APPENDIX–III GOLOGICAL DATA

APPENDIX - III GEOLOGICAL DATA

III-1 Drillhole

(1) List of Drillhole
(2) Classification of Drilled Core
(3) Geologic Log of Drillhole
(4) Method of Water Pressure Test
(5) Result of Water Pressure Test

III-2 Trench and Pit

(1) List of Trenche
(2) List of Pit
(3) Geologic Log of Trenche and Pit

III-3 Geophisical Prospecting

(1) Result of Seismic Prospecting
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III-4 Result of Microscopic Observation

III-5 Construction Materials

(1) Result of X-ray Diffraction Analysis and Polarized Microsopic Observation for Quarry Site
(2) List of Pit for Concreate Aggregate
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(5) Result of Soil Test

III-6 Locality of Sampling

III-1 Drillhole

(1) List of Drillhole

(2) Classification of Drilled Core

(3) Geologic Log of Drillhole

(4) Method of Water Pressure Test

(5) Result of Water Pressure Test

III-1 (1) List of Drillhole

Hole name	Location	Elevation (m)	Coordinate	Direction of hole	Length (m)	Water Pressure Test	Remarks
AD-1	El Siete No.1 Dam, Right Bank	1476.68	1,139.433N 1,098.128E	Vertical	30.00	0	*2
AD-2	"	1465.27	1,139.375N 1,098.113E	Vertical	50.00	0	*2
AD-3	"	1438.33	1,139.356N 1,098.203E	Vertical	30.00	0	*1 *2
AD-4	El Siete No.1 Dam, River bed	1423.98	1,139.317N 1,098.200E	S10°W, 46°	30.00	0	*1
AD-5	El Siete No.1 Dam, Left Bank	1478.79	1,139.221N 1,098.086E	Vertical	30.00	0	*1 *2
AD-6	El Siete No.1 Dam, Right Bank	1461.85	1,139.394N 1,098.166E	Vertical	30.00	0	*1 *2
AD-7	El Siete No.1 Dam, River bed	1426.09	1,139.265N 1,098.246E	N10°E, 48°	30.00	0	
AD-8	El Siete No.1 Dam, Left Bank	1480.67	1,139.151N 1,098.175E	Vertical	30.39	0	*2
AD-9	"	1481.28	1,139.171N 1,098.222E	Vertical	50.00	0	*1 *2
	Total: 9 holes 310.39 m						
BD-1	El Siete No.2 Near Head race tunnel	1109.32	1,137.872N 1.094.033E	Vertical	69.90	-	*1 *2
BD-2	El Siete No.2 Intake dam	1074.34	1,137.658N 1,094.235E	Vertical	9.50	-	
	Total: 2 holes 79.40 m						
CD-1	El Siete No.2 Powerhouse	694.50	1,129.603N 1,092.979E	Vertical	22.30	0	*1 *2
CD-2	El Siete No.2 Penstock	815.43	1,129.786N 1,091.776E	Vertical	46.38	0	*1 *2
	Total: 2 holes 68.68 m						

Remarks: 0 Hole with water pressure test.
*1 Hole with piezometer.
*2 Hole with standard penetration test.

III-1 (2) Classification of Drilled Core

The geological profile and the logs of drillholes in Appendix 10-1 (3) attached to the ATRATO HIDRO-ELECTRIC POWER PROJECT REPORT give classifications of drilled cores. The classifications comprise three elements - degree of weathering, hardness and core cutting (crack spacing).

Each element is further classified according to five grade based on the criteria given below.

Classification of Drilled Core

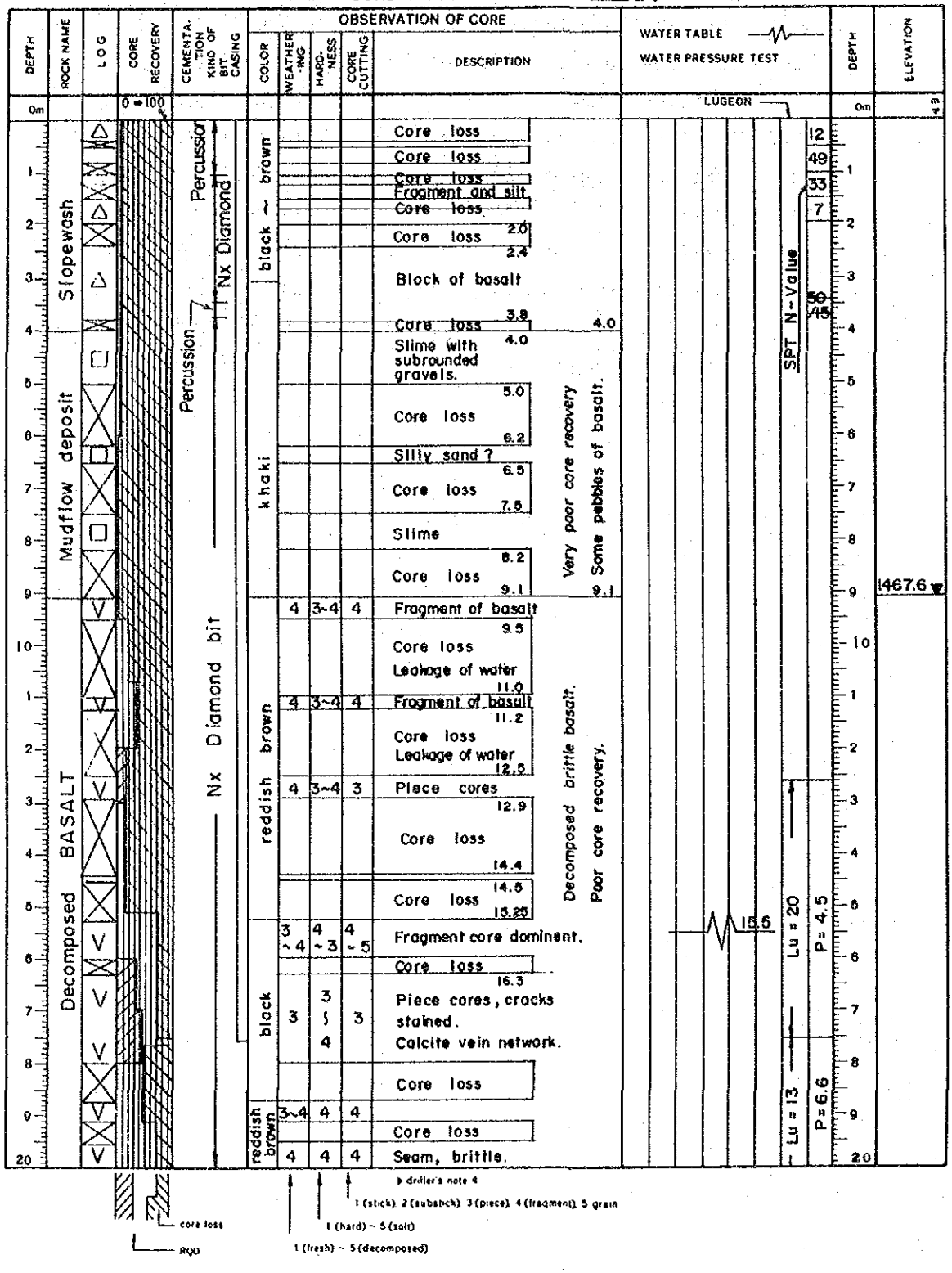
Grade	Weathering	Hardness	Core Cutting
1	Very fresh. No weathering of mineral component.	Very hard. Broken to knife-edged pieces by strong hammer blow.	Over 30cm
2	Fresh. Some minerals are weathered slightly. Usually no brown crack.	Hard. Broken to pieces by strong hammer blow.	10 - 30cm
3	Fairly fresh. Some minerals are weathered. Cracks are stained and with weathered material.	Brittle. Broken to pieces by medium hammer blow.	3 - 10cm
4	Weathered. Fresh portions still remain partially.	Very brittle. Easy broken to pieces by medium hammer blow.	1 - 3cm
5	Strongly weathered. Most minerals are weathered and altered to secondary minerals.	Soft. Able to dig with hammer.	Under 1cm

III-1 (3) Geologic Log of Drillhole

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT — HOLE No. AD-1 (SHEET 1 OF 2)

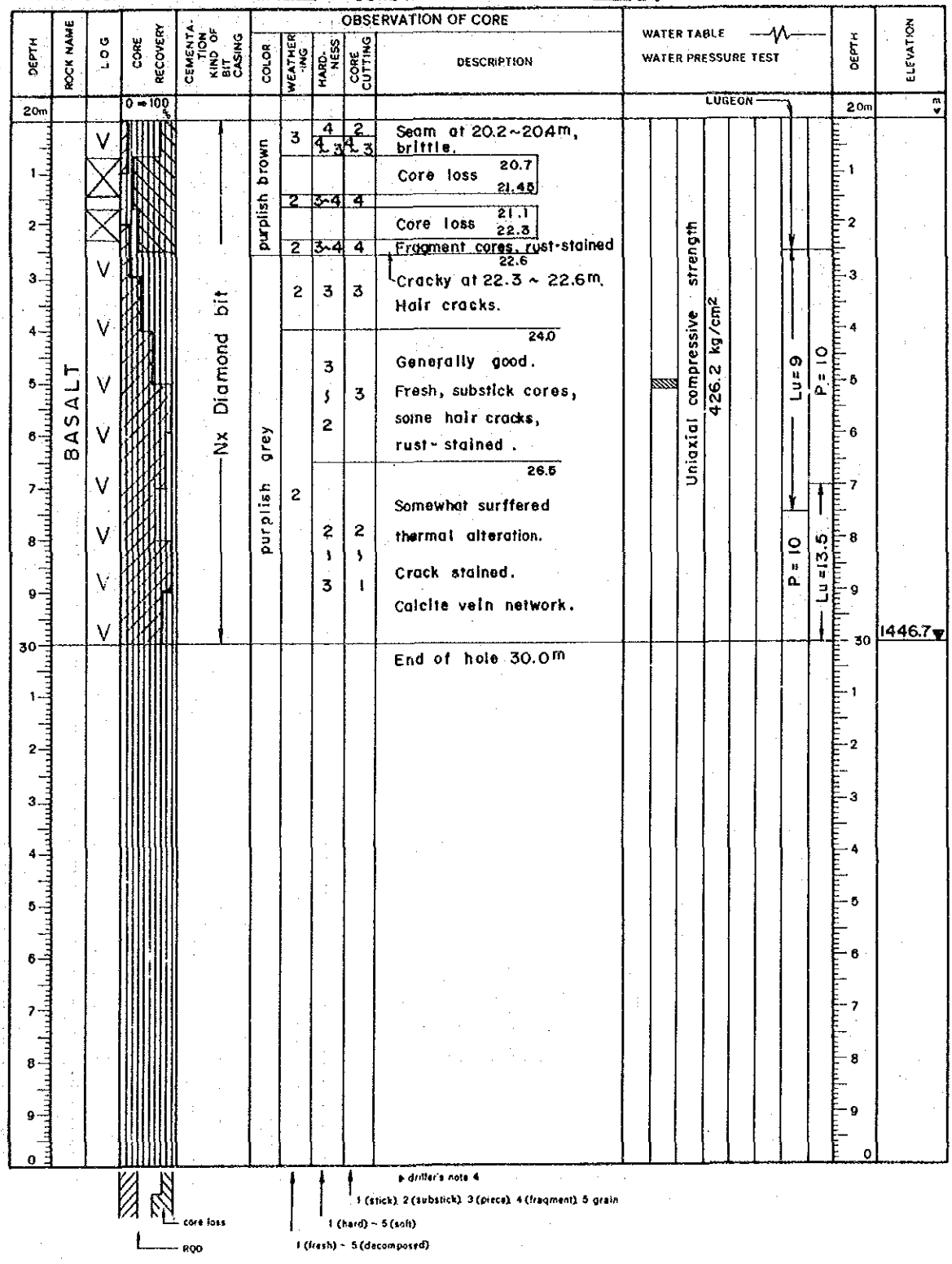
LOCATION	Dam, right bank	DEPTH OF HOLE	30.0 m	COMMENCED	Aug - 8 - 1984
ELEVATION	1476.68 m	DEPTH OF OVERBURDEN	9.1 m	COMPLETED	Aug - 21 - 1984
COORDINATE	1139.433N, 1098.128E	LENGTH OF ROCK DRILLING	20.9 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	50.3 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.1 PROJECT — HOLE No. A D - 1 (SHEET 2 OF 2)

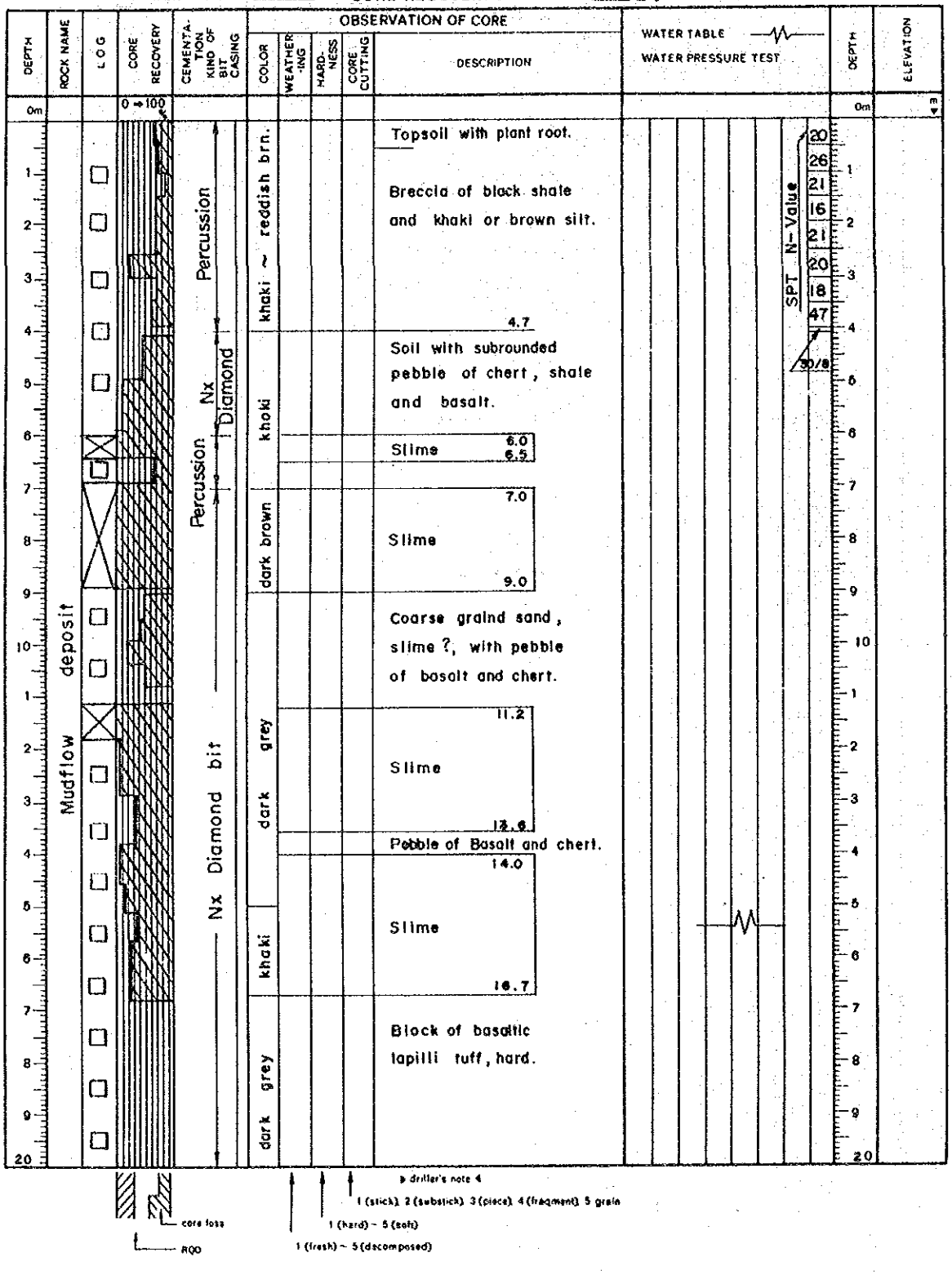
LOCATION	Dam, right bank	DEPTH OF HOLE	30.0 m	COMMENCED	Aug - 8 - 1984
ELEVATION	1476.68 m	DEPTH OF OVERBURDEN	9.1 m	COMPLETED	Aug - 21 - 1984
COORDINATE	1139.433N, 1098.128E	LENGTH OF ROCK DRILLING	20.9 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	50.3 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. I PROJECT HOLE No. AD-2 (SHEET 1 OF 3)

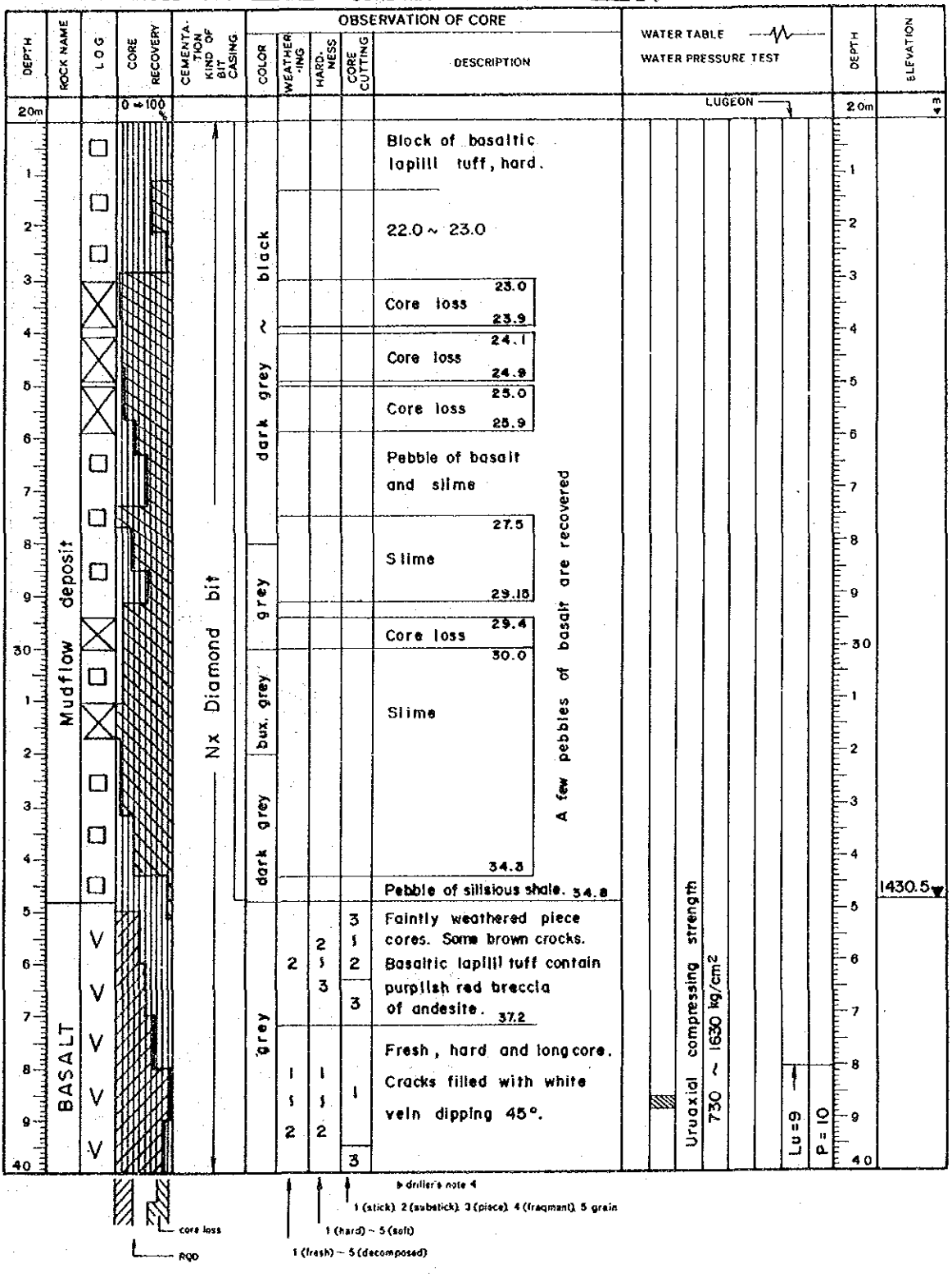
LOCATION	Dam, right bank	DEPTH OF HOLE	50.0 m	COMMENCED	Jun - 29 - 1984
ELEVATION	1465.27 m	DEPTH OF OVERBURDEN	34.8 m	COMPLETED	Aug - 3 - 1984
COORDINATE	1139.375N, 1098.113E	LENGTH OF ROCK DRILLING	15.2 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	57.1 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT HOLE No. AD-2 (SHEET 2 OF 3)

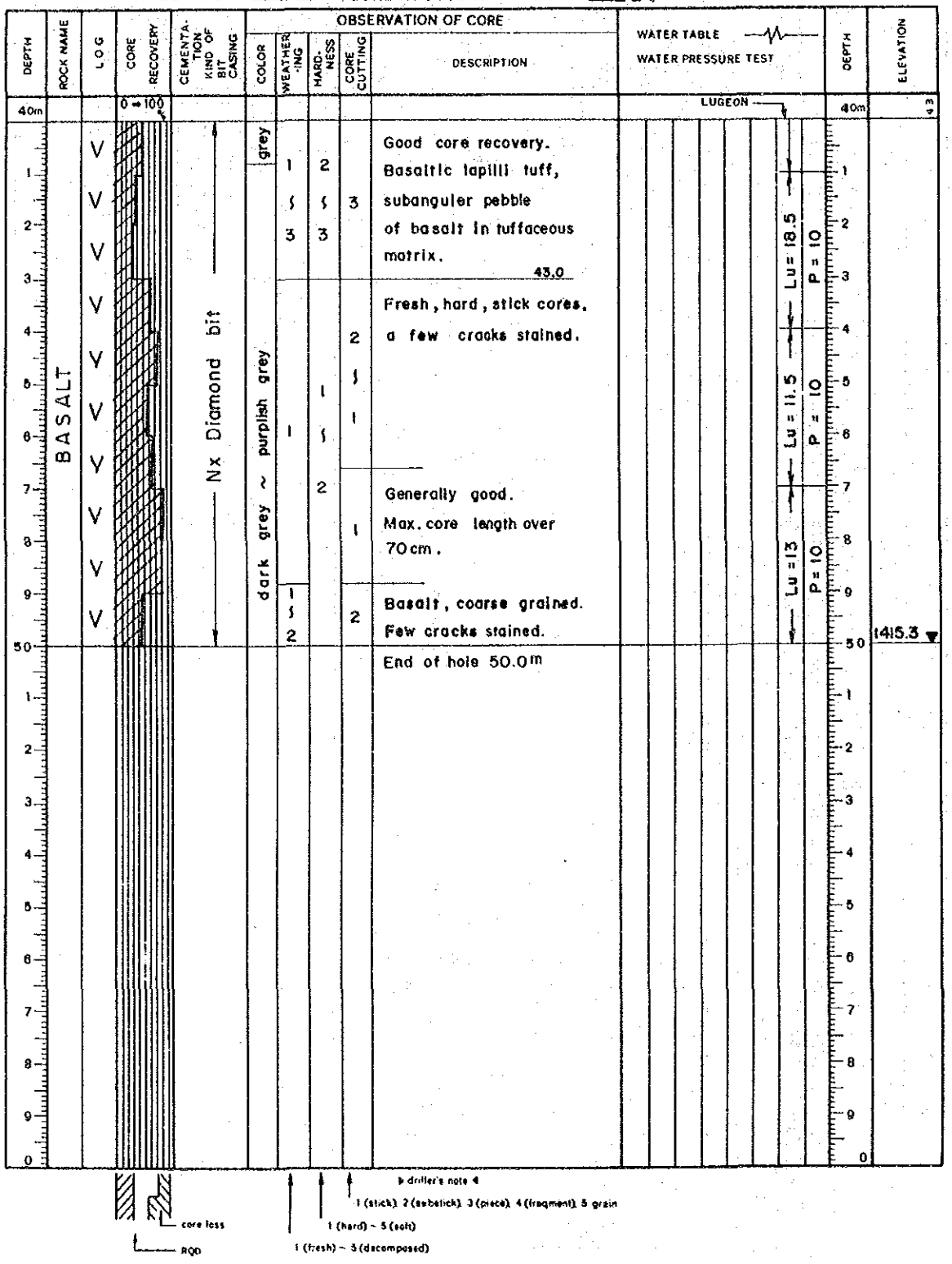
LOCATION	Dam, right bank	DEPTH OF HOLE	50.0 m	COMMENCED	Jun-29-1984
ELEVATION	1465.27 m	DEPTH OF OVERBURDEN	34.8 m	COMPLETED	Aug-3-1984
COORDINATE	1139.375N, 1098.113E	LENGTH OF ROCK DRILLING	15.2 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	57.1 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.1 PROJECT — HOLE No. AD-2 (SHEET 3 OF 3)

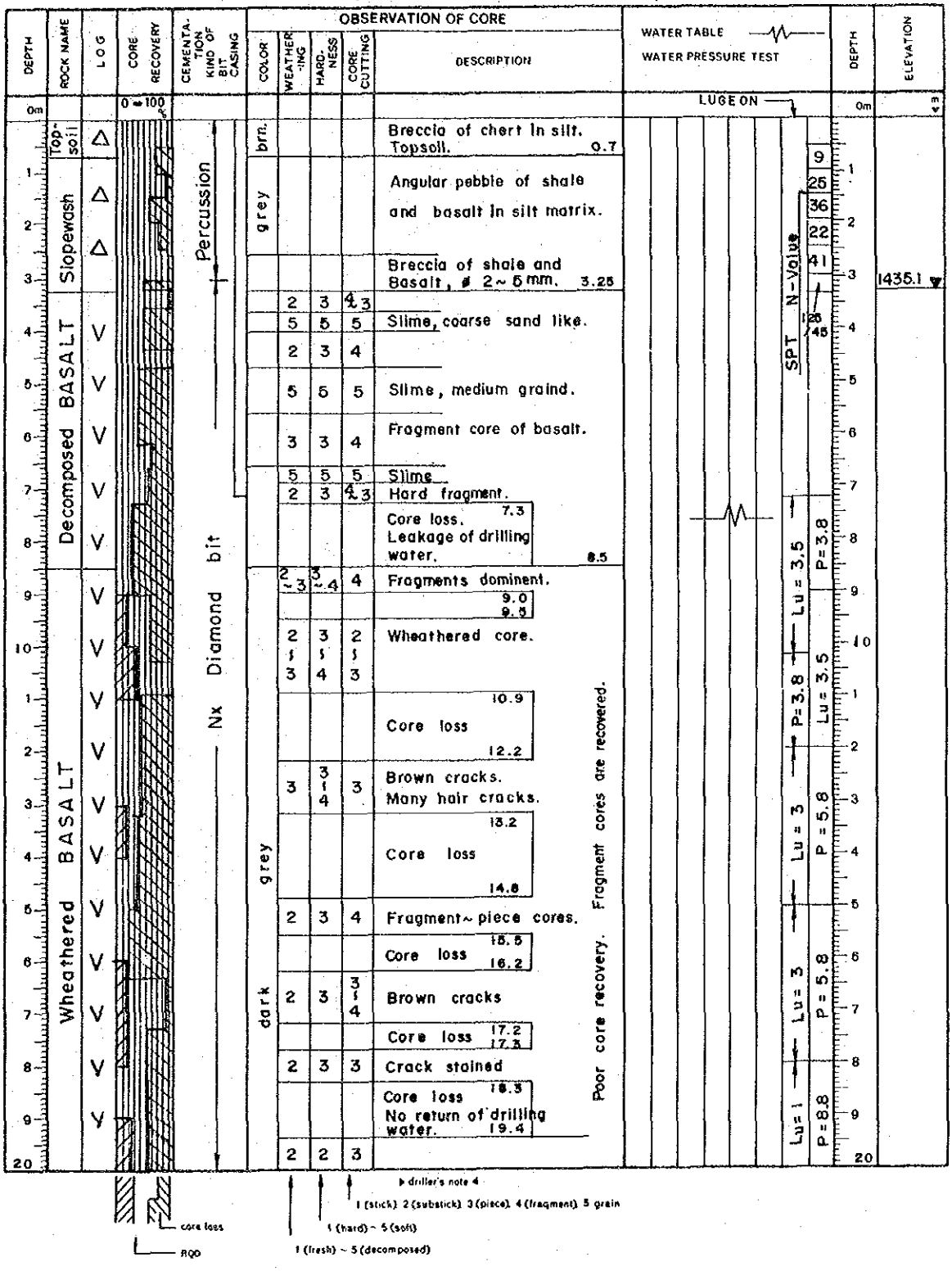
LOCATION	Dam, right bank	DEPTH OF HOLE	50.0 m	COMMENCED	Jun-29-1984
ELEVATION	1465.27 m	DEPTH OF OVERBURDEN	34.8 m	COMPLETED	Aug-3-1984
COORDINATE	1139.375N, 1098.113E	LENGTH OF ROCK DRILLING	15.2 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	57.1 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.1 PROJECT HOLE No. AD-3 (SHEET 1 OF 2)

LOCATION	Dam, right bank	DEPTH OF HOLE	30.0 m	COMMENCED	Oct. - 2 - 1984
ELEVATION	1438.33 m	DEPTH OF OVERBURDEN	3.25 m	COMPLETED	Oct. - 13 - 1984
COORDINATE	1139.356N, 1098.203E	LENGTH OF ROCK DRILLING	26.75 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	TSHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	67.8 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT — HOLE No. AD- 3 (SHEET 2 OF 2)

LOCATION	Dam, right bank	DEPTH OF HOLE	30.0 m	COMMENCED	Oct. - 2 - 1984
ELEVATION	1438.33 m	DEPTH OF OVERBURDEN	3.25 m	COMPLETED	Oct. - 13 - 1984
COORDINATE	1139.356N, 1098.203E	LENGTH OF ROCK DRILLING	26.75 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90 °	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	67.8 %		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION
20m			0 ⇔ 100 %						
1	BASALT	V		Nx Diamond bit	dark grey	2	3	3	Core loss 21.0
2		V							Basalt, coarse grained.
3		V						2	
4		V				1		5	Good core recovery.
5		V				5	2	1	Substick – stick core,
6		V				2			fresh, hard.
7		V							Few cracks stained.
8		V						1	26.4
9		V							Fresh, few cracks.
30									A few white veins.

WATER TABLE — WATER PRESSURE TEST — LUGEON

DEPTH	ELEVATION
20m	
30	1408.3

Lu = 0 P = 9.8 — Lu = 1.5 P = 8.8 — Lu = 0.5 P = 8.8

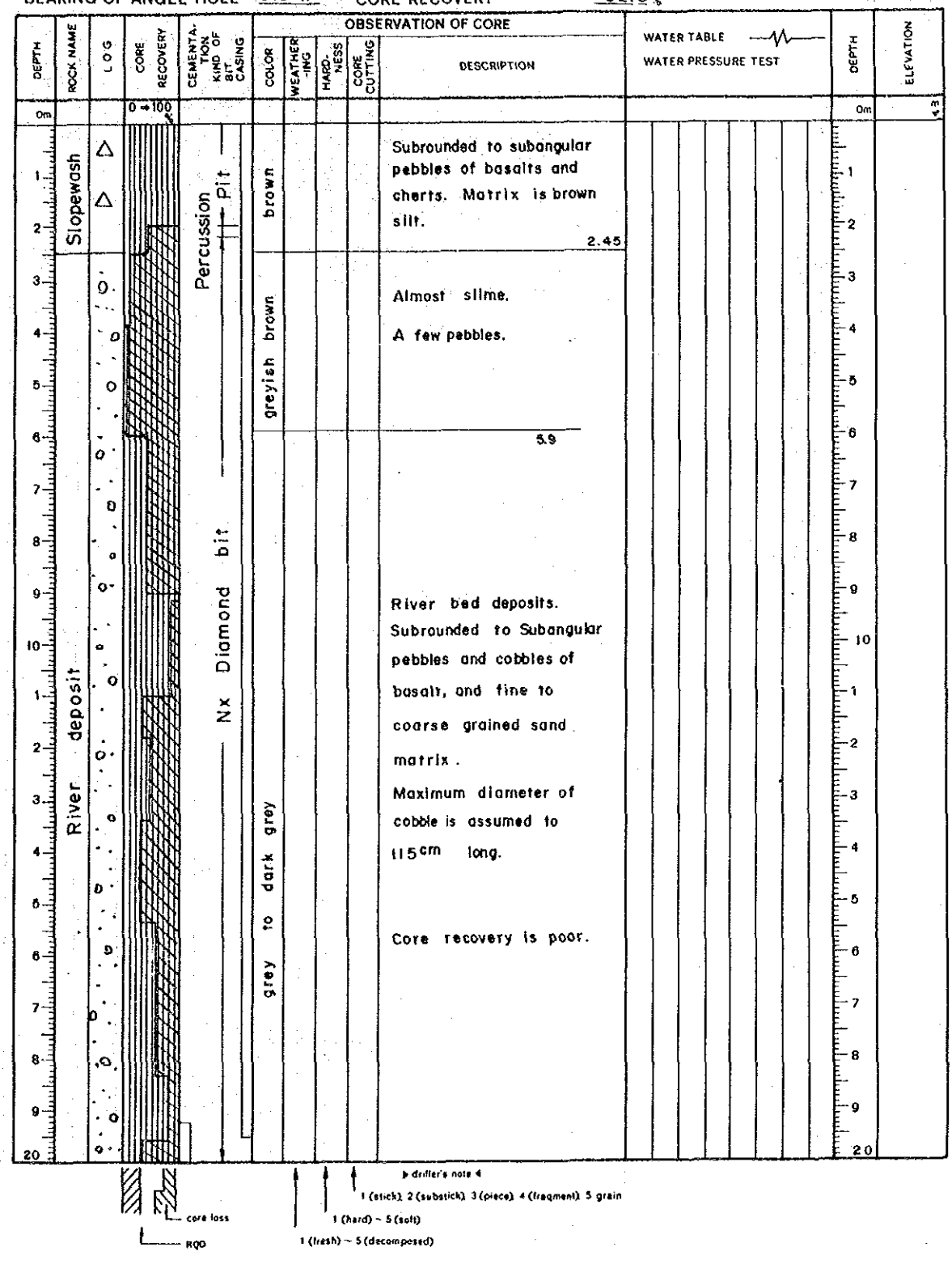
core loss — RQD

▶ driller's note ◀
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) – 5 (soft)
1 (fresh) – 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.1 PROJECT — HOLE No. AD-4 (SHEET 1 OF 2)

LOCATION	Dam, river bed	DEPTH OF HOLE	30.0 m	COMMENCED	Sep.-12-1984
ELEVATION	1423.98 m	DEPTH OF OVERBURDEN	22.85 m	COMPLETED	Sep.-26-1984
COORDINATE	1139.317N, 1098.200E	LENGTH OF ROCK DRILLING	7.15 m	DRILLED BY	
ANGLE FROM HORIZONTAL	46°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	S10°W	CORE RECOVERY	52.8%		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.1 PROJECT — HOLE No. AD-4 (SHEET 2 OF 2)

LOCATION	Dam, river bed	DEPTH OF HOLE	30.0 m	COMMENCED	Sep. - 12 - 1984
ELEVATION	1423.98 m	DEPTH OF OVERBURDEN	22.85 m	COMPLETED	Sep. - 26 - 1984
COORDINATE	1139.317N, 1098.200E	LENGTH OF ROCK DRILLING	7.15 m	DRILLED BY	
ANGLE FROM HORIZONTAL	46 °	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	S10°W	CORE RECOVERY	52.8%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST (LUGEON)	DEPTH	ELEVATION
20m			0 → 100 %								20m	
1–2	River deposit				grey to dark grey				Medium to fine grained sands or slime. 4.3 Pebble and cobble of basalt 22.0 and pebble of chert. Pebble of basalt and shale. 22.85			
3	BASALT	V		Nx Diamond bit	purplish grey	2	3	3	Some cracks are stained. 23.5			1407.5
4–5		V				1	2	2	Basaltic tuff, contains breccia, ϕ 1 ~ 3 cm. Some cracks are coated by milky clay. 25.5	Lu = 8, P = 9.4		
6		V				1	3	3	Cracky, cracks stained. 26.8			
7–9		V			dark grey	1	2	1	Good core recovery as stick. Hard and fresh basalt. Some calcite veins.	Lu = 6, P = 8.4		
30									End of hole 30.0 cm			1402.4

core loss

RQD

▶ driller's note ◀

1 (stick) 2 (subatick) 3 (piece) 4 (fragment) 5 grain

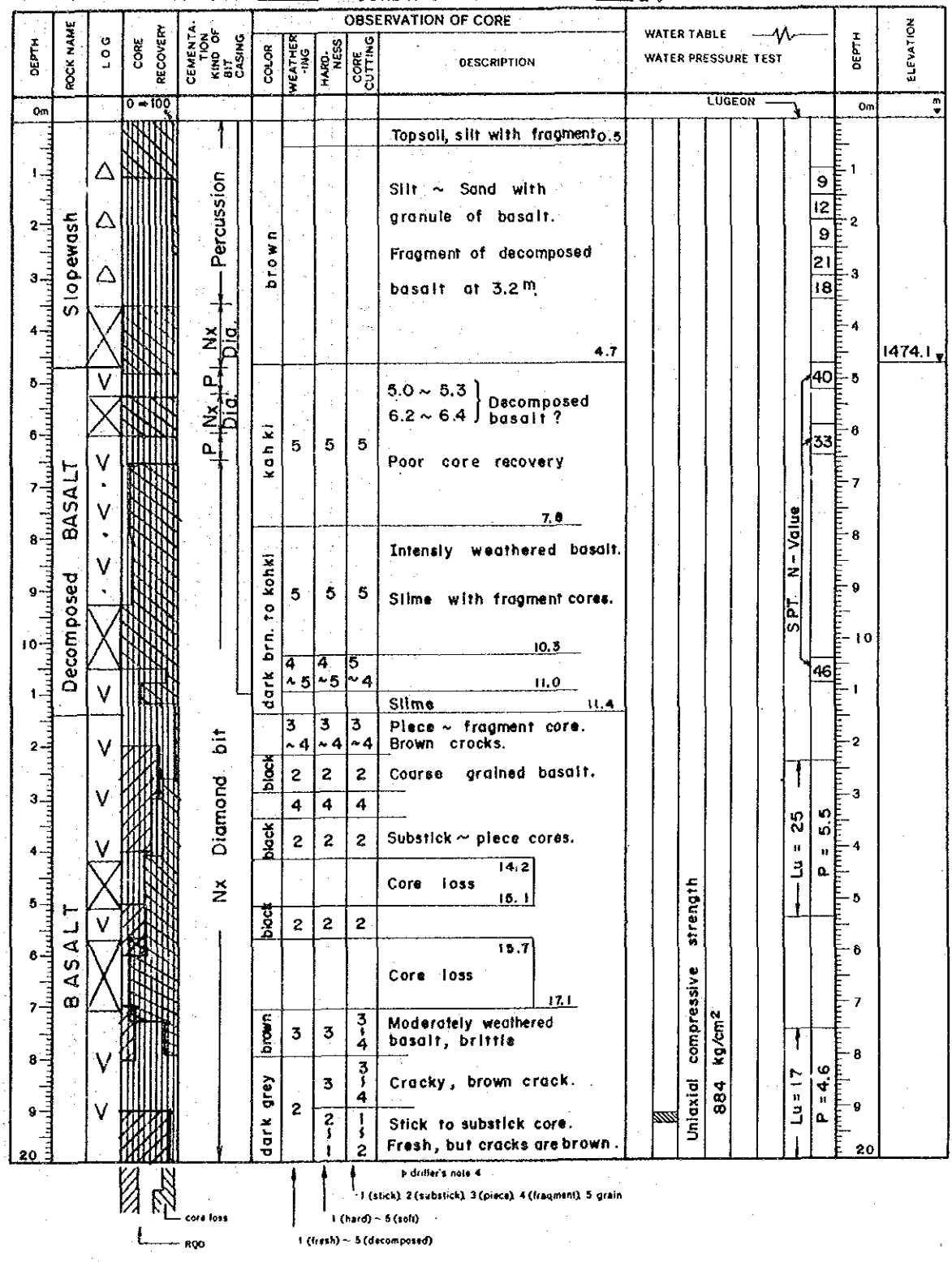
1 (hard) ~ 5 (soft)

1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT — HOLE No. AD-5 (SHEET 1 OF 2)

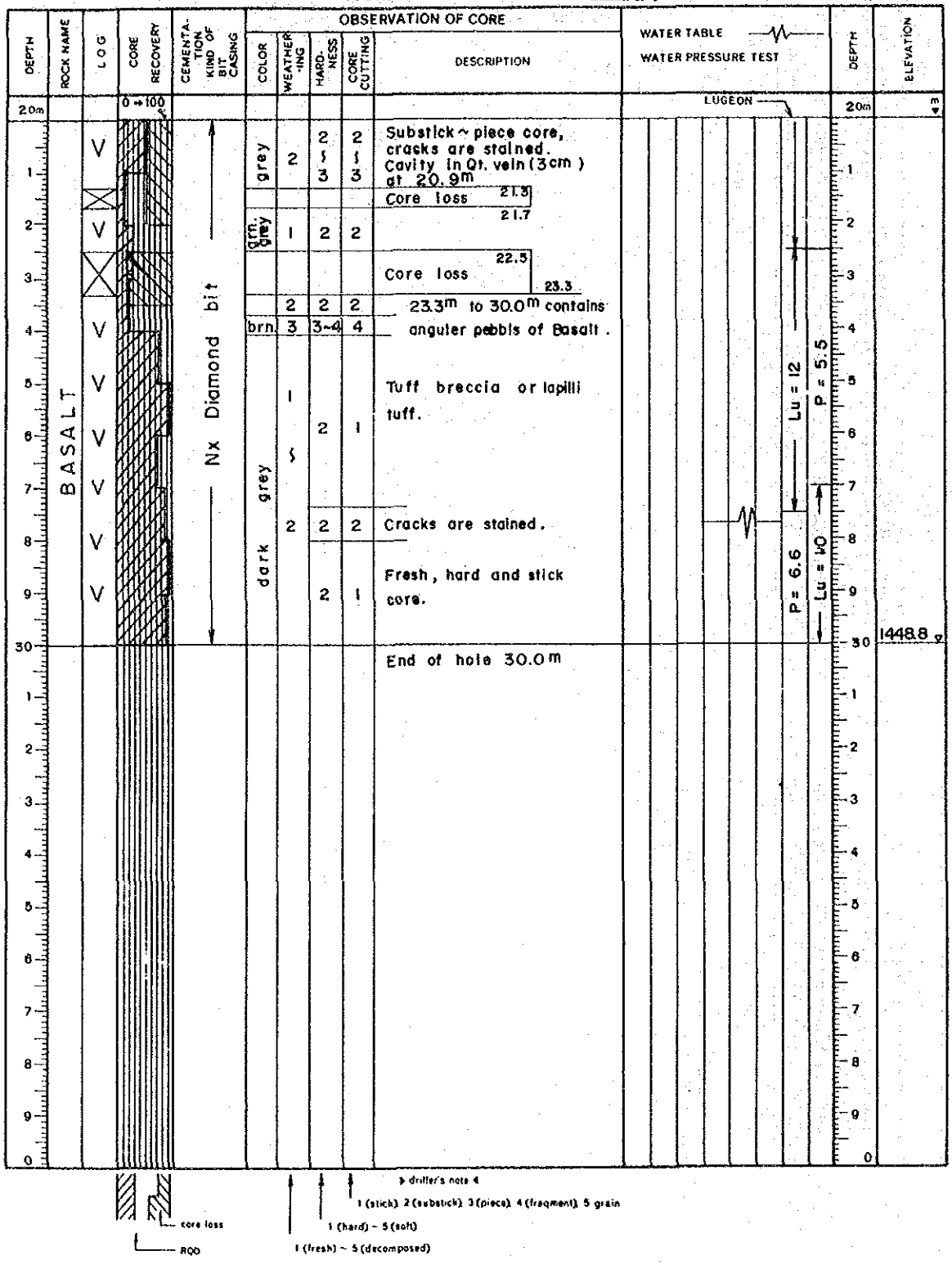
LOCATION	Dam, left bank	DEPTH OF HOLE	30.0 m	COMMENCED	Aug.-25-1984
ELEVATION	1478.79 m	DEPTH OF OVERBURDEN	4.7 m	COMPLETED	Sep.-9-1984
COORDINATE	1139.22N, 1048.086E	LENGTH OF ROCK DRILLING	25.3 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	61.5 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.1 PROJECT — HOLE No. AD - 5 (SHEET 2 OF 2)

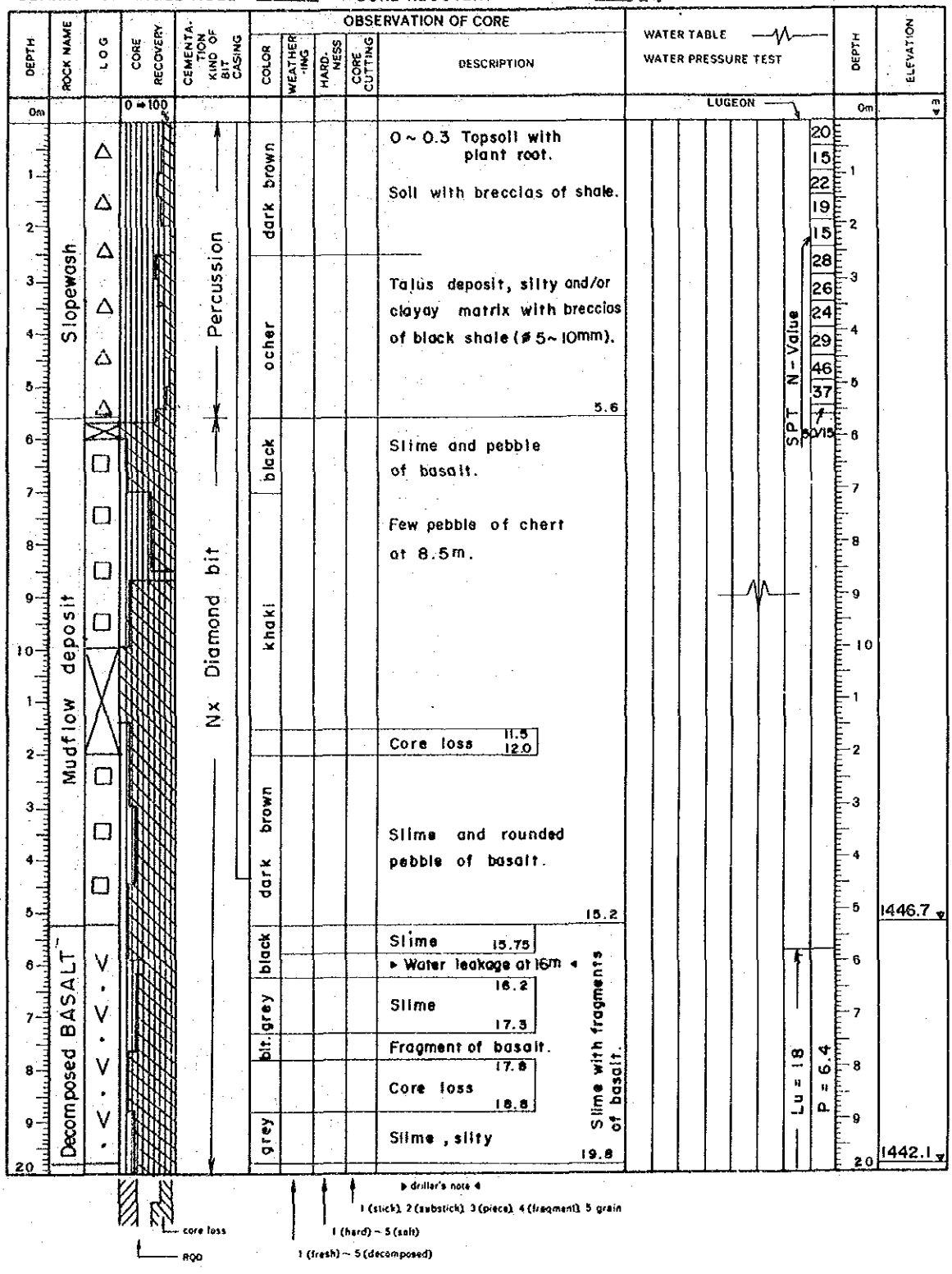
LOCATION	Dam, left bank	DEPTH OF HOLE	30.0 m	COMMENCED	Aug - 25 - 1984
ELEVATION	1478.79 m	DEPTH OF OVERBURDEN	4.7 m	COMPLETED	Sep. - 9 - 1984
COORDINATE	1139.22IN, 1048.086E	LENGTH OF ROCK DRILLING	25.3 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	61.5 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT HOLE No. AD-6 (SHEET 1 OF 2)

LOCATION	Dam, right bank	DEPTH OF HOLE	30.0 m	COMMENCED	Aug. 24 – 1984
ELEVATION	1461.85 m	DEPTH OF OVERBURDEN	15.2 m	COMPLETED	Sep. 7 – 1984
COORDINATE	1138.688N, 1096.769E	LENGTH OF ROCK DRILLING	14.8 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	50.8 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. I PROJECT HOLE No. AD-6 (SHEET 2 OF 2)

LOCATION	Dam, right bank	DEPTH OF HOLE	30.0 m	COMMENCED	Aug. - 24 - 1984
ELEVATION	1461.85 m	DEPTH OF OVERBURDEN	15.2 m	COMPLETED	Sep. - 7 - 1984
COORDINATE	1138.688N, 1096.769E	LENGTH OF ROCK DRILLING	14.8 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	50.8 %		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST	DEPTH	ELEVATION
20m			0 ~ 100 %							LUGEON	20m	
0	BASALT	V		Nx Diamond bit	black ~ purplish grey	2	3	4~5	Fairly fresh, substick ~ piece core, but rather brittle.		0	
1		V					3	2			1	
2		V				2	5	5			2	
3		V					4	3	Cracky at 22.0 ~ 22.7		3	
4		V							24.5		4	
5		V				2 ~ 4	3 ~ 5	3 ~ 5	Poor core recovery. Leakage of drilling water.	Lu = 12 P = 6.4	5	
6		V			grey				25.0		6	
7		V				2	3	3	Fairly fresh, cracky. Many brown cracks.		7	
8		V							27.3	Lu = 7 P = 10	8	
9		V			dark grey		2		Fresh, hard and substick core. Some cracks are stained.		9	
30		V				1	5 (3)	2	Cracks are filled with white calcite vein.		30	1431.9
									End of hole 30.0 m			

▶ driller's note 4

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

1 (hard) ~ 5 (soft)

1 (fresh) ~ 5 (decomposed)

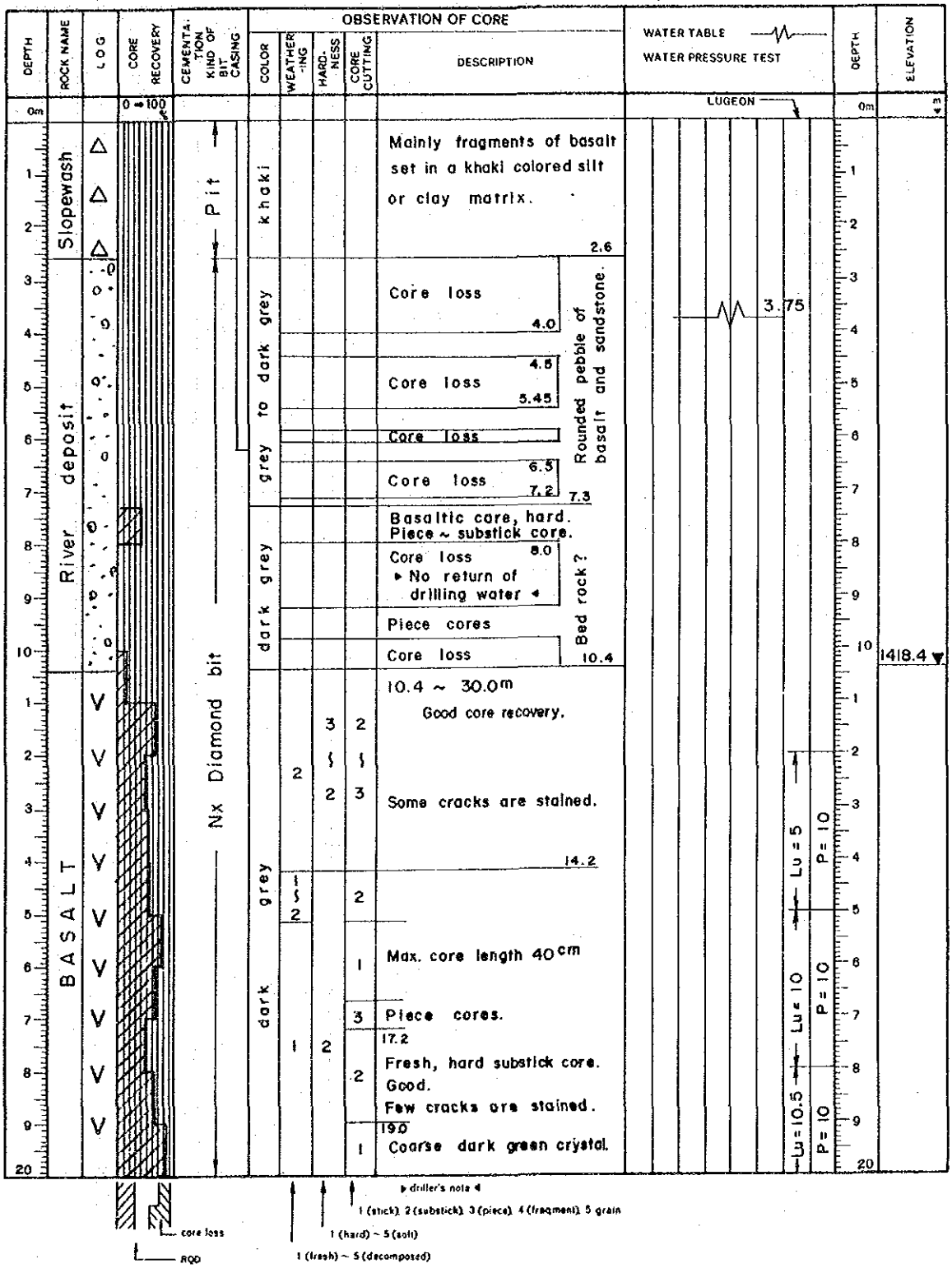
core loss

RQD

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT — HOLE No. AD - 7 (SHEET 1 OF 2)

LOCATION	Dam, river bed	DEPTH OF HOLE	30.0 m	COMMENCED	Jul. - 6 - 1984
ELEVATION	1426.09 m	DEPTH OF OVERBURDEN	10.4 m	COMPLETED	Jul. - 21 - 1984
COORDINATE	1139.265N, 1098.246E	LENGTH OF ROCK DRILLING	19.6 m	DRILLED BY	
ANGLE FROM HORIZONTAL	48°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	N10°E	CORE RECOVERY	80.3 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.1 PROJECT HOLE No. AD-7 (SHEET 2 OF 2)

LOCATION	Dam, river bed	DEPTH OF HOLE	30.0 m	COMMENCED	Jul. - 6 - 1984
ELEVATION	1426.09 m	DEPTH OF OVERBURDEN	10.4 m	COMPLETED	Jul. - 21 - 1984
COORDINATE	1139.265N, 1098.246E	LENGTH OF ROCK DRILLING	19.6 m	DRILLED BY	
ANGLE FROM HORIZONTAL	48 °	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	N10°E	CORE RECOVERY	80.3 %		

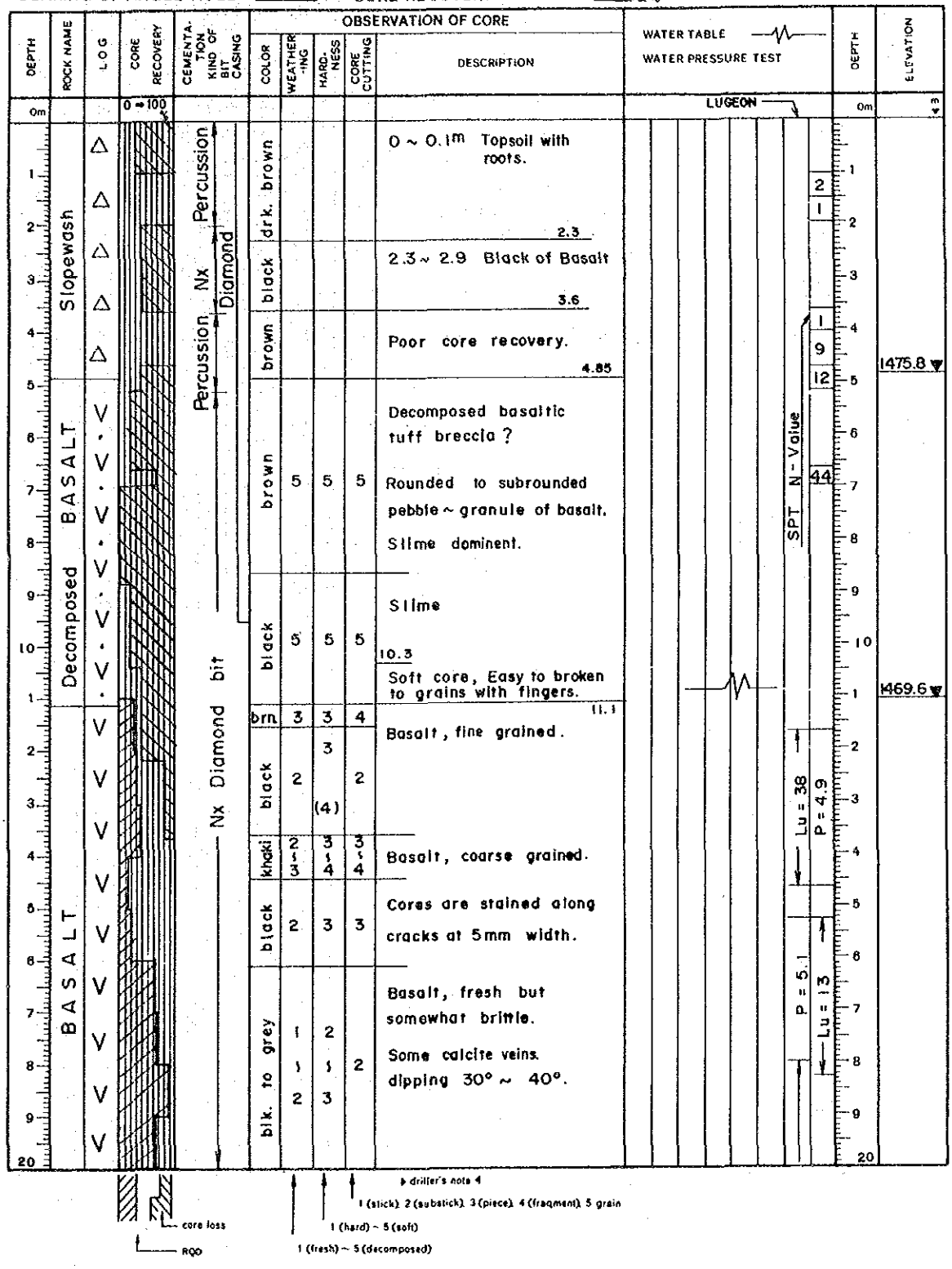
DEPTH (m)	ROCK NAME	LOG	CORE RECOVERY (0→100 %)	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER PRESSURE TEST (LUGEON)	DEPTH	ELEVATION (m)
20–20.7	BASALT	V		Nx Diamond bit	greenish grey to dark grey	2 ~ 1	2	1	Max. core length 40 cm	Lu = 8, P = 10 (21–24)		
20.7–23		V						2	20.7 Somewhat cracky.			
23–27.3		V					2 ~ 3	2 ~ 1; 1	Basalt, hard. Few fractures. One core, 70cm long.	Lu = 0, P = 10 (24–27)		
27.3–30		V			purplish dk. red	2	2 ~ 3	2	27.3 Cracks dipping at 40° to 60°. Suffered some hydrothermal alteration.	Lu = 16, P = 5.3 (27–30)	30	1403.8
30									End of hole 30.0m.			

Legend:
- Core recovery: core loss; RQD
- Weathering: 1 (fresh) ~ 5 (decomposed)
- Hardness: 1 (hard) ~ 5 (soft)
- Core cutting: 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
- ▶ driller's note ◀

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. I PROJECT HOLE No. AD - 8 (SHEET 1 OF 2)

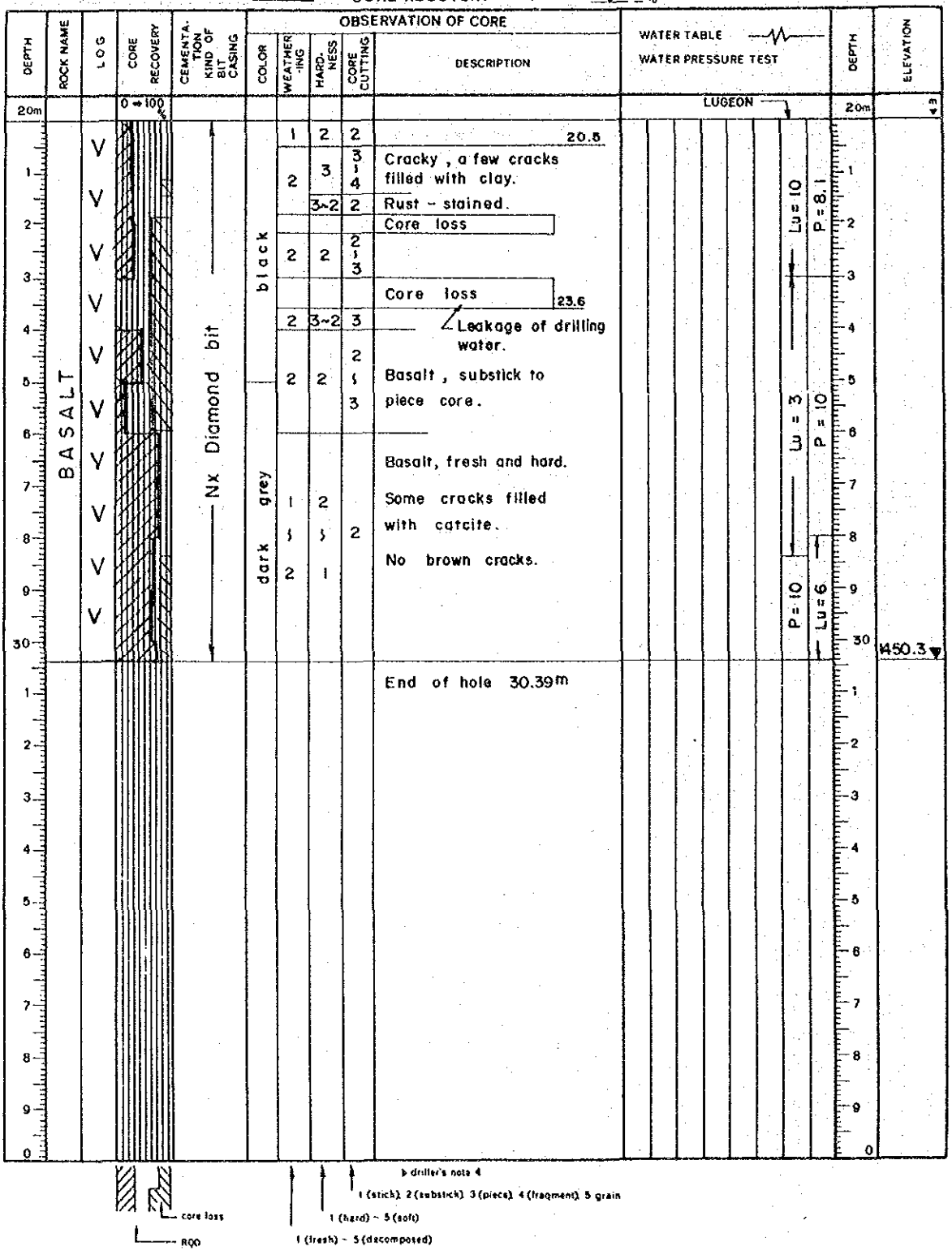
LOCATION	Dam, left bank	DEPTH OF HOLE	30.39 m	COMMENCED	Jul. - 28 - 1984
ELEVATION	1480.67 m	DEPTH OF OVERBURDEN	4.85 m	COMPLETED	Sep. - 15 - 1984
COORDINATE	1139.151N, 1098.175E	LENGTH OF ROCK DRILLING	25.54 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE		CORE RECOVERY	68.8%		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT — HOLE No. AD - 8 (SHEET 2 OF 2)

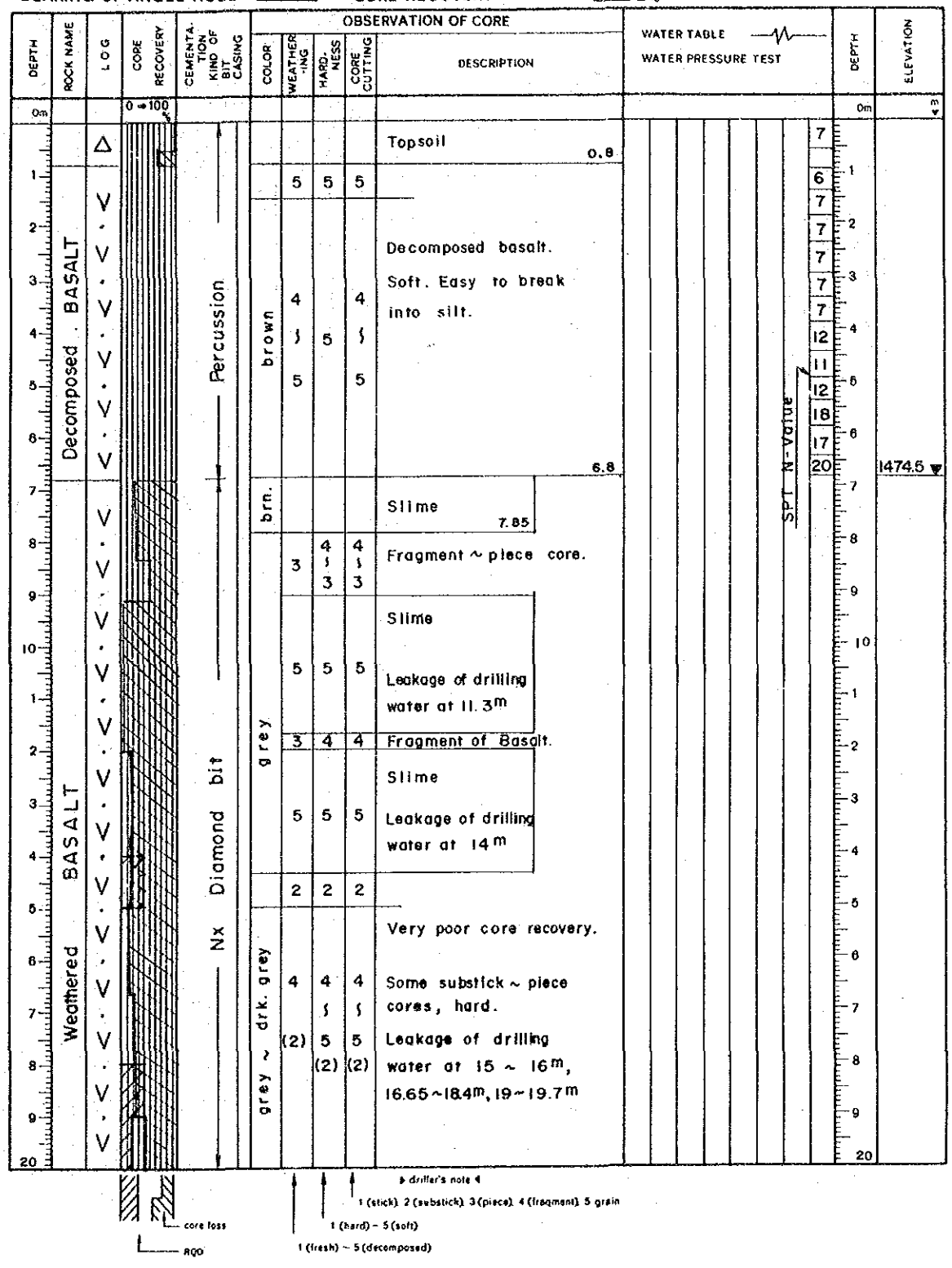
LOCATION	Dam, left bank	DEPTH OF HOLE	30.39 m	COMMENCED	Jul. - 28 - 1984
ELEVATION	1480.67 m	DEPTH OF OVERBURDEN	4.85 m	COMPLETED	Sep. - 15 - 1984
COORDINATE	1139.151N, 1098.175E	LENGTH OF ROCK DRILLING	25.54 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	68.8 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT HOLE No. AD-9 (SHEET 1 OF 3)

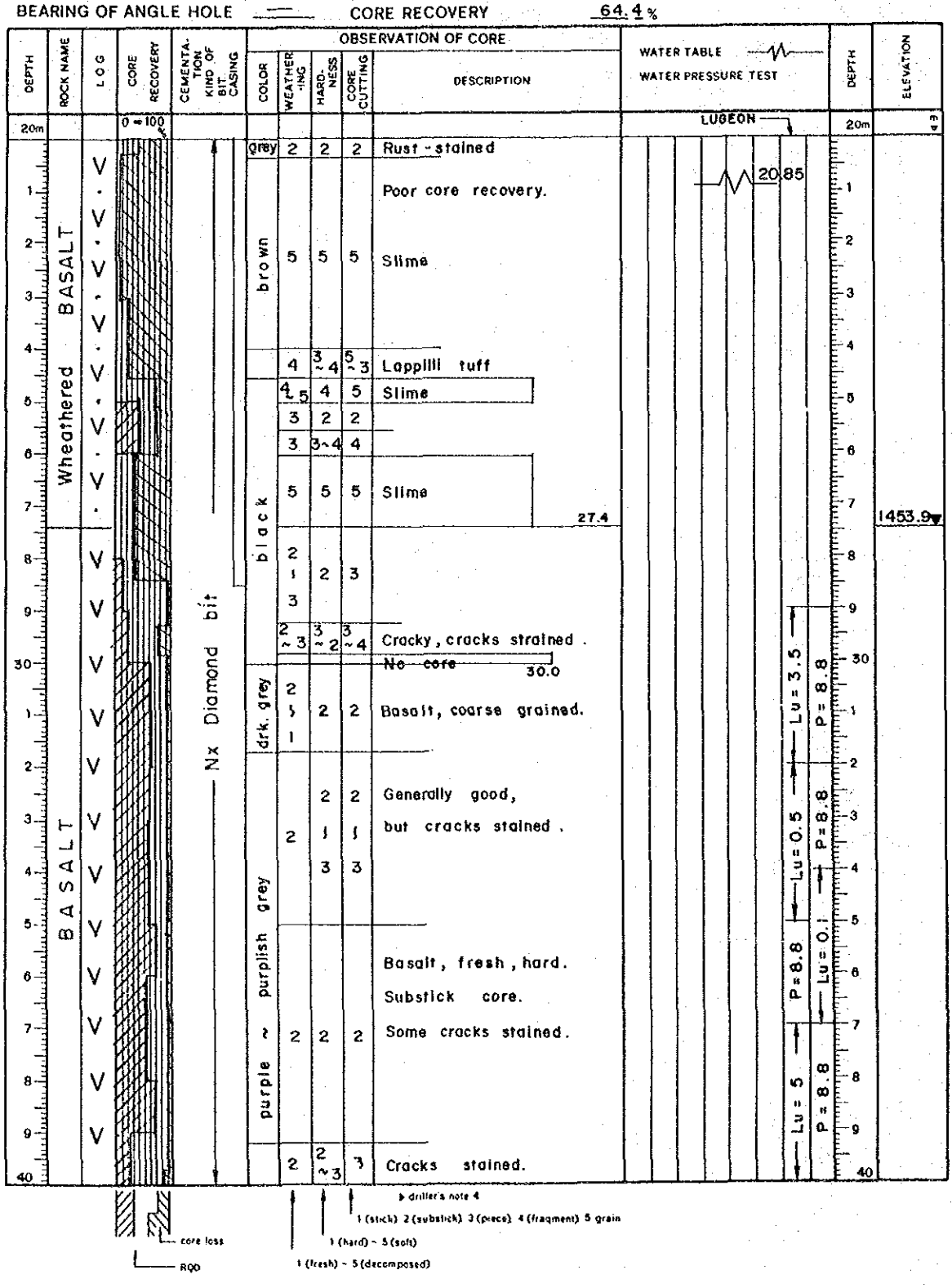
LOCATION	Dam, left bank	DEPTH OF HOLE	50.0 m	COMMENCED	Sep. 20 -1984
ELEVATION	1481.28 m	DEPTH OF OVERBURDEN	6.8 m	COMPLETED	Oct. 9 -1984
COORDINATE	1139.171N, 1098.222E	LENGTH OF ROCK DRILLING	43.2 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	64.4 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT — HOLE No. A D - 9 (SHEET 2 OF 3)

LOCATION	Dam, left bank	DEPTH OF HOLE	50.0 m	COMMENCED	Sep. - 20 - 1984
ELEVATION	1481.28 m	DEPTH OF OVERBURDEN	6.8 m	COMPLETED	Oct. - 9 - 1984
COORDINATE	1139.171N, 1098.222E	LENGTH OF ROCK DRILLING	43.2 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	64.4 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 1 PROJECT — HOLE No. AD - 9 (SHEET 3 OF 3)

LOCATION	Dam, left bank	DEPTH OF HOLE	50.0 m	COMMENCED	Sep. 20 - 1984
ELEVATION	1481.28 m	DEPTH OF OVERBURDEN	6.8 m	COMPLETED	Oct. - 9 - 1984
COORDINATE	1139.171N, 1098.222E	LENGTH OF ROCK DRILLING	43.2 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90 °	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	64.4 %		

DEPTH	ROCK NAME	LOG	CORE RECOVERY (0 → 100 %)	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST (LUGEON)	DEPTH	ELEVATION
40m											40m	43
40–41.34		V		Nx Diamond bit	drk. grey	2	3 ~ 2	3	Calcite vein network. 41~41.3 fragment core	Lu = 5, P = 10 (40–43)		
41.34–41.75	Fault	▲√				5	5	5	Fault ? grey silt.			
41.75–42.1						2~3	3	4	Slickenside			
42.1–50	BASALT	V			grey / dark grey	2	2 ~ 3	2	Basalt, coarse grained. Mainly substick cores. Cracks are coated with milky clay film until 44.5 m. Until 46.5 m cracks are rust stained.	Lu = 5, P = 10 (43–46.9); P = 10, Lu = 13 (46.9–50)	50	1431.3 ▼
50									End of hole 50.0 m			

▶ driller's note 4

Core cutting: 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

Hardness: 1 (hard) ~ 5 (soft)

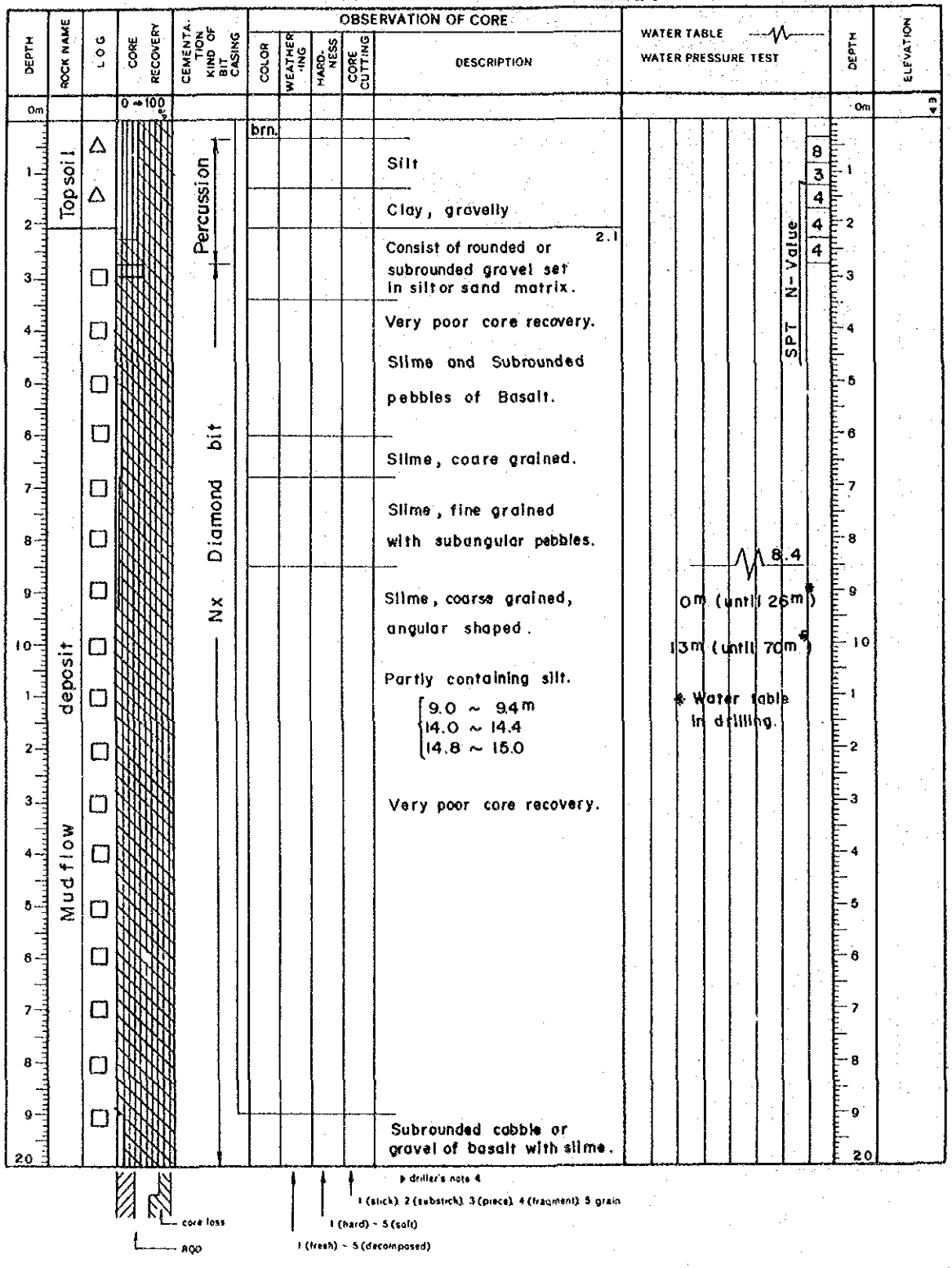
Weathering: 1 (fresh) ~ 5 (decomposed)

Core recovery legend: core loss; RQD

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 2 PROJECT — HOLE No. BD-1 (SHEET 1 OF 4)

LOCATION	Intake tunnel	DEPTH OF HOLE	69.9 m	COMMENCED	Oct. - 23 - 1984
ELEVATION	1109.32 m	DEPTH OF OVERBURDEN	42.1 m	COMPLETED	Nov. - 29 - 1984
COORDINATE	1137.872N, 1094.033E	LENGTH OF ROCK DRILLING	27.8 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90 °	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	---	CORE RECOVERY	10.9 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.2 PROJECT HOLE No. BD-1 (SHEET 2 OF 4)

LOCATION	Intake tunnel	DEPTH OF HOLE	69.9 m	COMMENCED	Oct. - 23 - 1984
ELEVATION	1109.32 m	DEPTH OF OVERBURDEN	42.1 m	COMPLETED	Nov. - 29 - 1984
COORDINATE	1137.872N, 1094.033E	LENGTH OF ROCK DRILLING	27.8 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	10.9%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST	DEPTH	ELEVATION
20m			0 ⇔ 100 %								20m	m
1–40	Mudflow deposit			Nx Diamond bit	dark grey				Very poor core recovery. Almost slime.			
									25.5 (Bed rock ?)			
					brown				29.7~30.0, 31.3~31.5 Subrounded pebble of basalt.			
									31.5			
					greyish brown							
					grey				Slime, medium~corse grained sand like. Silty sand.			
					brown				Silty sand 39.75~40.0m Pebble of basalt			

core loss

RQD

driller's note 4

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

1 (hard) ~ 5 (soft)

1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.2 PROJECT — HOLE No. BD-1 (SHEET 3 OF 4)

LOCATION	Intake tunnel	DEPTH OF HOLE	69.9 m	COMMENCED	Oct. - 23 - 1984
ELEVATION	1109.32 m	DEPTH OF OVERBURDEN	42.1 m	COMPLETED	Nov. - 29 - 1984
COORDINATE	1137.872 N, 1094.033 E	LENGTH OF ROCK DRILLING	27.8 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	10.9%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST	DEPTH	ELEVATION
40m			0 ~ 100 %								40m	m
1	Mudflow				dark brown				Very poor core recovery. Slime.		1	
2									42.1		2	1067.2 ▼
3	BASALT	V		Nx Diamond bit	black to dark grey	5 1 3	5 1 4	5 1 4	Slime and bentonite. Cobble or fragment of core.		3	
4		V									4	
5		V									5	
6		V									6	
7		V									7	
8		V							Subrounded ~ Subanguler pebble of basalt.		8	
9		V			bluish grey	5	5	5	Slime		9	
50		V				3	4	4	Fragment of basalt.		50	
1		V			dark grey	5	5	5	Bluish ~ greanish grey slime.		1	
2		V				2	3	3 ~ 4			2	
3		V			grey	5	5	5	Slime and cement.		3	
4		V				2	3 - 2	3	Pieces of Altered Diobase.		4	
5									55.0		5	1054.3 ▼
6	Alternation of ss. and sh.				dark grey	5	5	5	Slime and cement for protection of drilling wall.		6	
7					blk	2	3-4	4	Fragment of silicious shale		7	
8					dark grey	4 1 5	4 1 5	5	Slime or decomposed sand stone or cement.		8	
9											9	
60					blk	2	3-4	4	Silicious shale ~ chert.		60	

core loss

RQD

1 (fresh) ~ 5 (decomposed)

1 (hard) ~ 5 (soft)

▶ driller's note 4

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 2 PROJECT HOLE No. BD - 1 (SHEET 4 OF 4)

LOCATION	Intake tunnel	DEPTH OF HOLE	69.9 m	COMMENCED	Oct. - 23 - 1984
ELEVATION	1109.32 m	DEPTH OF OVERBURDEN	42.1 m	COMPLETED	Nov. - 29 - 1984
COORDINATE	1137.872N, 1094.033E	LENGTH OF ROCK DRILLING	27.8 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	10.9%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST	DEPTH	ELEVATION
60m			0 → 100 %								60m	43
1	Alternation of sandstone and shale			Nx Diamond bit	blk	2	3	4	Fragment of Basalt and chert.		1	
2					grey	5	5	5	Very poor core recovery.		2	
3									62.6		3	
					blk	2	3	3	Silisious shale or chart			
4									63.0		4	
					grey	5	5	5	Slime			
5											5	
6					blk	3	3	4	Fragment of black silisious shale.		6	
					grey	5	5	5	Slime			
7											7	
8					blk	3	3	4	Black shale		8	
9					grey	5	5	5	Slime, origin is sandstone?		9	1039.4 ▼
70									End of hole 69.9 m		70	

core loss
RQD

▶ driller's note 4
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 2 PROJECT — HOLE No. BD-2 (SHEET 1 OF 1)

LOCATION	Right bank of intake dam	DEPTH OF HOLE	9.5 m	COMMENCED	Dic. - 6 - 1984
ELEVATION	1074.34 m	DEPTH OF OVERBURDEN	9.5 m	COMPLETED	Dic. - 15 - 1984
COORDINATE	1137.658N, 1094.238E	LENGTH OF ROCK DRILLING	0 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	12.6%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST	DEPTH	ELEVATION
0m			0 ⇒ 100 %								0m	
1	Top soil	△		Tri-corne	dk. brn				Topsoil 0.6	0.6	1	
2	Terrace deposit	○		Nx Diamond bit	grey				Slime 2.5		2	
3		○			dark grey				dark green purplish grey basalt cobbles.		3	
4		○			black to dark grey				Terrace deposit ? Slime, nudium to coarse grained. Partly containing pebble of sandstone and basalt.		4	
5		○									5	
6		○									6	
7		○									7	
8		○									8	
9		○							9.0 ~ 9.5m Subrounded pebble of basalt.		9	1064.8
10									End of hole 9.5m		10	

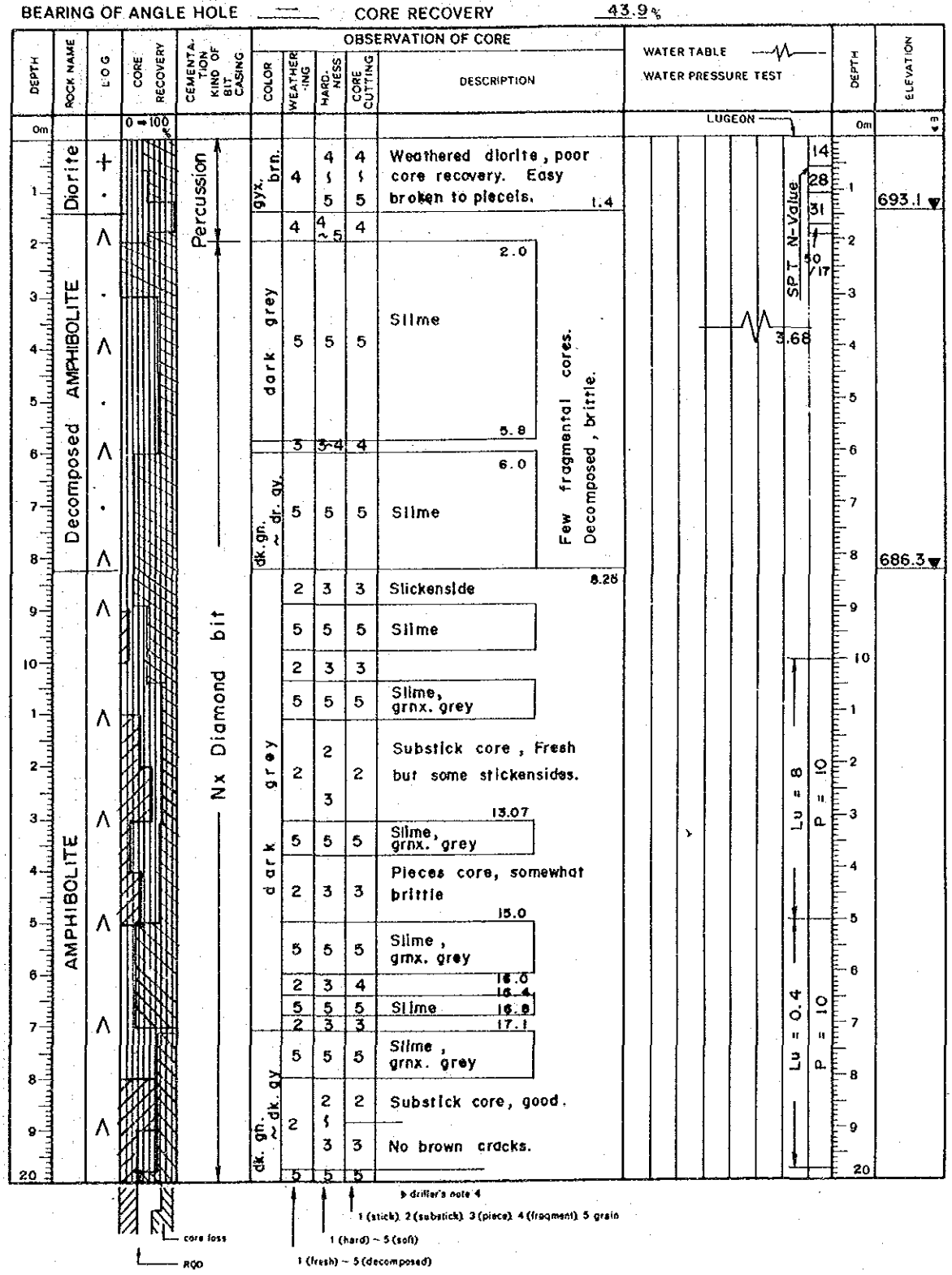
Drilling of this hole was suspended by the trouble occured at 9.5m depth.

core loss
RQD
driller's note 4
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No 2 PROJECT HOLE No. CD - 1 (SHEET 1 OF 2)

LOCATION	Powerhouse	DEPTH OF HOLE	22.3 m	COMMENCED	Nov. - 29 - 1984
ELEVATION	694.50 m	DEPTH OF OVERBURDEN	0 m	COMPLETED	Dic. - 6 - 1984
COORDINATE	1129.603N, 1091.979E	LENGTH OF ROCK DRILLING	22.3 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	43.9%		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 2 PROJECT — HOLE No. CD-1 (SHEET 2 OF 2)

LOCATION	Powerhouse	DEPTH OF HOLE	22.3 m	COMMENCED	Nov. - 29 - 1984
ELEVATION	694.50 m	DEPTH OF OVERBURDEN	0 m	COMPLETED	Dic. - 6 - 1984
COORDINATE	1129.603N, 1091.979E	LENGTH OF ROCK DRILLING	22.3 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	43.9%		

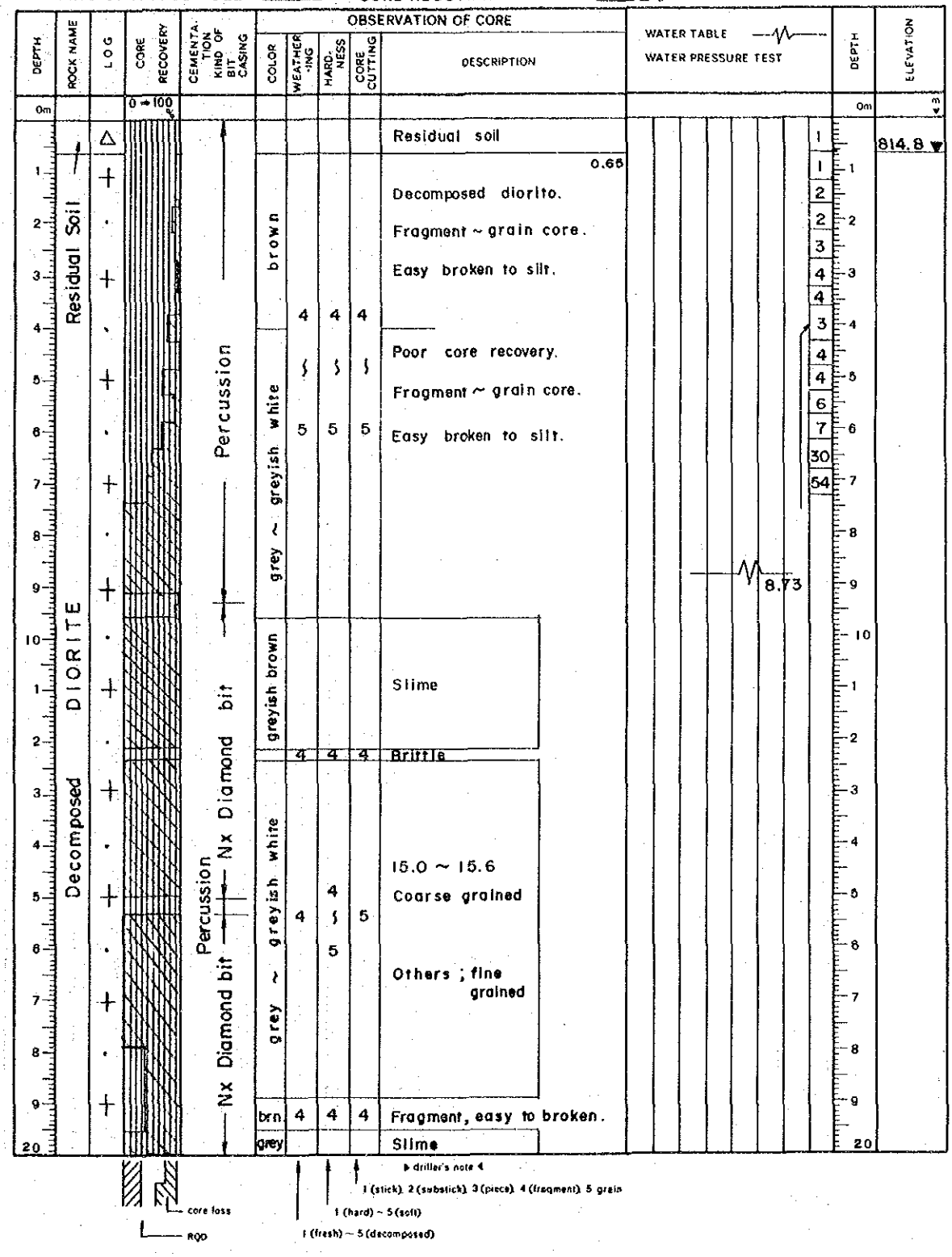
DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST (LUGEON)	DEPTH	ELEVATION
30m			0 → 100 %								30m	
1	AMPHIBOLITE	Λ		Nx Dia		5	5	5	Slime, dark grnx grey.		1	
		Λ			dark grey	1	4 → 2	3				
		Λ				5	5	5	Slime.			
2		Λ				1	3 → 2	3	Few cracks stained.	Lu = 0.4, P = 10	2	672.2 ▼
									End of hole 22.3m			

core loss
RQD
driller's note 4
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) – 5 (soft)
1 (fresh) – 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.2 PROJECT HOLE No. CD-2 (SHEET 1 OF 3)

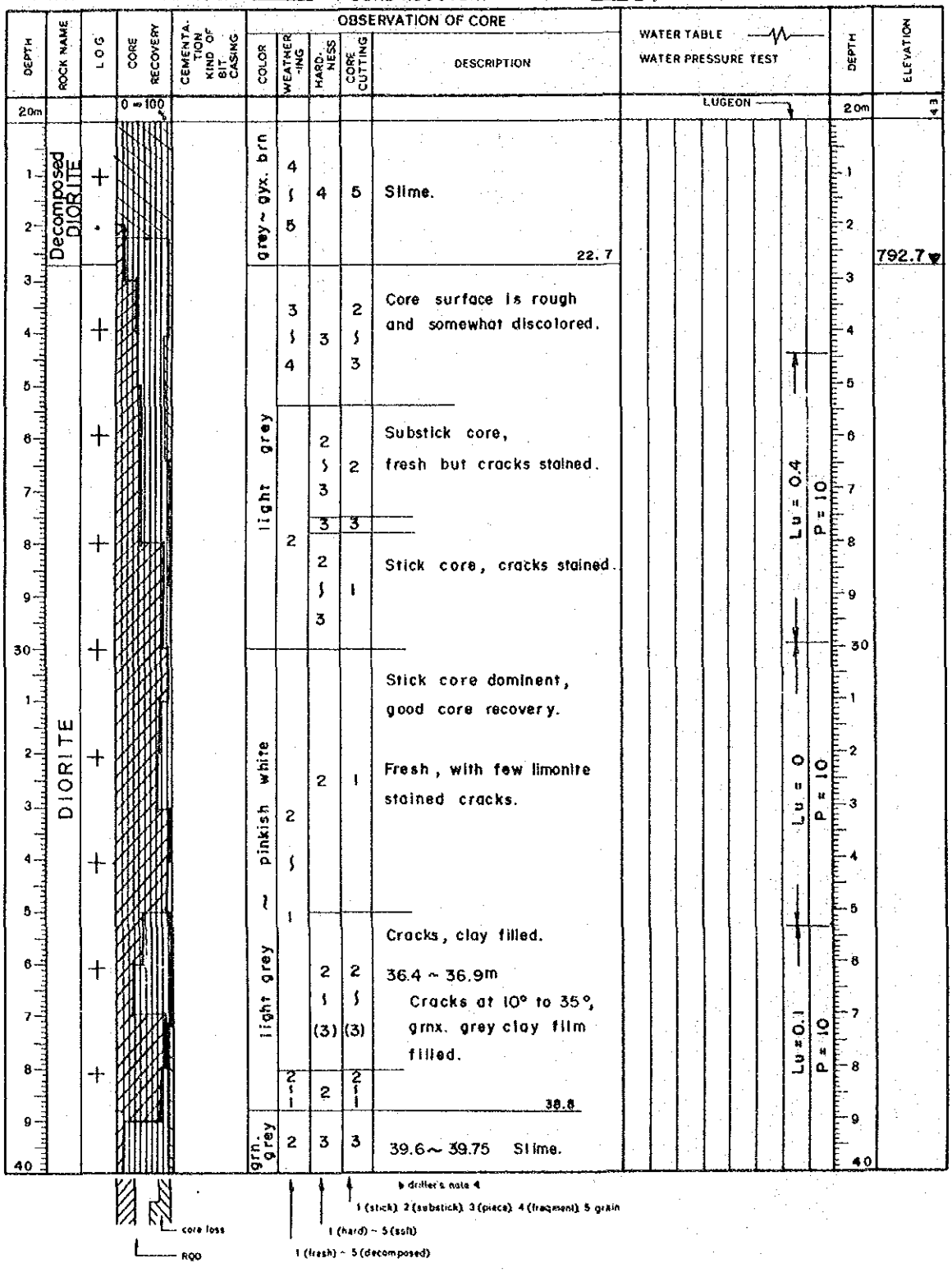
LOCATION	Penstock	DEPTH OF HOLE	46.38 m	COMMENCED	Oct. - 25 - 1984
ELEVATION	815.43 m	DEPTH OF OVERBURDEN	0.65 m	COMPLETED	Nov. - 17 - 1984
COORDINATE	1129.786N, 1091.776E	LENGTH OF ROCK DRILLING	45.73 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	68.4 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No.2 PROJECT — HOLE No. CD-2 (SHEET 2 OF 3)

LOCATION	Penstock	DEPTH OF HOLE	46.38 m	COMMENCED	Oct. - 25 - 1984
ELEVATION	815.43 m	DEPTH OF OVERBURDEN	0.65 m	COMPLETED	Nov. - 17 - 1984
COORDINATE	1129.786N, 1091.776E	LENGTH OF ROCK DRILLING	45.73 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	68.4 %		



GEOLOGIC LOG OF DRILL HOLE

EL SIETE No. 2 PROJECT — HOLE No. CD-2 (SHEET 3 OF 3)

LOCATION	Penstock	DEPTH OF HOLE	46.38 m	COMMENCED	Oct. - 25 - 1984
ELEVATION	815.43 m	DEPTH OF OVERBURDEN	0.65 m	COMPLETED	Nov. - 17 - 1984
COORDINATE	1129,786N, 1091.776E	LENGTH OF ROCK DRILLING	45.73 m	DRILLED BY	
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	ISHII
BEARING OF ANGLE HOLE	—	CORE RECOVERY	68.4 %		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST (LUGEON)	DEPTH	ELEVATION
40m			0 ➡ 100 %								40m	769.1 m
1–6	DIORITE	+			white	2	2 ~ 3	2 ~ 1	Diorite, substick ~ stick core. Whit vein dipping 20° at intervals of 20 ~ 40 cm.	Lu = 0, p = 10	1–6	
4–5	DIORITE				greyish white	2	3	3	Cracky, black cracks.			
5–6	DIORITE				greyish white	2 ~ 1	2	1	Fresh, stick core. Good.			
6–50	DIORITE								End of hole 46.38m		6–50	

▶ driller's note 4

core loss

RQD

1 (stick), 2 (substick), 3 (piece), 4 (fragment), 5 grain

1 (hard) ~ 5 (soft)

1 (fresh) ~ 5 (decomposed)

III-1 (4) Method of Water Pressure Test

The tests were conducted under the following conditions.

Hole Name	Method of Water Pressure Test	Diameter of Drillhole	Test Section Length(m)	Test Section (Times)	Testing Time (Minutes)	Remarks
AD-1	*	NX	5	4	10	Injection Pressure Cycles are mentioned below table.
AD-2	*	"	5	4	"	
AD-3	*	"	3	8	"	
AD-4	**	"	3	2	"	
AD-5	*	"	5 and/or 3	4	"	
AD-6	*	"	5	3	"	
AD-7	**	"	3	6	"	
AD-8	*	"	5	5	"	
AD-9	**	"	3	7	"	
CD-1	*	"	5	3	"	
CD-2	*	"	5	4	"	
Total: 11 holes 50 times						

* Single packer method
** Double packer method

Injection Pressure at hole head

Depth from Rock Surface to Packer	Injection Pressure Cycle kg/cm^2
Less than 5m	1-2-3-2-1
5 to 10m	1-3-5-3-1
More than 10m	1-5-1-5-1

III-1 (5) Result of Water Pressure Test

Hole Name	Test Section(m)	Water Table(m)	Effective Maximum Pressure (kg/cm^2)	Lugeon Value (l/min/m/10kg/cm^2)	Remarks
AD-1	12.55 - 17.55	14.00	4.5	20	*
	17.55 - 22.55	14.60	6.6	13	*
	22.55 - 27.55	16.00	11.7	9	
	27.00 - 30.00	17.00	11.8	13.5	
AD-2	38.10 - 41.00	15.55	11.7	9	
	41.00 - 44.00	15.55	11.7	18.5	
	44.00 - 47.00	15.55	11.7	11.5	
	47.00 - 50.00	15.55	11.7	13	
AD-3	7.20 - 10.20	6.45	3.8	3.5	*
	9.00 - 12.00	6.45	3.8	3.5	*
	12.00 - 15.00	6.45	5.8	3	*
	15.00 - 18.00	6.45	5.8	3	*
	18.00 - 21.00	6.45	8.8	1	*
	21.00 - 24.00	6.45	8.8	0.5	*
	24.00 - 27.00	6.45	8.8	1.5	*
	27.00 - 30.00	6.45	9.8	0	
AD-4	24.00 - 27.00	4.00	9.4	8	Inclined * drillhole
	27.00 - 30.00	4.50	8.4	6	*
AD-5	12.33 - 15.33	14.90	5.5	25	*
	17.50 - 22.50	-	4.6	17	*
	22.50 - 27.50	24.00	5.5	12	*
	27.00 - 30.00	24.77	6.6	10	*
AD-6	15.70 - 20.70	12.40	6.4	18	*
	20.70 - 25.70	12.40	6.4	12	*
	25.00 - 30.00	12.40	11.4	7	
AD-7	12.00 - 15.00	1.92	10.3	5	Inclined drillhole
	15.00 - 18.00	2.5	10.3	10	
	18.00 - 21.00	2.5	10.3	10.5	
	21.00 - 24.00	2.5	10.3	8	
	24.00 - 27.00	2.5	10.3	0	
	27.00 - 30.00	2.5	5.3	16	*

Hole Name	Test Section(m)	Water Table(m)	Effective Maximum Pressure (kg/cm^2)	Lugeon Value (1/min/m/10kg/cm^2)	Remarks
AD-8	11.69 - 14.69	8.25	4.9	38	*
	15.23 - 18.23	10.55	5.1	13	*
	18.00 - 23.00	10.55	8.1	10	*
	23.00 - 28.34	10.87	11.2	3	
	28.00 - 30.39	11.12	11.2	6	
AD-9	28.98 - 31.98	27.00	8.8	3.5	*
	31.98 - 34.98	27.00	8.8	0.5	*
	33.98 - 36.98	27.00	8.8	0.1	*
	36.98 - 39.98	27.00	8.8	5	*
	39.98 - 42.98	27.00	10.3	5	
	42.98 - 46.98	29.10	11.1	5	
	46.58 - 50.00	19.11	10.1	13	
CD-1	10.00 - 15.00	4.20	10.6	8	
	15.00 - 19.80	4.95	10.6	0.4	
	19.30 - 22.30	4.68	10.6	0.4	
CD-2	24.40 - 29.90	8.93	11.0	0.4	
	29.90 - 35.28	9.15	11.1	0	
	35.28 - 41.00	9.20	11.1	0.1	
	41.00 - 46.38	8.89	10.0	0	

* Lugeon value is calculated at maximum pressure.

$$\text{Lugeon value} = \frac{10 \times Q}{PL}$$

Q : Quantity of water injected (1/min)

P : Effective injection pressure (kg/cm^2)

L : Length of test section (m)

III-2 Trench and Pit

(1) List of Trench

(2) List of Pit

(3) Geologic Log of Trench and Pit

III-2 (1) List of Trench

(1/2)

Trench Name	Location	Elevation (m)	Coordinate	Direction	Length (m)
AT-101	El Siete No.1 Damsite, left bank	1501.98	1139.211N 1098.030E	NS	6.16
AT-102	Ditto	1498.95	1139.208N 1098.017E	N35°W	4.95
AT-103	Ditto	1487.48	1139.245N 1097.985E	EW	8.50
AT-104	Ditto	1480.61	1139.266N 1097.967E	N70°E	7.90
AT-105	Ditto	1491.75	1139.187N 1098.098E	EW	10.45
AT-106	Ditto	1465.89	1139.216N 1098.187E	NS	11.50
AT-110	El Siete No.1 Damsite, right bank	1476.64	1139.499N 1097.961E	N75°W	13.10
AT-111	Ditto	1476.20	1139.480N 1097.996E	N15°E	14.40
AT-112	Ditto	1482.65	1139.458N 1098.110E	N35°E	8.76
AT-113	Ditto	1473.14	1139.417N 1098.177E	N20°E	9.30
BT-201	No.1 Auxiliary Dam left bank	1500.00	1139.017N 1098.017E	NS	9.90
BT-202	Ditto	1478.35	1139.031N 1098.818E	NS	18.60
BT-203	No.1 Auxiliary Dam, right bank	1528.58	1139.243N 1099.047E	N65°E	8.65
AT-1	El Siete No.1 Penstock Alternative Plan	1202.02	1137.466N 1094.779E	N70°W	8.95
AT-2	Ditto	1200.40	1137.418N 1094.761E	N50°W	9.85
AT-3	Ditto	1177.03	1137.320N 1094.651E	N78°W	20.27

Trench Name	Location	Elevation (m)	Coordinate	Direction	Length (m)
AT-4	El State No.1 Penstock Alternative Plan	1163.20	1137.274N 1094.607E	N20°W	6.00
AT-5	Ditto	1154.99	1137.227N 1094.525E	N80°W	9.01
AT-6	Ditto	1113.36	1137.162N 1094.413E	N70°W	11.30
AT-9	Ditto	1193.35	1137.699N 1094.754E	N81°E	11.80
AT-10	Ditto	1169.00	1137.758N 1094.531E	N34°E	18.60
AT-11A	Ditto	1226.65	1137.770N 1094.788E	S50°W	11.90
AT-11	El Siete No.1 Penstock	1226.65	1137.509N 1094.725E	N60°W, N28°W	13.60
AT-12	Ditto	1201.17	1137.481N 1094.627E	N45°W	10.80
AT-13	Ditto	1120.00	1137.378N 1094.399E	N64°W	17.15
AT-14	El Siete No.1 Powerhouse	1122.50	1137.652N 1094.399E	N69°E	10.50
AT-15	El Siete No.1 Penstock	1166.00	1137.451N 1094.607E	N57°E	13.70
BT-10	El Siete No.2 Penstock	882.50	1129.844N 1091.481E	N7°W	9.60
BT-11	Ditto	873.00	1129.841N 1091.518E	N30°E	10.10
BT-12	Ditto	853.72	1129.803N 1091.606E	N45°E	10.00
BT-13	Ditto	826.31	1129.812N 1091.760E	N10°W, N65°E	18.35
BT-14	El Siete No.2 Powerhouse	706.50	1129.621N 1091.972E	N32°W	22.90
Total: 31 Trenches 376.55 m					

III-2 (2) List of Pit

Pit Name	Location	Elevation (m)	Coordinate	Depth (m)
ATA-107	El Siete No.1 Damsite, left bank	1431.51	1139.214N 1098.279E	1.50
ATA-108	Ditto	1431.64	1139.212N 1098.298E	1.00
ATA-109	Ditto	1423.98	1139.279N 1098.325E	1.00
ATA-7	El Siete No.1 Powerhouse Alternative	1033.01	1136.779N 1094.185E	1.85
ATA-8	Ditto	1034.83	1136.804N 1094.163E	1.80
Total: 5 pits 7.15 m				

III-2 (3) Geologic Log of Trench and Pit

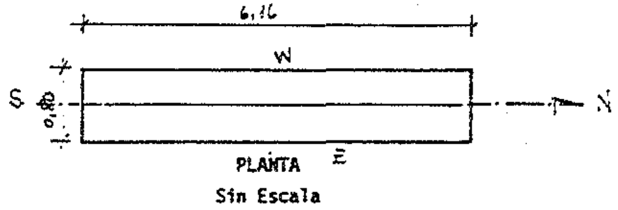
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

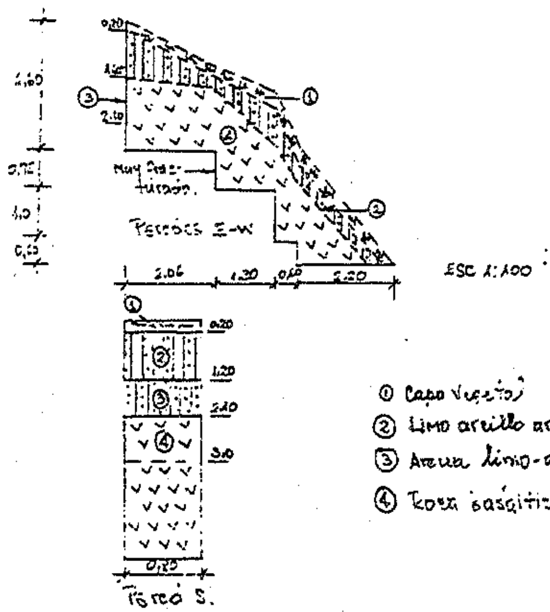
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-101 LOCALIZACION SITIO DE PRESA EL SIETE No. 1 - MARGEN IZQUIERDA

COORDENADAS: N 1'139.211 - E 1'098.030 RUMBO: S-N COTA 1.501,98





ESC 1:100

① Capa vegetal
② Limo arcillo arenoso amarillo
③ Arena limo-arcillosa, amarilla
④ Roca basáltica meteorizada.

FIG. No. 1

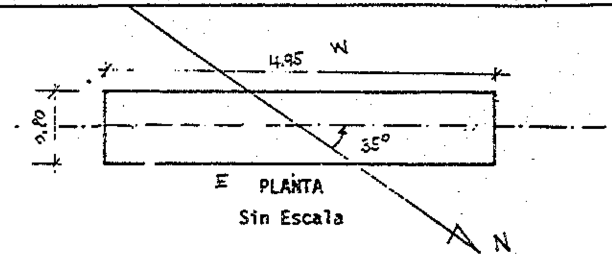
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

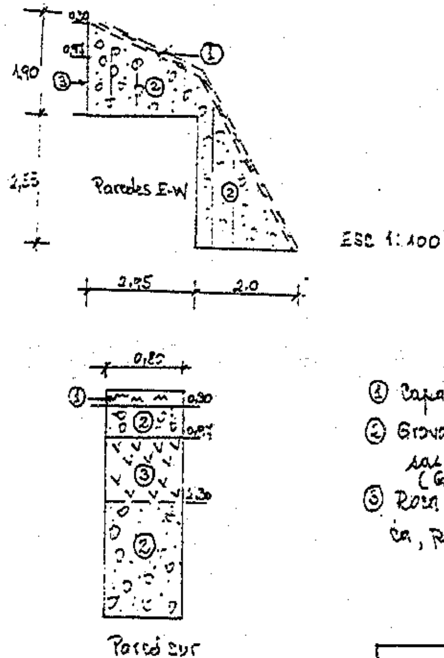
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-102 LOCALIZACION SITIO DE PRESA EL SIETE No. 1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.208 - E 1'098.017 RUMBO: N 35°W COTA 1.498,95





ESC 1:100

① Capa vegetal
② Grava y arena limosas, color carmelito. (GM, GP-GM).
③ Roca basáltica, fracturada, poco meteorizada.

FIG. No. 2

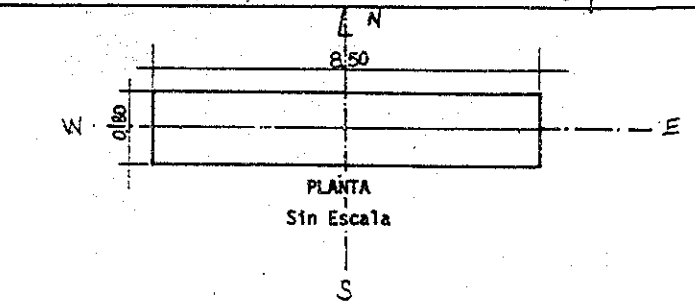
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

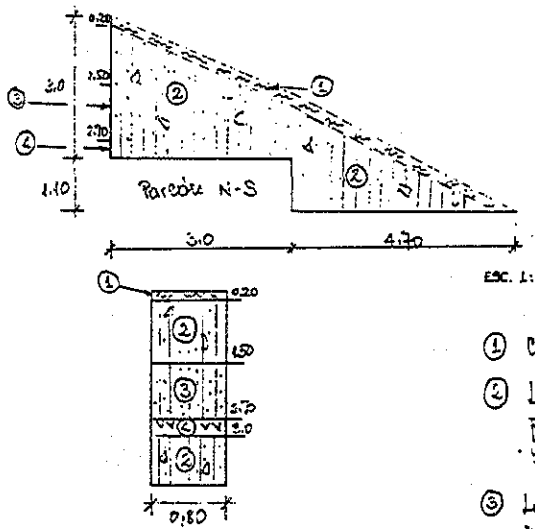
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-103 LOCALIZACION SITIO DE PRESA EL SIETE No.1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.245 - E 1'097.985 RUMBO: W - E COTA 1.487,48





① Capa vegetal

② Limo arcilloso, amarillo plástico, trazas arena y bloques de roca basáltica (MH)

③ Limo arcilloso amarillo plástico a med. plástico con arena. (MH-ML)

④ Roca basáltica, meteorizada

FIG.No. 3

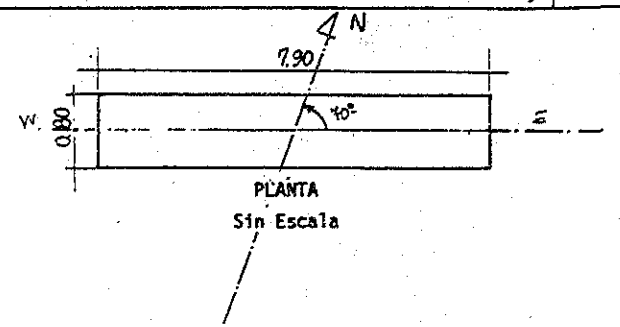
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

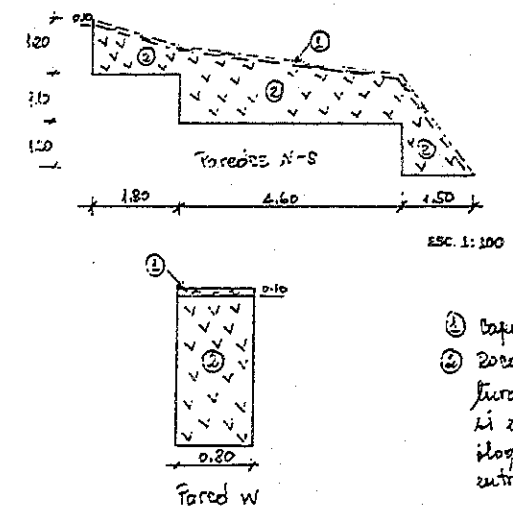
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-104 LOCALIZACION SITIO DE PRESA EL SIETE No. 1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.266 - E 1'097.967 RUMBO: N 70° E COTA 1.480,61





① Capa Vegetal

② Zona basáltica fracturada.
Al excavar se obtuvieron bloques de diámetro entre 0,60 y 1,0 metro

FIG.No. 4

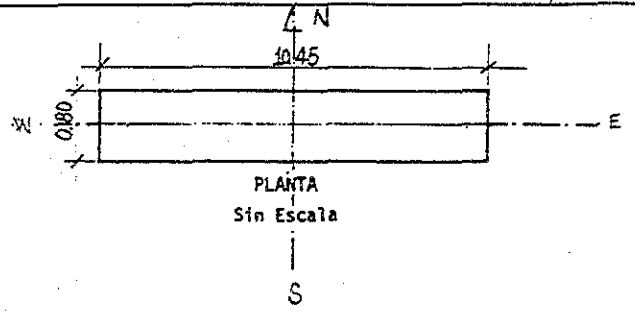
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

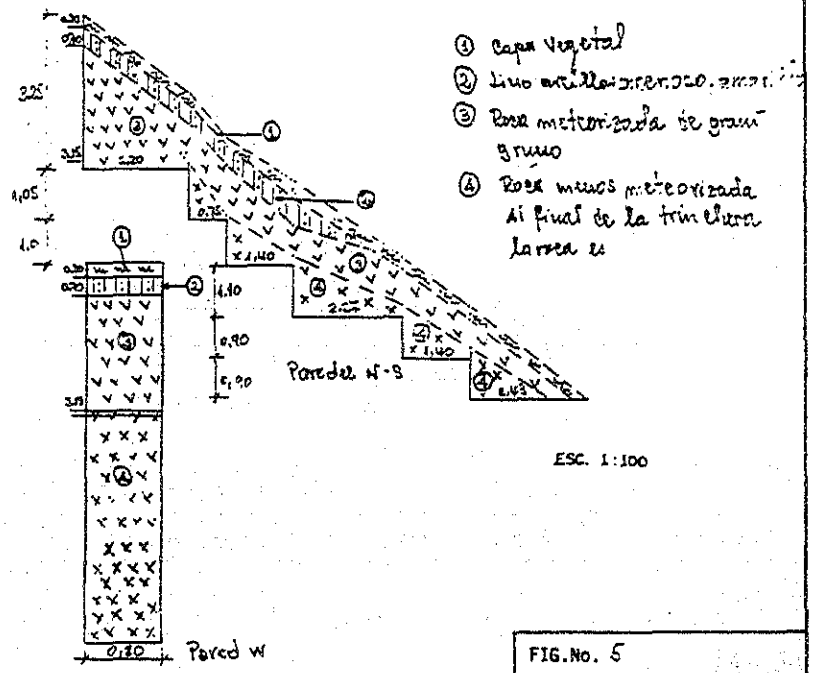
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-105 LOCALIZACION SITIO DE PRESA EL SIETE No. 1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.187 -E 1'098.098 RUMBO: W-E COTA 1.491,75





① Capa vegetal
② Limo arcillo-arenoso amar.
③ Roca meteorizada de grano grueso
④ Roca menos meteorizada al final de la trinchera

FIG.No. 5

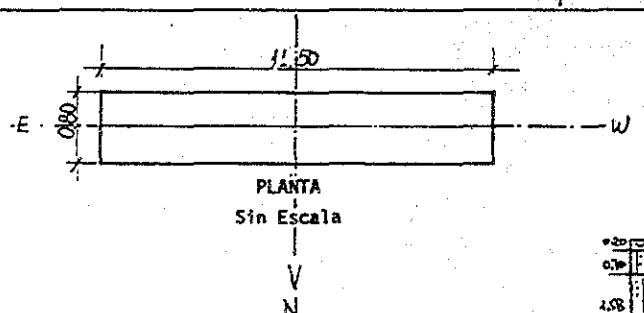
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

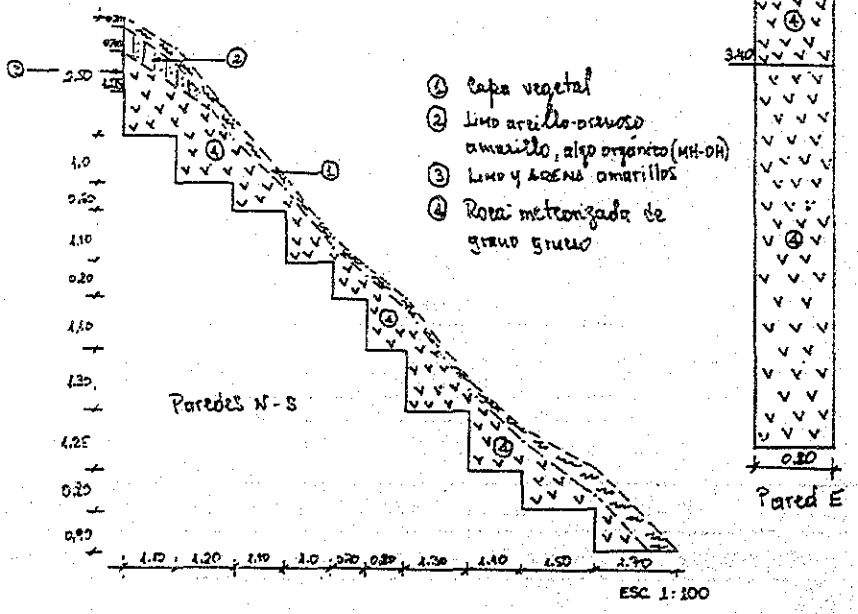
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-106 LOCALIZACION SITIO DE PRESA EL SIETE No. 1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.216 -E 1'098.187 RUMBO: E-W COTA 1.465,89





① Capa vegetal
② Limo arcillo-arenoso amarillo, algo orgánico (MH-OH)
③ Limo y ARENA amarillos
④ Roca meteorizada de grano grueso

FIG.No. 6

A-III-46

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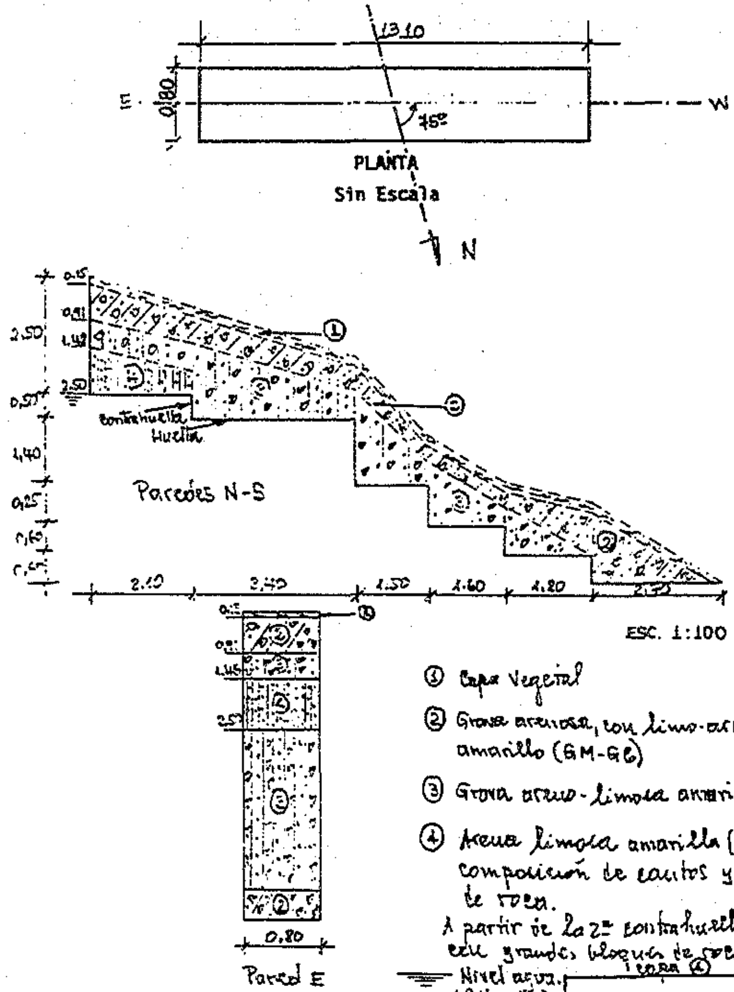
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-110 LOCALIZACION SITIO DE PRESA EL SIETE No.1 MARGEN DERECHA

COORDENADAS: N 1'139.499 - E 1'097.961 RUMBO: N 75° W COTA 1.476,64



① Capa Vegetal
② Grava arenosa, con limo-arcilloso amarillo (GM-GC)
③ Grava areno-limosa amarilla (GP-GM)
④ Arena limosa amarilla (SM). Descomposición de cantos y bloques de roca.
A partir de la 2ª contrahuella aparecen grandes bloques de roca. Desaparece capa ④
Nivel agua (filtración)

FIG. No. 10

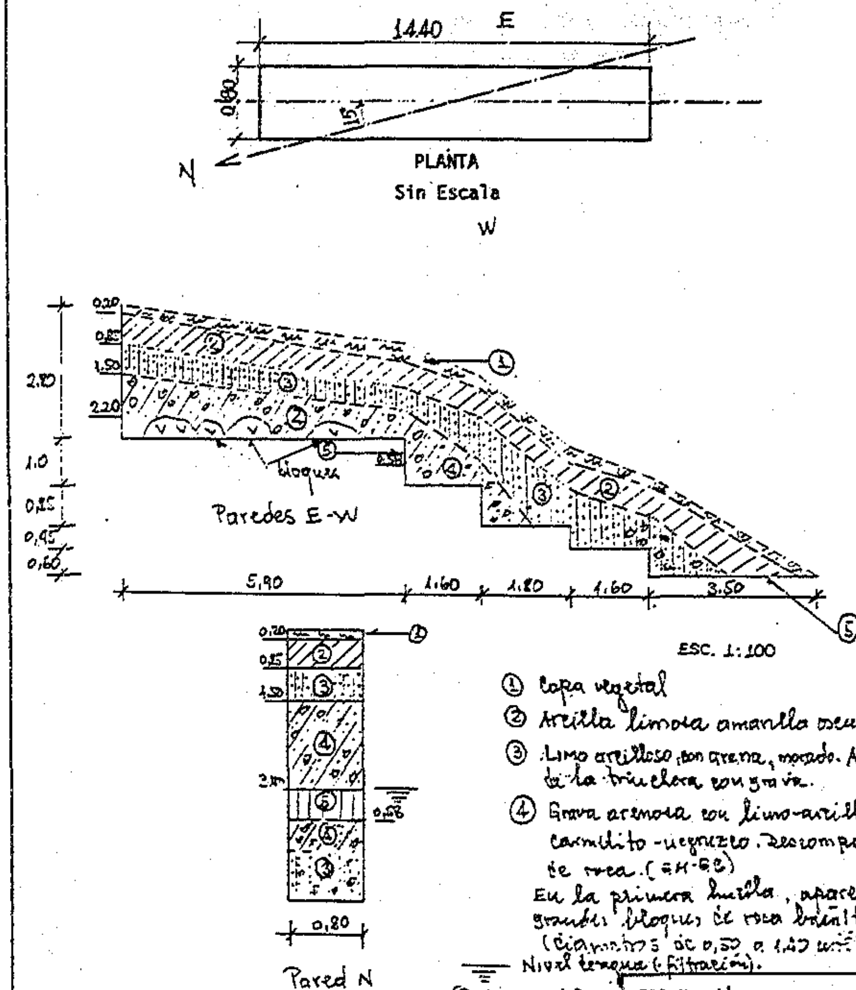
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-111 LOCALIZACION SITIO DE PRESA EL SIETE No.1 MARGEN DERECHA

COORDENADAS: N 1'139.480 - E 1'097.996 RUMBO: N 15° E COTA 1.476,20



① Capa vegetal
② Arcilla limosa amarilla oscura
③ Limo arcilloso con arena, morado. Al final de la trinchera con grava.
④ Grava arenosa con limo-arcilloso carmelito-negruzco. Descomposición de roca. (GM-GC)
En la primera huella, aparecen grandes bloques de roca basáltica (diámetros de 0,50 a 1,40 mts)
Nivel freático (filtración).
⑤ Limo arcilloso

FIG. No. 11

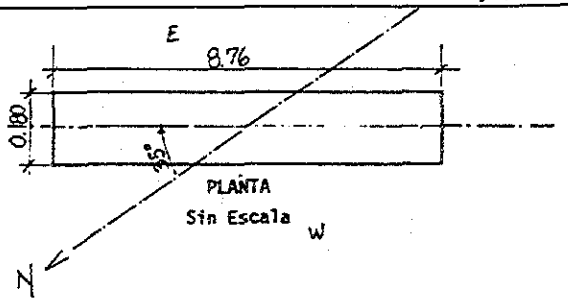
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

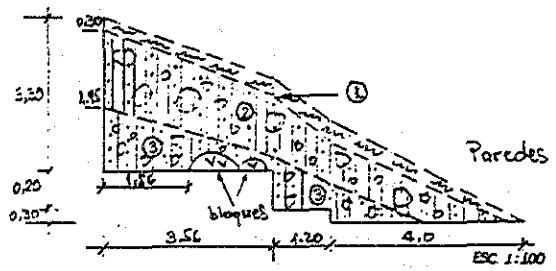
ESTUDIOS RIO ATRATO

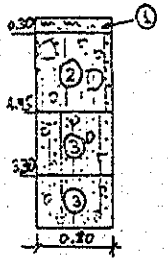
icel

TRINCHERA No. AT-112 LOCALIZACION SITIO DE PRESA EL SIETE No.1 MARGEN DERECHA

COORDENADAS: N 1'139.458 - E 1'098.110 RUMBO: N 35° E COTA 1482,65







① Capa vegetal

② Limo arcillo arenoso amarillo, con cantos y bloques redondeados de roca, diámetro 0.10 - 0.60 mts.

③ Arena limo-arcillosa, con cantos de roca de menor diámetro, menos que los cantos en relación con capa ② Diametro de los bloques en la 1ª linella 0.60 - 1.0 m. Roca poco meteorizada.

FIG.No. 12

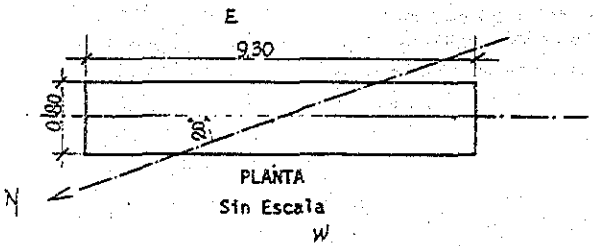
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

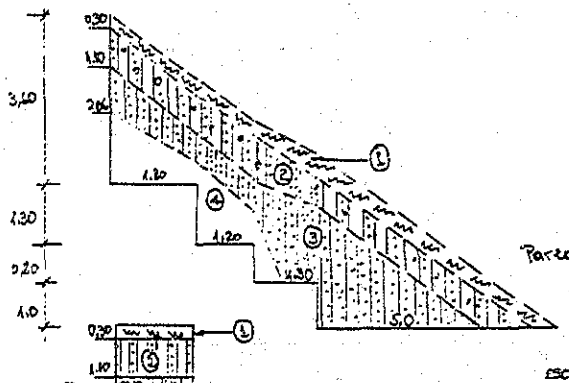
ESTUDIOS RIO ATRATO

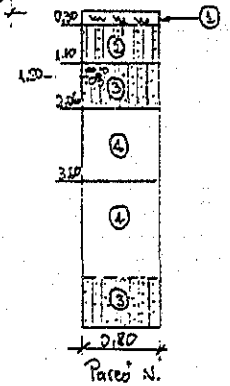
icel

TRINCHERA No. AT-113 LOCALIZACION SITIO DE PRESA EL SIETE No.1 MARGEN DERECHA

COORDENADAS: N 1'139.417 - E 1'098.177 RUMBO: N 20°E COTA 1493,14







① Capa vegetal

② Limo arcillo-arenoso amarillo, con grava.

③ Arena limo-arcillosa amarilla. En la pared N. a 1.50 m. cantos redondeados de roca meteorizada.

④ Roca meteorizada.

FIG.No. 13

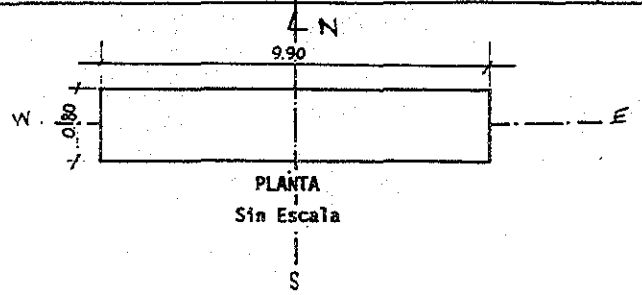
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

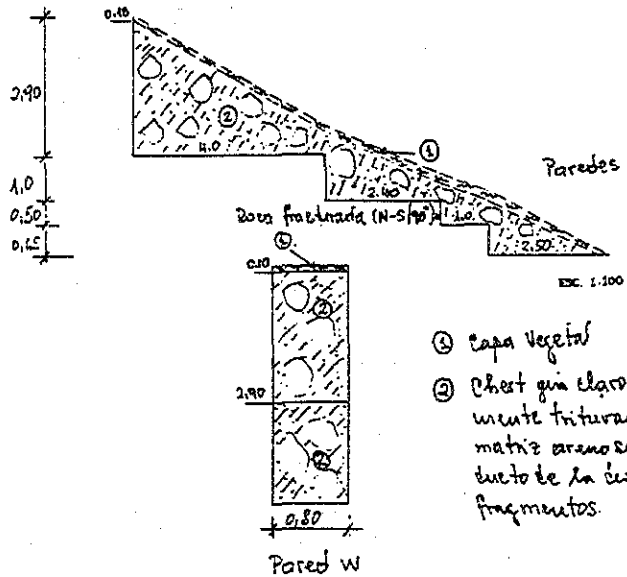
icel

TRINCHERA No. BT-201 LOCALIZACION ALTERNATIVA B SITIO DE PRESA EL SIETE No. 1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.017 -E 1'098.017 RUMBO: N-S COTA 1500,00



PLANTA
Sin Escala



① Capa Vegetal

② Chert gris claro y negruzco, totalmente triturado, embebido en matriz arenosa amarilla, producto de la descomposición de los fragmentos.

FIG.No. 14

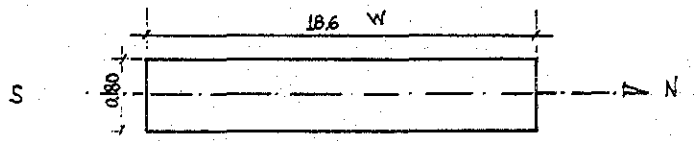
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

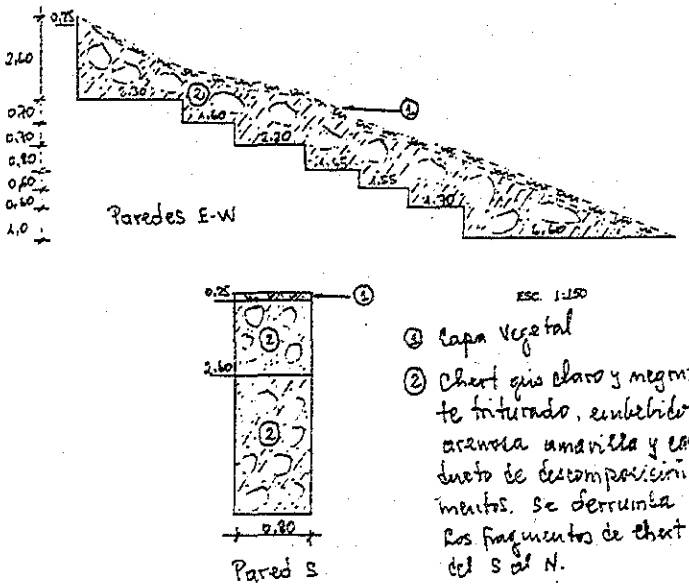
icel

TRINCHERA No. BT-202 LOCALIZACION ALTERNATIVA B SITIO DE PRESA EL SIETE No.1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.031 -E 1'098,818 RUMBO: S-N COTA 1.478,35



PLANTA
Sin Escala



① Capa Vegetal

② Chert gris claro y negruzco, totalmente triturado, embebido en matriz arenosa amarilla y cremelita, producto de descomposición de los fragmentos. Se derrumba con facilidad. Los fragmentos de chert disminuyen del S al N.

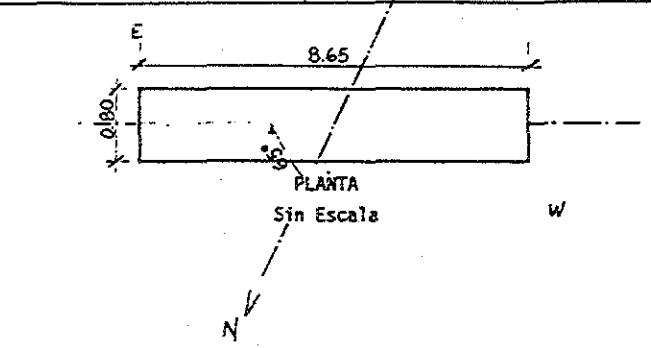
FIG.No. 15

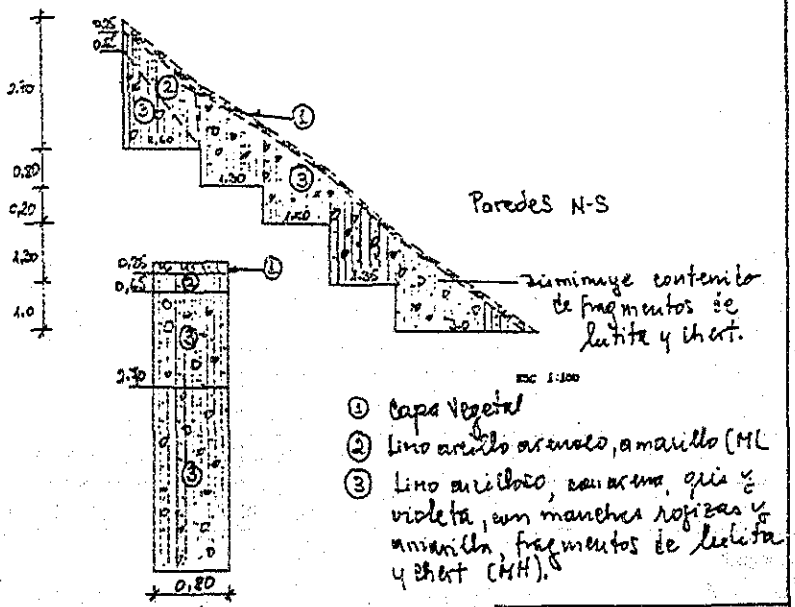
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

TRINCHERA No. BT-203 LOCALIZACION ALTERNATIVA B SITIO DE PRESA EL SIETE No.1 MARGEN DERECHA

COORDENADAS: N 1'139.243 -E 1099.047 RUMBO: N 65°E COTA 1528,58





① Capa Vegetal
② Limo arcilloso arenoso, amarillo (ML
③ Limo arcilloso, con arena, gris y violeta, con manchas rojizas y amarillo, fragmentos de lutita y chert (MH).

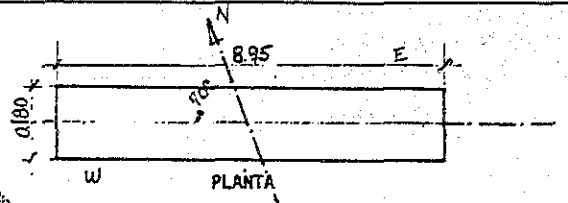
FIG.No. 16

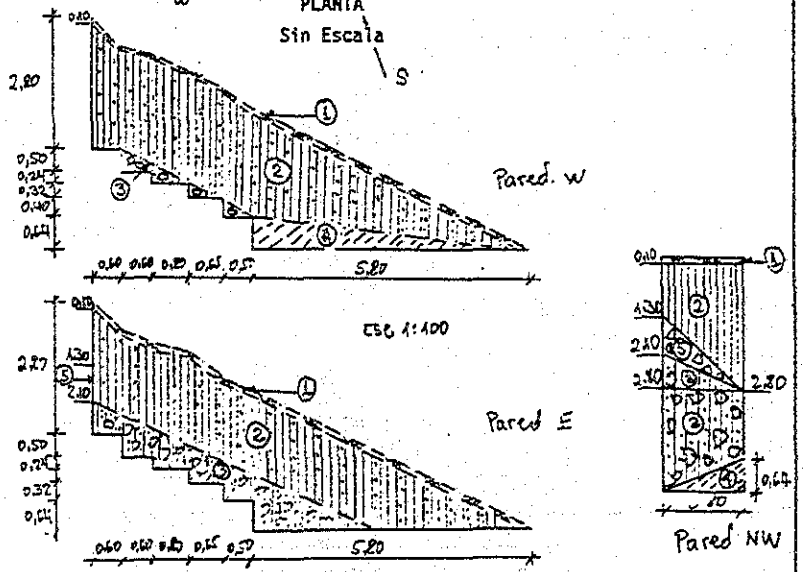
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

TRINCHERA No. AT-1 LOCALIZACION TUBERIA DE CARGA EL SIETE No. 1

COORDENADAS: N 1'137.446 -E 1'094.779 RUMBO: N 70°W COTA 1202,02





① Capa Vegetal
② Limo arcilloso amarillo, con arena (MH)
③ Limo y arena amarillos, con fragmentos y cantos angulares de roca totalmente descompuestos
④ Roca meteorizada.
⑤ Fragmentos y cantos angulares, altamente meteorizados. Conserva las características de fracturamiento. Buzamiento N 20°

FIG.No. 17

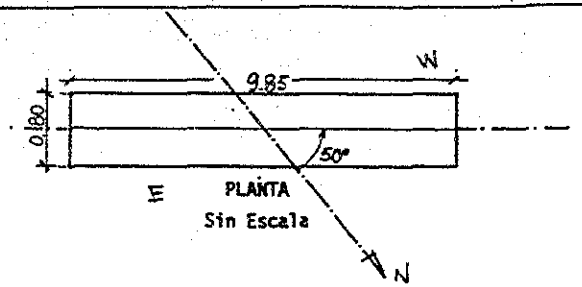
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

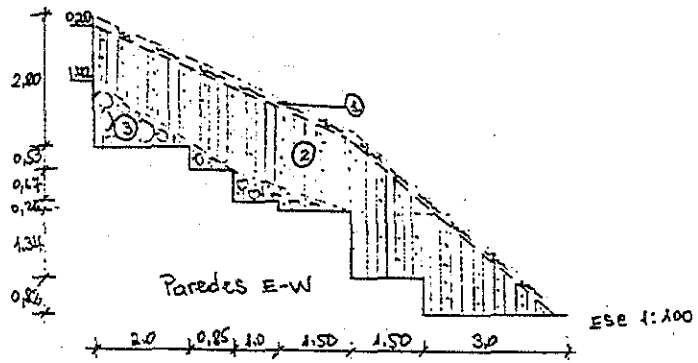
ESTUDIOS RIO ATRATO

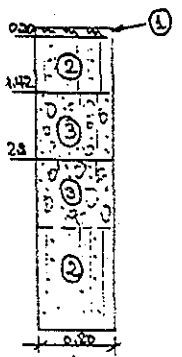
icel

TRINCHERA No. AT-2 LOCALIZACION TUBERIA DE CARGA EL SIETE No. 1

COORDENADAS: N 1'137.418 E 1'094.761 RUMBO: N 50° W COTA 1.200,40







① Capa Vegetal
② Limo arcilloso amarillo, con arena
③ Cantos y bloques de roca basáltica en matriz arenolimosa. (Diámetros de 0.40 a 1.0 mt). Los cantos disminuyen de tamaño y cantidad hacia la parte inferior de la trinchera.

FIG.No. 18

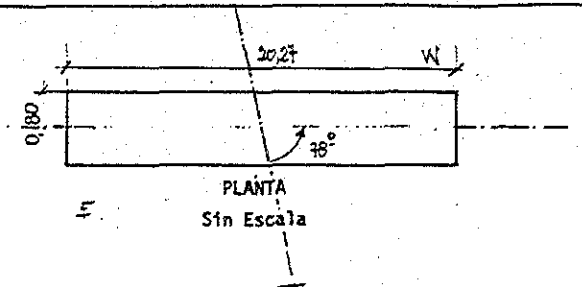
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

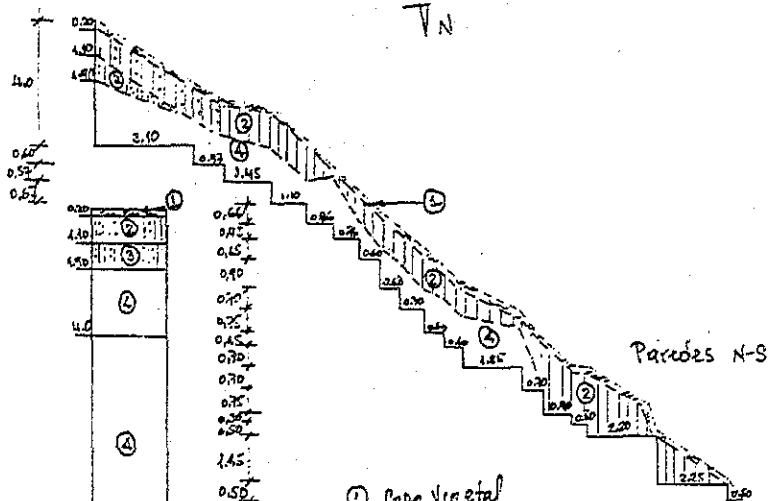
ESTUDIOS RIO ATRATO

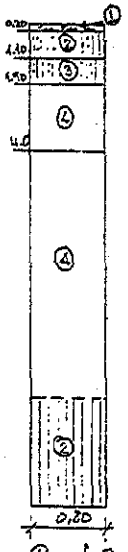
icel

TRINCHERA No. AT-3 LOCALIZACION TUBERIA DE CARGA EL SIETE No. 1

COORDENADAS: N 1'137.320 E 1'094.651 RUMBO: N 78°W COTA 1.177,03







① Capa Vegetal
② Limo arcilloso amarillo, con arena (MH.)
③ Arena limosa amarilla (SM)
④ Conglomerado totalmente alterado y diaclasado; basaltos muy fracturados y diaclasados (Brecha de falla?) Roca sedimentaria totalmente meteorizada

FIG.No. 19

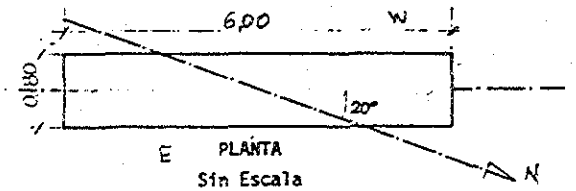
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

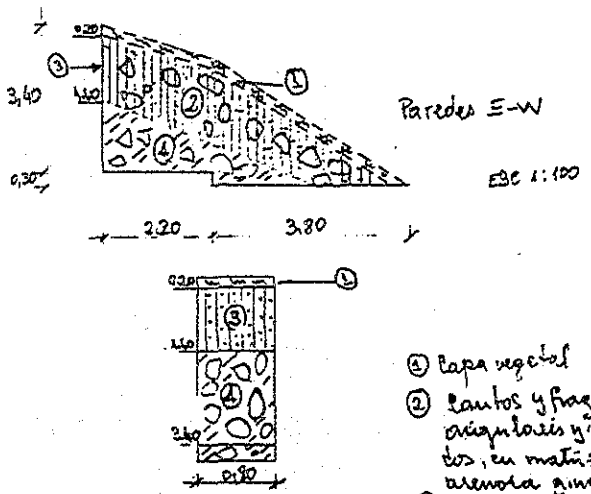
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-4 LOCALIZACION TUBERIA DE CARGA EL SIETE No. 1

COORDENADAS: N 1'137.274 -E 1094.607 RUMBO: N 20°W COTA 1.167,20





① Capa vegetal
② Cantos y fragmentos angulosos y redondeados, en matriz limo arenosa amarilla.
③ Limo arcillo-arenoso amarillento (MH)
④ Roca meteorizada

El importante anotar la presencia de roca muy fracturada y meteorizada. Zona de falla?

FIG.No. 20

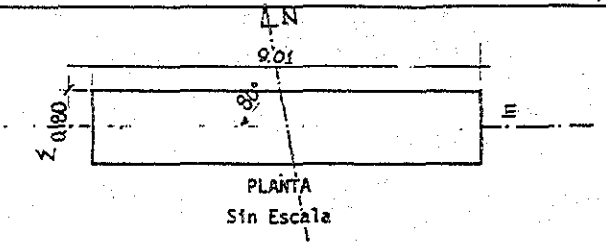
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

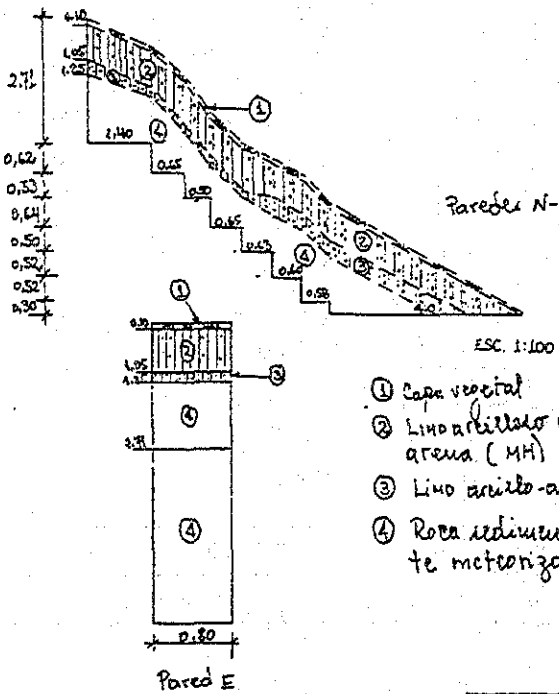
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-5 LOCALIZACION TUBERIA DE CARGA EL SIETE No.1

COORDENADAS: N 1137.227 -E 1.094535 RUMBO: N 80°W COTA 1.154,99





① Capa vegetal
② Limo arcilloso amarillento, poca arena (MH)
③ Limo arcillo-arenoso, rojizo (MH)
④ Roca sedimentaria totalmente meteorizada (limolita?)

FIG.No. 21

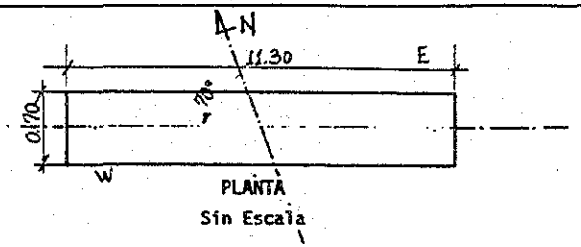
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

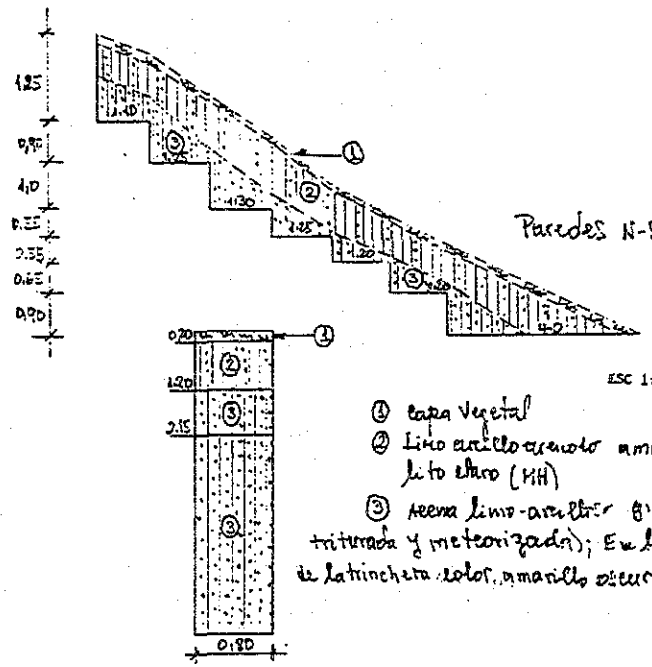
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. AT-6 LOCALIZACION TUBERIA DE CARGA EL SIETE No. 1

COORDENADAS: N 1'137.162 -E 1'094.413 RUMBO: N 70°W COTA 1.113.36





① Capa Vegetal
② Limo arcillo arenoso amarillo a carmelito claro (MH)
③ Arena limo-arcillosa gravillosa (roca triturada y meteorizada); En la parte inferior de la trinchera color amarillo oscuro.

FIG.No. 22

CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

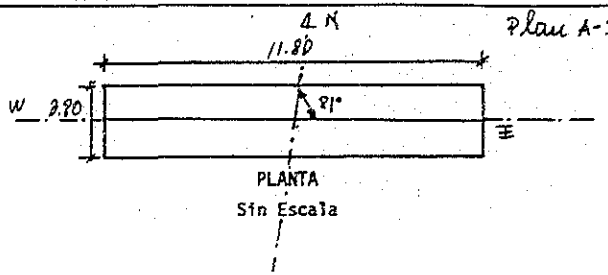
ESTUDIOS RIO ATRATO

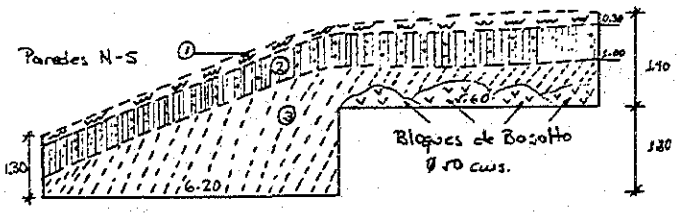
icel

TRINCHERA No. AT-9 LOCALIZACION TUBERIA DE CARGA. EL SIETE No. 1

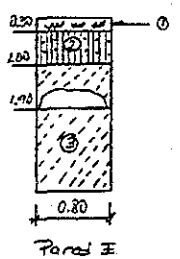
COORDENADAS: N 1'137.699 -E 1'094.754 RUMBO: N 81°E COTA 1193.35

Plan A-1





Esc. 1:100



① Capa Vegetal
② Limo - arcilloso amarillo, con arena (ML).
③ Roca basáltica meteorizada (blanda), color amarillo-rojizo.

Por su forma de meteorización parece que corresponde a bloques

FIG.No. 30

CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

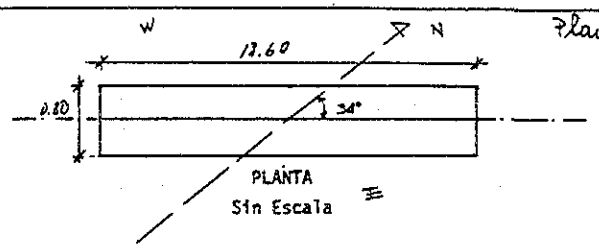
ESTUDIOS RIO ATRATO

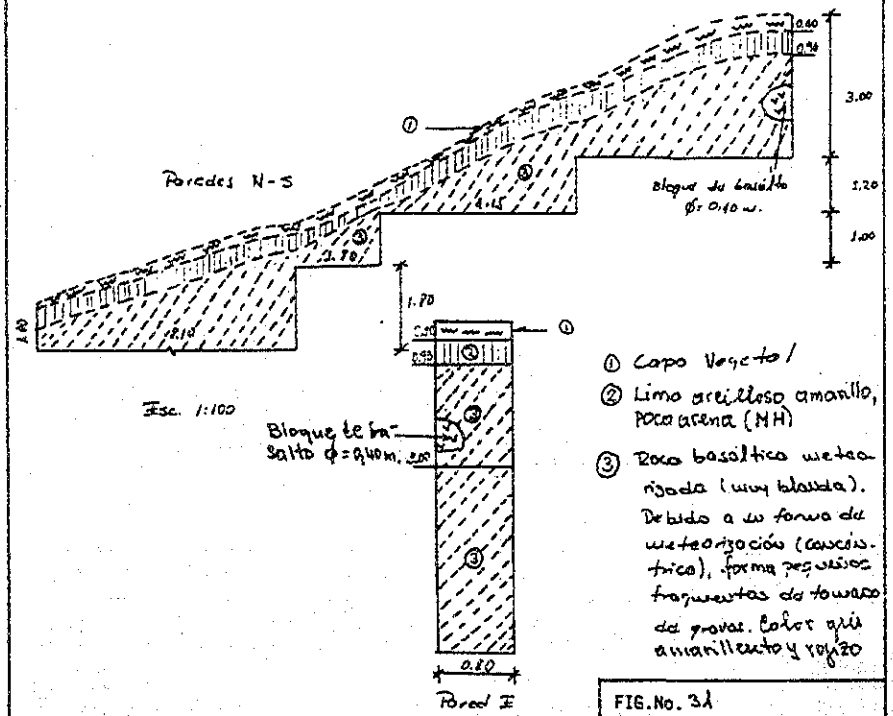
icel

TRINCHERA No. AT-10 LOCALIZACION TUBERIA DE CARGA. EL SIETE No 1

COORDENADAS: N 1137.758 -E 1094.539 . RUMBO: N 34°E COTA 1169.00

Plan A-1





① Capa Vegetal
② Limo arcilloso amarillo, poca arena (MH)
③ Roca basaltica meteorizada (muy blanda). Debido a su forma de meteorización (esferoidal) forma pequeños fragmentos de tamaño de grava. Color gris amarillento y rojizo

FIG.No. 31

CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

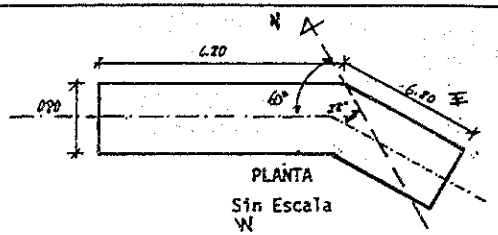
ESTUDIOS RIO ATRATO

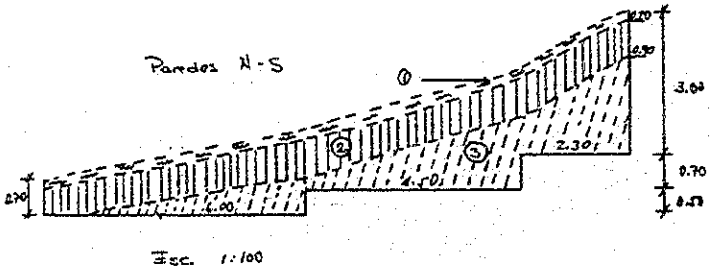
icel

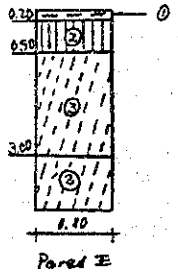
TRINCHERA No. AT-11 LOCALIZACION TUBERIA DE CARGA EL SIETE No 1

COORDENADAS: N 1137.509 -E 1094.725 RUMBO: N60°W - N22°W COTA 1201.65

Plan A-2







① Capa Vegetal
② Limo arcilloso amarillo (MH, ML)
③ Roca basáltica meteorizada (blanda). Debido a su forma de meteorización (esferoidal) forma pequeños fragmentos de tamaño de grava (GP-GM) color gris amarillento y rojizo

FIG.No. 32

CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

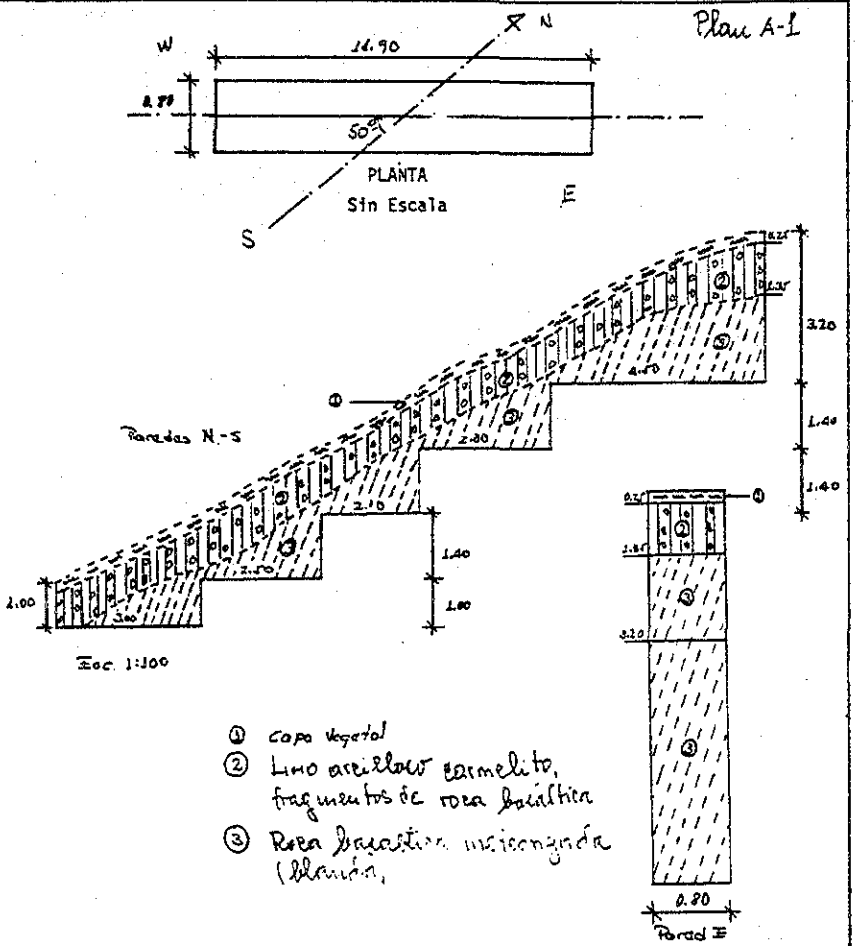
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. ST 11-1 LOCALIZACION TUBERIA DE CARGA EL SIETE No 1

COORDENADAS: N 1137.770 -E 1094.788 RUMBO: S-50°-W COTA 1.226,65

Plan A-1



① Capa Vegetal
② Limo arcilloso carmelito, fragmentos de roca basáltica
③ Roca basáltica meteorizada (blanda), gris-amarillo y rojizo.

FIG.No.33

CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

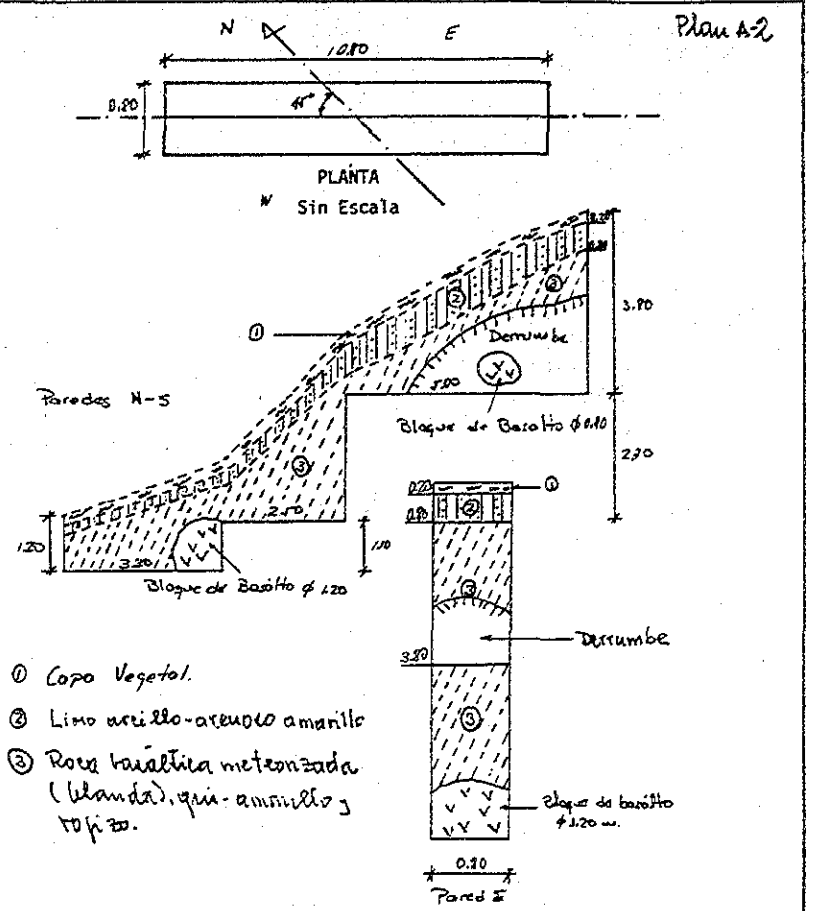
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. ST-12 LOCALIZACION TUBERIA DE CARGA EL SIETE No 1

COORDENADAS: N 1137.481 -E 1094.627 RUMBO: N 45° W COTA 1172,17

Plan A-2



① Capa Vegetal.
② Limo arcillo-arenoso amarillo
③ Roca basáltica meteorizada (blanda), gris-amarillo y rojizo.

FIG.No.34

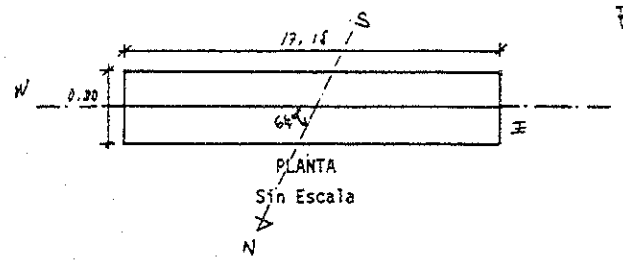
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

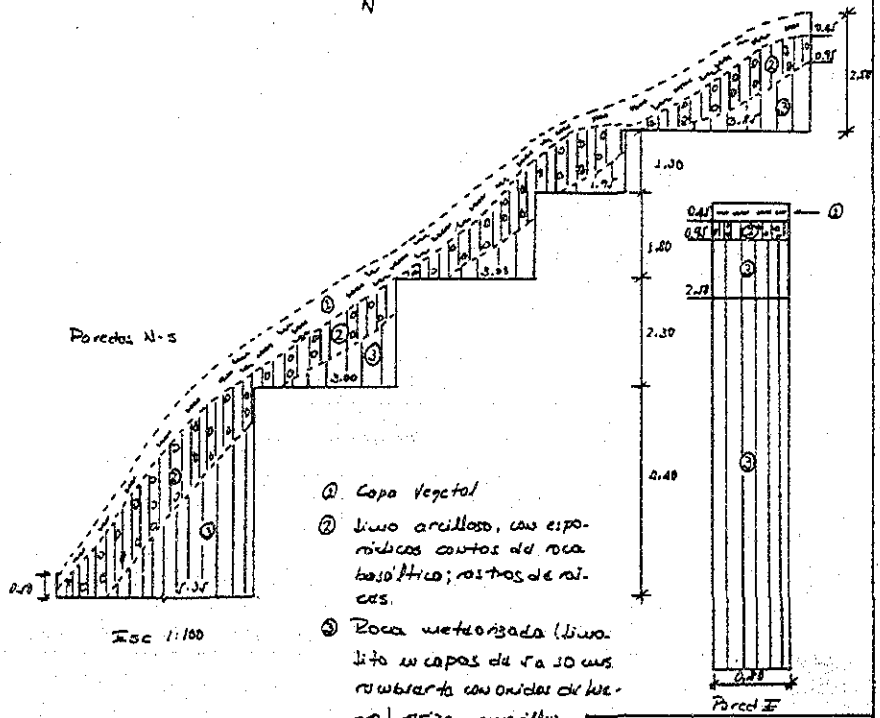
ESTUDIOS RIO ATRATO

TRINCHERA No. AT-13 LOCALIZACION . CASA DE MAQUINAS EL SIETE No 1

COORDENADAS: N 1'137.378 -E 1'094.399 RUMBO: N 64° W COTA: 1.120,00

Plan A-2





Esc 1:100

① Capa Vegetal

② Limo arcilloso, con esporádicos cantos de roca basáltica; restos de raíces.

③ Roca meteorizada (limolita en capas de 5 a 10 cms. recubierta con óxidos de hierro), rojizo y amarillentos.

FIG.No.35

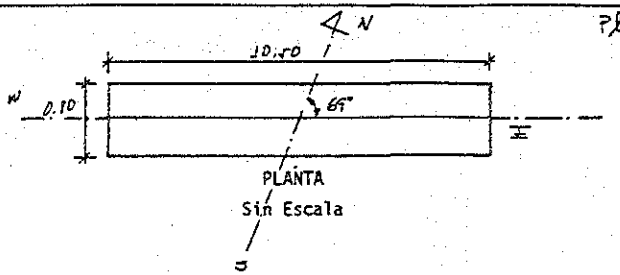
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

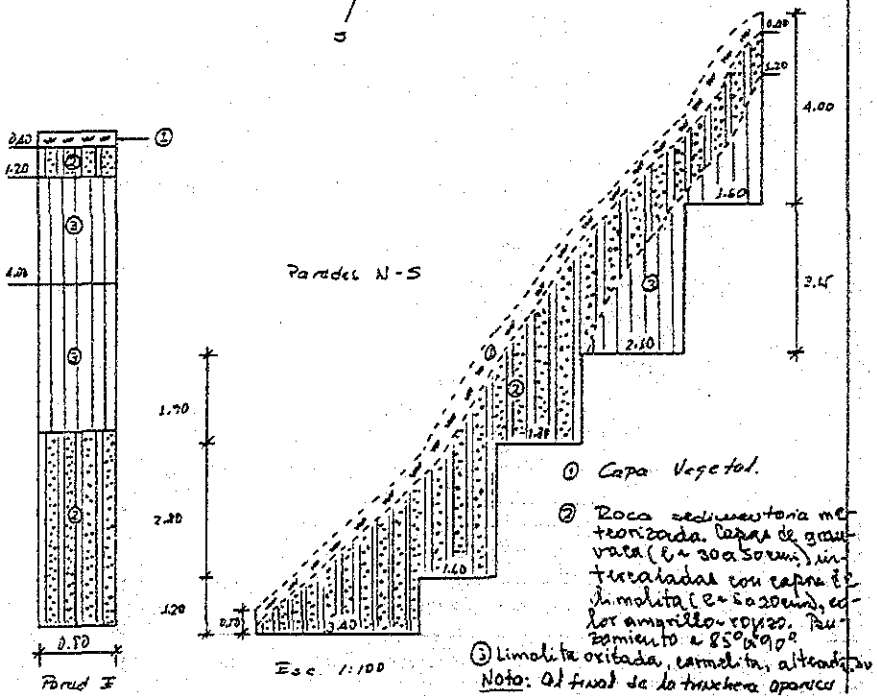
ESTUDIOS RIO ATRATO

TRINCHERA No. AT-1d LOCALIZACION . CASA DE MAQUINAS EL SIETE No 1.

COORDENADAS: N 1'137.652 -E 1'094.399 RUMBO: N 69°E COTA: 1.122,70

Plan A-1





Esc 1:100

① Capa Vegetal.

② Roca sedimentaria meteorizada. Capas de grauvaca (e = 30 a 50 cms.) intercaladas con capas de limolita (e = 5 a 20 cms.), color amarillo-rojizo. Rumbamiento a 85°a 90°.

③ Limolita oxitada, carmelita, alterada.

Nota: Al final de la trinchera aparece una roca meteorizada, dando la impresión de ser volcánica o la grauvaca de origen volcánico.

FIG.No. 36

CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

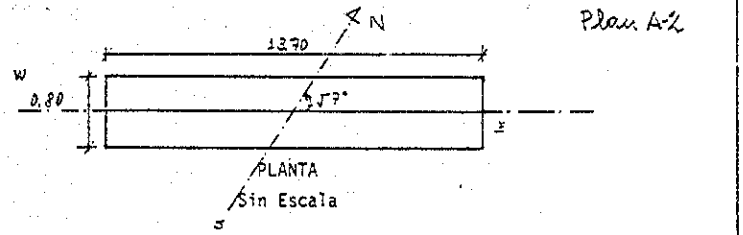
ESTUDIOS RIO ATRATO

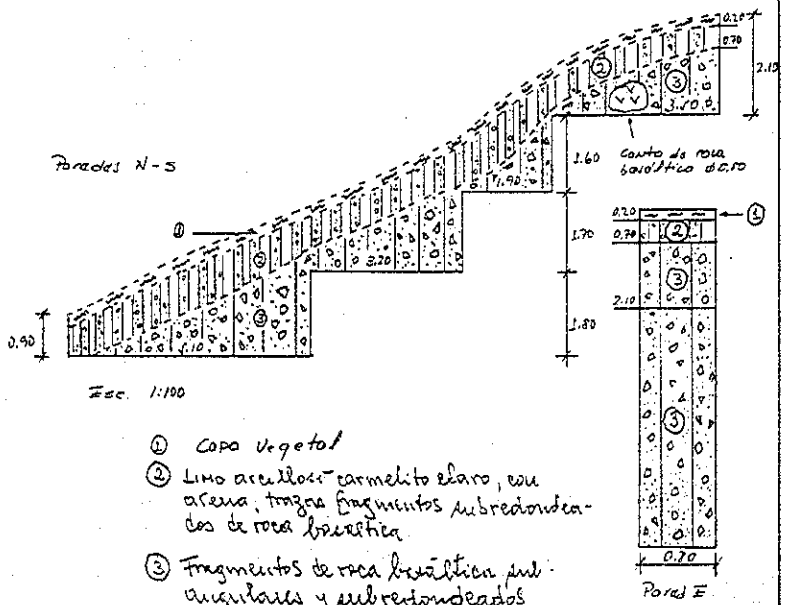
icel

TRINCHERA No. BT-17 LOCALIZACION TUBERIA DE CARGA EL SIETE No 1

COORDENADAS: N 1137.451 -E 1094.607 RUMBO: N 37°E COTA 1.166,00

Plan A-2





① Capa Vegetal
② Limo arcilloso carmelito claro, con arena, trazas fragmentos subredondeados de roca basaltica
③ Fragmentos de roca basáltica sub-angulares y subredondeados (tamaños 5 a 10 cms), en matriz limo arcillosa carmelita

FIG.No. 37

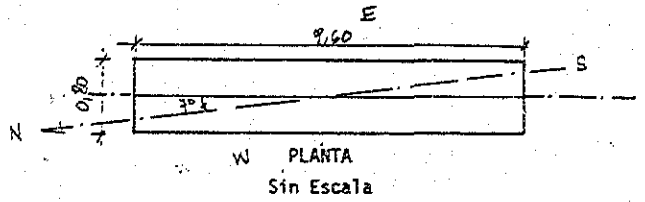
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

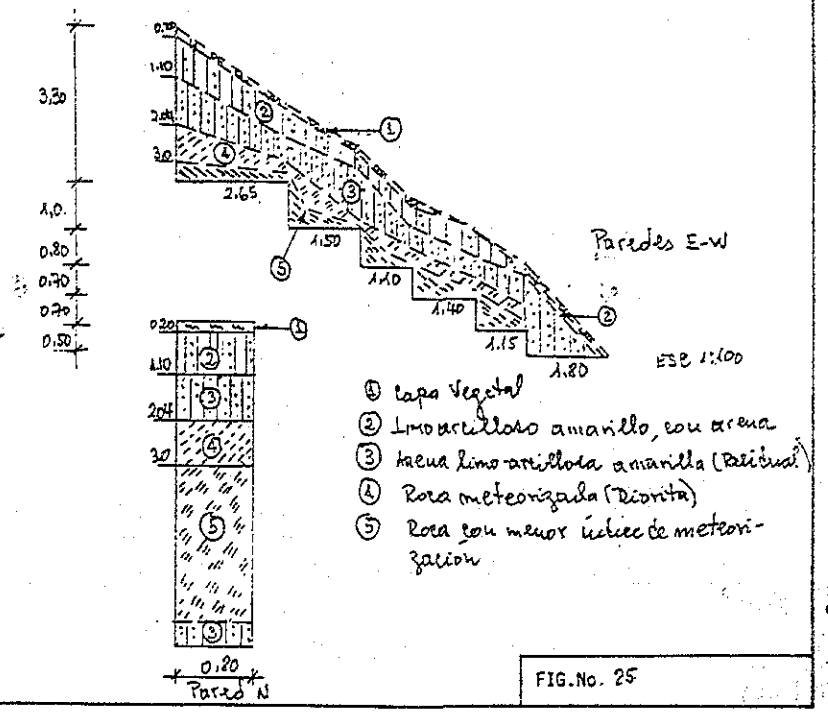
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. BT-10 LOCALIZACION TUBERIA DE CARGA EL SIETE Nº2

COORDENADAS: N 1'129.844 -E 1'091.481 RUMBO: N 7°W COTA 882,50





① Capa Vegetal
② Limo arcilloso amarillo, con arena
③ Arena limo arcillosa amarilla (Residual)
④ Roca meteorizada (Diorita)
⑤ Roca con menor incidencia de meteorización

FIG.No. 25

A-III-57

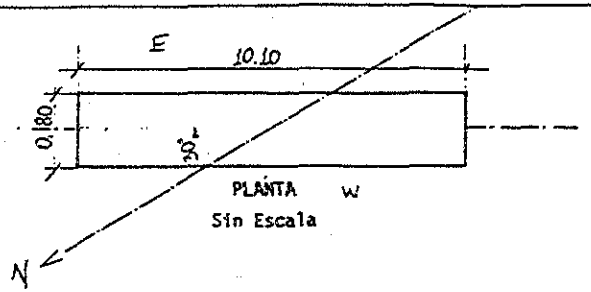
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

icel

TRINCHERA No. BT-11 LOCALIZACION TUBERIA DE CARGA EL SIETE No. 2.

COORDENADAS: N 1'129.841 -E 1'091.518 RUMBO: N 30° E COTA 873.0



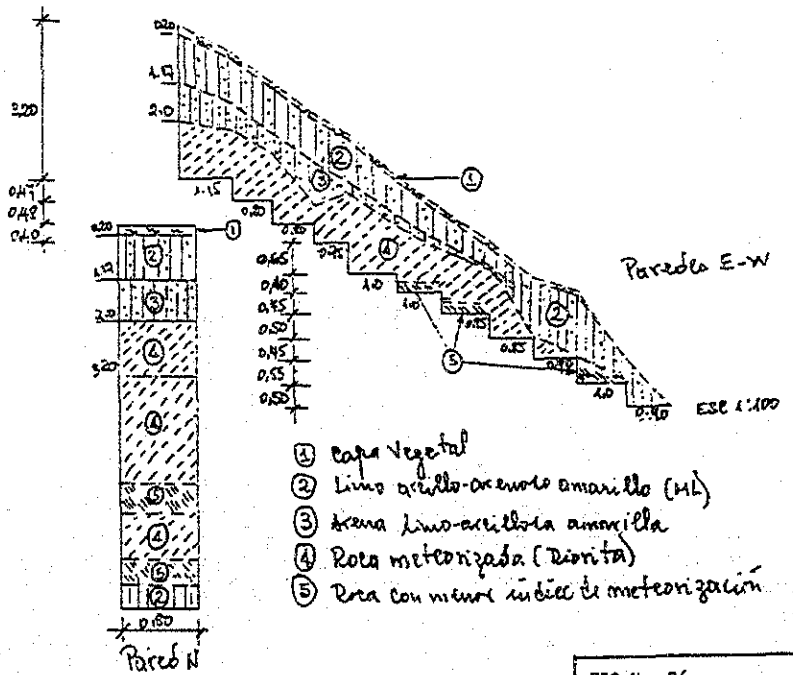


FIG. No. 26

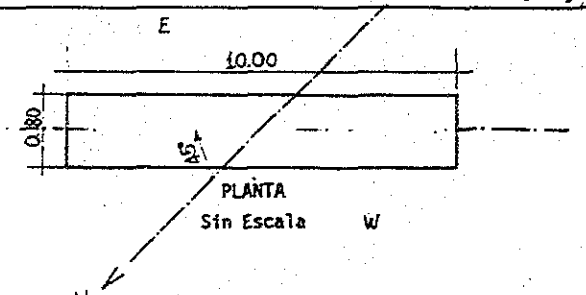
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

icel

TRINCHERA No. BT-12 LOCALIZACION TUBERIA DE CARGA EL SIETE No. 2

COORDENADAS: N 1'129.803 -E 1'091.606 RUMBO: N 45°E COTA 853,72.



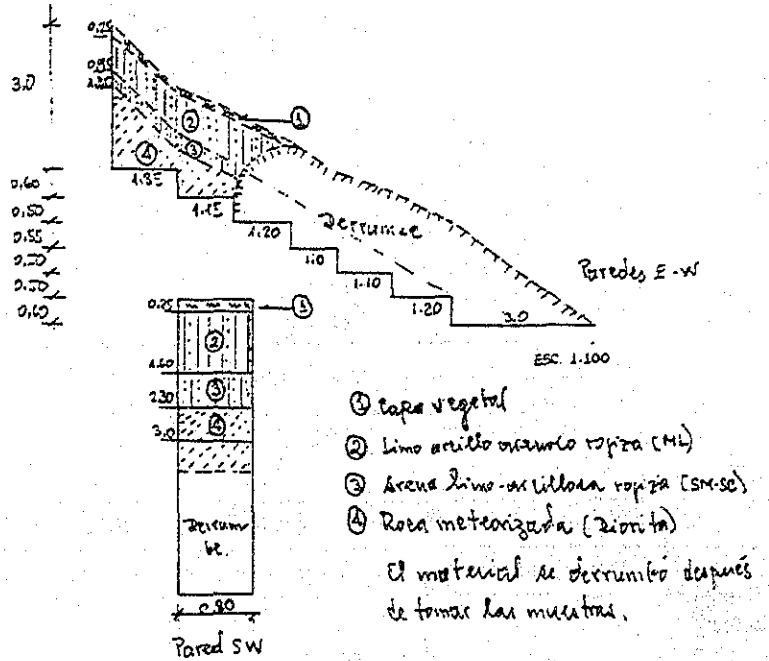


FIG. No. 27

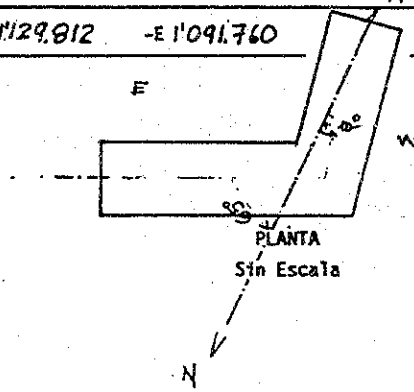
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

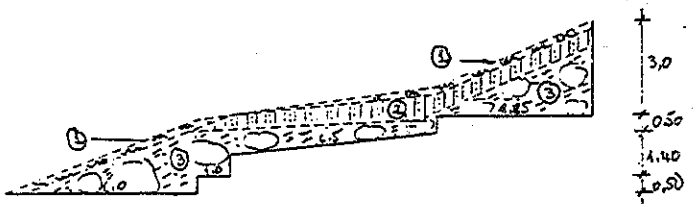
ESTUDIOS RIO ATRATO

icel

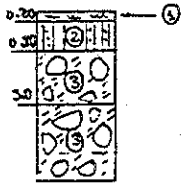
TRINCHERA No. BT-13 LOCALIZACION TUBERIA DE CARGA EL SIETE No. 2

COORDENADAS: N 1'129.812 -E 1'091.760 RUMBO: N 10°W / N 65° E COTA 826.31





ESC. 1:150



① Capa vegetal
② Limo arcillo arenoso amarilla (ML)
③ Bloques de lidita (diametro 0,80 y 1,00 m) en matriz limo-arcillosa amarilla.

FIG.No. 28

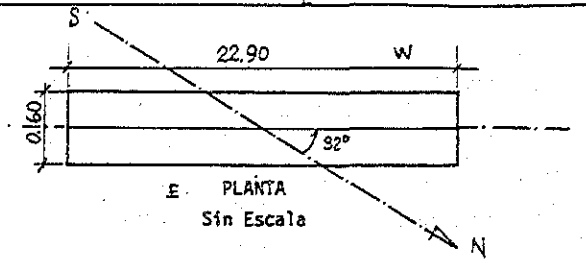
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

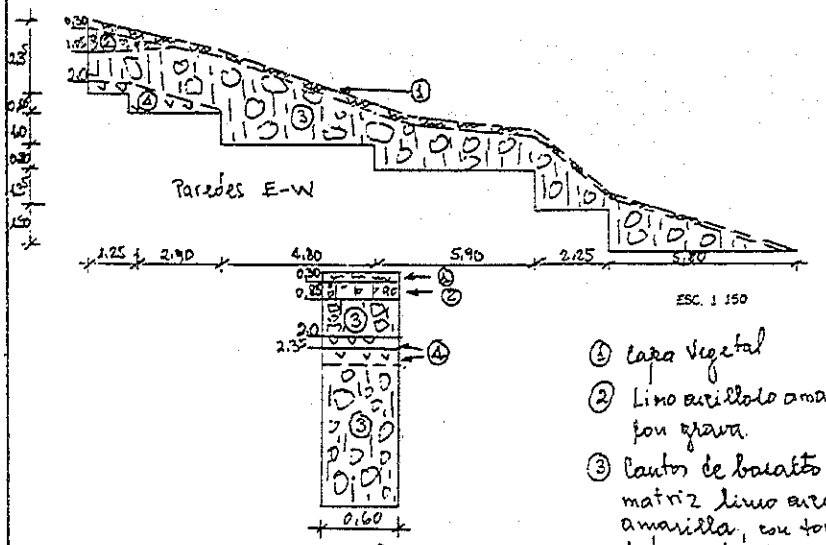
ESTUDIOS RIO ATRATO

icel

TRINCHERA No. BT-14 LOCALIZACION CASA DE MAQUINAS EL SIETE No. 2

COORDENADAS: N 1'129.621 -E 1'091.972 RUMBO: N 32°W COTA 706.50





ESC. 1:150

① Capa vegetal
② Limo arcillolo amarillo, con grava.
③ Cantos de basalto en matriz limo arcillosa amarilla, con tonalidades verdosas.
④ Grandes bloques de basalto, meteorizado

FIG.No. 29

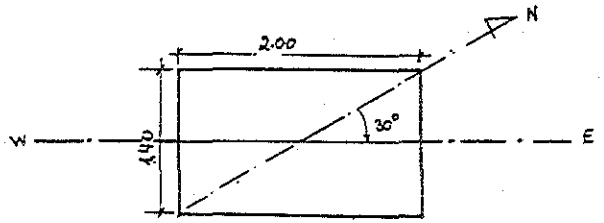
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

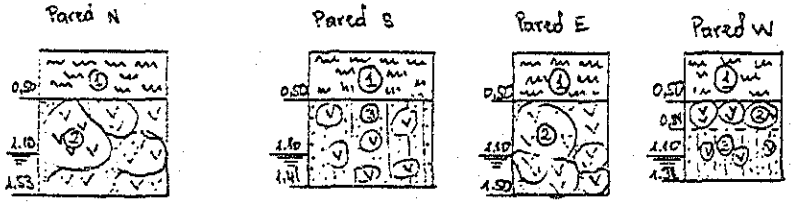
icel

APIQUE No. ATA-107 LOCALIZACION SITIO PRESA EL SIETE No.1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.214-E 1'098.279 RUMBO: N 30°E COTA 1.437



PLANTA
Sin Escala



Esc: V: 1:50

① Capa Vegetal
② Grandes bloques redondeados de roca basáltica. Diámetros 0,20 a 1,20 mts. Matriz arena-limosa (SM)
③ Arena limosa gris con cantos y bloques de roca basáltica.
⏚ Nivel freático.

FIG.No. 7

A-III-60

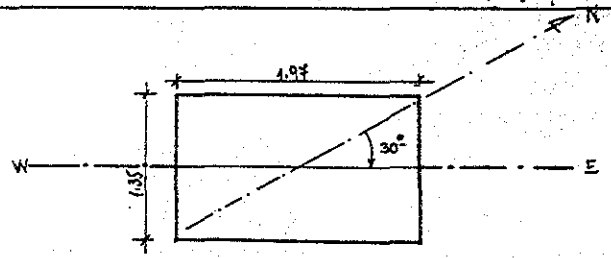
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

icel

APIQUE No. ATA-108 LOCALIZACION SITIO DE PRESA EL SIETE No. 1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.212-E 1'098.298 RUMBO: N 30°E COTA 1.431,64



PLANTA
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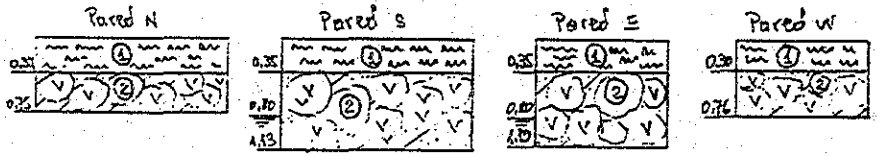


Esc V : 1:50

① Capa vegetal
② Grandes bloques de roca basáltica en matriz de grava arena-limosa gris (GM-GC)
⏚ Nivel freático

FIG.No. 8

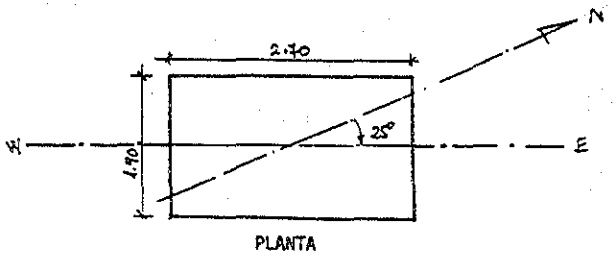
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

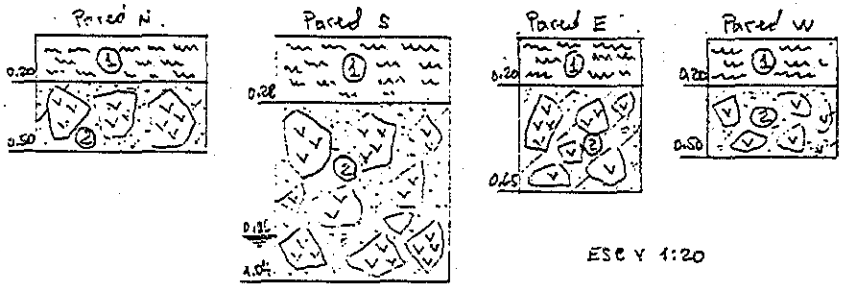
icel

APIQUE No. ATA-109 LOCALIZACION SITIO DE PRESA EL SIETE No. 1 MARGEN IZQUIERDA

COORDENADAS: N 1'139.279 E 1'098.375 RUMBO: N 25°E COTA 1.423,98



PLANTA
Sin Escala



Esc V 1:20

① Capa vegetal
② Bloques angulares de roca basáltica en matriz de grava arena-limosa (GM-GC)
Nivel freático

FIG.No. 9

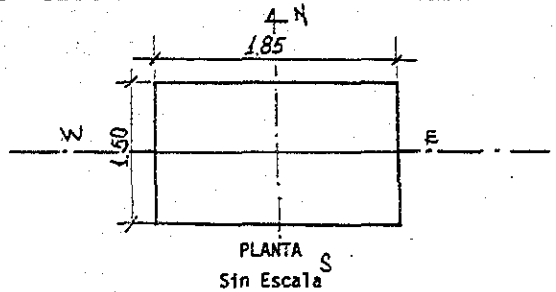
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

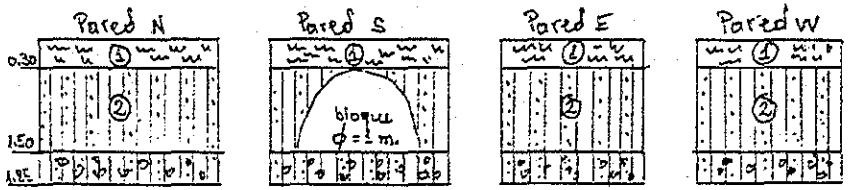
icel

APIQUE No. ATA-7 LOCALIZACION CASA DE MAQUINAS EL SIETE No. 1

COORDENADAS: N 1'136.779 -E 1'094.185 RUMBO: N-S COTA 1.035,01



PLANTA
Sin Escala



Esc V 1:50

① Capa vegetal
② Limo arcilloso orgánico gris (MH) de 1.50 a 1.85 m con grava en el fondo del apique aparecen cantos y bloques en matriz arena-limosa gris.

FIG.No. 23

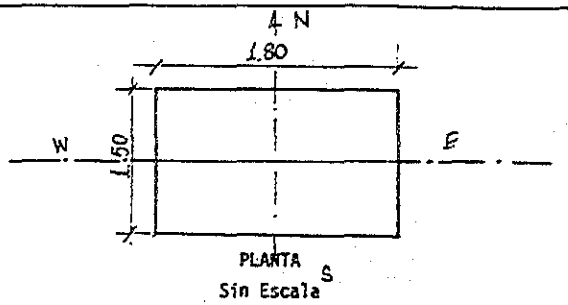
CONSORCIO
TECNOCONSULTA LTDA.
ARAL LTDA.
CONSUPA LTDA.

ESTUDIOS RIO ATRATO

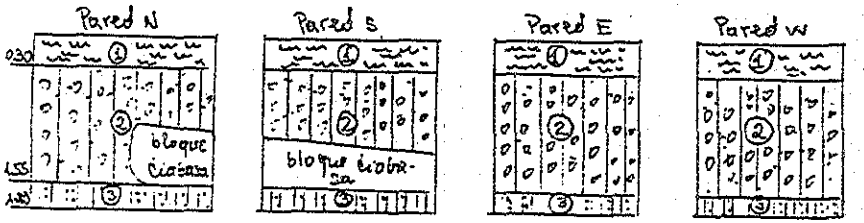
icel

APIQUE No. ATA-8 LOCALIZACION CASA DE MAQUINAS EL SIETE No.1

COORDENADAS: N 1'136.804 E 1'094.163 RUMBO: N-S COTA 1034,83



PLANTA
Sin Escala



ESC V 1:50

① Capa Vegetal
② Grava areno-limosa amarilla (GM-GC)
③ Limo arenoso gris

En el fondo del apique grandes bloques de roca.

FIG.No. 24

III-3 (1) Result of Seismic Prospecting

Seismic Refraction Method

Conditions of seismic meserments performed in this project site are mentioned as follows:

Recording device ; 12 channels type
Model; Nimbus Oyo ES-1200

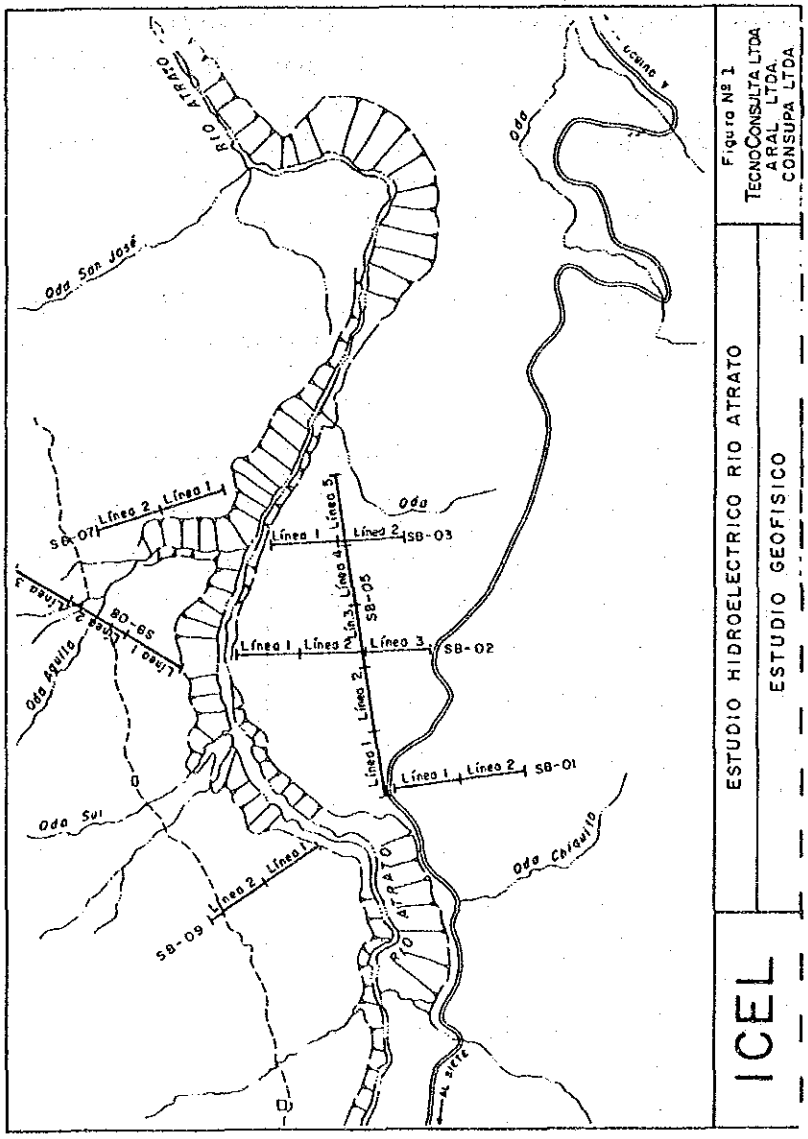
Generation of seismic energy ; Blows with a hammer of 5-lb.

Intervals between geophones ; 10 meters

Intervals between shots ; Approximately 50 meters and 4 shot points in 1 spread.

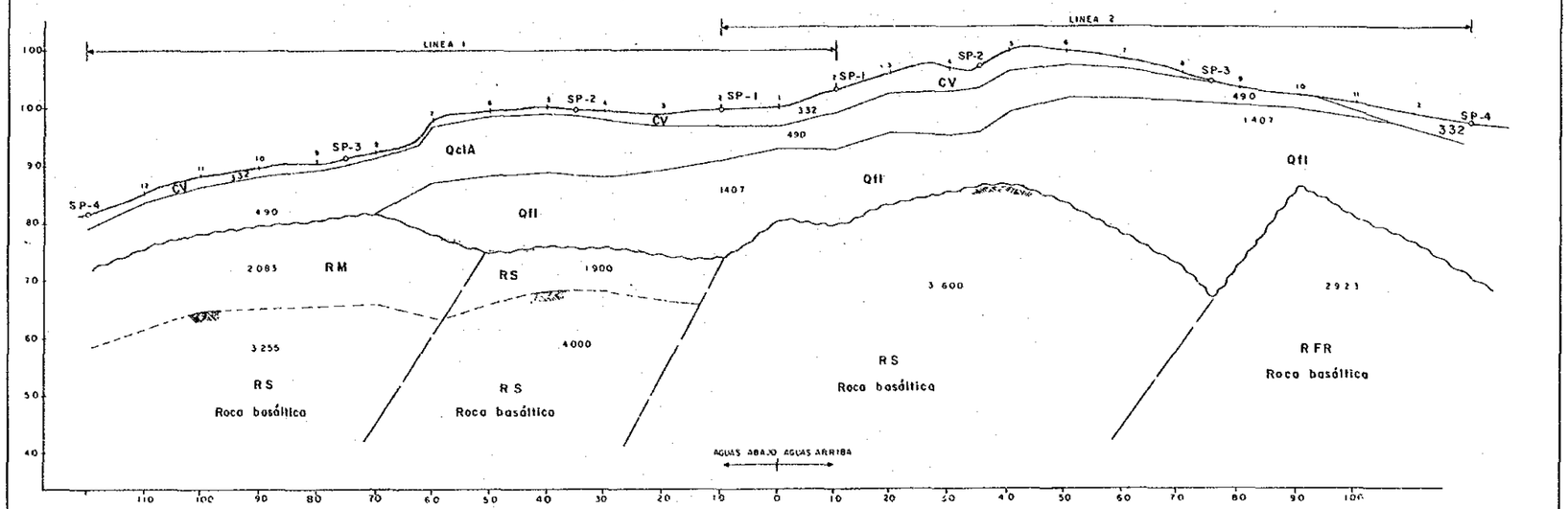
Quantitive Features of the Seismic Prospecting

Location		Mesuring	Length (m)	Spread	Geophone Stations	Shot Points	Remarks
EL SIETE NO.2	Damsite	SA-1	220	2	24	8	Dwg-08 shows location of Mesuring line
	Penstock and Powerhouse Sites	SB-7	220	2	24	8	
		SB-8	330	3	36	12	
		SB-9	220	2	24	8	
EL SIETE NO.1	Intake Damsite and Sedimentation Baisn Site	SB-1	220	2	24	8	
		SB-2	320	3	36	12	
		SB-3	220	2	24	8	
		SB-5	550	5	60	20	
Total: 8 Lines 2,300 m							

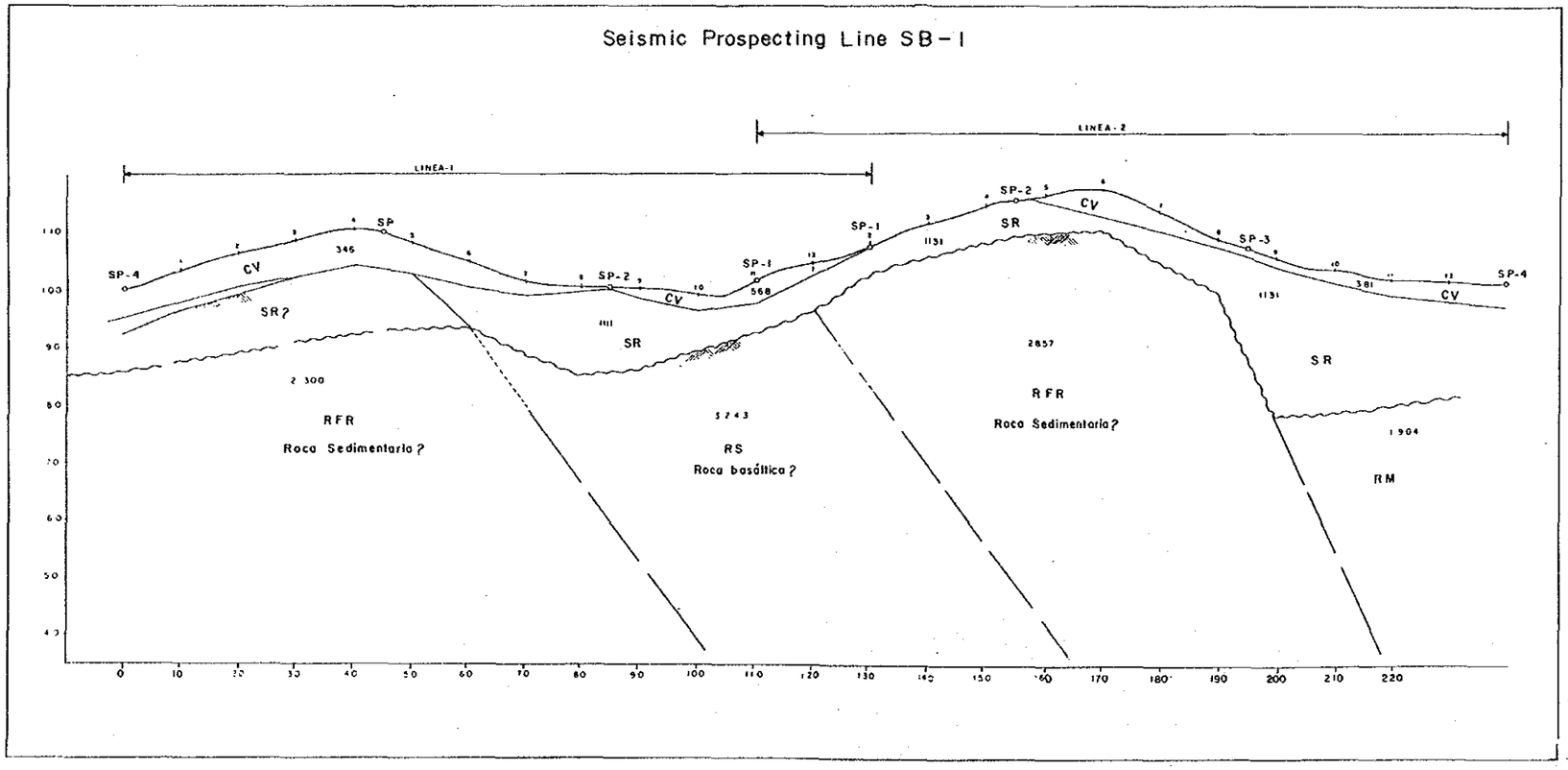


Location of Seismic Prospecting Lines at El Siete No.1 Penstock and Powerhouse Sites, and El Siete No.2 Intake Damsite and Sedimentation Basin Site.

Seismic Prospecting Line SA-I



Seismic Prospecting Line SB-I



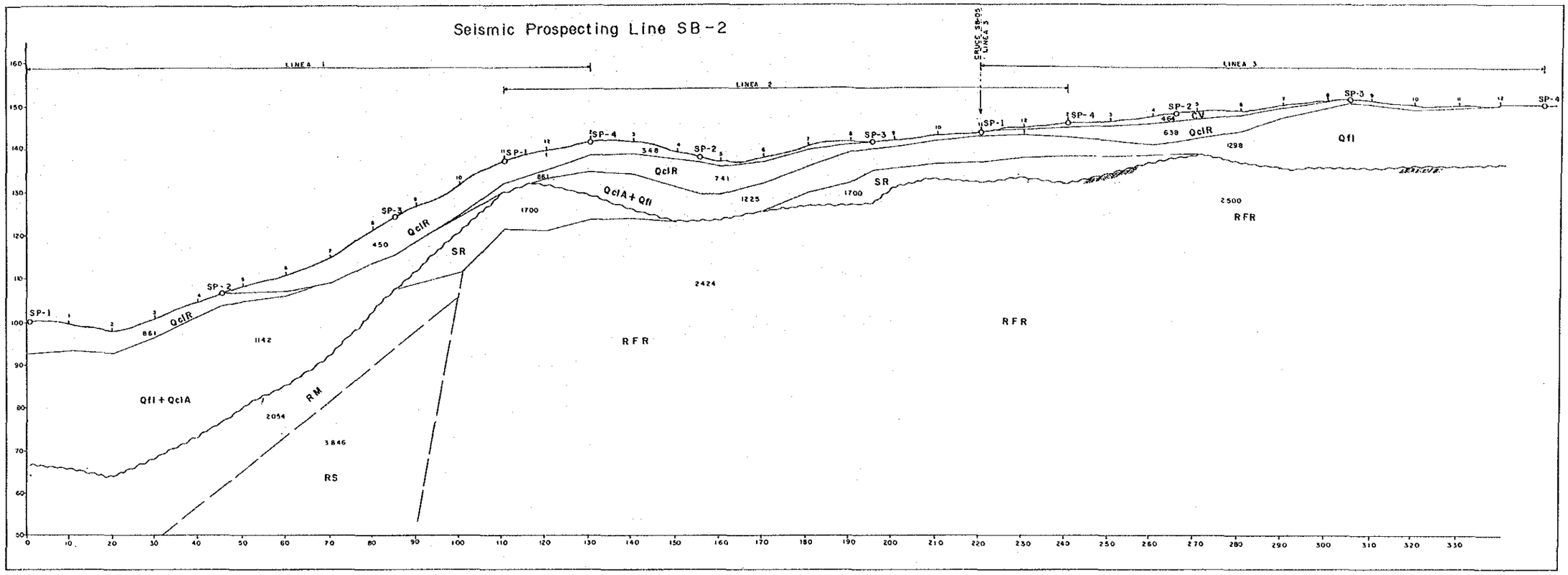
LEYENDA

CV	Capa vegetal
QclR	Coluviones recientes: Bloques sueltos.
QclA	*Coluvión "Antiguo". Cantos y bloques de basalto, chert,* dentro de una matriz limo-arcilloso.
Qfl	Depósito de flujo. Cantos y bloques generalmente de basalto embebidos en una matriz arcillo-arenosa.
SR	Suelo residual.
RM	Roca meteorizada.
RFR	Roca algo alterada y fracturada.
RS	Roca inalterada y muy poco fracturada.
~~	Discordancia

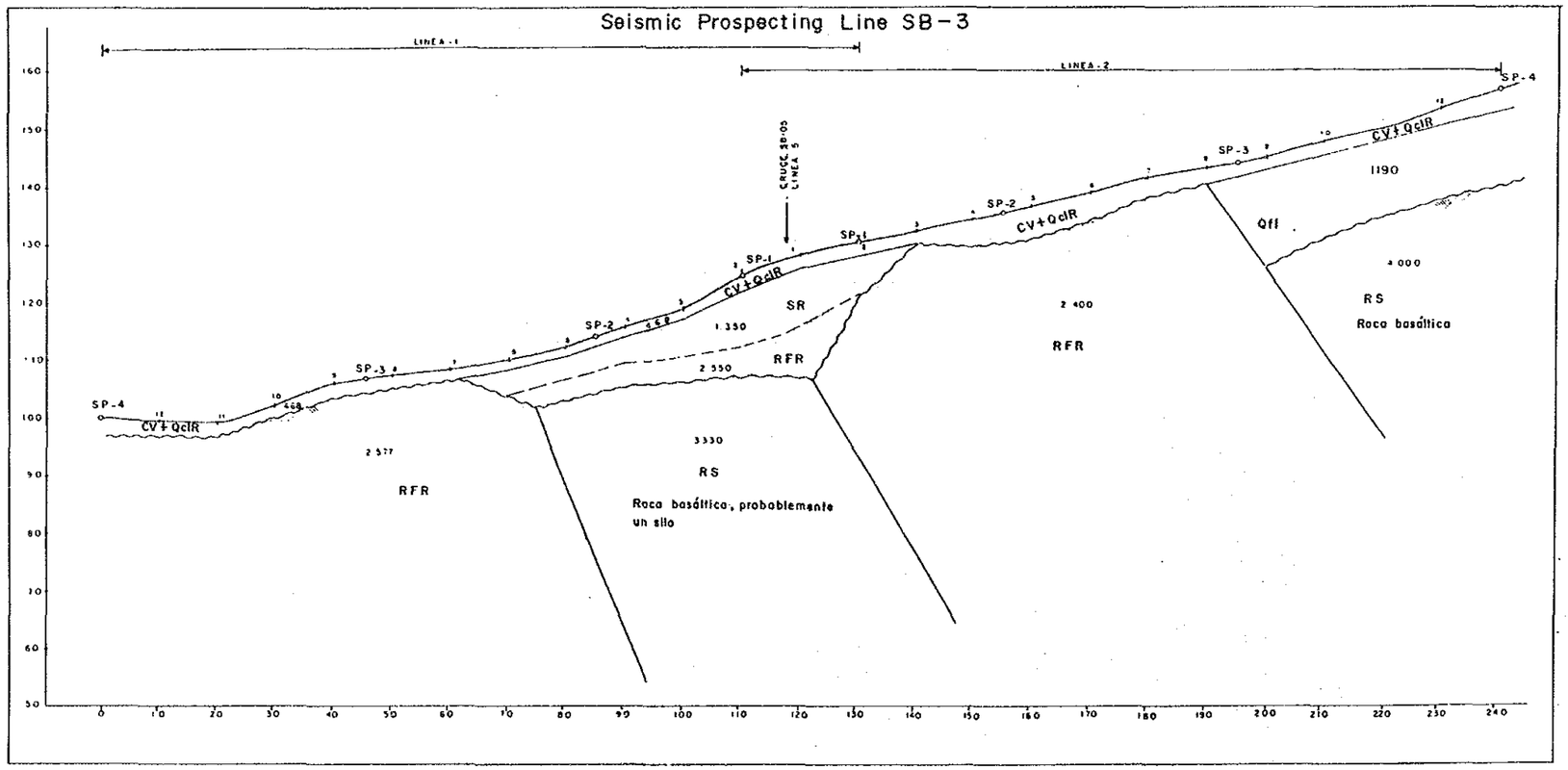
CONVENCIONES

SP-3	Punto de disparo
3	Localización de geófonos
	Contacto entre materiales calculado
	Contacto entre materiales deducido
	Roca
	Falla
	Discontinuidad
364	Velocidades (m/seg.)

Seismic Prospecting Line SB-2



Seismic Prospecting Line SB-3



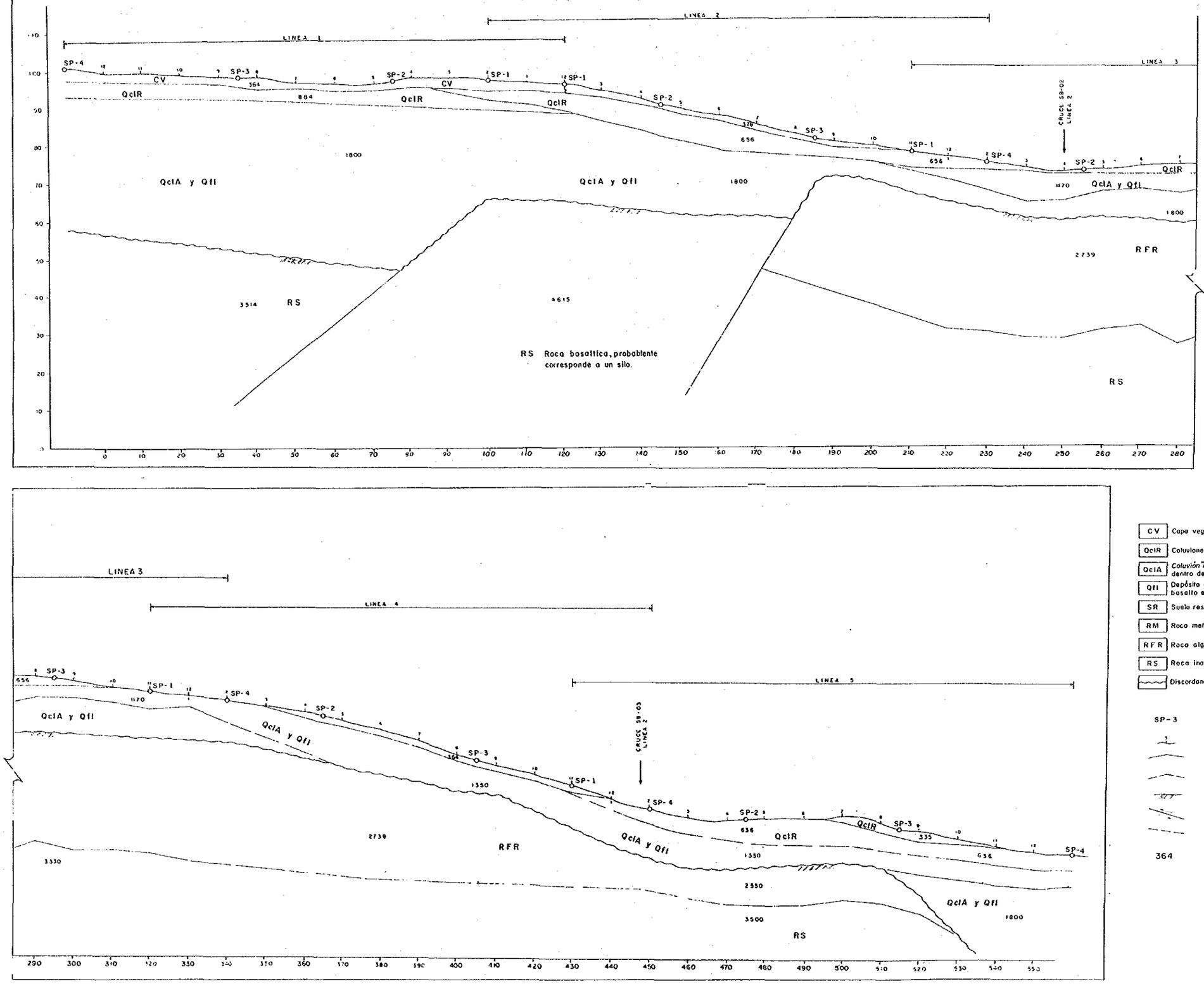
LEYENDA

- CV — Capa vegetal
- QclR — Coluviones recientes: Bloques sueltos.
- QclA — Coluvión "Antiguo". Cantos y bloques de basalto, chert, dentro de una matriz limo-arcillosa.
- Qfl — Depósito de flujo. Cantos y bloques generalmente de basalto embebidos en una matriz arcillo-arenosa.
- SR — Suelo residual.
- RM — Roca meteorizada.
- RFR — Roca algo alterada y fracturada.
- RS — Roca inalterada y muy poco fracturada.
- Discordancia

CONVENCIONES

- SP-3 — Punto de disparo
- Localización de geófonos
- Contacto entre materiales calculado
- Contacto entre materiales deducido
- Roca
- Falla
- Discontinuidad
- 364 — Velocidades (m/seg.)

Seismic Prospecting Line SB-5



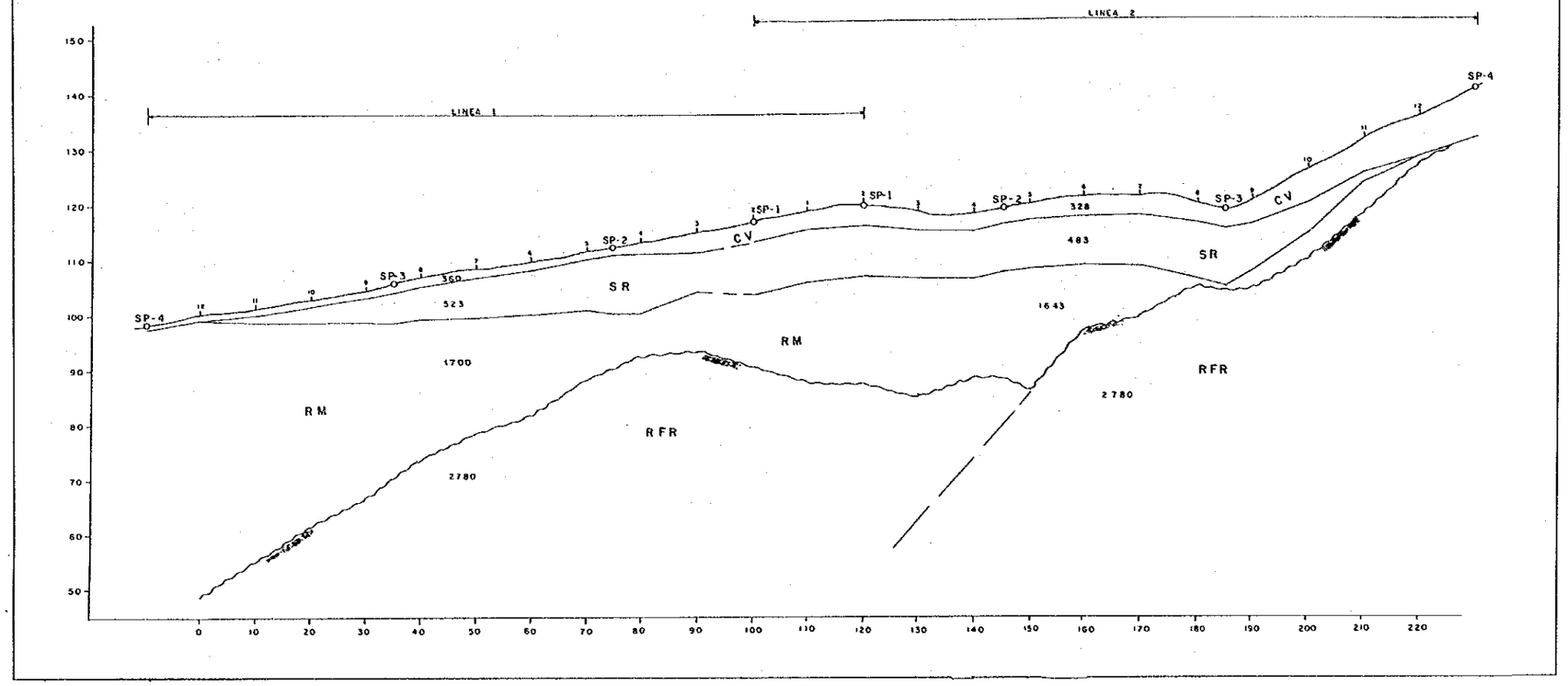
LEYENDA

CV	Capa vegetal
QclR	Coluviones recientes: Bloques sueltos.
QclA	*Coluvión "Antiguo". Cantos y bloques de basalto, chert,* dentro de una matriz limo-arcillosa.
Qfl	Depósito de flujo. Cantos y bloques generalmente de basalto embebidos en una matriz arcillo-arenoso.
SR	Suelo residual.
RM	Roca meteorizada.
RFR	Roca algo alterada y fracturada.
RS	Roca inalterada y muy poco fracturada.
	Discordancia

CONVENCIONES

SP-3	Punto de disparo
	Localización de geófonos
	Contacto entre materiales calculado
	Contacto entre materiales deducido
	Roca
	Falla
	Discontinuidad
364	Velocidades (m/seg.)

Seismic Prospecting Line SB-7



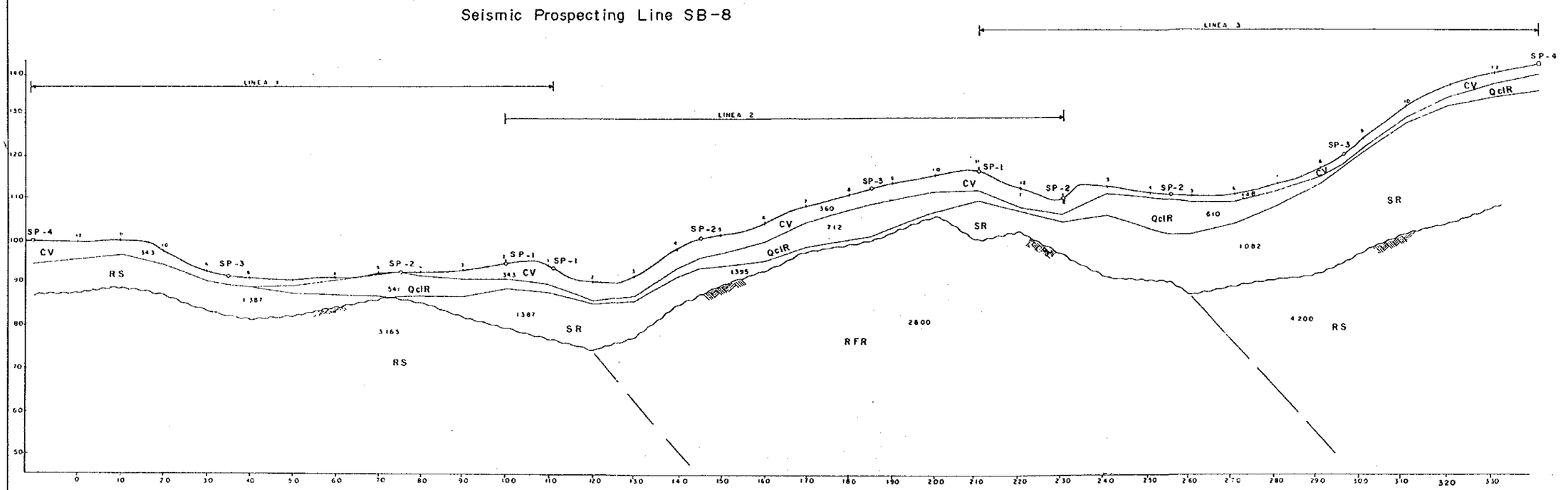
LEYENDA

CV	Capa vegetal
QclR	Coluviones recientes. Bloques sueltos.
QclA	Coluvión "Antiguo". Cantos y bloques de basalto, chert, dentro de una matriz limo-arcillosa.
Qfl	Depósito de flujo. Cantos y bloques generalmente de basalto embebidos en una matriz arcillo-arenoso
SR	Suelo residual.
RM	Roca meteorizada.
RFR	Roca algo alterada y fracturada.
RS	Roca inalterada y muy poco fracturada.
	Discordancia

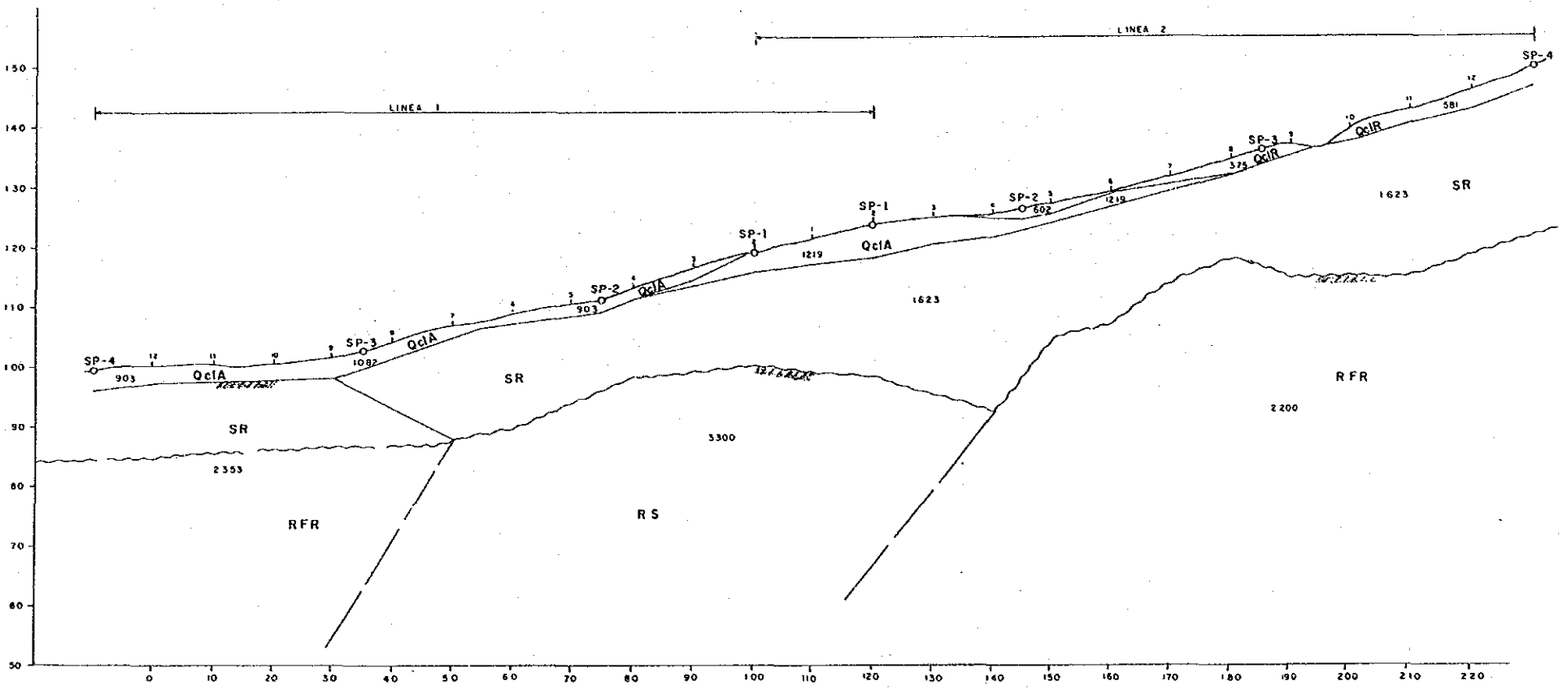
CONVENCIONES

SP-3	Punto de disparo
	Localización de geófonos
	Contacto entre materiales calculado
	Contacto entre materiales deducido
	Roca
	Falla
	Discontinuidad
364	Velocidades (m/seg.)

Seismic Prospecting Line SB-8



Seismic Prospecting SB-9



LEYENDA

CV	Capa vegetal
QclR	Coluviones recientes: Bloques sueltos.
QclA	Coluvión "Antiguo". Cantos y bloques de basalto, chert, dentro de una matriz limo-arcillosa.
Qfl	Depósito de flujo. Cantos y bloques generalmente de basalto embebidos en una matriz arcillo-arenoso.
SR	Suelo residual.
RM	Roca meteorizada.
RFR	Roca algo alterada y fracturada.
RS	Roca inalterada y muy poco fracturada.
	Discordancia

CONVENCIONES

SP-3	Punto de disparo
	Localización de geófonos
	Contacto entre materiales calculado
	Contacto entre materiales deducido
	Roca
	Falla
	Discontinuidad
364	Velocidades (m/seg.)

III-3 (2) Result of Vertical Electrical Sounding

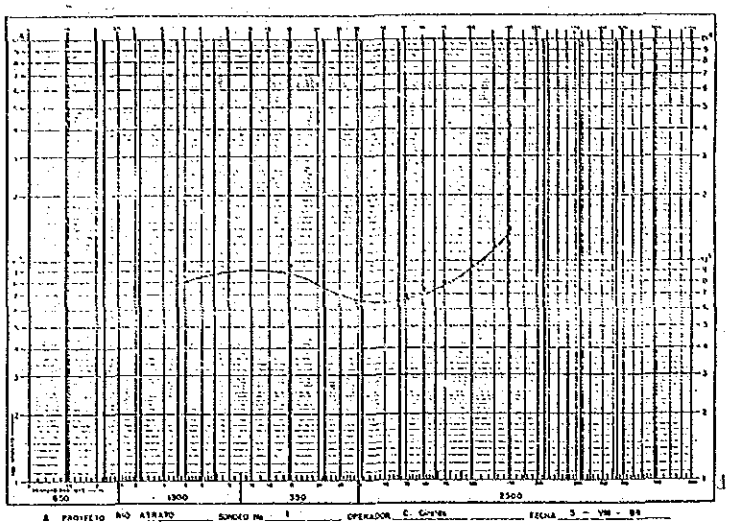
° Resistivity Layers in Project Area

° Sounding curves (S-1 - 8)

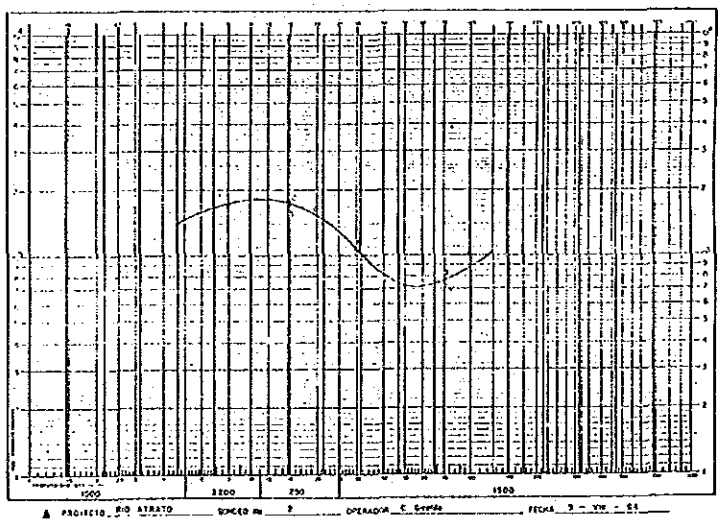
Resistivity Layers in Project Area (Vertical Electrical Sounding)

Location	Mesuring-Point	Resistivity (ohm·m) 1st layer	2nd layer	3rd layer	4th layer	Remarks
El Siete No.1 Penstock Site	S-4	110 (1)	860 (15)	19.5 (40)	3,000	Location of mesuring-points are shown in Dwg.-06.
	S-5	52 (5) / 70 (15)	200 (30)	22 (62)	200	
	S-6	240 (4)	600 (8)	24 (30)	180	
El Siete No.2 Penstock Site	S-1	650 (2.5)	1,300 (9)	350 (30)	2,500	
	S-2	1,500 (5)	3,200 (11)	250 (25)	1,500	
	S-3	640 (4.5)	1,400 (7.5)	185 (28)	3,000	

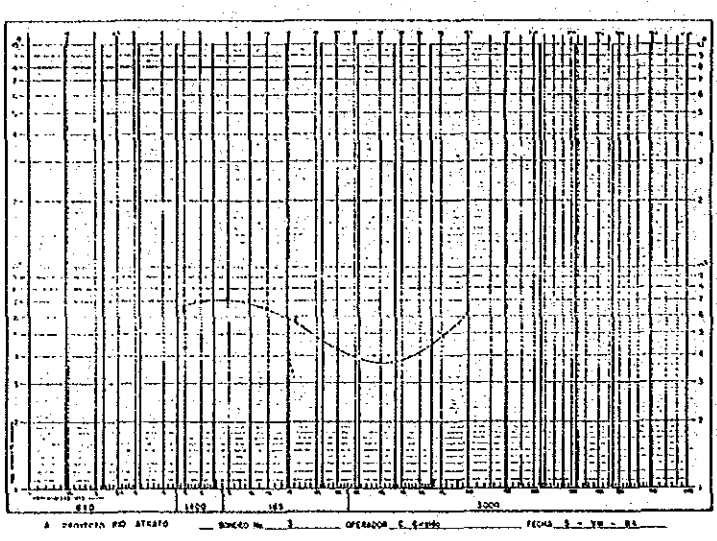
NOTE : ( ) shows depth of resistivity boundary in meter.



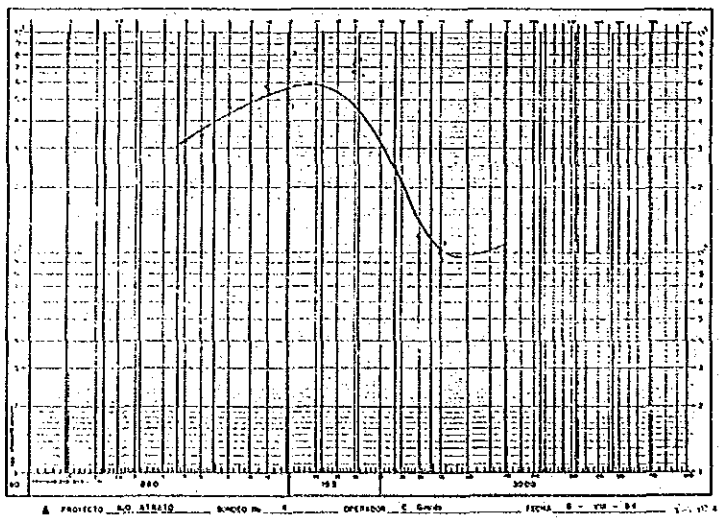
Sounding Curve S–1



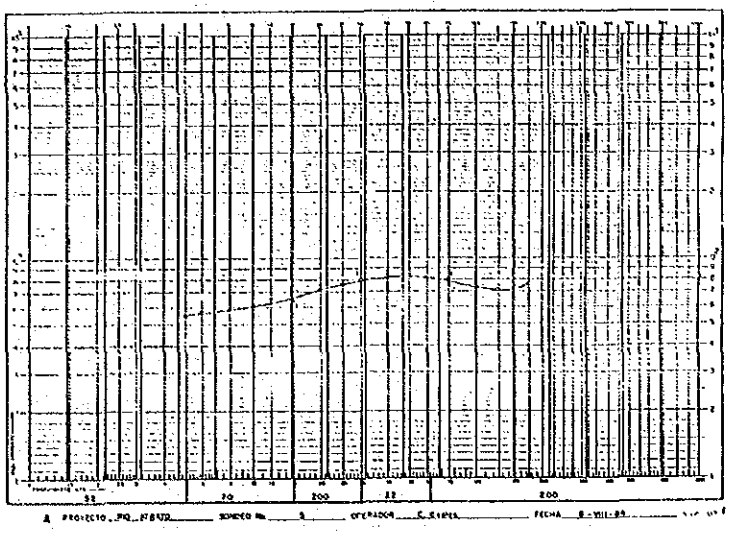
Sounding Curve S–2



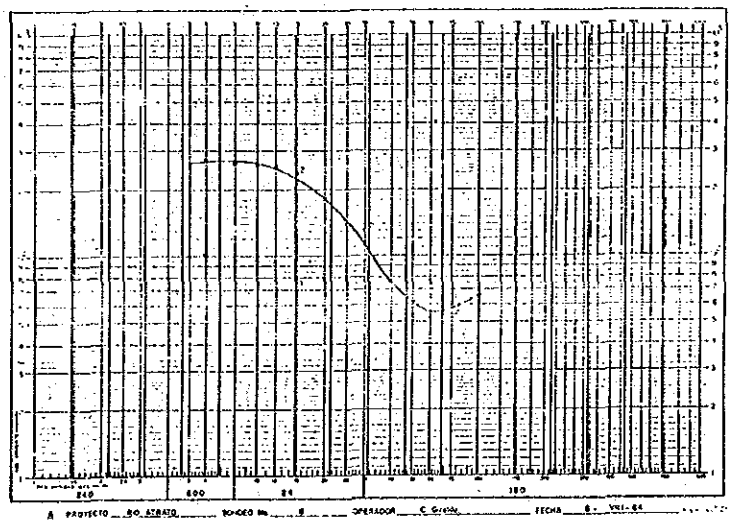
Sounding Curve S–3



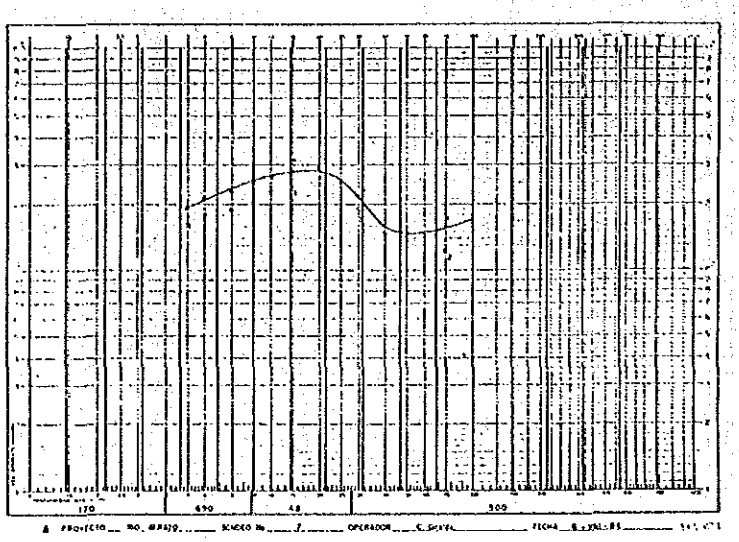
Sounding Curve S–4



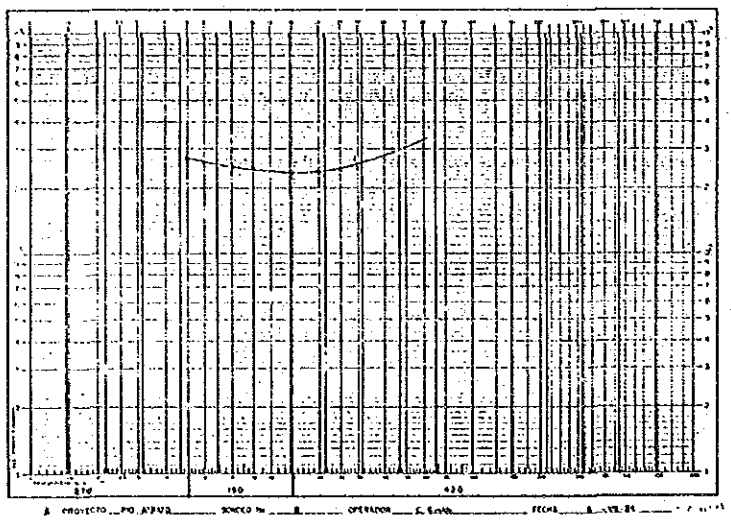
Sounding Curve S–5



Sounding Curve S–6



Sounding Curve S–7



Sounding Curve S–8

III-4 Result of Microscopic Observation

(Sample No. S-1 - S-5)

Microscopic Observation

Project; Atrato, Colombia

Locality; El Siete No.1 Penstock Route

Sample No.; S-1

Rock name; Altered, augite basalt

Texture; Volcanic rocks
Holocrystalline, granophyric structure.
Porphyritic texture, Intersertal texture.

	Name	Characteristcs
Rock forming mineral	Porphyritic phenocrysts:	
	Plagioclase:	Commonly, euhedral, 0.3 - 2.0 mm., in size; Labradorite in components.
	Augite:	Few, 0.1 - 1.0 mm
	In groundmass:	Intersertal texture.
	Plagioclase microlites:	Very aboundant, lath-crystals, 0.14 - 0.3 mm
	Augite microlite-granules:	Commonly, 0.02 - 0.08 mm, interstitual.
	2nd chlorite:	Few, interstituals, 0.06 - 0.16 mm
Description	This rock was determined by the texture, composited constituents and grain size, as the augite basalt.	
Degree of alteration	Chloritization weakly Pyritization weakly	

Macroscopic observation;

This rock is the greenish grey lighten colored, and altered basalt, with dark green pyroxene phenocrysts.

Microscopic Observation

Project; Atrato, Colombia

Locality; El Siete No.2 Waterway Route (Drilled core of BD-1, 54.3 m)

Sample No.; S-2

Rock name; Altered diabase

Texture; Volcanic rocks. granular
Holocrystalline, structure.
Intersertal texture.

	Name	Characteristcs
Rock forming mineral	In groundmass:	Intersertal texture
	Plagioclase:	Very aboundant, euhedral, twinning, 0.4 - 1.4 mm, in size, medium grained.
	Augite:	Commonly, 0.2 - 0.6 mm, altered partially with chlorite.
	2nd Chlorite:	Commonly, interstitual.
	Zeolite:	Commonly to few, sector-forming.
Description	This rock was determined by the texture, constituents, and grain-size (medium grained), as the altered diabase.	

Degree of alteration	Kaolonitization	weakly	Sericitization	weakly
	Albitization	strongly	Montmorillonitization	weakly
	Chloritization	strongly		
	Zeolitization	strongly		
	Carbonatization	weakly		
	Pyritization	weakly		

Macroscopic observation;

This rock is the bleaching whitish greenish grey colored, and altered diabase with dark green pyroxene phenocrysts.

Microscopic Observation

Project; Atrato, Colombia

Locality; El Siete No.2 Waterway Route

Sample No.; S-3

Rock name; Altered basalt or dolerite

Texture; Volcanic rocks.
Holocrystalline, Granular structure.
Subophitic texture.

	Name	Characteristcs
Rock forming mineral	In groundmass:	Subophitic texture.
	Constituents:	
	Plagioclase:	Aboundant, euhedral, twinnings, An_{54} labradorite in components 0.14 - 0.4 mm, in size.
	Actinolite - tremolite:	Aboundant, interstitual, pale greenish, Z ∧ C in extinction is 14°, 0.1 - 0.2 mm, reforming by uralitization from augite.
	Iron opaque granules:	Few.
Description	This rock was determined by the texture, composed constituents and grainsize, as the basalt or fine grained dolerite.	
Degree of alteration	Albitization	Few
	Uralitization	Very strongly

Macroscopic observation;

This rock is the dark greenish grey colored and altered basalt, as showing in the hand specimen.

Microscopic Observation

Project; Atrato, Colombia

Locality; El Siete No.2 Powerhouse Site (Drilled core of CD-1, 11.7 m)

Sample No.; S-4

Rock name; Hornblende - plagioclase mylonite

Texture; Dynamic metamorphosed rocks.
Holocrystalline, crystallobalstic fabric, Cataclasitic fabric.
Granulated texture, and Laminated texture.

	Name	Characteristcs
Rock forming mineral	Chief constituents:	
	Plagioclase:	Very aboundant, 0.04 - 0.6 mm, in most, to 1.6 mm, in size, oriented to parallel in lamination, and affected strongly by granulation.
	Hornblende:	Very aboundant, 0.04 - 0.4 mm, in most, to 0.8 mm, in size, orientated to parallel in lamination.
Description	This rock was determined by the fabric, texture and constituents, as the hornblende - plagioclase mylonite.	

Degree of alteration	Albitization	weakly	Make albite stringers
	Chloritization	weakly	
	Carbonatization	moderately	Make calcite stringers.

Macroscopic observation;

This rock is the bleaching pale grey colored and altered and clastic rocks.

Microscopic Observation

Project; Atrato, Colombia

Locality; El Siete No.2 Penstock Site

Sample No.; S-5

Rock name; Altered, hornblende - biotite granodiorite

Texture; Plutonic rocks.
Holocrystalline, equigranular structure.
Medium grained, hypidiomorphic-granular texture.

	Name	Characteristcs
Rock forming mineral	Constituents:	
	Quartz:	Few, anhedral, 0.1 - 0.6 mm.
	Orthoclase:	Few, anhedral, 0.1 - 0.6 mm, in size, altered by kaolinitization.
	Plagioclase:	Aboundant, anhedral to subhedral, 0.3 - 2.0 mm, An_{37}, andesine in components.
	Hornblende:	Commonly, green type, subhedral, 0.8 - 2.4 mm.
	Biotite:	Commonly to Few, green type, fibrous, anhedral, pleochloism remarkably, altered and replacing with chlorite, 0.8 - 2.4 mm, in size.
Description	This rock was determined by the plagioclase occupying near 2/3 in cover degree, hornblende and biotite, as the hornblende - biotite granodiorite.	

Degree of alteration	Albitization	weakly
	Chloritization	moderately
	Kaolinitization	moderately
	Sericitization	weakly
	Pylitization	weakly

Macroscopic observation;

This rock is the hornblende - biotite granodiorite, that consists of chiefly whitish grey colored plagioclase and mafic minerals of hornblende and biotite.

III-5 Construction Material

(1) Result of X-ray Diffraction Analysis and Polarized Microscopic Observation for Quarry Site.

(2) List of Pit for Concreate Aggregate

(3) List of Trench for Earth Material

(4) Gradation of Concrete Aggregate

(5) Result of Soil Test

III-5 (1) Result of X-ray Diffraction Analysis and Polarized Microscopic Observation for Quarry Site

Numbers and localities of specimens

Q-1, Q-2, Q-3

Quarry site on opposite bank of Quebrada Dos Quebrodas (Appendix-10.6).

Above noted three specimens were examined by thin section and polarized microscope method and X-ray diffraction method, with the following results.

(1) Q-1: Dark green coarse-grained augite meta-basalt

This rocks was originally coarse-grained augite basalt or augite dolerite chiefly composed of plagioclase (0.4 x 0.8 mm in average size), augite (0.3 - 3.0 mm in diameter) and magnetite. Plagioclase crystals were completely replaced by albite with minor amounts of epidote and chlorite. Augite crystals are generally very fresh but partly are replaced by chlorite and epidote. No expandable clay but only pale green chlorite is found.

(2) Q-2: Dark green fine grained augite meta-basalt

Original rock was a typical augite basalt mainly composed of augite phenocrysts (0.2 - 0.9 mm in diameter), plagioclase phenocrysts (size range of 0.3 x 1.0 - 0.7 x 1.4 mm), fine-grained groundmass of augite, plagioclase and magnetite with many gas pores or druses. By diagenetic hydrothermal alteration, however, plagioclases forming phenocrysts and groundmass have been completely replaced by albite, prehnite and minor amounts of sericite and all druses have been perfectly filled by prehnite, chlorite and pumpellyite. Augite phenocrysts are relatively fresh and well preserved. X-ray diffraction data obtained from clay minerals forming this rock specimen indicate that no expandable clay was formed.

(3) Q-3: Dark green medium-grained augite meta-basalt

Phenocrysts are augite of 0.7 x 1.2 mm in average diameter and plagioclase of 0.5 x 1.7 mm in average diameter. The groundmass was mainly composed of plagioclase (0.2 x 0.4 mm), augite (0.2 x 0.3 mm) and magnetite. Augite forming phenocrysts as well as groundmass are

not altered. Phenocryst and groundmass plagioclases, however, have been completely altered into albite with minor amounts of sericitic mineral. The volcanic glass of groundmass was also completely replaced by chlorite. Although most of irregular shaped or round shaped gas pores and druses in original basalt have been filled by secondary minerals such as chlorite and calcite, relatively large round shaped gas pores of 0.2 - 2.0 mm in diameter are still well observed. These pores are not believed to be connected with each other.

III-5 (2) List of Pit for Concreate Aggregate

Pit Name	Location	Elevation (m)	Coordinate	Depth (m)	Gradation analysis
AFb-1	Quebrada la Borrasca	-	-	1.5	O
AFb-1A	Ditto	-	-	1.5	-
AFb-2	Ditto	-	-	0.55	-
AFb-2A	Ditto	-	-	0.55	-
AFb-2B	Ditto	-	-	0.55	O
AFb-2C	Ditto	-	-	1.70	-
AFb-3	Ditto	-	-	0.60	-
AFb-5	Ditto	-	-	2.30	O
AFb-6	Ditto	-	-	2.20	O
AFb-7	Ditto	-	-	0.60	O
TFb-4*	Ditto	-	-	6.20**	-
	Total: 10 pits 12.05 m, 1 trench 6.20 m				
AFs-12	Puente de Sanchez Right Bank	-	-	2.00	-
AFs-13	Ditto	-	-	2.00	O
AFs-14	Ditto	-	-	2.00	O
AFs-15	Ditto	-	-	2.00	O
	Total: 4 pits 8.00 m				

* Trench ** Length in meter

III-5 (3) List of Trench for Earth Materials

Trench Name	Location	Elevation (m)	Coordinate	Direction	Length (m)	Gradation analysis	Test		
							Moisture-Density Relation	Liquid Limit	Plastic Limit
TFs-1	Terraza de Sanchez			N85°E	17.08	O	O	O	O
TFs-2	Ditto	-	-	N65°E	7.3	O	-	O	O
TFs-3	Ditto	-	-	N80°W	20.7	O	O	O	O
TFs-4	Ditto	-	-	N65°E	4.4	O	O	O	O
TFs-5	Ditto	-	-	N55°E	7.8	O	O	O	O
TFs-6	Ditto	-	-	N85°W	15.32	O	O	O	O
TFs-7	Ditto	-	-	N75°E	18.20	O	O	O	O
TFs-8	Ditto	-	-	N45°E	16.80	O	O	O	O
TFs-9	Ditto	-	-	N85°W	17.30	O	O	O	O
TFs-10	Ditto	-	-	N25°E	3.40	O	-	O	O
TFs-11	Ditto	-	-	N55°E	16.95	O	O	O	O
	Total: 11 trenches				145.25 m				

III-5 (4) Gradation of Concrete Aggregate

Sampling Spot	Trench or Pit Name	Coarse Aggregae (%)				Fine Aggregate (%)							Gradation (%)	
		76.2 - 38.1mm	38.1 - 19.0mm	19.0 - 9.51mm	9.51 - 4.76mm	4.76 - 2.38mm	2.38 - 1.19mm	1.19 - 0.595mm	0.595 - 0.297mm	0.297 - 0.149mm	0.149 - 0.074mm	<0.074 = mm	76.2 - 4.76mm	<4.76 = mm
	AFs-13	21	19	32	27	34	18	11	16	11	5	5	62	38
	AFs-14	23	25	26	26	31	15	10	13	15	5	10	61	39
	AFs-15	25	31	26	18	20	20	13	13	10	5	18	61	39
	AFb-1	25	29	24	22	20	20	14	12	8	6	18	51	49
	AFb-2B	33	26	21	20	53	26	5	5	0	0	11	81	19
	AFb-5	24	34	28	14	19	19	19	19	12	2	10	58	42
	AFb-6	8	31	29	31	24	23	18	16	6	3	10	38	62
	AFb-7	12	21	33	33	40	28	14	7	2	2	7	57	43

III-5 (5) Results of Soil Tests

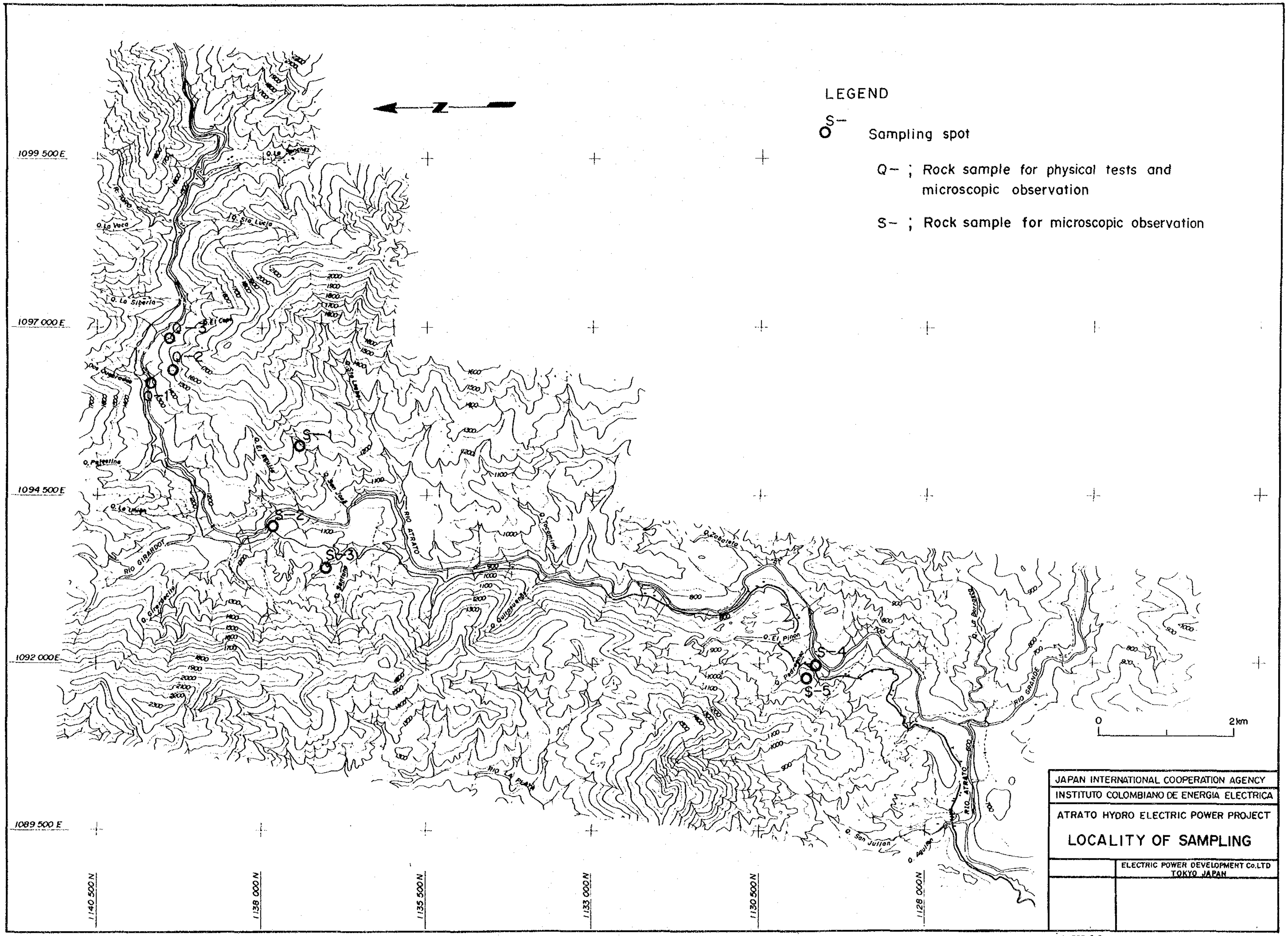
Borrow Area	Trench or Pit Name	Soil Classification Unified System	Water Content as received (%)	*1 Specific Gravity	Atterberg Limits LL (%)	PL (%)	PI	Gradation (Passing) (3") (%)	(2-1/2") (%)	(2") (%)	-38.1mm (1-1/2") (%)	-19.0mm (3/4") (%)	-4.75mm (No.4) (%)	-2.38mm (No.8) (%)	-0.595mm (No.30) (%)	-0.075mm (No.200) (%)	Compaction Optimum Water Content (%)	Maximum Dry Density (t/m^3)	Remarks
	TFs-1	GC	-	2.76	32	23	9		100	93	88	78	54	44	32	18	15.8	2.03	*2
	TFs-3	GM	-	2.67	48	31	17		100	85	85	75	56	49	38	25	20.2	1.72	*2
	TFs-4	GC	-	2.73	34	24	10			100	94	76	53	45	33	22	13.3	2.04	*2
	TFs-5	GM	32	-	-	-	-		100	91	88	72	53	44	32	19	23.5	1.59	*2
	TFs-6	GM	23	2.76	51	35	16			100	87	76	57	49	40	30	19.0	1.68	*2
	TFs-7	GM	30.2	2.74	50	36	14	100	88	85	81	65	50	44	36	25	26.7	1.53	*2
	TFs-7	GM	29.7	2.74	50	36	14	100	88	85	81	65	50	44	36	25	25.4	1.55	*2
	TFs-8	GM	26.7	2.72	37	29	8			100	92	83	67	60	52	36	25.0	1.60	*2
	TFs-8	GM	26.1	2.72	37	29	8			100	92	83	67	60	52	36	20.0	1.67	*3
	TFs-9	GM-GC	15.2	2.70	29	24	5			100	96	81	48	37	25	17	15.2	1.85	*2
	TFs-9	GM-GC	15.3	2.70	29	24	5			100	96	81	48	37	25	17	14.3	1.92	*3
	TFs-11	GM-GC	16.1	2.70	30	23	7		100	89	87	82	60	53	44	35	15.3	1.78	*2
	TFs-11	GM-GC	16.3	2.70	30	23	7		100	89	87	82	60	53	44	35	14.8	1.81	*3

*1 Specific Gravity of Soil passing No.4 sieve.

*2 The Moisture-Density Relations of Soils using a 5.5-lb Rammer and a 12-in. Drop (A 10.1 cm mold: soil material passing No.4 Sieve).

*3 The Moisture-Density Relations of Soils using a 10-lb Rammer and a 18-in. Drop (A 15.2 cm mold: soil material passing No.4 sieve).

III-6 Locality of Sampling


LEGEND
Sampling spot
Q- ; Rock sample for physical tests and microscopic observation
S- ; Rock sample for microscopic observation
N
1099 500 E
1097 000 E
1094 500 E
1092 000 E
1089 500 E
1140 500 N
1138 000 N
1135 500 N
1133 000 N
1130 500 N
1128 000 N
Q-1
Q-2
Q-3
S-1
S-2
S-3
S-4
S-5
RIO ATRATO
RIO GIRARDOT
RIO GRANDE
RIO LA PLATA
Q. La Vaca
Q. La Siberia
Q. Sta Lucia
Q. Palestina
Q. El Pinon
Q. Zabaleta
Q. San Julian
0
2km

JAPAN INTERNATIONAL COOPERATION AGENCY

INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA

ATRATO HYDRO ELECTRIC POWER PROJECT

LOCALITY OF SAMPLING

ELECTRIC POWER DEVELOPMENT Co.LTD
TOKYO JAPAN

APPENDIX-IV STUDY OF DEVELOPMENT PLAN

IV-1 KW and KWh Value to be Applied to Atrato Hydro Power Project

1. Alternative Standard Thermal Power Plant

(1) Termocartagena 300 MW x 1 Unit
(except for 230 KV transmission lines and transforming facilities)

(2) Construction cost (Prices in 1981)

Power plant	249,000,000 US$
Coal conveyer	9,800,000 US$
Land reclamation	1,050,000 US$
Total	259,850,000 US$

(3) Revised construction cost due to the price escalation

Foreign currency:

$$259,850,000 \times 0.8 \times 3.77/3.47 = 225,852,000 \text{ US\$}$$

Local currency:

$$259,850,000 \times 0.2 \times 21.51/13.33 \times 59.07/114.17 = 43,389,000 \text{ US\$}$$

Total 269,241,000 US$ at the end of 1984

Therefore, the unit construction cost in KW: 897.5 US$/KW

2. kW Value

$$\text{kW Value} = \frac{\text{Fixed cost of standard thermal Power Plant}}{\text{(Installed capacity of S.T.P.P.)} \times \text{(1-Station service ratio)} \times \text{(1-Outage ratio)} \times \text{(1-Scheduled outage ratio)}} \Big/ \text{(1-Transmission line loss factor)} + \text{Power transmission cost per kW}$$

$$= \frac{(33,385+1,615)\times 10^3}{(300,000)\times(1-0.04)\times(1-0.05)\times(1-0.10)\times(1-0.04)} + 6.6$$

Where: Discount rate(s) : 12% per year

Serviceable life : 30 years

Outage ratio : 5%

Scheduled outage ratio: 10%

O & M costs : 3% (without fuel costs)

Power transmission cost per kW

(220 kV, 2 cct, 86.4 km from Cartagena to Sabanalargu via ternera):

160 x 103 US$/km x 86.4 km x 0.144 x 1/300,000 kW

≈ 6.6 US$/kW

3. kWh

$$\text{kWh Value} = \frac{\text{Variable cost of standard thermal power plant (Annual energy production of S.T.P.P.)}}{\text{x(1-Sation service ratio)x(1-Transmission line loss factor)}}$$

$$= \frac{(30,873+6,462)\times 10}{(1,840 \times 10^6)\times(1-0.06)\times 1-0.03)}$$

≈ 22.3 US mils/kWh
(18.4 US mils/kWh in case of exception to O & M cost of 6,462,000 US$)

Where: Coal price at Termocartagena: 47.0 US$/ton

(Cerrejon mine mouth's price: 30.0 US$/ton

Calorific value of coal : 6,900 kcal/kg

Thermal efficiency of the power plants qt: 35%

Heat rate : 0.357 kg/kWh

Plant factor : 70%

Annual energy production : 1,840 GWh.

IV-2 Monthly Inflow at El Siete No. 1 Dam (CA = 256.3 km^2)

Unit: m^3/s-d

Year / Month	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total	Average
Jan	594.87	819.78	733.18	415.27	724.53	583.33	665.07	390.26	442.38	391.00	535.76	410.72	592.27	315.64	674.67	8288.73	552.58
Feb	454.00	412.41	629.98	462.70	780.58	675.64	462.64	308.91	326.75	262.28	436.88	332.16	558.38	270.58	543.69	6917.58	461.17
Mar	759.66	634.69	552.70	723.15	694.12	627.48	523.19	314.96	413.79	388.84	367.89	467.29	512.06	454.96	547.64	7982.42	532.16
Apr	920.32	904.98	935.79	927.48	702.47	790.58	616.93	350.06	1264.71	568.26	451.26	554.60	679.65	745.61	497.72	10910.42	727.36
May	736.94	1147.05	1163.20	788.46	635.67	746.39	643.03	657.65	1044.40	732.12	778.30	603.86	708.20	738.13	598.88	11722.28	781.48
Jun	786.68	960.65	1135.38	695.65	715.67	817.09	862.88	649.02	655.72	956.10	821.18	868.84	672.24	663.83	826.81	12087.74	805.84
Jul	433.08	857.72	806.58	671.68	908.32	1028.58	604.29	615.38	542.68	750.26	575.94	572.89	614.89	840.73	910.31	10733.33	715.55
Aug	700.97	957.88	949.94	760.92	927.02	1003.98	371.65	742.06	390.15	642.52	636.52	500.67	541.27	911.94	701.27	10738.76	715.91
Sep	947.18	1156.04	1032.92	949.46	786.90	815.99	313.26	496.34	536.49	730.34	396.67	509.74	523.78	829.45	874.98	10899.54	726.63
Oct	1274.53	999.85	1274.06	843.29	766.67	850.73	606.35	879.08	750.79	915.81	574.64	597.33	554.38	831.94	1007.56	12727.01	848.46
Nov	682.33	1126.07	1185.34	830.23	714.00	776.88	758.68	846.70	868.18	901.02	573.44	868.67	508.29	733.73	1338.63	12712.19	847.47
Dec	601.83	899.45	553.68	818.27	531.81	1041.97	539.98	623.55	690.92	691.17	594.06	755.58	407.21	693.17	736.55	10179.20	678.61
Total	8892.39	10876.57	10952.75	8886.56	8887.76	9758.64	6967.95	6873.97	7926.96	7929.72	6742.54	7042.35	6872.62	8029.71	9258.71	125899.20	8393.28
Average	741.03	906.38	912.73	740.55	740.65	813.22	580.66	572.83	660.58	660.81	161.88	586.86	572.72	669.14	771.56	10491.60	699.44

IV-3 Monthly Available Discharge for Power at El Siete No. 1 Power Station

Unit: m^3/s-d

Year / Month	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total	Average
Jan	530.76	665.56	674.07	414.92	632.05	542.30	601.43	390.03	441.94	390.74	534.65	410.34	562.86	315.56	642.88	7750.09	516.67
Feb	453.17	411.95	591.72	447.89	625.26	599.92	430.35	308.81	326.61	262.23	436.27	331.95	540.34	270.53	514.36	6551.36	436.76
Mar	565.07	573.46	551.12	654.81	642.64	598.76	522.05	314.87	397.27	388.55	367.70	466.58	511.17	453.98	529.02	7532.05	502.14
Apr	680.37	642.50	668.19	702.90	623.98	672.63	561.33	349.82	580.57	491.49	425.52	507.87	608.58	659.45	478.16	8653.36	576.89
May	643.11	697.72	720.18	701.98	621.85	693.81	589.44	607.77	737.21	650.36	642.23	570.50	662.78	691.62	567.92	9798.48	653.23
Jun	612.70	705.81	688.27	629.66	652.11	674.03	666.11	601.83	608.43	709.68	675.63	622.01	611.95	606.86	691.28	9756.36	650.42
Jul	432.51	650.60	673.60	631.49	674.17	704.45	570.80	595.67	529.87	667.65	525.64	559.61	600.64	680.55	744.02	9241.27	616.08
Aug	618.56	714.24	723.67	660.24	651.16	724.70	371.38	652.68	389.87	593.65	621.75	499.74	519.98	698.23	667.20	9107.05	616.08
Sep	639.22	659.46	685.76	702.51	677.79	703.36	313.09	484.37	500.39	656.85	396.36	492.54	487.98	682.76	684.97	8767.41	607.14
Oct	664.70	720.11	665.00	714.76	677.75	733.68	577.28	726.01	648.66	643.52	572.97	543.46	553.01	708.74	616.97	9766.62	584.49
Nov	616.52	671.46	660.97	695.06	651.84	689.50	624.14	709.71	666.81	732.28	571.73	706.73	495.09	668.59	611.74	9772.17	651.48
Dec	586.08	717.41	552.30	657.59	496.80	711.00	526.67	603.36	620.38	651.48	592.22	683.43	406.92	658.53	644.33	9118.50	607.90
Total	7042.77	7830.28	7854.85	7613.81	7627.40	8048.14	6354.07	6344.93	6448.01	6838.48	6362.67	6394.76	6561.30	7105.40	7392.85	105819.72	7054.64
Average	586.90	652.52	654.57	634.48	635.62	670.68	529.51	528.74	537.33	569.87	530.22	532.90	546.78	592.12	616.07	8818.31	587.89

IV-4 Monthly Firm Discharge for Power at El Siete No. 1 Power Station

Unit: $m^3/s-d$

Year / Month	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total	Average
Jan	377.46	381.30	381.30	370.13	381.30	381.29	381.30	373.95	380.38	364.48	381.30	370.96	380.30	315.64	381.30	5602.39	373.49
Feb	342.87	344.18	356.70	331.69	344.40	344.40	356.70	307.75	321.34	262.28	356.70	320.47	344.40	270.87	356.70	4961.45	330.76
Mar	381.30	379.07	381.30	381.30	381.30	381.30	380.31	311.51	356.24	358.88	355.98	377.64	381.30	365.87	381.30	5554.60	370.31
Apr	369.00	369.00	369.00	369.00	369.00	369.00	369.00	321.17	369.00	367.39	357.55	367.62	369.00	369.00	368.16	5471.89	364.79
May	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	5719.50	381.30
Jun	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	5535.00	369.00
Jul	371.41	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	381.30	380.83	381.30	381.30	5709.14	380.61
Aug	381.30	381.30	381.30	381.30	381.30	381.30	345.32	381.30	363.32	381.30	381.30	380.85	377.34	381.30	381.30	5661.13	377.41
Sep	369.00	369.00	369.00	369.00	369.00	369.00	297.06	369.00	368.70	369.00	355.08	369.00	366.81	369.00	369.00	5446.65	363.11
Oct	381.30	381.30	381.30	381.30	381.30	381.30	379.25	381.30	381.30	381.30	381.30	380.85	381.30	381.30	381.30	5717.00	381.13
Nov	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	369.00	368.81	369.00	369.00	5534.81	368.99
Dec	381.30	381.30	381.30	381.30	380.20	381.30	381.30	381.30	381.30	381.30	381.30	381.30	375.52	381.30	381.30	5712.62	380.84
Total	4474.24	4487.05	4501.8	4465.62	4488.40	4489.49	4390.84	4327.88	4422.18	4366.53	4451.11	4449.29	4475.91	4334.88	4500.96	66625.89	4441.72
Average	372.85	373.92	375.15	372.14	374.03	374.12	365.9	360.66	368.52	363.88	370.93	370.77	372.99	361.22	375.08	5552.16	370.14

IV-5 Monthly Inflow at El Siete No. 2 Intake Dam (CA = 41.6 km^2)

Unit: m^3/s-d

Year / Month	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total	Average
Jan	96.54	133.06	118.99	67.39	117.60	94.66	107.92	63.35	71.80	63.44	86.93	66.66	96.14	51.20	109.50	1345.18	89.67
Feb	73.69	66.95	102.26	75.11	126.69	109.66	75.11	50.08	53.02	42.60	70.93	53.91	90.63	43.92	88.23	1122.79	74.85
Mar	123.31	103.03	89.72	117.36	112.66	101.85	84.92	51.13	67.14	63.08	59.70	75.82	83.09	73.86	88.88	1295.55	86.37
Apr	149.33	146.88	151.89	150.54	114.00	128.33	100.15	56.79	205.27	92.23	73.25	90.02	110.30	121.01	80,78	1770.77	118.05
May	119.63	186.14	188.79	127.99	103.17	121.15	104.35	106.75	169.53	118.84	126.33	98.01	114.95	119.81	97.19	1902.63	126.84
Jun	127.70	155.92	184.27	112.91	116.16	132.63	140.04	105.31	106.43	155.23	133.30	141.02	109.12	107.75	134.22	1962.01	130.80
Jul	70.27	139.24	130.90	109.03	147.44	166.95	98.07	99.87	88.06	121.77	93.47	92.99	99.79	136.44	147.79	1742.08	116.13
Aug	113.78	155.48	154.17	123.52	150.46	162.95	60.30	120.44	63.31	104.27	103.31	81.23	87.85	147.98	113.83	1742.88	116.19
Sep	153.75	187.60	167.63	154.09	127.71	132.44	50.84	80.58	87.07	118.57	64.38	82.71	85.01	134.61	142.03	1769.02	117.93
Oct	206.83	162.28	206.79	136.88	124.46	138.09	98.42	142.71	121.87	148.62	93.28	96.93	89.96	135.04	163.53	2065.69	137.71
Nov	110.73	182.78	192.39	134.74	115.87	126.11	123.17	137.45	140.91	146.25	93.06	141.02	82.50	119.07	217.25	2063.30	137.55
Dec	97.66	146.00	89.83	132.78	86.31	169.13	87.65	101.19	112.14	112.17	96.43	122.64	66.05	112.47	119.56	1652.01	110.13
Total	1443.22	1765.36	1777.63	1442.34	1442.53	1583.95	1130.94	1115.65	1286.55	1287.07	1094.37	1142.96	1115.39	1303.16	1502.79	20433.91	1362.26
Average	120.27	147.11	148.14	120.20	120.21	132.00	94.25	92.97	107.21	107.26	91.20	95.25	92.95	108.86	125.23	1702.83	113.52

Note: Above inflow represents the inflow from remaining catchment area of No.1 Dam.

IV-6 Monthly Available Discharge for Power at El Siete No. 2 Power Station

Unit: m^3/s-d

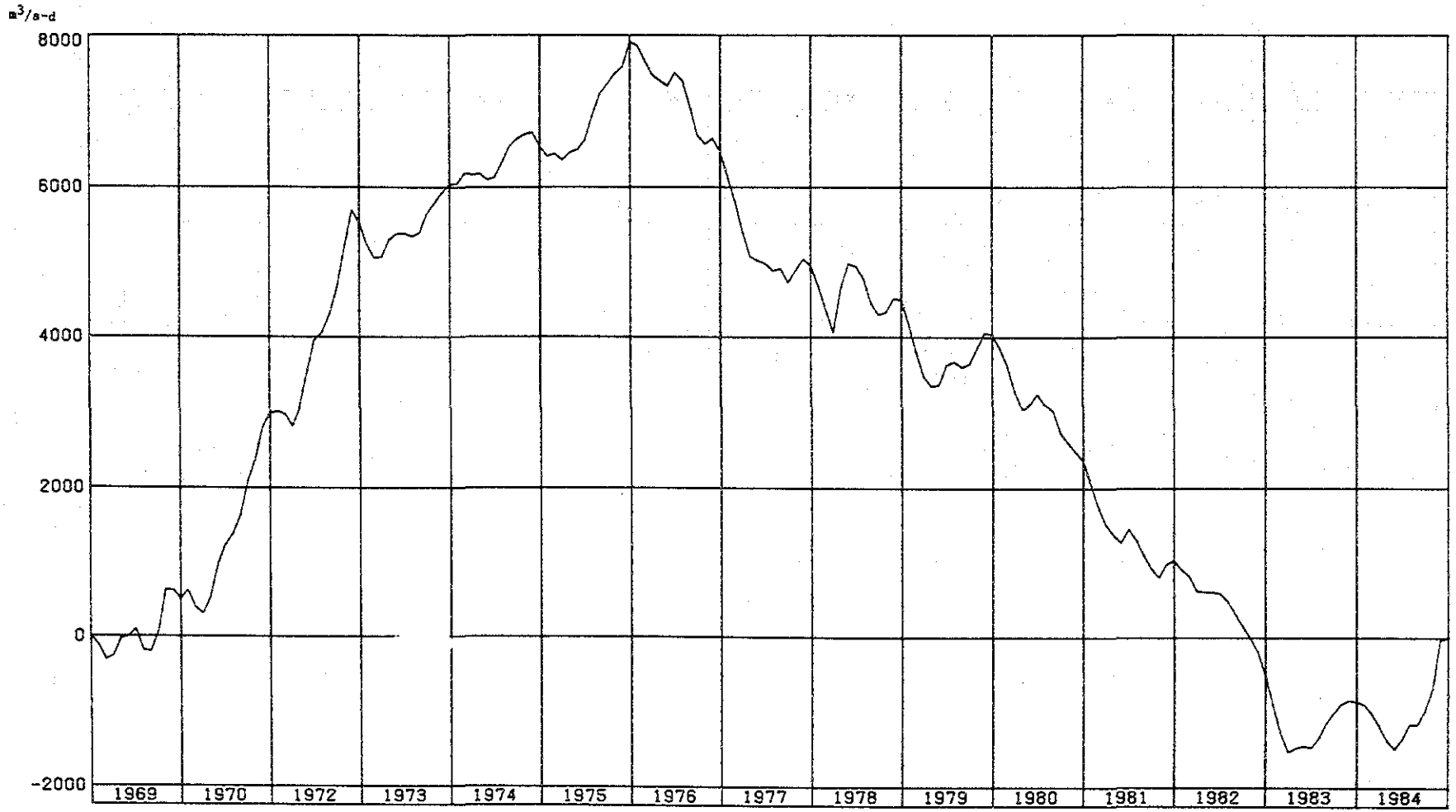
Year / Month	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total	Average
Jan	612.36	757.62	766.34	482.31	721.20	627.18	690.84	453.38	513.69	454.18	620.26	476.57	646.37	366.76	735.47	8924.53	594.97
Feb	525.86	478.90	673.71	518.90	709.26	683.70	500.07	358.89	379.63	304.83	506.38	385.48	622.22	314.45	595.26	7557.54	503.84
Mar	650.37	657.22	635.24	747.53	733.71	687.64	604.69	366.00	461.37	451.63	427.40	541.16	593.54	523.84	612.62	8693.96	579.60
Apr	770.37	730.73	758.11	792.90	711.93	762.63	644.89	406.61	670.57	568.88	493.34	586.34	695.42	749.23	554.98	9896.93	659.79
May	735.23	790.72	813.18	794.98	714.34	786.81	680.73	694.68	830.21	742.82	734.33	658.83	755.78	784.62	655.80	11173.06	744.87
Jun	699.44	795.81	778.27	719.18	741.45	764.03	756.11	691.57	696.52	799.68	765.63	711.65	698.97	695.47	781.28	11095.06	739.67
Jul	501.69	743.22	766.42	720.93	767.17	797.45	656.37	684.93	614.90	760.08	610.11	645.91	688.01	773.47	837.02	10567.68	704.51
Aug	708.41	807.24	816.67	751.33	742.37	817.70	431.30	743.99	452.88	684.71	713.16	579.61	599.83	791.23	760.10	10400.53	693.37
Sep	728.20	749.46	775.76	792.51	767.79	793.36	363.72	561.99	578.15	746.85	460.74	571.10	562.77	772.76	774.80	9999.96	666.66
Oct	757.70	813.11	758.00	807.70	770.75	826.68	665.56	819.01	741.66	736.46	660.93	625.52	639.96	801.74	709.28	11134.06	742.27
Nov	706.52	761.46	750.97	785.06	741.84	779.50	713.45	799.71	756.16	822.28	660.31	796.73	572.66	758.59	701.74	11106.98	740.46
Dec	673.12	810.41	638.89	749.82	573.21	804.00	611.94	694.33	710.81	744.01	683.57	776.43	472.97	761.53	734.14	10439.18	695.94
Total	8069.27	8895.90	8931.56	8663.15	8695.02	9130.68	7319.67	7275.09	7406.55	7816.41	7336.16	7355.33	7548.50	8093.69	8452.49	120989.47	8065.96
Average	672.44	741.33	744.30	721.93	724.59	760.89	609.97	606.26	617.21	651.37	611.35	612.94	629.04	674.47	704.37	10082.46	672.16

IV-7 Monthly Firm Discharge for Power at El Siete No.2 Power Station

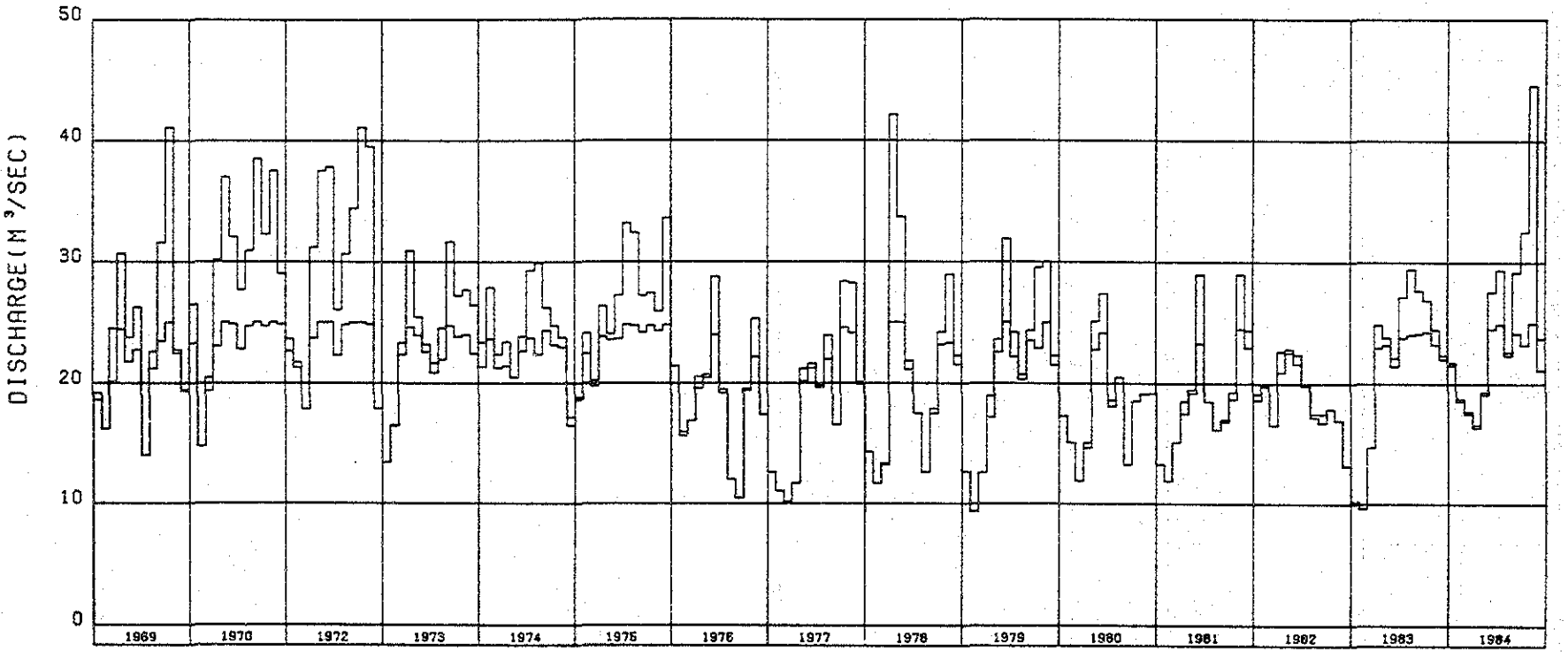
Unit: $m^3/s-d$

Year / Month	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total	Average
Jan	438.72	443.18	443.18	430.20	443.18	443.17	443.18	434.64	442.12	423.64	443.18	431.17	442.02	366.87	443.18	6511.63	434.10
Feb	398.52	400.04	414.59	385.52	400.30	400.30	414.59	357.70	373.49	304.85	414.59	372.48	400.30	314.50	414.59	5766.36	384.42
Mar	443.18	440.59	443.18	443.18	443.18	443.18	442.03	362.07	414.06	417.13	413.76	438.93	443.18	425.25	443.18	6456.08	430.40
Apr	428.89	428.89	428.89	428.89	428.89	428.89	428.89	373.30	428.89	427.02	415.58	427.28	428.89	428.89	427.91	6359.99	423.99
May	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	6647.70	443.18
Jun	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	6433.35	428.89
Jul	431.69	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	443.18	442.64	443.18	443.18	6635.67	442.37
Aug	443.18	443.18	443.18	443.18	443.18	443.18	401.37	443.18	422.29	443.18	443.18	442.66	438.58	443.18	443.18	6579.88	438.65
Sep	428.89	428.89	428.89	428.89	428.89	428.89	345.27	428.89	428.54	428.89	412.71	428.89	426.34	428.89	428.89	6330.65	422.04
Oct	443.18	443.18	443.18	443.18	443.18	443.18	440.80	443.18	443.18	443.18	443.18	442.66	443.18	443.18	443.18	6644.80	442.98
Nov	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.89	428.67	428.89	428.89	6433.13	428.87
Dec	443.18	443.18	443.18	443.18	441.91	443.18	443.18	443.18	443.18	443.18	443.18	443.18	436.47	443.18	443.18	6639.72	442.64
Total	5200.39	5215.27	5232.41	5190.36	5216.85	5218.11	5103.45	5030.28	5139.89	5075.21	5173.50	5171.39	5202.34	5038.08	5231.43	77438.96	5162.59
Average	433.37	434.61	436.03	432.53	434.74	434.84	425.29	419.19	428.32	422.93	431.13	430.95	433.53	419.84	435.95	6453.25	430.22

IV-8 Mass Curve of El Siete No. 1 Dam

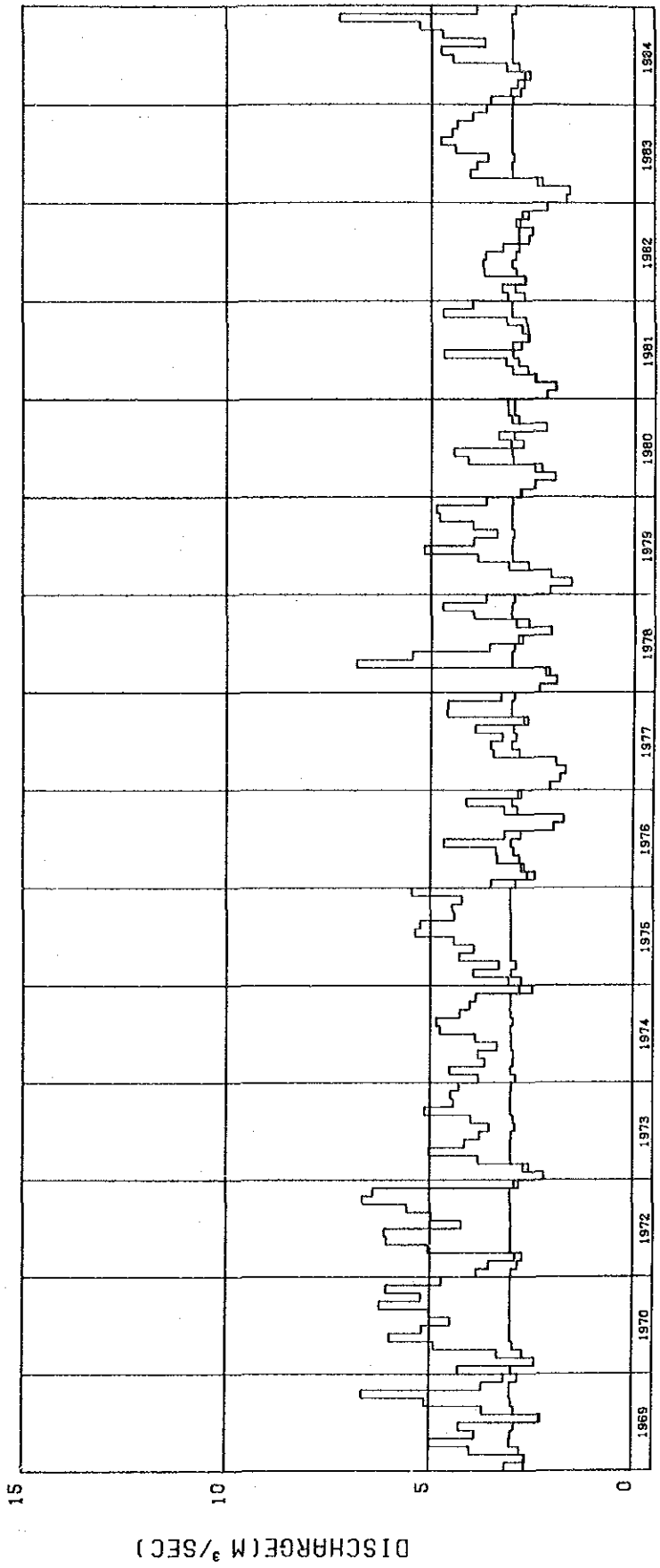


IV-9 Monthly Average Discharge at El Siete No. 1 Dam



A-IV-10

IV-10 Monthly Average Discharge at El Siete No. 2 Intake Dam



APPENDIX-V CONVERSION FACTORS BASED ON SHADOW PRICES

V-1 Calculation of Conversion Factors Based on the Shadow Prices

1. Civil Works

(1) Lobour Cost

	C.F	Cost ratio		Remarks
Urban unskilled labour	0.61	0.287	0.175	
Rural unskilled labour	0.46	0.287	0.132	
Semi and technical skilled	0.81	0.213	0.173	
Academically skilled	0.94	0.213	0.200	
Average (Total)	0.68	1.000	0.68	
(2) Materials				
Cement	0.83	0.808	0.671	
Steel bars	0.89	0.192	0.171	
Average (Total)	0.84	1.000	0.842	
(3) Fuel	3.00	1.000	3.000	
(4) Transportation	1.09	1.000	1.090	
(5) Administration and profit	1.00			Standard C.F
(6) Engineering & administration	1.00			Standard C.F

2. Electrical & Mechanical Equipment

(1) Labour cost

	C.F	Cost ratio		Remarks
Semi and technical skilled	0.81	0.560	0.454	
Academically skilled	0.94	0.440	0.414	
Average (Total)	0.87	1.000	0.868	
(2) Transportation	1.09	1.000	1.090	
(3) Installation materials	0.94	1.000	0.940	
(4) Engineering & administration	1.00			Standard C.F

3. Telecommunication Equipment

(1) Labour cost

	C.F	Cost ratio		Remarks
Semi and Technically skilled	0.81	1.000	0.810	
(2) Transpotation	1.09	1.000	1.090	

4. Transmission Lines

(1) Lahour cost

	C.F	Cost ratio		Remarks
Rural unskilled labour	0.46	0.250	0.115	
Semi and technically skilled	0.81	0.600	0.486	
Academically skilled	0.94	0.150	0.141	
Average (Total)	0.742	1.000	0.742	
(2) Transportation	1.09	1.000	1.090	
(3) Access road	0.87	1.000	0.870	
(4) Foundation concrete	0.83	1.000	0.830	
(5) Stringing facilities	0.94	1.000	0.940	

5. Operation and Maintenance Costs

			Financial cost
(1) Inport duties	(CIF x 0.2)		L.C206
(2) Local materials	0.94 1.000	0.940	L.C651
(3) Fuel	3.00 1.000	3.000	L.C109
(4) Labour cost	0.87 1.000	0.870	L.C1,411

Appendix V-2 Economic Costs Based on Conversion Factors

	Financial Cost			Economic Cost			Remarks
	F.C	L.C	Total	F.C	L.C	Total	
1. Civil Works							
(1) Civil Structure							
Labour cost	-	19,996	19,996	-	13,597	13,597	C.F: 0.68
Materials	-	65,765	65,765	-	55,243	55,243	C.F: 0.84
Construction machinery	21,786	-	21,786	21,786	-	21,786	
Fuel	-	2,323	2,323	-	6,969	6,969	C.F: 3.00
Admi. and profit	34,502	12,586	47,088	34,502	12,586	47,088	C.F: 1.00
	(56,288)	(100,670)	(156,958)	(56,288)	(88,395)	(144,683)	
Engineering & Admi.	5,629	10,067	15,696	5,629	10,067	15,696	C.F: 1.00
Sub-total	61,917	110,737	172,654	61,917	98,462	160,379	
(2) Hydraulic Equipment	13,645	-	13,645	13,645	-	13,645	
Import duties	-	2,481	2,481	-	0	0	
Transportation	-	1,240	1,240	-	1,352	1,352	C.F: 1.09
Labour cost	-	5,273	5,273	-	4,429	4,429	C.F: 0.84
Provisional installation	-	4,394	4,394	-	3,823	3,823	C.F: 0.87
Admi. and profit	-	4,188	4,188	-	4,188	4,188	C.F: 1.00
	(13,645)	(17,576)	(31,221)	(13,645)	(13,79)	(27,437)	
Engineering & admi.	1,501	999	2,500	1,501	999	2,500	C.F: 1.00
Sub-total	15,146	18,575	33,721	15,146	14,791	29,937	
Total	77,063	129,312	206,375	77,063	113,253	190,316	
2. E and M. Equipment	27,919	-	27,919	27,919	-	27,919	
Import duties	-	5,076	5,076	-	0	0	
Transportation	-	2,538	2,538	-	2,766	2,766	C.F: 1.09
Labour cost	-	1,626	1,626	-	1,416	1,415	C.F: 0.87
Installation materials	-	1,167	1,167	-	1,097	1,097	C.F: 0.94
	(27,919)	(10,407)	(38,326)	(27,919)	(5,278)	(33,197)	
Engineering & admi.	1,928	1,265	3,193	1,928	1,265	3,193	C.F: 1.00
Total	29,847	11,672	41,519	29,847	6,543	36,390	

	Financial Cost			Economic Cost			Remarks
	F.C	L.C	Total	F.C	L.C	Total	
3. Telecommunication Equip.	1,299	-	1,299	1,299	-	1,299	
Import duties	-	236	236	-	0	0	
Transportation	-	59	59	-	64	64	C.F: 1.09
Labour cost	-	23	23	-	17	17	C.F: 0.81
Total	1,299	318	1,617	1,299	81	1,380	
4. Transmission Line	9,199	-	9,199	9,199	-	9,199	
Import duties	-	1,768	1,768	-	0	0	
Transportation	-	442	442	-	482	482	C.F: 1.09
Access road	-	380	380	-	331	331	C.F: 0.87
Foundation concrete	-	925	925	-	768	768	C.F: 0.83
Stringing facilities	525	200	725	525	188	713	C.F: 0.94
Labour cost	-	3,432	3,424	-	2,534	24.534	C.F: 0.74
	(9,724)	(7,139)	(16,863)	(9,724)	(4,303)	(14,027)	
Engineering & admi.	778	571	1,349	778	571	1,349	C.F: 1.00
Total	10,502	7,710	18,212	10,502	4,874	15,376	
Grand Total	118,711	149,012	267,723	118,711	124,751	243,462