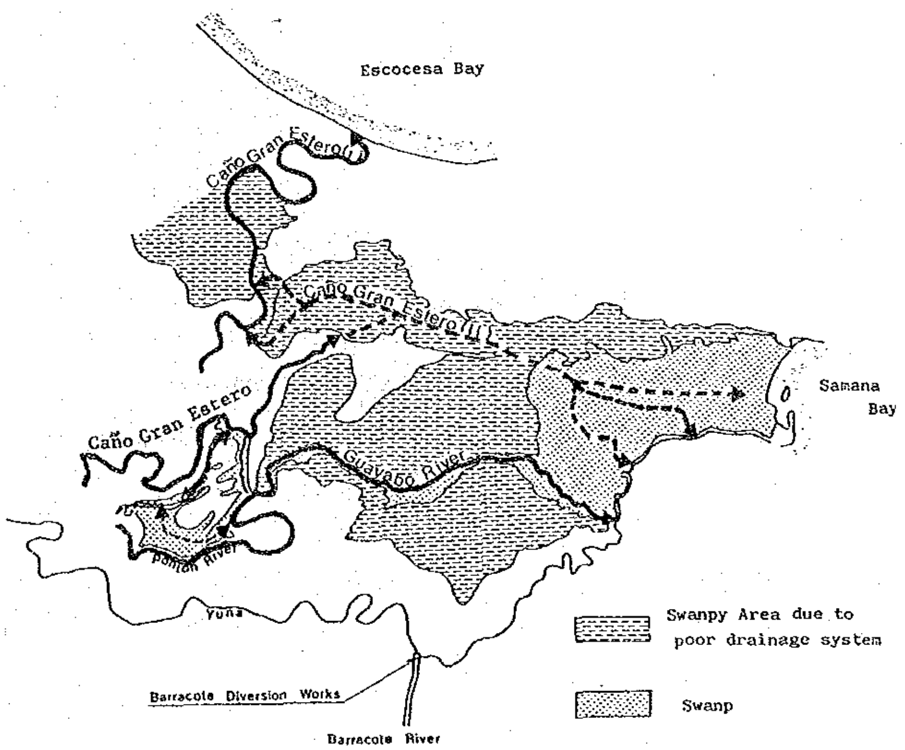
5.4 Drainage

The excess water within the study area is drained mainly through the Yuna River which runs the southern part of the zone to the east and through the Caño Gran Estero which flows the central part of the area to the north.

Others rivers which are used as drainage canals are the Caño Ponton, the Guayabo River, etc., but the thick growth of water plants and weeds causes the poor function of these draines; the topographically low elevation featured by this area - land with elevation less than 2 m covers one-third (8,000 ha) of the study area, is another component affecting the drainage system. Some part of the Aguacate sector is occupied by lakes and marshes with stagnated rain water.

The study area is, therefore, identified by inadequate land drainage except the natural banks along the Yuna River and the terrace in the Aguacate sector.

FIG. B.5.6 PRESENT DRAINAGE SITUATION

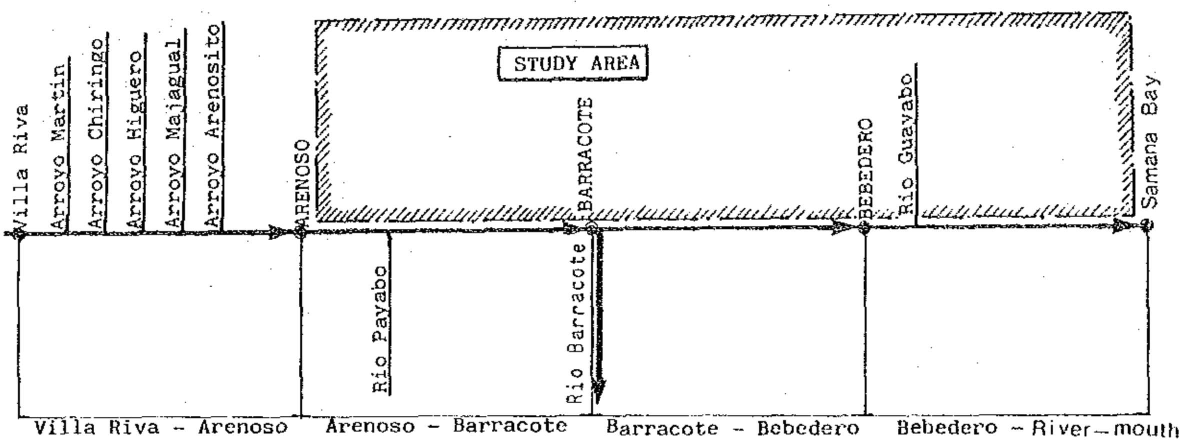


5.4.1 Yuna River

The Yuna River, within the study area, passes through Villa Riva, Arenoso and El Limon, diverts most part of its flow into the Barracote River, joins the flow from the Guayabo River at the confluence and inflows finally, to the Samaná Bay.

The river may be divided into the following four sections:

- Villa Riva - Arenoso (Main Stream of the flood area of the River)
- Arenoso - Barracote (Main stream of the River)
- Barracote - Bebedero (Flow diverted from the main stream)
- Bebedero - River-mouth (Tidal zone)



(1) Villa Riva - Arenso

This section is located between Villa Riva and Arenoso in which frequent inundation is observed. The following tributaries flow into the Yuna River; the catchment area of these tributaries vary from 1 km^2 to 5 km^2.

- Arroyo Martin
- Arroyo Chiringo
- Arroyo Higuero
- Arroyo Majagual
- Arroyo Arenosito

Especially, at the confluences of the Yuna River with such tributaries as the Arroyo Majagual and the Arroyo Arrenosito, the overflow is very often observed due to their topographic condition.

(2) Arenoso - Barracote Section

This section originates at 22 km from the river-mouth to the upper stream with sectional area ranging between 300 m^2 and 500 m^2. The greater portion of flows at this section diverts to the Barracote River. The riverbed slope in this sectin is approximate 1/3,000 and water level has been observed since 1969 at the El Limon gauging station. The ground level on both banks of the river is around 5 m at Barracote and around 13 m at Arenoso; no artificial bank is found in this section.

(3) Barracote - Bebedero Section

This section covers the section between the diversion point, 22 km from the river-mouth and Bebedero, 12 km from the river-mouth. At Bebedero tide's influence is observed. The sectional area is included in the range 180 m^2 - 220 m^2 with the riverbed slope of 1/9,000.

(4) Bebedero - the River-mouth

Tide of the Samaná Bay affects the water level up to Bebedero, 12 km from the river-mouth. The sectional area of the river becomes more narrow as the flow accesses to the river-mouth. It is supposed that the lowest catchment area near the Samana Bay is affected by the flooding of the river.

5.4.2 Actual Flow Capacity of the Yuna River

The actual flow capacity of the Yuna River was estimated on the basis of the information of flooding occurred in November, 1985.

Information of the water level at different stations are as follows:

Villa Riva	=	+13.82 (Q = 588 m^3/s)
El Limon	=	+8.64 (Q = 584 m^3/s)
La Jagua	=	+3.62 (Q = 67 m^3/s)
Conf. of Guayabo	=	+1.44
River-mouth	=	+0.21

Based on the above-mentioned information the surface slope related to each section was calculated as,

Villa Riva - La Jagua	=	1/3,300
La Jagua - Conf. of Guayabo	=	1/5,700
Conf. of Guayabo - River-mouth	=	1/5,700

Narrow area of the each section are identified as follows:

Villa Riva - Arenoso	....	No. 56 Section at Chiringo
Arenoso - Barracote	....	No. 32 Section at La Garza
Barracote - Bebedero	....	No. 18 Section at Barracote
Bebedero - River-mouth	....	No. 1 Section at River-mouth

In Table B.5.15 present flow capacity are computed.

This capacity was determined from the Manning Formula,

$$V = 1/n\ (A/P)^{2/3}\ I^{1/2}$$

where, n : 0.035

A : Area

P : Wetted perimeter

I : Slope

TABLE B.5.15 FLOW CAPACITY OF THE YUNA RIVER

	Control Section	Area	Wetted Perimeter (m)	Velocity (m/s)	Discharge (m^3/s)	Location
Villa Riva	Inlet	420	80	1.5	631	Villa Riva
	Narrow Section	350	65	1.53	535	Chiringo
Arenoso	Outlet	400	80	1.45	580	Arenoso
Arenoso	Inlet	420	84	1.45	610	Arenoso
	Narrow Section	392	65	1.65	646	La Garza
Barracote	Outlet	458	85	1.53	700	Barracote
Barracote	Inlet	222	65	1.13	250	Barracote
	Narrow Section	170	58	1.02	173	Barracote
Bebedero	Outlet	194	72	0.96	187	Conf. Guayabo
Bebedero	Inlet	170	70	0.68	116	Conf. Guayabo
	Narrow Section	110	70	0.51	56	River Mouth
River Mouth	Outlet	110	70	0.51	56	River Mouth

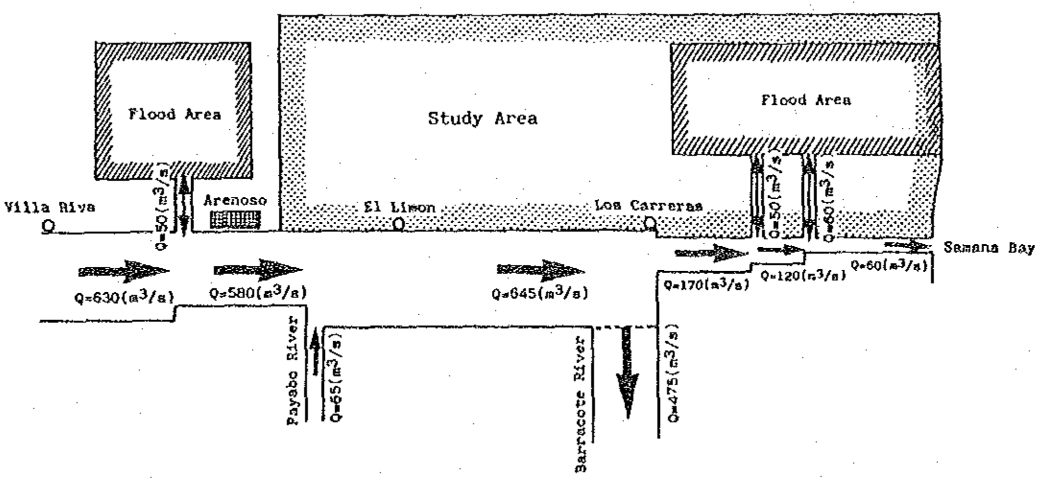
The above table discloses that a narrow area is found between Chiringo and Arenoso, within Arenoso-Villa Riva section, in which an overflow of the river occurs very often and a catchment area extended there constitutes flood storage plain.

5.4.3 Features of Flooding in 5 Years Return Period

Features of flooding in 5 years return period of the Yuna River are as summarized in the table below.

Section		Elevation of Bank (m)	Design Water Level (m)	Discharge (m^3/s)	Remarks
Villa Riva	Inlet	14.6	13.9	630	
Arenoso	Outlet	11.5	12.2	580	Overflow Q = 50 m^3/s
Arenoso	Inlet	12.1	12.0	580	Full Flow
	Conf. of Guayabo	10.1	9.9	645	Inflow of Payabok Q = 65 m^3/s
	Narrow Section	6.2	6.2	645	Full Flow
Barracote	Outlet	5.4	4.5	645	
Barracote	Inlet	5.2	4.4	170	Diversion of Barracote Q = 475 m^3/s
Bebedero	Outlet	2.1	1.4	170	
Bebedero	Inlet	0.8	1.2	120	
River Mouth	Outlet	0.2	0.2	60	

FIG. B.5.7 FEATURE OF FLOODING IN 5 YEARS RETURN PERIOD



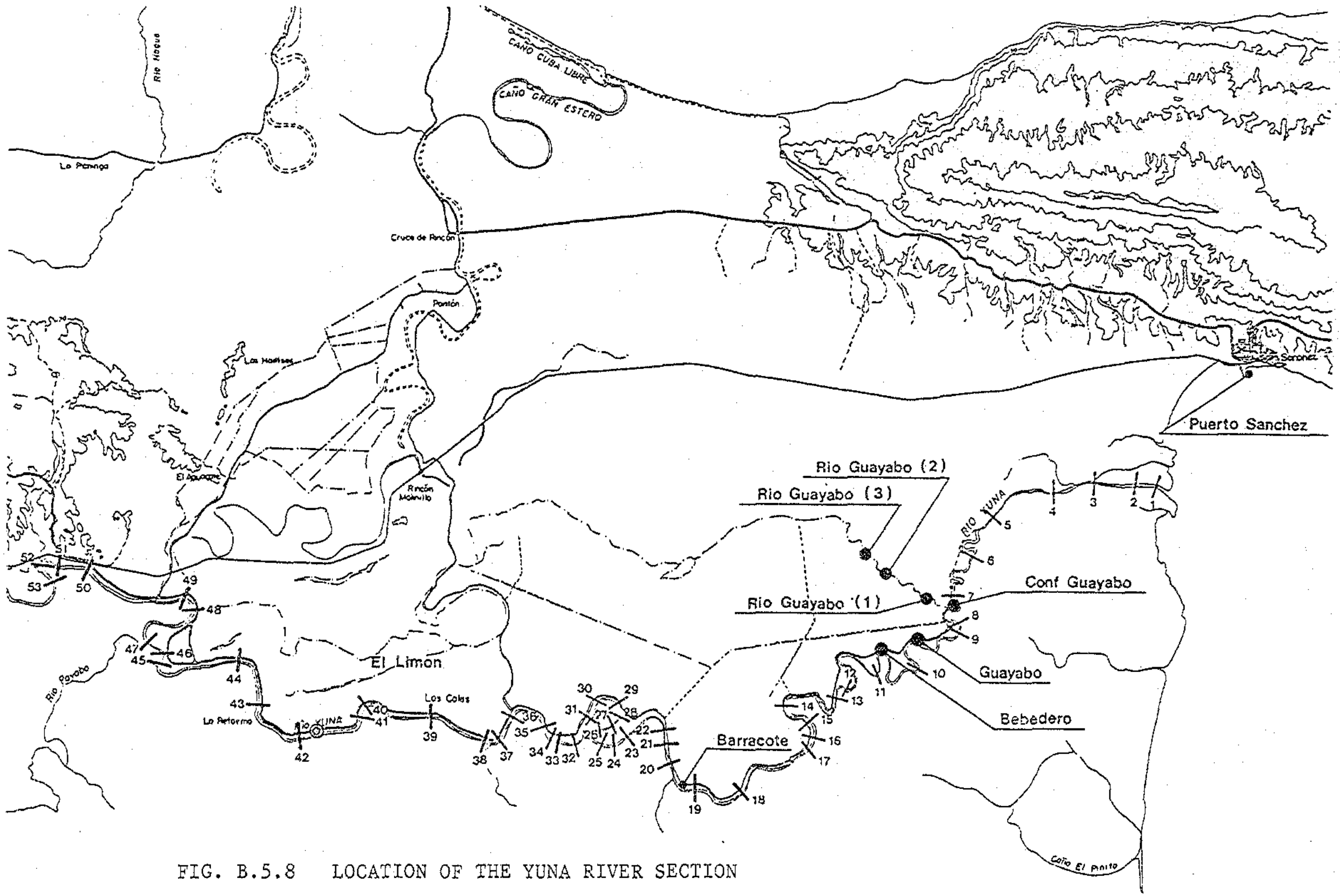


FIG. B.5.8 LOCATION OF THE YUNA RIVER SECTION

TABLE B.5.16 YUNA RIVER'S CONDITION

Section	Accumulated distance km	Levee level	EL Area (m^2)	Riverbed level	Reference
Yu-1	0.0	0.09	103.0	-2.83	River Mouth
-2	0.8	0.38	121.1		
-3	1.8	0.50	111.8		
-4	2.8	0.73	142.2		
-5	4.21	1.00	130.6	-3.42	
-6	5.5	1.48	144.9		Conf. Guayabo
-7	7.0	1.85	172.0		
-8	7.8	2.14	182.8		
-9	8.0	2.19	203.0		
-10	10.96	2.67	163.3	-3.38	
-11	12.5	3.44	184.6		
-12	14.5	3.78	216.4		
-13	15.0	3.86	206.2		
-14	17.0	4.38	194.1		
-15	18.15	4.28	190.1	-1.81	
-16	19.0	4.59	219.3		
-17	19.5	4.39	214.3		
-18	21.0	4.05	170.7		
-19	22.0	5.06	209.4		Barracote
-20	22.51	5.62	456.7	-2.28	
-21	23.0				
-22	23.5	5.24	436.2		
-23	24.5				
-24	25.0	4.90	295.4		
-25	25.58	5.80	359.6	-3.62	
-26	26.0	6.22	558.1		
-27	26.4	5.95	453.7		
-28	26.7				
-29	27.0	5.92	324.6		
-30	27.53	6.13	359.0	-3.55	
-31	27.9	6.65	527.0		
-32	28.4	6.02	286.5		
-33	28.8	6.76	362.2		
-34	29.0				
-35	29.34	6.60	356.4	0.12	
-36	30.5	7.06	366.9		
-37	31.0	7.51	434.1		
-38	31.5	7.34	288.4		
-39	33.0	7.90	342.1		
-40	34.40	7.96	364.0	0.87	
-41	34.9	8.40	377.6		
-42	36.0	8.50	394.9		
-43	38.3				
-44	39.3				
-45	40.88			2.61	
-46	41.2				
-47	41.5				

TABLE B.5.16 (Cont'd)

Section	Accumulated distance km	Levee level	EL Area (m^2)	Riverbed level	Reference
Yu-48	43.0	-	-	-	
-49	44.0	-	-	-	
-50	46.33	-	-	4.01	Arenoso
-51	47.5	-	-	-	
-52	48.0	-	-	-	
-53	48.5	-	-	-	
-54		-	-	-	
-55	49.68	-	-	4.32	
-56		-	-	-	
-57		-	-	-	
-58		-	-	-	
-59		-	-	-	
-60	52.16	-	-	1.13	Villa Riva

5.4.4 Drainage Systems of the Study Area

Drainage system within the study area are consisted of:

- Caño Gran Estero (I)
- Caño Gran Estero (II)
- Caño Ponton - Guayabo River
- Small streams in the Loma La Cordilleva

Escocesce Bay whose outlet faces with the exception of the Caño Gran Estero (I) system. Most of surplus water within the study area is stagnated for a long time in the above-mentioned systems, collected to one system after passing through swamps in El Guayabo, drained into the Yuna River, and finally flows into the Samaná Bay.

(1) Caño Gran Estero (I) System

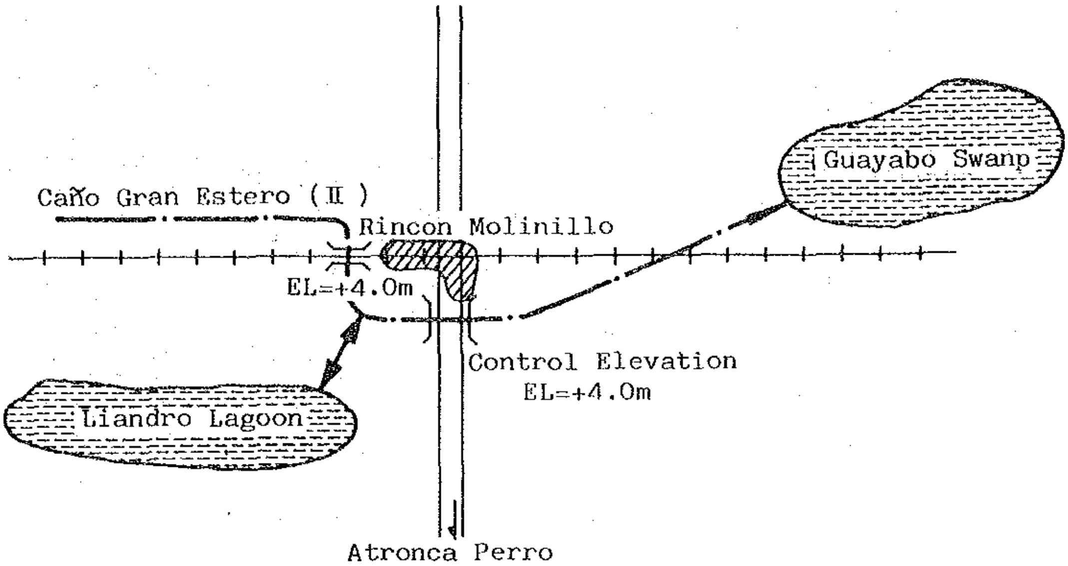
This system originates at near the Ponton village, passes through Cruce de Rincon and drains into the Escocesa Bay after removing surplus water from El Aguacate area. The cross-section at lower reach of the system is comparatively large in comparison with its catchment area. The draining capacity of this system has become very low due to: 1) closure of its outlet caused by accumulation of drifting sand and 2) thick growth of water plants and weeds within the system.

(2) Caño Gran Estero (II) System

This system originate at Cienega Vieja passes Ricon Molinillo crosses the old trace of railroad, and flows into the Guayabo swamp.

The collected water in this system is drained only when it rains and the course of this system can not be clearly identified because of the thick growth of weeds.

This system is communicated with Liandro swamp which is extended between the railroad and the Rincon Molinillo-Atronca Perro Road. The flow direction of this sytem depends on water level.



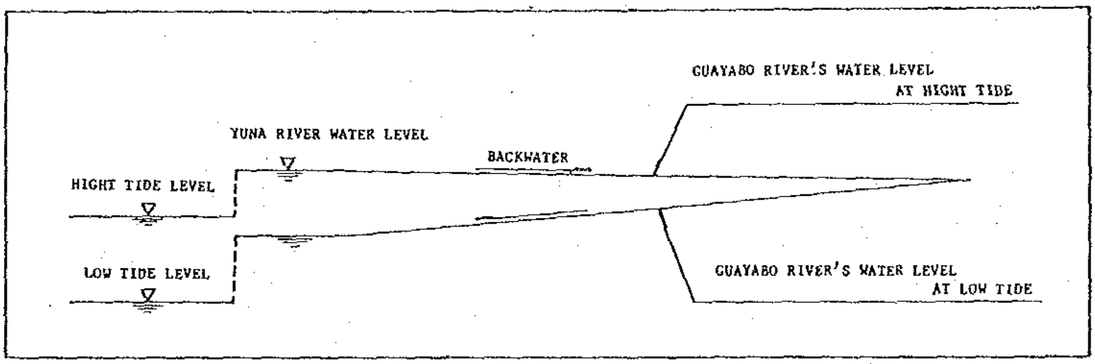
(3) Caño Ponton-Guayabo River System

Like the Caño Gran Estero System, this system is considered to be one of a flooded tributaries of the Yuna River. Originating at Ponton Vallage, this system passes by El Jobo village and reaches to the Yuna River. The drainage of this system is poor because of inferior draining capacity at the lower reach of the Caño Ponton, though its upper reach has a gradient sufficiently enough to drain adequately.

Guayabo River does not have a sufficient gradient, and the cource of the upper reach is clearly identified. Without independent flow, the river system is strongly affected by the flooded flow from the Yuna River and the sea water level. Due to the stagnation of the flow, the growth of weeds is very common in this river and the closing of section is also observed.

Fig. B.5.9 indicates the fluctuation of water level; according to this graph, the water level of the Guayabo River follows that of the confluence with the Yuna River: the river water inflows to the Yuna River at low tide and the reverse flow is occurred at high tide.

The correlation of the water level at the confluence of the Yuna River with the Guayabo River and the Guayabo River is as illustrated below:



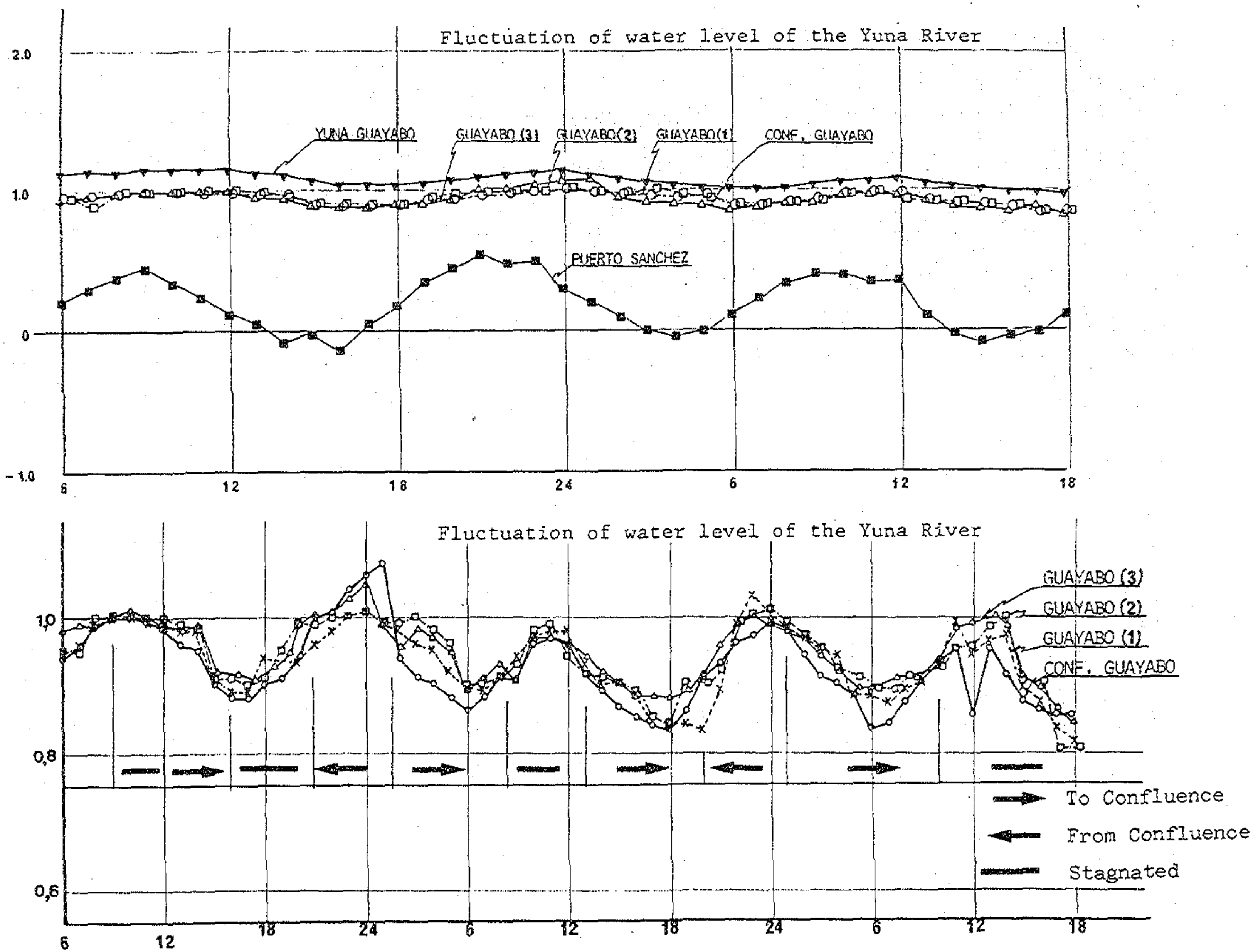


FIG. B.5.9 CORRELATION OF THE WATER LEVEL AT THE CONFLUENCE OF THE YUNA RIVER WITH THE GUAYABO RIVER

TABLE B.5.17 YUNA RIVER'S WATER LEVEL VARIATION

		Puerto Sanchez	Rio Yuna Conf. Guayabo	Rio Guayabo Guayabo	Rio Yuna Guayabo	Rio Yuna Bebedero	Rio Yuna La Jagua	Rio Yuna Barracote
8/22	6	-0.09	0.81	0.71	1.06	1.68	2.12	2.46
	7	-0.15	0.77	0.70	1.03	1.67	2.12	2.45
	8	-0.17	0.65	0.69	1.01	1.66	2.11	2.45
	9	-0.09	0.64	0.67	1.00	1.65	2.11	2.45
	10	0.11	0.65	0.65	0.99	1.64	2.11	2.45
	11	0.30	0.60	0.69	1.00	1.64	2.10	2.45
	12	0.49	0.76	0.74	1.05	1.65	2.09	2.45
	13	0.61	0.85	0.79	1.10	1.67	2.11	2.45
	14	0.71	0.90	0.84	1.11	1.69	2.12	2.45
	15	0.68	0.91	0.87	1.17	1.70	2.12	2.46
	16	0.50	0.91	0.89	1.19	1.72	2.14	2.46
	17	0.47	0.90	0.87	1.18	1.73	2.14	2.46
	18	0.26	0.85	0.86	1.17	1.73	2.16	2.48
	19	0.16	0.81	0.81	1.14	1.72	2.16	2.48
	20	0.06	0.78	0.79	1.12	1.72	2.16	2.48
	21	0.01	0.76	0.75	1.10	1.71	2.16	2.49
	22	0.11	0.74	0.77	1.08	1.71	2.16	2.49
	23	0.21	0.75	0.75	1.08	1.70	2.16	2.49
	24	0.26	0.78	0.79	1.09	1.70	2.16	2.49
8/23	1	0.31	0.80	0.79	1.10	1.71	2.16	2.49
	2	0.41	0.85	0.80	1.12	1.72	2.16	2.49
	3	0.36	0.82	0.82	1.13	1.72	2.16	2.49
	4	0.21	0.81	0.84	1.13	1.73	2.17	2.49
	5	0.11	0.76	0.79	1.13	1.73	2.17	2.49
	6	0.01	0.76	0.75	1.15	1.72	2.17	2.49
	7	-0.04	0.75	0.72	1.11	1.72	2.17	2.50
	8	-0.09	0.61	0.70	1.06	1.71	2.16	2.50
	9	-0.09	0.59	0.69	1.03	1.70	2.16	2.50
	10	0	0.58	0.69	1.03	1.69	2.16	2.49
	11	0.11	0.60	0.70	1.04	1.69	2.15	2.49
	12	0.29	0.75	0.74	1.06	1.69	2.15	2.49
	13	0.46	0.80	0.77	1.09	1.70	2.15	2.49
	14	0.61	0.83	0.73	1.12	1.71	2.15	2.49
	15	0.71	0.91	0.85	1.15	1.72	2.15	2.48
	16	0.66	0.92	0.87	1.18	1.73	2.15	2.48
	17	0.51	0.93	0.89	1.19	1.74	2.15	2.48
	18	0.31	0.90	0.87	1.18	1.74	2.16	2.48

TABLE B.5.18 GUAYABO RIVER'S WATER LEVEL VARIATION

(30 Aug. '85)

Puerto Sanchez		Rio Yuna Conf. Guayabo		Rio Guayabo (1)		Rio Guayabo (2)		Rio Guayabo (3)		Rio Yuna Guayabo	
hour	Elevo	hour	Elevo	hour	Elevo	hour	Elevo	hour	Elevo	hour	Elevo
6	0.21	6	0.94	6:10	0.95	6:20	0.95	6:20	0.98	6	1.13
7	0.31	7	0.96	7:10	0.96	7:10	0.90	7:20	0.99	7	1.14
8	0.39	8	0.98	8:10	0.99	8:20	1.00	8:20	0.99	8	1.14
9	0.46	9	1.00	9:10	1.00	9:10	1.00	9:20	1.00	9	1.15
10	0.35	10	1.00	10:10	1.00	10:10	1.00	10:20	1.01	10	1.15
11	0.26	11	1.00	11:10	0.99	11:10	1.00	11:20	1.00	11	1.15
12	0.13	12	0.99	12:10	0.99	12:00	1.00	12:20	0.99	12	1.15
13	0.06	13	0.96	13:10	0.98	13:10	0.99	13:20	0.98	13	1.13
14	-0.08	14	0.95	14:00	0.98	14:10	0.97	14:20	0.95	14	1.11
15	-0.01	15	0.90	15:10	0.90	15:20	0.91	15:20	0.99	15	1.08
16	-0.14	16	0.88	16:10	0.89	16:10	0.91	16:20	0.92	16	1.06
17	0.06	17	0.88	17:10	0.89	17:10	0.90	17:20	0.91	17	1.05
18	0.18	18	0.90	18:10	0.89	18:20	0.91	18:20	0.93	18	1.05
19	0.36	19	0.91	19:10	0.94	19:20	0.95	19:20	0.95	19	1.06
20	0.46	20	0.94	20:10	0.94	20:10	0.99	20:20	0.99	20	1.08
21	0.56	21	1.00	21:10	0.96	21:20	0.99	21:20	1.00	21	1.10
22	0.49	22	1.01	22:10	0.98	22:20	1.00	22:20	1.01	22	1.12
23	0.51	23	1.04	23:10	1.00	23:20	1.00	23:20	1.03	23	1.13
24	0.31	24	1.06	24:10	1.01	24:20	1.01	24:20	1.05	24	1.12
1	0.21	1	1.08	1:10	0.99	1:20	0.99	1:20	0.98	1	1.11
2	0.11	2	0.94	2:10	0.98	2:20	0.99	2:20	0.96	2	1.08
3	0.01	3	0.91	3:10	0.96	3:10	1.00	3:20	0.99	3	1.06
4	-0.03	4	0.90	4:10	0.95	4:20	0.98	4:20	0.97	4	1.04
5	0	5	0.88	5:10	0.27	5:20	0.96	5:20	0.95	5	1.02
6	0.11	6	0.86	6:10	0.89	6:20	0.90	6:20	0.89	6	1.01
7	0.24	7	0.88	7:10	0.89	7:20	0.90	7:20	0.91	7	1.01
8	0.34	8	0.91	8:10	0.91	8:20	0.91	8:20	0.93	8	1.02
9	0.41	9	0.91	9:10	0.94	9:20	0.93	9:20	0.91	9	1.04
10	0.40	10	0.96	10:10	0.97	10:20	0.98	10:20	0.97	10	1.06
11	0.36	11	0.97	11:10	0.98	11:20	0.99	11:20	0.99	11	1.07
12	0.36	12	0.96	12:10	0.98	12:20	0.94	12:20	0.96	12	1.07
13	0.11	13	0.92	13:10	0.93	13:10	0.92	13:20	0.94	13	1.05
14	0.01	14	0.89	14:10	0.90	14:20	0.91	14:20	0.92	14	1.03
15	-0.08	15	0.87	15:10	0.90	15:20	0.90	15:20	0.90	15	1.01
16	-0.03	16	0.85	16:10	0.88	16:20	0.89	16:20	0.87	16	0.99
17	0	17	0.88	17:10	0.84	17:20	0.85	17:20	0.88	17	0.98
18	0.11	18	0.83	18:10	0.84	18:20	0.84	18:20	0.88	18	0.98
19	0.26	19	0.86	19:10	0.84	19:20	0.90	19:20	0.89	19	0.99
20	0.41	20	1.01	20:10	0.83	20:20	0.90	20:20	0.91	20	1.01
21	0.49	21	0.93	21:10	0.89	21:20	0.92	21:20	0.96	21	1.04
22	0.56	22	0.96	22:10	0.99	22:20	0.99	22:20	0.99	22	1.07
23	0.36	23	0.97	23:10	1.03	23:20	1.00	23:20	1.00	23	1.08
24	0.26	24	0.99	24:10	1.00	24:20	1.01	24:20	0.99	24	1.09

TABLE B.5.18 (Cont'd)

(1 Sept. '85)

Puerto Sanchez		Rio Yuna Conf. Guayabo		Rio Guayabo (1)		Rio Guayabo (2)		Rio Guayabo (3)		Rio Yuna Guayabo	
hour	Elevo	hour	Elevo	hour	Elevo	hour	Elevo	hour	Elevo	hour	Elevo
1	0.11	1	0.98	1:10	0.98	1:20	0.99	1:20	0.98	1	1.09
2	0.06	2	0.94	2:10	0.97	2:20	0.97	2:20	0.97	2	1.07
3	0.01	3	0.91	3:10	0.95	3:20	0.95	3:20	0.97	3	1.06
4	-0.03	4	0.90	4:10	0.94	4:20	0.92	4:20	0.94	4	1.03
5	0	5	0.88	5:10	0.88	5:20	0.91	5:20	0.92	5	1.00
6	0.06	6	0.83	6:10	0.88	6:20	0.89	6:20	0.89	6	0.99
7	0.16	7	0.84	7:10	0.87	7:20	0.89	7:20	0.89	7	0.98
8	0.29	8	0.87	8:10	0.89	8:20	0.91	8:20	0.91	8	0.99
9	0.38	9	0.90	9:10	0.90	9:20	0.90	9:20	0.92	9	0.99
10	0.44	10	0.93	10:10	0.93	10:20	0.92	10:20	0.93	10	1.03
11	0.47	11	0.95	11:10	0.99	11:20	0.95	11:20	0.98	11	1.04
12	0.36	12	0.85	12:10	0.94	12:20	0.95	12:20	0.99	12	1.05
13	0.26	13	0.95	13:10	0.96	13:20	0.98	13:20	1.00	13	1.04
14	0.11	14	0.91	14:10	0.97	14:20	1.00	14:20	0.99	14	1.02
15	-0.03	15	0.87	15:10	0.89	15:20	0.90	15:20	0.90	15	1.01
16	0.01	16	0.86	16:10	0.87	16:20	0.90	16:20	0.89	16	0.99
17	0.01	17	0.85	17:10	0.83	17:10	0.80	17:20	0.86	17	0.98
18	0.09	18	0.85	18:10	0.81	18:20	0.80	18:20	0.84	18	0.96

(4) Small Streams in the Loma La Cordilleva

This system, composed of small streams more than ten, collects rain water falling in the Loma La Cordilleva and flows into swamps at El Guayabo. The flow of this system is observed only when it rains. The total catchment area covers in the range of 200 - 300 ha. A small reservoir located on the Arroyo El Catey is the only water resources within this system.

ANNEX C: GEOLOGY

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ANNEX C: GEOLOGY

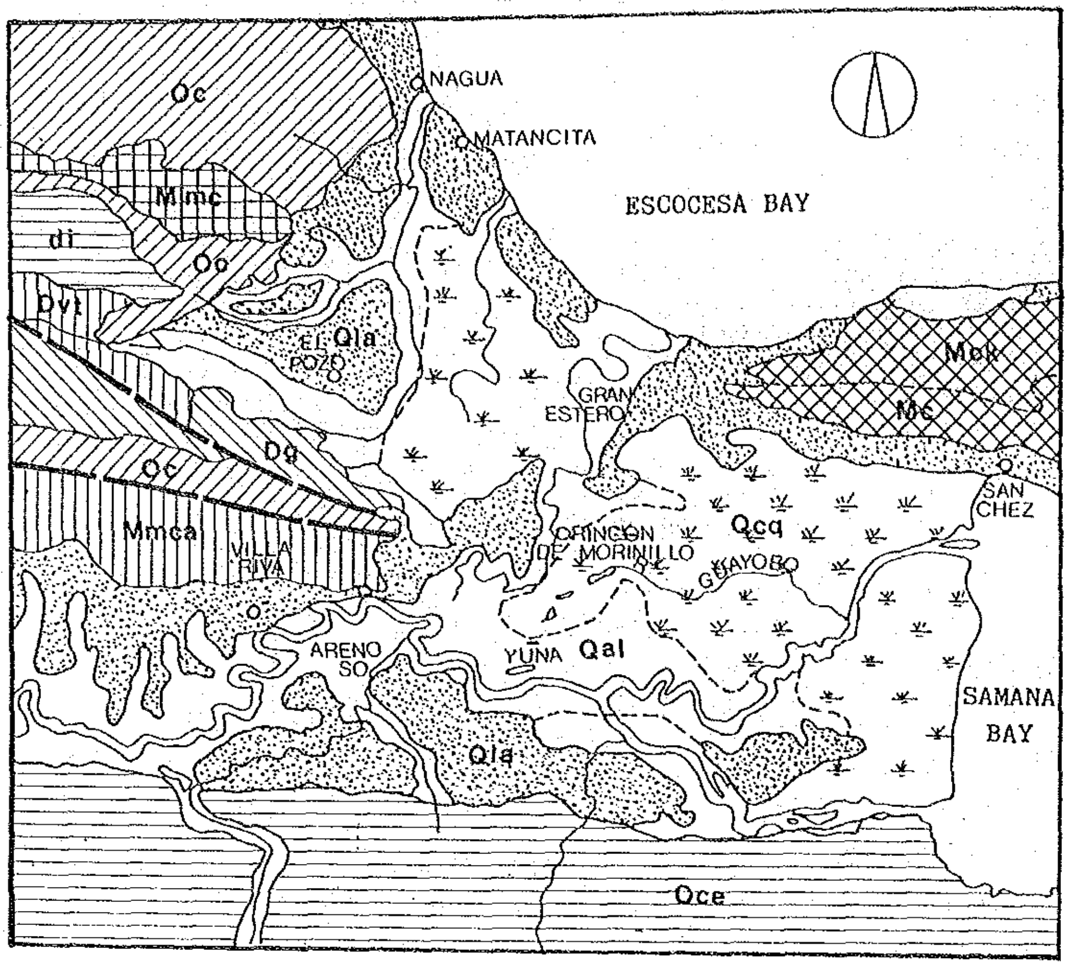
1. Geological Feature of the Study Area

The study area, formed by the flooded plain of the Yuna River, extends to a total are of 24,100 ha with ground elevation in the range of 0 - 10 m. The watershed of the Lower Yuna Basin is limited to the north by the Escocesa Bay and to the east by the Samaná Bay. The Basin is formed to the northeast by the Loma la Cordillera composed of Tertiary Miocene Indivisible limestone, to the south by the Cordillera Haitises composed of Tertiary Oligoceno Indivisible and to the west by mountains composed of Tertiary Miocene-Oligoceno Indivisible Gonglomerate, limestone and mudstone. Two faults are extended to the Samaná Bay passing through the study area.

The central part of the study area lies on Alluvium which consists of Quarternary Sedimentary deposits such as peat, clay and lacustrine and marine deposits (principally clay with sand and gravel) supported by Diluvial deposits (clay silt, sand, sand with gravel, etc.); a stratum extended from the western mountains constitute a foundation for this area.

The Loma la Cordillera is composed of Tertiary Moicene Indivisible limestone of Las Angosturas Formation and Las Salinas Formation. The Haitises mountains are consisted of limestone and calcareous sand stone corresponding to El Sambrerito, La Lemba and El Florentio Formations of Tertiary Oligoceno Indivisible.

Mountains located to the west of the study area are covered by conglomerate of Las Mismas Formation of Tertiary Oligoceno Indivisible, Limestone of Tabera Formation and limestone, mudstone and conglomerate of Tertiary Moicene Indivisible El Gurabo Formation; these Formations are connected with two faults with strike from east to west (See Fig. C.1.1).



STRATIGRAPHY OF PROJECT AREA

QUATERNARY	RECENT		Qal	ALLUVIUM
			Qcq	MARSH
			Qla	LACUSTRINE AND MARINE DEPOSIT PRINCIPALLY CLAY WITH SAND AND GRAVEL NEAR THE COAST, FREQUENTLY OCCUR THIN DEPOSITS ABOVE BEACH LIMESTONE,
TERTIARY	MIOCENE INDIVISIBLE		Mck	LIMESTONE
			Mc	LIMESTONE OF LAS ANGOSTURAS AND LAS SALINAS FORMATION
	MIOCENE MIDDLE		Mimc	LIMESTONE
			Mmca	LIMESTONE, MUDSTONE AND CONGLOMERATE OF LA GURABO FORMATION
	OLIGOCENO INDIVISIBLE		Og	CONGLOMELATE OF LA TABELA FORMATION
			Oce	LIMESTONE, CALCAREOUS SAND STONE AND CLAYEY SLATE INCLUDE PART OF LAS SOMBRERITO FORMATION
			Oc	LIMESTONE, INCLUDE PART OF LAS SOMBRERITO FORMATION
NON-DATES			dvt	VOLCANIC ROCK, PRINCIPALLY TUFF
			di	METAMORPHIC ROCK

GEOLOGICAL SYMBOLS

————	FORMATION BOUNDARY
— — —	FAULT , DASHED WHERE APPOXIMATELY LOCATED

FIG. C.1.1 GEOLOGICAL MAP

2. Outline of the Survey

The survey in this field has been made to have an acquiantance with geologicl feature of the study area required for planning and design of principal irrigation and drainage works included in the development plan.

The survey comprising mechanical boring test, sampling and analysis of materials, field investigation by means of cone-penetrometer and simple pumping test (upper part of peat soils formation) was carried out in relation to proposed sites for such structures as: water intake facilities from the Yuna River, regulating reservoir, driving canal, main drains, tide gate.

2.1 Mechanical Boring Test

Mechanical boring test was made in the following eight sites.

TABLE C.2.1 SUMMARY OF MECHANICAL BORING TEST

Proposed Structures	Location	Identification of Test Pits	Depth (m)	Standard Penetration Test (Nos.)	Samples Taken
Pumping Station	ARENOSO	A No. 1	25.00	25	3
	EL AGUACATE	A No. 2	21.00	19	3
	CHIRINGO	A No. 3	12.80	15	3
Headworks	VILLA RIVA	A No. 4	20.70	21	3
	CHIRINGO	A No. 5	23.00	25	4
Regulating Reservoir	ARENOSO	A No. 6	15.00	19	7
Tide Gate	GRAN ESTERO	GE-1	20.00	17	2
Main Drains	RICON MOLINILLO	RM-1	12.50	14	3
Borrow-Pit	ARENOSO	-	-	-	2
Total		8 pits	150.00	155	30

2.2 Cone-Penetrometer Test

In addition to the above-mentioned mechanical boring test, field investigation test by means of cone-penetrometer was performed as summarized below:

TABLE C.2.2 SUMMARY OF CONE-PENETROMETER TEST

Proposed Structures	Location	No. of Site Investigated	Depth (m)	Remarks
Regulating Reservoir	ARENOSO			
	DAM-AXIS A-LINE	3		
	B-LINE	5	1.5 - 10.0	
	C-LINE	3		
	C-LINE	3		C' LINE
Driving Channel	AGUACATE			
	ARENOSO	14	2.0 - 3.5	
	VILLA RIVA			
Main Drain	GRAN ESTERO	2		
	PONTON	1	3.3 - 9.0	
	BEBEDERO	4		
	RINCON MOLINILLO	2		
Total		37		

2.3 Sampling and Analysis

Sampling for the laboratory analysis is consisted of undisturbed materials taken by thin walled tube and disturbed materials produced in the course of the standard penetration test, and disturbed materials taken at the proposed two borrow-pits (TP-I, TP-2). Laboratory analysis was performed in due accordance with the ASTM.

2.4 Simple Pumping Test

Simple pumping test was realized for the purpose of getting an acuatic coefficient on the upper part of peat soils formation represented by the dam axis-A-Line for the regulating reservoir.

3. Regulating Reservoir

3.1 Description of the Geology

Tertiary Miocene Indivisible stratum is dominated extensively in proposed site for a regulating resevoir; this stratum is composed of conglomerate, limestones and mudstones. The strike is almost straight from east to west with dip 40°S in the northern part and 20°S - 5°S in the south. The lower plain of the site is formed by swamplands and swampy forests in which peat and clay of Quarternary Alluvium are distributed.

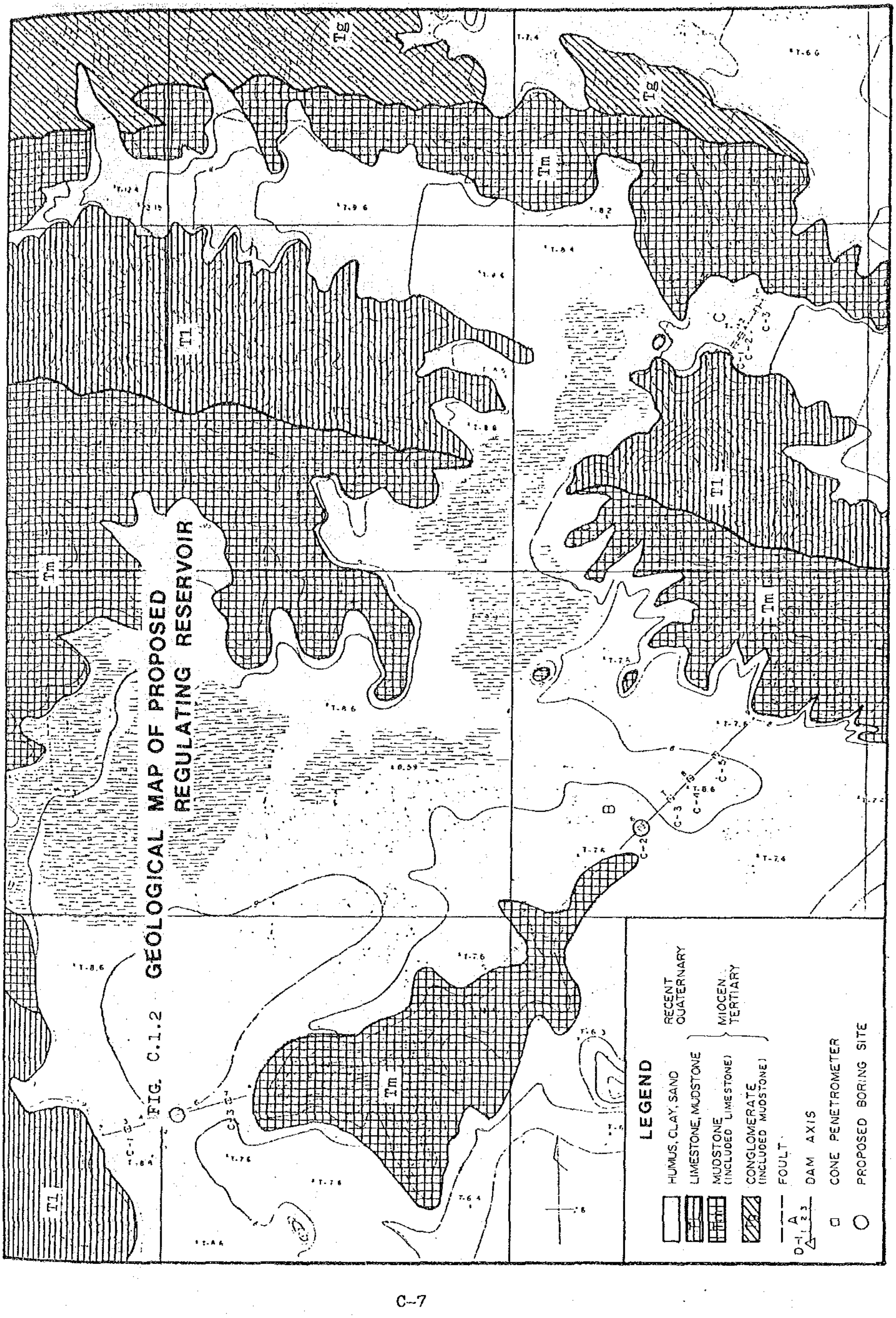
TABLE C.3.1 GEOLOGICAL FORMATION

	Period		Formation		Remarks
Cenozoic Era	Quarternary	Recent	Alluvium	Upper Layer of Humus (Apl)	Distributed in lower land Thickness: 3.5-5.5 m N 1 9C=0.3-2.4 kgf/cm^2
				Lower Layer of Humus (Ap2)	Distributed in lower land Thickness: 1.3-4.9 m N = 2 - 3 9C=3.0-14.0 kgf/cm^2
				Clay (Ap)	Thickness: 0.6-1.6 m N = 3 - 5
	Tertiary	Miocene	Gurabo	Conglome-rate (rg)	Sand and mudstone are included.
				Limestone & Mudstone(TL)	Limestone is dominated.
				Mudstone(Tm)	Limestone is included.

3.2 Dam Axis of a Regulating Reservoir and their Geology

A total of five dam axes were established (See Fig. C.10.1) and the shifting of bench marks and the surveying on proposed dam axes routes was carried out. The bench marks was introduced from the BM.V3215 (9.549 m) to get D-1, 8, 9 by direct method and D-2, 3, 4, 5, 6 by indirect method (See Figs. C.10.2 - C.10.3).

FIG. C.1.2 GEOLOGICAL MAP OF PROPOSED REGULATING RESERVOIR



Assuming that the desigh high water level is to be +14.0 m and the height of the crest of dam to be +16.0 m, the length of dam and the geological feature of the foundation are as follows:

TABLE C.3.2 LENGTH OF DAM CREST AND GEOLOGY OF FOUNDATION

Dam Axis	Length of Crest (m)	Formation of the Foundation	Remarks
A	650	Limestone and Mudstone	Distribution of Poor Foundation Maximum Thickness: 9.45 m (Ap1-3.85 m, Ap2-4.05 m and Ac-1.55 m) Length : 490 m
B	1,330	Mudstone (limestone is included)	Distribution of Poor Foundation Maximum Thickness: 10.00 m (Ap1-5.5 m & Ap2-4.5 m) Length : 742 m
C	310	Limestone and Mudstone	Distribution of Poor Foundation Maximum Thickness: 1.80 m (Ac-1.80 m) Length : 100 m
D	220	Mudstone (limestone is included)	Distribution of Poor Foundation is not observed.
E	355	Mudstone (limestone is included)	Distribution of Poor Foundation is not observed.
Total	2,865		Total length of poor foundation distribution: 1,332 m

Note: Ap1 - Upper Layer of Humus
Ap2 - Lower Layer of Humus
Ac - Clay

The foundation of proposed sites for dam axes is formed by limestone-mudstone layer (mudstone is dominated) and mudstone layer (limestone is included) of the Tertiary Miocene Gurabo Formation. Alluvial Formation formed by humus and clay is distributed on proposed dam axes of A, B and C.

In order to get an outline of distribution for above-mentioned soil layers, a mechanical boring and cone-penetrometer tests were carried out on the dam axis-A and the dam-axes-A, B, C, respectively. The results of these tests are indicated in Table C.3.3 and Figs. C.10.2 and C.10.3.

The total length of dam axes (A-B) is 2,865 m, in which poor foundation occupies as long as 1,332 m. The greater portion of poor foundation is distributed in the dam axes - A & B being composed of humus and clay; the maximum thickness of these foundations are 9.45 m for the dam axis-A and 10.0 m for the dam axis-B. As a result of simple pumping test realized for the upper layer of humus, the following aquatic coefficient was presented:

Transmissivity	$T = 2.0 \times 10^{-5}\ m^2/sec$
Storage Coefficient	$S = 0.125$
Coefficient of Permeability	$K = 1.33 \times 10^{-3}$ cm/sec

TABLE C.3.3 DAM AXES AND DISTRIBUTION OF POOR FOUNDATION

Dam Axis	Length of Dam Axis (m)	Height of Crest (m)	Poor Foundation		Upper Layer of Humus		Lower Layer of Humus		Clay Layer	
			Length (m)	Maxi. Thickness	Thickness (m)	N and qc Values	Thickness (m)	N and qc Values	Thickness (m)	N and qc Values
A	650	7.4	490	11.0	1.5 - 3.85	N 1 qc = 0.3 - 2.4 kgf/cm^2	3.5 - 4.05	N = 2 - 3 qc = 3 - 14 kgf/cm^2	1.55	N = 2 - 3
B	1,330	8.5	742	10.8	3.5 - 5.5	N 1 qc = 0.3 - 2.4 kgf/cm^2	2.5 - 4.5	N = 2 - 3 qc = 3 - 14 kgf/cm^2	n.a.	n.a.
C'	310	7.5	100	1.8	n.a.	n.a.	n.a.	n.a.	1.8	qc = 2 - 10 kgf/cm^2
D'	220	3.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
E	355	4.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total		2,865		1,332						

Note: High water level and height of dam crest are tentatively set up to be 14.0 m and 16.0 m, respectively.

4. Water Intake Sites

Pumping station and headworks have been proposed in the context of the irrigation plan and four sites located between El Aguacate and Villa Riva were investigated by means of mechanical boring and other appropriate methods. The result of the investigation is presented as summarized below.

Proposed Structures	Location	Identification of Test Pit	Depth (m)	Standard Penetration Test (Nos.)	Sample Taken (Nos.)
Pumping Station	A-1 El Aguacate	A No. 1	25	25	3
	A-2	A No. 2	20	19	3
Headworks	A-3	A No. 3	12.40	15	3
	Chiringo	A No. 4	22.95	25	3
	Villa Riva	A No. 5	19.25	21	4
Total	4 sites	5 pits	99.60	105	16

The geology of the area situated along the Yuna River between El Aguacate and Arenoso is dominated by limestono, mudstone and gravel of the Gurabo Formation, Tertiary Miocene of the Cenozoic Era; meanwhile, the study area comprises extensive distribution of limestone and mudstone (including siltstone). This distribution, formed under the influence of mountains situated to the north of the Yuna River, is observed in the ground lower than 23 m below the surface and the Alluvial Formation of the Quarternary represented by sand and clay is covering on it. These profiles are illustrated in Figs. C.10.5 - C.10.9. Of these profiles, all but A-3 (Chiringo) are delineated with assumption made on the basis of investigation realized on left margin of the Yuna River. Bearing stratums for each profile are summarized in the table below.

DISTRIBUTION OF STRATUM

Location	Depth from the Surface (cm)	Depth from the River Bed (m)	Component of Bedrock
El Aguacate	20.30	12.50	Siltstone
Arenoso	16.62	8.00	Siltstone
Chiringo	10.5-22.85	5.50-12.50	Siltstone declined to the right bank
Villa Riva	18.00	10.00	Weathering of siltstone: Gravel layer with a thickness of 4.0 m is existing and, if its continuance is stable, this layer may be constituted as a stratum.

PROFILE A-1: EL AGUACATE

This site was investigated as proposed location for the pumping station.

Formation		Thickness (m)	Ground Elevation of the Upper Extreme (m)	Remarks
Alluvium	Sand (Fine - Medium)	9.4	+11.00	Two thin layers of clay is included. N = 5 - 14
	Clay	7.5	- 1.00	N = 6 - 23
Diluvium	Hard Clay 1]	2.4	- 8.50	N = 26 - 46
Gurabo	Siltstone	3.1	-10.90	

Note: 1] Depth from the ground surface: G.L. -20.3 m
Depth from the river bed : 12.5 m

PROFILE A-2: ARENOSO

This site was investigated as proposed location for the headworks.

Formation		Thickness (m)	Ground Elevation of the Upper Extreme (m)	Remarks
Alluvium	Clay	9.4	+10.90	Silt to silty clay N = 3 - 15
Diluvium	Sand	4.5	+ 1.50	Medium to coarse Sand N = 29 - 37
	Hard Clay	2.72	- 3.00	N = 19 - 24
Gurabo	Siltstone 1]	3.38	- 5.72	N = 87 (weathering zone)

Note: 1] Depth

PROFILE A-3: CHIRINGO

This site was investigated as proposed location for headworks.

Formation		Thickness (m)	Ground Elevation of the Upper Extreme (m)	Remarks
Alluvium	Sand	9.00 - 10.95	+11.00 - +12.50	Fine sand and three thin layer of clay silt and thin sand. N = 4 - 18
	Gravel	1.75	- 1.65	Discontinuously distributed to the right bank. N = 63 - 70
Diluvium	Clay	10.15	- 0.10	Discontinuously distributed to the right bank. Humus layer is included in the upper part. N = 13 - 19
Gurabo	Limestone 1]	0.1 - 1.90	+20 - -10.25	Weathering zone of limestone distributed to the right bank. N = 68 - 150

Note: 1] Depth from the surface - right bank: G.L. -10.50 m
left bank : G.L. -22.85 m

Depth from the river bed - right bank: 5.5 m
left bank : 12.5 m

PROFILE A-4: VILLA RIVA

This site was investigated as proposed location for headworks.

Formation		Thickness (m)	Ground Elevation of the Upper Extreme (m)	Remarks
Alluvium	Sand	9.00	+13.53	Fine to silty sand N = 6 - 14
Diluvium	Gravel	4.00	+ 4.53	Coarse sand. Max. grain size: 2 mm N = 9 - 36
	Clay	5.00	+ 0.53	Thin layer of humus is included. N = 9 - 36
	Hard Clay 1]	1.25	- 4.47	N = 52 - 62

Note: 1] Depth from the ground surface: G.L. -18.0 m
Depth from the river bed : 10.00 m

5. Driving Canal Sites

Field investigation by means of cone-penetrometer was carried out with respect to proposed sites (18 sites in total) for the driving Canal.

The result of the investigation is summarized in data sheets. It has been confirmed that the geology of the route is composed of clay and clay sand and that poor ground is extended in the range 0.5 - 2.0 m below the surface; furthermore, it has been confirmed that the ground deeper than 2 m from the surface has converted N values of 5 - 8.

6. Tide Gate Site

The site around an outlet of the Caño Gran Estero, where the installation of a tide gate has been proposed, was investigated by boring machine and the result of which is illustrated in prismatic figures.

The geology of the site is consisted of dense sand layer (fine to medium sand) with thickness more than 2 m; the N value of the same ranges from 29 to 60, mean value being at 47. Sand bed with N value at 47 and existing in the depth more than 2 m below the ground surface constitutes the stratum without any reinforcement works.

7. Main Drain Sites

Main drain has been delineated in the course prolonged from Ponton to Bebedero via Rincon Molinillo (11.5 km). A total of 9 sites within the said course was investigated by boring machine (1 site) and cone-penetrometer (8 sites).

The geology of the three areas mentioned above is represented by clay layer with N value less than 5, which forms comparatively favorable stratum with thickness of: 1.0 m of Ponton, 2.0 m at Rincon Molinillo and 3.5 m at Bebedero. Nevertheless, the geology on some portion of land covered by swamps without any access has not been disclosed yet.

8. <u>Simple Pumping Test</u>

The simple pumping test was carried out with a view to attain an aquatic coefficient of the proposed dam axis A for the regulating reservoir. For this purpose, a test pit with diameter of 1.40 m and depth of 1.58 m was excavated. An aquatic coefficient has been calculated using the Jacob's method.

Jacob's Method

$$T = \frac{2.3Q}{4\pi\Delta s}$$

Given: s = 0, t = to

$$S = \frac{2.25\ t.to}{r^2}$$

where,	T	:	transmissivity m^2/sec.
		:	storage coefficient
	S	:	pumping volume 1.45×10^{-4} m^3/sec
		:	fall of water level within one logarithms circle
	to	:	1,360 sec, if given s = 0
	r	:	radius of well = 0.7 m

$$T = \frac{2.3 \times 1.45 \times 10^{-4}}{4 \quad \times 1.33}$$

$$= 2.0 \times 10^{-5}$$

$$S = \frac{2.25 \times 2.0 \times 10^{-5} \times 1,360}{(0.7)^2}$$

$$= 0.125$$

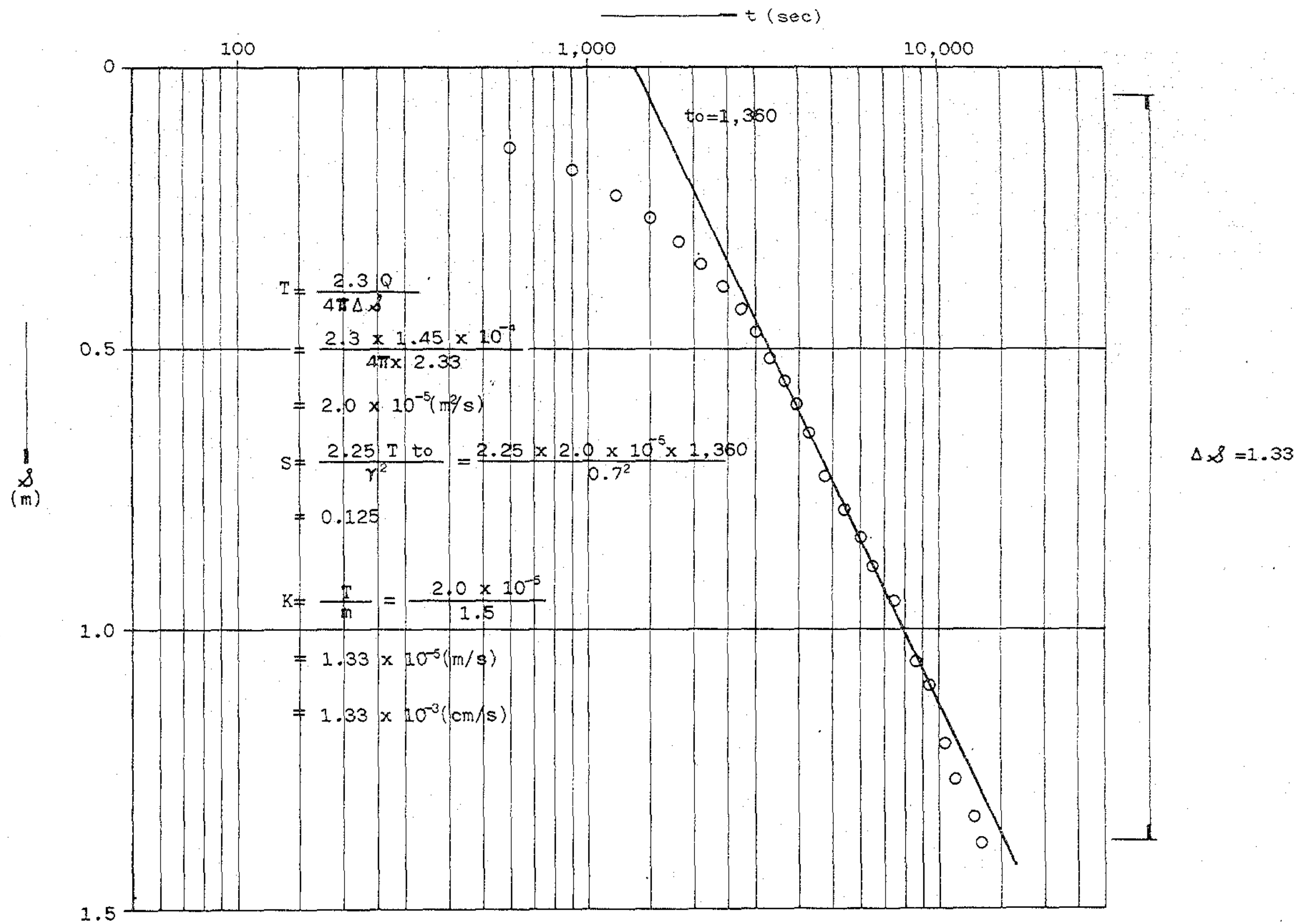
Given the thickness of test soil layer to be m = 1.5 m, the permeability coefficient (= K) is computed in the following manner:

$$K = \frac{T}{M}$$

$$= \frac{2.0 \times 10^{-5}}{1.5}$$

$$= 1.33 \times 10^{-5} \text{ m/sec}$$

$$= 1.33 \times 10^{-3} \text{ cm/sec}$$



$$T = \frac{2.3\,Q}{4\pi \Delta s} = \frac{2.3 \times 1.45 \times 10^{-4}}{4\pi \times 2.33} = 2.0 \times 10^{-5} (m^2/s)$$

$$S = \frac{2.25\,T\,t_o}{r^2} = \frac{2.25 \times 2.0 \times 10^{-5} \times 1,360}{0.7^2} = 0.125$$

$$K = \frac{T}{m} = \frac{2.0 \times 10^{-5}}{1.5} = 1.33 \times 10^{-5} (m/s) = 1.33 \times 10^{-3} (cm/s)$$

FIG. C.8.1 RESULTS OF PUMPING TEST (Jacob's Method)

9. Laboratory Analysis

Soil samples were taken from proposed sub-surfaces above which will be installed principal facilities; undisturbed samples were picked up by thin wall tube and disturbed ones by split-barrel used in the course of the Standard Penetration Test. Likewise, disturbed samples were taken by excavating test pit on proposed site for borrow-pit.

These samples were analysed their property at the laboratory in accordance with the ASTM as described below:

Sub-surface Soils

Item	Quantity
Specific Gravity	28
Moisture Content	28
Grain Size Analysis	28
Atterberg Test	
Liquid limit	16
Plastic limit	16
Plasticity index	16
Unit Weight	1
Unconfined Compression Test	1
Consolidation Test	1

Embankment Materials

Item	Quantity
Specific Gravity	3
Moisture Content	3
Grain Size Analysis	3
Atterberg Test	
Liquid limit	3
Plastic limit	3
Plasticity index	3
Compaction Test	3
CBR Test	3
Unconfined Compression Test	3
Permeability Test	3

The results of laboratory analysis are presented in the following tables and figures.

1) Sub-Surface Soils

Table C.9.1	Typical Properties of Sub-Surface Soils
Table C.9.2	Summary of Soil Test (1)
Table C.9.3	Summary of Soil Test (2)
Fig. C.9.1	Relative Chart of Depth and Soil Properties
Fig. C.9.2	Plasticity Chart
Fig. C.9.3	Gradation Curve
Fig. C.9.4	Frequency Chart of Moisture Content
Fig. C.9.5	Frequency Chart of Specific Gravity
Fig. C.9.6	Frequency Chart of Ateer Berg Test

2) Embankment Materials

Table C.9.2	Summary of Laboratory Test of Soils
Fig. C.9.7	Moisture-Density of Soil Using Rammer
Fig. C.9.8	Unconfined Compression Test
Fig. C.10.4	Location Map of Geological Exploration

Samples of embankment materials were taken from the expected borrow pits TP-1 and TP-2. TP-1 was taken from the weathering zone of mudstone at Arenoso and TP-2 from that of gravel (including mudstone). The latter is endowed with excellent property to be used as embankment materials.

TABLE C.9.1 PROPERTY OF SUB-SURFACE SOILS

Componetn	Soils					
	Humus		Clay		Sand	
	Range	Average	Range	Average	Range	Average
GRADIATION						
Gravel (%)			0 - 30.8	2.4	0 - 34.3	8.6
Sand (%)	0.4 - 6.7	1.4	0.6 - 21.2	10.8	35.3 - 88.8	74.6
Silt (%)	93.0 - 100	98.6	54.5 - 99.4	86.8	11.2 - 26.5	16.8
Clay (%)						
Maximum Diameter (mm)	0.075		0.075 - 19.50		0.42 - 19.5	
Coefficient of Uniformity (Uc)					2.57	
Coefficient of Curvature (Uc')					203	
CONSISTENCY						
Liquid Limit (WL%)			36.9 - 76.3	56.6		
Plastic Limit (Wp%)			21.4 - 36.0	28.7		
Plasticity Index (Ip)			12.6 - 43.2	27.9		
Flow Index (If)			10.2 - 24.3	17.2		
CLASSIFICATION						
Visual Classification	Humus		Silt, Clay		Sand, Gravel	
Unified Classification	Pt		CL, CH, OH		SM-SP	
SPECIFIC GRAVITY OF SOIL (Gs)	1.847 - 2.399	2.118	2.056 - 2.688	2.597	2.667 - 2.839	2.753
NATURAL STATE						
Water Content (W%)	203.2 - 222.8	213.0	19.4 - 50.8	35.1	17.1 - 32.7	24.9
Wet Density (t)						
Void Ratio (e)						
Degree of Saturation (Sr)						
IN-SITU TEST						
Cone Penetrometer Test qc (Kgf/cm^2)	Upper Part 0.3 - 2.4 Lower Part 3.0 - 14.0					

NAME OF LOCALITY		A. NO.1			A. NO.2			A. NO.3			A. NO.4			A. NO.5	
SAMPLE NO.		19	23	25	13	16	18	10	11	13	14	17	19	14	17
SAMPLE DEPTH m		18.40	21.10	21.90	7.90	12.40	15.40	4.90	6.40	9.40	10.95	15.4	18.40	12.25	13.90
GRADATION	GRAVEL %	–	–	–	–	–	–	–	–	30.8	12.2	–	4.9	34.3	–
	SAND %	0.8	0.6	1.3	24.2	85.6	9.6	10.9	35.2	14.7	61.2	5.2	9.5	53.3	0.9
	SILT %	99.2	99.4	98.7	75.8	14.4	90.4	89.1	64.8	54.5	26.6	94.8	85.6	12.4	99.1
	CLAY %														
	MAX. DIAMETER mm	0.075	0.075	0.075	0.15	0.42	2.00	0.15	0.15	19.5	12.00	0.42	9.5	19.5	0.075
	COEFFICENT OF UNIFORMITY Uc	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	COEFFICENT OF CURVATURE Uc'	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CONSISTENCY	LIQUID LIMIT WL %	66.4	64.4	72.6	–	–	44.5	39.3	–	46.0	–	91.1	56.3	–	85.7
	PLASTIC LIMIT Wp %	38.4	21.5	36.7	–	–	22.8	25.6	–	24.6	–	36.2	25.9	–	44.6
	PLASTICITY INDEX Ip	27.0	42.9	35.9	–	–	21.7	13.7	–	21.5	–	54.9	30.4	–	40.1
	FLOW INDIDEX Lf	19.0	14.0	15.0	–	–	7.0	11.0	–	15.0	–	28.5	21.0	–	20.0
CLASSI-FICATION	VISUAL CLASSIFICATION	SILTY CLAY	CLAY	CLAY	SAND	SAND	CLAY	SILT	SAND	CLAY	SAND	SILT	CLAY	GRAVEL	CLAY
	UNIFIED CLASSIFICATION	MH	CH	OH-MH	ML	SM	CL	OL·ML	OL	CL	SM	CH	CH	SM	OH
SPECIFIC GRAVITY OF SOIL Gs		2.78	2.69	2.59	2.56	2.79	2.55	2.58	2.60	2.57	2.63	2.62	2.69	2.69	2.30
NATURAL STATE	WATER CONTENT W %	37.7	32.0	28.47	17.0	35.2	40.1	35.9	40.1	35.0	16.9	39.0	20.7	31.6	73.2
	WET DENSITY γt (t/m³)														
	VOID RATIO e														
	DEGREE OF SATURATION Sr %														

NAME OF LOCALITY		A. NO.5		A. NO.6							RM. NO.1			GE. NO.1	
SAMPLE NO.		21	24	3	6	10	13	14	15	17	5	8	12	5	7
SAMPLE DEPTH m		19.90	22.85	1.25	1.55	4.25	6.45	7.90	9.95	11.45	2.15	3.40	9.40	2.25	4.95
GRADATION	GRAVEL %	–	2.7	–	–	–	–	–	2.1	0.7	–	–	5.0	–	–
	SAND %	21.4	15.2	–	–	–	0.4	6.7	4.3	6.0	21.2	1.9	78.1	80.6	88.8
	SILT %	78.6	82.1	100.0	100.0	100.0	99.6	93.3	93.6	93.3	78.8	98.1	16.9	19.4	11.2
	CLAY %														
	MAX. DIAMETER mm	0.075	4.75	0.075	0.075	0.075	0.075	0.42	4.75	4.75	0.15	0.15	4.75	2.00	0.42
	COEFFICENT OF UNIFORMITY Uc	–	–	–	–	–	–	–	–	–	–	–	–	–	[illegible]
	COEFFICENT OF CURVATURE Uc'	–	–	–	–	–	–	–	–	–	–	–	–	–	2.03
CONSISTENCY	LIQUID LIMIT WL %	68.8	42.8	–	–	79.6	–	–	79.5	49.4	34.4	78.2	–	–	–
	PLASTIC LIMIT Wp %	39.5	24.3	–	–	46.2	–	–	32.7	25.9	25.0	23.8	–	–	–
	PLASTICITY INDEX Ip	29.3	18.5	–	–	30.4	–	–	46.8	23.5	9.4	54.4	–	–	–
	FLOW INDEX Lf	23.0	15.5	–	–	11.8	–	–	27.2	14.0	7.8	21.0	–	–	–
CLASSI-FICATION	VISUAL CLASSIFICATION	CLAY	CLAY	PEAT	PEAT	PEAT	PEAT	PEAT	CLAY	CLAY	FINE SAND	SILT	SAND	FINE SAND	SAND
	UNIFIED CLASSIFICATION	OH	CL	Pt	Pt	Pt	Pt	Pt	CH	CL	ML	CH	SM	SM	SM SP
SPECIFIC GRAVITY OF SOIL		2.50	2.65	1.81	2.08	2.05	1.58	2.07	2.62	2.62	2.62	2.61	2.75	2.78	2.88
NATURAL STATE	WATER CONTENT W %	49.1	36.2	214.0	220.0	216.0	219.0	[illegible]	[illegible]	24.7	35.1	41.1	17.2	20.2	[illegible]
	WET DENSITY γt (t/m³)														
	VOID RATIO e														
	DEGREE OF SATURATION Sr %														

TABLE C.9.3 SUMMARY OF LABORATORY TEST OF SOILS (1)

PROJECT				SOILS & MATERIALS ENGINEER			
AGUACATE GUAYABO							
SAMPLING LOCATION			RM-NO.1				
SAMPLE NO.			T-1				
SAMPLING DEPTH		(m)	4.50				
GRADATION	GRAVEL	(%)	–				
GRADATION	SAND	(%)	1.9				
GRADATION	SILT–CLAY	(%)	98.1				
GRADATION – CLASSIFIED GRADING PASS	NO. 10 (2.00mm)	(%)					
GRADATION – CLASSIFIED GRADING PASS	NO. 40 (0.425mm)	(%)					
GRADATION – CLASSIFIED GRADING PASS	NO. 200 (0.075mm)	(%)					
LIQUID LIMIT		LL (%)	78.2				
PLASTICITY INDEX		PI	23.8				
CLASSIFICATION			54.4				
SPECIFIC GRAVITY		Gs	2.61				
NATURAL STATE	WATER CONTENT	ωn (%)	41.1				
NATURAL STATE	WET DENSITY	γt (g/cm³)	1.92				
NATURAL STATE	VOID RATIO	e	0.918				
NATURAL STATE	DEGREE OF SATURATION	S_r (%)					
UNCONFINED COMPRESSION	COMPRESSIVE STRENGTH	q_u (kg/cm²)	1.075				
UNCONFINED COMPRESSION	MODULUS OF ELASTICITY	E_{50} (kg/cm²)	16.1				
UNCONFINED COMPRESSION	SENSITIVITY RATIO	St					
TRIAXIAL COMPRESSION	TYPE OF TEST						
TRIAXIAL COMPRESSION	COHESION	C (kg/cm²)					
TRIAXIAL COMPRESSION	ANGLE OF INTERNAL FRICTION	$\phi°$					
CONSOLIDATION	YIELD STRESS OF CONSOLIDATION	P_Y (kg/cm²)	2.20				
CONSOLIDATION	COMPRESSION INDEX	C_c	0.369				
CONSOLIDATION							
COMPACTION	METHOD OF TEST						
COMPACTION	OPTIMUM MOISTURE CONTENT	ω opt. (%)					
COMPACTION	MAXIMUM DRY DENSITY	γ dmax. (g/cm³)					
CBR	SAMPLE CONDITION	(%)					
CBR	TEST CONDITION						
CBR	WATER CONTENT	ω (%)					
CBR	DRY DENSITY	γd (g/cm³)					
CBR	CBR	(%)					
REMARKS							

TABLE C.9.4 SUMMARY OF LABORATORY TEST OF SOILS (2)

PROJECT AGUACATE GUAYABO				SOILS & MATERIALS ENGINEER				
SAMPLING LOCATION				ARENOSO	YABACAO	YABACAO		
SAMPLE NO.				TP-1	TP-2(1)	TP-2(2)		
SAMPLING DEPTH (m)				1.00	1.00	1.50		
GRADATION	GRAVEL (%)			24.3	14.2	17.9		
	SAND (%)			8.1	42.8	35.3		
	SILT–CLAY (%)			67.6	43.0	46.8		
	CLASSIFIED GRADING PASS	NO. 10	(2.00mm) (%)	72.8	80.7	77.6		
		NO. 40	(0.425mm) (%)	70.9	59.6	61.6		
		NO. 200	(0.075mm) (%)	67.6	43.0	46.8		
LIQUID LIMIT	LL (%)			28.8	43.5	28.2		
PLASTICITY INDEX	PI			21.4	23.7	23.4		
CLASSIFICATION				CL	SM.SC	SM.SC		
SPECIFIC GRAVITY	Gs			2.60	2.70	2.70		
NATURAL STATE	WATER CONTENT	w_n (%)		19.9	11.1	12.3		
	WET DENSITY	γ_t (g/cm3)						
	VOID RATIO	e						
	DEGREE OF SATURATION	S_r (%)						
UNCONFINED COMPRESSION	COMPRESSIVE STRENGTH	q_u (kg/cm2)		4.06	4.05	4.30		
	MODULUS OF ELASTICITY	E_{50} (kg/cm2)		182.9	135.0	128.4		
	SENSITIVITY RATIO	St						
TRIAXIAL COMPRESSION	TYPE OF TEST	-						
	COHESION	C (kg/cm2)						
	ANGLE OF INTERNAL FRICTION	ϕ°						
CONSOLIDATION	YIELD STRESS OF CONSOLIDATION	P_Y (kg/cm2)						
	COMPRESSION INDEX	C_c						
COMPACTION	METHOD OF TEST			C	C	C		
	OPTIMUM MOISTURE CONTENT	w_{opt} (%)		14.0	10.8	11.5		
	MAXIMUM DRY DENSITY	γ_{dmax} (g/cm3)		1.705	1.950	1.930		
CBR	SAMPLE CONDITION	(%)						
	TEST CONDITION							
	WATER CONTENT	w (%)						
	DRY DENSITY	γ_d (g/cm3)						
	CBR	(%)		2.5	2.5	2.0		
REMARKS Permeability k (cm/sec)				3.5×10^{-6}	2.5×10^{-7}	9.1×10^{-8}		

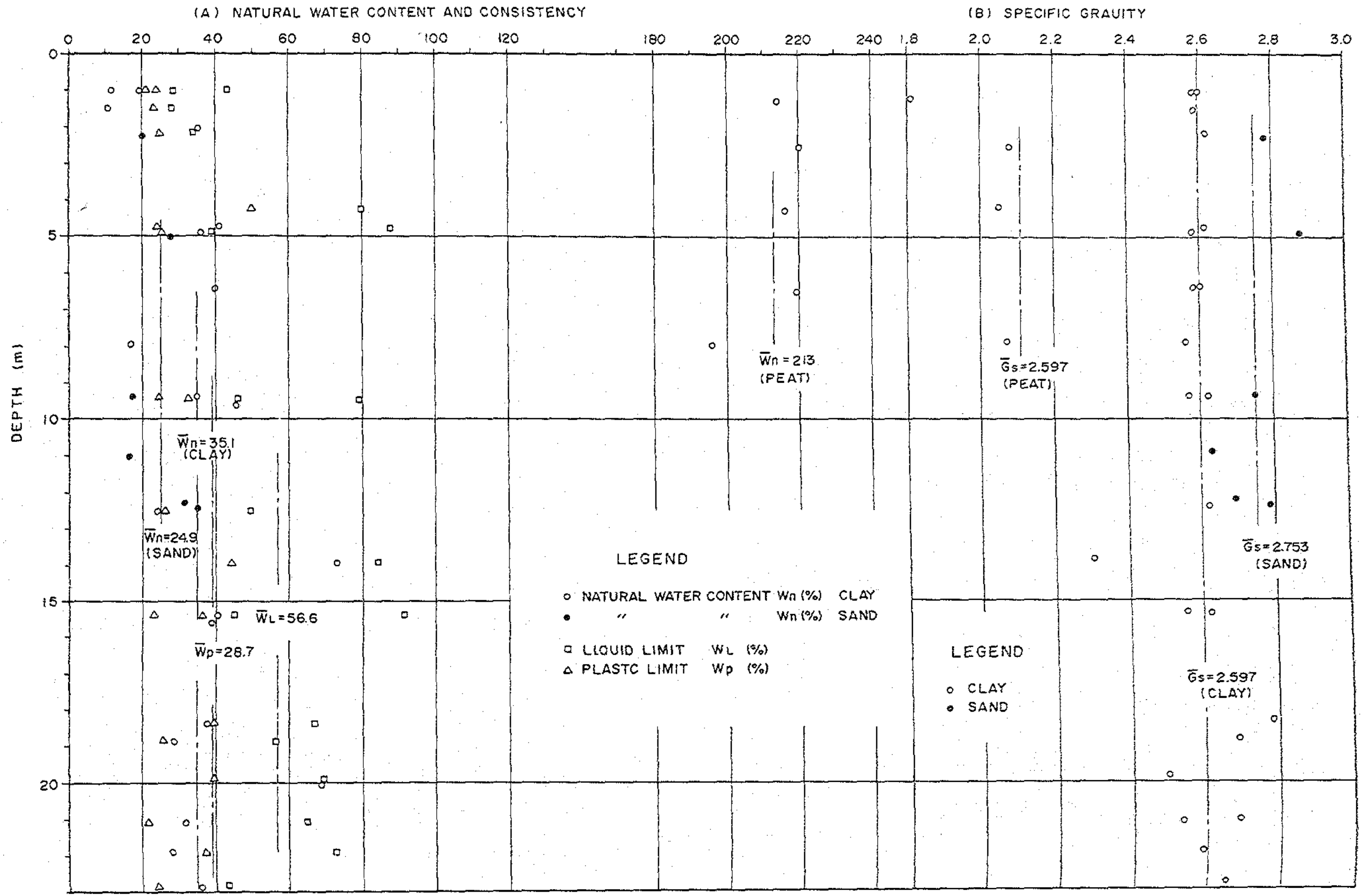


FIG. C.9.1 RELATIVE CHART OF DEPTH AND SOIL PROPERTIES

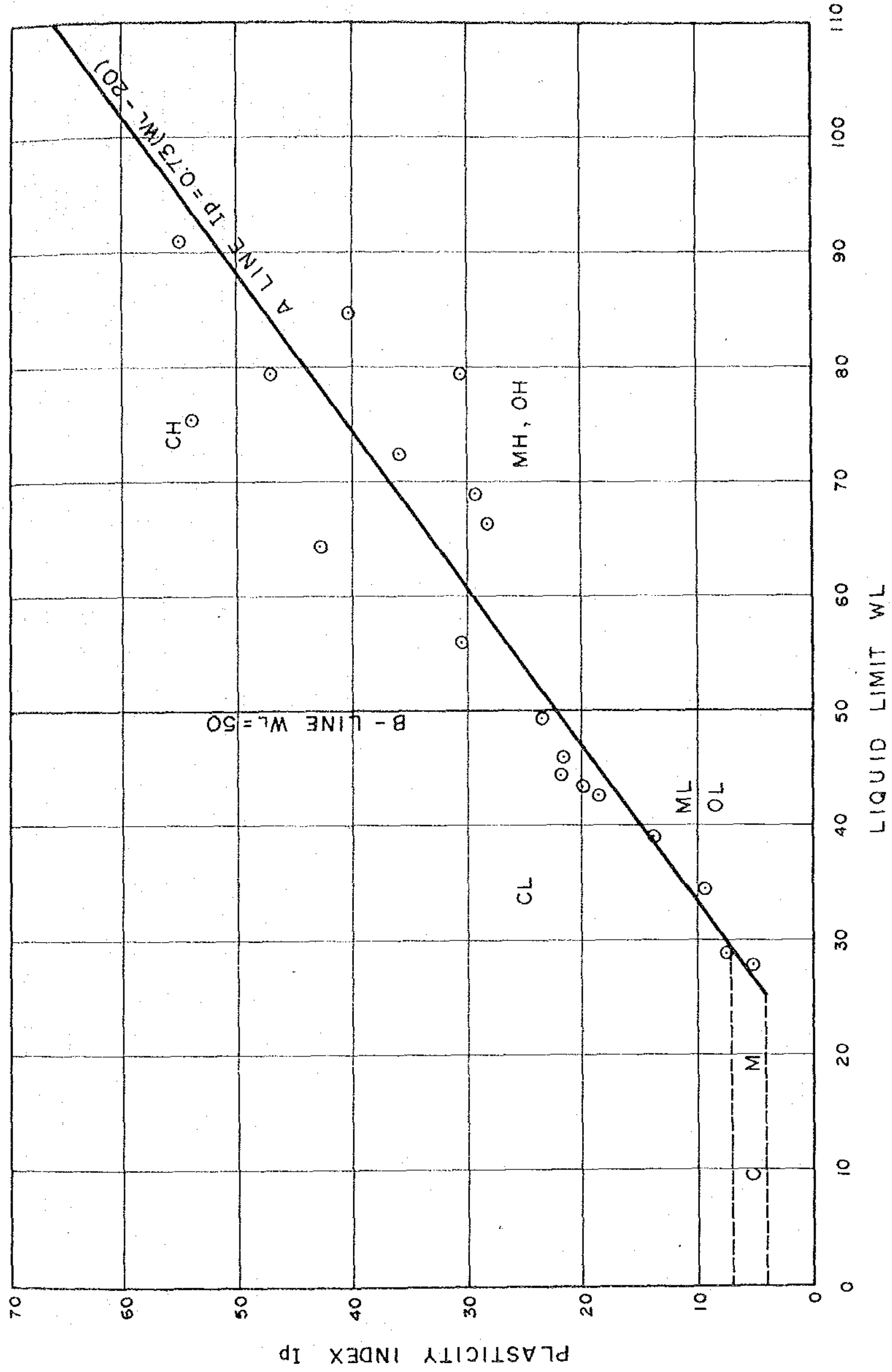
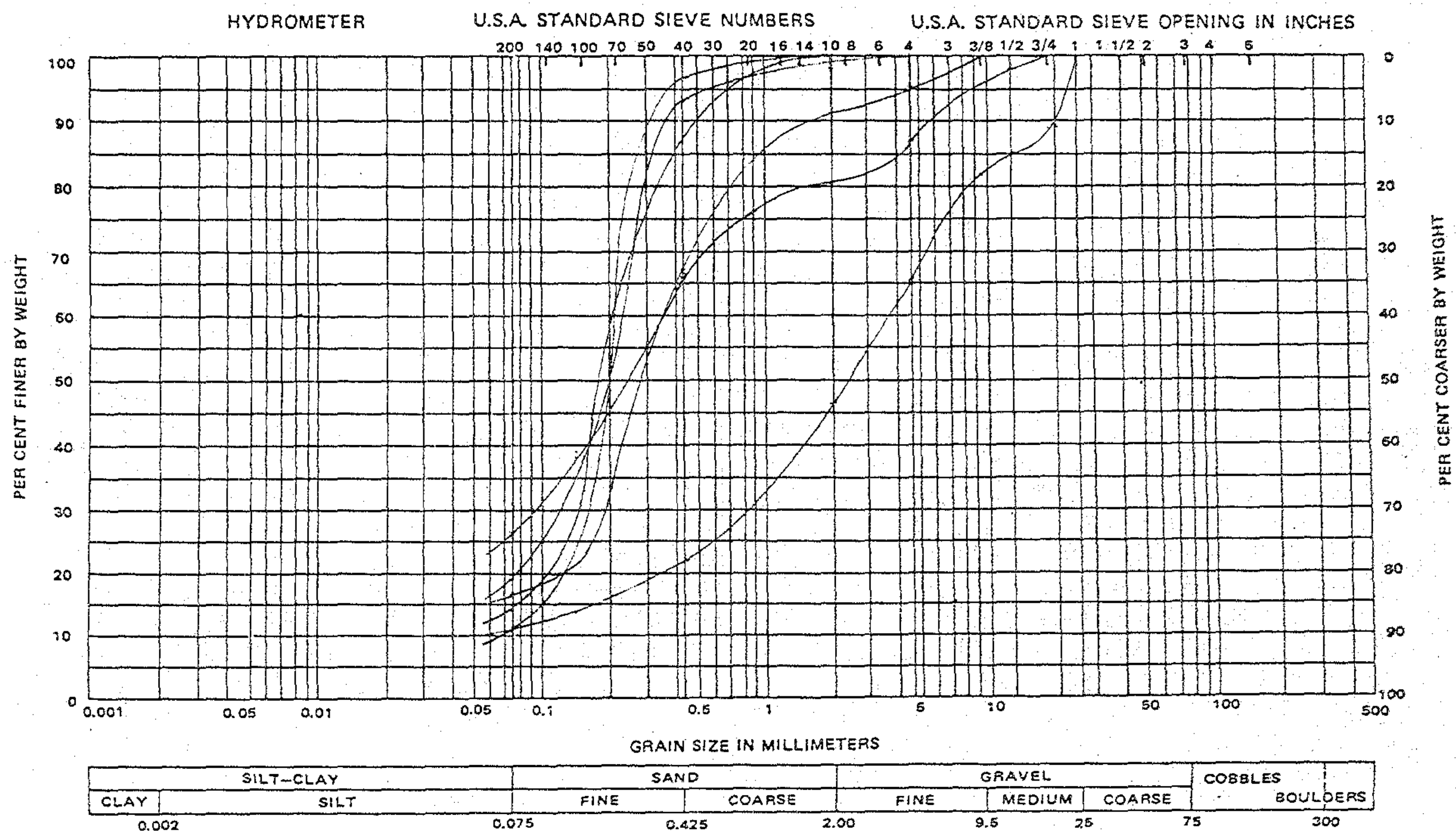


FIG. C.9.2 PLASTICITY CHART

FIG. C.9.3 GRADATION CURVES	DATE	TESTED BY
PROJECT	SAMLING LOCATION	SAMPLE NO.



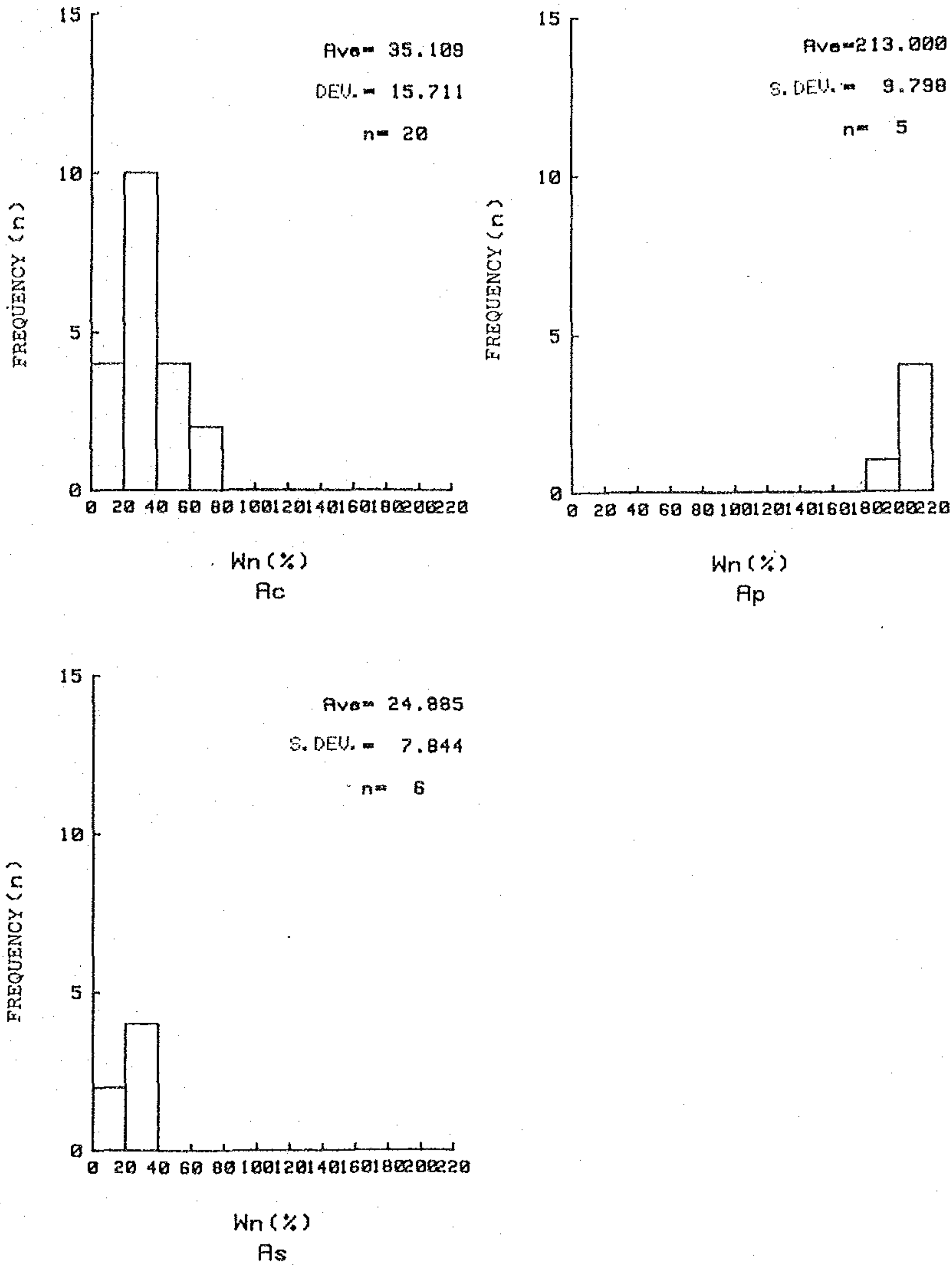
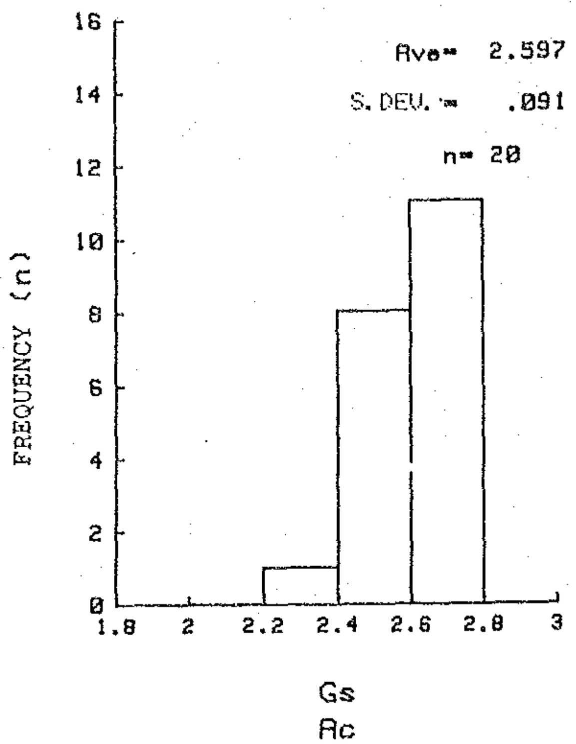
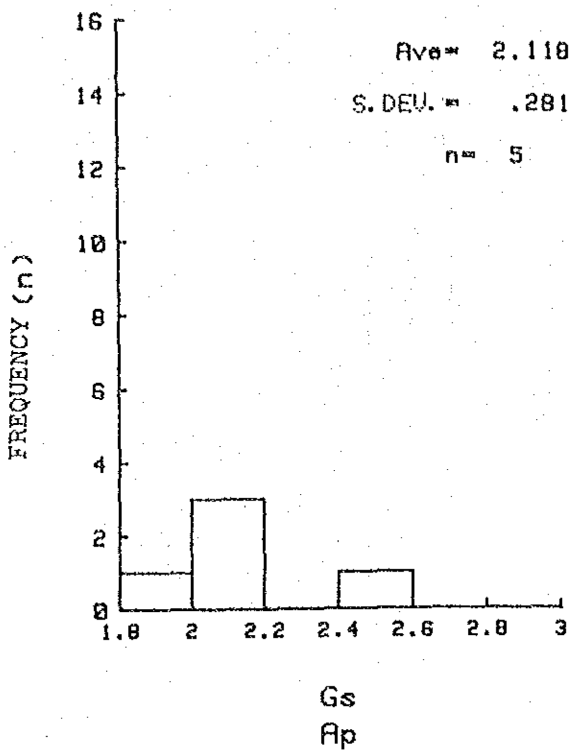


FIG. C.9.4 FREQUENCY CHART OF MOISTURE CONTENT





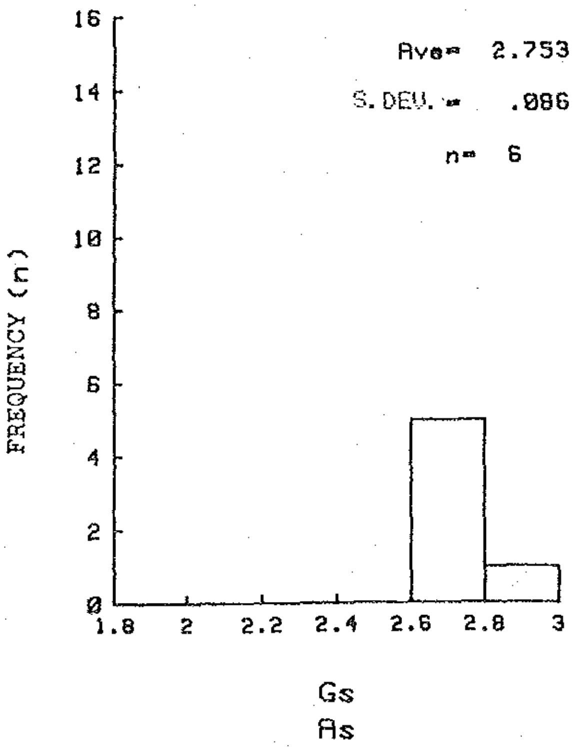


FIG. C.9.5 FREQUENCY CHART OF SPECIFIC GRAVITY

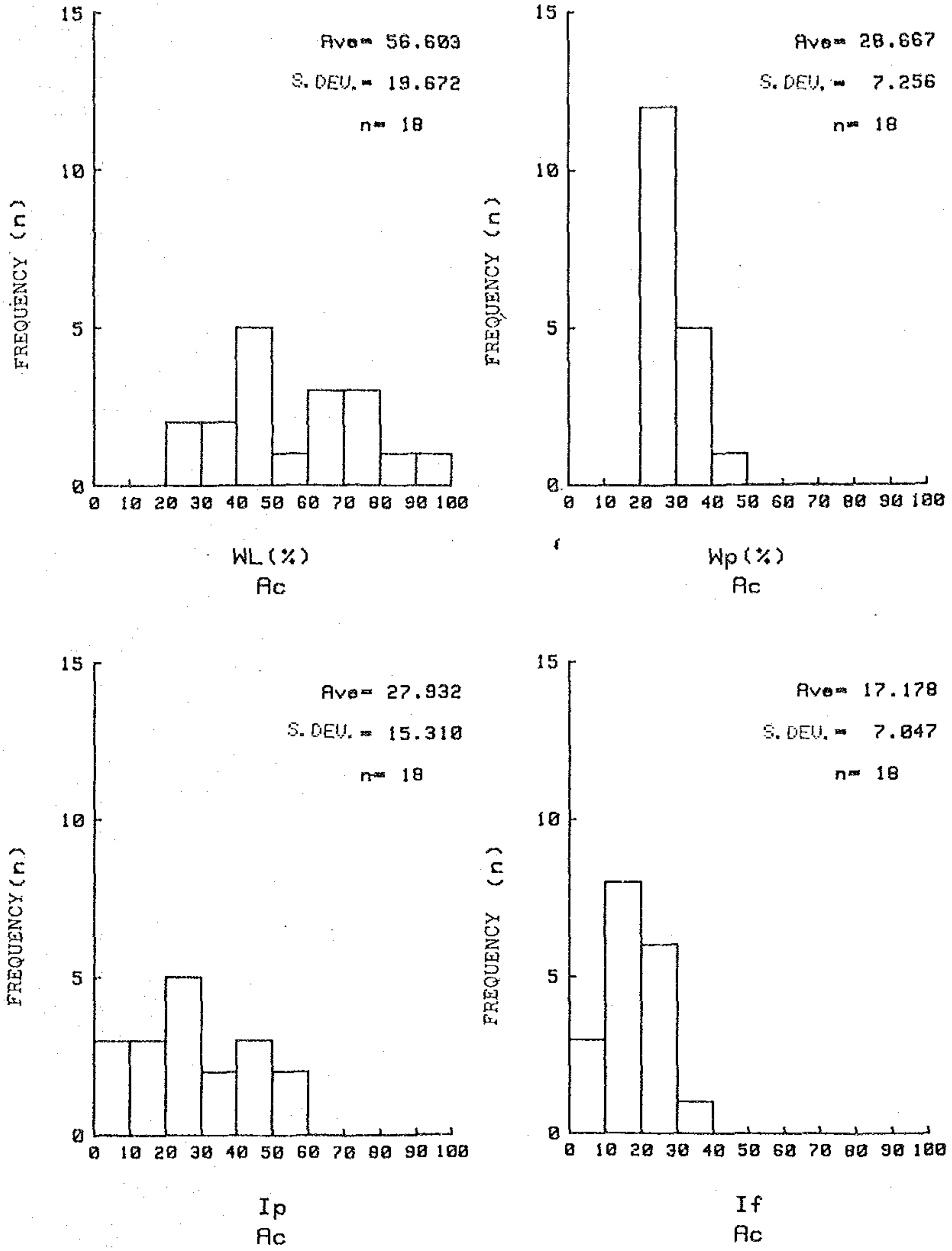


FIG.C.9.6 FREQUENCY CHART OF ATTERBERG TEST

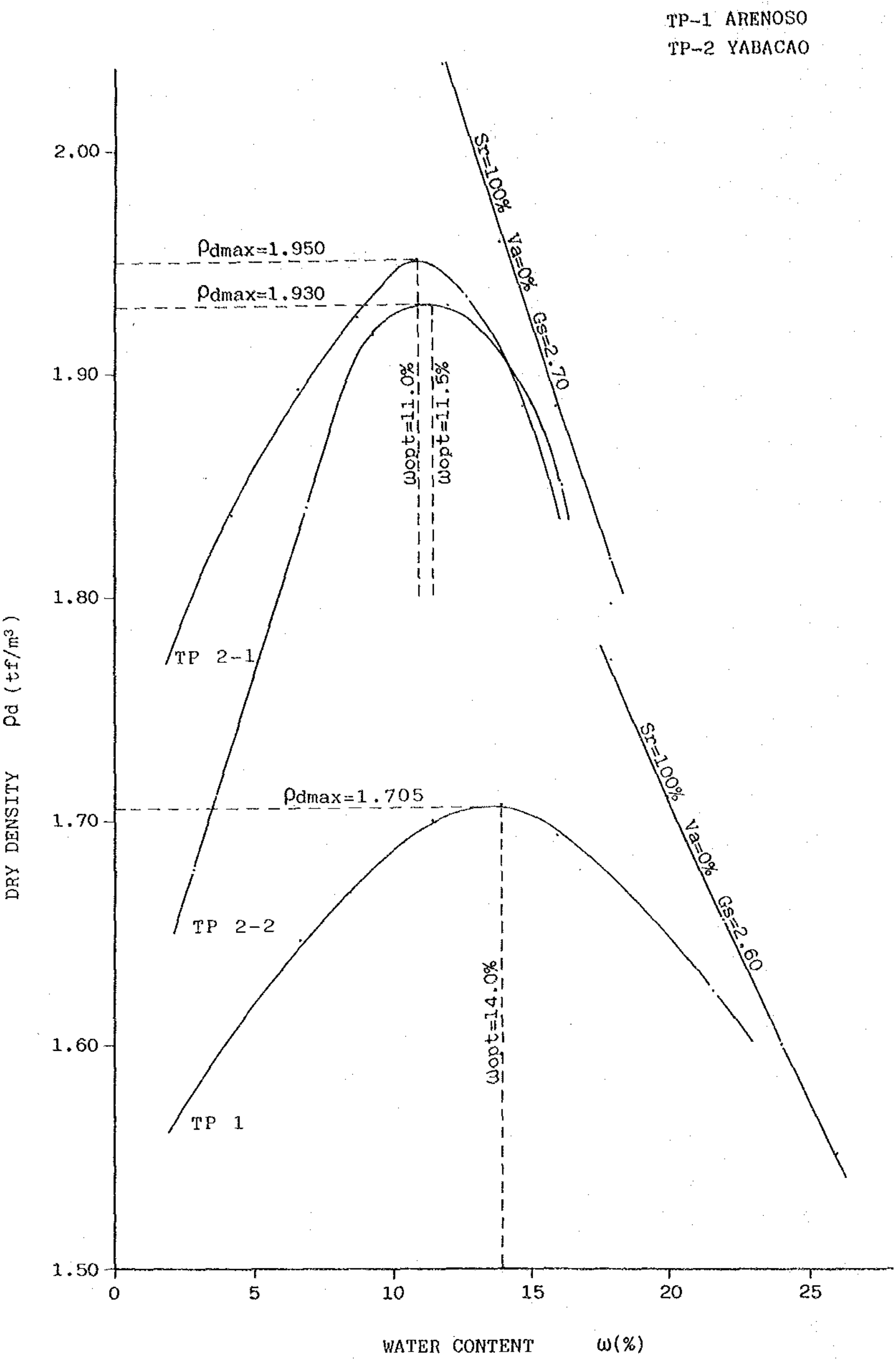
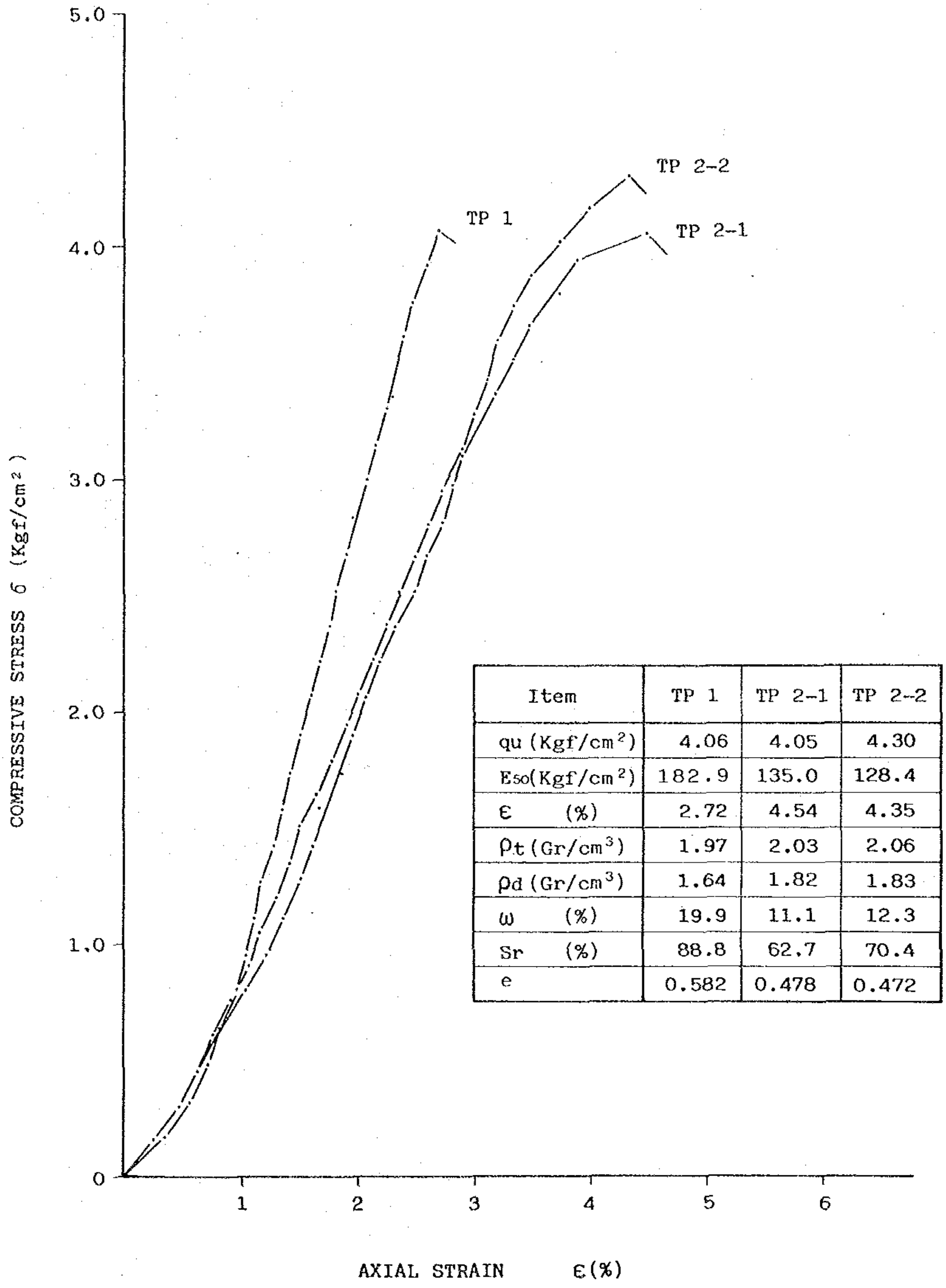


FIG.C.9.7 MOISTURE - DENSITY RELATION OF SOIL USING RAMMER



Item	TP 1	TP 2-1	TP 2-2
qu (Kgf/cm^2)	4.06	4.05	4.30
E_{50}(Kgf/cm^2)	182.9	135.0	128.4
ε (%)	2.72	4.54	4.35
ρ_t (Gr/cm^3)	1.97	2.03	2.06
ρ_d (Gr/cm^3)	1.64	1.82	1.83
ω (%)	19.9	11.1	12.3
Sr (%)	88.8	62.7	70.4
e	0.582	0.478	0.472

FIG. C.9.8 UNCONFINED COMPRESSION TEST

10. APPENDIX

10.1 LOCATION MAP AND GEOLOGICAL PROFILE

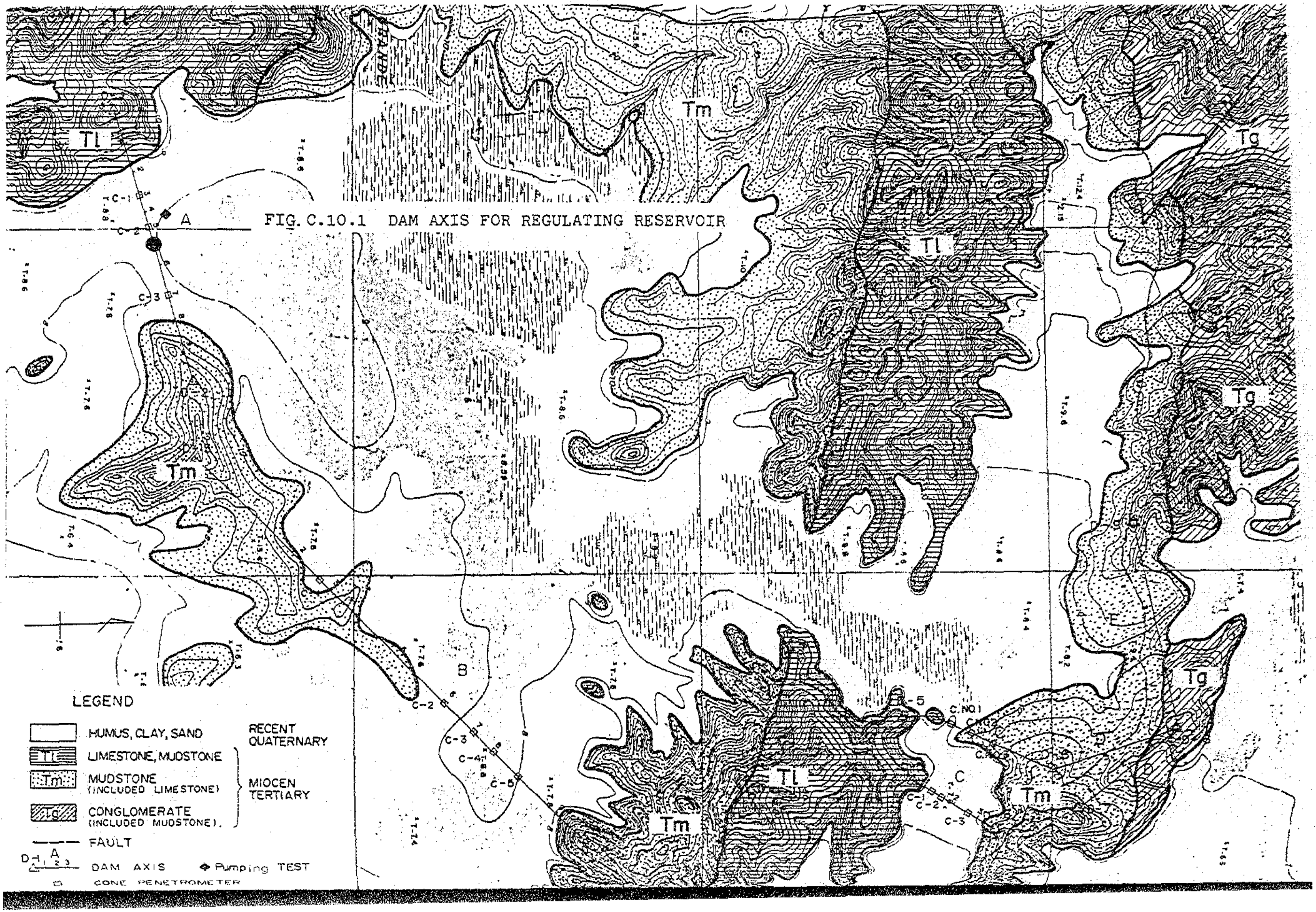


FIG.C.10.1 DAM AXIS FOR REGULATING RESERVOIR

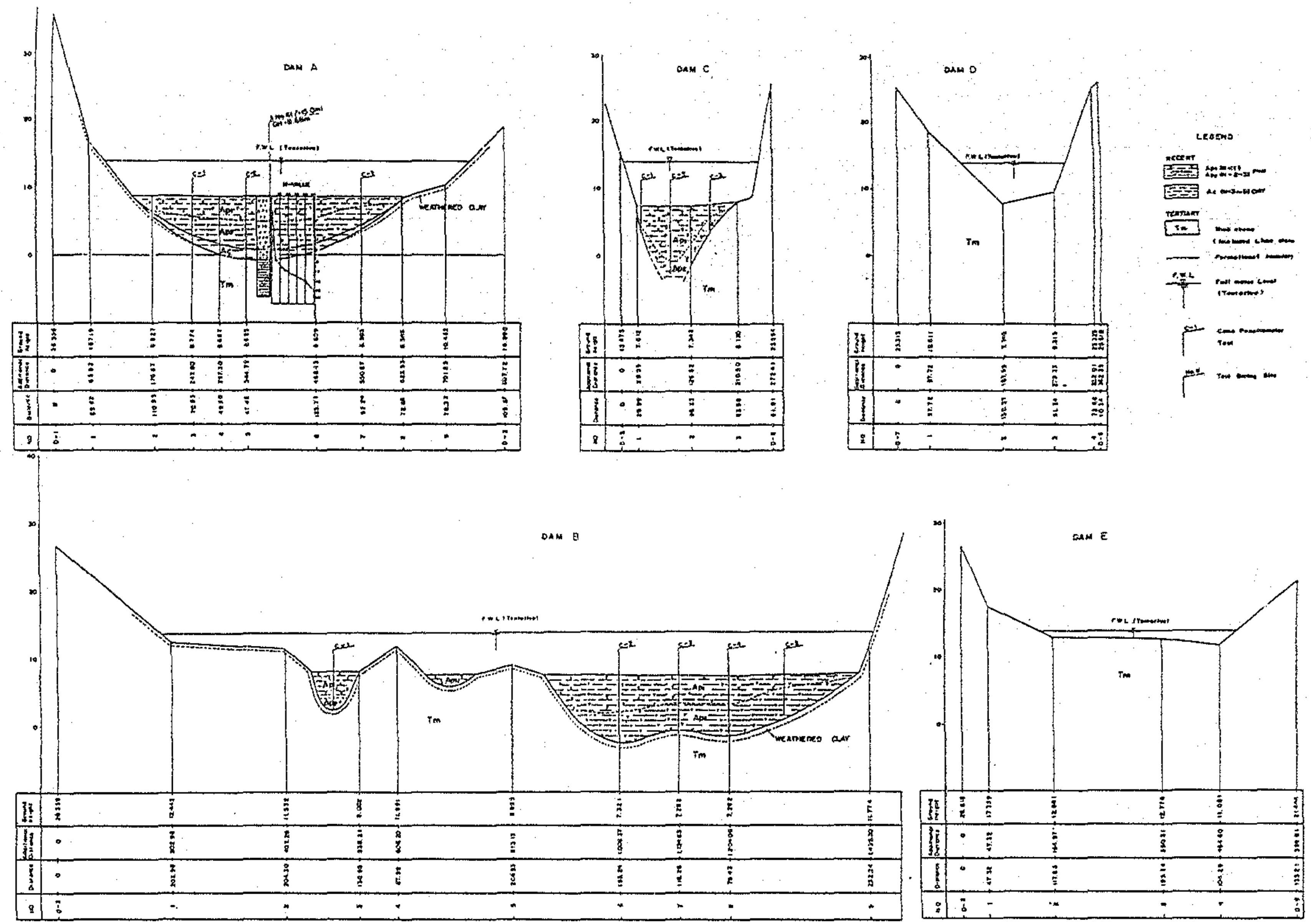
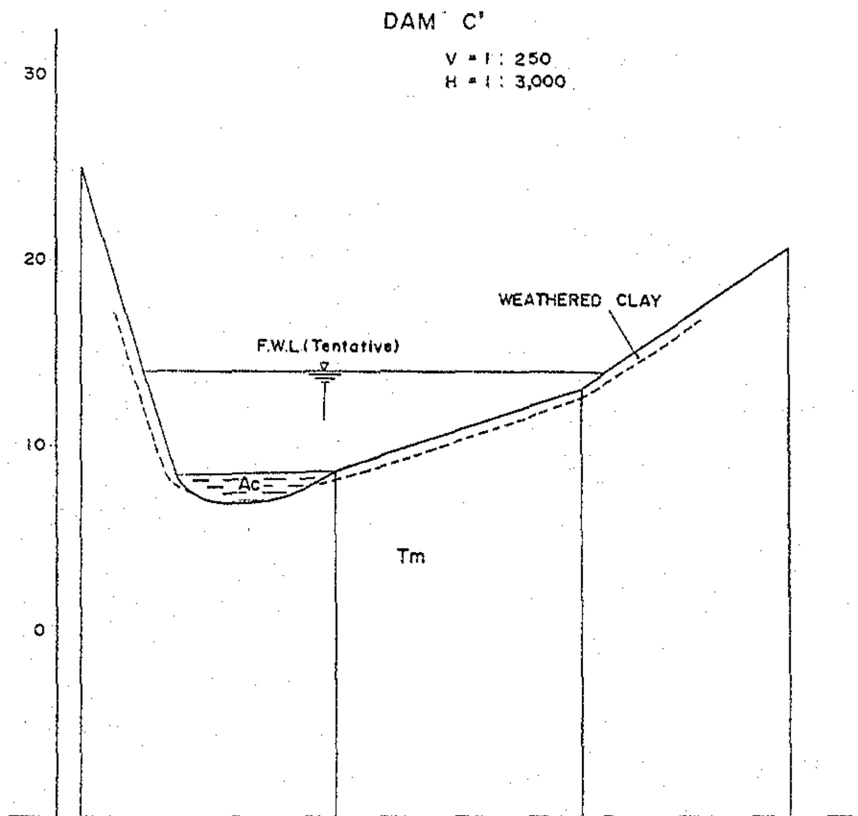
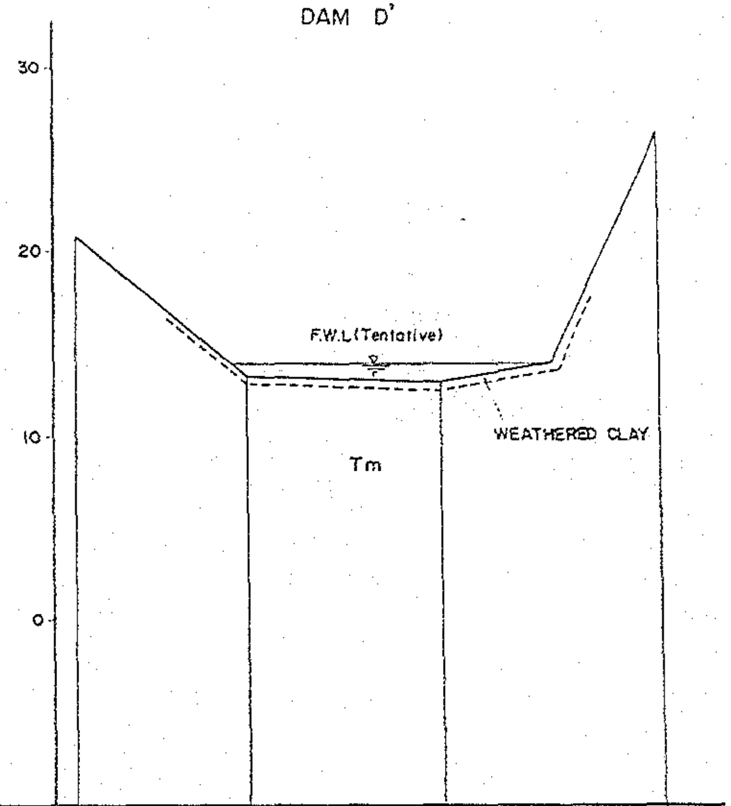


FIG.C.10.2 GEOLOGICAL PROFILE OF DAM AXIS A~E



Ground Height	24.939	8.600	13.070	20.655
Additional Distance	0	166.463	326.589	462.377
Distance	0	166.463	160.126	135.788
NO.	D-5	1	2	D-7



Ground Height	20.655	13.201	12.876	26.618
Additional Distance	0	112.563	238.832	379.967
Distance	0	112.563	126.269	141.135
NO.	D-7	1	2	D-8

FIG.C.10.3 GEOLOGICAL PROFILE OF DAM AXIS C', D'

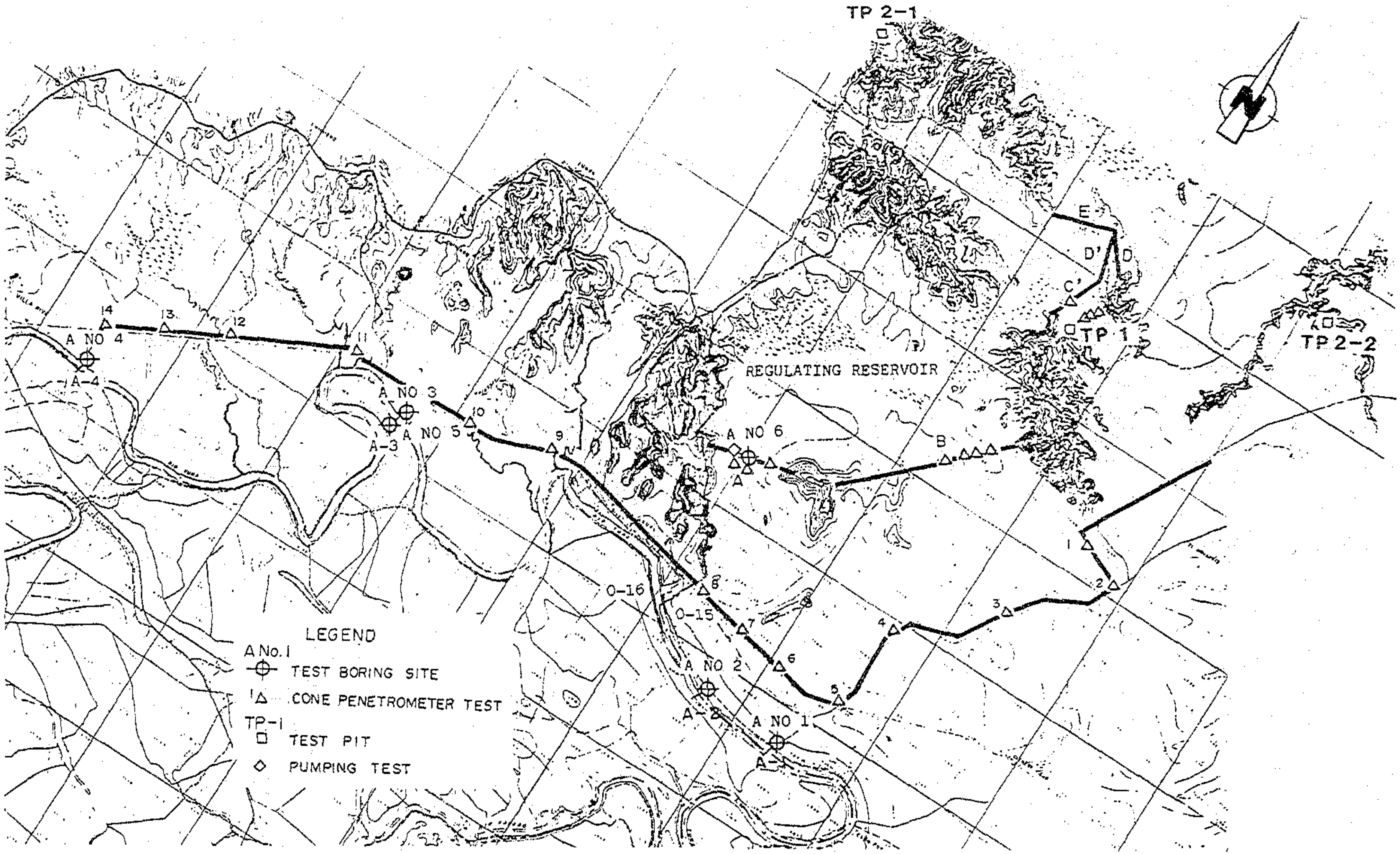


FIG. C.10.4 LOCATION MAP OF GEOLOGICAL EXPLORATION

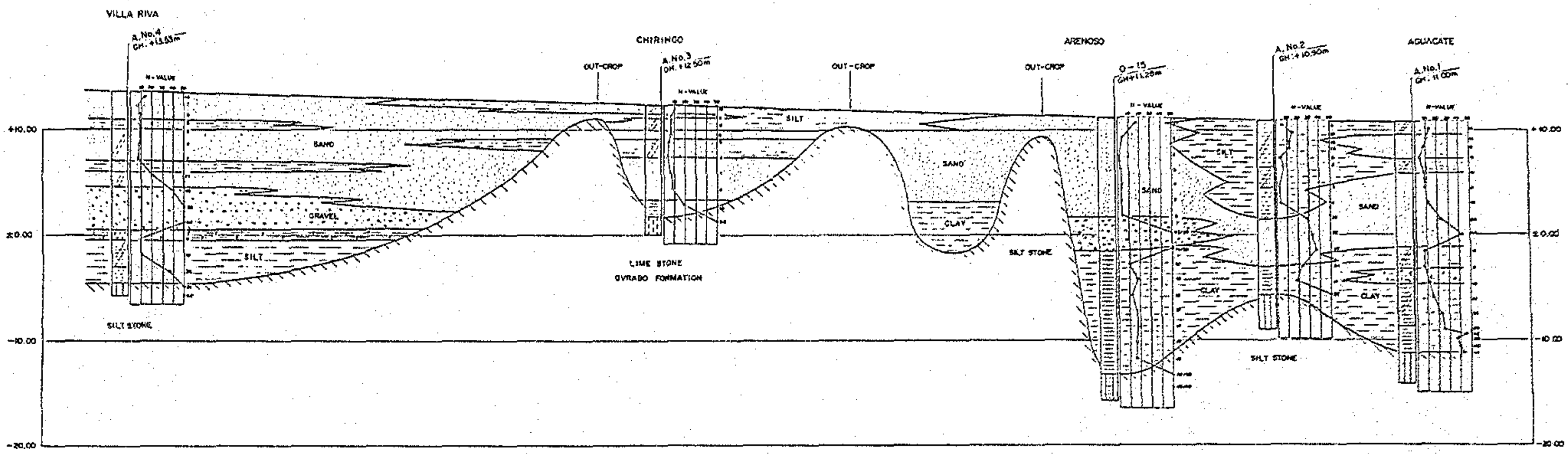


FIG.C.10.5 GEOLOGICAL PROFILE OF YUNA RIVER (LEFT BANK)

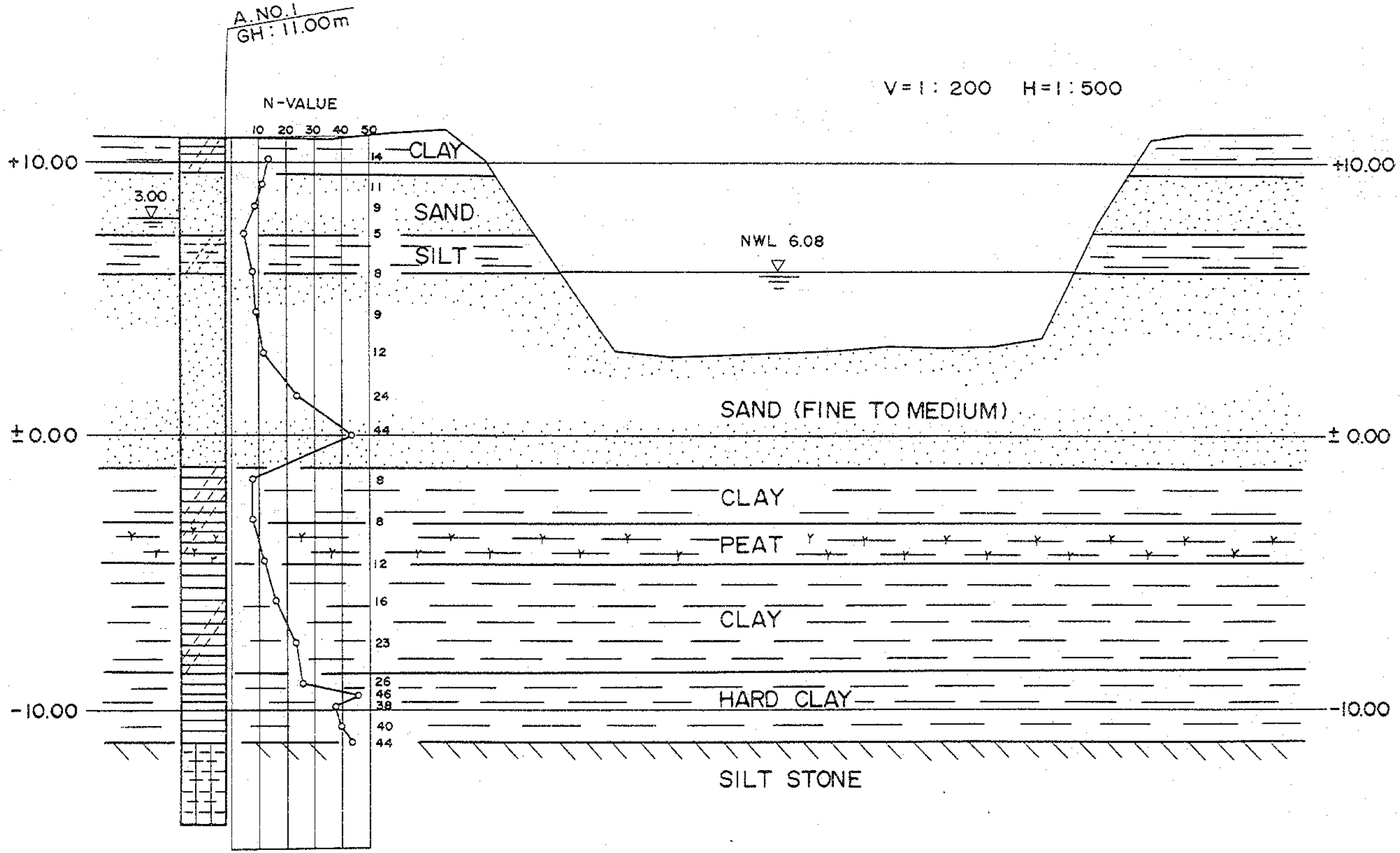


FIG.C.10.6 GEOLOGICAL PROFILE OF SECTION A-1 (Aguacate)

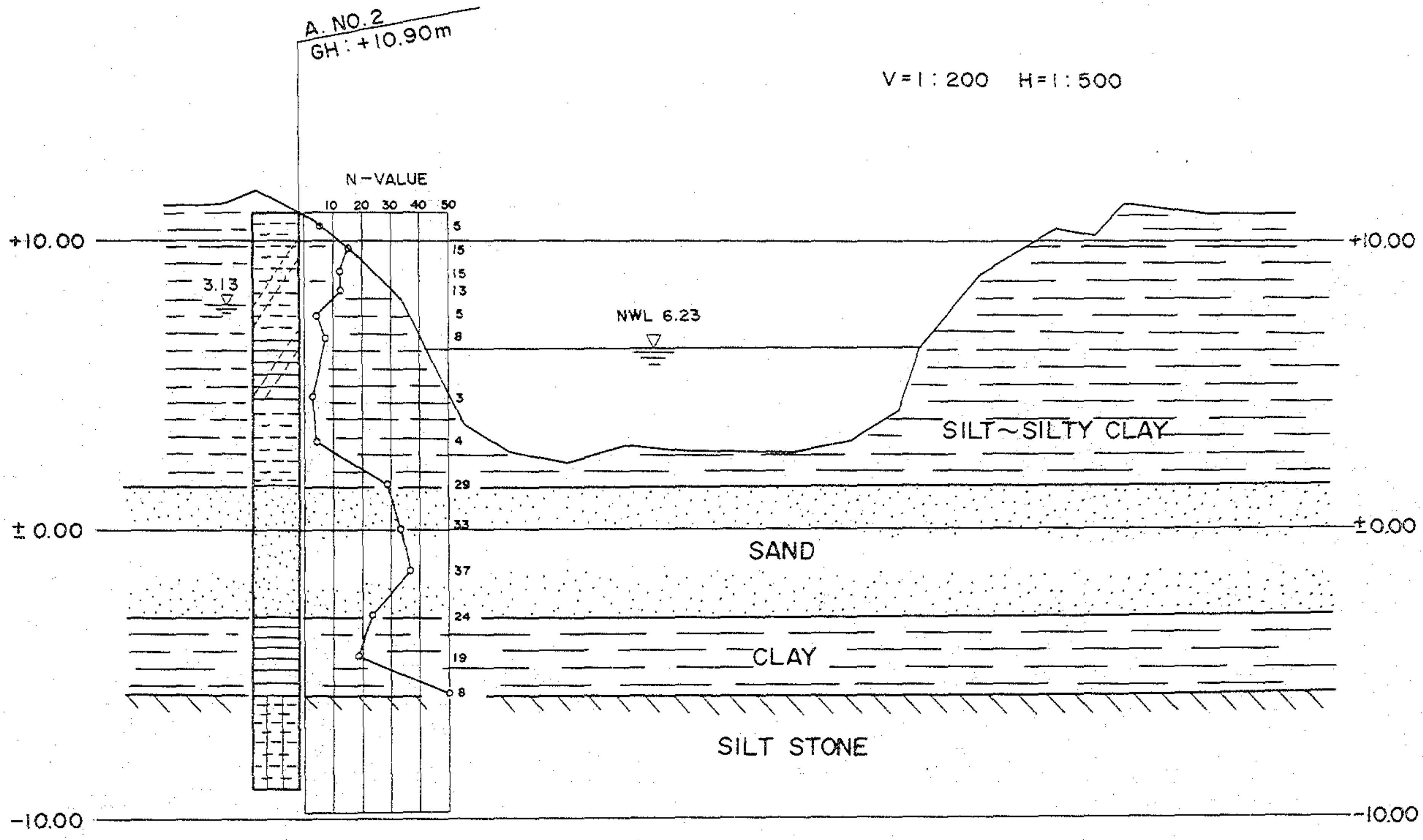


FIG.C.10.7 GEOLOGICAL PROFILE OF SECTION A-2 (Arenoso)

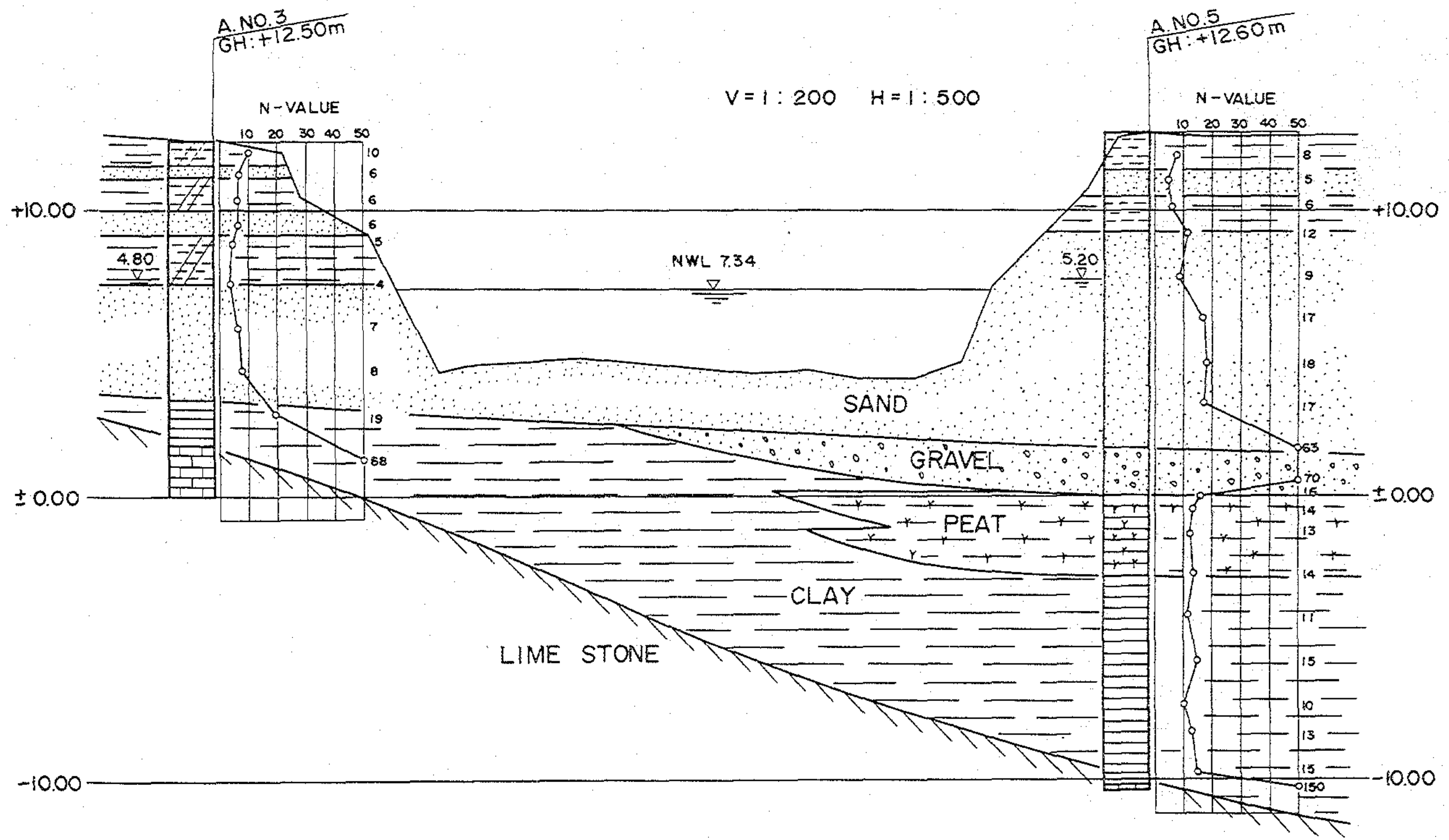


FIG.C.10.8 GEOLOGICAL PROFILE OF SECTION A-3 (Chiringo)

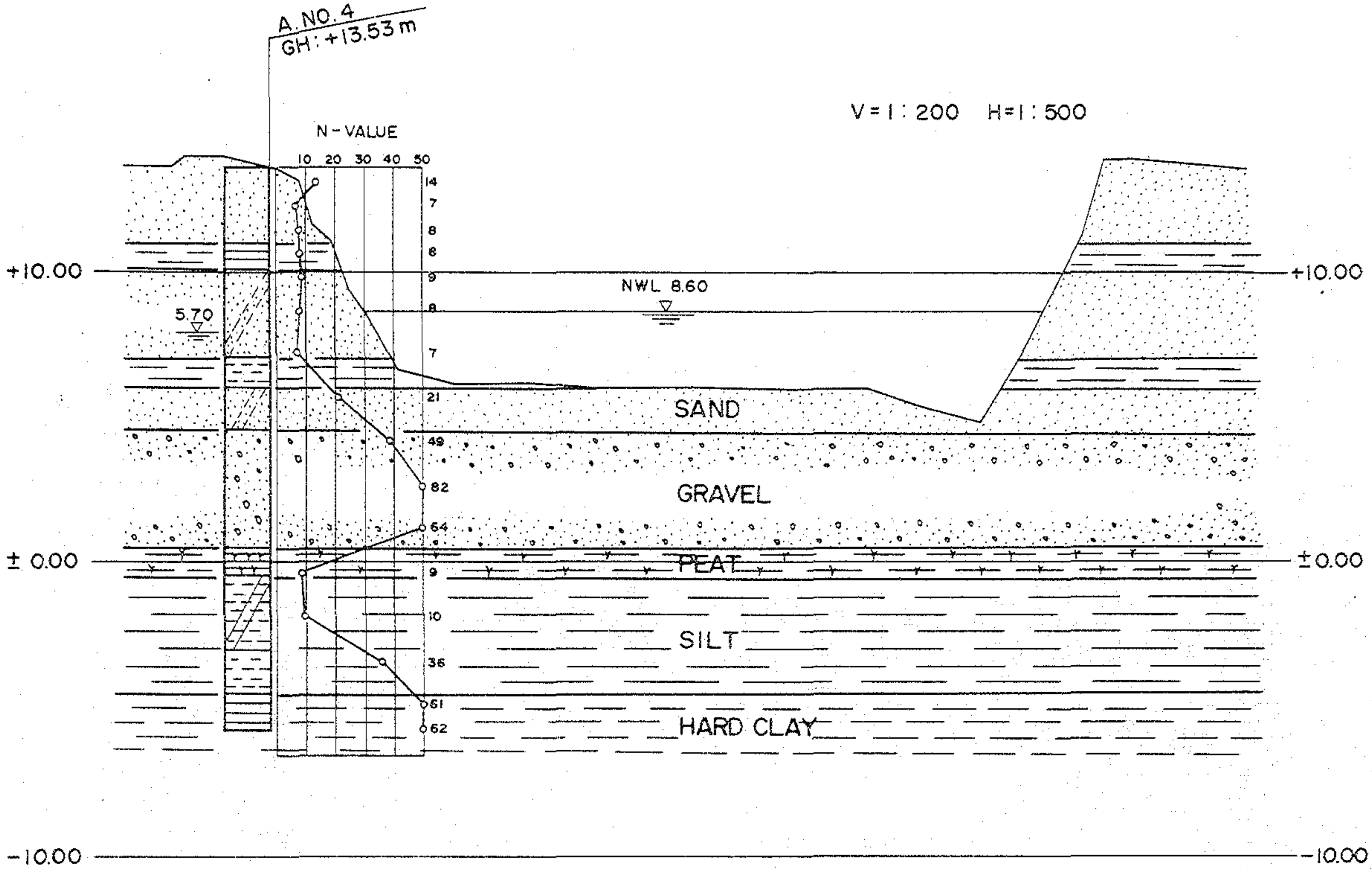


FIG.C.10.9 GEOLOGICAL PROFILE OF SECTION A-4 (Villa Riva)

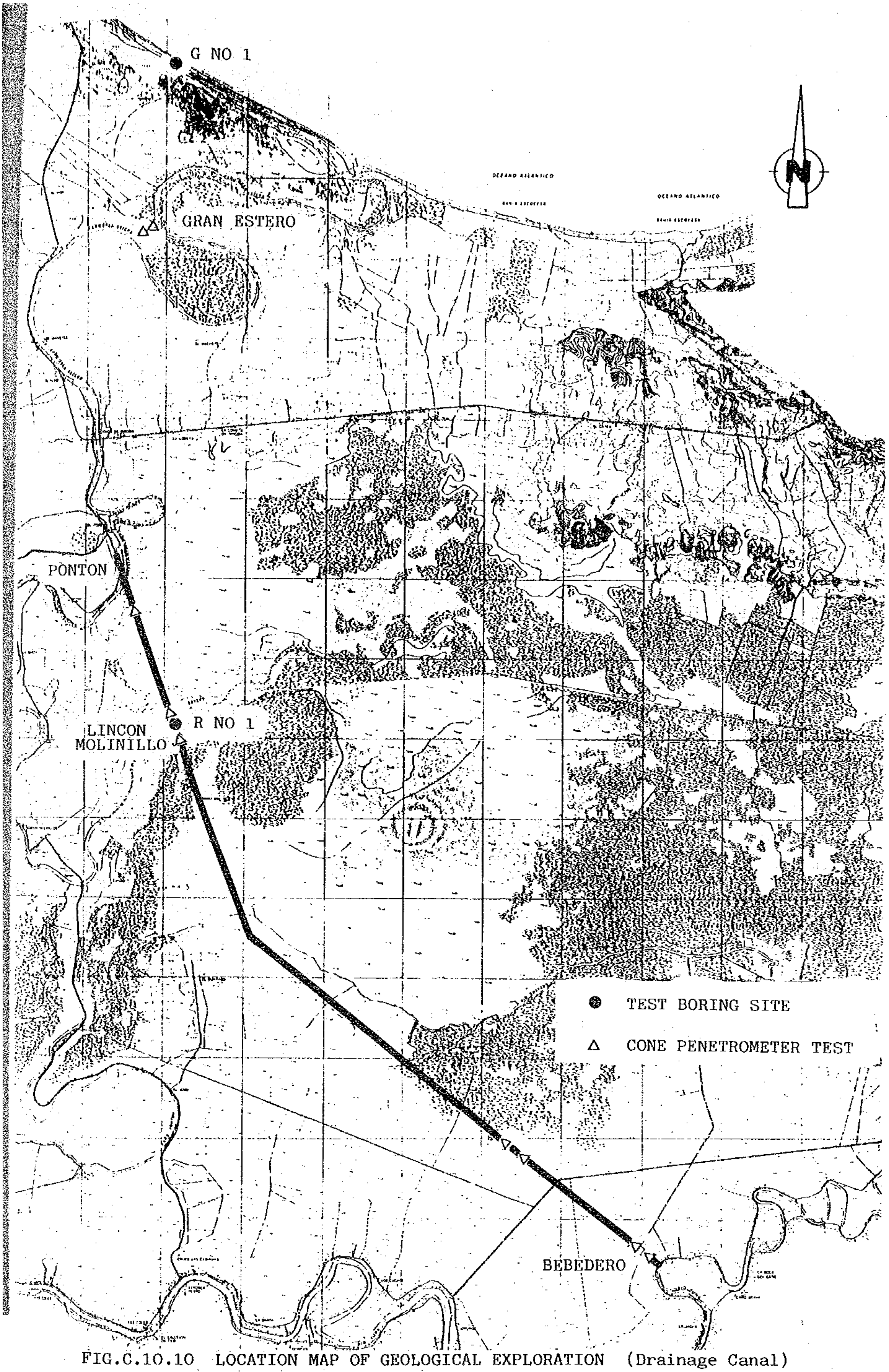


FIG.C.10.10 LOCATION MAP OF GEOLOGICAL EXPLORATION (Drainage Canal)

10.2 BORING LOGS

BORING LOG

NAME OF SURVEY & LOCALITY: AGUACATE GUAYABO — GROUND ELEVATION: + 11.00 m — DATE: 02.12.85 ~ 04.12.85

HOLE NO: ARENOSO NO. 1 (AGUACATE) — GROUND WATER LEVEL: GL - 3.00 m — SURVEYED BY: S. TAKADA, R. LORA

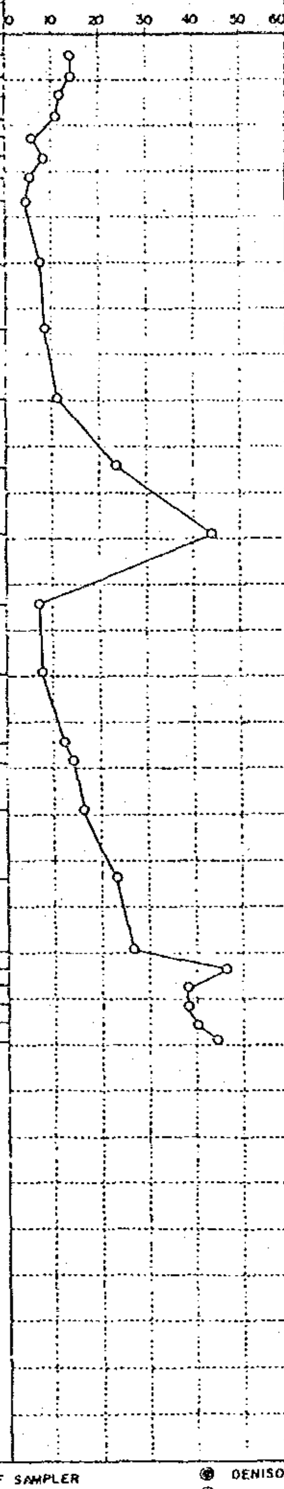
SOIL

ELEVATION (m)	DEPTH (m)	THICKNESS OF STRATUM (m)	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
9.65	1.35	1.35	SILTY CLAY	BROWN	VERY SANDY SILT; SILTY CLAY WITH A FEW OF SAND
9.20	1.00	0.45	SAND	BROWN	FINE SAND
7.40	3.60	1.00	SAND	BROWN	SILTY FINE SAND; FINE SAND
6.00	5.00	1.40	SILT	BROWN	SANDY SILT MEDIUM COHESION
3.50	7.50	2.50	SAND	BROWN	VERY FINE SAND WITH A FEW SILT
1.55	9.45	1.95	SAND	DARK BLUE ~ GREY	WITH A FEW OF CLAY FINE SAND
-1.00	12.00	2.35	SAND	GREY	SAND WITH A FEW OF SILT FINE~MEDIUM SAND
-8.50	19.50	7.50	SILTY CLAY	GREY ~ YELLOW	GREY SILT SUPERIOR COHESION; GREY SILT WITH A FEW OF ORGANIC MATERIALS (PEAT) DEP 14.00 ~ 15.50 m; YELLOW CLAY WITH SILT; SEDIMENTARY DIPOSIT OF CLAY
-10.90	21.90	2.40	CLAY	GREEN ~ YELLOW	HARD CLAY
-14.00	25.00	3.10	LIME STONE SILT STONE	BROWN	WEATHERED ALTERNATION

STANDARD PENETRATION TESTS / SOIL SAMPLES

DEPTH	NO. OF BLOWS / LENGTH OF PENETRATION (cm)	15 cm	30 cm	45 cm	NO. OF SAMPLE	DEPTH (m)	SYMBOL OF SAMPLER
0.45	14/30	5	6	8	1	0.45	O
0.90	14/30	5	7	7	2	0.90	O
1.35	12/30	3	5	7	3	1.35	O
1.80	11/30	4	6	5	4	1.80	O
2.25	6/30	2	3	3	5	2.25	O
2.70	9/30	3	4	5	6	2.70	O
3.15	6/30	3	3	3	7	3.15	O
3.60	5/30	3	2	3	8	3.60	O
4.95	8/30	3	5	3	9	4.95	O
6.45	9/30	4	4	5	10	6.45	O
7.95	12/30	5	6	6	11	7.95	O
9.45	24/30	7	11	13	12	9.45	O
10.95	44/30	9	20	24	13	10.95	O
12.45	8/30	2	4	4	14	12.45	O
13.95	8/30	4	4	4	15	13.95	O
15.45	12/30	3	4	5	16	15.45	O
15.85	14/30	5	4	5	17	15.85	O
16.90	16/30	4	6	6	18	16.90	O
10.40	23/30	7	8	8	19	18.40	O
19.90	26/30	7	9	10	20	19.90	O
20.30	46/30	13	15	18	21	20.30	O
20.70	38/30	12	13	13	22	20.70	O
21.10	38/30	11	13	14	23	21.10	O
21.50	40/30	12	12	16	24	21.50	O
21.90	44/30	12	14	18	25	21.90	O

N VALUE



REMARKS:

SYMBOLS OF SAMPLER
- ● THINWALL SAMPLER
- ○ SPLIT - SPOON SAMPLER
- ⊛ DENISON - TYPE SAMPLER
- ⊕ FOIL SAMPLER
- × OTHER SAMPLER

BORING LOG

NAME OF SURVEY & LOCALITY: AGUACAT GUAYABO
GROUND ELEVATION: +10.90 m. AM. G.L − 3.50
DATE: 5.12.85 ~ 7.12.85
HOLE NO.: ARENOSO NO. 2 (ARENOSO)
GROUND WATER LEVEL: GL − 3.23 m.
SURVEYED BY: S. TAKADA R. LORA

ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
6.50	4.40	4.40	SANDY SILT	BROWN	MEDIUM SANDY SILT
4.50	6.40	2.00	SILTY CLAY	BROWN	SUPERIOR COHESION SILTY CLAY
1.50	9.40	3.00	SILT	GREY	SANDY SILT ~ SILTY FINE SAND
-3.00	13.90	4.50	SAND	GREY	COARSE ~ MEDIUM SAND / FINE SAND
-5.72	16.62	2.72	CLAY	GREY	CALCAREAS CLAY
-6.70	17.60	0.98	SILT STONE	YELLOW	CREAM YELLOW WEATHERED SILT STONE
-10.10	21.00	3.40	SILT STONE	YELLOW	CREAM YELLOW SILT STONE

STANDARD PENETRATION TESTS / SOIL SAMPLES

DEPTH	NO. OF BLOWS / LENGTH OF PENETRATION cm	15 cm	30 cm	45 cm	NO. OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
0.40	5/30	1	2	2	1	0.40	○
0.80	6/30	2	2	2	2	0.80	○
1.20	11/30	3	6	6	3	1.20	○
1.60	13/30	4	3	6	4	1.60	○
2.00	13/30	3	5	5	5	2.00	○
2.40	8/30	2	3	3	6	2.40	○
2.80	13/30	4	5	4	7	2.80	○
3.20	3/30	1	1	1	8	3.20	○
3.60	5/30	1	2	2	9	3.60	○
4.00	4/30	1	1	2	10	4.00	○
4.40	8/30	2	3	3	11	4.40	○
6.40	3/30	1	1	1	12	6.40	○
7.90	4/30	1	1	2	13	7.90	○
9.40	29/30	5	13	11	14	9.40	○
10.90	33/30	10	9	14	15	10.90	○
12.40	37/30	12	12	13	16	12.40	○
13.90	24/30	5	9	10	17	13.90	○
15.40	19/30	4	7	8	18	15.40	○
16.62	87/30	25	60	2	19	16.62	○

REMARKS:

SYMBOLS OF SAMPLER
- ⊗ THINWALL SAMPLER
- ○ SPLIT-SPOON SAMPLER
- ⊙ DENISON-TYPE SAMPLER
- ⊕ FOIL SAMPLER
- × OTHER SAMPLER

BORING LOG

NAME OF SURVEY & LOCALITY: AGUACATE GUAYABO — GROUND ELEVATION: + 12.50 m — DATE: 7.12.85 ~ 8.12.85

HOLE NO.: ARENOSO NO. 3 (CHIRINGO) — GROUND WATER LEVEL: GL - 4.80 m — SURVEYED BY: S. TAKADA, R. LORA

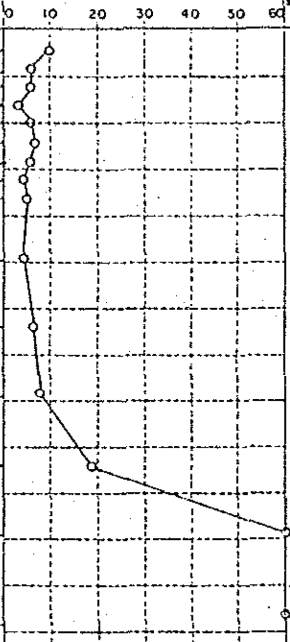
SOIL

ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
11.70	0.80	0.80	SILT	DARK BROWN	SANDY SILT
11.30	1.20	0.40	SAND	BROWN	SILTY SAND WITH A FEW [illegible]
10.10	2.40	1.20	SILT	BROWN	CLAYEY SILT WITH A FEW CLAY
9.30	3.20	0.80	SAND	BROWN	SILTY SAND
7.60	4.90	1.70	SILT	BROWN	CLAYEY SILT WITH A FEW CLAY
3.50	9.00	4.10	SAND	DARK GREY	FINE SAND ~ SILTY SAND WITH A FEW WEATHERED LIMESTONE
2.00	10.50	1.50	CLAY	LIGHT BROWN ~ YELLOW	CLAY AND WEATHERED SILTSTONE WITH A FEW SILT
-0.30	12.80	2.30	LIME STONE	YELLOW	WEATHERED LIMESTONE

STANDARD PENETRATION TESTS

DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	NO OF BLOWS AT EACH 10cm: 10 cm	20 cm	30 cm
0.40	10/30	3	3	4
0.80	6/30	2	2	2
1.20	6/30	2	2	2
1.60	3/30	1	1	1
2.00	6/30	1	2	3
2.44	7/30	2	2	3
2.80	6/30	2	2	2
3.20	4/30	2	1	1
3.60	5/30	1	2	2
4.90	4/30	1	1	2
6.40	7/30	2	2	3
7.90	8/30	2	3	3
9.40	19/30	6	6	7
10.90	68/30	18	20	30
12.90	91/30	13	18	60

N VALUE



SOIL SAMPLES

NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
1	0.40	○
2	0.80	○
3	1.20	○
4	1.60	○
5	2.00	○
6	2.44	○
7	2.80	○
8	3.20	○
9	3.60	○
10	4.90	○
11	6.40	○
12	7.90	○
13	9.40	○
14	10.90	○
15	12.80	○

REMARKS:

SYMBOLS OF SAMPLER
- ◉ THINWALL SAMPLER
- ○ SPLIT-SPOON SAMPLER
- ◉ DENISON-TYPE SAMPLER
- ⊕ FOIL SAMPLER
- × OTHER SAMPLER

BORING LOG

NAME OF SURVEY & LOCALITY: AGUACATE GUAYABO　　GROUND ELEVATION: + 13.53 m.　　DATE: 18.12.85 ~ 19.12.85

HOLE NO.: ARENOSO NO. 4 (VILLA RIVA)　　GROUND WATER LEVEL: GL − 6.00 m.　　SURVEYED BY: S. TAKADA　R. LORA

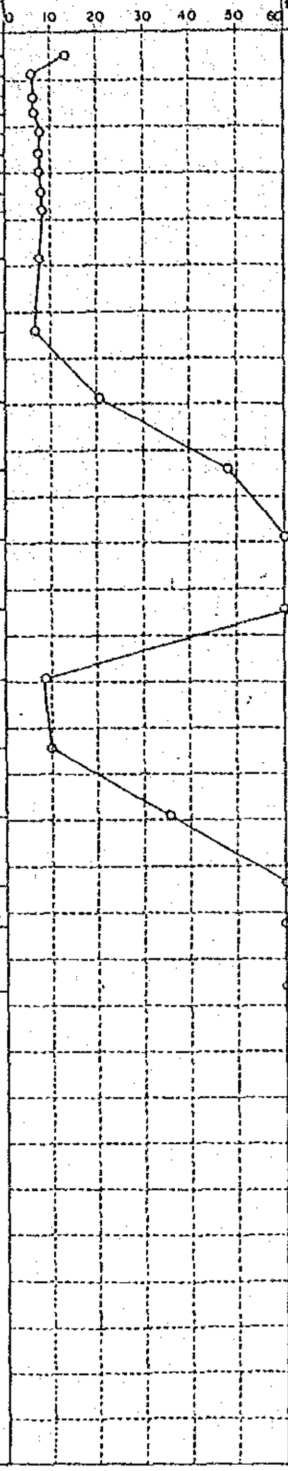
SOIL

ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
10.98	2.55	2.55	SAND	DARK BROWN	FINE SAND; SILTY SAND
10.13	3.40	0.85	CLAY	BROWN	SILTY CLAY WITH A FEW SAND
7.08	6.45	3.05	SAND	DARK GREY	GREY SILTY SAND WITH GRAVEL OF SILTSTONE
6.03	7.50	1.05	SILT	GREY	SANDY SILT
4.53	9.00	1.50	SAND	GREY	SILTY SAND
0.53	13.00	4.00	SAND	GREY	COARSE SAND WITH GRAVEL (MAX DIAMETER 2cm)
-0.42	13.95	0.95	BLACK	PEAT	PEAT WITH CLAY
-2.97	16.50	2.55	SILT	BLUE	CLAYEY SILT; SUPERIOR COHESION
-4.47	18.00	1.50	SILT	LIGHT BROWN	SILT AND WEATHERED SILTSTONE
-7.17	20.70	2.70	CLAY	BROWN	HARD CLAY SUPERIOR COHESION

STANDARD PENETRATION TESTS

DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	10 cm	20 cm	30 cm	Penetration per increment (cm)
0.45	14/30	4	6	9	
0.85	6/30	2	2	2	
1.30	7/30	3	2	4	
1.70	7/30	2	2	3	
2.15	8/30	3	4	4	
2.55	8/30	2	3	3	
3.00	9/30	3	4	4	
3.44	9/30	3	3	3	
3.85	9/30	3	4	3	
4.90	8/30	2	3	3	13, 13, 13
6.45	7/30	2	2	3	10, 10, 10
7.90	21/30	8	6	7	10, 10, 10
9.40	49/30	11	21	17	10, 10, 10
10.95	82/30	30	38	42	10, 10, 10
12.40	64/30	16	20	28	13, 13, 15
13.95	9/30	2	4	5	10, 10, 10
15.40	10/30	2	4	4	15, 15, 15
16.95	36/30	7	14	22	10, 10, 10
18.40	61/30	15	20	26	13, 15, 15
19.25	52/30		24	28	
20.70	62/30	12	20	30	

N VALUE



SOIL SAMPLES

NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
1	0.45	O
2	0.85	O
3	1.30	O
4	1.70	O
5	2.15	O
6	2.55	O
7	3.00	O
8	3.44	O
9	3.85	O
10	4.90	O
11	6.45	O
12	7.90	O
13	9.40	O
14	10.95	O
15	12.40	O
16	13.95	O
17	15.40	O
18	16.95	O
19	18.40	O
20	19.25	O
21	20.70	O

REMARKS:

SYMBOLS OF SAMPLER
- ● THINWALL SAMPLER
- ○ SPLIT-SPOON SAMPLER
- DENISON-TYPE SAMPLER
- FOIL SAMPLER
- × OTHER SAMPLER

BORING LOG

NAME OF SURVEY & LOCALITY: AGUACATE GUAYABO
GROUND ELEVATION: +12.60 m
DATE: 20. 12. 85 ~ 23. 12. 85

HOLE NO.: ARENOSO NO. 5 (CHIRINGO)
GROUND WATER LEVEL: GL - 5.20 m (- 4.50 ~)
SURVEYED BY: S. TAKADA R. LORA

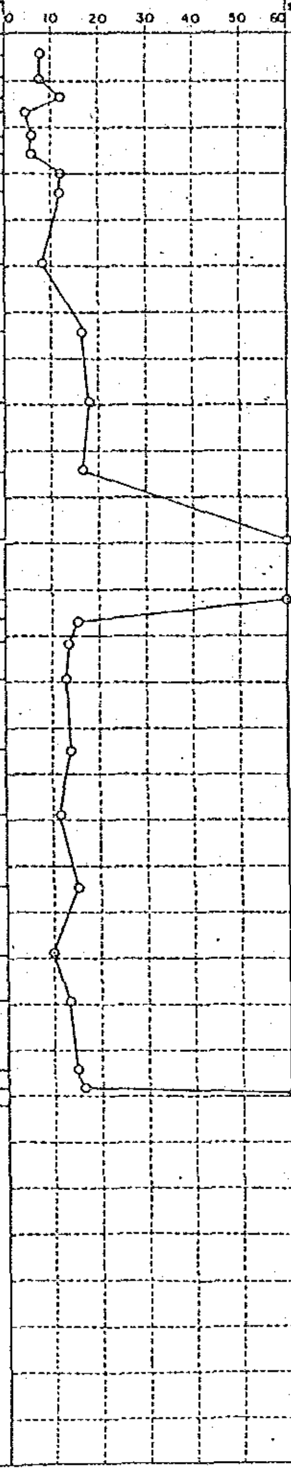
SOIL

ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
11.30	1.30	1.30	SILT	BROWN	SANDY SILT ~ SILTY FINE SAND
10.45	2.15	0.85	SAND	BROWN	FINE SAND
9.20	3.40	1.25	SILT	BROWN	SANDY SILT
3.20	9.40	6.00	SAND	BROWN / BLUE	FINE SAND
1.65	10.95	1.55	SAND	GREY	MEDIUM SAND
-0.10	12.70	1.75	GRAVEL	GREY	COARSE SAND WITH GRAVEL φ<10cm
-2.85	15.45	2.75	CLAY ~ PEAT	DARK GREY ~ BLACK	DARK GREY CLAY INCLUD PEAT ~ PEAT WITH A FEW CLAY
-10.25	22.85	7.40	CLAY	DARK GREY	SUPERIOR CONESION; CLAY WITH A FEW WOOD
-10.40	23.00	0.15	LIME STONE	BROWN	WEATHERED LIME STONE

STANDARD PENETRATION TESTS / SOIL SAMPLES

DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	15 cm	30 cm	45 cm	NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
0.45	8/30		3	5	1	0.45	○
0.85	8/30	3	2	3	2	0.85	○
1.30	12/30		6	6	3	1.30	○
1.70	3/30	2	1	2	4	1.70	○
2.15	6/30		3	3	5	2.15	○
2.55	6/30	2	2	2	6	2.55	○
3.00	12/30		6	6	7	3.00	○
3.40	12/30	3	3	4	8	3.40	○
4.95	9/30		5 / 15	4 / 15	9	4.95	○
6.40	17/30	5	6	6	10	6.40	○
7.95	10/30		8 / 15	10 / 15	11	7.95	○
9.40	17/30	4	7	6	12	9.40	○
10.95	63/30		29	34	13	10.95	○
12.25	70/30	29	20	21	14	12.25	○
12.70	16/30		7	9	15	12.70	○
13.15	14/30		5	9	16	13.15	○
13.90	13/30	3	4	6	17	13.90	○
15.45	14/30		6 / 15	8 / 15	18	15.45	○
16.90	11/30	3	4	4	19	16.90	○
18.45	13/30		9 / 15	7 / 15	20	18.45	○
19.90	10/30	3	4	3	21	19.90	○
20.95	13/30		6 / 15	7 / 15	22	20.95	○
22.40	15/30	7	4	4	23	22.40	○
22.85	16/30		7	9	24	22.85	○
23.00	30/10	30 / 10			25	23.00	○

N VALUE



REMARKS:

SYMBOLS OF SAMPLER
- ● THINWALL SAMPLER
- ○ SPLIT-SPOON SAMPLER
- ◉ DENISON-TYPE SAMPLER
- ⊕ FOIL SAMPLER
- × OTHER SAMPLER

BORING LOG

NAME OF SURVEY & LOCALITY: AGUACATE GUAYABO
GROUND ELEVATION: + 9.68 m.
DATE: 16. 12. 85 ~ 17. 12. 85

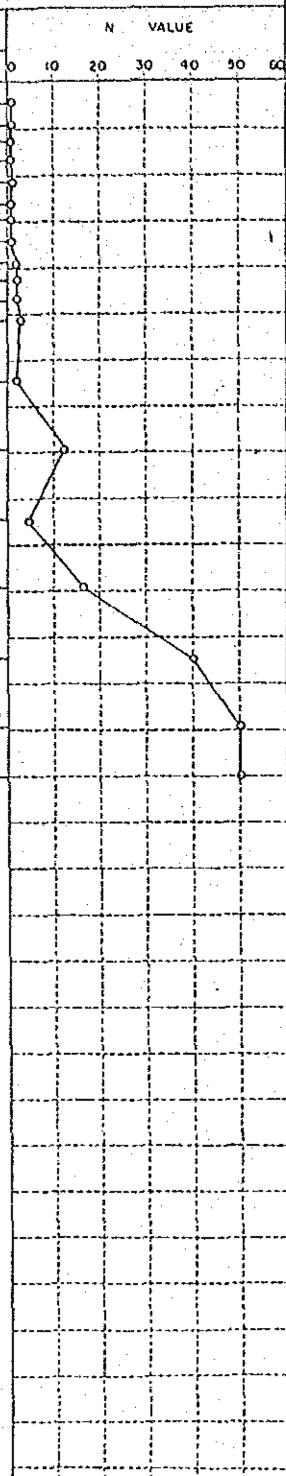
HOLE NO.: ARENOSO NO.6 (DAM AXIS A)
GROUND WATER LEVEL: GL ± 0 m.
SURVEYED BY: S. TAKADA R. LORA

SOIL

ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
6.13	2.55	2.55	PEAT	BLACK	WITH A FEW SILT
4.83	3.85	1.30	PEAT	BLACK	INDUDAD OLD WOOD WITH FINE MUD
3.58	5.10	1.25	PEAT	BLACK	WITH A FEW OF SILT AND MUD
1.78	7.90	2.80	PEAT	BLACK	WITH OLD WOOD AND A FEW OF MUD
-0.77	9.45	1.55	SILT	GREY	GREY SILT WITH PEAT
-2.22	10.90	1.45	CLAY	GREY	WITH GREY SILT
-6.32	15.00	4.10	CLAY	YELLOW ~ GREY	YELLOW HARD CLAY WITH GREY SILT

STANDARD PENETRATION TESTS / SOIL SAMPLES

DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	15 cm	30 cm	45 cm	NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
0.45	1/45				1	0.45	○
0.85	1/40				2	0.85	○
1.25	1/45				3	1.25	○
1.70	1/40				4	1.70	○
2.10	1/45				5	2.10	○
2.55	1/40				6	2.55	○
2.93	1/35				7	2.93	
3.40	1/40				8	3.40	○
3.85	2/30	2	1	1	9	3.85	○
4.25	2/30	1	1	1	10	4.25	○
4.70	2/30	2	1	1	11	4.70	○
5.10	3/30	1	1	2	12	5.10	○
6.45	2/30	1	1	1	13	6.45	○
7.90	12/30	1	1	10	14	7.90	○
9.45	5/30	2	2	3	15	9.45	○
10.90	17/30	3	6	8	16	10.90	○
12.45	40/30	11	16	24	17	12.45	○
13.90	30/30	14	15	21	18	13.90	○
15.00	50/30	13	15	22	19	15.00	○



REMARKS:

SYMBOLS OF SAMPLER
● THINWALL SAMPLER
○ SPLIT-SPOON SAMPLER
◉ DENISON-TYPE SAMPLER
FOIL SAMPLER
× OTHER SAMPLER

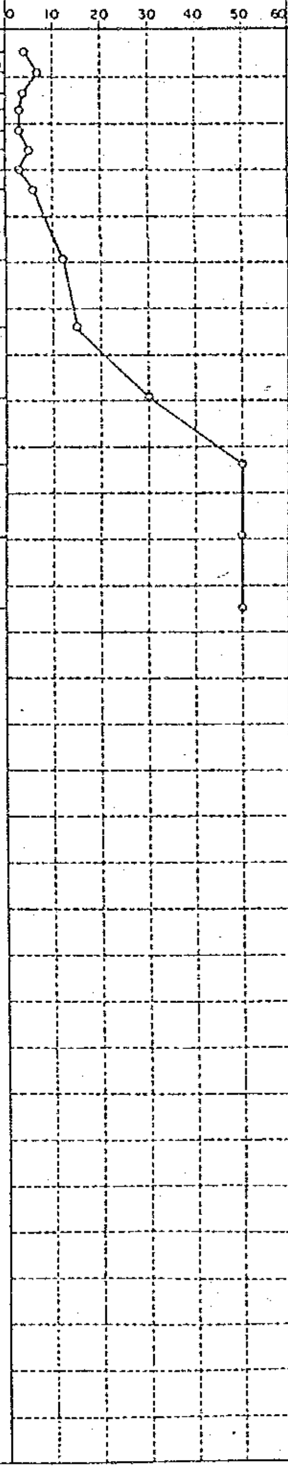
BORING LOG

NAME OF SURVEY & LOCALITY: AGUACATE GUAYABO — GROUND ELEVATION: 3.04 m — DATE: 08.01.86 ~ 09.01.86

HOLE NO.: RINCON MOLINILLO No. 1 — GROUND WATER LEVEL: GL − 0.20 m — SURVEYED BY: S. TAKADA, R. LORA

ELEVATION (m)	DEPTH (m)	THICKNESS OF STRATUM (m)	VISUAL CLASSIFICATION	COLOR	DESCRIPTION	SPT DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	BLOWS 10 cm	BLOWS 20 cm	BLOWS 30 cm	NO OF SAMPLE	SAMPLE DEPTH m
2.59	0.45	0.45	CALY	BROWN	SILTY CLAY	0.45	4/30	1/15	2/15	2/15	1	0.45
2.19	0.85	0.40	CLAY	BROWN	WLTH SAND	0.85	7/30	2/10	3/10	2/10	2	0.85
1.74	1.30	0.45	SAND	BROWN	SILTY SAND	1.30	4/30	2/15	2/15	2/15	3	1.30
						1.70	3/30	1/10	1/10	1/10	4	1.70
						2.15	3/30	2/15	1/15	2/15	5	2.15
						2.55	5/30	1/10	2/10	2/10	6	2.55
0.04	3.00	1.70	SILT	GREY	SANDY SILT	3.00	3/30	1/15	2/15	1/15	7	3.00
						3.40	6/30	2/10	2/10	2/10	8	3.40
-1.91	4.95	1.95	SILT	GREY	CLAYEY SILT	4.95	12/30	6/15	6/15	6/15	9	4.95
						6.40	15/30	4/10	5/10	6/10	10	6.40
-4.91	7.95	3.00	SAND	GREY	SILTY SAND	7.95	30/30	3/15	16/15	14/15	11	7.95
					DEPTH ABOUT 9.40m SAND WITH FINE GRAVEL	9.40	98/30	24/10	33/10	41/10	12	9.40
					DEPTH 10.50 ~ 12.40m GREY SAND WITH FINE GRAVEL	10.95	87/30	32/15	40/15	47/15	13	10.95
-9.46	12.50	4.55	SAND	GREY		12.50	100/20	40/10	60/10		14	12.50

N VALUE



REMARKS:

SYMBOLS OF SAMPLER

- ● THINWALL SAMPLER
- ○ SPLIT-SPOON SAMPLER
- ◉ DENISON-TYPE SAMPLER
- ⊕ FOIL SAMPLER
- × OTHER SAMPLER

BORING LOG

NAME OF SURVEY & LOCALITY: AGUACATE GUAYABO
GROUND ELEVATION: 1.14 m.
DATE: 27.11.85 ~ 02.12.85

HOLE NO.: GRAN ESTERO NO.1
GROUND WATER LEVEL: 3.12.85, 19.50 10.50 GL -1.53 ~ -2.46 m.
SURVEYED BY: S. TAKADA R LORA

Soil

Elevation (m)	Depth (m)	Thickness of Strata (m)	Visual Classification	Color	Description
	0.45	0.45	SANDY SILT	GREY	SANDY SILT
	1.35	0.90	SAND	GREY	FINE ~ MEDIUM SAND
	3.00	1.45	FINE SAND	GREY	FINE GREY SAND
	7.95	4.95	SAND	GREY	PIECE OF LIME STONE AND FINE GREY SAND. UNIFORM MEDIUM SAND
	9.45	1.50	FINE SAND	GREY	MEDIUM SAND
	12.00	2.55	SAND	GREY	FINE SAND
	16.50	4.50	SAND	DARK GREEN	FINE SAND INCLUDED SILT SILTY SAND; FINE SAND
	18.50	2.00	CLAY	DARK GREEN	SUPERIOR CONESION
	20.00	1.10	SILTY SAND	DARK GREEN	SILTY FINE SAND

Standard Penetration Tests / Soil Samples

Depth	No. of Blows / Length of Penetration (cm)	15 cm	30 cm	45 cm	No. of Sample	Depth (m)	Symbol of Sampler
0.45	3/30	1	1	2	1	0.45	O
0.90	16/30	3	7	9	2	0.90	O
1.35	18/30	7	7	11	3	1.35	O
1.80	37/30	11	15	22	4	1.80	O
2.25	55/30	13	25	30	5	2.25	O
3.45	36/30	20	15	21	6	3.45	O
4.95	64/30	17	27	37	7	4.95	O
6.45	60/30	20	20	40	8	6.45	O
7.95	29/30	10	12	17	9	7.95	O
9.45	30/30	13	12	18	10	9.45	O
10.95	39/30	12	20	19	11	10.95	O
12.45	52/30	18	24	28	12	12.45	O
13.95	32/30	4	7	25	13	13.95	O
15.45	72/30	14	30	42	14	15.45	O
16.95	50/30	9	18	32	15	16.95	O
18.45	52/30	19	22	30	16	18.45	O
20.00	51/30	15	26	25	17	20.00	O

REMARKS:

SYMBOLS OF SAMPLER
- ● THINWALL SAMPLER
- O SPLIT-SPOON SAMPLER
- DENISON-TYPE SAMPLER
- FOIL SAMPLER
- × OTHER SAMPLER

10.3 RESULTS OF CONE PENETROMETER TEST

PORTABLE CONE PENETROMETER TEST

PROJECT: ACTUACATE GUAYABO REGULATING RESERVOIR DAM A NO.3 -100m　DATE: 03. 09. 85

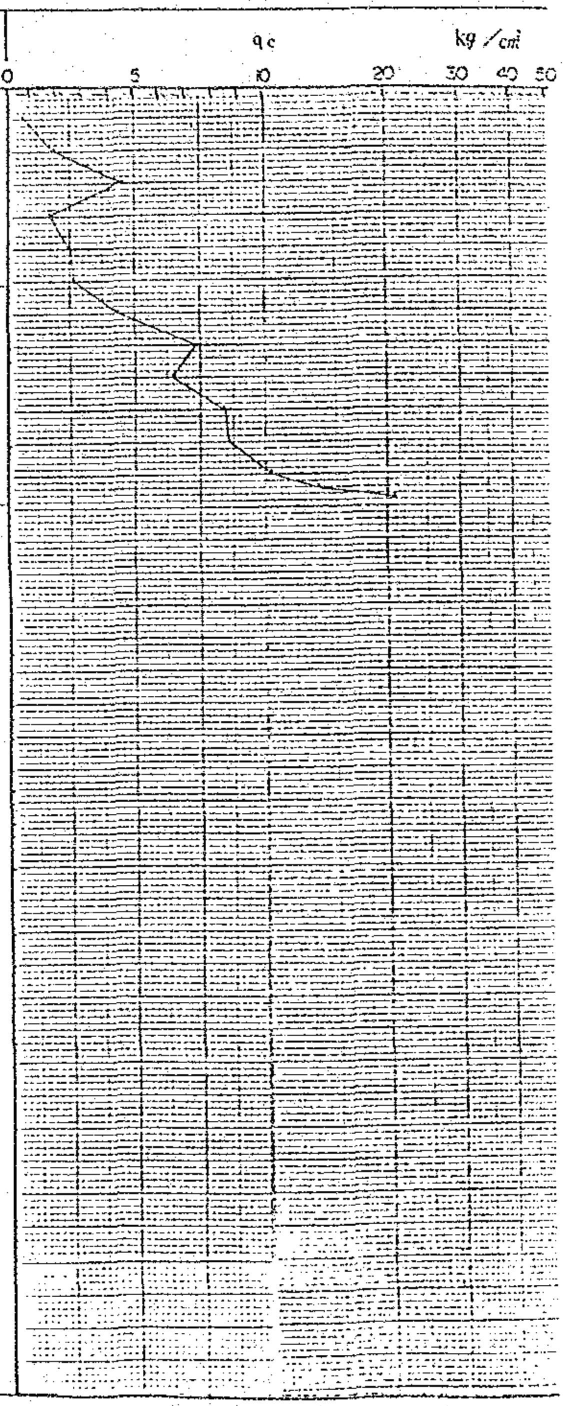
LOCATION: No. C-1　WEATHER: FINE　SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: $\alpha = 0.3608$ kg/ GRADUATION; $\beta = \alpha / A = 0.0559$ kg/cm² GRADUATION

GROUND ELEVATION: 8.27 m　AREA OF CONE: A = 6.45 cm²　VELOCITY OF PENETRATION: 1cm/sec

DEPTH m	RECORD OF P,R R	qc $=\beta \cdot R$ kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	10.0	0.56		Y Y Y	
1.0	35.5	1.98		Y Y	
1.5	81.5	4.56		Y Y Y	
2.0	28.5	1.59		Y Y	
2.5	40.5	2.26		Y Y Y	Ap 1
3.0	46.0	2.57	3.00	Y Y	PEAT
3.5	77.0	4.30		Y Y Y	
4.0	129.0	7.21		Y Y	
4.5	119.0	6.65		Y Y Y	
5.0	148.0	8.27		Y Y	
5.5	156.0	8.72		Y Y Y	Ap 2
6.0	185.5	10.37		Y Y	PEAT
6.4	243.0	13.58	6.45		
6.45	372.5	20.82			



LEGEND OF SYMBOLS

GRAVEL　CLAY　SILT　SAND　PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT AGUACATE GUAYABO REGULATING RESERVOIR DAM A NO.5 - 1.00m DATE 03 09 85

LOCATION : No. C-2 WEATHER FINE SURVEYED BY S. TAKADA

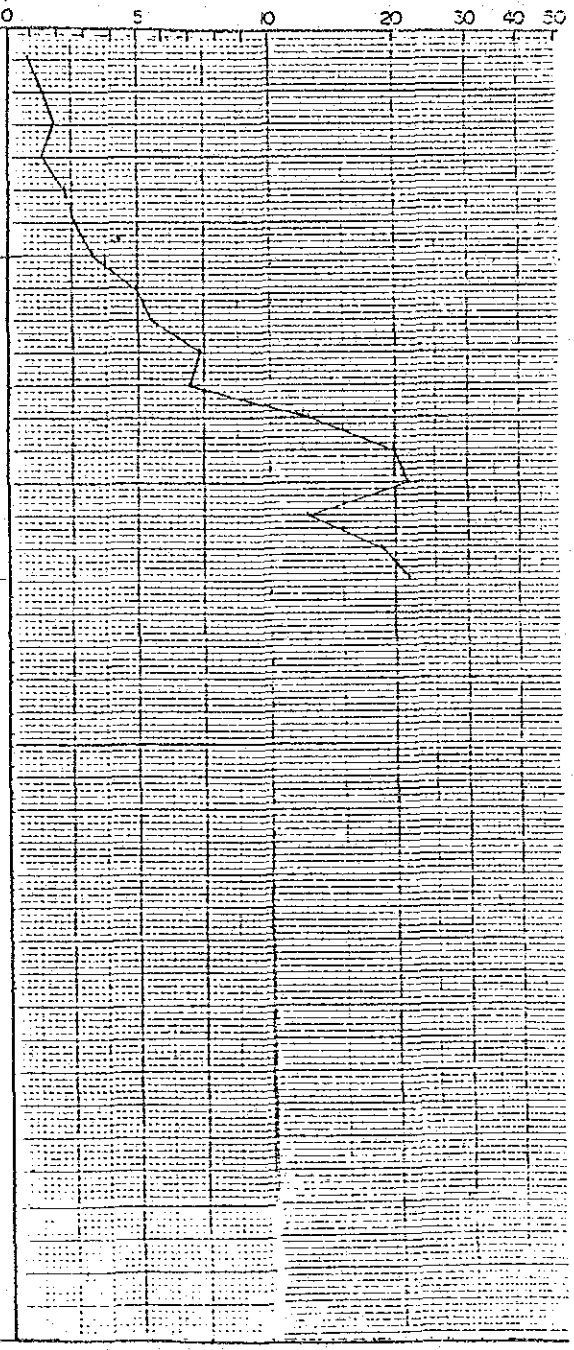
CAPACITY OF PROVING RING 100 kg

COEFFICIENT OF COMPARISON : α = 0.3608 kg/ GRADUATION ; β = α / A = 0.0559 kg/cm² GRADUATION

GROUND ELEVATION 9.68 m AREA OF CONE : A = 6.45 cm²

VELOCITY OF PENETRATION 1cm/sec

DEPTH m	RECORD OF P.R R	qc = β • R kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	15.0	0.84		v v v	
1.0	22.5	1.26		v v	
1.5	35.0	1.96		v v v	
2.0	28.0	1.57		v v	
2.5	40.5	2.26		v v v	
3.0	48.0	2.68		v v	Ap1 PEAT
3.5	59.5	3.33	3.5		
4.0	89.5	5.00		v v v	
4.5	105.0	5.87		v v	
5.0	132.5	7.41		v v v	
5.5	125.0	6.99		v v	
6.0	219.5	12.27		v v v	
6.5	358.5	20.04		v v	
7.0	387.5	21.66		v v v	
7.5	217.5	12.16		v v	Ap2 PEAT
8.0	322.5	18.31		v v	
8.95	380.5	21.27	8.95		



LEGEND OF SYIMBOLS: GRAVEL, CIAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAMA DATE: 03. 09. 85

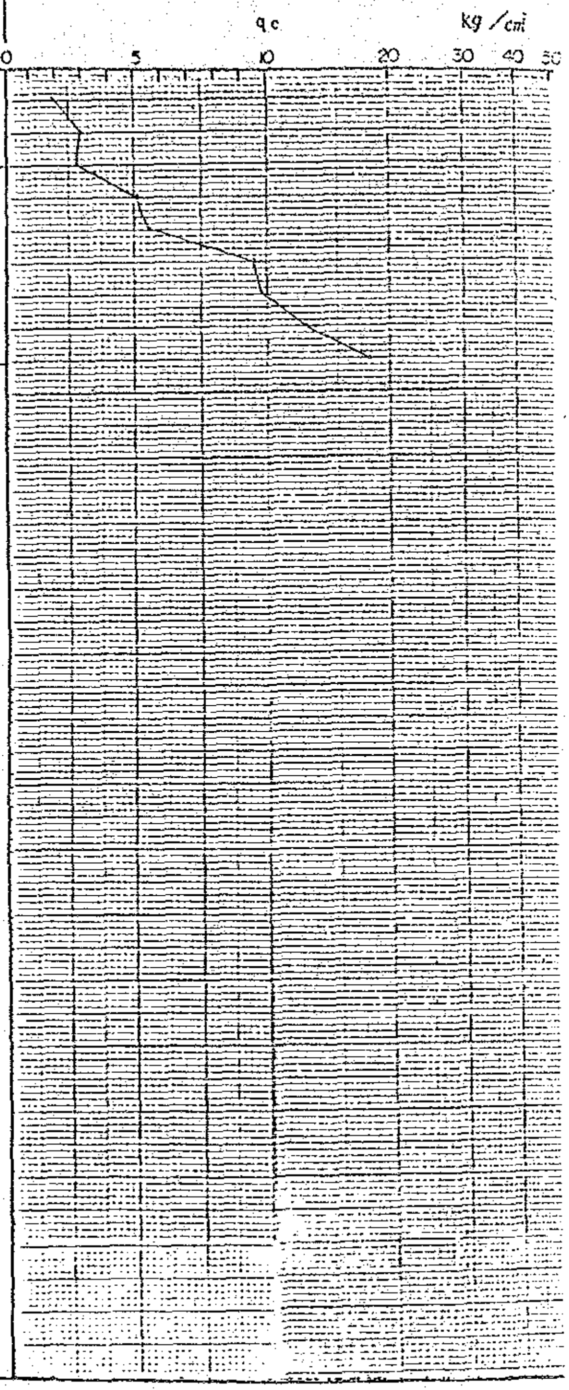
LOCATION: No.7-100m No. C-3 WEATHER: FINE SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: α = 0.3608 kg/ GRADUATION; β = α / A = 0.0559 kg/cm² GRADUATION

GROUND ELEVATION: 8.59 m AREA OF CONE: A = 6.45 cm² VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P.R R	qc = β · R kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	34.5	1.93		Y Y Y	
1.0	54.0	3.02		Y Y	Ap 1
1.5	48.0	2.68	1.5	Y Y Y	PEAT
2.0	93.5	5.23		Y Y	
2.5	101.5	5.67		Y Y Y	
3.0	170.0	9.50		Y Y	
3.5	176.0	9.82		Y Y Y	
4.0	225.0	12.58		Y Y	Ap.2
4.58	313.5	17.49	4.58		PEAT



LEGEND OF SYIMBOLS: GRAVEL, CIAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAM B — No.6 + 100 m DATE: 06. 29. 85

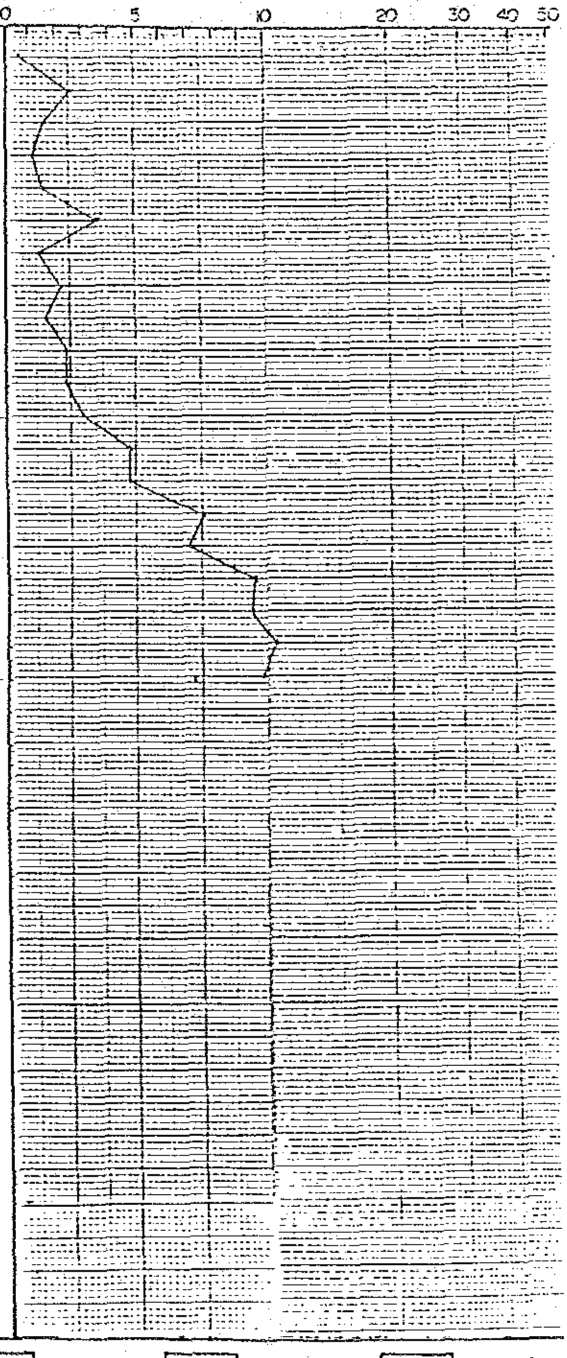
LOCATION: No. C-2 WEATHER: FINE SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: $\alpha = 0.3608$ kg/GRADUATION; $\beta = \alpha / A = 0.0559$ kg/cm² GRADUATION

GROUND ELEVATION: 7.52 m AREA OF CONE: A = 6.45 cm² VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P,R R	$q_c = \beta \cdot R$ kg/cm²	DEPTH m	SYMBOL	DISCREPTION
0.5	10.0	0.56		Y Y Y	
1.0	46.5	2.60		Y Y	
1.5	28.0	1.57		Y Y Y	
2.0	21.0	1.17		Y Y	
2.5	25.5	1.43			
3.0	61.0	3.41		Y Y Y	
3.5	23.0	1.29		Y Y	
4.0	39.5	2.21		Y Y Y	
4.5	31.5	1.76		Y Y	
5.0	43.5	2.43			Ap1
5.5	43.5	2.43		Y Y Y	
6.0	53.0	2.96	6.0		PEAT
6.5	86.5	4.84		Y Y	
7.0	87.0	4.86			
7.5	130.0	7.27		Y Y Y	
8.0	124.0	6.93		Y Y	
8.5	173.5	9.67		Y Y Y	
9.0	168.5	9.42		Y Y	Ap2
9.5	186.5	10.43			
10.0	175.5	9.81	10.0	Y Y Y	PEAT



LEGEND OF SYMBOLS: GRAVEL, CLAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAM B　　DATE: 06 . 09 . 85

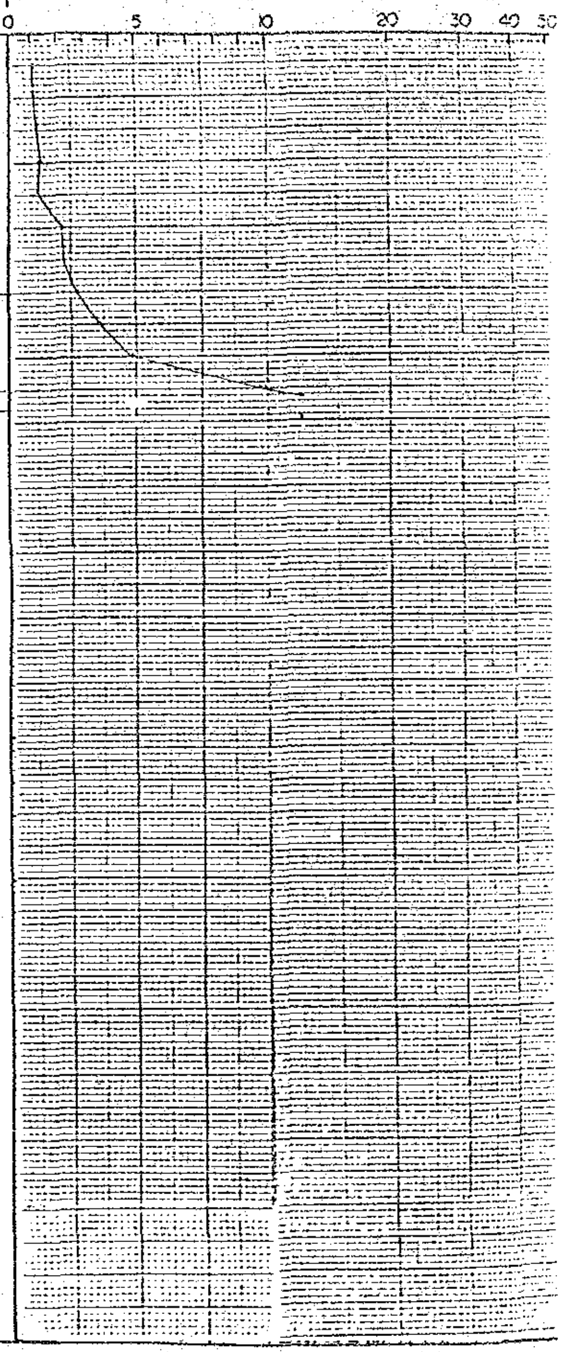
LOCATION: No.3 - 44.05m / C-1　　WEATHER: FINE　　SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: α = 0.3408 kg/ GRADUATION ; $\beta = \alpha / A$ = 0.0559 kg/cm² GRADUATION

GROUND ELEVATION: 8.00 m　　AREA OF CONE: A = 6.25 cm²　　VELOCITY OF PENETRATION: 1cm/sec

DEPTH m	RECORD OF P.R R	qc = β · R kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	20.0	1.12		v v	
1.0	20.0	1.12		v v v	
1.5	25.0	1.40		v v	
2.0	26.0	1.45		v v v	
2.5	25.0	1.40		v v	
3.0	38.0	2.12		v v v	Ap 1
3.5	41.0	2.29		v v	PEAT
4.0	50.5	2.82	4.0		
4.5	67.5	3.77		v v v	
5.0	88.0	4.92		v v	Ap 2
5.5	175.0	9.78	5.5	v v v	PEAT
5.62	215.5	12.05	5.62	— — —	Ac SILT



LEGEND OF SYMBOLS: GRAVEL　CLAY　SILT　SAND　PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAM.B — DATE: 06 . 09 . 85

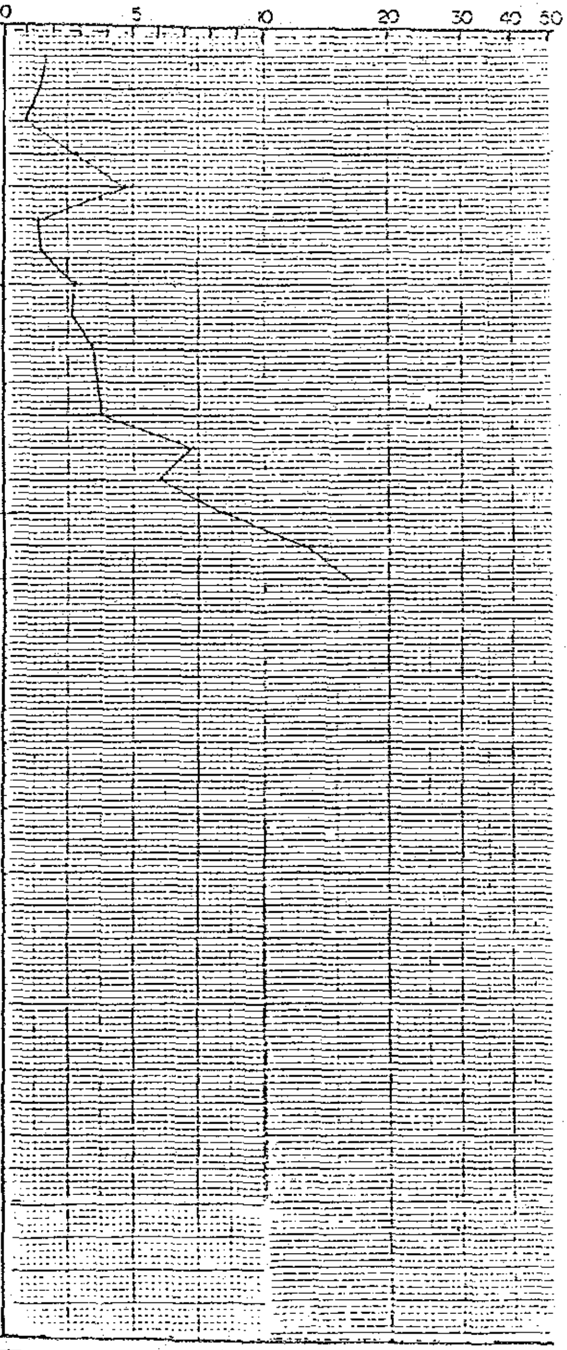
LOCATION: NO.7 + 1.00 m : No. C-3 — WEATHER: FINE — SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: α = 0.3608 kg/ GRADUATION ; β = α / A = 0.0559 kg/cm² GRADUATION

GROUND ELEVATION: 7.29 m — AREA OF CONE: A = 6.45 cm² — VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P.R R	qc = β • R kg/cm²	DEPTH m	SYMBOL	DISCREPTION
0.5	33.5	1.87		peat	
1.0	25.5	1.43		peat	
1.5	16.5	0.92		peat	
2.0	50.5	2.82		peat	
2.5	86.5	4.84		peat	
3.0	25.5	1.43		peat	
3.5	28.5	1.59		peat	Ap 1
4.0	50.0	2.80	4.0	peat	PEAT
4.5	46.5	2.60			
5.0	59.0	3.30		peat	
5.5	65.0	3.63		peat	
6.0	68.5	3.83		peat	
6.5	132.5	7.41		peat	
7.0	110.0	6.15		peat	Ap 2
7.5	149.5	8.36	7.5		PEAT
8.0	220.0	12.30		silt	Ac
8.5	287.0	16.04	8.5	silt	SILT



LEGEND OF SYIMBOLS: GRAVEL, CIAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAM B DATE: 06. 09. 85

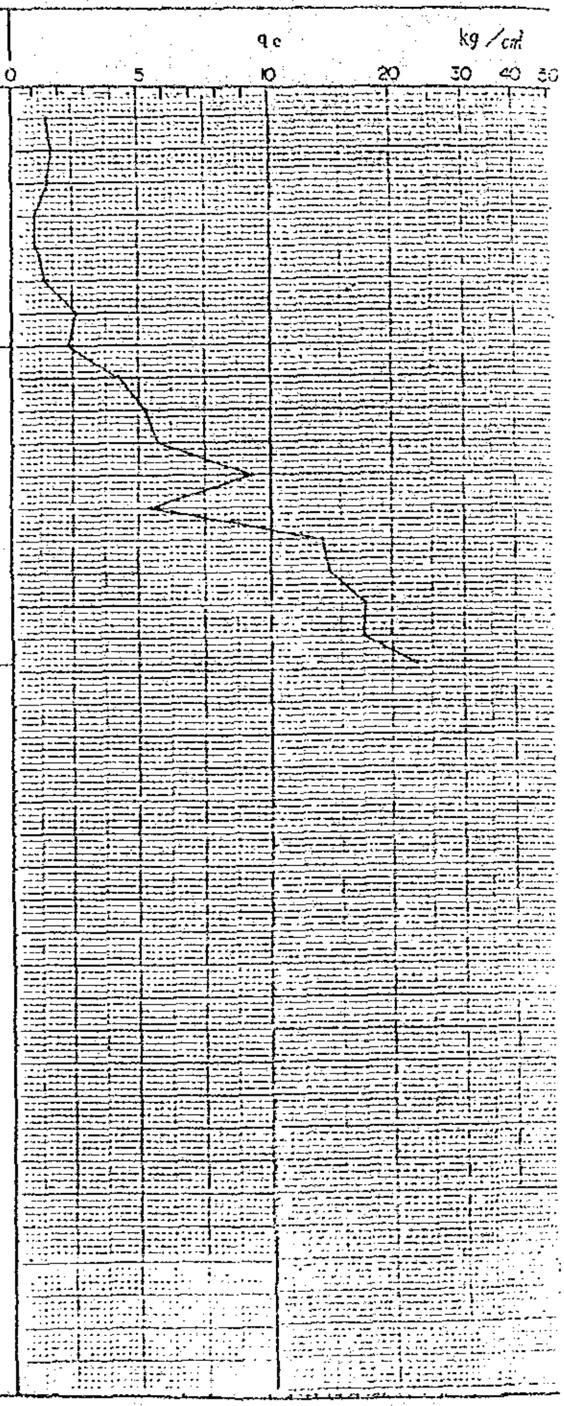
LOCATION: NO. 8 + 100 m : No. C-4 WEATHER: FINE SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: α = 0.3608 kg/ GRADUATION; $\beta = \alpha / A$ = 0.0559 kg/cm² GRADUATION

GROUND ELEVATION: 7.28 m AREA OF CONE: A = 6.45 cm² VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P.R R	qc = β • R kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	10.0	0.56		peat	
1.0	33.5	1.87		peat	
1.5	31.5	1.76		peat	
2.0	18.5	1.03		peat	
2.5	19.5	1.09		peat	
3.0	24.5	1.37		peat	
3.5	49.0	2.74		peat	Ap1
4.0	40.5	2.26	4.0	peat	PEAT
4.5	76.5	4.28		peat	
5.0	96.5	5.39		peat	
5.5	104.5	5.84		peat	
6.0	167.5	9.36		peat	
6.5	101.0	5.65		peat	
7.0	241.0	13.47		peat	
7.5	251.0	14.03		peat	
8.0	309.5	17.30		peat	Ap2
8.5	307.0	17.16		peat	PEAT
8.9	409.0	22.86	8.9	peat	



LEGEND OF SYMBOLS: GRAVEL, CLAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAM B — NO.8 + 100,00 m DATE: 06. 09. 85

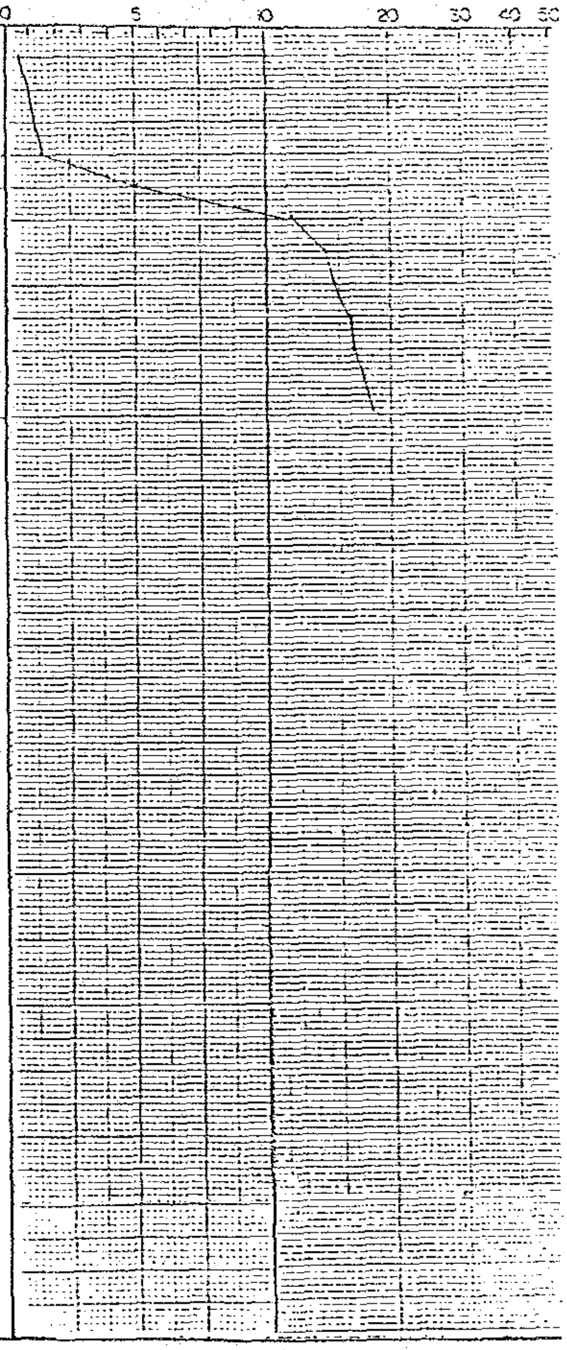
LOCATION: No. C-5 WEATHER: FINE SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg COEFFICIENT OF COMPARISON: α = 0.3608 kg/ GRADUATION; β = α / A = 0.0559 kg/cm² GRADUATION

GROUND ELEVATION: 7.28 m AREA OF CONE: A = 6.45 cm² VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P,R R	qc = β · R kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	10.5	0.59		PEAT	
1.0	18.5	1.03		PEAT	
1.5	20.5	1.15		PEAT	Ap1
2.0	22.0	1.23		PEAT	PEAT
2.5	91.5	5.11	2.5	PEAT	
3.0	208.0	11.63		SILT	
3.5	250.5	14.00		SILT	
4.0	264.5	14.79		SILT	
4.5	285.5	15.96		SILT	
5.0	288.5	16.13		SILT	
5.5	309.0	17.27		SILT	
6.0	315.0	17.61	6.0	SILT	SILT

qc kg/cm²



LEGEND OF SYMBOLS: GRAVEL, CLAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAM C — DATE: 03. 09. 85

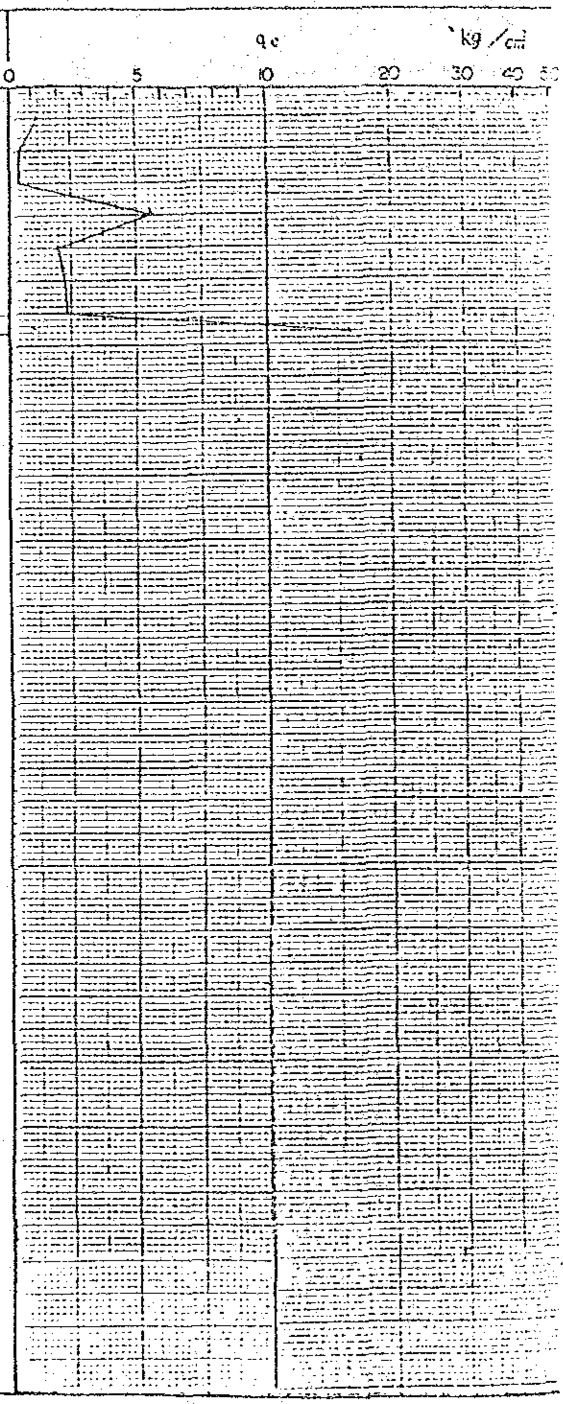
LOCATION: No. C-1 — WEATHER: FINE — SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: α = 0.3608 kg/ GRADUATION; β = α/A = 0.0559 kg/cm² GRADUATION

GROUND ELEVATION: 7.61 m — AREA OF CONE: A = 6.45 cm² — VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P.R R	qc = β • R kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	20.0	1.12		Y Y	
1.0	7.0	0.40		Y Y Y	
1.5	6.0	0.34		Y Y	
2.0	103.0	5.76		Y Y Y	
2.5	36.0	2.01		Y Y	
3.0	39.0	2.18		Y Y Y	PEAT
3.5	43.0	2.40	3.5		
3.8	286.0	15.99	3.8	— —	SILT



LEGEND OF SYIMBOLS: GRAVEL, CIAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE, GUAYABO REGULATING RESERVOIR DAM.C DAM.C DATE: 23 09 85

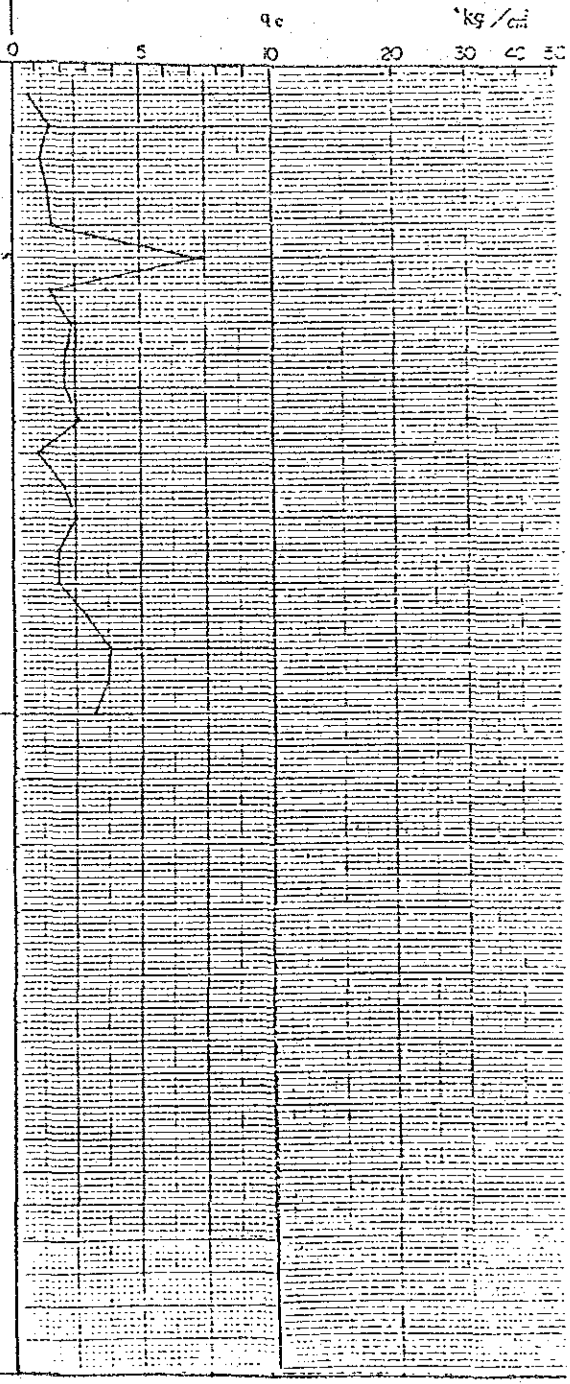
LOCATION: No. C-2 WEATHER: FINE SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: $\alpha = 0.3608$ kg/ GRADUATION ; $\beta = \alpha / A = 0.0559$ kg/cm² GRADUATION

GROUND ELEVATION: 7.34 m AREA OF CONE: A = 6.45 cm² VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P,R R	qc = β · R kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	10.0	0.56			
1.0	29.5	1.65			
1.5	21.5	1.20			
2.0	24.5	1.37			
2.5	30.0	1.68			
3.0	133.0	7.43			
3.5	28.0	1.57			
4.0	43.0	2.40			
4.5	38.0	2.12			
5.0	39.0	2.18			
5.5	48.5	2.71			
6.0	21.5	1.20			
6.5	37.0	2.07			
7.0	45.0	2.52			
7.5	34.0	1.90			
8.0	34.0	1.90			
8.5	55.0	3.07			
9.0	70.5	3.94			
9.5	68.0	3.80			
10.0	59.0	3.30	10.0		PEAT



LEGEND OF SYIMBOLS: GRAVEL, CIAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAM C DATE: 02 . 09 . 85

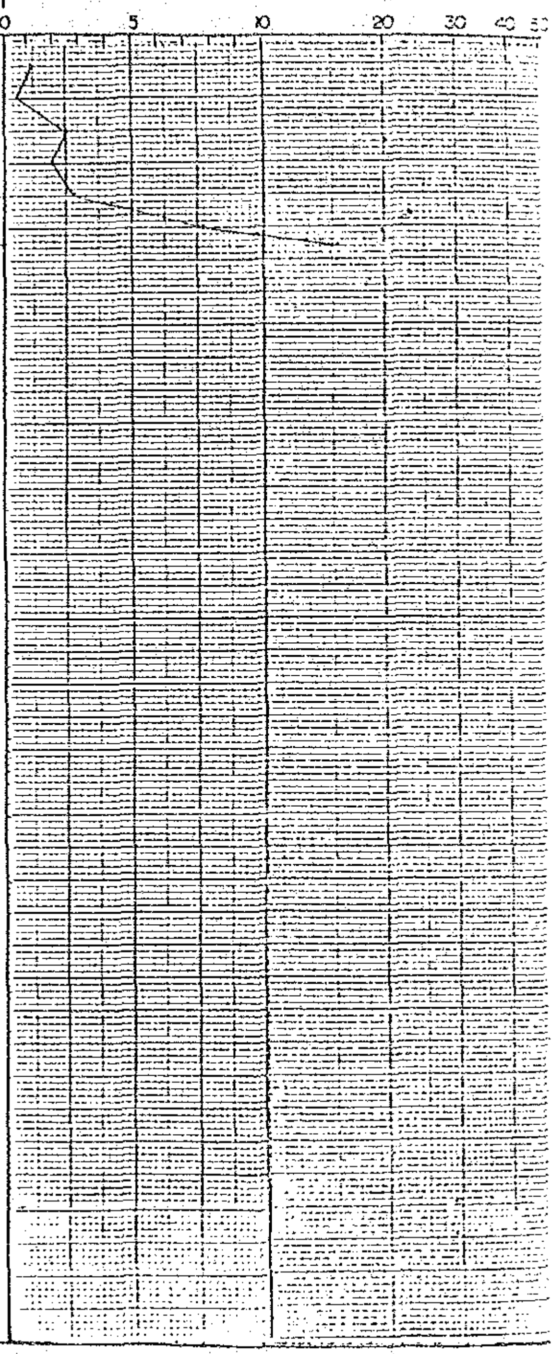
LOCATION: № C-3 WEATHER: FINE SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: α = 0.3608 kg/ GRADUATION; $\beta = \alpha / A$ = 0.0559 kg/cm² GRADUATION

GROUND ELEVATION: 8.10 m AREA OF CONE: A = 6.45 cm² VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P,R R	qc = β • R kg/cm²	DEPTH m	SYMBOL	DISCREPTION
0.5	22.0	1.23		Y Y	
1.0	13.5	0.75		Y Y Y	
1.5	45.0	2.52		Y Y	
2.0	36.0	2.01		Y Y Y	
2.5	52.5	2.93	2.5	Y Y Y	PEAT
3.0	48.0	2.71	3.25	— — —	SILT
3.25	274.0	15.32			



LEGEND OF SYMBOLS

GRAVEL CLAY SILT SAND PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAM C' DATE: 16. 12. 85

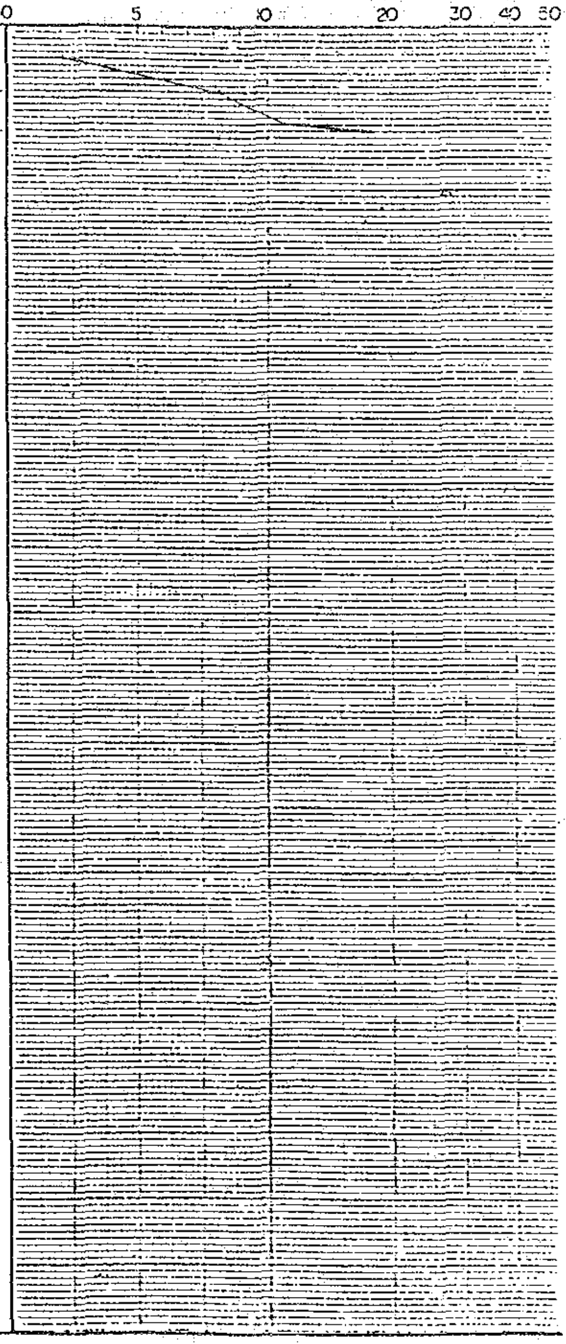
LOCATION: No. C-1 WEATHER: FINE SURVEYED BY: S TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: $\alpha = 0.4422$ kg/ GRADUATION; $\beta = \alpha / A$ = 0.06856 kg/cm² GRADUATION

GROUND ELEVATION: m AREA OF CONE: A = 6.45 cm² VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P.R R	qc = βαR kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	32.0	2.19			SOFT CLAY
1.0	119.0	8.15	1.0		
1.5	160.0	10.97	1.6		CLAY
1.6	275.0	18.85			



LEGEND OF SYMBOLS: GRAVEL, CLAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO REGULATING RESERVOIR DAM S' DATE 16 12 85

LOCATION: № C-No.1 WEATHER FINE SURVEYED BY S.TAKADA

CAPACITY OF PROVING RING 100 kg

COEFFICIENT OF COMPARISON: $\alpha = 0.4422$ kg/ GRADUATION

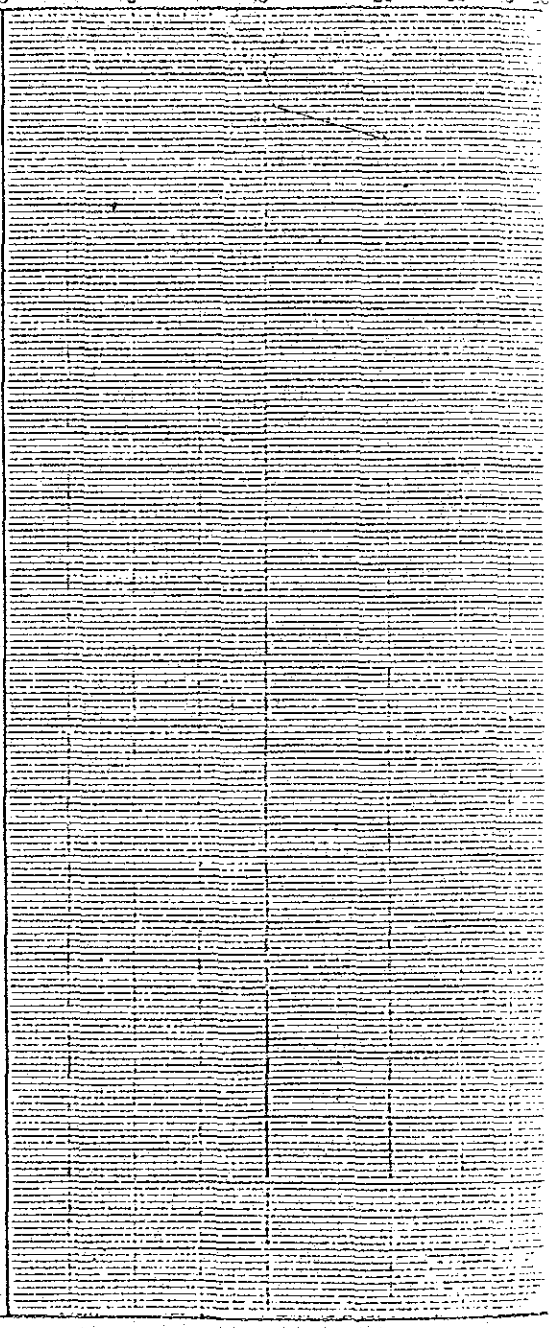
$\beta = \alpha / A$

$= 0.08656$ kg/cm² GRADUATION

GROUND ELEVATION .... m AREA OF CONE : A = 6.45 cm² VELOCITY OF PENETRATION 1cm/sec

DEPTH m	RECORD OF P.R R	qc = βαR kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	159.0	10.90			
1.0	146.0	10.00			
1.5	149.0	10.22			
1.9	288.0	19.74			

qc kg/cm² (0, 5, 10, 20, 30, 40, 50)



LEGEND OF SYMBOLS: GRAVEL, CIAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT AGUACATE GUAYABO REGULATING RESERVOIR DAM C' DAM C' — DATE 16. 12. 85

LOCATION : № C-NO.2 WEATHER FINE — SURVEYED BY S. TAKADA

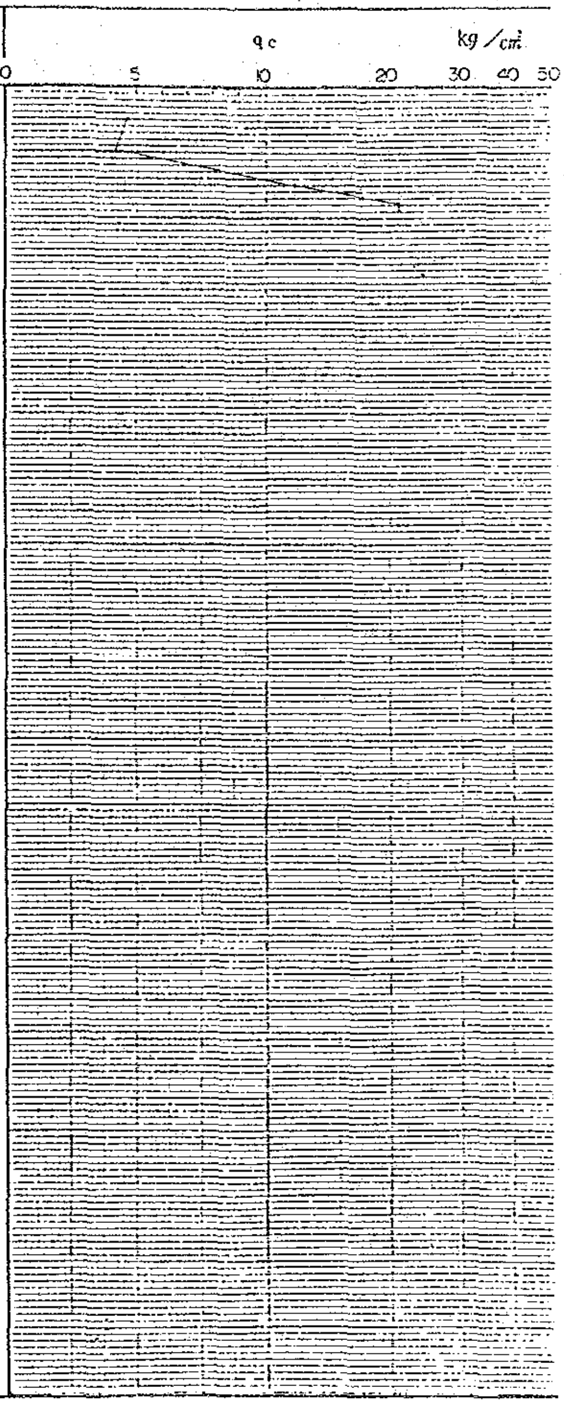
CAPACITY OF PROVING RING 100 kg

COEFFICIENT OF COMPARISON : $\alpha = 0.4422$ kg/ GRADUATION

: $\beta = \alpha / A$ $= 0.06856$ kg/cm² GRADUATION

GROUND ELEVATION ______ m — AREA OF CONE : $A = 6.45$ cm² — VELOCITY OF PENETRATION 1cm/sec

DEPTH m	RECORD OF P,R R	qc $= \beta \alpha R$ kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	70.0	4.80			
1.0	62.0	4.25			
1.5	176.0	12.07			
1.85	319.0	21.87			
1.90	319.0	21.87			

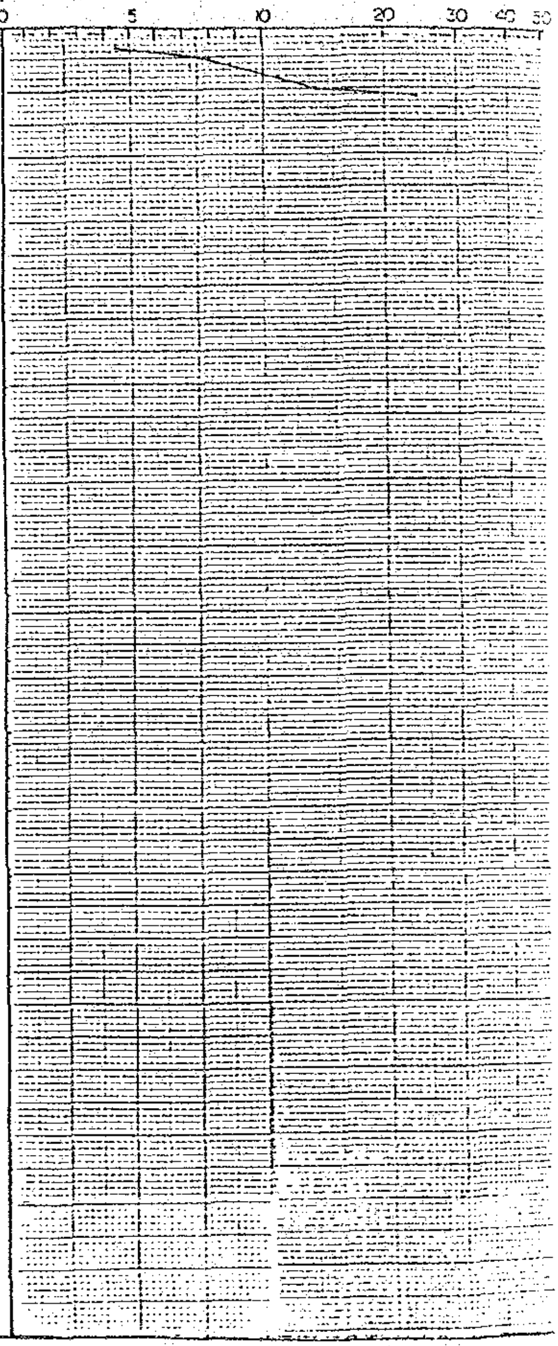


LEGEND OF SYMBOLS: GRAVEL, ClAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO
DATE: 12 12 85
LOCATION: GRAU ESTERO : № 2
WEATHER: CLOUDY
SURVEYED BY: S. TAKADA
CAPACITY OF PROVING RING: 100 kg
COEFFICIENT OF COMPARISON: α = 0.4422 kg/ GRADUATION; β = α / A = 0.06856 kg/cm² GRADUATION
GROUND ELEVATION: m
AREA OF CONE: A = 6.45 cm²
VELOCITY OF PENETRATION: 1cm/sec

DEPTH m	RECORD OF P.R R	qc = β • R kg/cm²	DEPTH m	SYMBOL	DISCREPTION
0.3	65.0	4.46			
0.5	106.0	7.28			
1.0	200.0	13.71			
1.1	350.0	24.00			



LEGEND OF SYIMBOLS: GRAVEL, CIAY, SILT, SAND, PEAT

PORTABLE CONE PENETROMETER TEST

PROJECT: AGUACATE GUAYABO — GRAN ESTERO DATE: 12 . 12 . 85

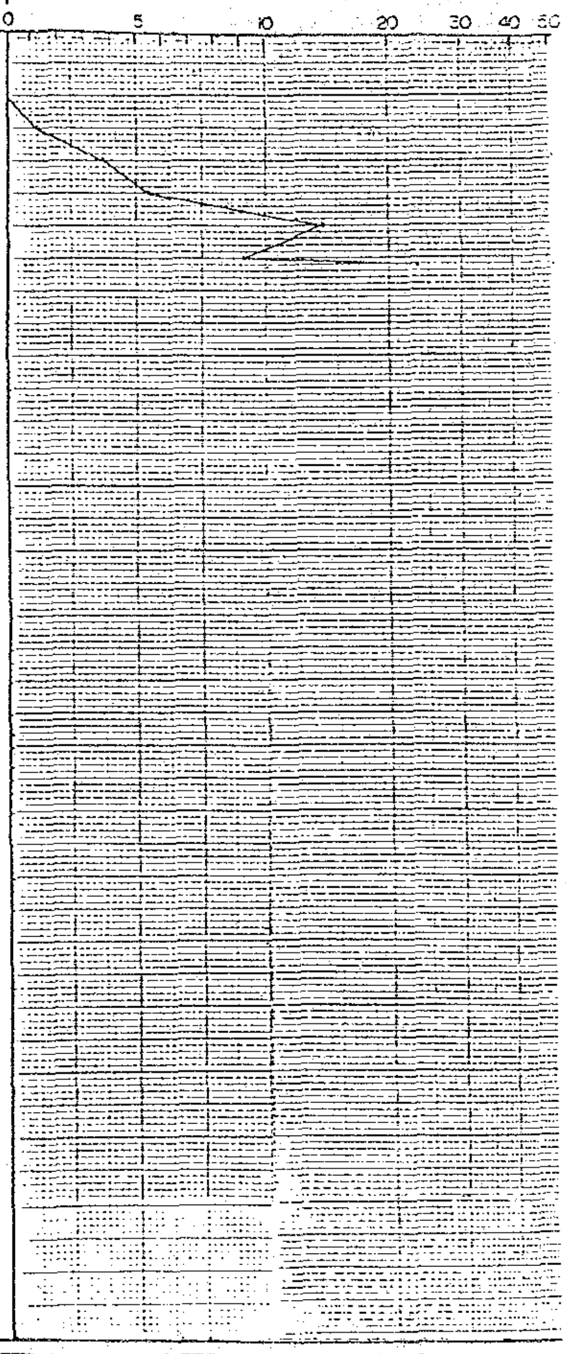
LOCATION: № 1 WEATHER: CLOUDY SURVEYED BY: S. TAKADA

CAPACITY OF PROVING RING: 100 kg

COEFFICIENT OF COMPARISON: α = 0.4422 kg/ GRADUATION; β = α / A = 0.06856 kg/cm² GRADUATION

GROUND ELEVATION: ______ m AREA OF CONE: A = 6.45 cm² VELOCITY OF PENETRATION: 1 cm/sec

DEPTH m	RECORD OF P.R R	qc = β · R kg/cm²	DEPTH m	SYMBOL	DISCRE-PTION
0.5	0	0			
1.0	0	0			
1.5	18.0	1.23			
2.0	55.0	3.77			
2.5	81.0	5.55			
3.0	205.0	14.05			
3.5	135.0	9.26			
3.55	342.0	23.45			



LEGEND OF SYMBOLS: GRAVEL, CLAY, SILT, SAND, PEAT