WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-1 Sheet NO. 2 of 3

Stage NO.	2	Depth of packer & hole bottom	5.0 m ~ 10.0 m	Test length	5.0 m	Reporter

Time		Elapsed min	Gauge pressure Po(kg/cm²)	Effective pressure P(kg/cm²)	Water pumped-in Integrated (ℓ)	Sectional flow (ℓ/min)	Const. rate of flow Q (ℓ/min)	Lugeon value (Lu)	Remarks
hr	min								
15	30	8	3	3.04	41				
	31	9	〃	〃	46				
	32	10	〃	〃	51		4.5		
15	33	0	5	5.04					
	34	1	〃	〃	61				
	35	2	〃	〃	71				
	36	3	〃	〃	82				
	37	4	〃	〃	92				
	38	5	〃	〃	102				
	39	6	〃	〃	114				
	40	7	〃	〃	126				
	41	8	〃	〃	137				
	42	9	〃	〃	148				
	43	10	〃	〃	160		10.9		
15	46	0	3	3.04					
	47	1	〃	〃	167				
	48	2	〃	〃	174				
	49	3	〃	〃	181				
	50	4	〃	〃	189				
	51	5	〃	〃	195				
	52	6	〃	〃	202				
	53	7	〃	〃	209				
	54	8	〃	〃	216				
	55	9	〃	〃	223				
	56	10	〃	〃	230		7.0		
15	57	0	1	1.04					
	58	1	〃	〃	235				
	59	2	〃	〃	239				
16	00	3	〃	〃	242				
	1	4	〃	〃	246				
	2	5	〃	〃	249				

Form B

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-1 Sheet NO. 3 of 3

Stage NO.	2	Depth of packer & hole bottom	5.0 m - 10.0 m	Test length	5 m	Reporter	

Time			Gauge pressure	Effective pressure	Water pumped-in			Lugeon value	Remarks
hr	min	Elapsed min	Po(kg/cm²)	P(kg/cm²)	Integrated (ℓ)	Sectional flow (ℓ/min)	Const. rate of flow Q (ℓ/min)	(Lu)	
16	3	6	1	1.04	253				
	4	7	〃	〃	257				
	5	8	〃	〃	260				
	6	9	〃	〃	263				
	7	10	〃	〃	266		3.6		

Form B

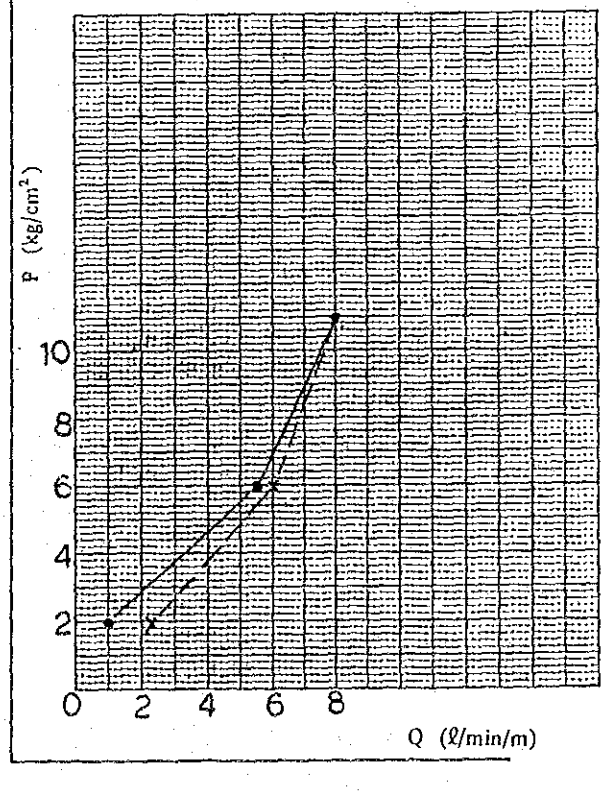
PERMEABILITY TEST IN DRILL HOLE (SHEET / OF /)

XE KATAM PROJECT HOLE No. K I – 1

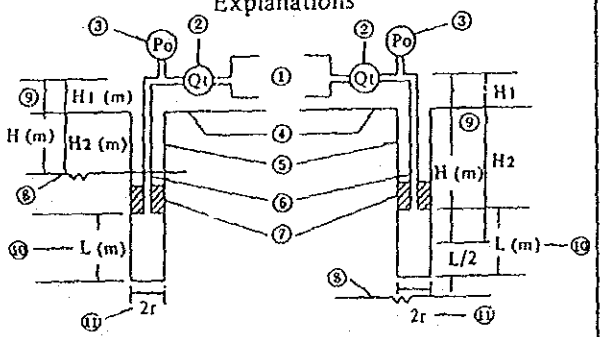
LOCATION	INTAKE DAM	DEPTH OF HOLE	15.0 m	TEST DATE	Mar. 13, '91
ELEVATION	468.0 m	DIAMETER OF HOLE	6.6 cm	TESTED BY	H. WATANABE
COORDINATE		DRILLED DEPTH	15.0 m	DRILLED BY	THONGSAY
ANGLE FROM HOLIZONTAL	90 °	LEVEL OF WATER TABLE		CHECKED BY	I. SHIMIZU
BEARING OF ANGLE HOLE	—	BEFORE.T. 8.0 m	AFTER.T. m		

TEST SECTION FROM 10.0 m TO 15.0 m

L (m)	H_1 (m)	H_2 (m)	Po (kg/cm²)	P (kg/cm²)	t (min)	Qt (ℓ)	Qo (ℓ/min)	Q (ℓ/min/m)	Lu (Lugeon)	K (cm/sec)
5	1.1	8.5	1.0	1.96	10	50	5.0	1.0	5.10	2.95×10^{-5}
5	〃	〃	5.0	5.96	10	277	27.7	5.54	9.30	5.38×10^{-5}
5	〃	〃	10.0	10.96	10	401	40.1	8.02	7.54	4.20×10^{-5}
5	〃	〃	5.0	5.96	10	308	30.8	6.10	10.23	5.92×10^{-5}
5	〃	〃	1.0	1.96	10	117	11.7	2.34	11.94	6.91×10^{-5}



Explanations



[Saturated strata] [Unsaturated strata]

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diameter of hole

Po : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water (Saturated Strata)
P : Effective pressure $P=P_0+H(m)/10$, $H=H_1+H_2$
t : Injected time
Qt : Water volume during time in "t"
Qo : Water volume per one min.
Lu : Lugeon value in ℓ/min/m/10kg/cm²
K : Coefficient of permeability

$$K=\frac{Q_o \cdot \mathrm{Log}(L/r)}{1200\ \pi L(H_1+H_2+10P_e)}$$

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-1 Sheet NO. 1 of 3

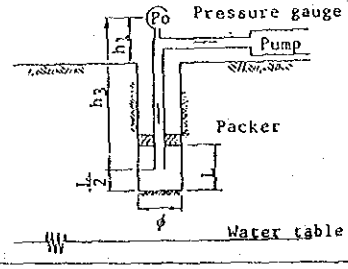
Feature project Xe Katam Country Lao P.D.R.

Location Intake Dam Coordinates Reporter THONGSAY

Date of test 3 - 13 -1991 Firm name (HEC)

Bore hole	Elevation of top	468.0 m	Diametar(ϕ) [illegible] mm; Size	
	Dip	90°	Bearing —	
Test section	Stage NO.	3	Geology	Basalt lava
	Depth of packer & hole bottom	[illegible] m- [illegible] m		
	Elev. of packer & hole bottom	m- m		
	Length (L)	m		
Height of gauge (h_1)	1.1 m			
Water table(h_2)	2.5 m	Temperature of infected water	°C	
Pump: Mfr. model	MG-5A	Flow meter: Type		
Pump: Max. discharge	70 ℓ/min	Flow meter: Min. graduation	1 ℓ	
Pump: Max. pressure	60 kg/cm²	Pressure gauge: Graduation Min.	0.1 kg/cm²	
Type of packer	kg/cm²	Pressure gauge: Graduation Max.	15 kg/cm²	

Unsaturated strata



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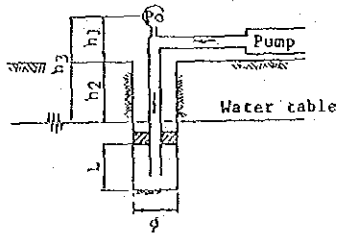


* Effective pressure(kg/cm²) : P = Po+ 1/(10(h3 - h4)) h4= head loss

** Lugeon value (Lu) to be calculated by following equation
Lugeon value (l/min/m/10kg/cm²) : Lu = 10 Q/(P·L)

Time hr	Time min	Elapsed min	Gauge pressure Po(kg/cm²)	Effective pressure P (kg/cm²)	Water pumped-in: Integrated (ℓ)	Water pumped-in: Sectional flow (ℓ/min)	Water pumped-in: Const. rate of flow Q (ℓ/min)	Lugeon value (Lu)	Remarks
11	50	0	1	1.96	0				
	51	1	"	"	5				
	[illegible]	"		"	10				
	[illegible]	"		"	15				
	[illegible]	"		"	21				
	[illegible]	5		"	[illegible]				
	56	6		"	[illegible]				
	[illegible]	1		"	[illegible]				
	[illegible]	"		"	[illegible]				
	[illegible]	"		"	41				
12	00	10		"	56		5.6		
13	[illegible]	[illegible]	5	5.96					
	[illegible]	"	"	"	78				
	[illegible]	"		"	105				
	[illegible]	"		"	133				
	[illegible]	"		"	161				
	[illegible]	"		"	188				
	[illegible]	"		"	216				
	15	"		"	244				

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-1 Sheet NO. 2 of 3

Stage NO.	3	Depth of packer & hole bottom	10.0 m ~ 15.0 m	Test length	5.0 m	Reporter

Time		Elapsed	Gauge pressure	Effective pressure	Water pumped-in			Lugeon value	Remarks
hr	min	min	Po(kg/cm²)	P(kg/cm²)	Integrated (ℓ)	Sectional flow (ℓ/min)	Const. rate of flow Q (ℓ/min)	(Lu)	
12	11	8	5	5.96	272				
	12	9	〃	〃	300				
	13	10	〃	〃	327		27.7		
12	21	0	10	10.96					
	22	1	〃	〃	368				
	23	2	〃	〃	408				
	24	3	〃	〃	448				
	25	4	〃	〃	488				
	26	5	〃	〃	528				
	27	6	〃	〃	568				
	28	7	〃	〃	608				
	29	8	〃	〃	648				
	30	9	〃	〃	688				
	31	10	〃	〃	728		40.1		
12	32	6	5	5.96					
	33	1	〃	〃	358				
	34	2	〃	〃	790				
	35	3	〃	〃	821				
	36	4	〃	〃	853				
	37	5	〃	〃	883				
	38	6	〃	〃	913				
	39	7	〃	〃	943				
	40	8	〃	〃	973				
	41	9	〃	〃	1.003				
	42	10	〃	〃	1.033		30.5		
12	43	0	1	1.96					
	44	1	〃	〃	1.045				
	45	2	〃	〃	1.057				
	46	3	〃	〃	1.069				
	47	4	〃	〃	1.081				
	48	5	〃	〃	1.092				

Form 8

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-1 Sheet NO. 3 of 3

Stage NO.	3	Depth of packer & hole bottom	10.0 m - 15.0 m	Test length	5 m	Reporter	

Time hr	Time min	Elapsed min	Gauge pressure Po(kg/cm²)	Effective pressure P(kg/cm²)	Water pumped-in Integrated (ℓ)	Water pumped-in Sectional flow (ℓ/min)	Water pumped-in Const. rate of flow Q (ℓ/min)	Lugeon value (Lu)	Remarks
12	49	6	1	1.96	1.104				
	50	7	〃	〃	1.115				
	51	8	〃	〃	1.127				
	52	9	〃	〃	1.139				
	53	10	〃	〃	1.150		11.7		

Form 8

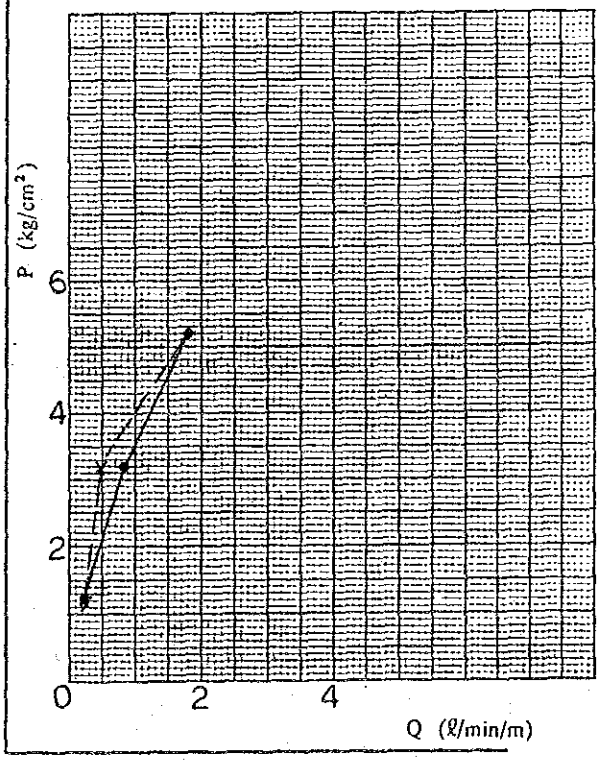
PERMEABILITY TEST IN DRILL HOLE (SHEET / OF /)

XE KATAM PROJECT HOLE No. K I – 2

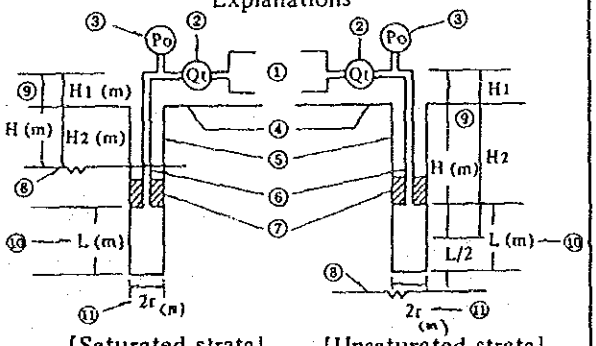
LOCATION	INTAKE DAM	DEPTH OF HOLE	15.0 m	TEST DATE	Mar. 15, '91
ELEVATION	463.9 m	DIAMETER OF HOLE	6.6 cm	TESTED BY	H. WATANABE
COORDINATE		DRILLED DEPTH	6.0 m	DRILLED BY	THONGSAY
ANGLE FROM HOLIZONTAL	90 °	LEVEL OF WATER TABLE		CHECKED BY	I. SHIMIZU
BEARING OF ANGLE HOLE		BEFORE. T. 1.0 m	AFTER. T. m		

TEST SECTION FROM 1.0 m TO 6.0 m

L (m)	H_1 (m)	H_2 (m)	Po (kg/cm²)	P (kg/cm²)	t (min)	Qt (ℓ)	Qo (ℓ/min)	Q (ℓ/min/m)	Lu (Lugeon)	K (cm/sec)
5	1.1	1.0	1.0	1.21	10	11	1.1	0.22	1.82	1.01×10^{-5}
5	4	4	3.0	3.21	10	43	4.3	0.86	2.68	1.55×10^{-5}
5	4	4	5.0	5.21	10	91	9.1	1.82	3.49	2.02×10^{-5}
5	4	4	2.0	2.21	10	25	2.5	0.50	1.56	0.90×10^{-5}
5	4	4	1.0	1.21	10	12	1.2	0.24	1.98	1.15×10^{-5}



Explanations



[Saturated strata] [Unsaturated strata]

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diameter of hole

Po : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water (Saturated Strata)
P : Effective pressure $P = P_0 + H(m)/10$, $H = H_1 + H_2$
t : Injected time
Qt : Water volume during time in "t"
Qo : Water volume per one min.
Lu : Lugeon value in ℓ/min/m/10kg/cm²
K : Coefficient of permeability

$$K = \frac{Q_o \cdot \mathrm{Log}(L/r)}{1200\ \pi L(H_1 + H_2 + 10P_o)}$$

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. KI-2 Sheet NO. 1 of 3

Feature Small-Scale Hydroelectric Power Plan Project Xe Katam Country Lao PDR.

Location Intake Dam Coordinates Reporter THONGSAI

Date of test 3 -/3 -1991 Firm name (HEC)

Bore hole	Elevation of top	463.7 m	Diametar(φ) 66 mm; Size	
	Dip	90°	Bearing —	
Test section	Stage NO.	1	Geology	
	Depth of packer & hole bottom	1.0 m - 6.0 m	Basal lava	
	Elev. of packer & hole bottom	m - m		
	Length (L)	5 m		
Height of gauge(h_1)	1.14			
Water table(h_2)	1.0 m	Temperature of infected water	°C	
Pump: Mfr. model	HG-5A	Flow meter: Type		
Pump: Max. discharge	70 ℓ/min	Flow meter: Min. graduation	1 ℓ	
Pump: Max. pressure	60 kg/cm²	Pressure gauge: Graduation Min.	0.1 kg/cm²	
Type of packer	kg/cm²	Pressure gauge: Graduation Max.	15 kg/cm²	

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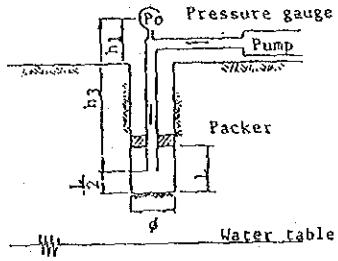
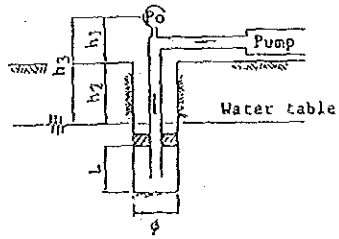


Saturated strata



* Effective pressure(kg/cm²) : $P = P_o + 1/\{10(h_3 - h_4)\}$, h_4= head loss

** Lugeon value (Lu) to be calculated by following equation
Lugeon value (l/min/m/10kg/cm²) : $Lu = 10\,Q/(P \cdot L)$

Time hr	Time min	Elapsed min	Gauge pressure Po(kg/cm²)	Effective pressure P (kg/cm²)	Water pumped-in: Integrated (ℓ)	Water pumped-in: Sectional flow (ℓ/min)	Water pumped-in: Const. rate of flow Q (ℓ/min)	Lugeon value (Lu)	Remarks
9	34	0	1	1.21	0				
	35	1	〃	〃	1				
	36	2	〃	〃	3				
	37	3	〃	〃	4				
	38	4	〃	〃	5				
	39	5	〃	〃	6				
	40	6	〃	〃	7				
	41	7	〃	〃	8				
	42	8	〃	〃	9				
	43	9	〃	〃	10				
	44	10	〃	〃	11		1.1		It should be better not to extend time interval.
10	6	0	3	3.21					
	7	1	〃	〃	16				
	8	2	〃	〃	19				
	9	3	〃	〃	25				
	10	4	〃	〃	30				
	11	5	〃	〃	34				
	12	6	〃	〃	38				
	13	7	〃	〃	42				

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-2 Sheet NO. 2 of 3

Stage NO.	1	Depth of packer & hole bottom	1.0 m - 6.0 m	Test length	5.0 m	Reporter

Time hr	Time min	Elapsed min	Gauge pressure Po(kg/cm²)	Effective pressure P(kg/cm²)	Water pumped-in Integrated (ℓ)	Water pumped-in Sectional flow (ℓ/min)	Water pumped-in Const. rate of flow Q (ℓ/min)	Lugeon value (Lu)	Remarks
10	14	8	3	3.21	46				
	15	9	〃	〃	50				
	16	10	〃	〃	54		4.3		
10	23	0	5	5.21					
	24	1	〃	〃	61				
	25	2	〃	〃	70				
	26	3	〃	〃	79				
	27	4	〃	〃	88				
	28	5	〃	〃	96				
	29	6	〃	〃	105				
	30	7	〃	〃	115				
	31	8	〃	〃	125				
	32	9	〃	〃	135				
	33	10	〃	〃	145		9.1		
									Test started in interval
10	40	0	3	3.21					
	41	1	〃	〃	148				
	42	2	〃	〃	151				
	43	3	〃	〃	154				
	44	4	〃	〃	156				
	45	5	〃	〃	158				
	46	6	〃	〃	160				
	47	7	〃	〃	162				
	48	8	〃	〃	165				
	49	9	〃	〃	168				
	50	10	〃	〃	170		2.5		
10	52	0	1	1.21					
	53	1	〃	〃	171				
	54	2	〃	〃	173				
	55	3	〃	〃	175				
	56	4	〃	〃	177				
	57	5	〃	〃	179				

Form B

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-2 Sheet NO. 3 of 3

Stage NO.	1	Depth of packer & hole bottom	1.0 m ~ 6.0 m	Test length	5.0 m	Reporter

Time		Elapsed	Gauge pressure	Effective pressure	Water pumped-in			Lugeon value	Remarks
hr	min	min	Po(kg/cm²)	P(kg/cm²)	Integrated (ℓ)	Sectional flow (ℓ/min)	Const. rate of flow Q (ℓ/min)	(Lu)	
10	58	6	1	1.21	180				
	59	7	〃	〃	180				
11	00	8	〃	〃	181				
	1	9	〃	〃	182				
	2	10	〃	〃	182		1.2		

Form B

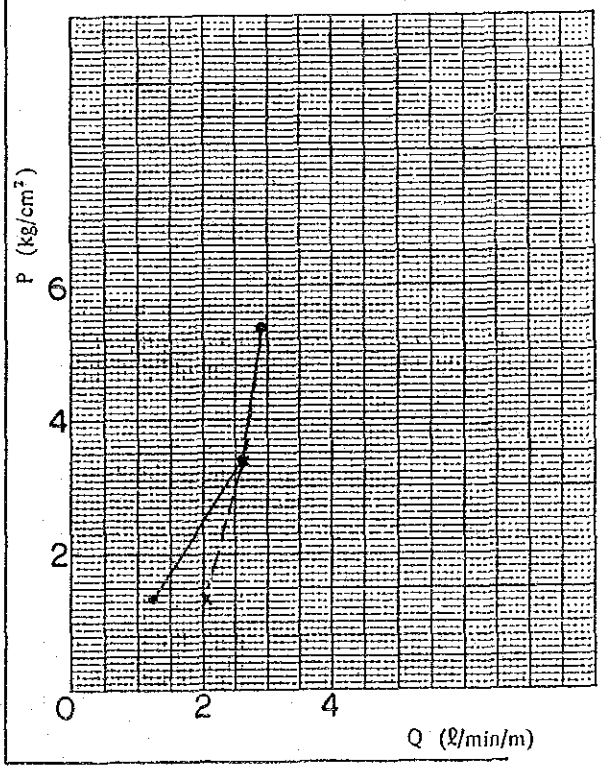
PERMEABILITY TEST IN DRILL HOLE (SHEET / OF /)

XE KATAM PROJECT HOLE No. K I – 2

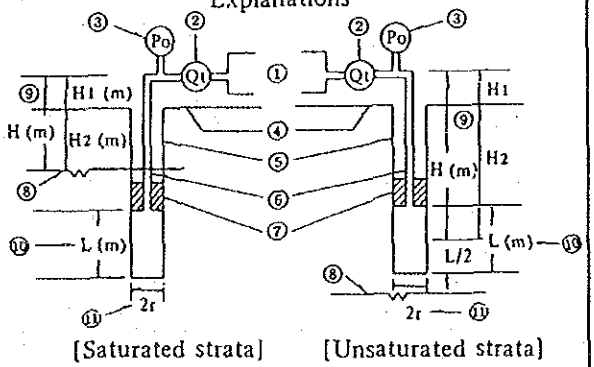
LOCATION	INTAKE DAM	DEPTH OF HOLE	15.0 m	TEST DATE	Mar. 16, '91
ELEVATION	463.9 m	DIAMETER OF HOLE	6.6 cm	TESTED BY	H. WATANABE
COORDINATE		DRILLED DEPTH	10.0 m	DRILLED BY	THONGSAY
ANGLE FROM HOLIZONTAL	90 °	LEVEL OF WATER TABLE		CHECKED BY	I. SHIMIZU
BEARING OF ANGLE HOLE	–	BEFORE. T. 3.4 m	AFTER. T. m		

TEST SECTION FROM 5.0 m TO 10.0 m

L (m)	H_1 (m)	H_2 (m)	Po (kg/cm²)	P (kg/cm²)	t (min)	Qt (ℓ)	Qo (ℓ/min)	Q (ℓ/min/m)	Lu (Lugeon)	K (cm/sec)
5	0.1	3.4	1.0	1.34	10	63	6.3	1.26	9.33	5.40×10^{-5}
5	〃	〃	2.0	2.34	10	132	13.2	2.64	7.88	4.56×10^{-5}
5	〃	〃	3.0	3.34	10	148	14.8	2.96	5.53	3.20×10^{-5}
5	〃	〃	2.0	2.34	10	133	13.3	2.66	7.96	4.59×10^{-5}
5	〃	〃	1.0	1.34	10	102	10.2	2.04	15.11	8.94×10^{-5}



Explanations



① : Pump
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⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diameter of hole

Po : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water (Saturated Strata)
P : Effective pressure $P=P_0+H(m)/10$, $H=H_1+H_2$
t : Injected time
Qt : Water volume during time in "t"
Qo : Water volume per one min.
Lu : Lugeon value in ℓ/min/m/10kg/cm²
K : Coefficient of permeability

$$K=\frac{Q_0\cdot\mathrm{Log}(L/r)}{1200\ \pi L(H_1+H_2+10P_0)}$$

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-2 Sheet NO. 1 of 3

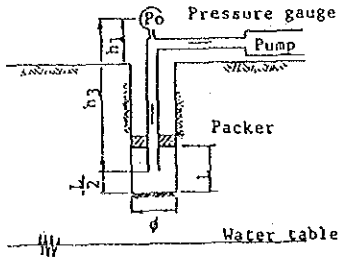
Feature project Xe Katam Country Lao PDR.

Location Intake Dam Coordinates Reporter THONGSAY

Date of test 3-16-1991 Firm name (HEC)

Bore hole	Elevation of top	443.9 m	Diametar(φ) 66 mm; Size	
	Dip	90°	Bearing	—
Test section	Stage NO.	2	Geology	Basalt lava
	Depth of packer & hole bottom	5.0 m - 10.0 m		
	Elev. of packer & hole bottom	m - m		
	Length (L)	5 m		
Height of gauge(h_1)	0.1 m			
Water table(h_2)	3.4 m		Temperature of infected water	°C
Pump: Mfr. model	MG-5A	Flow meter: Type		
Pump: Max. discharge	16 ℓ/min	Min. graduation	1 ℓ	
Pump: Max. pressure	60 kg/cm²	Pressure gauge: Graduation Min.	0.1 kg/cm²	
Type of packer	kg/cm²	Max.	15 kg/cm²	

Unsaturated strata



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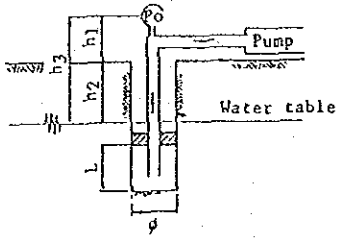


* Effective pressure(kg/cm²) : $P = Po + 1/(10(h_3 - h_4))$, h_4= head loss

** Lugeon value (Lu) to be calculated by following equation
Lugeon value (l/min/m/10kg/cm²) : $Lu = 10\ Q/(P \cdot L)$

Time hr	Time min	Elapsed min	Gauge pressure Po(kg/cm²)	Effective pressure P (kg/cm²)	Water pumped-in: Integrated (ℓ)	Water pumped-in: Sectional flow (ℓ/min)	Water pumped-in: Const. rate of flow Q (ℓ/min)	Lugeon value (Lu)	Remarks
15	50	0	1	1.35	0				
	51	1	〃	〃	7				
	52	2	〃	〃	13				
	53	3	〃	〃	19				
	54	4	〃	〃	26				
	55	5	〃	〃	32				
	56	6	〃	〃	39				
	57	7	〃	〃	45				
	58	8	〃	〃	51				
	59	9	〃	〃	57				
16	00	10	〃	〃	63		6.3		
16	2	0	3	3.35					
	3	1	〃	〃	76				
	4	2	〃	〃	89				
	5	3	〃	〃	102				
	6	4	〃	〃	116				
	7	5	〃	〃	130				
	8	6	〃	〃	140				
	9	7	〃	〃	156				

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-2 Sheet NO. 2 of 3

Stage NO.	2	Depth of packer & hole bottom	5.0 m - 10.0 m	Test length	5.0 m	Reporter

Time			Gauge pressure	Effective pressure	Water pumped-in			Lugeon value	Remarks
hr	min	Elapsed min	Po(kg/cm²)	P(kg/cm²)	Integrated (ℓ)	Sectional flow (ℓ/min)	Const. rate of flow Q (ℓ/min)	(Lu)	
16	10	8	3	3.35	169				
	11	9	〃	〃	182				
	12	10	〃	〃	195		13.2		
16	15	0	5	5.35					
	16	1	〃	〃	209				
	17	2	〃	〃	223				
	18	3	〃	〃	239				
	19	4	〃	〃	253				
	20	5	〃	〃	268				
	21	6	〃	〃	283				
	22	7	〃	〃	298				
	23	8	〃	〃	313				
	24	9	〃	〃	328				
	25	10	〃	〃	343		14.8		
16	27	0	3	3.35					
	28	1	〃	〃	356				
	29	2	〃	〃	369				
	30	3	〃	〃	383				
	31	4	〃	〃	396				
	32	5	〃	〃	409				
	33	6	〃	〃	422				
	34	7	〃	〃	435				
	35	8	〃	〃	448				
	36	9	〃	〃	462				
	37	10	〃	〃	476		13.3		
16	39	0	1	1.35					
	40	1	〃	〃	486				
	41	2	〃	〃	492				
	42	3	〃	〃	501				
	43	4	〃	〃	514				
	44	5	〃	〃	525				

Form B

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-2 Sheet NO. 3 of 3

Stage NO.	2	Depth of packer & hole bottom	5.0 m - 10.0 m	Test length	5.0 m	Reporter

Time hr	Time min	Elapsed min	Gauge pressure Po(kg/cm²)	Effective pressure P(kg/cm²)	Water pumped-in Integrated (ℓ)	Water pumped-in Sectional flow (ℓ/min)	Water pumped-in Const. rate of flow Q (ℓ/min)	Lugeon value (Lu)	Remarks
16	45	6	1	1.35	536				
	46	7	〃	〃	547				
	47	8	〃	〃	558				
	48	9	〃	〃	569				
	49	10	〃	〃	579		10.2		

Form 8

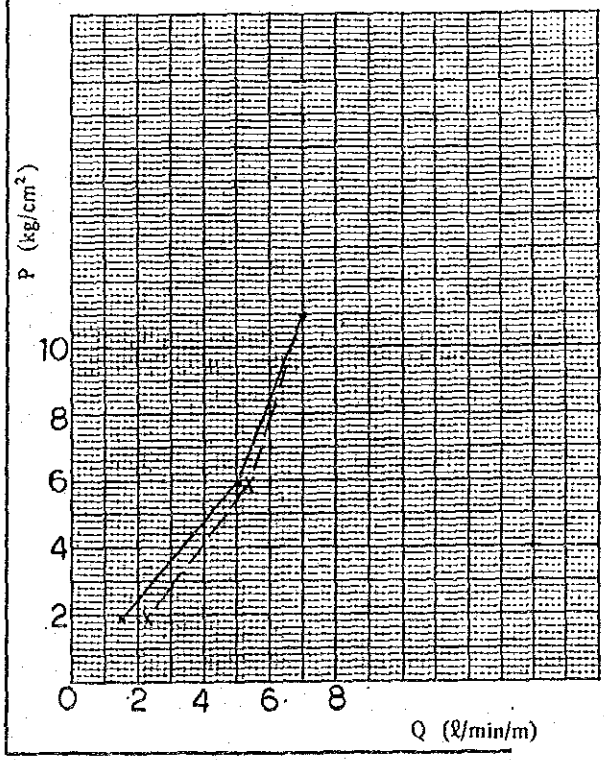
PERMEABILITY TEST IN DRILL HOLE (SHEET / OF /)

XE KATAM PROJECT HOLE No. K I – 2

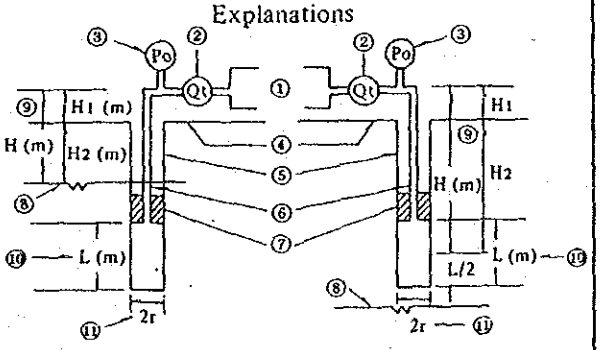
LOCATION	INTAKE DAM	DEPTH OF HOLE	15.0 m	TEST DATE	Mar. 17, '91
ELEVATION	463.9m	DIAMETER OF HOLE	6.6 cm	TESTED BY	H. WATANABE
COORDINATE		DRILLED DEPTH	15.0 m	DRILLED BY	THONGSAY
ANGLE FROM HOLIZONTAL	90°	LEVEL OF WATER TABLE		CHECKED BY	I. SHIMIZU
BEARING OF ANGLE HOLE	-	BEFORE T. 8.4 m	AFTER T. m		

TEST SECTION FROM 10.0 m TO 15.0 m

L (m)	H1 (m)	H2 (m)	Po (kg/cm²)	P (kg/cm²)	t (min)	Qt (ℓ)	Qo (ℓ/min)	Q (ℓ/min/m)	Lu (Lugeon)	K (cm/sec)
5	1.1	8.4	1.0	1.98	10	79	7.9	1.58	8.10	4.67×10^{-5}
5	〃	〃	5.0	5.98	10	254	25.4	5.08	8.54	4.94×10^{-5}
5	〃	〃	10.0	10.98	10	352	35.2	7.04	6.67	3.72×10^{-5}
5	〃	〃	5.0	5.98	10	270	27.0	5.40	9.08	5.25×10^{-5}
5	〃	〃	1.0	1.98	10	116	11.6	2.32	11.90	6.88×10^{-5}



Explanations



[Saturated strata] [Unsaturated strata]

- ①: Pump
- ②: Flow meter
- ③: Pressure gauge
- ④: Ground surface
- ⑤: Drill hole
- ⑥: Injection pipe
- ⑦: Packer
- ⑧: Water table
- ⑨: Hydrostatic head
- ⑩: Length of test section
- ⑪: Diameter of hole

- Po: Gauge pressure
- H_1: Height of Pressure gauge
- H_2: Depth of Ground water (Saturated Strata)
- P: Effective pressure $P=P_0+H(m)/10$, $H=H_1+H_2$
- t: Injected time
- Qt: Water volume during time in "t"
- Qo: Water volume per one min.
- Lu: Lugeon value in ℓ/min/m/10kg/cm²
- K: Coefficient of permeability

$$K=\frac{Q_o \cdot \mathrm{Log}(L/r)}{1200\ \pi L(H_1+H_2+10P_o)}$$

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. KI - 2 Sheet NO. 1 of 3

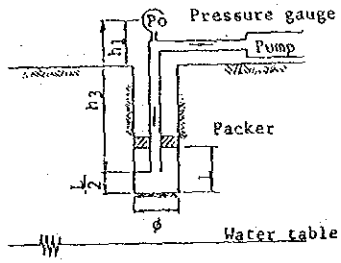
Feature project Xe Katam Country Lao PDR

Location Intake Dam Coordinates Reporter THONGSAT

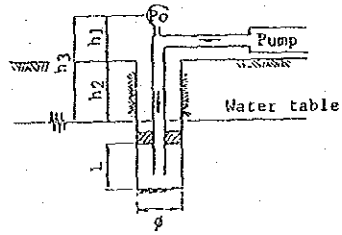
Date of test 3 -17 -1991 Firm name (HEC)

Bore hole	Elevation of top	463.9 m	Diametar(ϕ) 66 mm; Size	
	Dip	90°	Bearing –	
Test section	Stage NO.	3	Geology	
	Depth of packer & hole bottom	10.0 m - 15.0 m	Basalt lava	
	Elev. of packer & hole bottom	m - m		
	Length (L)	5 m		
Height of gauge (h_1)	1.1 m			
Water table (h_2)	8.4 m		Temperature of infected water	°C
Pump: Mfr. model	MG-3A	Flow meter: Type		
Pump: Max. discharge	70 ℓ/min	Min. graduation	1 ℓ	
Pump: Max. pressure	60 kg/cm²	Pressure gauge graduation: Min.	0.1 kg/cm²	
Type of packer	kg/cm²	Max.	15 kg/cm²	

Unsaturated strata



Saturated strata



* Effective pressure(kg/cm²) : P = Po + 1/10(h3 - h4), h4= head loss

** Lugeon value (Lu) to be calculated by following equation
Lugeon value (1/min/m/10kg/cm²) : Lu = 10 Q/(P·L)

Time hr	Time min	Elapsed min	Gauge pressure Po (kg/cm²)	Effective pressure P (kg/cm²)	Water pumped-in: Integrated (ℓ)	Sectional flow (ℓ/min)	Const. rate of flow Q (ℓ/min)	Lugeon value (Lu)	Remarks
9	14	0	1	1.95					
	15	1	〃	〃	9				
	16	2	〃	〃	16				
	17	3	〃	〃	25				
	18	4	〃	〃	32				
	19	5	〃	〃	39				
	20	6	〃	〃	47				
	21	7	〃	〃	55				
	22	8	〃	〃	63				
	23	9	〃	〃	71				
	24	10	〃	〃	79		7.9		
9	30	0	5	5.95					
	31	1	〃	〃	104				
	32	2	〃	〃	129				
	33	3	〃	〃	153				
	34	4	〃	〃	178				
	35	5	〃	〃	203				
	36	6	〃	〃	230				
	37	7	〃	〃	255				

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-2 Sheet NO. 2 of 3

Stage NO.	3	Depth of packer & hole bottom	10 m - 15 m	Test length	5 m	Reporter

Time hr	Time min	Elapsed min	Gauge pressure Po(kg/cm²)	Effective pressure P(kg/cm²)	Water pumped-in Integrated (ℓ)	Water pumped-in Sectional flow (ℓ/min)	Water pumped-in Const. rate of flow Q (ℓ/min)	Lugeon value (Lu)	Remarks
9	38	8	5	5.95	281				
	39	9	〃	〃	307				
	40	10	〃	〃	333		25.4		
9	43	0	10	10.95					
	44	1	〃	〃	369				
	45	2	〃	〃	405				
	46	3	〃	〃	440				
	47	4	〃	〃	475				
	48	5	〃	〃	510				
	49	6	〃	〃	545				
	50	7	〃	〃	580				
	51	8	〃	〃	615				
	52	9	〃	〃	650				
	53	10	〃	〃	685		35.2		
9	54	0	5	5.95					
	55	1	〃	〃	710				
	56	2	〃	〃	738				
	57	3	〃	〃	766				
	58	4	〃	〃	793				
	59	5	〃	〃	820				
10	00	6	〃	〃	847				
	1	7	〃	〃	874				
	2	8	〃	〃	901				
	3	9	〃	〃	928				
	4	10	〃	〃	955		27.0		
10	5	0	1	1.95					
	6	1	〃	〃	963				
	7	2	〃	〃	973				
	8	3	〃	〃	985				
	9	4	〃	〃	997				
	10	5	〃	〃	1009				

Form B

WATER PRESSURE TEST IN DRILL HOLE HOLE NO. K1-2 Sheet NO. 3 of 3

Stage NO.	3	Depth of packer & hole bottom	10.0 m - 15.0 m	Test length	5 m	Reporter

Time			Gauge pressure	Effective pressure	Water pumped-in			Lugeon value	Remarks
hr	min	Elapsed min	Po(kg/cm²)	P(kg/cm²)	Integrated (ℓ)	Sectional flow (ℓ/min)	Const. rate of flow Q (ℓ/min)	(Lu)	
10	11	6	1	1.95	1.021				
	12	7	〃	〃	1.033				
	13	8	〃	〃	1.045				
	14	9	〃	〃	1.058				
	15	10	〃	〃	1.071		11.6		

Form B

A2.4 Record of Water Level in Borehole During Drilling

RECORD OF WATER LEVEL IN BOREHOLE DURING DRILLNG

(DIAGRAM)

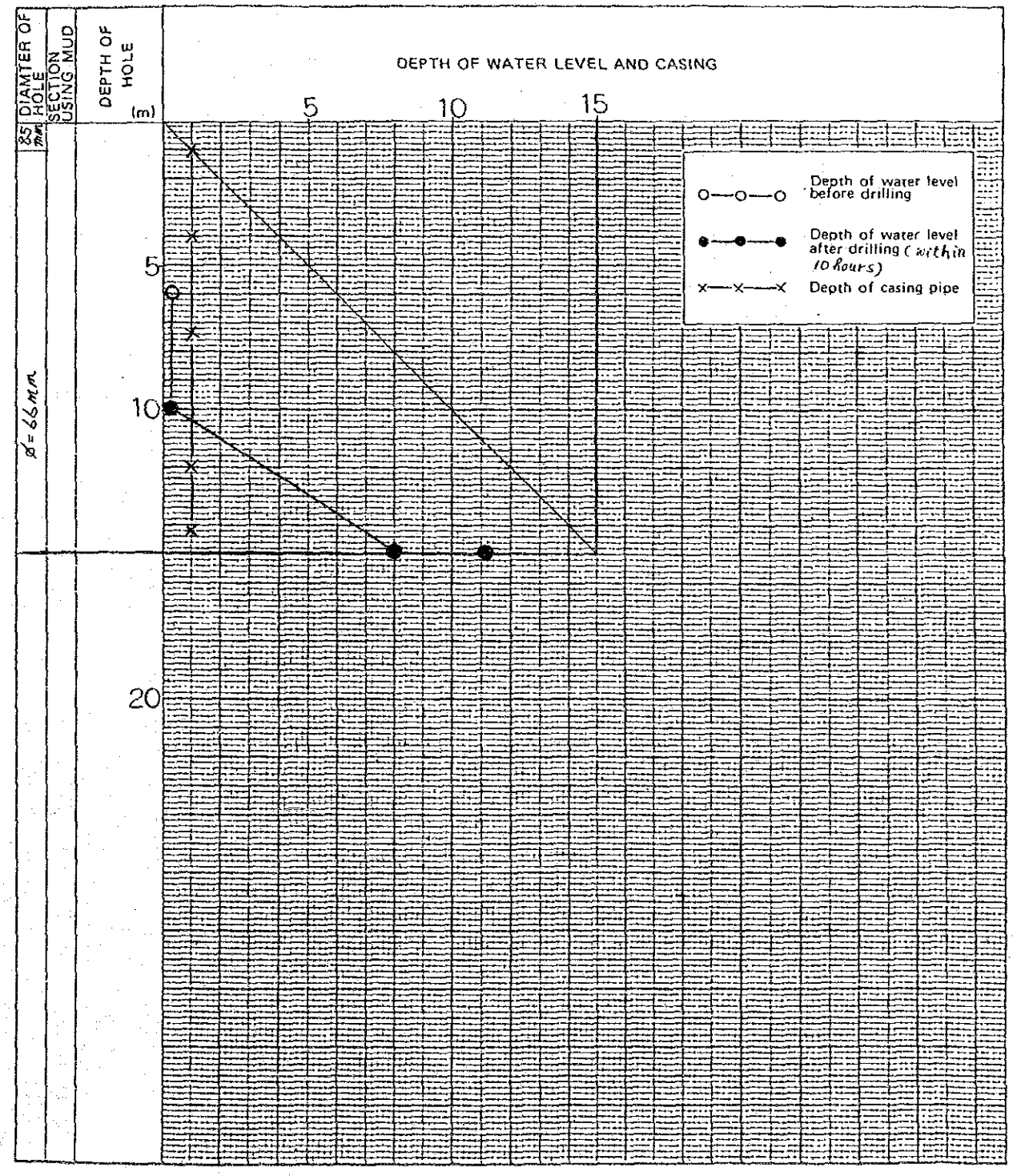
XE KATAM PROJECT HOLE No. KI-1 (SHEET 1 OF 7)

LOCATION INTAKE DAM DEPTH OF HOLE 15 m COMMENCED Mar. 10 '91

ELEVATION 468.0m DIAMETER OF HOLE 66 mm COMPLETED Apr. 9 '91

COORDINATE

ANGLE FROM HORIZONTAL 90° MEASURED BY THONGSAY



RECORD OF WATER LEVEL IN BOREHOLE DURING DRILLNG

(DIAGRAM)

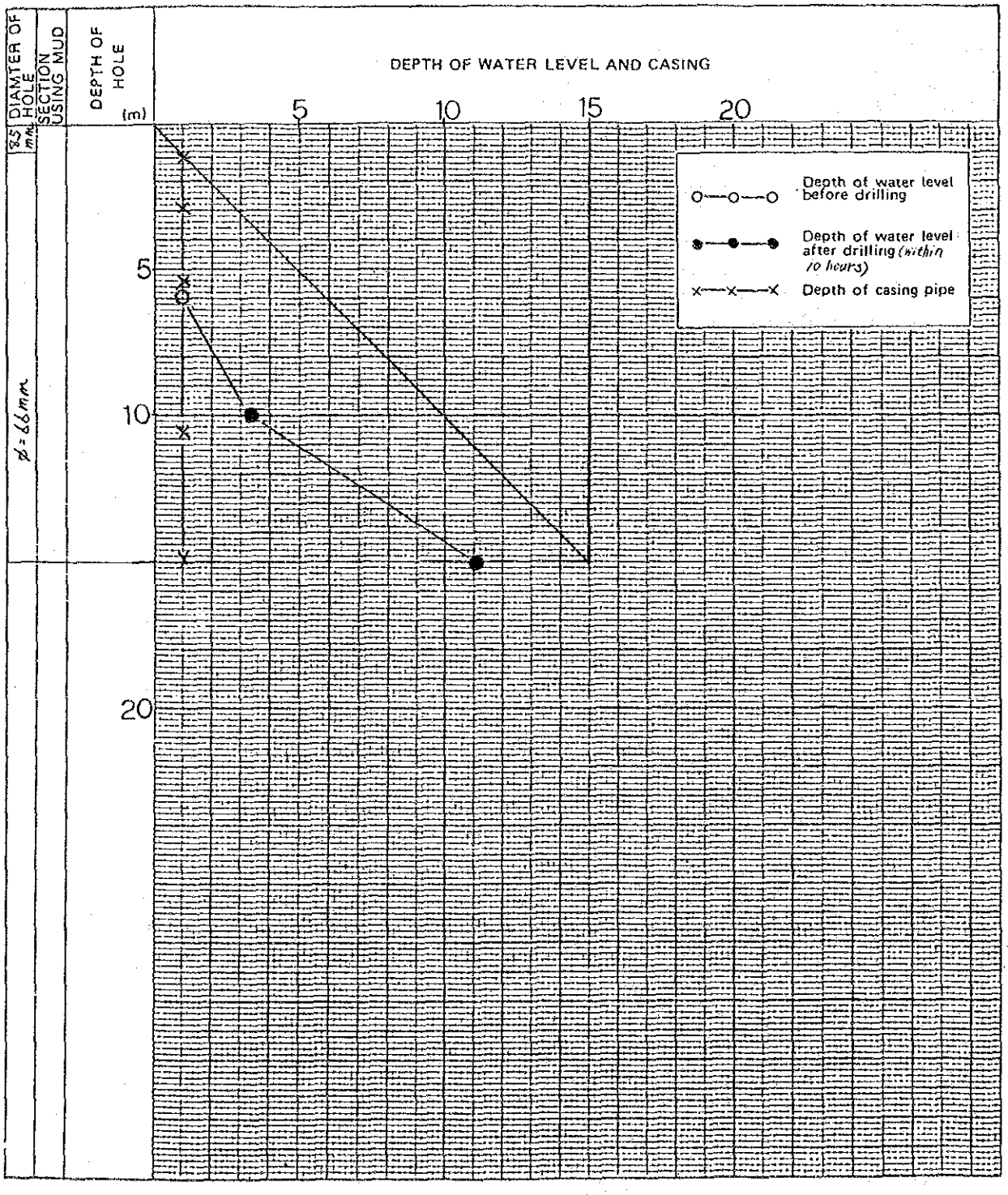
XE KATAM PROJECT HOLE No. K1-2 (SHEET 2 OF 7)

LOCATION INTAKE DAM DEPTH OF HOLE 15 m COMMENCED Mar. 15 .91

ELEVATION 463.9m DIAMETER OF HOLE 66 mm COMPLETED Apr. 10 .91

COORDINATE

ANGLE FROM HORIZONTAL 90° MEASURED BY - THONGSAY



RECORD OF WATER LEVEL IN BOREHOLE DURING DRILLNG

(DIAGRAM)

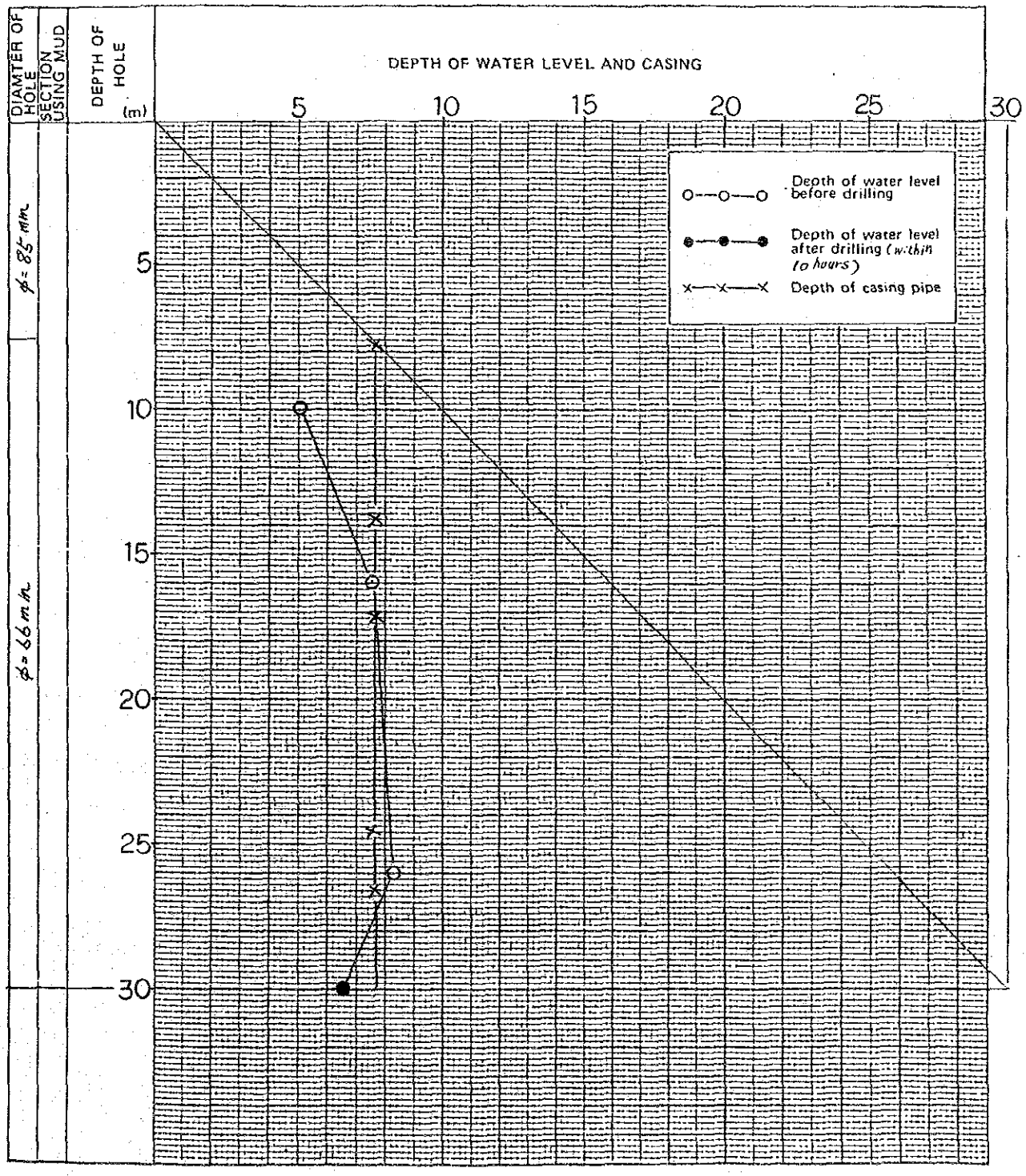
XE KATAM PROJECT — HOLE No. KT-1 — (SHEET 3 OF 7)

LOCATION TUNNEL — DEPTH OF HOLE 30 m — COMMENCED .'91

ELEVATION 473.3m — DIAMETER OF HOLE 66 mm — COMPLETED .'91

COORDINATE

ANGLE FROM HORIZONTAL 90° — MEASURED BY THONGSAY



RECORD OF WATER LEVEL IN BOREHOLE DURING DRILLNG

(DIAGRAM)

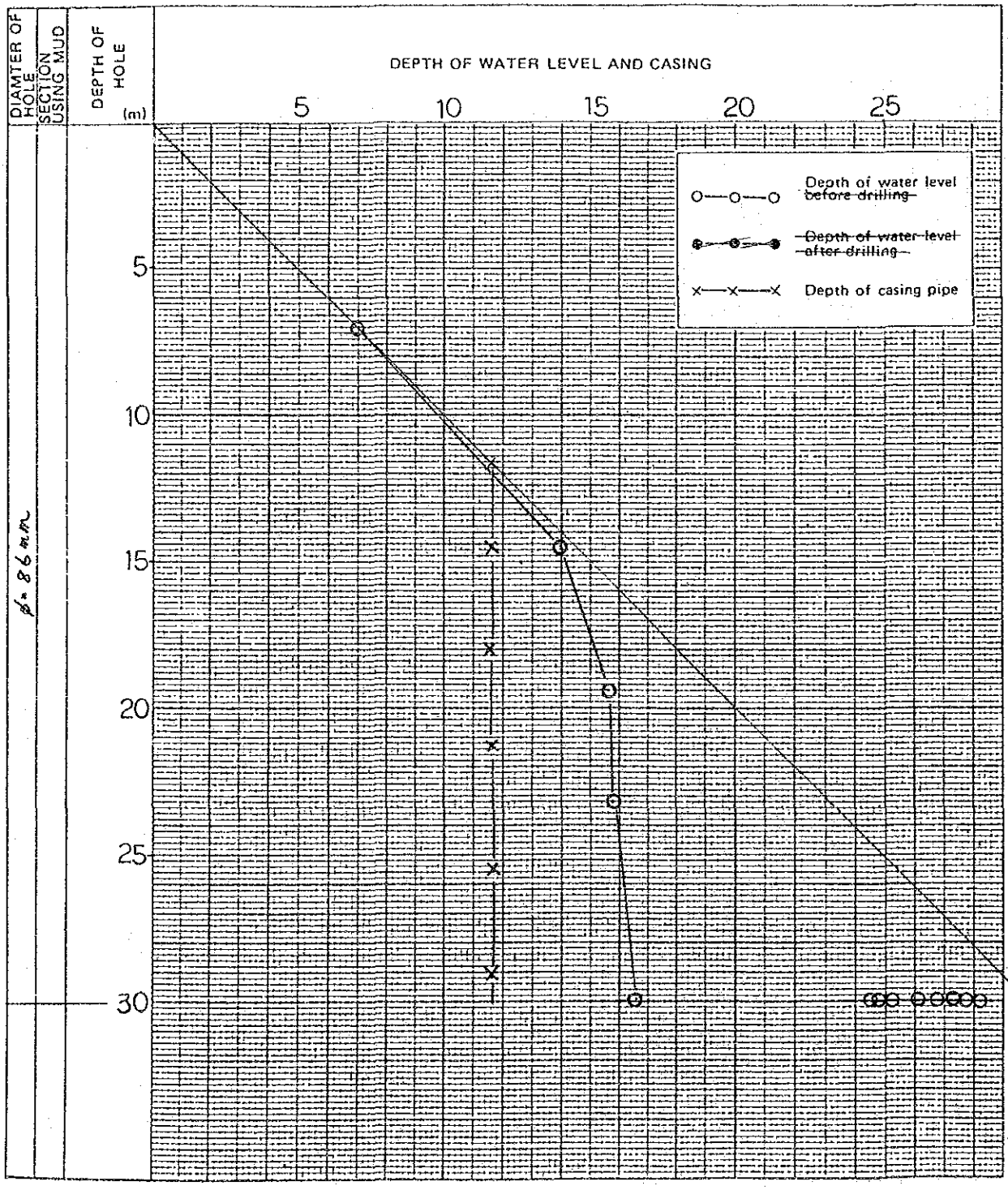
XE KATAM PROJECT HOLE No. KT-2 (SHEET 4 OF 7)

LOCATION TUNNEL DEPTH OF HOLE 30 m COMMENCED . .'91

ELEVATION 479.8m DIAMETER OF HOLE 86 mm COMPLETED . .'91

COORDINATE

ANGLE FROM HORIZONTAL 90° MEASURED BY THONGSAY



RECORD OF WATER LEVEL IN BOREHOLE DURING DRILLNG

(DIAGRAM)

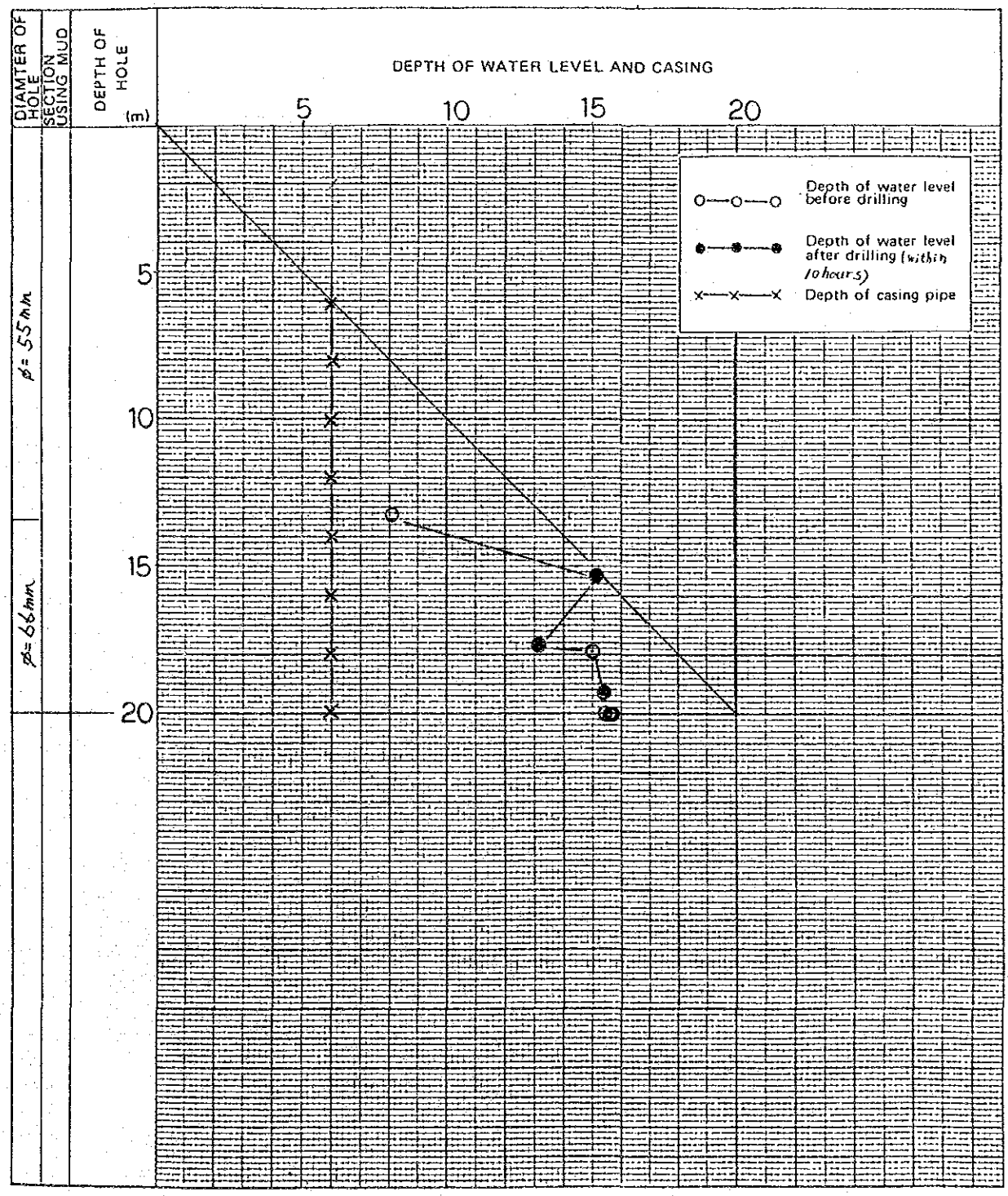
XE KATAM PROJECT HOLE No. KP-1 (SHEET 5 OF 7)

LOCATION PENSTOCK DEPTH OF HOLE 20 m COMMENCED . .91

ELEVATION 361.5m DIAMETER OF HOLE 66 mm COMPLETED . .91

COORDINATE

ANGLE FROM HORIZONTAL 90° MEASURED BY THONGSAY



RECORD OF WATER LEVEL IN BOREHOLE DURING DRILLNG

(DIAGRAM)

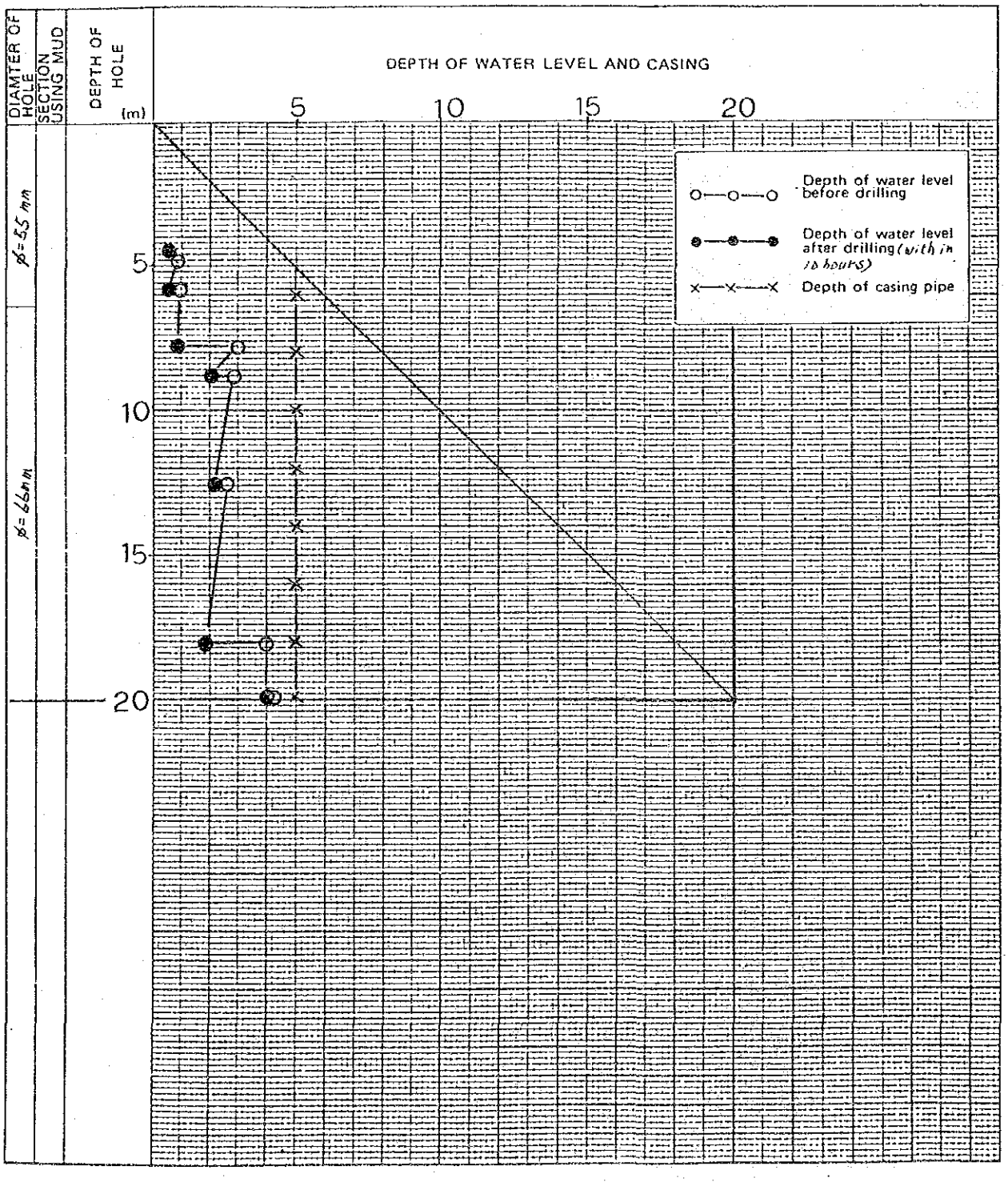
XE KATAM PROJECT HOLE No. KP - 2 (SHEET 6 OF 7)

LOCATION POWERHOUSE DEPTH OF HOLE 20 m COMMENCED .'91

ELEVATION 307.3m DIAMETER OF HOLE 66 mm COMPLETED .'91

COORDINATE

ANGLE FROM HORIZONTAL 90° MEASURED BY THONGSAY



RECORD OF WATER LEVEL IN BOREHOLE DURING DRILLNG

(DIAGRAM)

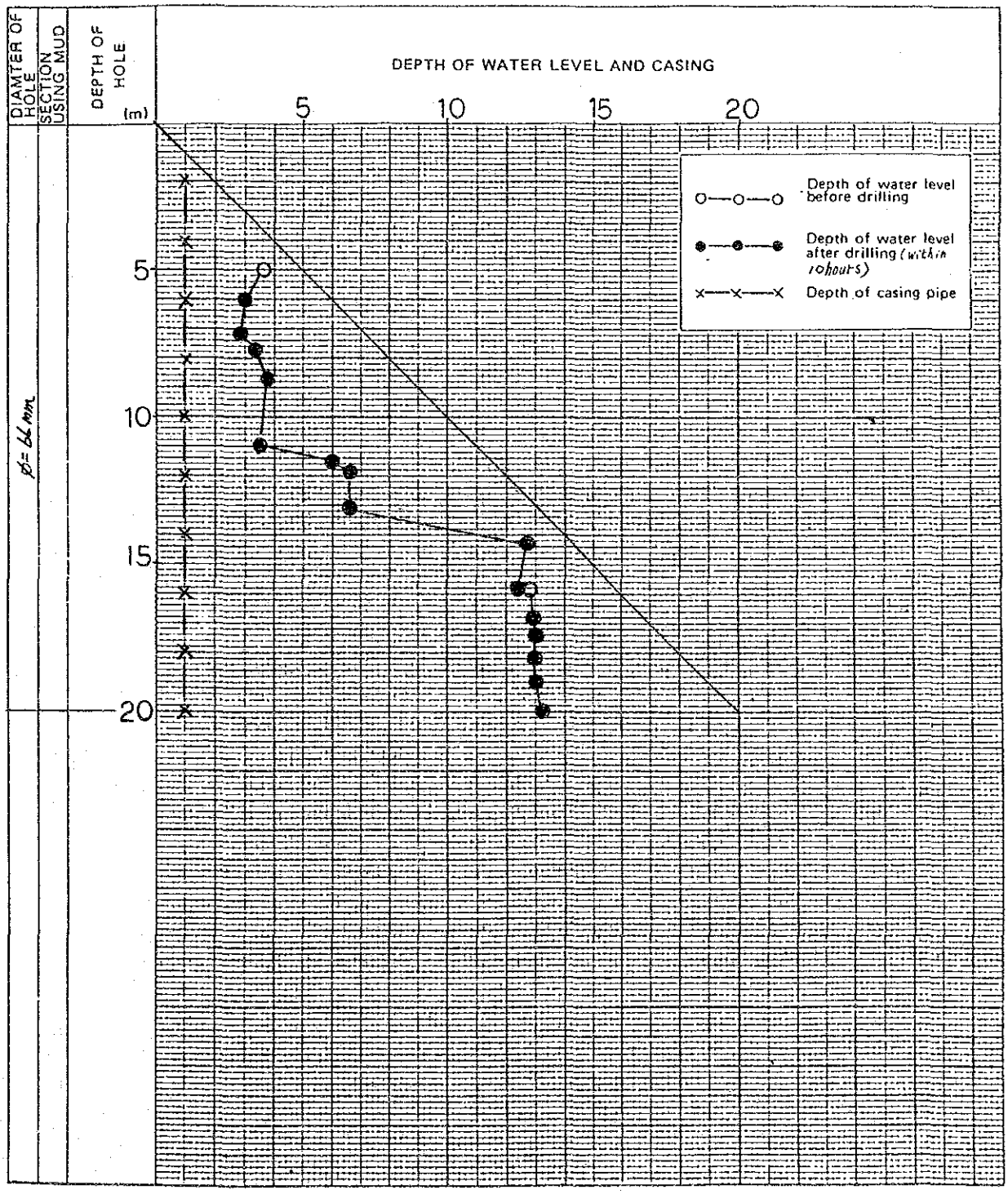
XE KATAM PROJECT HOLE No. KP-3 (SHEET 7 OF 7)

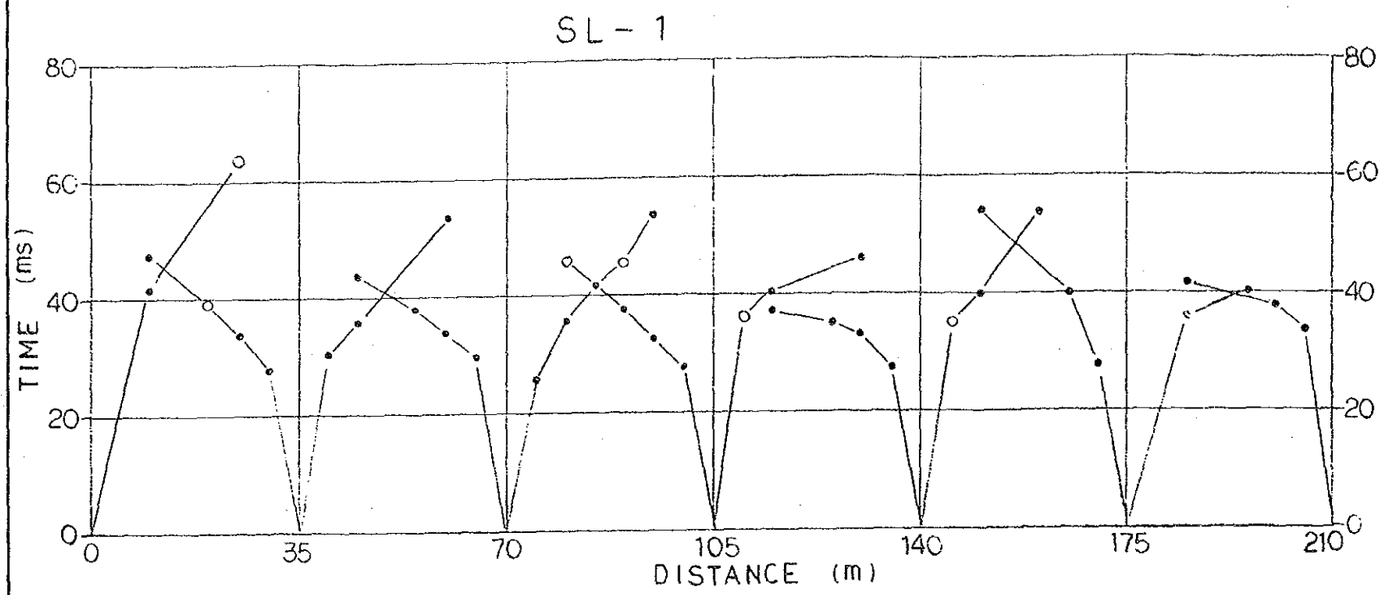
LOCATION POWERHOUSE DEPTH OF HOLE 20 m COMMENCED '91

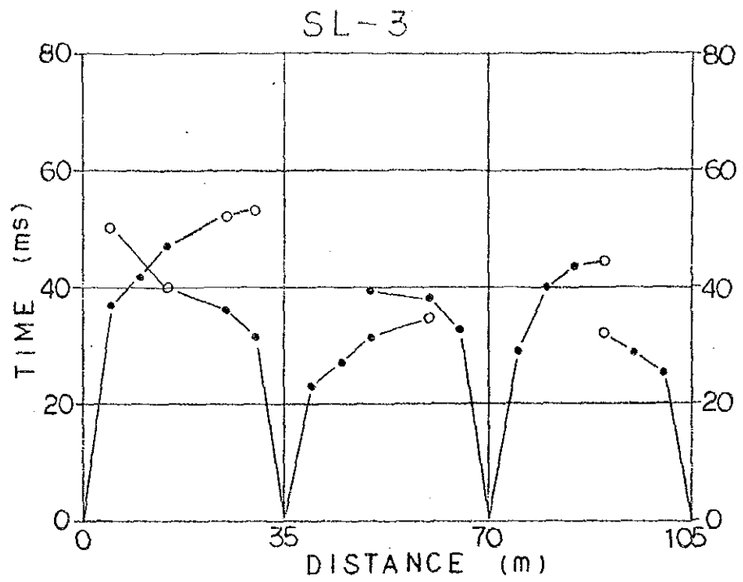
ELEVATION 308.5m DIAMETER OF HOLE 66 mm COMPLETED '91

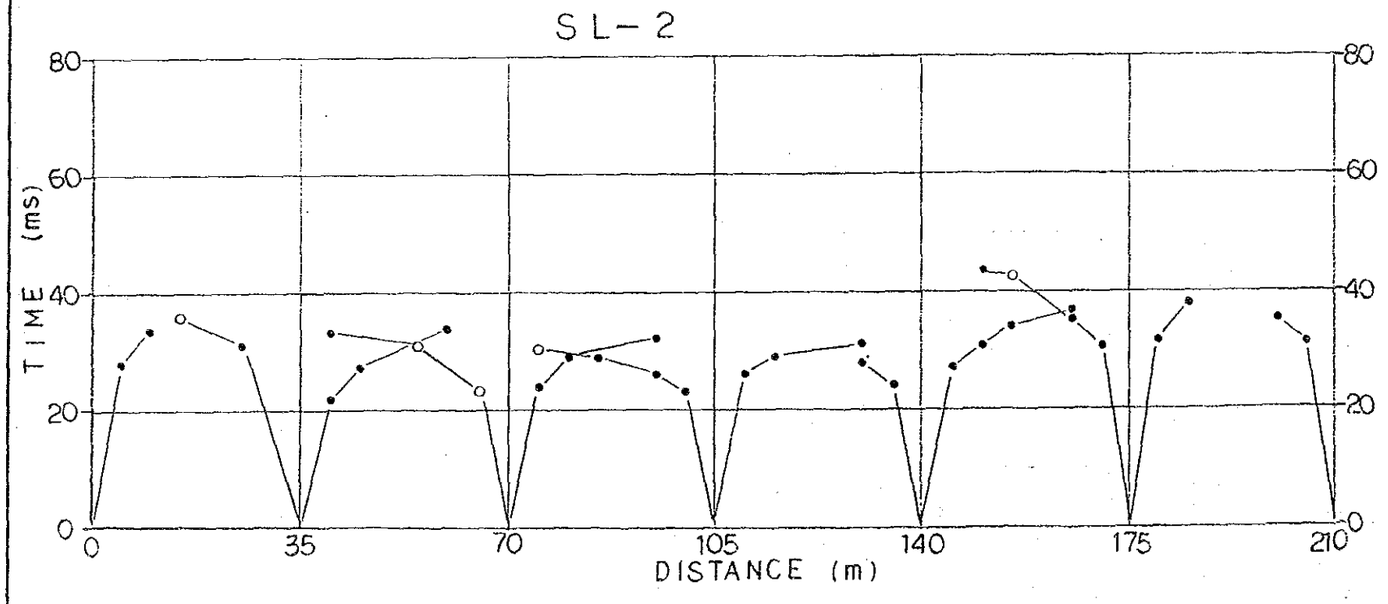
COORDINATE

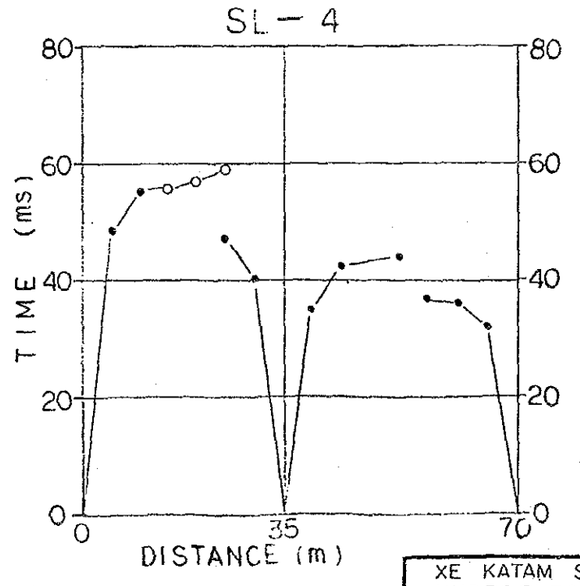
ANGLE FROM HORIZONTAL 90° MEASURED BY THONGSAY











CLEAR SEISMIC PRIMARY WAVE

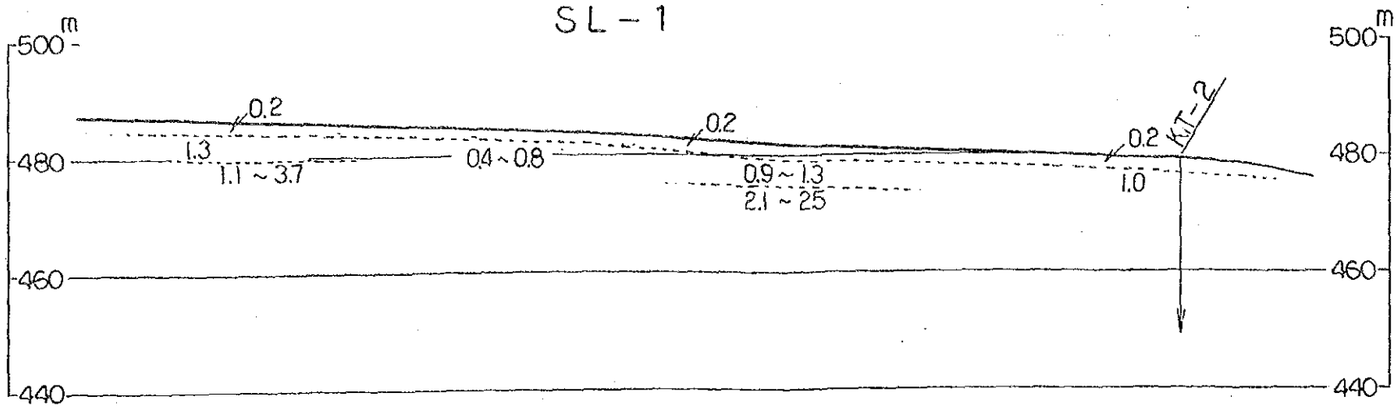
NOT SO CLEAR SEISMIC PRIMARY WAVE

XE KATAM SMALL-SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT

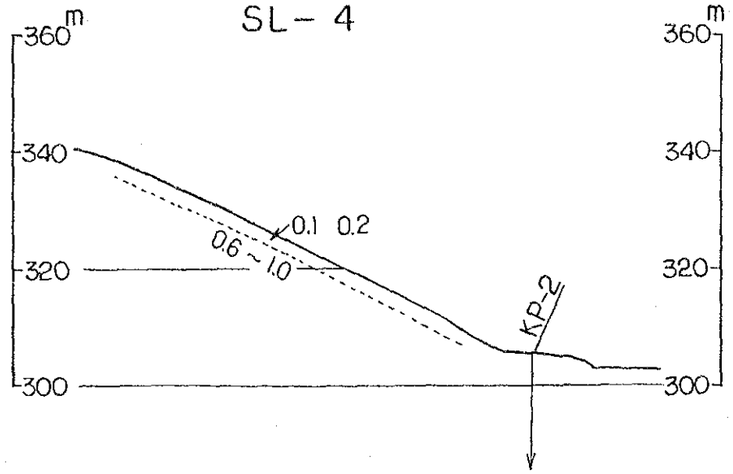
SEISMIC PROFILE TIME-DISTANCE CURVE

Fig.

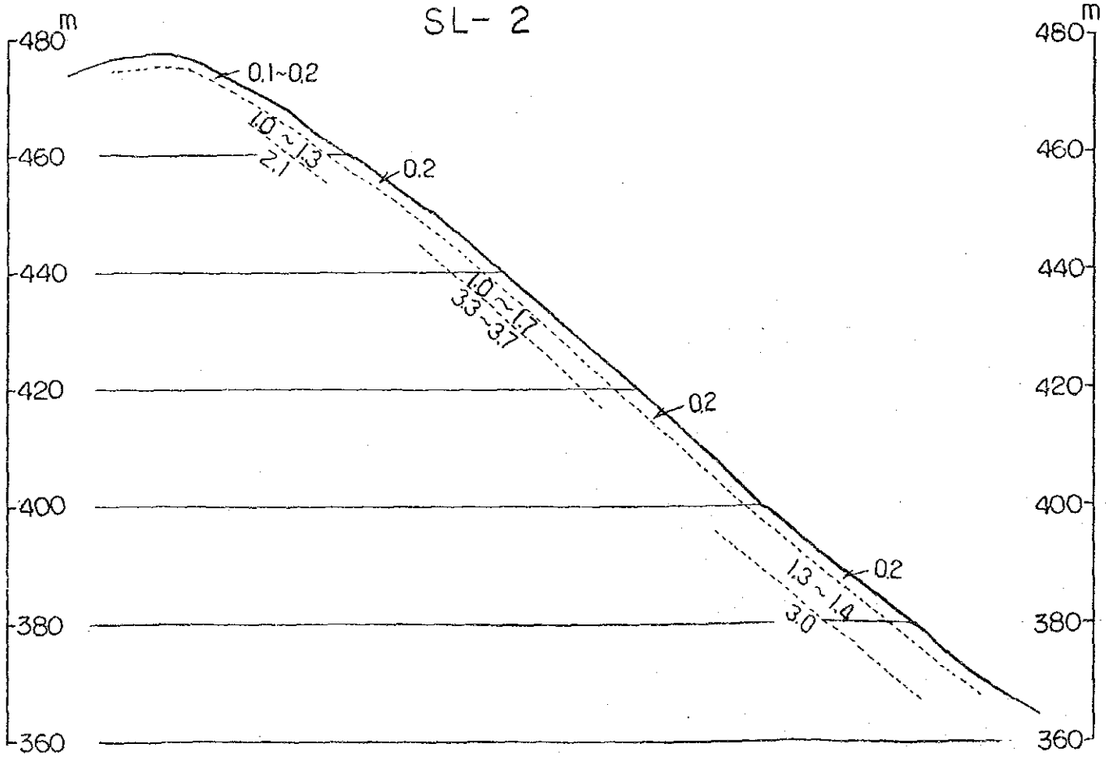
SL - 1



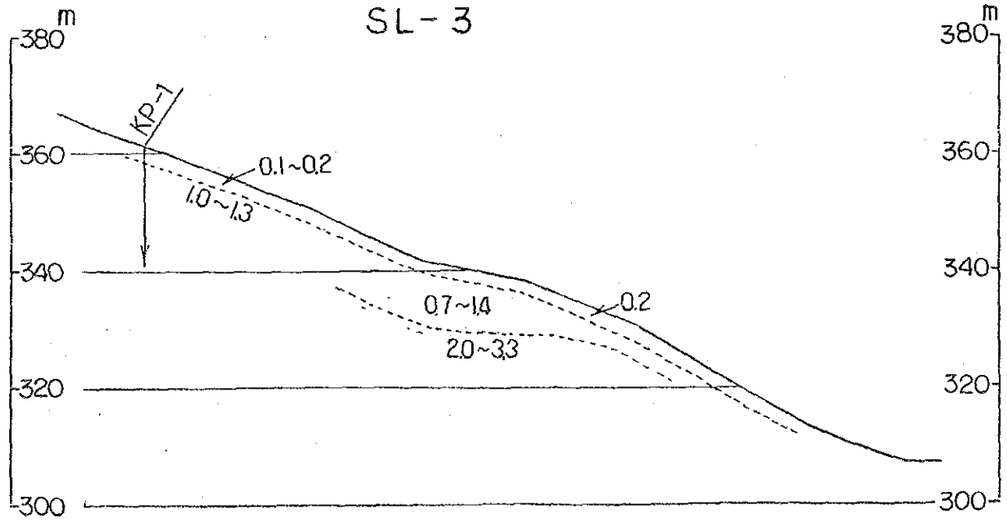
SL - 4



SL - 2



SL - 3



0 50m

0.2 / 1.4 BOUNDARY AND VELOCITY OF SEISMIC PRIMARY WAVE(in km/s)

XE KATAM SMALL - SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT

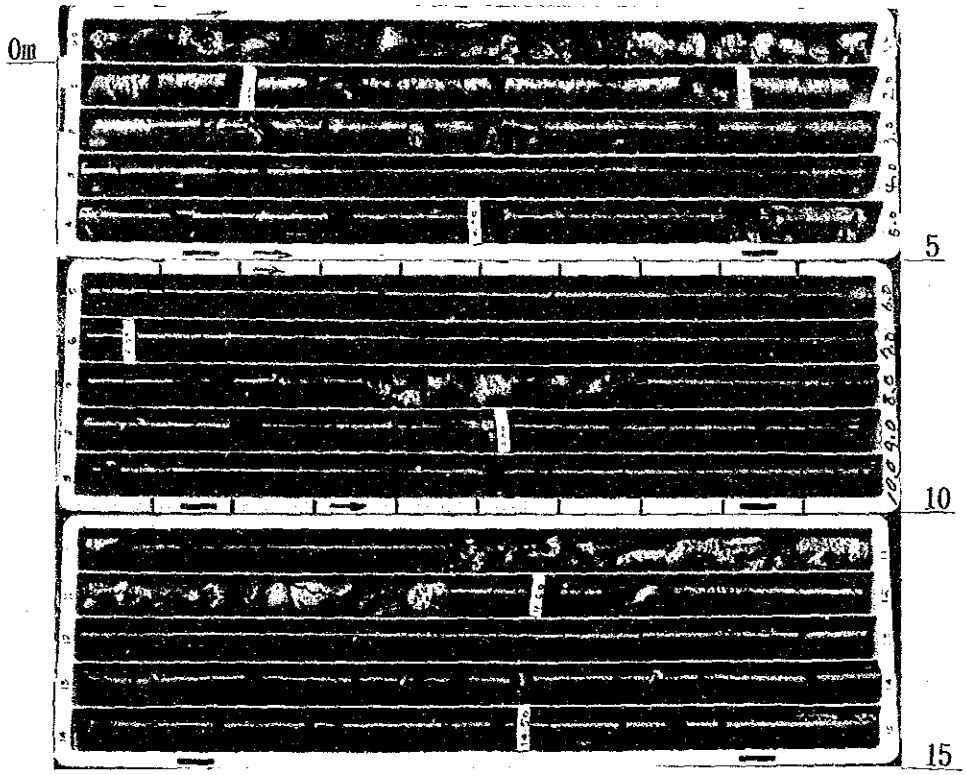
SEISMIC PROFILE

Fig.

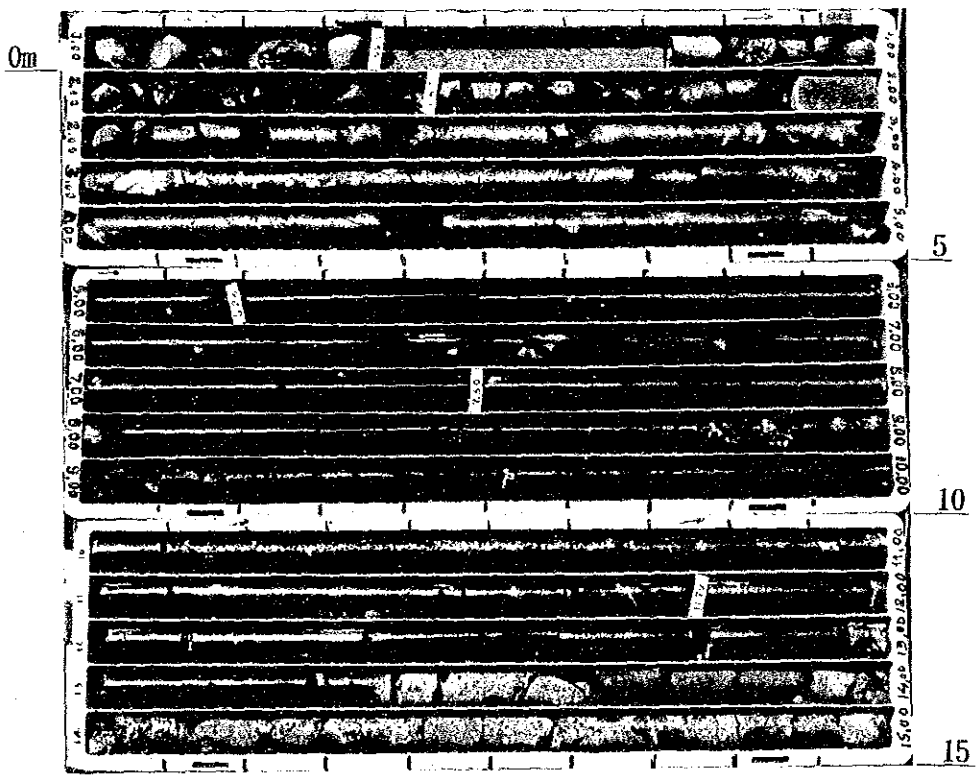
AP-2-57

Core-Photograph

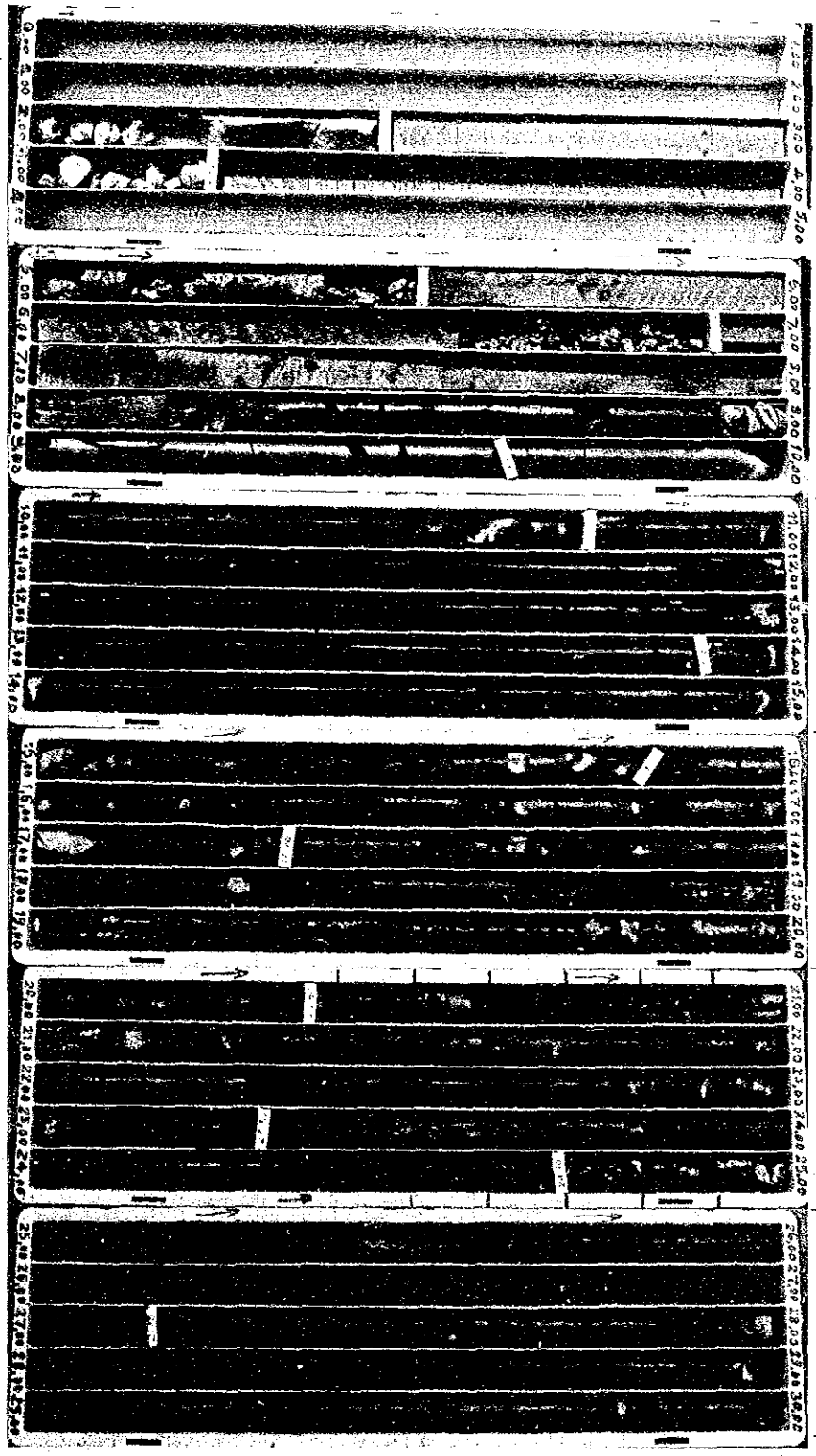
KI-1 :Length=15m



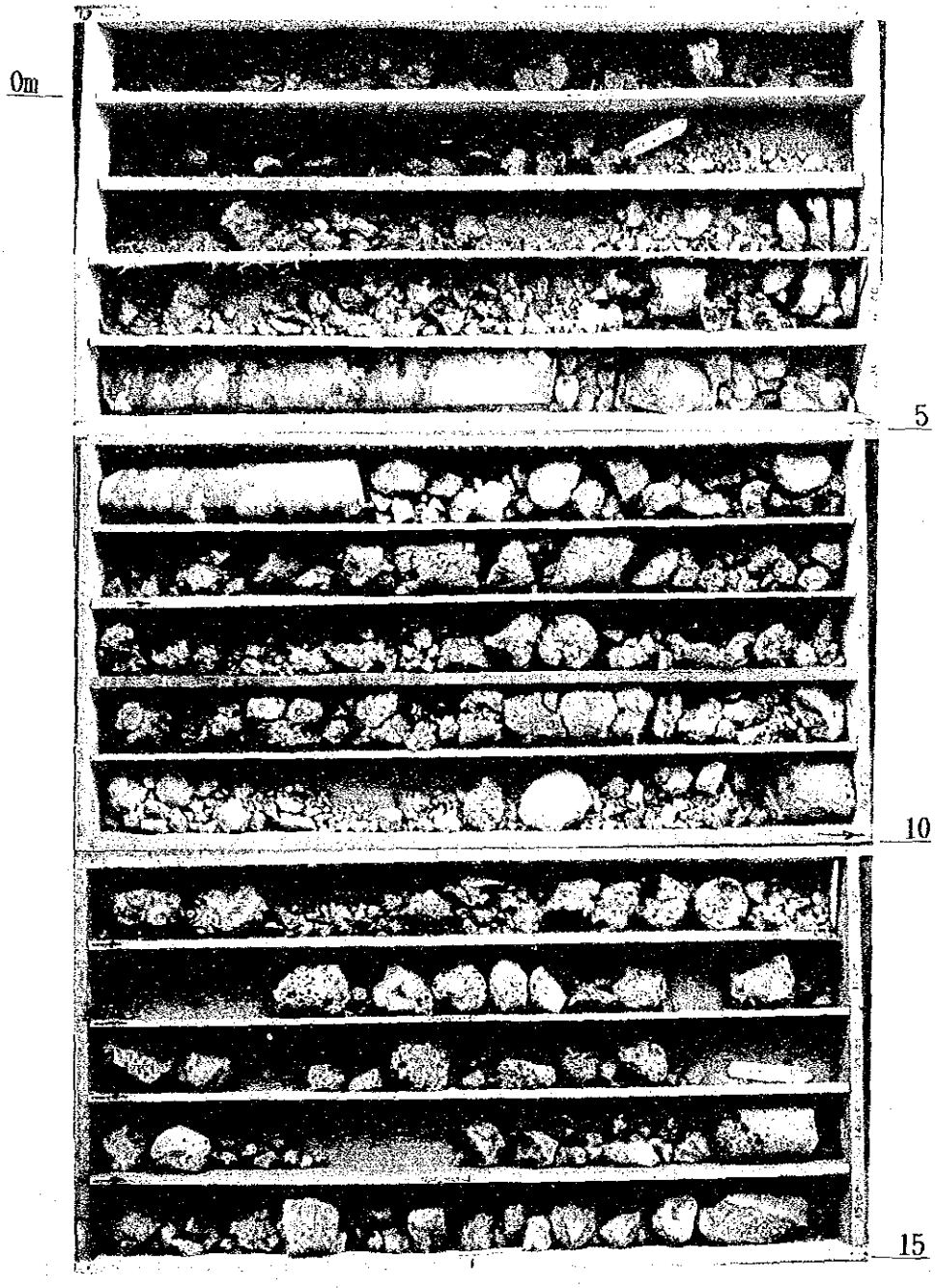
KI-2 :Length=15m



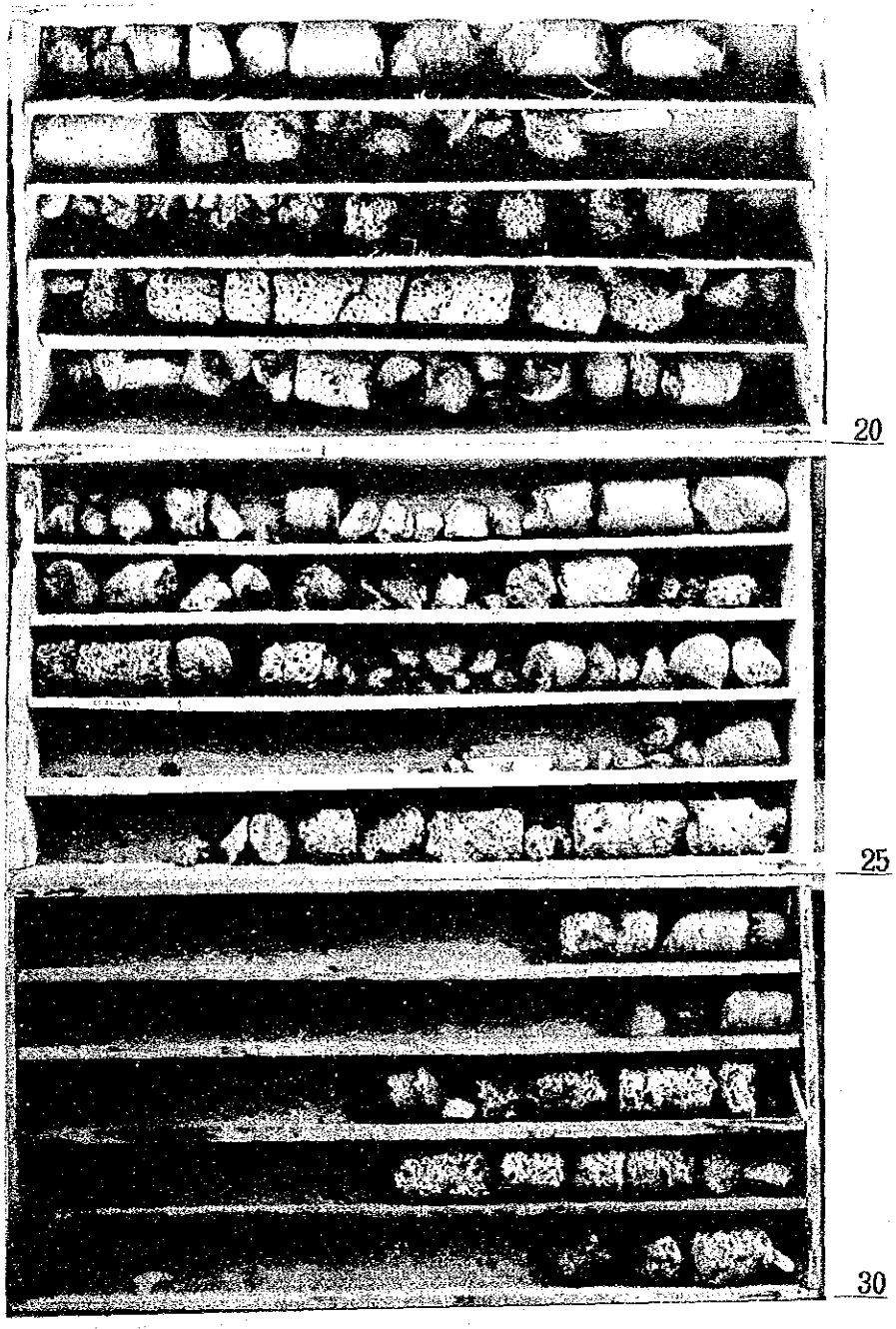
KT－1：Length=30m



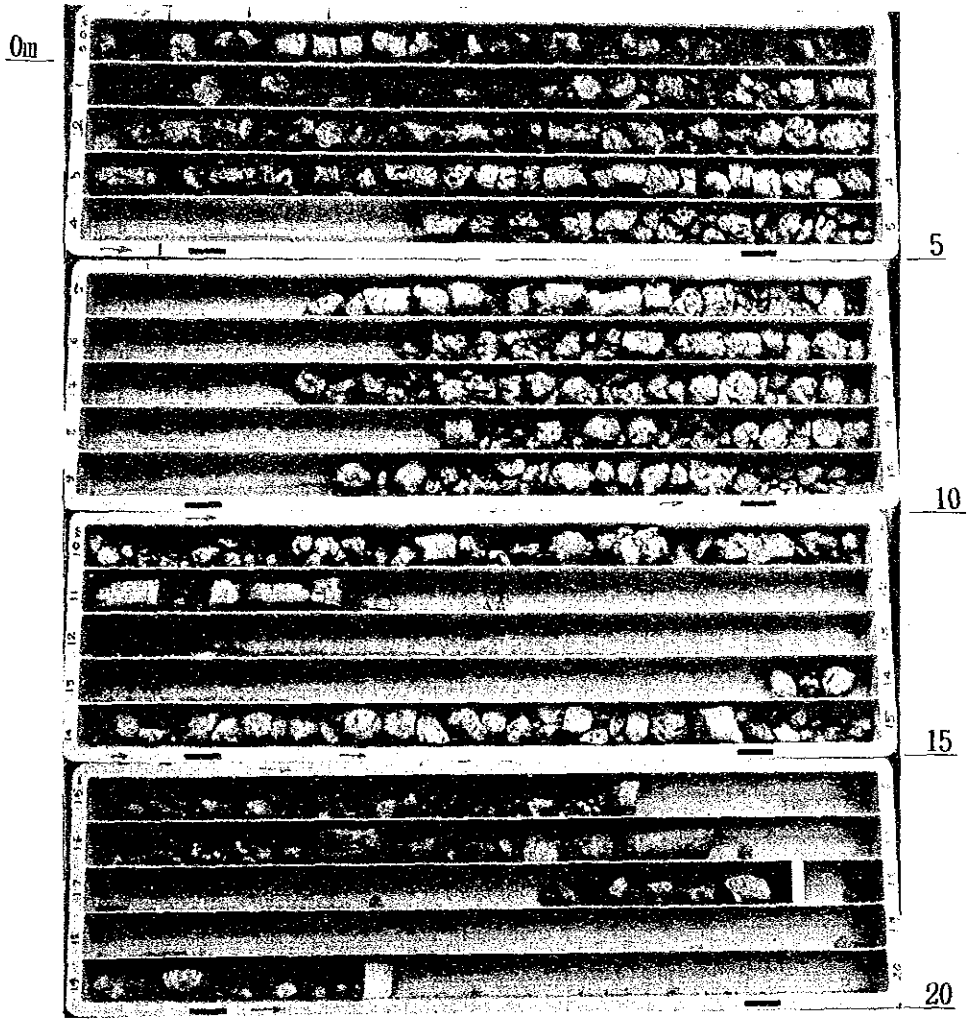
KT－2：Length=30m



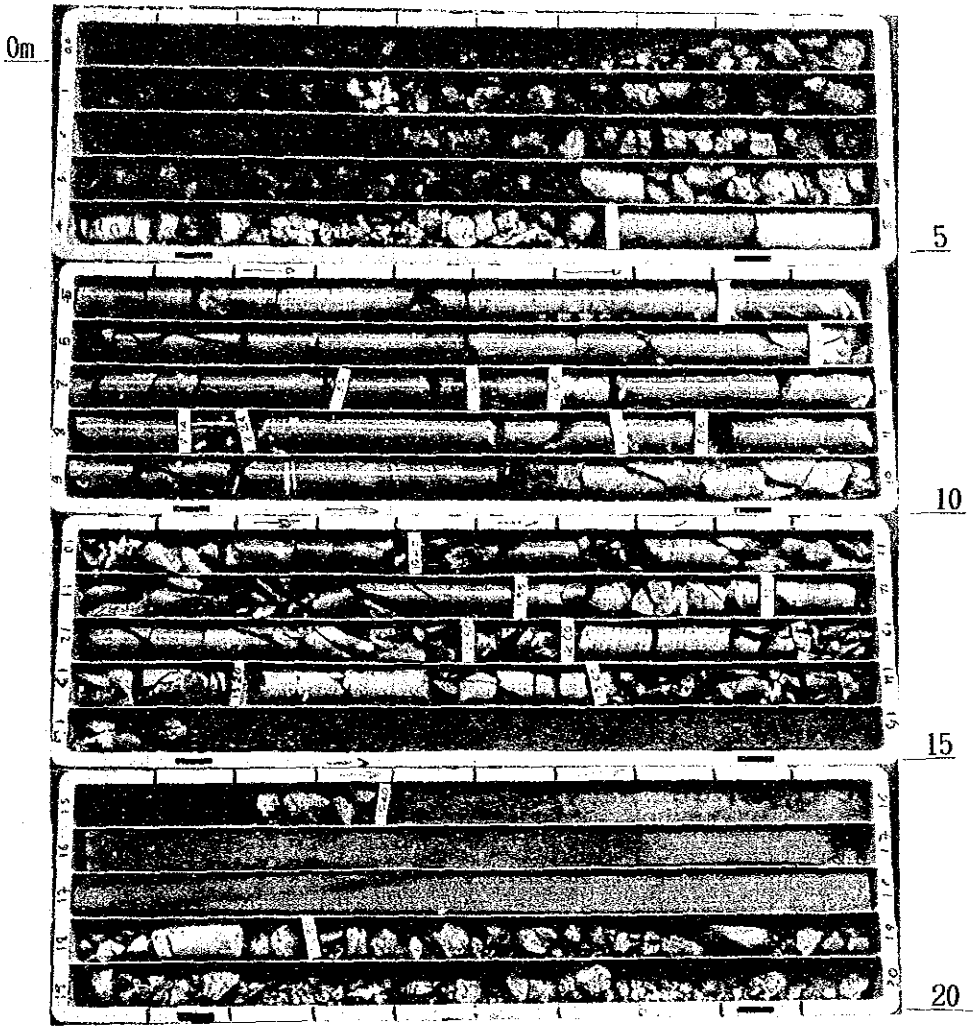
KT－2：Length=30m



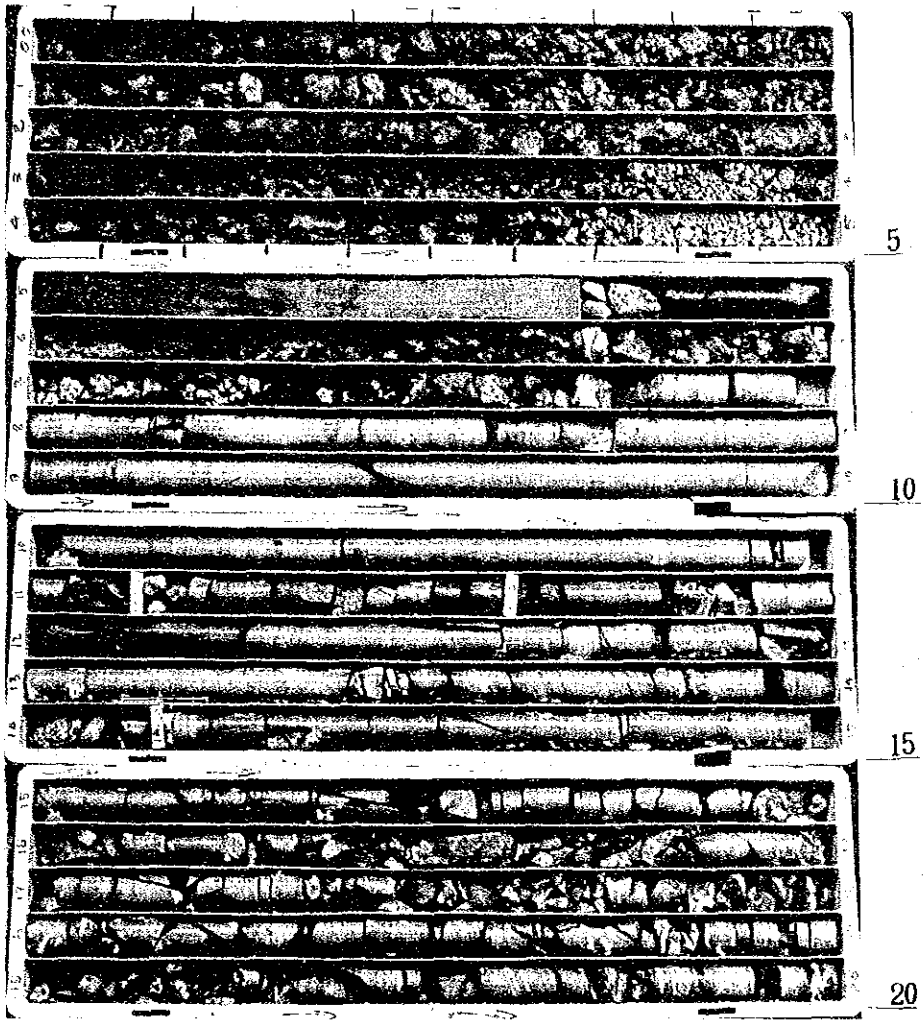
KP－1 :Length=20m



KP－2 :Length=20m



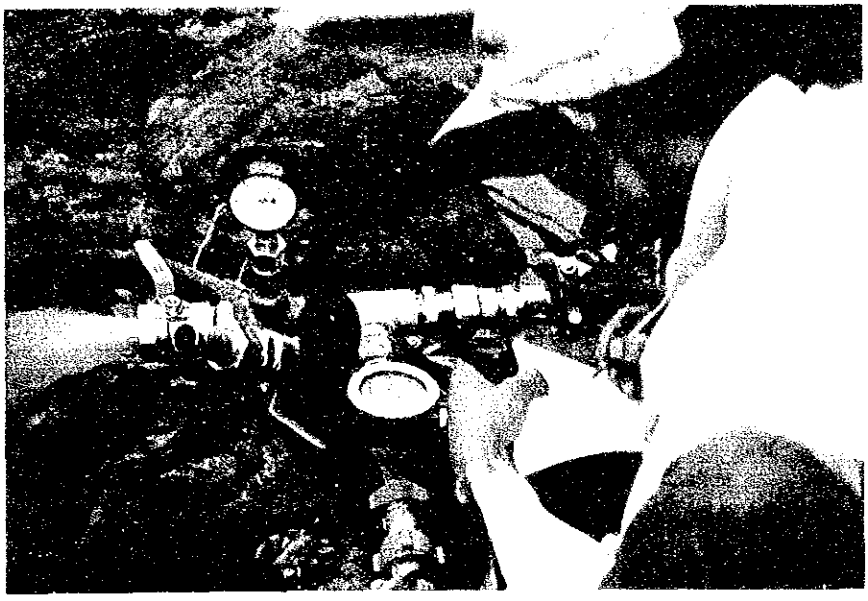
KP－3：Length=20m



Drilling Work Photograph

Drilling KI-2

Drilling KT-1



Performing permeability test at KI-2

Removing the core drilling equipments along penstock route

Micrograph and Petrographic Description of Rock

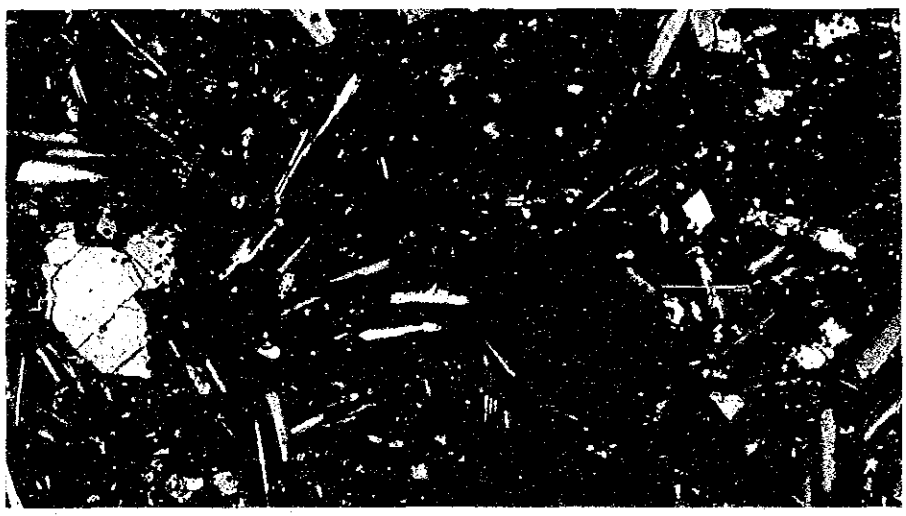
Sample No: R-1 Locality : Intake Dam

Rock Name: Olivine Basalt

Petrographic Description

Crystals are olivine, plagioclase. Olivines are idiomorphic crystals (0.1 ~ 1.0mm), plagioclases are idiomorphic laths (0.1 ~0.8mm). The constituents of the groundmass are plagioclase, pyroxene, olivine, and minor amounts of glass. Rock is very flesh.

0 0.2mm (Open nicols)



0 0.2mm (Crossed nicols)

Ol:olivine, Pl:Plagioclase, V:vacant

APPENDIX-3 Meteorology and Hydrology

APPENDIX-3 METEOROLOGY AND HYDROLOGY

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APPENDIX 3

A3.1 Rainfall and Runoff Survey Performed by JICA Study Team

A3.1.1 Installation of Rainfall Gauges

During the first field reconnaissance in this Study, installation sites of rainfall gauge were selected at two sites in the Xe Katam River Basin and three sites in the Xe Namnoy River Basin. After installation work, observations were started from February 1991. The locations of installation site are as follows:

No.	Basin	Location	Altitude*	Longitude*	Latitude*
1	Xe Katam	Ban Xekata	1,060 m	106°26'15"	15°14'00"
2	Xe Katam	Ban Tongvay	950 m	106°31'15"	15°12'30"
3	Xe Namnoy	Ban Houaikong	890 m	106°31'30"	15°07'45"
4	Xe Namnoy	Ban Latsasin	750 m	106°36'15"	15°03'15"
5	Xe Namnoy	Ban Namkong	700 m	106°34'30"	14°59'00"

* Altitudes, Longitudes and Latitudes are approximate values according to 1/100,000 topographical map.

The installation sites were selected with the principle of even arrangement of area division in the river basins. However, because of limited number of gauge units which could be installed, the locations were decided with following reasons.

- Because of the necessity to request maintenance of instruments and recording works to local residents, it was decided that installation should be inside of villages or at adjacent locations. Further, for convenience in installation of observation instruments and gathering of observed records, places where are accessible by vehicles were selected.

- In general, there is more rainfall in mountainous areas than in flat areas, and the run-off of a river will be strongly affected by rainfall in such intensive rainy areas. The basin of the Xe Katam River has mountains of

elevation approximately 1,500 m at its north side so that installation in this area was examined. However, accessibility in this area is very bad to install and maintain instrument. Accordingly, The Ban Xe Katam and Ban Tongvay sites were selected as being locations as close as possible to these mountains.

- Meanwhile, consideration was given to grasping the rainfall in flat areas as well, in order to observe contrasts with rainfall in mountainous areas. In this regard, installation at the Ban Nonghin site in the Xe Katam Basin was considered, but this site is located comparatively close to the Ban Tongvay site. Therefore, although out of the Xe Katam River Basin, the Ban Houaykong site which is connected topographically with Ban Nonghin was selected for installation.

- In the basin of Xe Namnoy mainstream, installation sites of water level gauge were selected at Ban Latsasin and Ban Namkong which are located in the left bank area of the Xe Namnoy midstream. It was given up to install gauges in the right bank area and upstream area of Xea Namnoy basin because of difficulty of access by vehicle.

A3.1.2 Installation of Water Level Gauges

During the first field reconnaissance of this Study, installation sites of water level gauge were selected at one site each on the Xe Katam River and the Xe Namnoy River mainstream, and after installation work, observations were started from February 1991. The locations of installation site are as follows:

No.	River	Location	EL.	Catchment Area
1	Xe Katam	Ban Nonghin	840 m	171 km^2
2	Xe Namnoy	Ban Latsasin	720 m	537 km^2

Installation sites were selected with following reasons:

- Predicated on commissioning local residents to handle care of water gauges, periodical observations of staff gauges, and runoff observations for

preparation of rating curves, locations were selected at sites adjacent to villages.

- Regarding the Xe Katam River, since there was no suitable village in the neighborhood of the Xe Katam project site located at the most downstream part of the river (catchment area 290 km^2), it was decided to install a gauge at the Ban Nonghin site on the middle stretch of the Xe Katam River (catchment area 171 km^2).

- Regarding the Xe Nammoy River, the Ban Latsasin site, which is located along the middle stretch of mainstream and is accessible by vehicle, was selected for installation.

A3.1.3 Discharge Measurements by JICA Team

Runoff measurements by current meters were performed by the study team during site survey at a number of sites in order to obtain runoff data on the various project sites on the Xe Katam and Xe Namnoy rivers to be examined in the Study. The results of measurements are given in Table A3-1.

Table A3-1 Discharge Measurement by JICA Team

River	Location	Catchment Area	Date	Discharge
Xe Katam	Ban Nonghin	171 km^2	Dec.28,1990	1.8 m^3/s
			Mar.28,1991	0.64 m^3/s
			Mar.30,1991	0.58 m^3/s
	Upstream of Planned Damsite	288 km^2	Dec.28,1990	3.3 m^3/s
			Mar.28,1991	0.80 m^3/s
			Mar.28,1991	0.78 m^3/s
			Jul. 5,1991	13.3 m^3/s
	Planned Damsite	290 km^2	Mar.28,1991	0.78 m^3/s
	Downstream of Planned Damsite	295 km^2	Mar.30,1991	0.75 m^3/s
Xe Katam	Ban Xekatam	49 km^2	Mar.27,1991	0.33 m^3/s
Xe Namnoy	Ban Latsasin	537 km^2	Dec.29,1990	5.2 m^3/s
			Mar.26,1991	0.55 m^3/s
			Mar.31,1991	0.48 m^3/s
	Powerhouse site of Xe Katam Project	784 km^2	Mar.30,1991	2.2 m^3/s
H. Makchan	H.Makchan Nikhon34	39 km^2	Mar.27,1991	0.28 m^3/s
			Jun.23,1991	1.9 m^3/s
			Jul. 8,1991	2.3 m^3/s
H. Champi	H. Champi Ban Itou	53 km^2	Apr. 1,1991	0.46 m^3/s

A3.2 Hydrological Records observed in the Xe Namnoy River Basin

A3.2.1 River Flow Survey on Xe Katam River in 1991

Discharge Measurement Records at Ban Nonghin

XEKATAM SMALL HYDRO-ELECTRIC POWER PROJECT

LIST OF DISCHARGE MEASUREMENT

RIVER : XEKATAM — HYDROLOGIC YEAR 1991

STATION : BAN NONGHIN — SHEET ....1.....

Made by : Mr.Sengchanh

Approved by : Mr.Somsack PHRASONTHI

No.	DATE	GAUGE HEIGHT m	AREA sq.m	MEAN VELOCITY m/s	DISCHARGE cu.m/s	G.H CHANGE	REMARKS
1	3-5-91	0,34	7,030	0,185	1,304		
2	8-5-91	0,34	6,830	0,212	1,450		
3	13-5-91	0,33	6,575	0,183	1,208		
4	16-5-91	0,45	9,345	0,255	2,383		
5	18-5-91	0,49	10,460	0,271	2,837		
6	22-5-91	0,49	9,985	0,265	2,654		
7	27-5-91	0,43	7,450	0,240	1,792		
8	30-5-91	0,42	8,100	0,222	1,805		
9	5-6-91	0,41	7,588	0,197	1,497		
10	13-6-91	0,55	11,490	0,333	3,826		
11	18-6-91	0,48	11,135	0,222	2,469		
12	26-6-91	0,68	11,950	0,440	6,134		
13	4-7-91	0,77	16,225	0,622	10,087		
14	7-7-91	0,69	14,023	0,630	6,30		
15	17-7-91	0,81	16,822	0,584	9,832		
16	24-7-91	1,14	28,05	1,198	33,029		
17	31-7-91	0,96	22,35	0,865	19,322		
18	7-8-91	0,94	21,575	0,843	18,186		
19	16-8-91	1,05	24,755	0,985	23,677		
20	17-8-91	1,24	31,45	1,275	40,080		
21	20-8-91	1,28	32,70	1,465	47,894		
22	27-8-91	1,15	27,875	1,189	33,158		
23	29-8-91	1,16	27,85	1,270	35,361		
24	3-9-91	0,96	20,15	0,934	18,817		
25	15-9-91	0,93	19,85	0,869	17,259		
26	18-9-91	0,84	17,666	0,796	14,069		
27	25-9-91	0,98	21,196	0,923	19,555		
28	4-10-91	1,13	27,413	1,294	35,487		

XEKATAM SMALL HYDRO-ELECTRIC POWER PROJECT

LIST OF DISCHARGE MEASUREMENT

RIVER : XEKATAM
STATION : BAN NONGHIN

HYDROLOGIC YEAR 1991
SHEET ...2.....

Made by : Mr.Sengchanh
Approved by : Mr.Somsack PHRASONTHI

No.	DATE	GAUGE HEIGHT m	AREA sq.m	MEAN VELOCITY m/s	DISCHARGE cu.m/s	G.H CHANGE	REMARKS
29	9-10-91	1,02	22,655	1,032	23,371		
30	16-10-91	0,90	18,280	0,893	16,338		
31	23-10-91	0,76	15,635	0,629	9,849		
32	30-10-91	0,67	14,027	0,455	6,389		
33	6-11-91	0,60	12,102	0,421	5,096		
34	27-11-91	0,50	9,899	0,304	3,007		
35	4-12-91	0,46	9,366	0,270	2,537		
36	11-12-91	0,44	9,946	0,270	2,694		
37	18-12-91	0,43	8,302	0,220	1,829		
38	25-12-91	0,40	8,172	0,226	1,849		
39	2-1-92	0,38	8,603	0,206	1,780		
40	8-1-92	0,38	8,848	0,227	2,011		
41	15-1-92	0,36	8,495	0,192	1,632		
42							
43							
44							
45							
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53							
54							
55							
56							

Station XEKATAM. 3/5/1991 (No.1) | V=0,698N+0,016

CURRENT-METERING AND CALCULATION OF FLOW (1–2–3 POINTS METHOD) Page 2

Vertical (Max. depth in m)	Results of current-metering: Depth of point (%·m)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	Calculation of velocities and of flow: Velocity (m.s⁻¹) in the point	Velocity (m.s⁻¹) mean in the vertical "VV"	Velocity (m.s⁻¹) average between verticals	Flow area "P" between verticals (m²)	Flow "Q" (10)=(8)x(9) (m³.s⁻¹)	Notes (times, gauge reading etc.)
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
0,5	20–						0,031	0,25	0,008	
	60–	4	60"	0,066	0,068	0,062				
	80–									
0,53	20–	11	50"	0,22	0,169	0,145	0,105	0,515	0,054	
	60–									
	80–	8	52"	0,153	0,122					
0,57	20–	21	48"	0,437	0,321	0,306	0,225	0,55	0,123	
	60–									
	80–	19	48"	0,395	0,291					
0,59	20–	15	47"	0,319	0,238	0,228	0,267	0,57	0,152	
	60–									
	80–	14	48"	0,291	0,219					
0,63	20–	14	46"	0,304	0,228	0,183	0,205	0,60	0,123	
	60–									
	80–	9	51"	0,176	0,138					
0,58	20–	13	46"	0,282	0,212	0,156	0,169	0,605	0,102	
	60–									
	80–	2	53"	0,122	0,101					
0,70	20–	14	48"	0,291	0,219	0,199	0,122	0,611	0,113	
	60–									
	80–	11	47"	0,234	0,179					
0,56	20–	31	46"	0,673	0,485	0,401	0,3	0,63	0,189	
	60–									
	80–	20	46"	0,431	0,318					
0,71	20–	18	47"	0,382	0,282	0,212	0,306	0,635	0,194	
	60–									
	80–	10	55"	0,181	0,142					
0,56	20–	9	49"	0,183	0,143	0,105	0,158	0,635	0,100	
	60–									
	80–	4	53"	0,075	0,068					
0,51	20–	12	45"	0,266	0,201	0,123	0,114	0,535	0,060	
	60–									
	80–	2	69"	0,043	0,046					
0,46	20–	11	45"	0,244	0,186	0,132	0,127	0,1185	0,061	
	60–									
	80–	5	55"	0,090	0,078					
0,30	20–						0,066	0,38	0,025	
	60–				0					
	80–									
	20–									
	60–									
	80–									
	20–									
	60–									
	80–									
							0,185	1,03	1,304	
							VP=ΣQ:ΣF	ΣP	ΣQ	

Station. LEKATAM. 8/5/1991 (No. 2)

CURRENT-METERING AND CALCULATION OF FLOW (1-2-3 POINTS METHOD)

Vertical (Max. depth in m)	Results of current-metering: Depth of point (%-m)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	Calculation of velocities and of flow: Velocity (m.s-1): in the point	mean in the vertical "VV"	average between verticals	Flow area "F" between verticals (m²)	Flow "Q" (10)=(8)×(9) (m³.s-1)	Notes (times, gauge reading etc.)
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
1 0,60	20–	3	53'	0,054	0,053	0,058	0,029	0,3	0,008	T-start: 10h30' H = 0,34m
	60–									
	80–	3	114'	0,068	0,063					
1 0,54	20–	13	47'	0,276	0,208	0,209	0,133	0,57	0,075	T-end: 11h00 H: 0,34m
	60–									
	80–	12	113'	0,249	0,210					
1 0,58	20–	18	50'	0,36	0,267	0,274	0,241	0,56	0,134	
	60–									
	80–	16	112'	0,380	0,281					
1 0,50	20–	23	114'	0,522	0,380	0,309	0,291	0,54	0,157	
	60–									
	80–	15	117'	0,319	0,238					
1 0,70	20–	16	113'	0,372	0,275	0,190	0,249	0,60	0,149	
	60–									
	80–	6	116'	0,130	0,106					
1 0,68	20–	18	113'	0,398	0,258	0,271	0,230	0,69	0,158	
	60–									
	80–	18	111'	0,386	0,285					
1 0,55	20–	26	112'	0,619	0,448	0,439	0,355	0,61	0,216	
	60–									
	80–	25	112'	0,595	0,431					
1 0,53	20–	19	111'	0,431	0,316	0,272	0,355	0,54	0,191	Khampha st A.B
	60–									
	80–	11	116'	0,304	0,228					
1 0,59	20–	8	113'	0,186	0,145	0,134	0,203	0,56	0,113	
	60–									
	80–	6	119'	0,122	0,101					
1 0,51	20–	7	115'	0,155	0,124	0,118	0,126	0,55	0,069	
	60–									
	80–	6	113'	0,139	0,113					
1 0,57	20–	11	111'	0,318	0,237	0,227	0,172	0,54	0,092	
	60–									
	80–	13	115'	0,288	0,217					
1 0,35	20–									
	60–	2	116'	0,043	0,046	0,046	0,136	0,46	0,062	
	80–									
1 0,28	20–									
	60–	7	113'	0,162	0,129	0,129	0,087	0,31	0,026	
	80–									
1 0,11	20–									
	60–	–	0	–	–					
	80–									
	20–									
	60–									
	80–									
							0,212	6,83	1,45	
							VP=ΣQ:ΣF	ΣF	ΣQ	

station XEKAIAM. 13/5/91 (No. 3)

CURRENT-METERING AND CALCULATION OF FLOW (1–2–3 POINTS METHOD)

Vertical (Max. depth in m)	Results of current-metering: Depth of point (s-m)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	Calculation of velocities and of flow: Velocity (m.s-1): in the point	mean in the vertical "VV"	average between verticals	Flow area "F" between verticals (m²)	Flow "Q" (10)=(8)×(9) (m³.s-1)	Notes (times, gauge reading etc.)
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
1 0,42	20–	2	113"	0,046	0,049	0,039	0,019	0,21	0,004	T. start: 10h 05'
	60–									T. end: 10h 50'
	80–	1	118"	0,020	0,029					H = 0,33 m
1 0,55	20–	7	116"	0,152	0,122	0,092	0,065	0,185	0,031	
	60–									
	80–	3	115"	0,066	0,062					
1 0,46	20–	10	115"	0,222	0,170	0,133	0,112	0,505	0,056	
	60–									
	80–	5	113'	0,116	0,096					
1 0,86	20–	14	112'	0,333	0,248	0,228	0,179	0,51	0,091	
	60–									
	80–	12	115"	0,266	0,201					
1 0,48	20–	18	113"	0,418	0,308	0,264	0,244	0,52	0,126	
	60–									
	80–	13	114'	0,295	0,221					
1 0,54	20–	16	111'	0,363	0,269	0,202	0,233	0,51	0,118	
	60–									
	80–	8	117"	0,170	0,134					
1 0,88	20–	22	113'	0,511	0,372	0,285	0,243	0,56	0,136	
	60–									
	80–	12	116'	0,260	0,197					
1 0,43	20–	20	113'	0,465	0,340	0,324	0,304	0,505	0,153	
	60–									
	80–	18	113'	0,418	0,307					
1 0,50	20–	17	113"	0,395	0,291	0,238	0,336	0,465	0,151	
	60–									
	80–	11	113'	0,244	0,186					
1 0,55	20–	6	115"	0,133	0,108	0,078	0,203	0,525	0,106	
	60–									
	80–	2	113"	0,046	0,048					
1 0,49	20–	12	115"	0,277	0,219	0,220	0,149	0,52	0,077	
	60–									
	80–	9	113"	0,209	0,161					
1 0,54	20–	12	114'	0,272	0,205	0,158	0,189	0,515	0,097	
	60–									
	80–	6	111'	0,136	0,110					
1 0,35	20–									
	60–	2	113'	0,046	0,048	0,048	0,103	0,445	0,045	
	80–									
1 0,25	20–									
	60–	5	113'	0,116	0,069	0,069	0,058	0,3	0,017	
	80–									
	20–									
	60–	—	—	—	—					
	80–									
							0,183	6,575	1,208	

VP=ΣQ:ΣF ΣF ΣQ

Station ЖЕКАТАМ. (No. 4) 16/5/1991 ; V = 0,698N + 0,016.

CURRENT-METERING AND CALCULATION OF FLOW (1–2–3 POINTS METHOD)

Vertical (Max. depth in m)	Results of current-metering: Depth of point (%-m)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	Calculation of velocities and of flow: Velocity (m.s-1) in the point	Velocity (m.s-1) mean in the vertical "VV"	average between verticals	Flow area "F" between verticals (m²)	Flow "Q" (10)=(8)x(9) (m³.s-1)	Notes (times, gauge reading etc.)
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
1 0,40	20–	7	115'	0,155	0,124	0,125	0,062	0,20	0,012	T start: 11h 05'
	60–									T end = 12h 07
	80–	7	118'	0,159	0,126					H = 0,45 m
1 0,64	20–	7	118'	0,159	0,126	0,117	0,121	0,52	0,062	
	60–									
	80–	6	115'	0,133	0,108					
1 0,62	20–	10	113'	0,232	0,177	0,169	0,113	0,63	0,090	
	60–									
	80–	9	113"	0,209	0,161					
1 0,72	20–	24	112'	0,531	0,414	0,352	0,260	0,67	0,174	
	60–									
	80–	17	113"	0,395	0,291					
1 0,72	20–	31	113"	0,720	0,518	0,420	0,402	0,72	0,289	
	60–									
	80–	19	113"	0,441	0,323					
1 0,85	20–	21	113"	0,488	0,356	0,312	0,366	0,785	0,287	
	60–									
	80–	16	111'	0,363	0,269					
1 0,81	20–	27	113"	0,627	0,453	0,383	0,317	0,83	0,288	
	60–									
	80–	18	112'	0,428	0,311					
1 0,71	20–	22	113"	0,511	0,372	0,323	0,353	0,76	0,268	
	60–									
	80–	16	113"	0,372	0,275					
1 0,67	20–	19	113"	0,441	0,323	0,331	0,327	0,69	0,225	
	60–									
	80–	20	113'	0,465	0,340					
1 0,71	20–	17	113'	0,395	0,291	0,258	0,294	0,69	0,202	
	60–									
	80–	13	113"	0,302	0,226					
1 0,62	20–	22	113'	0,511	0,372	0,351	0,304	0,665	0,202	
	60–									
	80–	19	112'	0,452	0,337					
1 0,37	20–	11	112'	0,261	0,198	0,236	0,293	0,1195	0,1115	
	60–									
	80–	16	113'	0,372	0,275					
1 0,115	20–	1	113'	0,023	0,039	0,032	0,131	0,141	0,054	
	60–									
	80–	1	113'	0,023	0,032					
1 0,33	20–	1	111'	0,022	0,031	0,031	0,078	0,39	0,012	
	60–									
	80–	1	111'	0,022	0,031					
1 0,27	20–									
	60–	11	115"	0,255	0,193	0,193	0,112	0,3	0,033	
	80–									
							VP=ΣQ:ΣF	ΣF	ΣQ	

Khampheh 9.

(No. 4-2)

CURRENT-METERING AND CALCULATION OF FLOW (1–2–3 POINTS METHOD)

Vertical (Max. depth in m)	Depth of point (%·m)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	Velocity (m.s-1) in the point	Velocity (m.s-1) mean in the vertical "VV"	Velocity (m.s-1) average between verticals	Flow area "F" between verticals (m²)	Flow "Q" (10)=(8)×(9) (m³.s-1)	Notes (times, gauge reading etc.)
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
0,26	20–									
	60–	1	43"	0,023	0,032	0,032	0,112	0,265	0,029	
	80–									
0,33	20–									
	60–	2	43"	0,046	0,048	0,048	0,04	0,295	0,011	
	80–									
	20–						0,255	9,345	2,383	
	60–									
	80–									
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							VP=ΣQ:ΣF	ΣF	ΣQ	

Station XEKATAN. 18/5/1991 (No. 5) Y=0,698 N ± 0,016.

CURRENT-METERING AND CALCULATION OF FLOW (1–2–3 POINTS METHOD)

Vertical (Max. depth in m)	Results of current-metering				Calculation of velocities and of flow			Flow area "F" between verticals (m^2)	Flow "Q" (10)=(8)x(9) ($m^3.s^{-1}$)	Notes (times, gauge reading etc.)
					Velocity ($m.s^{-1}$)					
	Depth of point (% m)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	in the point	mean in the vertical "VV"	average between verticals			
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
0,21	20–									T. start = 11 h 30' H start = 0,149 m. T. end = 12 h 00 H end = 0,149 m.
	60–		0	—	—					
	80–									
0,44	20–	1	42'	0,023	0,032	0,048	0,024	0,325	0,007	
	60–									
	80–	3	42'	0,071	0,065					
0,44	20–	1	43'	0,023	0,032	0,073	0,060	0,44	0,026	
	60–									
	80–	6	42'	0,142	0,115					
0,67	20–	0	–			0,137	0,105	0,555	0,058	
	60–									
	80–	0	–							
0,76	20–	21	42'	0,5	0,8265	0,339	0,238	0,715	0,170	
	60–									
	80–	18	42'	0,428	0,314					
0,86	20–	42	42'	1	0,744	0,555	0,447	0,76	0,339	
	60–									
	80–	23	42'	0,547	0,397					
0,88	20–	29	42'	0,690	0,1191	0,355	0,455	0,82	0,373	
	60–									
	80–	12	42'	0,288	0,214					
0,85	20–	29	42'	0,690	0,1191	0,341	0,348	0,865	0,301	
	60–									
	80–	10	41'	0,243	0,185					
0,73	20–	23	42'	0,547	0,397	0,282	0,311	0,79	0,245	
	60–									
	80–	9	42'	0,214	0,168					
0,64	20–	27	42"	0,642	0,1464	0,1444	0,363	0,685	0,248	
	60–									
	80–	24	41'	0,585	0,1424					
0,81	20–	18	42'	0,428	0,314	0,281	0,362	0,69	0,249	
	60–									
	80–	14	42'	0,333	0,248					
0,67	20–	12	42'	0,285	0,214	0,216	0,248	0,705	0,174	
	60–									
	80–	12	41'	0,292	0,219					
0,92	20–	26	41'	0,634	0,1488	0,1406	0,311	0,795	0,247	
	60–									
	80–	20	41'	0,487	0,355					
0,63	20–	3	42'	0,071	0,065	0,065	0,235	0,775	0,182	
	60–									
	80–	3	42'	0,071	0,065					
0,44	20–	15	42"	0,357	0,266	0,196	0,130	0,535	0,069	
	60–									
	80–	7	111'	0,159	0,126					
							VP=ΣQ:ΣF	ΣF	ΣQ	

(No. 5-2)

CURRENT-METERING AND CALCULATION OF FLOW (1–2–3 POINTS METHOD)

Vertical (Max. depth in m)	Results of current-metering: Depth of point (s-m)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	Calculation of velocities and of flow: Velocity (m.s-1) in the point	mean in the vertical "VV"	average between verticals	Flow area "F" between verticals (m²)	Flow "Q" (10)=(8)x(9) (m³.s-1)	Notes (times, gauge reading etc.)
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
0,31	20– 60– 6 80–	6	42'	0,142	0,115	0,115	0,155	0,375	0,058	
0,30	20– 60– 8 80–	8	42'	0,190	0,148	0,118	0,131	0,305	0,039	
0,35	20– 60– 9 80–	9	41'	0,219	0,168	0,158	0,158	0,325	0,051	
0,38	20– 60– – 80–	–	0	0	–		0,271 m/s	10,46 m²	2,836 m³/s	
	20– 60– 80–									
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	20– 60– 80–									
							VP=ΣQ:ΣF	ΣF	ΣQ	

Station ХЕКАТАМ. 22/5/91. (No. 6.) V= 0,698N + 0,016.

CURRENT-METERING AND CALCULATION OF FLOW (1–2–3 POINTS METHOD)

Vertical (Max. depth in m)	Results of current-metering: Depth of point (%-ni)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	Calculation of velocities and of flow: Velocity (m.s-1) in the point	mean in the vertical "VV"	average between verticals	Flow area "F" between verticals (m²)	Flow "Q" (10)=(8)x(9) (m³.s-1)	Notes (times, gauge reading etc.)
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
1 0,58	20–	12	48'	0,25	0,191	0,168	0,084	0,435	0,036	T.start = 14 h 15'
	60–									T.end = 16 h 45'
	80–	9	49"	0,184	0,144					
1 0,46	20–	9	49'	0,184	0,1401	0,114	0,1121	0,67	0,095	H.start = 0,49 m
	60–									H.end = 0,48 m
	80–	5	50'	0,1	0,085					
1 0,47	20–	18	46'	0,391	0,288	0,318	0,216	0,615	0,132	
	60–									
	80–	20	42'	0,476	0,348					
1 0,70	20–	32	44'	0,727	0,523	0,348	0,348	0,585	0,203	
	60–									
	80–	14	45'	0,311	0,233					
1 0,83	20–	33	45'	0,733	0,527	0,1482	0,193	0,715	0,307	
	60–									
	80–	26	43'	0,604	0,1437					
1 0,75	20–	28	44'	0,636	0,1459	0,305	0,393	0,744	0,290	
	60–									
	80–	9	46'	0,195	0,152					
1 0,72	20–	32	43'	0,7444	0,535	0,1442	0,373	0,735	0,274	
	60–									
	80–	22	44"	0,5	0,349					
1 0,17	20–									
	60–	29	44'	0,659	0,1475	0,1125	0,1158	0,1145	0,203	
	80–									
1 0,70	20–	25	47'	0,531	0,386	0,272	0,373	0,1435	0,162	
	60–									
	80–	10	49'	0,204	0,158					
1 0,94	20–	24	48'	0,5	0,365	0,365	0,318	0,82	0,262	
	60–									
	80–	22	44'	0,5	0,365					
1 0,74	20–	25	43'	0,581	0,1421	0,289	0,327	0,84	0,174	
	60–									
	80–	10	49'	0,204	0,158					
1 0,66	20–	15	45'	0,333	0,248	0,180	0,234	0,7	0,163	
	60–									
	80–	6	43'	0,139	0,113					
1 0,57	20–	3	50'	0,06	0,057	0,056	0,118	0,615	0,072	
	60–									
	80–	3	52'	0,057	0,055					
2 0,18	20–									
	60–	13	45'	0,288	0,217	0,217	0,136	0,75	0,102	
	80–									
1 0,26	20–									
	60–	5	111"	0,113	0,094	0,094	0,155	0,22	0,034	
	80–									
							VP=ΣQ:ΣF	ΣF	ΣQ	

(No. 6 - 2)

CURRENT-METERING AND CALCULATION OF FLOW (1–2–3 POINTS METHOD)

Results of current-metering					Calculation of velocities and of flow					
Vertical (Max. depth in m)	Depth of point (%·m)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	Velocity (m.s-1) in the point	Velocity (m.s-1) mean in the vertical "VV"	Velocity (m.s-1) average between verticals	Flow area "F" between verticals (m^2)	Flow "Q" (10)=(8)×(9) ($m^3 \cdot s^{-1}$)	Notes (times, gauge reading etc.)
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
1 0,23	20–						0,099	0,2113	0,024	
	60–	6	47"	0,127	0,104	0,104				
	80–									
2 0,19	20–						0,052	0,412	0,021	
	60–	0	0	–	–					
	80–									
	20–						0,265 m/s	9,985 m^2	2,6511 m^3/s	
	60–									
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							VP=ΣQ:ΣF	ΣF	ΣQ	

Station, XEKATAH. 23/5/1991 (No. 7) V= 0,698 N + 0,016.

CURRENT-METERING AND CALCULATION OF FLOW (1–2–3 POINTS METHOD)

Vertical (Max. depth in m)	Depth of point (×m)	Number of rotations	Time: partial and total (seconds)	Rotations per second (rps)	Velocity (m.s⁻¹) to the point	Velocity (m.s⁻¹) mean in the vertical "VV"	Calculation of velocities and of flow: average between verticals	Flow area "F" between verticals (m²)	Flow "Q" (10)=(8)×(9) (m³.s⁻¹)	Notes (times, gauge reading etc.)
1	2	3	4	5	6	7	8	9=6(P.1)	10	11
	20–		0	–	–					13h03
1,5 0,52	60–									13h30
	80–		0	–	–					
	20–	5	44'	0,113	0,094					H_1= 0,45 m
1 0,81	60–					0,096	0,048	0,615	0,029	
	80–	5	42'	0,119	0,099					H_2= 0,13 m
	20–	6	43'	0,139	0,113					
1 0,45	60–					0,095	0,095	0,58	0,055	
	80–	4	45'	0,088	0,077					
	20–	12	42'	0,285	0,214					
1 0,64	60–					0,179	0,137	0,545	0,074	
	80–	8	43'	0,186	0,145					
	20–	20	43'	0,465	0,340					
1 0,56	60–					0,237	0,228	0,6	0,136	
	80–	12	42'	0,285	0,214					
	20–	31	47'	0,659	0,475					
1 0,82	60–					0,363	0,322	0,69	0,222	Khamphat A.
	80–	15	43'	0,348	0,258					
	20–	22	44'	0,5	0,365					
1 0,63	60–					0,26	0,313	0,725	0,226	
	80–	9	45'	0,2	0,155					
	20–	25	46'	0,543	0,395					
1 0,62	60–					0,33	0,295	0,625	0,184	
	80–	15	42'	0,357	0,265					
	20–	24	43'	0,458	0,405					
1 0,47	60–					0,307	0,318	0,545	0,173	
	80–	12	43'	0,279	0,210					
	20–	22	44'	0,5	0,365					
1 0,66	60–					0,340	0,323	0,565	0,182	
	80–	19	44'	0,431	0,316					
	20–	16	43'	0,372	0,275					
1 0,60	60–					0,266	0,303	0,63	0,198	
	80–	15	43'	0,348	0,258					
	20–	24	50'	0,48	0,351					
1 0,59	60–					0,302	0,284	0,595	0,168	
	80–	15	44'	0,340	0,253					
	20–	14	44'	0,318	0,237					
1 0,31	60–					0,201	0,251	0,465	0,116	
	80–	9	42'	0,214	0,165					
	20–									
1 0,20	60–	11	45'	0,088	0,077	0,077	0,139	0,27	0,037	
	80–									
	20–									
1 0,12	60–	–	0	–	–					
	80–									
							0,210 m/s	3,415 m²	1,799 m³/s	

VP=ΣQ:ΣF ΣF : ΣQ