

マレーシア

リワグ川小水力発電開発計画調査

最終報告書

付属図書 VOL. I

1992年10月

国際協力事業団

鉱調資

C R (3)

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マレーシア

リワグ川小水力発電開発計画調査

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付属図書 VOL. I

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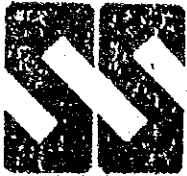
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Appendix 1

TOPOGRAPHIC SURVEY DATA

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SURCOM SERVICES SDN. BHD.

2nd Floor, No. 126 Jalan Gaya, Kota Kinabalu.

Land Surveyors: Land Title, Engineering, Topographic Hydrographic Surveyors

P. O. BOX No. 1125,
88812 KOTA KINABALU.

TEL: 81947
217027

P. O. BOX No. 278,
81007 Terasu.

FAX: 211033
TELEFAX: 779078

Our Ref: UBS/01/92

7th January 1992

Fengurus Besar,
Lembaga Elektrik Sabah,
Wisma LLS,
Kota Kinabalu.

Handwritten: 7/1/92

Handwritten: 07A(B)
Handwritten: Please check claims
Handwritten: KJ/HM

Tuan,

RE: SURVEY WORKS AT UPPER LIWAGU FIVES BASIN
TRIPER NO. T. 2155

Handwritten: Kerja-kerja pengukuran ini telah siap 100%. Buat maklumat ini untuk maklumat mengenai pangsarohan dari JICA terbahagi quality kerja ini. Surcom sudah menerima beberapa kali supaya pembayaran dibuat

We have the pleasure to inform you that we have completed the survey of the above mentioned. Enclosed herewith please find the followings for your reference and retention:

- 1) one set of tracing plans (SUR UPPER LIWAGU)
- 2) 1 Traversing book
- 3) 2 Levelling books
- 4) 2 Topographic field books
- 5) 2 Computation sheets
- 6) 1 set of List of T.P.M.s
- 7) Invoice No. UBS/92/1/2

Handwritten: Kami sampaikan supaya 70% daripada bayaran sepenuhnya dapat ditukarkan semestinya yang 30% lagi setelah mendapat pengesahan daripada JICA pada 7/2/92

Thank you.

Handwritten: (3) UPR KJ.

Yang Puan,
SURCOM SERVICES SDN. BHD.

Handwritten: Ditandatangani bucu.

Handwritten: 8/1/92

Handwritten: P 34,923.70

CHUA THIAM HUAT, A.S.D.K.
B. Sury. (Q'ld), MIS (Aust)
Jurukur Berlesen (Licensed Surveyor)

CTH/cj

Encl:

JURUKUR

CHUA THIAM HUAT ASOK. B. SURV., MIS (AUST.)

①

TRAVERSE LINE FOR UPPER LIWAGU RIVER BAS

WS-CLOSURE= -0.112 0.237 1/ 23558
 DISTANCE* 6166.581
 MISSING BRG. & DISTANCE: 115 21 39 1.262
 AREA= 877367.653

ST. NO.	ST. NAME	BEARING(DMS)	DISTANCE	LATITUDE	LONGITUDE	LAT. COR	DEP. COR	NORTHING	EASTING
1	TR16							660770.565	766991.164
2	TBM7	52 7 0	1016.117	625.16	303.562	-0.015	0.037	661791.154	767794.697
3	NP1	192 56 0	440.521	-429.36	-92.596	-0.009	0.017	660965.822	767696.074
4	NP2	10 48 10	547.213	537.52	102.564	-0.010	0.021	661304.332	767796.616
5	NP3	331 59 0	402.937	355.71	-199.271	-0.007	0.015	661665.076	767609.330
6	NP4	229 8 30	881.949	757.12	-452.377	-0.012	0.034	662177.205	767156.919
7	NP5	143 53 40	243.235	-196.62	143.219	-0.004	0.009	662426.512	767300.128
8	NP6	6 36 0	296.136	103.22	277.584	-0.005	0.011	662523.850	767577.700
9	NP7	48 50 19	61.950	49.12	45.962	-0.001	0.002	662584.937	767623.550
10	TBM2	326 3 50	47.055	41.62	-25.965	-0.001	0.002	662605.597	767597.597
11	NP8	148 55 30	49.235	-42.16	25.413	-0.001	0.002	662563.520	767623.104
12	NP9	228 42 30	60.646	-39.94	-45.637	-0.001	0.002	662523.567	767577.467
13	NP10	249 53 49	293.758	-101.65	277.740	-0.005	0.011	662421.927	767295.714
14	NP11	215 16 49	637.295	-624.22	-483.919	-0.015	0.032	661737.923	766513.762
15	TR16	161 43 59	962.722	-564.72	173.435	-0.019	0.033	660770.565	766991.164

②

TRAVERSE LINE FOR UPPER LIWAGU RIVER BR

IS-CLOSURE= 0.436 0.152 17-28621
 DISTANCE= 5829.652
 MISSING BRG. & DISTANCE: 48 7 17 0.204
 AREA= 1753.246

NO	ST. NAME	BEARING(DMS)	DISTANCE	LATITUDE	DEPARTURE	LAT. COR	DEF. COR	NORTHING	EASTING
	TR16							660770.965	766991.164
1	NP12	334 6 10	872.659	785.035	-381.145	0.020	0.023	661553.979	766609.956
2	NP13	0 47 0	273.559	273.524	3.740	0.006	0.007	661829.495	766613.726
3	NP14	293 49 9	1088.858	439.746	-996.121	0.025	0.026	662249.013	765617.536
4	NP15	357 50 29	345.830	365.570	-17.777	0.005	0.010	662574.180	765603.793
5	NP16	30 56 0	233.594	206.292	126.031	0.005	0.008	662825.861	765723.817
6	NP17	219 11 40	43.111	-37.252	-21.892	0.001	0.001	662937.814	765702.134
7	(TBM)	96 31 19	43.750	-0.399	43.748	0.001	0.001	662991.494	765745.881
8	NP18	271 42 9	45.060	1.337	-45.040	0.001	0.001	662991.492	765760.840
9	NP19	32 12 0	41.797	35.365	22.273	0.001	0.001	662934.109	765723.111
10	NP20	219 56 0	232.196	-199.170	-119.358	0.005	0.006	662634.334	765605.747
11	NP21	177 53 9	365.891	-365.645	13.496	0.005	0.010	662269.260	765617.254
12	NP22	113 49 9	1089.116	-439.845	996.342	0.025	0.023	661925.409	765613.554
13	NP23	179 45 29	275.895	-275.895	1.093	0.006	0.007	661550.510	765614.630
14	TR16	154 18 10	668.412	-782.524	376.557	0.026	0.023	660770.965	766991.164

IS-CLOSURE= -0.202 0.003 17-7529
 DISTANCE= 1625.796
 MISSING BRG. & DISTANCE: 179 18 25 0.208

NO	ST. NAME	BEARING(DMS)	DISTANCE	LATITUDE	DEPARTURE	LAT. COR	DEF. COR	NORTHING	EASTING
1	NP15							652534.759	755603.793
2	NP24	83 30 50	756.113	89.531	791.017	-0.106	0.001	652724.317	765394.905
3	NP4	93 2 40	769.695	-107.711	762.111	-0.102	0.001	652817.213	767156.919

STATION RECORD SHEET

Station Number:
TBM 1
(LIWAGU RIVER)

Latitude
Longitude
E.(W)
N.(S)

Elevation 1051.25

For Office Use

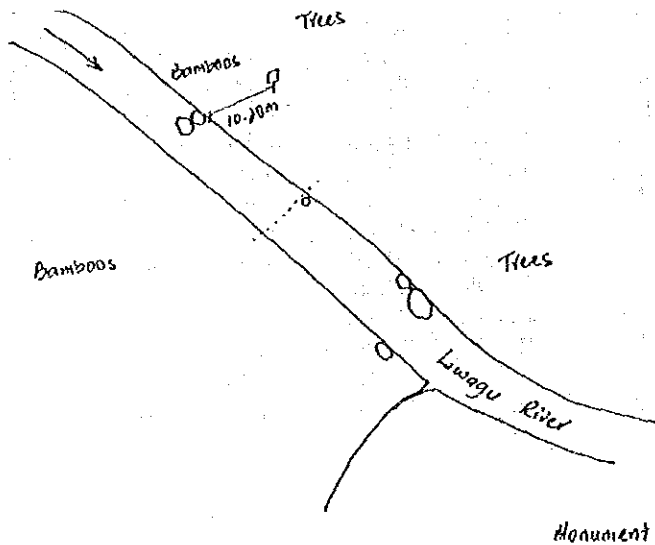
Station established by: Mr. Daniel Y.K. Wong

Date:

General Information :

Coordinates: Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level

Description of Mark



Diagrams

Snap-photos of Mark



STATION RECORD SHEET

Station Number:

TBM 2

(MESILAU RIVER)

Latitude

Longitude

E.(W)

N.(S)

Elevation

1045.09

For Office Use

Station established by: Mr. Daniel Y. K. Wong

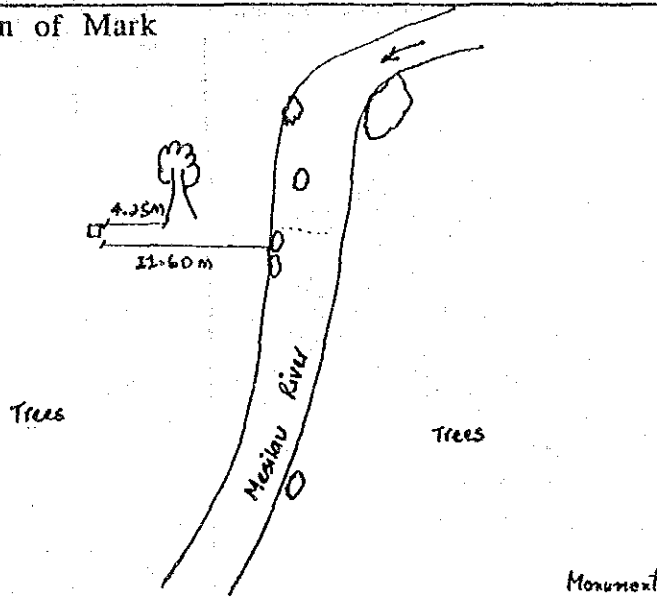
Date:

General Information :

Coordinates: Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level

Description of Mark

Diagrams



Snap-photos of Mark



STATION RECORD SHEET

Station Number:

TBM 3

Latitude

For Office Use

Longitude

E.(W)

N.(S)

Elevation

1858.01

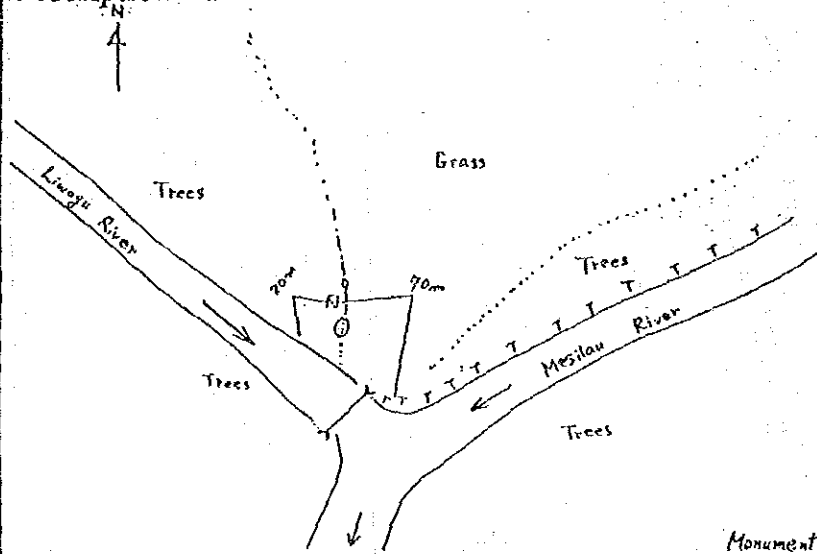
Station established by: TONKIN AND TAYLOR

Date:

General Information :

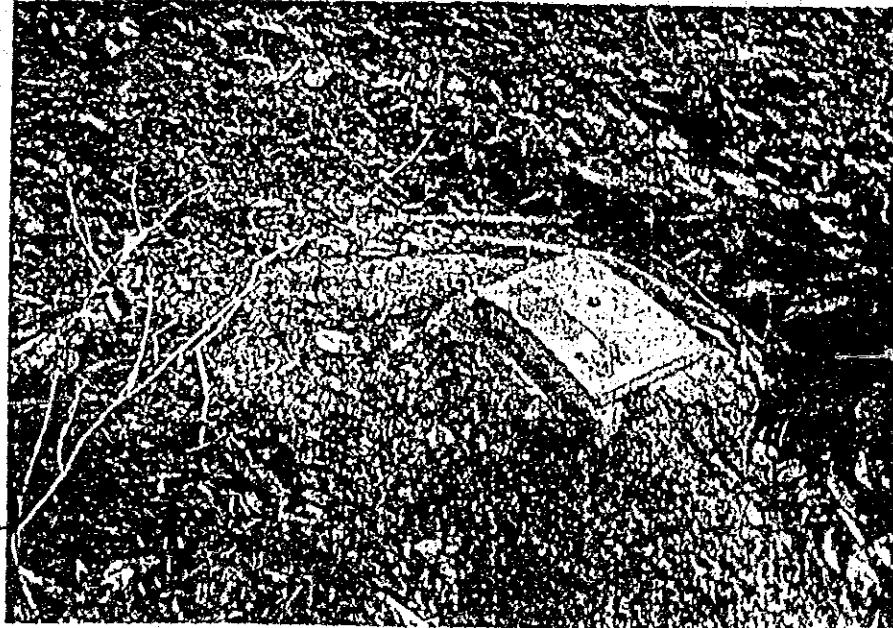
Coordinates : Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level

Description of Mark



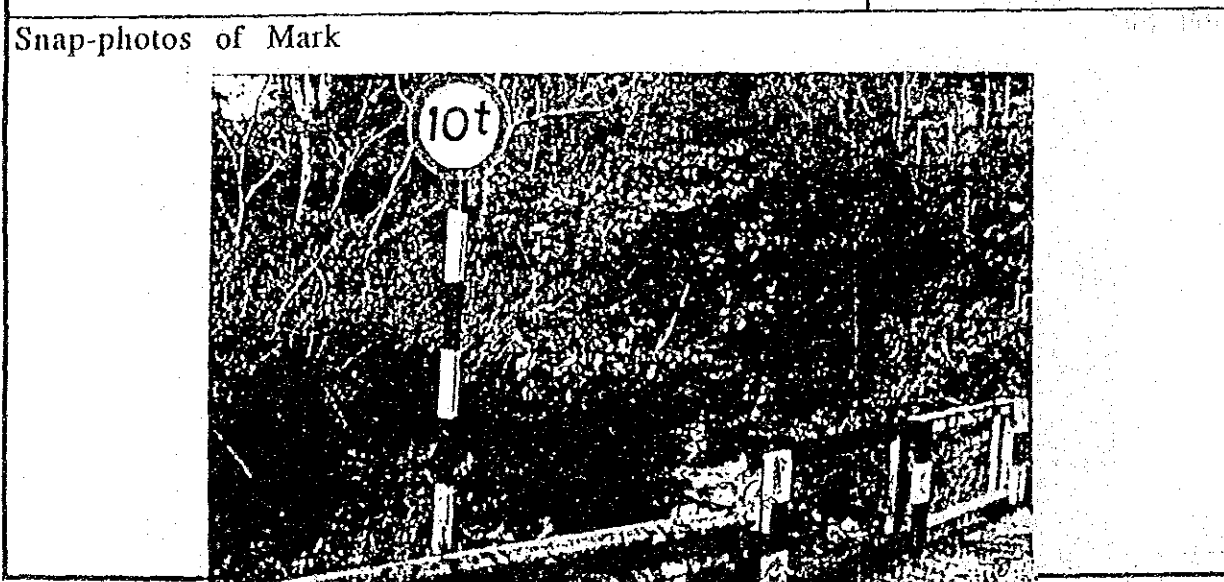
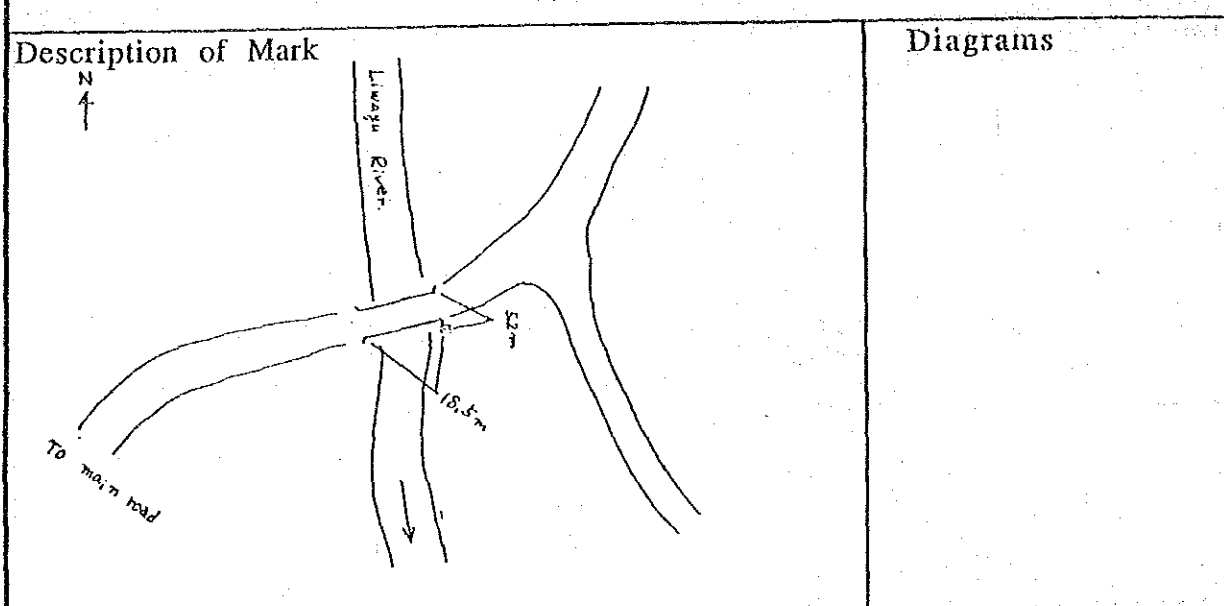
Diagrams

Snap-photos of Mark



STATION RECORD SHEET		Station Number: TBM 5 (LIWAGU RIVER)
Latitude	---	For Office Use
Longitude	---	
E.(W)	---	
N.(S)	---	Elevation (1041.20)
Station established by:		
Date:		
General Information :		
Coordinates: Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level		
The station is painted on the stone		
Description of Mark		Diagrams
<p>N ↑</p>		
Snap-photos of Mark		

STATION RECORD SHEET			Station Number: TBM 6 (LIWAGU RIVER)	
			For Office Use	
Latitude	---			
Longitude	---			
E.(W)	---			
N.(S)	---		Elevation	918.57
Station established by:				
Date:				
General Information :				
Coordinates: Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level				
The station is painted on the bridge girders of Russak Bridge				



STATION RECORD SHEET

Station Number:

TBM 7

Latitude

—

For Office Use

Longitude

—

E.(W)

N.(S)

Elevation

(969.07)

Station established by: SED

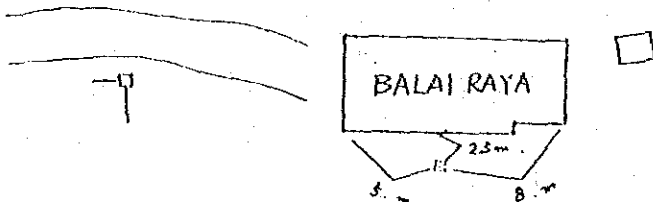
Date:

General Information :

Coordinates: Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level

Description of Mark

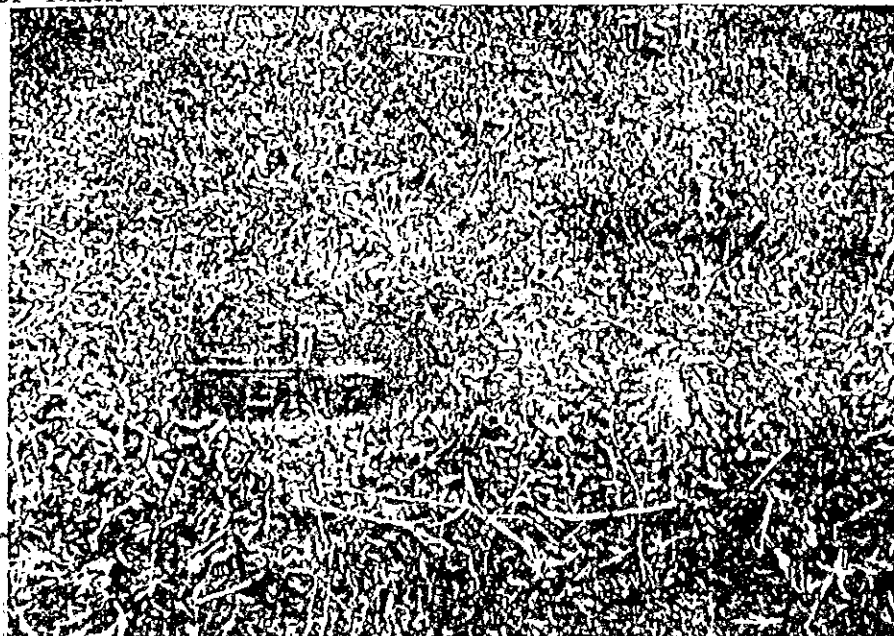
N
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Monument

Diagrams

Snap-photos of Mark



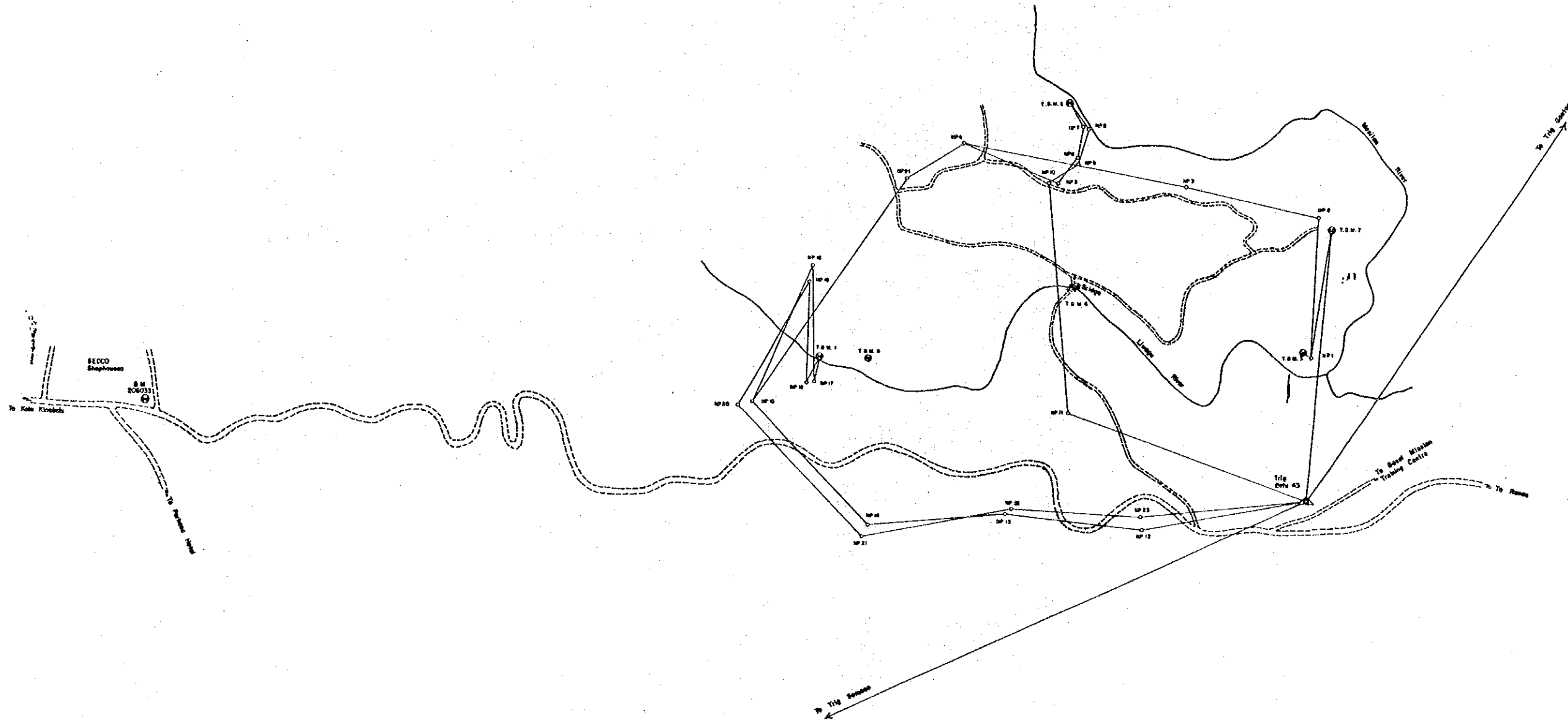
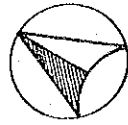
SURVEY WORKS AT UPPER LIWAGU RIVER BASIN

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SURCOM SERVICES SDN. BHD.

P.O. BOX NO. 11125
88812 KOTA KINABALU
SABAH
TEL. NO. 217927
FAX NO. 211933



PEMILIK : LEMBAGA LETRIK SABAH WISMA 113 88578 KOTA KINABALU					JURUKUR : SURCOM SERVICES SDN. BHD. P. O. BOX NO 11120 88512 KOTA KINABALU TEL. NO. 817927 FAX. NO. 811033		JURUTERA PERUNDING : JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		UKURAN : 1/10000		PROJEK : SURVEY WORKS AT UPPER LIWAGU RIVER BASIN (INDEX PLAN)			
	BIL. PINDAAN TARIKH DI LUKIS				DI UKUR BUKU BIL. TARIKH 6/1/98		DI REKA DI LUKIS		DI BENAK TARIKH		LUKISAN : BIL. LUKISAN SUR/UBS/347/1			

Appendix 2 GEOLOGICAL INVESTIGATION DATA

Appendix 2

GEOLOGY

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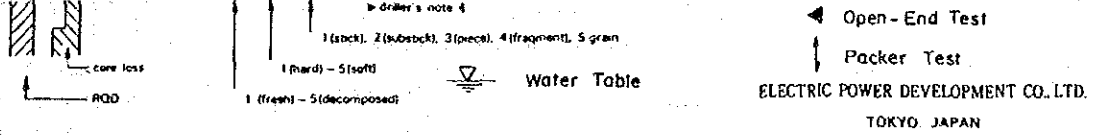
GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC

POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LI-1 (SHEET 1 OF 1)

LOCATION	<u>Liwaqu River Intake</u>	DEPTH OF HOLE	<u>15.00 m</u>	COMMENCED	<u>19 - 12 - 1991</u>
ELEVATION	<u>1049.91 m</u>	DEPTH OF OVERBURDEN	<u>3.00 m</u>	COMPLETED	<u>1 - 1 - 1992</u>
COORDINATE	<u>E765,742.5 N662,788.5</u>	LENGTH OF ROCK DRILLING	<u>12.00 m</u>	DRILLED BY	<u>Wil, M. Liew</u>
ANGLE FROM HORIZONTAL	<u>90°</u>	TOTAL LENGTH OF CORE	<u>15.00 m</u>	LOGGED BY	<u>T. Hatano</u>
BEARING OF ANGLE HOLE	<u>---</u>	CORE RECOVERY	<u>50-100 %</u>	X: APPLIED GEOTECHNICS	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				N-VALUE N: SPT Nd: CPT	PERMEABILITY K (cm/sec)	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING				
0m			0-100%							0.097m	0m	1049.91
0.92	GRAVEL				Brown						1	
2.00	SANDSTONE				Light grey				Nd > 50		2	
3.00	SANDSTONE				Grey				Nd > 50	1.05 x 10 ⁻²	3	1046.91
4.11	SANDSTONE				Grey	2	2	4	Nd > 50	8.96 x 10 ⁻²	4	
4.40	SANDSTONE				Grey				Nd > 50		4	
5.00	FAULT BRECCIA				Reddish grey	4	4	4	Nd > 50		5	
5.60	SANDSTONE				Grey	1	1	1	Nd > 50		6	
5.90	SANDSTONE				Grey				Nd > 50	8.41 x 10 ⁻³	6	
6.65	SANDSTONE				Grey	3	4		Nd > 50		7	
7.00	SANDSTONE				Grey	2	3	7.00	Nd > 50		7	
9.55	SANDSTONE				Grey	3	4		Nd > 50	1.61 x 10 ⁻²	8	
10.28	SANDSTONE				Light grey	2	2	3	Nd > 50	7.50 x 10 ⁻³	10	
11.45	SANDSTONE				Light grey	3	4		Nd > 50		11	
11.55	SANDSTONE				Light grey	2	3		Nd > 50		11	
13.65	SANDSTONE				Grey	3				8.98 x 10 ⁻⁴	12	
13.80	SANDSTONE				Grey	3	4				13	
14.31	SANDSTONE				Greenish Grey	2	3				14	
15.00	FAULT BRECCIA				Greenish Grey	3	4				15	1034.91
15.00	End of borehole										15	



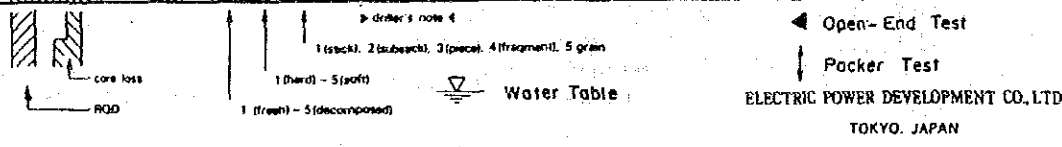
GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC

POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LI-2 (SHEET 1 OF 1)

LOCATION	Liwagu River Intake	DEPTH OF HOLE	15.00 m	COMMENCED	2 - 1 - 1992
ELEVATION	1049.81 m	DEPTH OF OVERBURDEN	0.75 m	COMPLETED	9 - 1 - 1992
COORDINATE	E765,732.5 N662,777.5	LENGTH OF ROCK DRILLING	14.25 m	DRILLED BY	Wil, M. Liew
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	15.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	85-100 %	X: APPLIED GEOTECHNICS	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF CASING	OBSERVATION OF CORE				N-VALUE N: SPT Nd: CPT	PERMEABILITY K (cm/sec)	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING				
0m			0-100%							0m	1049.81 m	
0.75	GRAVEL				Brown						1049.06	
1.00						2	2	3	1.60	Moderately to slightly weathered medium grained	Nd > 50	
2.00						2	3	4	2.00		Nd > 50	
2.63						2	2	2	2.63		Nd > 50	
3.00						3	3	3	3.00	SANDSTONE: partially strongly fractured, with coatings of brown silty clay along joints, with vein of calcite	Nd > 50	
4.00						2	2	2	4.00		Nd > 50	
4.25						3	3	4	4.25		Nd > 50	
6.50						3	3	3	6.50		Nd > 50	
7.00						4			7.00		Nd > 50	
9.10						2	2	3	9.10		Nd > 50	
11.19						3	3	4	11.19	Moderately weathered medium grained SANDSTONE: mainly sandstone fragments	Nd > 50	
13.55						2	2	3	13.55	Slightly weathered medium grained SANDSTONE: with vein of calcite	Nd > 50	
15.00						2			15.00	Slightly weathered SANDSTONE: mainly sandstone long core	Nd > 50	
15.00										End of borehole		1034.81



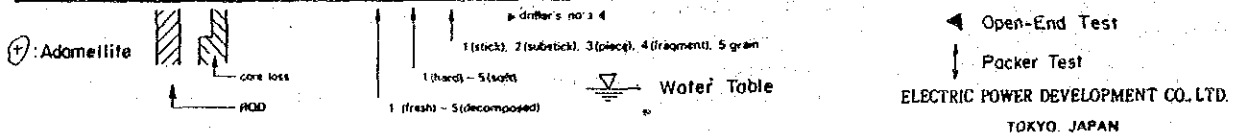
GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC

POWER DEVELOPMENT PROJECT AT UPPER LIMAGU RIVER HOLE No. LI - 4 (SHEET 1 OF 1)

LOCATION	Mesilau River Intake	DEPTH OF HOLE	15.00 m	COMMENCED	21 - 1 - 1992
ELEVATION	1035.34 m	DEPTH OF OVERBURDEN	6.25 m	COMPLETED	27 - 1 - 1992
COORDINATE	E 767,623.3 N 662,597.5	LENGTH OF ROCK DRILLING	8.75 m	DRILLED BY	Wil, M. Liew
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	15.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	35-100 %	X: APPLIED GEOTECHNICS	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				N-VALUE N: SPT Nd: CPT	PERMEABILITY K (cm/sec)	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING				
0m			0 → 100%							0m	1035.34 m	
1	GRAVEL		NMLC Corebarrel with Longyear Grade 3A core bit	Grey				6.25	COBBLES and BOULDERS; mainly subrounded to rounded, mostly adamellite and sandstone cobbles and boulders, approx. 75% adamellite cobbles and boulders	N > 50 Nd > 50 Nd > 50 Nd > 50	6.25	1029.09
2												
3												
4												
5												
6												
7	PINOSUK GRAVELS		Greenish grey				12.00	COBBLES with some boulders and sandy silt; subangular to angular, medium-grained sandstone cobbles, approx. 20 to 40% sandy silt, slightly cemented, dense	N > 50 Nd > 50 Nd > 50 Nd > 50	12.00	1023.34	
8												
9												
10												
11												
12	PINOSUK GRAVELS		Brownish grey				15.00	COBBLES with sandy silt; medium-grained sandstone cobbles with soft red mudstone pebble and sandy silt	Nd > 50	15.00	1020.34	
13												
14												
15	End of borehole											



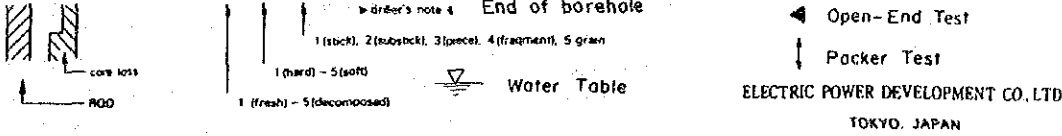
GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC

POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LT-1 (SHEET 1 OF 1)

LOCATION	Head Pond	DEPTH OF HOLE	20.00 m	COMMENCED	18 - 1 - 1992
ELEVATION	1031.62 m	DEPTH OF OVERBURDEN	3.80 m	COMPLETED	23 - 1 - 1992
COORDINATE	E 767,818.0 N 661,692.5	LENGTH OF ROCK DRILLING	16.20 m	DRILLED BY	Lito, M. Liew
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE		CORE RECOVERY	100 %	X: APPLIED GEOTECHNICS	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				N-VALUE N: SPT Nd: CPT	PERMEABILITY K (cm/sec)	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING				
0m			0 → 100%							0	1031.62	
0.45	SILT				Yellowish brown	Reddish br.			0.45 Soft sandy SILT with roots			
0.82	CLAY								0.82 Firm sandy silty CLAY	⊙ N=14		
1.75	CLAY								1.75 Sandy silty CLAY with sandstone fragments			
2.75	SILT								2.75 Sandy SILT with sandstone fragments	← 1.14 x 10 ⁻⁴		
3.80	CLAY								3.80 Sandysilty CLAY with sandstone fragments	⊙ N=16		
4.40	SANDSTONE				Brownish grey	Reddish brown	2	2	4.40 Medium grained SANDSTONE		1027.82	
6.70	SANDSTONE						3	4	6.70 Slightly weathered, brecciated SILTSTONE with sandstone interbeds; approx. 30 to 40% sandstone fragments,	Nd > 50		
6.90	SANDSTONE						3	3	6.90 approx. 70 to 60% siltstone fragments, with vein of calcite	Nd > 50		
10.40	SANDSTONE						3	4	10.40	Nd > 50		
10.70	SANDSTONE						3	3	10.70	Nd > 50		
12.00	SANDSTONE						2	2	12.00			
12.40	SANDSTONE						2	3	12.40 Slightly weathered, jointed and brecciated SANDSTONE; with occasional fault gouge, with vein of calcite	Nd > 50		
13.00	SANDSTONE						2	3	13.00	Nd > 50		
16.70	SANDSTONE						3	4	16.70			
18.50	SANDSTONE						3	3	18.50 Slightly weathered, brecciated SILTSTONE; with vein of calcite	Nd > 50		
20.00	SANDSTONE						3	3	20.00 Jointed and brecciated SANDSTONE; with fault gouge	Nd > 50		



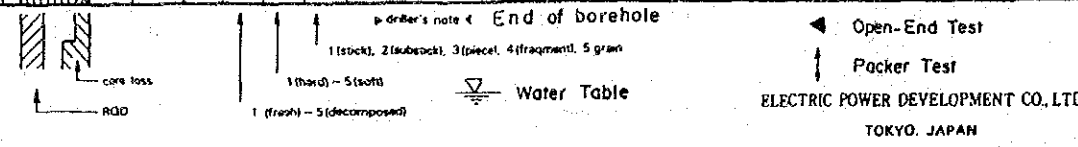
GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC

POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LT - 2 (SHEET 1 OF 1)

LOCATION	Head Pond	DEPTH OF HOLE	20.00 m	COMMENCED	11 - 1 - 1992
ELEVATION	1035.53 m	DEPTH OF OVERBURDEN	0.40 m	COMPLETED	17 - 1 - 1992
COORDINATE	E767,725.5 N661,707.5	LENGTH OF ROCK DRILLING	19.60 m	DRILLED BY	Litto, M. Liew
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	86-100 %	X: APPLIED GEOTECHNICS	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	N-VALUE N: SPT Nd: CPT	PERMEABILITY K (cm/sec)	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING					
0m			0 → 100%								0m	1035.53	
0.40	SILT				Dark brown	5	5	5	0.40				1035.13
0.70					Reddish brown	4	4	4	0.70				
1.25					Brownish grey	3	3	3	1.25	Nd > 50			
2.80					Greenish grey	2	2	2	2.80	Nd > 50	1.68 × 10 ⁻³		
5.00					Greenish grey	2	2	2	5.00	Nd > 50	3.47m 16-1-1992 1.69 × 10 ⁻⁴		
7.20					Greenish grey	1	1	1	7.20	Nd > 50	3.54 × 10 ⁻⁴		
7.75					Reddish brown	4	4	4	7.75	Nd > 50			
9.00					Reddish brown	2	4	4	9.00	⊙ N=27	4.03 × 10 ⁻⁵		
9.30					Greenish brown	2	2	2	9.30	N > 50	3.46 × 10 ⁻⁵		
11.85					Reddish brown	2	4	4	11.85	N=39 ⊙			
12.35					Greenish grey	2	2	1	12.35		2.65 × 10 ⁻⁵		
12.75					Reddish brown	4	4	4	12.75	N=33 ⊙			
14.20					Reddish brown	2	4	4	14.20				
14.50					Greenish grey	4	4	4	14.50	N=30 ⊙			
15.85					Greenish grey	3	3	3	15.85	Nd > 50			
16.80					Greenish grey	2	2	2	16.80				
20.00					Dark reddish brown	4	4	4	20.00		1.12 × 10 ⁻⁵		1015.53



ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO, JAPAN

GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC

POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LP - 1 (SHEET 1 OF 1)

LOCATION	Penstock	DEPTH OF HOLE	20.00 m	COMMENCED	6 - 12 - 1991
ELEVATION	975.08 m	DEPTH OF OVERBURDEN	4.56 m	COMPLETED	12 - 12 - 1991
COORDINATE	E 767,727.0 N 661,434.0	LENGTH OF ROCK DRILLING	15.44 m	DRILLED BY	Andy, M. Liew
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE		CORE RECOVERY	100 %	X: APPLIED GEOTECHNICS	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	N-VALUE N: SPT Nd: CPT	PERMEABILITY K (cm/sec)	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	COPE CUTTING					
0m	SILT		0-100%		Dark brown				0.25			0m	975.08 m
1	Sandy clayey SILT				Dark brown					⊙ N=9		1	
2	Sandy clayey SILT				Yellowish brown					⊙ N=23	1.18×10^{-3}	2	
3	Sandy clayey SILT				Yellowish brown					⊙ N=24	2.00×10^{-3}	3	
4	Sandy clayey SILT				Yellowish brown				4.56			4	970.52
5	SANDSTONE				Reddish brown	4	4	5		N=33 ⊙		5	
6	SANDSTONE				Brownish yellow		3	3	6.20		6.63×10^{-4}	6	
7	SANDSTONE				Brownish grey	3	4	5	7.00	N > 50		7	
8	SANDSTONE				Brownish grey	2	2	2	7.80	N > 50	8.90×10^{-4}	8	
9	Brecciated SANDSTONE				Yellowish brown	4				⊙ N=14	1.45×10^{-4}	9	
10	Brecciated SANDSTONE				Yellowish brown	4				⊙ N=16		10	
11	Brecciated SANDSTONE				Yellowish brown	4		4				11	
12	Brecciated SANDSTONE				Yellowish brown	4		4	12.00			12	
13	SILTSTONE				Reddish brown					⊙ N=27	1.45×10^{-4}	13	
14	SILTSTONE				Reddish brown				14.23			14	
15	SANDSTONE				Yellowish brown	3	3	3	15.05	⊙ N=15		15	
16	SANDSTONE				Yellowish brown	3	3	3	15.45		4.99×10^{-4}	16	
17	SANDSTONE				Yellowish brown	4		4	17.70			17	
18	SANDSTONE with siltstone				Brownish grey	4						18	955.08
19	SANDSTONE with siltstone				Brownish grey	4						19	
20	SANDSTONE with siltstone				Brownish grey	4			20.00			20	

▶ driller's note 4 End of borehole
 1 (stick), 2 (subrock), 3 (spiral), 4 (fragments), 5 green
 1 (hard) - 5 (soft)
 1 (fresh) - 5 (decomposed)

◀ Open-End Test
 ↓ Packer Test

Water Table

core loss
 PDD

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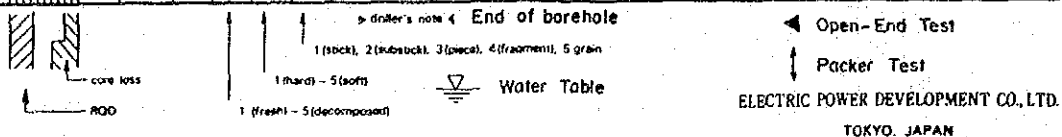
GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC

POWER DEVELOPMENT PROJECT AT UPPER LWAGU RIVER HOLE No. LP-2 (SHEET 1 OF 1)

LOCATION	Penstock	DEPTH OF HOLE	20.00 m	COMMENCED	21 - 1 - 1992
ELEVATION	913.65 m	DEPTH OF OVERBURDEN	1.90 m	COMPLETED	27 - 1 - 1992
COORDINATE	E 767,717.0 N 661,237.0	LENGTH OF ROCK DRILLING	18.10 m	DRILLED BY	Andy, M. Liew
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE		CORE RECOVERY	90-100 %	X: APPLIED GEOTECHNICS	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					N-VALUE N: SPT Nd: CPT	PERMEABILITY K (cm/sec)	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION				
0m			0-100%								0m	913.65	
0.50	SILT				Dark brown				0.50	Soft sandy SILT with pebbles			
1.90	SILT				Brown				1.90	Sandy clayey SILT with weathered sandstone fragments		911.75	
2.75	SANDSTONE				Yellowish grey				2.75	Slightly weathered SANDSTONE; substicks	2.92×10^{-4}		
3.00	SANDSTONE				Yellowish brown				3.00	Highly weathered SANDSTONE; fragments			
4.00	SANDSTONE				Yellowish brown				4.00	Moderately weathered SANDSTONE; fragments	3.42×10^{-3}		
4.30	SANDSTONE				Yellowish brown				4.30	Moderately weathered SANDSTONE; substicks			
4.63	SANDSTONE				Yellowish brown				4.63	Highly weathered SILTSTONE; disturbed core, brecciated fragments			
6.32	SANDSTONE				Reddish brown				6.32	Moderately weathered SANDSTONE; strongly brecciated, embedded grey silty clay matrix	5.53×10^{-3}		
8.90	SANDSTONE				Reddish grey or grey				8.90	Slightly weathered SANDSTONE; strongly jointed and brecciated cores, with iron oxide coating on joint planes, mainly sandstone fragments	3.41×10^{-4}		
17.25	SANDSTONE				Brownish grey				17.25	SANDSTONE; substick, with calcite vein	8.29×10^{-4}		
17.60	SANDSTONE				Grey				17.60	SANDSTONE, mainly sandstone fragments, slightly brecciated	6.37×10^{-5}		
20.00									20.00			893.65	



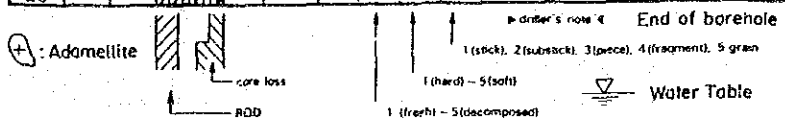
GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC

POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LP-3 (SHEET 1 OF 1)

LOCATION	Power House	DEPTH OF HOLE	20.00 m	COMMENCED	18 - 12 - 1991
ELEVATION	861.67 m	DEPTH OF OVERBURDEN	17.10 m	COMPLETED	15 - 1 - 1992
COORDINATE	E767,712.0 N661,075.0	LENGTH OF ROCK DRILLING	2.90 m	DRILLED BY	Andy, M. Liew
ANGLE FROM HORIZONTAL	90	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE		CORE RECOVERY	40-100 %	X: APPLIED GEOTECHNICS	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	N-VALUE N: SPT Nd: CPT	PERMEABILITY K (cm/sec)	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING					
0m			0-100%								0m	861.67	
0.49					Dark brown				Sandy clayey SILT with roots				
1	SILT				Brownish grey				PEBBLES, COBBLES and BOULDERS; mainly subrounded to rounded mostly adamellite and sandstone gravels, approx. 55% adamellite cobbles and boulders, adamellite big boulders at;	N > 50		1	
2										N > 50		2	
3										Nd > 50		3	
4												4	
5												5	
6										⊙N=27		6	
7										⊙N=29		7	
8												8	
9										⊙N=8		9	
10					Grey or whitish grey					⊙N=13	NO TEST	10	
11												11	
12										⊙N=27		12	
13												13	
13.18m											13.18m		
15-1-1992											15-1-1992		
17.10												17.10	
18					Brownish grey				Moderately weathered SILTSTONE; partially organic particle, softcore	⊙N=24		18	
19	SANDSTONE SILTSTONE				Reddish brown	3	4	4		Nd > 50		19	
19.50									Slightly weathered SANDSTONE; substick core			19.50	
20.00						2	2	2				20.00	
20												20	



ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO, JAPAN

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-1
 LOCATION Sg. Liwagu Intake DEPTH OF HOLE 15.0 m COMMENCED 19-12-91
 ELEVATION 1049.91m DIAMETER OF HOLE 80 mm COMPLETED 1-1-92
 COORDINATE E76 5742.5
N66 2788.5
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dip meter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
19-12-91	07 00	-	-	-	-	
19-12-91	13 00	1.00 m	none	1 hour	1.00 m	
20-12-91	07 00	1.75 m	1.050 m	13 hours	1.50 m	
20-12-91	13 00	2.60 m	1.030 m	1 hour	1.90 m	
21-12-91	07 00	2.60 m	0.100 m	13 hours	2.60 m	
23-12-91	07 00	3.68 m	0.031 m	38 hours	3.00 m	
23-12-91	12 20	4.00 m	0.0315 m	12 mins	3.10 m	
24-12-91	07 00	4.00 m	0.030 m	13 hours	4.00 m	
24-12-91	12 39	5.63 m	1.021 m	7 mins	4.00 m	
26-12-91	06 50	5.63 m	0.0305 m	38 hours	5.50 m	
26-12-91	13 00	6.00 m	0.0315 m	1 hour	5.90 m	
27-12-91	07 05	6.25 m	0.009 m	13 hours	6.25 m	
27-12-91	13 00	6.65 m	0.017 m	1 hour	6.25 m	
28-12-91	06 52	7.08 m	0.030 m	13 hours	6.60 m	
28-12-91	13 00	7.50 m	0.0305 m	1 hour	7.00 m	
29-12-91	07 00	8.00 m	0.032 m	13 hours	7.50 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro project Site HOLE NO. LI-1
 LOCATION Sg. Liwagu Intake DEPTH OF HOLE 15.0 m COMMENCED 19-12-91
 ELEVATION 1049.91m DIAMETER OF HOLE 80 mm COMPLETED 1-1-92
 COORDINATE E76 5742.5
N66 2788.5
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dip Meter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELAPSED ** TIME	CEMENTING CASING	REMARKS
29-12-91	11 32	8.78 m	0.0315 m	10 mins	8.19 m	
30-12-91	07 00	9.50 m	0.036 m	13 hours	8.80 m	
30-12-91	06 26	11.45	0.094 m	14 mins	10.00 m	
31-12-91	06 50	11.45 m	0.040 m	12½ hours	10.00 m	
31-12-91	18 15	14.00 m	0.109 m	6 mins	11.20 m	
1-1-92	06 50	14.00 m	0.043 m	13 hours	11.20 m	
1-1-92	09 05	15.00 m	0.097 m	12 mins	11.20 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Nini Hydro Project Site HOLE NO. LI-2
 LOCATION Liwagu River Intake DEPTH OF HOLE 15 m COMMENCED 2-1-92
 ELEVATION 1049.81m DIAMETER OF HOLE 80 mm COMPLETED 9-1-92
 COORDINATE E76 5732.5
N66 2777.5
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
2-1-92	07 00	-	-	-	-	
3-1-92	07 00	2.00 m	0.032 m	13 hours	1.32 m	
3-1-92	13 00	3.00 m	1.70 m	1 hour	2.53 m	
4-1-92	07 00	3.50 m	2.90 m	13 hours	2.53 m	
4-1-92	13 00	4.50 m	3.31 m	1 hour	2.53 m	
5-1-92	07 00	6.00 m	4.50 m	13 hours	4.49 m	
5-1-92	12 32	7.00 m	4.50 m	12 mins	6.52 m	
6-1-92	07 00	8.00 m	4.30 m	13 hours	7.30 m	
6-1-92	09 49	9.00 m	4.54 m	15 mins	9.00 m	
7-1-92	07 00	10.00 m	4.76 m	13 hours	9.64 m	
7-1-92	12 18	12.00 m	5.07 m	7 mins	9.64 m	
8-1-92	07 00	13.00 m	5.15 m	13 hours	9.64 m	
8-1-92	17 46	14.00 m	4.60 m	15 mins	9.64 m	
9-1-92	07 00	14.00 m	5.25 m	13½ hours	9.64 m	
9-1-92	09 50	15.00 m	4.60 m	16 mins	9.64 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-3
 LOCATION Mesilau Intake DEPTH OF HOLE 15.0 m COMMENCED 31-1-92
 ELEVATION 1035.96 m DIAMETER OF HOLE _____ mm COMPLETED 8-2-92
E76 7594
 COORDINATE N66 2603
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY W11
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dip meter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELAPSED ** TIME	CEMENTING CASING	REMARKS
31-1-92	07 00	-	-	-	-	
31-1-92	18 35	3.00 m	0.45 m	10 mins	2.60 m	
1-2-92	07 00	3.00 m	0.60 m	12½ hours	2.60 m	
1-2-92	18 43	5.50 m	0.50 m	13 mins	4.20 m	
2-2-92	07 00	5.50 m	0.50 m	12½ hours	4.20 m	
2-2-92	20 18	9.00 m	0.72 m	18 mins	8.00 m	
3-2-92	06 30	9.00 m	1.03 m	10½ hours	8.00 m	
3-2-92	12 23	10.00 m	1.18 m	20 mins	10.00 m	
7-2-92	09 43	10.00 m	0.62 m	4 day	10.00 m	
7-2-92	18 22	12.00 m	0.41 m	5 mins	12.00 m	
8-2-92	06 30	12.00 m	0.63 m	12 hours	12.00 m	
8-2-92	17 44	15.00 m	1.37 m	22 mins	13.00 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-4
 LOCATION Sg. Mesilau Intake DEPTH OF HOLE 15 m COMMENCED 21-1-92
 ELEVATION 1035.34m DIAMETER OF HOLE 80 mm COMPLETED 27-1-92
 COORDINATE E76 7571
N66 2597
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Ampahon
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
21-1-92	06 00	-	-	-	-	
21-1-92	18 28	2.00 m	0.21 m	10 mins	1.50 m	
22-1-92	06 30	2.00 m	0.15 m	12 hours	2.00 m	
22-1-92	18 35	4.00 m	0.22 m	10 mins	4.00 m	
23-1-92	07 00	4.00 m	0.21 m	12½ hours	4.00 m	
23-1-92	18 32	6.00 m	0.26 m	12 mins	4.90 m	
24-1-92	07 00	6.00 m	0.30 m	12½ hours	4.90 m	
24-1-92	18 00	8.00 m	0.12 m	13 mins	7.20 m	
25-1-92	06 50	8.00 m	0.20 m	12½ hours	7.20 m	
25-1-92	18 00	10.00 m	0.08 m	7 mins	10.0 m	
26-1-92	06 55	10.00 m	0.06 m	12½ hours	10.0 m	
26-1-92	18 10	12.00 m	0.12 m	7 mins	12.0 m	
27-1-92	07 00	12.00 m	0.16 m	12½ hours	12.0 m	
27-1-92	17 10	15.00 m	1.38 m	12 mins	12.0 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LT-1
 LOCATION Head Pond DPETH OF HOLE 20 m COMMENCED 18-1-92
 ELEVATION 1031.62m DIAMETER OF HOLE 80 mm COMPLETED 23-1-92
 COORDINATE E76 7818
NG66 1692.5
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELAPSED ** TIME	CEMENTING CASING	REMARKS
18-1-92	07 00	-	-	-	-	
18-1-92	16 51	5.00 m	2.80 m	10 mins	3.00 m	
19-1-92	07 00	5.00 m	3.20 m	13 hours	4.50 m	
19-1-92	16 04	8.00 m	2.35 m	18 mins	7.50 m	
20-1-92	07 00	8.00 m	5.50 m	13 hours	8.00 m	
20-1-92	07 40	11.0 m	1.25 m	16 mins	10.0 m	
20-1-92	18 30	11.00 m	1.83 m	12 mins	11.00 m	
21-1-92	07 00	11.00 m	7.50 m	13 hours	11.00 m	
21-1-92	18 10	13.00 m	8.80 m	10 mins	13.00 m	
22-1-92	07 00	13.00 m	12.73 m	13 hours	13.00 m	
22-1-92	18 20	16.00 m	9.70 m	10 mins	16.00 m	
23-1-92	07 00	16.00 m	10.20 m	13 hours	16.00 m	
23-1-92	20 00	20.00 m	9.90 m	10 mins	18.00 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LT-2
 LOCATION Head Pond DPETH OF HOLE 20 m COMMENCED 11-1-92
 ELEVATION 1035.53m DIAMETER OF HOLE 80 mm COMPLETED 17-1-92
 COORDINATE E76 7725.5
N66 1707.5
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELAPSED ** TIME	CEMENTING CASING	REMARKS
11-1-92	13 00	-	-	-	-	
12-1-92	13 00	3.00 m	1.50 m	18½ hours	3.00 m	
13-1-92	07 00	4.00 m	2.15 m	13 hours	3.00 m	
13-1-92	16 20	8.00 m	2.75 m	17 mins	8.00 m	
14-1-92	07 00	8.00 m	4.20 m	12 hours	8.00 m	
14-1-92	13 00	10.00 m	4.15 m	1 hour	10.00 m	
15-1-92	07 00	12.00 m	3.70 m	13 hours	12.00 m	
15-1-92	-	15.00 m	2.20 m	15 mins	12.00 m	
16-1-92	07 00	15.00 m	7.30 m	12½ hours	15.00 m	
16-1-92	14 39	20.00 m	3.47 m	12 mins	15.00 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-1
 LOCATION Kundasang DEPTH OF HOLE 20 m COMMENCED 6-12-91
 ELEVATION 975.08m DIAMETER OF HOLE 80 mm COMPLETED 12-12-91
 COORDINATE E76 7727
N66 1434
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
6-12-91	07 00	-	-	-	-	
7-12-91	07 00	2.50 m	2.12 m	13 hours	2.00 m	
7-12-91	13 00	4.00 m	2.03 m	1 hour	3.00 m	
8-12-91	07 30	5.00 m	2.37 m	13½ hours	5.00 m	
9-12-91	07 00	8.00 m	3.59 m	13 hours	7.00 m	
9-12-91	13 00	9.00 m	6.53 m	1 hour	8.50 m	
10-12-91	07 00	11.50 m	9.50 m	13 hours	11.00 m	
10-12-91	13 00	12.50 m	4.03 m	1 hour	12.00 m	
11-12-91	07 00	15.00 m	6.60 m	13 hours	13.00 m	
11-12-91	13 00	15.50 m	11.55 m	1 hour	14.35 m	
12-12-91	07 00	18.00 m	17.65 m	13 hours	14.35 m	
12-12-91	13 00	18.80 m	7.97 m	1 hour	17.35 m	
13-12-91	07 00	20.00 m	13.35 m	13 hours	17.35 m	
13-12-91	08 20	20.00 m	17.63 m	½ hour	18.78 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-2
 LOCATION Penstock DEPTH OF HOLE 20 m COMMENCED 21-1-92
 ELEVATION 913.65m DIAMETER OF HOLE 80 mm COMPLETED 27-1-92
 COORDINATE E76 7717.5
N66 1236
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Andy
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELAPSED ** TIME	CEMENTING CASING	REMARKS
21-1-92	07 00	-	-	-	-	
21-1-92	14 25	3.95 m	2.42 m	15 mins	3.95 m	
21-1-92	18 30	6.00 m	4.10 m	15 mins	6.00 m	
22-1-92	07 00	6.00 m	5.80 m	9½ hours	6.00 m	
22-1-92	12 00	7.50 m	5.70 m	10 mins	6.00 m	
23-1-92	07 00	7.50 m	6.09 m	18 hours	6.00 m	
23-1-92	18 25	10.00 m	5.89 m	10 mins	10.00 m	
24-1-92	07 00	10.00 m	9.65 m	12½ hours	10.00 m	
24-1-92	12 30	11.00 m	9.82 m	21 mins	10.45 m	
24-1-92	18 00	12.00 m	9.45 m	25 mins	10.45 m	
25-1-92	07 00	12.00 m	10.00 m	13 hours	10.45 m	
25-1-92	13 15	13.85 m	11.27 m	19 mins	10.45 m	
26-1-92	07 00	15.00 m	10.8 m	13 hours	13.06 m	
26-1-92	12 00	16.00 m	9.45 m	20 mins	13.06 m	
26-1-92	18 30	16.95 m	9.92 m	31 mins	13.06 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-3

LOCATION Power House DEPTH OF HOLE 20.0 m COMMENCED 18-12-91

ELEVATION 861.67m DIAMETER OF HOLE 80 mm COMPLETED 15-1-92

COORDINATE E76 7662.5
N66 1075

ANGLE FROM HORIZONTAL 90 ° MEASURED BY Ampahon

BEARING OF ANGLE HOLE _____

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELAPSED ** TIME	CEMENTING CASING	REMARKS
17-12-91	13 00	-	-	-	-	
18-12-91	07 05	65 cm	0.08 m	14 hours	-	
18-12-91	18 35	2.50 m	0.31 m	8 mins	1.50 m	
19-12-91	06 50	2.50 m	0.45 m	12½ hours	2.50 m	
19-12-91	12 17	3.00 m	1.43 m	8 mins	2.50 m	
20-12-91	07 00	3.29 m	1.66 m	13 hours	2.50 m	
20-12-91	06 07	4.62 m	0.93 m	12 mins	2.50 m	
21-12-91	06 52	4.62 m	1.92 m	13 hours	2.50 m	
21-12-91	17 54	6.00 m	1.07 m	10 mins	2.50 m	
22-12-91	07 00	6.00 m	1.19 m	13 hours	2.50 m	
22-12-91	08 15	6.50 m	None	13 mins	2.50 m	
23-12-91	07 00	8.00 m	None	12 hours	2.50 m	BH caving cement grouting
24-12-91	-	-	-	-	-	No work at site
25-12-91	-	-	-	-	-	No work at site
26-12-91	07 00	7.10 m	1.97 m	2½ day	2.50 m	BH caving cement grouting
27-12-91	07 00	6.00 m	2.01 m	13 hours	2.50 m	

* Mark "none" when water level exists under the bottom of hole

** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-3
 LOCATION Power House DEPTH OF HOLE 20.0 m COMMENCED 18-12-91
 ELEVATION 861.67m DIAMETER OF HOLE 80 mm COMPLETED 15-1-92
 COORDINATE E76 7662.5
N66 1075
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Ampahon
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED** TIME	CEMENTING CASING	REMARKS
27-12-91	13 00	7.35 m	2.06 m	1 hour	3.25 m	
28-12-91	07 00	7.35 m	1.81 m	13 hours	3.25 m	
28-12-91	13 00	7.35 m	2.16 m	1 hour	4.78 m	
29-12-91	07 00	8.00 m	2.13 m	13 hours	4.78 m	
29-12-91	13 00	9.00 m	2.19 m	1 hour	4.78 m	BH casing cement grouting
30-12-91	07 00	8.00 m	2.70 m	15 hours	4.78 m	
30-12-91	13 15	9.75 m	2.41 m	18 mins	4.78 m	BH casing cement grouting
31-12-91	07 00	8.00 m	2.14 m	14 hours	4.78 m	Hardened cement 8.0 m - 10.0 m
1-1-92	07 00	10.0 m	2.20 m	13 hours	4.78 m	
1-1-92	12 31	10.50 m	2.48 m	15 mins	4.78 m	
2-1-92	07 00	9.50 m	2.91 m	13 hours	4.78 m	Hardened cement 11.0 m - 9.5 m
2-1-92	16 35	12.00 m	2.53 m	10 mins	4.78 m	
3-1-92	07 00	10.50 m	2.44 m	13 hours	4.78 m	Hardened cement 10.5 m - 12.0 m
3-1-92	13 00	12.06 m	2.39 m	1 hour	4.78 m	
4-1-92	07 00	12.06 m	1.30 m	13 hours	4.78 m	
4-1-92	13 00	12.06 m	1.15 m	1 hour	4.78 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-3
 LOCATION Power House DPETH OF HOLE 20.0 m COMMENCED 18-12-91
 ELEVATION 861.67m DIAMETER OF HOLE 80 mm COMPLETED 15-1-92
 COORDINATE E76 7662.5
N66 1075
 ANGLE FROM HORIZONTAL 90 ° MEASURED BY Ampahon
 BEARING OF ANGLE HOLE _____
 EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
5-1-92	07 00	12.06 m	1.20 m	13 hours	4.78 m	
6-1-92	13 00	12.06 m	1.39 m	1 hour	4.78 m	
7-1-92	07 00	12.06 m	1.08 m	13 hours	4.78 m	
7-1-92	13 00	12.06 m	2.48 m	1 hour	4.78 m	
8-1-92	07 00	12.06 m	3.92 m	13 hours	4.78 m	
8-1-92	18 15	13.46 m	2.09 m	10 mins	4.78 m	
9-1-92	07 00	13.46 m	3.49 m	13 hours	4.78 m	
9-1-92	14 05	14.00 m	13.22 m	25 mins	4.78 m	
10-1-92	19 00	12.32 m	4.13 m	15 hours	4.78 m	Cement Grout 12.32 m - 14.0 m
10-1-92	14 16	15.00 m	13.06 m	35 mins	4.78 m	
11-1-92	07 00	12.90 m	3.71 m	15 hours	4.78 m	
11-1-92	14 45	16.09 m	12.94 m	25 mins	4.78 m	
14-1-92	14 15	16.13 m	4.59 m	70 hours	4.78 m	Cement Grout 16.13 m - 14 m
15-1-92	07 00	16.72 m	5.73 m	13 hours	4.78 m	
	16 30	20.00 m	13.18 m	20 mins	4.78 m	

* Mark "none" when water level exists under the bottom of hole
 ** Elapsed time from shutting off of drilling water

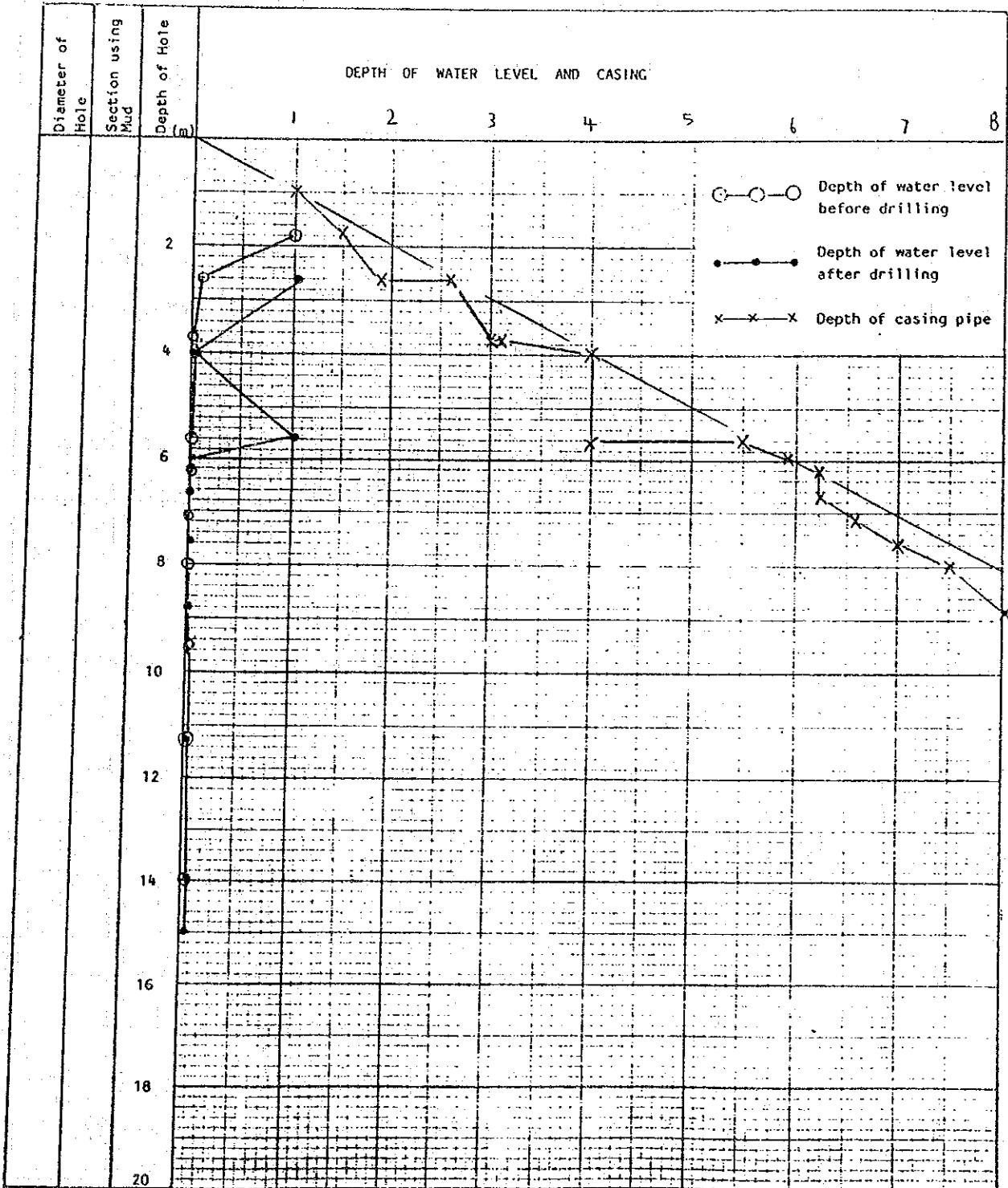
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-1 (Sheet 1 of 1)

LOCATION: Sg. Liwagu Intake DEPTH OF HOLE: 15 m COMMENCED: 19-12-91

ELEVATION: 1049.91m DIAMETER OF HOLE: 80 mm COMPLETED: 1-1-92

COORDINATE: E76 5742.5
N66 2788.5 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



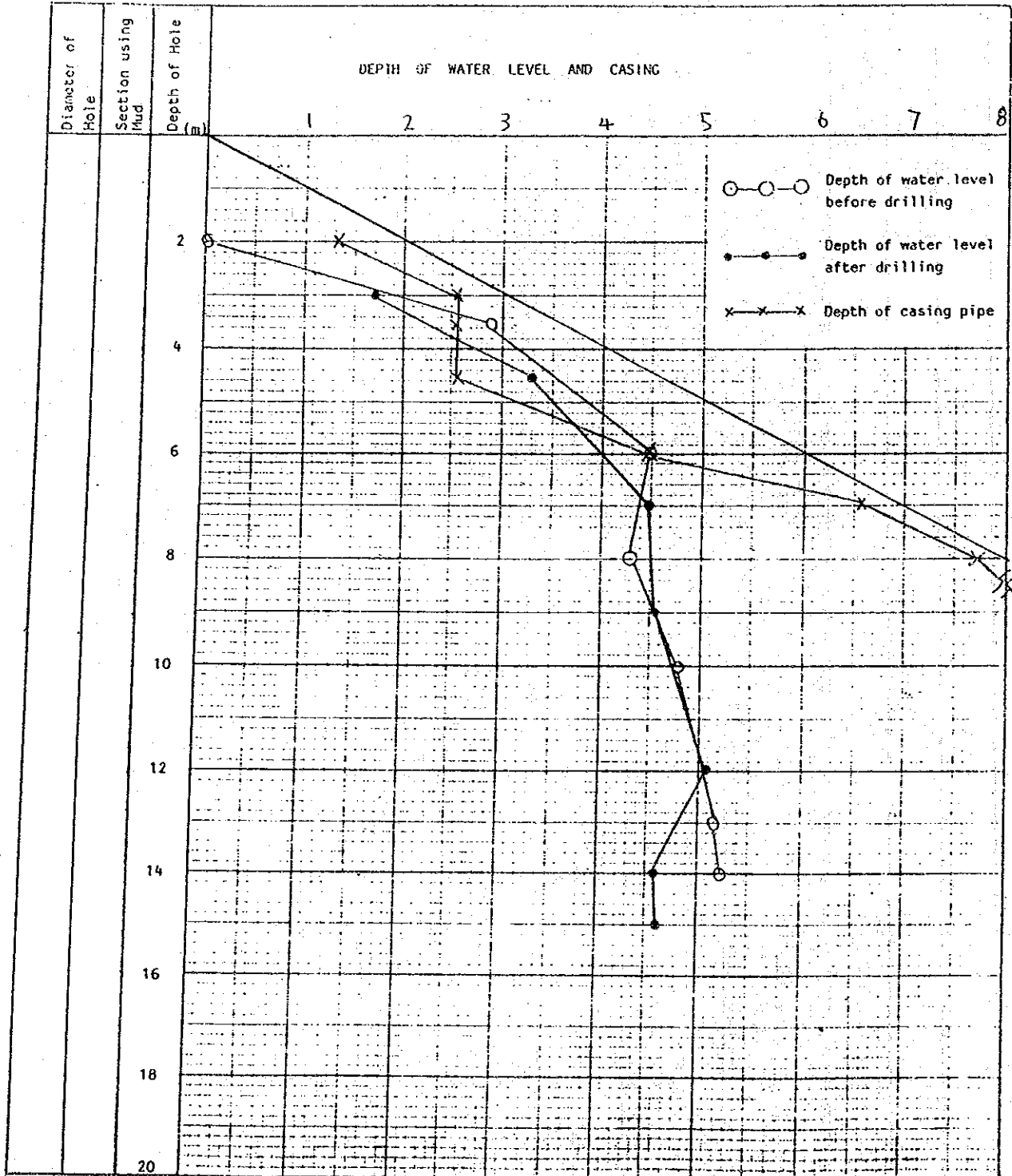
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. EI-2 (Sheet 1 of 1)

LOCATION: Liwagu River Intake DEPTH OF HOLE: 15 m COMMENCED: 2-1-92

ELEVATION: 1049.81m DIAMETER OF HOLE: 80 mm COMPLETED: 9-1-92

COORDINATE: E76 5732.5 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

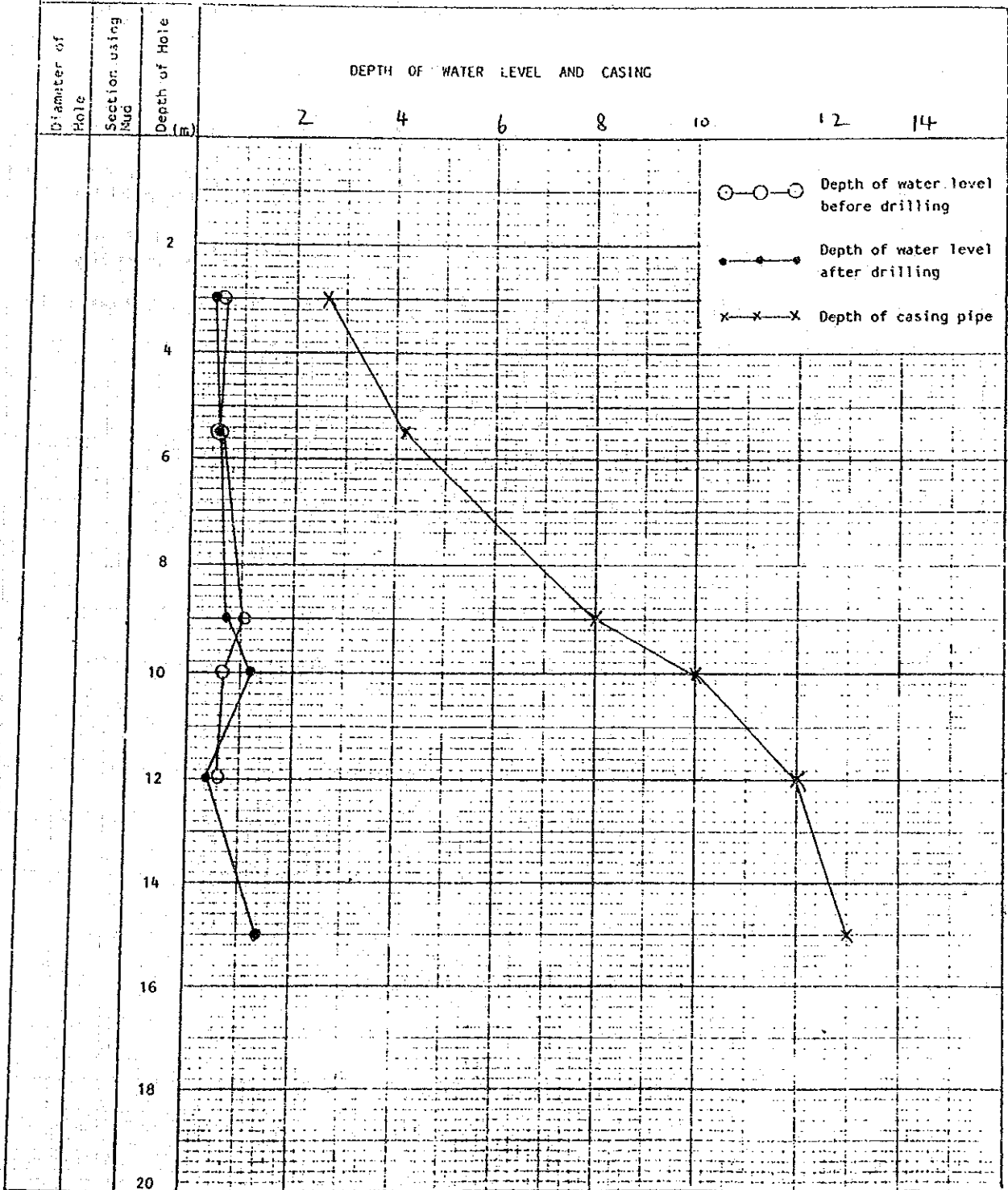
PROJECT: Geological Investigation At Upper Liwaqu HOLE NO. LI-3 (Sheet 1 of 1)

Mini Hydro Project Site

LOCATION: Mesilau Intake DEPTH OF HOLE: 15 m. COMMENCED: 31-1-92

ELEVATION: 1035.96 m DIAMETER OF HOLE: 80 mm COMPLETED: 8-2-92

COORDINATE: E76 7594 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Wil
N66 2603



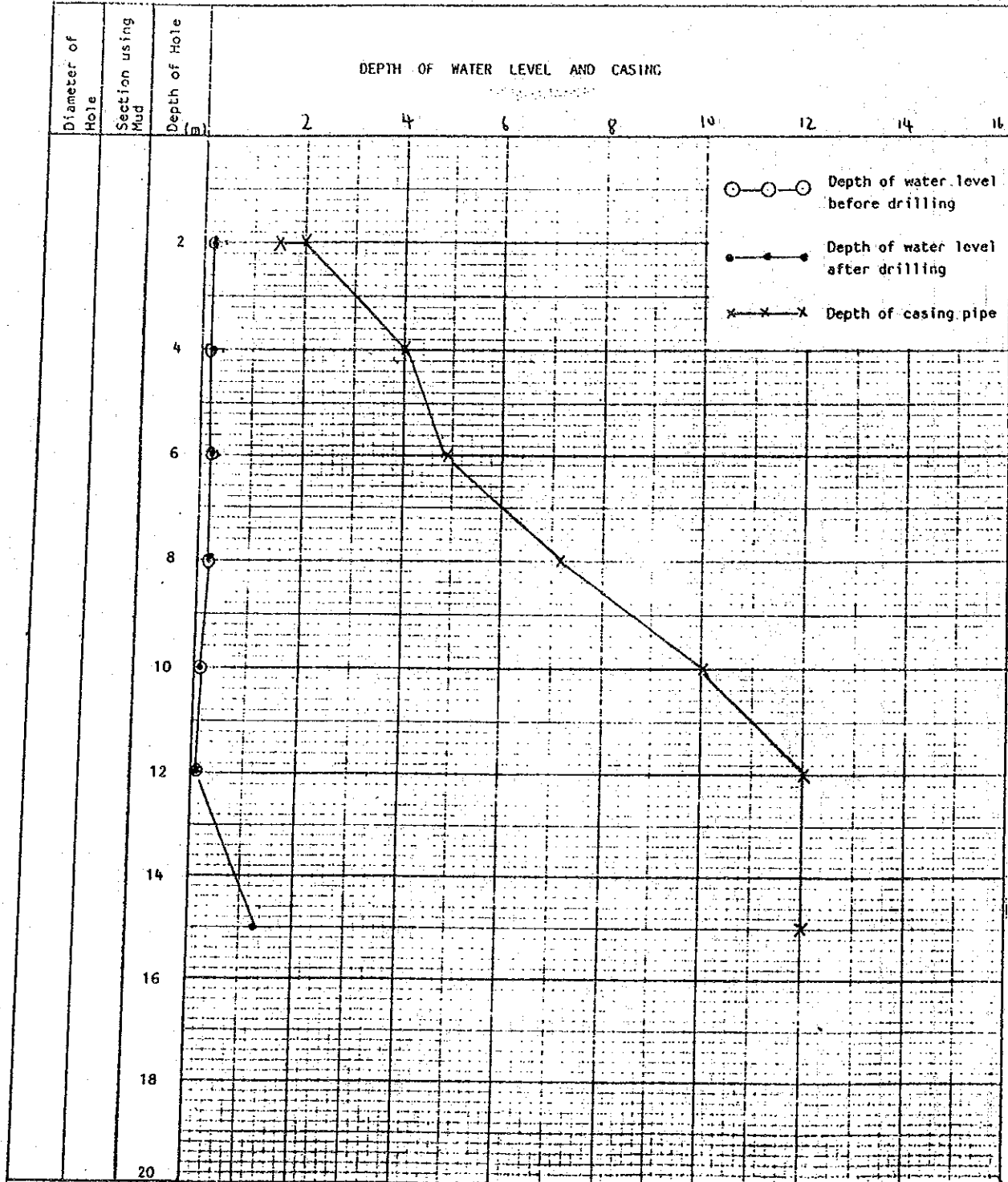
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-4 (Sheet 1 of 1)

LOCATION: Sg. Mesilau Intake DEPTH OF HOLE: 15 m COMMENCED: 21-1-92

ELEVATION: 1035.34m DIAMETER OF HOLE: 80 mm COMPLETED: 27-1-92

COORDINATE: E76 7571 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Ampahon



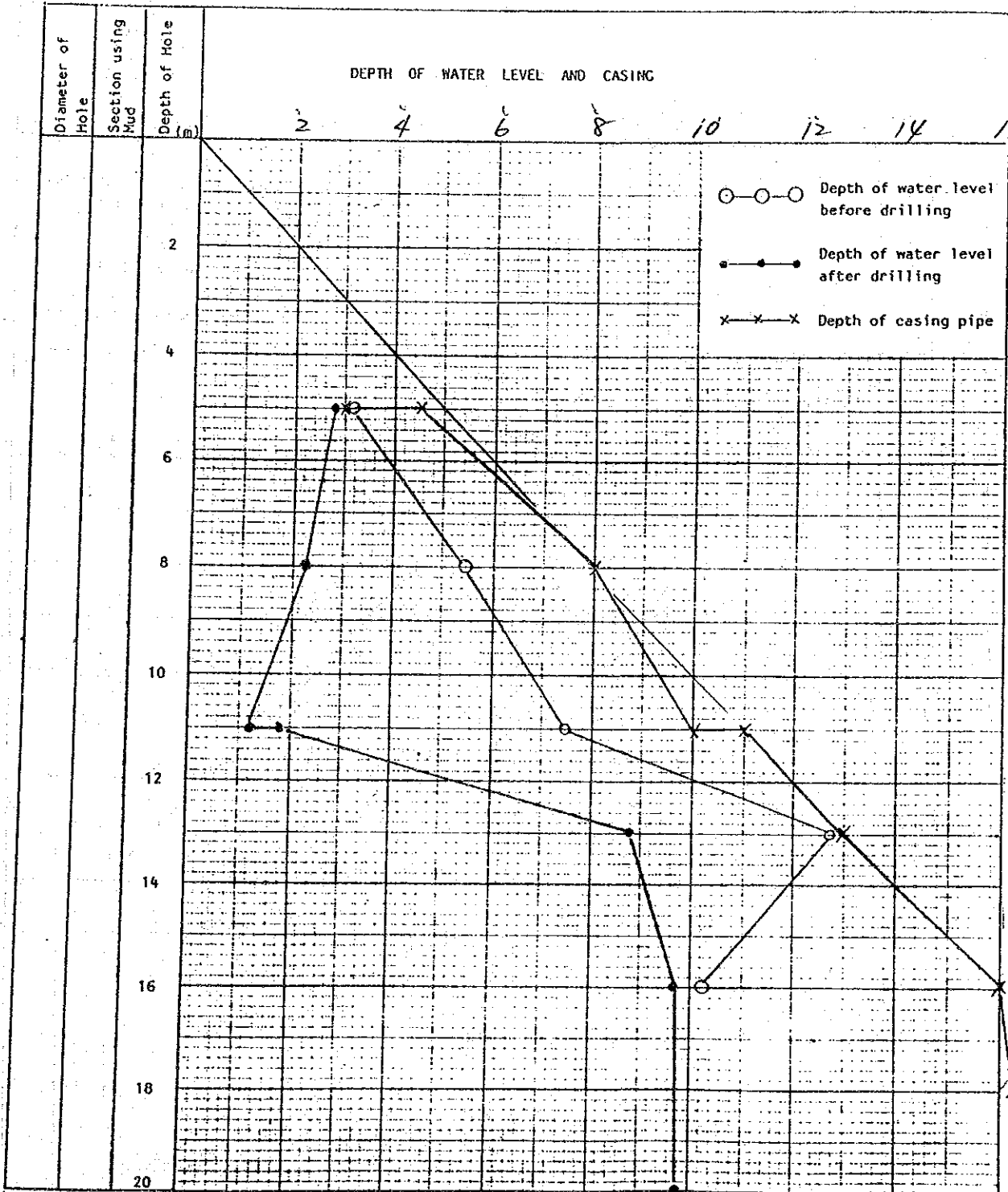
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO: LT-1 (Sheet 1 of 1)

LOCATION: Head Pond DEPTH OF HOLE: 20 m COMMENCED: 18-1-92

ELEVATION: 1031.62m DIAMETER OF HOLE: 80 mm COMPLETED: 23-1-92
E76 7818

COORDINATE: N66 1692.5 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



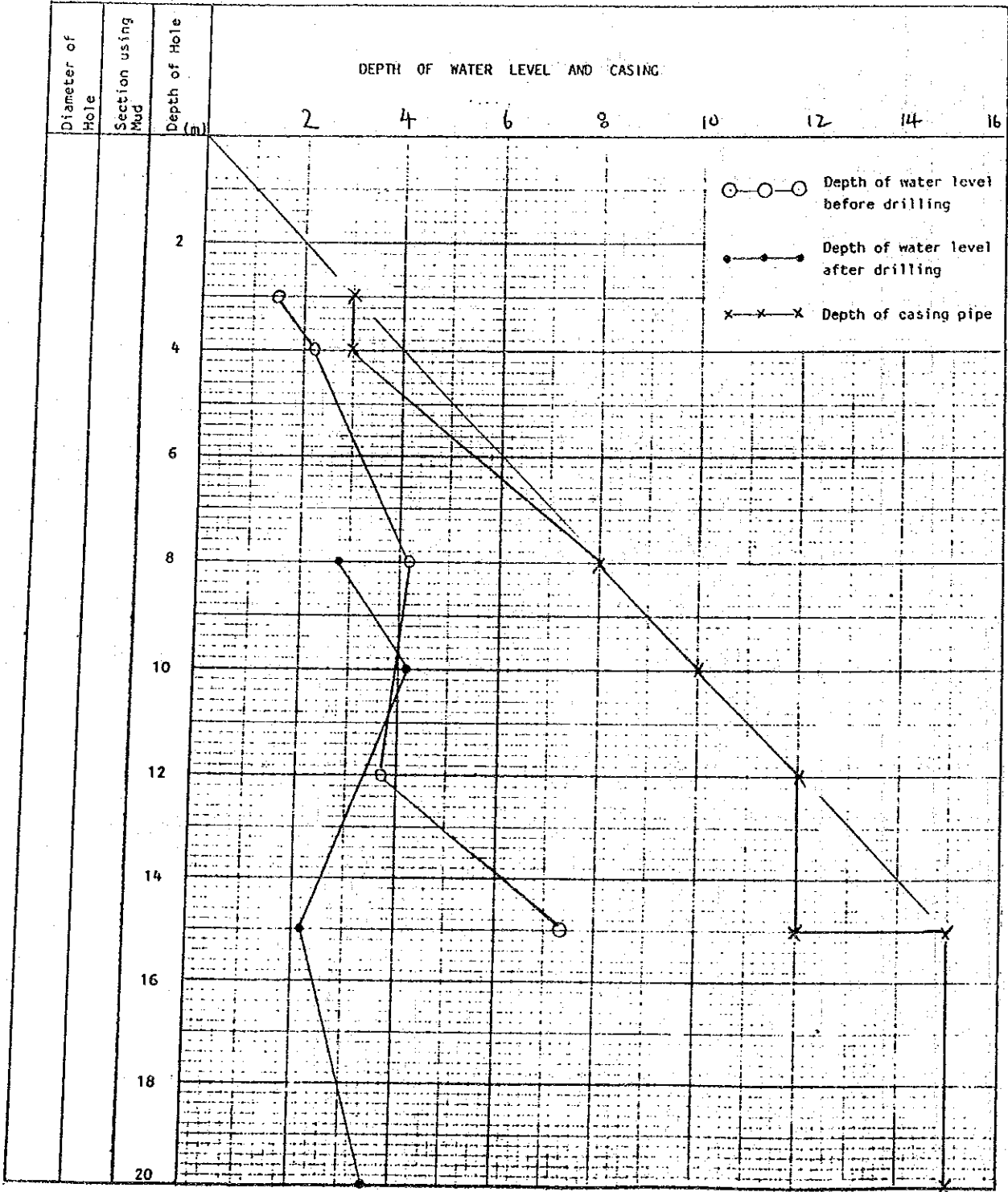
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LT-2 (Sheet 1 of 1)

LOCATION: Head Pond DEPTH OF HOLE: 20 m COMMENCED: 11-1-92

ELEVATION: 1035.53m DIAMETER OF HOLE: 80 mm COMPLETED: 17-1-92

COORDINATE: E76 7725.5
N66 1797.5 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

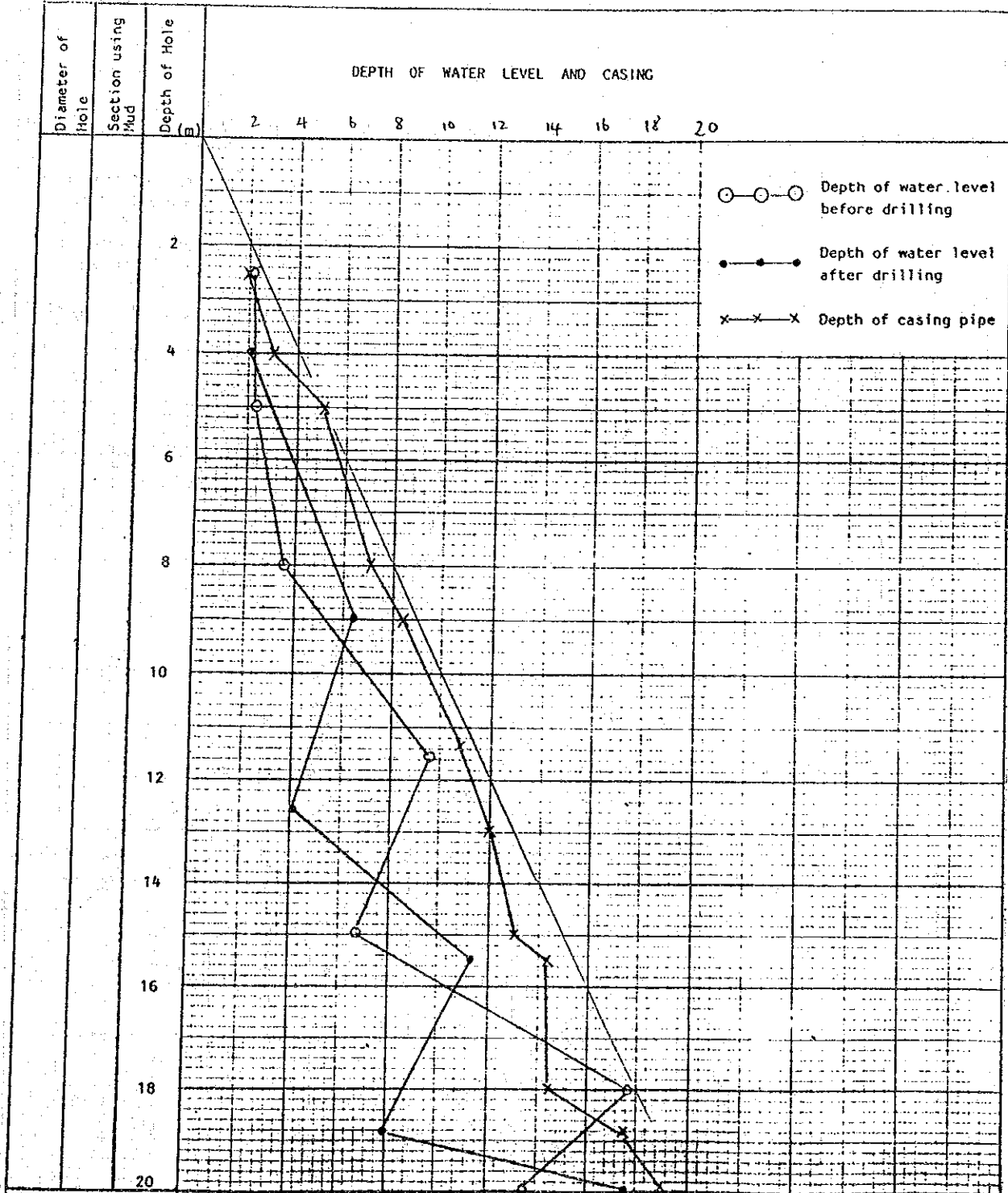
PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-1 (Sheet 1 of 1)

LOCATION: Kundasang DEPTH OF HOLE: 20 m COMMENCED: 6-12-91

ELEVATION: 975.08m DIAMETER OF HOLE: 80 mm COMPLETED: 12-12-91

E76 7727

COORDINATE: N66 1434 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



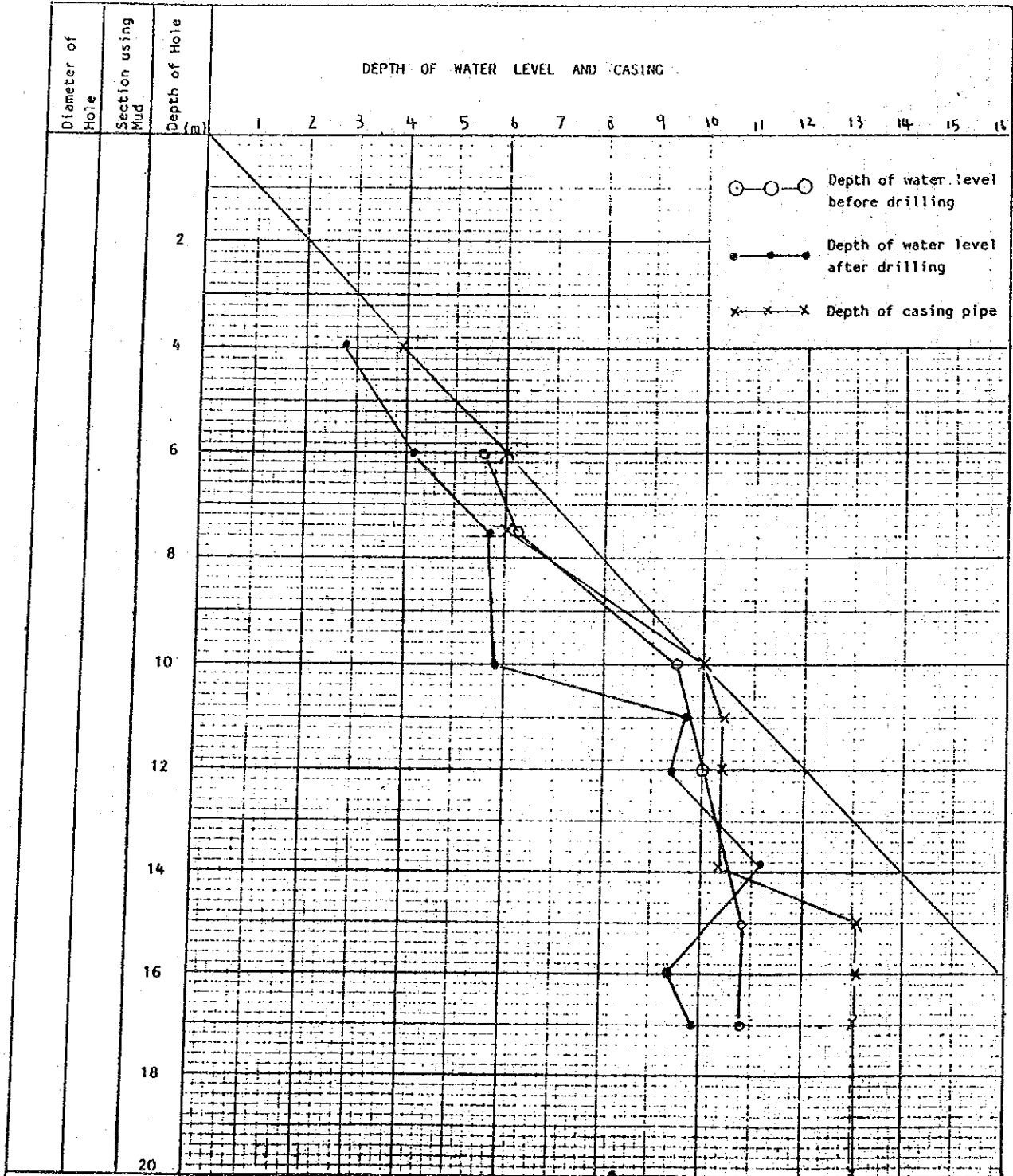
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-2 (Sheet 1 of 1)

LOCATION: Penstock DEPTH OF HOLE: 20 m COMMENCED: 21-1-92

ELEVATION: 913.65m DIAMETER OF HOLE: 80 mm COMPLETED: 27-1-92

COORDINATE: E76 7717.5 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Andy



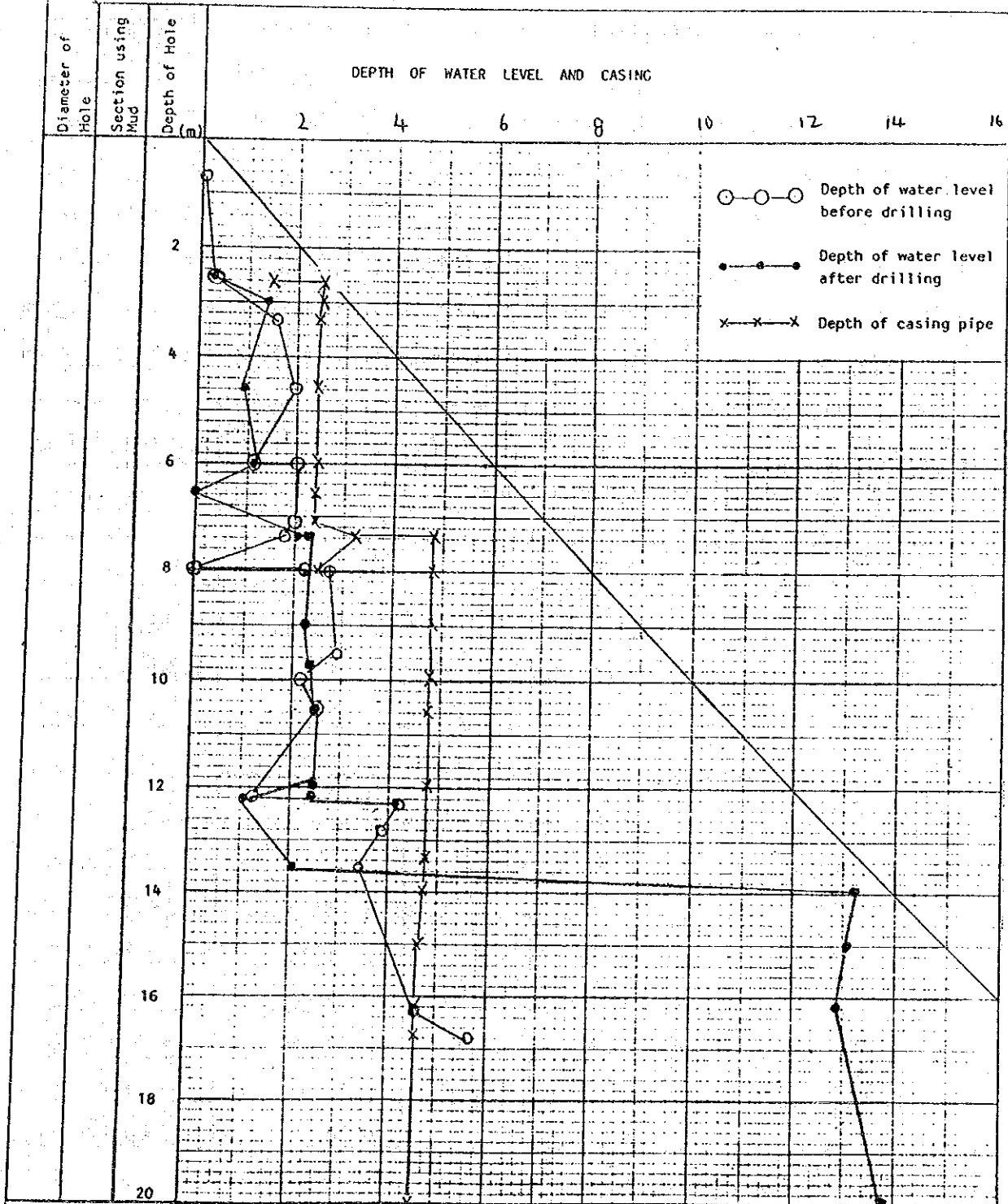
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G. I. At Upper Liwagu Mini Hydro Project SITE NO. LP-3 (Sheet 1 of 1)

LOCATION: Power House DEPTH OF HOLE: 20 m COMMENCED: 18-12-91

ELEVATION: 861.67m DIAMETER OF HOLE: 80 mm COMPLETED: 15-1-92

COORDINATE: E76 7662.5
N66 1075 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Ampahon



OPEN - END PERMEABILITY TEST

(Sheet 1 OF 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-1

LOCATION Liwagu Intake DATE OF TEST 20-12-91 TESTED BY Ampahon

GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Yellowish grey weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 260 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 46 cm

INTERNAL RADIUS OF CASING : $r =$ 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 31 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 31.5 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
16	21		0			
16	26		5.50	1.10	18.33	0.0111
16	31		11.00	1.10	18.33	0.0111
16	36		17.00	1.20	20.00	0.0122
16	41		23.50	1.30	21.67	0.0121
16	46		29.50	1.20	20.00	0.0122
16	51	77	33.50	0.80	13.33	8.07X10 ⁻³
16	56		38.00	0.90	15.00	9.08X10 ⁻³
17	01		44.00	1.20	20.00	0.0122
17	06		49.00	1.00	16.67	0.0101
17	11		53.50	0.90	15.00	9.08X10 ⁻³
17	16		58.25	0.95	15.83	9.58X10 ⁻³
17	21		62.50	0.85	14.17	8.58X10 ⁻³

Constant Rate Of Flow For Steady State Condition : $Q =$ 17.36 cm³/sec

Coefficient Of Permeability For Steady State Condition : $K =$ 1.05 x 10⁻² cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 2 of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. L1-1

LOCATION Liwagu Intake DATE OF TEST 23-12-91 TESTED BY Ampahon

GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Yellowish grey weathered SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 400 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 36 cm

INTERNAL RADIUS OF CASING : $r =$ 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 30.50 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 11.50 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
15	45	0	0			
15	50		3.70	0.74	12.33	8.64X10 ⁻³
15	55		7.70	0.80	13.33	9.35X10 ⁻³
16	00		12.20	0.90	15.00	0.0105
16	05		16.40	0.84	14.00	9.81X10 ⁻³
16	10		19.90	0.70	11.67	8.18X10 ⁻³
16	15	66.5	23.80	0.78	13.00	9.11X10 ⁻³
16	20		27.60	0.76	12.67	8.88X10 ⁻³
16	25		31.80	0.84	14.00	9.81X10 ⁻³
16	30		36.10	0.86	14.33	0.01005
16	35		39.30	0.64	10.67	7.48X10 ⁻³
16	40		42.20	0.58	9.67	6.78X10 ⁻³
16	45		46.00	0.76	12.67	8.88X10 ⁻³

Constant Rate Of Flow For Steady State Condition : $Q =$ 12.78 cm³/sec

Coefficient Of Permeability For Steady State Condition : $K =$ 8.96X10⁻³ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 3 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-1

LOCATION Liwagu Intake DATE OF TEST 26-12-91 TESTED BY LU

GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 625 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 37 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 21 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 7 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	Hr min min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
15	22	0	0			
15	27		3.0	0.60	10.00	8.04X10 ⁻³
15	32		5.90	0.58	9.67	7.77X10 ⁻³
15	37		8.65	0.55	9.17	7.37X10 ⁻³
15	42		11.95	0.66	11.00	8.84X10 ⁻³
15	47		14.45	0.50	8.33	6.70X10 ⁻³
15	52	58	17.90	0.69	11.50	9.24X10 ⁻³
15	57		21.65	0.75	12.50	0.01005
16	02		25.65	0.80	13.33	0.01071
16	07		29.10	0.69	11.50	9.24X10 ⁻³
16	12		32.00	0.58	9.67	7.77X10 ⁻³
16	17		34.65	0.53	8.83	7.10X10 ⁻³
16	22		37.65	0.60	10.00	8.04X10 ⁻³

Constant Rate Of Flow For Steady State Condition : Q = 10.46 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 8.41X10⁻³ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 4 of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-1

LOCATION Liwagu Intake DATE OF TEST 29-12-91 TESTED BY Ampahon & Will

GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 830.00 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 40.50 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 35.50 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 13.0 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	Hr min min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
08	38	0	0			
08	43		7.10	1.42	23.67	0.01452
08	48		16.70	1.92	32.00	0.01963
08	53		24.10	1.48	24.67	0.01513
08	58		32.20	1.62	27.00	0.01656
09	03		39.70	1.50	27.00	0.01656
09	08	76	47.30	1.52	25.33	0.01554
09	13		55.10	1.56	26.00	0.01595
09	18		62.50	1.48	24.67	0.01513
09	23		69.40	1.38	23.00	0.01411
09	28		75.80	1.28	21.33	0.01308
09	33		85.95	2.03	33.83	0.02075
09	38		93.90	1.59	26.50	0.01626

Constant Rate Of Flow For Steady State Condition : Q = 26.25 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 1.61 x 10⁻² cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 5 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-1
 LOCATION Liwagu Intake DATE OF TEST 30-12-91 TESTED BY Ampahon & Will
 GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M. Liew
 GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 975.00 cm
 HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 43.00 cm
 INTERNAL RADIUS OF CASING : $r =$ 3.9 cm
 GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C
 DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 43 cm
 DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 11 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	Hr min min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
09	43	0	0			
09	48		4.30	0.86	14.33	7.77×10^{-3}
09	53		8.05	0.75	12.50	6.78×10^{-3}
09	58		12.85	0.96	16.00	8.67×10^{-3}
10	03		16.70	0.77	12.83	6.96×10^{-3}
10	08		21.70	1.00	16.67	9.04×10^{-3}
10	13	86	25.60	0.78	13.00	7.05×10^{-3}
10	18		28.80	0.64	10.67	5.78×10^{-3}
10	23		32.70	0.78	13.00	7.05×10^{-3}
10	28		36.20	0.70	11.67	6.33×10^{-3}
10	33		41.00	0.96	16.00	8.67×10^{-3}
10	38		45.0	0.80	13.33	7.23×10^{-3}
10	43		49.80	0.96	16.00	8.67×10^{-3}

Constant Rate Of Flow For Steady State Condition : $Q =$ 13.83 cm³/sec

Coefficient Of Permeability For Steady State Condition : $K =$ 7.50×10^{-3} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 1 Of 5)

PROJECT : G.I.At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 3-1-92 TESTED BY LU

GROUND ELEVATION 1049.81 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE : Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 263 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 20 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 131 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 115 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
08	25	0	0			
08	30		16.20	3.24	54.00	0.0167
08	35		33.20	3.40	56.67	0.0175
08	40		49.50	3.26	54.33	0.0168
08	45		66.25	3.35	55.83	0.0172
08	50		81.85	3.12	52.00	0.0161
08	55	151	99.65	3.56	59.33	0.0183
09	00		117.65	3.60	60.00	0.0185
09	05		134.05	3.28	54.67	0.0169
09	10		151.50	3.49	58.17	0.0180
09	15		168.00	3.30	55.00	0.0169
09	20		183.70	3.14	52.33	0.0161
09	25		200.10	3.28	54.67	0.0169

Constant Rate Of Flow For Steady State Condition : Q = 55.58 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 1.72x10⁻² cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 2 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 4-1-92 TESTED BY LU

GROUND ELEVATION 1049.81 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 400 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 49 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 313 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 175 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
09	05		0			
09	10		4.80	0.96	16.00	2.06x10 ⁻³
09	15		10.00	1.04	17.33	2.23x10 ⁻³
09	20		14.50	0.90	15.00	1.93x10 ⁻³
09	25		19.60	1.02	17.00	2.19x10 ⁻³
09	30		24.60	1.00	16.67	2.15x10 ⁻³
09	35	362	29.35	0.95	15.83	2.04x10 ⁻³
09	40		34.45	1.02	17.00	2.19x10 ⁻³
09	45		39.45	1.00	16.67	2.15x10 ⁻³
09	50		44.15	0.94	15.67	2.02x10 ⁻³
09	55		48.65	0.90	15.00	1.93x10 ⁻³
10	00		53.75	1.02	17.00	2.19x10 ⁻³
10	05		59.05	1.06	17.67	2.28x10 ⁻³

Constant Rate Of Flow For Steady State Condition : Q = 16.40 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 2.11x10⁻³ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 3 OF 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 5-1-92 TESTED BY LU

GROUND ELEVATION 1049.81 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 652 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 39.5 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 403 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 188 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	Hr min min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
10	03		0			
10	08		12.50	2.50	41.67	4.39x10 ⁻³
10	13		23.30	2.16	36.00	3.79x10 ⁻³
10	18		35.75	2.49	41.50	4.37x10 ⁻³
10	23		46.75	2.20	36.67	3.86x10 ⁻³
10	28		60.20	2.69	44.83	4.72x10 ⁻³
10	33	442.5	71.15	2.19	36.50	3.85x10 ⁻³
10	38		82.65	2.30	38.33	4.04x10 ⁻³
10	43		95.00	2.47	41.17	4.34x10 ⁻³
10	48		108.00	2.60	43.33	4.57x10 ⁻³
10	53		119.20	2.24	37.33	3.93x10 ⁻³
10	58		131.50	2.46	41.00	4.32x10 ⁻³
11	03		144.70	2.64	44.00	4.64x10 ⁻³

Constant Rate Of Flow For Steady State Condition : Q = 40.19 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 4.23x10⁻³ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 4 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 5-1-92 TESTED BY LU

GROUND ELEVATION 1042.81 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 775 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 42 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 407 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 136 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	Hr min min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
14	26	0	0			
14	31		6.0	1.20	20.00	2.08x10 ⁻³
14	36		12.80	1.36	22.67	2.35x10 ⁻³
14	41		19.90	1.42	23.67	2.46x10 ⁻³
14	46		26.30	1.28	21.33	2.21x10 ⁻³
14	51		32.10	1.16	19.33	2.01x10 ⁻³
14	56	449	38.85	1.35	22.50	2.34x10 ⁻³
15	01		45.85	1.40	23.33	2.42x10 ⁻³
15	06		52.35	1.30	21.67	2.25x10 ⁻³
15	11		59.45	1.42	23.67	2.46x10 ⁻³
15	16		65.40	1.19	19.83	2.06x10 ⁻³
15	21		71.85	1.29	21.50	2.23x10 ⁻³
15	26		78.70	1.37	22.83	2.37x10 ⁻³

Constant Rate Of Flow For Steady State Condition : Q = 21.86 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 2.27x10⁻³ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 5 of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 6-1-92 TESTED BY LU

GROUND ELEVATION 1049.81 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 964 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 33.5 cm

INTERNAL RADIUS OF CASING : $r =$ 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 21 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 387 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 93 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
15	49	0	0			
15	54		18.30	3.66	61.00	6.76×10^{-3}
15	59		35.80	3.50	58.33	6.47×10^{-3}
16	04		53.60	3.56	59.33	6.58×10^{-3}
16	09		72.60	3.80	63.33	7.02×10^{-3}
16	14		89.10	3.30	55.00	6.10×10^{-3}
16	19	420.5	105.80	3.34	55.67	6.17×10^{-3}
16	24		123.80	3.60	60.00	6.65×10^{-3}
16	29		141.10	3.46	57.67	6.39×10^{-3}
16	34		155.60	2.90	48.33	5.36×10^{-3}
16	39		176.00	4.08	68.00	7.54×10^{-3}
16	44		192.85	3.37	56.17	6.23×10^{-3}
16	49		210.20	3.47	57.83	6.41×10^{-3}

Constant Rate Of Flow For Steady State Condition : $Q =$ 58.39 cm³/sec

Coefficient Of Permeability For Steady State Condition : $K =$ 6.47×10^{-3} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 1 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-3

LOCATION Mesilau Intake DATE OF TEST 31-1-92 TESTED BY WILL/LU

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Sandstone and adamellite cobbles

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 200 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 52 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 47 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 31 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
14	04		0.00			
14	09		10.00	2.00	33.33	0.0157
14	14		21.20	2.24	37.33	0.0176
14	19		32.40	2.24	37.33	0.0176
14	24		45.30	2.58	43	0.0202
14	29		57.50	2.44	40.67	0.0192
14	34	99	65.90	1.68	28	0.0132
14	39		77.70	2.36	39.33	0.0185
14	44		85.20	1.50	25	0.0118
14	49		97.40	2.44	40.67	0.0192
14	54		109.60	2.44	40.67	0.0192
14	59		122.30	2.54	42.33	0.0199
15	04		131.60	1.86	31	0.0146

Constant Rate Of Flow For Steady State Condition : $Q = \underline{36.56} \text{ cm}^3/\text{sec}$

Coefficient Of Permeability For Steady State Condition : $K = \underline{0.0172} \text{ cm/sec}$

OPEN - END PERMEABILITY TEST

(Sheet 2 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. L1-3

LOCATION Mesilau Intake DATE OF TEST 1-2-92 TESTED BY Will/LU

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE
cobbles

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 400 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 66 cm

INTERNAL RADIUS OF CASING : $r =$ 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 55 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 37 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
12	01		0			
12	06		8.30	1.66	27.67	0.0107
12	11		19.50	2.24	37.33	0.0144
12	16		29.40	1.98	33.00	0.0127
12	21		43.10	2.24	45.67	0.0176
12	26		52.40	1.86	31.00	0.0119
12	31	121	63.70	2.26	37.67	0.0145
12	36		70.50	1.36	22.67	8.73×10^{-3}
12	41		80.00	1.90	31.67	0.0122
12	46		87.40	1.48	24.67	9.51×10^{-3}
12	51		96.50	1.82	30.33	0.0117
12	56		109.20	2.54	42.33	0.0163
13	01		122.20	2.60	43.33	0.0167

Constant Rate Of Flow For Steady State Condition : $Q =$ 33.95 cm³/sec

Coefficient Of Permeability For Steady State Condition : $K =$ 0.0131 cm/sec

OPEN - END PERMEABILITY TEST

Sheet 3 of 6

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-3

LOCATION Mesilau Intake DATE OF TEST 2-2-92 TESTED BY Will/LU

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 600 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 34 cm

INTERNAL RADIUS OF CASING : $r =$ 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 107 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 45 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
09	10		0.00			
09	15		5.20	1.04	17.33	5.73×10^{-3}
09	20		12.00	1.36	22.67	7.50×10^{-3}
09	25		18.40	1.28	21.33	7.05×10^{-3}
09	30		26.70	1.66	27.67	9.15×10^{-3}
09	35		35.40	1.74	29.00	9.59×10^{-3}
09	40	141	43.10	1.54	25.67	8.49×10^{-3}
09	45		50.80	1.54	25.67	8.49×10^{-3}
09	50		56.30	1.10	18.33	6.06×10^{-3}
09	55		67.10	2.16	36	0.0119
10	00		77.30	2.04	34	0.0112
10	05		83.90	1.32	22	7.27×10^{-3}
10	10		90.20	1.26	21	6.94×10^{-3}

Constant Rate Of Flow For Steady State Condition : $Q =$ 25.06 cm³/sec

Coefficient Of Permeability For Steady State Condition : $K =$ 8.29×10^{-3} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 4 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-3

LOCATION Mesilau Intake DATE OF TEST 2-2-92 TESTED BY Will/ Lu

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 800 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 35 cm

INTERNAL RADIUS OF CASING : $r = 3.9$ cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 137 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 19 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	Hr min min.		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
17	05		0			
17	10		1.50	0.3	5.0	1.36×10^{-3}
17	15		2.70	0.24	4.0	1.08×10^{-3}
17	20		4.80	0.42	7.0	1.90×10^{-3}
17	25		5.80	0.20	3.33	9.03×10^{-3}
17	30		6.70	0.18	3.00	8.13×10^{-4}
17	35	172	8.30	0.32	5.33	1.44×10^{-3}
17	40		9.30	0.20	3.33	9.03×10^{-4}
17	45		10.80	0.30	5.00	1.36×10^{-3}
17	50		11.10	0.06	1.00	2.71×10^{-4}
17	55		12.90	0.36	6.00	1.63×10^{-3}
18	00		13.40	0.10	1.67	4.53×10^{-4}
18	05		15.30	0.38	6.33	1.72×10^{-3}

Constant Rate Of Flow For Steady State Condition : $Q = 4.25$ cm³/sec

Coefficient Of Permeability For Steady State Condition : $K = 1.15 \times 10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 5 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-3

LOCATION Mesilau Intake DATE OF TEST 3-2-92 TESTED BY Willi/ Lu

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey silt-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 1000 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 45 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 92 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 12 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	Hr min min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
11	03		0			
11	08		1.10	0.22	3.67	1.25x10 ⁻³
11	13		2.00	0.18	3.00	1.02x10 ⁻³
11	18		2.80	0.16	2.67	9.09x10 ⁻⁴
11	23		3.50	0.14	2.33	7.93x10 ⁻⁴
11	28		4.50	0.20	3.33	1.13x10 ⁻³
11	33	137	5.10	0.30	5.00	1.70x10 ⁻³
11	38		6.00	0.18	3.00	1.02x10 ⁻³
11	43		7.20	0.24	4.00	1.36x10 ⁻³
11	48		8.40	0.24	4.00	1.36x10 ⁻³
11	53		9.10	0.14	2.33	7.93x10 ⁻⁴
11	58		10.00	0.18	3.00	1.02x10 ⁻³
12	03		11.00	0.20	3.33	1.13x10 ⁻³

Constant Rate Of Flow For Steady State Condition : Q = 3.31 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 1.13x10⁻³ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 6 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-3
 LOCATION Mesilau Intake DATE OF TEST 8-2-92 TESTED BY Will/LU
 GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY N. Liew
 GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 1300 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 22 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 178 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 7 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
10	41		0	0		
10	46		0.70	0.14	2.33	5.43x10 ⁻⁴
10	51		1.80	0.22	3.67	8.55x10 ⁻⁴
10	56		2.40	0.12	2.00	4.66x10 ⁻⁴
11	01		3.40	0.20	3.33	7.76x10 ⁻⁴
11	06		4.60	0.24	4.00	9.32x10 ⁻⁴
11	11	200	5.90	0.26	4.33	1.01x10 ⁻³
11	16		6.90	0.20	3.33	7.76x10 ⁻⁴
11	21		7.50	0.12	2.00	4.66x10 ⁻⁴
11	26		8.20	0.14	2.33	5.43x10 ⁻⁴
11	31		9.00	0.16	2.67	6.22x10 ⁻⁴
11	36		10.10	0.22	3.67	8.55x10 ⁻⁴
11	41		11.00	0.18	3.00	6.99x10 ⁻⁴

Constant Rate Of Flow For Steady State Condition : Q = 3.06 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 7.13x10⁻⁴ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 1 Of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-4

LOCATION Sg. Mesilau Intake DATE OF TEST 22-1-92 TESTED BY Willi & Ampahon

GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY Michael Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey SANDSTONE and ADAMELLITE
boulders

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 200 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 61 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 15 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 15 cm

Time		Differential Head Of Water H (cm)	Water Volumes			Coefficient Of Permeability K (cm ³ /sec)
Clock	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
06	10		0			
06	15		4.2	0.84	14	8.59X10 ⁻³
06	20		8.0	0.76	12.67	7.77X10 ⁻³
06	25		12.0	0.80	13.33	8.18X10 ⁻³
06	30		15.9	0.78	13.0	7.97X10 ⁻³
06	35		19.4	0.70	11.67	7.16X10 ⁻³
06	40	76	23.9	0.90	15	9.20X10 ⁻³
06	45		28.5	0.92	15.33	9.40X10 ⁻³
06	50		33.0	0.90	15	9.20X10 ⁻³
06	55		38.1	1.02	17	0.0104
07	00		42.8	0.94	15.67	9.61X10 ⁻³
07	05		46.7	0.78	13	7.97X10 ⁻³
07	10		50.7	0.80	13.33	8.18X10 ⁻³

Constant Rate Of Flow For Steady State Condition : Q = 14.08 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 8.64X10⁻³ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 2 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-4

LOCATION Sg. Masilau Intake DATE OF TEST 22-1-92 TESTED BY Will & Ampahon

GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey medium to coarse SAND

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 400 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 86.5 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 20 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 20 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
17	25		0			
17	30		2.50	0.5	8.3	3.63X10 ⁻³
17	35		4.80	0.46	7.67	3.36X10 ⁻³
17	40		7.30	0.5	8.33	3.65X10 ⁻³
17	45		9.70	0.48	8.00	3.50X10 ⁻³
17	50		12.10	0.48	8.00	3.50X10 ⁻³
17	55	106.5	14.80	0.54	9.00	3.94X10 ⁻³
18	00		17.30	0.50	8.33	3.65X10 ⁻³
18	05		19.90	0.52	8.67	3.80X10 ⁻³
18	10		22.10	0.44	7.33	3.21X10 ⁻³
18	15		24.90	0.56	9.33	4.08X10 ⁻³
18	20		27.50	0.52	8.67	3.80X10 ⁻³
18	25		29.90	0.48	8.00	3.50X10 ⁻³

Constant Rate Of Flow For Steady State Condition : $Q = \frac{8.30}{\text{cm}^3/\text{sec}}$

Coefficient Of Permeability For Steady State Condition : $K = \frac{3.63 \times 10^{-3}}{\text{cm}/\text{sec}}$

OPEN - END PERMEABILITY TEST

(Sheet 3 of 6)

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site

HOLE No. LI-4

LOCATION: Sg. Mesilau Intake

DATE OF TEST: 24-1-92

TESTED BY: Will & Ampahon

GROUND ELEVATION: 1035.34 m

SIZE OF CASING: NW

CHECKED BY: M. Liew

GEOMORPHOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE: Lightly grey mottled black ADAMELLITE boulders

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING: 600 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING: 76 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE: 25 °C WATER TEMPERATURE: 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST: 26 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST: 24 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
10	05		0			
10	10		0.40	0.08	1.33	6.08X10 ⁻⁴
10	15		0.75	0.07	1.17	5.35X10 ⁻⁴
10	20		1.20	0.09	1.5	6.86X10 ⁻⁴
10	25		1.62	0.084	1.4	6.40X10 ⁻⁴
10	30		2.06	0.088	1.47	6.72X10 ⁻⁴
10	35	102	2.47	0.082	1.37	6.26X10 ⁻⁴
10	40		2.89	0.084	1.40	6.40X10 ⁻⁴
10	45		3.32	0.086	1.43	6.54X10 ⁻⁴
10	50		3.76	0.088	1.47	6.72X10 ⁻⁴
10	55		4.18	0.084	1.40	6.40X10 ⁻⁴
11	00		4.56	0.076	1.27	5.80X10 ⁻⁴
11	05		4.92	0.072	1.20	5.48X10 ⁻⁴

Constant Rate Of Flow For Steady State Condition : Q = 1.37 cm³/sec

Coefficient Of Permeability For Steady State Condition : K = 6.26X10⁻⁴ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 4 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-4
 LOCATION Sg. Mesilau Intake DATE OF TEST 25-1-92 TESTED BY Will & Ampahon
 GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY M. Liew
 GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 800 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 64 cm

INTERNAL RADIUS OF CASING : $r =$ 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 22 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 4 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
09	02		0			
09	07		0.25	0.05	0.83	4.50×10^{-4}
09	12		0.50	0.05	0.83	4.50×10^{-4}
09	17		0.74	0.048	0.80	4.34×10^{-4}
09	22		1.00	0.052	0.87	4.72×10^{-4}
09	27		1.30	0.06	1.00	5.42×10^{-4}
09	32	86	1.58	0.056	0.93	5.04×10^{-4}
09	37		1.83	0.05	0.83	4.50×10^{-4}
09	42		2.03	0.04	0.67	3.63×10^{-4}
09	47		2.25	0.044	0.73	3.96×10^{-4}
09	52		2.50	0.05	0.83	4.50×10^{-4}
09	57		2.75	0.05	0.83	4.50×10^{-4}
10	02		2.95	0.04	0.67	3.63×10^{-4}

Constant Rate Of Flow For Steady State Condition : $Q =$ 0.82 cm³/sec

Coefficient Of Permeability For Steady State Condition : $K =$ 4.45×10^{-4} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 5 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. L1-4

LOCATION Sg. Mesilau Intake DATE OF TEST 25-1-92 TESTED BY Will & Ampahon

GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 1000 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 60 cm

INTERNAL RADIUS OF CASING : $r =$ 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 27 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 3 cm

Time		Differential Head of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm ³ /sec)	
-16	41	0	0			
16	46		0.20	0.04	0.67	3.59×10^{-4}
16	51		0.40	0.04	0.67	3.59×10^{-4}
16	56		0.60	0.04	0.67	3.59×10^{-4}
17	01		0.80	0.04	0.67	3.59×10^{-4}
17	06		1.05	0.05	0.83	4.45×10^{-4}
17	11	87	1.25	0.04	0.67	3.59×10^{-4}
17	16		1.45	0.04	0.67	3.59×10^{-4}
17	21		1.65	0.04	0.67	3.59×10^{-4}
17	26		1.90	0.05	0.83	4.45×10^{-4}
17	31		2.20	0.06	1.00	5.36×10^{-4}
17	36		2.45	0.05	0.83	4.45×10^{-4}
17	41		2.68	0.046	0.77	4.13×10^{-4}

Constant Rate Of Flow For Steady State Condition : $Q =$ 0.75 cm³/sec

Coefficient Of Permeability For Steady State Condition : $K =$ 4.02×10^{-4} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 6 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-4
 LOCATION Sg. Mesilau Intake DATE OF TEST 26-1-92 TESTED BY Will & Ampahon
 GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY M. Liew
 GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 1200 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 66 cm

INTERNAL RADIUS OF CASING : $r =$ 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 0.10 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 5 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock	Hr min min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rgte Of Flow Q (cm ³ /sec)	
17	03	0	0			
17	08		0.5	0.1	1.67	1.18×10^{-3}
17	13		0.9	0.08	1.33	9.38×10^{-4}
17	18		1.40	0.1	1.67	1.17×10^{-3}
17	23		1.45	0.01	0.17	1.19×10^{-4}
17	28		1.80	0.07	1.17	8.25×10^{-4}
17	33	66.10	2.20	0.08	1.33	9.38×10^{-4}
17	38		2.58	0.076	1.27	8.96×10^{-4}
17	43		3.00	0.084	1.4	9.87×10^{-4}
17	48		3.35	0.07	1.17	8.25×10^{-4}
17	53		3.80	0.09	1.5	1.06×10^{-3}
17	58		4.20	0.08	1.33	9.38×10^{-4}
18	03		4.55	0.07	1.17	8.25×10^{-4}

Constant Rate Of Flow For Steady State Condition : $Q =$ 1.265 cm³/sec

Coefficient Of Permeability For Steady State Condition : $K =$ 2.93×10^{-3} cm/sec