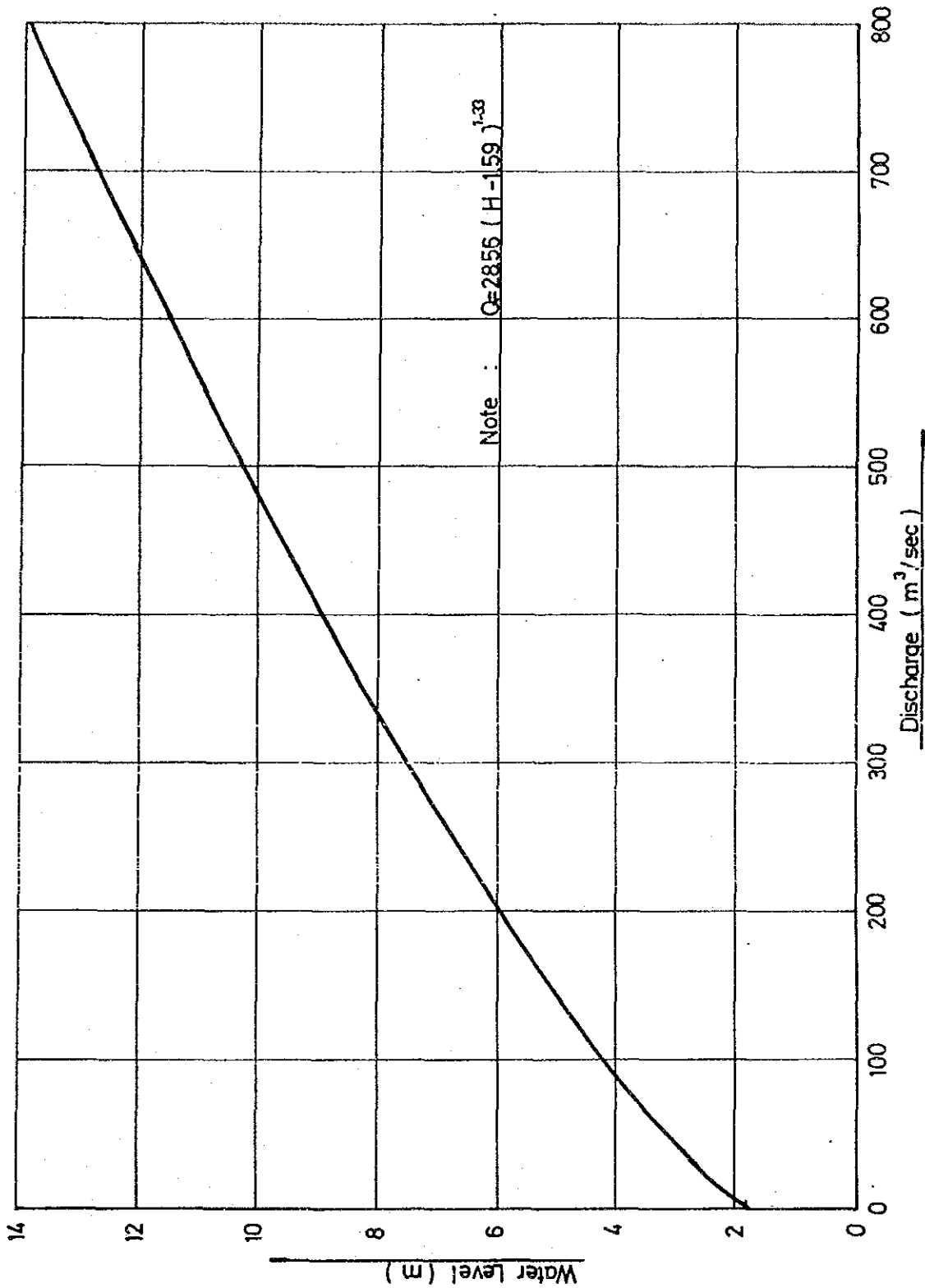
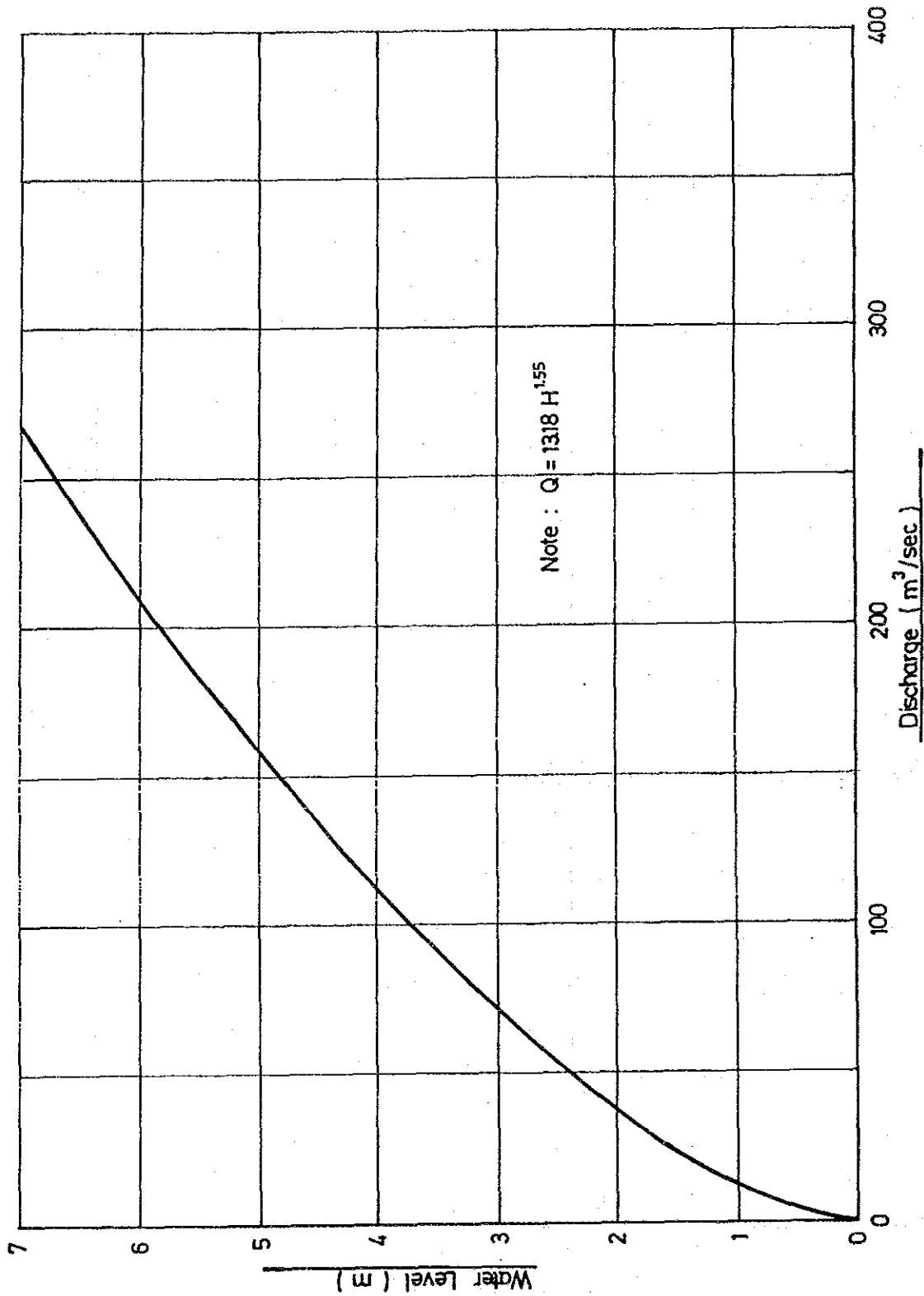


RATING CURVE



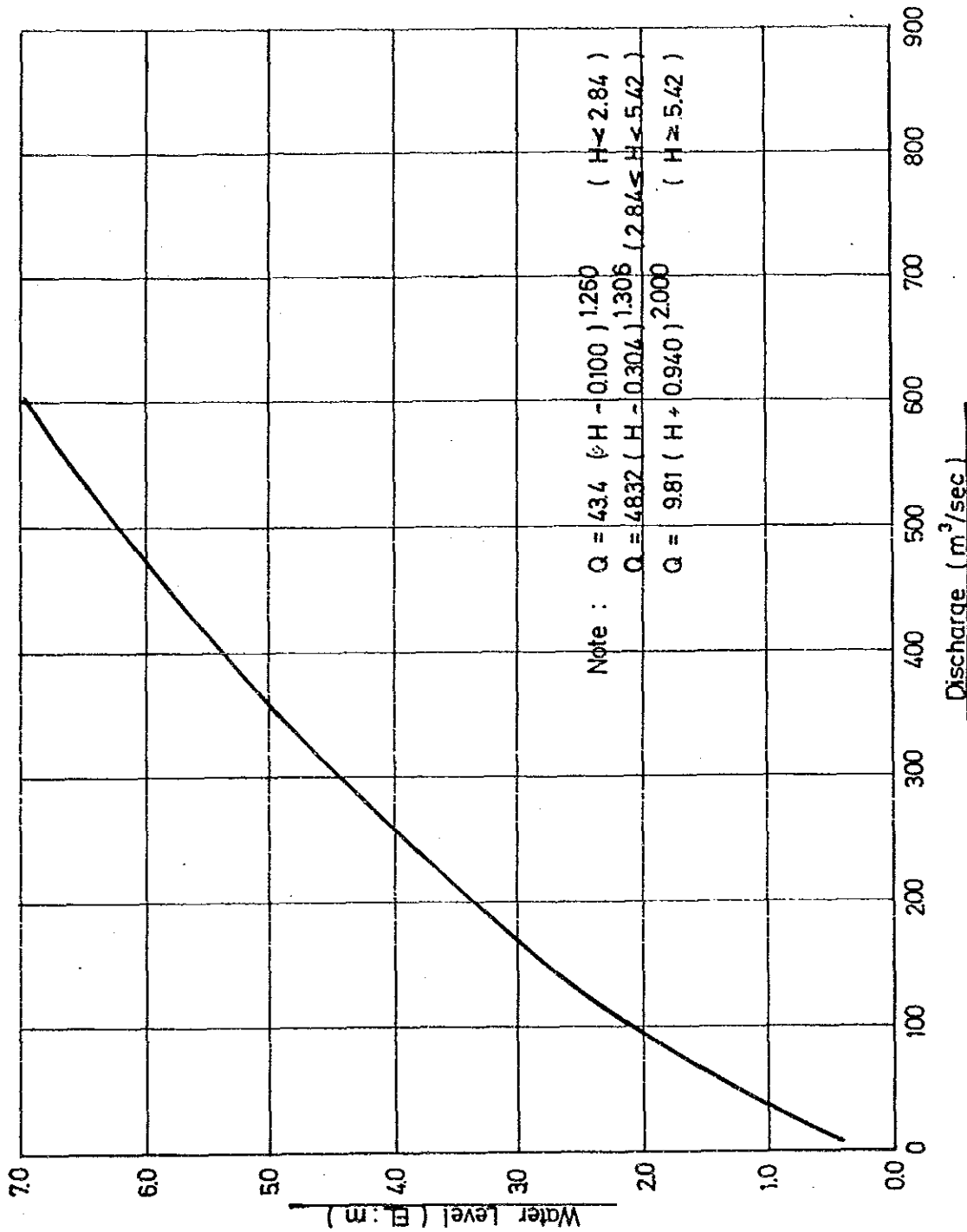
Rating Curve at Kpg. Git

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Rating Curve at Buan Bidi

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Rating Curve at Nanga Medamit

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK

JAPAN INTERNATIONAL COOPERATION AGENCY

EVAPORATION DATA

Station No. 0905339

Station Name : Muara Mongkos

(Unit : mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1971	113.8		108.9	103.5	125.8	104.1	129.1	101.2	135.7	114.2	107.9	107.6	
1972	110.7	99.5	114.4	124.4	152.3	109.3	143.0	117.3	107.3	116.8	119.2	157.7	1471.9
1973	104.1	98.8	106.3	120.0	117.4	125.4	155.3	136.4	112.3	137.1	116.5	92.4	1422.0
1974	91.2	91.9	107.1	129.6		122.5	135.6	121.5	136.6	118.6	117.4	164.5	
1975	119.9	89.8	143.1	101.7	121.2	123.1	105.9	125.5	108.6	120.7	117.5	116.6	1393.6
1976	80.4		116.3	122.9	135.2	123.4	130.7	112.2	115.4	126.8	124.4	102.6	
1977	109.6	97.5	102.1	99.3	115.0	111.5	111.5	124.6	128.2	98.7	88.7	97.1	1283.8
1978	107.3	112.4	148.5	135.6	135.5	112.0	113.3	128.9	117.7	132.1	110.4	123.3	1477.0
1979	109.6	110.9	124.4	120.4	136.0	124.3	119.3	125.5	123.1	118.5	118.8	109.6	1440.4
1980	108.4	96.3	127.7	121.4	109.1	118.3	127.9	125.5	135.4	118.9	135.0	108.1	1432.0
1981	119.7	106.5	129.0	120.8	125.7	129.5	119.5	137.7	137.8	140.1	120.5	104.5	1491.3
1982	131.6	100.1	129.1	128.1	139.5	126.3	109.7	122.4	128.0	108.4	99.9	128.6	1451.7
Max.	131.6	112.4	148.5	135.6	152.3	129.5	155.3	137.7	137.8	140.1	135.0	164.5	1491.3
Min.	80.4	89.8	102.1	99.3	109.1	104.1	105.9	101.2	107.3	98.7	88.7	92.4	1283.8
Ave.	108.9	100.4	121.4	119.0	128.4	119.1	125.1	123.2	123.8	120.9	114.7	117.7	1429.3

Station No. 1401305

Station Name : Bau

(Unit : mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1971	101.5		109.6	115.6	125.3	116.8	128.5	105.6	121.2	115.6	105.1	143.2	
1972	106.1	98.2	125.8	122.5	112.9	123.1	158.7	151.3	128.2	189.0	204.9	194.6	1715.3
1973	154.2	102.0	110.1	125.8	138.1	131.0	127.7	126.0	133.3	118.0	127.0	126.3	1519.5
1974	114.2	90.7	140.2	141.2	145.3	127.2	147.6	136.3	117.2	98.3	106.8	115.3	1480.3
1975	116.6	84.6	98.6	118.7	140.0	122.4	101.6	132.1	110.2	128.5	96.5	104.9	1354.7
1976	99.6	105.5	137.5	110.4	119.4	121.4	118.4	145.5	115.1	112.5	118.4	117.8	1421.5
1977	85.6		109.8	106.6	116.4	122.3	117.5	121.9	115.2	126.7	100.0	80.7	
1978	102.3	93.1	102.6	123.0	115.8	128.4	117.3	118.7	121.0	112.6	89.4	73.5	1297.7
1979	90.3	105.5	115.3	121.2	134.4	110.0	122.3	127.2	104.0	130.7	107.3	105.6	1373.8
1980	95.1	100.8	128.8	130.8	139.5	133.4	130.6	132.9	133.7	133.7		101.8	
1981	103.4	101.4	103.6	127.5	113.7	122.6	116.8	129.1	120.6	121.3	116.1	112.7	1388.8
1982	94.2	99.2	118.1	121.0	124.9	134.5	140.9	124.0	120.6	113.9	100.5	121.5	1413.3
Max.	154.2	105.5	140.2	141.2	145.3	134.5	158.7	151.3	133.7	189.0	204.9	194.6	1715.3
Min.	85.6	84.6	98.6	106.6	112.9	110.0	101.6	105.6	104.0	98.3	89.4	73.5	1297.7
Ave.	105.3	98.1	116.7	122.0	127.1	124.4	127.3	129.2	120.0	125.1	115.6	116.5	1440.5

Station No. 2029301 Station Name : Kapit

(Unit : mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1963	120.6	137.2	152.7	164.9	144.9	135.1	144.9	152.7	162.1	143.5	133.7	163.4	
1964	154.2	137.2	152.7	164.9	144.9	140.3	151.6	153.7	138.6	141.3	116.6	122.6	1718.6
1965	107.8	111.6	137.3	130.1	142.6	132.3	156.2	155.7	126.7	155.0	141.7	138.7	1635.7
1966	143.8	111.9	149.2	135.3	152.4	150.6	130.9	158.8	144.6	139.2	127.2	131.6	1675.5
1967	120.2	112.7	133.3	145.4	153.4	135.1	142.2	132.5	147.3	176.9	137.9	156.3	1693.2
1968	109.1	128.4	162.9	164.8	131.8	140.6	142.1	147.7	139.6	166.6	122.7	135.8	1692.1
1969	156.4	119.2	138.4	137.8	180.2	147.3	144.7	154.7	121.4	161.3	104.1	129.5	1695.0
1970	132.4	134.0	133.3	130.0	132.0	150.1	134.9	146.6	166.8	144.6	122.6	163.0	1690.3
1971	106.7	116.1	159.6	155.9	154.2	145.5	155.9	151.6	132.6	143.3	129.9	142.9	1694.2
1972	116.9	129.9	132.7	143.9	143.8	134.2	140.5	123.1	160.7	168.4	150.7	163.8	1708.6
1973	136.5	147.7	132.0	156.8	140.5	152.5	150.3	142.5	147.5	164.8	125.3	121.1	1717.5
1974	118.1	99.4	149.3	178.4	151.1	137.8	162.4	131.0	161.1	131.5	125.2	145.8	1691.1
1975	132.5	132.4	133.0	152.1	139.9	133.0	136.6	153.8	137.6	145.1	114.0	143.4	1653.4
1976	102.8	117.1	128.4	134.3	127.8	111.6	149.0	152.7	138.0	139.2	129.9	110.6	1541.4
1977	96.3	97.5	121.5	120.4	123.9	119.5	118.9	113.3	78.4	103.0	104.4	117.4	1314.5
Max.	156.4	147.7	162.9	178.4	180.2	152.5	162.4	158.8	166.8	176.9	150.7	163.8	1718.6
Min.	96.3	97.5	121.5	109.0	123.9	111.6	118.9	113.3	78.4	103.0	104.1	110.6	1314.5
Ave.	123.8	121.0	140.1	143.9	143.7	137.7	144.1	144.7	140.2	148.2	125.7	139.1	1651.5

Station No. 4548304 Station Name : Ukong P.T.S.

(Unit : mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1973	141.4		152.7	181.6	147.2	124.7	131.8	134.2	128.8	136.9	111.8	127.8	
1974	102.9	92.6	117.8	123.5	118.9	116.1	132.3	136.1	134.5	120.5	107.6	99.4	1402.2
1975	135.5	100.4	115.8	109.3	126.4	120.6	126.4	132.7	110.5	119.9	120.4	107.5	1425.4
1976	90.8	114.8	126.1	126.1	126.5	132.7	126.2	119.3	125.6	127.0	123.2	117.4	1455.7
1977	115.2	88.7	125.4	131.2	126.8	131.7	100.0	106.9	120.2	113.9	89.7	107.1	1356.8
1978	105.4	101.1	124.5	108.0	126.4	107.6	102.3	94.9	107.7	101.7	86.4	108.6	1274.6
1979	104.0	101.5	114.8	102.5	110.3	110.7	98.8	117.6	100.0	100.2	93.0	105.8	1259.2
1980	93.9	107.2	108.2	118.7	125.5	107.7	122.9	122.5	128.9	126.3	91.8	92.6	1346.2
1981	97.0	106.5	133.6	132.9	125.9	114.9	138.5	142.1	119.4	112.8	117.7	112.4	1453.7
1982	105.1	89.3	115.8	127.6	132.1	103.0	112.0	116.2	117.3	111.3	120.6	100.4	1350.7
1983	113.9	128.9	155.0	137.4	137.3	118.8	119.7	116.7	113.2	123.7	98.5	113.4	1476.5
1984	119.0	106.4	128.3	129.3	123.5	115.7	112.3	123.1	112.0	110.7	129.0	121.0	1430.3
1985	120.7	124.1	149.7	147.7	157.1	134.4	136.9	115.7	106.3	95.5	102.4	83.2	1473.8
1986	73.0	92.1	105.7	118.3	115.2	100.5	117.6	111.0	113.9	113.8	97.1	106.3	1264.5
Max.	141.4	128.9	155.0	181.6	157.1	134.4	138.5	142.1	134.5	136.9	129.0	127.8	1476.5
Min.	73.0	88.7	105.7	102.5	110.3	100.5	98.8	94.9	100.0	95.5	86.4	83.2	1259.2
Ave.	108.4	104.1	126.7	128.2	128.5	117.1	119.8	120.6	117.0	115.3	106.4	107.4	1382.3

NEWLY ESTABLISHED GAUGING STATION

8.1 Mukoh site

(1) General condition

Location map of newly established gauging stations are shown on Ref.1.

(2) Staff gauge

A total of seven (7) metres of staff gauges were installed at the opposite bank of the initial proposed powerhouse site at about 2 km downstream of the intake on 26 July 1987. These consist of three 1-metre long staff gauges which were anchored onto the rock outcrop by rock bolts, a 2-metre long and two (2) 1-metre long staff gauges piled into the ground. The site was chosen in view of the following factors:

- a) A pool is present to ensure a recording of waterlevel at extremely low flow
- b) The site is easily accessible by observer who lives in the farm but near the gauging site
- c) Discharge measurement is possible at the staff gauge site.
- d) River cross section would not change because of the rock outcrop at both banks.

Two (2) readings are recorded daily at 6.30 a.m and 6.30 p.m and the maximum and minimum water level observed are 4.35 m and 1.71 m respectively in July 1987 as given in Ref.2.

The reduced level of DID TBM in 59.230 m as related to a bench mark BM1 which is arbitrarily taken as +60.00 m. The zero of the staff gauge corresponds to 53.832 m.

(3) Discharge measurement

A total of 20 discharge measurements were carried out at the staff gauge site between 26 June 1987 to 17 July 1987 for water level ranging from 1.71 m to 2.15 m. Maximum and minimum values measured were 16.3 m³/sec and 5.8 m³/sec respectively. Field records are attached as given in Ref.3,4 and 5.

The river cross section and the assumed rating curve where discharge measurement is carried out are shown on Ref.6 and 7.

(4) Rain gauge

A manual rain gauge was also installed on 26 June 1987 behind the farm hut near to the staff gauge site. A daily reading of rainfall is also recorded as given in Ref.8. The observed maximum rainfall from July to September, 1987 is 83.2 mm corresponding to flood water level of 4.35 m.

Ref.2 Daily Discharge Record at Mukoh Site

Station : Sg. Mukoh

Year : 1987 Month : July

Day	Waterlevel(m)	Discharge(m ³ /sec)
1	1.98	11.75
2	2.12	13.80
3	1.99	12.00
4	1.94	10.70
5	1.91	9.55
6	1.86	8.60
7	1.82	7.65
8	1.80	7.55
9	1.79	7.45
10	1.84	8.50
11	1.79	7.45
12	1.76	6.75
13	1.75	6.50
14	1.74	6.40
15	1.74	6.40
16	1.73	6.20
17	1.72	6.10
18	1.71	5.90
19	2.03	12.10
20	1.91	9.55
21	1.77	7.00
22	1.81	7.60
23	2.28	16.30
24	1.93	10.10
25	4.18	*721.50
26	4.00	*668.43
27	4.05	*682.94
28	****	
29	****	
30	****	
31	****	
Min	1.71	
Mean	2.11	
Max	4.18	

Notes: Min. and Max. are instantaneous value.

**** Stick gauge damaged by flood

* Discharge values from computed rating curve

DRAINAGE AND IRRIGATION DEPARTMENT

RIVER DISCHARGE MEASUREMENT NOTES

SG. MUKOH SMALL HYDRO-POWER PROJECT
 Power House NO. RIVER Sg. Tekalit.

Date 1.7.87 Field Party Ismail

Weather Sunny Wind Direction and Force

Flow Condition Steady Flow Turbid/Clear. Water Temperature °C

Observation Time	Gauge Reading in metre	
	Recorder	S. Gauge
Start 10.30	1.98	
Finish 11.14	1.98	
Average		

Change in Gauge Height m. Rate of Rise/Fall m/hr.

Used Current Meter Seba F512 No. V =

Measured from Cableway, Boat, Bridge, Wading. Weight Kg/lb.

Measured m. Down/Up stream at

DISCHARGE 11.528 cumecs AREA 21.56 Sq. metres

MEAN VELOCITY 0.535 m/sec WIDTH 17.5 metres

Remarks: Gauge height of zero flow m

Calculated by Checked by Date

Area Coefficient	Diameter from which velocity point	V/mph	Depth	Number of readings	Time in seconds	VELOCITY		Adjusted for barograph or other	AREA	DISCHARGE
						At point	Mean in vertical			
L/B	0	1	0.10		60					.85
	2	2	1.09	0.65	91	60	0.492	0.497	2.18	1.083
	4	2	1.06	0.64	121	60	0.648	0.638	2.12	1.353
	6	2	1.52	0.91	106	60	0.570	0.578	3.04	1.757
	8	2	1.67	1.00	114	60	0.612	0.602	3.34	2.011
	10	2	1.56	0.94	70	60	0.383	0.368	3.12	1.148
	12	2	1.28	0.77	108	60	0.380	0.367	2.56	1.452
	14	2	1.42	0.85	98	60	0.528	0.518	2.84	1.471
⊙	16	1.75	1.35	0.81	97	60	0.523	0.531	2.36	1.254
	17.50	0.75	0.80		100	60	0.539			
		17.5							21.56	11.528
										.97
										.96
										.94
										.92
										.90
										.85

DRAINAGE AND IRRIGATION DEPARTMENT

RIVER DISCHARGE MEASUREMENT NOTES

SG. MUKOH SMALL HYDRO-POWER PROJECT

STATION Power House NO. RIVER Sg. Tekalit.

Date 2.7.87 Field Party Ismail

Weather Cloudy Wind Direction and Force

Flow Condition Steady Flow Turbid/Clear, Water Temperature °C

Observation Time	Gauge Reading in metre		Correction
	Recorder	S. Gauge	
Start 8.28		2.14	
Finish 9.05		2.12	
Average			

Change in Gauge Height m, Rate of Rise/Fall m/hr.

Used Current Meter Seba F512 No. V =

Measured from Cableway, Boat, Bridge, Wading. Weight Kg/lb.

Measured m, Down/Up stream at

DISCHARGE 16.278 cumecs AREA 23.49 Sq. metres

MEAN VELOCITY 0.693 m/sec WIDTH 17.2 metres

Remarks: Gauge height of zero flow m

Calculated by Checked by Date

Area Contained	Distance from cross section point	Width	Depth	Cross-section area	Time in seconds	VELOCITY		Advance for last 100 ft	AREA	DISCHARGE
						A ₁	V ₁			
L/B	0	1	0.10							.85
	2	2	1.31	0.79	127	60	0.680	0.691	2.62	1.810
	4	2	1.17	0.70	157	60	0.841	0.860	2.34	2.012
	6	2	1.70	1.02	133	60	0.712	0.728	3.40	2.475
	8	2	1.84	1.10	138	60	0.739	0.742	3.68	2.731
	10	2	1.74	1.04	121	60	0.648	0.633	3.48	2.203
	12	2	1.24	0.74	129	60	0.691	0.699	2.48	1.734
	14	2	1.60	0.96	108	60	0.580	0.580	3.20	1.856
①	16	1.60	1.43	0.86	119	60	0.638	0.638	2.29	1.460
	17.20	0.6	1.0		119	60	0.638			
		17.2							23.49	16.278
										.98
										.97
										.96
										.94
										.92
										.90
										.85

DRAINAGE AND IRRIGATION DEPARTMENT

RIVER DISCHARGE MEASUREMENT NOTES

SG. MUKOH SMALL HYDRO-POWER PROJECT

STATION Power House NO. RIVER Sg. Tekalit.

Date 17/7/87 Field Party Ismail, Chai & 3 workers

Weather Sunny Wind Direction and Force

Flow Condition Turbid/Clear. Water Temperature °C

Observation Time	Gauge Reading in metre	
	Recorder	S. Gauge
Start 11.00		1.72
Finish 11.35		1.72
Average		

Change in Gauge Height m, Rate of Rise/Fall m/hr.

Used Current Meter No. V=

Measured from Cableway, Boat, Bridge, Wading. Weight Kg/lb.

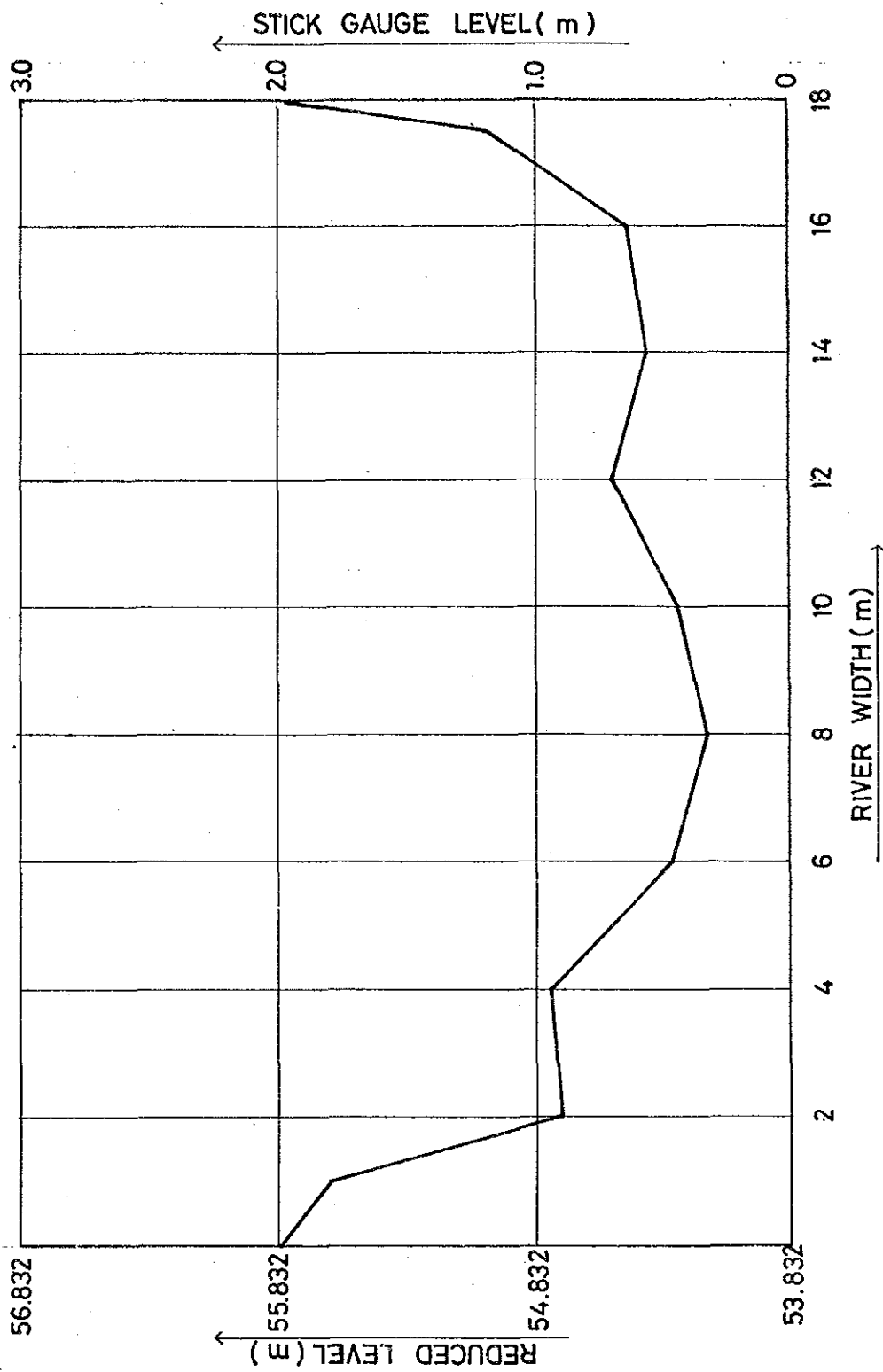
Measured m, Down/Up stream at

DISCHARGE	5.845	cumees	AREA	19.76	Sq. metres
MEAN VELOCITY	0.296	m/sec	WIDTH	17.5	metres

Remarks: Gauge height of zero flow m

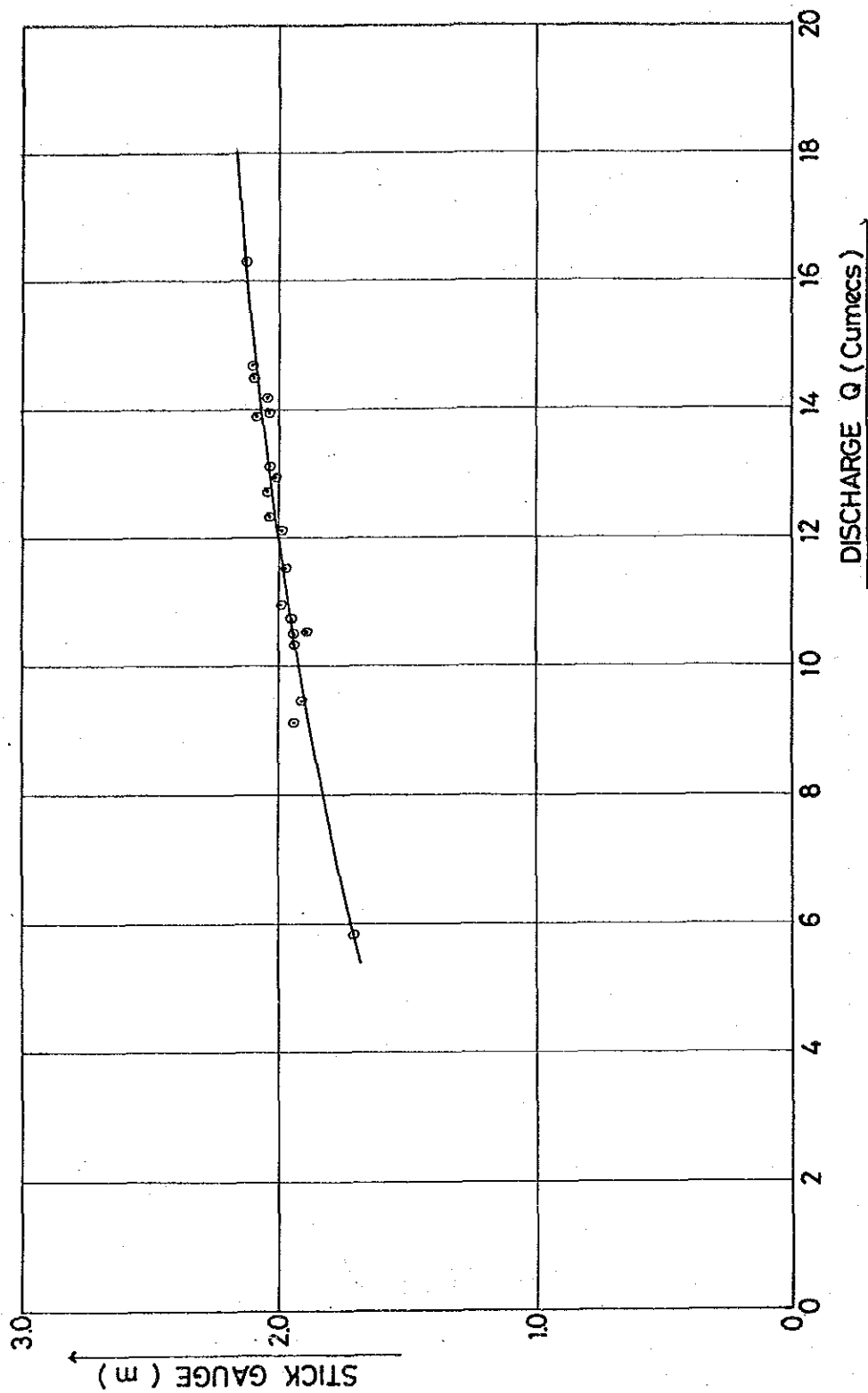
Calculated by Checked by Date

Area Contained	Distance from upstream point	Width	Depth	Time in seconds	Time in minutes	VELOCITY At point	Area	SP. CHARGE
L/B	0							
	2	2	0.8	48	60	0.269	1.60	0.430
	4	2	0.87	61	60	0.336	1.74	0.595
	6	2	1.35	63	60	0.347	2.70	1.307
	8	2	1.43	59	60	0.326	2.86	0.947
	10	2	1.32	46	60	0.268	2.64	0.710
	12	2	1.07	48	60	0.269	2.14	0.721
	14	2	1.18	35	60	0.201	2.36	0.481
	16	2	1.16	53	60	0.295	2.32	0.654
	17.5	1.5	0.7	48	60	0.269	1.40	
		17.5					19.76	5.845



Ref.6 River Cross Section at
Waterlevel Gauging Station

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



Ref.7 Assumed Rating Curve at
Waterlevel Gauging Station

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

Ref.8 Daily Rainfall Record at Mukoh Site

Station: Sg. Mukoh

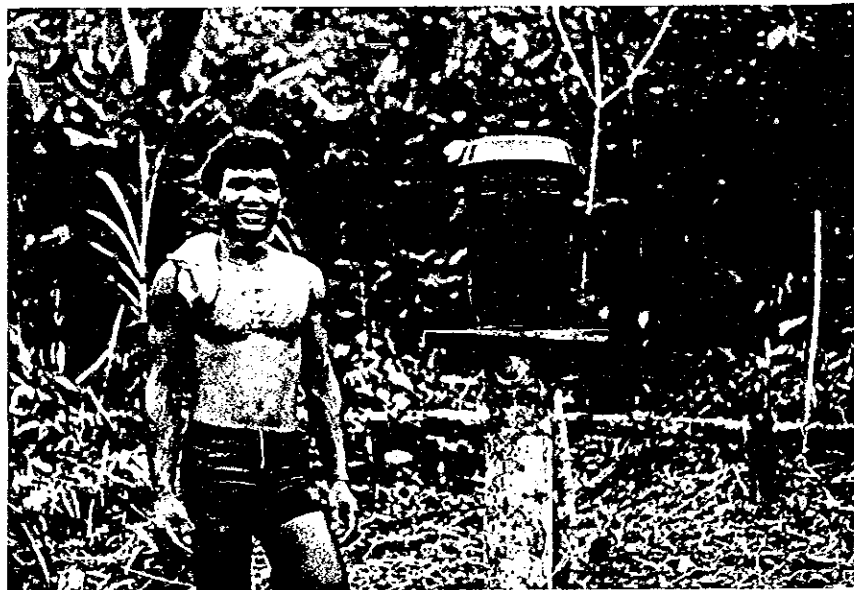
Year : 1987 Month : June to August

(Unit : mm)

Day	June	July	August
1		53	52
2		54	40
3		0	30
4		0	53
5		0	0
6		0	0
7		1	1
8		0	10
9		0	10
10		0	15
11		0	12
12		0	0
13		0	0
14		0	0
15		0	0
16		0	0
17		0	25
18		10	0
19		0	0
20		0	0
21		55	0
22		50	52
23		0	10
24	2	83	0
25	3	50	0
26	37	40	0
27	32	23	0
28	0	0	0
29	0	0	0
30	23	0	0
31		1	



COLLECTION OF WATER SAMPLE FOR ANALYSIS



RAIN GAUGE BEHIND THE FARM HUT NEAR TO
THE STAFF GAUGE SITE



SETTING UP OF STAFF GAUGE



RIVER DISCHARGE MEASUREMENT AT STAFF GAUGE

8.2 Medamit-2 site

(1) General condition

Drainage & Irrigation Department, Limbang assists to undertake the installation and maintenance of the hydrological station at the site.

(2) Staff gauge

A total of 5 m of staff gauges are proposed at Lubok Lalang about 29 km along river course downstream and 8.5 km downstream in the air distance of the intake site. The site was chosen in view of the following reasons:-

- a) There is no inhabitation in the vicinity of the intake area and the nearest logging camp is situated at Lubok Lalang where educated observers can be easily employed
- b) The site is easily accessible by observer residing at logging camp
- c) Discharge measurement is possible at staff gauge site
- d) A safe and secure location with vertical face of rock outcrop for anchoring of staff gauges is also possible.

As the station is located further downstream from the dam site an additional 34 km² of the catchment area is incurred as to the catchment area of the proposed hydro scheme.

(3) Discharge measurement

A total of eight (8) discharge measurements were carried out at the staff gauge site from 29 June 1987 to 15 September 1987 and the maximum and minimum values measured were 15.76 m³/sec and 5.58 m³/sec respectively. The typical data sheet is given in Ref.1.

Water level was not indicated in the attached discharge measurement data sheet since staff gauges are yet to be installed.

River cross section at Waterlevel gauging station is shown on Ref.2.

(4) Rain gauge

A manual rain gauge with wind shield will be installed to replace the existing logging camp's rain gauge at Lubok Lalang. Three years of daily readings from 1983 to 1986 and seven years of monthly readings from 1979 to 1986 were available from the past record.

DRAINAGE AND IRRIGATION DEPARTMENT

RIVER DISCHARGE MEASUREMENT NOTES

STATION LUPOK LALANG NO. RIVER SG. MESAMIT

Date 29/06/87 Field Party ANC. BAKIR

Weather Wind Direction and Force

Flow Condition Turbid/Clear, Water Temperature °C

Observation Time	Gauge Reading in metre		Correction
	Recorder	S. Gauge	
Start 1200			
Finish 1220			
Average 1210			

Change in Gauge Height m, Rate of Rise/Fall m/hr.

Used Current Meter A.OTT KEMPTEN No. C31-00 V = Ref. *

Measured from Cableway/(Boat) Bridge, Wading. Weight 20 Kg./lb

Measured m. Down/Up stream at

DISCHARGE	8.12	cumecs	AREA	53.40	Sq. metres
MEAN VELOCITY	0.15	m/sec	WIDTH	36.00	metres

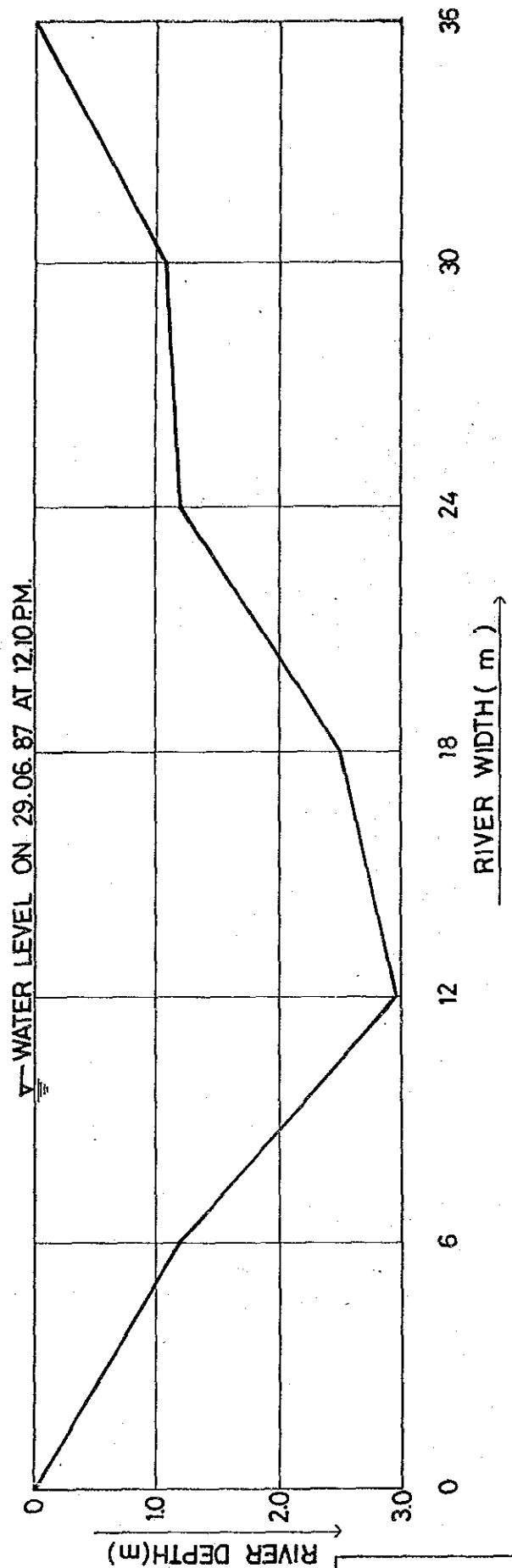
Remarks: Gauge height of zero flow m

* $V = \frac{0.441}{T} + 0.023$ (0.040 to 0.155 m/s)

(ii) $\frac{0.514}{T} + 0.001$ (0.155 to 5.00 m/s)

Calculated by Checked by Darr

Area Coefficient	Distance from initial point (m)	Width (m)	Depth (m)	Slope (1:100)	Slope (1:100)	Area (sq. m)	Area (sq. m)	Area (sq. m)	VELOCITY		Adjusted for bar, slope or velocity	DISCHARGE CUMecs
									At point	Mean		
LB	0	6	0	0	0	0	0	0	0	0	0	0
	6	6	1.18	0.24	1	50	0.03	0.05	0.03	0.05	7.08	0.35
	12	6	2.95	0.59	11	50	0.12	0.11	0.12	0.11	17.70	1.95
	18	6	2.50	0.50	25	50	0.26	0.24	0.26	0.24	15.00	3.60
	24	6	1.20	0.24	21	50	0.22	0.21	0.22	0.21	7.20	1.51
	30	6	1.07	0.21	6	50	0.08	0.11	0.08	0.11	6.42	0.71
	36	0	0	0	0	50	0	0	0	0	0	0
0												100
											53.40	8.12



▽ WATER LEVEL ON 29.06.87 AT 12.10 PM.

Ref.2 River Cross Section at
Waterlevel Gauging Station

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

