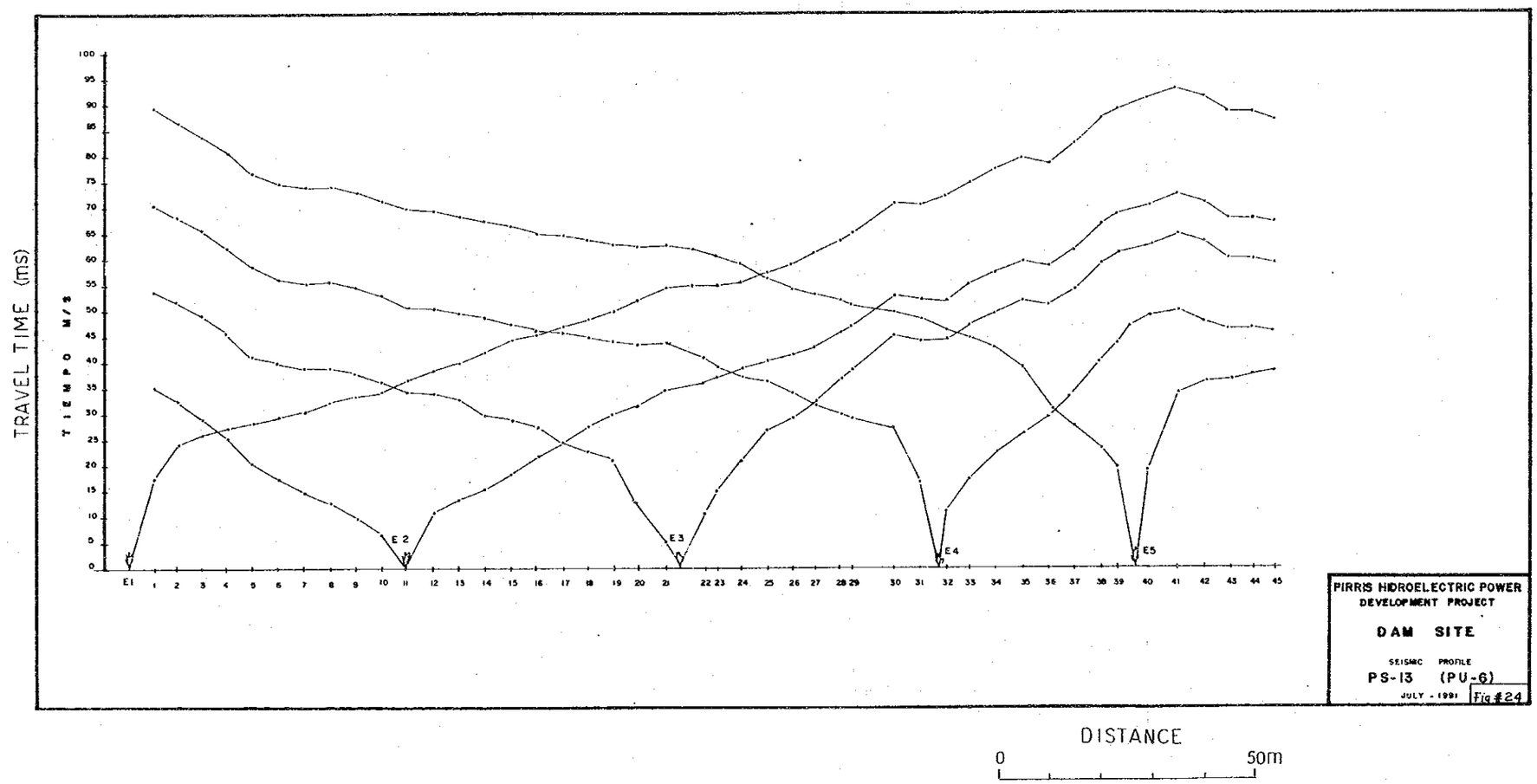


REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

TIME-DISTANCE PLOT
PU-5
(UPPER DAM SITE)

A-5-5-(5)

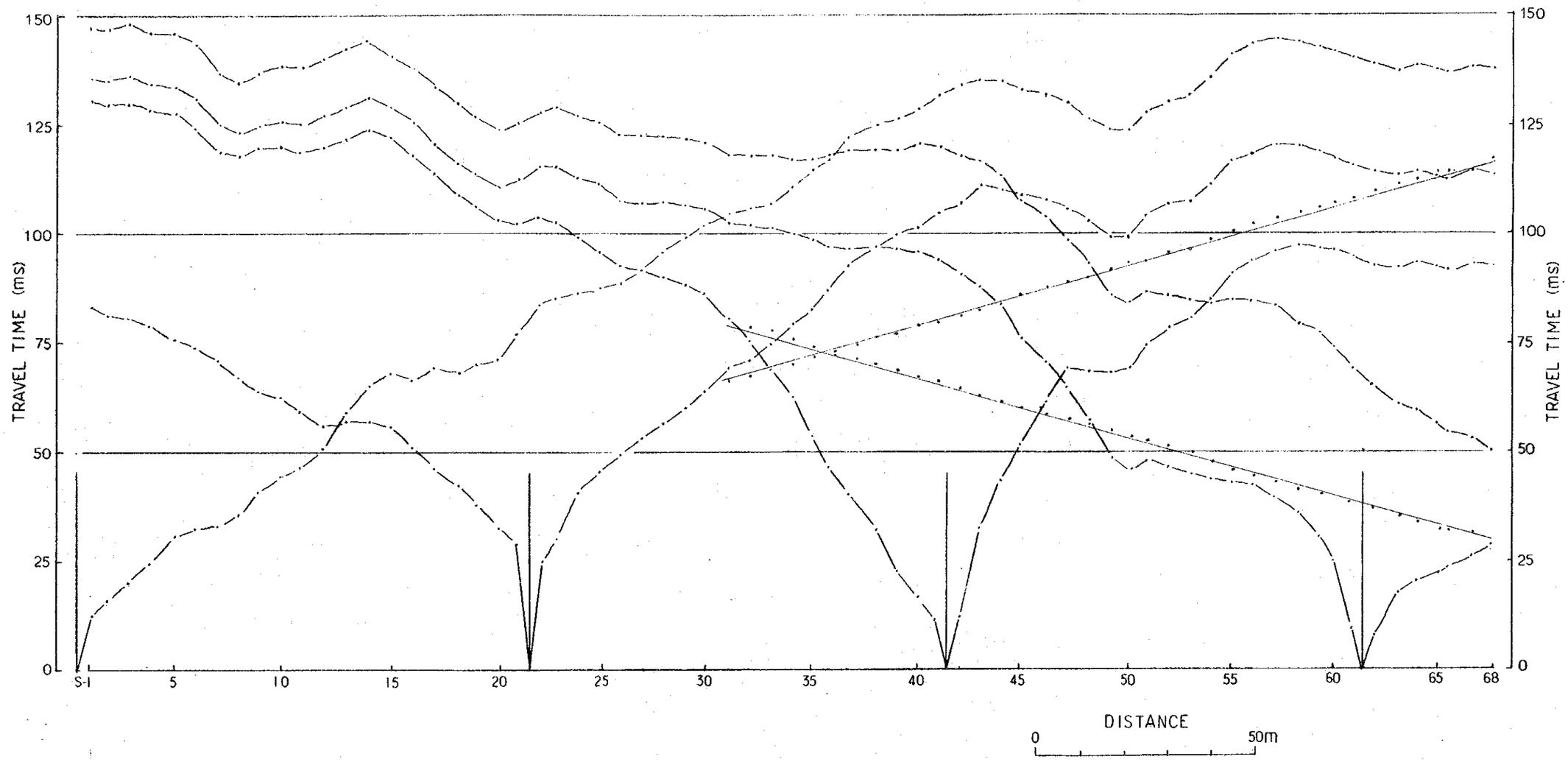


REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

TIME-DISTANCE PLOT
PU-6
(UPPER DAM SITE)

A-5-5-(6)

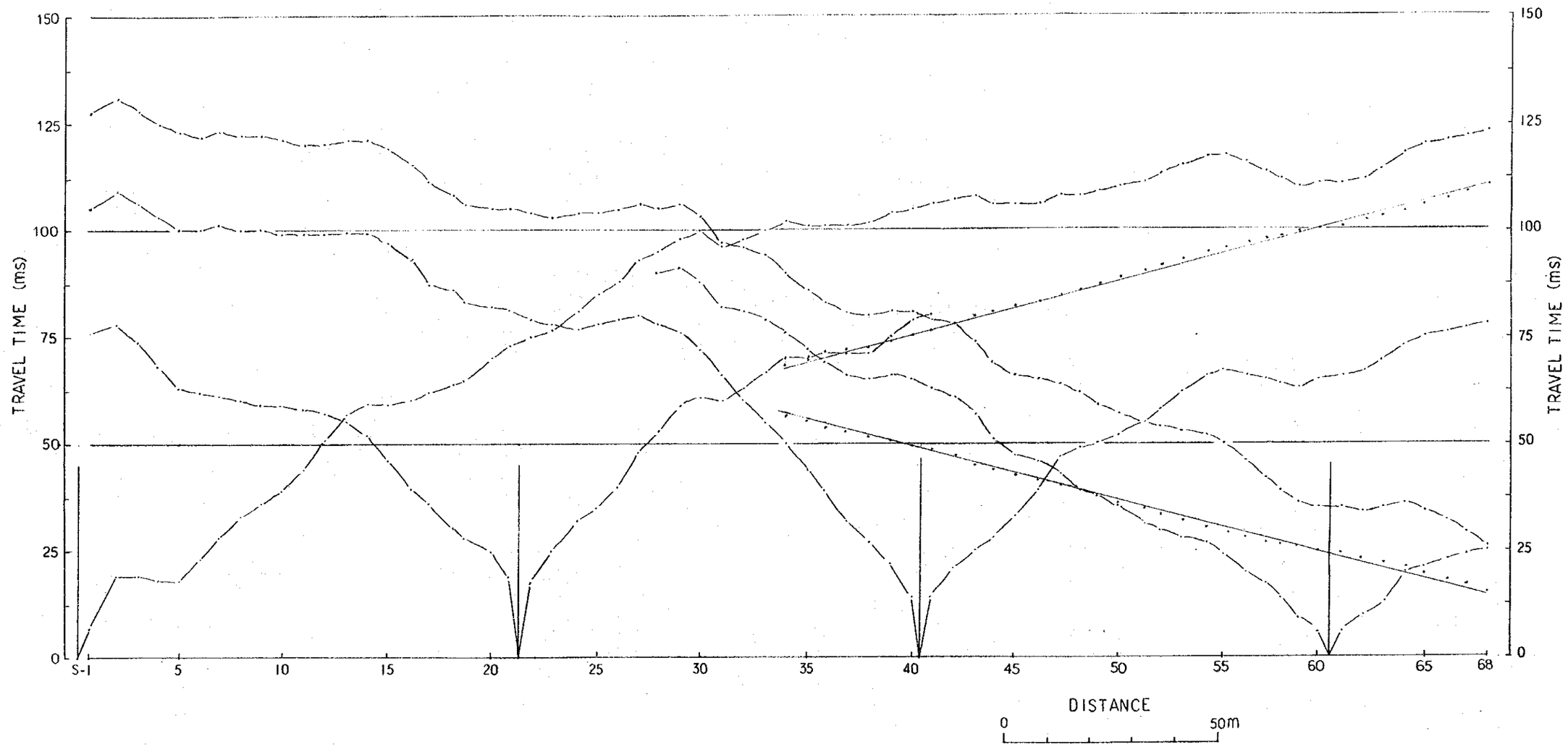


REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

TIME-DISTANCE PLOT
PL-1
(LOWER DAM SITE)

A-5-5-(7)

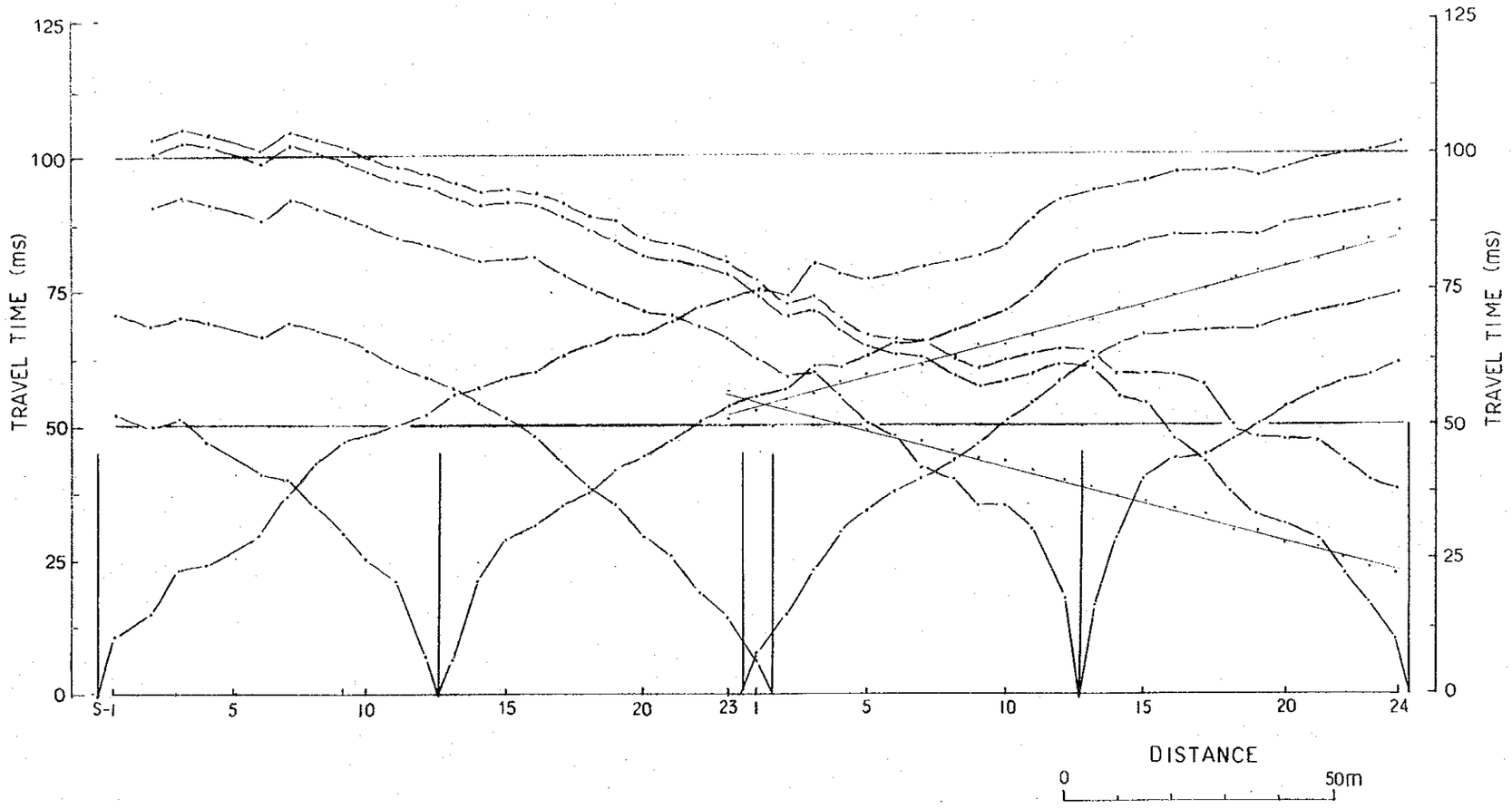


REPUBLIC OF COSTA RICA

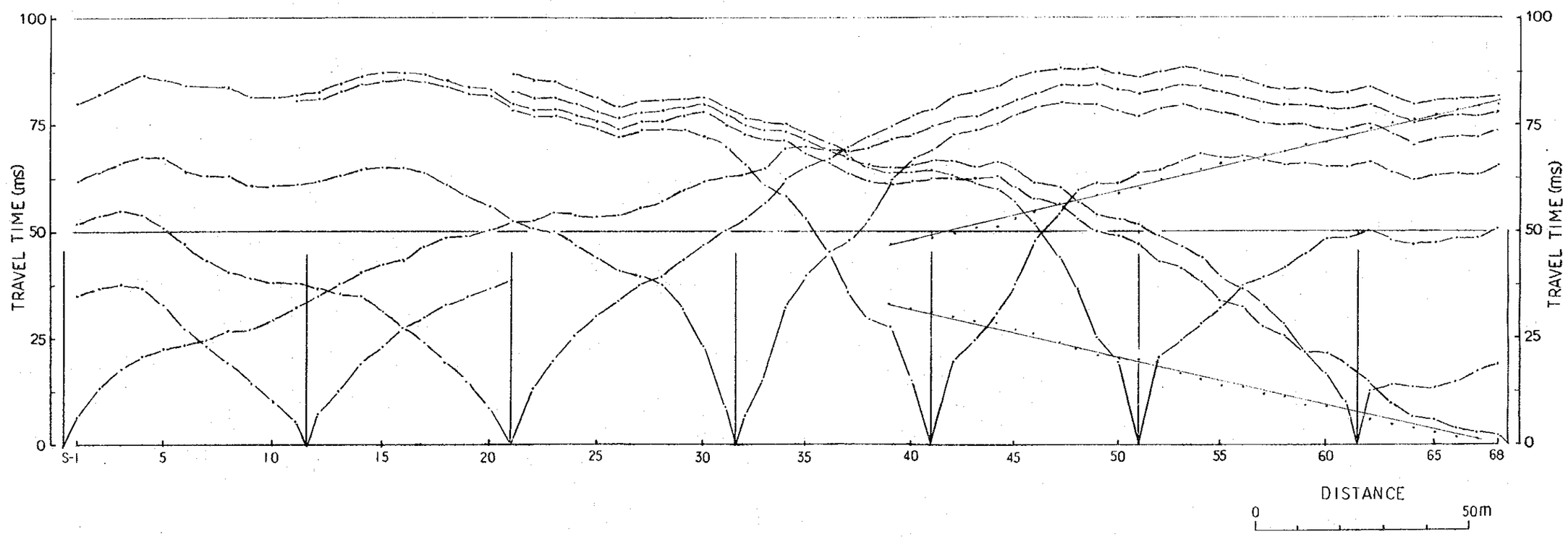
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

TIME-DISTANCE PLOT
PL-2
(LOWER DAM SITE)

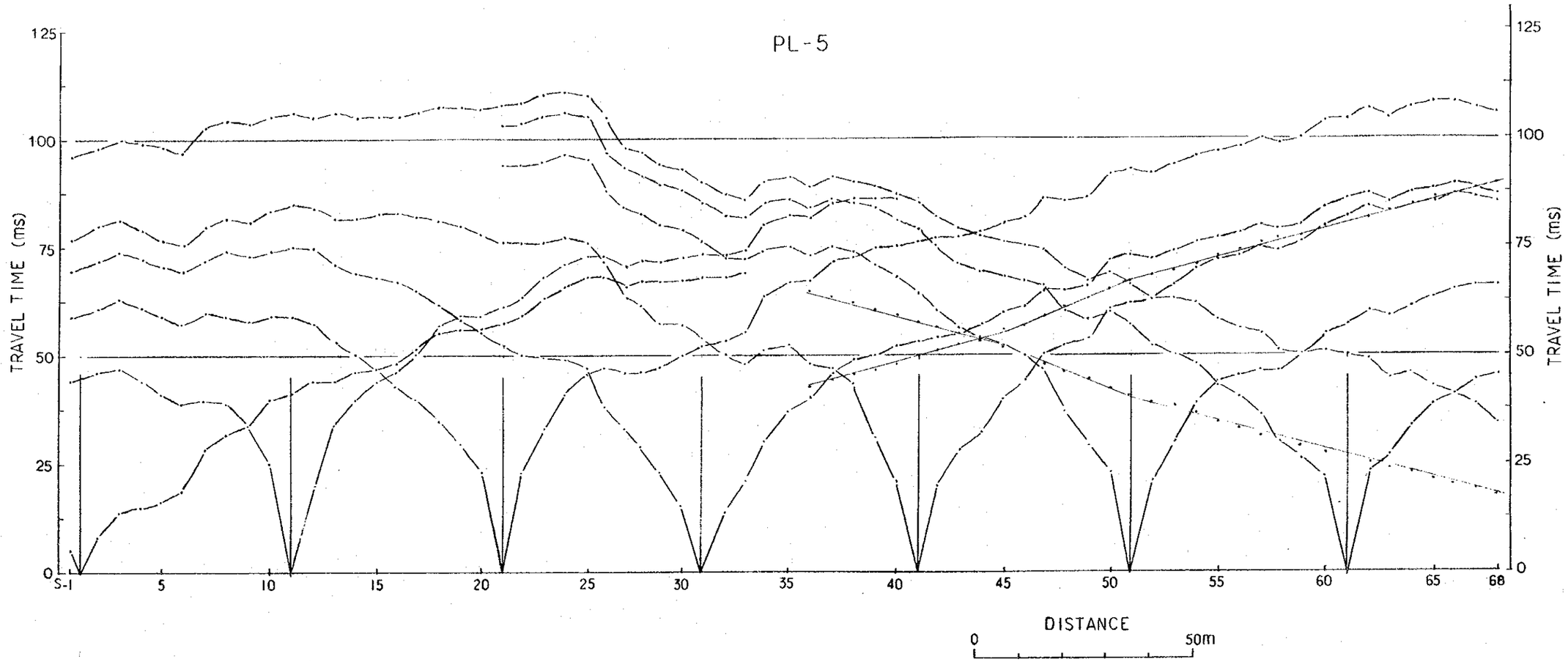
A-5-5-(8)

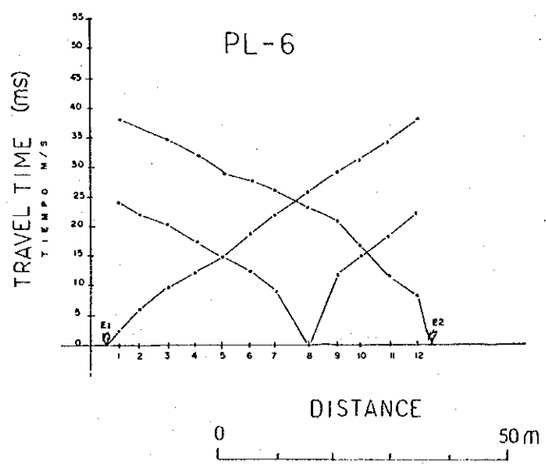


REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
TIME-DISTANCE PLOT PL-3 (LOWER DAM SITE)
A-5-5-(9)



REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
TIME-DISTANCE PLOT PL-4 (LOWER DAM SITE)
A-5-5-(10)



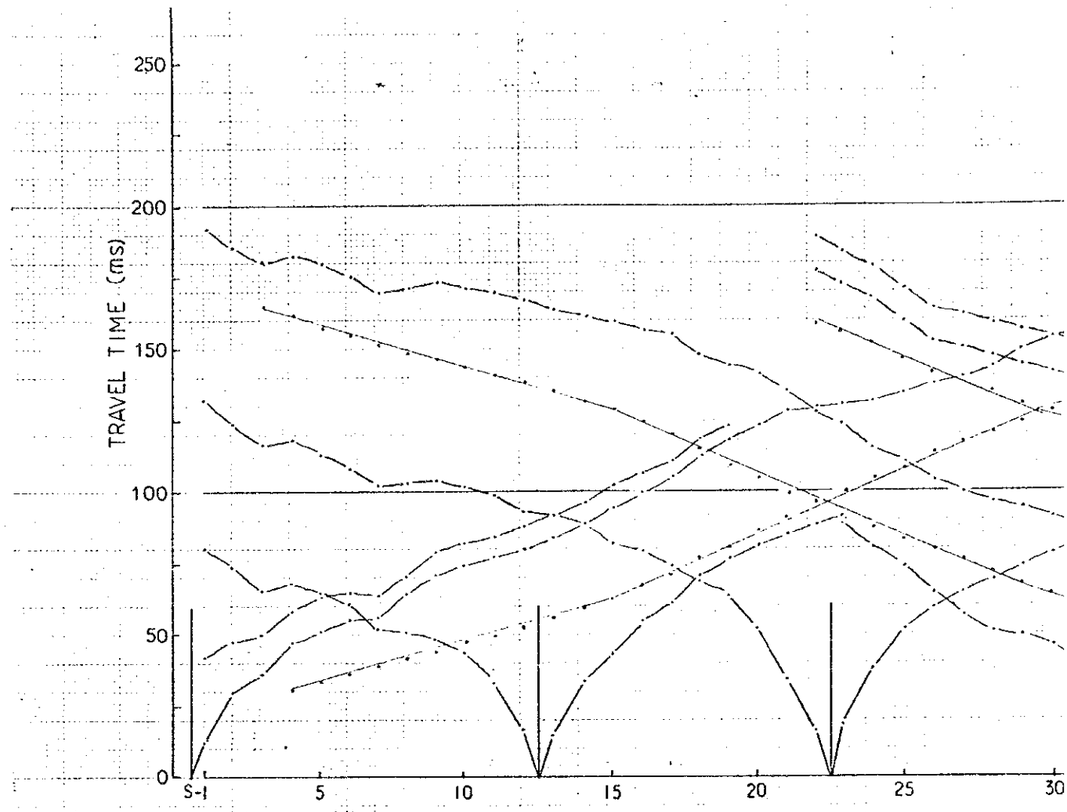


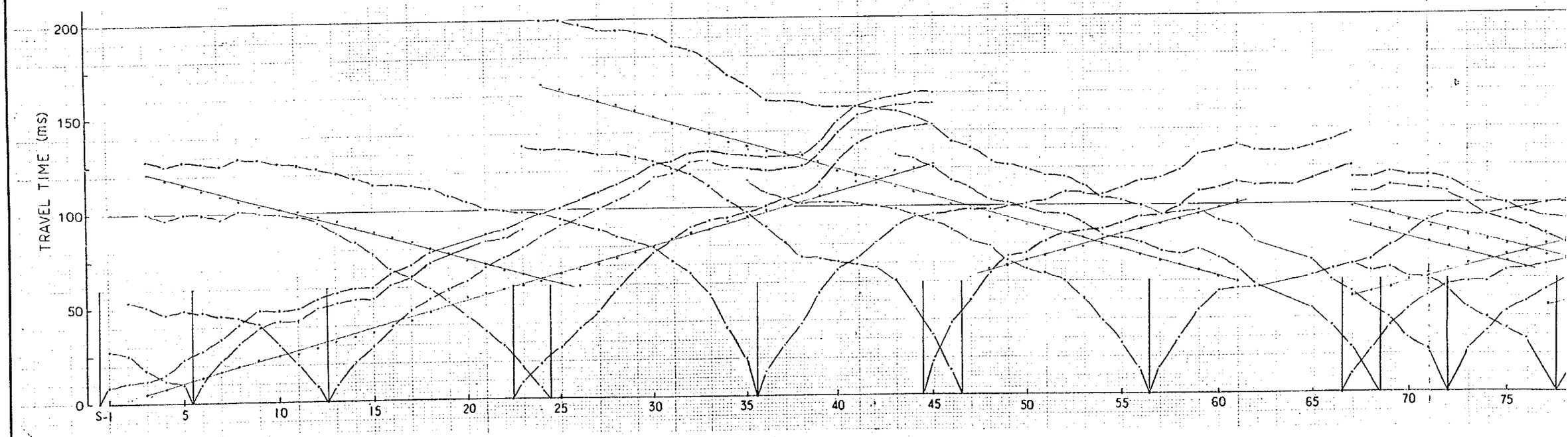
REPUBLIC OF COSTA RICA

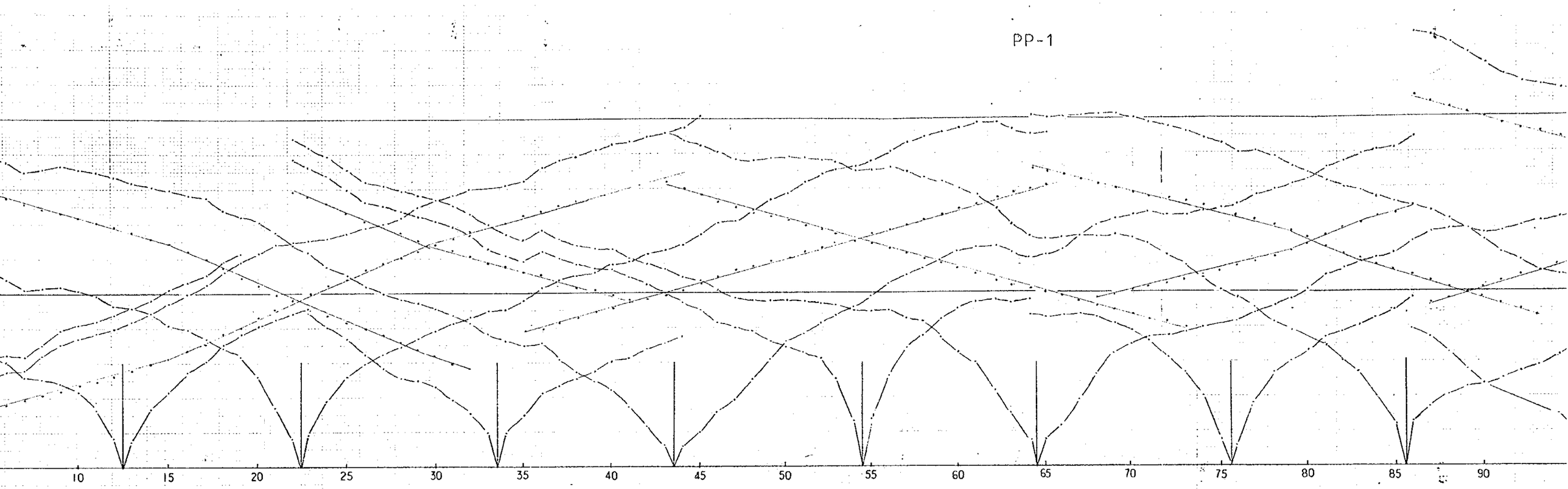
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

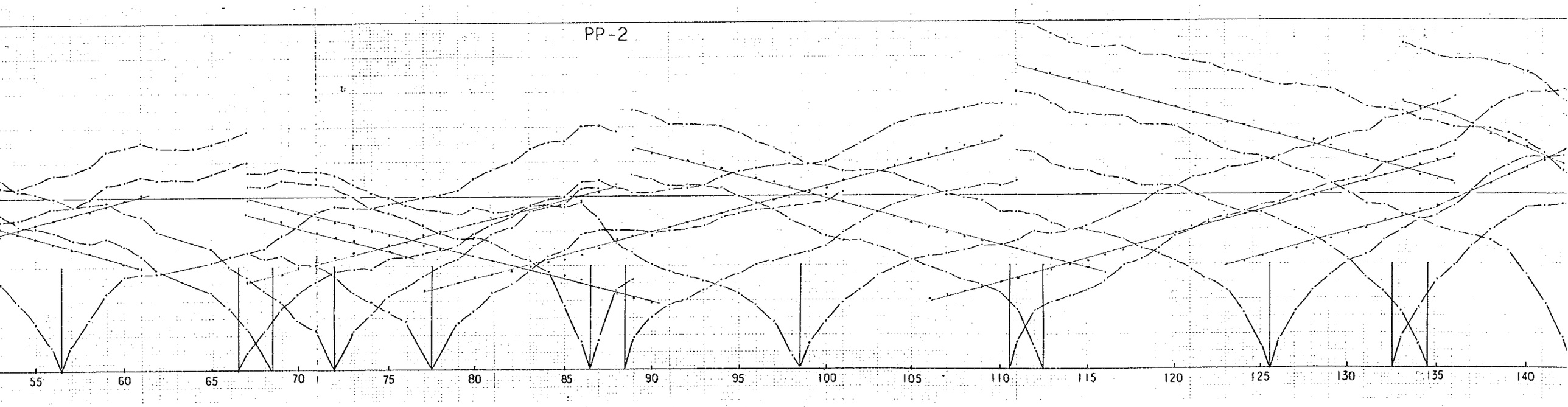
TIME-DISTANCE PLOT
PL-5, PL-6
(LOWER DAM SITE)

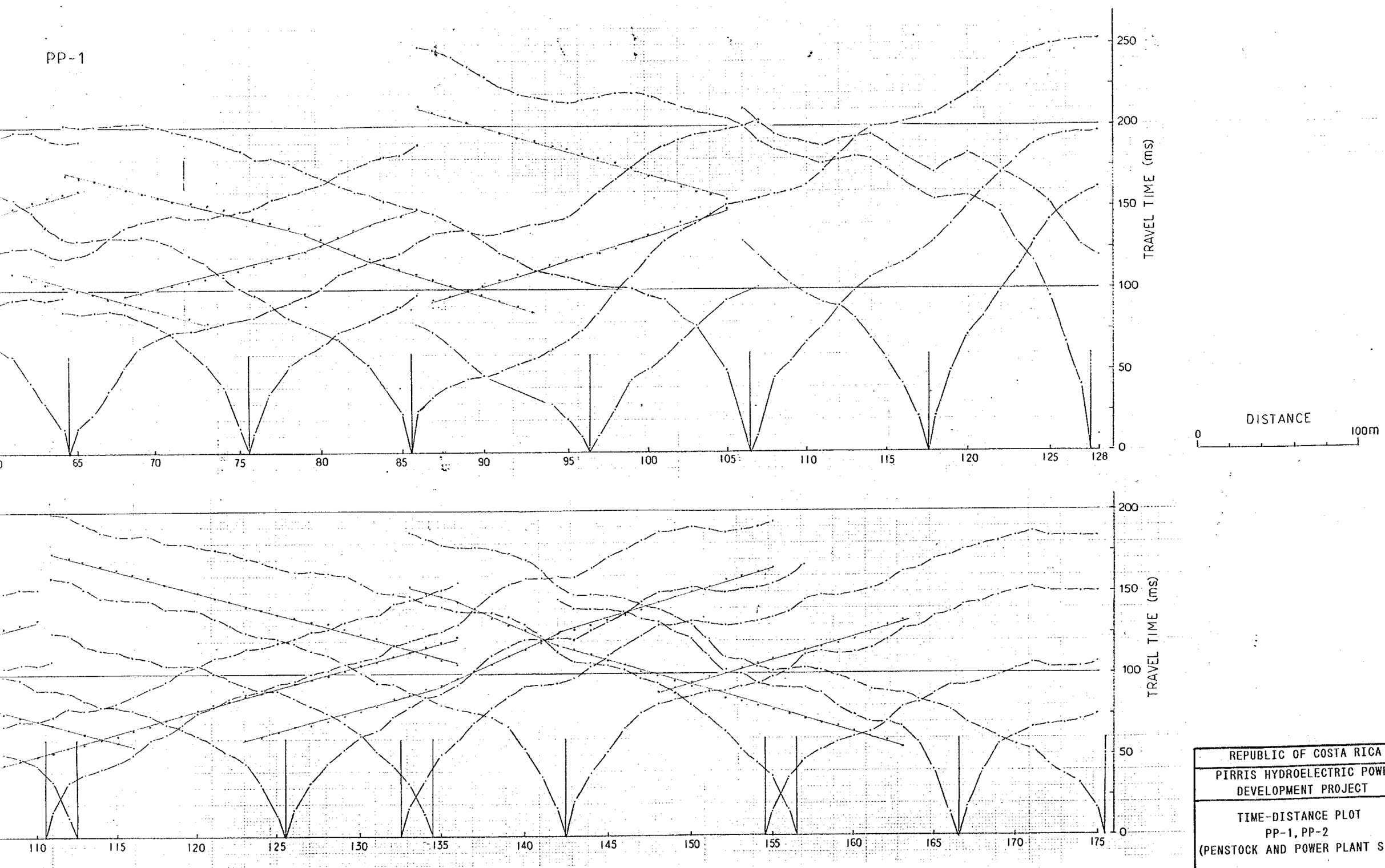
A-5-5-(11)


TRAVEL TIME (ms)
250
200
150
100
50
0
S-1
5
10
15
20
25
30


TRAVEL TIME (ms)
200
150
100
50
0
S-1
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75


PP-1
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90


PP-2
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140

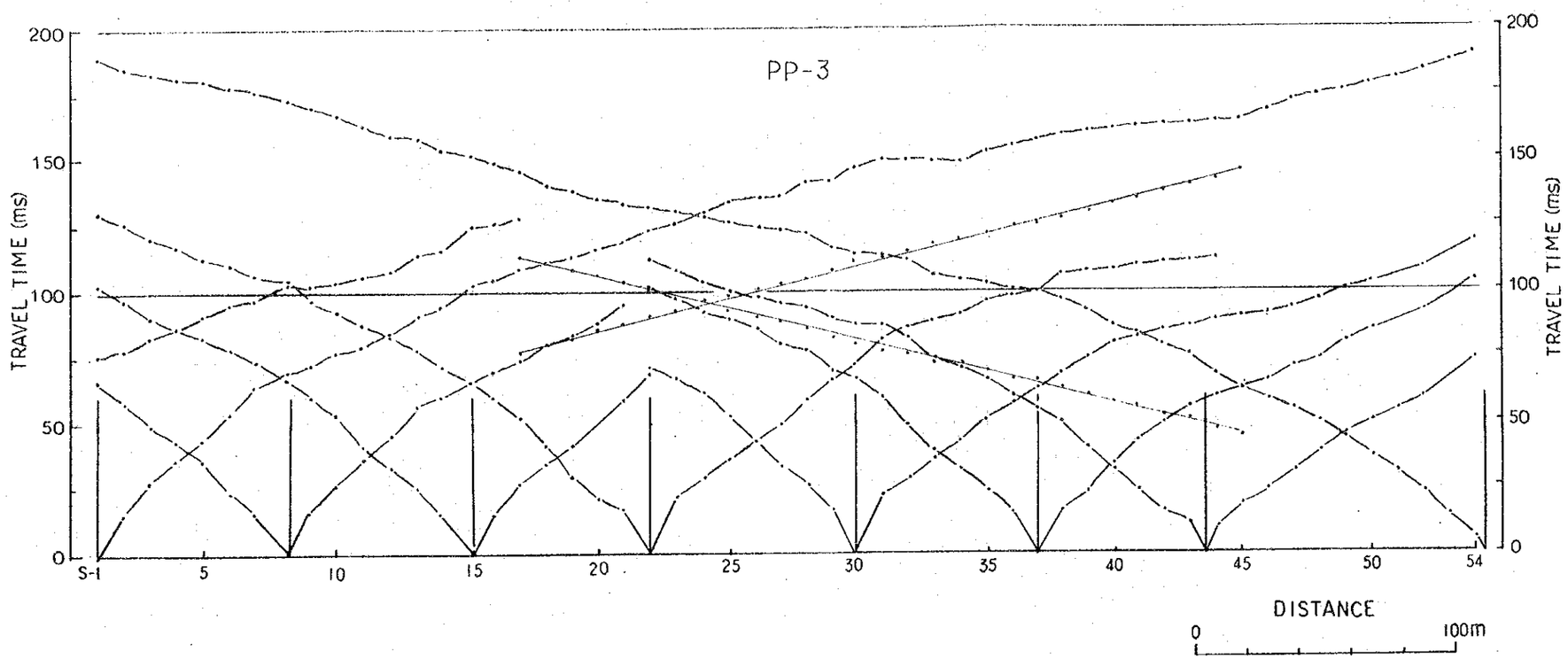


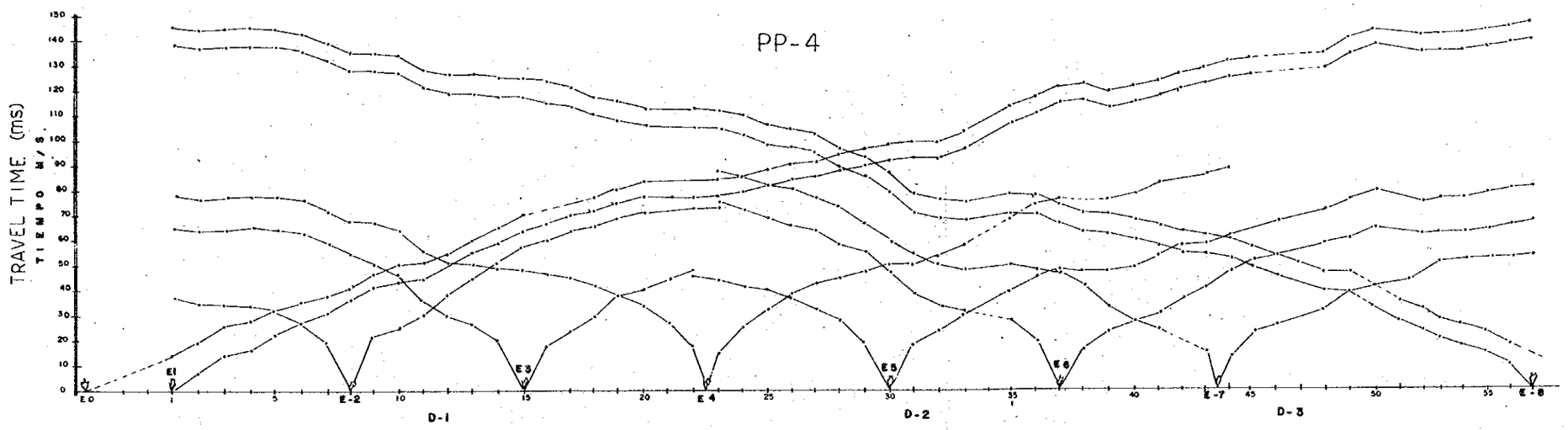
REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

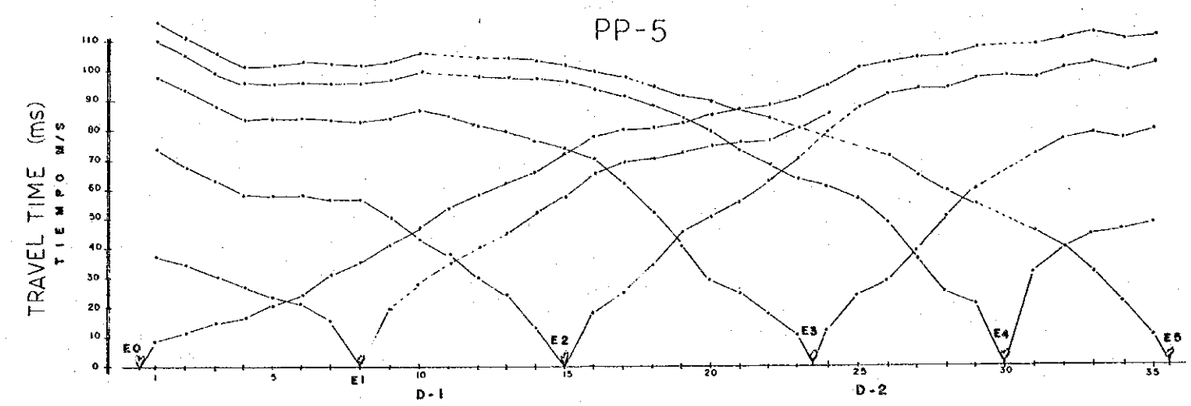
TIME-DISTANCE PLOT
PP-1, PP-2
(PENSTOCK AND POWER PLANT SITE)

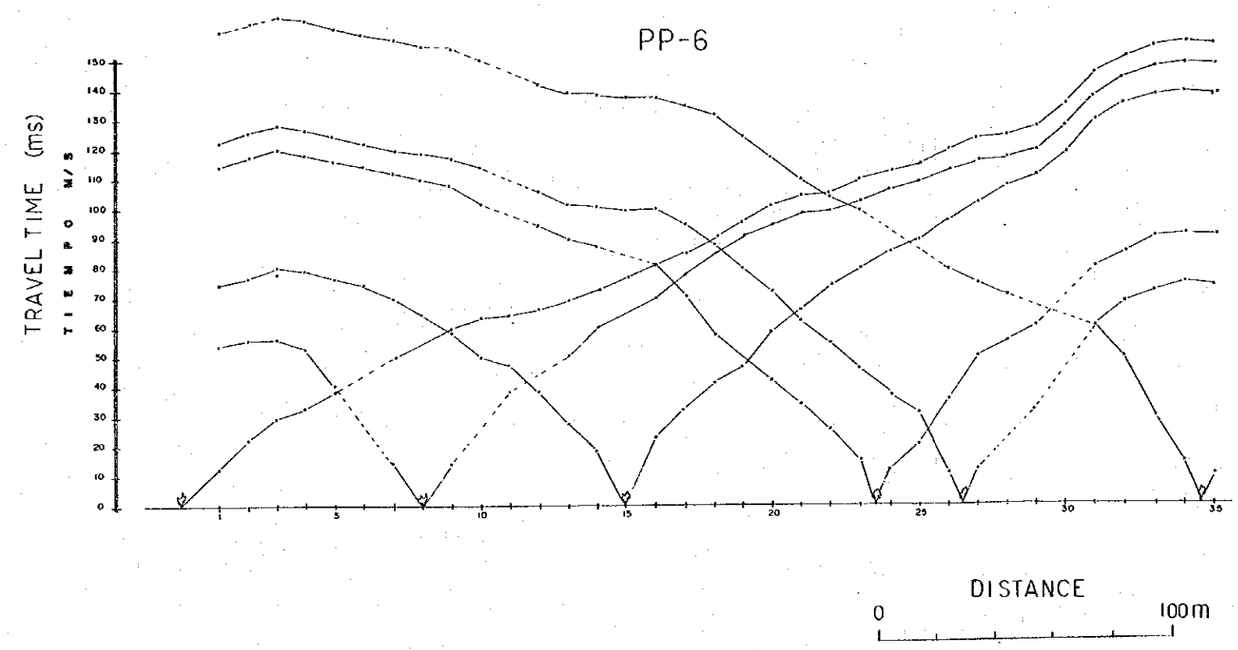
A-5-5-(12)



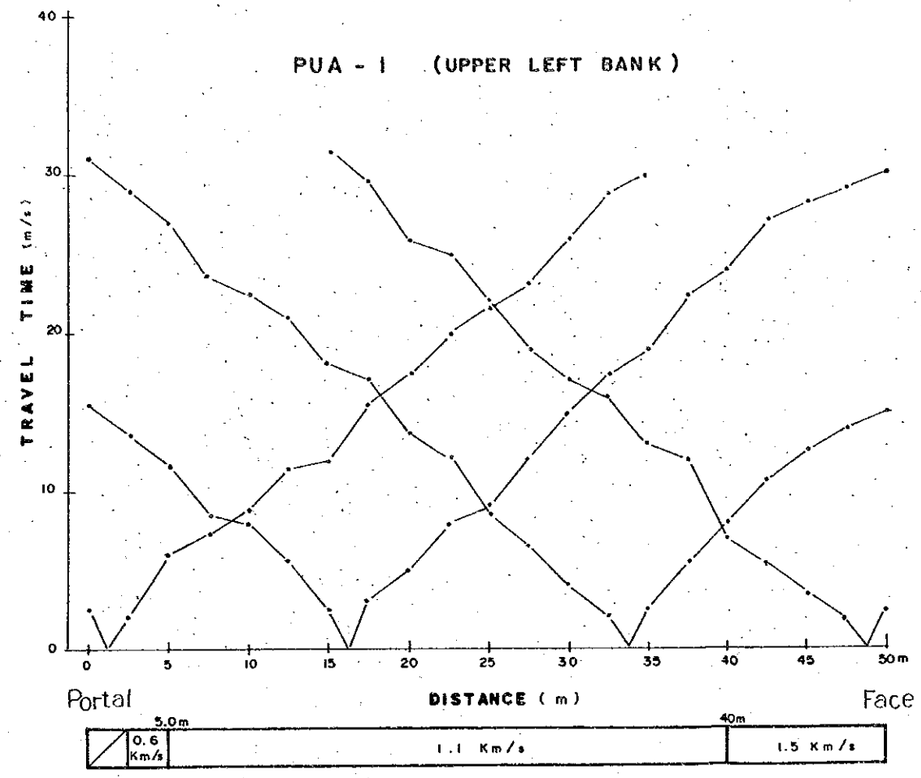


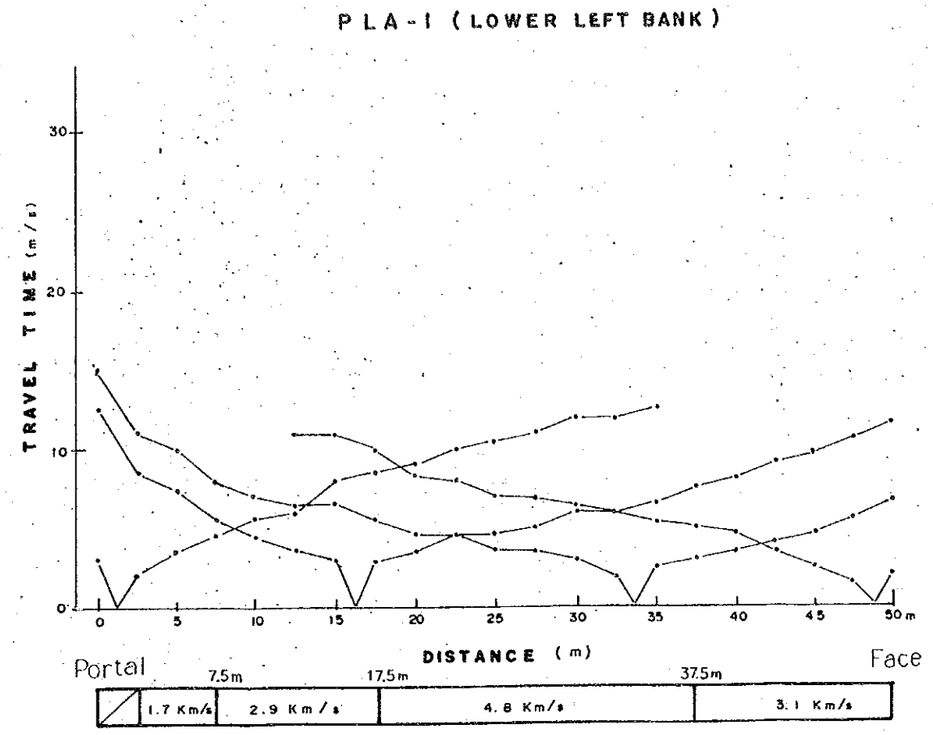
REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
TIME-DISTANCE PLOT PP-3, PP-4 (PENSTOCK AND POWER PLANT SITE)
A-5-5-(13)

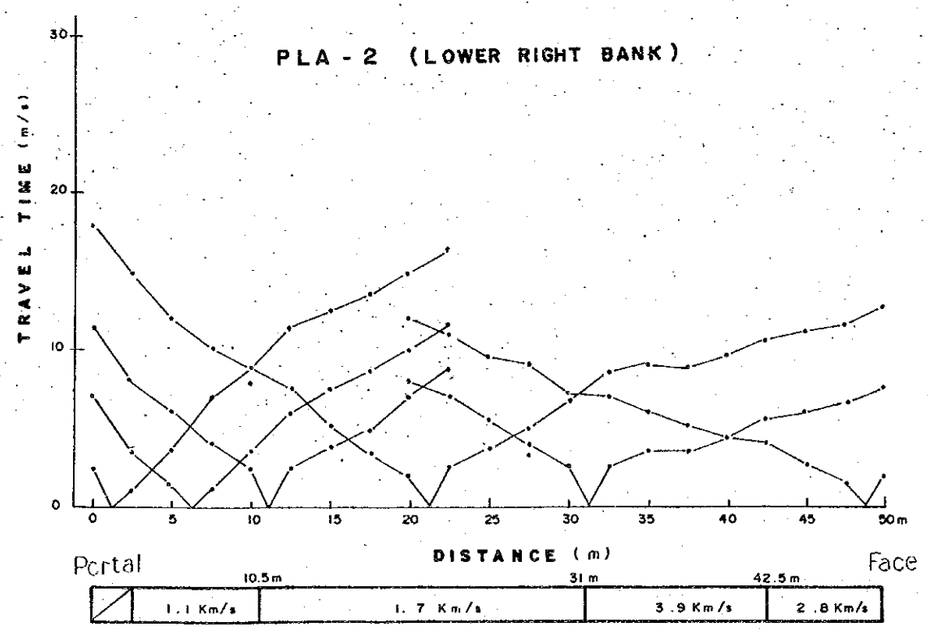




REPUBLIC OF COSTA RICA
PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT
TIME-DISTANCE PLOT PP-5, PP-6 (PENSTOCK AND POWER PLANT SITE)
A-5-5-(14)







REPUBLIC OF COSTA RICA

PIRRIS ELDROELECTRIC POWER DEVELOPMENT PROJECT

RESULT OF SEISMIC PROSPECTING IN ADITS (DAM SITES)

A-5-6

APPENDIX A-6 LABORATORY TESTS OF CONSTRUCTION MATERIALS

APPENDIX A-6 LABORATORY TESTS OF CONSTRUCTION MATERIALS

Contents

Fig. A-6-1 Alkali Aggregate Reaction Tests of Quarry Site and LA-2 Adit

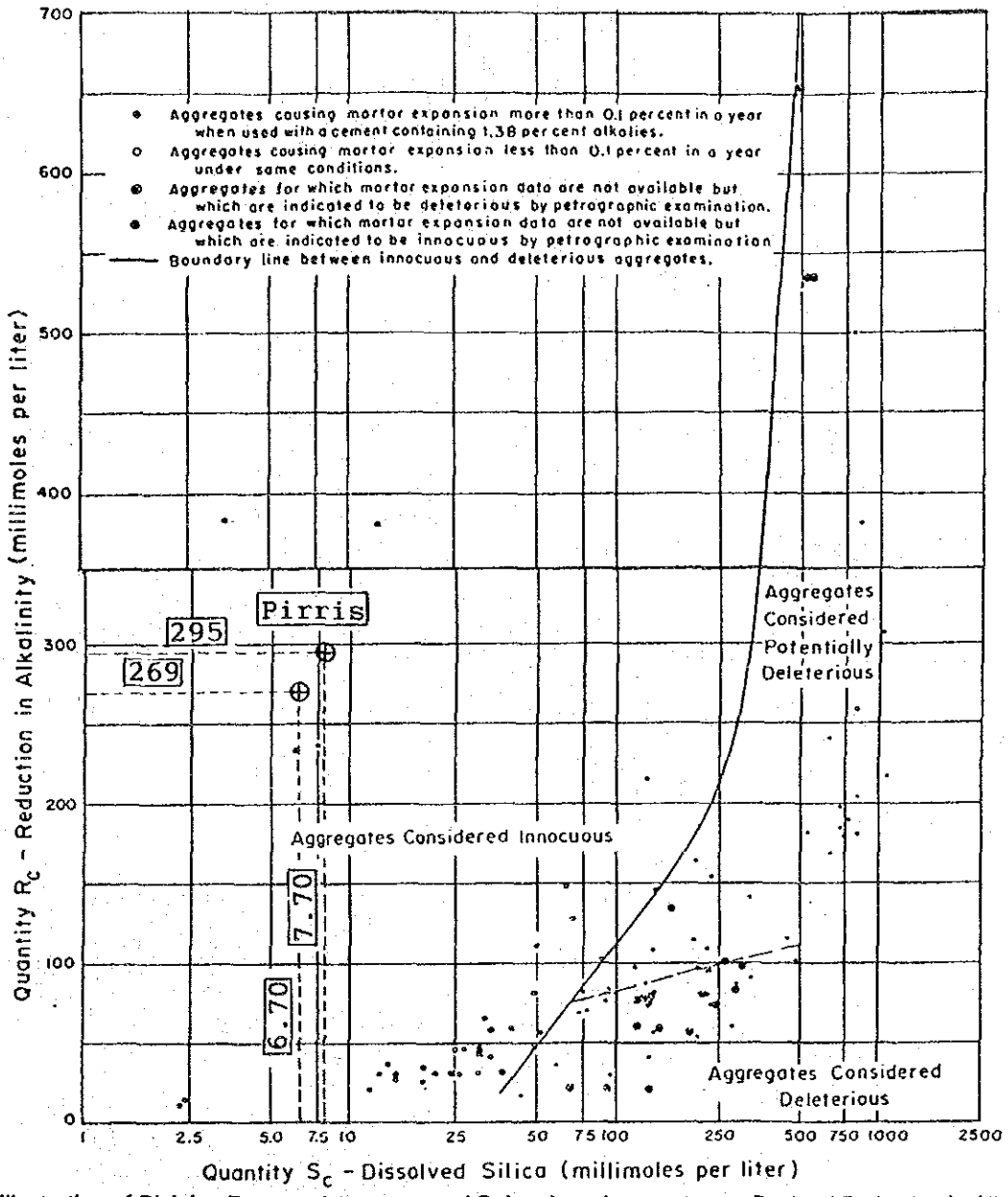


Illustration of Division Between Innocuous and Deleterious Aggregates on Basis of Reduction in Alkalinity Test

Fig. A-6-2 Strain Curve of Unconfined Compression Strength Tests

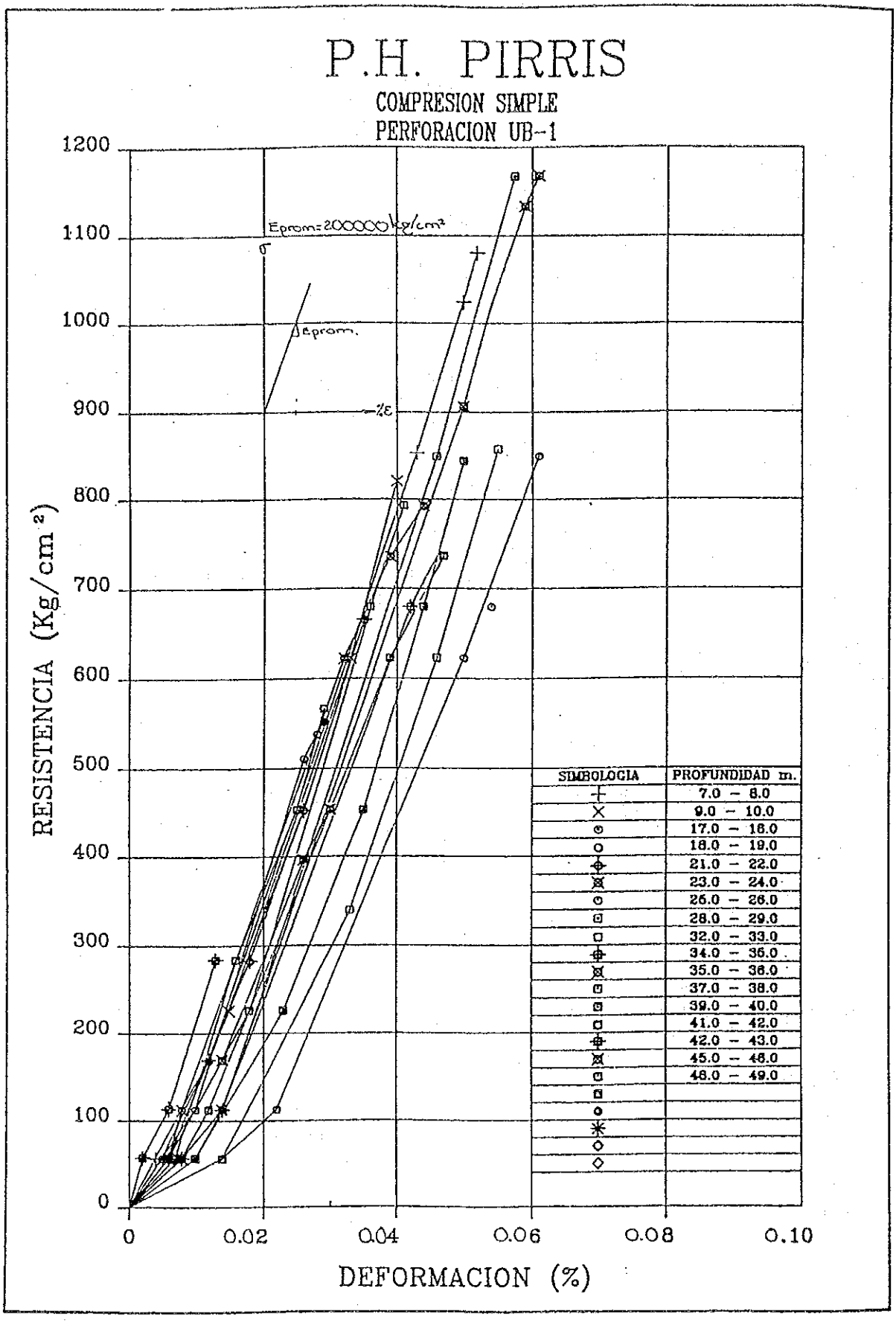


Fig. A-6-2 Strain Curve of Unconfined Compression Strength Tests

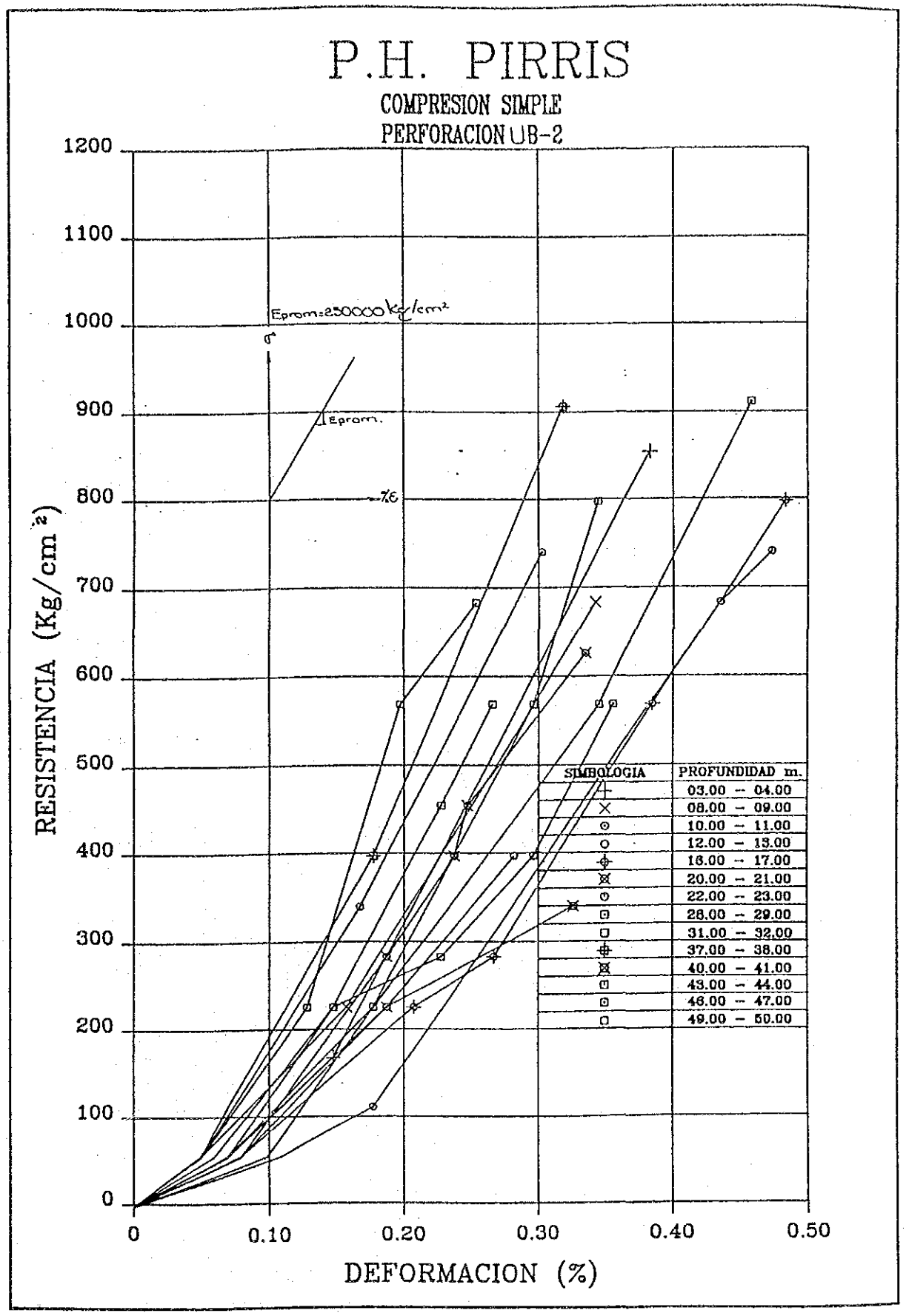


Fig. A-6-2 Strain Curve of Unconfined Compression Strength Tests

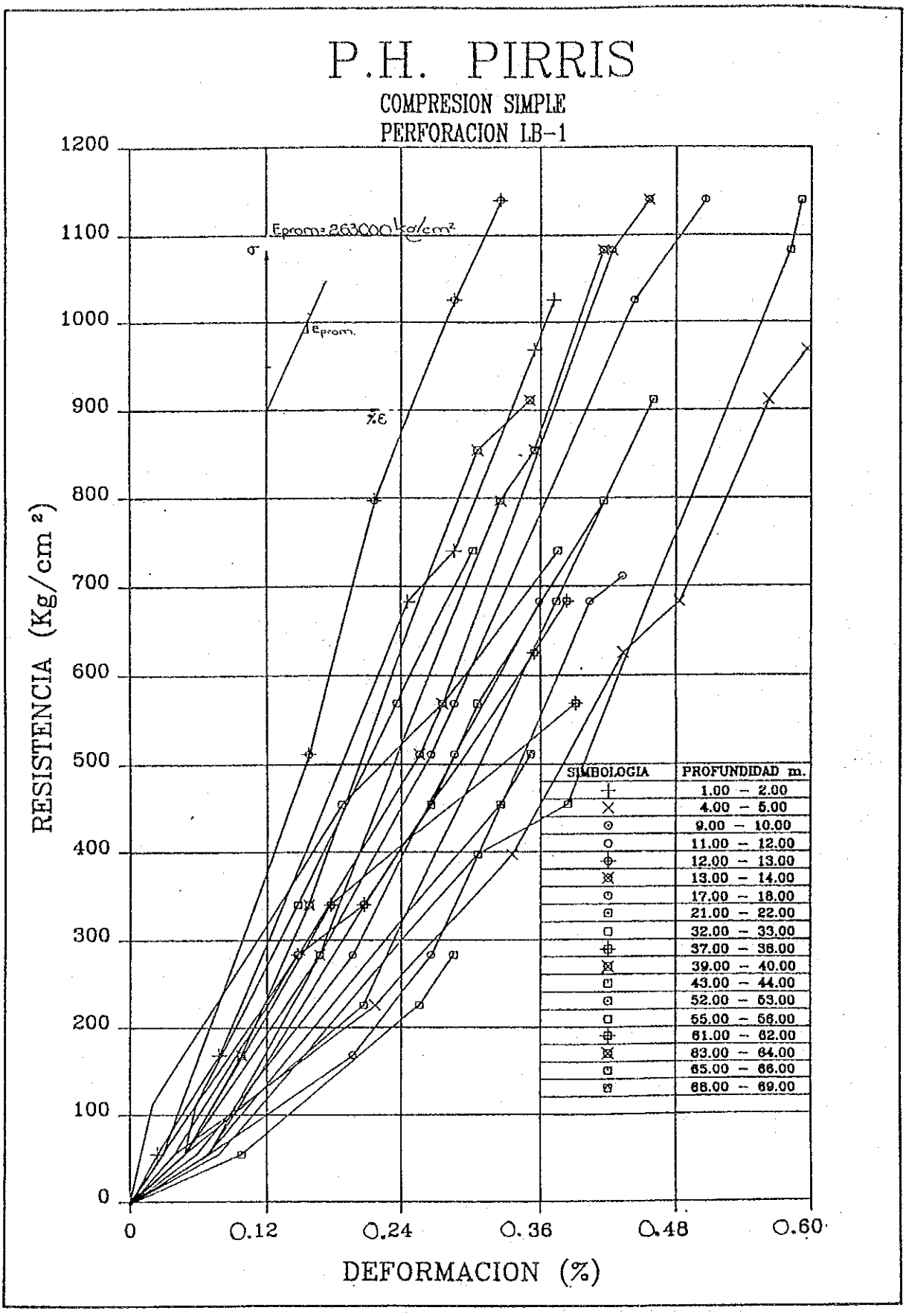


Fig. A-6-2 Strain Curve of Unconfined Compression Strength Tests

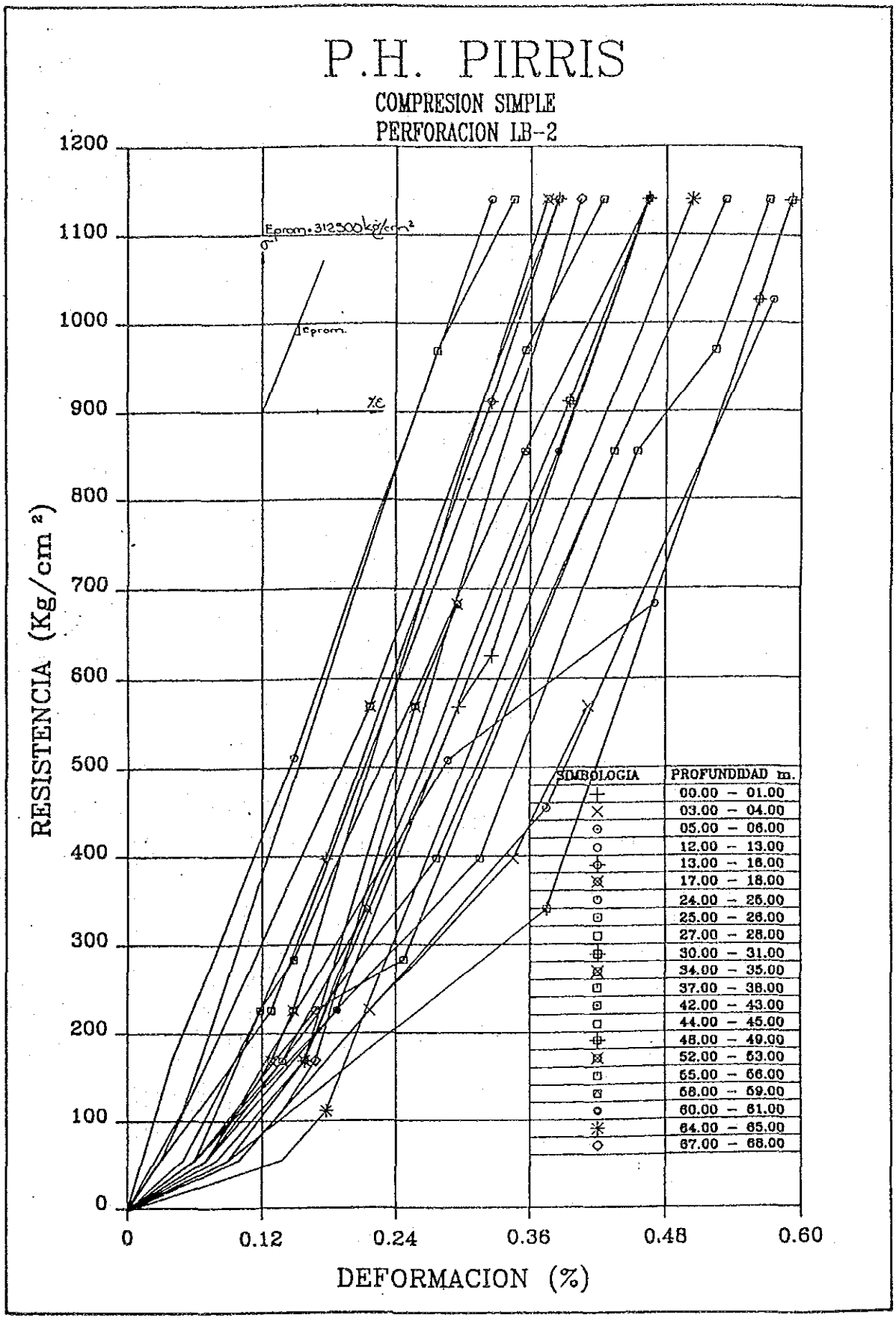


Fig. A-6-2 Strain Curve of Unconfined Compression Strength Tests

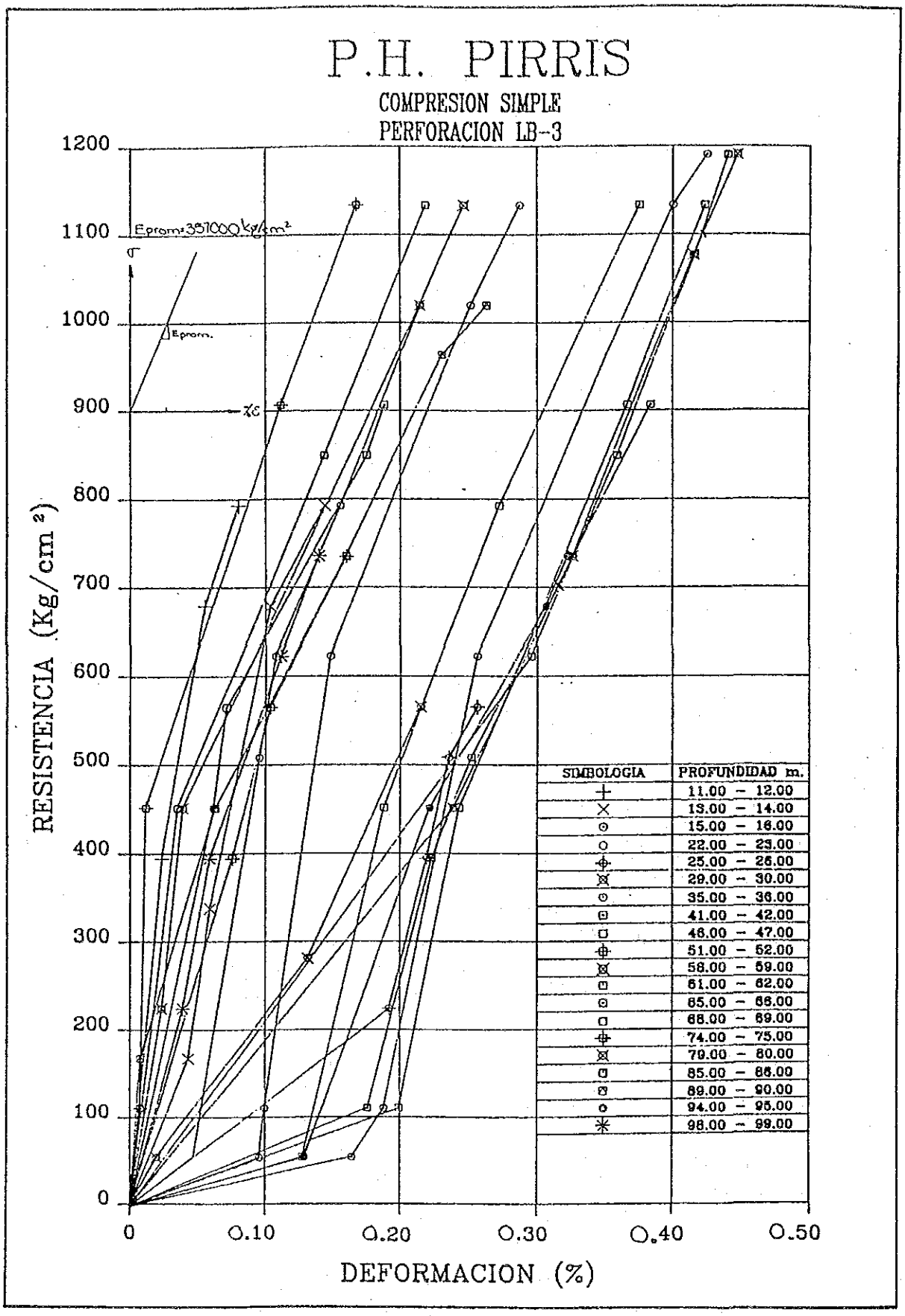


Fig. A-6-2 Strain Curve of Unconfined Compression Strength Tests

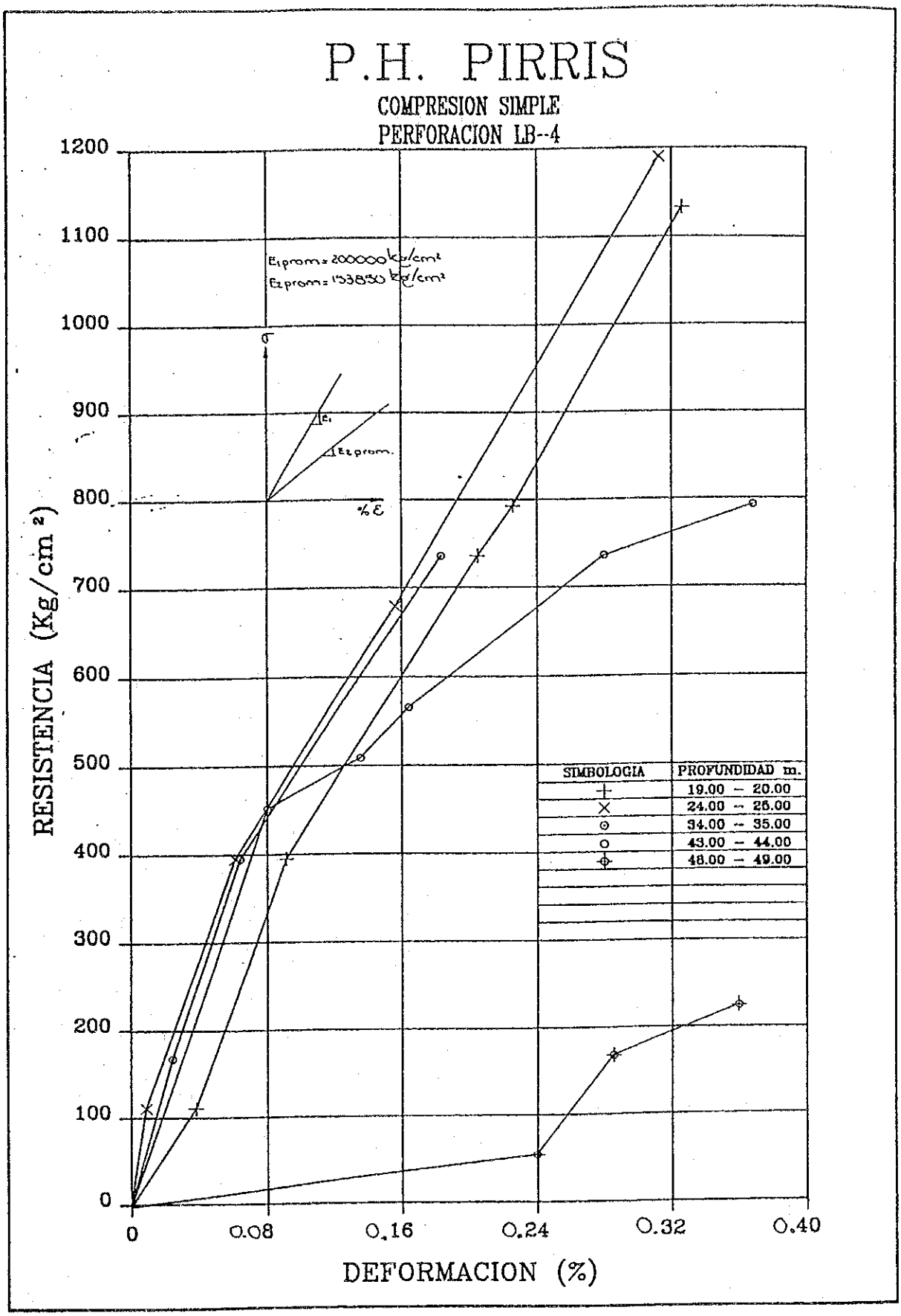
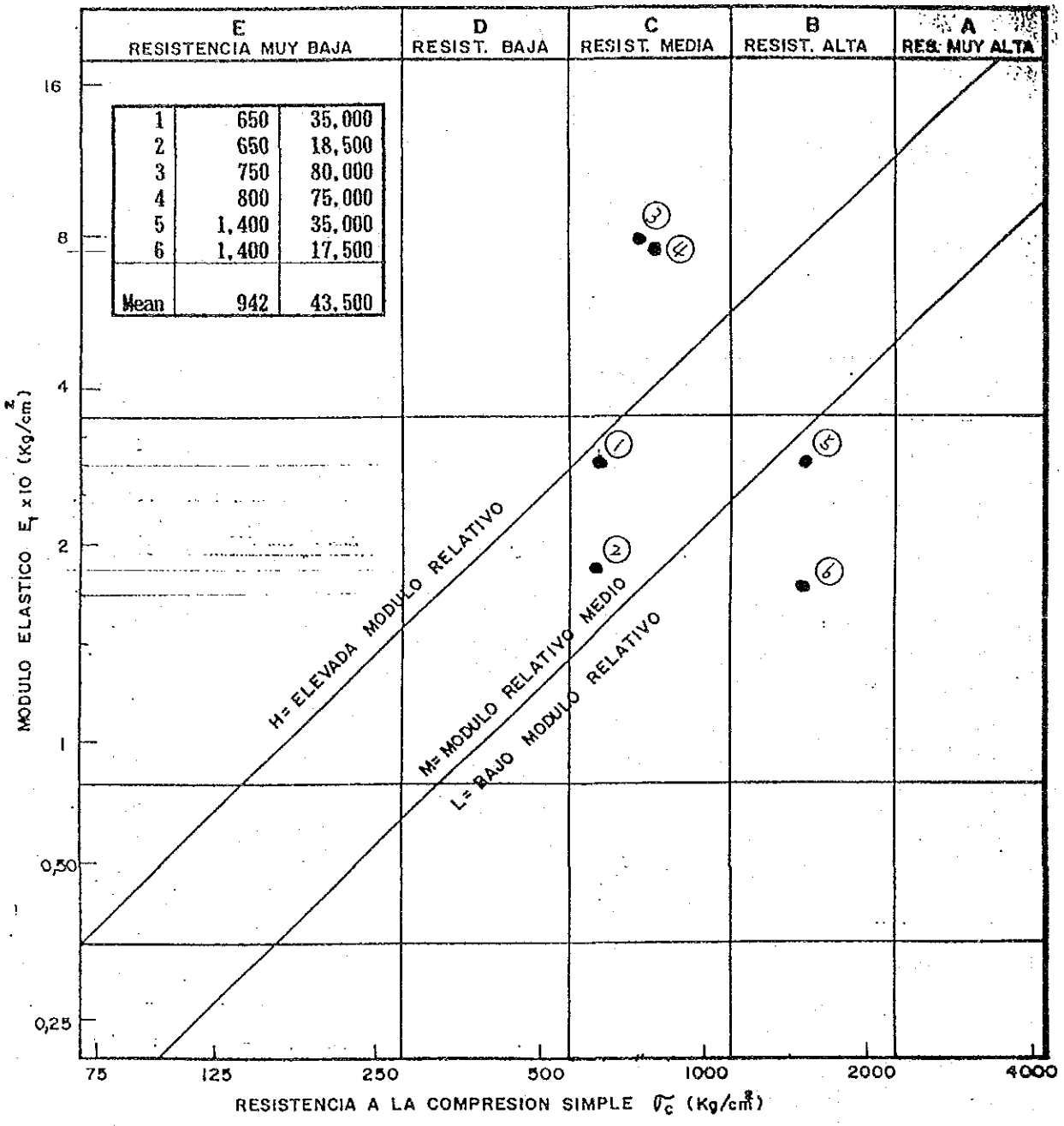


Fig. A-6-3 Compression Strength and Modulus of Elasticity of UB-3 Boring Cores



1	650	35,000
2	650	18,500
3	750	80,000
4	800	75,000
5	1,400	35,000
6	1,400	17,500
Mean	942	43,500

● Perforación UB-3

CLASIFICACION DE LA ROCA INTACTA
SEGUN DEERE.

Fig. A-6-4 Location of Borrow Area (CP-1, CP-2, CP-3)

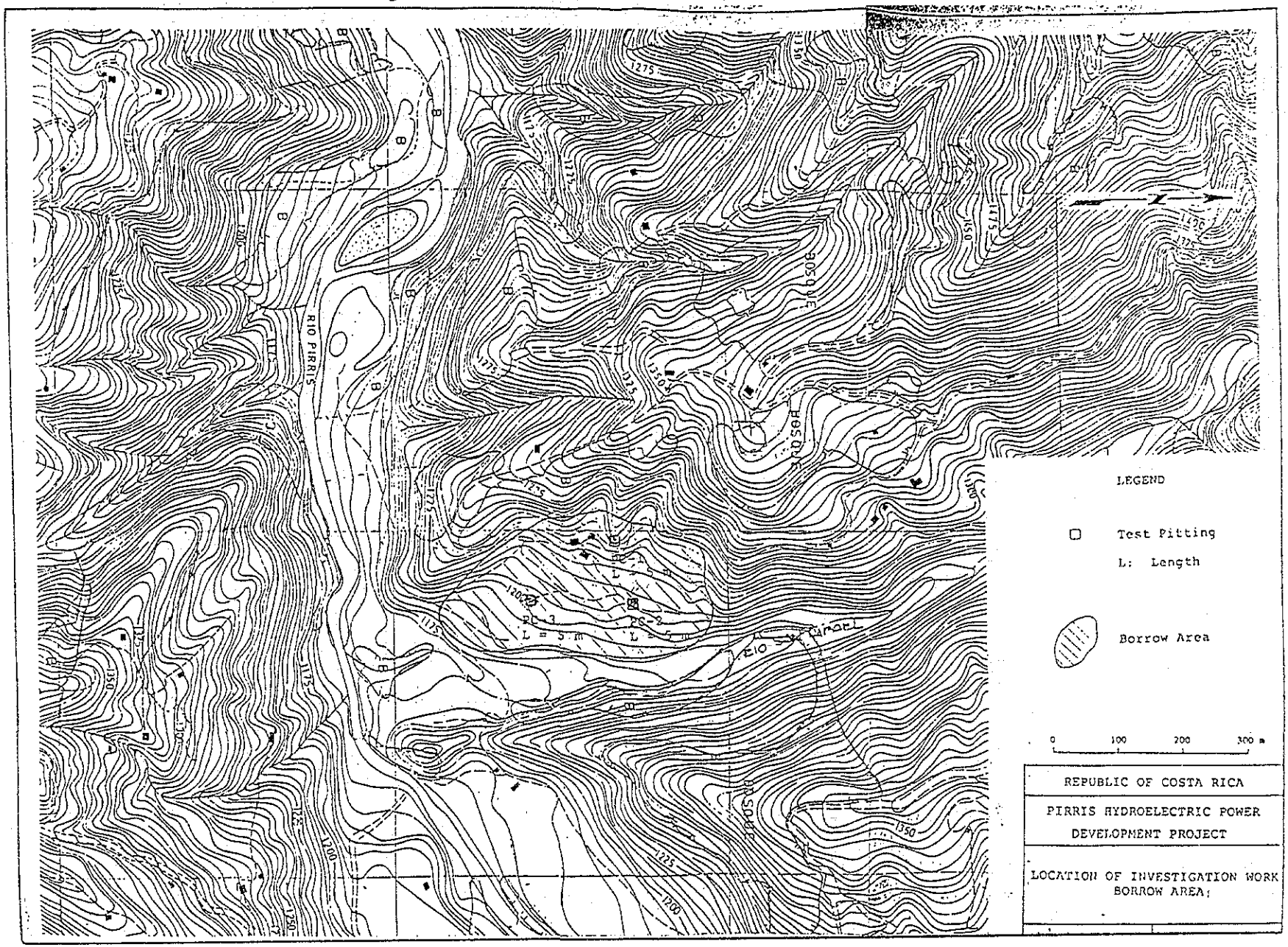


Fig. A-6-5 Grain-size Analysis Test of CP-1

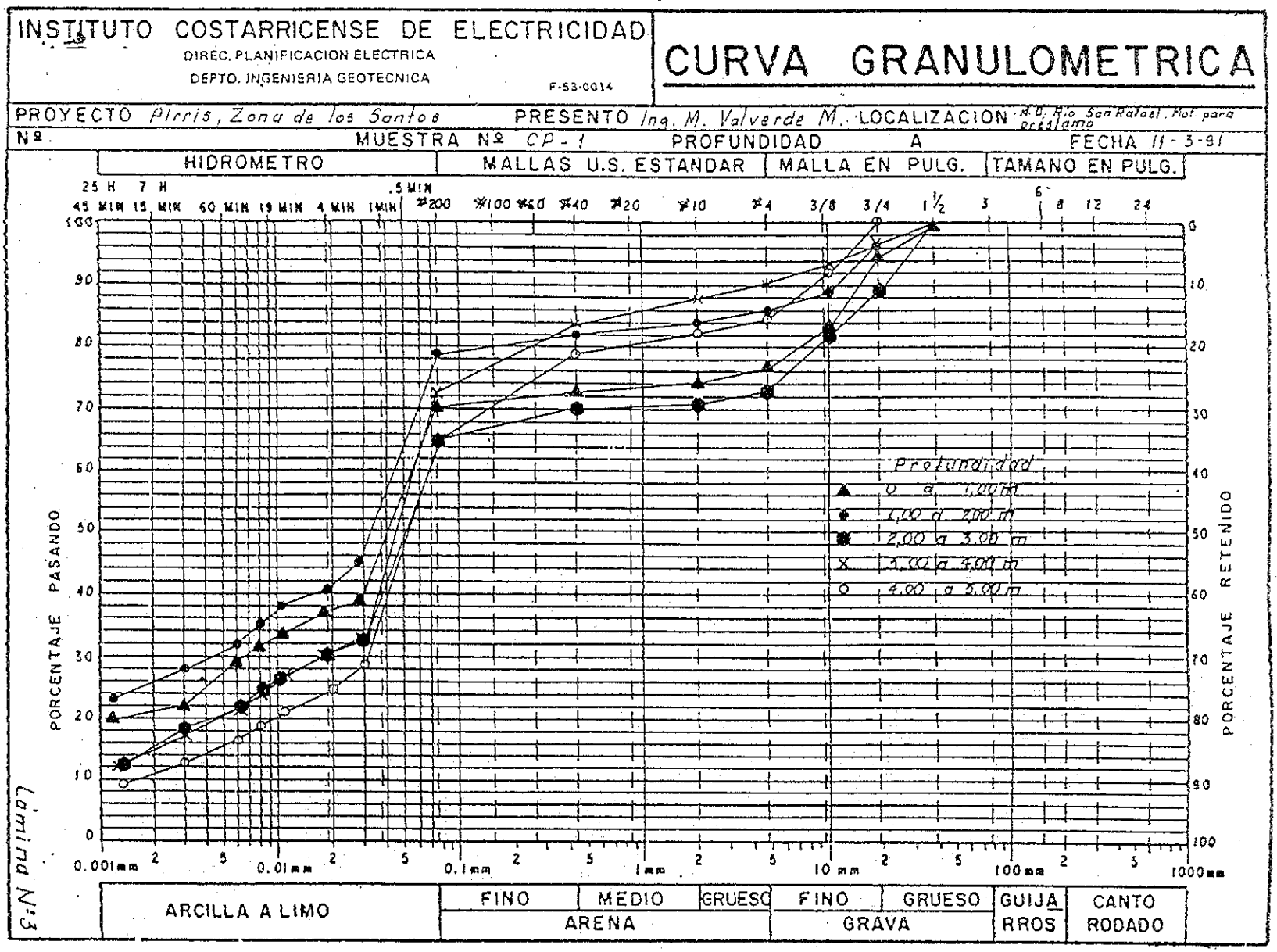


Fig. A-6-6 Plasticity Chart of Liquid Limit, Plasticity Index of CP-1

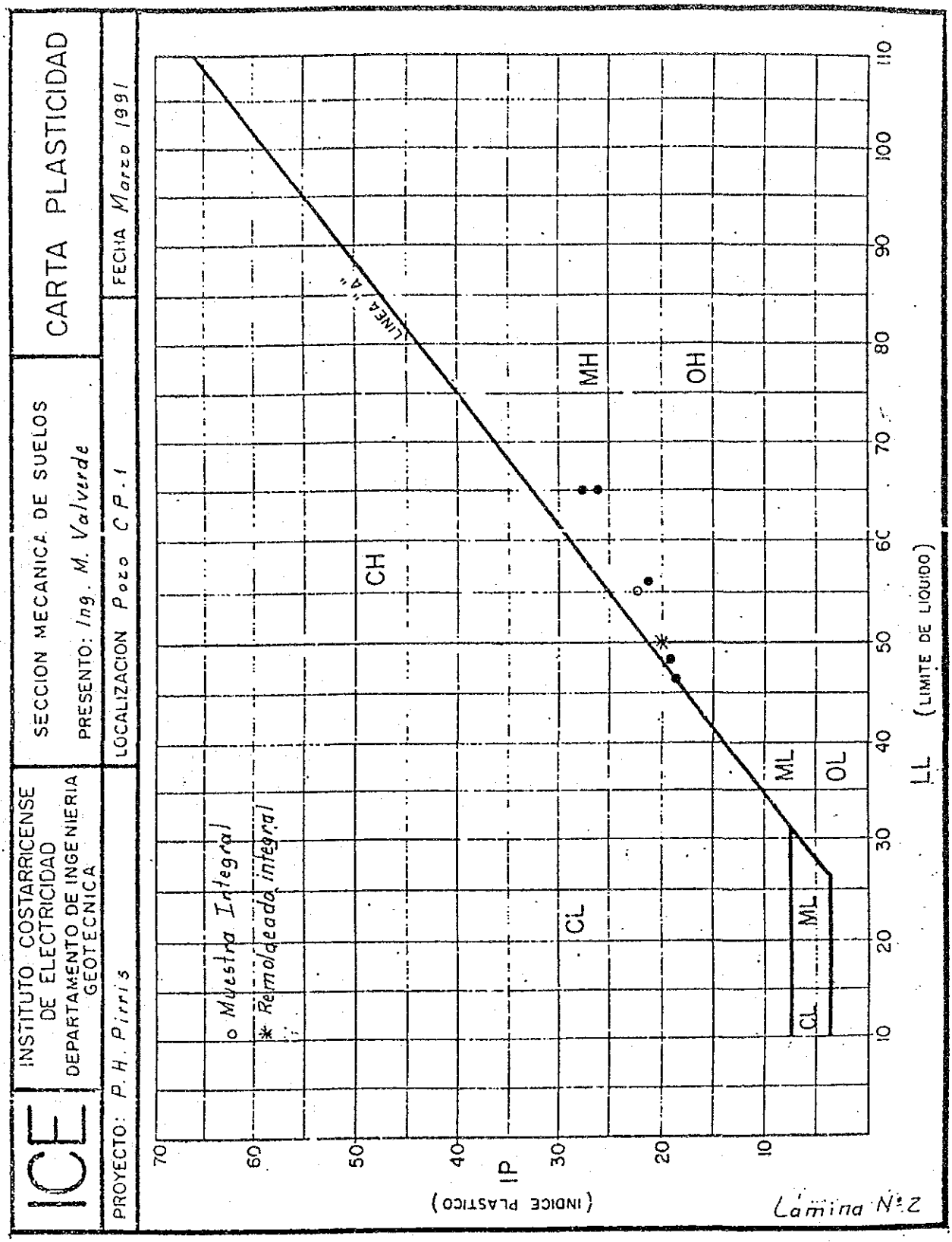


Fig. A-6-7 Grain-size Analysis Test of CP-2

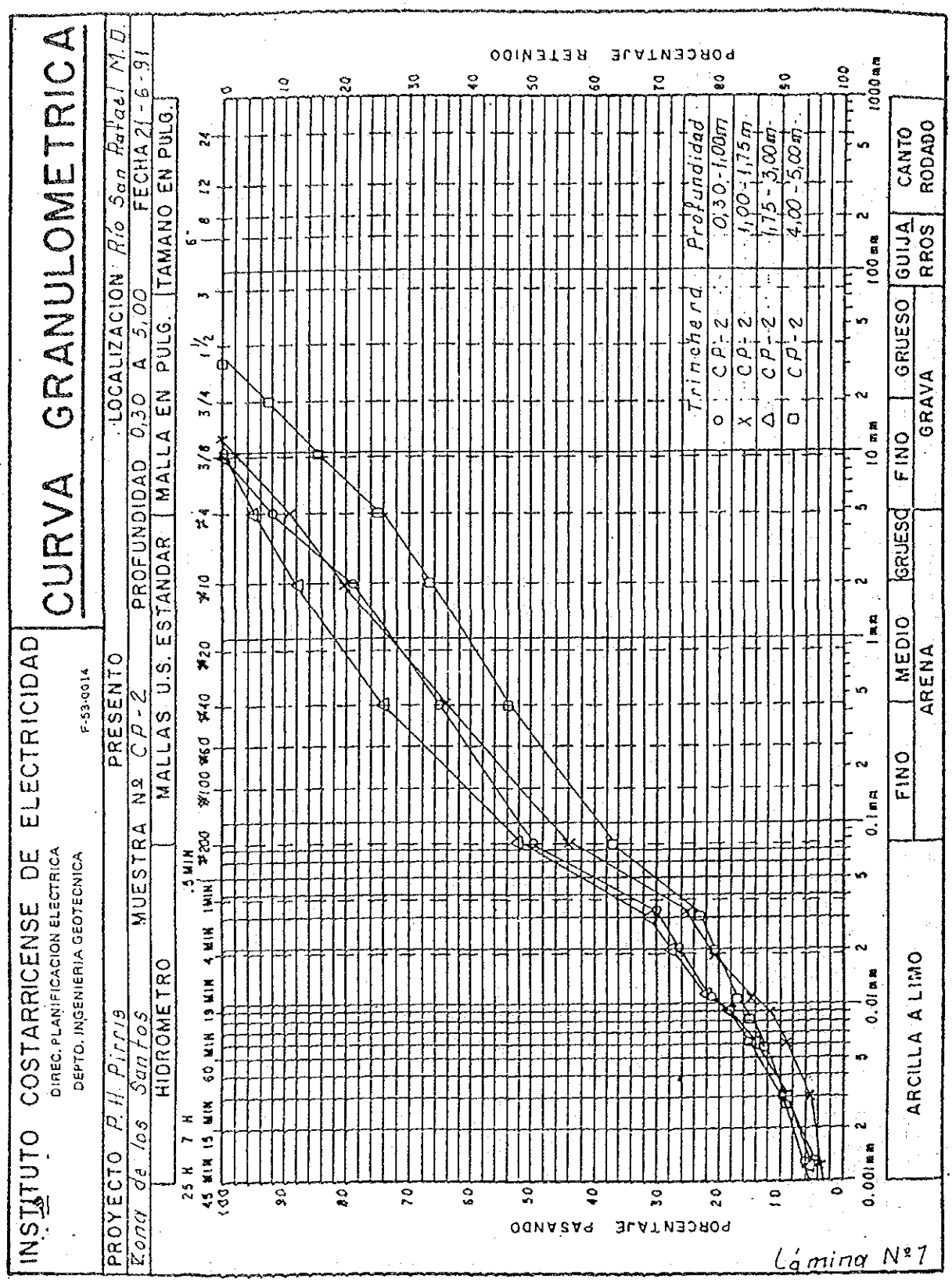


Fig. A-6-8 Plasticity Chart of Liquid Limit, Plasticity Index of CP-2

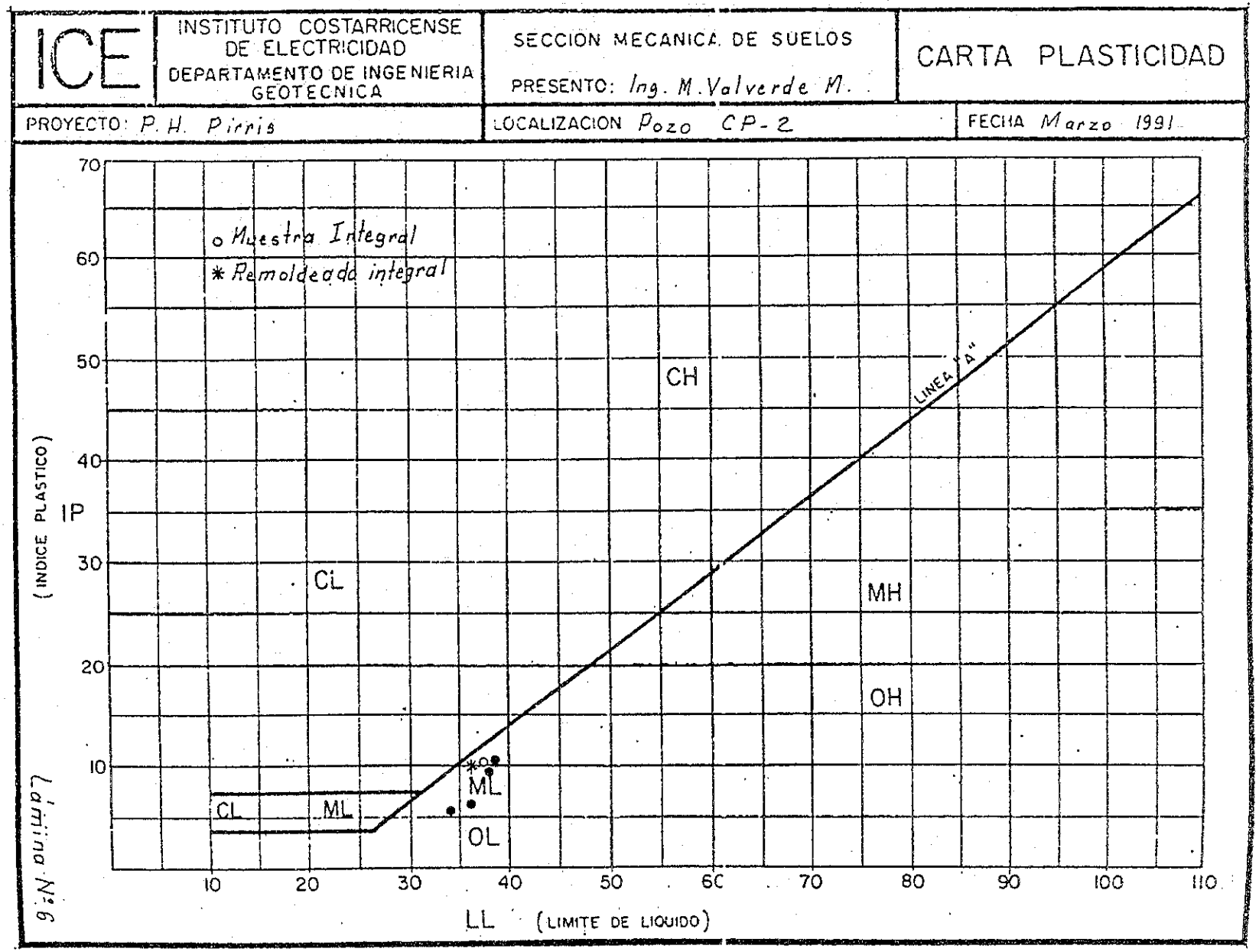


Fig. A-6-9 Grain-size Analysis Test of CP-3

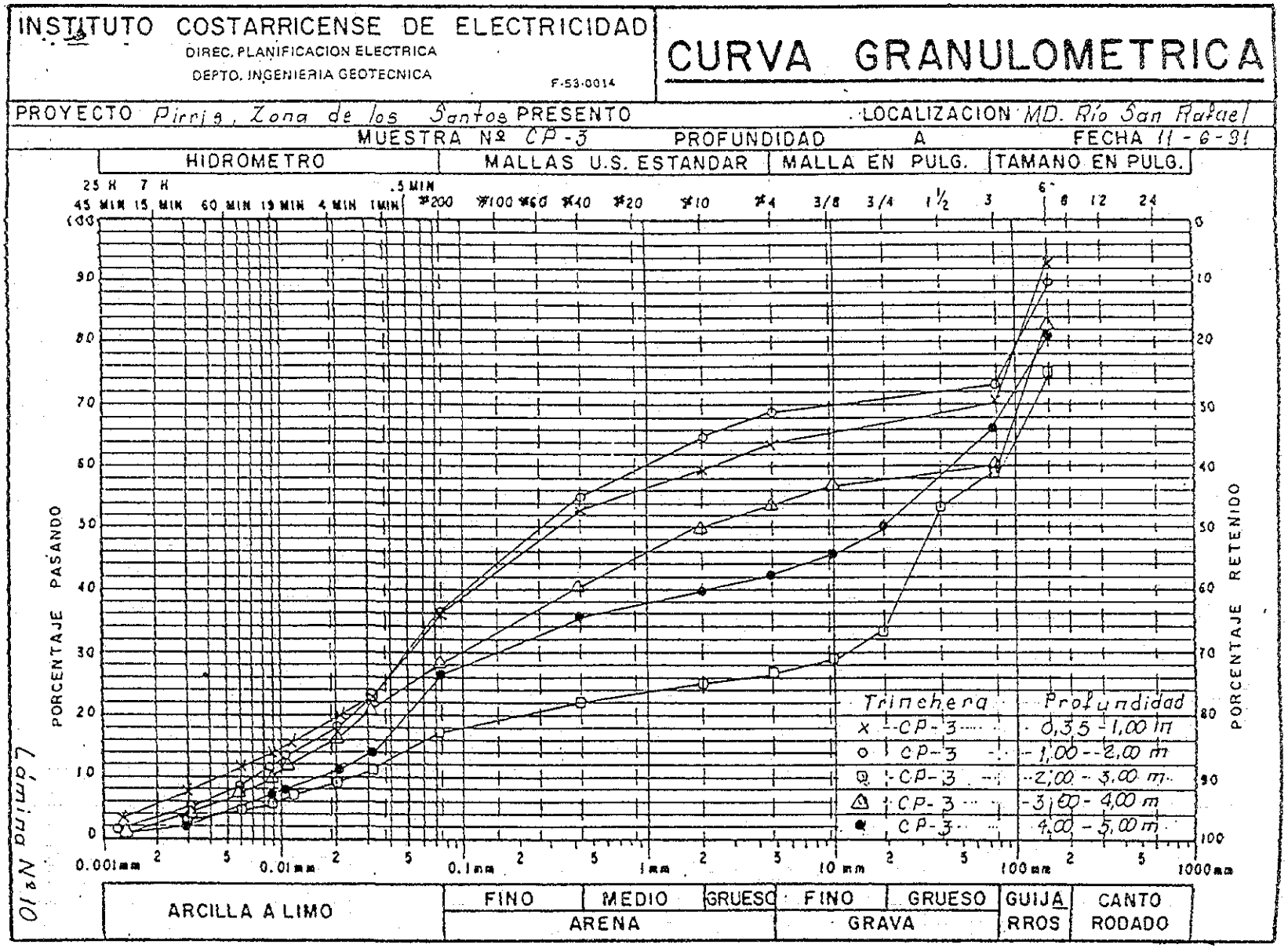


Fig. A-6-10 Plasticity Chart of Liquid Limit, Plasticity Index of CP-3

ICE	INSTITUTO COSTARRICENSE DE ELECTRICIDAD DEPARTAMENTO DE INGENIERIA GEOTECNICA	SECCION MECANICA DE SUELOS PRESENTO: Ing. M. Valverde M.	CARTA PLASTICIDAD
PROYECTO: P. H. Pirris		LOCALIZACION Pozo CP3	FECHA Mayo 1991

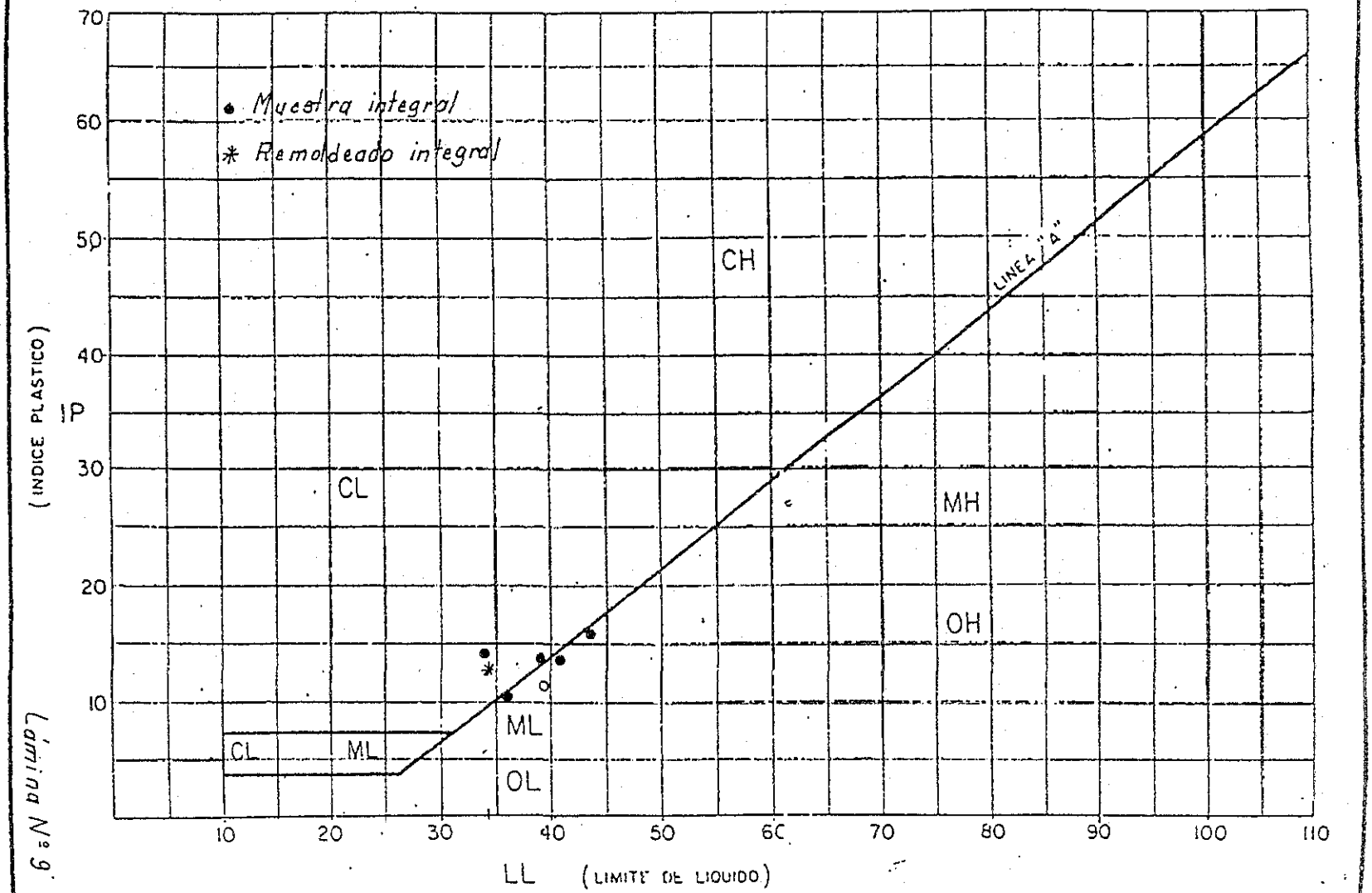
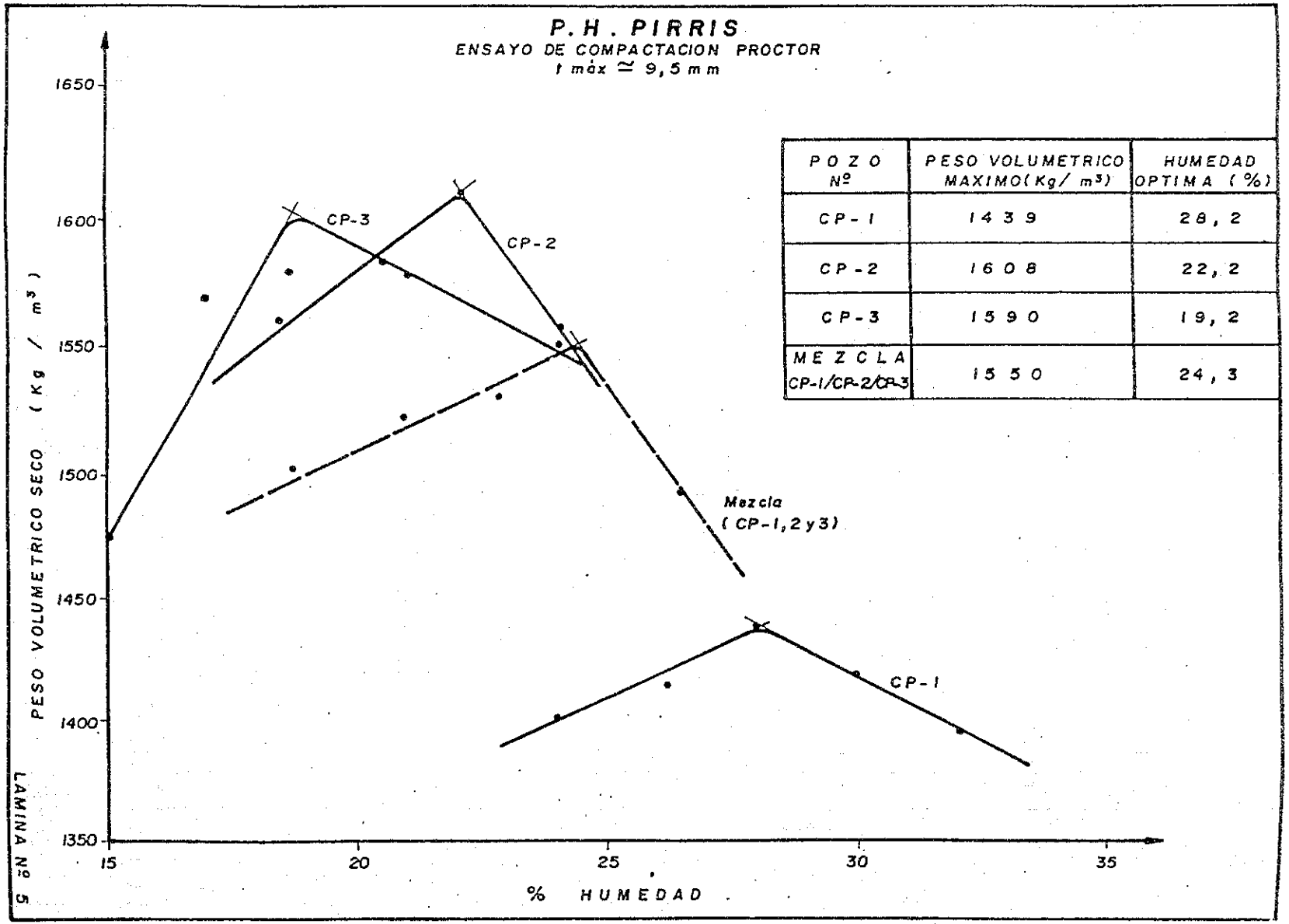


Lámina Nº 9

Fig. A-6-11 Compaction Test of CP-1, CP-2, CP-3, CP-M



POZO Nº	PESO VOLUMETRICO MAXIMO (Kg/ m³)	HUMEDAD OPTIMA (%)
CP-1	1439	28,2
CP-2	1608	22,2
CP-3	1590	19,2
MEZCLA CP-1/CP-2/CP-3	1550	24,3

Fig. A-6-12 Mohr Stress Circles of CP-1, CP-2, CP-3

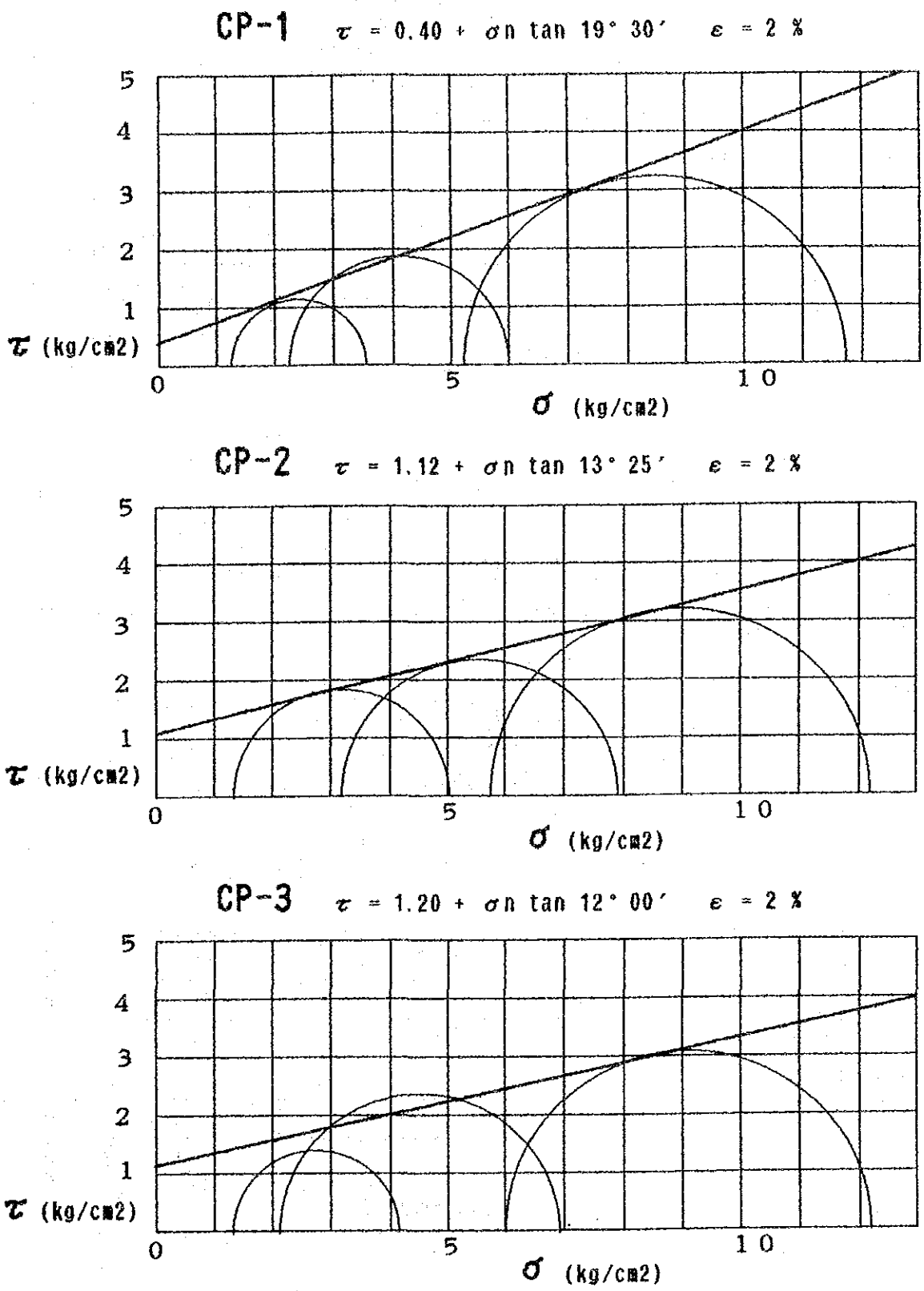
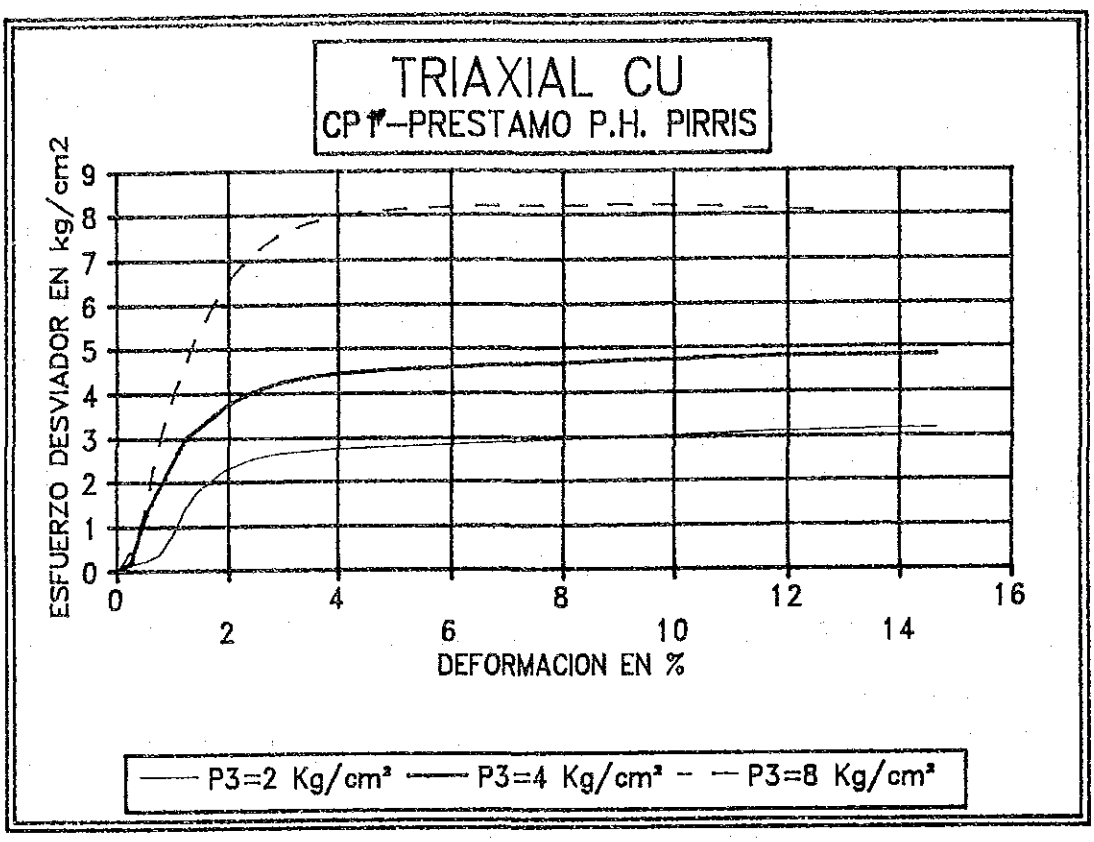


Fig. A-6-13 Strain - Stress History of Triaxial Compression Test of CP-1



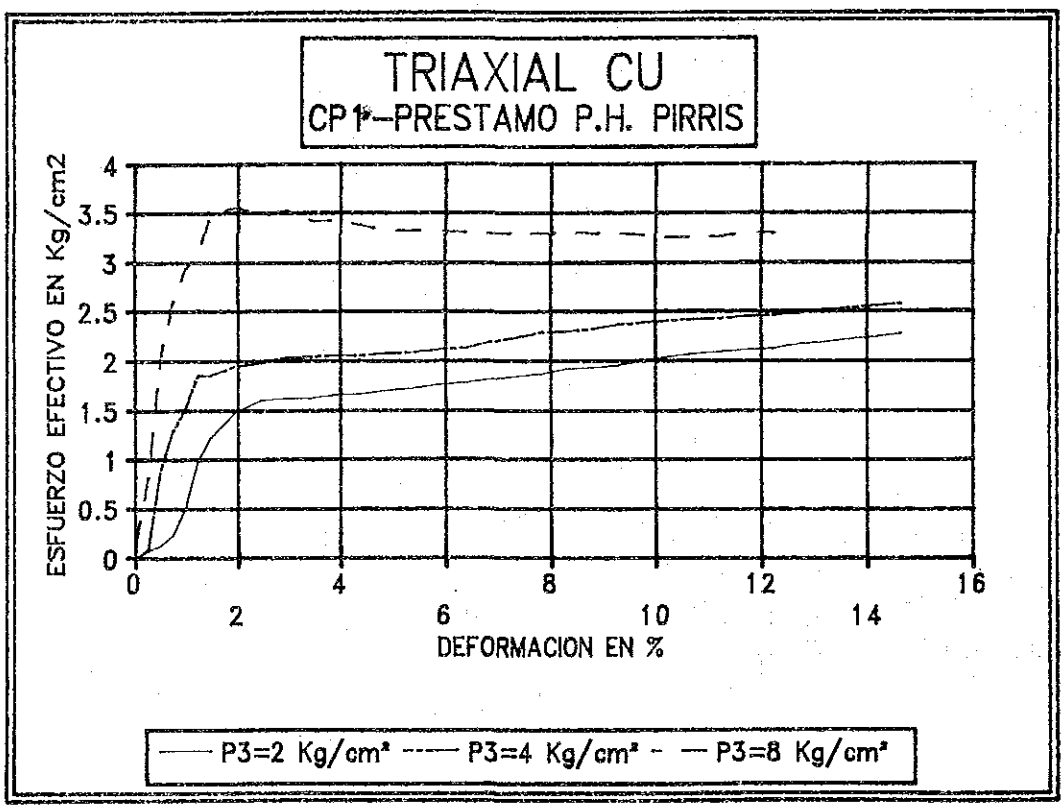
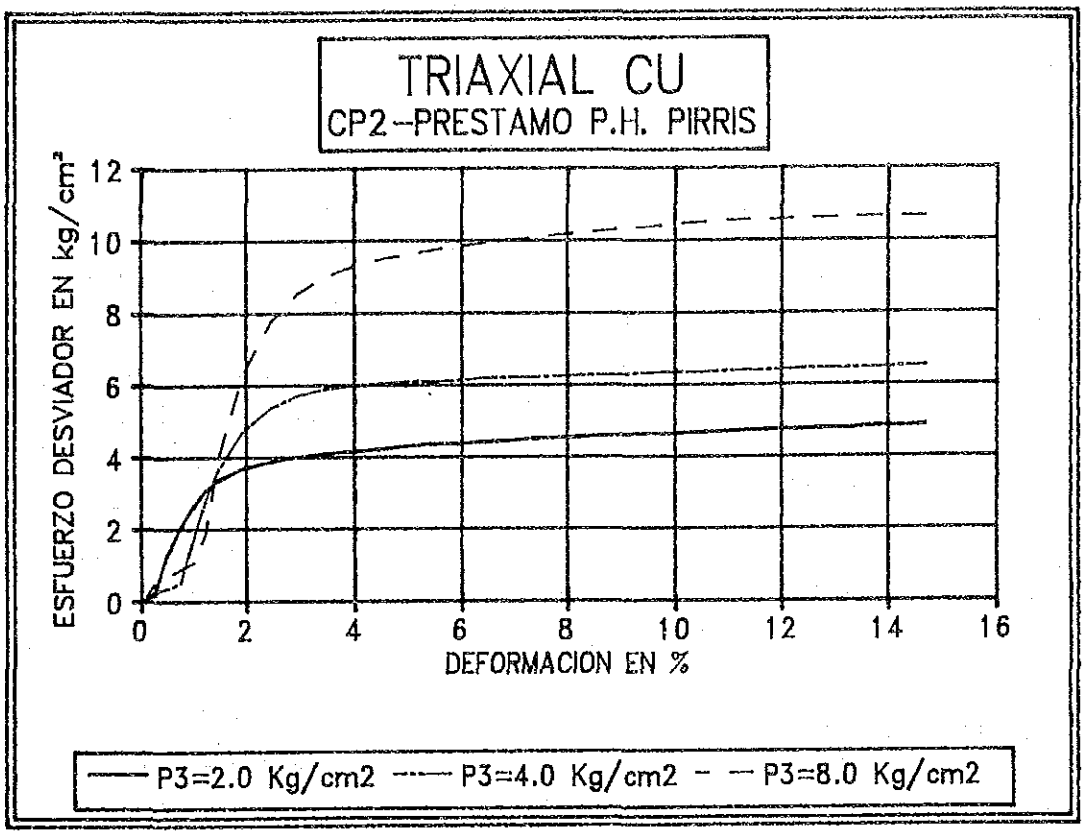


Fig. A-6-14 Strain - Stress History of Triaxial Compression Test of CP-2



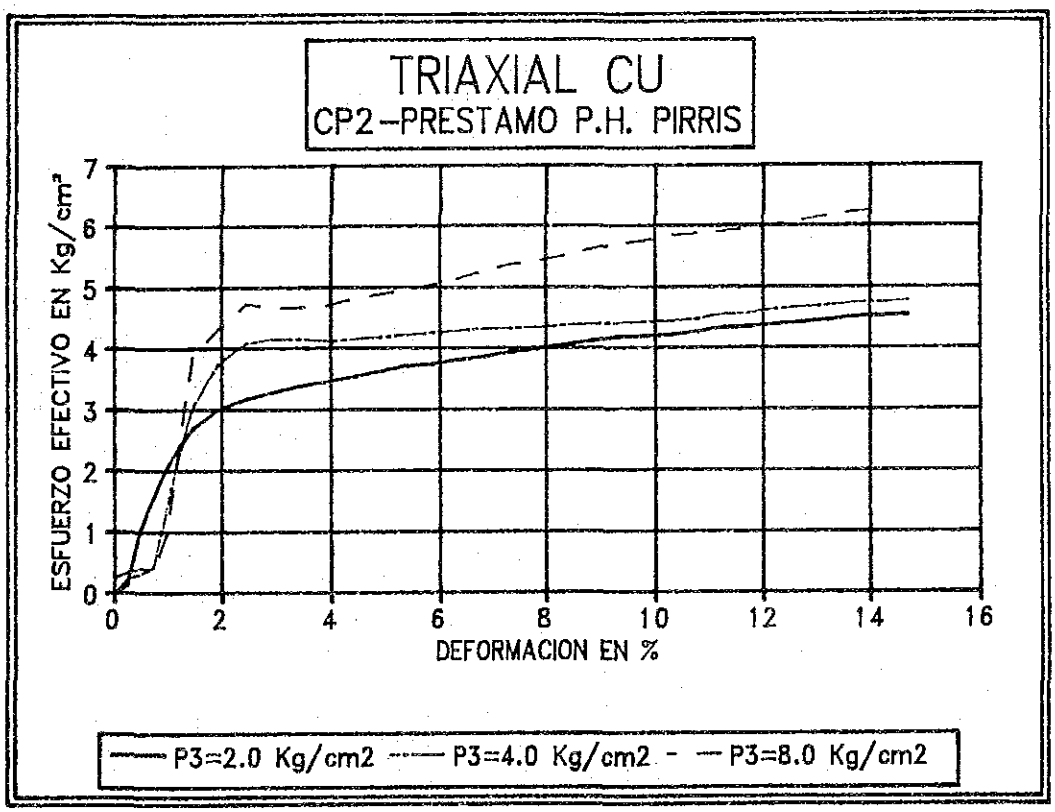
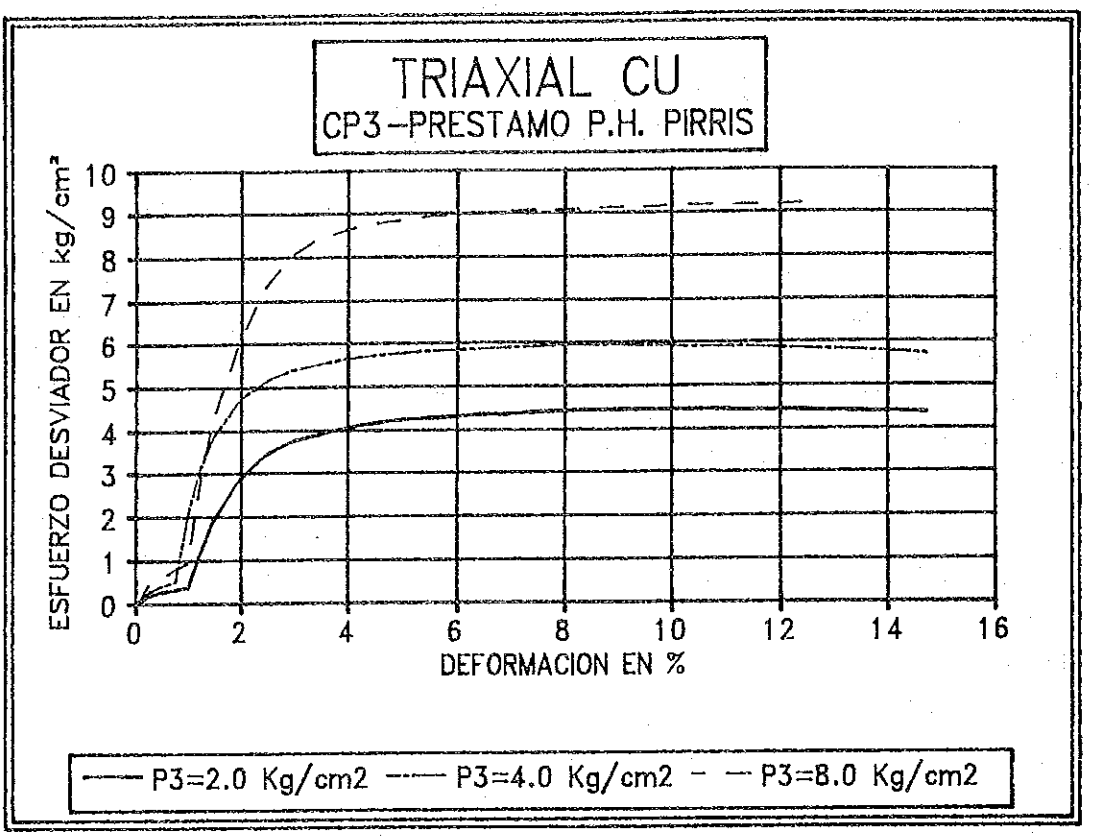


Fig. A-6-15 Strain - Stress History of Triaxial Compression Test of CP-3



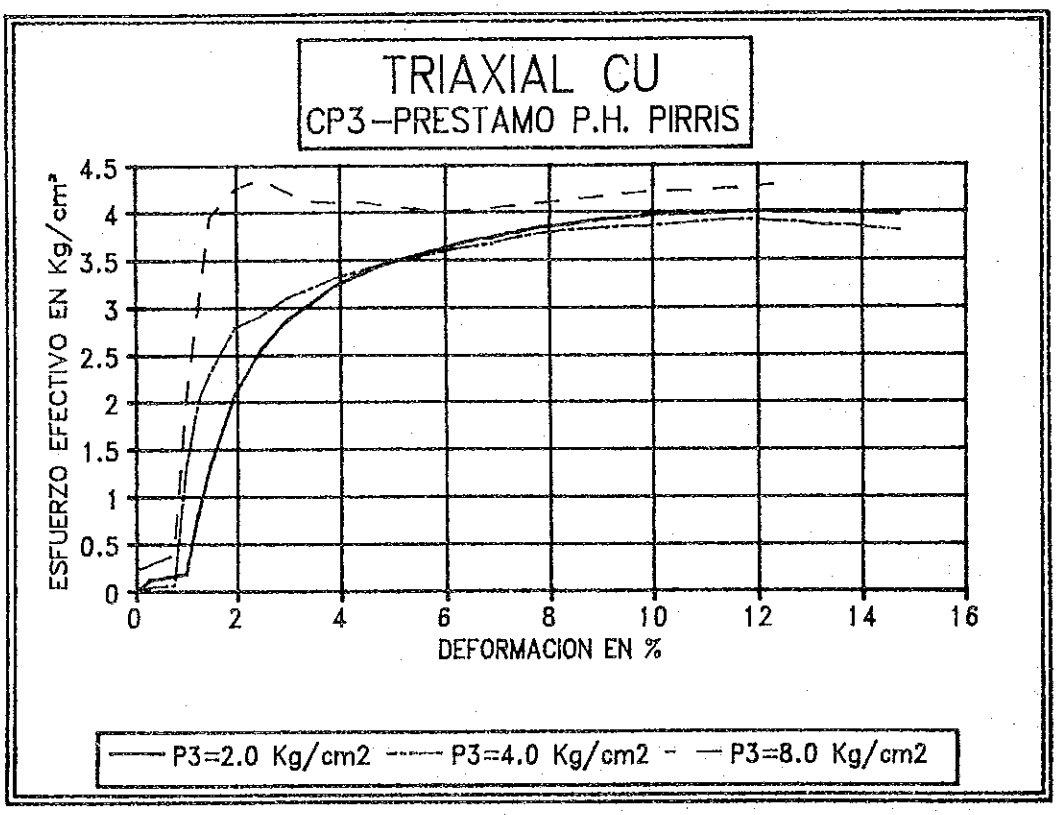


Table A-6-1 Quantity and Sampling Location of Laboratory Tests

Test Item	ASTM	Quantity	Sampling Location
1. Concrete Aggregate			
(1) Specific gravity and absorption	C 127-84 C 128-84	2	Quarry Site (Right Bank of Upstream Dam site) and Right Bank Adit of Downstream Dam site. (LA-2 Adit)
(2) Soundness test	C 88-83	2	
(3) Abrasion Loss Test	C 131-81	2	
(4) Slake Durability Test	D 4644-87	2	
(5) Alkali Aggregate Reaction Tests	C 289-81 C 227-81	2	
(6) Crushing Test	T.S-L.T	2	
2. Laboratory Test of Boring Core			
(1) Specific gravity, absorption Tests	C 127-84 C 128-84	7	UB-1, UB-2, UB-3 and LB-1, LB-2, LB-3, LB-4
(2) Ultrasonic Test	D 2845-83	7	
(3) Unconfined Compression Test	D 2938-79	7	
(4) Tensile Test	D 3967-81	7	
3. Rock Materiales			
(1) Specific gravity and absorption	C 127-84 C 128-84	1	Right Bank Adit of Downstream Dam site. (LA-2 Adit)
(2) Unconfined Compression Test	D 2938-79	1	
4. Soil Materiales			
(1) Specific gravity Test	C 127-84 D 854-83	4	CP-1, CP-2, CP-3 and CP-M (Mixture CP-1, -2, -3)
(2) Moisture Test	D 2216-80	4	
(3) Grain-size Analysis Test	D 422-63	4	
(4) Liquid Limit & Plastic Limit Test	D 4318	4	
(5) Compaction Test	D 698-78	4	
(6) Permeability Test	T.S-L.T	4	
(7) Triaxial Compression Test	T.S-L.T	4	

Table A-6-2 Result of Concrete Aggregate and Boring Core on Laboratory Tests

Test Item / Sampling Location	Specific Gravity	Absorption (%)	Soundness (%)	Abrasion Loss (A) (%)	Slake Durability (%)	Alkali Reaction	Crushing	Remarks
1. Concrete Aggregate								(Co= Coarse) (Fi= Fine)
Quarry Site (Right bank of Upstream Dam site)	2.51 (Co)	3.7 (Co)	3.5 (Coarse) 9.5 (Fine)	16.4	97.2	Innocuous	0.44 (FL) 1.86 (SL)	(FL= Flatness) (SL= Slenderness)
LA-2 Adit (Right bank of Downstream Dam site)	2.80 (Co) 2.49 (Fi)	1.7 (Co) 5.1 (Fi)	2.4 (Coarse) 4.0 (Fine)	14.7	98.7	Innocuous	---	

Test Item / Sampling Location	Specific Gravity	Absorption (%)	Ultrasonic		Modulus of Elasticity		Unconfined Compression Strength (kg/cm2)	Tensile Strength (kg/cm2)	Remarks
			Vp (km/sec)	Vs (km/sec)	Dynamic (kg/cm2)	Static (kg/cm2)			
2. Laboratory Test of Boring Core									
UB-1 (Left bank of U. Dam site)	2.71	0.50	5.25	3.00	468,000	250,000	781	---	
UB-2 (Right bank of U. ' ')	2.70	0.76	5.31	2.92	433,000	236,000	694	---	
UB-3 (' ' of U. ' ')	2.72	0.93	----	----	--------	--------	942	---	
LB-1 (Left bank of D. Dam site)	2.87	1.25	5.36	2.99	484,000	261,000	856	80	
LB-2 (Right bank of D. ' ')	2.90	0.58	5.57	2.99	484,000	265,000	1,089	96	
LB-3 (' ' of D. ' ')	2.88	0.59	5.53	3.05	502,000	272,000	1,065	93	
LB-4 (' ' of D. ' ')	2.93	1.02	5.27	2.93	433,000	230,000	1,530	---	

Table A-6-3 Result of Rock and Soil Materiales on Laboratory Tests

Test Item / Sampling Location	Specific Gravity	Absorption (%)	Unconfined Compression (kg/cm2)	Remarks
3. Rock Materiales LA-2 Adit (Right bank of Downstream Dam site)	2.88	1.03	1,135	

Test Item / Sampling Location	Specific -Gravity	Optimum Moisture (Natural) (%)	Grain-size Analysis -0.005 (mm)	-0.074 (mm)	-4.8 (mm)	Liquid Limit LL (%)	Plasti-city Index PI (%)	Compaction (kg/m3)	Perme-ability x10^-6 (cm/sec)	Triaxial Compression C (kg/cm2)	φ	Classifica-tion of Soils
4. Soil Materiales												
CP-1 (Right bank of Upstreamward)	2.73	28.2 (30.8)	16~31	65~79	73~90	46~65	19~27	1,439	0.095	0.40	19° 30	MH
CP-2 (' ' of ')	2.68	22.2 (23.5)	8~14	37~52	75~95	34~38	6~11	1,608	0.340	1.12	13° 25	SM
CP-3 (' ' of ')	2.68	19.2 (23.0)	4~11	17~36	27~69	34~38	6~11	1,590	-----	1.20	12° 00	SM
CP-M (' ' of ')	----	24.3 (----)	----	----	----	----	----	1,550	-----	----	------	----

Table A-6-4 Specific Gravity, Absorption and Crushing Tests of Quarry Site

Este ensayo se realizó bajo el procedimiento de la norma ASTM C127-88 y C128-88, y fue ejecutado para 8 tamaños por separado según el siguiente cuadro:

	TAMAÑO MUESTRA					
MALLA	2-1 1/2	1 1/2-1	1-3/4	3/4-5/8	5/8-3/8	3/8-4
DIAMETRO	51-38	38-25	25-19	19-16	16-9	9-5
Gb (*)	2.27	2.65	2.60	2.56	2.51	2.44
Abs %	4.9	1.7	2.5	5.0	3.4	4.9

(*) Gravedad específica bruta seca.

ENSAYO DE QUEBRADO

Para este ensayo se utilizò el quebrador del laboratorio de muelas, el cual tiene una abertura màxima de 80 mm y se le fijò su abertura mìnima en 25 mm.

Seguidamente se escogiò una muestra de 40 kg de material entre 60 y 120 mm de tamaño y se procedió a quebrarla en su estado natural. La granulometría resultante fue la siguiente:

MALLA	1 1/2	1	3/4	5/8	3/8	4	8	16	30	50	100	200
DIAMETRO	38	25	19	16	9	5	2	1.2	0.6	0.3	0.15	0.079
% Pas.	93	59	36	29	19	11	10	7	5	3	2	1

Utilizando este mismo material se realizó un segundo quebrado resultando la siguiente granulometría:

MALLA	1 1/2	1	3/4	5/8	3/8	4	8	16	30	50	100	200
DIAMETRO	38	25	19	16	9	5	2	1.2	0.6	0.3	0.15	0.079
% Pas.	-	-	-	99	95	45	22	20	14	10	6	2

Con el propósito de cuantificar la forma geométrica del producto quebrado se listan a continuación por tamaño 30 determinaciones de tamaño.

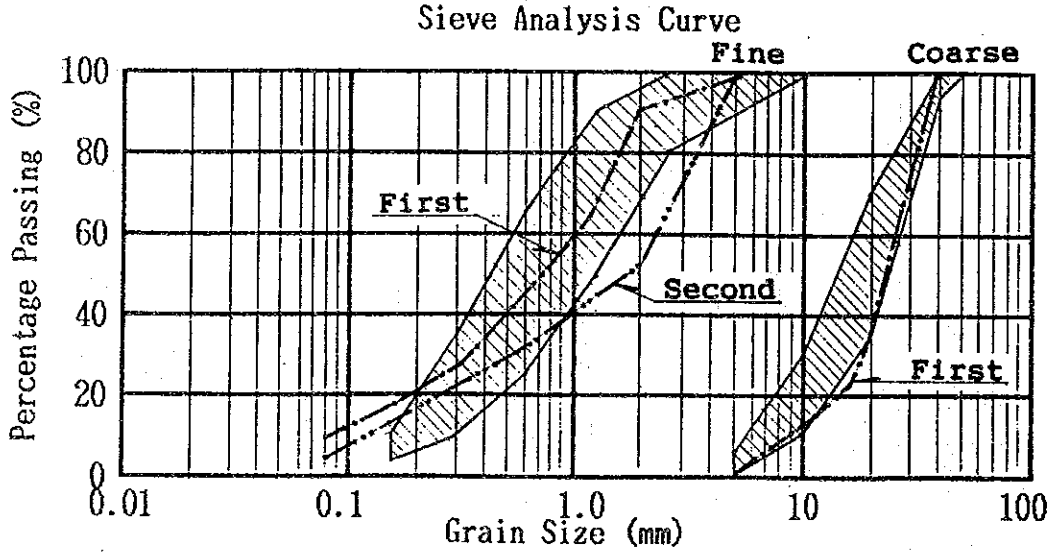


Table A-6-5 Specific, Absorption, Ultrasonic, Modulus of Elasticity and Compression Strength Tests of Boring Cores

PERFORACION UB-1

MUEST #	PROF m.	LONG (mm)	DIAM. (mm)	γd (kg/m3)	Qu (kg/cms2)	Gs (bruta)	Abs (%)	Vp (km/seg)	Vs (km/seg)	μ	MED (T/cm2)	GD (T/cm2)
1	7- 8	124.9	47.3	2703.8	1081.3	2.60	0.47	4.53	3.02	0.10	497.5	251.3
2	9-10	124.8	47.4	2693.6	821.7	2.71	0.46	4.67	3.09	0.11	518.3	262.4
3	17-18	125	47.4	2721.1	552.5	2.73	0.63	5.53	3.25	0.24	552.8	292.9
4	18-19	124.8	47.4	2700.0	538.4	2.72	0.61	5.29	3.01	0.26	467.3	250.5
5	21-22	125	47.4	2689.8	665.9	2.70	0.42	5.17	3.11	0.22	506.3	265.5
6	23-24	125	47.4	2720.2	835.9	2.74	0.72	4.88	3.26	0.10	582.7	294.3
7	25-26	125	47.4	2737.4	850.1	2.75	0.20	5.43	3.09	0.26	498.9	267.6
8	28-29	125	47.4	2718.3	1164.6	2.73	0.55	5.39	3.08	0.26	491.3	263.1
9	32-33	115.3	47.4	2696.4	855.7	2.71	0.24	4.43	2.59	0.24	346.3	184.0
10	34-35	125	47.4	2693.0	850.1	2.71	0.35	5.53	2.84	0.32	398.1	221.9
11	35-36	125	47.4	2684.8	1388.4	2.70	0.69	5.53	2.89	0.31	414.4	229.5
12	37-38	124.3	47.4	2714.5	793.4	2.73	0.55	5.36	2.76	0.32	379.9	211.5
13	39-40	125	47.4	2699.8	844.4	2.72	0.39	5.39	2.95	0.29	439.9	239.6
14	41-42	122.4	47.4	2690.0	566.7	2.70	0.24	5.67	3.01	0.30	453.5	249.6
15	42-43	124.8	47.4	2670.0	283.4	2.68	0.70	5.43	3.03	0.27	462.8	250.1
16	45-46	125	47.4	2694.8	453.4	2.71	0.42	5.53	2.95	0.30	434.8	239.1
17	48-49	124.1	47.4	2686.5	736.7	2.70	0.63	5.44	3.17	0.24	517.0	274.9

PERFORACION UB-2

MUEST #	PROF m.	LONG (mm)	DIAM. (mm)	γd (kg/m3)	Qu (kg/cm2)	Gs (bruta)	Abs (%)	Vp (km/seg)	Vs (km/seg)	μ	MED (T/cm2)	GD (T/cm2)
1	3-4	121.0	47.2	2705.5	857.3	2.70	1.15	5.31	2.87	0.29	415.0	227.1
2	8-9	121.0	47.2	2717.3	685.8	2.71	0.68	5.35	2.92	0.29	434.7	237.0
3	10-11	120.8	47.2	2706.2	743.0	2.69	0.51	5.44	2.96	0.29	443.8	242.2
4	12-13	121.0	47.2	2719.6	400.1	2.72	0.36	5.17	2.94	0.26	446.2	239.5
5	16-17	120.9	47.2	2703.9	971.6	2.70	1.22	5.35	2.98	0.28	452.4	244.8
6	20-21	121.0	47.2	2712.6	628.7	2.71	0.52	5.40	2.92	0.29	432.5	236.6
7	22-23	108.5	47.2	2707.4	685.8	2.69	0.62	4.89	2.61	0.30	342.0	188.0
8	28-29	120.9	47.2	2721.9	914.4	2.71	0.83	5.35	2.98	0.28	455.5	246.4
9	31-32	120.9	47.2	2694.5	571.5	2.71	0.98	5.26	3.01	0.26	464.9	248.8
10	37-38	120.8	47.2	2702.9	857.3	2.71	0.72	5.44	2.92	0.30	428.1	235.0
11	40-41	121.0	47.2	2673.8	342.9	2.68	0.64	5.45	2.91	0.30	420.1	231.0
12	43-44	120.1	47.2	2726.7	800.1	2.71	0.77	5.18	2.92	0.27	439.2	236.6
13	46-47	120.5	47.2	2706.3	571.5	2.71	0.70	5.29	2.95	0.27	446.1	241.0
14	49-50	120.8	47.2	2696.7	685.8	2.70	0.93	5.49	2.98	0.29	445.9	243.7

γd = Peso Volumétrico seco.
Qu = Resistencia.
Gs = Gravedad Específica.
Abs = Absorción.
Vp = Velocidad de Onda.
Vs = Velocidad de Onda.
MED = Módulo Elástico Dinámico.
Gd = Módulo de Cizalle.
μ = Relación de Poisson.

Table A-6-5 Specific, Absorption, Ultrasonic, Modulus of Elasticity and Compression Strength Tests of Boring Cores

PERFORACION LB-1

MUEST #	PROF m.	LONG (mm)	DIAM. (mm)	γd (kg/m3)	Qu (kg/cm2)	Gs (bruta)	Abs (%)	Vp (km/seg)	Vs (km/seg)	μ	MED (T/cm2)	GD (T/cm2)
1	1-2	120.6	47.2	2881.7	1028.7	2.88	0.49	5.69	3.17	0.27	548.2	296.4
2	4-5	120.7	47.2	2884.1	971.6	2.90	0.30	4.99	3.08	0.19	537.7	279.2
3	9-10	120.6	47.2	2866.1	685.8	2.89	2.12	4.98	2.90	0.24	462.5	245.9
4	11-12	120.6	47.2	2932.4	714.4	2.93	0.76	4.98	2.96	0.23	495.8	261.6
5	12-13	120.6	47.2	2868.5	1257.3	2.87	1.72	5.74	3.05	0.30	492.9	271.6
6	13-14	120.9	47.2	2867.5	1143.0	2.88	0.54	5.65	3.18	0.27	550.2	296.4
7	17-18	120.9	47.2	2866.1	1143.0	2.88	1.19	5.26	2.95	0.27	471.7	254.4
8	21-22	120.8	47.2	3022.7	800.1	2.97	0.64	5.54	3.13	0.27	561.8	302.3
9	32-33	120.8	47.2	2834.4	743.0	2.84	0.53	5.30	2.76	0.31	396.8	220.1
10	37-38	120.9	47.2	2885.9	571.5	2.90	0.74	5.60	2.92	0.31	453.3	251.3
11	39-40	120.9	47.2	2853.8	914.4	2.87	0.68	5.30	2.89	0.29	447.0	243.8
12	43-44	120.9	47.2	2607.5	285.8	2.63	2.88	4.23	2.86	0.08	434.6	218.5
13	52-53	121.0	47.2	2842.9	914.4	2.86	1.38	5.55	3.06	0.28	498.7	271.0
14	55-56	121.0	47.2	2862.3	1200.2	2.87	2.97	5.99	3.07	0.32	494.2	275.6
15	61-62	120.8	47.2	2881.2	685.8	2.89	0.10	5.44	3.00	0.28	459.4	265.6
16	63-64	120.8	47.2	2743.5	1085.9	2.75	3.04	5.21	2.82	0.29	408.2	223.1
17	65-66	120.9	47.2	2885.5	743.0	2.91	2.42	5.35	2.98	0.28	482.8	261.2
18	68-69	120.5	47.2	2871.8	514.4	2.89	0.05	5.63	3.01	0.30	484.4	266.1

PERFORACION LB-2

MUEST #	PROF m.	LONG (mm)	DIAM. (mm)	γd (kg/m3)	Qu (kg/cm2)	Gs (bruta)	Abs (%)	Vp (km/seg)	Vs (km/seg)	μ	MED (T/cm2)	GD (T/cm2)
1	0-2	119.7	47.2	2902.4	1143.0	2.88	0.97	5.25	2.80	0.30	421.3	231.8
2	3-4	120.0	47.2	2940.4	571.5	2.92	0.40	5.66	3.11	0.28	533.5	290.2
3	5-6	120.0	47.2	2932.8	1257.3	2.92	0.42	5.31	3.06	0.25	525.8	280.6
4	12-13	116.8	47.2	2975.0	1257.3	2.89	0.41	5.31	3.04	0.26	525.3	281.0
5	13-16	119.3	47.2	2848.5	1257.3	2.89	0.24	5.97	2.97	0.34	454.6	256.1
6	17-18	119.6	47.2	2873.8	342.9	2.89	1.46	4.56	2.89	0.17	476.3	244.9
8	24-25	119.6	47.2	2865.7	685.8	2.86	1.18	5.54	2.87	0.32	435.6	241.8
9	25-26	120.0	47.2	2886.1	1257.3	2.88	0.86	5.71	2.94	0.32	457.7	254.9
10	27-28	120.0	47.2	2929.0	1257.3	2.91	0.46	5.88	3.06	0.31	505.1	280.2
11	30-31	120.0	47.2	2881.4	1257.3	2.87	1.02	5.77	3.02	0.31	482.8	267.4
12	34-35	119.9	47.2	2920.5	914.4	2.90	0.08	5.40	2.97	0.26	483.0	262.6
13	37-38	120.0	47.2	2908.0	1257.3	2.90	0.69	5.71	2.96	0.32	466.5	259.4
14	42-43	120.0	47.2	2901.9	1257.3	2.91	0.74	5.56	2.91	0.31	454.2	251.3
15	44-45	120.3	47.2	2875.1	1257.3	2.89	0.56	5.84	2.99	0.32	468.5	261.6
16	48-49	120.2	47.2	2870.9	1257.3	2.88	0.65	5.51	3.11	0.27	528.3	284.2
17	52-53	120.3	47.2	2896.0	685.8	2.90	0.28	5.42	2.96	0.29	476.5	259.6
18	55-56	120.5	47.2	2912.1	914.4	2.92	0.52	5.58	3.11	0.28	530.0	286.8
19	58-59	120.5	47.2	2925.9	1257.3	2.93	0.24	5.79	3.07	0.30	512.4	282.3
20	60-61	120.4	47.2	2888.9	1257.3	2.89	0.26	5.56	2.97	0.30	471.7	259.4
21	64-65	120.7	47.2	2930.0	1257.3	2.93	0.29	5.92	2.93	0.34	455.0	256.8
22	67-68	120.6	47.2	2952.8	1257.3	2.95	0.43	5.64	3.02	0.30	498.9	274.1

γd = Peso Volumétrico.
Qu = Resistencia.
Gs = Gravedad Específica.
Abs = Absorción.
Vp = Velocidad de Onda.
Vs = Velocidad de Onda.
MED = Módulo Elástico Dinámico.
GD = Módulo de Cizalle.
μ = Relación de Poisson.

Table A-6-5 Specific, Absorption, Ultrasonic, Modulus of Elasticity and Compression Strength Tests of Boring Cores

PERFORACION LB-3

MUEST #	PROF m.	LONG (mm)	DIAM. (mm)	γd (kg/m3)	Qu (kg/cm2)	Gs (bruta)	Abs (%)	Vp (km/seg)	Vs (km/seg)	μ	MED (T/cm2)	GD (T/cm2)
1	11-12	123.3	47.4	2911.2	850.1	2.92	0.32	5.82	2.94	0.33	456.9	256.2
2	13-14	123.3	47.4	2814.2	793.4	2.82	1.00	—	—	—	—	—
4	15-16	123.2	47.4	2779.2	1190.1	2.80	1.89	5.40	2.91	0.30	437.3	239.6
5	22-23	123.5	47.4	2867.9	1246.7	2.89	0.03	5.56	3.07	0.28	509.2	276.4
7	25-26	123.2	47.4	2800.4	566.7	2.81	1.08	—	—	—	—	—
9	29-30	123.6	47.4	2857.8	566.7	2.88	0.34	4.79	2.99	0.18	502.8	260.1
12	35-36	123.7	47.4	2842.2	1020.1	2.85	1.00	5.38	3.16	0.24	545.3	289.0
14	41-42	110	47.4	2823.2	906.7	2.84	1.09	—	—	—	—	—
15	46-47	123.6	47.4	2812.4	1586.8	2.83	1.34	5.28	2.78	0.31	402.9	222.5
18	51-52	123.4	47.4	2827.5	736.7	2.85	0.11	5.51	3.21	0.24	561.3	298.1
19	58-59	123.9	47.4	2849.5	1360.1	2.88	0.35	—	—	—	—	—
20	61-62	123.3	47.4	2868.9	1303.4	2.89	0.42	5.41	3.19	0.23	565.6	298.9
22	65-66	123.3	47.4	2875.3	906.7	2.90	0.38	—	—	—	—	—
23	68-69	123.6	47.4	2879.8	1360.1	2.90	0.30	5.78	2.99	0.32	471.2	262.1
25	74-75	123.8	47.4	2915.9	1473.4	2.93	0.24	—	—	—	—	—
27	79-80	123.7	47.4	2862.4	1416.8	2.89	0.14	5.52	2.92	0.31	450.8	248.7
30	85-86	123.4	47.4	2891.4	1530.1	2.93	0.19	—	—	—	—	—
31	89-90	123.7	47.4	2904.1	1020.1	2.94	0.49	5.95	3.14	0.31	529.5	292.3
33	94-95	122.1	47.4	2888.3	736.7	2.90	0.29	—	—	—	—	—
35	98-99	123.8	47.4	2904.9	736.7	2.94	0.74	5.90	3.28	0.28	587.5	318.1

PERFORACION LB-4

MUEST #	PROF m.	LONG (mm)	DIAM. (mm)	γd (kg/m3)	Qu (kg/cm2)	Gs (bruta)	Abs (%)	Vp (km/seg)	Vs (km/seg)	μ	MED (T/cm2)	GD (T/cm2)
1	19-20	118.0	47.4	2850.1	1246.7	2.90	0.30	5.27	2.86	0.29	441.8	241.2
2	24-25	113.6	47.4	2897.4	1530.1	2.92	0.10	4.98	2.67	0.30	383.0	210.4
5	34-35	123.8	47.4	2875.2	736.7	2.88	1.02	4.91	2.93	0.22	480.2	252.6
7	43-44	123.2	47.4	2387.3	793.4	2.93	0.13	—	—	—	—	—
8	48-49	123.5	47.4	2802.3	226.7	2.82	0.88	4.06	2.74	0.08	428.2	215.5

γd = Peso Volumétrico.
Qu = Resistencia.
Gs = Gravedad Específica.
Abs = Absorción.
Vp = Velocidad de Onda.
Vs = Velocidad de Onda.
MED = Módulo Elástico Dinámico.
Gd = Módulo de Cizalle.
μ = Relación de Poisson.

Table A-6-6 Tensil Strength Tests of Boring Croes

PERF.No.	PROF. (m)	Do. (mm)	Lo (mm)	Ws (gr)	P (kg)	&d (k/m3)	TRACCION*
LB 1	1.0 - 2.0	47.2	126.0	647.2	9500	2935	101
LB 1	12 - 13	47.3	103.4	573.4	6875	3155	89
LB 1	17 - 18	47.2	116.0	589.2	6000	2902	69
LB 1	37 - 38	47.3	110.0	567.5	8400	2936	102
LB 1	43 - 44	47.2	99.0	458.5	3000	2646	40
LB 2	5 - 6	47.5	110.0	580.0	6400	2975	77
LB 2	12 - 13	47.7	116.0	577.5	7900	2785	90
LB 2	24 - 25	47.5	113.5	574.0	10000	2853	118
LB 2	44 - 45	47.2	120.6	609.4	8000	2887	89
LB 2	67 - 68	47.4	94.0	499.0	7500	3008	107
LB 3	3 - 4	47.4	115.0	541.0	6560	2665	76
LB 3	8 - 9	47.5	81.0	384.3	4920	2677	81
LB 3	16 - 17	47.5	87.4	428.0	8000	2763	122
LB 3	20 - 21	47.5	108.0	515.0	6460	2690	80
LB 3	30 - 31	47.3	112.0	536.8	9000	2727	108

	Tensil Strength
LB-1	80.2 +- 23.4 kg/cm2
LB-2	96.2 +- 14.5 kg/cm2
LB-3	93.4 +- 18.3 kg/cm2

* Resistencia a la traccion en Kg/cm2

Table A-6-7 Specific, Absorption, Optimum Moisture, Liquid Limit, Plasticity Index, and Compaction Tests of Borrow Area

INSTITUTO COSTARRICENSE DE ELECTRICIDAD
DIRECCION INGENIERIA CIVIL

DEPARTAMENTO INGENIERIA GEOTECNICA
PROYECTO: P.H. Pirrís

NOMBRE DEL AREA DE PRESTAMO: M.D. Río San Rafael
LOCALIZACION GENERAL:
COORDENADAS LIMITES: E / N

ELEVACION: Muy variable
TIPO DE MATERIAL: Roca meteorizada coluvio-aluvion
AREA DE PRESTAMO:

ACCESIBILIDAD: Mala
FECHA: Marzo 91
REVISION:

Pozo Nº	Coord.	Elevacion (m)	Muestra Nº	Prof. (m)	N.F. (m)	GRANULOMETRIA M a C %	S a G %	> 3" %	D_{10} (mm)	D_{60} (mm)	C_u	LL %	IP %	G_s	IN SITU e_o	$W_{nat.}$ %	SUCS	PRUEBA DE COMPACTACION γ_{max} Kg/m³	W %	S %	G_s	e min.	OBSERVACIONES
CP-1	E / N		1	0,0-1,0	No Hay	70	30	—	—	0,055	—	65	26	2,74		31,4	MH						
	E / N		2	1,0-2,0	"	79	21	—	—	0,045	—	65	27	2,69		32,2	MH						
	E / N		3	2,0-3,0	"	65	35	—	—	0,070	—	56	22	2,72		31,3	MH						
	E / N		4	3,0-4,0	"	73	27	—	—	0,060	—	48	19	2,76		32,3	ML						
	E / N		5	4,0-5,0	"	64	36	—	0,0015	0,070	47	47	19	2,73		26,8	ML-CL						
	E / N		I	1,0-5,0		71	29	—	—	006	—	55	22	2,81		—	MH	1439	28,2	—	2,81	—	
CP-2	E / N		1	0,3-1,0	No Hay	50	50	—	0,002	0,27	135	36	7	2,70		23,0	SM						
	E / N		2	1,0-1,75	"	44	56	—	0,007	0,30	43	38	9	2,67		25,0	SM						
	E / N		3	1,75-3,0	"	52	48	—	0,003	0,15	50	34	6	2,70		25,0	ML						
	E / N		4	4,0-5,0	"	37	63	—	0,004	1,00	250	38	11	2,65		21,0	SM						
	E / N		I	0,3-5,0		52	48	—	0,006	0,45	75	37	10	—		—	ML	1608	22,2	—	—	—	
CP-3	E / N		1	0,3-1,0	No Hay	39	24	30	0,006	2,0	333	36	7	2,70		23	SM						
	E / N		2	1,0-1,75	"	36	33	28	0,005	0,95	190	38	9	2,67		25	SM						
	E / N		3	1,75-3,0	"	17	10	39	0,022	7,5	340	34	6	2,70		25	SM						
	E / N		4	4,0-5,0	"	29	25	40	0,003	0,25	28	38	11	2,65		21	SM						
	E / N		I	0,3-5,0		—	—	—	—	—	—	38	11	—	—	—	GM	1590	19,2	—	—	—	

TABLA Nº 1