マレイシア国
レビルダム計画

調査報告書
APPENDIX

1989年3月

国際協力事業団

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レビルダム計画

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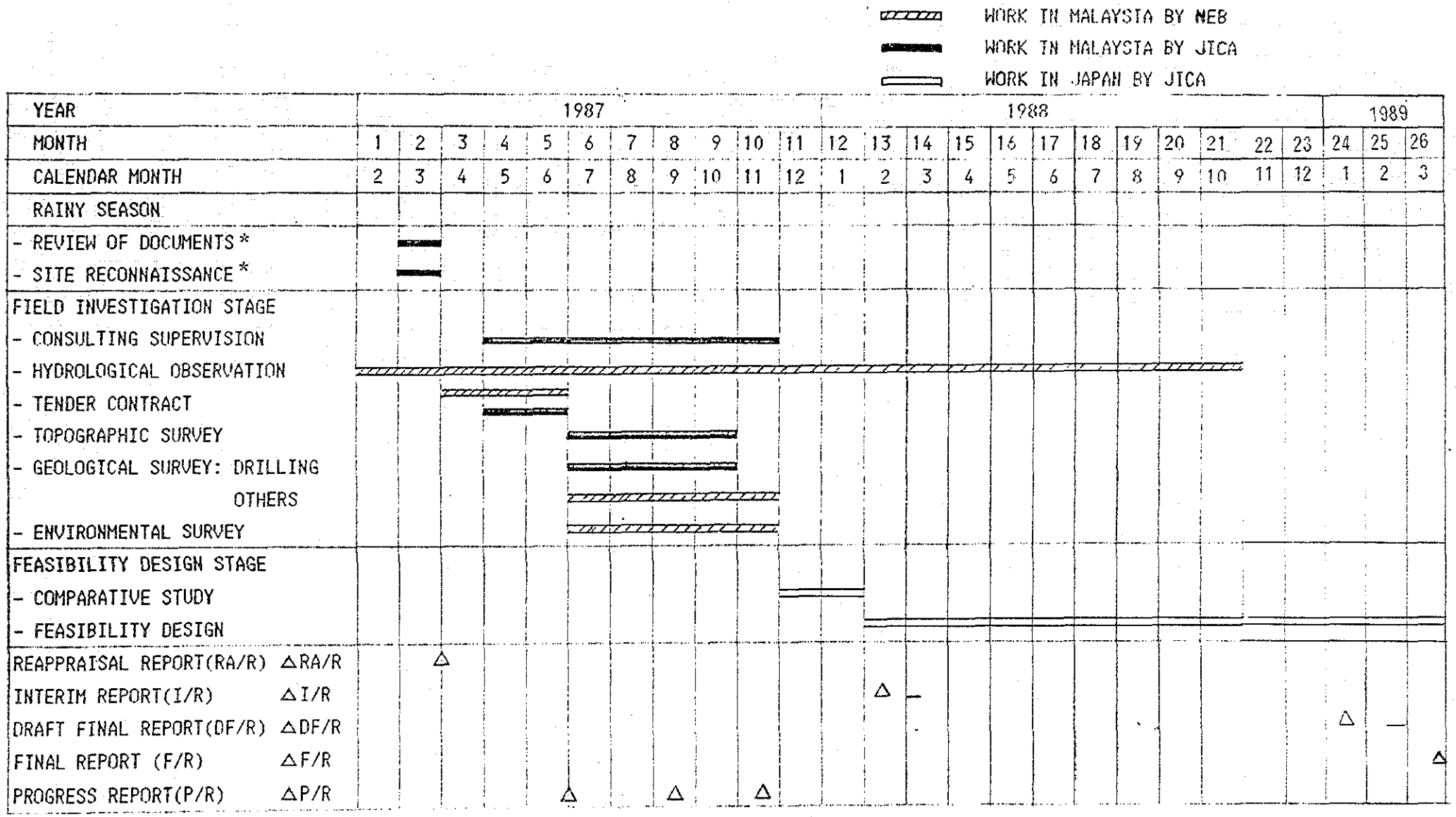
1-2	MOM of Steering Committee Meeting (08/3/1988) March 11, 1988
1-3	Notes of Discussions for Technical Committee Meeting (February 25, 1989)
1-4	MOM on Draft Final Report for the Feasibility Study of the Lebir Dam Project (March 1, 1989)
4-1	Technical Specification for Topographic Survey
4-2	Technical Specification for Core Drilling
11-0-1	CHECK LIST OF JICA STUDY TEAM'S REACTION RE DOE'S COMMENT ON EIS FEB. 1988
11-0-2	DATA ON MEDICAL-ECOLOGY STUDIED BY IMR (at briefing in March 1988)
13-1	Explanatory Demonstration of Project Cost Allocation
14-1	Explanatory Note on Economic Evaluation Method
14-2	Economic Evaluation of the Lebir Dam Project with Updated Parameters for Alternarive Plants

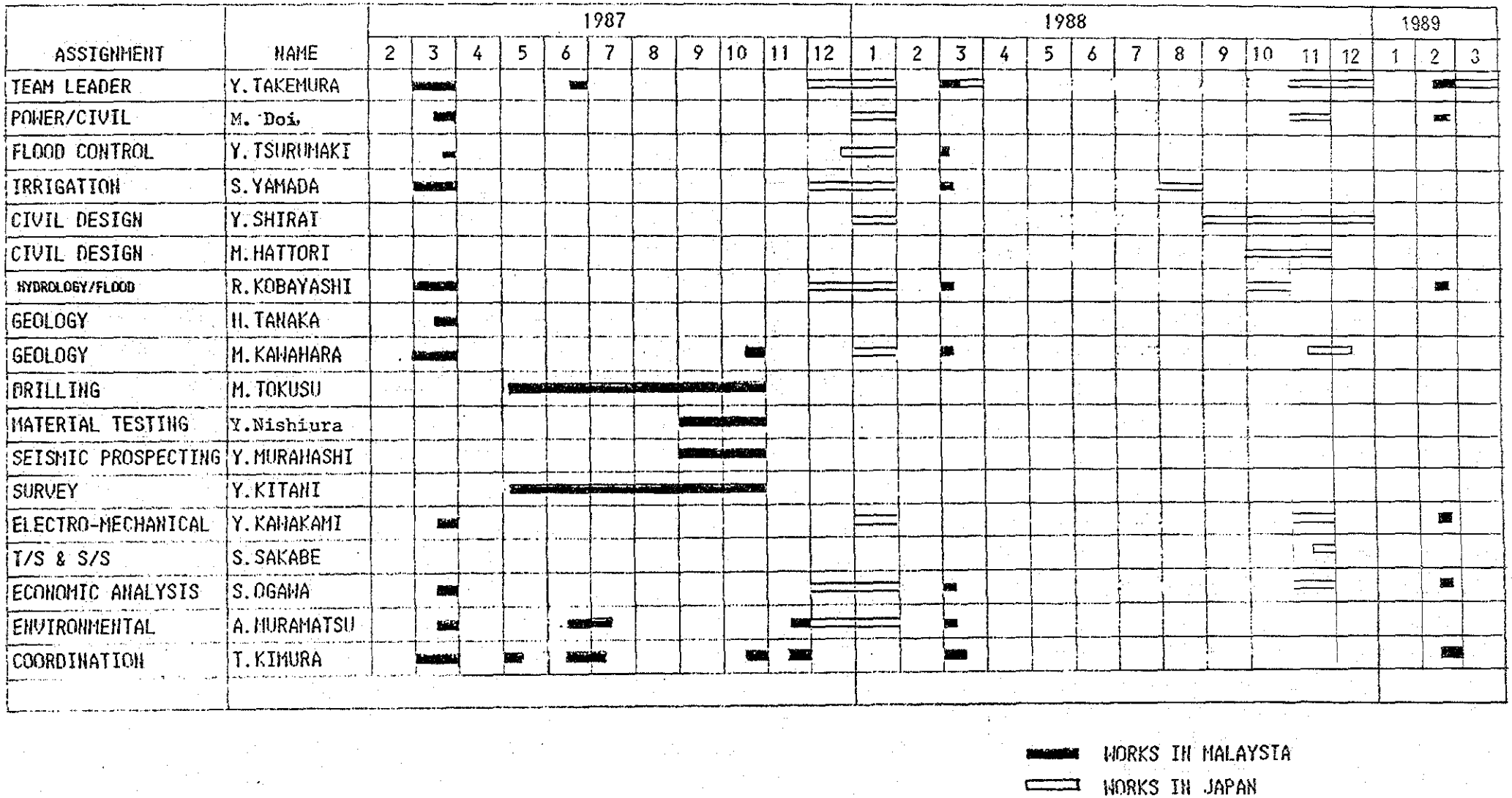
FIGURES

FIG. 1-1 SCHEDULE FOR FEASIBILITY STUDY OF LEBIR DAM PROJECT



Note : * Shifted backward by 0.5 months from the agreed schedule in S/W

FIG. 1-2 PERSONNEL MANNING SCHEDULE



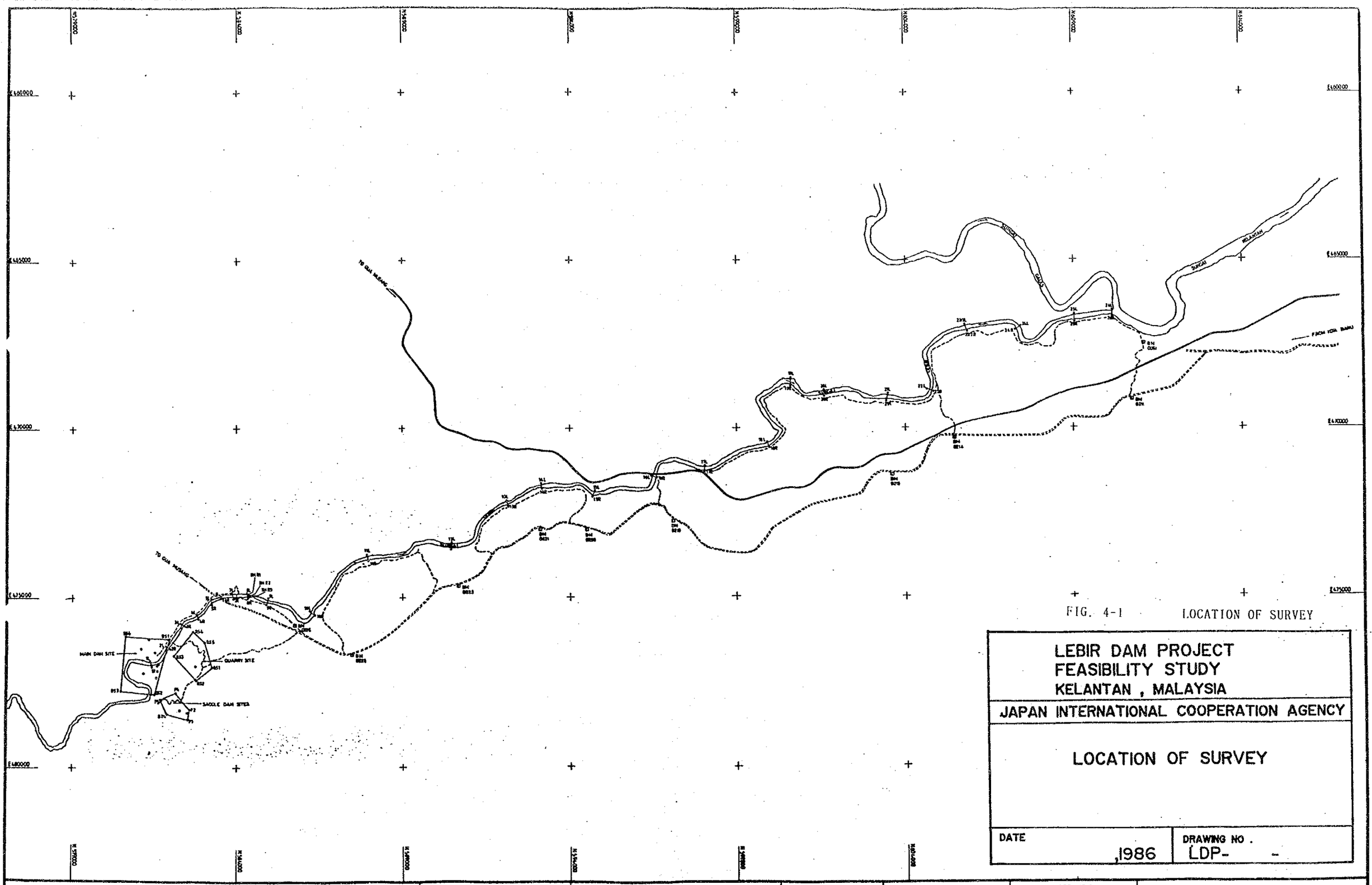


FIG. 4-1 LOCATION OF SURVEY

LEBIR DAM PROJECT
FEASIBILITY STUDY
KELANTAN , MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION OF SURVEY

DATE ,1986

DRAWING NO . LDP- -

LEGEND	ABBREVIATION	DESCRIPTION				
RIVER CROSS SECTION SURVEY; EARTH TRACK; TAR ROAD; TOPOGRAPHIC SURVEY; RAIL WAY LINE; BENCH MARK	SL = TRAVERSE LEFT; SR = TRAVERSE RIGHT; BH = BORE HOLE; SUNGAI = RIVER	LOCATION AND SITE PLAN	SCALE : 1 : 50 000	JURUKUR TEKNIK SDN BHD SURVEYED BY : DRAWN BY : CHECK BY :	JAPAN INTERNATIONAL COOPERATION AGENCY APPROVED BY : HEWJEC SUPERVISOR : Y. KIYAJI	LEBIR DAM PROJECT FEASIBILITY STUDY KELANTAN, MALAYSIA. DATE : OCT 86 / DRAWING NO : LDP-SL-04

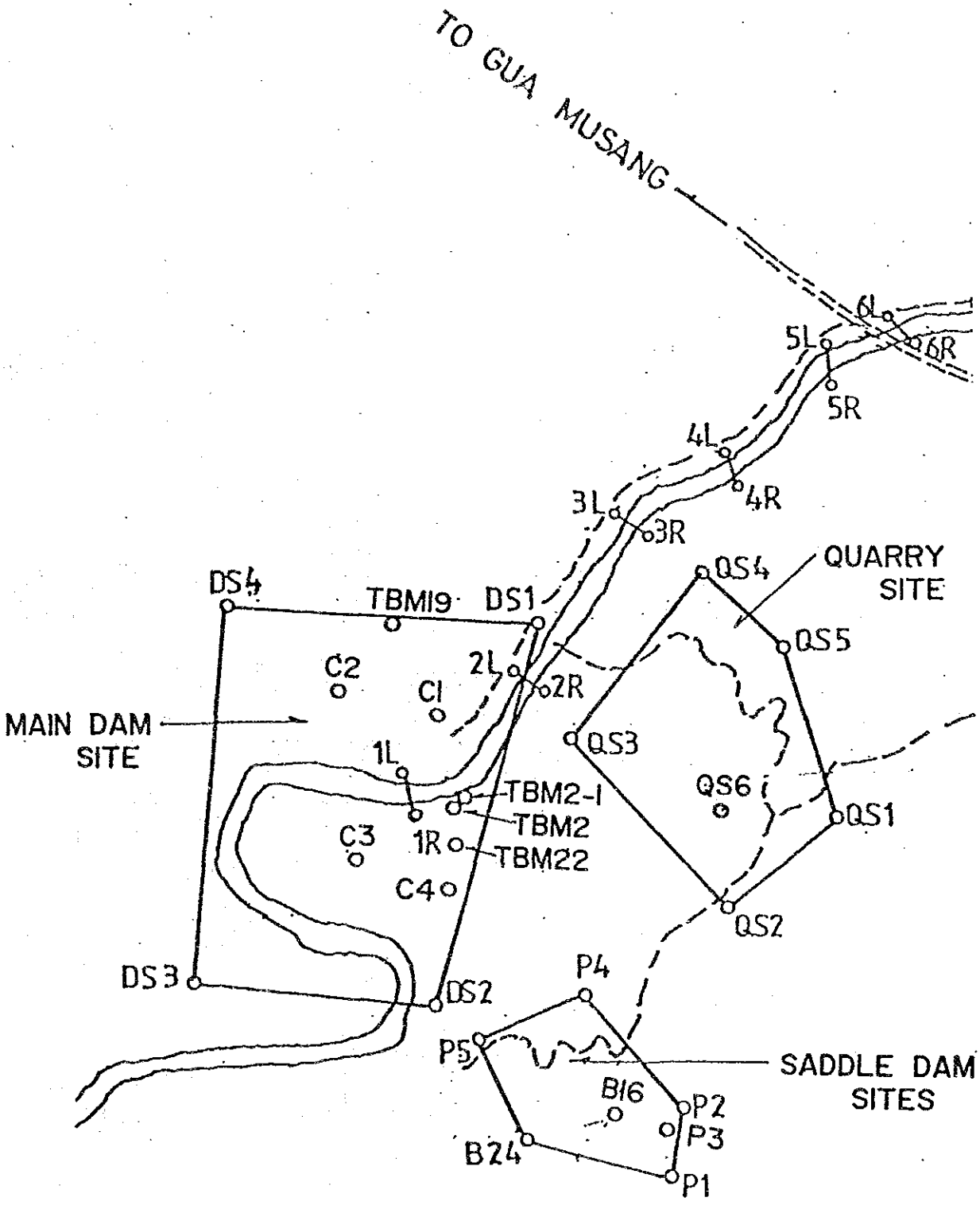


FIG. 4-2 LOCATION MAP OF TBM AND BM

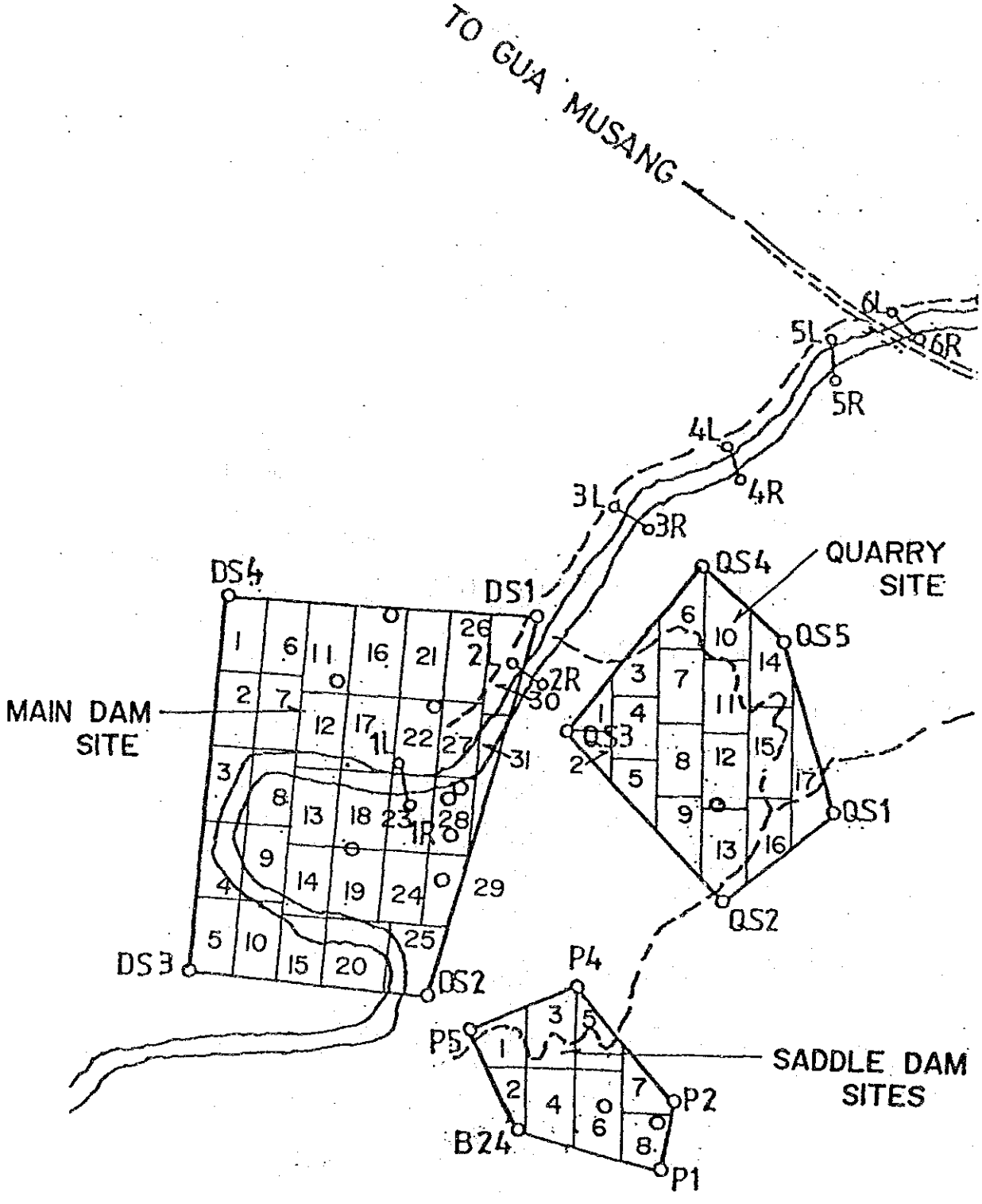
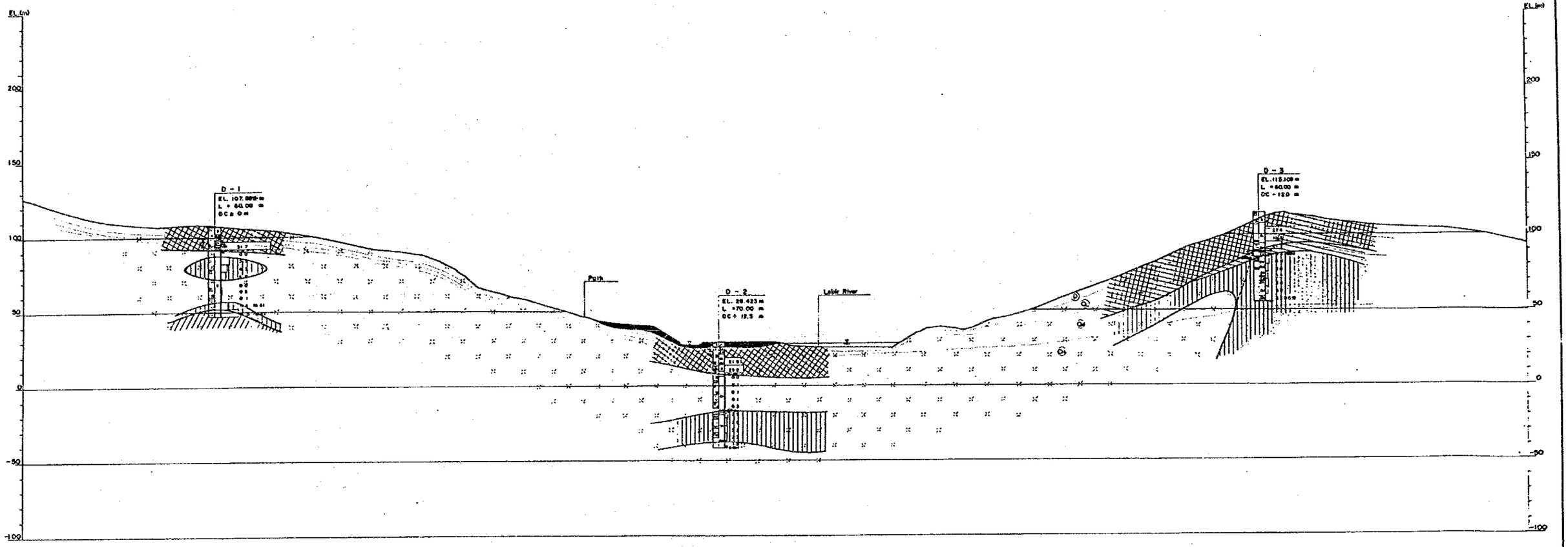


Fig4-3 INDEX MAP OF TOPOGRAPHIC MAP

Main Dam Axis Lugeon Map

S = 1 : 2,000



Legend

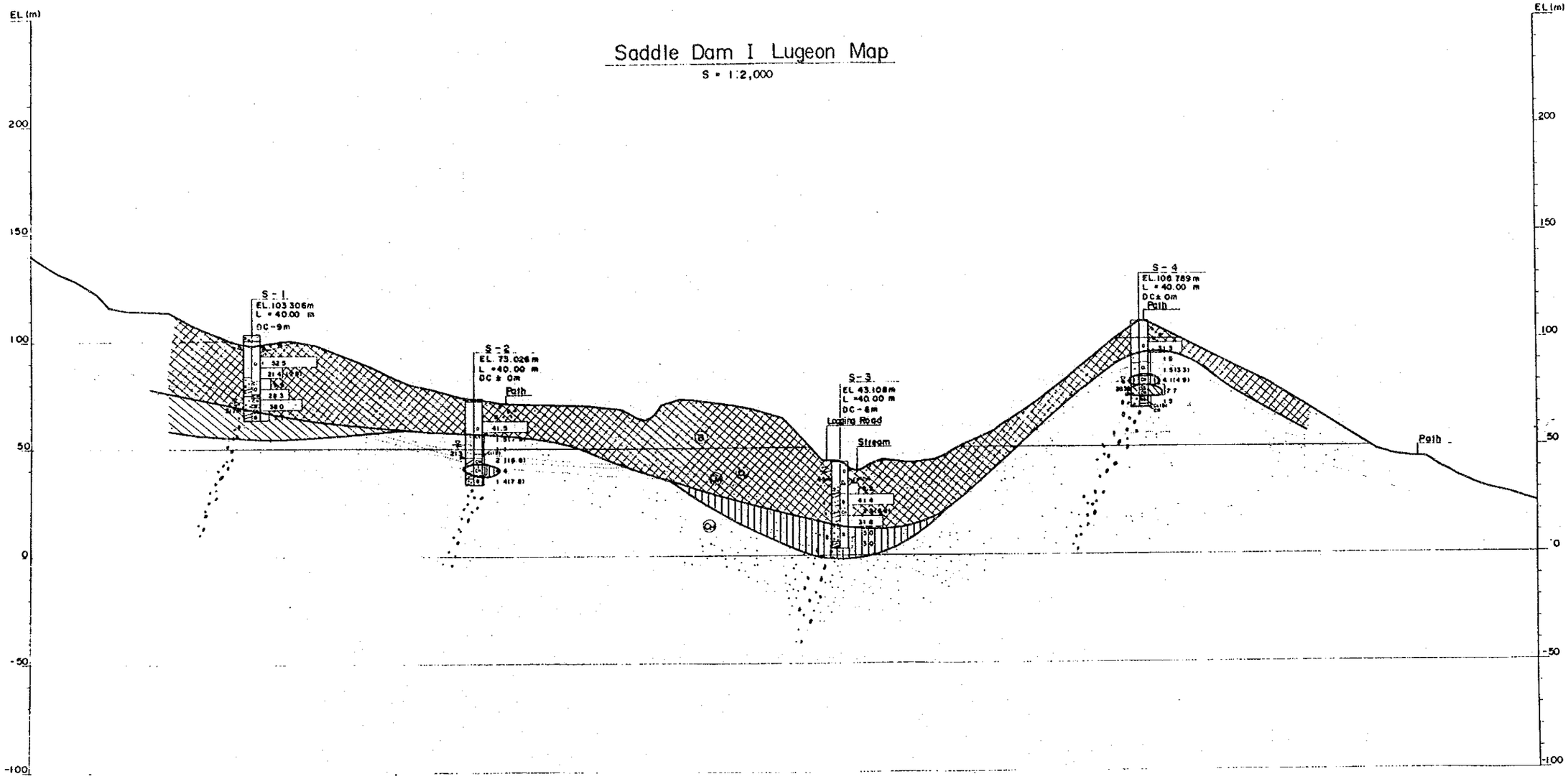
- Sediments
- 20 ≤ Lugeon zone
- 10 ≤ Lugeon < 20 zone
- 5 ≤ Lugeon < 10 zone
- 2 ≤ Lugeon < 5 zone
- Lugeon < 2 zone
- Lugeon zone boundary

Fig. 4-4

LEBIR DAM PROJECT FEASIBILITY STUDY KELANTAN, MALAYSIA	
JAPAN INTERNATIONAL COOPERATION AGENCY	
Title Lugeon Map. along the main dam axis	
DATE 1988	DRAWING NO LDP-G-008

Saddle Dam I Lugeon Map

S = 1:2,000



Legend

- 20 ≤ Lugeon zone
- 10 ≤ Lugeon < 20 zone
- 5 ≤ Lugeon < 10 zone
- 2 ≤ Lugeon < 5 zone
- Lugeon < 2 zone
- Lugeon zone boundary

Fig. 4-5

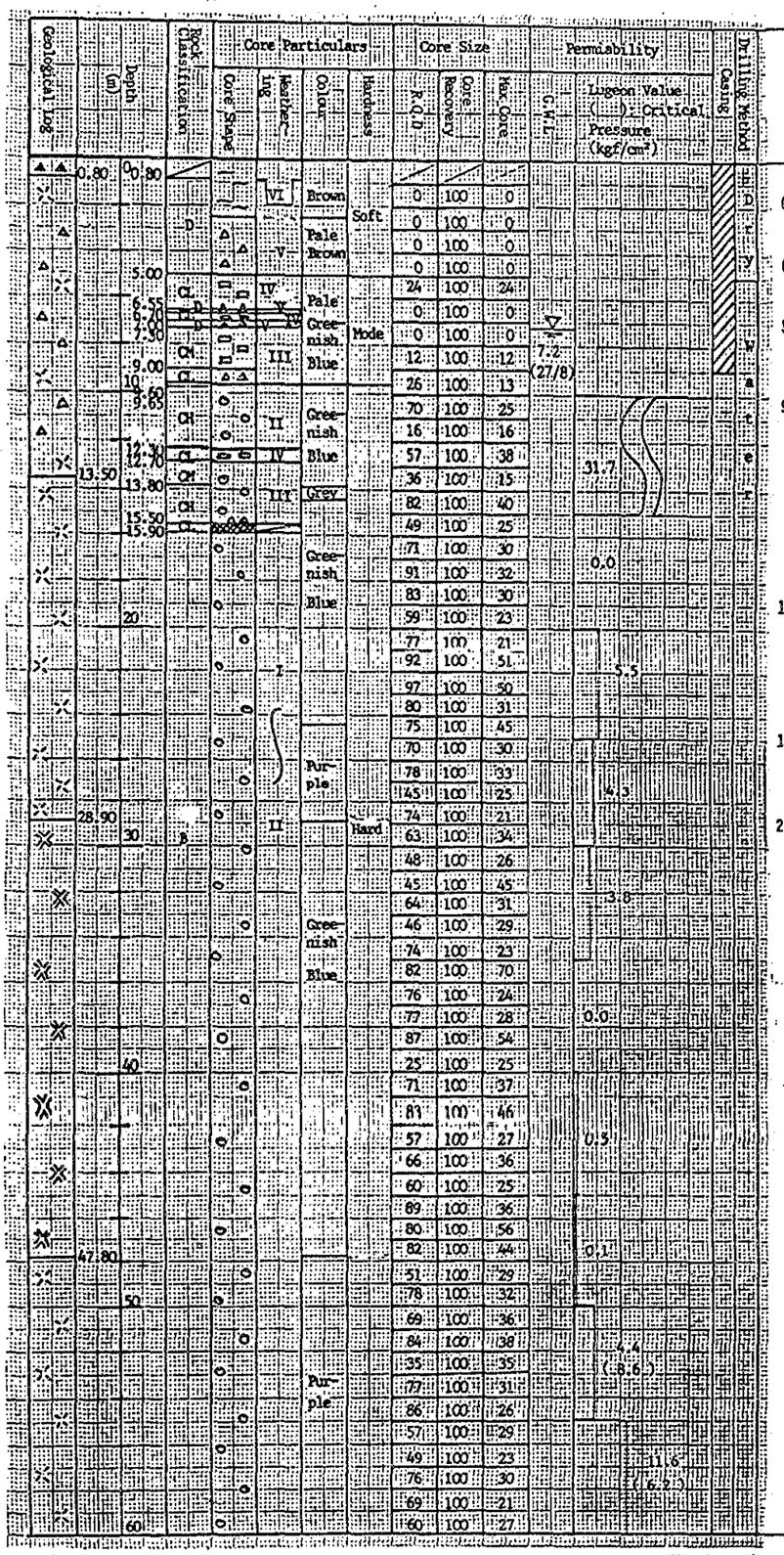
LEBIR DAM PROJECT
FEASIBILITY STUDY
KELANTAN, MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Title
Lugeon Map
along the saddle dam I axis

DATE 1988

DRAWING NO. LDP-G-009



Geological Log
- Top Soil
- Tuff Breccia ～ Tuff
- Tuff (Purple)
- Tuff (Greenish Blue)

Core Shape
- Clay ～ Sand
- Fragment ～ Rhomb.
- Rhomb. ～ Short Pole
- Pole
- Core recovery 0 portion

Hardness

Hard	A dull sound or a slightly dull sound is emitted when hammered.
Mode	Rock fragments cannot be broken by finger, but it's easy to be broken by hammer.
Soft	Rock fragments can be taken to pieces by finger.

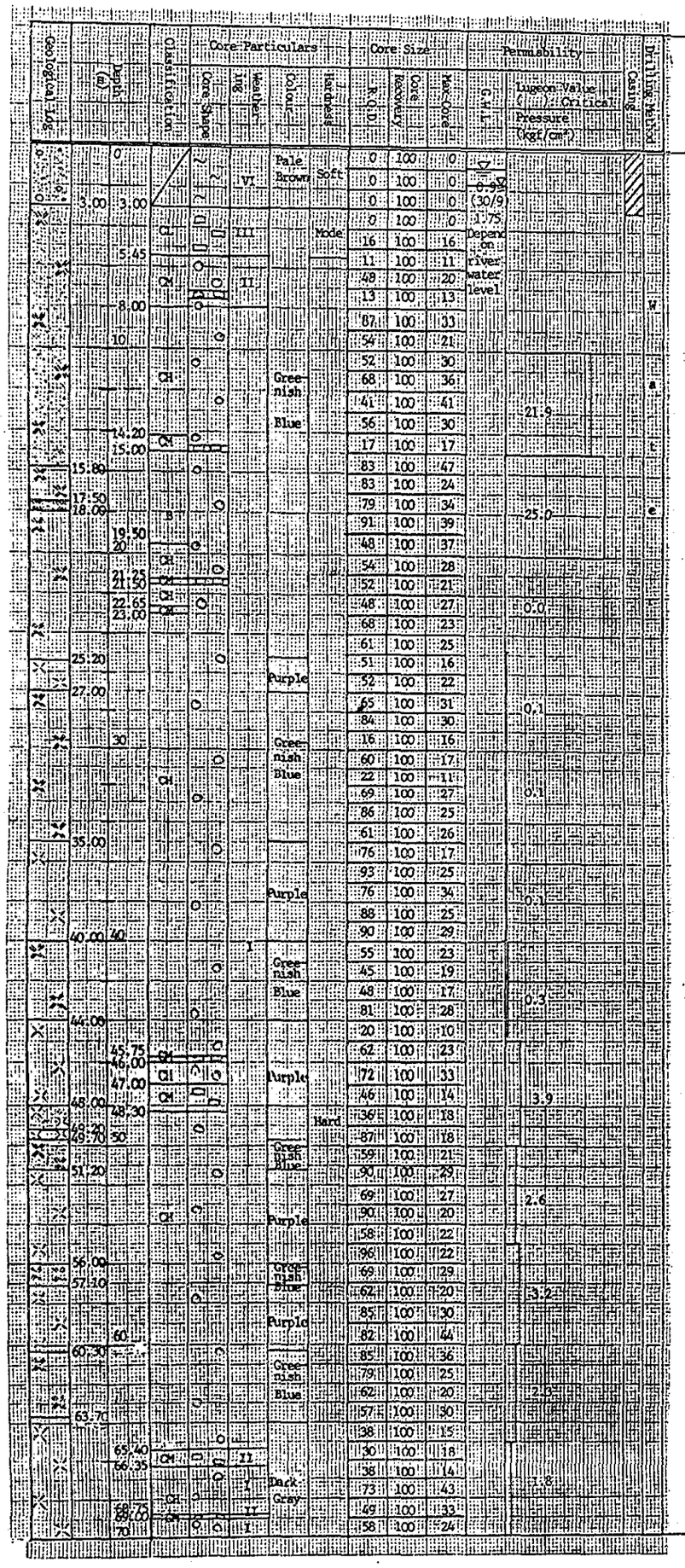
Weathering

VII	No visible signs of weathering. Rock fresh, crystals bright. Few discontinuities may show slight staining.
II	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material. Discontinuities are discoloured and discolouration can extend into rock up to a few mm from discontinuity surface.
III	Slight discolouration extends through the greater part of the rock mass. The rock material is not friable (except in the case of poorly cemented sedimentary rocks). Discontinuities are stained and/or contain a filling comprising altered materials
IV	Weathering extends throughout rock mass and the rock material is partly friable Rock has no lustre. All material except quartz is discoloured. Rock can be excavated with geologist's pick.
V	Rock is totally discoloured and decomposed and in a friable condition with only fragments of the rock texture and structure preserved. The external appearance is that of a soil.
VI	Soil material with complete disintegration of texture, structure and mineralogy of the parent rock.

I Unweathered rock
II Slightly weathered rock
III Moderately weathered rock
IV Highly weathered rock
V Completely weathered rock
VI Residual soil

Fig. 4-6

Drilling Number	D-1
Location	Dam Site Left-Upper Bank
Length	L = 60 m
Level	EL. 107.889
Direction	Vertical



Geological Log
- River Accumulation
- Tuff (fine, purple- dark grey)
- Tuff (coarse, purple)
- Tuff (fine, greenish blue)
- Tuff (coarse, greenish blue)

Core Shape
- Clay - Sand
- Rhomb. - Short Pole
- Pole

Hardness
- Hard — A dull sound or a slightly dull sound is emitted when hammered.
- Mode — Rock fragments cannot be broken by finger, but it's easy to be broken by hammer.
- Soft — Rock fragments can be taken to pieces by finger.

Weathering
- I — No visible signs of weathering. Rock fresh, crystals bright. Few discontinuities may show slight staining.
- II — Penetrative weathering developed on open discontinuity surface but only slight weathering of rock material. Discontinuities are discoloured and discolouration can extend into rock up to a few mm from discontinuity surface.
- III — Slight discolouration extends through the greater part of the rock mass. The rock materials is not friable (except in the case of poorly cemented sedimentary rocks). Discontinuities are stained and/or contain a filling comprising altered materials.
- IV — Weathering extends throughout rock mass and the rock material is partly friable. Rock has no lustre. All materials except quartz is discoloured. Rock can be excavated with geologist's pick.
- V — Rock is totally discoloured and decomposed and in a friable condition with only fragments of the rock texture appearance is that of a soil.
- VI — Soil material with complete disintegration of texture, structure and mineralogy of the parent rock.

I Unweathered rock
II Slightly weathered rock
III Moderately weathered rock
IV Highly weathered rock
V Completely weathered rock
VI Residual soil

Fig. 4-7

Drilling Number	D-2
Location	Main Dam Bottom Of River
Length	L = 70 m
Level	EL. 28.423
Direction	Vertical

Geological Log	Depth (m)	Classification	Core Particulars: Core Shape	Core Particulars: Weather-ing	Core Particulars: Colour	Core Particulars: Hardness	Core Size: R.Q.D.	Core Size: Recovery	Core Size: Max. Core	Core Size: G.W.L.	Permeability: Lugeon Value ( ): Critical Pressure (kgf/cm²)	Casing	Drilling Method	Description
	0.20	D		VI	Brown	Soft	0	100	0				D	0.00～0.20m Soft,brown,sandy silty clay.
	7.45	D		V	Pale Brown	Soft	0	100	0				W	0.20～6.00m Loose to dense,pale brown,clayey silty fine sand.
	8.75			III	Pale Brown	Soft	11	100	11				W	6.00～8.75m Very weak,pale brown,highly fractured and partly decomposed.
	19.53			IV	Pale Brown	Mode	0	100	0		27.4		a	8.75～19.53m Very weak to weak,pale brown to gray, highly fractured and slightly decomposed, tuffaceous sandstone.
	20.50				Gray		12	100	12		14.3		e	19.53～20.50m Weak,black,shale.
	22.00				Black		0	100	0				f	20.50～22.00m Weak,pale greenish blue,tuffaceous sandstone.
	25.50			II	Pale Greenish Blue		14	100	14		21.7			22.00～25.50m Weak to moderately weak,black,partly fractured,shale.
	26.20	CH			Black		11	100	11					22.20～22.35m quartz vein(70° inclination).
	26.70	CH			Pale Greenish Blue		26	100	15					
	27.25	CH		III	Black		33	100	11					25.50～30.00m Moderately weak to strong,pale greenish blue,partly fractured,tuffaceous sandstone.
	29.90	CH			Pale Greenish Blue		11	100	11		5.3 (8.3)			
	30.00	CH			Black		10	100	10					30.00～33.60m Weak,black,partly fractured,shale.
	32.65	CH			Pale Greenish Blue		48	100	17					
	32.80	CH		II	Black	Hard	59	100	33					33.60～37.85m Weak,pale greenish blue,partly fractured, tuffaceous sandstone.
	33.60	CH			Pale Greenish Blue		64	100	22	28.50				
	36.90	CH			Black		14	100	14	(13/10				37.85～39.00m Weak,black,shale.
	37.85	CH		I	Pale Greenish Blue		27	100	14		4.8			
	39.00	CH			Black		0	100	0					39.00～48.00m Weak,pale greenish blue,gravelly fractured,tuffaceous sandstone.
	40	CH		II	Pale Greenish Blue		0	100	0					
	43.00	CH			Black		28	100	18		3.8			
	43.80	CH		III	Pale Greenish Blue		0	100	0					
	46.15	CH		II	Black		15	100	15					
	48.00	CH		III	Pale Greenish Blue		31	100	17					48.00～56.30m Weak to moderately weak,pale greenish blue,partly fractured,tuffaceous sandstone.
	50	CH		II	Pale Greenish Blue		15	100	15					
	56.30	CH			Black		0	100	0		3.2			
	58.60	CH		I	Pale Greenish Blue		0	100	0					
	60.00	CH			Black		24	100	13					56.30～60.00m Moderately weak to moderately strong, pale greenish blue,partly fractured, tuffaceous sandstone.
					Pale Greenish Blue		12	100	12					
					Black		0	100	0					
					Pale Greenish Blue		24	100	13					
					Black		56	100	18		3.2			
					Pale Greenish Blue		43	100	16					
					Black		56	100	20					
					Pale Greenish Blue		24	100	13					
					Black		41	100	18		3.3 (10.8)			
					Pale Greenish Blue		69	100	33					
					Black		26	100	16					
					Pale Greenish Blue		50	100	19					

Geological Log

- Top Soil
- Tuff (fine, Greenish Blue)
- Tuffaceous Sandstone (Pale Greenish Blue)
- Shale (Black)

Core Shape

- Clay ~ Sand
- Fragment ~ Rhomb
- Rhomb ~ Short Pole
- Pole

Hardness

- Hard: A dull sound or a slightly dull sound is emitted when hammered.
- Mode: Rock fragments cannot be broken by finger, but it's easy to be broken by hammer.
- Soft: Rock fragments can be taken to pieces by finger.

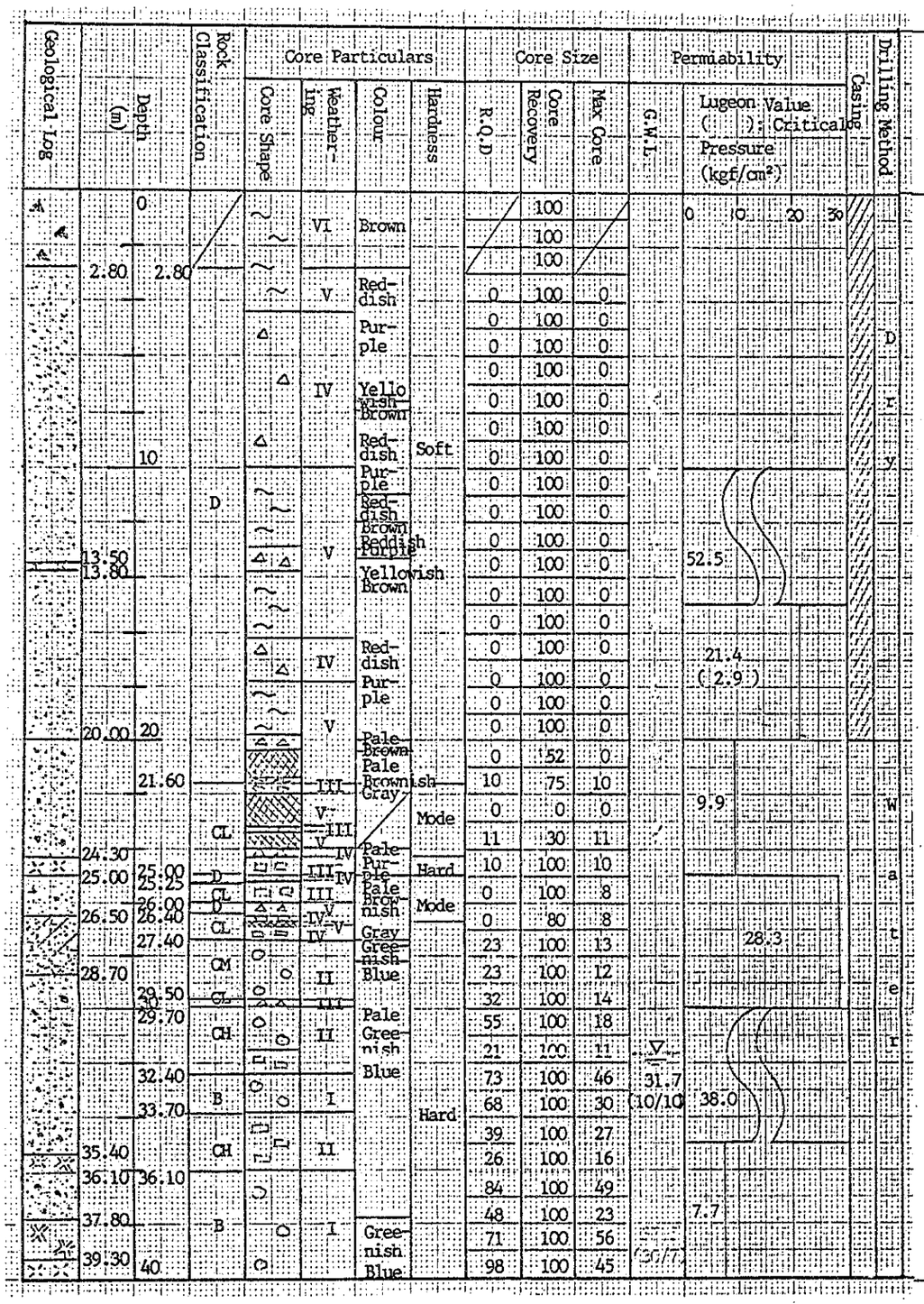
Weathering

- I: No visible signs of weathering. Rock fresh, crystals bright. Few discontinuities may show slight staining.
- II: Penetrative weathering developed on open discontinuity surface but only slight weathering of rock material. Discontinuities are discoloured and discolouration can extend into rock up to a few mm from discontinuity surface.
- III: Slight discolouration extends through the greater part of the rock mass, the rock material is not friable except in the case of poorly cemented sedimentary rocks. Discontinuities are stained and/or contain a filling comprising altered materials.
- IV: Weathering extends throughout rock mass and the rock material is partly friable. Rock has no lustre. All material except quartz is discoloured. Rock can be excavated with geologist's pick.
- V: Rock is totally discoloured and decomposed and in a friable condition with structure preserved. The external appearance is that of a soil.
- VI: Soil material with complete disintegration of texture, structure and mineralogy of the parent rock.

I Unweathered rock
II Slightly weathered rock
III Moderately weathered rock
IV Highly weathered rock
V Completely weathered rock
VI Residual soil

Fig. 4-8

Drilling Number	D-3
Location	Dam Site Right-Upper Bank
Length	L = 60 m
Level	El. 115.109
Direction	Vertical



Geological Log

- Top Soil and Talus Deposit
- Tuff (Purple)
- Tuff (Greenish Blue)
- Tuffaceous Sandstone
- Tuffaceous Conglomerate

Core Shape

- Clay - Sand.
- Fragment - Rhomb.
- Rhomb. - Short Cylindric
- Cylindric
- Core recovery 0 portion

Hardness

Hard	A dull sound or a slightly dull sound is emitted when hammered.
Mode	Rock fragments cannot be broken by finger, but it's easy to be broken by hammer.
Soft	Rock fragments can be taken to pieces by finger.

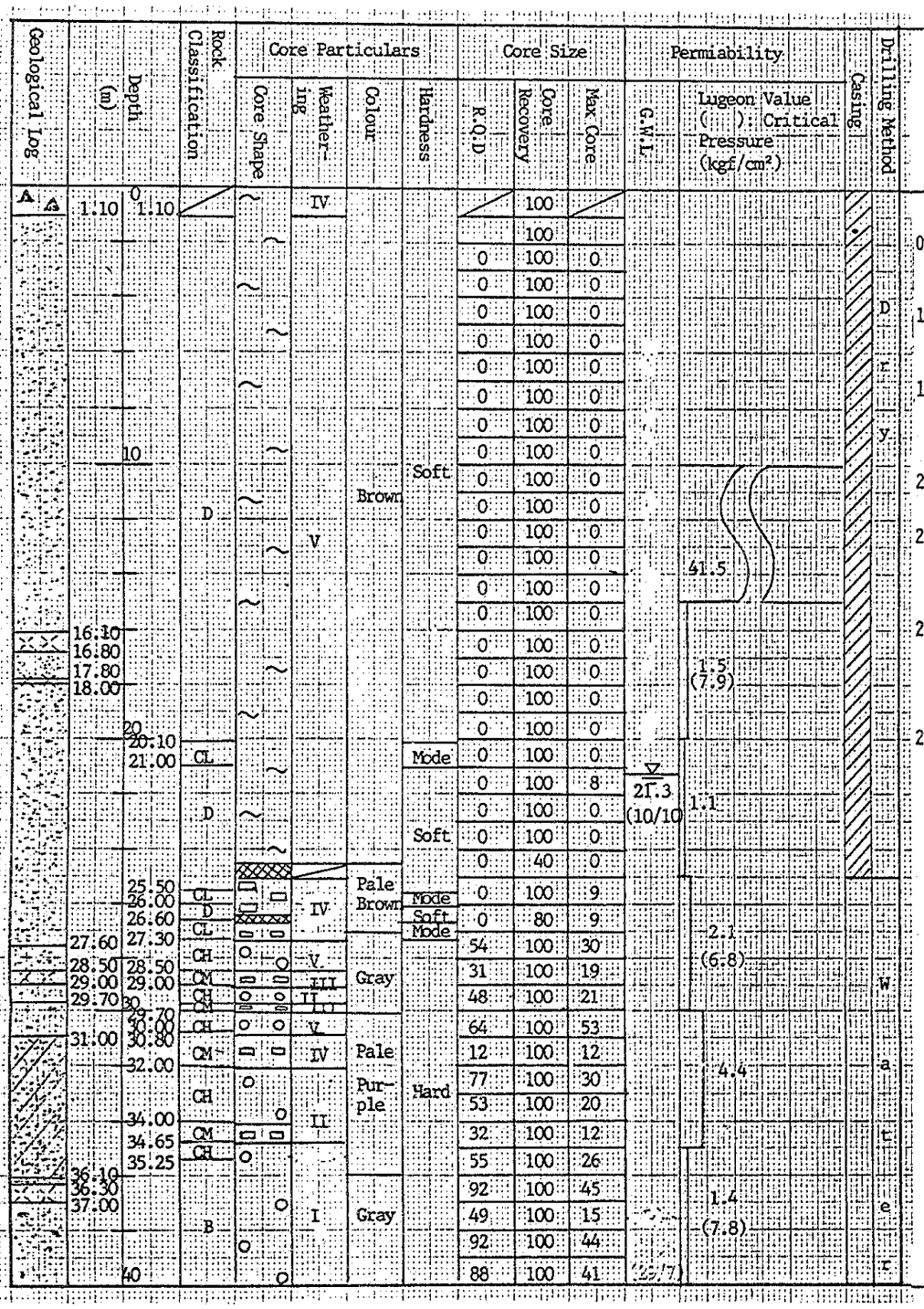
Weathering

I	No visible signs of weathering. Rock fresh, crystals bright. Few discontinuities may show slight staining.
II	Penetrative weathering developed on open discontinuity surface but only slight weathering of rock material. Discontinuities are discoloured and discolouration can extend into rock up to a few mm from discontinuity surface
III	Slight discolouration extends through the greater part of the rock mass. The rock material is not friable (except in the case of poorly cemented sedimentary rocks). Discontinuities are stained and/or contain a filling comprising altered materials.
IV	Weathering extends throughout rock mass and the rock material is partly friable. Rock has no lustre. All materials except quartz is discoloured. Rock can be excavated with geologist's pick.
V	Rock is totally discoloured and decomposed and in a friable condition with only fragments of the rock texture and structure preserved. The external appearance is that of a soil.
VI	Soil material with complete disintegration of texture, structure and mineralogy of the parent rock.

I Unweathered rock
II Slightly weathered rock
III Moderately weathered rock
IV Highly weathered rock
V Completely weathered rock
VI Residual soil

Fig. 4-9

Drilling Number	S-1
Location	Saddle Dam I Left-Upper Bank
Length	L = 40 m
Level	EL. 103 . 306
Direction	Vertical



Geological Log

- Top Soiland Talus Deposit
- Tuff (purple)
- Tuffaceous Sandstone
- Tuffaceous Conglomerate

Core Shape

- Clay - Sand
- Rhomb. - Short Pole
- Pole
- Core recovery 0 portion

Hardness

- Hard - A dull sound or a slightly dull sound is emitted when hammered.
- Mode - Rock fragments cannot be broken by fin-ger, but it's easy to be broken by hammer.
- Soft - Rock fragments can be taken to pieces by finger.

Weathering

- I — No visible signs of weathering. Rock fresh, crystals bright. Few discontinuities may show slight staining.
- II — Open discontinuity surface but only slight weathering of rock material. Discontinuities are discoloured and discolouration can extend into rock up to a few mm from discontinuity surface.
- III — Slight discolouration extends through the greater part of the rock mass. The rock material is not friable(except in the case of poorly cemented sedimentary rocks). Discontinuities are stained and/or contain a filling comprising al-tered materials.
- IV — Weathering extends throughout rock mass and the rock material is partly friable Rock has no lustre. All material except quartz is discoloured. Rock can be ex-cavated with geologist's pick.
- V — Rock is totally discoloured and decom-posed and in a friable condition with only fragment of the rock texture and structure preserved. The external app-earance is that of a soil.
- VI — Soil material with complete disintegra-tion of texture, structure and mine-ralogy of the parent rock.

I Unweathered rock
II Slightly weathered rock
III Moderately weathered rock
IV Highly weathered rock
V Completely weathered rock
VI Residual soil

Fig. 4-10

Drilling Number	S - 2
Location	Saddle Dam I Left ..-Lower Bank
Length	L = 40 m
Level	EL. 73 . 026
Direction	Vertical

Depth (m)	Rock Classification	Core Particulars: Core Shape	Weathering	Colour	Hardness	Core Size: R.Q.D	Core Recovery	Max Core	G.W.L	Permiability: Lugeon Value ( ): Critical Pressure (kgf/cm²)	Casing	Drilling Method	Description
0			V	Pale Brown		0	100	0					0.00～2.50m Loose, pale brown, clayey silty sand.
						0	100	0					
						0	100	0					
						0	100	0					
				Pale Purple	Soft	0	100	0					
			IV			0	100	0	4.5 (19/7) (10/10				2.50～8.70m Medium dense, pale purple, clayey silt sand with a little rock fragments.
						0	100	0					
						0	100	0					
						0	100	5					
8.70 9.40 10			III		Mode	0	100	5					8.70～10.85m Very weak, gravelly and highly decomposed tuffaceous sandstone-conglomerate, cracks are narrow with fine grained material.
	CL					0	80	7					
10.85						45	100	23		9.2			
	CM		II			70	100	18					10.85～14.00m Moderately weak to moderately strong, tuffaceous conglomerate. Lamina is remarkable(50° ～60° inclination).
13.50						60	100	34					
14.00	CH			Pale		56	100	23					
14.60 14.85	CM			Gray		96	100	49					
15.40 16.00						84	100	28					14.00～21.60m Moderately strong to very strong, tuffaceous sandstone-conglomerate.
						53	100	20		41.4			
18.30 19.00	B		I			86	100	50					
20						85	100	43					
20.50						76	100	39					21.60～25.00m Moderately strong, tuffaceous sandstone-conglomerate.
21.60					Hard	75	100	42					
22.00						66	100	22		3.9 (8.6)			
23.00	CH		II			32	100	18					
24.00 24.80						62	100	22					
24.90 25.00						87	100	32					25.00～40.00m Very strong, alternation which consists of tuffaceous sandstone, tuffaceous conglomerate and tuff.
25.65 26.10						80	100	70					
26.50						96	100	54					
27.95						82	100	28		31.8			
28.35			I			65	100	38					
29.55 30	B					98	100	57					
30.20 30.85						94	100	71					
31.00						98	100	42					
						89	100	63		5.0			
						96	100	29					
						79	100	60					
						90	100	45					
37.00						93	100	57		3.0			
37.30 38.00						88	100	40					
38.40 38.70						97	100	60					
39.80 40													

Geological Log

- Tuff (purple)
- Tuffaceous Sandstone
- Tuffaceous Conglomerate

Core Shape

- Clay - Sand
- Pole
- Rhomb. - Short Pole
- Core recovery 0 portion

Hardness

- Hard - A dull sound or a slightly dull sound is emitted when hammered.
- Mode - Rock fragments cannot be broken by finger, but it's easy to be broken by hammer.
- Soft - Rock fragments can be taken to pieces by finger.

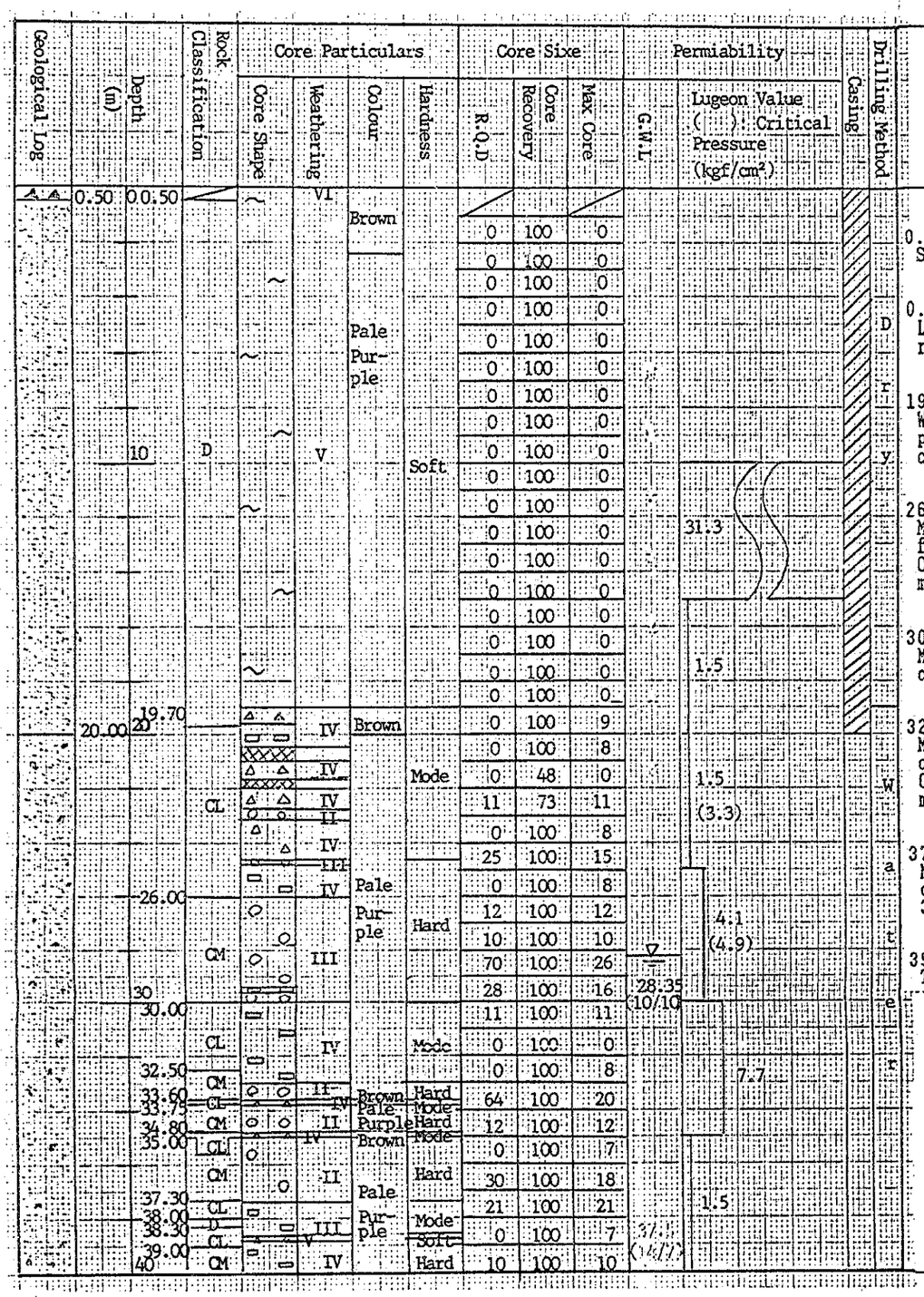
Weathering

I	No visible signs of weathering. Rock fresh, crystals bright. Few discontinuities may show slight staining.
II	Penetrative weathering developed on open discontinuity surface but only slight weathering of rock material. Discontinuities are discoloured and discolouration can extend into rock up to a few mm from discontinuity surface.
III	Slight discolouration extends through the greater part of the rock mass. The rock material is not friable(except in the case of poorly cemented sedimentary rocks). Discontinuities are stained and/or contain a filling comprising altered materials.
IV	Weathering extends throughout rock mass and the rock material is partly friable. Rock has no lustre. All material except quartz is discoloured. Rock can be excavated with geologist's pick.
V	Rock is totally discoloured and decomposed and in a friable condition with only fragment of the rock texture and structure preserved. The external appearance is that of a soil.
VI	Soil material with complete disintegration of texture, structure and mineralogy of the parent rock.

I Unweathered rock
II Slightly weathered rock
III Moderately weathered rock
IV Highly weathered rock
V Completely weathered rock
VI Residual soil

Fig. 4-11

Drilling Number	S - 3
Location	Saddle Dam I Bottom Of River
Length	L = 40 m
Level	EL. 43 . 108
Direction	Vertical



0.00～0.50m
Soft, brown, sandy silty clay.

0.50～19.70m
Loose to dense, clayey silty sand with a little rock fragments.

19.70～26.00m
Weak to maderately weak, highly fractured and partly decomposed, tuffaceous sandstone-conglomerate.

26.00～30.00m
Moderately weak to moderately strong, partly fractured, tuffaceous conglomerate.
Cracks are narrow with much fine grained material.

30.00～32.50m
Moderately weak, highly fractured, tuffaceous conglomerate.

32.50～37.30m
Moderately strong, partly fractured, tuffaceous conglomerate.
Cracks are narrow with much fine grained material.

37.30～39.00m
Moderately weak highly fratured, tuffaceous conglomerate.
38.00～38.30m rock fragments with clay.

39.00～40.00m
The same condition as 32.50～37.30m section.

Geological Log

- Top Soil
- Tuffaceous Sandstone
- Tuffaceous Conglomerate

Core Shape

- Clay - Sand
- Fragment - Rhomb.
- Rhomb. - Short Pole
- Pole
- Core recovery 0 portion

Hardness

- Hard – A dull sound or a slightly dull sound is emitted when hammered.
- Mode – Rock fragments cannot be broken by finger, but it's easy to be broken by hammer.
- Soft – Rock fragments can be taken to pieces by finger.

Weathering

- I — No visible signs of weathering. Rock fresh, crystals bright. Few discontinuities may show slight staining.
- II — Open discontinuity surface but only slight weathering of rock material. Discontinuities are discoloured and discolouration can extend into rock up to a few mm from discontinuity surface.
- III — Slight discolouration extends through the greater part of the rock mass. The rock material is not friable (except in the case of poorly cemented sedimentary rocks). Discontinuities are stained and/or contain a filling comprising altered materials.
- IV — Weathering extends throughout rock mass and the rock material is partly friable. Rock has no lustre. All material except quartz is discoloured. Rock can be excavated with geologist's pick.
- V — Rock is totally discoloured and decomposed and in a friable condition with only fragment of the rock texture and structure preserved. The external appearance is that of a soil.
- VI — Soil material with complete disintegration of texture, structure and mineralogy of the patent rock.

I Unweathered rock
II Slightly weathered rock
III Moderately weathered rock
IV Highly weathered rock
V Completely weathered rock
VI Residual soil

Fig. 4－12

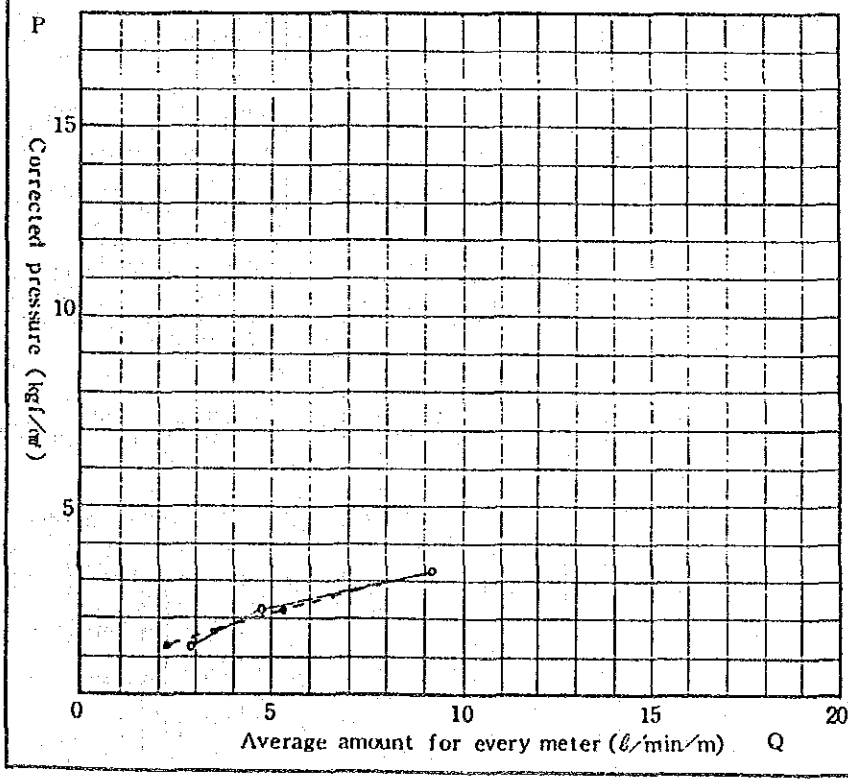
Drilling Number	S－4
Location	Saddle Dam I Right Upper Bank
Length	L = 40 m
Level	EL. 108．789
Direction	Vertical

Lugeon Test Data Sheet

Stage No. 1

Location	Main Dam	Name of hole	D - 1	Depth (m)	10.0 ~ 15.0	Length of test section (m)	5.0
Water Level (m)	Nothing	Hight of gauge (m)	1.0	Length of rod (m)	11.0	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	15/8

Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
0.0	0.2	1.3	14	15	6	22	15	14.3	2.9
			14	15	14	14	14		
1.0	0.5	2.3	23	25	22	26	23	24.2	4.8
			28	21	25	23	26		
2.0	1.6	3.2	42	49	51	46	46	45.9	9.2
			41	46	45	45	48		
1.0	0.5	2.3	25	23	29	28	26	26.6	5.3
			28	27	26	28	26		
0.0	0.1	1.3	12	12	12	11	12	11.0	2.2
			11	11	10	9	10		



Lugeon value (Lu)	-
Calculated Lugeon Value (Lu')	31.7
Maximum pressure (kgf/cm²)	3.2
Critical pressure (kgf/cm²)	-

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)

P : Corrected pressure (kgf/cm²)

P_0 : Reading of gauge (kgf/cm²)

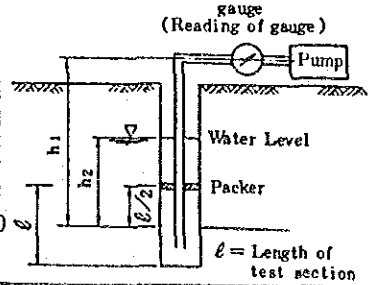
γ_w : Unitweight of water

$h_3 = \alpha Q_0^2 L$

Q_0 : Average amount (ℓ/min)

L : Length of Rod (m)

α : A coefficient (7×10^{-5} min²/ℓ²)

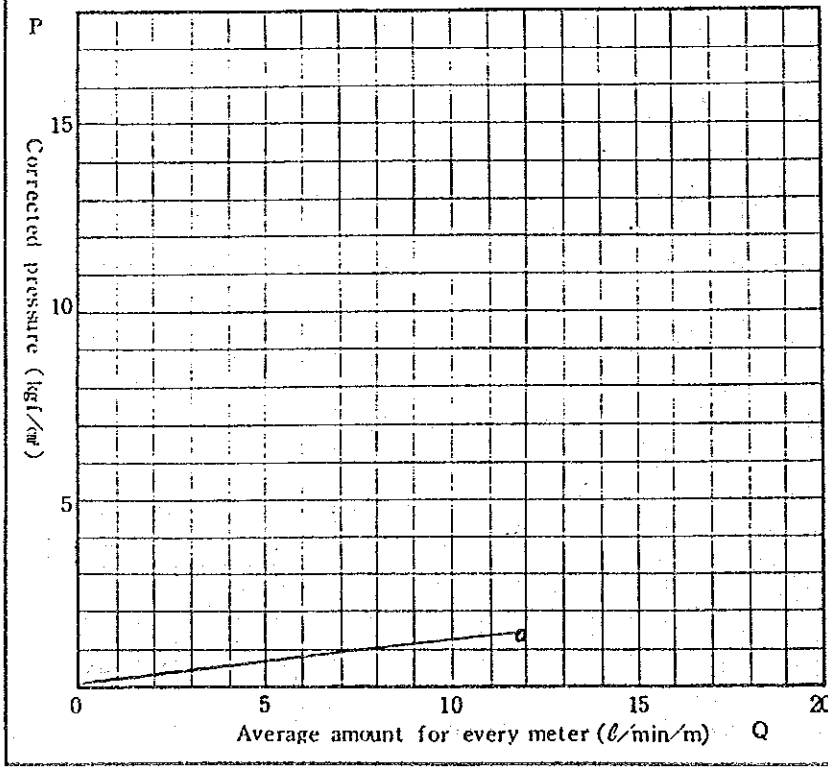


Lugeon Test Data Sheet

Stage No. 2

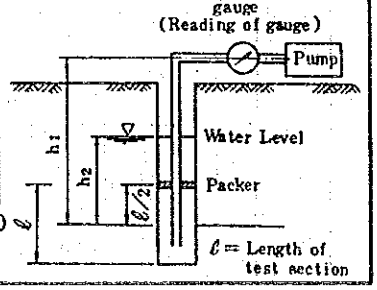
Location	Main Dam	Name of hole	D - 1	Depth (m)	15.0~20.0	Length of test section (m)	5.0
Water Level (m)	Nothing	Hight of gauge (m)	0.5	Length of rod (m)	15.5	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	16/8

Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
			61	60	59	57	65		
0.0	3.8	1.4	61	60	59	57	55	59.4	11.9
	Open crack exist in 15.50 - 16.00m in depth. The water injected								
	leak through these cracks.								
	There was not water return from the mouth of the hole.								



Lugeon value (Lu)	—
Calculated Lugeon Value (Lu')	—
Maximum pressure (kgf/cm²)	—
Critical pressure (kgf/cm²)	—

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)
P : Corrected pressure (kgf/cm²)
P_0 : Reading of gauge (kgf/cm²)
γ_w : Unitweight of water
$h_3 = \alpha Q_0^2 L$
Q_0 : Average amount (ℓ/min)
L : Length of Rod (m)
α : A coefficient (7×10^{-5} min²/ℓ²)

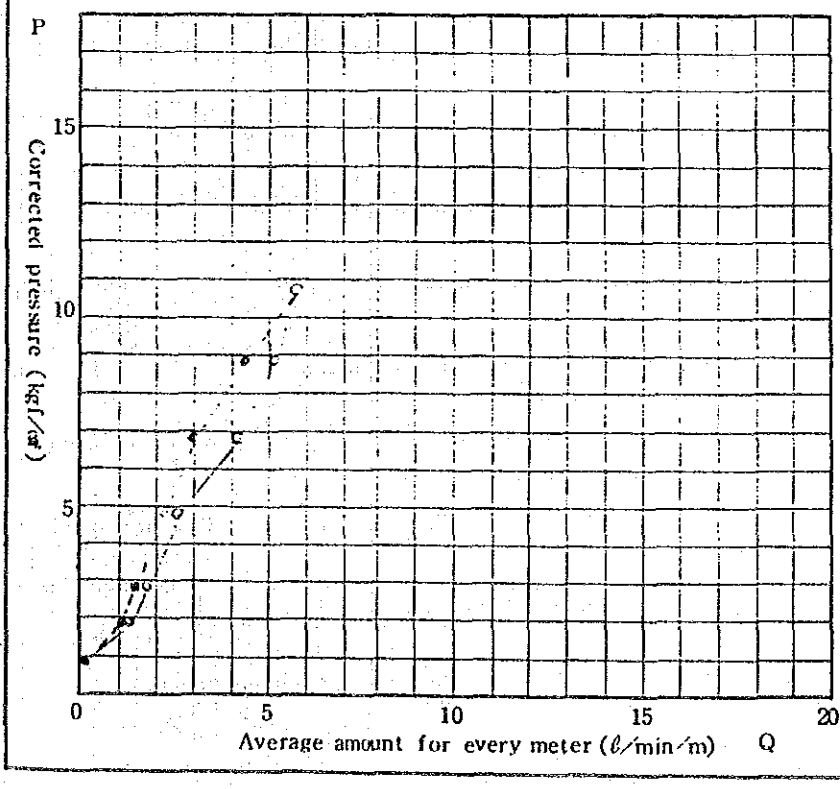


Lugeon Test Data Sheet

Stage No. 3

Location	Main Dam	Name of hole	D - 1	Depth (m)	20.0~ 25.0	Length of test section (m)	5.0
Water Level (m)	8.0	Hight of gauge (m)	1.5	Length of rod (m)	21.5	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	17/8

Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
0.0	0.0	0.9	0	1	0	1	0	0.4	0.1
			0	1	0	1	0		
1.0	0.1	1.9	6	7	5	6	6	6.1	1.2
			5	7	7	6	6		
2.0	0.1	2.9	9	10	11	8	9	9.2	1.8
			10	9	8	9	9		
4.0	0.2	4.9	12	13	13	12	11	12.8	2.6
			11	11	12	11	22		
6.0	0.6	6.9	18	20	19	37	18	20.7	4.1
			18	18	20	20	19		
8.0	1.0	8.9	25	24	25	26	27	25.3	5.1
			25	25	26	26	24		
10.0	1.2	10.8	30	28	29	29	29	28.8	5.8
			30	28	29	28	28		
8.0	0.7	8.9	22	21	23	22	23	22.1	4.4
			22	21	22	22	23		
6.0	0.3	6.9	16	15	15	15	15	15.2	3.0
			14	15	15	16	16		
4.0	0.2	4.9	10	11	12	11	11	10.8	2.2
			11	10	10	11	11		
2.0	0.1	2.9	9	8	8	8	9	7.9	1.6
			8	9	8	7	5		
1.0	0.0	1.9	6	5	5	4	4	5.3	1.1
			6	6	6	6	5		
0.0	0.0	0.9	1	0	1	0	1	0.5	0.1
			0	0	1	0	1		



Lugeon value (Lu)	5.5
Calculated Lugeon Value (Lu')	-
Maximum pressure (kgf/cm²)	10.8
Critical pressure (kgf/cm²)	-

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)

P : Corrected pressure (kgf/cm²)

P_0 : Reading of gauge (kgf/cm²)

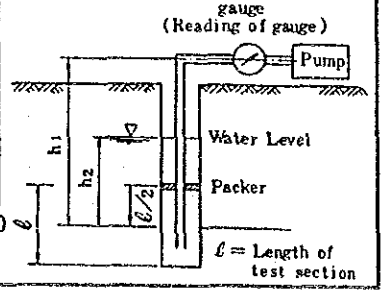
γ_w : Unitweight of water

$h_3 = \alpha Q_0^2 L$

Q_0 : Average amount (ℓ/min)

L : Length of Rod (m)

α : A coefficient (7×10^{-5} min²/ℓ²)

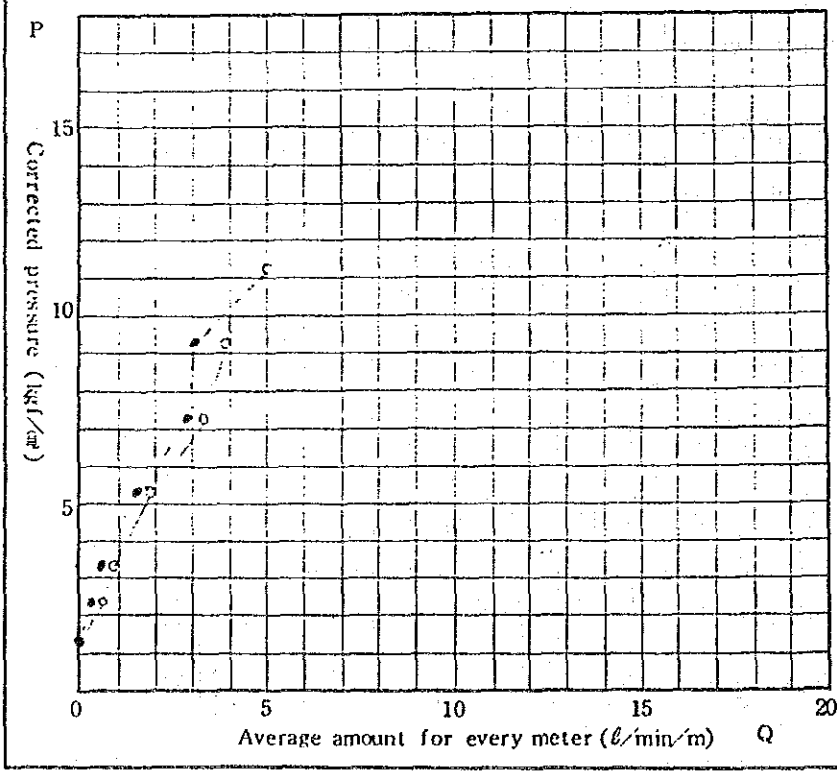


Lugeon Test Data Sheet

Stage No. 4

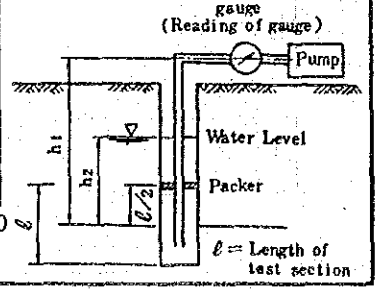
Location	Main Dam	Name of hole	D - 1	Depth (m)	25.0 ~ 30.0	Length of test section (m)	5.0
Water Level (m)	8.0	Hight of gauge (m)	5.0	Length of rod (m)	25.5	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	20/8

Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
0.0	0.0	1.3	0	1	0	0	1	0.3	0.1
			0	0	1	0	0		
1.0	0.0	2.3	4	4	4	2	2	2.8	0.6
			3	4	3	1	1		
2.0	0.0	3.3	5	6	6	5	4	4.5	0.9
			5	3	5	3	3		
4.0	0.2	5.3	4	11	11	11	11	9.7	1.9
			10	11	9	9	10		
6.0	0.5	7.3	17	16	15	16	17	16.2	3.2
			17	16	16	16	16		
8.0	0.7	9.2	19	20	20	20	19	19.3	3.9
			20	19	18	19	19		
10.0	1.1	11.2	26	49	24	24	15	25.1	5.0
			24	25	25	14	25		
8.0	0.4	9.3	17	17	16	16	10	15.6	3.1
			14	17	16	16	17		
6.0	0.4	7.3	14	13	23	14	14	14.7	2.9
			13	14	14	14	14		
4.0	0.1	5.3	8	8	8	7	7	7.6	1.5
			6	8	8	8	8		
2.0	0.0	3.3	3	3	4	3	2	3.1	0.6
			4	3	3	3	3		
1.0	0.0	2.3	1	2	2	1	1	1.7	0.3
			1	3	2	2	2		
0.0	0.0	1.3	0	0	0	1	0	0.3	0.1
			0	1	0	0	1		



Lugeon value (Lu)	4.3
Calculated Lugeon Value (Lu')	-
Maximum pressure (kgf/cm²)	11.2
Critical pressure (kgf/cm²)	-

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)
P : Corrected pressure (kgf/cm²)
P_0 : Reading of gauge (kgf/cm²)
γ_w : Unitweight of water
$h_3 = \alpha Q_0^2 L$
Q_0 : Average amount (ℓ/min)
L : Length of Rod (m)
α : A coefficient (7×10^{-5} min²/ℓ²)

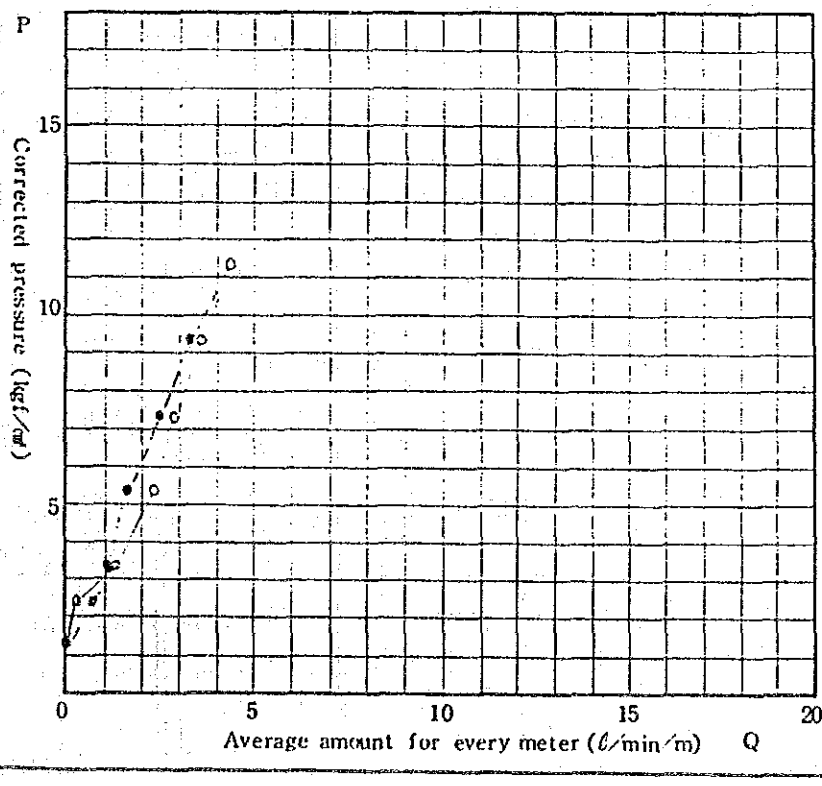


Lugeon Test Data Sheet

Stage No. 5

Location	Main Dam	Name of hole	D - 1	Depth (m)	30.0~35.0	Length of test section (m)	5.0
Water Level (m)	9.2	Hight of gauge (m)	5.0	Length of rod (m)	30.5	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	22/8

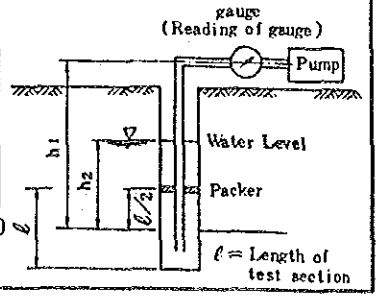
Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
			0	0	0	1	0		
0.0	0.0	1.4	0	0	1	0	0	0.2	0.0
			1	1	1	2	1		
1.0	0.0	2.4	2	2	2	2	2	1.6	0.3
			5	6	6	6	6		
2.0	0.1	3.4	6	6	6	6	5	5.8	1.2
			10	11	11	11	12		
4.0	0.3	5.4	11	11	11	11	11	11.0	2.2
			14	15	14	15	15		
6.0	0.5	7.4	15	16	15	14	13	14.6	2.9
			19	17	18	17	16		
8.0	0.7	9.4	18	17	19	18	19	17.8	3.6
			20	21	26	21	21		
10.0	1.0	11.3	22	21	20	21	20	21.3	4.3
			18	17	18	17	18		
8.0	0.6	9.4	17	17	18	16	16	17.2	3.4
			12	13	14	13	12		
6.0	0.4	7.4	11	14	13	13	14	12.9	2.6
			10	9	8	10	10		
4.0	0.2	5.4	9	9	8	8	8	8.7	1.7
			5	7	6	6	5		
2.0	0.1	3.4	5	6	5	5	6	5.6	1.1
			3	3	3	3	12		
1.0	0.0	2.4	3	3	3	3	2	3.8	0.8
			0	0	0	0	0		
0.0	0.0	1.4	0	1	0	0	0	0.1	0.0



Lugeon value (Lu)	3.8
Calculated Lugeon Value (Lu')	-
Maximum pressure (kgf/cm²)	11.3
Critical pressure (kgf/cm²)	-

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)
P : Corrected pressure (kgf/cm²)
P_0 : Reading of gauge (kgf/cm²)
γ_w : Unitweight of water

$h_3 = \alpha Q_0^2 L$
Q_0 : Average amount (ℓ/min)
L : Length of Rod (m)
α : A coefficient (7×10^{-5} min²/ℓ²)

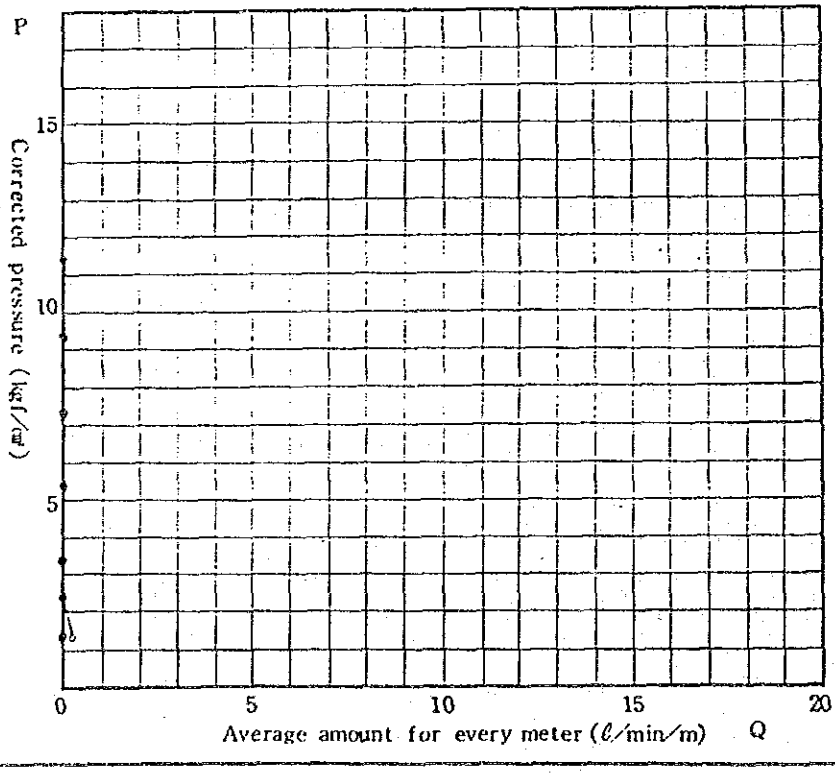


Lugeon Test Data Sheet

Stage No. 6

Location	Main Dam	Name of hole	D - 1	Depth (m)	35.0~40.0	Length of test section (m)	5.0
Water Level (m)	8.7	Hight of gauge (m)	5.0	Length of rod (m)	36.5	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	23/8

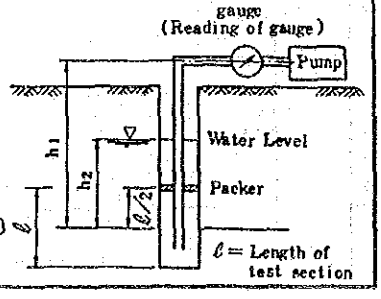
Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
0.0	0.0	1.4	0	1	2	1	1	1.1	0.2
			1	1	2	1	1		
1.0	0.0	2.4	1	0	1	0	0	0.2	0.0
			0	0	0	0	0		
2.0	0.0	3.4	0	0	0	0	0	0.1	0.0
			1	0	0	0	0		
4.0	0.0	5.4	0	0	0	0	0	0.1	0.0
			0	1	0	0	0		
6.0	0.0	7.4	0	0	0	0	0	0.1	0.0
			0	1	0	0	0		
8.0	0.0	9.4	0	0	0	0	0	0.0	0.0
			0	0	0	0	0		
10.0	0.0	11.4	0	0	0	0	0	0.0	0.0
			0	0	0	0	0		
8.0	0.0	9.4	0	0	0	0	0	0.0	0.0
			0	0	0	0	0		
6.0	0.0	7.4	0	0	0	0	0	0.0	0.0
			0	0	0	0	0		
4.0	0.0	5.4	0	0	0	0	0	0.0	0.0
			0	0	0	0	0		
2.0	0.0	3.4	0	0	1	0	0	0.1	0.0
			0	0	0	0	0		
1.0	0.0	2.4	0	0	0	0	0	0.0	0.0
			0	0	0	0	0		
0.0	0.0	1.4	0	0	0	0	0	0.0	0.0
			0	0	0	0	0		



Lugeon value (Lu)	0.0
Calculated Lugeon Value (Lu')	-
Maximum pressure (kgf/cm²)	11.4
Critical pressure (kgf/cm²)	-

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)
P : Corrected pressure (kgf/cm²)
P_0 : Reading of gauge (kgf/cm²)
γ_w : Unitweight of water

$h_3 = \alpha Q_0^2 L$
Q_0 : Average amount (ℓ/min)
L : Length of Rod (m)
α : A coefficient (7×10^{-5} min²/ℓ²)

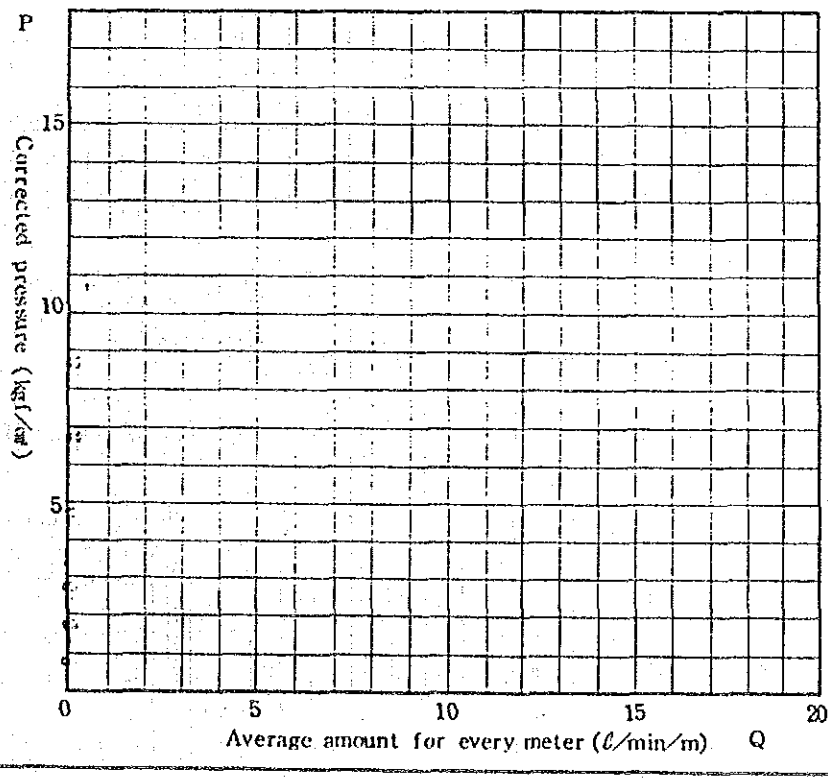


Lugeon Test Data Sheet

Stage No. 7

Location	Main Dam	Name of hole	D - 1	Depth (m)	40.0~45.0	Length of test section (m)	5.0
Water Level (m)	8.0	Hight of gauge (m)	0.5	Length of rod (m)	40.5	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	24/8

Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
0.0	0.0	0.8	0	0	0	2	0	0.2	0.0
			0	0	0	0	0		
1.0	0.0	1.8	1	0	0	0	1	0.3	0.1
			0	0	0	0	1		
2.0	0.0	2.8	1	0	1	0	1	0.7	0.1
			1	1	0	1	1		
4.0	0.0	4.8	1	0	0	1	0	0.4	0.1
			0	0	1	1	0		
6.0	0.0	6.8	3	1	2	2	2	1.7	0.3
			2	1	1	2	1		
8.0	0.0	8.8	4	2	2	2	2	1.4	0.3
			0	1	1	0	0		
10.0	0.0	10.8	2	3	2	3	3	2.9	0.6
			3	3	3	4	3		
8.0	0.0	8.8	0	1	0	0	0	0.4	0.1
			0	2	0	1	0		
6.0	0.0	6.8	1	0	0	0	1	0.4	0.1
			1	0	1	0	0		
4.0	0.0	4.8	0	0	0	0	1	0.1	0.0
			0	0	0	0	0		
2.0	0.0	2.9	0	0	0	0	0	0.0	0.0
			0	0	0	0	0		
1.0	0.0	1.8	0	0	1	0	0	0.1	0.0
			0	0	0	0	0		
0.0	0.0	0.9	0	0	0	0	0	0.0	0.0
			0	0	0	0	0		



Lugeon value (Lu)	0.5
Calculated Lugeon Value (Lu')	-
Maximum pressure (kgf/cm²)	10.8
Critical pressure (kgf/cm²)	-

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)

P : Corrected pressure (kgf/cm²)

P_0 : Reading of gauge (kgf/cm²)

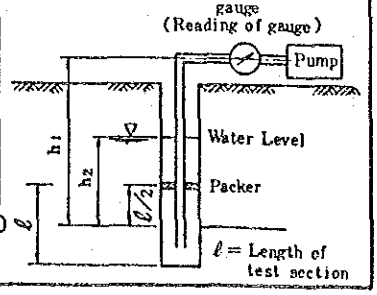
γ_w : Unitweight of water

$h_3 = \alpha Q_0^2 L$

Q_0 : Average amount (ℓ/min)

L : Length of Rod (m)

α : A coefficient (7×10^{-5} min²/ℓ²)

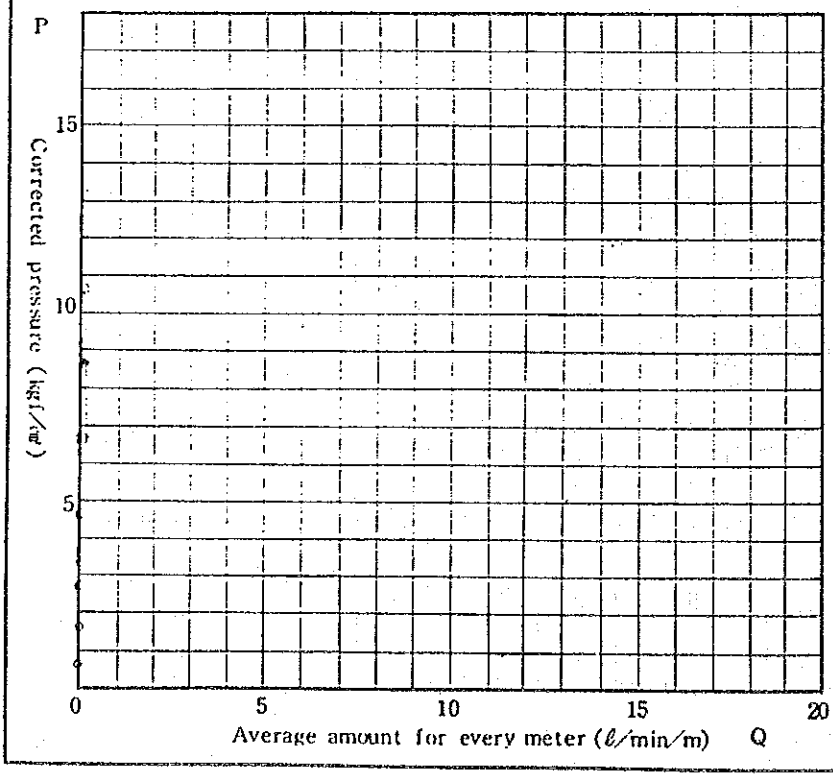


Lugeon Test Data Sheet

Stage No. 8

Location	Main Dam	Name of hole	D - 1	Depth (m)	45.0 ~ 50.0	Length of test section (m)	5.0
Water Level (m)	6.9	Hight of gauge (m)	0.5	Length of rod (m)	45.5	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	25/8

Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
0.0	0.0	0.7	0	0	1	0	0	0.2	0.0
			0	0	1	0	0		
1.0	0.0	1.7	0	0	0	1	0	0.2	0.0
			0	0	1	0	0		
2.0	0.0	2.7	1	0	0	0	0	0.2	0.0
			0	1	0	0	0		
4.0	0.0	4.7	0	0	0	0	1	0.2	0.0
			0	0	1	0	0		
6.0	0.0	6.7	0	0	0	1	0	0.3	0.1
			1	0	0	1	0		
8.0	0.0	8.7	0	1	0	1	0	0.4	0.1
			1	0	0	1	0		
10.0	0.0	10.7	0	0	1	1	1	0.6	0.1
			1	1	0	1	0		
8.0	0.0	8.7	0	1	0	0	1	0.3	0.1
			0	0	1	0	0		
6.0	0.0	6.7	0	0	1	0	0	0.2	0.0
			0	1	0	0	0		
4.0	0.0	4.7	0	0	1	0	0	0.2	0.0
			0	0	0	0	1		
2.0	0.0	2.7	0	0	0	0	0	0.1	0.0
			1	0	0	0	0		
1.0	0.0	1.7	0	0	0	0	0	0.1	0.0
			0	0	0	1	0		
0.0	0.0	0.7	0	0	0	0	0	0.1	0.0
			0	0	0	1	0		



Lugeon value (Lu)	0.1
Calculated Lugeon Value (Lu')	-
Maximum pressure (kgf/cm²)	10.7
Critical pressure (kgf/cm²)	-

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)

P : Corrected pressure (kgf/cm²)

P_0 : Reading of gauge (kgf/cm²)

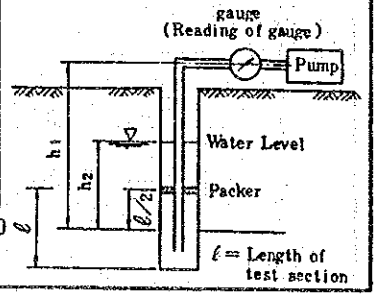
γ_w : Unitweight of water

$h_3 = \alpha Q_0^2 L$

Q_0 : Average amount (ℓ/min)

L : Length of Rod (m)

α : A coefficient (7×10^{-5} min²/ℓ²)

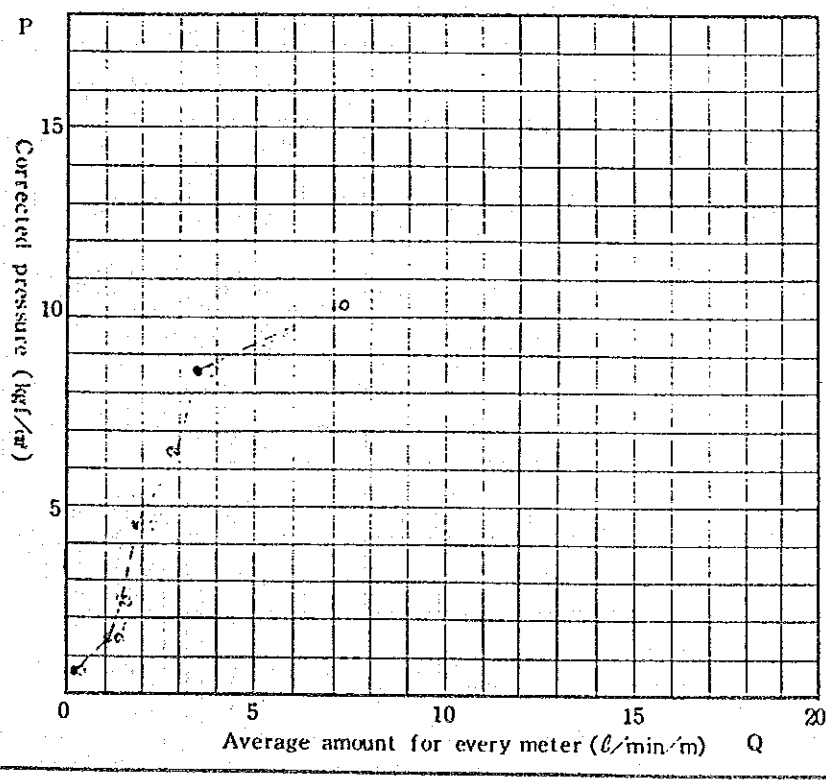


Lugeon Test Data Sheet

Stage No. 9

Location	Main Dam	Name of hole	D - 1	Depth (m)	50.0~55.0	Length of test section (m)	5.0
Water Level (m)	7.1	Hight of gauge (m)	0.5	Length of rod (m)	50.5	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	26/8

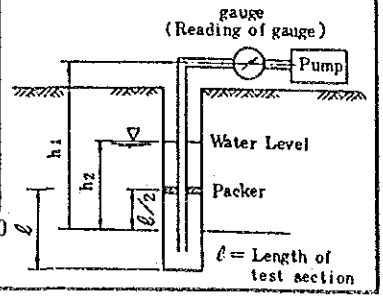
Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
0.0	0.0	0.8	2	2	1	1	1	2.0	0.4
			2	2	4	3	2		
1.0	0.2	1.7	1	6	8	6	7	6.8	1.4
			8	8	9	7	8		
2.0	0.2	2.7	9	9	8	9	8	8.2	1.6
			8	7	9	8	7		
4.0	0.5	4.7	12	12	12	11	11	11.3	2.3
			11	12	11	11	10		
6.0	0.7	6.7	16	15	14	14	14	14.2	2.8
			14	13	14	15	13		
8.0	1.4	8.6	16	20	20	20	20	19.7	3.9
			20	21	20	21	19		
10.0	4.5	10.3	38	37	36	37	36	35.8	7.2
			37	38	27	36	36		
8.0	1.2	8.6	16	21	18	17	17	18.2	3.6
			19	19	19	19	17		
6.0	0.8	6.7	14	15	15	15	14	14.7	2.9
			14	15	15	15	15		
4.0	0.3	4.7	10	10	11	11	10	9.6	1.9
			9	9	9	9	8		
2.0	0.2	2.7	8	8	8	8	8	7.3	1.5
			7	7	7	6	6		
1.0	0.1	1.7	6	6	6	5	5	5.4	1.1
			6	5	5	5	5		
0.0	0.0	0.8	1	1	2	2	1	1.0	0.2
			1	0	1	1	0		



Lugeon value (Lu)	-
Calculated Lugeon Value (Lu')	4.4
Maximum pressure (kgf/cm²)	10.3
Critical pressure (kgf/cm²)	8.6

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)
P : Corrected pressure (kgf/cm²)
P_0 : Reading of gauge (kgf/cm²)
γ_w : Unitweight of water

$h_3 = \alpha Q_0^2 L$
Q_0 : Average amount (ℓ/min)
L : Length of Rod (m)
α : A coefficient (7×10^{-5} min²/ℓ²)

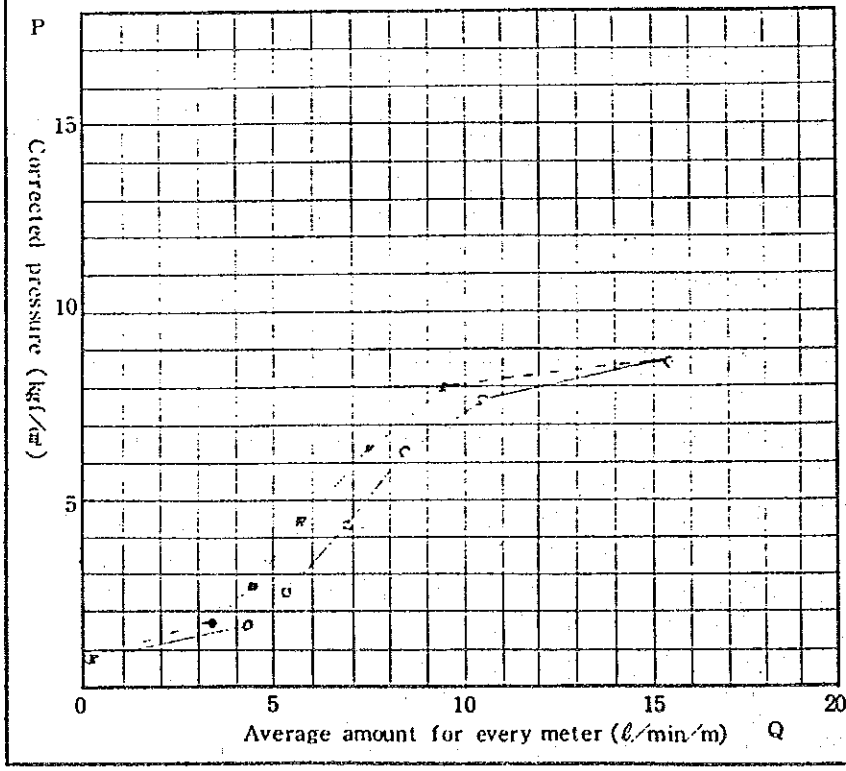


Lugeon Test Data Sheet

Stage NO. 10

Location	Main Dam	Name of hole	D - 1	Depth (m)	55.0 ~ 60.0	Length of test section (m)	5.0
Water Level (m)	8.2	Hight of gauge (m)	0.5	Length of rod (m)	55.5	Direction, Dip	Vertical
Diamiter of pipe (mm)	35	Type of packer	Expansion			Date	27/8

Reading of gauge Po (kgf/cm²)	Head loss h_3 (m)	Corrected pressure P (kgf/cm²)	Amount of injection per minutes (ℓ) 1	2	3	4	5	Average amount Q_0 (ℓ/min)	Average amount for every meter Q (ℓ/min/m)
			6	7	8	9	10		
0.0	0.0	0.9	1	0	1	0	1	0.6	0.1
			1	0	1	1	0		
1.0	1.8	1.7	20	26	22	23	23	21.8	4.4
			22	21	20	22	19		
2.0	2.9	2.6	28	29	26	27	29	27.2	5.4
			28	26	27	26	26		
4.0	4.6	4.4	35	35	33	36	34	34.3	6.9
			26	44	35	34	31		
6.0	6.6	6.2	45	43	44	43	40	41.3	8.3
			40	40	41	38	39		
8.0	10.4	7.8	52	52	49	52	52	51.7	10.3
			51	53	52	52	52		
10.0	23.0	8.6	67	76	66	164	66	77.0	15.4
			65	67	66	67	66		
8.0	8.8	8.0	50	48	48	48	48	47.7	9.5
			47	47	47	47	47		
6.0	5.3	6.3	39	38	38	37	37	36.9	7.4
			36	36	36	36	36		
4.0	3.3	4.5	30	30	30	29	29	29.0	5.8
			29	29	28	28	28		
2.0	2.1	2.7	25	25	23	23	23	23.0	4.6
			23	22	22	22	22		
1.0	1.1	1.8	19	18	17	17	17	16.9	3.4
			17	16	16	16	16		
0.0	0.0	0.9	2	2	0	1	1	0.9	0.2
			0	1	1	0	1		



Lugeon value (Lu)	-
Calculated Lugeon Value (Lu')	11.6
Maximum pressure (kgf/cm²)	8.6
Critical pressure (kgf/cm²)	6.2

$P = P_0 + \gamma_w (h_1 - h_2 - h_3)$ (kgf/cm²)
P : Corrected pressure (kgf/cm²)
P_0 : Reading of gauge (kgf/cm²)
γ_w : Unitweight of water
$h_3 = \alpha Q_0^2 L$
Q_0 : Average amount (ℓ/min)
L : Length of Rod (m)
α : A coefficient (7×10^{-5} min²/ℓ²)