Rio Paquita Site:	3 samples
Rio Naranjo Site:	7 samples
Rio Canas Site:	1 sample
Damsite Adit No.1:	1 sample
Quebrada Azul Site:	2 samples
Los Alacranes Site:	1 sample

7.2.3 Sites

(1) Riverbed Deposits Site

(a) Location

As the riverbed deposits sites, ICE has conducted surveys at three sites, such as, the Rio Paquita, Rio Naranjo, and Rio Canas sites.

The Rio Paquita site is located at an elevation of about 40m, 1.7km downstream from the power station site of this project.

Distance in a straight line from the planned damsite is approximately 8km.

The Rio Naranjo site is located at a place where the Rio Naranjo has come out on a lowland along the coast almost completely, at an elevation of about 70m, far downstream from the planned damsite in this project.

Distance in a straight line from the Rio Naranjo site to the damsite is about 12km.

The Rio Canas is a tributary river which joins the Rio Paquita from the right bank side at a point about 10m above the sea level, approximately 3km before reaching the river-mouth. The Rio Canas site is located at a spot about 50m above the sea level where the Rio Canas has come out on a lowland along the coast almost completely; a place about 15km west of the damsite in a straight line.

(b) Field Investigations

As mentioned before, ICE has already collected samples at the three riverbed deposits sites and conducted laboratory tests. However, no field investigations have been realized

yet at any of the points to grasp their quantities of riverbed deposits as potential concrete aggregates.

(c) Laboratory Tests

Table 7-28 shows the outcome of measurements of soundness and abrasion conducted as laboratory tests on the samples already gathered by ICE from the riverbed deposits sites. The results of the said tests are as shown below.

Soundness is 32-53% at the Rio Paquita Site, 5-28% at the Rio Naranjo Site, and 22% at the Rio Canas Site.

Abrasion amounts to 22-30% at the Rio Paquita Site, 9-21% at the Rio Naranjo Site, and 21% at the Rio Canas Site.

(d) Assessments

Soundness at the Rio Naranjo Site may be considered good for the most part as many of the samples collected there show values less than 18%, while soundness at the other two sites, indicating high values, can not be satisfactory.

As for abrasion, all of the sites give values less than 50% and there seems to be no particular problems.

In this way, the laboratory tests have already been carried out for the three riverbed deposits sites, some of which seem to have no qualitative problems. However, at any of the sites no field investigations have been conducted yet to know their quantities of riverbed deposits as potential concrete aggregates. Since all of these three sites are located far from the damsite in addition to the above fact, it does not seem that they are ideal sites for the concrete aggregate for the Los Llanos dam, especially, from a view point of their transportation costs.

(2) Rock Quarry Site

(a) Location

ICE has conducted surveys at the three quarry sites for the concrete aggregates including a site around the damsite, Quebrada Azul, and Los Alacranes sites.

The site around the damsite is expected that the conglomerate occurring around the damsite can be used for a rock quarry. In a sense of its quality, Adit No.1 on the right bank of the damsite has proved to be able to use it as the concrete aggregates.

The Quebrada Azul site is situated at a point about 580m above the sea level, upstream of the Rio Naranjillo. Distance in a straight line from the damsite is approximately 3km.

The Los Alacranes site is located about 520m above the sea level near the riverhead of a tributary (the Quebrada Lagartija) which joins the Rio Naranjo from the right bank side at a spot some 290m above the sea level. Distance in a straight line from the damsite is approximately 4km.

(b) Field Investigations

As already mentioned, of the three rock quarry sites, the only site at which ICE has conducted field investigations is the Quebrada Azul site.

Particulars of the investigations are shown in Tables 7-26 and 7-27.

At this site, according to the results of drillhole and seismic prospecting, the deep part of surface deposits of maximum about 10m in thickness and several meters thick weathered layer shows a uniform distribution of fresh sandstone partly accompanied with conglomerate.

There are minor faults, of which sheared zone however is small.

(c) Laboratory Tests

Table 7-28 shows the outcome of measurements of soundness and abrasion at the rock quarry sites. The outline is as shown below.

Soundness is 23% at the damsite adit No.1, 7-8% at the Quebrada Azul site, and 57% at the Los Alacranes site.

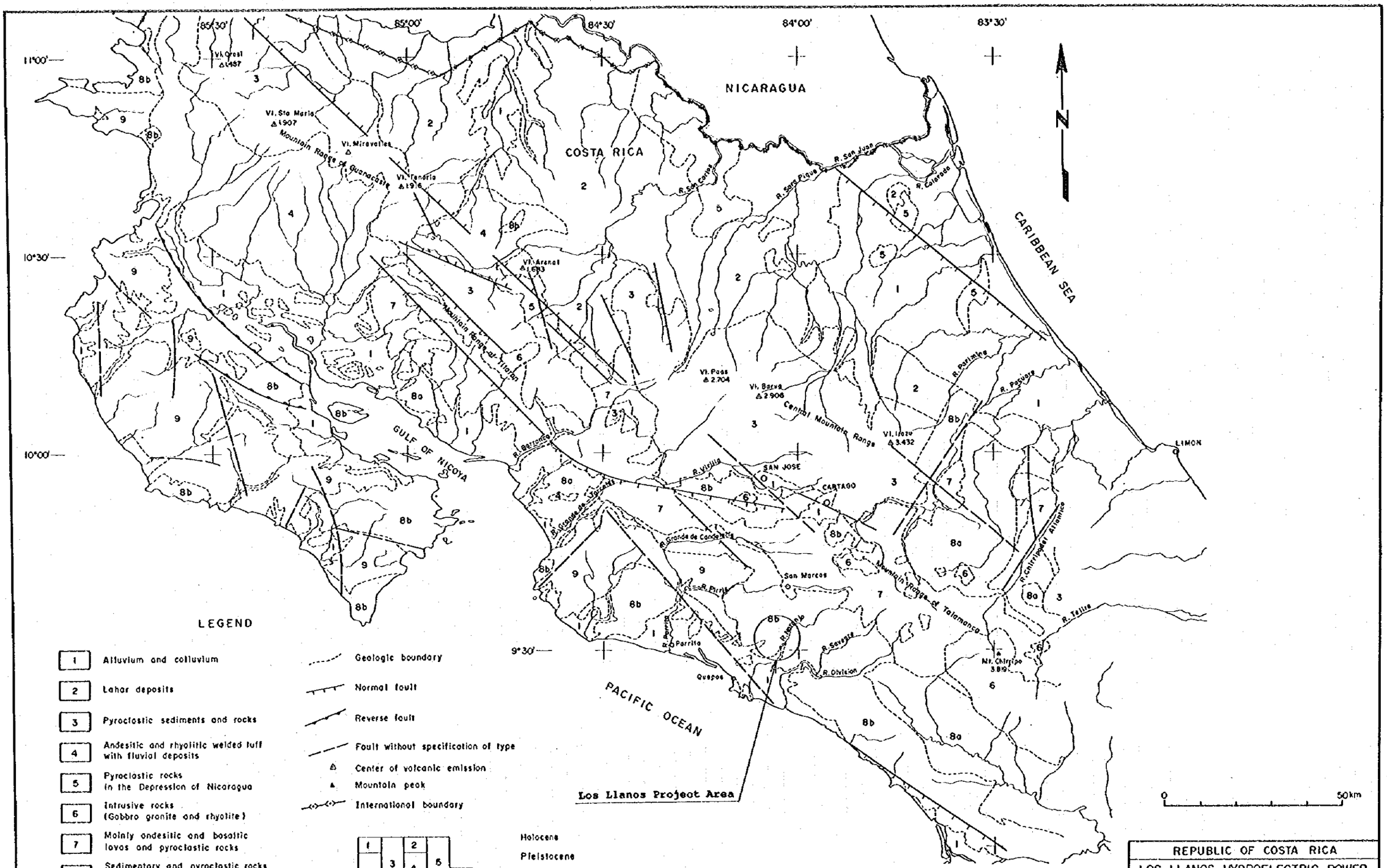
Abrasion amounts to 40% at the damsite adit No.1, 25-26% at the Quebrada Azul site, and 32% at the Los Alacranes site.

(d) Assessments

Soundness at the Quebrada Azul site alone may be considered good as it shows values less than 18%, while soundness at the other two sites, indicating high values, cannot be satisfactory.

As for abrasion, all of the sites give values less than 50% and there seems to be no particular problem.

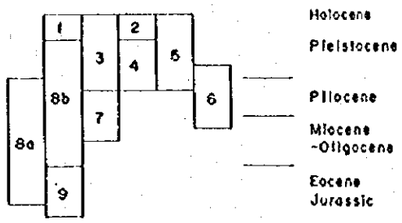
As mentioned above, the laboratory tests have been made for the three rock quarry sites and the Quebrada Azul site alone gives values which suggest that the site seems to have no qualitative problems. Considering geological and weathering conditions based on the outcome of field investigations conducted at this point, the site as a rock quarry is vested with a sufficient quantity of potential rocks for concrete aggregates (fresh sandstone in case of this site) for construction of the dam in this project. However, distance between this site and the damsite is somewhat too far, namely about 6km along the stream of the Rio Naranjillo. Consequently, it is desirable to have rock quarry sites somewhere closer to the damsite, such as, a site around the conjunction of Rio Naranjo and Rio Naranjillo.



LEGEND

1	Alluvium and colluvium
2	Lahar deposits
3	Pyroclastic sediments and rocks
4	Andesitic and rhyolitic welded tuff with fluvial deposits
5	Pyroclastic rocks in the Depression of Nicaragua
6	Intrusive rocks (Gabbro granite and rhyolite)
7	Mainly andesitic and basaltic lavas and pyroclastic rocks
8a	Sedimentary and pyroclastic rocks with limestone
8b	Sedimentary rocks (Limestone sandstone and claystone)
9	Peridotite and tholeiitic basalt intercalated with pelagic sedimentary rocks

- Geologic boundary
- Normal fault
- Reverse fault
- Fault without specification of type
- △ Center of volcanic emission
- ▲ Mountain peak
- International boundary



Column of stratigraphic correlation

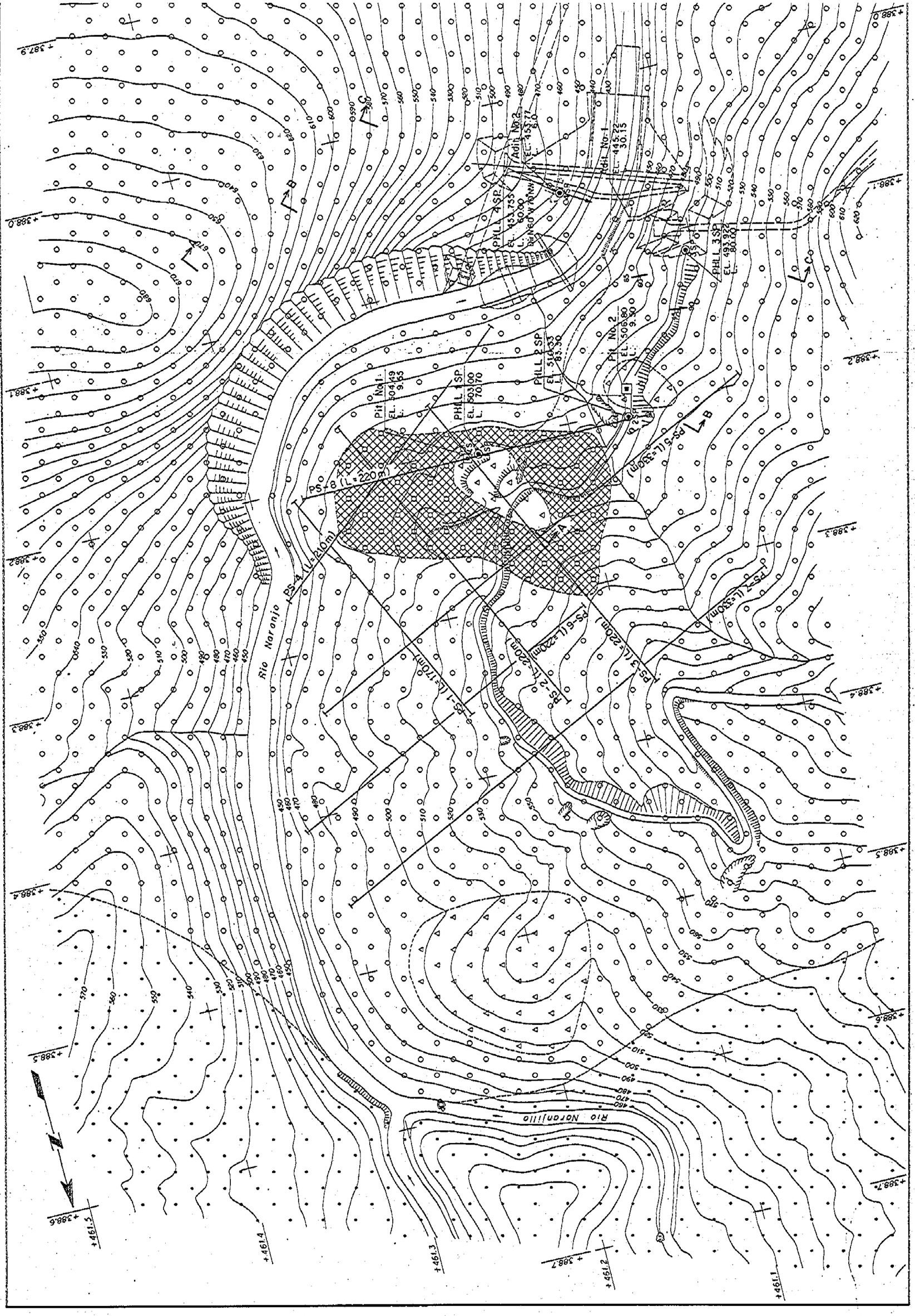
Note: This map is quoted from "INFORME FINAL MAPA GEOLOGICO DE COSTA RICA" by ICE in 1988.

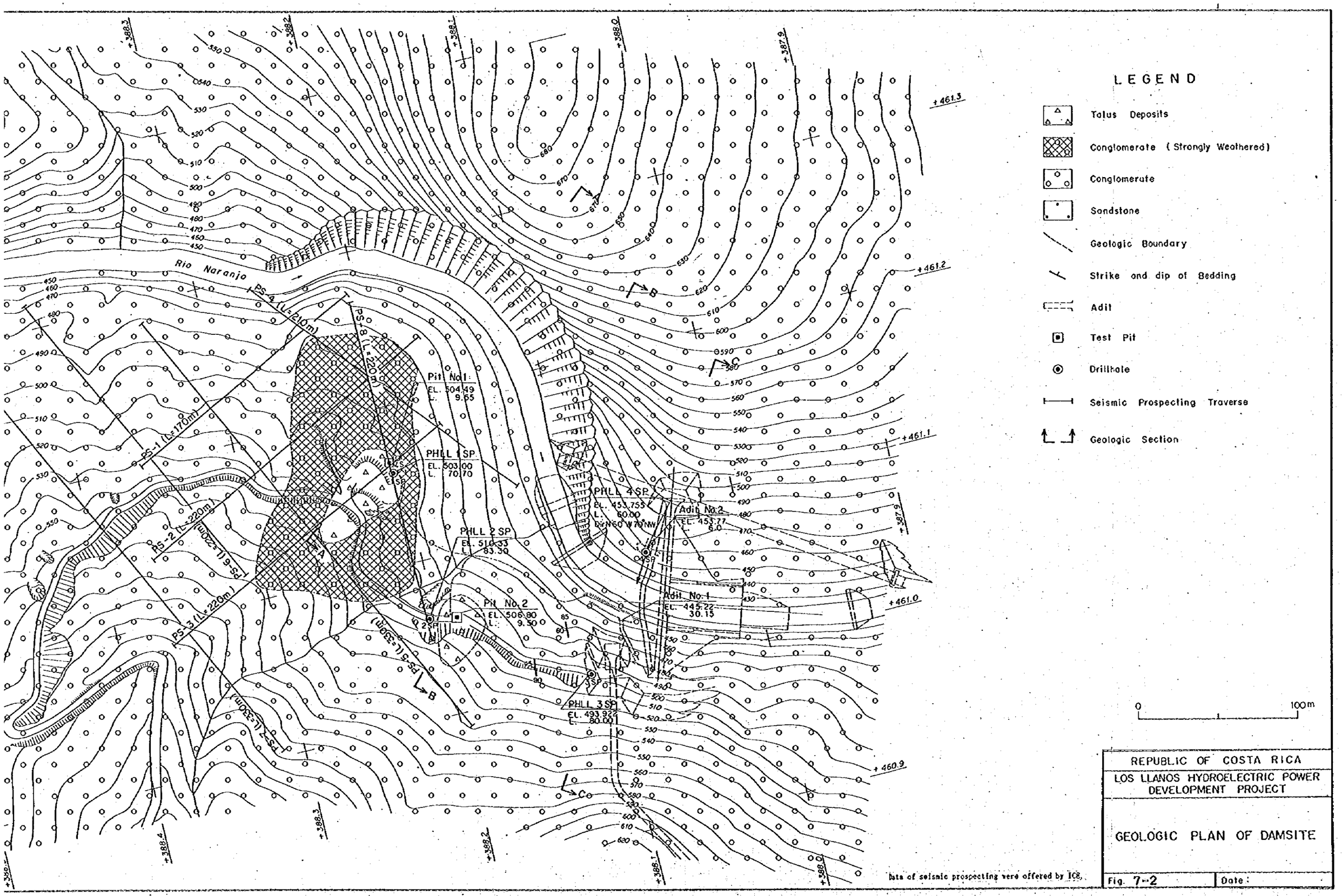
REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC MAP OF COSTA RICA

Fig. 7-1


Rio Naranjo
Rio Nornalillo
Pit No.1
EL. 504.49
L. 9.95
PHILL 1 SP
EL. 503.00
L. 70.70
PHILL 2 SP
EL. 510.33
L. 83.30
Pit No.2
EL. 506.80
L. 9.30
PHILL 3 SP
EL. 493.92
L. 80.30
PHILL 4 SP
EL. 453.75
L. 60.00
Adit No.2
EL. 455.77
L. 8.0
Adit No.1
EL. 445.22
30.15
PS-1 (L=170m)
PS-2 (L=220m)
PS-3 (L=220m)
PS-4 (L=210m)
PS-5 (L=330m)
PS-6 (L=220m)
PS-7 (L=330m)
PS-8 (L=220m)
A
B
C
+388.0
+388.1
+388.2
+388.3
+388.4
+388.5
+388.6
+388.7
+461.5
+461.4
+461.3
+461.2
+461.1



LEGEND

- Talus Deposits
- Conglomerate (Strongly Weathered)
- Conglomerate
- Sandstone
- Geologic Boundary
- Strike and dip of Bedding
- Adit
- Test Pit
- Drillhole
- Seismic Prospecting Traverse
- Geologic Section

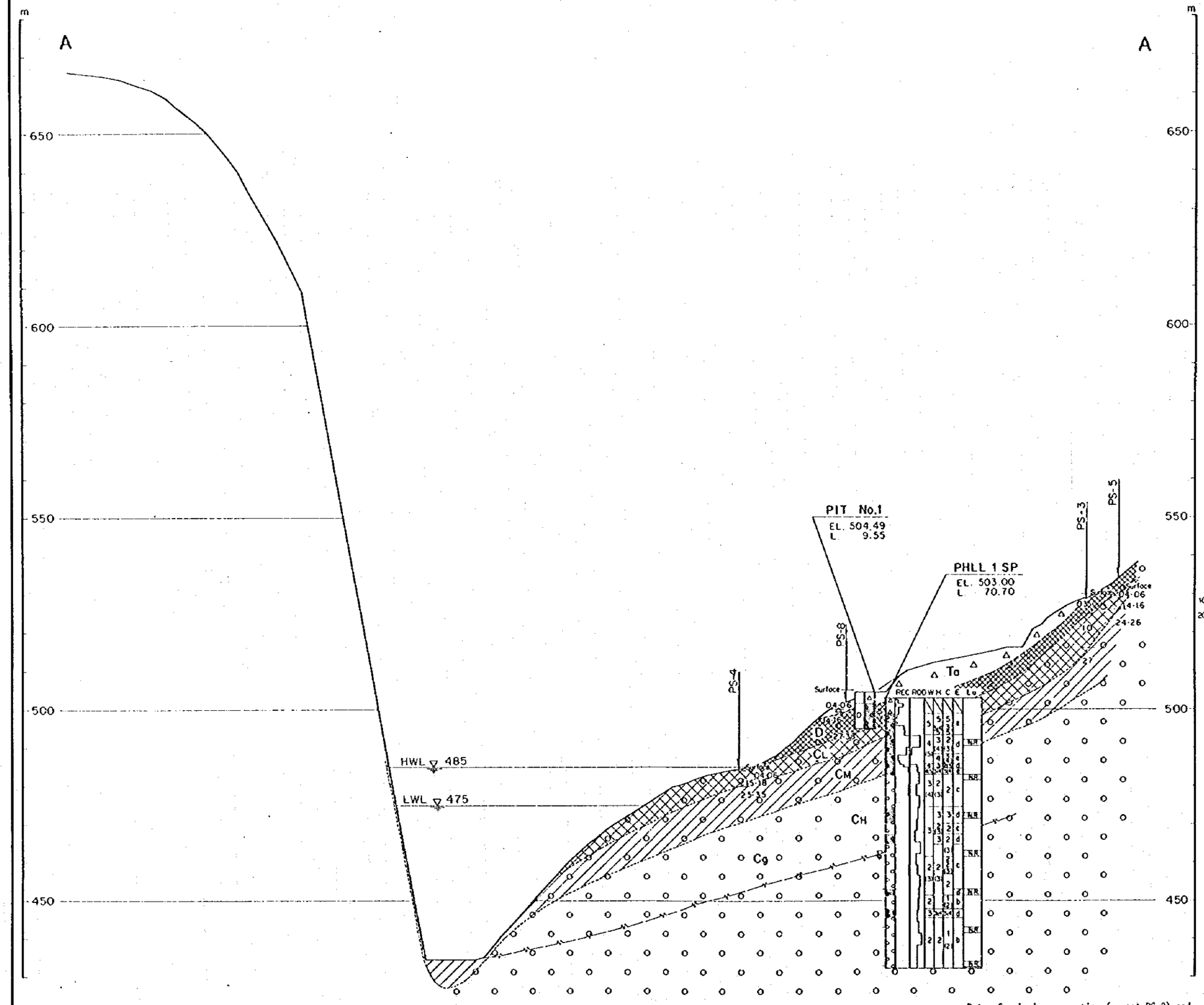
Data of seismic prospecting were offered by ICE.

REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC PLAN OF DAMSITE

Fig. 7-2 | Date :



LEGEND

- Talus Deposits (Ta)
- Conglomerate (Cg)
- Geologic boundary
- Boundary of rock mass classification
- Ground water level
- Pit No. / EL. / L — EL.: Elevation (m), L: Length (m)

(Seismic Velocity Distribution)

- Traverse Line Number
- 2.4 / 4.4 — Velocity (km/s) and boundary of velocity layer

(Rock Moss Classification)

- CH — Somewhat cracky but not loosened rocks
- CM — Somewhat cracky and slightly loosened rocks
- CL — Cracky and loosened rocks due to weathering and/or creeping
- D — Soft or brittle rocks due to weathering or shearing

(Drillhole Log)

PHLL
EL.
L
DIR.
REC RQD W H C E Lu

- Hole number
- Elevation of hole head (m)
- Length drilled (m)
- Direction and dip of inclined hole
- Result of Lugeon test
- Lu Value assumed from P-Q Curve
- Lu Value (l/min/m/under injection pressure ×10kgf/cm²)
- Test section
- Core evaluation
- Rock classification { W: Weathering, H: Hardness, C: Interval of cracks
- RQD (Rock Quality Designation)
- REC: Core Recovery
- Geologic log
- Depth (m)
- Cracky cores
- a, b, c, d, e — Core Evaluation (See core classification and Evaluation)

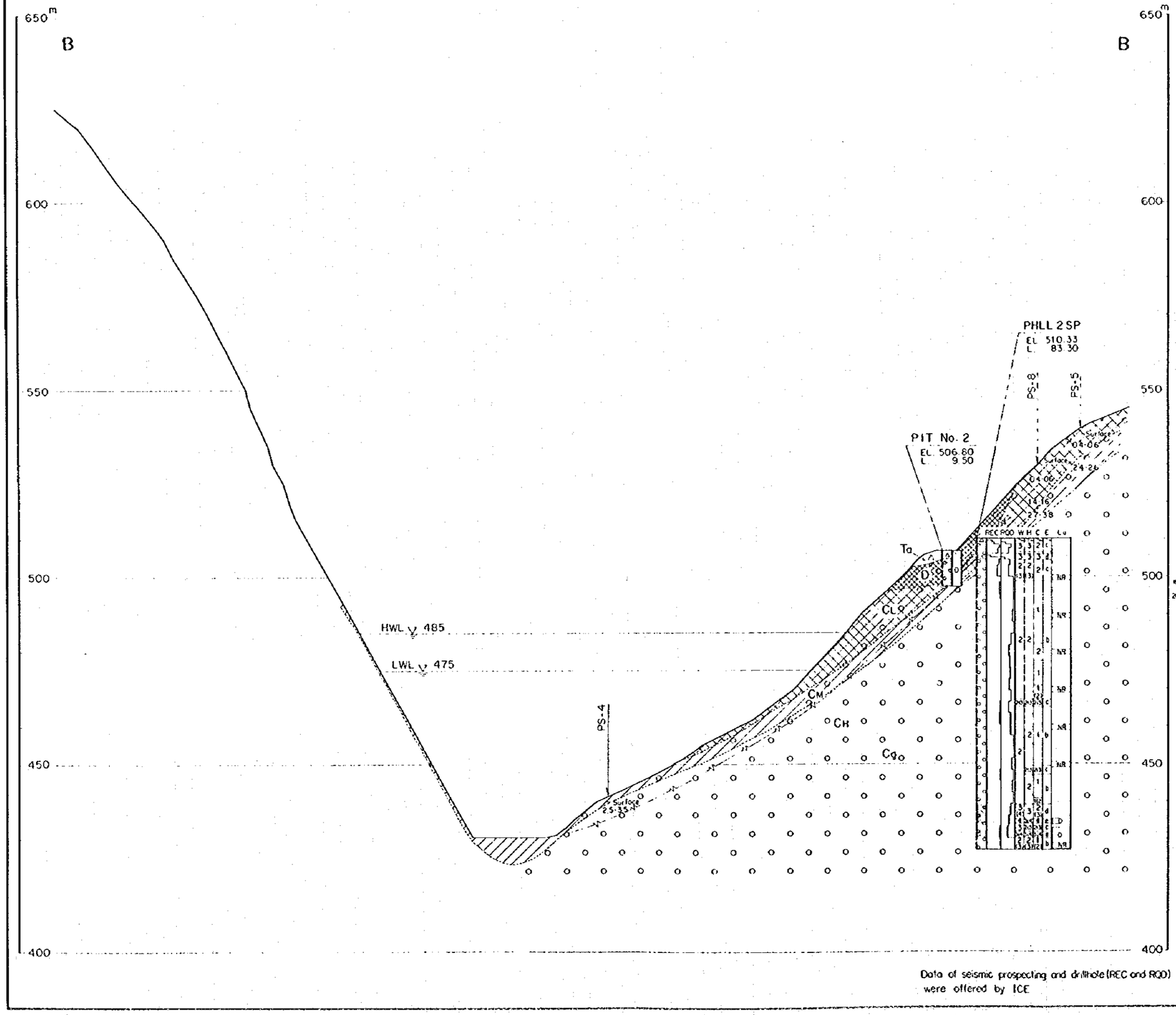
0 — 50m

REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC SECTION OF UP - STREAM DAM SITE

Fig. 7-3 | Date :



LEGEND

- Talus Deposits
- Conglomerate
- Geologic boundary
- Boundary of rock mass classification
- Ground water level
- Pit No. / EL. / L. — EL. : Elevation (m), L. : Length (m)

(Seismic Velocity Distribution)

- Traverse Line Number
- 24/44 — Velocity (km/s) and boundary of velocity layer

(Rock Mass Classification)

- CH — Somewhat cracky but not loosened rocks
- CM — Somewhat cracky and slightly loosened rocks
- CL — Cracky and loosened rocks due to weathering and/or creeping
- D — Soft or brittle rocks due to weathering or shearing

(Drillhole Log)

- PHLL / EL. / L. / DIR.
- Hole number
- Elevation of hole head (m)
- Length drilled (m)
- Direction and dip of inclined hole
- REC ROD W H C E Lu
- Result of Lugeon test
- Lu Value assumed from P-Q Curve
- Lu Value (L/min/m/under injection pressure 10kgf/cm²)
- Test section
- Core evaluation
- Rock classification — W: Weathering, H: Hardness, C: Interval of cracks
- ROD (Rock Quality Designation)
- REC : Core Recovery
- Geologic log
- Depth (m)
- Cracky cores
- Core Evaluation (See core classification and Evaluation)

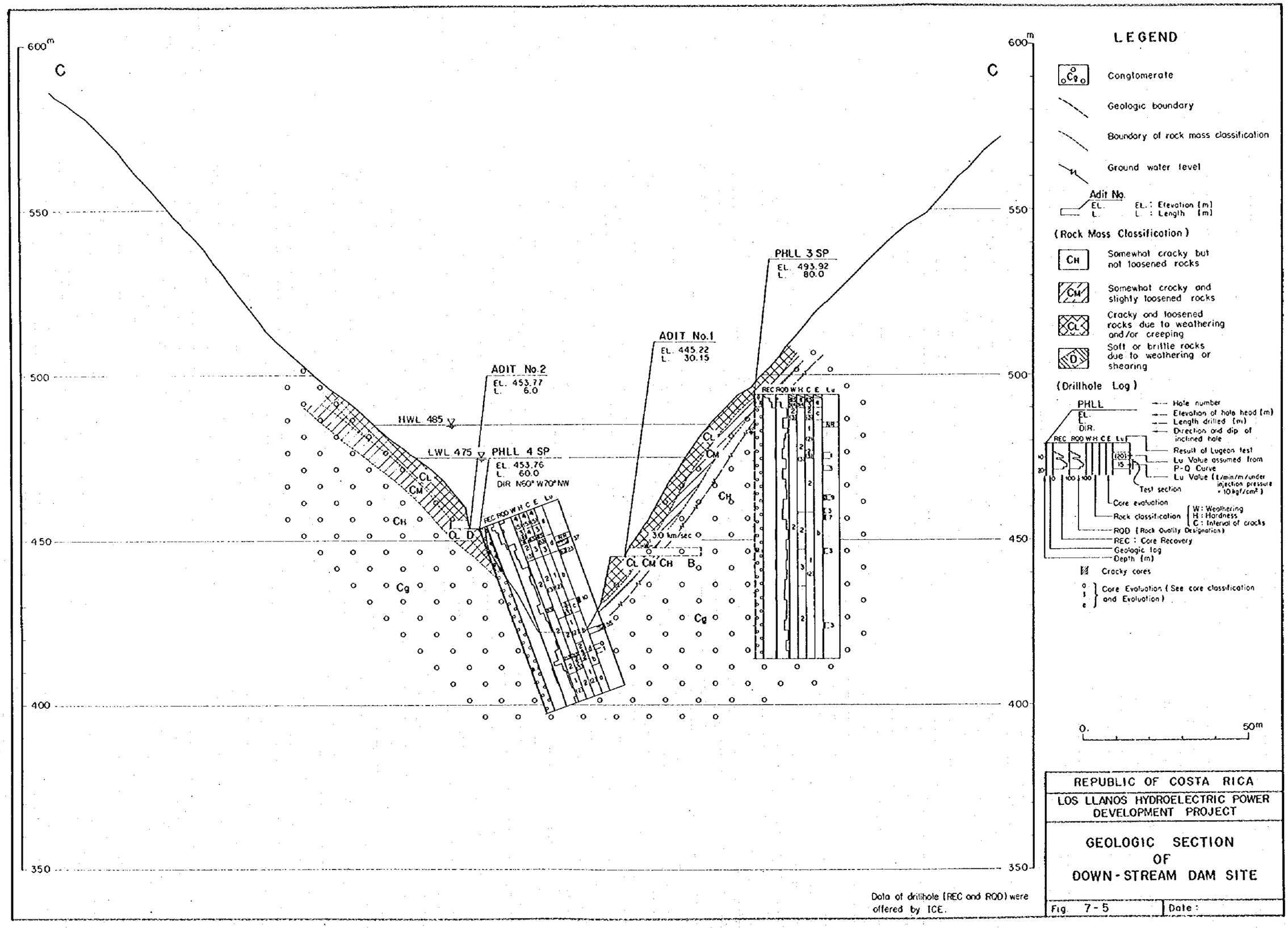
0 — 50m

REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC SECTION OF MID - STREAM DAM SITE

Fig. 7 - 4 | Date :



Data of drillhole (REC and ROD) were offered by ICE.

REPUBLIC OF COSTA RICA

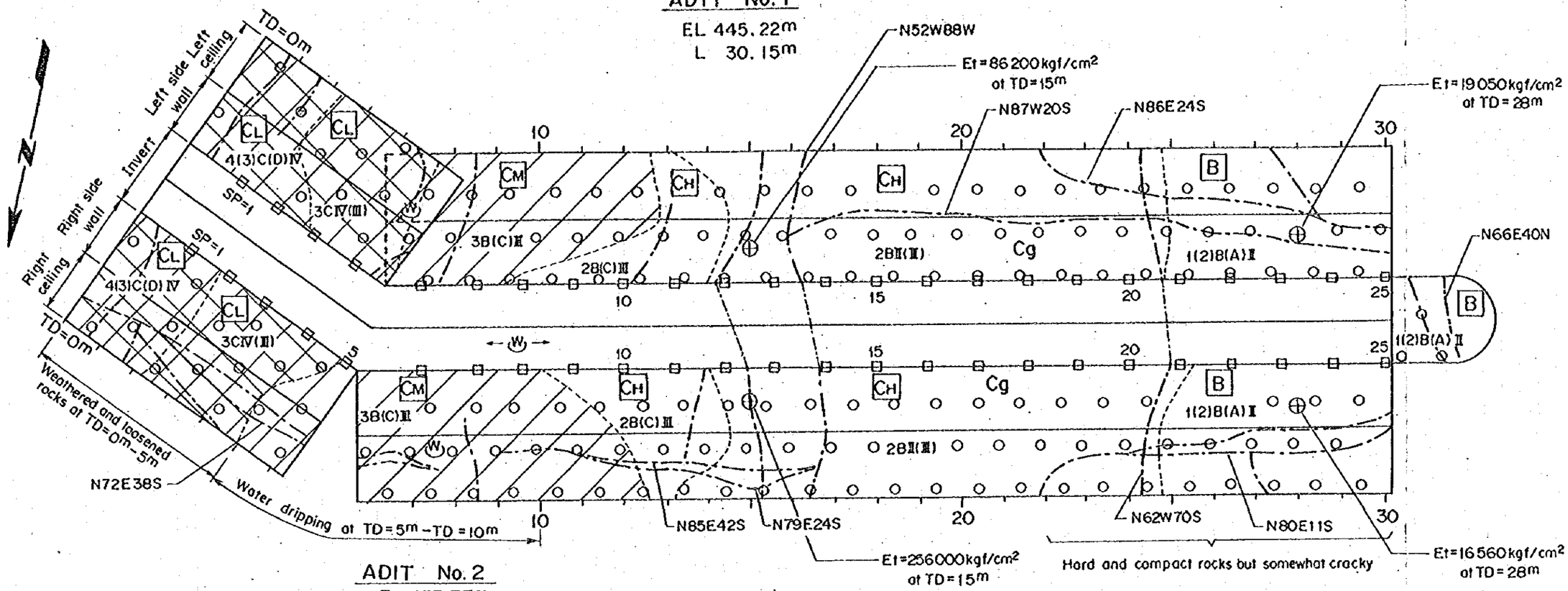
LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC SECTION OF DOWN-STREAM DAM SITE

Fig. 7-5 | Date :

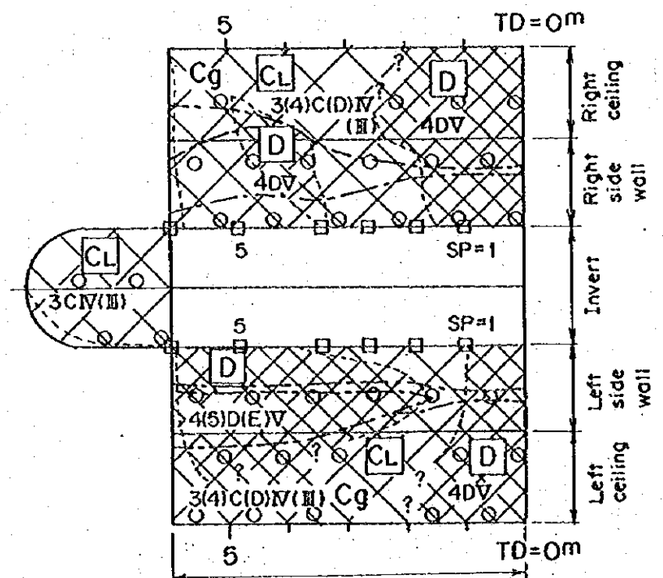
ADIT No. 1

EL 445.22m
L 30.15m

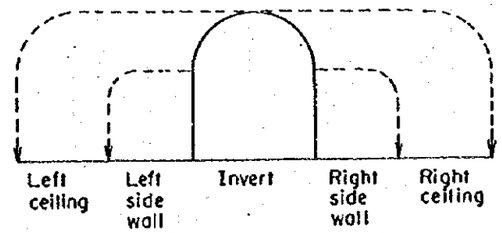


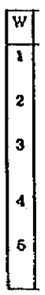
ADIT No. 2

EL 453.77m
L 6.0 m



Weathered and loosened rock with brittle and/or softened parts at TD=0m-TD=6m



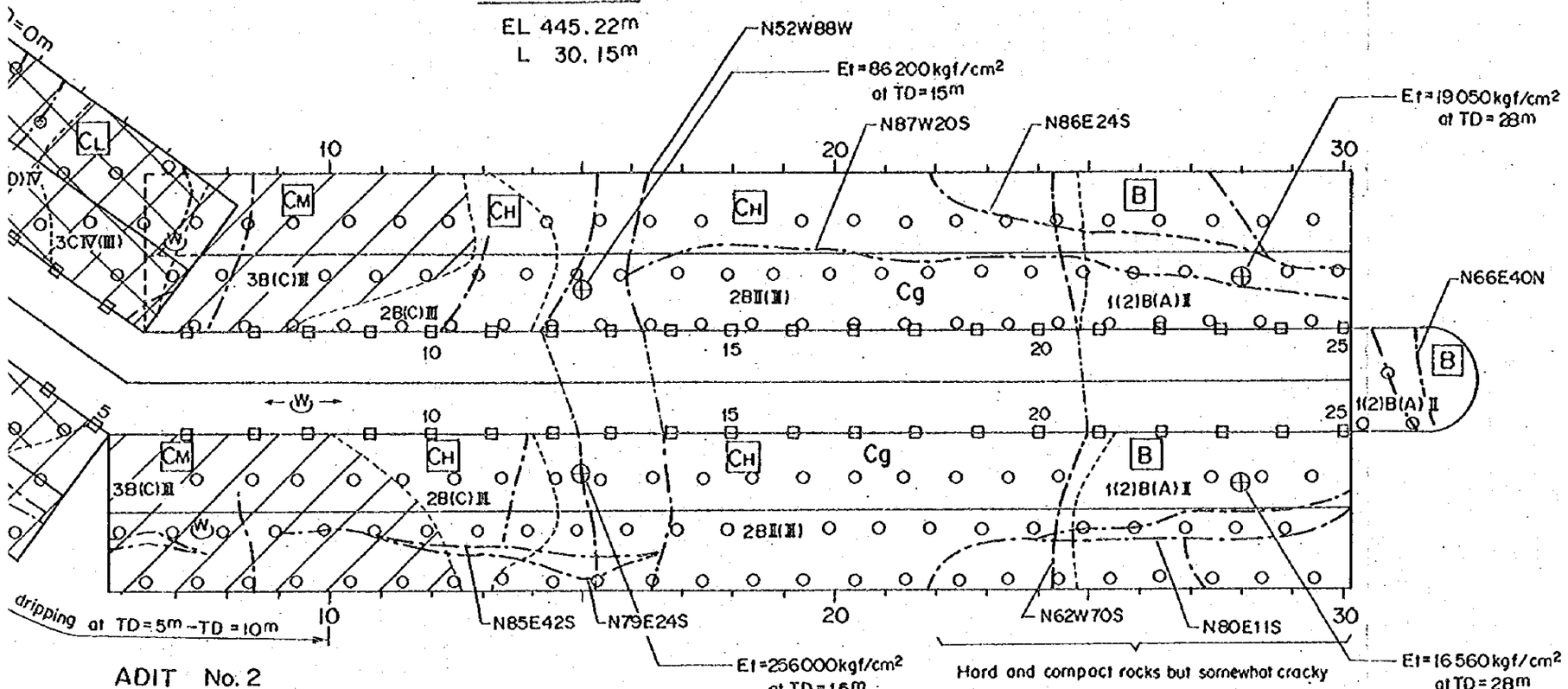


0 5m

Data of direction of adit and plate bearing test wer
by IC.

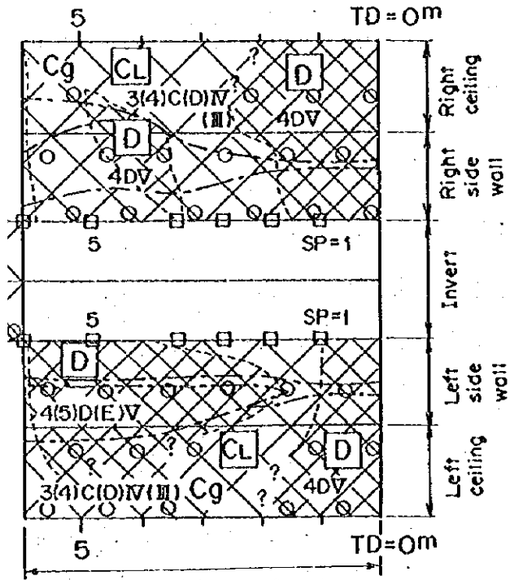
ADIT No. 1

EL 445.22m
L 30.15m

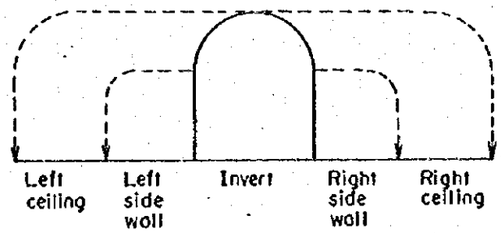


ADIT No. 2

EL 453.77m
L 6.0 m



Weathered and loosened rock with brittle and/or softened parts at TD=0m-TD=6m



LEGEND

- Cg — Conglomerate
- Crack and/or joint
- W — Dripping water
- 3BII / 3CIV — Rock classification and its boundary
- T D — Adit distance (m) from its portal
- SP= — Supporting of adit and its number

(Rock Mass Classification)

- B — Generally fresh and solid but a little weathered rocks
- CH — Somewhat cracky but not loosened rocks
- CM — Somewhat cracky and slightly loosened rocks
- CL — Cracky and loosened rocks due to weathering and/or creeping
- D — Soft or brittle rocks due to weathering or shearing
- Et= — Location of plate jack test and its result (Et: Tangential elastic modulus)

Standard of Rock Classification for Adits

W	Weathering	H	Hardness	C	Interval of Cracks
1	Very fresh. No weathering of mineral component.	A	Very hard. Broken into knifeedged pieces by strong hammer blow.	I	Over 100cm
2	Fresh. Some minerals are weathered slightly. Usually no brown crack.	B	Hard. Broken into pieces by strong hammer blow.	II	40-100cm
3	Fairly fresh. Some minerals are weathered. Cracks are stained and with weathered materials.	C	Somewhat brittle. Broken into pieces by medium hammer blow.	III	20-40cm
4	Weathered. Fresh portions still remain partially.	D	Very brittle. Easily broken into pieces by medium hammer blow.	IV	5-20cm
5	Strongly weathered. Most minerals are weathered and altered to second minerals.	E	Soft. Able to dig with hammer.	V	Under 5cm

0 — 5m

Data of direction of adit and plate bearing test were offered by ICE.

REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

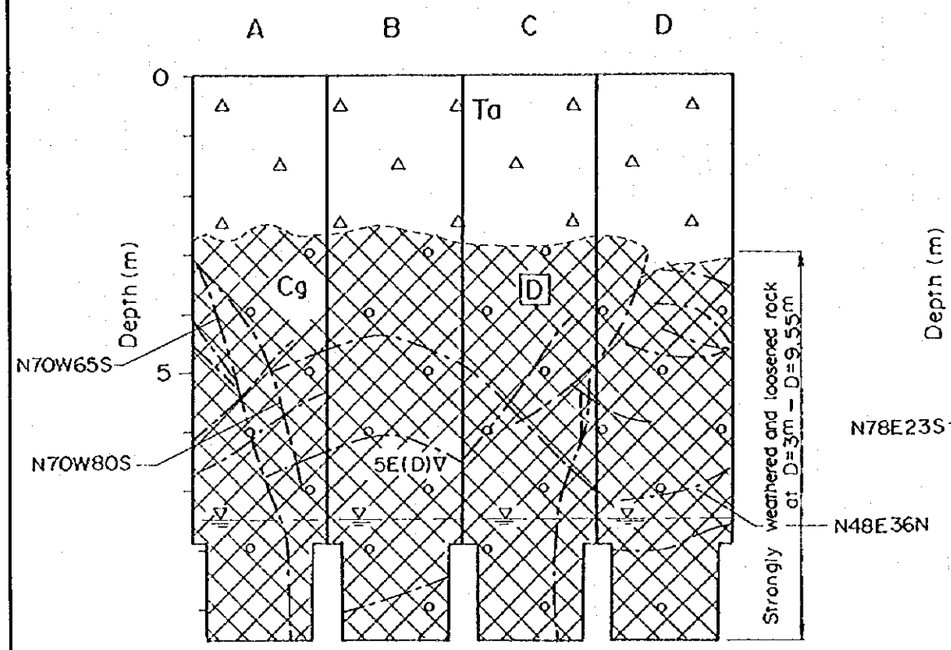
GEOLOGIC LOG OF ADIT

(ADITS No.1 and No.2)

Fig. 7-6 | Date:

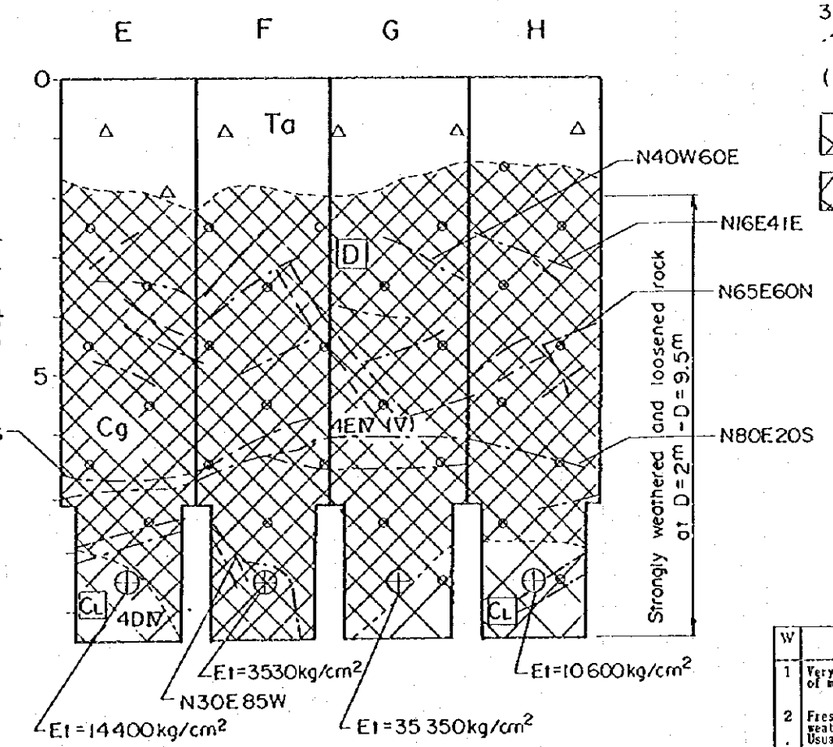
PIT No.1

EL 504.49m
L 9.55m



PIT No.2

EL 506.80m
L 9.5 m



LEGEND

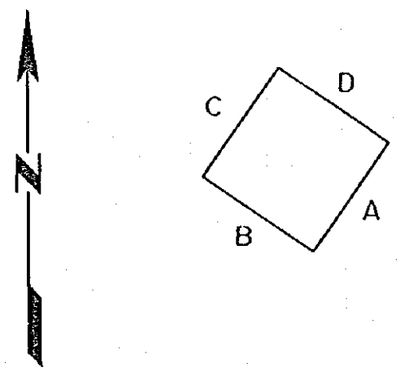
- Talus deposits (Ta)
- Conglomerate (Cg)
- Crack and/or joint
- 3BII / 3CIV — Rock classification and its boundary

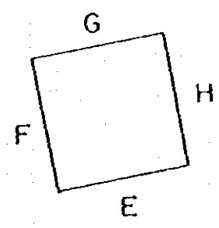
(Rock Mass Classification)

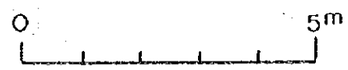
- CL — Cracky and loosened rocks due to weathering and/or creeping
- D — Soft or brittle rocks due to weathering or shearing
- E1 — Location of plate jack test and its result (E1 : Tangential elastic modulus)

Standard of Rock Classification for Pits

W	Weathering	H	Hardness	C	Interval of Cracks
1	Very fresh. No weathering of mineral component.	A	Very hard. Broken into knifeedged pieces by strong hammer blow.	I	Over 100cm
2	Fresh. Some minerals are weathered slightly. Usually no brown crack.	B	Hard. Broken into pieces by strong hammer blow.	II	40-100cm
3	Fairly fresh. Some minerals are weathered. Cracks are stained and with weathered materials.	C	Somewhat brittle. Broken into pieces by medium hammer blow.	III	20-40cm
4	Weathered. Fresh portions still remain partially.	D	Very brittle. Easily broken into pieces by medium hammer blow.	IV	5-20cm
5	Strongly weathered. Most minerals are weathered and altered to second minerals.	E	Soft. Able to dig with hammer.	V	Under 5cm







Data of geology, crack/joint and plate bearing test were offered by ICE.

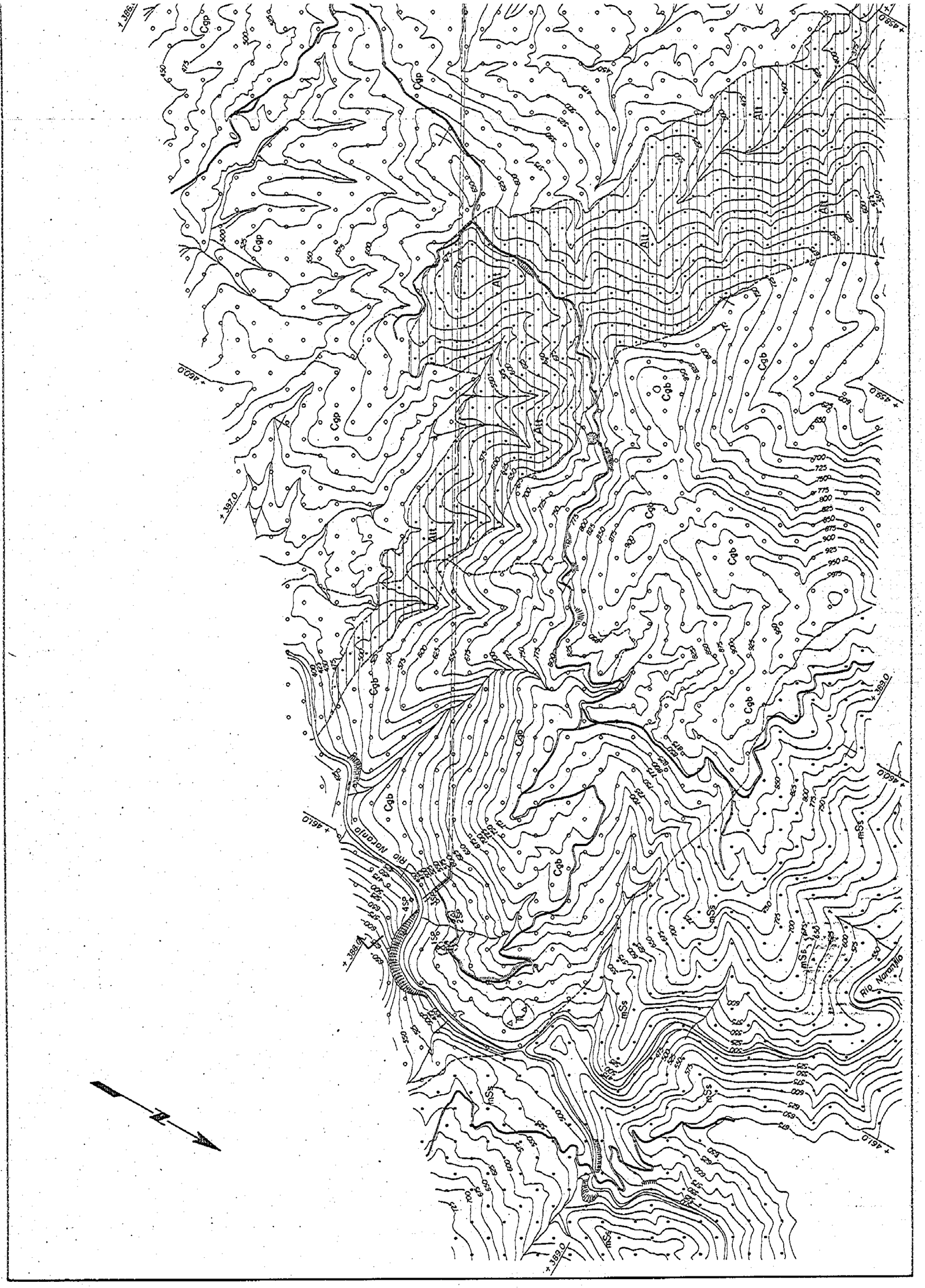
REPUBLIC OF COSTA RICA

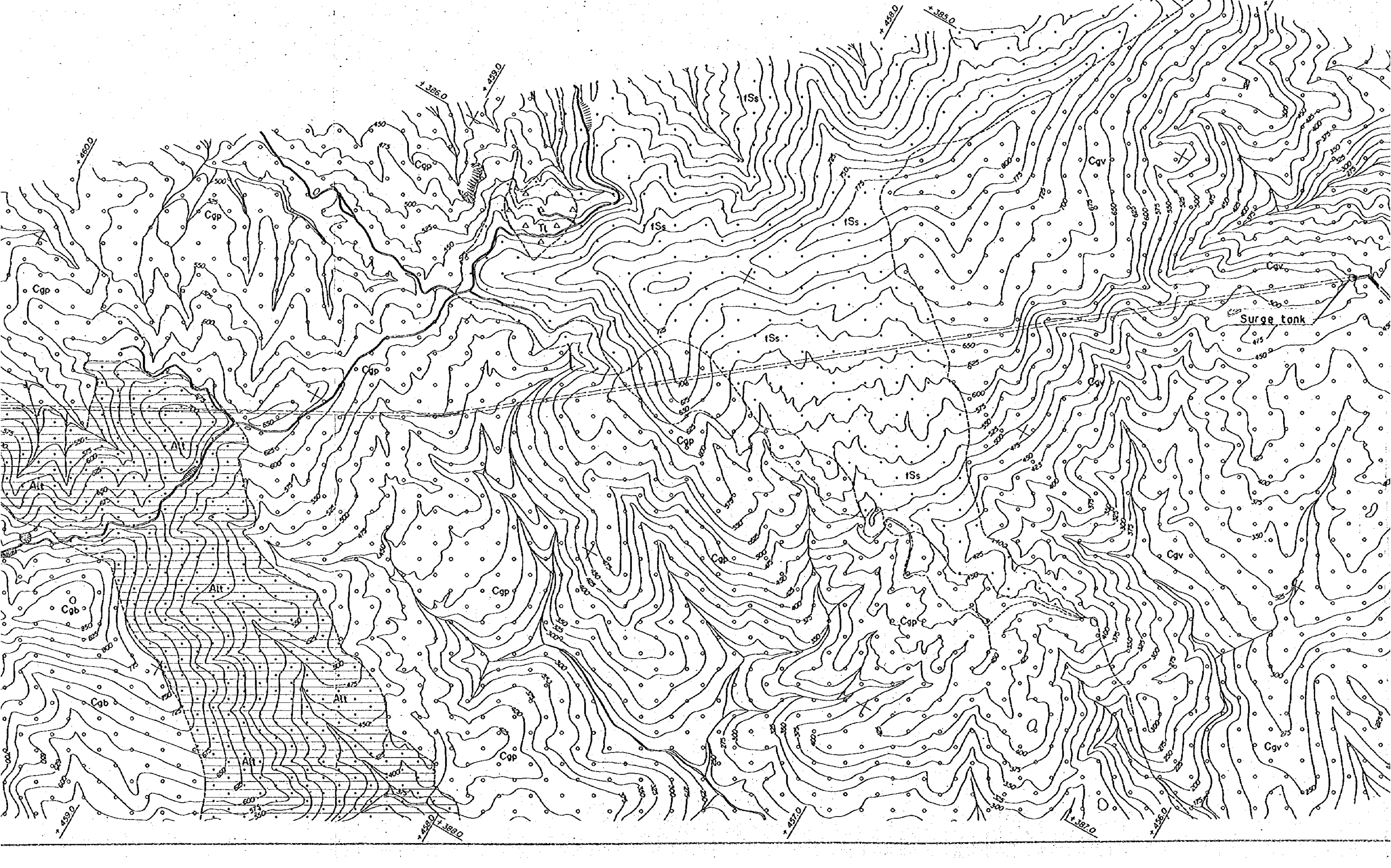
LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

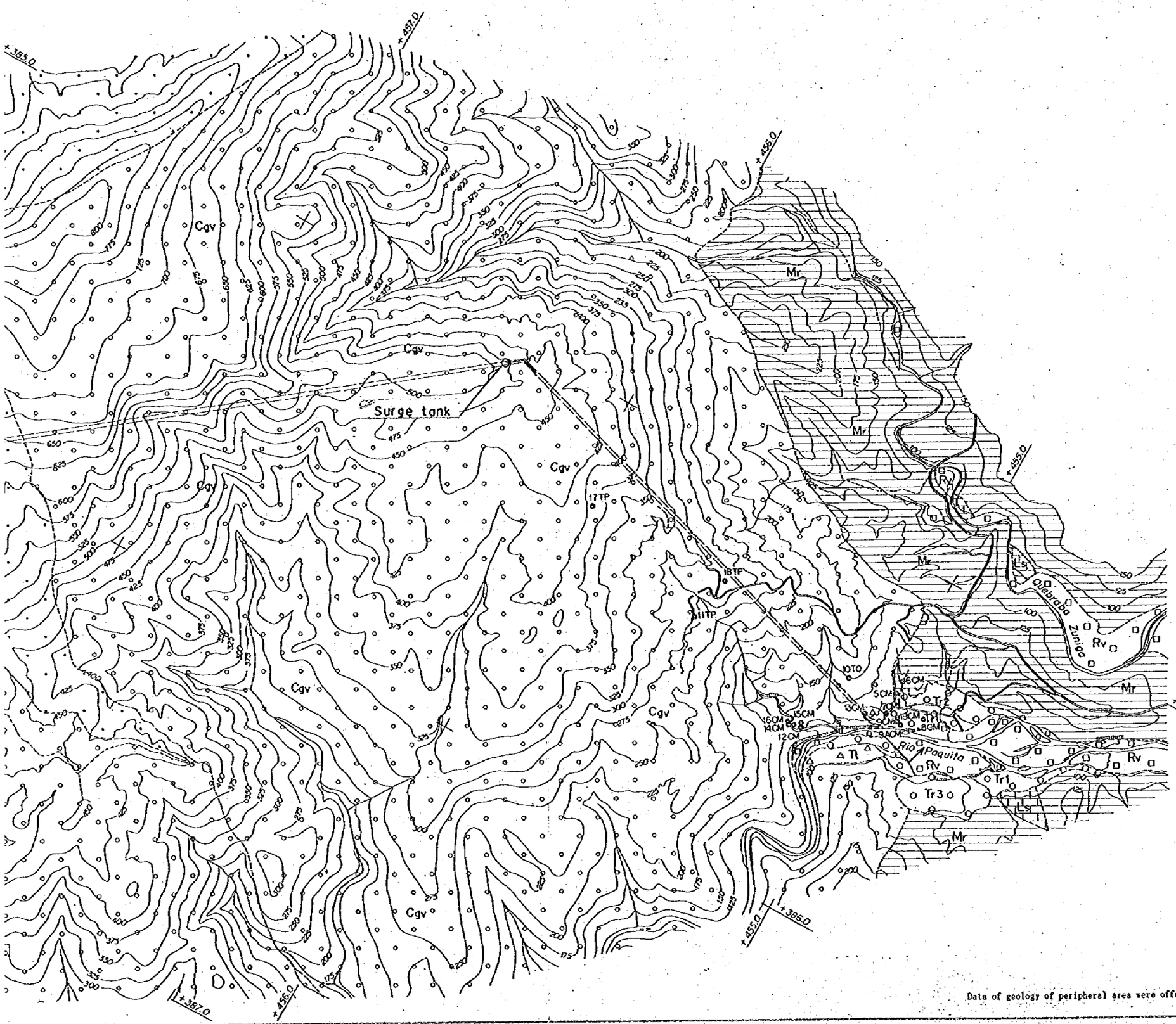
GEOLOGIC LOG OF PIT

(PITS No.1 and No.2)

Fig. 7-7 | Date :


Cgp
Cgb
Alt
mSs
Río Nacaome
Río Nacaome
N


+460.0
+386.0
+459.0
+458.0
+385.0
+457.0
Cgp
fSs
Cgv
Tl
Surge tonk
Alt
Cgb
+459.0
+458.0
+388.0
+457.0
+387.0
+456.0



LEGEND

- Rv — Riverbed Deposits
- Tl — Talus Deposits
- Tr1 — Terrace Deposits (Lower)
- Tr2 — Terrace Deposits (Middle)
- Tr3 — Terrace Deposits (Upper)
- mSs — Sandstone (Medium)
- Cgb — Conglomerate (Boulder)
- Alt — Alternation of Sandstone and Siltstone
- Cgp — Conglomerate (Pebble)
- fSs — Sandstone (Fine)
- Cgv — Conglomerate (Volcanic)
- Mr — Mudstone (Marl)
- Ls — Limestone
- Geologic boundary
- Fault
- Geologic Section

0 — 500m

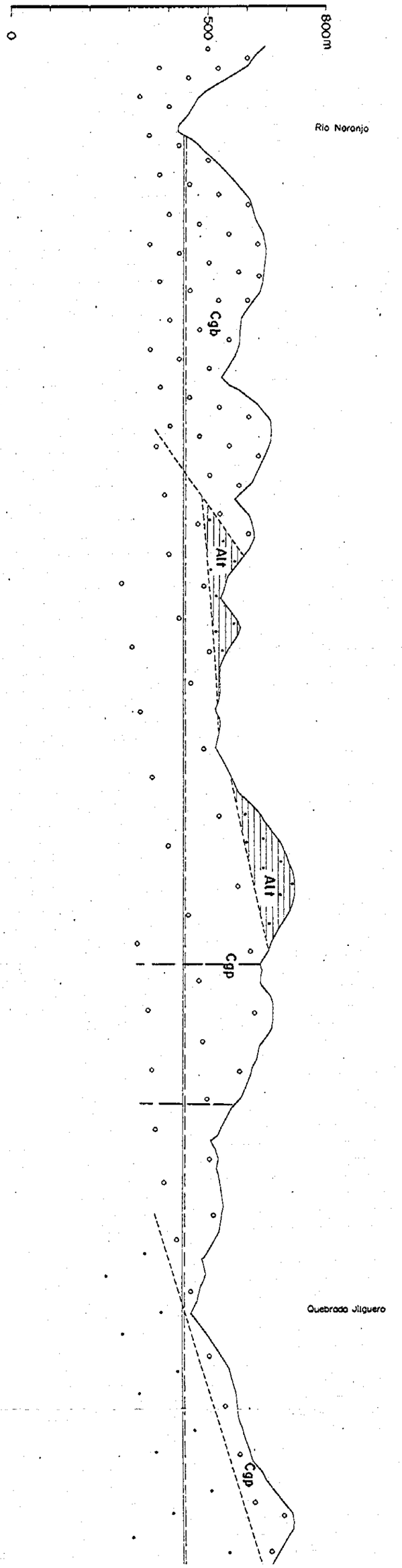
Data of geology of peripheral area were offered by ICE.

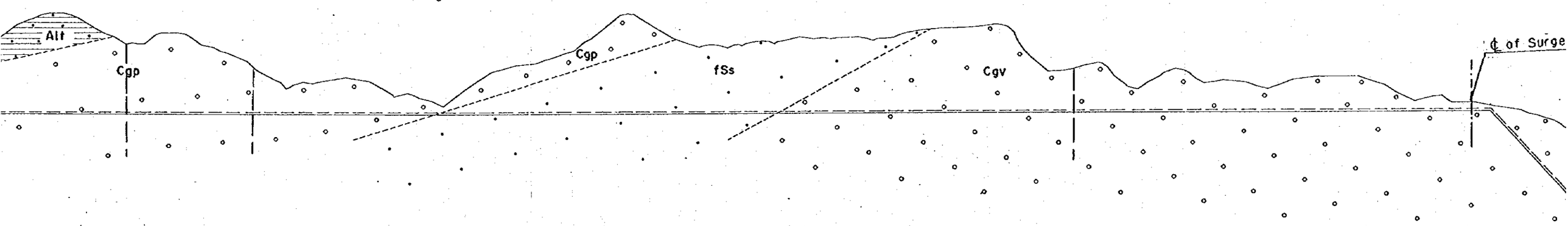
REPUBLIC OF COSTA RICA

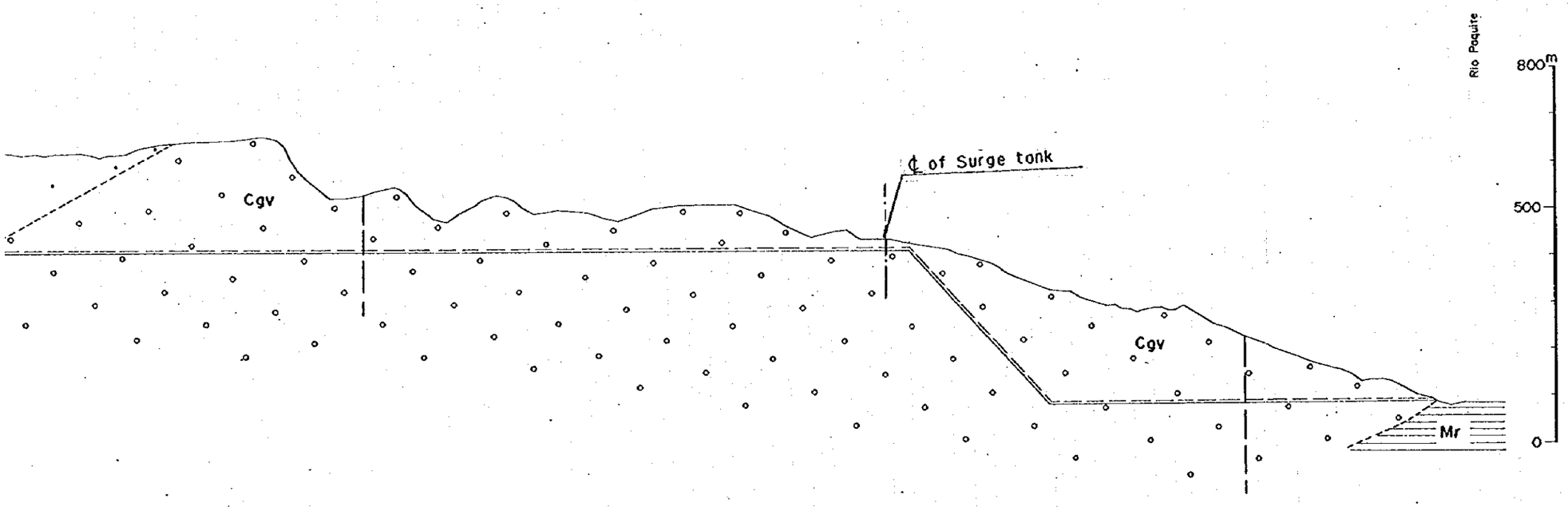
LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC PLAN OF WATERWAY ALIGNMENT ROUTE

Fig. 7-8 | Date:


0
500
800m
Rio Naranjo
Cgb
Alt
Alt
Cgp
Cgp
Quebrada Jilguero


Quebrada Jilguero
Alf
Cgp
Cgp
fSs
Cgv
℄ of Surge



LEGEND

- Rv — Riverbed Deposits
- Tl — Talus Deposits
- Trl — Terrace Deposits (Lower)
- Cgb — Conglomerate (Boulder)
- Alt — Alternation of Sandstone and Siltstone
- Cgp — Conglomerate (Pebble)
- fSs — Sandstone (Fine)
- Cgv — Conglomerate (Volcanic)
- Mr — Mudstone (Marl)
- Geologic boundary
- Lineament by aero-photo interpretation

0 500m

REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC SECTION
ALONG
HEADRACE TUNNEL ROUTE

Fig. 7-9 | Date:

N

+ 385.2

+ 385.4

PP-1 (L=1380m)

PP-2 (L=1360m)

PHLL18TP
EL 297.205
L 30.20

PHLL11TP
EL 278.718
L 30.80

PHLL16CM
EL 104.197
L 26.00

PHLL14CM
EL 103.851
L 34.15

PHLL15CM
EL 103.173
L 26.40

PHLL12CM
EL 101.276
L 30.85

PHLL10TO
EL 148.463
L 36.40

PHLL7CM
EL 95.086
L 28.00

PHLL6CM
EL 95.540
L 24.30

PHLL5CM
EL 97.503
L 30.00

PHLL13CM
EL 102.035
L 30.00

PHLL9CM
EL 88.296
L 31.50

PC-5 (L=115m)

PC-6 (L=85m)

PC-4 (L=93m)

PC-3 (L=115m)

Cg

Mr

Tr1

Tr2

Tl

Rv

455.6

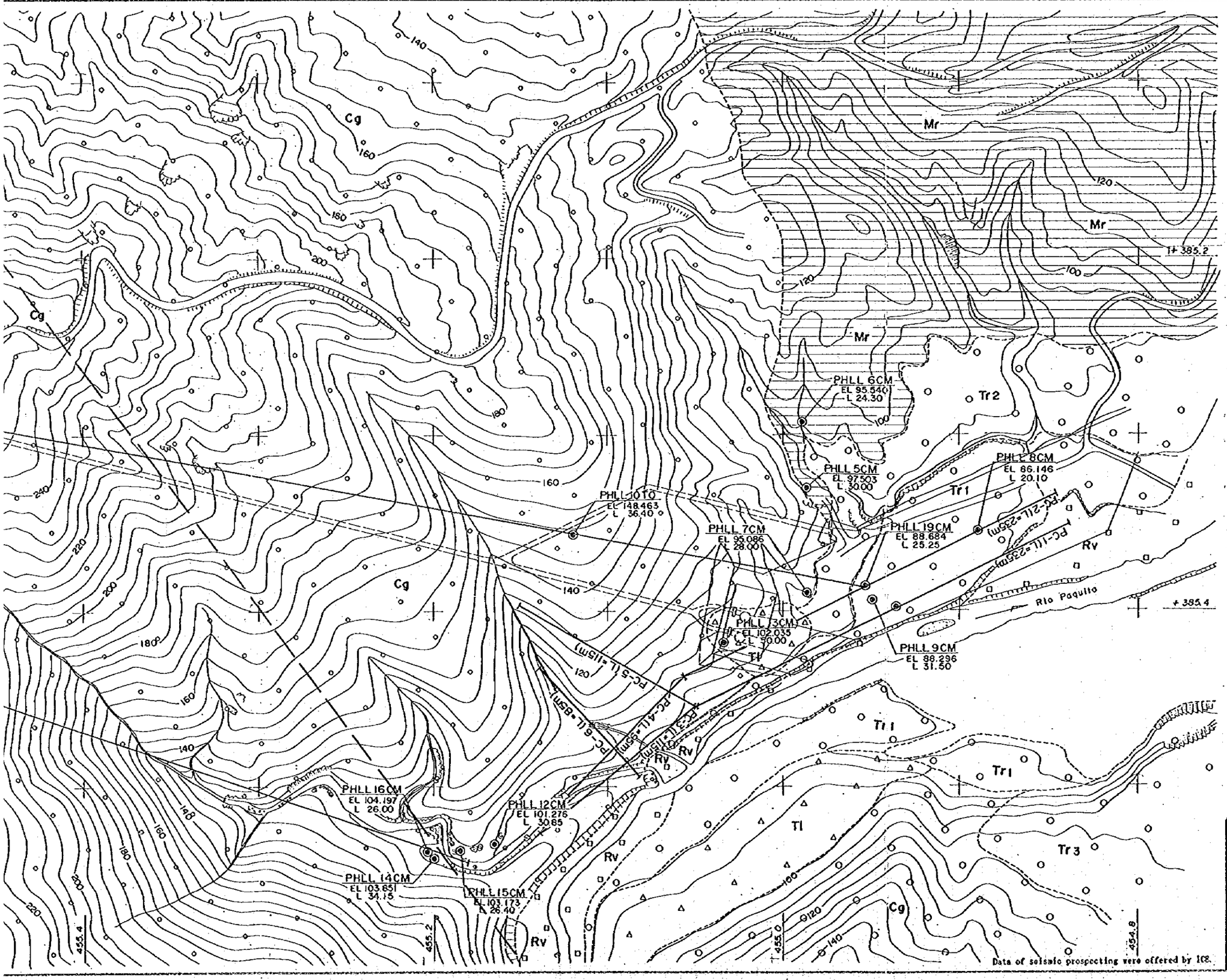
455.4

455.2

455.0

Data of

57-4



LEGEND

- Rv — Riverbed Deposits
- Tl — Talus Deposits
- Tr1 — Terrace Deposits (Lower)
- Tr2 — Terrace Deposits (Middle)
- Tr3 — Terrace Deposits (Upper)
- Cg — Conglomerate
- Mr — Mudstone (Marl)
- Geologic boundary
- Lineament by aero-photo interpretation
- Drillhole
- Seismic Prospecting Traverse
- Geologic Section

100 m

Data of seismic prospecting were offered by ICE.

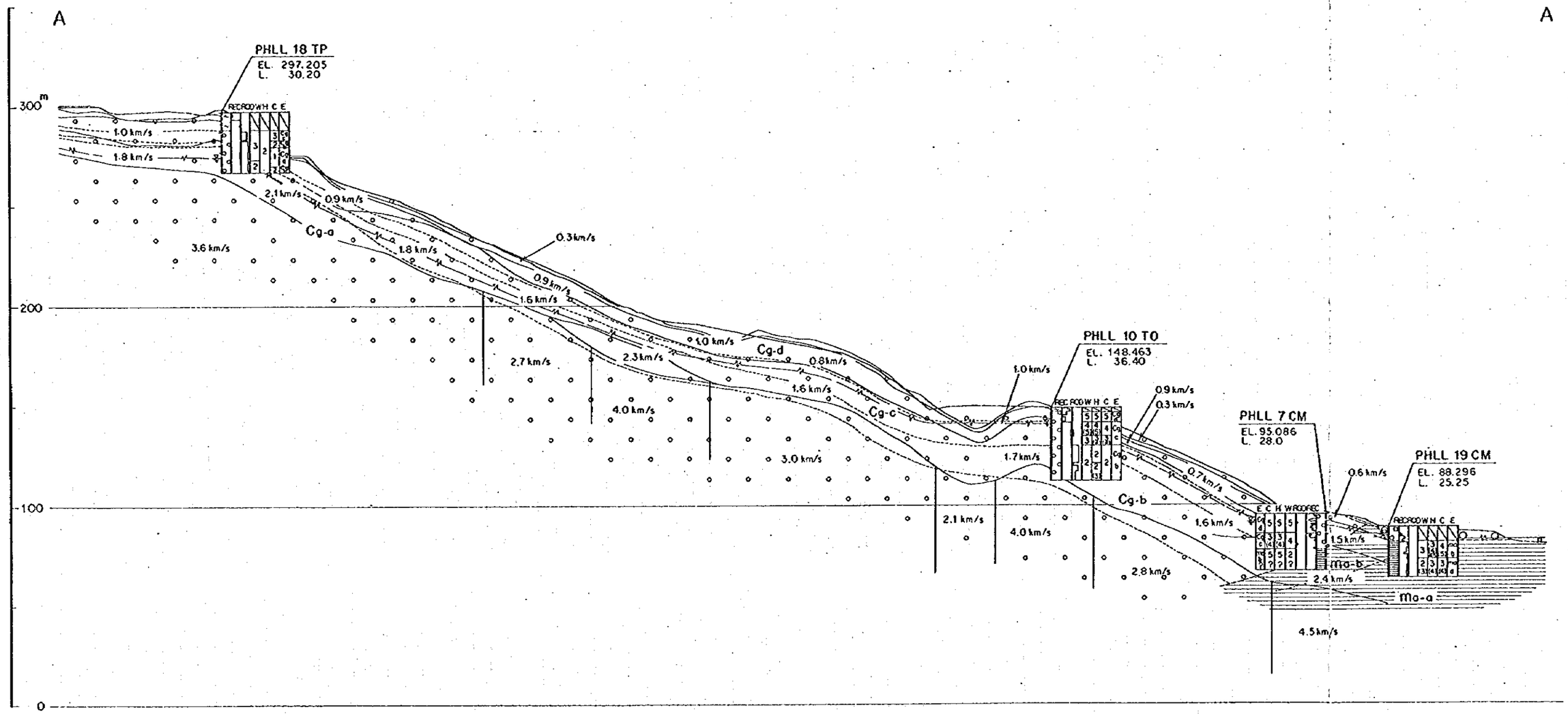
REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC PLAN OF PENSTOCK ROUTE AND POWER STATION SITE

Fig. 7-10 | Date:

A

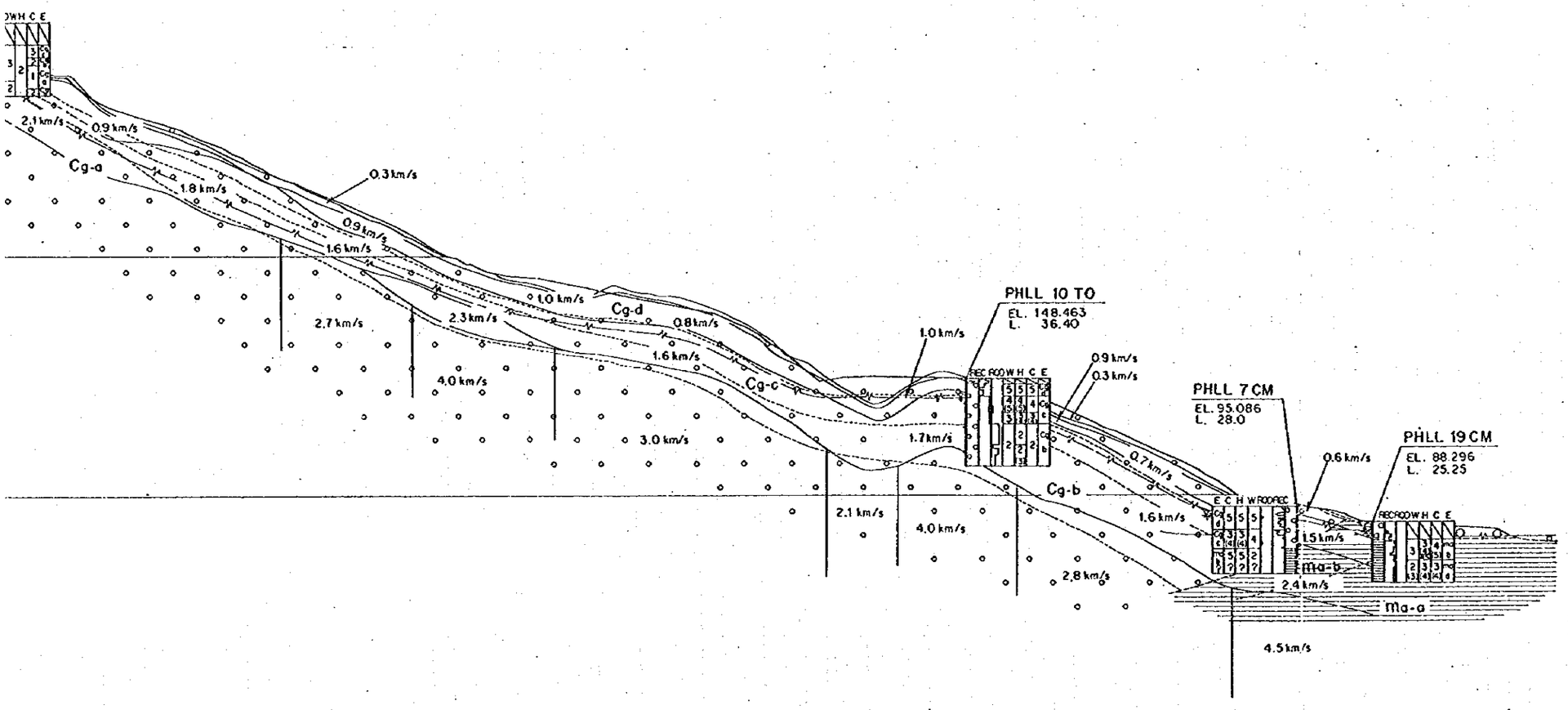


A

Data of drillhole(REC and RQD) were offered l

A

PHLL 18 TP
EL. 297.205
L. 30.20



LEGEND

- Rv — Riverbed Deposits
- Tr1 — Terrace Deposits (Lower)
- Tr2 — Terrace Deposits (Middle)
- Cg — Conglomerate
- Mr — Mudstone (Marl)
- Geologic boundary
- Boundary of rock mass classification
- Ground water level

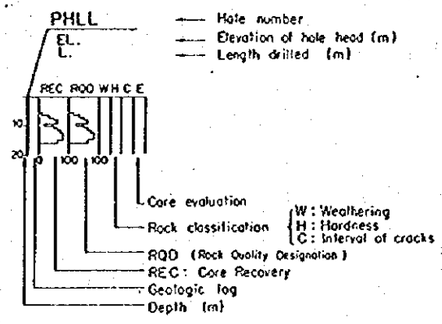
(Seismic Velocity Distribution)

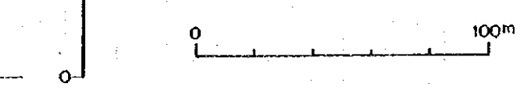
- 2.4 / 4.4 — Velocity (km/s) and boundary of velocity layer

(Rock Mass Classification)

- ma-a — See text

(Drillhole Log)





Data of drillhole(REC and RQD) were offered by ICE.

REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC SECTION OF PENSTOCK ROUTE (SECTION A - A)

Fig. 7-11 | Date :

B

B

PHLL 18 TP
EL. 297.205
L. 30.20

REC RQD W H C E

300 m

200

100

0

Cg-a

Cg-b

Cg-c

Cg-d

PHLL 13 CM
EL. 102.035
L. 50.00

REC RQD W H C E

Tri

Rv

My

: Data of drillhole(REC and RQD) were offered by ICE.

B

PHLL 18 TP
EL. 297.205
L. 30.20

PHLL 13 CM
EL. 102.035
L. 50.00

Cg-a
Cg-b
Cg-c
Cg-d
Tri
Rv
Mr

300 m
200
100
0

LEGEND

- Rv — Riverbed Deposits
- Ti — Talus Deposits
- Tr1 — Terrace Deposits (Lower)
- Tr2 — Terrace Deposits (Middle)
- Cg — Conglomerate
- Mr — Mudstone (Marl)
- Geologic boundary
- Lineament by aero-photo interpretation
- Boundary of rock mass classification
- Ground water level

(Seismic Velocity Distribution)

2.4 / 4.4 — Velocity (km/s) and boundary of velocity layer

(Rock Mass Classification)

Cg-a — See text

(Drillhole Log)

PHLL — Hole number
EL. — Elevation of hole head (m)
L. — Length drilled (m)

REC RQD W H C E

Core evaluation
Rock classification (W: Weathering, H: Hardness, C: Interval of cracks)
RQD (Rock Quality Designation)
REC: Core Recovery
Geologic log
Depth (m)

0 — 100 m

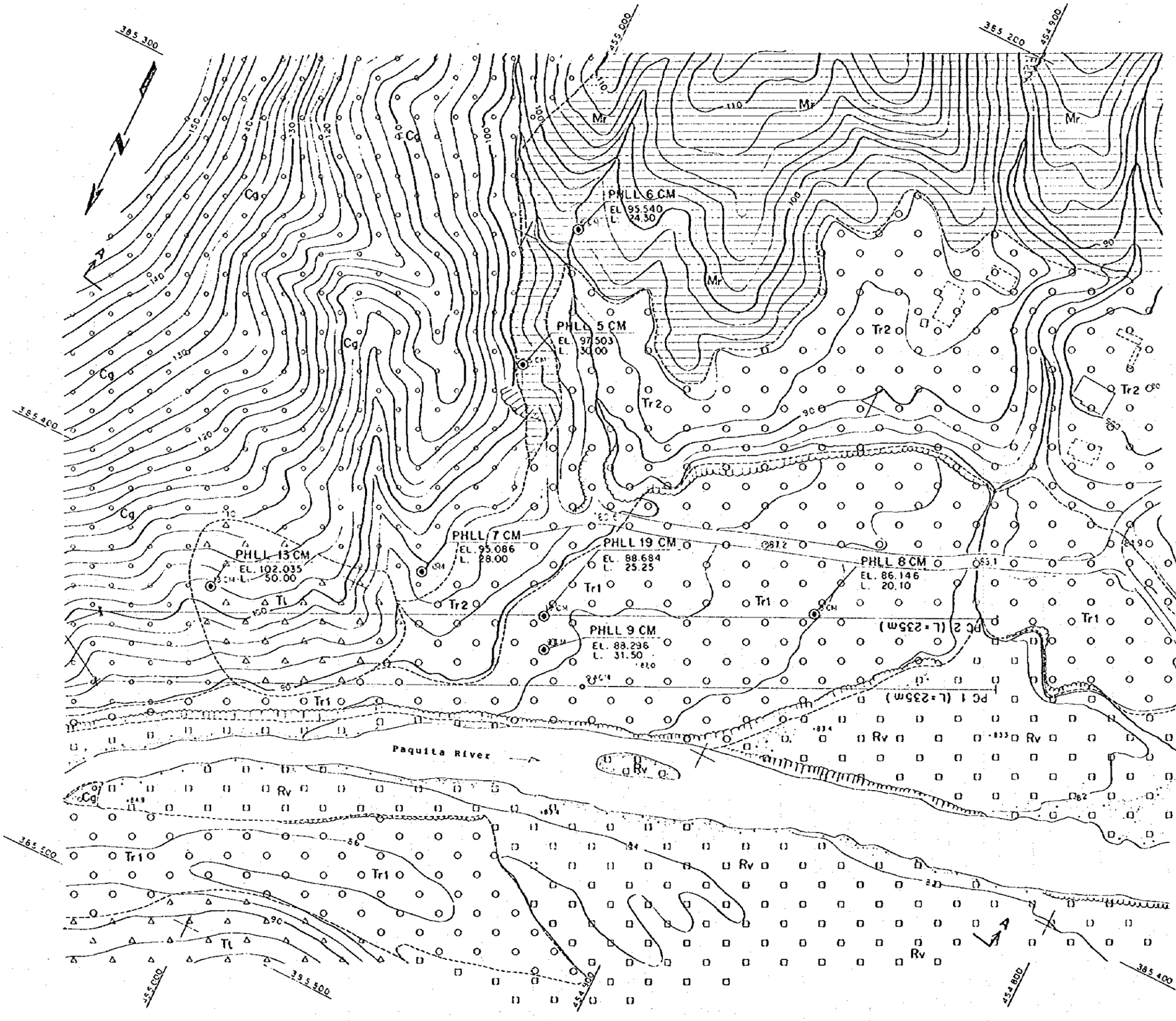
: Data of drillhole(REC and RQD) were offered by ICE.

REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC SECTION OF PENSTOCK ROUTE (SECTION B - B)

Fig. 7-12 | Date :



LEGEND

- Riverbed Deposits (Rv)
- Talus Deposits (Tl)
- Terrace Deposits (Lower) (Tr1)
- Terrace Deposits (Middle) (Tr2)
- Conglomerate (Cg)
- Mudstone (Marl) (Mr)
- Geologic boundary
- Drillhole
- Seismic Prospecting Traverse
- Geologic Section

. Data of seismic prospecting were offered by ICE.

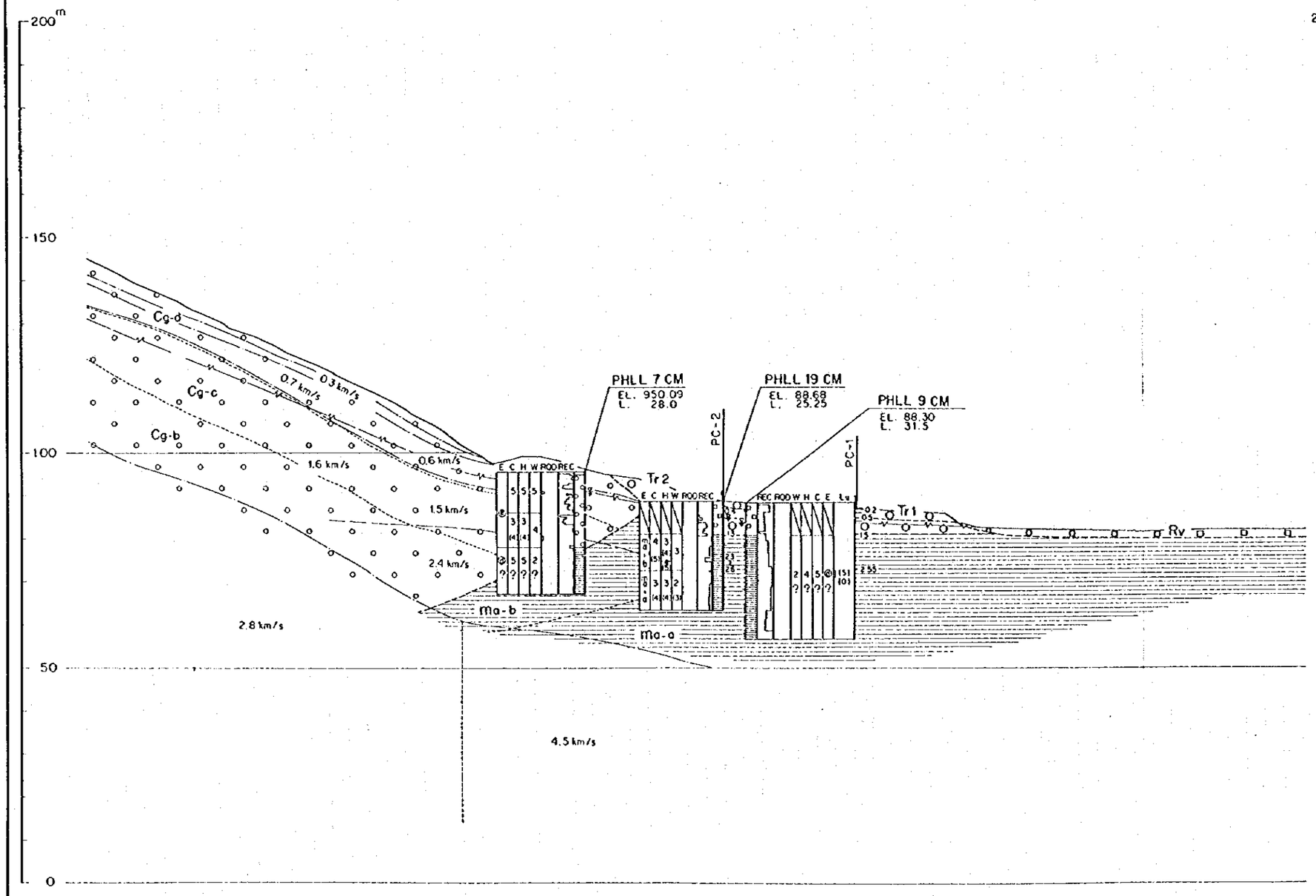
REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC PLAN OF POWER STATION SITE

Fig. 7-13

Los Llanos Power Plant Site



LEGEND

- Riverbed Deposits (Rv)
- Terrace Deposits (Lower) (Tr1)
- Terrace Deposits (Middle) (Tr2)
- Conglomerate (Cg)
- Mudstone (Marl) (Mr)
- Geologic boundary
- Boundary of rock mass classification
- Ground water level

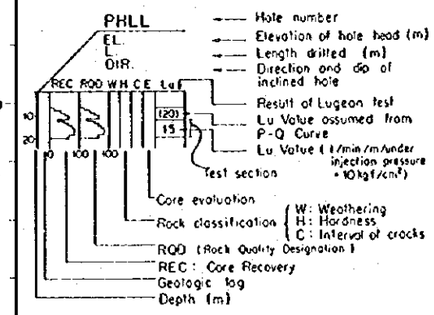
(Seismic Velocity Distribution)

- 2.4 / 4.4 — Velocity (km/s) and boundary of velocity layer

(Rock Mass Classification)

- ma-a — See text

(Drillhole Log)



0 — 50m

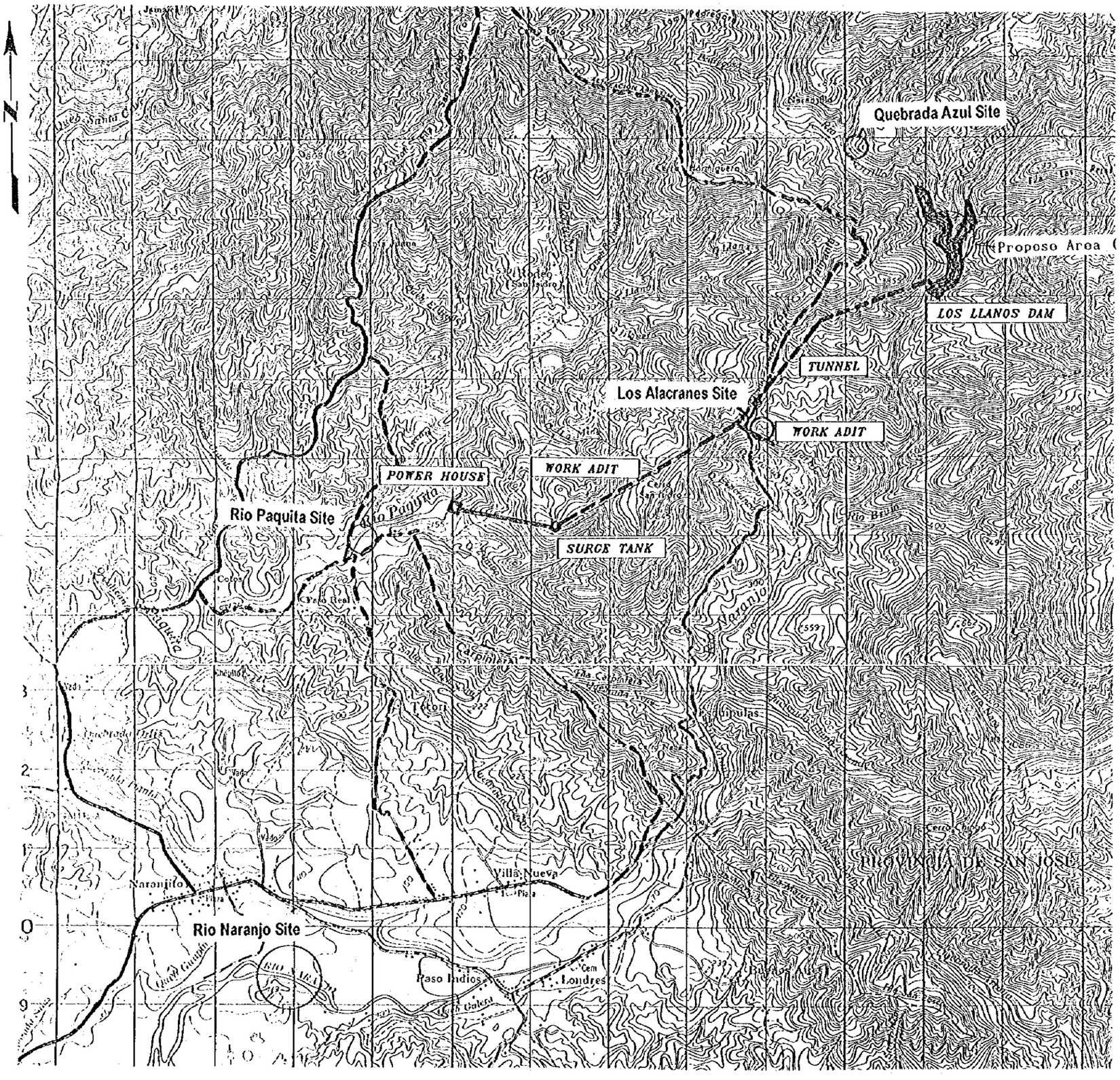
Data of drillhole(REC and RQD) were offered by ICE.

REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

GEOLOGIC SECTION OF POWER STATION SITE (section A-A)

Fig. 7-14 | Date :



REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

Location Map of Riverbed Deposits Sites and Rock Quarry Sites

Fig.7-15 | Date :

Table 7-1 Core-drillholes in the Project Area

Drillhole No.	Location	Elevation m	Length m	Dir deg	Water Level Measurement	Remarks
PHLL1SP	Up Stream Damsite Right Bank	503.001	70.70	Ver.	done	Lugeon tests; 7 sections
PHLL2SP	Mid Stream Damsite Right Bank	510.332	83.30	Ver.	done	Lugeon tests; 9 sections Deformation Tests 5 sections
PHLL3SP	Down Stream Damsite Right Bank	493.922	80.00	Ver.	done	Lugeon tests; 8 sections Deformation Tests 6 sections
PHLL4SP	Down Stream Damsite Left Bank	453.755	60.00	70 300	none	Lugeon tests; 7 sections Deformation Tests 7 sections
	subtotal		294.00			
PHLL5CM	Power Station No.1 site	97.503	30.00	Ver.	done	
PHLL6CM	Power Station No.1 site	95.54	24.30	Ver.	done	
PHLL7CM	Power Station No.1 site	95.086	28.00	Ver.	done	
PHLL8CM	Power Station No.1 site	86.146	20.10	Ver.	done	
PHLL9CM	Power Station No.1 site	88.296	31.50	Ver.	done	Lugeon tests; 2 sections
PHLL10TO	Penstock Route No.1 route	148.463	36.40	Ver.	done	
PHLL11TP	Penstock Route No.2 route	278.718	30.80	Ver.	none	
PHLL12CM	Power Station No.2 site	101.276	30.85	Ver.	done	
PHLL13CM	Power Station No.1 site	102.035	50.00	Ver.	none	
PHLL14CM	Power Station No.2 site	103.851	34.15	Ver.	none	Lugeon tests; 2 sections
PHLL15CM	Power Station No.2 site	103.173	26.40	Ver.	done	
PHLL16CM	Power Station No.2 site	104.197	26.00	Ver.	none	Vp/Vs measurement (22m in length)
PHLL17TP	Penstock Route No.2 route	391.319	21.60	Ver.	none	
PHLL18TP	Penstock Route No.1 route	297.205	30.20	Ver.	none	Deformation Tests 8 sections
PHLL19CM	Power Station No.1 site	88.684	25.25	Ver.	none	Deformation Tests 6 sections
	subtotal		445.55			
	Total ; 19 drillholes		739.55			

Table 7-2 Exploratory Adits at Damsitos

Adit No.	Location	Elevation m	Length m	Remarks
Adit No.1	Down Stream Damsite Right Bank	445.219	30.15	Plate Jack Tests at TD;15.0m and 28.0m Vp/Vs Measurement
Adit No.2	Down Stream Damsite Left Bank	453.766	6.00	Open Cut 5.5m in front of entrance

(Total: 2 adits, 36.15 m)

Note:Data of Length were offered by ICE

Table 7-3 Test Pits at Damsites

Pit No.	Location	Elevation m	Depth m	Remarks
Pit No.1	Up Stream Damsite Right Bank	504.492	9.55	
Pit No.2	Mid Stream Damsite Right Bank	506.798	9.50	Plate Jack Tests at ;8.5m depth

(Total: 2 pits, 19.05 m)

Note:Data of Depth were offered by ICE

Table 7-4 Seismic Prospecting Traverse in the Project Area

Traverse No	Location	Length(m)	Remarks
PS-1	Up Stream Damsite Right Bank	170	Crossing with PS-4,5,6
PS-2	Up Stream Damsite Right Bank	220	Crossing with PS-4,5,6,8
PS-3	Up-Mid Stream Damsite Right Bank	220	Crossing with PS-4,5,7,8
PS-4	Up Stream Damsite Right Bank	210	Crossing with PS-1,2,3,8
PS-5	Up Stream Damsite Right Bank	330	Crossing with PS-1,2,3
PS-6	Up Stream Damsite Right Bank	220	Crossing with PS-1,2
PS-7	Up Stream Damsite Right Bank	330	Crossing with PS-3
PS-8	Up-Mid Stream Damsite Right Bank	220	Crossing with PS-2,3,4
	sub total ; 8 lines	1,920	
PL-1	Headrace Tunnel Route	940	Middle part
PL-2	Headrace Tunnel Route	390	Lower part
	sub total ; 2 lines	1,330	
PP-1	Penstock Route No.1	1,380	Connecting with PC-2
PP-2	Penstock Route No.2	1,360	
	sub total ; 2 lines	2,740	
PC-1	Power Station No.1	235	Connecting with PC-3,5
PC-2	Power Station No.1	235	Connecting with PC-4
PC-3	Between Power Station No.1 and 2	115	Connecting with PC-1,5 Crossing with PC-6
PC-4	Between Power Station No.1 and 2	95	Connecting with PC-2 Crossing with PC-5,6
PC-5	Between Power Station No.1 and 2	115	Connecting with PC-1,3 Crossing with PC-4
PC-6	Between Power Station No.1 and 2	85	Crossing with PC-3,4
	sub total ; 6 lines	880	
	Total ;18 lines	6,870	

Table 7-5 Resistivity Survey in the Project Area

Traverse No.	Location	Length(m)	Remarks
RL-1	Headrace Tunnel Route	800	Middle part same as PL-1
RL-2	Headrace Tunnel Route	229	Lower part same as PL-2
	sub total ; 2 lines	1,029	
RP-1	Penstock Route No.1	1,330	same as PP-1
RP-2	Penstock Route No.2	1,110	same as PP-2
	sub total ; 2 lines	2,440	
RC-1	Power Station No.1	230	same as PC-1
	sub total ; 1 line	230	
	Total ;5 lines	3,699	

Correlation of Velocity and Resistivity at Power Station Site

Layer	Velocity km/sec	Resistivity ohm-m	Lithology
1	0.4-0.5	15-20 40-80	Aluvial deposits
2	2.3-2.5	15-40 10-15	Conglomerate Marlstone
3	2.8	5-10	Conglomerate Marlstone
4	3.1-4.7	-10	Conglomerate Marlstone

Note)Data were offered by ICE

Table 7-6 In-adit Vp/Vs Measurement at Damsite

Adit No.	Location	Length (m)	Remarks
Adit No.1	Down Stream Damsite Right Bank	22	

(Total: 1 adit 22 m)

Table 7- 7 Vp/Vs Logging at Power Station Site

Drillhole No.	Location	Length m	Remarks
PHLL16CM	Power Station No.2	22.00	
	Total ; 1 drillhole	22.00	

Table 7-8 Results of Plate Jack Test in Adits and Test Pits

Adit No.1

T.D. (m)	Rock Species	W	H	C	Eval	D (kg/cm2)	Et (kg/cm2)	Es (kg/cm2)	E (kg/cm2)	E/D	Cp	Def. Max.	Def. Fin.	Fin./ Max.	
15	conglomerate	2	B	II(III)	C H	60,500	256,000	144,700	317,000	5.23	0.48	24	20	83	H.R.
15	conglomerate	2	B	II(III)	C H	75,100	86,200	97,000	139,250	1.85	0.68	34	24	70	H.L.
28	conglomerate	1(2)	B	II	B	16,560	25,150	23,240	48,200	2.90	0.96	85	48	56	H.R.
28	conglomerate	1(2)	B	II	B	12,800	19,050	18,100	42,000	3.28	1.16	110	58	53	H.L.

Test Pit No.2

Depth (m)	Rock Species	W	H	C	Eval	D (kg/cm2)	Et (kg/cm2)	Es (kg/cm2)	E (kg/cm2)	E/D	Cp	Def. Max.	Def. Fin.	Fin./ Max.	
8.5	conglomerate	4	D	IV	C L	6,100	10,600	9,200	15,900	2.61	5.00	250	155	62	Par.H.R.
8.5	conglomerate	4	E	IV(V)	D	1,570	3,530	2,900	6,200	3.92	19.50	975	750	77	Par.H.L.
8.5	conglomerate	4	D	IV	C L	6,300	14,400	12,500	13,600	2.16	3.00	295	185	62	Per.H.R.
8.5	conglomerate	4	E	IV(V)	D	18,650	35,350	31,100	29,900	1.60	0.75	100	45	45	Per.H.L.

D:Modulus of deformation
Et:Tangential modulus of elasticity
Es:Secont modulus of elasticity
E:Modulus elasticity
Cp:Coefficient of deformation performance
Def.Max:Maximum deformation
Def.Fin:Final deformation

H:Horizontal
R:Right
L:Left
Par.:Pararel
Per.:Perpendicular

Note:Test Results are offered by ICE

Table 7-9 Geological Sequence and Lithological Characters in the Los Llanos Project Area and the Vicinity

Geologic Age			Symbol Mark DW1	Symbol Mark DW2	Symbol Mark DW3	Kind of Uncosolidated Deposits and/or Rocks	Remarks
Cenozoic Era	Quaternary Period	Holocene	1			Alluvium and colluvium	
				Gl	Gl	Riverbed deposits	
				Co		Colluvial deposits (Includes residual soil)	
					Ta	Talus deposits	
		Oligocene - Pleistocene		Te	Te	Terrace deposits	
			6			Intrusive rocks (Gabbro, granite, rhyolite)	
				Ir		Intrusive rocks (Monzodiorites, monzonites)	
	Tertiary Period	Oligocene - Pleistocene	8b			Sedimentary rocks (Limestone, sandstone, claystone)	
				T_I		Siltstone, claystone	
				T_{II}		Sandstone with shale and conglomerate	So-called "Terraba Formation", according to Reference No (2).
					S_i	Siltstone (Siliceous)	
					S_s	Sandstone with siltstone and shale	
		Jurassic - Eocene		T_{III}		Sandstone, volcanic sandstone, tuff	
Mesozoic Era			9			Peridotite, tholeiite basalt with pelagic sedimentary rocks	So-called "Nicoya Complex", according to Reference No. (4).
				D_o/B_a	$D_o - B_a$	Dolerite - basalt	

Notes: 1. "Symbol mark" in the above table refers to geological abbreviations in figures attached to this report.

2. "DW1", "DW2", and "DW3" correspond to "Fig. 7-1", "Fig. 7-2 and Fig. 7-9", and "Fig. 7-3 and Fig. 7-5", respectively.

Table 7-10 Distribution of Seismic Velocity Layers at the Damsite

Layer No.	PS-1-PS-8 *1)			PS-3 2)		
	Seismic Velocity (km/sec)	Depth(*) to Layer's Lower Boundary (m)	Remarks	Seismic Velocity (km/sec)	Depth(*) to Layer's Lower Boundary (m)	Remarks
1	0.4-0.6	0-10	Rather shallow on the foot of bank or thinned out	0.35-0.7	2-5	Rather shallow on the foot of the bank
2	1.4-1.8	5-14	Rather shallow on the the foot of the bank	0.9-1.1	10-21	Rather shallow on the foot of the bank
3	2.0-3.5	8-21	Rather shallow on the foot of the bank	2.7-3.1		
4	3.5-4.0		Rather shallow on the foot of the bank			

Note:*"Depth" is counted from the ground surface.
1) Based on interpreted profiles offered from ICE
2) Based on interpreted profile of re-analysis by JICA Study Team

Table 7-11 Distribution of Seismic Velocity Layers along Headrace Tunnel Route

Layer No.	PL-1 (Middle part)			PL-2 (Lower part)		
	Seismic Velocity (km/sec)	Depth(*) to Layer's Lower Boundary (m)	Remarks	Seismic Velocity (km/sec)	Depth(*) to Layer's Lower Boundary (m)	Remarks
1	0.3-0.4	0-2	On top of ridge only	0.3	0-6	On top of ridge only
2	0.5-0.8	0-9	On top of ridge only	0.6-0.7	6-19	On top of ridge only
3	1.0	0-12	On top of ridge only	1.0-1.1	11-31	Thinned out in part
4	1.4-1.5	0-18	Not continuous	1.4-1.7	19-37	Thinned out in part
5	1.7-2.5	5-36	Not continuous	2.0-2.2	34-66	Not continuous
6	4.5-5.0			3.4-4.6		

Note:*"Depth" is counted from the ground surface.
Based on interpreted profiles of re-analysis by JICA Study Team

Table 7-12 Distribution of Seismic Velocity Layers along Penstock Routes

Layer No.	PP-1			PP-2		
	Seismic Velocity (km/sec)	Depth(*) to Layer's Lower Boundary (m)	Remarks	Seismic Velocity (km/sec)	Depth(*) to Layer's Lower Boundary (m)	Remarks
1	0.3	0-7	Thin and partially missing	0.3	0-5	Thin and partially missing
2	0.6-1.0	0-15	Partially missing	0.6-1.0	0-15	Thin and in part only
3	1.2-1.5	0-14	High elev. part only	1.0	0-12	Thin and in part only
4	1.5-2.6	15-38		1.4-1.6	0-32	Prtially missing
5	2.3-2.4	24-40	Low elev. part only	2.5-2.9	0-96	Thick at high elev. part Thinned out at the foot of slope
6	3.6-4.5			4.3		

Note:*"Depth" is counted from the ground surface.
Based on interpreted profiles of re-analysis by JICA Study Team

Table 7-13 Distribution of Seismic Velocity Layers at the Power Station Site

Layer No.	Seismic Velocity (km/sec)	Depth(*) to Layer's Lower Boundary (m)	Remarks
1	0.2-0.3	0-4	Partially missing
2	0.5-0.6	0-7	Thin and missing at the lower part
3	1.3-1.7	3-14	Rather thin at the lower part
4	2.3-3.4		

Note:*"Depth" is counted from the ground surface.
Based on interpreted profiles of re-analysis by JICA Study Team

Table 7-14 Correlation between Seismic Velocity Layers and Geologic Conditions at the Damsite

Geologic Conditions / Layers	Topsoil	Residual Soil	Talus	Rocks			
				Strongly Weathered	Moderately Weathered	Slightly Weathered	Fresh, Sound
Layer No. 1	———	———	———	———			
Layer No. 2				———	———		
Layer No. 3					———	———	———

Table 7-15 Correlation between Seismic Velocity Layers and Geologic Conditions at Penstock Route and Power Station Site

Geologic Conditions / Layers	Topsoil	Residual Soil	Talus	Rocks			
				Strongly Weathered	Moderately Weathered	Slightly Weathered	Fresh, Sound
Layer No. 1	———	———	———				
Layer No. 2				———			
Layer No. 3				———	———		
Layer No. 4					———	———	
Layer No. 5						———	
Layer No. 6						———	———

Table 7-16 Standard of Rock Classification for Drilling Core

W	Weathering	H	Hardness	C	Interval of Cracks
1	Very fresh. No weathering of mineral component.	1	Very hard. Broken into knifeedged pieces by strong hammer blow.	1	Over 50cm
2	Fresh. Some minerals are weathered slightly. Usually no brown crack.	2	Hard. Broken into pieces by strong hammer blow.	2	20-50cm
3	Fairly fresh. Some minerals are wethered. Cracks are stained and with weathered materials.	3	Somewhat brittle. Broken into pieces by medium hammer blow.	3	5-20cm
4	Weathered. Fresh portions still remain partially.	4	Very brittle. Easilly broken into pieces by medium hammer blow.	4	1-5cm
5	Strongly weathered. Most minerals are weathered and altered to second minerals.	5	Soft. Able to dig with hammer.	5	Under 1cm

Table 7-17 Grouping of Rock Classification for Drilling Core

Symbol Mark of Grouping	Rock Calssification for Drilling Core	Remarks
a	W=1>2 H=1>2 C=1>2	W:Weathering degree H:Hardness C:Interval of cracks
b	W=1<2 H=2>3 C=1<2	
c	W=2<3>4 H=2<3 C=2>3	
d	W=3>4>5 H=3>4 C=2<3>4	
e	W=3<4<5 H=3<4<5 C=3<4<5	

Table 7-18 Standard of Rock Mass Classification for Adits

W	Weathering	H	Hardness	C	Interval of Cracks
1	Very fresh. No weathering of mineral component.	A	Very hard. Broken into knifeedged pieces by strong hammer blow.	I	Over 100cm
2	Fresh. Some minerals are weathered slightly. Usually no brown crack.	B	Hard. Broken into pieces by strong hammer blow.	II	40-100cm
3	Fairly fresh. Some minerals are wethered. Cracks are stained and with weathered materials.	C	Somewhat brittle. Broken into pieces by medium hammer blow.	III	20-40cm
4	Weathered. Fresh portions still remain partially.	D	Very brittle. Easilly broken into pieces by medium hammer blow.	IV	5-20cm
5	Strongly weathered. Most minerals are weathered and altered to second minerals.	E	Soft. Able to dig with hammer.	V	Under 5cm

Table 7-19 Grouping of Rock Mass Classification for Adits

Symbol Mark of Grouping	Rock Calssification for Drilling Core	Remarks
A	W=1>2 H=A>B C=I>II	W:Weathering degree H:Hardness C:Interval of cracks
B	W=1>2>3 H=A>B>C C=I>II>III	
C_H	W=1<2>3 H=A<B>C C=I<II>III	
C_M	W=2>3>4 H=B>C>D C=II>III>IV	
C_L	W=2<3-4>5 H=B<C-D>E C=II<III-IV>V	
D	W=4<5 H=D<E C=IV<V	

Table 7-20 General Figures of the Headrace Tunnel Cover in its Up-stream Half and Down-stream Half Sections

Tunnnel Section	Tunnel Cover (m)	Approximate Tunnel Length (m)	Remarks
Up-stream half section	Less than 100	495	The thinnest cover is around the intake site.
	100 to 200	1,370	
	200 to 280*1	905	*1:The thickest cover in the up-stream half section.
Down-stream half section	Less than 100	945	The thinnest cover is around Quebrada Jilguero.
	100 to 200	840	
	200 to 280*2	1,050	*2:The thickest cover in the up-stream half section.

Table 7-21 Location with Thin Cover in the Headrace Tunnel

Location	Distance(TD) from Intake Site (m)	Approximate Tunnel Cover (m)	Remarks
Quebrada (A)*	630	100	
Quebrada (B)*	1,570	80	
Quebrada Jilquero	3,010	20	
Quebrada La Mina	5,320	70	

Note : *(A) and (B) are named temporarily in the report.

Table 7-22 Results of Deformation Test in Drillholes at Damsite

PHLL2SP

DEPTH(m)	ROCK	EVAL	W	H	C	Db(kgf/cm2)	Eb(kgf/cm2)
8.7	conglomerate	c	3(2)	3(2)	2	27,200	46,500
15.0	conglomerate	b	2	2	1	152,300	224,400
15.5	conglomerate	b	2	2	1	128,450	120,200
25.0	conglomerate	b	2	2	1	61,550	100,300
25.4	conglomerate	b	2	2	1	92,700	95,000
		b	AVERAGE			109,000	135,000
			S.D.			39,900	60,600
		c	AVERAGE			27,200	46,500
			S.D.			----	----

PHLL3SP

DEPTH(m)	ROCK	EVAL	W	H	C	Db(kgf/cm2)	Eb(kgf/cm2)
7.0	conglomerate	c	3(2)	3(2)	3(2)	80,000	99,500
8.0	conglomerate	b	2	2(3)	2(1)	132,336	172,050
24.5	conglomerate	b	2	2(3)	2	212,000	115,350
25.0	conglomerate	b	2	2(3)	2	129,450	158,000
39.3	conglomerate	b	2	2	1(2)	210,350	256,300
39.8	conglomerate	b	2	2	1(2)	128,150	125,700
		b	AVERAGE			162,000	165,000
			S.D.			44,500	55,800
		c	AVERAGE			80,000	99,500
			S.D.			----	----

PHLL4SP

DEPTH(m)	ROCK	EVAL	W	H	C	Db(kgf/cm2)	Eb(kgf/cm2)
20.1	conglomerate	b	2	2(3)	1(2)	34,100	77,000
29.7	conglomerate	b	2	2(3)	1(2)	48,500	77,300
30.7	conglomerate	c	2(3)	3(2)	3	47,600	60,850
40.0	conglomerate	b	2	2	1(2)	75,325	104,300
40.3	conglomerate	b	2	2	1(2)	98,525	184,438
49.8	conglomerate	b	2	2(3)	2(1)	158,850	250,665
50.3	conglomerate	b	2	2(3)	2(1)	100,160	111,300
		b	AVERAGE			86,000	134,000
			S.D.			44,400	69,300
		c	AVERAGE			47,600	60,850
			S.D.			----	----

All data

b	AVERAGE	123,000	139,000
	S.D.	51,200	55,500
c	AVERAGE	51,000	72,000
	S.D.	26,600	27,400

Note:Test Result are offered by ICE

Table 7-23 Results of Deformation Test in Drillholes at Penstock Route and Power Sation Site

PHLL18TP

DEPTH(m)	ROCK	EVAL	W	H	C	DIA(mm)	POISSON R	Db(kgf/cm2)	Eb(kgf/cm2)
10.3	conglomerate	cg-c	3	2	3	76.2	0.25	37,000	33,000
10.5	conglomerate	cg-c	3	2	3	76.2	0.25	26,000	59,000
16.1	conglomerate	cg-b	3	2	2	76.2	0.25	98,000	79,000
16.5	conglomerate	cg-b	3	2	2	76.2	0.25	108,000	72,000
22.3	conglomerate	cg-a	3	2	1	76.2	0.25	126,000	100,000
22.5	conglomerate	cg-a	3	2	1	76.2	0.25	101,000	91,000
29.3	conglomerate	cg-b	2	2	2	76.2	0.25	91,000	78,000
29.5	conglomerate	cg-b	2	2	2	76.2	0.25	54,000	65,000
		cg-a	AVERAGE					114,000	96,000
			S.D.					17,700	6,400
		cg-b	AVERAGE					88,000	74,000
			S.D.					23,600	6,500
		cg-c	AVERAGE					32,000	46,000
			S.D.					7,800	18,400

PHLL19CM

DEPTH(m)	ROCK	EVAL	W	H	C	DIA(mm)	POISSON R	Db(kgf/cm2)	Eb(kgf/cm2)
4.9	terrace dep					76.66	0.25	3,000	10,000
9.1	mudstone(marl)	ma-b	3	3(4)	4(5)	76.49	0.25	6,000	13,000
12.2	mudstone(marl)	ma-b	3	3(4)	4(5)	76.32	0.25	2,000	7,000
17.5	mudstone(marl)	ma-a	3(2)	3(4)	4(3)	75.95	0.25	9,000	19,000
22.0	mudstone(marl)	ma-a	3(2)	3(4)	4(3)	77.49	0.25	9,000	24,000
24.5	mudstone(marl)	ma-a	3(2)	3(4)	4(3)	76.79	0.25	4,000	16,000
		ma-a	AVERAGE					7,000	20,000
			S.D.					2,900	4,000
		ma-b	AVERAGE					4,000	10,000
			S.D.					2,800	4,200

Note:Result of PHLL18TP and Test Data of PHLL19CM are offered by ICE

Table 7-24 Results of Laboratory Test of Drillcore at Damsite (1/3)

PHLL1SP

DEPTH (m)	ROCK	EVAL	W	H	C	Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
9.75	conglomerate	d	4(5)	3(4)	2(3)	0.82	2.75	493
20.50	conglomerate	c	3(4)	3(2)	2	1.30	2.77	483
32.60	conglomerate	d	3	3	3	1.36	2.66	251
49.45	conglomerate	c	2(3)	2(3)	2	0.68	2.73	560
51.50	conglomerate	d	3(2)	2(3)	2	1.10	2.70	222
58.00	conglomerate	b	2	2	2(1)	0.25	2.75	964
64.75	conglomerate	b	2	2	2(1)	0.55	2.75	236
		b	AVERAGE			0.40	2.75	600
			S.D.			0.21	0.00	515
		c	AVERAGE			0.99	2.75	521
			S.D.			0.44	0.03	55
		d	AVERAGE			1.09	2.70	322
			S.D.			0.27	0.05	149

PHLL2SP

DEPTH (m)	ROCK	EVAL	W	H	C	Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
2.50	conglomerate	c	3	3	2	2.20	2.69	678
11.10	conglomerate	c	3(2)	3(2)	2	1.69	2.68	1,129
14.70	conglomerate	b	2	2	1	1.75	2.67	1,017
19.60	conglomerate	b	2	2	1	1.48	2.68	623
24.40	conglomerate	b	2	2	1	1.71	2.70	847
30.70	conglomerate	b	2	2	2	1.81	2.69	679
		b	AVERAGE			1.69	2.69	791
			S.D.			0.14	0.01	178
		c	AVERAGE			1.95	2.69	904
			S.D.			0.36	0.01	319

Table 7-24 Results of Laboratory Test of Drillcore at Dam Site (2/3)

PHLL3SP

DEPTH (m)	ROCK	EVAL	W	H	C	Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
4.70	conglomerate	c	3(2)	3(2)	3(2)	1.09	2.76	451
7.00	conglomerate	c	3(2)	3(2)	3(2)	2.00	2.68	422
10.80	conglomerate	b	2	2(3)	2(1)	0.69	2.77	1,154
14.34	conglomerate	b	2	2(3)	2(1)	0.73	2.82	635
20.30	conglomerate	b	2	2(3)	2	1.76	2.67	621
24.50	conglomerate	b	2	2(3)	2	2.07	2.81	285
30.15	conglomerate	b	2	2(3)	2	0.82	2.88	851
36.75	conglomerate	b	2	2	1(2)	1.32	2.76	567
40.00	conglomerate	b	2	2	1(2)	0.71	2.75	959
45.80	conglomerate	e	3	4	5	1.09	2.78	1,185
51.25	conglomerate	b	2	3	2(1)	1.19	2.76	850
53.60	conglomerate	b	2	3	2(1)	1.04	2.78	1,132
61.90	conglomerate	b	2	2	1(2)	1.27	2.84	340
65.55	conglomerate	b	2	2	1(2)	1.37	2.76	902
68.80	conglomerate	b	2	2	1(2)	0.68	2.79	796
74.50	conglomerate	b	2	2	1(2)	1.17	2.78	732
80.00	conglomerate	b	2	2	1(2)	0.78	2.79	847
		b	AVERAGE			1.11	2.78	762
			S.D.			0.43	0.05	256
		c	AVERAGE			1.55	2.72	436
			S.D.			0.64	0.06	20
		e	AVERAGE			1.09	2.78	1,185
			S.D.			---	---	---

PHLL4SP

DEPTH (m)	ROCK	EVAL	W	H	C	Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
12.75	conglomerate	d	3(2)	3	3	1.17	2.72	670
20.80	conglomerate	b	2	2(3)	1(2)	1.53	2.75	223
26.00	conglomerate	b	2	2(3)	1(2)	1.16	2.71	488
29.00	conglomerate	b	2	2(3)	1(2)	1.85	2.73	153
36.00	conglomerate	b	2	2	1(2)	3.11	2.77	1,207
40.00	conglomerate	b	2	2	1(2)	0.70	2.79	581
49.70	conglomerate	b	2	2(3)	2(1)	1.06	2.72	699
53.80	conglomerate	a	2(1)	2	1(2)	0.96	2.70	565
59.50	conglomerate	a	2(1)	2	1(2)	1.09	2.71	819
		a	AVERAGE			1.03	2.71	692
			S.D.			0.09	0.01	179
		b	AVERAGE			1.57	2.75	558
			S.D.			0.85	0.03	380
		d	AVERAGE			1.17	2.72	670.48
			S.D.			---	---	---

Table 7-24 Results of Laboratory Test of Drillcore at Dam Site (3/3)

Total

		Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
a	AVERAGE	1.03	2.71	692
2 samples	S.D.	0.09	0.01	179
b	AVERAGE	1.25	2.76	707
26 samples	S.D.	0.61	0.05	294
c	AVERAGE	1.49	2.72	620
6 samples	S.D.	0.58	0.04	266
d	AVERAGE	1.11	2.71	409
4 samples	S.D.	0.22	0.04	212
e	AVERAGE	1.09	2.78	1,185
1 sample	S.D.	---	---	---
all sample	AVERAGE	1.26	2.74	675
39 samples	S.D.	0.55	0.05	293

Note:Test Result are offered by ICE

Table 7-25 Results of Laboratory Test of Drillcore at Power Station Site and Penstock Route

(1/3)

PHLL10TO

DEPTH (m)	ROCK	EVAL	W	H	C	Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
11.88	conglomerate	e	5(4)	4(5)	4	15.20	2.21	----
16.35	conglomerate	d	3	4(3)	3(4)	6.43	2.54	134
17.10	conglomerate	d	3	4(3)	3(4)	7.40	2.54	211
20.25	conglomerate	b	2	2	2	4.77	2.44	396
26.75	conglomerate	b	2	2	2	8.20	2.47	96
30.25	conglomerate	b	2	2(3)	2	4.55	2.50	306
33.50	conglomerate	b	2	2(3)	2	8.16	2.45	50
		b	AVERAGE			6.42	2.47	212
			S.D.			2.03	0.03	166
		d	AVERAGE			6.92	2.54	173
			S.D.			0.69	0.00	54
		e	AVERAGE			15.20	2.21	----
			S.D.			----	----	----

PHLL11TP

DEPTH (m)	ROCK	EVAL	W	H	C	Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
9.52	conglomerate	b	2(3)	3	2(3)	7.83	2.47	45
13.42	conglomerate	b	2(3)	3	2(3)	5.64	2.59	186
16.00	conglomerate	b	2(3)	3	2(3)	6.23	2.58	130
17.10	conglomerate	b	2(3)	3	2(3)	5.07	2.54	211
21.40	conglomerate	b	2(3)	3	2(3)	7.53	2.51	33
26.25	conglomerate	b	2	2(3)	2	5.45	2.61	176
		b	AVERAGE			6.29	2.55	130
			S.D.			1.14	0.05	75

PHLL12CM

DEPTH (m)	ROCK	EVAL	W	H	C	Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
6.40	conglomerate	c	2(3)	3(4)	2(3)	6.90	2.48	----
12.20	conglomerate	c	3	4(3)	3	9.20	2.46	----
19.28	conglomerate	c	3	3	3	6.84	2.52	134
24.87	conglomerate	c	3	3	3(2)	11.10	2.42	----
		c	AVERAGE			8.51	2.47	134
			S.D.			2.05	0.04	----

Table 7-25 Results of Laboratory Test of Drillcore at Power Station Site and Penstock Route (2/3)

PHLL13CM

DEPTH (m)	ROCK	EVAL	W	H	C	Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
9.25	conglomerate	c	4(3)	4(3)	3(4)	4.90	2.58	----
12.95	conglomerate	c	4(3)	4(3)	3(4)	3.70	2.64	----
17.41	conglomerate	c	4(3)	4(3)	3(4)	4.30	2.62	----
22.35	conglomerate	c	4(3)	4(3)	3(4)	2.80	2.67	----
33.75	conglomerate	c	3(2)	3	3(4)	7.90	2.35	----
37.10	conglomerate	c	4(3)	3(4)	3(4)	5.40	2.54	----
40.66	conglomerate	c	4(3)	3(4)	3(4)	3.30	2.57	172
		c	AVERAGE			4.61	2.57	172
			S.D.			1.71	0.11	----

PHLL14CM

DEPTH (m)	ROCK	EVAL	W	H	C	Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
1.20	conglomerate	e	3	3(4)	4	3.39	2.51	195
5.15	conglomerate	b	2	3(2)	2(1)	2.22	2.49	332
8.80	conglomerate	b	2	3(2)	2(1)	3.37	2.44	335
9.40	conglomerate	b	2	3(2)	2(1)	3.10	2.53	320
18.63	conglomerate	d	2	3	4	4.32	2.66	----
23.57	conglomerate	c	2	3(2)	3	2.20	2.58	311
24.28	conglomerate	c	2	3(2)	3	2.73	2.52	294
27.87	conglomerate	c	2(3)	3(2)	3	3.67	2.43	362
28.60	conglomerate	c	2(3)	3(2)	3	3.37	2.47	369
		b	AVERAGE			2.90	2.49	329
			S.D.			0.60	0.05	7.94
		c	AVERAGE			2.99	2.50	334
			S.D.			0.66	0.06	37
		d	AVERAGE			4.32	2.66	----
			S.D.			----	----	----
		e	AVERAGE			3.39	2.51	195
			S.D.			----	----	----

Table 7-25 Results of Laboratory Test of Drillcore at Power Station Site and Penstock Route (3/3)

Total

		Absorption (%)	Specific Gravity	Unconfined Compression Strength (kgf/cm2)
b	AVERAGE	5.55	2.51	201
13samples	S.D.	1.98	0.06	126
c	AVERAGE	5.22	2.52	274
15samples	S.D.	2.63	0.09	99
d	AVERAGE	6.05	2.58	173
3samples	S.D.	1.57	0.07	54
e	AVERAGE	9.30	2.36	195
2samples	S.D.	8.35	0.21	----
all data	AVERAGE	5.67	2.51	218
33samples	S.D.	2.79	0.09	113

Note:Test data are offered by ICE.

Table 7-26 Drillholes at Quebrada Azul

Number	Depth (m)	Elev. (m)	Dir.	Location	Remarks
QA-1	11.60	581.92	V	Up-stream, Middle part of slope	
QA-2	12.45	586.73	V	Mid-stream, Middle part of slope	
QA-3	11.60	588.73	V	Down-stream, Middle part of slope	
QA-4	15.60	602.89	V	Mid-stream, Top part of slope	
QA-5	17.00	613.94	V	Mid-stream, Top part of slope	
QA-6-1	1.80	565.95	V	Mid-stream, Foot of slope	Blasting
QA-6-2	1.80	565.94	V	Mid-stream, Foot of slope	Blasting
QA-6-3	1.80	565.94	V	Mid-stream, Foot of slope	Blasting
QA-7	11.55	601.01	V	Down-stream Middle part of slope	
Total	85.20 (m)			9 holes	

Note:Data are offered by ICE

Table 7-27 Seismic Prospecting Traverses at Quebrada Azul

Name	Length (m)	Location	Remarks
PQA1	235	Foot of slope, pararell to slope	1)
PQA2	115	Top of slope, pararell to slope	2)
PQA3	107	Down-stream, perpendicular to slope	2)
PQA4	106	Mid-stream, perpendicular to slope	1)
PQA5	116	Up-stream, oblique to slope	2)
PQA6	115	Top of slope, pararell to slope	2)
Total	794	6 lines	

1) Data were offered by ICE.

2) Data have not been offered yet.

Table 7-28 Results of Laboratory Test for Concrete Aggregate

	Soundness		Abrasion
	Fine Aggregate	Coarse Aggregate	
Rock Quarry			
Dam Site Adit No.1	-	23.45 %	40 %
Quebrada Azul			
Outcrop	-	7.00 %	25 %
QA-6	-	8.15 %	26 %
Los Alacranes	-	56.50 %	32 %
Alluvial Sediments			
Rio Paquita			
Trench No.2	34.00 %	32.00 %	25 %
Trench No.7	39.80 %	50.30 %	22 %
Trench No.12	32.90 %	53.00 %	26 %
Trench No.13	-	-	30 %
Rio Naranjo			
Trench No.6	-	14.59 %	15 %
Trench No.7	-	-	-
Trench No.8	21.00 %	11.67 %	21 %
Trench No.11	-	-	-
Trench No.14	16.25 %	5.12 %	16 %
Trench No.15	-	-	17 %
Trench No.17	-	-	-
Trench No.18	-	-	-
Trench No.33	16.36 %	11.41 %	18 %
Trench No.43	-	-	-
Trench No.54	28.34 %	28.13 %	-
Trench No.61	10.91 %	15.19 %	9 %
Trench No.65	-	12.50 %	18 %
Rio Canas			
Trench No.4	24.21 %	22.30 %	21 %