6. Engineering Geological Assessment

6-1. Introduction

The subject of this chapter is an engineeirng geological assessment as a dam foundation to the general geological conditions of each site described in previous chapter and a guide for a foundation treatment.

6-2. Left Saddle Dam

The Left Saddle damsite has the most troublesome foundation geology among three damsites in the project site because an extension of the great tectonic line which controls a geography of the region is passing through the damsite.

The extension is not only one big fault but a fault complex composed of many faults and sheared zones. A trending of the fault complex is nearly NW-SE direction and dip is almost vertical as a total (each fault consisting the fault complex has varying dips and strikes). The tectonic line is presumed to turn almost vertically to southwest at downstream of the site and pass through a downstream area of the Main dam.

Nevertheless the site was crossed by the fault complex the bedrock (each block of the bedrock in exactly) is rather hard because the elastic wave velocity of the one is ranging from 3.2 to 3.5 km/sec except a slate having a heavy schistosity. These hard bedrock has been cut into blocks by numerous faults and altered into fragile phase or clay by hydrothermal alteration. Thus the bedrock of the site degenerates into inhomogeneous and unstable condition, geologically and physically. And such a condition is never suitable for a dam foundation.

Farthermore, these heavily altered or sheared zones occupying considerable parts of the foundation have a low permeability and also low critical pressure simultaneously. The critical pressures of these zones are mainly ranging from 2 to 5 kg/cm^2 and the full water head of proposed reservoir is about 5 kg/cm^2. This means a dangerous situation for a dam foundation that the critical pressure of considerable part of the foundation will be less than the water head of the reservoir if it will have been filled up.

In usually a critical pressure got by a permeability test has a closed relation with a critical point pressure or a strength of the rock. Although the strength of the bedrock got by the jack test and result of the reconnaissance indicate the bedrock generally has an almost enough bearing capacity for an earth fill dam, but they shows simultaneously a considerable part of the foundation has nearly same or less critical point pressure to the load by embanking. From these consideration a base of the dam should have a wide core trench to avoid a stress-concentration by embankment and be treated enough to improve and consolidate a strength and a permeability of it using a consolidation grout (or any other method capable).

The permeability of the bedrock is ranging widely from less than 1 to more than 100 lugeons as mentioned above, and a zone having a high permeability coefficient shows extreme volume of grout-intake more than one ton per meter of grout hole. From the situation a curtain grouting is not only indispensable but also required to conduct by grout rows as many as possible. These many curtain grout rows should be grouted orderly from outer rows to inner rows to form a tight impervious curtain and these grouting should contribute also to consolidate uniformly the bedrock.

The core trench should be excavated to contact a core zone with a base-rock, at least up to the base-velocity-layer (V>2.7 km/sec) drived from the seismic exploration. And concerning to the width of the core trench, the wider it is the better from a view of the foundation treatment. On the other hand, the bedrock has a tendency to be weathered rapidly by exposing to the air because the most of bedrock has been altered heavily or slightly. It means an embanking work should be required to conduct rapidly after an excavation work has completed.

An excavation of a top-soil throughout a base of the dam should be need but the required depth of excavation is only one or two meters because the overburden at the site is generally well compacted.

The most sirious geological risk at the site is that heavily altered or sheared zones have a low permeability and a low critical pressure simultaneously. As a countermeasure for the risk a consolidation grout in the core trench is proposed from a view of availability and economization, but the availability (or efficiency) must be confirmed actually soon.

At the site, a faint sense of uneasiness for a stability of the dam foundation shall be remained even if it has been treated by excavation of wide core trench, consolidation grout and thick curtain grout (it is mainly derived from 'a behavior of the tectonic line at when an eathquake has happened). Then, to set a relief wells at a downstream toe of the dam and to observe continuously a leakage water through the dam foundation should be proposed.

Farthermore, to set a grout gallery should be considered in the near future from a view points of a conduction term for huge volume of a grouting works, an additional grouting work after completion of dam embanking and a laying or a control of various observation appliances for dam.

On the basis of these assessment and consideration a scheme for foundation treatment enumerated below has been led.

- Excavation of a foundation
  - i. wide and deep core trench
  - ii. excavation of topsoil throughout the dam foundation
- Consolidation grout ———— throughout the core trench
- Curtain grout ———— as many lows as possible

- Relief wells ———— continuous observation of water level and quality
- Others ———— consideration of grout gallery

6-3. Main Damsite

The bedrock of the site consists of sandstone (and or sandy quartzite) and a few thin shale beds intercalated. The elastic wave velocity of the bedrock is high in the riverbed and rather low ($V \doteqdot 2.6$ km/sec) in the both abutments. This situation seems to be derived from large scaled faults passing through a beneath of both abutments and they subjected mainly to a mountain side. It means the foundation at riverbed has rather good geological conditions than the one at both abutments in contrast with general damsites. The situation is favorable for a construction at riverbed area where occupies the most of total embanking volume and will be subjected by the maximum load by embankment, but on the other hand, the fact that both ends of riverbed which means a turning point of a bottom of the core zone have a weak zone and the rocks at both abutments where the core clings inclinedly to it are considerably cracked or loosened requires an utmost cares for construction. Especially the faults passing through a beneath of both abutments should be researched more exactly on a scale, a grade of shearing, a permeability, bearing capacity and so on, and be executed a scrupulous fault treatment based on the result.

A part of the bedrock (sound and massive sandstone) shows a low permeability of few lugeons but the other most part (cracked sandstone) shows a permeability ranging from 10 to 40 lugeons and more than 100 lugeons locally. The situation suggests a leakage of water through the dam foundation is rather heavy and an impervious treatment (usually by curtain grout) shall be necessary. In the case of using a curtain grout method, the grout holes should be drilled up to the depths because the bedrock has no tendency to decrease a permeability according to the depth. And, the limb grout at the right abutment should be connected with the grout curtain of the spillway.

At the Main damsite, a river deposit distrubutes extensively and deeply, and at some part the depth of the deposit exceeds 20 meters. The river deposit consists of mainly sand and they are generally loose, especially an upper part of it is very loose (2 - 5 of N-value). Farther, the groundwater table at the site is extremely high. These loose sediments should not be allowed to remain under the embankment, not only beneath a main part but even under the toes of dam. It means the upper loose part of the river deposit should be excavated out throughout the dam foundation. Farthermore, all of the river deposit under the core zone should be cut off completely and the core should be holded directly by the bedrock from a view points of a permeability and a bearing capacity. These consideration leads inevitably to a necessity of huge amount of excavation volume, therefore a diverting use of the deposit for embanking material should be studied in the near future.

Beside, a shutting off of the main flow and any kinds of a groundwater reduction method should be conducted throughout the dam foundation.

In the case that any structure like as a river outlet should be set under the dam, the spot at a base of the right abutment (ST.No: 10 + 30 - No: 11) should be adopted from a view of the depth of overburden and the rock quality.

At any rate, the site has the most favorable geological condition for a dam foundation among three damsites even though it has a deep river deposit and two large faults at both ends of the riverbed. The foundation treatments required at the site are follows from the consideration or assessment described above.

- Excavation of a foundation
  - i. cut off trench up to a bedrock at core zone
  - ii. excavation of upper loose layer throughout dam foundation
- Curtain grout
- Fault treatments —— two zones

6-4. Right Saddle Damsite

The site has the most big Height-Span Ratio because of the gentle slopes of both abutments and plain riverbed lying in high elevaiton. Almost all of the bedrock is composed of sandstone and rarely intercalating thin shale beds.

The most severe problem for a foundation of the site from a view point of engineering geology is existing of a fault complex composed by numerous faults in between from a slightly right bank side of the riverbed to a foot of the right abutment. Though the complex is rather small scaled in comparison with the one passing through the Left Saddle damsite but the width of it is about 200 meters and through the spread the bedrock has been cut into blocks by numerous faults and altered into friable phase by hydrothermal alteration. And, at the spread bedrock had been eroded deeply compared with around area, and it means the depth of overburden is large (about 15 m in average).

At the part where the fault complex passes through a core trench should be cut off up to the base-velocity-layer (by seismic exploration) even if it needs a large excavation volume. Farthermore the core trench at the part should be cut widely off and treated by a consolidation grout throughout its spread or by curtain and blanket grout rows covering its width because the foundation of the part have anxieties concerning to a permeability and a bearing capacity.

At other part of the site the core trench should be excavated up to the III velocity layer which means a weathered rock zone. The topsoil excavation should be conducted throughout the dam foundation in about one meter depth.

The characteristically thick weathered zone distributes in the damsite except a part passed through by the fault complex. These thick weathered zone is presumed to be derived from the complex but it indicate an elastic wave velocity ranging from 1.8 to 2.2 km/sec and has no problem for a bearing capacity. Then it should be treated only from a view point of permeability.

In addition to that, two small scaled low-velocity-zones were discovered besides of the fault complex by seismic exploration. These have also need to be confirmed their properties but at the present time they are supposed not to be so serious problem because they are mainly recognized only at the base-velocity-layer and not obvious at the III velocity layer.

From these assessment described above, the following items for a foundation treatment are proposed.

- Excavation of a foundation
  - i. core trench
    - * up to the base-velocity layer at the fault complex zone
    - * up to the II velocity layer throughout the dam axis
  - ii. excavation of topsoil throughout the dam foundation
- Curtain grout
- Consolidation grout or wide grout curtain at the fault complex zone
- Fault treatment —— There's a possibility to be canceled according to the following investigaiton.

6-5. Spillway

The ridge of an isolated small mountain at right bank of the Main dam, where is proposed spillway site, consists of mainly sandstone (or sandy quartzite). The depth of overburden is generally thin but at both slopes of the ridge a talus deposit distributes with the depth of 7, 8 meters. The bedrock is devided into two phases, weathered one and sound one (in precisely speaking there is one more phase but it distributes in far depths). The weathered sandstone is heavily cracked phase having an elastic wave velocity ranging from 1.5 to 1.8 km/sec and distributes thickly (15 - 20 meters). The sound sandstone underlying the weathered zone is considerably hard phase and indicates an elastic wave velocity about 3.3 km/sec. The situation of thick weathered phase is presumed to be affected by several faults running parallel to a trending of the ridge.

A permeability of the bedrock is presumed to be about 10 lugeons or more actually from the consideration to their elastic wave velocity and other data, nevertheless the previous investigation result showed the permeability ranging from 1 to 10 lugeons. Therefore, also the spillway site should have a grout curtain connected with the one of the Main Dam to prevent a leakage of water through the foundation and not to get an uplift pressure to the structures of spillway.

The overburden at the downstream side slope of the ridge where means a base of the chute has a depth only ranging from 6 to 8 meters, so the structure should be based on the rock (weathered rock). Farther the chute should have a lining and certainly any foundation treatment to combine tightly the structure with the bedrock like as a rock bolt should be need because the chute is presumed to cross four or five fault zones and the rock phase is weathered and cracked.

At the flood plane where the stilling basin has been set very thick river deposit, new and old, is distributed. The depth is about 10 meters beneath the slope and farther becomes more deep according to the distance from the slope. The deposit consists of mainly sand and sand-gravels, and although its lower part is rather compacted but its upper part and a part nearby the groundwater table are very loose. It means that the important structure like as a stilling basin should be based on the rock even though an excavation volume becomes so much.

The excavated materials owing to a construction of the spillway consist of mainly weathered sandstone because an overburden is not so thick generally. The rock quality of the weathered zone is presumed to be hard in each block nevertheless the zone is heavily cracked and altered locally by hydrothermal alteration. Then, these materials are certainly able to divert as an embanking materials (rock materials) and as a riprap materials partly.

From the assessment and consideration, the following scheme for a foundation treatment is proposed.

- Curtain grout ——— connected from the Main damsite.
- Rock bolt ———— at the base of chute structure

7. Recommendation

7-1. Subjects to be Solved

a) Left Saddle Damsite

i. Total four lines of seismic exploration surveys should be conducted to grasp a distribution of main sheared zones or altered zone in the fault complex and to draw up a contour map of the rock surface throughout the dam foundation. (two lines parallel to the damaxis and two lines crossing the axis vertically)

ii. About two drilling holes should be drilled at both abutments to research a strength and a permeability of the II velocity layer to conclude to be cut off or not.

iii. A large scaled grouting test according to a pattern of the design should be conducted to confirm the effectiveness of a grout method.

iv. Several rock shearing tests should be conducted at adits excavated in the bottom of present core trench to grasp a cohesion and an internal friction angle actually.

b) Main Damsite

i. Total four lines of seismic exploration surveys should be conducted to draw up a contour line map of a rock surface to judge an excavation line throughout the dam foundation. (two lines parallel to the damaxis two lines crossing the axis vertically)

ii. Two or three drilling holes at both abutments should be drilled to conclude to be cut off or not concerning to the II velocity layer and to grasp a quality of the III-1 layer (V = 2.6 km/sec).

iii. Researching works for two large faults passing through the both ends of the riverbed should be done to draw up a treating plan.

iv. Grouting test should be conducted to confirm an effectivity and to conclude an optimum grout pattern effectively and economically.

c) Right Saddle Damsite

i. Four lines of seismic exploration surveys should be conducted to grasp an extend of the fault complex and to draw up the contour line map of the rock surface throughout the dam foundation. (two lines parallel to the damaxis, two lines crossing the axis)

ii. Two or three holes of drilling should be conducted at right side of the riverbed on the damaxis to grasp a property of the fault complex and to conclude to be cut off or not for the II-2 velocity layer.

iii. Fault investigation drilling should be carried out at left abutment and left side of the riverbed to grasp a property of them and to study for a necessicy and treatment methods.

d) Spillway

i. Two lines of seismic exploration surveys should be conducted to confirm a distribution of the rock surface at spillway site. (a line along the center line and a line crossing the center line)

ii. Two drilling holes should be drilled at the point of the stilling basin proposed to grasp a foundation condition exactly.

iii. Some drillings should be conducted at the ridge to search a rock quality and foundation condition for a grouting plan and investigation for an embanking materials.

e) Others

i. Throughout the all damsites, more detailed field survey should be conducted to draw up a topographic maps enough exact to produce a working plan (including the present trenches).

7-2. Procedure, Equipments and Notes

a) Investigation Drilling

i. An overburden should be drilled by all coreing method.

ii. Weak or soft layers intercalated like as heavily weathered rock, sheared zone and fault-clay (gouge) should be recovered using a so-called "non-fluid method" immediate after it occured.

iii. The operaters of drilling should study and be trained for several technicalities concerning to a protection of drilling hole and core recovery (like as casing, cementation, water-supply, drilling-pressure and speed, non-fluid drilling and so on) by experts.

iv. The drilling cores should be stored in a core-box immediately after recovered from a hole and be kept on during the construction term. The core box should provide a capacity of 5 meters in each (five rows with one meter length) and a cover.

b) Permeability Test

i. A water-pump capable for more than 100 litters per minute of delivery, an accurate flow-meter and pressure gage should be provided for the pressure permeability test.

ii. At least three kinds of packer or packing method should be provided (like as an air packer, an expansion packer, a cement packer etc.) physically and technically.

iii. The test should be conducted using a double (up and down) stepped pressure injection method and the result should be arranged as a "pressure-intake curve" on a logarithms section graph. The testing time (keeping on time in a certain pressure step) of each step should be more than 15 minutes at least.

c) Jack Test

i. A jack with separated oil-pump should be provided for easily measurement in a restricted testing space.

ii. A dialgage with 1/100 milimeter graduations and a leg more than 50 milimeters should be provided.

iii. A loading plate should be made by steel and be enough thickness (at least more than 25 milimeters).

d) Seismic Exploration

i. Upmost care should be taken for a control and management of the explosives. The consumption diary must be taken severely.

ii. For the safety of the work, every engineer and worker should put on a helmet and tough shoes.

iii. To keep the safe explosion, 2 - 3 watchmen should be arranged with enough distance from a blusting point and keep villagers out from a dangerous area.

iv. All shooters must be qualified and having enough experience.

v. All engineers should take cares for the safety blusting not to harm villagers, houses, buildings or constructions, cattles or domestic animals etc.

e) Equipments

The equipments which should be provided for investigation work or tests for a foundation of dams or canals in the near future are listed up below.

i. Lateral loading tester —— able to test a strength of rock or sheared zone easily using a drilling hole.

ii. Probe set for a velocity logging —— to velocity log in a drilling hole and for a measurement of inter-holes elastic wave velocity using a "PS-10" already provided. (Available for judging a grout effect)

iii. Coreing tools for 65 m/m —— the equipments mentioned above are for 65 m/m diameters. (double tube core barrel, single tube core barrel, bitts etc.)

iv. Water quality tester —— able to measure a temperature and electric conductivity of water in the drilling hole or in groundwater.

v. Large oil jack (about 100 tons) —— for jack test, especially for a rock shearing test (2 sets).

vi. Others —— equipments or tools mentioned in this or previous chapters.

8. Data and Records (sub-contents)

8-1 Geological Loggs of Drilling Hole

GEOLOGICAL LOG OF BORE HOLE

PROJECT	The Mae Kuang Project			SITE	Left Saddle
HOLE NO	LAD - 1	ANGLE FROM HOLIZONTAL	45°	FORE MAN	
Ground Elevation	367.50 m	COMMENCED		LOGGED BY A. YAMAZAKI	
HOLE DIA	NX	COMPLETED		CHECKED BY R. KAWASAKI	

DATE	ELEVATION (m)	DEPTH (m)	THICKNESS (m)	LOG	ROCK TYPE	DESCRIPTION AND STRUCTURES	ROCK CLASS	MAX. CORE LENGTH (m) 20 40 60 80	ROCK QUALITY DESIGNATION (%) 20 40 60 80	WATER PRESSURE TEST / STANDARD PENETRATION
	366.08	2.00	2.00		SURFACE DEPOSIT and TALUS DEPOSIT	CLAY, SANDY CLAY, SAND mingled with GRAVEL of s.s & slate				
	364.53	4.20	2.20		TERRACE DEPOSIT (OVERBURDEN)	GRAVEL of s.s & slate mingled with CLAY & SAND subrounded to rounded				
	362.55	7.00	2.80		SLATE	light gray to white, clayey and soft mostly weathered and highly broken core	D			
	361.49	8.50	1.50		SANDSTONE	brownish gray, fine to medium grained, slightly weathered and highly broken core	CL ~ D			
		10			SANDSTONE with Slate	pale gray to gray fine to medium grained, slightly weathered and highly broke core alternated with black to dark gray slate sandstone is rich	CL			
	357.39	14.30	5.80		SLATE with Sandstone	darkgray to black, slightly weathered and highly broken core alternated with gray sandstone, slate is rich	CL			
	354.98	17.70	3.40		SANDSTONE	yellowish gray to gray, fine to medium grained, slightly weathered and broken core	CL ~ CM			
	353.64	19.60	1.90		SLATE	darkgray to greenish gray, weathered broken core along many slaty cleavage	CL ~ D			
	351.94	20 / 22.00	2.40		SLATE with Sandstone	dark gray to greenish gray, weathered, highly broken core alternated with gray sandstone, slate rich clayey and crushed zone at 19.00m–20.00m	D ~ CL			
	350.60	23.90	1.90		SANDSTONE	yellowish gray to gray, fine to medium grained with white quartz and slate patch, slightly weathered	CM			
	350.14	24.55	0.65		SLATE with S.S	mostly crushed and creyey	D			
	342.68	30 / 35.10	10.55		SANDSTONE	gray to pale gray, fine to medium grained with black shale patch near the top, fresh to slightly weathered locally with milky quartz vein, max. Qz vein at 34.30m – 34.35m. broken core at 25.70m – 27.00m pyrite fill in the fissure at 34.75m	CM / CL / CM / CH / CM / CH			
	342.04	36.00	0.90		SANDSTONE with Slate	gray, fine to medium grained, fresh alternated with black slate lamina.	CH			

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GEOLOGIC LOG OF DRILL HOLE

FEATURE ... LEFT SADDLE DAM ... PROJECT .... MAE KUANG .... Chv CHIANG MAI ....
HOLE No. LAD-2 .. LOCATION .... GROUND ELEVATION .. 369.136 m. .... ANGLE FROM VERTICAL ... 0° ....
COORDINATES ....
BEGUN ...... FINISHED .... DEPTH OF OVERBURDEN 1.5 m. TOTAL DEPTH .. 35 m BEARING OF ANGLE HOLE .. - ......
DEPTH OR ELEV. OF WATER TABLE ~ 0.90 m. HOLE LOGGED BY. T. SIRINAWIN .. FOREMAN .... PAISAN ....

NOTES (on water table, water loss, character of drilling etc.)	R.Q.D. %	CORE RECOVERY (%)	PERCOLATION TEST: DEPTH (m) FROM (P, Cs or Cm)	TO	LOSS IN (LPM)	PRESSURE (PSI)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG (SAMPLES FOR TESTING)	CLASSIFICATION AND PHYSICAL CONDITION
									0–1.60		OVERBURDEN
	17	100							1.60–2.95		FROM 1.60–12.83 m. SLATY SHALE grayish black inter bedded with thick bed of fine grained greenish gray sandstone steeply dip nearly 90°
									2.95–3.15		CORE LOSS AT 2.95–3.15 m.
	0	100									Slighly weathered, core are highly broken into small pieces
		100									
		100									
	0	100									
	0	100									
		100									
		90							5.70–6.10		CORE LOSE AT 570–6.10 m
		100						43.8			
	0	100						43.8 / 20.7			
	0										
	21										
	0							20.7	10		

EXPLANATION

CORE LOSS	Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Churn	ANGLE HOLE ☐
CORE RECOVERY	Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
	Approximate size of hole (X-series)	Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series) ...	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
	Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series) .	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

HOLE No. LAD-2
SHEET 1 OF 4

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GEOLOGIC LOG OF DRILL HOLE

FEATURE ...LEFT SADDLE DAM.......... PROJECT.... MAE KUANG.......... CHW CHIANGMAI......
HOLE No LAD-2.... LOCATION......-......... GROUND ELEVATION....369.136 m..ANGLE FROM VERTICAL....0°........
COORDINATES........-.......
BEGUN. ....FINISHED ....DEPTH OF OVERBURDEN .1.5m...TOTAL DEPTH.35m..BEARING OF ANGLE HOLE...-....
DEPTH OR ELEV. OF WATER TABLE -.0.90 m HOLE LOGGED BY..T.SIRINAWIN. FOREMAN.....PAISAN............

NOTES On water table levels, water return, character of drilling etc	R.Q.D. %	CORE RECOVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P.CS OR Cm)	TO	LOSS IN (LPM)	PRESSURE (PSI)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	0	100, 100						20.7	10–11		
	0	100, 100						20.7	11–12		
	0	100, 100, 90							12–13		CORE LOSE AT 12.50–12.83 m. FROM 12.83–13.76 m. SANDSTONE greenish gray medium
	0	45, 100						29.1	13–14		CORE LOSE AT 13.17–13.48 m. fine grained fresh to slightly weathered calcite vein
	0	20, 100							14–15		CORE LOSE AT 13.76–14.61 m.
	13	100							15–16		FROM 14.61–15.86 m. SANDSTONE greenish gray fine to medium grained interbedded with black slaty shale fresh with calcite vein filled, fracture dip 50°, 60°
	24	100, 100						29.1	16–17		FROM 15.86–17.25 m. SANDSTONE gray fine to medium grained fresh, fracture dip 60°, smooth, filled with calcite vein
	20	100, 100, 100							17–18		FROM 17.25–21.30 m. SLATY SHALE grayish black interbedded with fine to medium grained, greenish gray, thick bed sandstone, steeply dip approx. 80° fracture dip 60° smooth
	0	100, 100							18–19		CORE LOSE AT 18.65–19.00 m.
	0								19–20		CORE LOSE AT 19.35–19.68 m.

EXPLANATION

CORE LOSS	Type of hole..................	D=Diamond, H=Hoystellite, S=Shot, C=Churn
CORE RECOVERY	Hole sealed..................	P=Packer, Cm=Cemented, Cs=Bottom of casing
	Approximate size of hole (X-series)......	Ex=1½" Ax=1⅞" Bx=2⅜" Nx=3"
	Approximate size of core (X-series)......	Ex=⅞" Ax=1⅛" Bx=1⅝" Nx=2⅛"
	Outside diameter of casing (X-series)	Ex=1 13/16" Ax=2¼" Bx=2⅞" Nx=3½"
	Inside diameter of casing (X-series)..	Ex=1½" Ax=1 29/32" Bx=2⅜" Nx=3"

ANGLE HOLE ☐
VERTICAL HOLE ☐

HOLE No LAD-2...
SHEET..2..OF 4....

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GEOLOGIC LOG OF DRILL HOLE

FEATURE LEFT SADDLE DAM PROJECT MAE KUANG City CHIANGMAI
HOLE No LAD-2 LOCATION - GROUND ELEVATION 369.136 m ANGLE FROM VERTICAL 0°
COORDINATES -
BEGUN ... FINISHED ... DEPTH OF OVERBURDEN 1.5 m TOTAL DEPTH 35 m BEARING OF ANGLE HOLE -
DEPTH OR ELEV OF WATER TABLE ~0.90 m HOLE LOGGED BY T. SIRINAWIN FOREMAN PAISAN

NOTES (on water table, water return, character of drilling etc)	R.Q.D. %	CORE RECOVERY (%)	PERCOLATION TEST: DEPTH (m) FROM (P CS OR Cm)	TO	LOSS IN (LPM)	PRESSURE (P.S.I)	LENGTH OF TEST (min)	K, LUGEON	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	21	40, 100							21		crushed zone at 19.80–20.05 m. 18.55–18.65 m. 21.11 – 21.30 m.
	45	100							22		FROM 21.30.–24.35 m. SANDSTONE greenish gray fine grained interbedded with thick bed, grayish black slaty shale sandstone are highly filled with calcite vein crushed zone at 21.50–21.57 m. 22.00–22.20 m. 23.60–23.76 m. 23.86–23.93 m.
	0	100, 100, 100							23		
	0	100, 100							24		CORE LOSE AT 24.22–24.35 m.
	0	100							25		FROM 24.35–24.70 m. SLATY SHALE grayish black moderate weathered, core are highty broken into small pièce crushed zone at 24.60–24.70 m.
	0	100, 100, 100							26		CORE LOSE AT 24.70 –26.65 m
	0	100, 100							27		FROM 26.65–29.95 m. SANDSTONE gray fine to medium grained fresh to moderate weathered, fracture dip 40°,60°,70° smooth, calcite coated and vein filling along fracture, crushed zone at 26.74 – 26.82
	12	100							28		
	23	100, 100							29		
	22	100							30		

CORE LOSS
CORE RECOVERY

EXPLANATION

Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Churn	ANGLE HOLE ☐
Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
Approximate size of hole (X-series)	Ex = 1½" Ax = 1⅞" Bx = 2⅜" Nx = 3"	
Approximate size of core (X-series)	Ex = ⅞" Ax = 1⅛" Bx = 1⅝" Nx = 2⅛"	
Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2¼" Bx = 2⅞" Nx = 3½"	
Inside diameter of casing (X-series)	Ex = 1½" Ax = 1 29/32" Bx = 2⅜" Nx = 3"	

HOLE No. LAD-2
SHEET 3 OF 4

K. ENGINEERING CONSULTANTS CO, LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE LEFT SADDLE DAM PROJECT MAE KUANG Chv CHIANGMAI
HOLE No LAD-2 LOCATION – GROUND ELEVATION 369.136 m ANGLE FROM VERTICAL 0°
COORDINATES –
BEGUN FINISHED DEPTH OF OVERBURDEN 1.5 m TOTAL DEPTH 35 m BEARING OF ANGLE HOLE –
DEPTH OR ELEV. OF WATER TABLE ~0.90 m HOLE LOGGED BY T SIRINAWIN FOREMAN PAISAN

NOTES On water table levels, water return, character of drilling etc	R.Q.D. %	CORE RECOVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P.CS OR Cm)	TO	LOSS IN (LPM)	PRESSURE (PSI)	LENGTH OF TEST (min)	K, LUGEON	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	22	100									FROM 29.95 – 32.15 m. SANDSTONE gray fine to medium grained interbedded with thick bed grayish black slaty shale slightly weathered
	27	100							31		
		100							32		
	26	100									FROM 32.15 – 32.73 m. SANDSTONE pale gray fine grained fresh to slightly weathered fracture dip 50°, smooth, with calcite vein
	76								33		
	33	100							34		FROM 32.73 – 35.00 m SANDSTONE pale gray fine grained interbedded with thick bed, grayish black slaty shale fresh to moderate weathered fracture dip 60°, smooth calcite coated and vein filling along fracture Dreccialed zone at 33.60-33.68 m. filledwith calcite, core are highly broken into small piece at 34.70 m.–35.00 m.
		100							35		

BOTTOM OF HOLE

EXPLANATION

CORE LOSS / CORE RECOVERY	Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Churn	ANGLE HOLE ☐
	Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
	Approximate size of hole (X-series)	Ex = 1½" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series)	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2⅛"	
	Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series)	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

K. ENGINEERING CONSULTANTS CO, LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE LEFT SADDLE DAM PROJECT MAE KUANG Chv CHIANGMAI
HOLE No LAD-3 LOCATION GROUND ELEVATION 369,136 m ANGLE FROM VERTICAL 0°
COORDINATES
BEGUN FINISHED DEPTH OF OVERBURDEN 1.50 m. TOTAL DEPTH 35 m. BEARING OF ANGLE HOLE -
DEPTH OR ELEV OF WATER TABLE ~0.90 m HOLE LOGGED BY T. SIRINAWIN FOREMAN PAISAN

NOTES On water table levels, water return, character of drilling etc	R.Q.D. (%)	CORE RECOVERY (%)	PERCOLATION TEST: DEPTH (m) FROM (P CS OR Cm)	TO	LOSS IN (L.P.M)	PRESSURE (P.S.I)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	0	0							1		SLATY SHALE black carbonaceous partly calcareous, thin bedded folded calcite veins commonly filled along fracture core broken into small peices with average core length about 3 cm. moderate to slightly weathered
	0	0							2		
	0	57.89							3		
	0	100							4		fracture dip 45° 50° and 55° smooth with clay minerals partly coated
	0	78.50							5		
	0	100							6		SHEARED OR CRUSHED ZONE at 3.14 – 3.28 m. 3.50 – 3.66 m. 6.80 – 7.00 m. 7.72 – 8.00 m. 9.45 – 10.00 m
	0	100							7		
	0	100							8		CORE LOSS AT 0.00 – 1.50 m. 1.60 – 2.00 m. 3.77 – 4.00 m.
	0	100							9		
	0	100							10		
		100									

CORE LOSS
CORE RECOVERY

EXPLANATION

Type of hole	D=Diamond, H=Haystellite, S=Shot, C=Churn			
Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing			
Approximate size of hole (X-series)	Ex = 1 1/2"	Ax = 1 7/8"	Bx = 2 3/8"	Nx = 3"
Approximate size of core (X-series)	Ex = 7/8"	Ax = 1 1/8"	Bx = 1 5/8"	Nx = 2 1/8"
Outside diameter of casing (X-series)	Ex = 1 13/16"	Ax = 2 1/4"	Bx = 2 7/8"	Nx = 3 1/2"
Inside diameter of casing (X-series)	Ex = 1 1/2"	Ax = 1 29/32"	Bx = 2 3/8"	Nx = 3"

ANGLE HOLE ☐
VERTICAL HOLE ☐

K ENGINEERING CONSULTANTS CO,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE LEFT SADDLE .... PROJECT... MAEKUANG ... . Chv ...CHIANGMAI.. ..
HOLE No LAD-3.. .LOCATION. .....-.. GROUND ELEVATION 369.136 m... ANGLE FROM VERTICAL.....0°. .....
COORDINATES ... - .....
BEGUN ....FINISHED .. .... .DEPTH OF OVERBURDEN 1..50m TOTAL DEPTH. 35m BEARING OF ANGLE HOLE . -. .
DEPTH OR ELEV OF WATER TABLE. - 0.90m. HOLE LOGGED BY. T. SIRINAWIN . FOREMAN. .. PAISAN . .. . .

NOTES On water table levels, water return, character of drilling etc	R.Q.D (%)	CORE RECOVERY (%)	PERCOLATION TEST: DEPTH (m) FROM (P CS OR Cm)	TO	LOSS IN (LPM)	PRESSURE (PSI)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	0	7727						72.7	11		SHALE : (continued)
	0	100						72.7			fracture dip 90° smooth calcite veins common core broken mostly into small pieces
		75							12		
	0	222							13		SHEARED OR CRUSHED ZONE
	0	100						15.4			AT 11.55-11.85 m.
		100							14		16.55-16.87 m.
	0	100									17.44-17.80 m.
		100							15		18.24-18.65 m.
	0	100									
		100							16		
	0	100						15.4			CORE LOSS AT
									17		10.00-10.25 m.
	0										11.85-12.00 m.
		5133							18		12.12-13.00 m.
	0	100							19		17.27-18.00 m.
	0							14.9	20		

EXPLANATION

CORE LOSS	Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Churn	ANGLE HOLE ☐
CORE RECOVERY	Hole sealed..........	P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
	Approximate size of hole (X-series).......	Ex = 1½" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series)...	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
	Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series)	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

K. ENGINEERING CONSULTANTS CO., LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE LEFT SADDLE DAM .... PROJECT MAE KUANG .... Chv. CHIANGMAI ....

HOLE No LAD – 3 ... LOCATION .... – .... GROUND ELEVATION 369.136 m .... ANGLE FROM VERTICAL .... 0° ....

COORDINATES .... – ....

BEGUN .... FINISHED .... DEPTH OF OVERBURDEN 1.50 m TOTAL DEPTH 35 m BEARING OF ANGLE HOLE ... – ...

DEPTH OR ELEV OF WATER TABLE .. ~ 0.90 m HOLE LOGGED BY .. T SIRINAWIN FOREMAN .. PAISAN ....

NOTES On water table levels, water return, character of drilling etc	R.Q.D. (%)	CORE RECOVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P. CS OR Cm)	TO	LOSS IN (L.P.M.)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG	SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	0	100						14.9				SHALE . (continued)
	0	100						14.9	21			fracture dip 30° smooth clay minerals coated calcite veins invaded along fracture average core length 3 cm.
	0	86.65							22			
	0	89.33							23			
	0	100							24			SHEARED OR CRUSHED ZONE AT 20.82 – 21.00 m 21.11 – 21.45 m. 22.32 – 22.59 m. 25.07 – 25.34 m. 28.00 – 28.26 m.
	0	86							25			
	0								26			
	0	49.33										
		24							27			CORE LOSS AT 22.15 – 22.33 m. 24.06 – 24.20 m. 25.66 – 26.42 m. 26.62 – 27.11 m. 27.33 – 27.60 m. 28.59 – 30.00 m.
	0	62							28			
	0	59							29			
	0	0							30			

EXPLANATION

CORE LOSS

CORE RECOVERY

Type of hole .... D=Diamond, H=Hoystellite, S=Shot, C=Churn

Hole sealed .... P=Packer, Cm=Cemented, Cs=Bottom of casing

Approximate size of hole (X–series) ...... Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"

Approximate size of core (X–series) ... Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"

Outside diameter of casing (X–series) Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"

Inside diameter of casing (X–series) . Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"

ANGLE HOLE ☐

VERTICAL HOLE ☐

HOLE No. LAD – 3 ...

SHEET 3 OF 4 .

K. ENGINEERING CONSULTANTS CO,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE LEFT SADDE DAM PROJECT MAE KUANG Chv. CHIANGMAI
HOLE No LAD-3 LOCATION - GROUND ELEVATION 369.136 m ANGLE FROM VERTICAL 0°
COORDINATES -
BEGUN FINISHED DEPTH OF OVERBURDEN 1.50m TOTAL DEPTH 35 m BEARING OF ANGLE HOLE -
DEPTH OR ELEV. OF WATER TABLE ~0.90m HOLE LOGGED BY T. SIRINAWIN FOREMAN PAISAN

NOTES On water table levels, water return, character of drilling etc	R.Q.D. (%)	CORE RE-COVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P CS OR Cm)	TO	LOSS IN (LPM)	PRESSURE (PSI)	LENGTH OF TEST (min)	K, LUGEON	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	0	0							31		SHALE : (continued) fracture dip 30° smooth
	0	0							32		
	0	0							33		CORE CUTTING AT 30.00 – 30.20 m. 30.88 – 31.00 m. 31.32 – 32.77 m. 33.12 – 33.40 m. 33.56 – 33.85 m. 34.50 – 34.73 m.
	0	0							34		
	0	0							35		Bottom of hole

EXPLANATION

Type of hole .... D=Diamond, H=Hoystellite, S=Shot, C=Churn
Hole sealed .... P=Packer, Cm=Cemented, Cs=Bottom of casing
Approximate size of hole (X-series) ...... Ex = 1½" Ax = 1⅞" Bx = 2⅜" Nx = 3"
Approximate size of core (X-series) ...... Ex = ⅞" Ax = 1⅛" Bx = 1⅝" Nx = 2⅛"
Outside diameter of casing (X-series) ...... Ex = 1$\frac{13}{16}$" Ax = 2¼" Bx = 2⅞" Nx = 3½"
Inside diameter of casing (X-series) ...... Ex = 1½" Ax = 1$\frac{29}{32}$" Bx = 2⅜" Nx = 3"

CORE LOSS
CORE RECOVERY

ANGLE HOLE ☐
VERTICAL HOLE ☐

HOLE No LAD-3
SHEET 4 OF 4

K. ENGINEERING CONSULTANTS CO,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE DAM .... PROJECT... MAE KUANG .... City CHIANGMAI ....
HOLE No MAD-1 .. LOCATION .... GROUND ELEVATION .. 338.257 m. ... ANGLE FROM VERTICAL ... 0° ....
COORDINATES ....
BEGUN .... FINISHED .... DEPTH OF OVERBURDEN 14.0 m. TOTAL DEPTH 50 m. BEARING OF ANGLE HOLE ... - ...
DEPTH OR ELEV OF WATER TABLE - 2.00 m. HOLE LOGGED BY ... T. SIRINAWIN FOREMAN ... PAISAN ....

NOTES On water table levels, water return, character of drilling etc	R.Q.D. (%)	CORE RE-COVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P, CS OR Cm)	TO	LOSS IN (LPM)	PRES-SURE (PSI)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG	SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
									1			CLAY brown, moderate to slightly plasticity, wet N=4
									2			SANDY CLAY greenish black slightly plasticity, wet N=2
									3			SANDY GRAVEL of quartz grain subangular, max. size 4 cm. N=14
									4			SANDY GRAVEL of sandstone and quartz grain subangular max. size 2 cm., N=23
									5			
									6			
									7			
									8			
									9			
									10			

EXPLANATION

CORE LOSS
CORE RECOVERY

Type of hole .... D=Diamond, H=Hoystellite, S=Shot, C=Churn
Hole sealed .... P=Packer, Cm=Cemented, Cs=Bottom of casing
Approximate size of hole (X-series) ...... Ex=1 1/2" Ax=1 7/8" Bx=2 3/8" Nx=3"
Approximate size of core (X-series) ... Ex=7/8" Ax=1 1/8" Bx=1 5/8" Nx=2 1/8"
Outside diameter of casing (X-series) Ex=1 13/16" Ax=2 1/4" Bx=2 7/8" Nx=3 1/2"
Inside diameter of casing (X-series) . Ex=1 1/2" Ax=1 29/32" Bx=2 3/8" Nx=3"

ANGLE HOLE ☐
VERTICAL HOLE ☐

HOLE No MAD-1...
SHEET 1 OF 5

K. ENGINEERING CONSULTANTS CO, LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE MAIN DAM PROJECT MAE KUANG Chw CHIANG MAI
HOLE No. MAD - 1 LOCATION - GROUND ELEVATION 338 257 m. ANGLE FROM VERTICAL 0°
COORDINATES -
BEGUN. FINISHED DEPTH OF OVERBURDEN 14.0 m. TOTAL DEPTH 50.0 m. BEARING OF ANGLE HOLE -
DEPTH OR ELEV. OF WATER TABLE - 2.00 m. HOLE LOGGED BY T. SIRINAWIN FOREMAN PAISAN

NOTES On water table levels, water return, charactor of drilling etc.	R.Q.D. (%)	CORE RECOVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P. CS OR Cm)	TO	LOSS IN (L.P.M)	PRESSURE (P.S.I)	LENGTH OF TEST (min)	K, LUGEON	DEPTH	LOG	CLASSIFICATION AND PHYSICAL CONDITION
		6.47							13		METASANDSTONE pale gray fine to medium grained
		0									core lose at 13.00–14.00 m.
	0	100							14		METASANDSTONE pale gray fine to medium grained highly broken core
		40							15		core lose at 14.72–15.23 m.
	0	76.36									METASANDSTONE pale gray fine to medium grained highly broken core
									16		core lose at 15.62– 15.75 m.
	0	100									METASANDSTONE pale gray fine to medium grained with black shale patch and interbeded at 9.00–9.07 m. and 9.26–9.43 m. fresh to slightly weathered fracture dip 50°, 60° smooth with iron oxide coated, highly broken core at 16.35–16.60 m.
	52	100							17		
	60	100						17.9	18		
		100						17.9 / 5.7	19		
	30							5.7	20		

SAMPLES FOR TESTING

EXPLANATION

CORE LOSS	Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Churn	ANGLE HOLE ☐
CORE RECOVERY	Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
	Approximate size of hole (X-series)	Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series)	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
	Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series)	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

HOLE No. MAD - 1
SHEET 2 OF 5

K. ENGINEERING CONSULTANTS CO.,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE MAIN DAM PROJECT MAE KUANG CHV. CHIANG MAI
HOLE No. MAD-1 LOCATION - GROUND ELEVATION 338.257 m. ANGLE FROM VERTICAL 0°
COORDINATES -
FINISHED DEPTH OF OVERBURDEN 14.0 m. TOTAL DEPTH 50.0 m. BEARING OF ANGLE HOLE -
DEPTH OR ELEV OF WATER TABLE ~ 2.00 m. HOLE LOGGED BY T. SIRINAWIN FOREMAN PAISAN

NOTES (on water table, water losses, character of drilling etc)	R.Q.D. (%)	CORE RECOVERY (%)	PERCOLATION TEST: DEPTH (m) FROM (P. CS OR Cm)	TO	LOSS IN (LPM)	PRESSURE (P.S.I)	LENGTH OF TEST (min)	K, LUGEON	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	63	100						5.7	20–21		
	89	100							21–22		SLATYSHALE black with greenish gray sandstone patch slightly weathered
	22								22–23		METASANDSTONE gray fine to medium grained fresh to slightly weathered fracture dip 50° smooth calcite and iron oxide filled
	12	100						57 / 77.9	23–24		SLATYSHALE black moderate to slighly weathered
	22	100							24–25		
	57	100							25–26		METASANDSTONE yellowish gray to greenish gray fine to medium grained with black shale patch at the top and local quartz vein highly quartz veinlet at 30.00 – 34.00 m. fresh to slightly weathered fracture dip 30°, 55°, 60°, 70°, 90° smooth with iron oxide coated highly fracture, crushed zone at 23.80 – 23.92 m. 24.30 – 24.60 m. 26.50 – 26.70 m. 35.70 – 35.80 m.
	26	100							26–27		
	76	100, 100							27–28		
	10	100, 100, 100							28–29		
	33						77.9 / 79.8	79.8	29–30		

EXPLANATION

CORE LOSS	Type of hole	D=Diamond, H=Haystellite, S=Shot, C=Churn	ANGLE HOLE ☐
CORE RECOVERY	Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
	Approximate size of hole (X-series)	Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series)	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
	Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series)	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

HOLE No. MAD-1
SHEET 3 OF 5

K. ENGINEERING CONSULTANTS CO, LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE ....MAIN DAM.................PROJECT. ..MAE KUANG..............Chw. ....CHIANG MAI

HOLE No MAD - 1 ...LOCATION.......-.......GROUND ELEVATION. ..338.157 m....ANGLE FROM VERTICAL.....0°.........

COORDINATES ....-........

BEGUN. .... FINISHED ....DEPTH OF OVERBURDEN .14.0 m.TOTAL DEPTH .50.0 m.BEARING OF ANGLE HOLE...-.....

DEPTH OR ELEV OF WATER TABLE -2 . m. HOLE LOGGED BY. T. SIRINAWIN FOREMAN.... PAISAN.........

NOTES On water table levels, water return, character of drilling etc.	R.Q.D (%)	CORE RECOVERY (%)	PERCOLATION TEST: DEPTH (m) FROM (P. CS OR Cm)	TO	LOSS IN (LPM)	PRESSURE (PSI)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	65										
	42	100 / 100 / 100 / 100							31		
	88	100 / 100							32		
	72	100					79.8 / 84.2		33 / 34		
	63								35		
	42	100 / 100							36		core lose at 36.21–36.34 m.
	27								37		METASANDSTONE pale gray fine to medium grained fresh to slightly weathered fracture dip 50°, 60° smooth calcite and clay mineral filled
	38	93.16							38		core lose at 38.23–38.47 m.
	28						84.2 / 96.3		39		METASANDSTONE pale gray fine to medium grained fresh to slightly weathered fracture dip 60°, 70° smooth with small pyrite crystals filled and iron oxide coated
	57						96.3		40		

EXPLANATION

☐ CORE LOSS	Type of hole.......... D=Diamond, H=Hoystellite, S=Shot, C=Churn	ANGLE HOLE ☐
■ CORE RECOVERY	Hole sealed.......... P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
	Approximate size of hole (X-series)....... Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series)... Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
	Outside diameter of casing (X-series) Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series) Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

K. ENGINEERING CONSULTANTS CO,LTD

GEOLOGIC LOG OF DRILL HOLE

...TURE MAIN DAM ... PROJECT ... MAE KUANG ... CITY CHIANG MAI
HOLE No MAD-1 ... LOCATION ... - ... GROUND ELEVATION ... 338.257 m. ANGLE FROM VERTICAL ... 0°
COORDINATES ... - ...
...FINISHED ... DEPTH OF OVERBURDEN ... 14 m. TOTAL DEPTH ... 50 m. BEARING OF ANGLE HOLE ... - ...
DEPTH OR ELEV OF WATER TABLE ... ~2 m HOLE LOGGED BY ... T. SIRINAWIN FOREMAN ... PAISAN

NOTES	R.Q.D. (%)	CORE RECOVERY (%)	PERCOLATION TEST: DEPTH (m) FROM (P.CS OR Cm)	TO	LOSS IN (L.P.M)	PRESSURE (P.S.I)	LENGTH OF TEST (min)	K, LUGEON	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	0	100									
		100							41		local quartz veins, cores, are highly broken at 40.53 – 40.60 m. 41.20 – 41.32 m. 42.60 – 42.80 m.
	40	100							42		
	38	100							43		
	45	100						96.3	44		STATY SHALE black, fresh to slightly weathered with thin laminated and convolute patch of greenish gray sandstone fracture dip 40°, 50°, 60° smooth with clay mineral filled crashed zone at 43.13 – 43.19 m. 45.30 – 45.40 m. 45.68 – 45.76 m.
	33	100							45		
	0	100							46		
	0	100									METASANDSTONE greenish gray fine to medium grained fresh to slightly weathered fracture dip 50° 60° 70° smooth with small pyrite crystal and clay mineral filled local quartz veins, crushed zone at 47.26 – 47.46 m.
		100							47		
	0	100							48		
	0	100									
		100							49		
	19	100							50		BOTTOM OF HOLE

EXPLANATION

CORE LOSS
CORE RECOVERY

Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Churn				ANGLE HOLE ☐
Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing				VERTICAL HOLE ☐
Approximate size of hole (X-series)	Ex=1½"	Ax=1 7/8"	Bx=2 3/8"	Nx=3"	
Approximate size of core (X-series)	Ex=7/8"	Ax=1 1/8"	Bx=1 5/8"	Nx=2 1/8"	
Outside diameter of casing (X-series)	Ex=1 13/16"	Ax=2 1/4"	Bx=2 7/8"	Nx=3 1/2"	
Inside diameter of casing (X-series)	Ex=1 1/2"	Ax=1 29/32"	Bx=2 3/8"	Nx=3"	

HOLE No. MAD-1
SHEET 5 OF 5

K. ENGINEERING CONSULTANTS CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE DAM PROJECT MAE KUANG CH. CHIANGMAI
HOLE No MAD-2 LOCATION GROUND ELEVATION 340.678 m. ANGLE FROM VERTICAL 0°
COORDINATES
BEGUN FINISHED DEPTH OF OVERBURDEN 16.30 TOTAL DEPTH 50 m. BEARING OF ANGLE HOLE -
DEPTH OR ELEV OF WATER TABLE ~ 2.00 m. HOLE LOGGED BY T. SIRINAWIN FOREMAN PAISAN

NOTES On water table levels, water return, character of drilling etc.	RQD (%)	CORE RE-COVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P. CS OR Cm)	TO	LOSS IN (L.P.M)	PRES-SURE (P.S.I)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
									1		From 1.00 – 1.45 m. N = 14 SILTY SAND brown
									2		From 2.00 – 2.45 m. N = 6 SILTY CLAY brownish gray slightly plastic
									3		From 3.00 – 3.45 m. N = 21 SILTY GRAVEL brown subrounded of quartz approx. Ø 2 cm
									4		
									5		From 4.85 – 5.20 m SANDSTONE white medium grained approx. Ø 2 cm.
									6		From 5.80 – 6.00 m. GRAVEL OF SANDSTONE white, medium grained and white quartz max. Ø 4 cm.
									7		From 6.85 – 7.00 m. QUARTZ BOULDER
									8		From 8.00 – 8.45 m. N = 30 blows/3" SILTY SAND brown
									9		From 9.00 – 9.45 m. N = 54 10.00 – 10.15 m. N = 70 blows/6" 11.00 – 11.15 m. N = 70 blows/6" 12.00 – 12.10 m. N = 80 blows/4"
									10		

EXPLANATION

CORE LOSS
CORE RECOVERY

Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Churn				
Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing				
Approximate size of hole (X-series)	Ex = 1 1/2"	Ax = 1 7/8"	Bx = 2 3/8"	Nx = 3"	ANGLE HOLE ☐
Approximate size of core (X-series)	Ex = 7/8"	Ax = 1 1/8"	Bx = 1 5/8"	Nx = 2 1/8"	VERTICAL HOLE ☐
Outside diameter of casing (X-series)	Ex = 1 13/16"	Ax = 2 1/4"	Bx = 2 7/8"	Nx = 3 1/2"	
Inside diameter of casing (X-series)	Ex = 1 1/2"	Ax = 1 29/32"	Bx = 2 3/8"	Nx = 3"	

HOLE No. MAD-2
SHEET 1 OF 5

K. ENGINEERING CONSULTANTS CO, LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE: MAIN DAM   PROJECT: MAE KUANG   Chw. CHIANG MAI
HOLE No. MAD-2   LOCATION   GROUND ELEVATION 340.678 m.   ANGLE FROM VERTICAL 0°
COORDINATES
BEGUN   FINISHED   DEPTH OF OVERBURDEN 16.30 m   TOTAL DEPTH 50 m.   BEARING OF ANGLE HOLE -
DEPTH OR ELEV. OF WATER TABLE - 2.00 m.   HOLE LOGGED BY T. SIRINAWIN   FOREMAN PAISAN

NOTES (water table, water loss, character of drilling etc)	R.Q.D (%)	CORE RECOVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P.CS OR Cm)	TO	LOSS IN (L.P.M)	PRESSURE (P.S.I)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
									10–11		SANDSTONE yellowish brown completely weathered
									13		From 13.00 - 13.16 m. N = 80 blows/5" SANDY GRAVEL brown quartz grain, angular, max. Ø 1.5 cm.
									14		From 14.00 - 14.23 m N=50 blows/3" CLAYEY SAND yellowish brown, friable
									15		From 15.00 - 15.10 m. N= 50 blows/4" SANDSTONE yellowish brown; completely weathered
									16		From 16.00 - 16.23 m. N= 50 blows/3" SHALE grayish black completely weathered with calcite veins
	0	100							16.3–17.5		SANDSTONE greenish gray, fine grained, micaceous, fresh to slightly weathered
	26							21.3	17.5–18.7		SANDSTONE pale gray, fine to medium grained with deep gray mudstone lens approx. 3 X 0.5 cm. fracture dip. 45°, 60°
	18	100							18.7–19.8		SANDSTONE greenish gray, fine grained interbedded with thin bedded gray shale
	31	100						21.3	19.8–20		SHALE grayish black fresh to slightly weathered

WATER LOSS / CORE RECOVERY

EXPLANATION

Type of hole	D=Diamond, H=Haystellite, S=Shot, C=Churn	ANGLE HOLE ☐
Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
Approximate size of hole (X-series)	Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
Approximate size of core (X-series)	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
Inside diameter of casing (X-series)	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

HOLE No. MAD-2
SHEET 2 OF 5

K. ENGINEERING CONSULTANTS CO,LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE MAIN DAM PROJECT MAE KUANG Chw. CHIANG MAI
HOLE No. MAD-2 LOCATION - GROUND ELEVATION 340.678 M. ANGLE FROM VERTICAL 0°
COORDINATES -
BEGUN FINISHED DEPTH OF OVERBURDEN 16.30 M. TOTAL DEPTH 50 M. BEARING OF ANGLE HOLE -
DEPTH OR ELEV. OF WATER TABLE ~2.00 M. HOLE LOGGED BY T. SIRINAWIN FOREMAN PAISAN

NOTES On water table levels, water return, character of drilling etc.	R.Q.D %	CORE RECOVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P.CS OR Cm)	TO	LOSS IN (L.P.M)	PRESSURE (P.S.I)	LENGTH OF TEST (min)	K, LUGEON 50	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	10	100, 100						21.3	20–21		SHALE crushed zone at 20.00–20.17 m. SANDSTONE greenish gray fine grained interbedded with black mudstone slightly weathered
	14							21.3	21–22		
	53	100							22–23		SANDSTONE gray fine to medium grained, massive, with quartz veins mostly filled fracture clay minerals partly coated along fracture fraceture dip 30°, 50°, 55°, 60° and 70° smooth iron oxide coated fresh to slightly weathered
	50	100							23–24		
	61	100							24–25		
	23	100, 100							25–26		SHALE pale gray with small patch of greenish gray, fine grained sandstone slightly weathered
	20	100						38.9	26–27		SANDSTONE gray, fine to medium grained massive with quartz veins at 29.72–29.88 m. are highly quartz veinlets fracture dip 30°, 50° and 60° smooth fresh to slightly weathered
	35								27–28		
	67	100							28–29		
	52	100						38.9	29–30		

CORE LOSS
CORE RECOVERY

EXPLANATION

Type of hole .... D=Diamond, H=Hoystellite, S=Shot, C=Churn
Hole sealed .... P=Packer, Cm=Cemented, Cs=Bottom of casing
Approximate size of hole (X-series) ...... $Ex = 1\frac{1}{2}$" $Ax = 1\frac{7}{8}$" $Bx = 2\frac{3}{8}$" $Nx = 3$"
Approximate size of core (X-series) ... $Ex = \frac{7}{8}$" $Ax = 1\frac{1}{8}$" $Bx = 1\frac{5}{8}$" $Nx = 2\frac{1}{8}$"
Outside diameter of casing (X-series) $Ex = 1\frac{13}{16}$" $Ax = 2\frac{1}{4}$" $Bx = 2\frac{7}{8}$" $Nx = 3\frac{1}{2}$"
Inside diameter of casing (X-series) ... $Ex = 1\frac{1}{2}$" $Ax = 1\frac{29}{32}$" $Bx = 2\frac{3}{8}$" $Nx = 3$"

ANGLE HOLE ☐
VERTICAL HOLE ☐

HOLE No. MAD-2
SHEET 3 OF 5

K. ENGINEERING CONSULTANTS CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE MAIN DAM PROJECT MAE KUANG CHV. CHIANG MAI
HOLE No. MAD-2 LOCATION GROUND ELEVATION 340.678 M. ANGLE FROM VERTICAL 0°
COORDINATES
BEGUN FINISHED DEPTH OF OVERBURDEN 16.30 M. TOTAL DEPTH 50 M. BEARING OF ANGLE HOLE –
DEPTH OR ELEV. OF WATER TABLE ~2.00 M. HOLE LOGGED BY T. SIRINAWIN FOREMAN PAISAN

R.Q.D (%)	CORE RECOVERY (%)	K, LUGEON	DEPTH	CLASSIFICATION AND PHYSICAL CONDITION
24	100	38.9		SANDSTONE (continued)
20	100	38.9 / 20.9	31	fracture dip 30°, 40°, 50°, 65° and 75° smooth surface slightly quartz veinlet injected along fracture plane
89			32	all crack are coated by calcite film at 31.54 m. 38.15 m. 38.43 m. 39.36 m. 35.95 m.
75	100		33	
	100		34	
34				have small void and filled by quartz crystals
54			35	
37	100	20.9 / 15.9	36	
15			37	
70	100		38	
0	100		39	
		15.9	40	SHALE light greenish gray moderately weathered

EXPLANATION

CORE LOSS / CORE RECOVERY	Type of hole	D=Diamond, H=Haystellite, S=Shot, C=Churn	ANGLE HOLE ☐
	Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
	Approximate size of hole (X-series)	Ex=1½" Ax=1 7/8" Bx=2 3/8" Nx=3"	
	Approximate size of core (X-series)	Ex=7/8" Ax=1 1/8" Bx=1 5/8" Nx=2 1/8"	
	Outside diameter of casing (X-series)	Ex=1 13/16" Ax=2 1/4" Bx=2 7/8" Nx=3 1/2"	
	Inside diameter of casing (X-series)	Ex=1 1/2" Ax=1 29/32" Bx=2 3/8" Nx=3"	

HOLE No. MAD-2
SHEET 4 OF 5

K. ENGINEERING CONSULTANTS CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE MAIN DAM PROJECT MAE KUANG Chw. CHIANG MAI
HOLE No MAD - 2 LOCATION GROUND ELEVATION 340.678 M. ANGLE FROM VERTICAL 0
COORDINATES -
BEGUN FINISHED DEPTH OF OVERBURDEN 16.30 M. TOTAL DEPTH 50 M. BEARING OF ANGLE HOLE -
DEPTH OR ELEV. OF WATER TABLE ~2.00 M. HOLE LOGGED BY T. SIRINAWIN FOREMAN PAISAN

NOTES On water table levels, water return, character of drilling etc	R.Q.D (%)	CORE RECOVERY (%)	PERCOLATION TEST DEPTH (m) FROM (P. CS OR Cm.)	TO	LOSS IN (LPM)	PRESSURE (P.S.I)	LENGTH OF TEST (min.)	K, LUGEON 50	DEPTH	LOG	SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	23	100						15.9	41			SANDSTONE light gray slightly weathered at 41.32 – 42.00 m. dissolved cracked strained by iron oxide
	15							15.9 / 1.64				
	74								42			SHALE light grayish black at 31.59 – 32.62 m. sandstone patch
	55	100							43			slightly calcite veinlet injected along fracture plane fracture dip 50° and coated by calcite film at 45.15-45.45 m 45.70-46.00 m.
	0	100							44			crush zone
	16	100							45			
	51	100 / 100						1.64 / 19.4	46			SANDSTONE shale lens interbedded veinlet of quartz injected along fracture plane, dip 50° 80° calcite and clay coated average lenghth of core ~7 cm.
	53	100							47			
	70								48			at 49.05 m pyrite filled in crack
	10	100						19.4	49 / 50			

EXPLANATION

CORE LOSS	Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Churn	ANGLE HOLE ☐
CORE RECOVERY	Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of casing	VERTICAL HOLE ☐
	Approximate size of hole (X-series)	Ex = 1½" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series)	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
	Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series)	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

HOLE No. MAD-2
SHEET 5 OF 5

K. ENGINEERING CONSULTANTS CO., LTD

GEOLOGIC LOG OF DRILL HOLE

...AL MAIN DAM .... PROJECT...MAE KUANG DAM ... CHW.. CHIANGMAI........
...O MAD-3 .... LOCATION.... ...... GROUND ELEVATION 339.111 m. .ANGLE FROM VERTICAL.. 0° ....
COORDINATES. .
...26/6/81 FINISHED 9/7/81 DEPTH OF OVERBURDEN 11.85 m. TOTAL DEPTH 30 m. ..BEARING OF ANGLE HOLE –.... .
...OR ELEV OF WATER TABLE.. 2.25 m. HOLE LOGGED BY. S.SHOOSUWAN. FOREMAN. SOMCHART.... .

NOTES ...water table ...color ...character of ...sit	R.Q.D. %	CORE RE-COVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
					0–2	N 1	SILTY SAND; blackish brown, brown, 20% silt, 80% fine sand, wet.
...ndard ...etration ...istance ... Drop ... 140 lbs ...fall =				337.111	2–4	N 12; N 7	GRANULE SAND; reddish brown-brown, 10 % granule, 15% silt, 75% fine sand, granule of Quartz; subangular, max size 2.50 cm., wet
				333.111	4–6.25	N 5; N 21	SAND; blackish brown, fine-medium grained, wet.
				332.861	6.25–8	N 17; N 3	GRANULE SAND; greenish-black gray, 5% granule, 15% silt, 80% fine medium sand, granule of Quartz and sandstone; subangular, max size 3.50 cm, wet.
				331.111	8–	N 21; N 31	GRANULE SAND; greenish gray, gray; 10% granule, 20% clay, 70% medium-coarse sand, granule of Quartz and sandstone; angular-subangular, max size 1.5cm., wet.

EXPLANATION

...LOSS	Type of hole	D=Diamond, H=Haystellite, S=Shot, C=Chrn	
...RECOVERY	Hole sealed.	P=Packer, Cm=Cemented, Cs=Bottom of Casing	ANGLE HOLE □
	Approximate size of hole (X-series)........	Ex = $1\frac{1}{2}$" Ax = $1\frac{7}{8}$" Bx = $2\frac{3}{8}$" Nx = 3"	VERTICAL HOLE ■
	Approximate size of core (X-series)	Ex = $\frac{7}{8}$" Ax = $1\frac{1}{8}$" Bx = $1\frac{5}{8}$" Nx = $2\frac{1}{8}$"	
	Outside diameter of casing (X-series)	Ex = $1\frac{13}{16}$" Ax = $2\frac{1}{4}$" Bx = $2\frac{7}{8}$" Nx = $3\frac{1}{2}$"	
	Inside diameter of casing (X-series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{29}{32}$" Bx = $2\frac{3}{8}$" Nx = 3"	

K. ENGINEERING CONSULTANTS CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE: MAIN DAM PROJECT: MAE KUANG DAM Chw.: CHIANGMAI
HOLE NO: MAD-3 LOCATION: GROUND ELEVATION: 339.111 ANGLE FROM VERTICAL: 0°
COORDINATES:
BEGUN: 26/6/81 FINISHED: 9/7/81 DEPTH OF OVERBURDEN: 11.85 m. TOTAL DEPTH: 30 m BEARING OF ANGLE HOLE: —
DEPTH OR ELEV. OF WATER TABLE: 2.25 m. HOLE LOGGED BY: S. SHOOSUWAN FOREMAN: SOMCHART

NOTES (On water table levels, water return, character of drilling etc.):
Rock was drilled by diamond core bit of Nx size. From 10.00-30.00m.
Casing; Nx size from 0.00-20.00m.

R.Q.D. %	CORE RECOVERY (%)	ELEVATION	DEPTH	CLASSIFICATION AND PHYSICAL CONDITION
	100	328.911		GRAVELLY SAND; greenish–greenish brown, sub angular max size 4 cm wet.
	0	328.511		CORE LOSS AT 10.20–10.60 m
0	68.62		11	BOULDER AND GRAVEL; of quartz, quartzitic sandstone, white, greenish gray, gray, angular–subangular
	100	327.681		
0	0	327.261		CORE LOSS AT 11.43–11.85 m
	100		12	SANDSTONE; brown-gray, gray, fine medium grained, highly weathered fracture dip 20°–25°, 40°–45°, highly fracture; uneven coated with clay mineral at 11.90–11.95m. Thin layer of black gray SHALE core highly broken into pieces (crushed zone) at 12.20 – 12.30 m, 13.70 – 13.80 m, 14.00 – 14.10 m
32	100		13	
46	100		14	
	100	325.011		
	0			CORE LOSS AT 14.10–16.40 m
0	0		15	
	0			
0			16	
		322.711		SANDSTONE, same as 11.85–14.10 m core highly broken into pieces (crushed zone) at 16.40 – 16.56 m, 16.70 – 16.90 m
17	40	322.211	17	SHALE; black gray–gray, highly weathered to clay, core highly broken into pieces (crushed zone) at 17.19 – 17.26 m, 17.48 – 17.60 m.
29		321.511	18	CORE LOSS AT 17.60–19.50 m
0	32.5		19	
0	50	319.611		SANDSTONE, gray-brown, medium grain, highly weather to clay, core highly broken into pieces.

CORE LOSS / CORE RECOVERY

EXPLANATION

Type of hole .... D=Diamond, H=Haystellite, S=Shot, C=Chrn
Hole sealed .... P=Packer, Cm=Cemented, C=Bottom of Casing
Approximate size of hole (X-series) .... E = $1\frac{1}{2}$" A = $1\frac{7}{8}$" B = $2\frac{3}{8}$" N = 3"
Approximate size of core (X-series) .... E = $\frac{7}{8}$" A = $1\frac{1}{8}$" B = $1\frac{5}{8}$" N = $2\frac{1}{8}$"
Outside diameter of casing (X-series) .... E = $1\frac{13}{16}$" A = $2\frac{1}{4}$" B = $2\frac{7}{8}$" N = $3\frac{1}{2}$"
Inside diameter of casing (X-series) .... E = $1\frac{1}{2}$" A = $1\frac{29}{32}$" B = $2\frac{3}{8}$" N = 3"

ANGLE HOLE ☐ VERTICAL HOLE ■

HOLE NO. MAD-3
SHEET 2 OF -

K. ENGINEERING CONSULTANTS CO., LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE . MAIN DAM .... PROJECT... MAE KUANG DAM ..... CHW. CHIANG MAI
HOLE NO. MAD-3 .. LOCATION.. ..... GROUND ELEVATION . 339.111 .. ANGLE FROM VERTICAL .0°
COORDINATES. .
BEGUN 26/6/81. FINISHED 9/7/81 . DEPTH OF OVERBURDEN 11.85 m. TOTAL DEPTH 30 m. .BEARING OF ANGLE HOLE. -
DEPTH OR ELEV OF WATER TABLE. .2.25 m. .HOLE LOGGED BY S.SHOOSUWAN . FOREMAN .SOMCHART.

NOTES On water table levels, water-return, character of drilling etc.	R.Q.D. %	CORE RE-COVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
				319.011			SANDSTONE (CONTINUED)
							CORE LOST AT 20.10 - 20.80 m.
Permeability test could not be done because high leakage water	0			318.311 / 318.211	21		SHALE ; black, black grey, moderate weathered core are cutting.
	20	65					SANDSTONE ; brown grey-greenish brown, fine-medium grained moderate to highly weathered to clay (locally), core highly broken into pieces at 21.00 - 21.23 m. 21.43 - 21.55 m. 21.69 - 22.00 m.
				317.111 / 316.861	22		CORE LOST AT 22.00-22.25 m
	45				23		SANDSTONE ; greenish grey, brown grey, light grey, fine medium grained, moderate-highly weathered, thick bedded, highly fracture, fracture filled with quartz, fracture dip. 20°-35°, 40°-75° and coated with iron oxide and clay mineral, core highly broken into pieces (crushed zone). at 22.92 - 22.95 m. 23.00 - 23.20 m 24.43 - 24.55 m. 24.72 - 25.86 m. 25.08 - 25.37 m. 25.70 - 25.80 m. 26.00 - 26.75 m.
	73				24		
	50	91.66			25		
	0	100			26		
	0	100		312.361	27		SHALE ; black grey-black ; slightly-moderate weathered. fracture dip. 32°-35°, fracture smooth and coated with clay mineral, core highly broken into pieces and clay (crushed zone) at 27.00 - 27.95 m. 28.00 - 28.90 m. 29.29 - 29.58 m. 29.60 - 29.95 m. AT 29.00 - 29.15 m, MUDSTONE ; grey brown ; primary structure of turbidites current.
	0	100			28		
	10	100			29		
	10	100			30		BOTTOM OF HOLE

EXPLANATION

CORE LOSS CORE RECOVERY	Type of hole .... D=Diamond, H=Haystellite, S=Shot, C=Chrn Hole sealing .... P=Packer, C=Cemented, C=Bottom of Casing Approximate size of hole (X-series) .... Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3" Approximate size of core (X-series) .... Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8" Outside diameter of casing (X-series) .... Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2" Inside diameter of casing (X-series) .... Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	ANGLE HOLE ☐ VERTICAL HOLE ■

HOLE NO MAD-3

K ENGINEERING CONSULTANTS CO.,LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE..RIGHT SADDLE.................PROJECT...MAE. KUANG DAM .........CHW..CHIANGMAI.......
HOLE NO RAD-1 ...LOCATION COORDINATES.............GROUND ELEVATION.. 367.120 m ...ANGLE FROM VERTICAL...0°.........
BEGUN 29/6/81 FINISHED 11/7/81 DEPTH OF OVERBURDEN 7.0 m. TOTAL DEPTH. 28 m ..BEARING OF ANGLE HOLE.-- .....
DEPTH OR ELEV. OF WATER TABLE..10.65 m..HOLE LOGGED BY.S.SHOOSUWAN FOREMAN.SOMCHART........

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RE-COVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
Standard Penetration resistance test. Drop wt = 140 lbs., Free fall = 30"							SILTY SAND; reddish brown, yellowish brown, fine—medium grained.
				366.120	1	N 14	SANDY SILT; reddish brown, greenish red, Lateritic soil, very fine sand, medium plasticity, wet.
				365.120	2	N 19	SANDY CLAY; reddish brown, light—greenish brown, 30% sand, 70% clay, low—moderate plasticity, wet.
				364.120	3	N 15	SILTY CLAY; reddish brown, greenish gray, 10% fine sand, 90% clay, highly plasticity.
				363.120	4	N 36	CLAYEY SILT; reddish brown, greenish gray, 40% clay, 60% silt, moderate plasticity, wet.
Rock was drilled by diamond core bit of Nx size. From 7.00-28.00 m.				362.120	5	N 67	GRANULE SAND; 10% granule of quartz, sub angular, 90% medium grained sand.
					6		SANDY GRAVEL; 15% medium—coarse grained sand, 85% gravel of Quartz and Quartzite, angular—subangular, max size 3.5 cm.
		100		360.120	7		QUARTZITE; White weathered. QUARTZITIC SANDSTONE; light gray fine grained. SHALE; light greenish gray, core highly broken, shale at 7.20-7.30 m., 7.60-7.85 m.
	10	100		359.270	8		QUARTZITIC SANDSTONE, light gray, fine grained, good compacted fracture dip 50°-60°.
	34	100		358.820			QUARTZITE; White, light gray, slightly weathered. good compacted, highly fractures, dip 35°, 60°, 80°, 90°.
				358.220	9		CORE LOSS AT 8.90-9.10 m.
	42			358.020			QUARTZITIC SANDSTONE; metamorphosed to QUARTZITE, light gray, slightly weathered highly fractures and joints, fracture dip 25°, 60°.

□ CORE LOSS
■ CORE RECOVERY

EXPLANATION

Type of hole..........................D=Diamond, H=Hayestellite, S=Shot, C=Churn
Hole sealed...........................P=Packer, Cm=Cemented, Cs=Bottom of Casing
Approximate size of hole (X-series)........Ex = $1\frac{1}{2}$" Ax = $1\frac{7}{8}$" Bx = $2\frac{3}{8}$" Nx = 3"
Approximate size of core (X-series)........Ex = $\frac{7}{8}$" Ax = $1\frac{1}{8}$" Bx = $1\frac{5}{8}$" Nx = $2\frac{1}{8}$"
Outside diameter of casing (X-series)........Ex = $1\frac{13}{16}$" Ax = $2\frac{1}{4}$" Bx = $2\frac{7}{8}$" Nx = $3\frac{1}{2}$"
Inside diameter of casing (X-series)........Ex = $1\frac{1}{2}$" Ax = $1\frac{29}{32}$" Bx = $2\frac{3}{8}$" Nx = 3"

ANGLE HOLE □
VERTICAL HOLE ■

HOLE NO. RAD-1...
SHEET..1...OF. 3 ..

K ENGINEERING CONSULTANTS CO.,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE. RIGHT SADDLE ... PROJECT. MAE KUANG DAM ... C/W. CHIANGMAI
HOLE NO. RAD-1 ... LOCATION ... GROUND ELEVATION .. 367.120 m ... ANGLE FROM VERTICAL .. 0°
COORDINATES ...
BEGUN 29/6/81 FINISHED 11/7/81 DEPTH OF OVERBURDEN 7.0 m TOTAL DEPTH 28 m BEARING OF ANGLE HOLE .. –
DEPTH OR ELEV OF WATER TABLE .. 10:65 m. HOLE LOGGED BY S. SHOOSUWAN ; FOREMAN. SOMCHART

NOTES (on water table levels, water return, character of drilling etc.)	R.Q.D. %	CORE RECOVERY (%)	K, LUGEON	ELEVATION	DEPTH	CLASSIFICATION AND PHYSICAL CONDITION
Casing; Nx size from 0.00-7.52 m.	48, 32	84.61, 100			11	QUARTZITIC SANDSTONE; locally metamorphosed to QUARTZITE, white, ligth gray, fine grained, good compacted, highly fracture, fracture dip 30°–35°, 50°–60°, 80°–90°, coated with iron oxide. AT 9.80–9.84, 10.08–10.23, 11.61–11.67 m. Thin layer of greenish gray–black gray SLATY SHALE.
Permeability	59	100	13.65	354.150	12, 13	QUARTZTIC SANDSTONE; light-brownish gray, Slightly metamorphosed; fine–medium grained, slightly– moderate weathered, highly joints and fractures, fracture dip 30°–35°, iron oxide coated. AT 12.97–13.00, 13.10–13.12, 13.15–13.19 m Thin layer of reddish brown SHALE, layer dip 40°
test; Use		100		353.520		CORE LOSS AT 13.60–14.00 m
Single-packer system.	25, 0	50, 100		353.120, 352.420, 352.120	14, 15	QUARTZITIC SANDSTONE; light gray, fine–medium grained, good compacted, highly fracture, core highly broken into pieces, highly quartz veinlets. Thin layersof greenish gray–light gray SHALE at 14.55–14.57m, 15.11–15.25m. CORE LOSS AT 14.70–15.00m.
Depth tested 7.00-17.00m, 17.00-22.00m, 22.00-28.00m	42, 82, 10, 44, 70	58.40, 100, 100, 100, 100, 100, 100	13.65, 18.95	351.520	16, 17, 18, 19	QUARTZITIC SANDSTONE; light gray, gray, fine–medium grained, locally metamorphoshed to QUARTZITE, good compacted, slightly weathered, highly joints and fractures, dip 20°–30°, 50°–60° and coated with iron oxide, highly quartz veinlets. AT 17.63–17.64 very Thin layer of black gray SHALE. CORE highly broken at 17.00–17.26 m, 17.46–17.64 m, 18.21–18.32 m, 20.66–20.73 m.

CORE LOSS
CORE RECOVERY

EXPLANATION

Type of hole	D=Diamond, H=Hoyatellite, S=Shot, C=Chrn	
Hole sealed	P=Packer, Cm=Cemented, C=Bottom of Casing	ANGLE HOLE ☐
Approximate size of hole (X–series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{7}{8}$" Bx = $2\frac{3}{8}$" Nx = 3"	
Approximate size of core (X–series)	Ex = $\frac{7}{8}$" Ax = $1\frac{1}{8}$" Bx = $1\frac{5}{8}$" Nx = $2\frac{1}{8}$"	VERTICAL HOLE ■
Outside diameter of casing (X–series)	Ex = $1\frac{13}{16}$" Ax = $2\frac{1}{4}$" Bx = $2\frac{7}{8}$" Nx = $3\frac{1}{2}$"	
Inside diameter of casing (X–series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{29}{32}$" Bx = $2\frac{3}{8}$" Nx = 3"	

HOLE NO. RAD-1
SHEET. 2 OF 3

K ENGINEERING CONSULTANTS CO.,LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE. RIGHT. SADDLE ....PROJECT. MAE. KUANG DAM . CH. CHIANGMI
HOLE NO RAD-1 ....LOCATION ..... GROUND ELEVATION..367.120 m ..ANGLE FROM VERTICAL... 0°
COORDINATES.
BEGUN 29/6/81.FINISHED 11/7/81. DEPTH OF OVERBURDEN 7.0m TOTAL DEPTH 28m .BEARING OF ANGLE HOLE. -
DEPTH OR ELEV OF WATER TABLE. 10.65m..HOLE LOGGED BY. S. SHOOSUWAN FOREMAN SOMCHART...

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RECOVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	LOG (SAMPLES FOR TESTING)	CLASSIFICATION AND PHYSICAL CONDITION
	54	100		346.020	21		QUARTZTIC SANDSTONE; light gray, gray, fine-medium grained, slightly metamorphosed, good compacted, Slightly weathered; highly fractures, fracture dip 40°-45° coated with iron oxide. AT 21.36-21.38, 22.16-22.19 m. thin layer of greenish gray SHALE. Core highly broken at 21.22-21.58 m. 21.86-21.92 m.
	20	100	16.95		22		
		100		344.720			
	59	100	3.90		23		QUARTZTIC SANDSTONE, light gray, fine grained, good compacted, slightly metamorphosed, Slightly-moderate weathered, highly fractures and quartz veinlets, fracture dip 30°-45°, coated with iron oxide.
	34				24		
		100		342.470			
	74	50			25		SHALE; black gray, gray, slightly-moderate weathered, slightly metamorphosed, core highly broken into pieces at 25.60—25.75 m. CORE LOSS AT 24.70-2500 m. AT 25.35-25.38 QUARTZTIC SANDSTONE, fine-medium grained.
	11	100		341.320			
				341.020	26		QUARTZTIC SANDSTONE; black gray, medium grained
	72	100			27		QUARTZTIC SANDSTONE; light gray, gray, fine grained, slightly metamorphoshed, good compacted, slightly weathered, Highly fractures, fracture' dip 40°-65°, coated with Iron oxide. AT 27.68-27.70 thin layer of black gray SHALE.
	48	100	3.90	339.120	28		BOTTOM OF HOLE
					29		
					30		

	EXPLANATION	
CORE LOSS	Type of hole .... D=Diamond, H=Hoyatellite, S=Shot, C=Chrn	ANGLE HOLE
CORE RECOVERY	Hole sealed .... P=Packer, Cm=Cemented, C=Bottom of Casing	VERTICAL HOLE
	Approximate size of hole (X-series) .... Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series) .... Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
	Outside diameter of casing (X-series) .... Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series) .... Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

HOLE NO. RAD-1.
SHEET. 3 ...OF. 3

K ENGINEERING CONSULTANTS CO ,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE RIGHT SADDLE . . . . . PROJECT .... MAE KUANG DAM .Chw CHIANGMAI
HOLE NO RAD-2 .. LOCATION . . GROUND ELEVATION 364·250 m. .ANGLE FROM VERTICAL .....0°... .
COORDINATES .
BEGUN 29/6/81 FINISHED 10/7/81 DEPTH OF OVERBURDEN 5·50m TOTAL DEPTH 28 m...BEARING OF ANGLE HOLE. .—... ..
DEPTH OR ELEV OF WATER TABLE. 6·70 m. .HOLE LOGGED BY S. SHOOSUWAN FOREMAN SOMCHART.

NOTES (On water table levels, water return, character of drilling etc.):

Standard Penetration resistance test. Drop wt. = 140 lbs., Free fall = 30"

Rock was drilled by diamond core bit of Nx size. from 5.50-28.00m.

Elevation	Depth (m)	R.Q.D. %	Core recovery (%)	Samples for testing	Classification and physical condition
364·250 – 363·450	0 – 0.80				SILTY SAND, top soil, reddish brown to brown.
363·450 – 362·250	0.80 – 2			N 27	SANDY CLAY; reddish brown, brownish-greenish gray, 15% fine sand, 85% clay, lateritic clay, moderate plastic, with moisture.
362·250 – 362·250	2 – 4			N 23, N 17	SILTY CLAY, reddish brown, greenish-light gray, 10% silt, 90% clay, moderate plastic, moisture are moist.
362·250 – 358·750	4 – 5.50			N 41	GRANULE CLAY; reddish brown, light gray, 10% fine sand, 10% granule of quartz, 80% clay, granule of quartz max. 1.5 cm., slightly plastic, wet.
358·750	5.50 – 6.10		100		QUARTZITIC SANDSTONE; brownish gray, fine-medium grained, good compacted, moderate weathered, fracture dip 60°, core highly broken.
– 356·550	6.10 – 7.70	64	100		QUARTZITIC SANDSTONE; light gray- gray, fine-medium grained, good compacted, slightly-moderate weathered, highly joints and fracture, many quartz vienlet, quartz vein max. 1 cm., fracture dip 55-60° cooted with iron oxide and clay mineral.
356·550	7.70 – 8.00	44			CORE LOSS at 7.70-8.00 m.
	8.00		62.5		QUARTZITIC SANDSTONE; same as 6.10-7.70 m
					SLATY SHALE; light gray, core highly broken into pieces.
	8.50 – 8.80				CORE LOSS at 8.50- 8.80 m.
355.450	8.80 – 10	0, 36			QUARTZITIC SANDSTONE; light gray, fine-medium grained, moderate weathered, highly joint and fracture, many quartz veinlets, fracture dip 55-60° coated with iron oxide and clay mineral, core highly broken at 9.00-9.08, 9.18- 9.24 m.

EXPLANATION

CORE LOSS ▯ CORE RECOVERY ▮

Type of hole..................... D=Diamond, H=Hoyetallite, S=Shot, C=Churn
Hole sealed..................... P=Packer, Cm=Cemented, C=Bottom of Casing
Approximate size of hole (X—series)........ Ex = $1\frac{1}{2}$" Ax = $1\frac{7}{8}$" Bx = $2\frac{3}{8}$" Nx = 3"
Approximate size of core (X—series)........ Ex = $\frac{7}{8}$" Ax = $1\frac{1}{8}$" Bx = $1\frac{5}{8}$" Nx = $2\frac{1}{8}$"
Outside diameter of casing (X—series)....... Ex = $1\frac{13}{16}$" Ax = $2\frac{1}{4}$" Bx = $2\frac{7}{8}$" Nx = $3\frac{1}{2}$"
Inside diameter of casing (X—series)........ Ex = $1\frac{1}{2}$" Ax = $1\frac{29}{32}$" Bx = $2\frac{3}{8}$" Nx = 3"

ANGLE HOLE ☐ VERTICAL HOLE ■

HOLE NO. RAD-2..
SHEET 1 OF 3

K ENGINEERING CONSULTANTS CO.,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE RIGHT SADDLE PROJECT MAE KUANG DAM Chw. CHIANGMAI
HOLE NO RAD-2 LOCATION COORDINATES GROUND ELEVATION 364·250 m. ANGLE FROM VERTICAL 0°.
BEGUN 29/6/81 FINISHED 10/7/81 DEPTH OF OVERBURDEN 5·50m. TOTAL DEPTH 28 m. BEARING OF ANGLE HOLE
DEPTH OR ELEV OF WATER TABLE 6·70m HOLE LOGGED BY S. SHOOSUWAN FOREMAN SOMCHART.

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RECOVERY (%)	K, LUGEON	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
Casing; Nx size from 0.00-9.44m.	52	81 81 / 100	16 54	353·400	11		SANDSTONE; black gray, fine-medium grained, slightly-moderate weathered, moderate compacted, highly joints and fractures, fracture dip 30-55°, coated with iron-oxide and clay mineral.
							SHALE; greenish-black gray, slightly weathered, core highly broken into piece.
	62				12		SANDSTONE; greenish gray, pale gray, slightly-moderate weathered, highly quartz veinlets, fracture dip 25°, 60°, 78° and coated with iron oxide. Thin layers of black gray SHALE at 11·42 and 11·48m
Permeability test; Use single-packer System.	84			351 750	13		SANDSTONE; light gray, fine-medium grained, moderate weathered, slightly metamorphosed, highly quartz veinlets, fracture dip 30°, 60-70°, coated with clay mineral, highly broken at 13·09-13·62m.
Depth tested 10.50-15.50m. 17.70-22.70m.	14	100		350 630	14		SANDSTONE; light-greenish gray, medium grained, moderate weathered, highly quartz veinlets, fracture filled with quartz dip 40°, 65-70°, coated with clay mineral. Core highly broken at 14·15-14·21 m.
	48	100	16·54	348750	15		CORE LOSS at 15·50-15·85 m.
	30				16		SANDSTONE; greenish gray, light-pale gray, fine-medium grained, slightly-moderate weathered, many quartz veinlets, highly joints and fractures, fractures coated with clay mineral and filled with quartz, fracture dip 30-35°, 50-60° Locally, thin layers of black gray SHALE. Core highly broken at 15·85-16·11 m. 16·28-16·33m. 16·45-16·60m. 16·67-17·00m. 18·00-18·25 m.
	15	74·1			17		
	100	100	23·08		18		
	45	100 / 100		349 080	19		SLATY SHALE; black gray, slightly metamorphosed
	82				20		SANDSTONE; light gray-gray, fine-medium grained, good compacted, fracture dip 55°.

EXPLANATION

CORE LOSS	Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Chrn	ANGLE HOLE
CORE RECOVERY	Hole sealed	P=Packer, Cm=Cemented, Cb=Bottom of Casing	VERTICAL HOLE
	Approximate size of hole (X-series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{7}{8}$" Bx = $2\frac{3}{8}$" Nx = 3"	
	Approximate size of core (X-series)	Ex = $\frac{7}{8}$" Ax = $1\frac{1}{8}$" Bx = $1\frac{5}{8}$" Nx = $2\frac{1}{8}$"	
	Outside diameter of casing (X-series)	Ex = $1\frac{13}{16}$" Ax = $2\frac{1}{4}$" Bx = $2\frac{7}{8}$" Nx = $3\frac{1}{2}$"	
	Inside diameter of casing (X-series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{29}{32}$" Bx = $2\frac{3}{8}$" Nx = 3"	

HOLE NO. RAD-2
SHEET 2 OF 3

K ENGINEERING CONSULTANTS CO ,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE . RIGHT SADDLE ... PROJECT ... MAE KUANG DAM Chw CHIANGMAI..
HOLE NO RAD-2 .. LOCATION ... GROUND ELEVATION 364·250 m. ANGLE FROM VERTICAL. 0° ......
COORDINATES . ...
BEGUN 29/6/81 FINISHED 10/7/81 DEPTH OF OVERBURDEN 5·50m. TOTAL DEPTH 28 m. BEARING OF ANGLE HOLE ......
DEPTH OR ELEV OF WATER TABLE . 6·70 m ... HOLE LOGGED BY. S· SHOOSUWAN FOREMAN . SOMCHART

NOTES On water table levels, water return, character of drilling etc	R.Q.D. %	CORE RE-COVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
		100		343.87			SANDSTONE;continued from 19·43 m.
	62	100			21		SANDSTONE; light gray-greenish gray, fine-medium grained, slightly-moderate weathered, highly joints and fractures, many quartz veinlet, fracture dip 40°-50°, 68°-75° and coating with clay mineral.
	88				22		
		100	23·08	341.65			
	20				23		SANDSTONE, light-greenish gray, fine grained, good compacted, fracture dip 50°-60°, uneven, cooted with clay mineral and steep dip quartz vein filled, SLATY SHALE, cutting at 23·11-23·23 m.
				340.62			
	24	100			24		SANDSTONE: geenish-light gray, fine-medium grained, good compacted, slightly-moderate weathered, highly fracture and quartz veinlets fracture dip 20°-35°, 58°-65°, 80°, cooted with clay mineral. core highly broken at 24.80-24.85 m 25.25-25.43 m.
	73	100			25		
	25	100		338.35	26		SHALE; light gray, gray, good compacted, slightly weathered, fracture uneven, dip. 60°, 85°, SANDSTONE; greenish gray, very fine grained, patch at 26·40-26·50 m.
		100					
	32			337.25	27		SANDSTONE; light gray, fine grained, good compact highly fractures and dip 50-55°, core highly broken at 27·13-27·30 m., 27·37-27·53 m.
		100					
	32	100		336.45			SHALE; light gray, moderate-highly weathered.
				336.25	28		BOTTOM OF HOLE at 28·00 m.

EXPLANATION

CORE LOSS	Type of hole	D=Diamond, H=Heystellite, S=Shot, C=Chrn	ANGLE HOLE ☐
CORE RECOVERY	Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of Casing	VERTICAL HOLE ■
	Approximate size of hole (X-series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{7}{8}$" Bx = $2\frac{3}{8}$" Nx = 3"	
	Approximate size of core (X-series)	Ex = $\frac{7}{8}$" Ax = $1\frac{1}{8}$" Bx = $1\frac{5}{8}$" Nx = $2\frac{1}{8}$"	
	Outside diameter of casing (X-series)	Ex = $1\frac{13}{16}$" Ax = $2\frac{1}{4}$" Bx = $2\frac{7}{8}$" Nx = $3\frac{1}{2}$"	
	Inside diameter of casing (X-series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{29}{32}$" Bx = $2\frac{3}{8}$" Nx = 3"	

HOLE NO. RAD-2.
SHEET 3 OF 3 .

K ENGINEERING CONSULTANTS CO.,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE RIGHT SADDLE ..PROJECT.... MAE KUANG DAM. .Chv. CHIANGMAI
HOLE NO RAD-3 ..LOCATION .. GROUND ELEVATION .370.280 m ANGLE FROM VERTICAL..0°..
COORDINATES.
BEGUN 11/7/81 FINISHED 16/7/81 DEPTH OF OVERBURDEN 17.03 m. TOTAL DEPTH 28 m...BEARING OF ANGLE HOLE ..-
DEPTH OR ELEV. OF WATER TABLE. 14:25 m...HOLE LOGGED BY. S. SHOOSUWAN FOREMAN ..SOMCHART..

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RECOVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
Standard Penetration resistance test. Drop wt = 140 lbs Free fall = 30 "					0–1		SANDY CLAY; reddish brown; 15% fine sand, 75 % clay, moderate plasticity; wet.
				369.28	1	N 13	SILTY CLAY; reddish brown-brown; 10 % fine sand, 15 % silt, 75 % clay, moderate plasticity, wet.
				368.28	2	N 18	CLAY; Light gray, reddish brown, highlyplasticity, Some gravel of quartz, max. size 0.30 cm, sub angular
				367.28	3	N 13	CLAY; Light gray, yellowish - reddish brown, moderate - highly plasticity, some gravel of quartz max. size 0.8 cm., angular - subangular.
					4	N 17	
Rock was drilled by diamond core bit of Nx size. from 10.50-28.00m					5	N 18	
				364.28	6	N 27	SANDY CLAY; yellowish brown-brown, 10 % sand 90% clay, moderate plasticity wet.
				363.28	7	N 37	SILTY CLAY; yellowish brown, light gray, 5 % fine sand, 15 % silt, 80% clay, moderate plasticity, wet, some gravel of quartz max. size 0.20 cm, angular-sub angular.
					8	N 48	
				361.28	9	N 59	SANDY CLAY; greenish gray, yellowish brown, 10% sand, 90 % clay, moderate plasticsity, some granules of quartz, wet.
					10		

EXPLANATION

CORE LOSS
CORE RECOVERY

Type of hole	D=Diamond, H=Hayatellite, S=Shot, C=Chrn
Hole sealed	P=Packer, Cm=Cemented, Cs=Bottom of Casing
Approximate size of hole (X-series)	Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"
Approximate size of core (X-series)	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"
Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"
Inside diameter of casing (X-series)	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"

ANGLE HOLE ☐
VERTICAL HOLE ■

HOLE NO. RAD-3.
SHEET 1 OF 3.

K ENGINEERING CONSULTANTS CO.,LTD

GEOLOGIC LOG OF DRILL HOLE

FEATURE RIGHT SADDLE ... PROJECT MAE KUANG DAM ... CHV. CHIANGMAI
HOLE NO. RAD-3 ... LOCATION ... GROUND ELEVATION 370.280 m ... ANGLE FROM VERTICAL 0°
COORDINATES ...
BEGUN 11/7/81 FINISHED 16/7/81 DEPTH OF OVERBURDEN 17.03 m. TOTAL DEPTH 28.0 m. BEARING OF ANGLE HOLE –
DEPTH OR ELEV OF WATER TABLE 14:25 m. HOLE LOGGED BY S. SHOOSUWAN FOREMAN SOMCHART

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RECOVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
						N 57	GRANULE CLAY; yellowish brown, light gray, 5 % sand, 5 % granule of quartz, angular-sub angular, moderate plasticity.
Casing; Nx size from 0.00-16.50m.		42.85		359 580			BOULDER AND GRAVEL; of quartz, sandstone, sub angular.
		0		359 430	11		CORE LOSS AT 10.85-11.60 m
				358 680			SANDY CLAY; yollowish brown, moderate plasticity, boulder of sandstone at 11.60-11.64 m.
		30		358 380	12		CORE LOSS AT 11.90-12.20 m.
		0		358 080			CLAY; reddish brown-brown, highly plasticity.
Permeability test; Use single-packer system.		100		357 400	13		CLAY, light gray-reddish brown, highly plasticity.
				356 980			GRANULE CLAY; yellowish brown-brown, granule of quartz, sub angular, moderate - highly plasticity.
Depth tested 17.50-22.50m. 23.00-28.00m.		33.96		356 500	14, 15		CORE LOSS AT 13.78-15.83 m
		50		354 450	16		BOULDER AND GRAVEL; of quartzitic sanstone, quartzite, sub angular-subround.
				354 150			CORE LOSS AT 16.13-16.58 m.
		50		353 700	17		Same as 15.83-16.13 m
	78	74.61	19.87	353 250	18		QUARTZITIC SANDSTONE; pale gray-brownish gray, fine-medium grained, moderate compacted, moderate weathered, some joints and quartz veinlets, highly fracture, fracture dip 15°-20°, 25°-30°, 55°-60°, fracture uneven and cooted with iron oxide. core highly broken at 18.80-18.87 m 20.32-20.40 m
		100		352 28			CORE LOSS AT 18.00-18.33 m
	100			351 95	19		

EXPLANATION

CORE LOSS	Type of hole	D=Diamond, H=Hayatellite, S=Shot, C=Churn	ANGLE HOLE ☐
CORE RECOVERY	Hole sealed	P=Packer, C=Cemented, C=Bottom of Casing	VERTICAL HOLE ■
	Approximate size of hole (X-series)	Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series)	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
	Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series)	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

HOLE NO. RAD-3
SHEET 2 OF 3

K ENGINEERING CONSULTANTS CO.,LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE RIGHT SADDLE PROJECT MAE KUANG DAM Chw. CHIANGMAI
HOLE NO. RAD-3 LOCATION COORDINATES GROUND ELEVATION 370.280 m. ANGLE FROM VERTICAL 0°
BEGUN 11/7/81 FINISHED 16/7/81 DEPTH OF OVERBURDEN 17.03 m TOTAL DEPTH 28.00 m BEARING OF ANGLE HOLE —
DEPTH OR ELEV. OF WATER TABLE HOLE LOGGED BY S. SHOOS FOREMAN SOMCHART

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RECOVERY (%)	K.LUGEON 50	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	77	100			21		QUARTZITIC SANDSTONE (continued)
	43	100		348 73	22		QUARTZITIC SANDSTONE ; brownish gray, pale gray, fine-medium grained, good compacted, slightly-moderate weathered, highly fractures and quartz veinlets, fracture dip 25°-30°, 50°-60°, uneven coated with iron oxide.
	60	100	19-87				
		100	2-65	347 000	23		SANDSTONE ; black gray-gray, fine-medium grained, moderate compacted; slightly-moderate weathered, Some fracture and quartz veinlet, fracture dip 20°-25°
	81			346 210	24		CORE LOSS AT 24 07-24 37 m.
				345 910			SLATY SHALE, black-black gray, slightly metamorphosed and slightly weathered, with turbidite structure, core highly broken.
	23	81.08		345 410	25		CORE LOSS AT 24 87-25.37 m
				344 910			SLALY SHALE , same as 24 37-24 87 m
				344 680			SANDSTONE ; greenish gray, fine grain Thin layer of light gray SHALE, core cutting
	10	64.28		344 380	26		Quartzitic sandstone, light gray, fine medium grained good compacted, at 26 22-26 25 patches of greenish shale (cutting).
	94			343 88	27		SANDSTONE ; Same as 23.28-24.07 m
	81	100	2-65	342 98	28		QUARTZITIC SANDSTONE ; light gray, fine-medium grained, good compacted, slightly weathered some fracture and quartz veinlets, fracture dip 70°-75°.
							BOTTOM OF HOLE
					29		

EXPLANATION

CORE LOSS
CORE RECOVERY

Type of hole .... D=Diamond, H=Haystellite, S=Shot, C=Churn
Hole sealed .... P=Packer, Cm=Cemented, C=Bottom of Casing
Approximate size of hole (X-series) .... E= 1 1/2" A= 1 7/8" B= 2 3/8" N= 3"
Approximate size of core (X-series) .... E= 7/8" A= 1 1/8" B= 1 5/8" N= 2 1/8"
Outside diameter of casing (X-series) .... E= 1 13/16" A= 2 1/4" B= 2 7/8" N= 3 1/2"
Inside diameter of casing (X-series) .... E= 1 1/2" A= 1 29/32" B= 2 3/8" N= 3"

ANGLE HOLE
VERTICAL HOLE

HOLE NO. RAD.-3
SHEET 3 OF 3

K. ENGINEERING CONSULTANTS CO.,LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE .. RIGHT......SADDLE .. ..PROJECT....MAE. .KUANG DAM.. .... CHW...CHIANGMAI.... ....
HOLE NO. RAD-4...LOCATION... ... . GROUND ELEVATION.369·190 m. .ANGLE FROM VERTICAL..0°. ....
COORDINATES. .
BEGIN 10/7/81 FINISHED 16/7/81. DEPTH OF OVERBURDEN 17.00m. TOTAL DEPTH 28 m. .BEARING OF ANGLE HOLE ..–. ..
DEPTH OR ELEV OF WATER TABLE..11:95 m. .HOLE LOGGED BY. S. SHOOSUWAN FOREMAN. SOMCHART.. .. ..

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RECOVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
					0		TOP SOIL; 0 60 m.
Standard penetration resistance test. Drop wt = 140 lbs free fall = 30"				368 590	0.60	N 20 (1–1.5); N 26 (2–2.5); N 28 (3–3.5); N 25 (4–4.5)	SILTY CLAY, reddish brown, greenish-light gray, 5% very fine sand, 10% silt, 85% clay, moderate-strong plasticity, wet.
Rock was drilled by diamond core bit of Nx size. from 15.60-28.00m.				364 190	5	N 20; N 14	SILTY CLAY; yellowish-reddish brown, light gray, 10% fine sand, 10% silt, 80% clay, moderate plasticity, wet.
				362 190	7	N 24	CLAY; reddish brown, light gray, highly plasticity, wet.
				361 190	8	N 44	SILTY CLAY, yellowish brown, light yellow, light gray, 10% silt, 90% clay, moderate plasticity, wet.
				360·190	9	N 28	CLAY, light yellow, yellowish brown, light gray, highly plasticity, wet.

EXPLANATION

CORE LOSS	Type of hole	..D=Diamond, H=Hoystellite, S=Shot, C=Churn	ANGLE HOLE ☐
CORE RECOVERY	Hole sealed	... P=Packer, Cm=Cemented, C=Bottom of Casing	VERTICAL HOLE ■
	Approximate size of hole (X-series)	....Ex = $1\frac{1}{2}$" Ax = $1\frac{7}{8}$" Bx = $2\frac{3}{8}$" Nx = 3"	
	Approximate size of core (X-series)	....Ex = $\frac{7}{8}$" Ax = $1\frac{1}{8}$" Bx = $1\frac{5}{8}$" Nx = $2\frac{1}{8}$"	
	Outside diameter of casing (X-series) .	.....Ex = $1\frac{13}{16}$" Ax = $2\frac{1}{4}$" Bx = $2\frac{7}{8}$" Nx = $3\frac{1}{2}$"	
	Inside diameter of casing (X-series)	... .. .Ex = $1\frac{1}{2}$" Ax = $1\frac{29}{32}$" Bx = $2\frac{3}{8}$" Nx = 3"	

HOLE NO. RAD.-4
SHEET 1 OF 3

K ENGINEERING CONSULTANTS CO.,LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE ... RIGHT SADDLE .... PROJECT ... MAE KUANG DAM ...... Chw. CHIANGMAI
HOLE NO. RAD-4 .. LOCATION ... COORDINATES .... GROUND ELEVATION .. 369.190 m .. ANGLE FROM VERTICAL ... 0°
BEGUN 10/7/81 FINISHED 16/7/81 DEPTH OF OVERBURDEN 17.00 m TOTAL DEPTH 28 m .. BEARING OF ANGLE HOLE -
DEPTH OR ELEV OF WATER TABLE .. 11.95 m .. HOLE LOGGED BY .. S. SHOOSUWAN FOREMAN ... SOMCHART

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RE-COVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
Casing; Nx size from 0.00-17.23m.						N 28	SANDY CLAY ; 10% fine sand, 90% clay, moderate plasticity, wet.
				358.190	11	N 14, N 19, N 36	CLAY, yellowish brown, light-greenish gray highly plasticity, wet.
Permeability test; Use single-packer system.					12, 13		
Depth tested 17.00-22.00m. 23.00-28.00m.				355.190	14	N 42	SANDY CLAY ; yellowish brown-brown, 15% sand, 85% clay, moderate plasticity, wet.
				354.190	15	N 44	GRANULE SAND; reddish brown-brown, 10% granules of quart subangular maxsize 3 cm. 30% clay, 60% sand.
				353.590			CORE LOSS AT 15.60-16.10 m.
	0	16.66, 33.33, 33.33		353.090	16		BOULDER AND GRAVEL of Quartz, sandstone, angular-subangular. CORE LOSS AT 16.20-16.40 m. and 16.50-16.70 m
	45, 64, 79	100, 100, 100	27.52	352.190	17, 18, 19		SANDSTONE ; light brown-brown, thick bed, medium grained, moderate weathered, highly fractures and some quartz veinlets, fracture dip 15-22°, 45-50°, fracture filled with quartz and coated with iron oxide. At quartz veins highly werthered to laterite, core highly broken at 17.34 - 17.52 m. 18.14 - 18.23 m.

EXPLANATION

CORE LOSS	Type of hole .... D=Diamond, H=Haystellite, S=Shot, C=Chrn	ANGLE HOLE
CORE RECOVERY	Hole sealed .... P=Packer, C=Cemented, C=Bottom of Casing	VERTICAL HOLE
	Approximate size of hole (X-series) .... E=1 1/2" A=1 7/8" B=2 3/8" N=3"	
	Approximate size of core (X-series) .... E=7/8" A=1 1/8" B=1 5/8" N=2 1/8"	
	Outside diameter of casing (X-series) .... E=1 13/16" A=2 1/4" B=2 7/8" N=3 1/2"	
	Inside diameter of casing (X-series) .... E=1 1/2" A=1 29/32" B=2 3/8" N=3"	

HOLE NO. RAD-4
SHEET 2 OF 3

K ENGINEERING CONSULTANTS CO.,LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE RIGHT SADDLE ... PROJECT MAE KUANG DAM ... CITY CHIANGMAI

HOLE NO. RAD-4 ... LOCATION ... GROUND ELEVATION 369.190 ... ANGLE FROM VERTICAL 0°

COORDINATES

BEGUN 10/7/81 FINISHED 16/7/81 DEPTH OF OVERBURDEN 17.00 m. TOTAL DEPTH 28 m. BEARING OF ANGLE HOLE -

DEPTH OR ELEV OF WATER TABLE 11.95 m. HOLE LOGGED BY S.SHOOSUWAN FOREMAN SOMCHART

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RECOVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	93			349.010	21		SANDSTONE; reddish brown-brown, fine-medium grained, thick bed, modorate weathered, modorate-good compocted, highly fractures and some quartz veinlets, fracture dip 15°-25°, 30°-35°, fracture uneven, coated with iron oxide, at fracture highly weathered to laterite.
	72	100	27.52		22		
				346.71			SHALE; greenish grey, greenish brown, highly weathered to clay, core cutting and clay sludge.
	55		5.64	346.36	23		SANDSTONE; reddish brown-brown, fine-medium grained, good compacted, at 23.85-24.30 m metamorphoshed to QUARTZITE; white, light-greenish gray, highly joints and fractures, highly quartz veins max. size 4 cm, fracture dip 25°-30°, 40°-55°, uneven, at fracture highly weathered to laterite.
	100				24		
		100		344.890			SHALE; light brown, greenish gray, gray, moderate-highly weathered to clay, highly joints and fracture. Joints and fractures have iron oxide and quartz filled when highly weathered to clay.
	58				25		
	84				26		
	25	100			27		
				341.890			SANDSTONE; light-grayish brown, medium grained, moderate weathered, some quartz veinlets and fractures, fracture dip 20°-25°, 70°-75°.
	73	100	5.64		28		BOTTOM OF HOLE
					29		

EXPLANATION

CORE LOSS	Type of hole	D=Diamond, H=Hoyatellite, S=Shot, C=Churn	ANGLE HOLE ☐
CORE RECOVERY	Hole sealed	P=Packer, Cm=Cemented, C=Bottom of Casing	VERTICAL HOLE ■
	Approximate size of hole (X-series)	Ex = 1 1/2" Ax = 1 7/8" Bx = 2 3/8" Nx = 3"	
	Approximate size of core (X-series)	Ex = 7/8" Ax = 1 1/8" Bx = 1 5/8" Nx = 2 1/8"	
	Outside diameter of casing (X-series)	Ex = 1 13/16" Ax = 2 1/4" Bx = 2 7/8" Nx = 3 1/2"	
	Inside diameter of casing (X-series)	Ex = 1 1/2" Ax = 1 29/32" Bx = 2 3/8" Nx = 3"	

HOLE NO RAD-4

SHEET 3 OF 3

K ENGINEERING CONSULTANTS CO.,LTD.

GEOLOGIC LOG OF DRILL HOLE

FEATURE .... PROJECT.....MAE. KUANG DAM ...... Chw...CHIANGMAI
HOLE NO RAD-6 ....LOCATION .... GROUND ELEVATION.. 362.461 m ..ANGLE FROM VERTICAL.... .0°.....
COORDINATES..............
BEGUN.12/7/81 FINISHED 16/7/81 DEPTH OF OVERBURDEN 3.90m TOTAL DEPTH. 20m ..BEARING OF ANGLE HOLE.. – ...
DEPTH OR ELEV OF WATER TABLE.4.65 m. ..HOLE LOGGED BY.S.SHOOSUWAN.. FOREMAN SOMCHART....

NOTES On water table levels, water return, character of drilling etc.	R.Q.D. %	CORE RECOVERY (%)	K, LUGEON 50	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
Standard Penetration resistance test. Drop wt = 140 lbs Free fall = 30"					0–1.60	N 20	GRANULE CLAY; yellowish brown-reddish brown. LATERITIC SOIL. Granule of Quartz and Sandstone; Subangular max Size 3 cm Moderate plasticity.
	12			360.861			CORE LOSS AT 1.60–1.85 m.
				360.611	2		LATERITE; reddish brown-brown, LATERITIC SOIL, BOULDER AND GRAVEL of SANSTONE, Subanguler
		75		360.161			CLAY; brownish-greenish gray, moderate plasticity.
	33			359.861	3		CORE LOSS AT 2.60–3.15 m
		52.17		359.311			CLAY; light gray, lightbrown, moderate plasticity
	0			358.711			CORE LOSS AT 3.75–3.90 m
Rock was drilled by diamond core bit of Nx size. From 1.60-20.00m.	62	80		358.561	4, 5		SANDSTONE; Light gray-light brown, fine-medium grained, moderate-highly weathered to clay, highly fracture, fracture dip 20°–25°, 40°–60°, uneven, coated with Iron oxide and clay mineral.
		100		357.011			CORE LOSS AT 5.45–5.92 m
	11			356.461	6		SANDSTONE; Same as 3.90–5.45 m
	281	63.84			7		SANDSTONE; Light gray; fine-medium grained, moderate weathered, highly joints and fracture, dip 30°–35°. AT 6.70–6.90m Patch with thin layers black SLATY SHALE, core highly broken into pieces at 6.40–6.50m, 6.73–6.87m.
		100		355.361			CORE LOSS AT 7.10–7.45m
	0	52.25		355.011			SANDSTONE; Same as 6.00–7.10m
	12	100		354.561	8, 9		SHALE; greenish-light gray; moderate weathered, highly joints, with small patch of greenish gray, fine grained SANDSTONE at 8.54 8.63 m, core highly broken into pieces at 8.00–8.37 m 8.70–9.25m
		100					
		100		353.211			CORE LOSS AT 9.25–9.60 m.
	0			352.861			SHALE; Same as 7.90–9.25 m.
				352.611			SANDSTONE

CORE LOSS
CORE RECOVERY

EXPLANATION

Type of hole	D=Diamond, H=Hayetellite, S=Shot, C=Chra
Hole sealed	P=Packer, Cm=Cemented, C=Bottom of Casing
Approximate size of hole (X-series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{7}{8}$" Bx = $2\frac{3}{8}$" Nx = 3"
Approximate size of core (X-series)	Ex = $\frac{7}{8}$" Ax = $1\frac{1}{8}$" Bx = $1\frac{5}{8}$" Nx = $2\frac{1}{8}$"
Outside diameter of casing (X-series)	Ex = $1\frac{13}{16}$" Ax = $2\frac{1}{4}$" Bx = $2\frac{7}{8}$" Nx = $3\frac{1}{2}$"
Inside diameter of casing (X-series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{29}{32}$" Bx = $2\frac{3}{8}$" Nx = 3"

ANGLE HOLE ☐
VERTICAL HOLE ☒

HOLE NO RAD-6
SHEET 1 OF 2

K. ENGINEERING CONSULTANTS CO.,LTD

GEOLOGIC LOG OF DRILL HOLE

HOLE NO. RAD-6 ... LOCATION ... PROJECT MAE KUANG DAM ... CHW. CHIANGMAI

COORDINATES ... GROUND ELEVATION 362.461 m. ... ANGLE FROM VERTICAL 0°

...2/7/81 FINISHED 16/7/81 DEPTH OF OVERBURDEN 3.90 m. TOTAL DEPTH 20.00 m. BEARING OF ANGLE HOLE –

...ELEV OF WATER TABLE 4.65 m. HOLE LOGGED BY S. SHOOSUWAN FOREMAN SOMCHART

NOTES (water table, ..., character of ..., etc.)	R.Q.D. %	CORE RECOVERY (%)	K, LUGEON	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
...ing: Nx		68.18		362.111			SANDSTONE ; light-greenish gray, fine-medium grained, very thick bed, slightly-moderate, weathered moderate compacted, highly fractures and Joints, highly Quartz veinlets, Fracture dip 20°-35°, 60°-65° 80°-83°, fracture uneven, coated with clay mineral and some filled with Quartz
...from	19			351.311	11		Core highly Fracture and highly broken at
...-2.00 m.	11	36	2.27	350.861			11.55 – 11.60 m. (cutting)
				350.661	12		12.45 – 12.89 m. (cutting)
...eability	25	84.84			13		13.00 – 13.15 m.
...Use		100		349.061			13.25 – 13.44 m.
				348.911			13.80 – 14.10 m.
...le-packer	37	78.57			14		15.71 – 15.82 m.
...tem.							16.30 – 16.40 m.
...tested	48	100	2.27 / 2.81		15		16.93 – 17.00 m.
...-16.50m.							17.60 – 17.78 m.
...-20.00m	56				16		18.00 – 18.30 m.
		100					18.71 – 18.80 m.(cutting)
	12	100			17		CORE LOSS AT 10.35 – 11.15 m
	10	100			18		11.60 – 11.80 m.
		100		343.661			13.40 – 13.55 m.
	22				19		SANDSTONE ; lightgray – greenish gray, Thick bed, fine grained, Slightly-moderate weathered, moderate compacted, Some fractures and Quartz veines, fractured dip 30°-35° and coated with clay mineral.
	67	100	2.81	342.461	20		BOTTOM OF HOLE

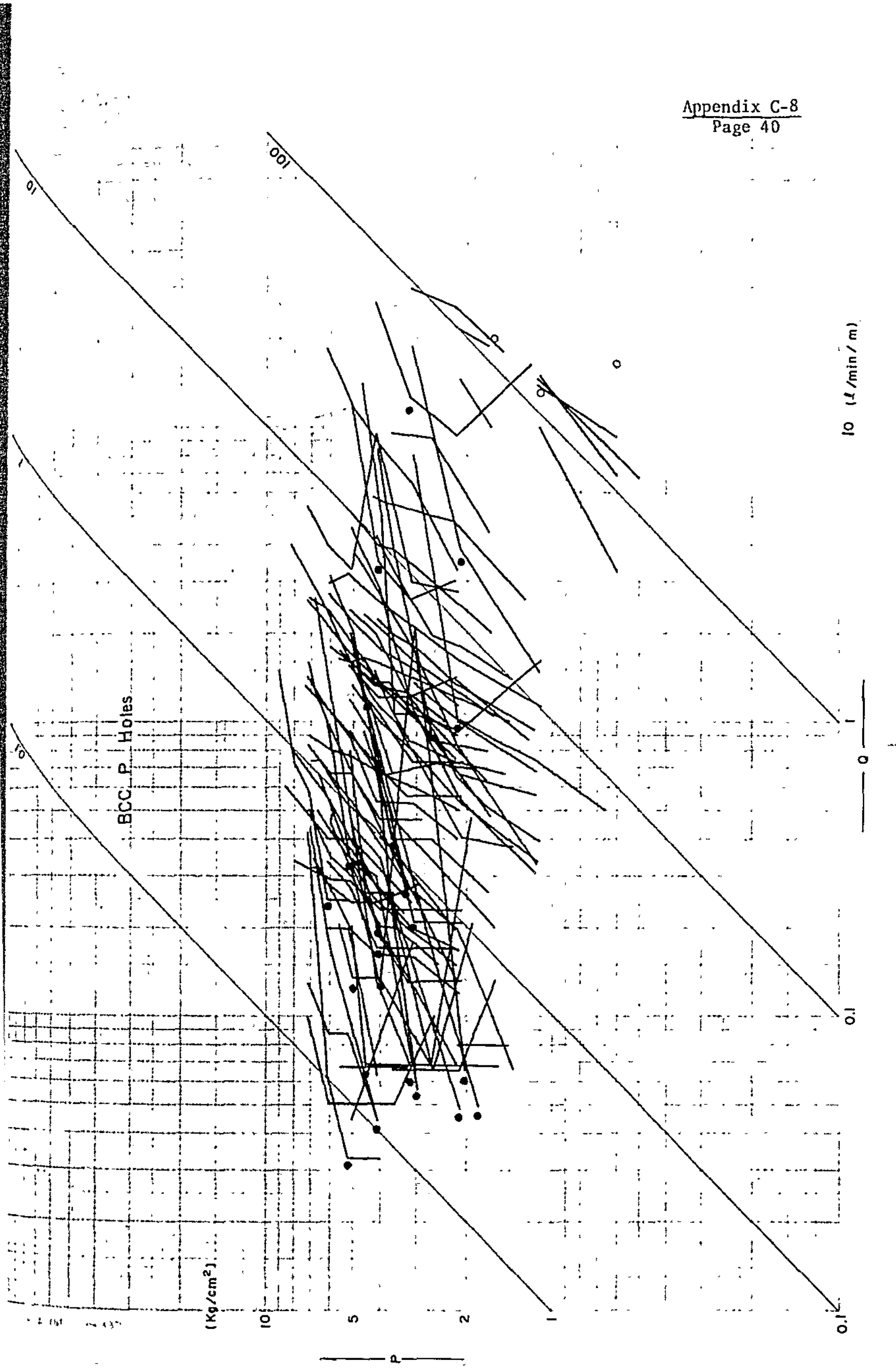
EXPLANATION

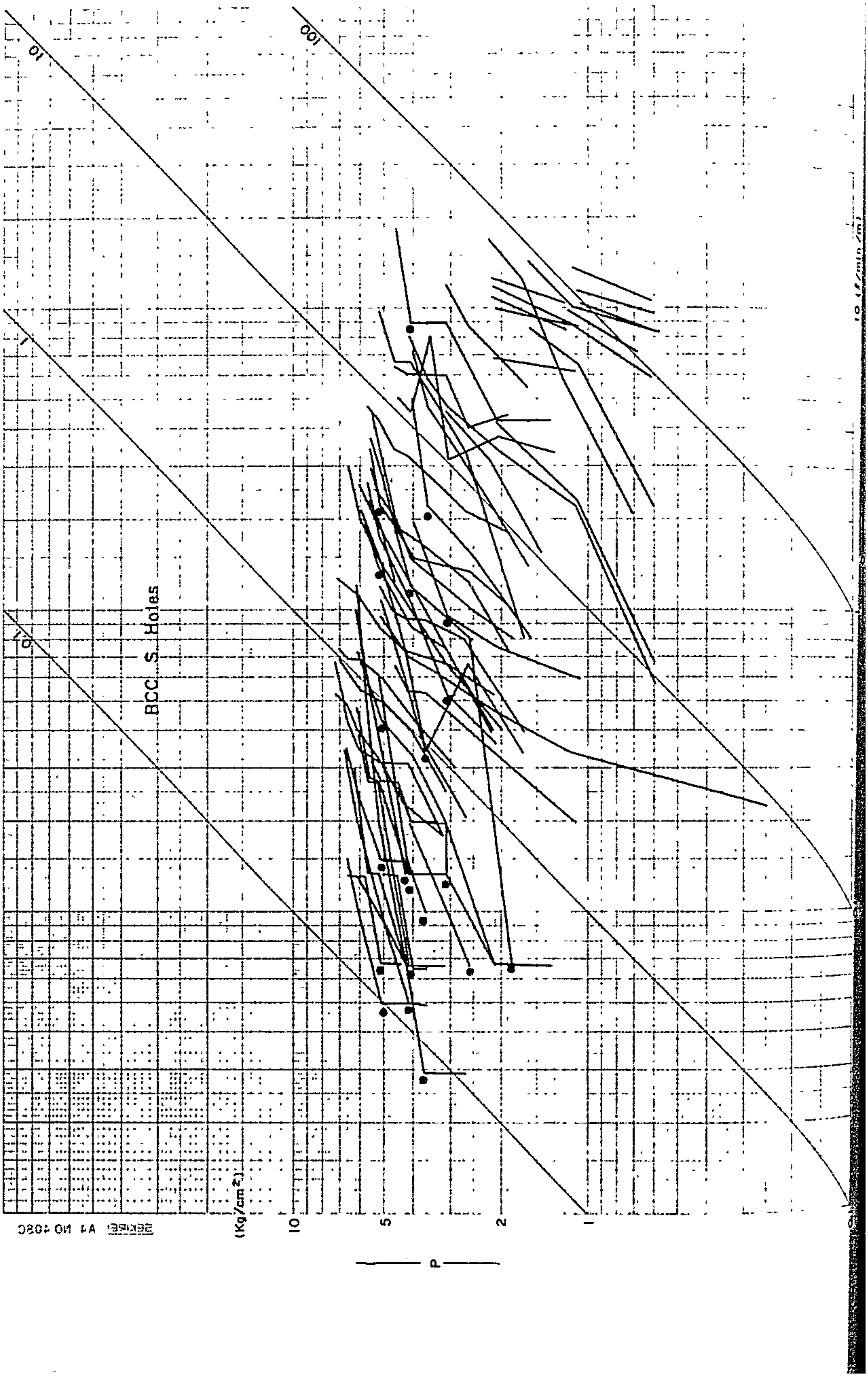
Type of hole	D=Diamond, H=Hoystellite, S=Shot, C=Churn	ANGLE HOLE ☐
Hole sealed	P=Packer, C=Cemented, C=Bottom of Casing	VERTICAL HOLE ■
Approximate size of hole (X-series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{7}{8}$" Bx = $2\frac{3}{8}$" Nx = 3"	
Approximate size of core (X-series)	Ex = $\frac{7}{8}$" Ax = $1\frac{1}{8}$" Bx = $1\frac{5}{8}$" Nx = $2\frac{1}{8}$"	
Outside diameter of casing (X-series)	Ex = $1\frac{13}{16}$" Ax = $2\frac{1}{4}$" Bx = $2\frac{7}{8}$" Nx = $3\frac{1}{2}$"	
Inside diameter of casing (X-series)	Ex = $1\frac{1}{2}$" Ax = $1\frac{29}{32}$" Bx = $2\frac{3}{8}$" Nx = 3"	

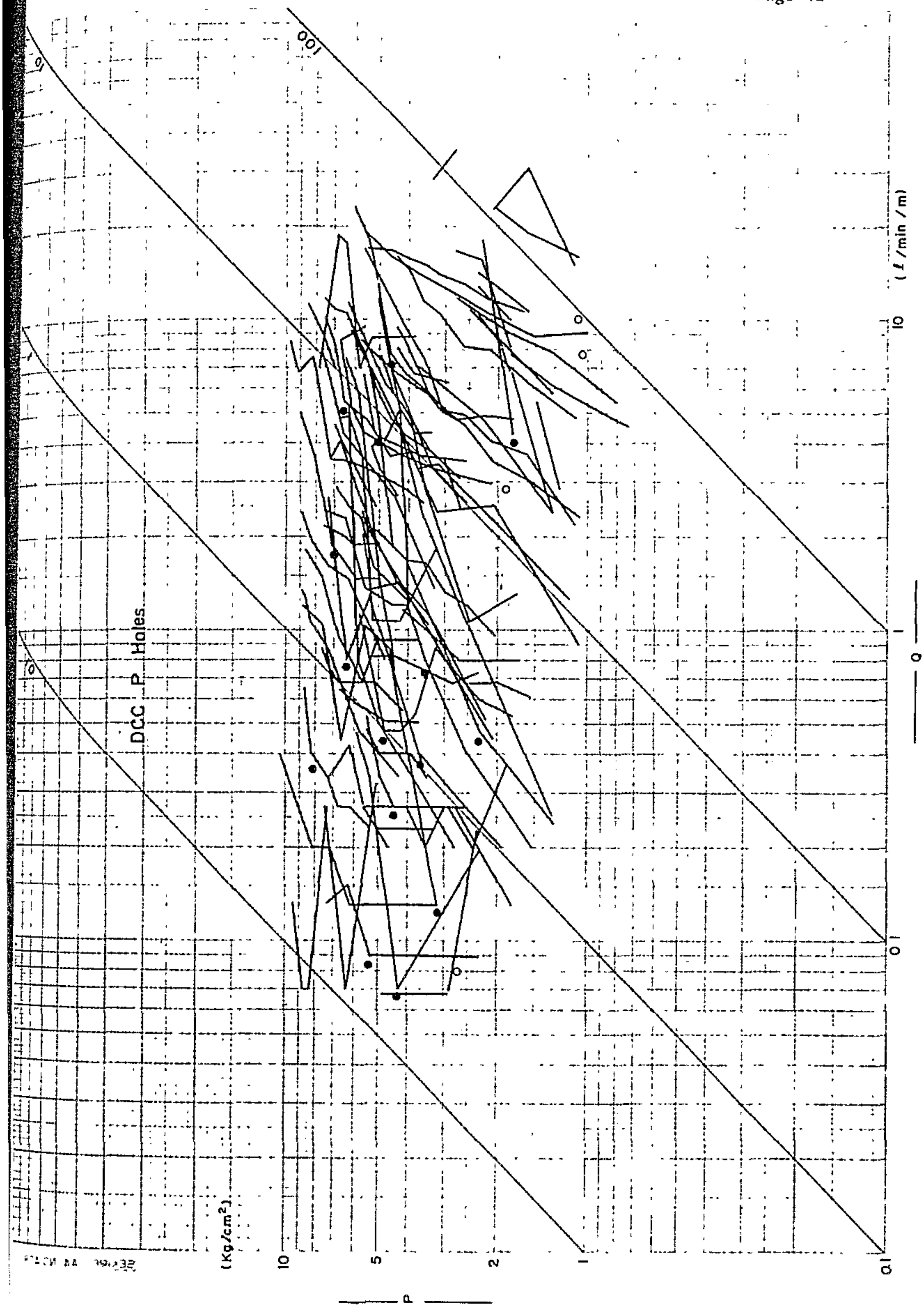
LOSS / RECOVERY

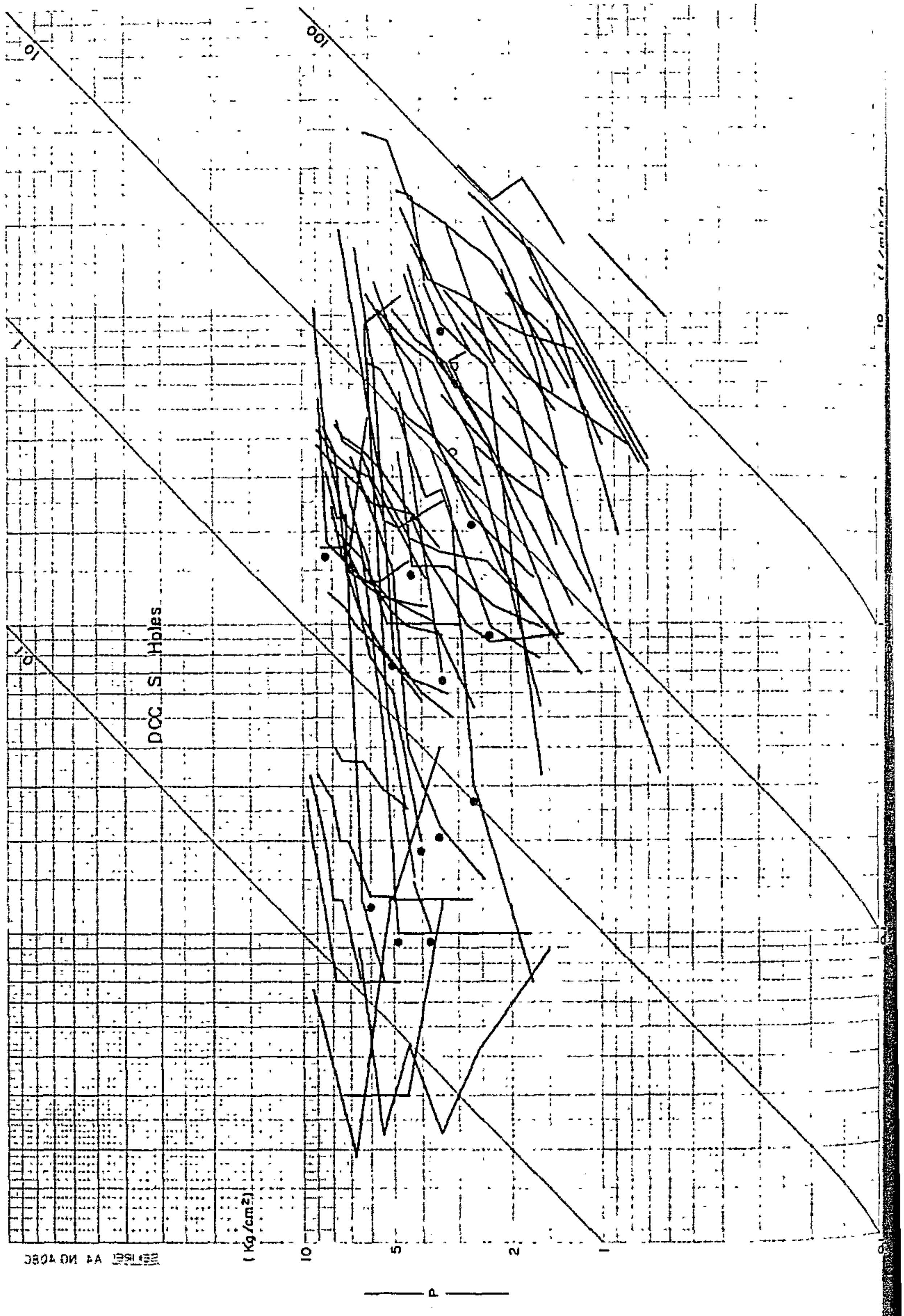
HOLE NO RAD-6
SHEET 2 OF 2

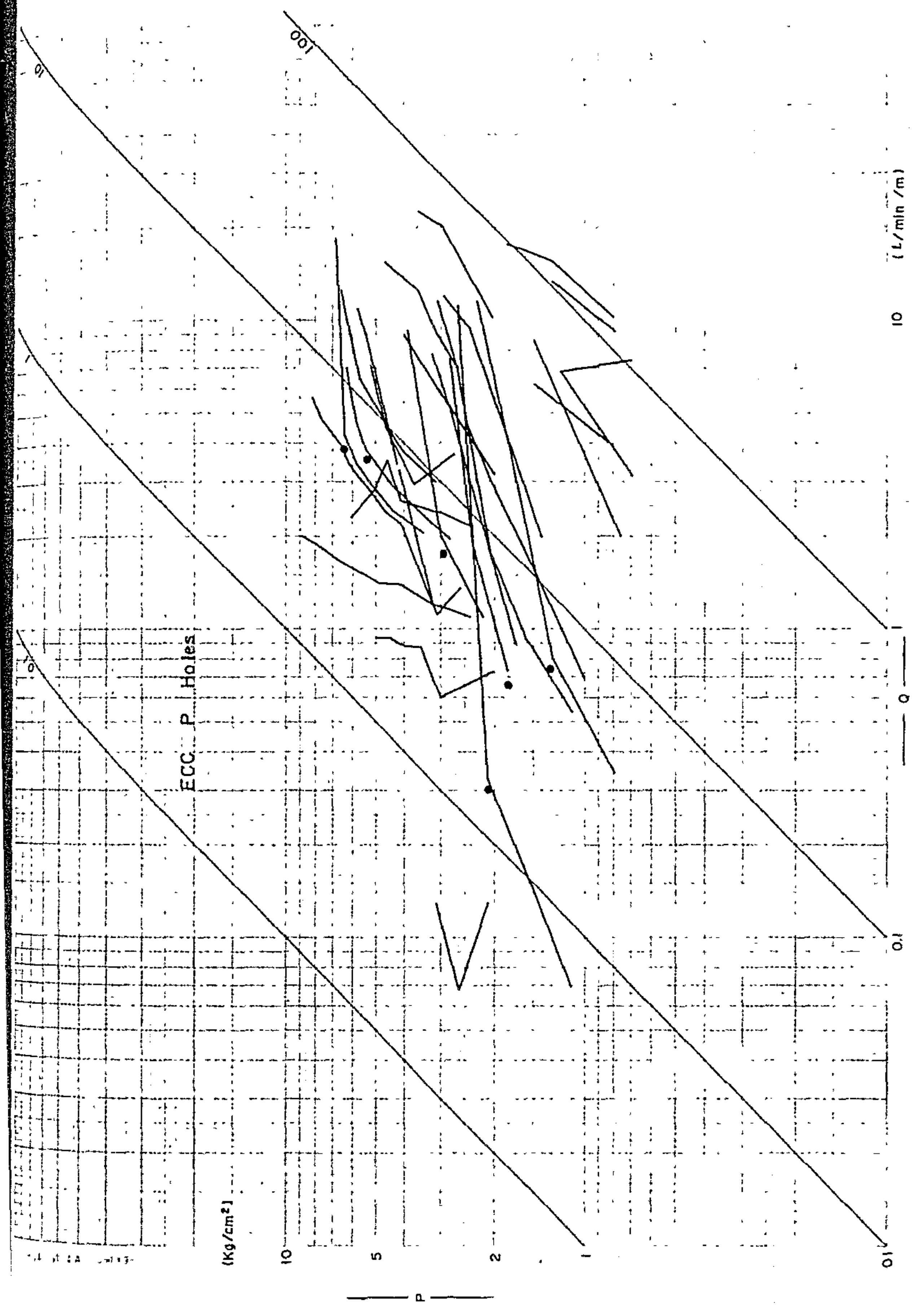
8-2 Analysing Charts of Permeability Test

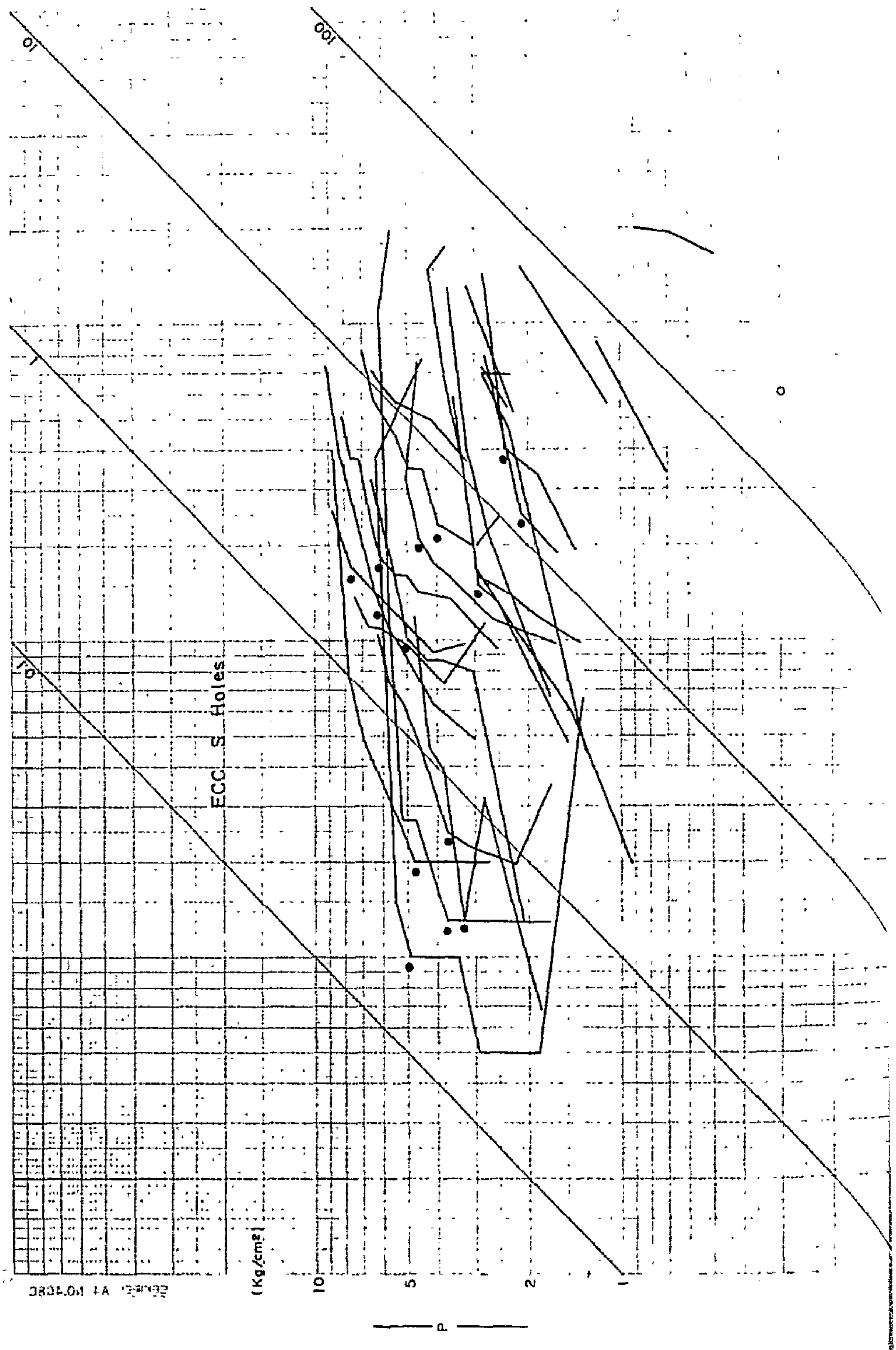

BCC P Holes
(Kg/cm²)
P
10
5
2
1
Q
10 (l/min/m)
1
0.1
100
10
1
10


BCC S. Holes
10
100
1
(Kg/cm²)
10
5
2
1
P


DCC P Holes
(ℓ/min/m)
Q
P
(Kg/cm²)
10
5
2
1
0.1
1
10
100


DCC S Holes
(Kg/cm2)
10
5
2
1
P
10
1
0.1
(l/min/m)
100
10
1.0


ECC P Holes
(Kg/cm²)
P
10
5
2
1
Q
(L/min/m)
0.1
1
10
100


ECC S Holes
(Kg/cm²)
10
5
2
1
P
10
100
1
10

8-3 Records of Lateral Loading Test

TEST NO: 1
HOLE NO: DAD 1
DEPTH : 8.00
GEOLOGY SANDSTONE

PRESS	RH	RI	PG	RJ	PO
0.0	-0.70	20.040		20.040	29.667
4.0	0.69	25.158		25.158	33.230
6.0	7.48	32.002		32.002	39.072
8.0	7.54	32.041		32.041	39.112
12.0	7.59	32.074	0.0067	32.068	39.138
10.0	6.69	31.468		31.468	38.564
8.0	6.69	31.468		31.468	38.564
6.0	6.73	31.496		31.496	38.591
4.0	5.51	30.599		30.599	37.759
2.0	0.81	25.384		25.384	33.402
0.0	-0.90	16.942		16.942	27.560
4.0	3.10	28.443		28.443	35.876
6.0	7.46	31.989		31.989	39.059
8.0	7.50	32.015		32.015	39.085
10.0	7.53	32.035		32.035	39.105
12.0	7.56	32.055	0.0067	32.048	39.118
14.0	7.58	32.068	0.0135	32.054	39.125
16.0	7.61	32.088	0.0203	32.067	39.138
18.0	7.63	32.101	0.0271	32.074	39.144
20.0	7.65	32.114	0.0339	32.080	39.151
18.0	7.65	32.114	0.0271	32.087	39.158
16.0	7.65	32.114	0.0203	32.093	39.164
14.0	7.65	32.114	0.0135	32.100	39.171
12.0	7.64	32.107	0.0067	32.100	39.172
10.0	7.63	32.101		32.101	39.172
8.0	7.63	32.101		32.101	39.172
6.0	7.63	32.101		32.101	39.172
4.0	7.63	32.101		32.101	39.172
2.0	1.62	26.677		26.677	34.411
0.0	-0.22	22.781		22.781	31.531
4.0	3.61	28.956		28.956	36.313
8.0	7.54	32.041		32.041	39.112
10.0	7.56	32.055		32.055	39.125
12.0	7.57	32.061	0.0067	32.054	39.125
14.0	7.60	32.081	0.0135	32.067	39.138
16.0	7.62	32.094	0.0203	32.074	39.145
18.0	7.63	32.101	0.0271	32.074	39.144
20.0	7.65	32.114	0.0339	32.080	39.151
22.0	7.67	32.127	0.0406	32.086	39.157
24.0	7.69	32.140	0.0474	32.093	39.164
26.0	7.73	32.166	0.0542	32.112	39.183
28.0	7.75	32.179	0.0610	32.118	39.189
30.0	7.78	32.199	0.0678	32.131	39.202
32.0	7.80	32.212	0.0745	32.137	39.209
34.0	7.83	32.231	0.0813	32.150	39.222
36.0	7.85	32.244	0.0881	32.156	39.228
38.0	7.88	32.264	0.0949	32.169	39.241
40.0	7.91	32.283	0.1017	32.182	39.253
36.0	7.91	32.283	0.0881	32.195	39.267
32.0	7.91	32.283	0.0745	32.209	39.281
28.0	7.89	32.270	0.0610	32.209	39.281
24.0	7.88	32.264	0.0474	32.216	39.289
20.0	7.88	32.264	0.0339	32.230	39.302
16.0	7.88	32.264	0.0203	32.244	39.316
12.0	7.87	32.257	0.0067	32.251	39.323
8.0	7.84	32.238		32.238	39.310
4.0	7.83	32.231		32.231	39.304
0.0	-0.24	22.705		22.705	31.479
4.0	3.49	28.838		28.838	36.212
8.0	7.62	32.094		32.094	39.165
12.0	7.66	32.120	0.0067	32.114	39.185
16.0	7.69	32.140	0.0203	32.120	39.191
20.0	7.73	32.166	0.0339	32.132	39.204
24.0	7.77	32.192	0.0474	32.145	39.216
28.0	7.83	32.231	0.0610	32.170	39.242
32.0	7.86	32.251	0.0745	32.176	39.248
36.0	7.87	32.257	0.0881	32.169	39.241
40.0	7.93	32.296	0.1017	32.195	39.266
44.0	7.98	32.329	0.1152	32.213	39.285
48.0	8.05	32.372	0.1288	32.243	39.316
52.0	8.12	32.415	0.1423	32.273	39.345
56.0	8.22	32.476	0.1559	32.320	39.393
60.0	8.27	32.506	0.1695	32.337	39.410
64.0	8.36	32.560	0.1830	32.377	39.451
68.0	8.43	32.603	0.1966	32.406	39.480
72.0	8.50	32.692	0.2101	32.482	39.557
76.0	8.61	32.710	0.2237	32.487	39.561
80.0	8.68	32.752	0.2373	32.515	39.590
70.0	8.68	32.752	0.2034	32.549	39.624
60.0	8.69	32.752	0.1695	32.582	39.658
50.0	8.74	32.787	0.1356	32.652	39.728
40.0	8.70	32.764	0.1017	32.662	39.739
30.0	8.60	32.752	0.0678	32.684	39.761
20.0	8.50	32.692	0.0339	32.659	39.735
10.0	8.27	32.506		32.506	39.581
0.0	-0.23	22.744		22.744	31.505
5.0	6.94	31.639		31.639	38.727
10.0	8.09	32.397		32.397	39.471
15.0	8.16	32.439	0.0169	32.422	39.497
20.0	8.21	32.470	0.0339	32.436	39.510
25.0	8.25	32.494	0.0508	32.443	39.518
30.0	8.31	32.530	0.0678	32.463	39.537
35.0	8.37	32.567	0.0847	32.482	39.557
40.0	8.43	32.603	0.1017	32.501	39.576
45.0	8.48	32.633	0.1186	32.514	39.589
50.0	8.54	32.669	0.1356	32.533	39.608
55.0	8.57	32.698	0.1525	32.546	39.621
60.0	8.64	32.728	0.1695	32.559	39.634
65.0	8.71	32.770	0.1864	32.583	39.659
70.0	8.76	32.799	0.2034	32.596	39.672
75.0	8.83	32.841	0.2203	32.620	39.697
80.0	8.90	32.882	0.2373	32.645	39.721
85.0	8.98	32.929	0.2542	32.675	39.751
90.0	9.25	33.086	0.2712	32.815	39.893
95.0	9.29	33.109	0.2881	32.821	39.899
100	9.30	33.161	0.3051	32.856	39.935
90.0	9.37	33.155	0.2712	32.884	39.962
80.0	9.36	33.150	0.2373	32.912	39.991
70.0	9.34	33.138	0.2034	32.935	40.014
60.0	9.31	33.121	0.1695	32.951	40.031
50.0	9.27	33.098	0.1356	32.962	40.042
40.0	9.22	33.069	0.1017	32.967	40.047
30.0	9.14	33.022	0.0678	32.954	40.034
20.0	9.00	32.941	0.0339	32.907	39.986
10.0	8.78	32.811		32.811	39.889

TEST NO: 2
HOLE NO: BAD-2
DEPTH : 11.00
GEOLOGY SLATY SHALE

PRESS	RN	RI	PG	RS	RO
0.0	-0.45	21.767		21.767	30.841
2.0	0.60	24.980		24.980	33.025
4.0	2.96	28.295		28.295	35.751
6.0	9.59	33.201		33.201	40.373
8.0	9.83	33.418		33.418	40.515
10.0	9.94	33.480		33.480	40.579
8.0	9.97	33.497		33.497	40.597
6.0	9.93	33.474		33.474	40.573
4.0	8.75	32.793		32.793	39.871
2.0	3.07	28.411		28.411	35.849
0.0	0.02	23.579		23.579	32.085
4.0	3.59	28.937		28.937	36.296
8.0	9.93	33.474		33.474	40.573
12.0	10.03	33.530	0.0098	33.520	40.621
16.0	10.12	33.578	0.0294	33.549	40.651
20.0	10.20	33.621	0.0490	33.572	40.675
16.0	10.20	33.621	0.0294	33.591	40.695
12.0	10.18	33.610	0.0098	33.600	40.704
8.0	10.14	33.589		33.589	40.692
4.0	9.13	33.016		33.016	40.097
0.0	0.02	23.579		23.579	32.085
5.0	9.32	33.126		33.126	40.212
10.0	10.10	33.567		33.567	40.670
15.0	10.15	33.594	0.0245	33.570	40.672
20.0	12.22	34.657	0.0490	34.608	41.759
25.0	10.30	33.674	0.0735	33.600	40.704
30.0	10.36	33.706	0.0980	33.608	40.712
35.0	10.43	33.743	0.1225	33.620	40.725
40.0	10.47	33.764	0.1470	33.617	40.722
35.0	10.46	33.759	0.1225	33.636	40.742
30.0	10.46	33.759	0.0980	33.661	40.767
25.0	10.45	33.753	0.0735	33.680	40.787
20.0	10.43	33.743	0.0490	33.694	40.801
15.0	10.39	33.722	0.0245	33.697	40.805
10.0	10.32	33.685		33.685	40.792
5.0	10.12	33.578		33.578	40.681
0.0	-0.08	23.270		23.270	31.869
5.0	9.07	32.981		32.981	40.061
10.0	10.05	33.541		33.541	40.642
15.0	10.16	33.599	0.0245	33.575	40.678
20.0	10.25	33.647	0.0490	33.598	40.702
25.0	10.32	33.685	0.0735	33.611	40.715
30.0	10.38	33.716	0.0980	33.618	40.723
35.0	10.42	33.737	0.1225	33.615	40.720
40.0	10.47	33.764	0.1470	33.617	40.722
45.0	10.51	33.785	0.1715	33.613	40.718
50.0	10.56	33.811	0.1960	33.615	40.720
55.0	10.60	33.832	0.2205	33.612	40.716
60.0	10.65	33.858	0.2450	33.613	40.718
50.0	10.63	33.848	0.1960	33.652	40.758
40.0	10.61	33.837	0.1470	33.690	40.798
30.0	10.58	33.822	0.0980	33.724	40.833
20.0	10.51	33.785	0.0490	33.736	40.845
10.0	10.36	33.706		33.706	40.814
0.0	-0.01	23.409		23.409	32.022
5.0	9.34	33.138		33.138	40.224
10.0	10.10	33.567		33.567	40.670
15.0	10.19	33.615	0.0245	33.591	40.695
20.0	10.27	33.658	0.0490	33.609	40.713
25.0	10.35	33.700	0.0735	33.627	40.732
30.0	10.40	33.727	0.0980	33.629	40.734
35.0	10.45	33.753	0.1225	33.631	40.736
40.0	10.50	33.780	0.1470	33.633	40.738
45.0	10.54	33.801	0.1715	33.629	40.734
50.0	10.58	33.822	0.1960	33.626	40.731
55.0	10.62	33.843	0.2205	33.622	40.727
60.0	10.66	33.864	0.2450	33.619	40.723
65.0	10.70	33.885	0.2695	33.615	40.720
70.0	10.74	33.905	0.2940	33.611	40.716
75.0	10.80	33.937	0.3185	33.618	40.723
80.0	10.86	33.968	0.3430	33.625	40.730
70.0	10.84	33.958	0.2940	33.664	40.770
60.0	10.82	33.947	0.2450	33.702	40.810
50.0	10.79	33.931	0.1960	33.735	40.845
40.0	10.76	33.916	0.1470	33.769	40.880
30.0	10.71	33.890	0.0980	33.792	40.903
20.0	10.61	33.837	0.0490	33.788	40.900
10.0	10.46	33.759		33.759	40.869
0.0	0.00	23.520		23.520	32.044
5.0	9.72	33.356		33.356	40.450
10.0	10.16	33.599		33.599	40.703
15.0	10.24	33.642	0.0245	33.618	40.722
20.0	10.32	33.685	0.0490	33.636	40.741
25.0	10.40	33.727	0.0735	33.653	40.760
30.0	10.45	33.753	0.0980	33.655	40.762
35.0	10.51	33.785	0.1225	33.662	40.769
40.0	10.55	33.806	0.1470	33.659	40.765
45.0	10.59	33.827	0.1715	33.655	40.762
50.0	10.63	33.848	0.1960	33.652	40.758
55.0	10.67	33.869	0.2205	33.648	40.754
60.0	10.72	33.895	0.2450	33.650	40.756
65.0	10.76	33.916	0.2695	33.646	40.752
70.0	10.80	33.937	0.2940	33.643	40.749
75.0	10.84	33.958	0.3185	33.639	40.745
80.0	10.89	33.983	0.3430	33.640	40.746
85.0	10.95	34.015	0.3675	33.647	40.753
90.0	11.04	34.061	0.3920	33.669	40.776
95.0	11.14	34.113	0.4165	33.696	40.804
100.0	11.26	34.174	0.4410	33.733	40.843
90.0	11.23	34.159	0.3920	33.767	40.878
80.0	11.21	34.149	0.3430	33.806	40.918
70.0	11.19	34.138	0.2940	33.844	40.958
60.0	11.16	34.123	0.2450	33.878	40.993
50.0	11.12	34.102	0.1960	33.906	41.023
40.0	11.06	34.071	0.1470	33.924	41.011
30.0	10.90	34.030	0.0980	33.932	41.049
20.0	10.87	33.973	0.0490	33.924	41.041

TEST NO: 3
HOLE NO: RAD-3
DEPTH : 17.65
GEOLOGY WEATHERED SANDSTONE

PRESS	RN	RI	PG	RS	RO
0.0	0.84	25.439		25.439	33.443
2.0	1.23	26.096		26.096	33.947
4.0	6.54	31.364		31.364	38.466
6.0	6.60	31.406		31.406	38.505
8.0	6.65	31.440		31.440	38.538
10.0	6.70	31.475		31.475	38.571
8.0	6.70	31.475		31.475	38.571
6.0	6.71	31.482		31.482	38.578
4.0	6.71	31.482		31.482	38.578
2.0	6.68	31.461		31.461	38.558
0.0	1.88	27.033		27.033	34.697
4.0	6.72	31.489		31.489	38.584
8.0	6.84	31.571		31.571	38.663
12.0	6.95	31.646	0.0086	31.638	38.726
16.0	7.02	31.694	0.0259	31.668	38.754
20.0	7.06	31.721	0.0433	31.678	38.764
16.0	7.05	31.714	0.0259	31.688	38.774
12.0	7.02	31.694	0.0086	31.685	38.771
8.0	6.96	31.653		31.653	38.740
4.0	6.93	31.633		31.633	38.721
0.0	2.02	27.216		27.216	34.849
5.0	6.85	31.578		31.578	38.669
10.0	6.94	31.639		31.639	38.727
15.0	7.10	31.748	0.0216	31.726	38.810
20.0	7.22	31.829	0.0433	31.785	38.866
25.0	7.26	31.855	0.0649	31.791	38.871
30.0	7.32	31.896	0.0866	31.809	38.889
35.0	7.35	31.916	0.1082	31.807	38.887
40.0	7.39	31.942	0.1299	31.812	38.892
35.0	7.36	31.922	0.1082	31.814	38.893
30.0	7.33	31.902	0.0866	31.816	38.895
25.0	7.26	31.855	0.0649	31.791	38.871
20.0	7.23	31.835	0.0433	31.792	38.872
15.0	7.20	31.815	0.0216	31.794	38.874
10.0	7.10	31.748		31.748	38.831
5.0	7.06	31.721		31.721	38.805
0.0	2.31	27.569		27.569	35.142
5.0	6.90	31.612		31.612	38.702
10.0	7.25	31.849		31.849	38.926
15.0	7.35	31.916	0.0216	31.894	38.969
20.0	7.42	31.962	0.0433	31.919	38.993
25.0	7.45	31.982	0.0649	31.917	38.991
30.0	7.51	32.022	0.0866	31.935	39.008
35.0	7.55	32.048	0.1082	31.940	39.013
40.0	7.58	32.068	0.1299	31.938	39.011
45.0	7.63	32.101	0.1515	31.949	39.022
50.0	7.66	32.120	0.1732	31.947	39.020
55.0	7.70	32.147	0.1948	31.952	39.024
60.0	7.74	32.173	0.2165	31.956	39.028
50.0	7.66	32.120	0.1732	31.947	39.020
40.0	7.60	32.081	0.1299	31.951	39.024
30.0	7.52	32.028	0.0866	31.942	39.015
20.0	7.44	31.975	0.0433	31.932	39.005
10.0	7.10	31.748		31.748	38.831
0.0	2.37	27.639		27.639	35.201
5.0	6.96	31.653		31.653	38.740
10.0	7.03	31.701		31.701	38.786
15.0	7.38	31.936	0.0216	31.914	38.988
20.0	7.42	31.962	0.0433	31.919	38.993
25.0	7.46	31.989	0.0649	31.924	38.997
30.0	7.52	32.028	0.0866	31.942	39.015
35.0	7.55	32.048	0.1082	31.940	39.013
40.0	7.60	32.081	0.1299	31.951	39.024

TEST NO: 4
HOLE NO: RAD-4
DEPTH : 18.10
GEOLOGY SANDSTONE

PRESS	RN	RI	PG	RC	RO
0.0	0.88	25.511		25.511	33.498
2.0	2.54	27.835		27.835	35.363
4.0	7.26	31.855		31.855	38.933
6.0	7.28	31.869		31.869	38.945
8.0	7.29	31.876		31.876	38.952
10.0	7.30	31.882		31.882	38.958
8.0	7.30	31.882		31.882	38.958
6.0	7.30	31.882		31.882	38.958
4.0	7.30	31.882		31.882	38.958
2.0	7.29	31.876		31.876	38.952
0.0	2.08	27.290		27.290	34.911
4.0	7.28	31.869		31.869	38.945
8.0	7.35	31.916		31.916	38.990
12.0	7.40	31.949	0.0098	31.939	39.012
16.0	7.48	32.002	0.0294	31.972	39.044
20.0	7.52	32.028	0.0490	31.979	39.050
16.0	7.49	32.008	0.0294	31.979	39.050
12.0	7.45	31.982	0.0098	31.972	39.044
8.0	7.42	31.962		31.962	39.034
4.0	7.41	31.955		31.955	39.028
0.0	2.36	27.509		27.509	35.093
5.0	7.36	31.922		31.922	38.996
10.0	7.41	31.955		31.955	39.028
15.0	7.49	32.008	0.0245	31.984	39.055
20.0	7.55	32.048	0.0490	31.999	39.069
25.0	7.63	32.101	0.0735	32.027	39.097
30.0	7.68	32.133	0.0980	32.035	39.106
35.0	7.76	32.186	0.1225	32.063	39.134
40.0	7.82	32.225	0.1470	32.078	39.149
35.0	7.79	32.205	0.1225	32.083	39.154
30.0	7.76	32.186	0.0980	32.088	39.159
25.0	7.70	32.147	0.0735	32.073	39.144
20.0	7.64	32.107	0.0490	32.058	39.129
15.0	7.61	32.088	0.0245	32.063	39.134
10.0	7.56	32.055		32.055	39.125
5.0	7.53	32.035		32.035	39.105
0.0	2.38	27.651		27.651	35.210
5.0	7.40	31.949		31.949	39.021
10.0	7.44	31.975		31.975	39.047
15.0	7.52	32.028	0.0245	32.004	39.074
20.0	7.58	32.068	0.0490	32.019	39.089
25.0	7.64	32.107	0.0735	32.034	39.104
30.0	7.71	32.153	0.0980	32.055	39.126
35.0	7.79	32.205	0.1225	32.083	39.154
40.0	7.83	32.231	0.1470	32.084	39.155
45.0	7.88	32.264	0.1715	32.092	39.163
50.0	7.94	32.303	0.1960	32.107	39.178
55.0	7.98	32.329	0.2205	32.108	39.179
60.0	8.07	32.384	0.2450	32.139	39.211
50.0	7.95	32.309	0.1960	32.113	39.184
40.0	7.86	32.251	0.1470	32.104	39.175
30.0	7.79	32.205	0.0980	32.107	39.178
20.0	7.68	32.133	0.0490	32.084	39.155
10.0	7.60	32.081		32.081	39.152
0.0	2.43	27.709		27.709	35.258
5.0	7.43	31.969		31.969	39.040
10.0	7.47	31.995		31.995	39.065
15.0	7.55	32.048	0.0245	32.024	39.094
20.0	7.61	32.088	0.0490	32.039	39.109
25.0	7.68	32.133	0.0735	32.060	39.131
30.0	7.74	32.173	0.0980	32.075	39.145
35.0	7.80	32.212	0.1225	32.089	39.160
40.0	7.84	32.238	0.1470	32.091	39.162
45.0	7.89	32.270	0.1715	32.099	39.170
50.0	7.94	32.303	0.1960	32.107	39.178
55.0	8.03	32.360	0.2205	32.139	39.211
60.0	8.09	32.397	0.2450	32.152	39.223
65.0	8.12	32.415	0.2695	32.145	39.217
70.0	8.19	32.458	0.2940	32.164	39.235
75.0	8.27	32.506	0.3185	32.188	39.259
80.0	8.34	32.548	0.3430	32.205	39.277
70.0	8.24	32.488	0.2940	32.194	39.266
60.0	8.14	32.427	0.2450	32.182	39.254
50.0	8.05	32.372	0.1960	32.176	39.248
40.0	7.94	32.303	0.1470	32.156	39.227
30.0	7.86	32.251	0.0980	32.153	39.224
20.0	7.77	32.192	0.0490	32.143	39.215
10.0	7.68	32.133		32.133	39.205
0.0	2.58	27.880		27.880	35.401
5.0	7.49	32.008		32.008	39.079
10.0	7.53	32.035		32.035	39.105
15.0	7.61	32.088	0.0245	32.063	39.134
20.0	7.67	32.127	0.0490	32.078	39.149
25.0	7.73	32.166	0.0735	32.093	39.164
30.0	7.79	32.205	0.0980	32.107	39.178
35.0	7.83	32.231	0.1225	32.109	39.180
40.0	7.89	32.270	0.1470	32.123	39.195
45.0	7.94	32.303	0.1715	32.131	39.203
50.0	7.98	32.329	0.1960	32.133	39.204
55.0	8.05	32.372	0.2205	32.152	39.223

TEST NO: 5
HOLE NO: RAD-6
DEPTH : 6.50
GEOLOGY WEATHERED SANDSTONE

PRESS	RH	RI	PG	RS	RO
0.0	0.32	24.369		24.369	32.649
2.0	1.04	25.787		25.787	33.708
4.0	3.49	28.838		28.838	36.212
6.0	14.84	35.883		35.883	43.124
8.0	14.86	35.892		35.892	43.133
10.0	14.88	35.900		35.900	43.142
8.0	14.88	35.900		35.900	43.142
6.0	14.89	35.905		35.905	43.147
4.0	14.89	35.905		35.905	43.147
2.0	14.89	35.905		35.905	43.147
0.0	1.18	26.017		26.017	33.883
4.0	10.18	33.610		33.610	40.715
8.0	14.87	35.896		35.896	43.138
12.0	14.98	35.944	0.0226	35.921	43.165
16.0	15.09	35.992	0.0678	35.924	43.168
20.0	15.25	36.061	0.1130	35.948	43.194
16.0	15.16	36.022	0.0678	35.954	43.201
12.0	15.00	35.953	0.0226	35.930	43.174
12.0	15.07	35.983	0.0226	35.960	43.207
8.0	14.98	35.944		35.944	43.189
4.0	14.98	35.944		35.944	43.189
0.0	1.42	26.387		26.387	34.179
5.0	14.94	35.927		35.927	43.171
10.0	14.95	35.931		35.931	43.175
15.0	15.11	36.000	0.0565	35.944	43.190
20.0	15.27	36.070	0.1130	35.957	43.203
25.0	15.46	36.152	0.1695	35.982	43.231
30.0	15.66	36.238	0.2260	36.012	43.263
35.0	15.85	36.319	0.2825	36.036	43.289
40.0	16.48	36.586	0.3390	36.247	43.517
35.0	16.38	36.544	0.2825	36.261	43.532
30.0	16.27	36.497	0.2260	36.271	43.543
25.0	16.15	36.447	0.1695	36.277	43.549
20.0	16.06	36.408	0.1130	36.295	43.569
15.0	16.03	36.396	0.0565	36.339	43.616

TEST NO: 6
HOLE NO: MAD-3
DEPTH : 12.40
GEOLOGY GRAVELS

PRESS	RH	RI	PG	RS	RO
0.0	-0.41	21.969		21.969	30.979
4.0	2.44	27.721		27.721	35.268
6.0	12.73	34.906		34.906	42.071
8.0	13.65	35.346		35.346	42.544
10.0	13.81	35.422		35.422	42.625
8.0	13.83	35.431		35.431	42.636
6.0	13.73	35.384		35.384	42.585
4.0	9.17	33.040		33.040	40.121
2.0	1.82	26.952		26.952	34.632
0.0	-0.22	22.781		22.781	31.531
4.0	3.02	28.359		28.359	35.805
8.0	13.86	35.445		35.445	42.651
12.0	14.03	35.525	0.0197	35.505	42.716
16.0	14.66	35.804	0.0592	35.745	42.974
20.0	15.56	36.195	0.0988	36.096	43.354
16.0	15.58	36.203	0.0592	36.144	43.406
12.0	15.54	36.186	0.0197	36.166	43.430
8.0	15.53	36.182		36.182	43.446
4.0	10.62	33.843		33.843	40.956
0.0	-0.20	22.856		22.856	31.582
5.0	8.69	32.758		32.758	39.835
10.0	14.23	35.614		35.614	42.833
15.0	14.86	35.892	0.0494	35.842	43.080
20.0	15.60	36.212	0.0988	36.113	43.372
25.0	16.99	36.800	0.1482	36.652	43.954

8-4 References

G-1 Report on Geological Investigation of the Mae Kuang Project
1974, R.I.D.

G-2 Report on Geological Investigation of the Mae Kuang Project Additional Drillings
1979, R.I.D.

G-3 Drilling Loggs and Profiles, Investigation for Overburden
1978, R.I.D.

G-4 Grouting Records of Zone B, C, D and E
1981, R.I.D.

G-5 Permeability Tests Records of Zone B, C, D and E
1981, R.I.D.

G-6 Geological Map "Changwat Chiang Rai" (1/250,000)
D.M.R.

G-7 Geological Map of Thailand (1/1,000,000)
D.M.R.

G-8 Report of Master Plan Study of the Greater Mae Klong River Basin Development Project
1980, JICA

G-9 Grouting Plan of the Left Saddle Dam
R.I.D.

G-10 Contact Grouting Plan at Outlet in the Left Saddle Dam
R.I.D.

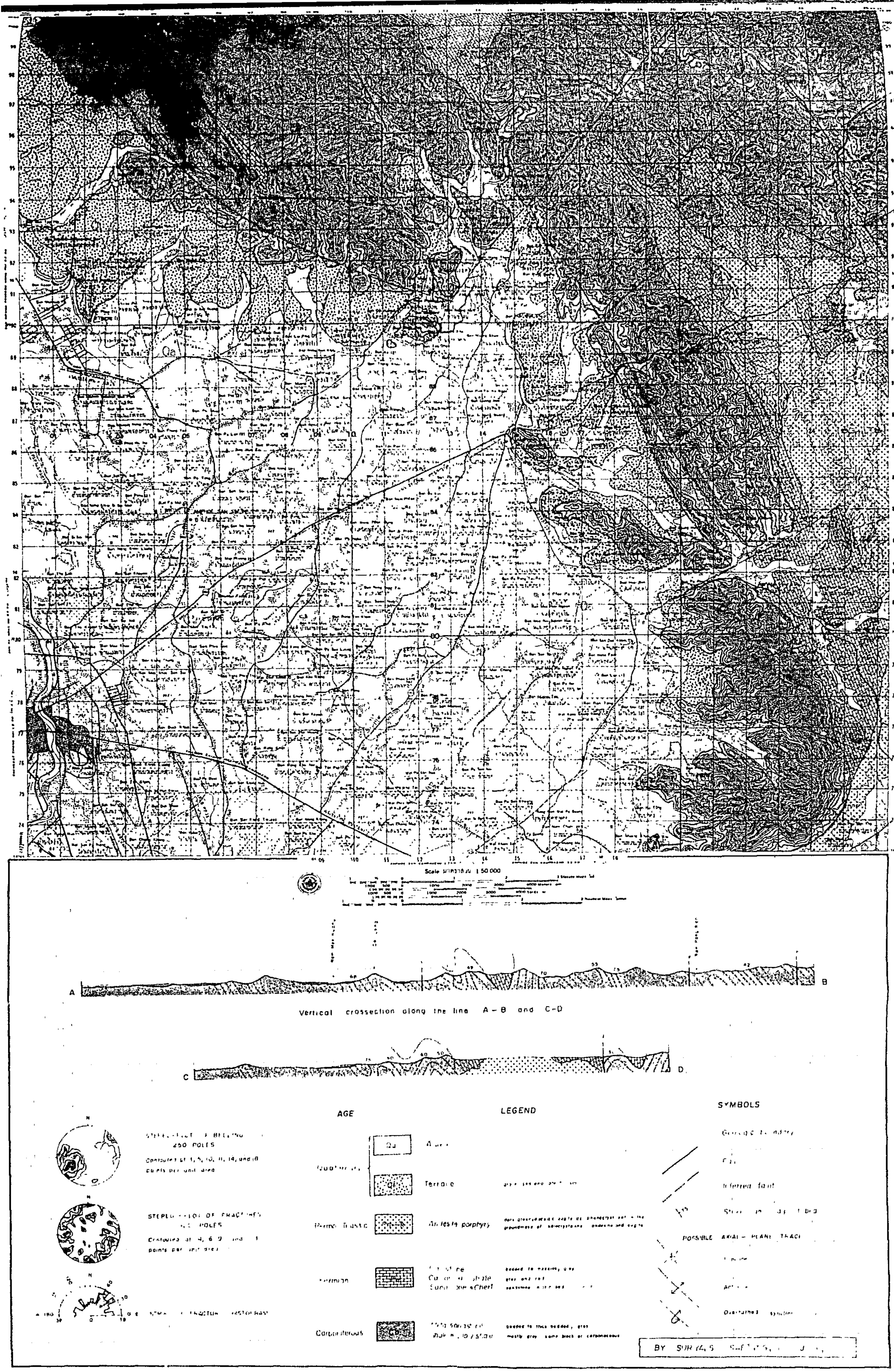
G-11 Brieflet of Mae Ngat Project
1977, R.I.D.

G-12 Design of Small Dams
Bureau of Reclamation, USA

G-13 Design Criteria for Fill-Dam
M.A.F. Japan

G-14 Geology and Palaeontology of Southeast Asia
1964, T. KOBAYASHI, Japan

9. Attached Figures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Vertical crossection along the line A – B and C – D
A
B
C
D
AGE
LEGEND
SYMBOLS
250 POLES
Terrace
Permo Triassic
Andesite porphyry
Permian
Carboniferous
POSSIBLE AXIAL – PLANE TRACE
Inferred fault
Anticline
Overturned syncline
Qa

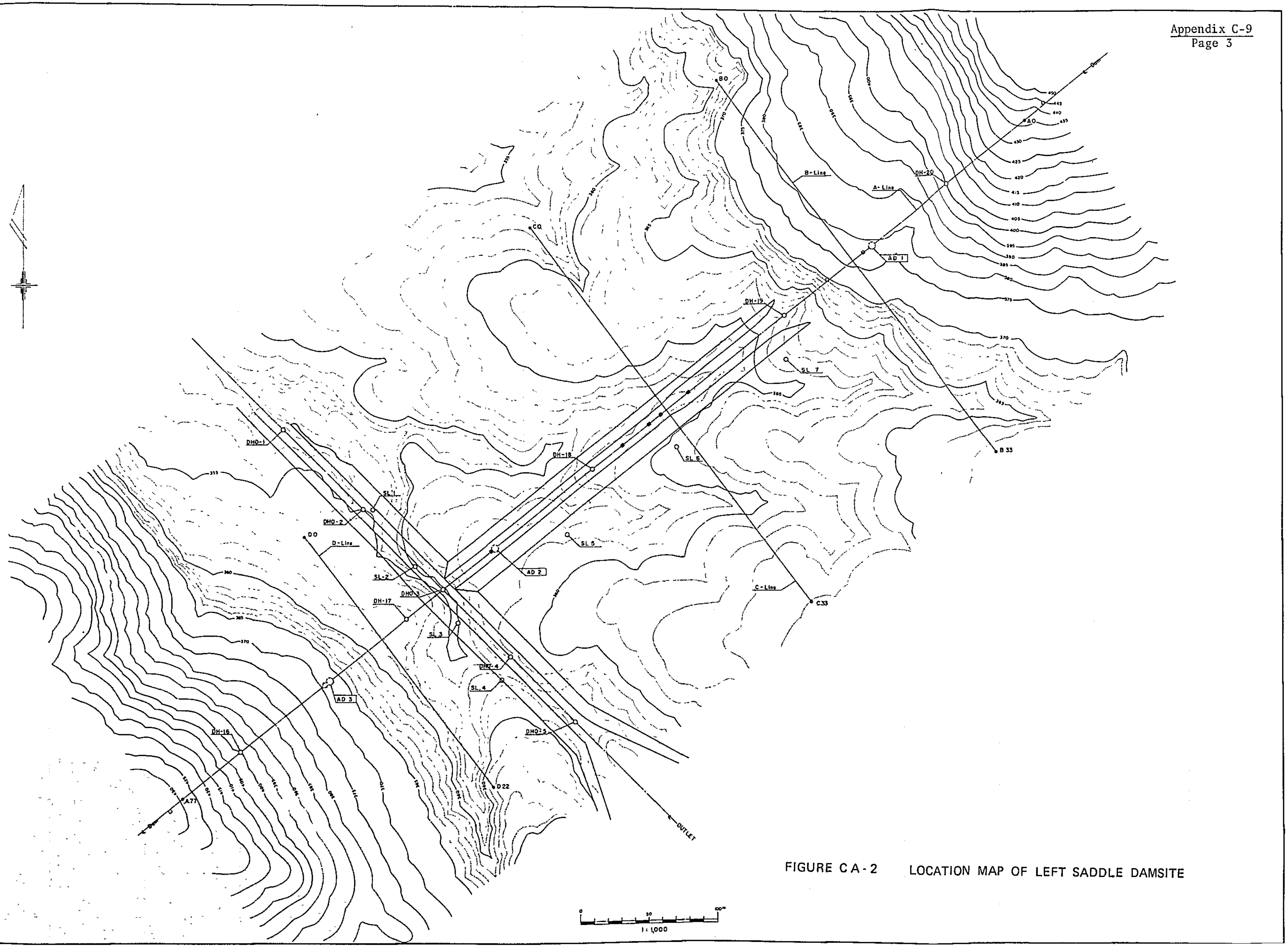


FIGURE CA-2 LOCATION MAP OF LEFT SADDLE DAMSITE

FIGURE CA-3 LOCATION MAP OF MAIN DAMSITE

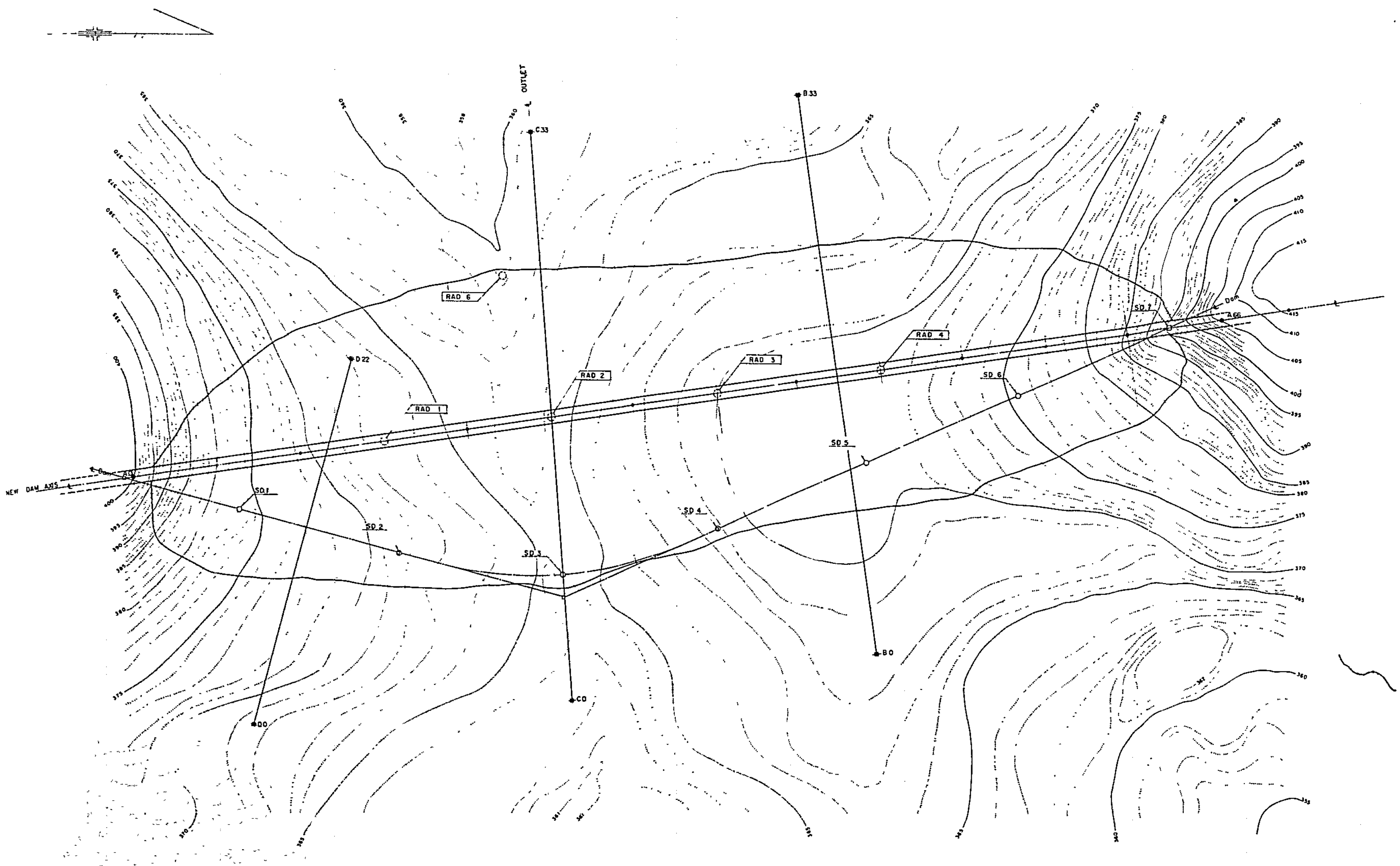


FIGURE CA-4 LOCATION MAP OF RIGHT SADDLE DAMSITE

1:1000

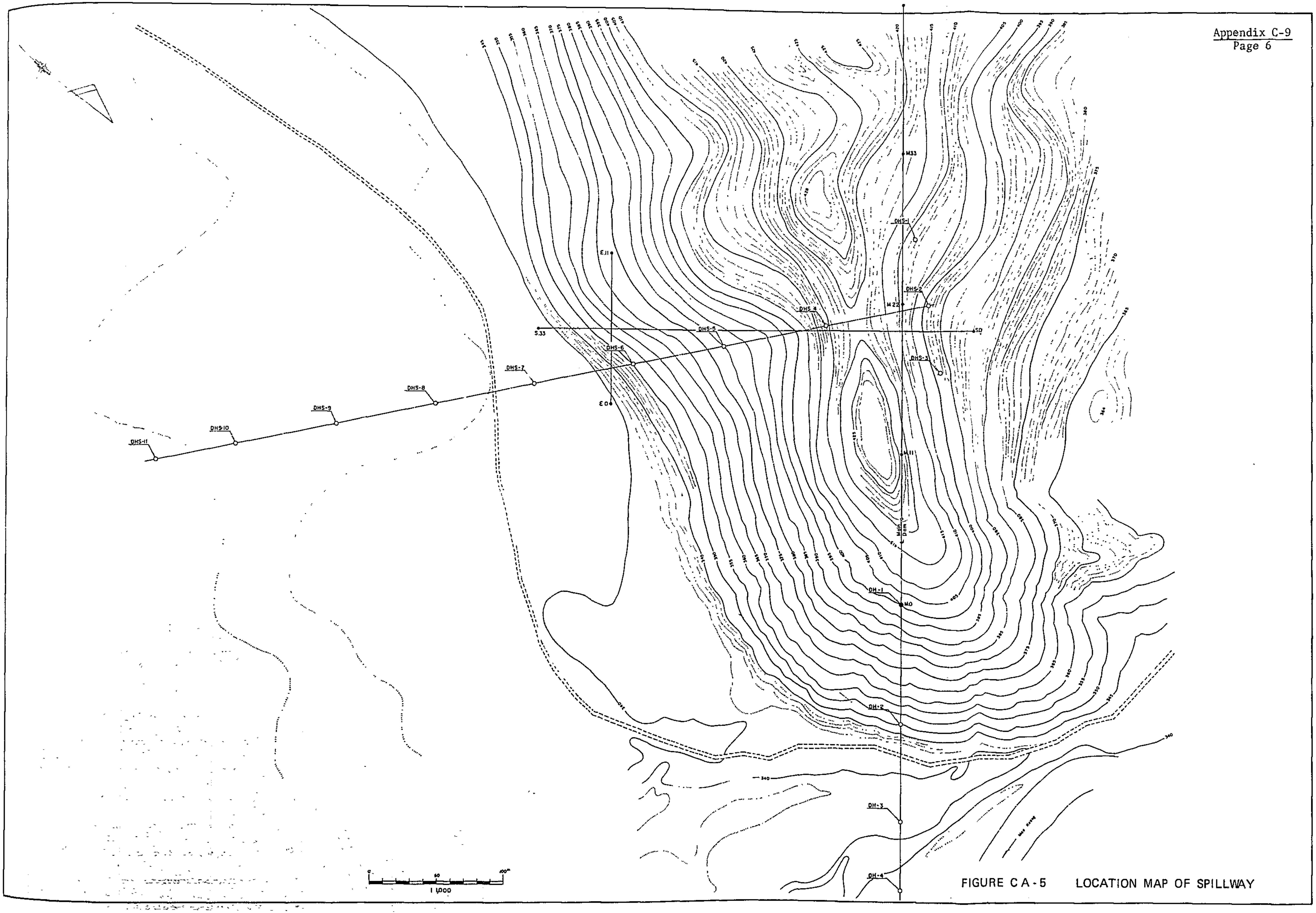


FIGURE C A - 5 LOCATION MAP OF SPILLWAY

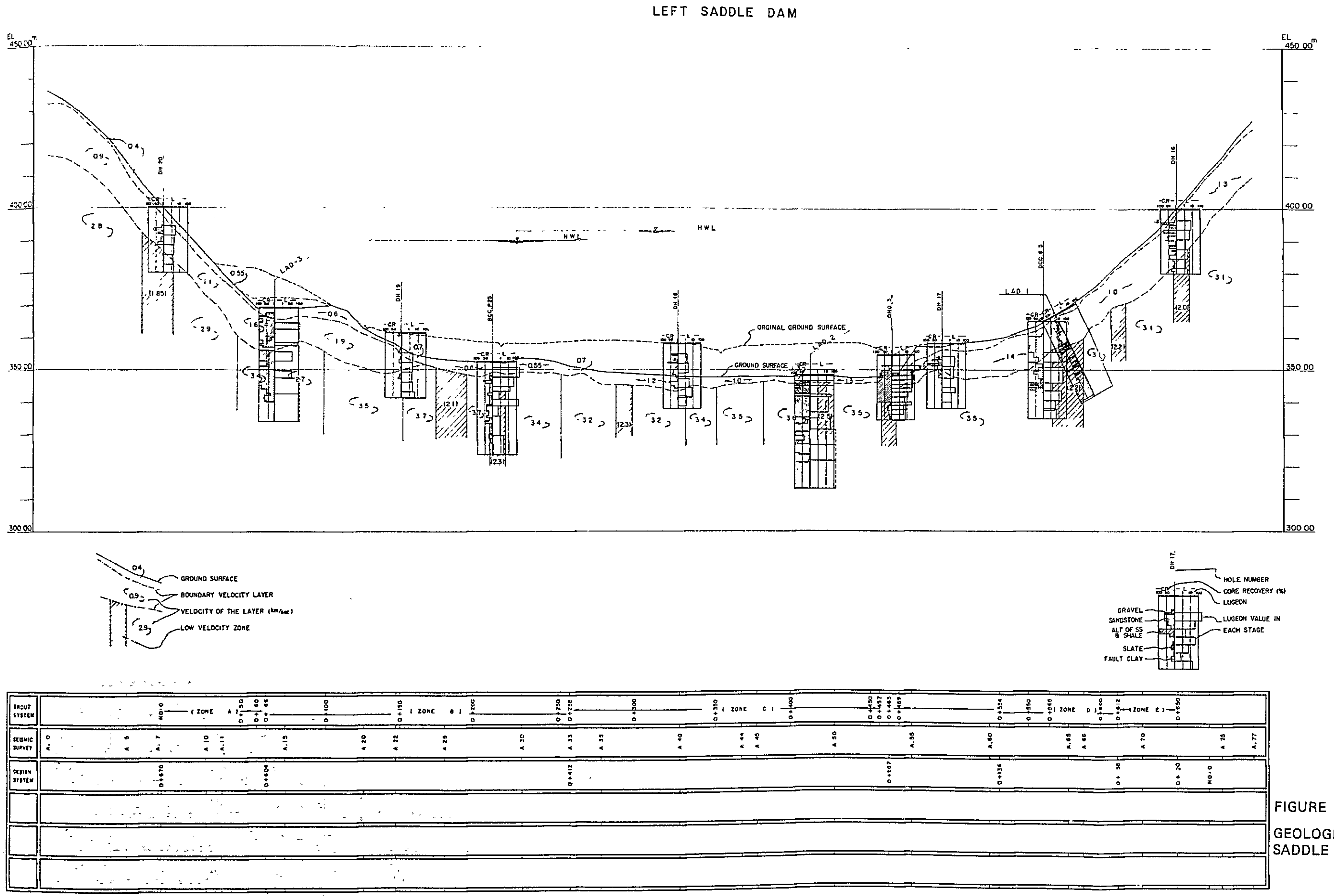
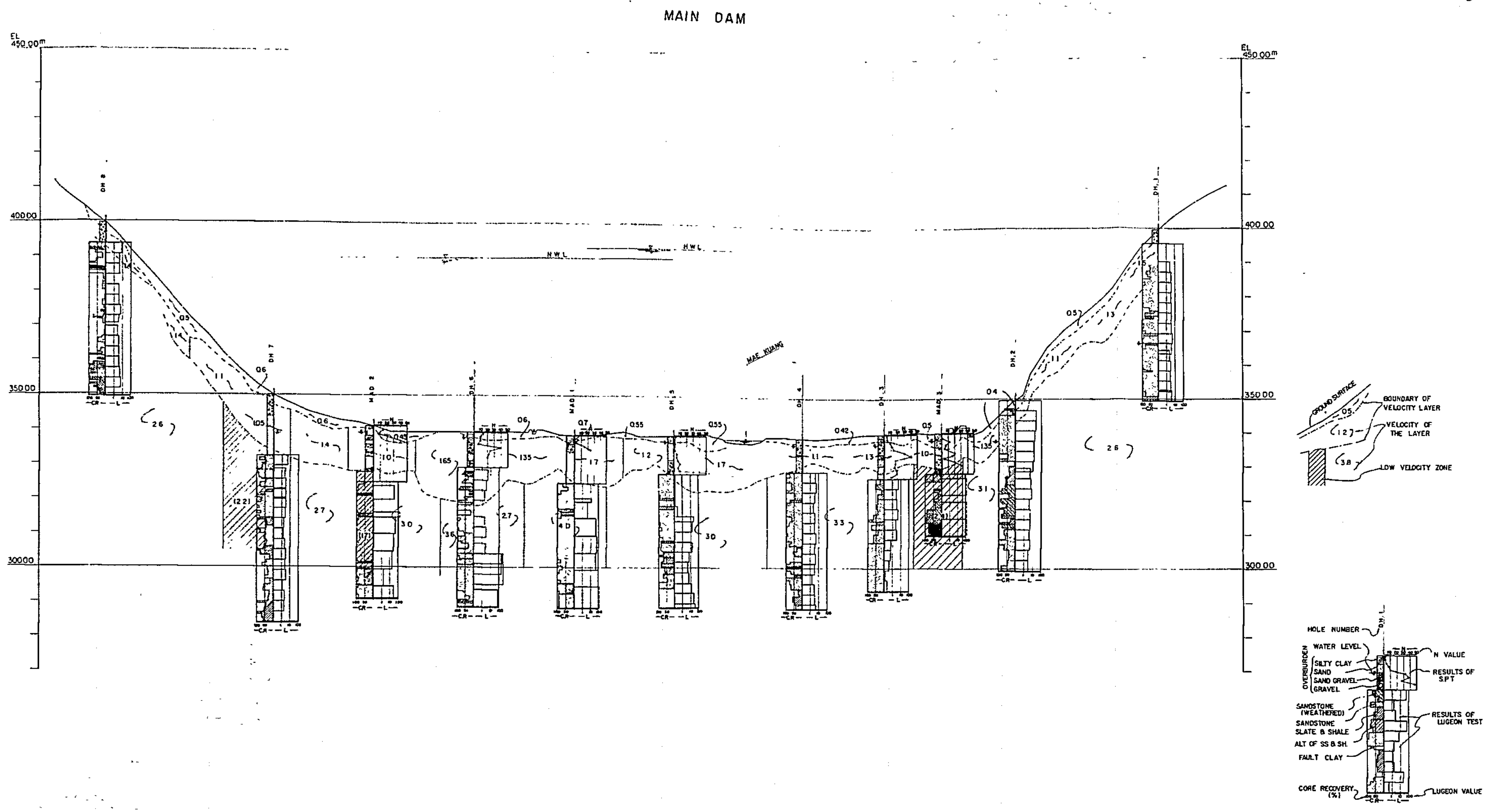


FIGURE C A - 6

GEOLOGICAL PROFILE OF LEFT SADDLE DAMSITE



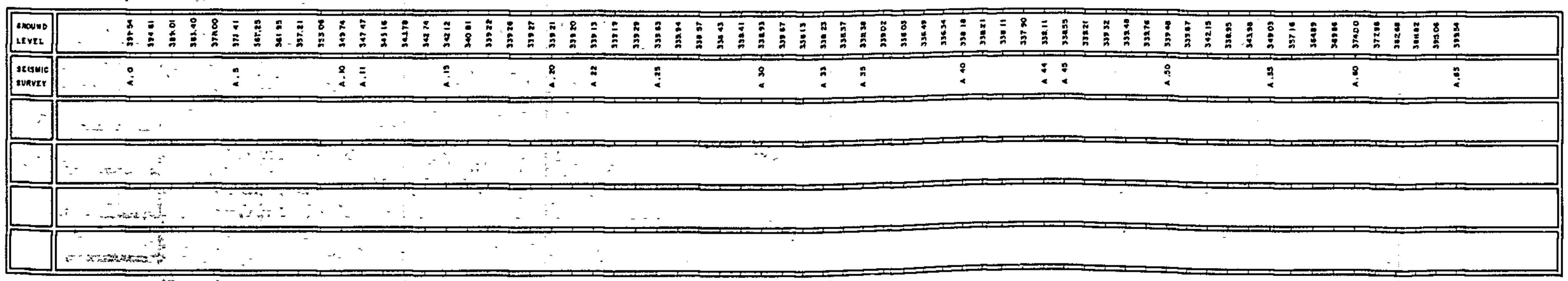


FIGURE CA-7

GEOLOGICAL PROFILE OF MAIN DAMSITE

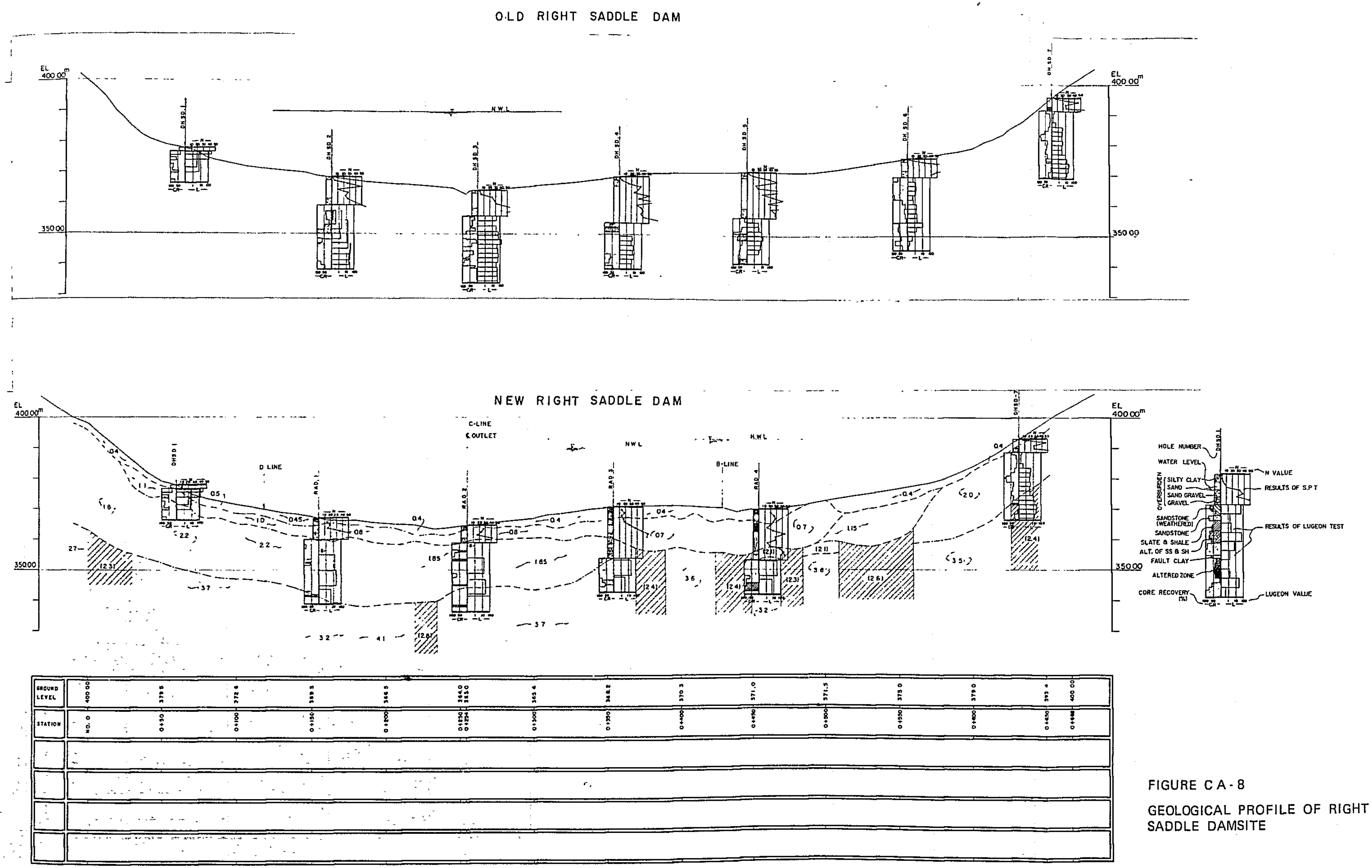


FIGURE CA-8

GEOLOGICAL PROFILE OF RIGHT SADDLE DAMSITE

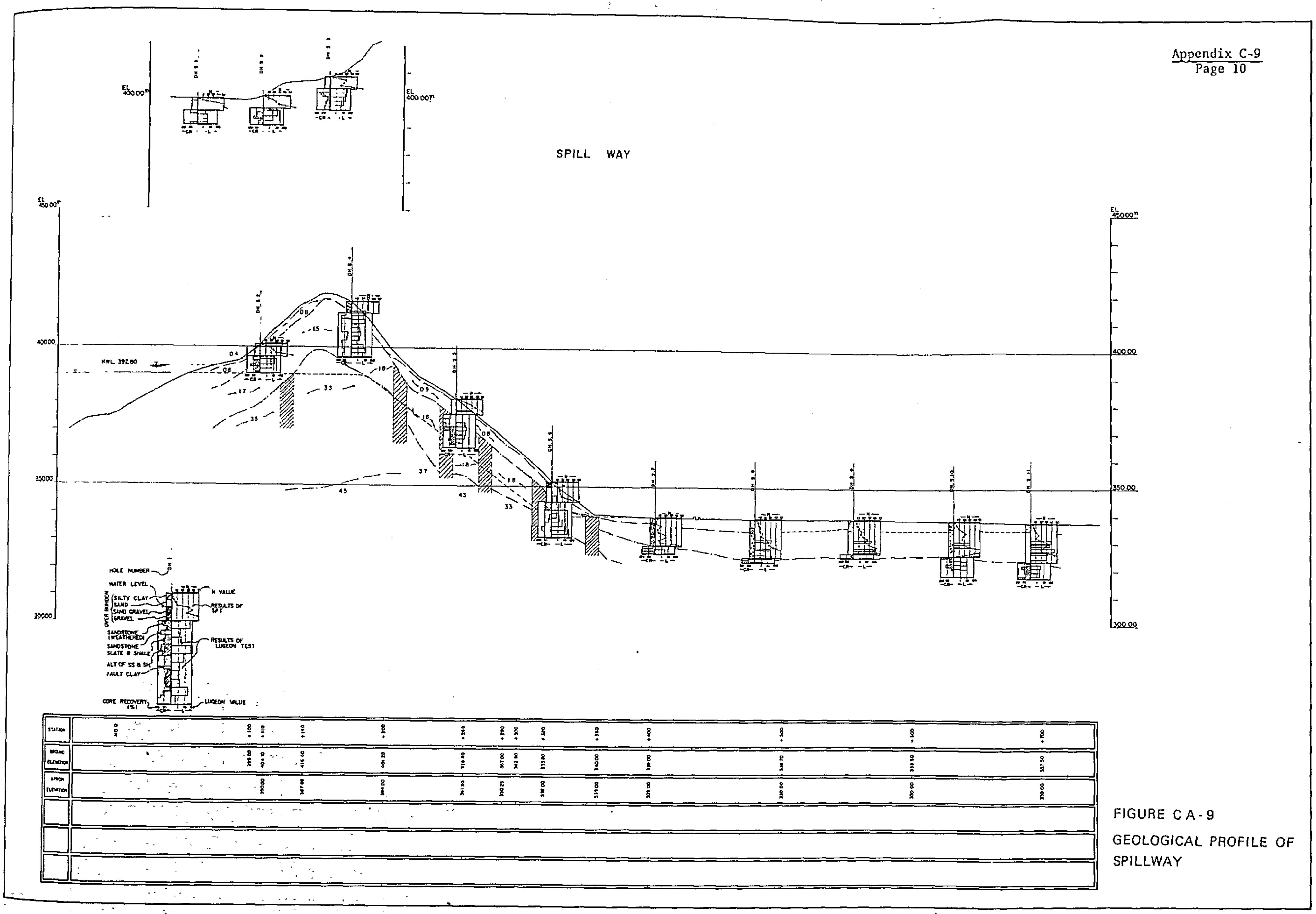
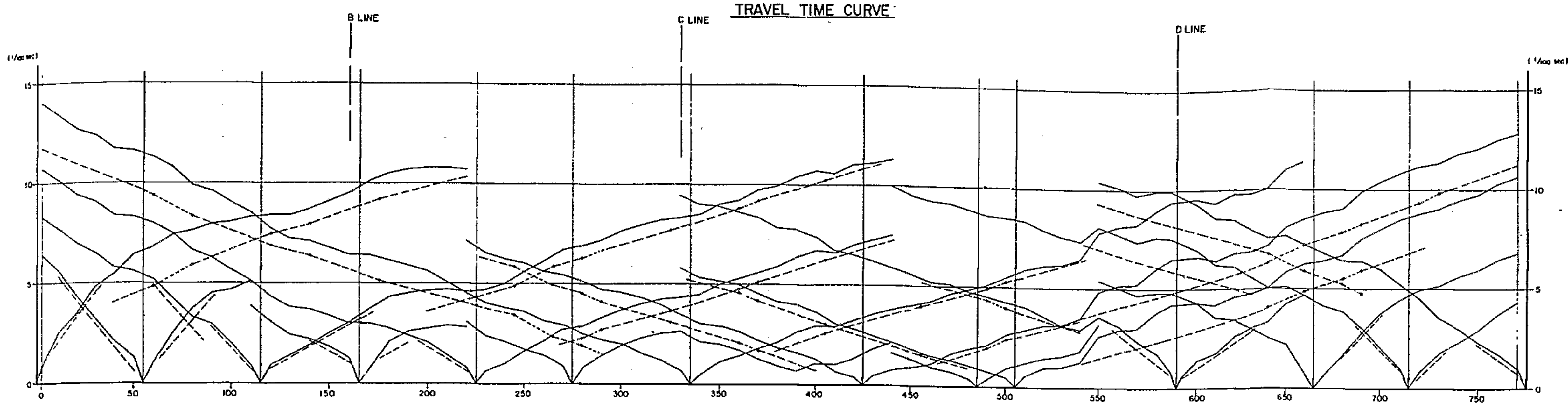


FIGURE CA-9
GEOLOGICAL PROFILE OF SPILLWAY

LFET SADDLE A-LINE

TRAVEL TIME CURVE



PROFILE

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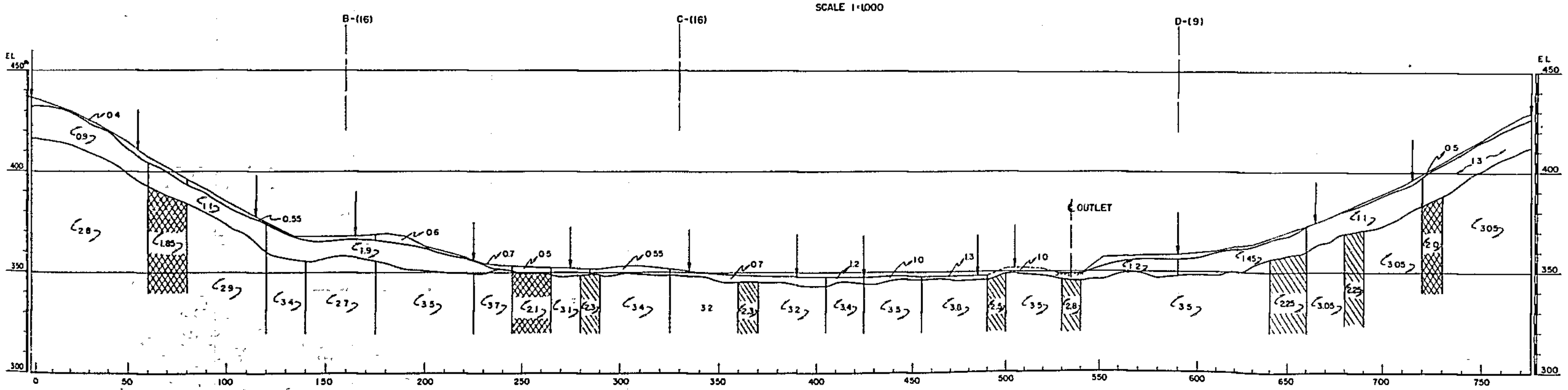
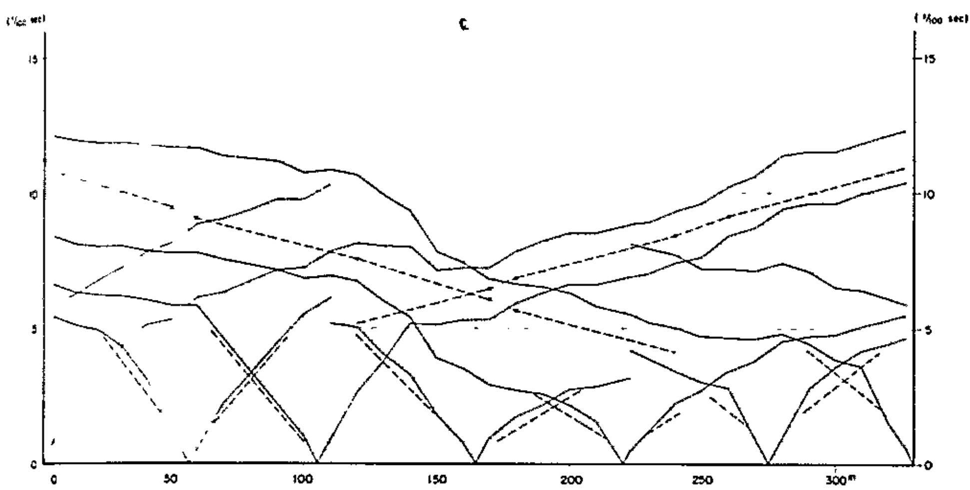


FIGURE CA-10 ANALYSING CHART OF SEISMIC EXPLORATION (I)
(LEFT SADDLE A-LINE)

LEFT SADDLE B-LINE

TRAVEL-TIME CURVE



PROFILE
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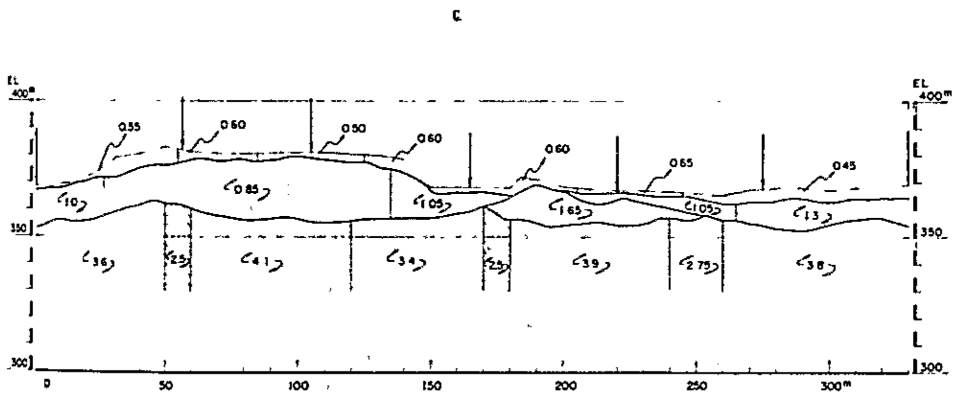
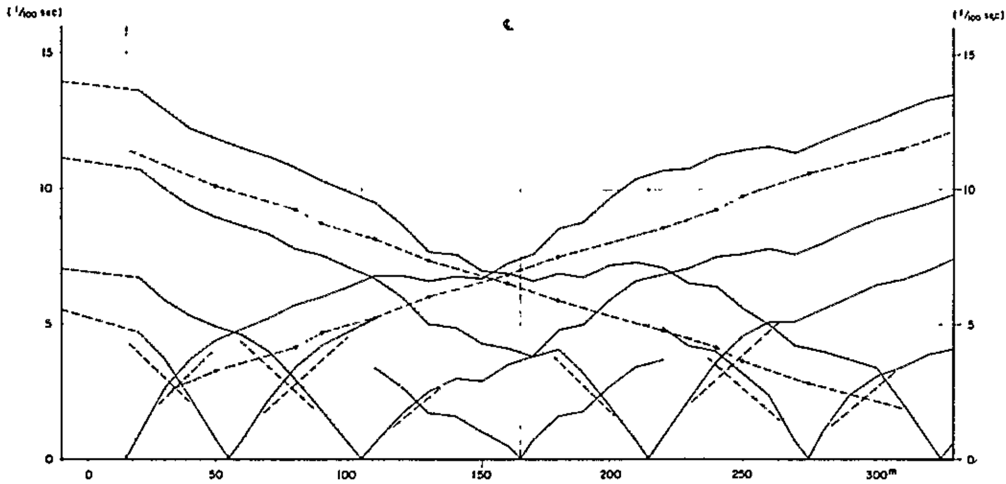


LEFT SADDLE C-LINE

TRAVEL-TIME CURVE



PROFILE
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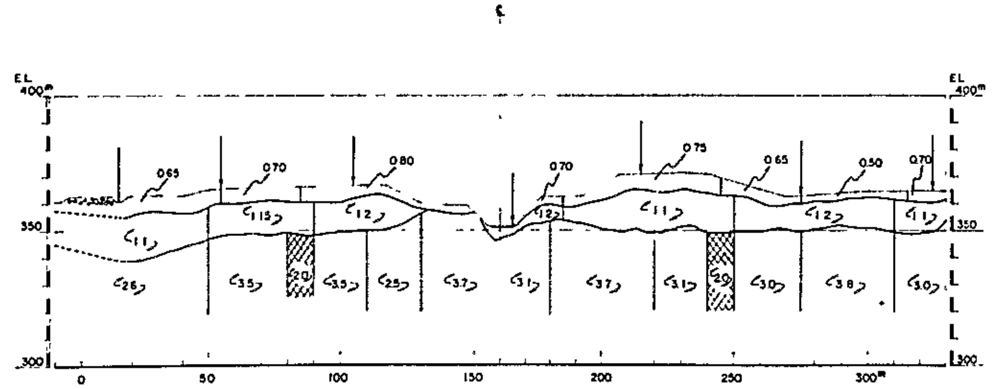
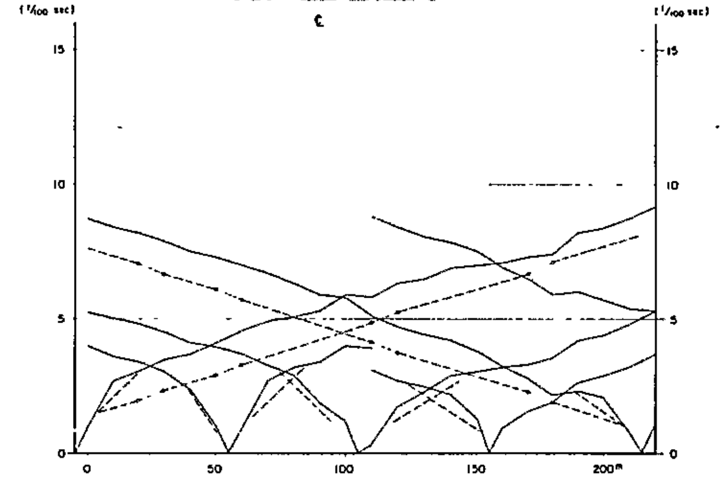


LEFT SADDLE D-LINE

TRAVEL-TIME CURVE



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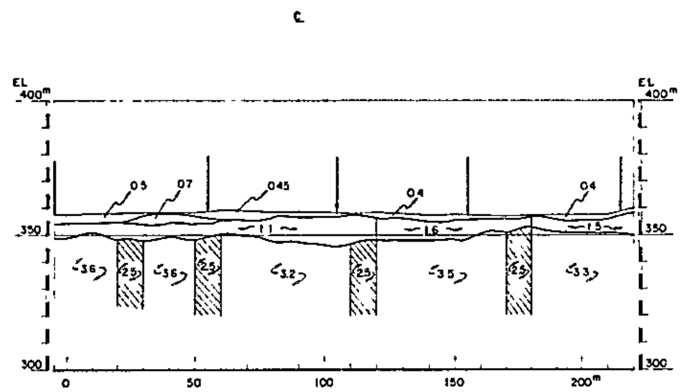
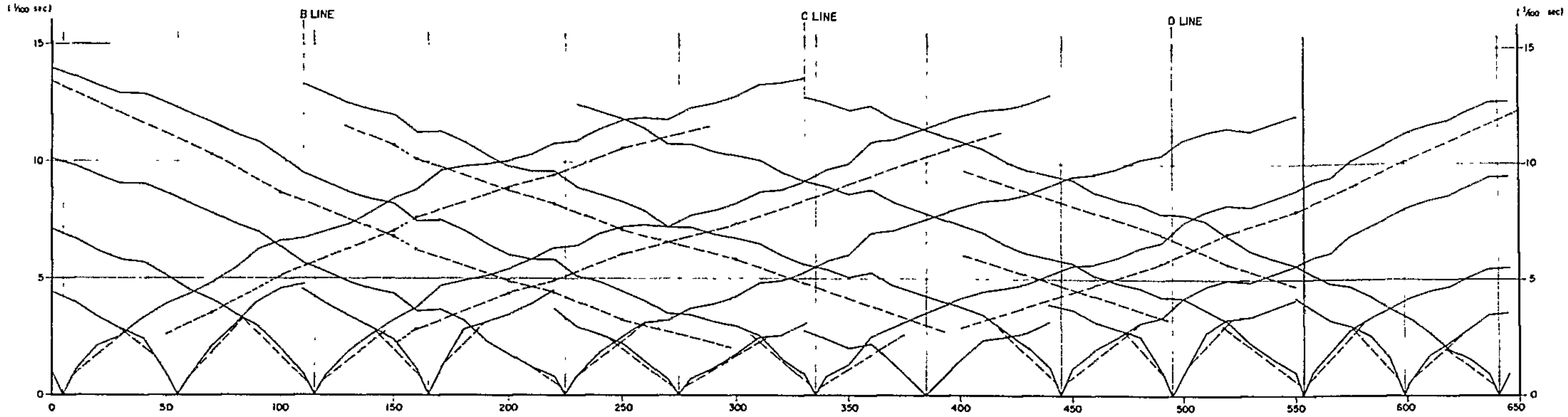


FIGURE CA-11 ANALYSING CHART OF SEISMIC EXPLORATION (II)
(LEFT SADDLE B, C, D-LINES)

MAIN DAM A-LINE

TRAVEL-TIME CURVE



PROFILE

SCALE 1:1000

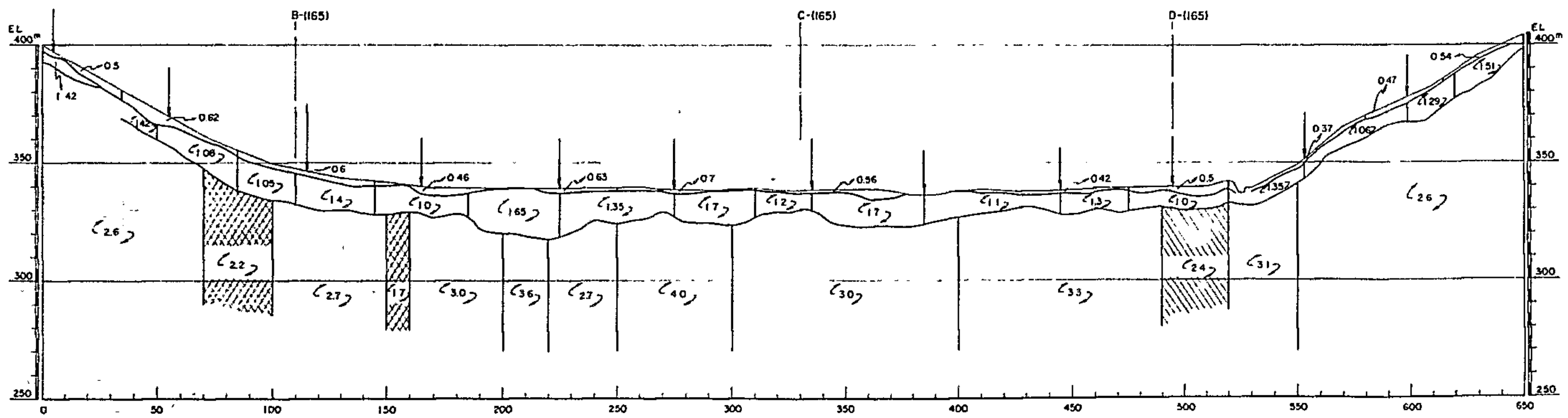
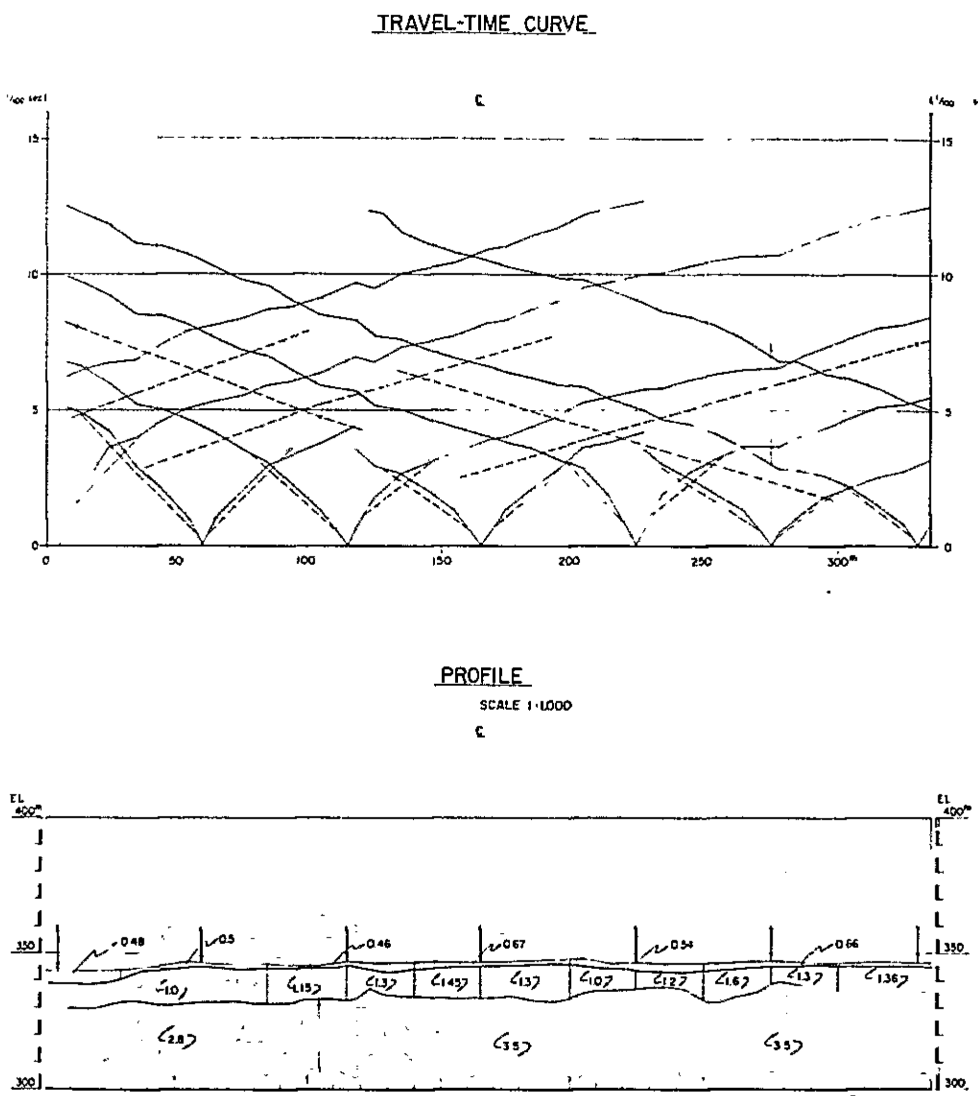
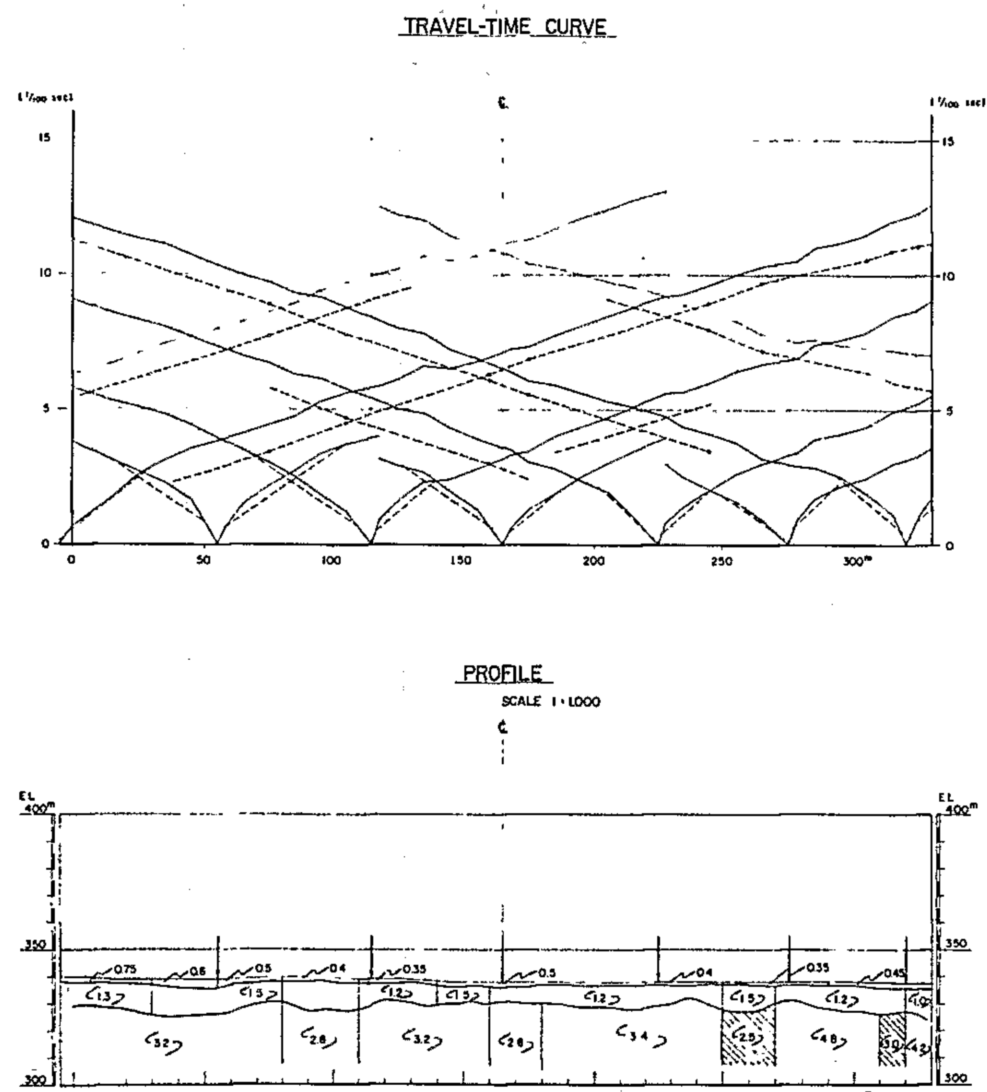


FIGURE CA-12 ANALYSING CHART OF SEISMIC EXPLORATION (III)
(MAIN DAM A-LINE)

MAIN DAM B-LINE



MAIN DAM C-LINE



MAIN DAM D-LINE

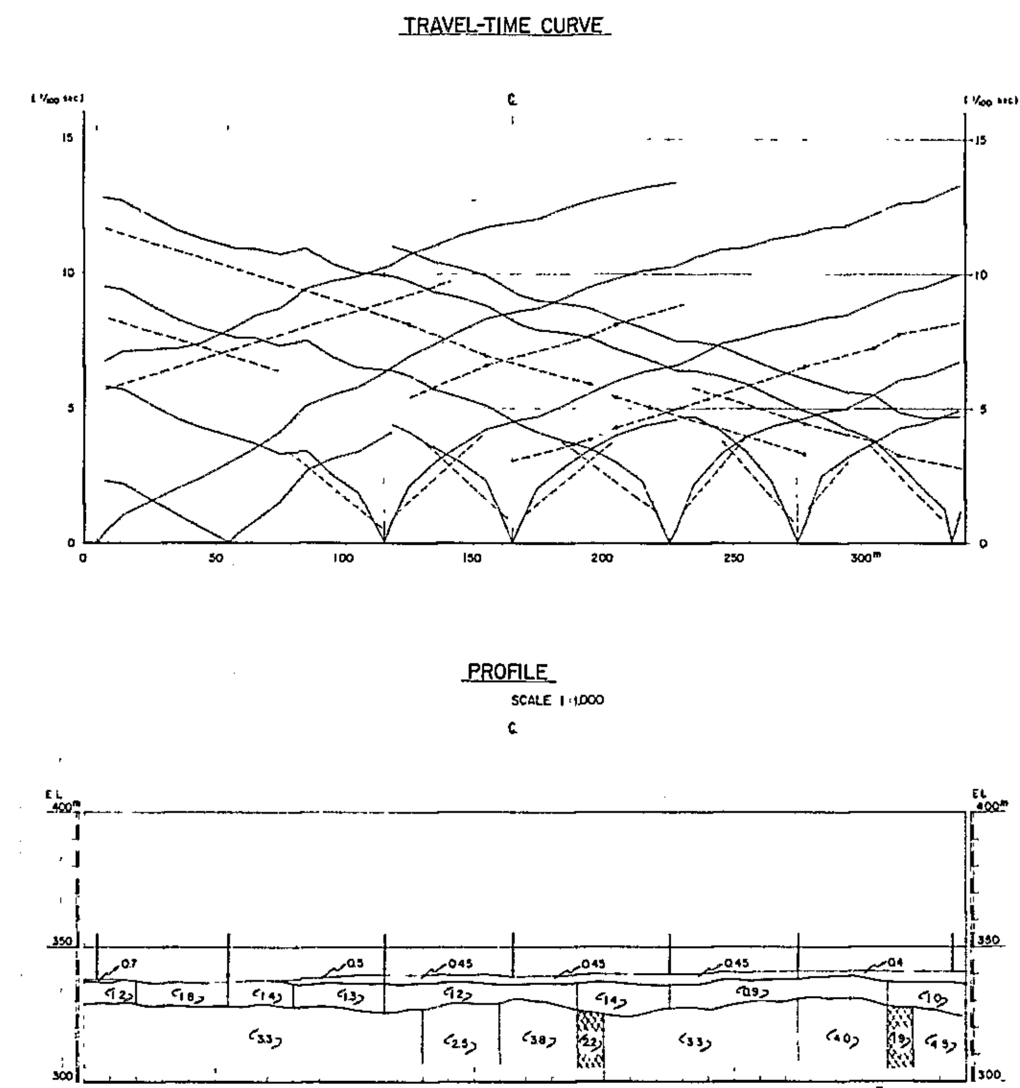
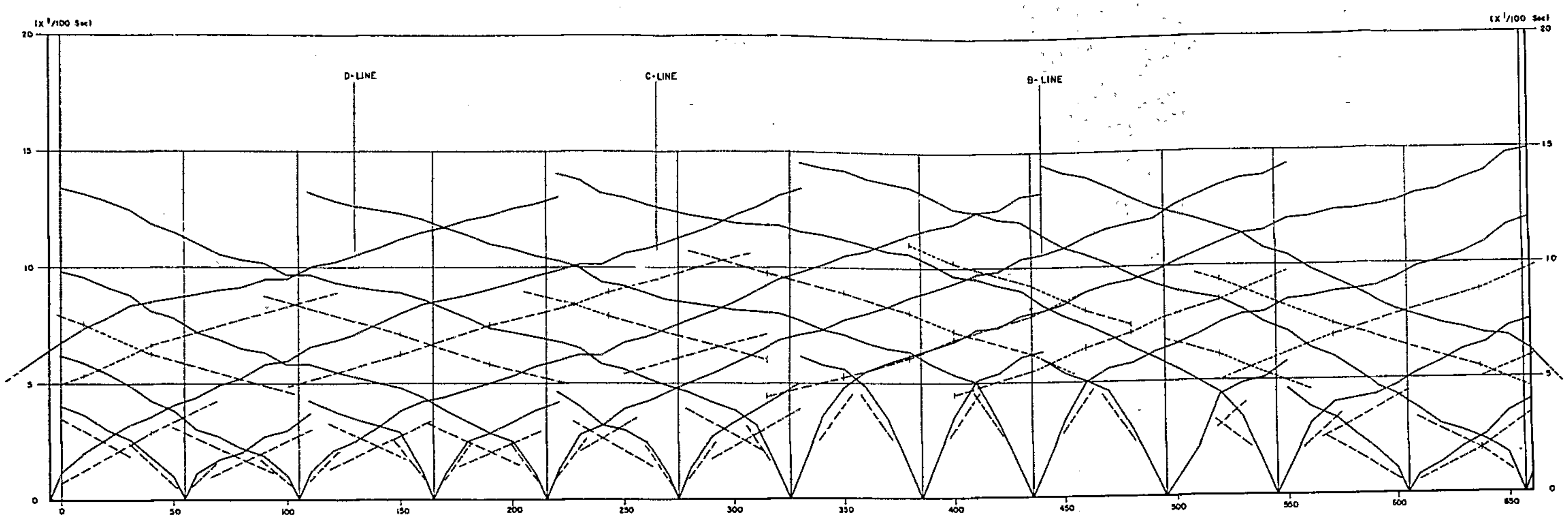


FIGURE CA-13 ANALYSING CHART OF SEISMIC EXPLORATION (IV)
(MAIN DAM B, C, D-LINES)

RIGHT SADDLE A-LINE

TRAVEL-TIME CURVE



PROFILE

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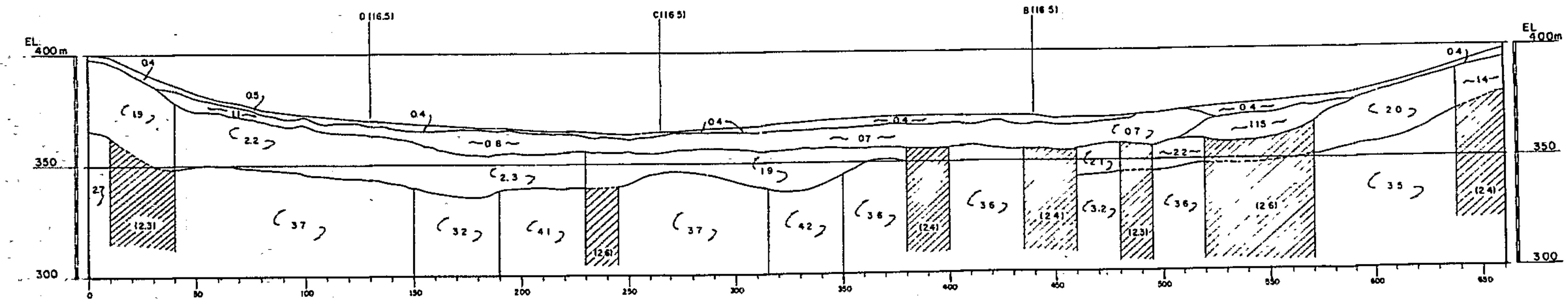
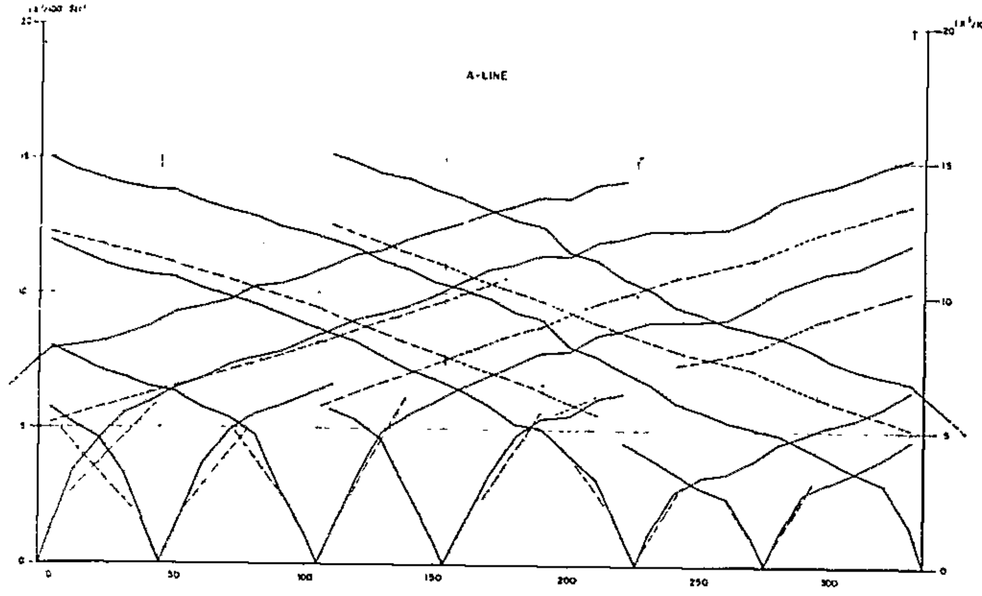


FIGURE CA-14 ANALYSING CHART OF SEISMIC EXPLORATION (V)
(RIGHT SADDLE A-LINE)

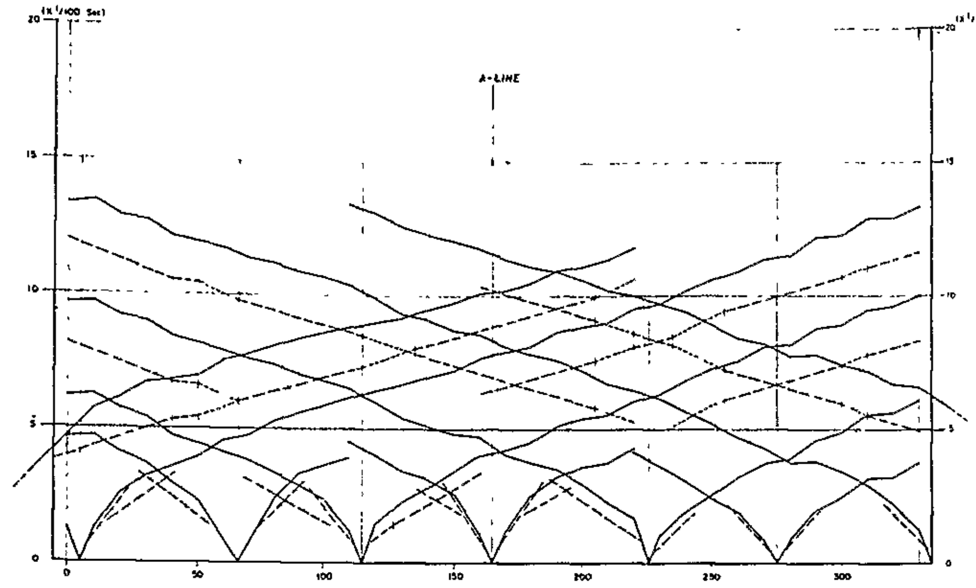
RIGHT SADDLE B-LINE

TRAVEL-TIME CURVE



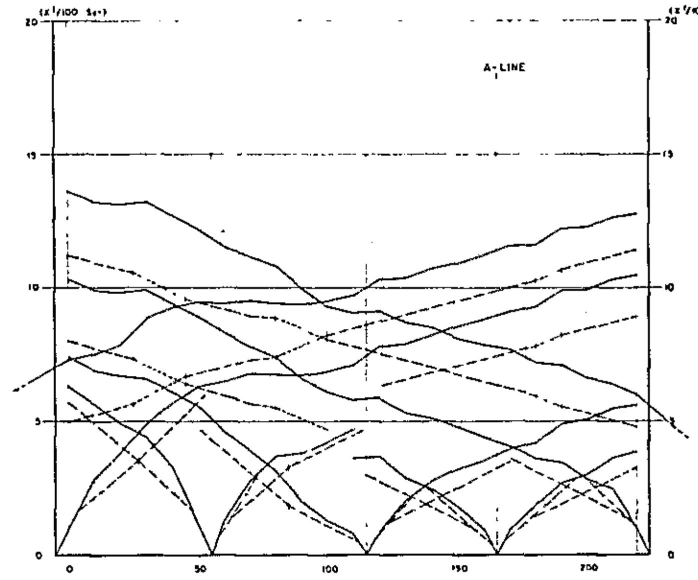
RIGHT SADDLE C-LINE

TRAVEL-TIME CURVE



RIGHT SADDLE D-LINE

TRAVEL-TIME CURVE



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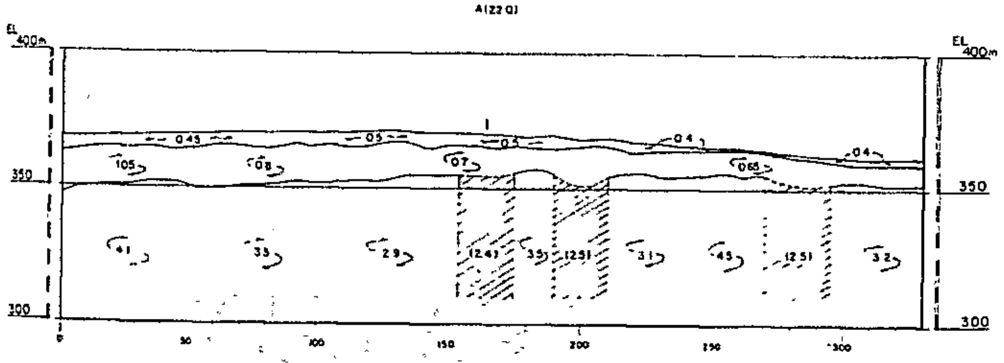

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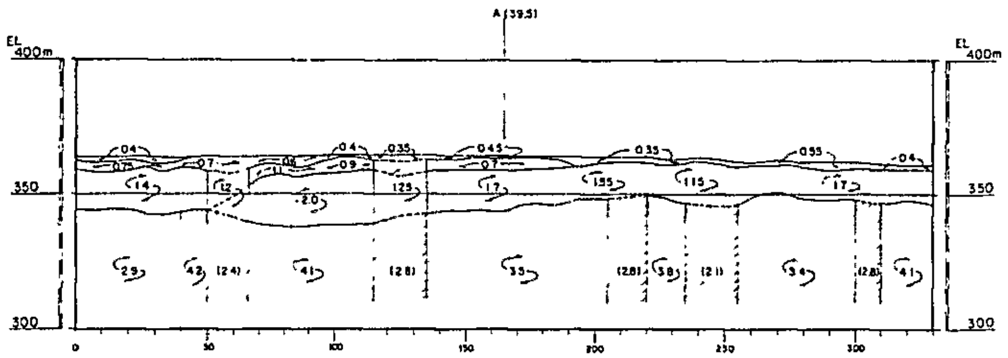

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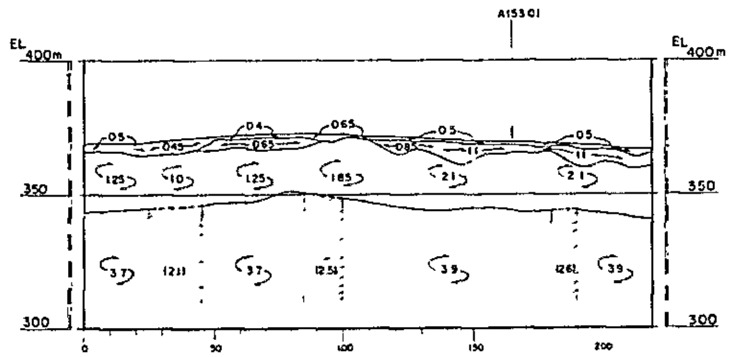
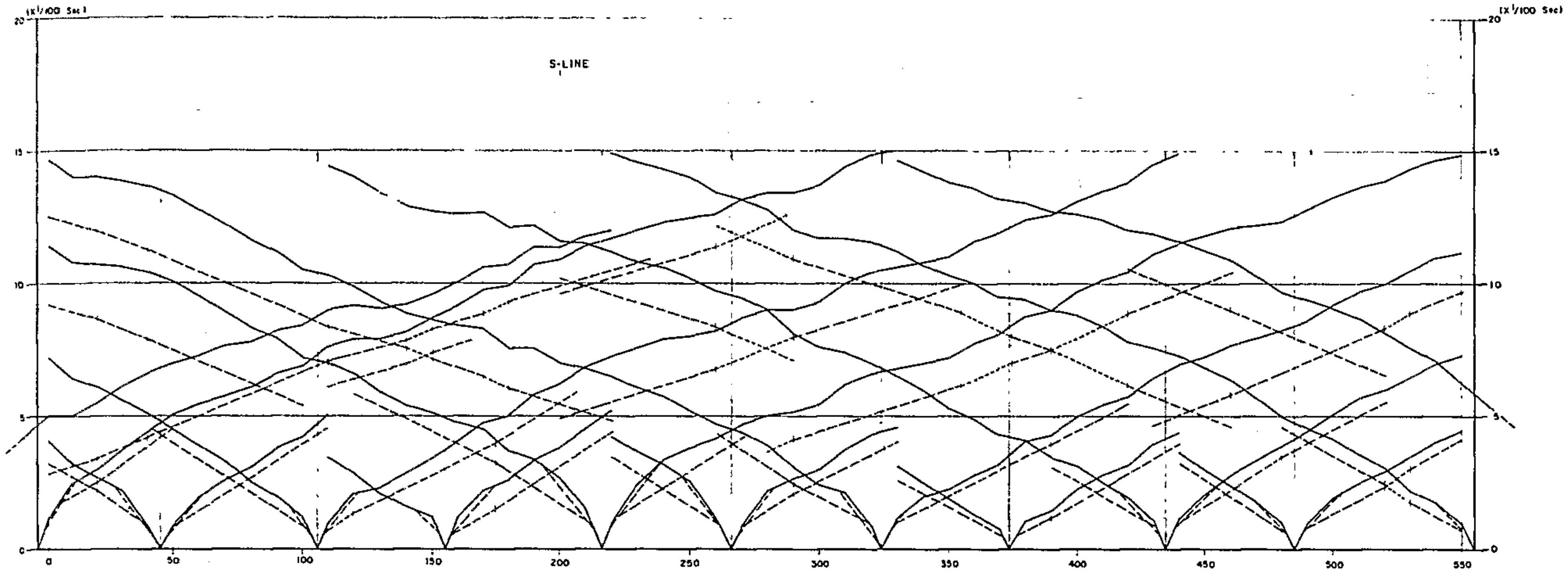


FIGURE CA-15 ANALYSING CHART OF SEISMIC EXPLORATION (VI)
(RIGHT SADDLE B, C, D-LINES)

SPILL WAY M-LINE

TRAVEL-TIME CURVE



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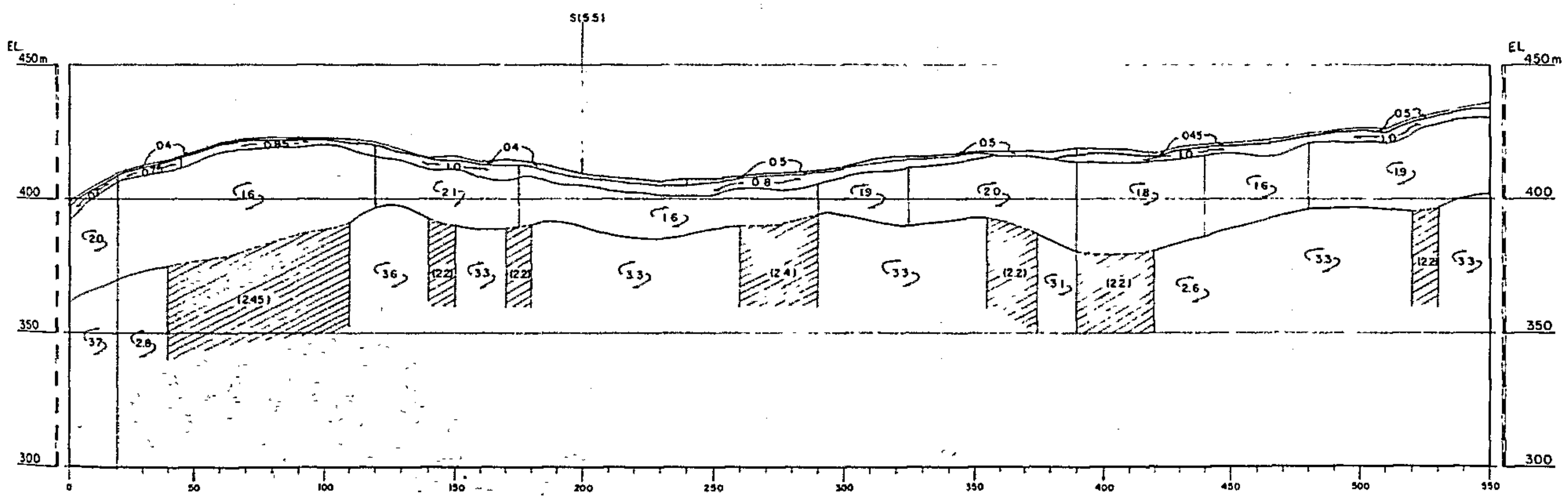
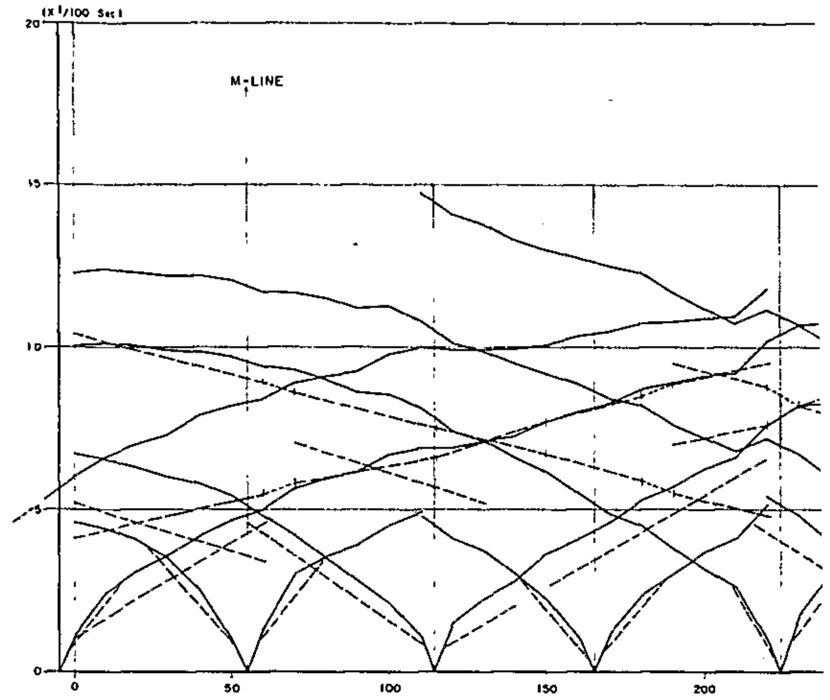


SPILL WAY S-LINE

TRAVEL-TIME CURVE



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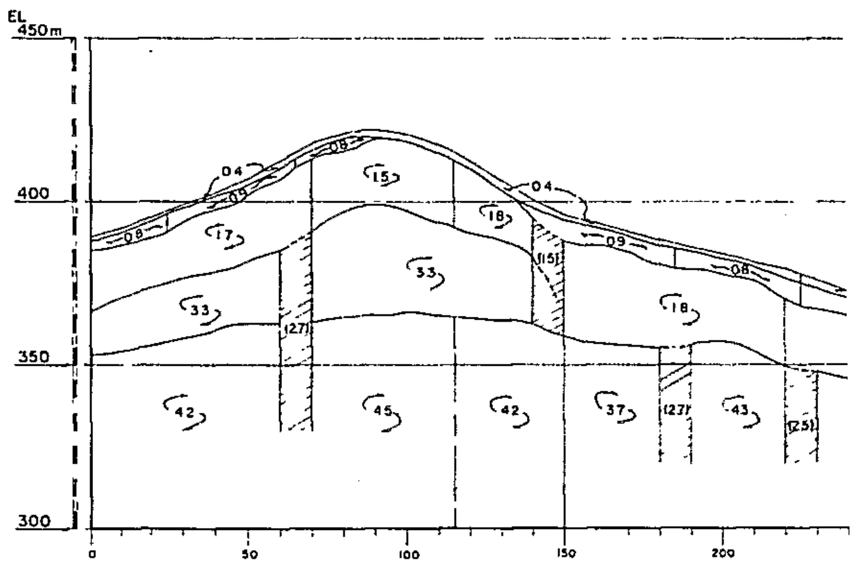
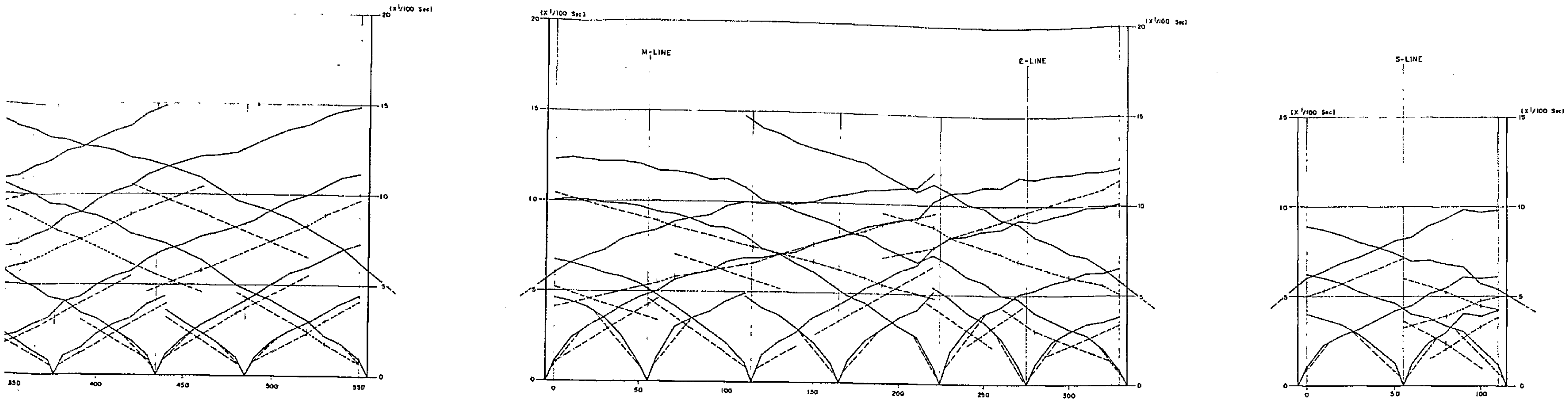


SPILL WAY S-LINE

SPILL WAY E-LINE

TRAVEL-TIME CURVE



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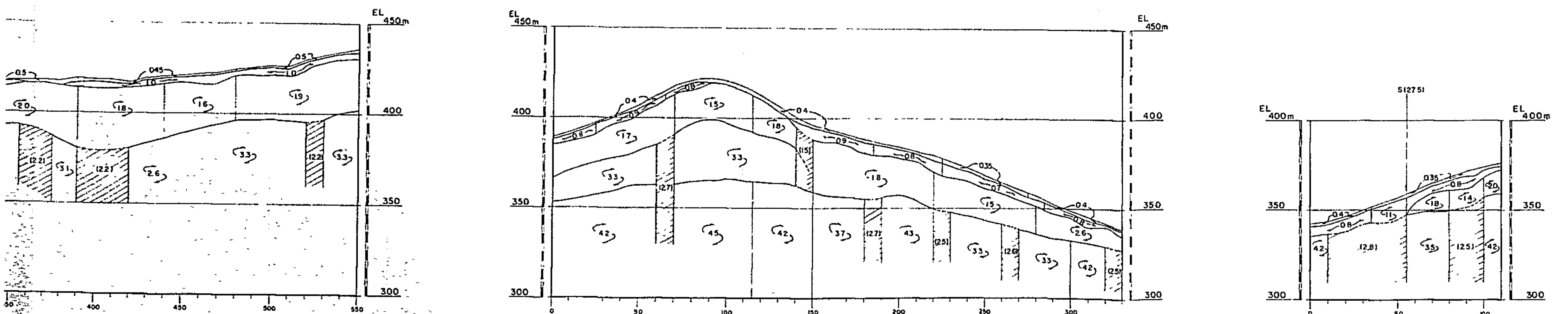

FIGURE CA-16 ANALYSING CHART OF SEISMIC EXPLORATION (VII)
(SPILLWAY M, S, E-LINES)