Summary of Project Cost Estimate

	River / SHP name	Maiwa Khola	Leguwa Khola	Sabha Khola	Molung Khola	Ghami Khola	Mujkot Khola	Galwa Gad	Gandi Gad	Jamadi Gad	Nilgarh Gad
General information	Location	Taplejung	Dhankuta	Sankhuwa	Okhaldhunga	Mustang	Jajarkot	Humla	Doti	Baitadi	Baitadi
	Drainage area (km2)	166.66	23.53	110.00	166.00	233.00	257.00	101.40	137.09	209.34	37.27
	Design discharge (m3/s)	0.95	0.09	1.39	1.10	1.05	2.62	0.16	1.22	2.18	0.08
	Design capacity (kW)	1,920	560	1,260	640	1,080	950	100	1,280	1,300	240
	Total generation cost (US$)	2,620,729	1,082,514	2,508,515	1,758,046	2,204,496	2,533,629	842,313	2,905,368	3,476,156	1,373,021
	Specific generation cost (US$/kW)	1,365	1,933	1,991	2,747	2,041	2,667	8,423	2,270	2,674	5,721
	Total project cost (US$)	3,818,729	1,165,014	2,742,515	2,579,046	2,540,496	3,352,629	995,313	3,141,368	3,677,156	1,466,021
	Specific project cost (US$/kW)	1,989	2,080	2,177	4,030	2,352	3,529	9,953	2,454	2,829	6,108
Breakdown of cost (US$)	A. Total cost for access road	6,000	8,000	4,000	4,000	5,000	4,000	5,000	4,000	4,000	4,000
	B. Weir and intake	100,428	66,595	135,465	113,830	101,549	99,139	40,781	611,631	151,831	96,597
	C. Gravel spilling system	7,669	3,064	7,200	8,591	19,685	20,043	3,062	18,506	30,176	2,692
	D. Sand trap	21,504	8,168	33,867	23,802	61,506	61,901	7,373	57,966	49,998	4,757
	E. Total cost of headrace canal	411,028	86,280	579,878	386,364	544,934	757,613	198,695	533,189	1,310,059	527,867
	F. Surge chamber	14,477	7,126	23,383	22,828	39,682	39,366	6,043	34,135	34,671	3,857
	G. Penstock	171,029	103,262	79,101	68,837	177,016	39,232	19,271	53,732	85,141	54,953
	H. Spillway	34,976	12,763	26,511	1,602	14,191	16,474	13,190	1,979	39,598	3,648
	I. Powerhouse	110,240	43,464	117,455	81,624	85,038	104,138	24,057	98,737	110,543	30,856
	K. Tailrace	6,425	8,000	15,624	4,761	20,815	7,168	5,306	26,281	8,857	3,929
	Direct cost fo civil works	883,776	346,722	1,022,484	716,239	1,069,416	1,149,074	322,778	1,440,156	1,824,874	733,156
	Indirect costs of civil works @ 10%	88,378	34,672	102,248	71,624	106,942	114,907	32,278	144,016	182,487	73,316
	Total cost of civil works	972,154	381,394	1,124,732	787,863	1,176,358	1,263,981	355,056	1,584,172	2,007,361	806,472
	M. Total cost of E&M equipment	1,368,498	466,792	1,091,508	733,509	752,104	982,355	331,122	1,005,222	1,121,728	359,074
Summary of cost (US$)	Total cost of scheme	2,340,652	848,186	2,216,240	1,521,372	1,928,462	2,246,336	686,178	2,589,394	3,129,089	1,165,546
	Total cost of studies	241,618	171,746	247,804	203,802	236,279	253,387	132,424	276,372	307,335	183,683
	Total cost of initial works	23,459	22,582	19,471	14,872	18,255	18,906	8,711	19,602	19,732	10,792
	Total cost of other structures	15,000	40,000	25,000	18,000	21,500	15,000	15,000	20,000	20,000	13,000
	Total cost of power plant	2,620,729	1,082,514	2,508,515	1,758,046	2,204,496	2,533,629	842,313	2,905,368	3,476,156	1,373,021
	Transmission and distribution cost	1,198,000	82,500	234,000	821,000	336,000	819,000	153,000	236,000	201,000	93,000
	Total project cost	3,818,729	1,165,014	2,742,515	2,579,046	2,540,496	3,352,629	995,313	3,141,368	3,677,156	1,466,021

SHPP - IDENTIFICATION SHEET

REGION : CENTRAL | ANNEX : 5.4 / 1

0 GENERAL SCHEME CHARACTERISTICS

(THIS CHAPTER HAS TO BE FILLED OUT COMPLETELY)

SCHEME Nr : 1

ALTERNATIVE : 1

RIVER : KHANI KHOLA

LOCATION, NAME OF SCHEME : PYUTHAR VDC, LALITPUR

TYPE OF SCHEME : T : 1 (T = 1 RUN OF RIVER, T = 2 PEAK (DAILY STORAGE))

DRAINAGE AREA : A : 102 km²

DISCHARGE FOR HEADRACE : Q1 : 0.98 m³/s — GROSS HEAD : H : 135 m

DESIGN DISCHARGE : Q2 : 0.98 m³/s — DESIGN CAPACITY : P : 1030 kW (Per Hon.

GENERAL INTRODUCTION	CODE No	DEGREE OF DIFFICULTY DD	GEOLOGICAL CONDITIONS GC	NATURAL SLOPE NS	VEGETATION FACTOR VF
SNx SNx HAS TO BE FILLED OUT	1	VERY EASY (0,8)	COMPACT ROCK	10 - 15 deg	DENSE FOREST
SNx = 0 STRUCTURE IS NOT NEEDED	2	EASY (0,9)	LOOSE ROCK	15 - 30 deg	DENSE BUSHES
SNx = 1 ONE STRUCTURE ONLY	3	MEDIUM (1,0)	LOOSE CONGLOMERATE	30 - 40 deg	DISPERSED VEGETATIO
SNx = 2 MORE THAN ONE STRUCTURE IS NEEDED (FOR EACH STRUCTURE 1 SHEET HAS TO BE FILLED OUT)	4	DIFFICULT (1,1)	HARD SOIL	40 - 50 deg	FIELDS
	5	VERY DIFFICULT (1,2)	LOOSE SOIL	50 - 70 deg	COMPLETE FREE TERR

FIELDS FOR POSSIBLE DATA INPUT

1 ACCESS A

(NEW STRUCTURES)

		1 ACCESS TO POWER HOUSE	2 ACCESS TO WEIR, INTAKE	3 ACCESS TO SURGE CHAMBER	4 ACCESS TO OTHER LOCATIONS
1.1 TRUCKABLE ROADS A1 SNA1 = 0		REMARKS :			
LENGTH OF ROADS	LA1	m	m	m	m
TOTAL LENGTH OF BRIDGES	LA11	m	m	m	m
TOTAL LENGTH OF TUNNELS	LA12	m	m	m	m
DEGREE OF DIFFICULTY	DDA1	PERCENTAGE 1PDA1	PERCENTAGE 2PDA1	PERCENTAGE 3PDA1	PERCENTAGE 4PDA1
VERY EASY	(1)	%	%	%	%
EASY	(2)	%	%	%	%
MEDIUM	(3)	%	%	%	%
DIFFICULT	(4)	%	%	%	%
VERY DIFFICULT	(5)	%	%	%	%
TOTAL		100 %	100 %	100 %	100 %
OTHER STRUCTURES	COA1	US $	US $	US $	US $
1.2 JEEPABLE ROADS A2 SNA2 = 0		REMARKS :			
LENGTH OF ROADS	LA2	m	m	m	m
TOTAL LENGTH OF BRIDGES	LA21	m	m	m	m
TOTAL LENGTH OF TUNNELS	LA22	m	m	m	m
DEGREE OF DIFFICULTY	DDA2	PERCENTAGE 1PDA2	PERCENTAGE 2PDA2	PERCENTAGE 3PDA2	PERCENTAGE 4PDA2
VERY EASY	(1)	%	%	%	%
EASY	(2)	%	%	%	%
MEDIUM	(3)	%	%	%	%
DIFFICULT	(4)	%	%	%	%
VERY DIFFICULT	(5)	%	%	%	%
TOTAL		100 %	100 %	100 %	100 %
OTHER STRUCTURES	COA2	US $	US $	US $	US $
1.3 CABLE CAR A3 SNA3 = 0		REMARKS :			
LENGTH OF CABLE CAR	LA3	m	m	m	m
DEGREE OF DIFFICULTY	DDA3	(CODE No)	(CODE No)	(CODE No)	(CODE No)
OTHER STRUCTURES	COA3	US $	US $	US $	US $
1.4 OTHER ACCESS A4 SNA4 = 1				COA4 :	5,000 US $

SHPP - IDENTIFICATION SHEET

REGION : CENTRAL | ANNEX : 5.4 / -2

(2) WEIR, INTAKE B

SNB = 1

REMARKS :

TYPE OF WEIR	TB	1	(CODE No)
DEGREE OF DIFFICULTY	DDB	3	(CODE No)
GEOLOGICAL CONDITIONS	GCB	3	(CODE No)
LENGTH OF CREST	LCB	25	m
LENGTH OF FOUNDATION	LFB	30	m
HEIGHT OF WEIR	HB	1.5	m
DEPTH OF FOUNDATION	DB	1.5	m

TIROLER WEIR B1 — CODE No TB : 1
WEIR WITH LATERAL INTAKE B2 — CODE No TB : 2
CONCRETE GRAVITY DAM B3 — CODE No TB : 3
ROCKFILL DAM B4 — CODE No TB : 4
OTHER TYPE B5 — CODE No TB : 5

LENGTH OF ROCKFILL SECTION	LCB41	m
LENGTH OF OVERFLOW SECTION	LCB42	m
FOUNDATION LENGTH OF ROCKFILL SECTION	LFB41	m
FOUNDATION LENGTH OF OVERFLOW SECTION	LFB42	m

INPUT FOR TYPE B4 - ROCKFILL DAM (CODE No 4) ONLY (INSTEAD OF LCB AND LFB)

NUMBER OF GATES 1 NB	1 ≤ 3	GATE No 1	GATE No 2	GATE No 3
WIDTH OF GATES WB		2 m	m	m
HEIGHT OF GATES GB		2 m	m	m

OTHER STRUCTURES OR TYPE B5 — COB5 — US $

TYPE :

(3) GRAVEL SPILLING SYSTEM C

SNC = 1

REMARKS :

DEGREE OF DIFFICULTY	DDC	3	(CODE No)
GEOLOGICAL CONDITIONS	GCC	3	(CODE No)

OTHER STRUCTURES OR TYPE C1 — COC1 — US $ — TYPE :

(4) SAND TRAP D

SND = 1

REMARKS :

NUMBER OF CHAMBERS	ND	1	
DEGREE OF DIFFICULTY	DDD	3	(CODE No)
GEOLOGICAL CONDITIONS	GCD	3	(CODE No)

OTHER STRUCTURES OR TYPE D1 — COD1 — US $ — TYPE :

(5) HEADRACE E

SNE = 1

REMARKS :

TYPE OF HEADRACE		LENGTH LE	DEGREE OF DIFFICULTY DDE		GEOLOGICAL CONDITIONS GCE		NATURAL SLOPE NSE	
			CODE No.	PERC. OF LENGTH PDE	CODE No	PERC. OF LENGTH PGE	CODE No	PERC. OF LENGTH PNE
RECTANGULAR CANAL E1	LE1	3200 m						
CANAL BRIDGES E11	LE11	m						
SYPHONS E12	LE12	m						
TRAPEZOIDAL CANAL E2	LE2	m	1	%	1	10 %	1	50 %
NON-LOW PRESSURE TUNNEL E3	LE3	m	2	20 %	2	30 %	2	50 %
PRESSURE TUNNEL E4	LE4	m	3	50 %	3	50 %	3	%
EMBEDDED SLOPE PIPE E5	LE5	100 m	4	30 %	4	10 %	4	%
SUPPORTED SLOPE PIPE E6	LE6	m	5	%	5	%	5	%
TOTAL LENGTH OF HEADRACE	ΣLE	3300 m	TOTAL	100 %	TOTAL	100 %	TOTAL	100 %

PERCENTAGE OF CANAL COVER	PCE	10 %	INPUT FOR TYPE E1 ONLY
NET CROSS AREA OF TUNNEL E3	AE3	m²	INPUT FOR TYPE E3 ONLY
NET CROSS AREA OF TUNNEL E4	AE4	m²	INPUT FOR TYPE E4 ONLY
GRADIENT OF TUNNEL E4	GRIE4	‰	INPUT FOR TYPE E4 ONLY

OTHER STRUCTURES OR TYPE E7 — COE7 — US $

TYPE :

(6) SURGE CHAMBER F

SNF = 1

REMARKS :

TYPE OF SURGE CHAMBER	TF	1	(CODE No)
DEGREE OF DIFFICULTY	DDF	3	(CODE No)
GEOLOGICAL CONDITIONS	GCF	3	(CODE No)
NATURAL SLOPE	NSF		(CODE No)

SURGE BAY F1 — CODE No TF : 1
SURGE SHAFT F2 — CODE No TF : 2
EMBEDDED SURGE PIPE F3 — CODE No TF : 3
SUPPORTED SURGE PIPE F4 — CODE No TF : 4
OTHER TYPE F5 — CODE No TF : 5

OTHER STRUCTURES OR TYPE F5 — COF5 — US $ — TYPE :

SHPP - IDENTIFICATION SHEET

REGION : ..... | ANNEX : 5.4 / ..... -3

(7) PENSTOCK G

SNG = [1]

REMARKS : .....

TYPE OF PENSTOCK TG		LENGTH LG
EMBEDDED STEEL PIPE G1	LG1	..... m
SUPPORTED STEEL PIPE G2	LG2	220 m
TOTAL LENGTH OF PENSTOCK	ELG	220 m
NUMBER OF EMBEDDED PIPES	NG1	.....
NUMBER OF SUPPORTED PIPES	NG2	1
OTHER STRUCTURES OR TYPE G3	COG3	US $

TYPE : .....

DEGREE OF DIFFICULTY DDG		GEOLOGICAL CONDITIONS GCG		NATURAL SLOPE NSG	
CODE No	PERC. OF LENGTH PDG	CODE No	PERC. OF LENGTH PGG	CODE No	PERC. OF LENGTH PN
1	..... %	1	10 %	1	20 %
2	..... %	2	30 %	2	80 %
3	20 %	3	30 %	3	..... %
4	80 %	4	20 %	4	..... %
5	..... %	5	10 %	5	..... %
TOTAL	100 %	TOTAL	100 %	TOTAL	100 %

(8) SPILLWAY H

SNH = [1]

REMARKS : .....

TYPE OF SPILLWAY	TH	2	(CODE No)
LENGTH OF SPILLWAY	LSH	300	m
DEGREE OF DIFFICULTY	DDH	4	(CODE No)
GEOLOGICAL CONDITIONS	GCH	3	(CODE No)
NATURAL SLOPE	NSH	2	(CODE No)
OTHER STRUCTURES OR TYPE H4	COH4		US $

TYPE :

RECTANGULAR CANAL H1	CODE No TH = 1
TRAPEZOIDAL CANAL H2	CODE No TH = 2
SYNCLINAL CANAL H2	CODE No TH = 3
DELIVERY PIPE FOR TUNNELS H3	CODE No TH = 4
OTHER TYPES H4	CODE No TH = 5

(9) POWER HOUSE I

SNI = [1]

REMARKS : .....

TYPE OF POWER HOUSE	TI	1	(CODE No)
NUMBER OF UNITS	NI	2	
DEGREE OF DIFFICULTY	DDI	2	(CODE No)
OTHER STRUCTURES OR TYPE I3	COI3		US $

EXTERNAL TYPE I1	CODE No TI = 1
SLOPE TYPE I2	CODE No TI = 2
OTHER TYPE I3	CODE No TI = 3

TYPE :

(10) TAILRACE K

SNK = [1]

REMARKS : .....

LENGTH OF TAILRACE	LK	100	m
DEGREE OF DIFFICULTY	DDK	2	(CODE No)
GEOLOGICAL CONDITIONS	GCK	3	(CODE No)
OTHER STRUCTURES OR TYPE K1	COK1		US $

TYPE

(11) DAILY STORAGE BASIN L

SNL = [0] 4-VL = 6028 x Q2)

REMARKS : .....

TYPE OF BASIN	TL		(CODE No)
DEGREE OF DIFFICULTY	DDL		(CODE No)
GEOLOGICAL CONDITIONS	GCL		(CODE No)
OTHER STRUCTURES OR TYPE L3	COL3		US $

TRAPEZOIDAL EARTH BASIN L1	CODE No TL = 1
RECTANGULAR STONE BASIN L2	CODE No TL = 2
OTHER TYPE L3	CODE No TL = 3

TYPE :

(12) ADDITIONAL INPUTS M,N

SN = [1]

DISTANCE TO THE PROJECT AREA FROM (PROVINCE CAPITAL) : .....

VEGETATION FAKTOR	VFN1	4	(CODE No)
DISTANCE FROM HARBOUR	LM4	1290	km

REMARKS CONCERNING EXISTING ACCESS CONDITIONS

ASPHALT MAIN ROAD	..... km
TRUCKABLE SECONDARY ROAD	..... km
JEEPABLE SECONDARY ROAD	..... km
TOTAL	..... km

(13) OTHER STRUCTURES P

SNP = [1]

REMARKS : .....

OTHER STRUCTURE P1	COP1	5,000	US $
OTHER STRUCTURE P2	COP2	5,000	US $
OTHER STRUCTURE P3	COP3		US $

TYPE :	Land
TYPE :	Office
TYPE :	

(14) GENERAL REMARKS

SN = [0]

.....

.....

.....

REGION: central DATE: 21/11/2002

GENERAL CHARACTERISTICS SCHEME No : 1
ALTERNATIVE: 1

RIVER ..... : Khani khola
LOCATION, NAME OF SCHEME : Pyuthar VDC Lalitpur

TYPE OF SCHEME T = 1 ... RUN OF RIVER
DRAINAGE AREA A = 102.00 km2
DISCHARGE FOR HEADRACE Q1= 0.98 m3/s GROSS HEAD H = 135.0 m
DESIGN DISCHARGE Q2= 0.98 m3/s DESIGN CAPACITY = 1030.0 kW

TOTAL COSTS FOR POWER PLANT TCOST : 1590084 US$
SPECIFIC COST <TOTAL COSTS / DESIGN CAPACITY> : 1544 US$/kW

A4	OTHER ACCESS:	5000 US$			0.3%
A	TOTAL COSTS FOR ACCESS A:			5000 US$	0.3%
B	TOTAL COSTS FOR WEIR AND INTAKE B			56209 US$	3.5%
C	TOTAL COSTS FOR GRAVEL SPILLING SYSTEM C:			7855 US$	0.5%
D	TOTAL COSTS OF SANDTRAP D:			22540 US$	1.4%
E1	TOTAL COSTS FOR RECTANGULAR CANAL E1:	359672 US$			22.6%
E5	TOTAL COSTS FOR EMBEDDED SLOPE PIPE E5	30502 US$			1.9%
E	TOTAL COSTS FOR HEADRACE E:			390173 US$	24.5%
F	TOTAL COSTS FOR SURGE CHAMBER F:			16253 US$	1.0%
G	TOTAL COSTS FOR PENSTOCK G:			56362 US$	3.5%
H	TOTAL COSTS FOR SPILLWAY H:			23352 US$	1.5%
I	TOTAL COSTS FOR POWER HOUSE I:			63604 US$	4.0%
K	TOTAL COSTS FOR TAILRACE K:			10515 US$	0.7%
*	TOTAL DIRECT COSTS FOR CIVIL WORKS:		TCCW1	651863 US$	41.0%
*	INDIRECT COST OF CIVIL WORKS: 10.00 % OF		TCCW1	65186 US$	4.1%
*	TOTAL COSTS FOR CIVIL WORKS:		TCCW	717049 US$	45.1%
M	TOTAL COSTS OF ELECTRO-MECHANICAL EQUIPMENT M:			650559 US$	40.9%
*	TOTAL COSTS OF SCHEME:		TCTOT	1367608 US$	86.0%
N	TOTAL COSTS OF STUDIES N:			194573 US$	12.2%
O	TOTAL COSTS FOR INITIAL WORKS O:			17903 US$	1.1%
P	TOTAL COSTS FOR OTHER STRUCTURES P			10000 US$	0.6%
**	TOTAL COSTS FOR POWER PLANT:		TCOST	1590084 US$	100.0%

PROJECT FEATURES

- Maiwa Khola Small Hydropower Project
- Leguwa Khola Small Hydropower Project
- Sabha Khola Small Hydropower Project
- Molung Khola Small Hydropower Project
- Ghami Khola Small Hydropower Project
- Mojkot Khola Small Hydropower Project
- Galwa Gad Small Hydropower Project
- Gandi Gad Small Hydropower Project
- Jamadi Gad Small Hydropower Project
- Nilgarh Gad Small Hydropower Project

Maiwa Khola Small Hydropower Project

MAIWA KHOLA SMALL HYDROPOWER PROJECT (1920 KW)

Location

Maiwa Khola Small Hydropower Project (MKSHP) is located in Dhungesangu VDC of Taplajung district of the Eastern development region of Nepal. The proposed intake of the project lies at approximately 87° 33'46" E and 27° 22'26" N and an elevation of 920 m. Likewise the powerhouse is located at approximately 87° 36'51" and 27°22'17". The elevation of the powerhouse is 660 m.

Access

The nearest motorable road is not available presently under construction and expected to be completed in the near future, will be available at Taplejung Bazar which is about 15 Km from the Project site. The nearest airport consists of a fair weather STOL airfield at suketar in Taplejung District to the east of Taplejung Bazar. Schedule flights, operate by RNAC connected Taplejung airport to Biratnagar.

Geology

Regional Geology

Maiwa Khola Small Hydropower Project site geologically falls at the upper northwestern portion of a large anticlinal dome (Tamor Window) in Ulleri type gneissic rocks (Ul). Regional geological mapping of this area in 1"=1mile scale was carried out by DMG (B. M. Jnawali and R. N. Yadav).

Site Geology

No detailed geological and geotechnical studies were carried out to date along Maiwa Khola. During reconnaissance site visit it was observed that the area consists of loose soil, conglomerate with small rock outcrops at intervals. Boulder and shingle deposits could also be found on both banks of the river. The project structures are located along the right bank of the river because of the presence of vertical cliffs and steep rugged terrain along the left bank.

At the intake site left bank of the river has a hard rock cliff whereas its right bank is comprosed of large and small boulders in a gravelly sandy matrix. Gravel trap and desanding basin sites are made up of mainly conglomerate and hard rock. The headrace canal alignment passes through an average natural slope of 300 over an initial canal length of approximately 1km and the rest passes through 200 slope. The canal passes through cultivated, bushy and thinly forested terrain. Geological formation through which the headrace canal passes through is not mentioned. The surge bay area is located on a 100 to 150 slope cultivated paddy field consisting of hard soil and loose rock. The spillway canal passes through a gully with similar geology as in surge bay. The penstock alignment is composed of loose and hard soil, and loose conglomerate with a natural slope of about 250. The powerhouse area is located on a cultivated field with approximately 50 slope and is mostly made up of loose and hard soil, and loose conglomerate. The tailrace has the same geological composition as that of powerhouse with some large and small boulders along river banks.

The above geological description is based on a reconnaissance site visit. Therefore detailed geological mapping and shallow geotechnical investigation (pit, Auger drilling) with laboratory testing of soil and rock samples is recommended during detailed design stage.

Hydrology

The Maiwa Khola is one of the tributary of Tamor river. It meets Tamor at Dhungesagu. The catchment area of the proposed project site measured calculated from topographical maps 2787-10 and 2787-11 (produced by Department of Survey, HMGN) is 167 sq km. Average slope of the river is 5 %.

Maiwa Khola is an ungauged river, therefore direct measurements are not available for this river. Catchments of similar size and characteristics are not also available to correlate the flow characteristics of this river. Therefore in order to estimate hydrological parameters of this river the following methods are used

HydrA-Nepal

Summary of results obtained from HydrA is as follows:

Mean flow: 8.80 m^3/s

Average annual runoff: 1665 mm

Flow duration curve:

Probability of exceedance %	5	20	40	60	80	90	95
Discharge m^3/s	28.07	13.93	5.75	3.23	2.16	1.73	1.36

HYDEST results

Summary of results is as follows:

Input parameters:

Area of basin below 5000 m elevation: 166.66 km^2

Area of basin below 3000 m elevation: 135.85 km^2

Monsoon wetness index: 1250

Low flows:

For RoR plants 1day low flow event will be the parameter of concern for the planners compared to the higher duration (30 days or monthly) events, so only 1-day low flow events are summarized below:

1 day low flow events

Return period	Low flow discharge m^3/s
2	1.234
10	0.7298
20	0.6056

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	88	141
10	162	296
20	192	365
50	233	463
100	264	542

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.13	2.81	1.63	1.67	2.24	7.32	22.56	27.15	20.73	9.19	3.89	2.56

Flow duration curves:

Probability of exceedance %	0	5	20	40	60	80	95	100
Discharge m^3/s	51.69	30.96	15.39	4.49	2.19	1.59	1.05	0.91

Flow duration curve:

Probability of exceedance %	5	20	40	60	80	90	95
Discharge m^3/s	30.96	15.39	4.49	2.19	1.59	1.23	1.05

MIP method

In order to apply this method to compute mean monthly flows, we need to know at least one actual flow measurement during the low flow period (November to April). Such data are not available in the previous study, so this method cannot be applied during this stage of the study.

MHSP method

Summary of results is as follows:

Input parameters:

Total drainage area: 166.66 km^2

Mean monsoon precipitation: 500 km^2

Monsoon wetness index: 1250

Low flows:

For RoR plants 1day low flow event will be the parameter of concern for the planners compared to the higher duration (30 days or monthly) events, so only 1-day low flow events are summarized below:

Flood flows:

Return period	Flood discharge m^3/s
5	413
20	618
50	478
100	892

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.60	2.13	1.95	2.37	2.70	6.40	16.47	20.36	15.97	7.85	3.85	2.53

Flow duration curve:

Probability of exceedance %	max	25	45	65	85	90	95	min
Discharge m^3/s	175.87	3.04	1.18	0.87	0.55	0.46	0.37	0.29

Previous studies

During the reconnaissance study conducted in September 1993, the following methods were used to compute the hydrological parameters of this project:

Mean monthly flows were computed using linear reservoir model using the precipitation data of Aiselukharka station and runoff coefficient and retention constants of Rawa Khola.

But the results were unrealistic and inconsistent because only rainfall data are not sufficient to apply this method.

A catchment area ratio method was applied to correlate flows with Rawa Khola at Dovan (catchment area 420 km^2), however the size and characteristics of these catchments can not compared.

So, the results of the previous study are not reliable enough to be used for further studies.

Recommended values

HydrA and HYDEST results are recommended to use. Hydra Q90 has been selected as design discharge.

Layout

Maiwa Khola Small Hydro Project is a runoff river project. The available gross head is 260 m and the design discharge is 0.95 m^3/sec (90 % exceedance minus 35% of it as downstream release) giving a total installed capacity of 1920 kW. The headworks consist of 25 m long crest length of the weir including tyrolean intake. The length of the weir along its foundation is estimated to be about 28 m and height and depth of foundation is about 5 m each. The intake level is proposed at elevation of 949 masl.

Headrace canal passes through the right bank of the river and the length of he canal will be about 5350 m.

A forebay of 12.5 m x 4.5 m x 3.5 m has been proposed.

The penstock is about 523 m long and the natural slope of the terrain under the penstock alignment is about 25°.

Powerhouse is planned to be of the external type, total area of the powerhouse is estimated to be about 293 m^2.

4 unit of turbine and generator are used. The length of the tailrace canal will be about 50 m long.

The whole structures of the project would be laid on the right bank of the river.

Energy

Energy production by the Maiwa Khola SHP scheme is calculated using HydrA. The Table given below shows a brief summary of the generated energy.

Summary of generated energy.

S.N.	Turbine Type	No. of Units	Gross average annual Energy (MWh)	Net average annual energy (MWh)
1	Pelton	4	15277	14859

Considering the discharge and energy output 4 Pelton turbine units is suggested to use.

Transmission

Total length of HT line (11 kV): 67 km

Total length of LT line (400 V): 85 km

Environmental aspect

The report is silent in terms of information on physical, biological and socio-economic environmental impacts. Some physical impacts during the construction period are anticipated. However, no significant biological and socio-economic impacts are anticipated. Overall, the environmental impact is rated as satisfactory.

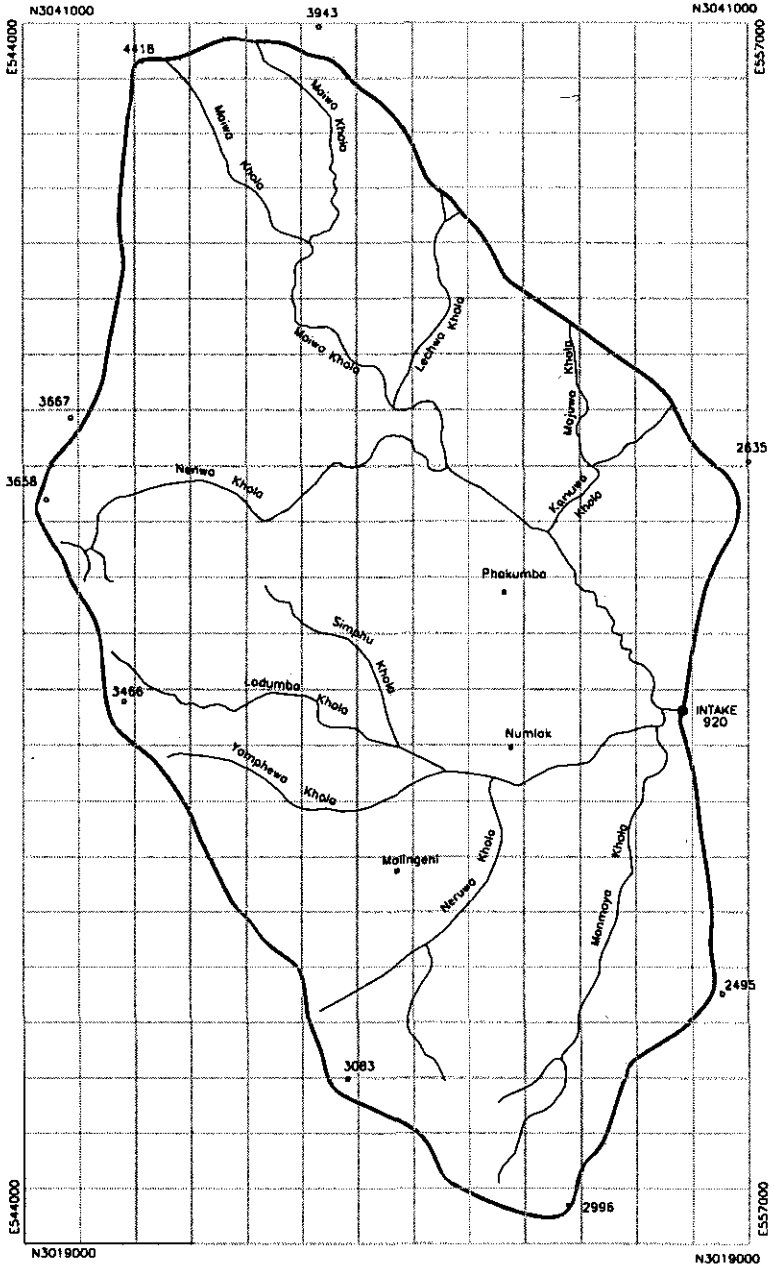
Socio-economic aspect

Economic Analysis

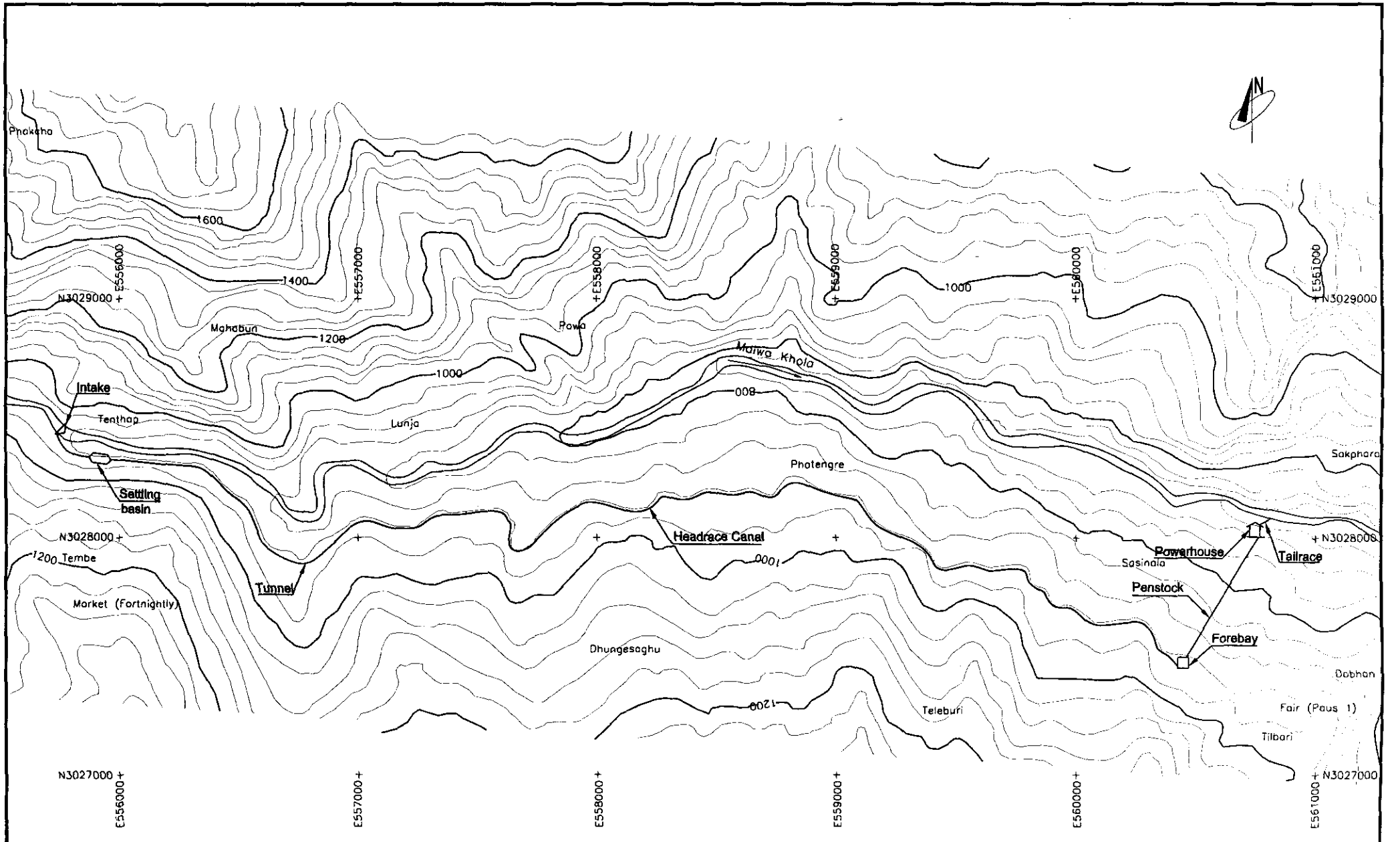
The specific construction cost per kW of Maiwa is US$ 1989 and Operation and maintenance cost is 5 % of the total cost. The EIRR is estimated 6.1%. The benefit cost ratio is 0.75. The generation cost is US$ 0.03 per kWh and the break-even tariff is US$ 0.18 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 1.21. The ratio of willingness to pay of household with respect to electricity bill per month is 0.61 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0.82.



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	MAIWA KHOLA SHP Taplejung, EDR, Nepal CATCHMENT AREA	Scale 0 1000 2000 3000(m) 1:100000	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 483764, Fax 482298 Web site: www.soset.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11726, Kumaripati, Lalitpur Tel: 535505, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. Sheet No.



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	MAIWA KHOLA SHP Taplegunj, EDR, Nepal GENERAL LAYOUT PLAN	Scale 0 150 300 450(m) 1:15000	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482268 Web site: www.sosef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535565, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drown:	Drawing No. Sheet No.

Load Demand Forecast : Maiwa Khola SHP

Parameters	Year 2002	Growth rate 2012	Growth rate 2022	Input Parameters	Year 2002	Growth rate 1st Dec.	Growth rate 2nd Dec.
Population	62239	1.14%	1.14%	Public sector growth		2.00%	2.00%
Person per household	5.14	0.00%	0.00%	Commercial sector growth		2.50%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	45%	-2.02%	-1.74%				
Medium income group (%)	39%	0.77%	0.54%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	16%	2.26%	1.84%	Cons. medium cons. (kWh/a)	360	0.00%	0.00%
				Cons. high consumers (kWh/a)	480	1.00%	1.00%
Household / commercial center	34	-1.92%	-1.95%	Cons. per HH (weighted ave.)	318	0.00%	0.00%
Household / public service	74	-1.91%	-1.97%				
Household / public light	40	-2.84%	-3.97%	Commercial consumption (kWh/a)	750	0.00%	0.00%
				Industrial consumption (MWH/a)	54.6	2.68%	1.34%
El. coeff. low and medium cons.	30%	7.18%	1.55%				
El. coeff. high consumers	60%	1.55%	1.34%	System losses	18%	0.00%	0.00%
El. coeff. commercial centers	30%	2.92%	2.26%	Annual hours of utilization (h)	1314	3.50%	3.50%
El. coeff. public light	30%	2.92%	2.26%				
El. coeff. public services	70%	0.69%	0.65%				

Autonomous Demand : Domestic / Income Level

Year	Populati on	No. of househo	Number of Potential Consumers Low	Medium	High	Total	Unit Consumption (kWh/yr) Low	Medium	High	Domestic Demand (MWh/yr) Low	Medium	High	Total
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
2002	62239	12116	1636	1418	1163	4217	240	360	480	393	510	558	1461
2003	62949	12254	1738	1549	1221	4508	240	360	485	417	558	592	1567
2004	63666	12393	1846	1692	1282	4820	240	360	490	443	609	628	1680
2005	64392	12535	1961	1848	1347	5156	240	360	495	471	665	666	1802
2006	65126	12678	2083	2019	1415	5517	240	360	499	500	727	707	1933
2007	65868	12822	2212	2205	1486	5903	240	360	504	531	794	750	2074
2008	66619	12968	2349	2409	1561	6319	240	360	510	564	867	795	2226
2009	67379	13116	2495	2632	1640	6767	240	360	515	599	948	844	2390
2010	68147	13266	2651	2875	1723	7249	240	360	520	636	1035	896	2567
2011	68924	13417	2815	3140	1810	7765	240	360	525	676	1130	950	2756
2012	69710	13570	2990	3430	1901	8321	240	360	530	718	1235	1008	2960
2013	70504	13724	3018	3542	1984	8544	240	360	536	724	1275	1062	3062
2014	71308	13881	3045	3658	2071	8774	240	360	541	731	1317	1120	3168
2015	72121	14039	3073	3777	2162	9012	240	360	546	738	1360	1181	3278
2016	72943	14199	3102	3900	2257	9259	240	360	552	744	1404	1245	3394
2017	73775	14361	3130	4027	2356	9513	240	360	557	751	1450	1313	3514
2018	74616	14525	3159	4159	2459	9777	240	360	563	758	1497	1384	3639
2019	75466	14690	3188	4295	2567	10050	240	360	568	765	1546	1459	3771
2020	76327	14858	3218	4436	2680	10334	240	360	574	772	1597	1539	3908
2021	77197	15027	3247	4581	2797	10625	240	360	580	779	1649	1622	4050
2022	78077	15199	3277	4731	2920	10928	240	360	586	787	1703	1710	4200

Autonomous Demand : Commercial / Public Service / Industry

Year	No. of Comm. Cons.	Comm. Unit Cons. kWh/yr	Comm. Load MWh/yr	Industry Load MWh/yr	No. of Public Service	No. of Public Lights	Public Service Load MWh/a	Annual Hours of Utiliz.	Net Load MWh/a	Losses MWh/a	Gross Load MWh/a	Max. Load kW	Power Factor	Indut. Load kW	Peak Load kW
14	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*
2002	107	750	80	55	115	91	154	1314	1750	315	2065	1572	0.02	42	1530
2003	113	750	85	56	119	97	162	1360	1870	337	2207	1623	0.02	43	1580
2004	120	750	90	58	124	104	171	1408	1999	360	2358	1675	0.02	44	1632
2005	128	750	96	59	128	112	180	1457	2137	385	2522	1731	0.03	45	1686
2006	136	750	102	61	133	120	190	1508	2286	411	2697	1789	0.03	46	1742
2007	144	750	108	62	138	128	200	1561	2444	440	2884	1848	0.03	47	1801
2008	153	750	115	64	144	137	211	1615	2616	471	3087	1911	0.03	49	1862
2009	162	750	122	66	149	147	222	1672	2800	504	3304	1976	0.03	50	1926
2010	172	750	129	67	155	158	234	1730	2998	540	3537	2044	0.04	51	1993
2011	183	750	137	69	161	169	247	1791	3210	578	3787	2115	0.04	53	2062
2012	194	750	145	71	167	181	261	1854	3438	619	4057	2189	0.04	54	2134
2013	204	750	153	72	173	195	276	1918	3563	641	4205	2192	0.04	55	2137
2014	216	750	162	73	180	210	292	1986	3695	665	4360	2196	0.04	56	2140
2015	227	750	171	74	187	226	310	2055	3833	690	4523	2201	0.05	56	2144
2016	240	750	180	75	194	243	328	2127	3977	716	4693	2206	0.05	57	2149
2017	253	750	190	76	201	262	348	2201	4127	743	4870	2212	0.05	58	2155
2018	267	750	200	77	209	282	369	2278	4285	771	5057	2219	0.05	59	2161
2019	282	750	211	78	217	304	391	2358	4451	801	5252	2227	0.05	59	2168
2020	297	750	223	79	226	328	415	2441	4625	832	5457	2236	0.06	60	2176
2021	313	750	235	80	234	353	440	2526	4806	865	5671	2245	0.06	61	2184
2022	330	750	248	81	243	380	467	2615	4996	899	5896	2255	0.06	62	2193

ECONOMIC ANALYSIS: MAIWA KHOLA SHP

year	CC	O&M	Total	Generation	Energy	Benefit	Capacity	Total	Net Cash
	000 US$	000 US$	Cost	Cap (MWh	MWh	000 US$	Benefit	Benefit	Flow
2002	1077.71	0	1077.71	14859	0	0		0	-1077.71
2003	1436.947	0	1436.947	14859	0	0		0	-1436.95
2004	1077.71	0	1077.71	14859	0	0		0	-1077.71
2005		171.8424	171.8424	14859	2136.97	157.6386	207.36	364.9986	193.1562
2006		171.8424	171.8424	14859	2285.525	168.4287	207.36	375.7887	203.9463
2007		171.8424	171.8424	14859	2444.487	179.9588	207.36	387.3188	215.4764
2008		171.8424	171.8424	14859	2615.733	192.3685	207.36	399.7285	227.8861
2009		171.8424	171.8424	14859	2799.882	205.6997	207.36	413.0597	241.2173
2010		171.8424	171.8424	14859	2997.564	219.9953	207.36	427.3553	255.5129
2011		171.8424	171.8424	14859	3209.702	235.3179	207.36	442.6779	270.8355
2012		171.8424	171.8424	14859	3437.747	251.7643	207.36	459.1243	287.2819
2013		171.8424	171.8424	14859	3563.313	261.8118	207.36	469.1718	297.3294
2014		171.8424	171.8424	14859	3695.075	272.3725	207.36	479.7325	307.8901
2015		171.8424	171.8424	14859	3832.675	283.4267	207.36	490.7867	318.9443
2016		171.8424	171.8424	14859	3976.738	295.0183	207.36	502.3783	330.5359
2017		171.8424	171.8424	14859	4127.452	307.1631	207.36	514.5231	342.6807
2018		171.8424	171.8424	14859	4285.373	319.9012	207.36	527.2612	355.4188
2019		171.8424	171.8424	14859	4450.824	333.2739	207.36	540.6339	368.7915
2020		171.8424	171.8424	14859	4624.581	347.336	207.36	554.696	382.8536
2021		171.8424	171.8424	14859	4805.761	362.017	207.36	569.377	397.5346
2022		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2023		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2024		849.2489	849.2489	14859	4996.324	377.4835	207.36	584.8435	-264.405
2025		849.2489	849.2489	14859	4996.324	377.4835	207.36	584.8435	-264.405
2026		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2027		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2028		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2029		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2030		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2031		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2032		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2033		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
2034		171.8424	171.8424	14859	4996.324	377.4835	207.36	584.8435	413.0011
NPV	3274.695	1497.665	4772.359	156411.4	26488.23	1966.371		3581.879	-1190.48

IRR	0.060647	
B/C R	0.750547	
BET	0.180169	US$
	13.87302	NRs.
Generation Cost	0.030512	US$/kWh
	2.349392	NRs./kWh
Rev/OM Cost Ratio	0.917344	

Financial / Economic Cost

	US $ (000)	NRs. (000)
Capital Cost	3818.729	294042
O&M Cost	190.936	14702
RR Cost	1368.498	105374
Exchange Rate	1	77
Foreign	1727.898	133048
Local	2090.831	160994

Financial Costs

1st Year	1145.619	0.3
2nd Year	1527.492	0.4
3rd Year	1145.619	0.3
Total	3818.729	

Economic Costs

	R&RC			
	1354.813	0.99	1710.619	Foreign
		0.9	1881.748	Local
			171.8424	O&M
	Total		3592.367	

Economic Costs

1st Year	1077.71
2nd Year	1436.947
3rd Year	1077.71
Total	3592.367

Leguwa Khola Small Hydropower Project

LEGUWA SMALL HYDROPOWER PROJECT (280 KW)

Location

Leguwa Khola Small Hydropower Project (LKSHP) is located in Dandagaon VDC of Dhankuta district of the Eastern development region of Nepal. The proposed intake of the project lies at approximately 87° 21'25" E and 27°10'23" N and an elevation of 1540 m. two power house sites are proposed for SHP development with cascade system. And the first powerhouse is located at approximately 87° 20'10" and 27°9'56". The elevation of the first powerhouse is 1121 m.

The second powerhouse, it's intake is the tailrace of the first powerhouse and lies at 87° 20'10" and 27° 9'56" and elevation 1121 m and the powerhouse lies at approximately 87° 20'04" and 27° 9'37" and elevation 740 m.

Access

The nearest motorable road is available at Basantapur, in Terhathum Disrick about 15 Km from the Project site. The Project site is accessible by local trails.

Geology

Regional Geology

Leguwa Khola SHP geologically falls within the Higher Himalayan Crystallines of Himal Group made up of gneiss, schist, micaceous quartzite with thin bands of marble. Regional geological mapping of this part in 1"=1mile scale was carried out by DMG (G.S Thapa).

Site Geology

During reconnaissance site visit hard soil, loose conglomerate and breccia with small rock outcrops at intervals were observed. Boulder and shingle deposits are scattered along both banks of the river. The project structures are located along right bank of the river.

The temporary type of intake structure made of boulder for water diversion into the existing irrigation canal is proposed to be modified into a permanent type for power generation. There is no sufficient space readily available for the gravel trap and desilting basin. Minor excavation work is deemed necessary. No geological description for the above structures could be found in the report. The headrace canal alignment has a natural slope of 150 to 400 for over 90% of its total length and the rest has a slope of 400 to 500. The alignment follows the existing earthen irrigation canal with some minor gully crossings and is mainly composed of hard soil, loose conglomerate and breccia with small rock outcrops at intervals. The surge bay is located on a cultivated terraced land with a slope of 150 to 300 and is composed of mainly loose soil. Penstock pipe alignment has a slope of about 500 and is composed of compact rock, loose rock, conglomerate with hard soil with loose soil at intervals. The spillway canal has a mean slope of about 350 and passes through terraced cultivated field with the same geological condition as that of the surge bay site.

The powerhouse is located on a flat cultivated field made up of loose soil and loose conglomerate. The powerhouse is planned for two stages, the second stage powerhouse also is located on a flat cultivated land about 50m above the Leguwa Khola bed and the geology is similar to that of the first stage powerhouse. The tailrace canal passes through cultivated field for about 20m and reaches to a steep rocky slope from where the tail water can be directly discharged into the Leguwa Khola.

The above geological description is based on a reconnaissance site visit. Therefore detail geological mapping and shallow geotechnical investigation (pitting, auger boring) with laboratory testing of soil and rock samples is recommended during detailed design stage.

Hydrology

The Leguwa Khola is one of the tributaries of Arun River. It meets Arun at beltar. The catchment area of the proposed project site measured calculated from topographical maps 2787-14 A and 2787-14 B (produced by Department of Survey, HMGN) is 23.53 sq km. Average slope of the river is 32 %.

Leguwa Khola is an ungauged river, therefore direct measurements are not available for this river. Catchments of similar size and characteristics are not available to correlate the flow characteristics of this river. Therefore in order to estimate hydrological parameters of this river the following methods are used

HydrA-Nepal

Summary of results obtained from HydrA is as follows:

Mean flow: 0.50 m^3/s

Average annual runoff: 700 mm

Flow duration curve:

Probability of exceedance %	5	20	40	60	80	90	95
Discharge m^3/s	1.59	0.79	0.33	0.19	0.13	0.10	0.080

HYDEST results

Summary of results is as follows:

Input parameters:

Area of basin below 5000 m elevation: 23.53 km^2

Area of basin below 3000 m elevation: 23.53 km^2

Monsoon wetness index: 1000

Low flows:

For RoR plants 1day low flow event will be the parameter of concern for the planners compared to the higher duration (30 days or monthly) events, so only 1-day low flow events are summarized below:

1 day low flow events

Return period	Low flow discharge m^3/s
2	0.1642
10	0.0407
20	0.0187

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	17	31
10	35	75
20	43	96
50	53	127
100	62	153

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.33	0.28	0.24	0.22	0.28	0.98	3.07	3.77	2.90	1.30	0.54	0.36

Flow duration curves:

Probability of exceedance %	0	5	20	40	60	80	95	100
Discharge m^3/s	7.81	4.42	2.04	0.58	0.29	0.22	0.13	0.09

Flow duration curve:

Probability of exceedance %	5	20	40	60	80	90	95
Discharge m^3/s	4.42	2.04	0.58	0.29	0.22	0.16	0.13

MIP method

In order to apply this method to compute mean monthly flows, we need to know at least one actual flow measurement during the low flow period (November to April). Such data are not available in the previous study, so this method cannot be applied during this stage of the study.

MHSP method

Summary of results is as follows:

Input parameters:

Total drainage area: 23.53 km^2

Mean monsoon precipitation: 1500 km^2

Monsoon wetness index: 1000

Low flows:

For RoR plants 1day low flow event will be the parameter of concern for the planners compared to the higher duration (30 days or monthly) events, so only 1-day low flow events are summarized below:

Flood flows:

Return period	Flood discharge m^3/s
5	89
20	141
50	181
100	215

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.48	0.38	0.34	0.36	0.41	1.31	4.00	4.91	3.93	1.93	0.92	0.59

Flow duration curve:

Probability of exceedance %	max	25	45	65	85	90	95	min
Discharge m^3/s	31.85	1.83	0.66	0.43	0.27	0.225	0.18	0.03

Previous studies

During the reconnaissance study conducted in December 1994, the following methods were used to compute the hydrological parameters of this project:

Mean monthly flows were estimated with the help of precipitation data of Dhankuta station has been taken as representative for Leguwa Khola basin.

For the estimation of mean monthly discharge of Leguwa khola, Hydest was used. The discharge at 95 percent probability of excedence was taken as design discharge which was 0.13 cubic meter per second where as the Leguwa Khola SHP was going to utilize the existing irrigation intake and canal with some modification, and its capacity to discharge was only 0.1 cubic meter per second.

The catchment area of Leguwa is small, so the use of hydest result is not reliable enough for further studys.

Recommended values

HydrA results are recommended to use. Hydra Q90 has been selected as design discharge.

Layout

Leguwa Khola Small Hydro Project is a runoff river project. The available gross head is 400 m and the design discharge is 0.09 m^3/sec, giving a total installed capacity of 280 kW. The headworks consist of 17-m weir including Tyrolean intake. The length of the weir along its foundation is estimated to be about 18 m and height of weir and depth of foundation is 2 m. The intake level is proposed at elevation of 1524 masl.

Headrace canal passes through the Right Bank of the river and the length of he canal will be about 1800 m.

A forebay of 2.63 m x .98 m x 2.39 m has been proposed.

The penstock is about 700 m long and the natural slope of the terrain under the penstock alignment is about 50°.

Powerhouse is planned to be of the external type, total area of the powerhouse is estimated to be about 54 m^2.

1 unit of turbine and generator are used. The length of the tailrace canal will be about 20 m long.

For powerhouse-II, no need of Headwork's structure like Powerhouse-I, but simply forbay and spilling is proposed. Rests of all things are similar.

The whole structures of the project would be laid on the right bank of the river.

Energy

Energy production by the Leguwa Khola SHP scheme is calculated using HydrA. The Table given below shows a brief summary of the generated energy.

Leguwa powerhouse-I

Summary of generated energy

S.N.	Turbine Type	No. of Units	Gross average annual Energy (MWh)	Net average annual energy (MWh)
1	Pelton	1	2279	2217

Leguwa powerhouse-II

Summary of generated energy

S.N.	Turbine Type	No. of Units	Gross average annual Energy (MWh)	Net average annual energy (MWh)
1	Pelton	1	2279	2217

Considering the discharge and energy output 1 Pelton turbine unit is suggested to use.

Transmission

Total length of HT line (11 kV): 4.5 km

Total length of LT line (400 V): 6 km

Total length of HT line (33 kv): 28 km

Environmental aspect

The project report is silent on physical and biological impacts. There are indications on water rights issue with an existing and another planned irrigation projects. No significant impacts on physical environment are anticipated during the construction stage because very small discharge is diverted for power generation. A thorough IEE must be carried to assess the environmental condition along with technical and economic studies.

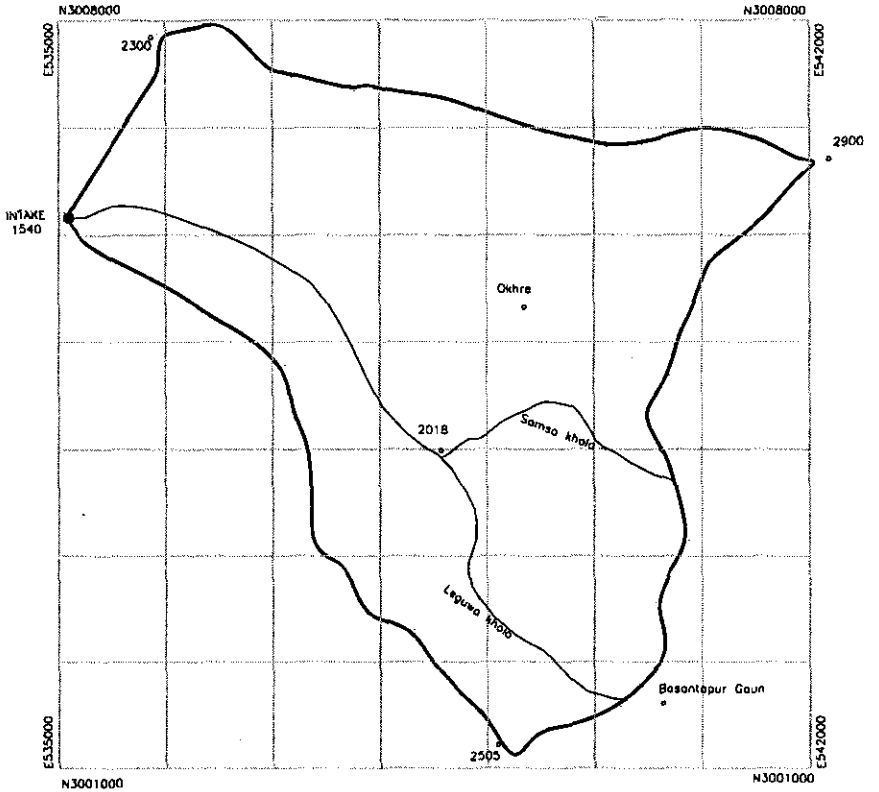
Socio-economic aspect

Economic Analysis

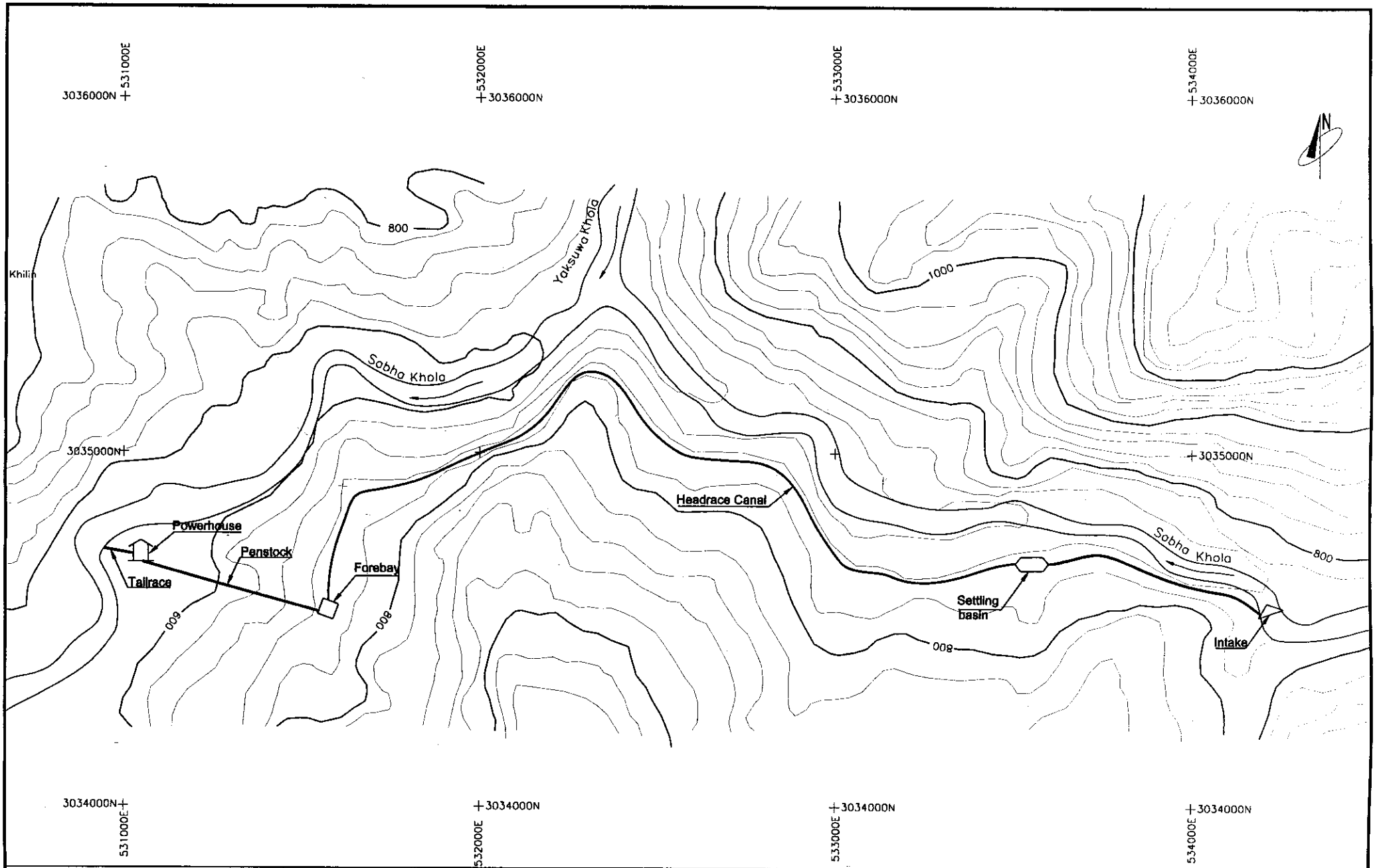
The specific construction cost per kW of Leguwa is US$ 2080 and Operation and maintenance cost is 5 % of the total cost. The EIRR is estimated 3.4%. The benefit cost ratio is 0.62. The generation cost is US$ 0.06 per kWh and the break-even tariff is US$ 0.24 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 1.11. The ratio of willingness to pay of household with respect to electricity bill per month is 0.61 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0..58.



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	LEGUWA KHOLA SHP Dhankuta, EDR, Nepal CATCHMENT AREA	Scale 0 500 1000 1500(m) 1:50,000	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 483784, Fax 482298 Web site: www.acaf.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. Sheet No.



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	SABHA KHOLA SHP Sankhuwasabha, EDR, Nepal GENERAL LAYOUT PLAN	Scale 0 100 200 300(m) 1:10000	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493784, Fax 482268 Web site: www.scaaf.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11726, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. Sheet No.

Load Demand Forecast : Leguwa Khola SHP

Parameters	Year 2002	Growth rate 2012	Growth rate 2022	Input Parameters	Year 2002	Growth rate 1st Dec.	Growth rate 2nd Dec.
Population	13569	1.45%	1.45%	Public sector growth		2.00%	2.00%
Person per household	5.29	0.00%	0.00%	Commercial sector growth		2.50%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	38%	-2.02%	-1.74%				
Medium income group (%)	48%	0.77%	0.54%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	14%	2.26%	1.84%	Cons. medium cons. (kWh/a)	360	0.00%	0.00%
				Cons. high consumers (kWh/a)	480	1.00%	1.00%
Household / commercial center	34	-1.92%	-1.95%	Cons. per HH (weighted ave.)	318	0.00%	0.00%
Household / public service	74	-1.91%	-1.97%				
Household / public light	40	-2.84%	-3.97%	Commercial consumption (kWh/a)	750	0.00%	0.00%
				Industrial consumption (MWH/a)	23.4	2.68%	1.34%
El. coeff. low and medium cons.	30%	7.18%	1.55%				
El. coeff. high consumers	60%	1.55%	1.34%	System losses	18%	0.00%	0.00%
El. coeff. commercial centers	30%	2.92%	2.26%	Annual hours of utilization (h)	1314	3.50%	3.50%
El. coeff. public light	30%	2.92%	2.26%				
El. coeff. public services	70%	0.69%	0.65%				

Autonomous Demand : Domestic / Income Level

Year	Populati on	No. of househo	Number of Potential Consumers Low	Medium	High	Total	Unit Consumption (kWh/yr) Low	Medium	High	Domestic Demand (MWh/yr) Low	Medium	High	Total
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
2002	13569	2564	292	369	215	876	240	360	480	70	133	103	306
2003	13766	2601	311	404	226	941	240	360	485	75	145	110	330
2004	13965	2639	331	443	238	1012	240	360	490	80	159	117	356
2005	14168	2677	353	485	251	1089	240	360	495	85	175	124	383
2006	14373	2716	376	531	264	1171	240	360	499	90	191	132	413
2007	14582	2755	401	582	278	1261	240	360	504	96	210	140	446
2008	14793	2795	427	638	293	1358	240	360	510	102	230	149	481
2009	15008	2835	455	699	309	1463	240	360	515	109	252	159	520
2010	15225	2877	485	766	326	1577	240	360	520	116	276	169	562
2011	15446	2918	516	839	343	1698	240	360	525	124	302	180	606
2012	15670	2961	550	920	361	1831	240	360	530	132	331	191	655
2013	15897	3004	557	953	378	1888	240	360	536	134	343	202	679
2014	16128	3047	564	987	396	1947	240	360	541	135	355	214	705
2015	16362	3091	570	1022	415	2007	240	360	546	137	368	227	732
2016	16599	3136	578	1059	435	2072	240	360	552	139	381	240	760
2017	16839	3182	585	1097	456	2138	240	360	557	140	395	254	789
2018	17084	3228	592	1136	477	2205	240	360	563	142	409	268	819
2019	17331	3275	599	1177	499	2275	240	360	568	144	424	284	851
2020	17583	3322	606	1219	522	2347	240	360	574	146	439	300	884
2021	17838	3370	614	1263	547	2424	240	360	580	147	455	317	919
2022	18096	3419	621	1308	573	2502	240	360	586	149	471	336	956

Autonomous Demand : Commercial / Public Service / Industry

Year	No. of Comm. Cons.	Comm. Unit Cons. kWh/yr	Comm. Load MWh/yr	Industry Load MWh/yr	No. of Public Service	No. of Public Lights	Public Service Load MWh/a	Annual Hours of Utiliz.	Net Load MWh/a	Losses MWh/a	Gross Load MWh/a	Max. Load kW	Power Factor	Indut. Load kW	Peak Load kW
14	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*
2002	23	750	17	23	24	19	33	1314	379	68	447	340	0.20	18	323
2003	24	750	18	24	25	21	34	1360	406	73	479	352	0.22	18	334
2004	26	750	19	25	26	22	36	1408	436	78	514	365	0.23	19	347
2005	27	750	20	25	27	24	38	1457	468	84	552	379	0.25	19	360
2006	29	750	22	26	29	26	41	1508	502	90	592	393	0.27	20	373
2007	31	750	23	27	30	28	43	1561	539	97	636	407	0.29	20	387
2008	33	750	25	27	31	30	45	1615	579	104	683	423	0.31	21	402
2009	35	750	26	28	32	32	48	1672	622	112	734	439	0.33	21	418
2010	37	750	28	29	34	34	51	1730	669	120	790	456	0.36	22	434
2011	40	750	30	30	35	37	54	1791	719	129	849	474	0.38	23	451
2012	42	750	32	30	36	39	57	1854	774	139	913	493	0.41	23	469
2013	45	750	34	31	38	43	60	1918	804	145	949	495	0.43	24	471
2014	47	750	36	31	39	46	64	1986	836	150	986	497	0.44	24	473
2015	50	750	38	32	41	50	68	2055	869	156	1025	499	0.46	24	475
2016	53	750	40	32	43	54	72	2127	904	163	1067	502	0.48	24	477
2017	56	750	42	33	45	58	77	2201	941	169	1110	504	0.50	25	480
2018	59	750	44	33	46	63	82	2278	979	176	1155	507	0.52	25	482
2019	63	750	47	33	48	68	87	2358	1019	183	1202	510	0.54	25	484
2020	66	750	50	34	50	73	93	2441	1061	191	1251	513	0.56	26	487
2021	70	750	53	34	53	79	99	2526	1105	199	1304	516	0.59	26	490
2022	74	750	56	35	55	85	105	2615	1151	207	1359	520	0.61	27	493

ECONOMIC ANALYSIS: LEGUWA KHOLA SHP

CC 000 US$	O&M 000 US$	Total Cost	Generatio Cap (MWh	Energy MWh	Benefit 000 US$	Capacity Benefit	Total Benefit	Net Cash Flow
327.8254	0	327.8254	2217	0	0		0	-327.825
437.1006	0	437.1006	2217	0	0		0	-437.101
327.8254	0	327.8254	2217	0	0		0	-327.825
	52.4259	52.4259	2217	467.6979	34.27627	60.48	94.75627	42.33037
	52.4259	52.4259	2217	501.731	36.72281	60.48	97.20281	44.77691
	52.4259	52.4259	2217	538.7795	39.38546	60.48	99.86546	47.43956
	52.4259	52.4259	2217	578.9557	42.27177	60.48	102.7518	50.32587
	52.4259	52.4259	2217	622.2567	45.38212	60.48	105.8621	53.43622
	52.4259	52.4259	2217	669.2339	48.75286	60.48	109.2329	56.80696
	52.4259	52.4259	2217	719.2269	52.32637	60.48	112.8064	60.38047
	52.4259	52.4259	2217	773.7455	56.21686	60.48	116.6969	64.27096
	52.4259	52.4259	2217	804.0338	58.57852	60.48	119.0585	66.63262
	52.4259	52.4259	2217	835.7467	61.0591	60.48	121.5391	69.1132
	52.4259	52.4259	2217	869.0024	63.66692	60.48	124.1469	71.72102
	52.4259	52.4259	2217	904.2067	66.42962	60.48	126.9096	74.48372
	52.4259	52.4259	2217	941.0477	69.32736	60.48	129.8074	77.38146
	52.4259	52.4259	2217	978.9297	72.30563	60.48	132.7856	80.35973
	52.4259	52.4259	2217	1018.897	75.44999	60.48	135.93	83.50409
	52.4259	52.4259	2217	1060.558	78.73554	60.48	139.2155	86.78964
	52.4259	52.4259	2217	1104.995	82.25116	60.48	142.7312	90.30526
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	283.4879	283.4879	2217	1151.339	85.9241	60.48	146.4041	-137.084
	283.4879	283.4879	2217	1151.339	85.9241	60.48	146.4041	-137.084
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
	52.4259	52.4259	2217	1151.339	85.9241	60.48	146.4041	93.9782
996.1196	462.6313	1458.751	23336.97	5976.766	439.6367		910.8266	-547.924

IRR	0.033905	
B/C R	0.624388	
BET	0.24407	US$
	18.79341	NRs.
Generation Cost	0.062508	US$/kWh
	4.813127	NRs./kWh
Rev/OM Cost Ratio	0.653804	

Financial / Economic Analysis

	US $ (000)	NRs. (000)	
Capital Cost	1165.014	89706	
O&M Cost	58.251	4485	0.06
R & R Cost	466.792	35943	
Exchange Rate	1	77	
Foreign	491.542	37849	
Local	673.472	51857	

Financial Costs			R&RC		Economic Costs	
1st Year	349.5042	0.3	462.1241	0.99	486.6266	Foreign
2nd Year	466.0056	0.4		0.9	606.1248	Local
3rd Year	349.5042	0.3			52.4259	O&M
Total	1165.014			Total	1092.751	

Economic Costs	
1st Year	327.8254
2nd Year	437.1006
3rd Year	327.8254
Total	1092.751

Sabha Khola Small Hydropower Project

SABHA KHOLA SMALL HYDROPOWER PROJECT (1260 KW)

Location

Sabha Khola Small Hydropower Project (Sabha khola SHP) is located in Sabhapokhari VDC of Sankhuwasabha district of the Eastern development region of Nepal. The proposed intake of the project lies at approximately 533900 E and 3034750N (87°20'37"E, 27°25'48" N) and at elevation of 730 metres above mean sea level (msl). Likewise the powerhouse is located at 531150 E and 3034750 N (87°18'58" E, 27°25'49" N). The elevation of the powerhouse is 600 metres above mean sea level (msl).

Access

The nearest motorable road is available at Hile, which lies at about two days walking distance from Tumlingtar. The district headquarters of Sankhuwasabha, Khandbari is about 32 km far from the proposed project site. There is a STOL airport in Tumlingtar, which is 40 km away from the proposed project site.

Geology

Regional Geology

Sabha Khola SHP geologically falls on Ulleri gneiss (Ul) just to the west of its contact with Kushma Formation (Ks) which essentially is made up of quartzite intercalated with phyllite having frequent basic rock intrusions. Regional geological mapping of this area in 1"=1mile scale was carried out by DMG (B. M. Jnawali and R. N. Yadav)

Site Geology

Loose rock, colluvial soil and hard soil with sporadic occurance of loose soil and conglomerate were observed during reconnaissance site visit. The right bank at the intake site is made up of hard rock while the left bank has mainly loose soil and conglomerate. Geological description of desilting basin and headrace canal is not provided in the report. The forbay site is located on a sloping ground of 20^0 and of site is very much narrow. The site is made up of hard rock, loose conglomerate and hard soil. The spillway canal passes through a small gully with similar geological conditions as in forbay. The penstock alignment passes through a natural slope of 300 with compact and loose rock, conglomerate and hard soil. The powerhouse and the tailrace sites are located on cultivated terraced field comprosed of hard soil and conglomerate.

The above geological description is based on a reconnaissance visit. Therefore detailed geological and shallow geotechnical studies should be carried out prior to detailed design stage.

Hydrology

The Sabha Khola is one of the main tributary of Arun River. It meets at Tumlingtar. The catchment area of the proposed project site measured from topographical maps 2787-10 and 2787-06 (produced by Department of Survey, HMGN) is 109.5 sq km. Average slope of the river is 1 in 40.

Though there is a gauging station in Sabha Khola, measured discharege are not available. Therefore direct measurements are not available for this river. Catchments of similar size and characteristics are not also available to correlate the flow characteristics of this river. Therefore in order to estimate hydrological parameters of this river the following methods are used:

HydrA-Nepal

Summary of results obtained from HydrA is as follows:

Mean flow: 7.60 m^3/s

Average annual runoff: 2178 mm

Flow duration curves:

Probability of exceedance %	0	5	20	40	60	80	95
Discharge m^3/s	32.00	24.11	12.04	5.01	2.83	1.91	1.22

HYDEST results

Summary of results is as follows:

Input parameters:

Area of basin: 109.48 km^2

Area of basin below 5000 m elevation: 109.48 km^2

Area of basin below 3000 m elevation: 82.0 km^2

Monsoon wetness index: 2400

Low flows:

For RoR plants 1 day low flow event will be the parameter of concern for the planners compared to the higher duration (30 days or monthly) events, so only 1-day low flow events are summarized below:

1 day low flow events

Return period	Low flow discharge m^3/s
2	0.80
10	0.43
20	0.34

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	55	91
10	103	199
20	124	248
50	151	318
100	173	378

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.42	1.21	1.08	1.08	1.42	5.71	17.5	21.3	16.6	7.15	3.36	2.17

Flow duration curves:

Probability of exceedance %	0	5	20	40	60	80	95	100
Discharge m^3/s	44.57	24.47	13.58	3.63	1.75	1.03	0.67	0.57

MIP method

In order to apply this method to compute mean monthly flows, we need to know at least one actual flow measurement during the low flow period (November to April). Such data are not available in the previous study, so this method can not be applied during this stage of the study.

MHSP method

Summary of results is as follows:

Input parameters:

Total drainage area: 109.48 km^2

Mean monsoon precipitation: 2100

Monsoon wetness index: 2400

Flood flows:

Return period	Flood discharge m^3/s
5	297
20	450

50	563
100	657

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.81	1.47	1.34	1.59	1.80	6.07	18.6	22.2	17.4	8.17	3.92	2.52

Flow duration curve:

Probability of exceedance %	max	25	45	65	85	90	95	min
Discharge m^3/s	177	9.91	3.28	1.74	1.12	0.94	0.76	0.18

Previous studies

During the inventory study conducted in June 1999, the following methods were used to compute the hydrological parameters of this project:

A catchment area ratio method was applied to correlate flows with Arun river at Uwa Gaon (catchment area 26750 km^2), however the size and characterisctics of these catchments can not compared. So, the results of the study are not reliable enough to be used.

Mean monthly flows were computed by Hydest (DHM/WECS) method. The result from this method is more appropriate for the catchment. Hence, the value obtained from Hydest method is adopted for further study.

Recommended values

The results from MHSP are higher than the HydrA and Hydest. HydrA and HYDEST results are recommended to use. Hydra Q90 has been selected as design discharge.

Layout

Sabha Khola Small Hydro Project is a runoff river project. The available gross head is 130 m and the design discharge is 1.39 m^3/sec (90 % exceedance) giving a total installed capacity of 1260 kW. The headworks consist of approximately 26 m long diversion weir including lateral intake. The length of the weir along its foundation is estimated to be about 28 m and height and depth of foundation is about 2.0 m. The intake level is proposed at elevation of 730 masl.

A double chambered settling basin to remove finer particles by proper flushing system is recommended. There is an open space about 300 m downstream of the headwork site, which suffices for the construction of settling basin.

Headrace canal passes through the left bank of the river and the length of the canal will be about 3800 m.

The space available at the proposed site is not enough therefore some modification might be required in design of forebay from that of conventional design. Detail geological investigation should be made before designing the capacity and shape of the forebay.

A spillway canal is proposed to divert spilled water from forebay back to Sabha Khola via a small gully nearby the fore bay. The length of the spillway is estimated to be about 300 m over a gully with a mean slope of about 30°.

The penstock is about 250 m long and the natural slope of the terrain under the penstock alignment is about 35°.

Powerhouse is planned to be of the external type, total area of the powerhouse is estimated to be about 370 m^2. Four units of turbine and generator are used. The length of the tailrace canal will be about 120 m long.

The whole structures of the project would be laid on the left bank of the river.

Energy

Energy production by the Sabha Khola SHP scheme is calculated using HydrA. The net annual energy supply from the scheme would be 10007 MWh. The Table given below shows a brief summary of the generated energy.

Summary of generated energy

S.N.	Turbine Type	No. of Units	Gross avg annual Energy (MWh)	Net avg annual energy (MWh)
1	Pelton	4	10289	10007
2	Turgo	4	10106	9829
3	Crossflow	4	9346	9090

Considering the discharge and energy output 4 Pelton turbine unit is suggested to use.

Transmission

Total length of HT line (11 kV): 12 km

Total length of LT line (400 V): 18 km

Environmental aspect

The previous study is silent on physical, biological and socioeconomic impacts. A detailed EIA may be required as it is located close to Sagarmatha national park for the purpose of environmental clearance. Minor environmental impacts during construction period are anticipated. Overall the environmental condition of the project is rated as satisfactory.

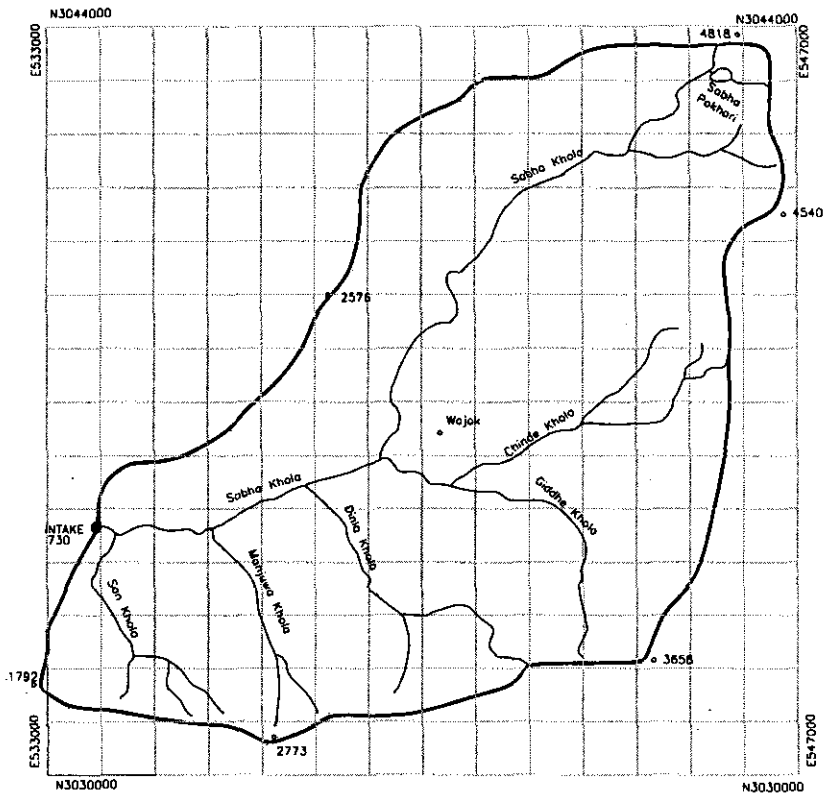
Socio-economic aspect

Economic Analysis

The specific construction cost per kW of Sabha is US$ 2177 and Operation and maintenance cost is 4 % of the total cost. The EIRR is estimated –2.6%. The benefit cost ratio is 0..43. The generation cost is US$ 0.03 per kWh and the break-even tariff is US$ 0.69 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 1.11. The ratio of willingness to pay of household with respect to electricity bill per month is 0.61 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0.26.



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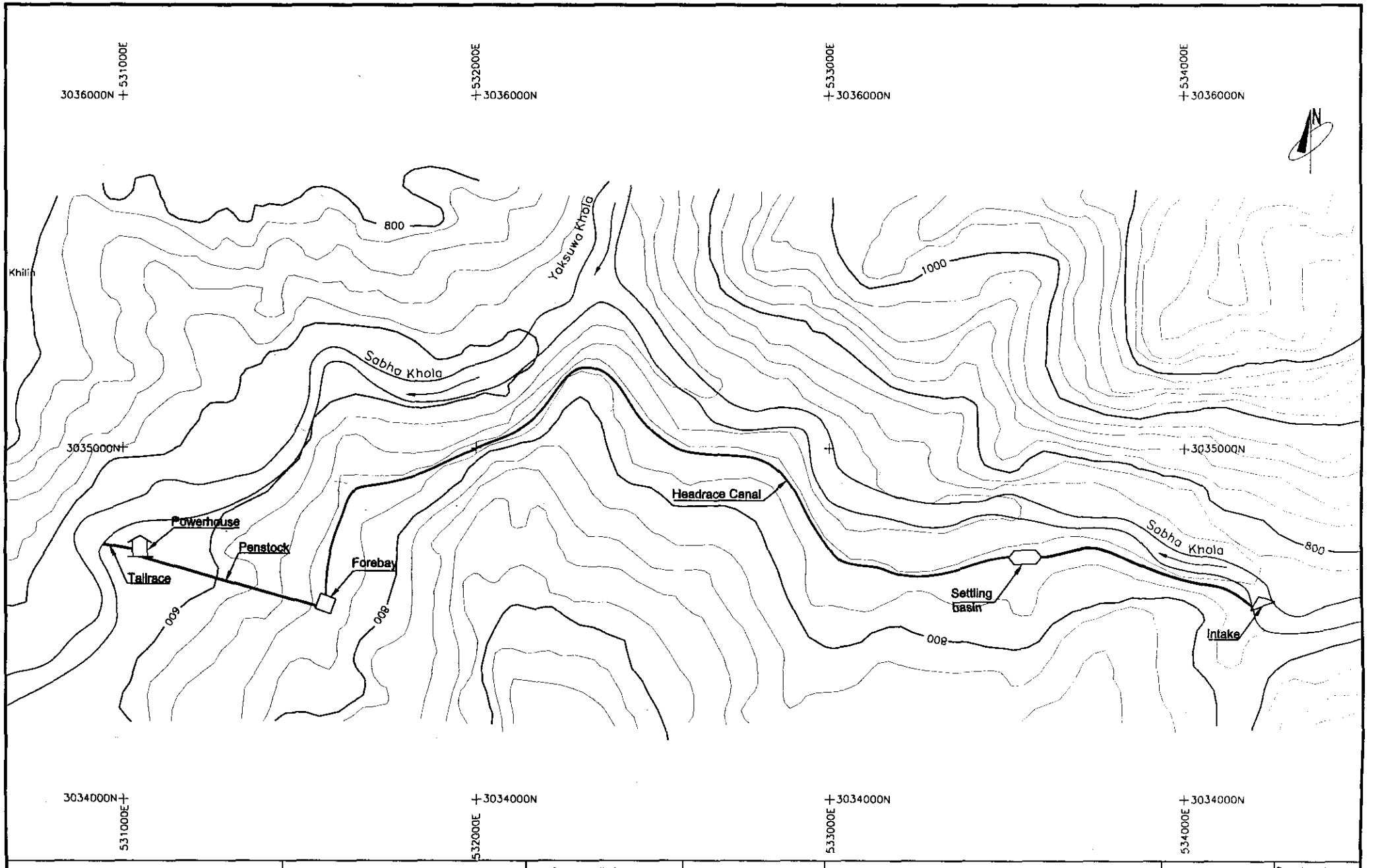


Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	SABHA KHOLA SHP Sankhuwasabha, EDR, Nepal GENERAL LAYOUT PLAN	Scale 0 100 200 300(m) 1:10000	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 463764, Fax 462298 Web site: www.scast.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11726, Kumaripati, Lalitpur Tel: 535565, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. Sheet No.

Load Demand Forecast : Sabha Khola SHP

Parameters	Year 2002	Growth rate 2012	Growth rate 2022	Input Parameters	Year 2002	Growth rate 1st Dec.	Growth rate 2nd Dec.
Population	11231	1.18%	1.18%	Public sector growth		2.00%	2.00%
Person per household	5.40	0.00%	0.00%	Commercial sector growth		2.50%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	38%	-2.02%	-1.74%				
Medium income group (%)	50%	0.77%	0.54%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	12%	2.26%	1.84%	Cons. medium cons. (kWh/a)	360	0.00%	0.00%
				Cons. high consumers (kWh/a)	480	1.00%	1.00%
Household / commercial center	34	-1.92%	-1.95%	Cons. per HH (weighted ave.)	318	0.00%	0.00%
Household / public service	74	-1.91%	-1.97%				
Household / public light	40	-2.84%	-3.97%	Commercial consumption (kWh/a)	750	0.00%	0.00%
				Industrial consumption (MWH/a)	31.2	2.68%	1.34%
El. coeff. low and medium cons.	30%	7.18%	1.55%				
El. coeff. high consumers	60%	1.55%	1.34%	System losses	18%	0.00%	0.00%
El. coeff. commercial centers	30%	2.92%	2.26%	Annual hours of utilization (h)	1314	3.50%	3.50%
El. coeff. public light	30%	2.92%	2.26%				
El. coeff. public services	70%	0.69%	0.65%				

Autonomous Demand : Domestic / Income Level

Year	Populati on	No. of househo	Number of Potential Consumers Low	Medium	High	Total	Unit Consumption (kWh/yr) Low	Medium	High	Domestic Demand (MWh/yr) Low	Medium	High	Total
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
2002	11231	2079	237	312	150	699	240	360	480	57	112	72	241
2003	11364	2103	252	341	158	751	240	360	485	60	123	77	260
2004	11498	2128	268	373	166	807	240	360	490	64	134	81	280
2005	11633	2153	285	408	174	867	240	360	495	68	147	86	301
2006	11771	2179	302	446	183	931	240	360	499	73	161	91	325
2007	11909	2204	321	487	192	1000	240	360	504	77	175	97	349
2008	12050	2231	341	532	202	1075	240	360	510	82	192	103	376
2009	12192	2257	363	581	212	1156	240	360	515	87	209	109	405
2010	12336	2283	385	635	223	1243	240	360	520	92	229	116	437
2011	12482	2310	410	694	234	1338	240	360	525	98	250	123	471
2012	12629	2338	435	759	246	1440	240	360	530	104	273	130	508
2013	12778	2365	439	784	257	1480	240	360	536	105	282	138	525
2014	12929	2393	444	810	268	1522	240	360	541	106	292	145	543
2015	13081	2421	448	837	280	1565	240	360	546	107	301	153	562
2016	13236	2450	452	865	292	1609	240	360	552	109	311	161	581
2017	13392	2479	457	894	305	1656	240	360	557	110	322	170	601
2018	13550	2508	461	923	318	1702	240	360	563	111	332	179	622
2019	13710	2538	465	954	332	1751	240	360	568	112	343	189	644
2020	13871	2568	470	986	347	1803	240	360	574	113	355	199	667
2021	14035	2598	474	1019	362	1855	240	360	580	114	367	210	691
2022	14201	2629	479	1053	378	1910	240	360	586	115	379	221	715

Autonomous Demand : Commercial / Public Service / Industry

Year	No. of Comm. Cons.	Comm. Unit Cons. kWh/yr	Comm. Load MWh/yr	Industry Load MWh/yr	No. of Public Service	No. of Public Lights	Public Service Load MWh/a	Annual Hours of Utiliz.	Net Load MWh/a	Losses MWh/a	Gross Load MWh/a	Max. Load kW	Power Factor	Indut. Load kW	Peak Load kW
14	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*
2002	18	750	14	31	20	16	26	1314	313	56	369	281	0.04	24	257
2003	19	750	15	32	20	17	28	1360	334	60	395	290	0.04	24	266
2004	21	750	16	33	21	18	29	1408	358	64	422	300	0.04	25	275
2005	22	750	16	34	22	19	31	1457	382	69	451	310	0.05	26	284
2006	23	750	17	35	23	21	33	1508	409	74	483	320	0.05	26	294
2007	25	750	19	36	24	22	34	1561	438	79	517	331	0.05	27	304
2008	26	750	20	37	25	24	36	1615	469	84	553	343	0.06	28	315
2009	28	750	21	38	26	25	38	1672	502	90	592	354	0.06	29	326
2010	30	750	22	39	27	27	40	1730	538	97	635	367	0.06	29	338
2011	31	750	24	40	28	29	43	1791	577	104	680	380	0.07	30	350
2012	33	750	25	41	29	31	45	1854	619	111	730	394	0.07	31	363
2013	35	750	26	41	30	34	48	1918	641	115	756	394	0.08	31	363
2014	37	750	28	42	31	36	50	1986	663	119	782	394	0.08	32	362
2015	39	750	29	42	32	39	53	2055	687	124	811	394	0.08	32	362
2016	41	750	31	43	33	42	57	2127	712	128	840	395	0.08	33	362
2017	44	750	33	43	35	45	60	2201	738	133	870	395	0.09	33	362
2018	46	750	35	44	36	49	64	2278	764	138	902	396	0.09	34	362
2019	49	750	36	45	38	53	68	2358	793	143	935	397	0.09	34	363
2020	51	750	38	45	39	57	72	2441	822	148	970	398	0.10	34	363
2021	54	750	41	46	40	61	76	2526	853	154	1007	399	0.10	35	364
2022	57	750	43	46	42	66	81	2615	886	159	1045	400	0.10	35	364

ECONOMIC ANALYSIS: SABHA KHOLA SHP

year	CC	O&M	Total	Generatio	Energy	Benefit	Capacity	Total	Net Cash
	000 US$	000 US$	Cost	Cap (MWH	MWh	000 US$	Benefit	Benefit	Flow
2002	771.8452	0	771.8452	10007	0	0		0	-771.845
2003	1029.127	0	1029.127	10007	0	0		0	-1029.13
2004	771.8452	0	771.8452	10007	0	0		0	-771.845
2005		98.7309	98.7309	10007	382.3746	27.74524	136.08	163.8252	65.09434
2006		98.7309	98.7309	10007	409.3095	29.66465	136.08	165.7446	67.01375
2007		98.7309	98.7309	10007	437.8026	31.68884	136.08	167.7688	69.03794
2008		98.7309	98.7309	10007	468.9267	33.9027	136.08	169.9827	71.2518
2009		98.7309	98.7309	10007	502.0335	36.24964	136.08	172.3296	73.59874
2010		98.7309	98.7309	10007	538.0912	38.80836	136.08	174.8884	76.15746
2011		98.7309	98.7309	10007	576.6929	41.537	136.08	177.617	78.8861
2012		98.7309	98.7309	10007	618.7722	44.51242	136.08	180.5924	81.86152
2013		98.7309	98.7309	10007	640.5	46.19387	136.08	182.2739	83.54297
2014		98.7309	98.7309	10007	663.0351	47.93472	136.08	184.0147	85.28382
2015		98.7309	98.7309	10007	686.866	49.78342	136.08	185.8634	87.13252
2016		98.7309	98.7309	10007	711.5552	51.69564	136.08	187.7756	89.04474
2017		98.7309	98.7309	10007	737.602	53.72083	136.08	189.8008	91.06993
2018		98.7309	98.7309	10007	764.1207	55.78493	136.08	191.8649	93.13403
2019		98.7309	98.7309	10007	792.5066	57.99663	136.08	194.0766	95.34573
2020		98.7309	98.7309	10007	822.3583	60.33029	136.08	196.4103	97.67939
2021		98.7309	98.7309	10007	853.1381	62.73444	136.08	198.8144	100.0835
2022		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2023		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2024		639.0274	639.0274	10007	885.549	65.27252	136.08	201.3525	-437.675
2025		639.0274	639.0274	10007	885.549	65.27252	136.08	201.3525	-437.675
2026		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2027		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2028		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2029		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2030		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2031		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2032		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2033		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
2034		98.7309	98.7309	10007	885.549	65.27252	136.08	201.3525	102.6216
NPV	2345.304	895.909	3241.213	105337.4	4732.852	344.2961		1404.473	-1836.74

IRR	-0.03%	
B/C R	0.433317	
BET	0.684833	US$
	52.73213	NRs.
Generation Cost	0.03077	US$/kWh
	2.369275	NRs./kWh
Rev/OM Cost Ratio	0.281019	

Financial / Economic Cost

	US $ (000)	NRs. (000)
Capital Cost	2742.515	211174
O&M Cost	109.701	8447
R&R Cost	1091.508	84046
Exchange Rate	1	77
Foreign	1161.708	89452
Local	1580.807	121722
	2742.515	

Financial Costs

1st Year	822.7545	0.3
2nd Year	1097.006	0.4
3rd Year	822.7545	0.3
Total	2742.515	

Economic Costs

R&RC				
1080.593	0.99	1150.091	Foreign	
	0.9	1422.726	Local	
		98.7309	O&M	
Total		2572.817		

Economic Costs

1st Year	771.8452
2nd Year	1029.127
3rd Year	771.8452
Total	2572.817

Molung Khola Small Hydropower Project

MOLUNG KHOLA SMALL HYDROPOWER PROJECT (640 KW)

Location

Molung Khola Small Hydropower Project (Molung Khola SHP) is located in Srichour VDC of Okhaldhunga district of the Eastern development region of Nepal. The proposed intake of the project lies at approximately 444700 E and 3028950 N (86°26'27" E, 27°22'35" N) and at elevation of 1048 metres above mean sea level (msl). Likewise the powerhouse is located at 444500E and 3027500 N (86°26'19" E, 27°21'49" N). The elevation of the powerhouse is 965 metres above mean sea level (msl).

Access

The project area lies at about five hours walking distance from Okhaldhunga Bazar, the district headquarters. The access to Okhaldhunga Bazar is via air route to Rumjatar and a walking distance of about eight hours. There is a road under construction starting from Katari at Udayapur district to connect Okhaldhunga with East West Highway.

Geology

Regional Geology

Molung Khola SHP geologically falls on Seti Formation (St) rocks made up of phyllite, phyllitic quartzite and quartzite. Regional geological mapping of the area in 1"=1mile scale was carried out by DMG (T. P. Adhikari and D. R. Kansakar).

Site Geology

Detailed surface and sub-surface geological / engineering geological, shallow geotechnical investigations (pitting) and laboratory testing were carried out in the project area for detailed engineering design. In addition to the above mentioned investigation a separate survey for construction material was also carried out . The project structures are located along the right bank of the khola.

Bed rocks (quartzite and phyllite) are exposed on both banks and on the river bed itself of the proposed intake site. The gravel trap and desanding basin sites are located on a very thin pile of unconsolidated sediments of the lower terrace deposit. All the other project structures - the headrace canal alignment, forbay, penstock, powerhouse and tailrace are located mainly on cultivated land with thin overburden and have similar geological condition as that of intake site. The rocks in the area except bedding/ foliation joints are intact and are free of other joints. A northerly dipping fault running along Pukting and Kulkhola passes through the confluence of Pukting and Molung Khola which is approximately located at 700m downstream of the proposed powerhouse site. Series of landslides, associated with the fault, are observed especially along Pukting Khola which has deposited a huge amount of debris at its confluence with Molung Khola.

Sufficient geological/ engineering geological, geotechnical (pitting at each structural sites and laboratory testing of rock and soil samples) investigations and construction material survey has been already completed for the project. Therefore no additional geological/ geotechnical investigation is deemed necessary prior to construction works. Should it be felt necessary to carry out few additional geological/ geotechnical investigations it can be carried out during construction stage.

Hydrology

The Molung Khola is one of the main tributary of Sunkoshi River.The catchment area of the proposed project site measured from topographical maps 2786-10 and 2786-11 (produced by Department of Survey, HMGN) is 165.9 sq km. Average slope of the river is 1 in 20.

There is no gauging station on Molung Khola. Catchments of similar size and characteristics are not available to correlate the flow characteristics of this river. Therefore in order to estimate hydrological parameters of this river the following methods are used:

HydrA-Nepal

Summary of results obtained from HydrA is as follows:

Mean flow: 7.20 m^3/s

Average annual runoff: 1360 mm

Flow duration curves:

Probability of exceedance %	0	5	20	40	60	80	95
Discharge m^3/s	40.00	27.69	11.12	3.74	1.69	0.91	0.46

HYDEST results

Summary of results is as follows:

Input parameters:

Area of basin: 166.0 km^2

Area of basin below 5000 m elevation: 166.0 km^2

Area of basin below 3000 m elevation: 152.0 km^2

Monsoon wetness index: 1100

Low flows:

For RoR plants 1day low flow event will be the parameter of concern for the planners compared to the higher duration (30 days or monthly) events, so only 1-day low flow events are summarized below:

1 day low flow events

Return period	Low flow discharge m^3/s
2	1.23
10	0.72
20	0.60

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	98	156
10	179	324
20	212	398
50	256	503
100	290	588

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.12	1.81	1.62	1.66	2.23	7.05	21.8	26.1	19.9	8.84	3.69	2.43

Flow duration curves:

Probability of exceedance %	0	5	20	40	60	80	95	100
Discharge m^3/s	49.09	29.81	14.49	4.29	2.1	1.58	1.04	0.91

MIP method

In order to apply this method to compute mean monthly flows, we need to know at least one actual flow measurement during the low flow period (November to April). Such data are not available in the previous study, so this method can not be applied during this stage of the study.

MHSP method

Summary of results is as follows:

Input parameters:

Total drainage area: 166 km^2

Mean monsoon precipitation: 1000

Monsoon wetness index: 1100

Flood flows:

Return period	Flood discharge m^3/s
5	412
20	616
50	766
100	890

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.59	2.12	1.94	2.36	2.69	7.54	20.96	25.43	19.89	9.53	4.63	3.01

Flow duration curve:

Probability of exceedance %	max	25	45	65	85	90	95	min
Discharge m^3/s	163.7	11.6	4.12	2.53	1.64	1.39	1.13	0.29

Previous studies

During the detail engineering study conducted in June 1997, the following methods were used to compute the hydrological parameters of this project:

A catchment area ratio method was applied to correlate flows with Dudh Koshi at Rabuwa Bazar, station 670 (catchment area 4100 km^2) and Solu Khola at Salme, station 668.5 (catchment area 407 km^2). The results of the study are higher than the adopted discharge. The regional flood frequency analysis, flood frequency and regression had been adopted for the flood estimation.

The recommendations of the previous study are:

- install staff gauge recording station
- the 100 year design flood estimate was 500 m^3/s for the intake and 530 m^3/s for the powerhouse site
- 1.54 m^3/s and 3.37 m^3/s to be considered for 90% and 50% dependable flow respectively.

Recommended values

The results from the HYDEST are near to the recommended values and HydrA results are very low and MHSP method result is higher than the recommended. So HYDEST results are recommended to use. Q90 has been selected as design discharge.

Layout

Molung Khola Small Hydro Project is a runoff river project. The available gross head is 83 m and the design discharge is 1.1 m^3/sec (90 % exceedance) giving a total installed capacity of 640 kW. The headworks consist of approximately 17.5 m long diversion weir. A side intake on the right bank is proposed to feed the discharge into the settling basin. The length of the weir along its foundation is estimated to be about 23 m. The intake level is proposed at elevation of 1048 metres above msl.

A gravel trap would be fixed at 55 metres downstream from the intake. The length and width of the gravel trap would be 6 m and 1.1 m respectively with 1.2 m depth of flow.

A single chamber settling basin to remove finer particles by proper flushing system is recommended. There is a flat terrace about 570 m downstream of the headwork site, which suffices for the construction of settling basin. The total length and width of basin would be 42 m and 4 m respectively.

Headrace canal passes through the right bank of the river and the length of the canal including closed duct, gravel trap, aqueducts and settling basin will be about 1766 m.

At the end of the headrace canal a rectangular shaped forebay has been designed with storage capacity of 400 m^3.

A spillway canal is proposed to divert spilled water from forebay back to Gaule Khola nearby the fore bay. The length of the spillway is estimated to be about 19 m.

The penstock is about 244 m long and the natural slope of the terrain under the penstock alignment is about 35°.

Powerhouse is planned to be of the external type, the size of the powerhouse is estimated to be about 23m x 9m x 5m in length, width and height respectively. Three units of turbine and generator are used. The length of the tailrace canal will be about 20 m long.

The whole structures of the project would be laid on the right bank of the river.

Energy

Energy production by the Molung Khola SHP scheme is calculated using HydrA with the Hydest results. The net annual energy supply from the scheme would be 5063 MWh. The Table given below shows a brief summary of the generated energy.

Summary of generated energy

S.N.	Turbine Type	No. of Units	Gross avg annual Energy (MWh)	Net avg annual energy (MWh)
1	Pelton	3	5206	5063
2	Turgo	3	5115	4975
3	Crossflow	3	4730	4600

Considering the discharge and energy output 3 Pelton turbine unit is suggested to use.

Transmission

Total length of HT line (11 kV): 50 km

Total length of LT line (400 V): 53 km

Environmental aspect

The environmental conditions of the project are acceptable in terms of physical, biological and socio-economic impacts. No serious physical impacts are anticipated during operational phase. However, during the construction phase, localized impacts in the form of increase in noise level, turbity, social disturbance etc. are anticipated. The project requires two houses to be resettled. Overall the environmental condition of the project is rated as satisfactory.

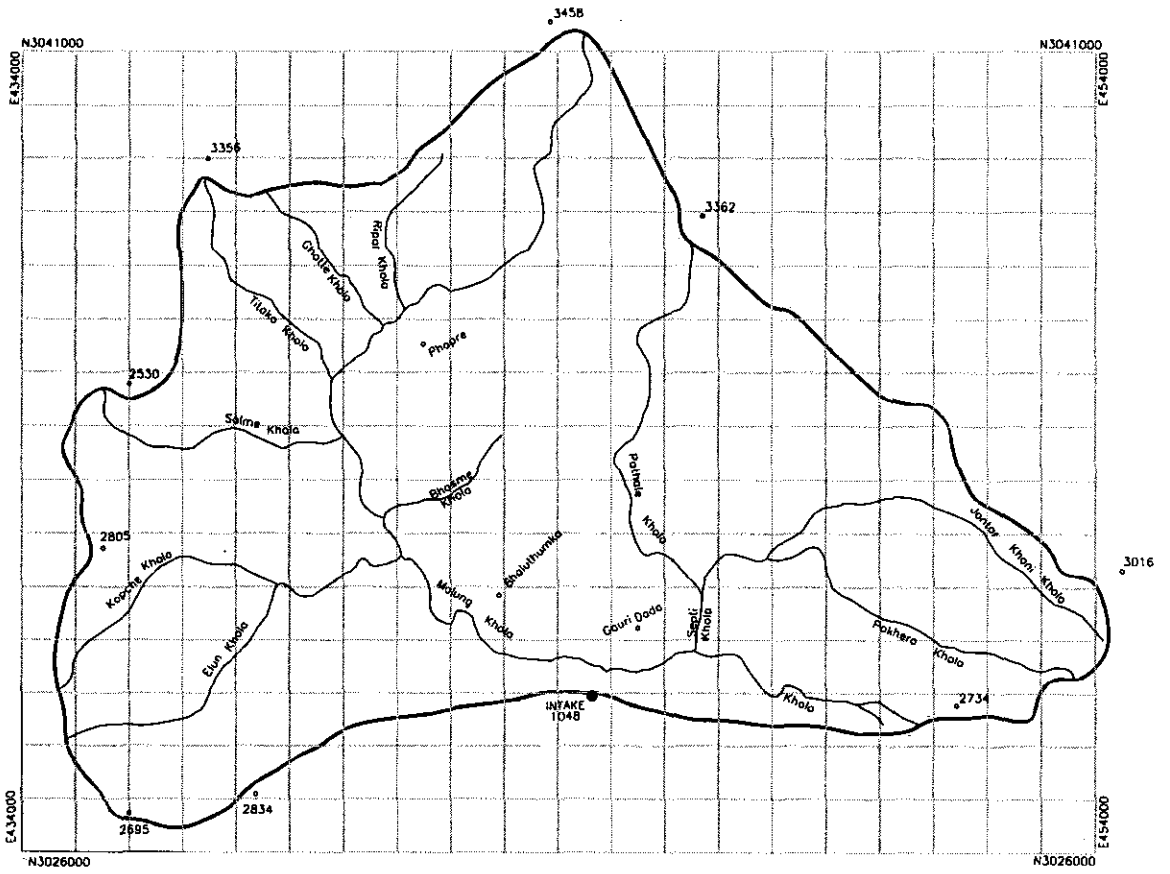
Socio-economic Aspect

Economic Analysis

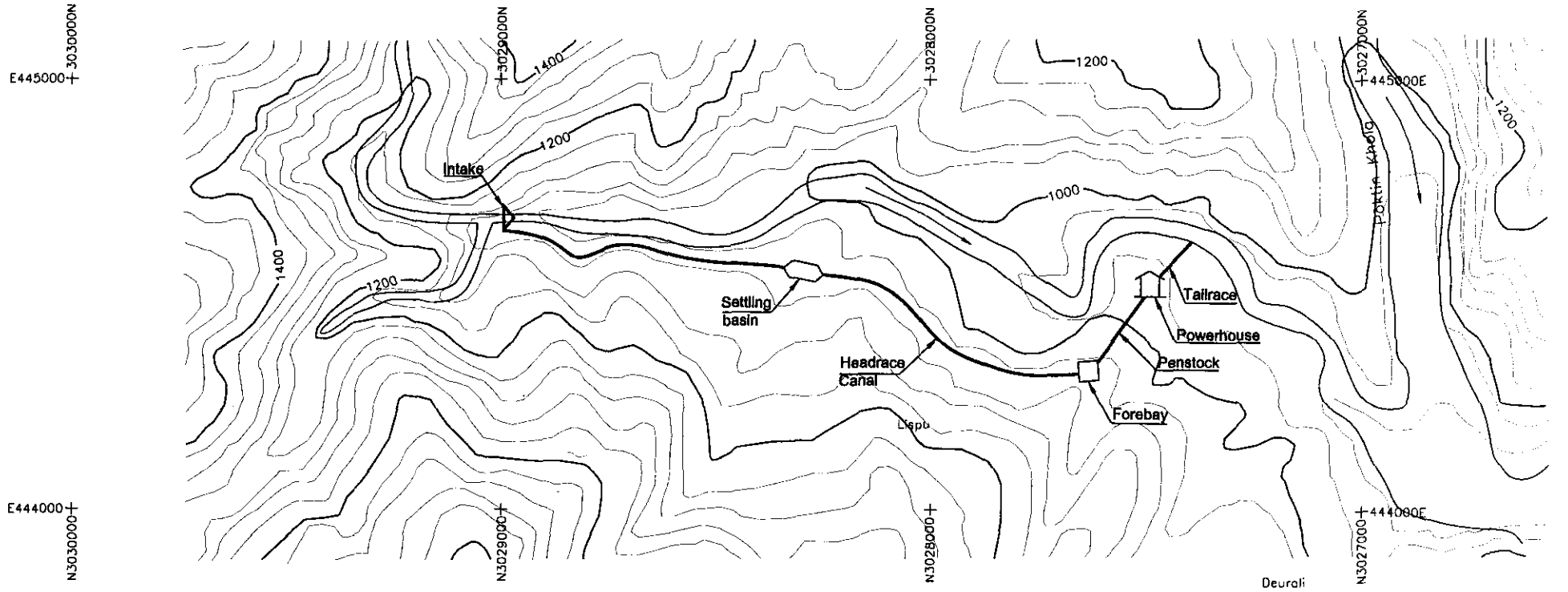
The specific construction cost per kW of Molung is US$ 4030 and Operation and maintenance cost is 6 % of the total cost. The EIRR is estimated 3.2%. The benefit cost ratio is 0.61. The generation cost is US$ 0.06 per kWh and the break-even tariff is US$ 0.23 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 1.34. The ratio of willingness to pay of household with respect to electricity bill per month is 0.61 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0.76.



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	MOLUNG KHOLA SHP Okhaldhunga, EDR, Nepal CATCHMENT AREA	Scale 0 1000 2000 3000(m) 1:100000	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493784, Fax 482298 Web site: www.scaaf.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconeult.com.np	Prepared: Checked: Drawn:	Drawing No. Sheet No.



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	MOLUNG KHOLA SHP Okhaldhunga, EDR, Nepal	Scale 0 100 200 300(m)	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482296 Web site: www.soset.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11726, Kumaripati, Lalitpur Tel: 535595, Fax 527801 Email: bpc@hydroconsult.com.np	Prepared:	Drawing No.
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Load Demand Forecast : Molung Khola SHP

Parameters	Year 2002	Growth rate 2012	Growth rate 2022	Input Parameters	Year 2002	Growth rate 1st Dec.	Growth rate 2nd Dec.
Population	48582	1.14%	1.14%	Public sector growth		2.00%	2.00%
Person per household	5.02	0.00%	0.00%	Commercial sector growth		2.50%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	38%	-2.02%	-1.74%				
Medium income group (%)	50%	0.77%	0.54%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	12%	2.26%	1.84%	Cons. medium cons. (kWh/a)	360	0.00%	0.00%
				Cons. high consumers (kWh/a)	480	1.00%	1.00%
Household / commercial center	34	-1.92%	-1.95%	Cons. per HH (weighted ave.)	318	0.00%	0.00%
Household / public service	74	-1.91%	-1.97%				
Household / public light	40	-2.84%	-3.97%	Commercial consumption (kWh/a)	750	0.00%	0.00%
				Industrial consumption (MWH/a)	23.4	2.68%	1.34%
El. coeff. low and medium cons.	30%	7.18%	1.55%				
El. coeff. high consumers	60%	1.55%	1.34%	System losses	18%	0.00%	0.00%
El. coeff. commercial centers	30%	2.92%	2.26%	Annual hours of utilization (h)	1314	3.50%	3.50%
El. coeff. public light	30%	2.92%	2.26%				
El. coeff. public services	70%	0.69%	0.65%				

Autonomous Demand : Domestic / Income Level

	Populati	No. of	Number of Potential Consumers				Unit Consumption (kWh/yr)			Domestic Demand (MWh/yr)			
Year	on	househo	Low	Medium	High	Total	Low	Medium	High	Low	Medium	High	Total
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
2002	48582	9676	1103	1451	697	3251	240	360	480	265	522	335	1122
2003	49136	9786	1172	1585	732	3489	240	360	485	281	571	355	1207
2004	49696	9898	1245	1731	769	3745	240	360	490	299	623	377	1298
2005	50263	10011	1322	1891	808	4021	240	360	495	317	681	400	1398
2006	50836	10125	1404	2066	849	4319	240	360	499	337	744	424	1505
2007	51415	10240	1492	2257	892	4641	240	360	504	358	813	450	1621
2008	52001	10357	1584	2466	937	4987	240	360	510	380	888	477	1745
2009	52594	10475	1683	2694	984	5361	240	360	515	404	970	506	1880
2010	53194	10594	1787	2943	1033	5763	240	360	520	429	1059	537	2025
2011	53800	10715	1898	3215	1085	6198	240	360	525	456	1157	570	2183
2012	54413	10837	2016	3512	1140	6668	240	360	530	484	1264	604	2353
2013	55034	10961	2035	3627	1190	6852	240	360	536	488	1306	637	2431
2014	55661	11086	2054	3746	1242	7042	240	360	541	493	1349	672	2513
2015	56295	11212	2073	3868	1296	7237	240	360	546	497	1392	708	2598
2016	56937	11340	2092	3994	1353	7439	240	360	552	502	1438	747	2686
2017	57586	11469	2111	4124	1412	7647	240	360	557	507	1485	787	2778
2018	58243	11600	2130	4259	1474	7863	240	360	563	511	1533	830	2874
2019	58907	11732	2150	4398	1539	8087	240	360	568	516	1583	875	2974
2020	59578	11866	2170	4542	1607	8319	240	360	574	521	1635	923	3079
2021	60258	12001	2190	4690	1677	8557	240	360	580	526	1688	972	3186
2022	60944	12138	2210	4843	1751	8804	240	360	586	530	1743	1026	3299

Autonomous Demand : Commercial / Public Service / Industry

Year	No. of Comm. Cons.	Comm. Unit Cons. kWh/yr	Comm. Load MWh/yr	Industry Load MWh/yr	No. of Public Service	No. of Public Lights	Public Service Load MWh/a	Annual Hours of Utiliz.	Net Load MWh/a	Losses MWh/a	Gross Load MWh/a	Max. Load kW	Power Factor	Indut. Load kW	Peak Load kW
14	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*
2002	85	750	64	23	92	73	123	1314	1332	240	1572	1196	0.31	18	1178
2003	91	750	68	24	95	78	130	1360	1428	257	1685	1239	0.33	18	1221
2004	96	750	72	25	99	83	136	1408	1532	276	1807	1284	0.36	19	1265
2005	102	750	77	25	102	89	144	1457	1643	296	1939	1331	0.38	19	1312
2006	108	750	81	26	106	96	151	1508	1764	317	2081	1380	0.41	20	1360
2007	115	750	86	27	110	102	160	1561	1893	341	2234	1431	0.44	20	1411
2008	122	750	92	27	115	110	168	1615	2033	366	2399	1485	0.47	21	1464
2009	130	750	97	28	119	118	177	1672	2183	393	2576	1541	0.51	21	1519
2010	137	750	103	29	124	126	187	1730	2344	422	2766	1599	0.55	22	1577
2011	146	750	109	30	128	135	197	1791	2519	453	2973	1660	0.59	23	1637
2012	155	750	116	30	133	144	208	1854	2708	487	3195	1724	0.63	23	1701
2013	163	750	122	31	138	156	220	1918	2805	505	3310	1726	0.65	24	1702
2014	172	750	129	31	144	168	233	1986	2907	523	3430	1728	0.68	24	1704
2015	182	750	136	32	149	181	247	2055	3013	542	3556	1730	0.70	24	1706
2016	192	750	144	32	155	194	262	2127	3124	562	3687	1733	0.73	24	1709
2017	202	750	152	33	161	209	278	2201	3240	583	3823	1737	0.76	25	1712
2018	213	750	160	33	167	226	294	2278	3361	605	3967	1741	0.78	25	1716
2019	225	750	169	33	173	243	312	2358	3489	628	4116	1746	0.81	25	1720
2020	237	750	178	34	180	262	331	2441	3622	652	4274	1751	0.84	26	1725
2021	250	750	188	34	187	282	352	2526	3760	677	4437	1756	0.88	26	1730
2022	264	750	198	35	194	303	373	2615	3905	703	4608	1763	0.91	27	1736

ECONOMIC ANALYSIS: MOLUNG KHOLA SHP

year	CC	O&M	Total	Generation	Energy	Benefit	Capacity	Total	Net Cash
	000 US$	000 US$	Cost	Cap (MWh	MWh	000 US$	Benefit	Benefit	Flow
2002	722.7973	0	722.7973	5063	0	0		0	-722.797
2003	963.7297	0	963.7297	5063	0	0		0	-963.73
2004	722.7973	0	722.7973	5063	0	0		0	-722.797
2005		139.2687	139.2687	5063	1643.339	118.4896	69.12	187.6096	48.34087
2006		139.2687	139.2687	5063	1763.614	127.0322	69.12	196.1522	56.88349
2007		139.2687	139.2687	5063	1893.073	136.2168	69.12	205.3368	66.06812
2008		139.2687	139.2687	5063	2032.655	146.1059	69.12	215.2259	75.9572
2009		139.2687	139.2687	5063	2182.827	156.7312	69.12	225.8512	86.5825
2010		139.2687	139.2687	5063	2344.483	168.1524	69.12	237.2724	98.00369
2011		139.2687	139.2687	5063	2519.121	180.4839	69.12	249.6039	110.3352
2012		139.2687	139.2687	5063	2707.604	193.7841	69.12	262.9041	123.6354
2013		139.2687	139.2687	5063	2805.264	201.3354	69.12	270.4554	131.1867
2014		139.2687	139.2687	5063	2907.196	209.2284	69.12	278.3484	139.0797
2015		139.2687	139.2687	5063	3013.154	217.4485	69.12	286.5685	147.2998
2016		139.2687	139.2687	5063	3124.247	226.0865	69.12	295.2065	155.9378
2017		139.2687	139.2687	5063	3239.982	235.0965	69.12	304.2165	164.9478
2018		139.2687	139.2687	5063	3361.496	244.5716	69.12	313.6916	174.4229
2019		139.2687	139.2687	5063	3488.505	254.4957	69.12	323.6157	184.347
2020		139.2687	139.2687	5063	3621.616	264.9114	69.12	334.0314	194.7627
2021		139.2687	139.2687	5063	3759.978	275.7486	69.12	344.8686	205.5999
2022		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2023		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2024		502.3557	502.3557	5063	3905.375	287.161	69.12	356.281	-146.075
2025		502.3557	502.3557	5063	3905.375	287.161	69.12	356.281	-146.075
2026		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2027		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2028		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2029		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2030		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2031		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2032		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2033		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
2034		139.2687	139.2687	5063	3905.375	287.161	69.12	356.281	217.0123
NPV	2196.268	1170.173	3366.441	53295.04	20692.69	1498.839		2037.342	-1329.1

IRR	0.03247	
B/C R	0.605192	
BET	0.162687	US$
	12.52693	NRs.
Generation Cost	0.063166	US$/kWh
	4.863791	NRs./kWh
Rev/OM Cost Ratio	0.850798	

Financial / Economic Cost

	US $ (000)	NRs. (000)
Capital Cost	2579.046	198587
O&M Cost	154.743	11915
R&R Cost	733.509	56480
Exchange Rate	1	77
Foreign	979.809	75445
Local	1599.237	123141
	2579.046	

Financial Costs			R&R Cost		Economic Costs	
1st Year	773.7138	0.3	726.1739	0.99	970.0109	Foreign
2nd Year	1031.618	0.4		0.9	1439.313	Local
3rd Year	773.7138	0.3			139.2687	O&M
Total	2579.046			Total	2409.324	

Economic Costs	
1st Year	722.7973
2nd Year	963.7297
3rd Year	722.7973
Total	2409.324

Ghami Khola Small Hydropower Project

WESTERN DEVELOPMENT REGION

GHAMI KHOLA SMALL HYDROPOWER PROJECT (1080 KW)

Location

Ghami Khola Small Hydropower Project (GKSHP) is located in Ghami VDC of Muatang district of the Western Development Region of Nepal. The proposed intake of the project lies at approximately 83 51 15 E and 29 4 14 N and an elevation of 3697 masl. Likewise the powerhouse is located at approximately 83 52 20 E and 29 3 58 N. The elevation of the powerhouse is 3550 masl.

Access

Presently the project area is not accessible by motorized vehicles. The nearest roadhead with a connection to the national highway is at Beni, which is about 150 km away from the project site. The all weather foot trail connects the project area to the roadhead and it takes about 5 days in normal trek to traverse the distance. However, the motorable road has reached upto Lomangthan from the territory of Tibet. The total road distance from Tatopani in Nepal to Lomangthan via Tibet is 450 km. Lomangthan, the very popular historic place and also the tourist destination, is situated about 25 km away from Ghami.

The nearest airport is at Jomsom, the district headquarter of Mustang district, which is about 65 km far from the project area. RNAC and other Private Airlines operate regular flights to Jomsom from Pokhara throughout the year.

Geology

Regional Geology

Ghami Khola SHP geologically falls within the Tibetan Sedimentary (Tethyan) zone in Upper Chelegaon Formation covered by thick fluvial and fluvio-torrential sediments of Mustang valley. The Chelegaon Formation consis of alternation of sandstone, pebbly conglomerate, limestone (marl) and clay beds. Regional geological mapping of the area in 1"=1mile scale is carried out by DMG (K. R. Poudyal, A. N. Bhandary and L. D. Tshering, and J. N. Shrestha)

Site Geology

The project area is studied geologically and geotechnically in semi-detail scale. Geological study of the project area and project structures with pit excavation at desanding basin (depth 2.6m), forbay (depth 2.10m) and powerhouse (depth 1.60m) sites with few laboratory tests were carried out for the project. The project structures are located along the right bank of the river.

The left bank at the intake site is comparatively steeper (55^0 - 75^0) than the right bank (35^0). The left bank is composed of gravelly to bouldery compacted clayey sand to silty sand and the right bank consists of gravelly to bouldery silty sand. The desanding basin consists of loose silty sand and compact silty clay at the top (0.70m) with sandy gravel below it. The headrace canal alignment passes mainly through almost flat terrace composed of gravelly to bouldery silty sand. The forbay is located at the bottom of hill slope consisting of silty sand with some gravel. The spillway canal passes through silty to gravelly sand. The penstock alignment passes through cultivated terrace composed of silty sand with some gravel. The powerhouse and tailrace are located on recent alluvial terrace consisting of clayey silt at the top (0.30m) followed by gravelly sand (1.30m) and sandy gravel (1.60m)

The field study report of Ghami Khola SHP is of the feasibility study standard. Therefore additional detailed geological/ engineering geological and geotechnical studies should be carried out prior to detail design stage.

Hydrology

Ghami Khola is one of the main tributary of Kaligandaki River. It meets Kaligandaki at Namja Dovan. The catchment area of the proposed project site calculated from topographical maps no 2983 11 and 2983 15 and 298316 (produced by Department of Survey, HMGN) is 232.32 sq km. Average slope of the Khola is 8%.

Ghami Khola is an ungauged river, therefore direct measurements are not available for this river. Catchments of similar size and characteristics are not also available to correlate the flow characteristics of this river. Therefore in order to estimate hydrological parameters of this river the following methods are used.

HydrA-Nepal

Summary of results obtained from HydrA is as follows:

Mean flow:	4.3 m^3/s
Q90	1.33 m^3/s
Q95	1.12 m^3/s
Average annual runoff:	587 mm

HYDEST results

Summary of results is as follows:

Input parameters:

Drainage basin area	232.32 km^2
Area of basin below 5000 m elevation:	16.87 km^2
Area of basin below 3000 m elevation:	0 km^2
Monsoon wetness index:	250

Low flows:

For RoR plants 1day low flow event will be the parameter of concern for the planners compared to the higher duration (30 days or monthly) events, so only 1-day low flow events are summarized below:

1 day low flow events

Return period	Low flow discharge m^3/s
2	0.12
10	0.02
20	0.01

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	1	2
10	2	6
20	3	8
50	3	12
100	4	15

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.24	0.20	0.18	0.16	0.20	6.7	1.57	1.91	1.42	0.67	2.86	1.96

Flow duration curves:

Probability of exceedance %	0	5	20	40	60	80	95	100
Discharge m^3/s	3.45	2.24	10.49	3.73	1.88	0.16	0.09	0.06

MIP method

In order to apply this method to compute mean monthly flows, we need to know at least one actual flow measurement during the low flow period (November to April). Such data are not available in the previous study, so this method cannot be applied during this stage of the study.

MHSP method

Summary of results obtained from Medium Hydropower Study Method is as follows:

Input parameters:

Total drainage area: 232.32 km^2

Mean monsoon precipitation: 250 mm

Monsoon wetness index: 250

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)
5	225
20	339
50	424
100	494

Long term average discharges (m^3/s):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.46	2.84	2.62	3.26	3.72	7.43	17.50	22.03	17.21	8.62	4.28	2.84

Flow duration curves:

Probability of exceedance %	Max	25	45	65	85	90	95	Min
Discharge m^3/s	97.56	10.14	4.17	3.43	2.24	1.90	1.56	0.43

Previous studies

During the feasibility study conducted in April 2002, the following methods were used to compute the hydrological parameters of this project:

Mean monthly flows were computed at the proposed intake site from the available data of Kaligandaki, Station No 410 at Seti Beni with an appropriate precipitation factor using catchment area ratio method. The other methods used are multiple regression technique using hydrological stations within the Narayani basin and WECS/DHM method.

In calculating hydrological parameters at proposed intake site by catchment area ratio method the data of gauging station no 410 at Seti Beni has been used. The catchment area at Seti Beni is eight times larger than that at the proposed intake site.

So the results of the previous hydrological study are not reliable enough to be used for further studies.

According to the previous study on water users, the estimated downstream irrigation water requirement is 0.15 m^3/s.

Recommended values

HydrA results are recommended to use. Hydra Q90 has been selected for computation of design discharge. While computing design discharge the residual flow in the river (taken as 10% of 90% dependable flow) and downstream irrigation requirement should be deducted from the 90% dependable flow (Q90). HYDEST results are not recommended to use because 93% of the catchment area lies above 5000 masl.

Layout

Ghami Khola Small Hydro Project is a runoff river project. The available gross head is 147 m and the design discharge is 1.05 m^3/sec. The design discharge is calculated by deducting the residual flow as 10% of 90% exceedance flow and downstream irrigation water requirement from 90% exceedance flow giving a total installed capacity of 1080 kW. The headworks consist of approximately 16 m long diversion weir including lateral intake. The length of the weir along its foundation is estimated to be about 20 m and height and depth of foundation is about 1.5 m each. The intake level is proposed at elevation of 3697 masl.

Headrace canal passes through the right bank of the Ghami Khola and the length of the canal will be about 1750 m.

A forebay with spillway has been proposed. A spillway of length 150 m has been proposed to divert the spilled water from forebay back to the Ghami Khola.

The penstock is about 580 m long and the natural slope of the terrain under the penstock alignment is about 39° at the forebay side and 11° at powerhouse side.

Powerhouse is planned to be of the external type. Two units of turbines and generators are used. The length of the tailrace canal will be about 22 m long.

The whole structures of the project would be laid on the right bank of the river.

Energy

Energy production by the Ghami Khola SHP scheme is calculated using HydrA. The annual energy supply from the scheme would be 8553 MWh. The Table given below shows a brief summary of the generated energy.

Summary of generated energy:

S.N.	Turbine Type	No. of Units	Gross avg annual Energy (MWh)	Net avg annual energy (MWh)
1	Pelton	2	8794	8553
2	Turgo	2	8638	8402
3	Crossflow	2	7989	7770

Considering the discharge and energy output 2 Pelton turbine units are suggested to use.

Transmission

Total length of HT line (11 kV): 28 km

Total length of LT line (400 V): 12 km

Environmental aspect

The report is silent on physical, biological and socio-economic environmental impacts. The project area and its catchment lie in Annapurna conservation area and hence requires detailed EIA to proceed with implementation. The project is anticipated to have positive impacts on the tourism activities. The project will have minor impacts on physical environment during construction period. Some problems due to freezing are anticipated during winter period. Overall, the project is considered satisfactory from environmental considerations.

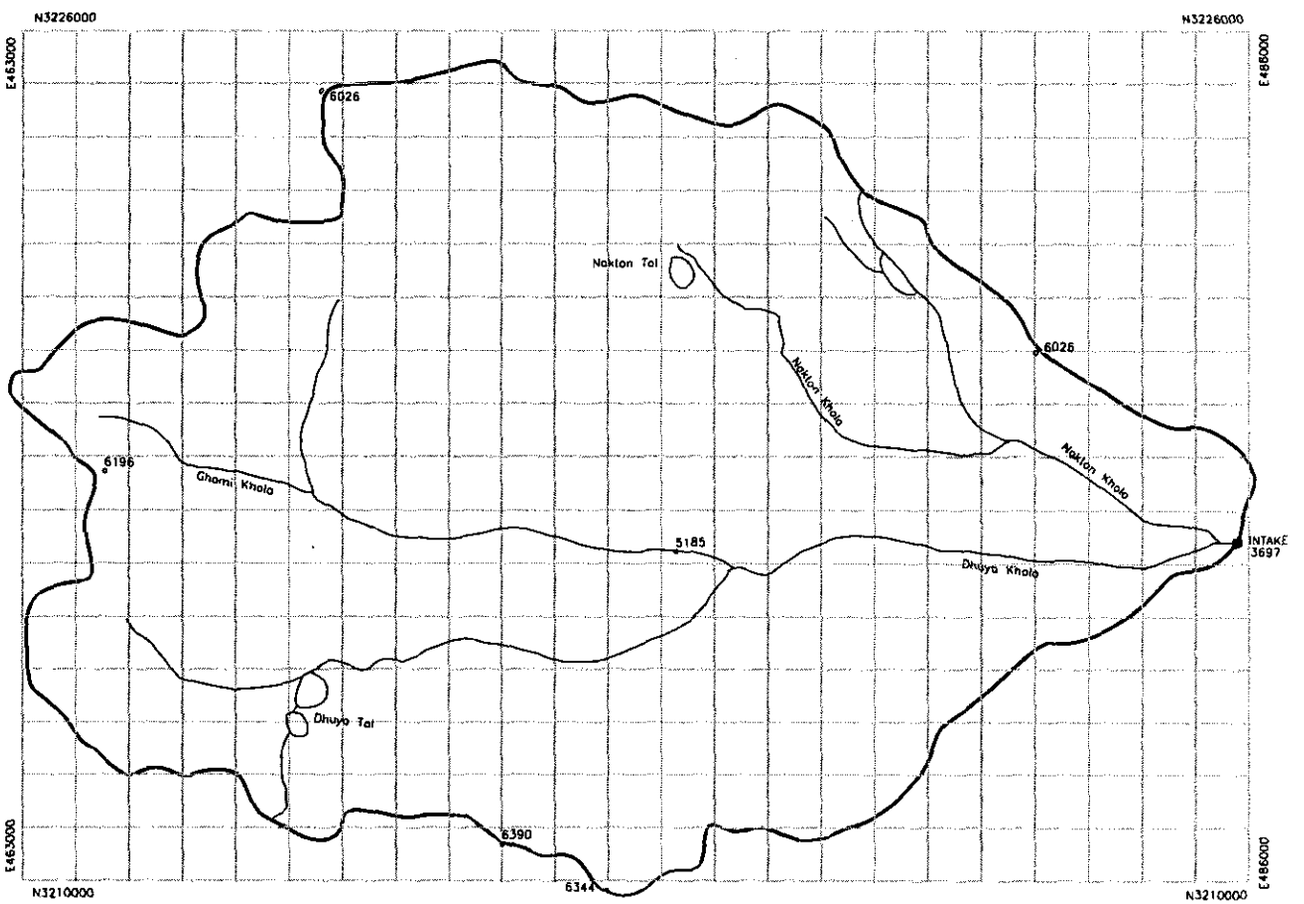
Socio-economic aspect

Economic Analysis

The specific construction cost per kW of Ghami is US$ 2352 and Operation and maintenance cost is 4% of the total cost. The EIRR is estimated –1.1%. The benefit cost ratio is 0.44. The generation cost is US$ 0.03 per kWh and the break-even tariff is US$ 0.58 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 1.05. The ratio of willingness to pay of household with respect to electricity bill per month is 0.73 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0.27.



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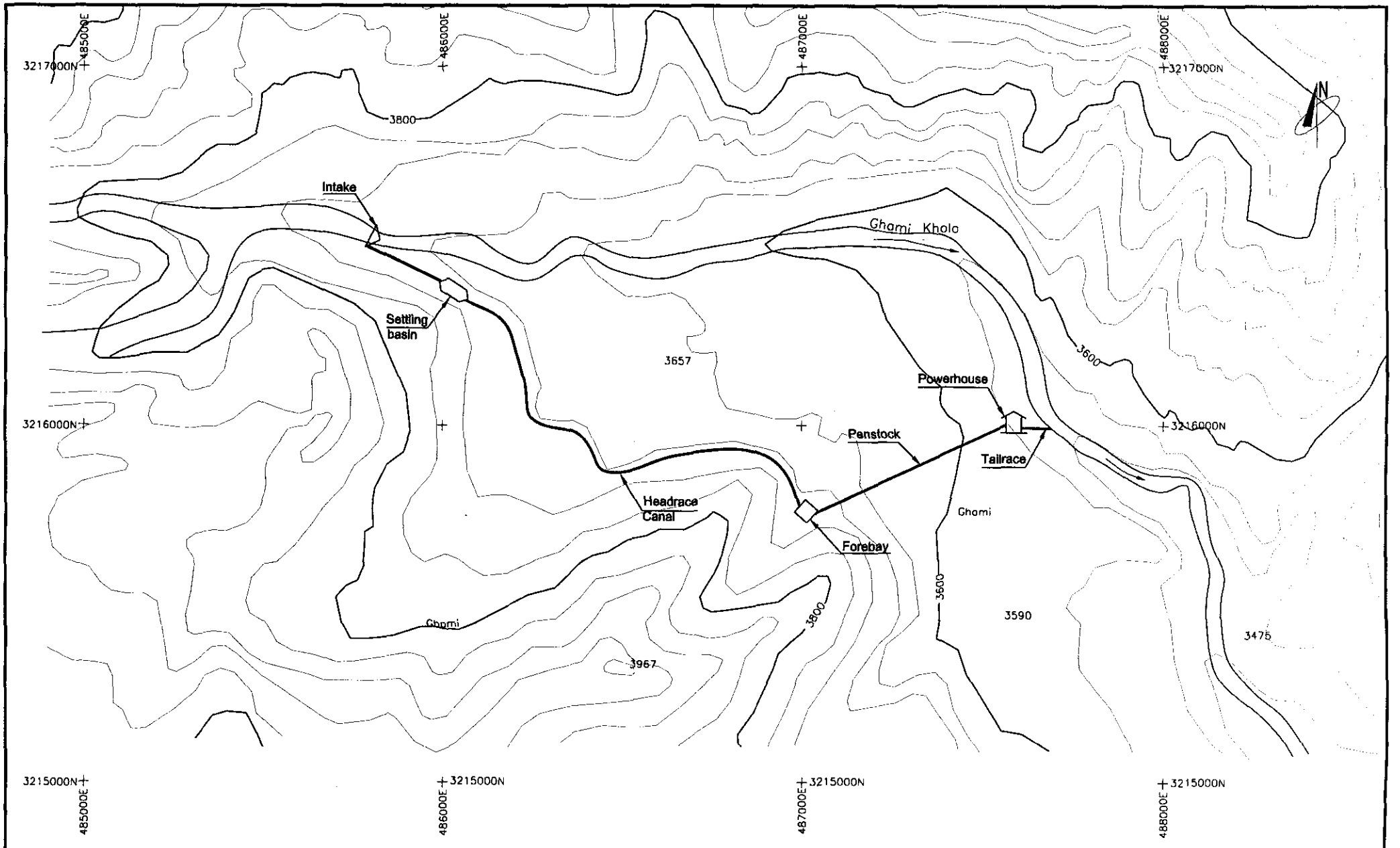
		CATCHMENT AREA	1:100000				



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal	Scale 0 100 200 300(m) 1:10000	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scael.com/itecunepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535585, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared:	Drawing No.
		GENERAL LAYOUT PLAN				Checked:	Sheet No.
						Drawn:	

Load Demand Forecast : Ghami Khola SHP

Parameters	Year 2002	Growth rate 2012	Growth rate 2022	Input Parameters	Year 2002	Growth rate 1st Dec.	Growth rate 2nd Dec.
Population	15740	1.44%	1.44%	Public sector growth		2.00%	2.00%
Person per household	5.16	0.00%	0.00%	Commercial sector growth		2.50%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	37%	-0.55%	0.00%				
Medium income group (%)	47%	0.39%	-0.19%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	11%	0.00%	0.74%	Cons. medium cons. (kWh/a)	360	0.00%	0.00%
				Cons. high consumers (kWh/a)	480	1.00%	1.00%
Household / commercial center	65	-2.00%	-2.00%	Cons. per HH (weighted ave.)	318	0.00%	0.00%
Household / public service	190	-2.00%	-2.00%				
Household / public light	40	-3.00%	-3.00%	Commercial consumption (kWh/a)	750	0.00%	0.00%
				Industrial consumption (MWH/a)	23.4	2.68%	1.34%
El. coeff. low and medium cons.	15%	8.00%	2.25%				
El. coeff. high consumers	60%	7.50%	1.50%	System losses	18%	0.00%	0.00%
El. coeff. commercial centers	30%	5.00%	8.00%	Annual hours of utilization (h)	1314	3.50%	3.50%
El. coeff. public light	30%	5.00%	2.00%				
El. coeff. public services	70%	2.50%	1.00%				

Autonomous Demand : Domestic / Income Level

	Populati	No. of	Number of Potential Consumers				Unit Consumption (kWh/yr)			Domestic Demand (MWh/yr)			
Year	on	househo	Low	Medium	High	Total	Low	Medium	High	Low	Medium	High	Total
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
2002	15740	3050	169	215	201	585	240	360	480	41	77	96	214
2003	15967	3094	184	236	219	639	240	360	485	44	85	106	235
2004	16197	3139	200	260	239	699	240	360	490	48	94	117	259
2005	16430	3184	218	286	261	765	240	360	495	52	103	129	284
2006	16666	3230	238	315	285	838	240	360	499	57	113	142	313
2007	16906	3276	259	346	311	916	240	360	504	62	125	157	344
2008	17150	3323	282	381	339	1002	240	360	510	68	137	173	378
2009	17397	3371	308	419	370	1097	240	360	515	74	151	190	415
2010	17647	3420	335	461	404	1200	240	360	520	80	166	210	456
2011	17901	3469	365	507	441	1313	240	360	525	88	183	232	502
2012	18159	3519	398	558	481	1437	240	360	530	96	201	255	551
2013	18421	3570	413	578	499	1490	240	360	536	99	208	267	574
2014	18686	3621	428	598	518	1544	240	360	541	103	215	280	598
2015	18955	3673	444	619	537	1600	240	360	546	107	223	293	623
2016	19228	3726	461	641	557	1659	240	360	552	111	231	307	649
2017	19505	3780	478	664	578	1720	240	360	557	115	239	322	676
2018	19786	3834	495	687	599	1781	240	360	563	119	247	337	703
2019	20071	3889	514	711	621	1846	240	360	568	123	256	353	732
2020	20360	3945	533	736	644	1913	240	360	574	128	265	370	763
2021	20653	4002	553	762	668	1983	240	360	580	133	274	387	794
2022	20950	4060	574	789	693	2056	240	360	586	138	284	406	828

Autonomous Demand : Commercial / Public Service / Industry

Year	No. of Comm. Cons.	Comm.Unit Cons. kWh/yr	Comm. Load MWh/yr	Industry Load MWh/yr	No. of Public Service	No. of Public Lights	Public Service Load MWh/a	Annual Hours of Utiliz.	Net Load MWh/a	Losses MWh/a	Gross Load MWh/a	Max. Load kW	Power Factor	Indut. Load kW	Peak Load kW
14	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*
2002	14	750	11	23	11	23	26	1314	274	49	323	246	0.04	18	228
2003	15	750	11	24	12	25	28	1360	299	54	352	259	0.04	18	241
2004	17	750	12	25	13	28	30	1408	326	59	385	273	0.05	19	255
2005	18	750	14	25	13	30	33	1457	356	64	420	288	0.05	19	269
2006	20	750	15	26	14	33	36	1508	389	70	459	305	0.05	20	285
2007	21	750	16	27	15	37	39	1561	425	77	502	321	0.06	20	301
2008	23	750	17	27	16	40	42	1615	465	84	548	339	0.06	21	319
2009	25	750	19	28	17	44	46	1672	508	91	599	359	0.07	21	337
2010	27	750	21	29	18	48	50	1730	556	100	656	379	0.08	22	357
2011	30	750	22	30	19	53	54	1791	608	109	717	401	0.08	23	378
2012	32	750	24	30	20	58	59	1854	665	120	785	423	0.09	23	400
2013	36	750	27	31	21	62	63	1918	695	125	820	427	0.10	24	404
2014	40	750	30	31	22	66	66	1986	726	131	857	432	0.10	24	408
2015	45	750	34	32	23	71	70	2055	759	137	895	436	0.10	24	412
2016	51	750	38	32	24	75	75	2127	793	143	936	440	0.11	24	416
2017	57	750	42	33	25	81	79	2201	830	149	980	445	0.11	25	420
2018	63	750	47	33	27	86	84	2278	868	156	1024	450	0.12	25	424
2019	71	750	53	33	28	92	89	2358	908	163	1072	454	0.13	25	429
2020	79	750	59	34	29	98	95	2441	951	171	1122	460	0.13	26	434
2021	88	750	66	34	30	104	101	2526	996	179	1175	465	0.14	26	439
2022	99	750	74	35	32	111	107	2615	1044	188	1231	471	0.14	27	444

ECONOMIC ANALYSIS: GHAMI KHOLA SHP

year	CC	O&M	Total	Generation	Energy	Benefit	Capacity	Total	Net Cash
	000 US$	000 US$	Cost	Cap (MW	MWh	000 US$	Benefit	Benefit	Flow
2002	708.9623	0	708.9623	8550	0	0		0	-708.962
2003	945.2831	0	945.2831	8550	0	0		0	-945.283
2004	708.9623	0	708.9623	8550	0	0		0	-708.962
2005		91.458	91.458	8550	356.1282	27.26755	116.64	143.9075	52.44955
2006		91.458	91.458	8550	389.2402	29.81901	116.64	146.459	55.00101
2007		91.458	91.458	8550	425.1071	32.58656	116.64	149.2266	57.76856
2008		91.458	91.458	8550	464.5863	35.62762	116.64	152.2676	60.80962
2009		91.458	91.458	8550	507.9463	38.97537	116.64	155.6154	64.15737
2010		91.458	91.458	8550	555.684	42.66389	116.64	159.3039	67.84589
2011		91.458	91.458	8550	607.8982	46.70102	116.64	163.341	71.88302
2012		91.458	91.458	8550	665.1447	51.12458	116.64	167.7646	76.30658
2013		91.458	91.458	8550	694.9869	53.49536	116.64	170.1354	78.67736
2014		91.458	91.458	8550	726.2508	55.99112	116.64	172.6311	81.17312
2015		91.458	91.458	8550	758.8805	58.59415	116.64	175.2342	83.77615
2016		91.458	91.458	8550	793.4975	61.36283	116.64	178.0028	86.54483
2017		91.458	91.458	8550	830.1941	64.3054	116.64	180.9454	89.4874
2018		91.458	91.458	8550	868.0826	67.34932	116.64	183.9893	92.53132
2019		91.458	91.458	8550	908.2424	70.58428	116.64	187.2243	95.76628
2020		91.458	91.458	8550	950.7906	74.0208	116.64	190.6608	99.2028
2021		91.458	91.458	8550	995.8547	77.67033	116.64	194.3103	102.8523
2022		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2023		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2024		463.7495	463.7495	8550	1043.573	81.54541	116.64	198.1854	-265.564
2025		463.7495	463.7495	8550	1043.573	81.54541	116.64	198.1854	-265.564
2026		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2027		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2028		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2029		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2030		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2031		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2032		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2033		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
2034		91.458	91.458	8550	1043.573	81.54541	116.64	198.1854	106.7274
NPV	2154.23	799.8458	2954.076	90000.51	5110.786	395.0801		1303.803	-1650.27

IRR	-0.01%	
B/C R	0.441358	
BET	0.578008	US$
	44.50662	NRs.
Generation Cost	0.032823	US$/kWh
	2.527362	NRs./kWh
Rev/OM Cost Ratio	0.298143	

Financial / Economic Cost

	US $ (000)	NRs. (000)
Capital Cost	2540.496	195618
O&M Cost	101.62	7825
R&R Cost	752.104	57912
Exchange Rate	1	77
Foreign	852.904	65674
Local	1687.592	129945
	2540.496	

Financial Costs

1st Year	762.1488	0.3
2nd Year	1016.198	0.4
3rd Year	762.1488	0.3
Total	2540.496	

Economic Costs

R&R Cost				
744.583	0.99	844.375	Foreign	
	0.9	1518.833	Local	
		91.458	O&M	
	Total	2363.208		

Economic Costs

1st Year	708.9623
2nd Year	945.2831
3rd Year	708.9623
Total	2363.208