Mujkot Khola Small Hydropower Project

MID WESTERN DEVELOPMENT REGION

MUJKOT KHOLA SMALL HYDROPOWER PROJECT (950 KW)

Location

Mujkot Khola Small Hydropower Project (MKSHP) is located in Garkhakot VDC of Jajarkot district of the mid western development region of Nepal. The proposed intake of the project lies at approximately 81° 59' 07" E and 28° 47' 37" N and an elevation of 998 m. Likewise the powerhouse is located at approximately 82° 00' 59" E and 28° 47' 03" N and an elevation of 940.9 m.

Access

Access to the project site is 76 km long foot track from Birendranagar, Surkhet. The nearest airport consist of an all-weather STOL airfield at Chaurjhari, in Rukum district about 10 km to the south of Jajarkot district headquarters.

Geology

Regional Geology

Mujkot Khola SHP geologically falls on Lesser Himalayan metasandimants and crystallines represented by Ranimatta/ Seti Formation (Rm/St) and Raduwa Formation (Ra) equivalent rocks, respectively. The crystalline formation consists of garnet schist and quartzite whereas the metasedimentary formation consists of phyllite, phylitic quartzite and conglomerate. The project area forms the northern limb of a faulted anticline which plunges westward. Regional geological mapping of the area in 1"=1mile scale is carried out by DMG (N. B. Kaystha).

Site Geology

The project area is studied in detail geologically/ engineering geologically and geotechnically. The project structures are located along the left bank of the khola. The project structures, especially the headrace canal alignment, is studied in detail and described chainage wise.

The intake site on the river bed flour consists of boulder, cobble, pebble and gravel of gneiss, quartzite and schist in a medium to coarse sandy matrix, while the banks of the river are made up of garnet schist and (?) gritty phyllite. The gravel trap is located at ch. 0+080 and consists of the same material as at intake site river bed floor. The desanding basin is located at ch. 0+500 on a rocky slope with granet schist. The headrace canal alignment passes through rocky slope (represented by garnet schist and phyllite), cultivated land etc. Numerous gully crossings and minor landslides are noted along the canal alignment. Chainage wise detail description of the alignment is provided in the report. The forbay is located on a stable hill slope made up of intensively fractured to crushed quartzite covered with colluvial soil blanket consisting of gravel and boulder. The penstock alignment passes through a terrain consisting of bed rock (quartzite) lying below a cover (overburden) of quartzite fragments. The powerhouse and the tailrace sites are located on an alluvial terrace consisting of subangular to subrounded cobble and gravel with occasional boulders in a silty sandy matrix.

The detail study report provides comprehensive information about the project structures. During construction stage some additional subsurface investigation and laboratory testing on soil and rock samples is recommended for better understanding and design of project structures.

Hydrology

The Mujkot Khola is one of the tributary of Chhera Khola, located in Bheri basin. The catchment area of the proposed project measured at headworks site from the topographical maps 2881 04, 2882 01, 2982 13 and 2981 16 (produced by Department of Survey, HMGN) is 260 sq km. Average slope of the river is 6 %.

The Mujkot Khola 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: 11.00 m^3/s
Average annual runoff: 1333 mm

Flow duration curve:

Probability of exceedance %	5	20	40	60	80	90	95
Discharge m^3/s	32.70	17.58	7.85	4.81	3.48	2.91	2.39

HYDEST results

Input parameters:
Area of basin below 5000 m elevation: 260 km^2
Area of basin below 3000 m elevation: 196.7 km^2
Monsoon wetness index: 1500
Summary of results is as follows:
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	1.94
10	1.24
20	1.07

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	126	195
10	225	397
20	265	486
50	319	610
100	361	710

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.28	2.79	2.53	2.65	3.63	11.96	36.93	44.26	33.86	14.86	6.41	4.17

Flow duration curve:

Probability of exceedance %	5	20	40	60	80	90	95
Discharge m^3/s	50.19	25.81	7.45	3.61	2.52	1.97	1.69

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

Input parameters:
Total drainage area: 260 km^2
Mean monsoon precipitation: 1250 mm
Monsoon wetness index: 1500
Summary of results is as follows:

Flood flows:

Return period	Flood discharge m^3/s
5	248
20	373
50	466
100	543

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.81	3.14	2.90	3.63	4.15	12.16	34.29	41.12	31.95	15.05	7.30	4.75

Flow duration curve:

Probability of exceedance %	max	25	45	65	85	90	95	min
Discharge m^3/s	278.15	19.22	6.64	3.79	2.49	2.11	1.73	0.49

Previous studies

During the Feasibility study conducted in January 1997, the following methods were used to compute the hydrological parameters of this project:

Lohore Khola at Bale Budha (catchment area 1019 sq. km) and Chham Gad at Gita Chaur (catchment area 300.5 sq. km) were considered to be reasonable for catchment correlation.
Long term mean monthly flows were derived from the HYDEST method and linera reservoir model was also used (the model was tested for Chham Gad and constants were determined for Mujkot basin. Rainfall data of the station at Jajarkot were used.

Recommended values

Because of lack of actual measurements from Mujkot Khola, HydrA and HYDEST results are recommended to use. Hydra Q90 has been selected as design discharge.

Layout

Mujkot Khola Small Hydro Project is a run-of-river project. The available gross head is 52 m and the design discharge is 2.62 m^3/sec (90 % exceedance minus 10% of it as downstream release) giving a total installed capacity of 950 kW. The headworks consist of approximately 30 m long diversion weir including tyrolean intake. The intake level is proposed at elevation of 998 masl.
Headrace canal passes through the right bank of the river and the length of the canal will be about 3008 m.

The penstock is about 78 m long and the natural slope of the terrain under the penstock alignment is about 40°.

Powerhouse is planned to be of the external type. The length of the tailrace canal will be about 20 m.

Energy

Energy production by the Mujkot 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	Francis spiral case	3	7494	7288
2	Crossflow	3	7112	6917

Considering the discharge and energy output 3 Francis spiral case turbine units are suggested to use.

Transmission

The proposed load centers of the project are Majkot, Garkhakot, Salma, Suwanauli, Jungathapachaur, Padaru, Jhapra, Jajarkot-Khalanga, Dasera VDCs of Jajarkot district.
Total length of HT line (33 kV): 42 km to Dailekh
Total length of HT line (11 kV): 63.2 km
Total length of LT line (400 V): 36 km

Environmental aspect

The project is run-of-river type and the study shows that the project is favorable and no serious impacts are anticipated. Some adverse impacts will require mitigation procedures. No water rights issues are identified in the project area. Some clearance of trees in the intake and penstock alignment is required. The canal alignment will also affect habitat of wild life. Some slope stability problems are reported in the project area. Some mitigation measures such as compensation plantation and bioengineering will be required. The measures will require monitoring during construction and initial stages of operation. Overall, the project is considered to be environmentally favorable, however, further investigations are required in sensitive areas.

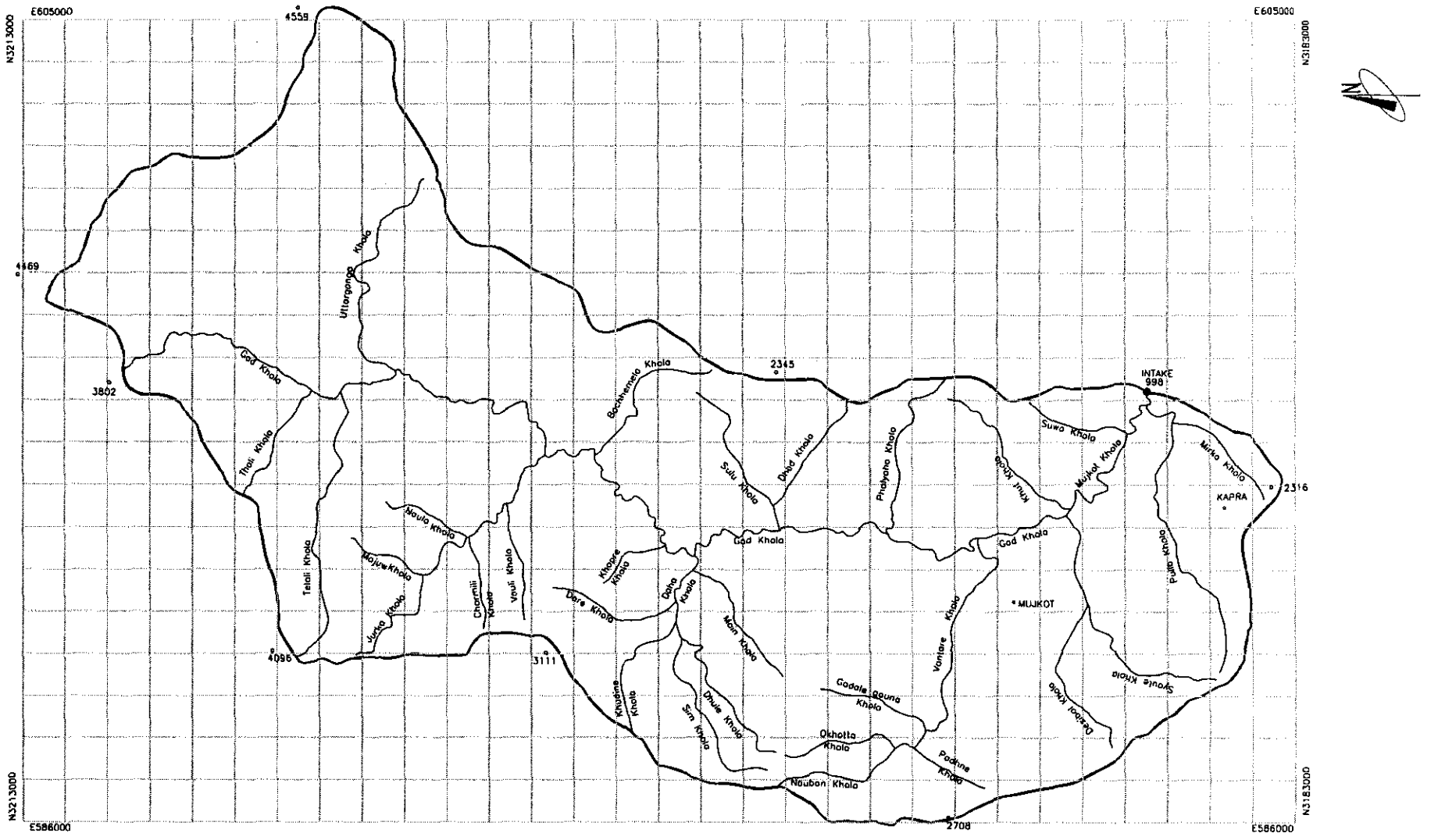
Socio-economic aspect

Economic Analysis

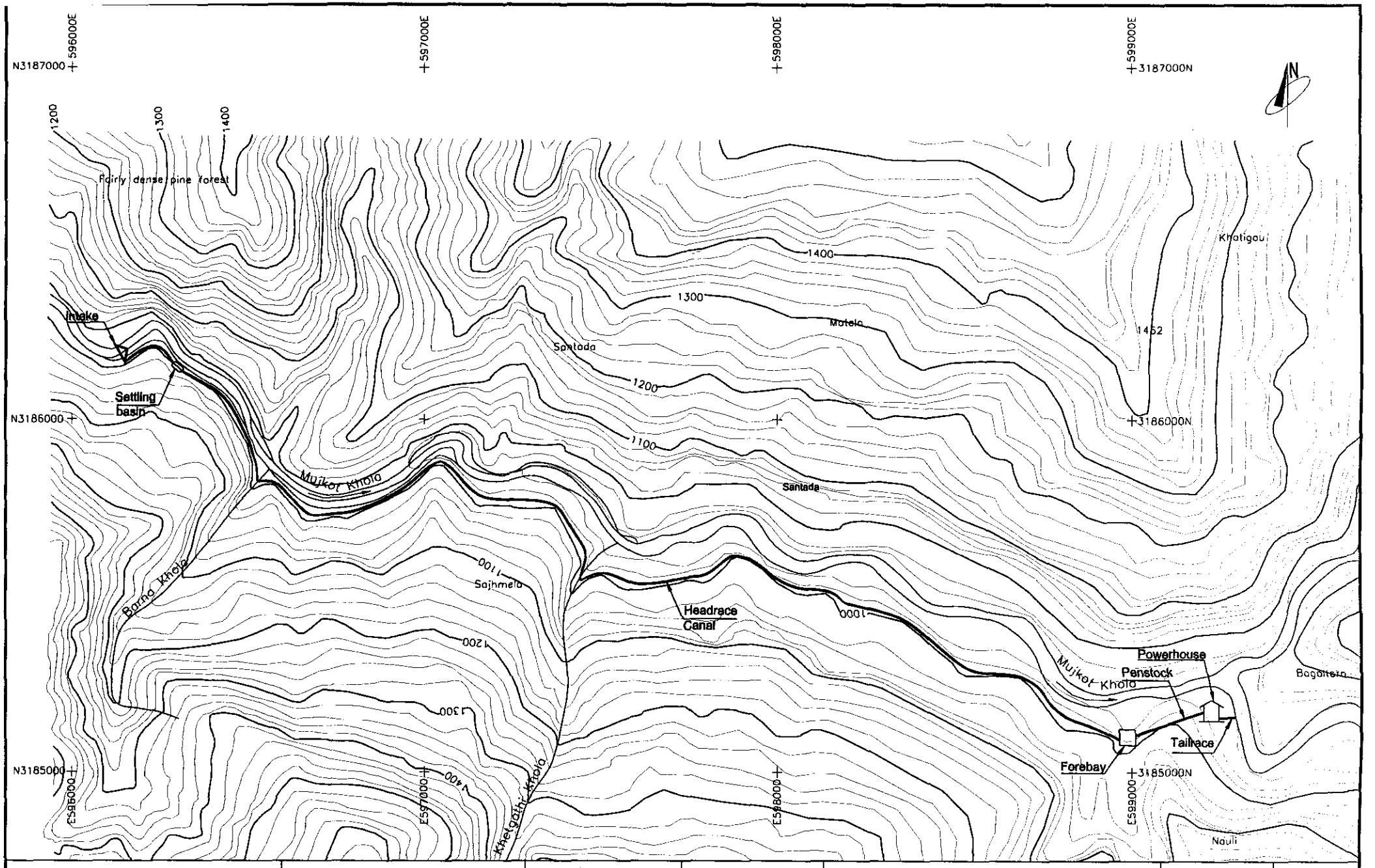
The specific construction cost per kW of Mujkot is US$ 3529 and Operation and maintenance cost is 5% of the total cost. The EIRR is estimated 11.2%. The benefit cost ratio is 1.04. The generation cost is US$ 0.02 per kWh and the break-even tariff is US$ 0.11 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 0.54. The ratio of willingness to pay of household with respect to electricity bill per month is 0.52 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0.33.



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	MUJKOT KHOLA SHP Jajarkot, MWDR, 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 482295 Web site: www.scsef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11729, 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	MUJKOT KHOLA SHP Jajarkot, MWDR, 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 482298 Web site: www.sceef.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 : Mujkot Khola SHP

Parameters	Year 2002	Growth rate 2012	Growth rate 2022	Input Parameters	Year 2002	Growth rate 1st Dec.	Growth rate 2nd Dec.
Population	48413	1.60%	1.60%	Public sector growth		2.00%	2.00%
Person per household	5.58	0.00%	0.00%	Commercial sector growth		2.50%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	44%	-0.46%	-0.49%				
Medium income group (%)	47%	0.47%	0.45%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	11%	0.00%	0.00%	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	199	-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)	70.2	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

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	48413	8682	573	612	573	1758	240	360	480	138	220	275	633
2003	49188	8821	626	675	626	1927	240	360	485	150	243	303	697
2004	49975	8962	684	744	684	2112	240	360	490	164	268	335	767
2005	50774	9105	747	820	747	2314	240	360	495	179	295	369	844
2006	51587	9251	816	904	816	2536	240	360	499	196	325	408	929
2007	52412	9399	891	997	891	2779	240	360	504	214	359	449	1022
2008	53251	9549	973	1099	973	3045	240	360	510	233	396	496	1125
2009	54103	9702	1063	1212	1063	3338	240	360	515	255	436	547	1238
2010	54968	9857	1160	1336	1161	3657	240	360	520	279	481	603	1363
2011	55848	10015	1267	1473	1268	4008	240	360	525	304	530	666	1500
2012	56741	10175	1384	1624	1385	4393	240	360	530	332	585	734	1651
2013	57649	10338	1431	1695	1428	4554	240	360	536	343	610	765	1718
2014	58572	10503	1479	1769	1473	4721	240	360	541	355	637	797	1789
2015	59509	10671	1529	1846	1519	4894	240	360	546	367	665	830	1861
2016	60461	10842	1581	1926	1566	5073	240	360	552	379	693	864	1937
2017	61428	11016	1635	2010	1615	5260	240	360	557	392	724	900	2016
2018	62411	11192	1690	2097	1665	5452	240	360	563	406	755	937	2098
2019	63410	11371	1747	2188	1717	5652	240	360	568	419	788	976	2183
2020	64424	11553	1806	2283	1771	5860	240	360	574	433	822	1017	2272
2021	65455	11738	1867	2382	1826	6075	240	360	580	448	858	1059	2365
2022	66502	11926	1930	2486	1883	6299	240	360	586	463	895	1103	2461

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	40	750	30	70	31	65	72	1314	805	145	950	723	0.13	53	669
2003	44	750	33	72	32	72	78	1360	880	158	1038	763	0.14	55	708
2004	47	750	36	74	34	79	85	1408	961	173	1134	806	0.16	56	750
2005	52	750	39	76	37	87	92	1457	1051	189	1240	851	0.17	58	793
2006	56	750	42	78	39	95	101	1508	1150	207	1357	900	0.19	59	840
2007	61	750	46	80	41	105	110	1561	1258	226	1484	951	0.20	61	890
2008	67	750	50	82	44	115	119	1615	1377	248	1624	1006	0.22	63	943
2009	73	750	54	84	47	127	130	1672	1507	271	1779	1064	0.24	64	1000
2010	79	750	59	87	50	139	142	1730	1651	297	1948	1126	0.27	66	1060
2011	86	750	65	89	53	153	155	1791	1808	325	2134	1191	0.29	68	1124
2012	94	750	70	91	56	169	168	1854	1981	357	2338	1261	0.32	70	1192
2013	105	750	79	93	59	180	179	1918	2069	372	2441	1273	0.33	71	1202
2014	117	750	88	94	61	192	190	1986	2161	389	2550	1284	0.35	71	1213
2015	131	750	99	95	64	206	202	2055	2258	406	2664	1296	0.37	72	1224
2016	147	750	110	96	67	220	215	2127	2359	425	2784	1309	0.38	73	1235
2017	165	750	124	98	71	235	229	2201	2466	444	2910	1322	0.40	74	1248
2018	184	750	138	99	74	251	243	2278	2578	464	3043	1335	0.42	75	1260
2019	207	750	155	100	77	268	259	2358	2697	485	3183	1350	0.44	76	1273
2020	231	750	173	102	81	286	275	2441	2823	508	3331	1365	0.46	77	1287
2021	259	750	194	103	85	306	293	2526	2955	532	3487	1380	0.48	78	1302
2022	290	750	217	104	89	327	312	2615	3095	557	3652	1397	0.50	80	1317

ECONOMIC ANALYSIS: MUJKOT 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	132	0	132	7288	0	0		0	-132
2003	175	0	175	7288	0	0		0	-175
2004	132	0	132	7288	0	0		0	-132
2005		150.8679	150.8679	7288	1051.038	61.01547	102.6	163.6155	12.74757
2006		150.8679	150.8679	7288	1149.645	66.70209	102.6	169.3021	18.43419
2007		150.8679	150.8679	7288	1257.869	72.93888	102.6	175.5389	24.67098
2008		150.8679	150.8679	7288	1376.559	79.77051	102.6	182.3705	31.50261
2009		150.8679	150.8679	7288	1507.37	87.29051	102.6	189.8905	39.02261
2010		150.8679	150.8679	7288	1650.681	95.54351	102.6	198.1435	47.27561
2011		150.8679	150.8679	7288	1808.234	104.602	102.6	207.202	56.33406
2012		150.8679	150.8679	7288	1981.367	114.5922	102.6	217.1922	66.32432
2013		150.8679	150.8679	7288	2068.793	125.5421	102.6	228.1421	77.27419
2014		150.8679	150.8679	7288	2160.965	137.5843	102.6	240.1843	89.31642
2015		150.8679	150.8679	7288	2257.611	150.8257	102.6	253.4257	102.5578
2016		150.8679	150.8679	7288	2358.952	157.6079	102.6	260.2079	109.34
2017		150.8679	150.8679	7288	2466.144	164.7778	102.6	267.3778	116.5099
2018		150.8679	150.8679	7288	2578.473	172.3063	102.6	274.9063	124.0384
2019		150.8679	150.8679	7288	2697.219	180.2129	102.6	282.8129	131.945
2020		150.8679	150.8679	7288	2822.713	188.5956	102.6	291.1956	140.3277
2021		150.8679	150.8679	7288	2954.735	197.3975	102.6	299.9975	149.1296
2022		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2023		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2024		637.1336	637.1336	7288	3094.609	206.7262	102.6	309.3262	-327.807
2025		637.1336	637.1336	7288	3094.609	206.7262	102.6	309.3262	-327.807
2026		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2027		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2028		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2029		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2030		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2031		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2032		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2033		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
2034		150.8679	150.8679	7288	3094.609	206.7262	102.6	309.3262	158.4583
NPV	400.1818	1289.428	1689.61	76716.23	15166.3	951.557		1750.897	61.28669

IRR	0.11%	
B/C R	1.036273	
BET	0.111406	US$
	8.578228	NRs.
Generation Cost	0.022024	US$/kWh
	1.69586	NRs./kWh
Rev/OM Cost Ratio	0.40443	

Financial / Economic Cost

	US $ (000)	NRs. (000)
Capital Cost	3352.629	258152
O&M Cost	167.631	12908
R&R Cost	982.355	75641
Exchange Rate	1	77
Foreign	1228.055	94560
Local	2124.574	163592
	3352.629	

Financial Costs

1st Year	1005.789	0.3
2nd Year	1341.052	0.4
3rd Year	1005.789	0.3
Total	3352.629	

Economic Costs

R&R Cost				
972.5315	0.99	1215.774	Foreign	
	0.9	1912.117	Local	
		150.8679	O&M	
	Total	3127.891		

Economic Costs

1st Year	938.3673
2nd Year	1251.156
3rd Year	938.3673
Total	3127.891

Galwa Gad Small Hydropower Project

GALWA GAD SMALL HYDROPOWER PROJECT (100 KW)

Location

Galwa Gad Small Hydropower Project (GGSHP) is located in Shreenagar of Humla and Mihi of Mugu district of the mid western development region of Nepal. The proposed intake of the project lies at approximately 81° 52' 25" E and 29° 40' 03" N and an elevation of 1398 m. Likewise the powerhouse is located at approximately 81° 52' 44" E and 29° 39' 32" N and an elevation of 1321 m.

Access

Road access is not available to the site. Access by air is available upto Simikot (district headquarter of Humla), project site is located at about 2 days walk from the airport.

Geology

Regional Geology

Galwa Gad SHP geologically falls within the Midland Metasediments of Nawakot Complex (na) in Benighat/Kuncha (Bg/Kn) Formation consisting mainly of slate/ phyllitic slate. Regional geological mapping of the area in 1"=1mile scale is not carried out by DMG.

Site Geology

During detailed engineering design study, limited feasibility stage standard geological/ engineering geological and geotechnical investigations were carried out in the project area. The project structures are located along the left bank of the khola. The area consists of slate / phyllitic slate with colluvial and alluvial surficial deposits.

The intake is located near the intake of existing irrigation canal. Both the river bank slopes at the intake site are made up of colluvial soil represented by gravel and boulder of quartzite upstream of the weir site whereas the downstream side generally contains gravel and boulder of slate/ phyllitic slate. The left bank is barrern (without vegetation) and comparatively steeper (400-650) than the right bank which is cultivated. The left bank is covered by landslides. Nothing is mentioned about the desanding basin. The headrace canal alignment follows an existing irrigation canal. The canal alignment has an average slope of 35^0 - 45^0 and passes through rock (45%) and colluvial soil (55%). There are few small landslides along the canal alignment (no detail provided). The rock is represented by soft to medium soft slate/ phyllitic slate and the colluvial soil is made up of light grey slity gravel with subangular rock fragments of phyllitic slate and quartzite up to a depth of 2.90m. At stretches the rock makes near vertical cliffs where the width of the exising canal is very narrow. The forbay site is located on a stable hill slope of 300 to 400. The hill side of the forbay is barren whereas its valley side is cultivated. It is made up of clayey silt (0.15m) and fine to medium sand (2.20m). Below the sand (>2.20m) alluvial soil consisting of rounded to subrounded gravel and boulder of quartzite is encountered. The penstock alignment passes through a terrain with similar geological composition as that of forbay, but its lower section passes through alluvial terrace. The powerhouse and the tailrace sites are located on a river terrace at the right bank of Humla Karnali river. The alluvial terrace consists of silty clayey topsoil (0.35m) and fine to medium sand with sandy gravel below it (2.10m). The tailrace alignment is composed of similar alluvial soil as that of the powerhouse.

Though the project is studied to detailed engineering design stage, it needs additional detailed geological/ engineering geological and geotechnical studies (1:2000 and 1:5000 scale) prior to construction stage.

Hydrology

The Galwa Gad is one of the tributary of Humla Karnali river. The catchment area of the proposed project measured at headworks site from the topographical maps 2981 08 and 2981 04 (produced by Department of Survey, HMGN) is 101.4 sq km. Average slope of the river is 14.3 %.
Galwa Gad is an ungauged river; therefore direct measurements are not available for this river.

HydrA-Nepal

Summary of results obtained from HydrA is as follows:
Mean flow: 2.50 m^3/s
Average annual runoff: 788 mm

Flow duration curve:

Probability of exceedance %	5	20	40	60	80	90	95
Discharge m^3/s	10.10	3.84	1.22	0.51	0.26	0.18	0.08

HYDEST results

Input parameters:
Area of basin below 5000 m elevation: 101.3 km^2

Area of basin below 3000 m elevation: 65.5 km^2
Monsoon wetness index: 400
Summary of results is as follows:
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	0.74
10	0.39
20	0.30

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	44	75
10	85	166
20	102	209
50	125	269
100	144	319

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.31	1.12	1.00	1.00	1.31	3.31	10.28	12.31	9.16	4.23	1.55	1.05

Flow duration curve:

Probability of exceedance %	5	20	40	60	80	90	95
Discharge m^3/s	14.07	5.71	1.88	0.94	0.95	0.73	0.62

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

Input parameters:
Total drainage area: 101.3 km^2
Mean monsoon precipitation: 600 mm
Monsoon wetness index: 400
Summary of results is as follows:

Flood flows:

Return period	Flood discharge m^3/s
5	110
20	167
50	210
100	247

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.69	1.38	1.25	1.47	1.67	4.18	11.10	13.75	10.84	5.34	2.61	1.70

Flow duration curve:

Probability of exceedance %	max	25	45	65	85	90	95	min
Discharge m^3/s	63.90	5.40	2.13	1.62	1.04	0.88	0.71	0.16

Previous studies

An effort was made to derive the mean monthly flows at the proposed intake site from the available data of the Chameliya river at Karkale gaon station no 120 on the pro-rata basis (catchment area 1150 sq km). However the catchment size and characteristics are quite different to compare.

Recommended values

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

Layout

Galwa Gad Small Hydro Project is a runoff river project. The available gross head is 77 m and the design discharge is 0.16 m^3/sec (90 % exceedance minus 10% of it as downstream release) giving a total installed capacity of 100 kW. The headworks consist of approximately 14 m long diversion weir including tyrolean intake. The length of the weir along its foundation is estimated to be about 15 m and height and depth of foundation is about 1.5 m each. The intake level is proposed at elevation of 1398 masl.
Headrace canal passes through the left bank of the river and the length of the canal will be about 1460 m.
The penstock is about 175 m long and the natural slope of the terrain under the penstock alignment is about 15-40°.

Powerhouse is planned to be of the external type. 1 unit of Pelton turbine and generator is used. The length of the tailrace canal will be about 86 m.

Energy

Energy production by the Galwa Gad 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	1	709	689
2	Turgo	1	696	677
3	Crossflow	1	644	626

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

Transmission

Load centers are, Shreenagar, Kalika and Jair of Humla and Mihi, Natharpuand Dhaina of Mugu district.
Total length of HT line (11 kV): 10 km
Total length of LT line (400 V): 9 km

Environmental aspect

The project report is silent on environmental aspects. The project diverts very small discharge for hydropower and therefore no signification physical environmental impacts are anticipated during construction and operation phase. The project will have positive socio-economic impact in the load centers. A thorough environmental examination will be required prior to implementation.

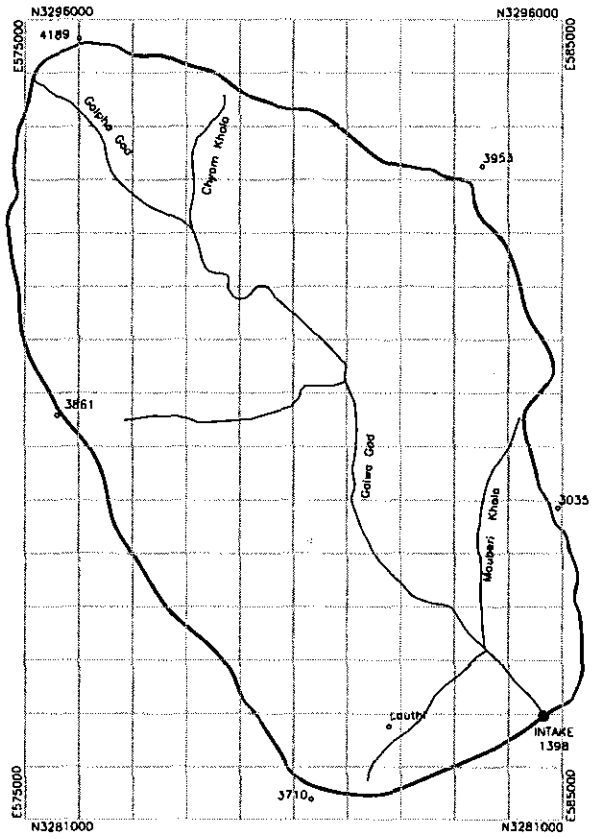
Socio-economic aspect

Economic Analysis

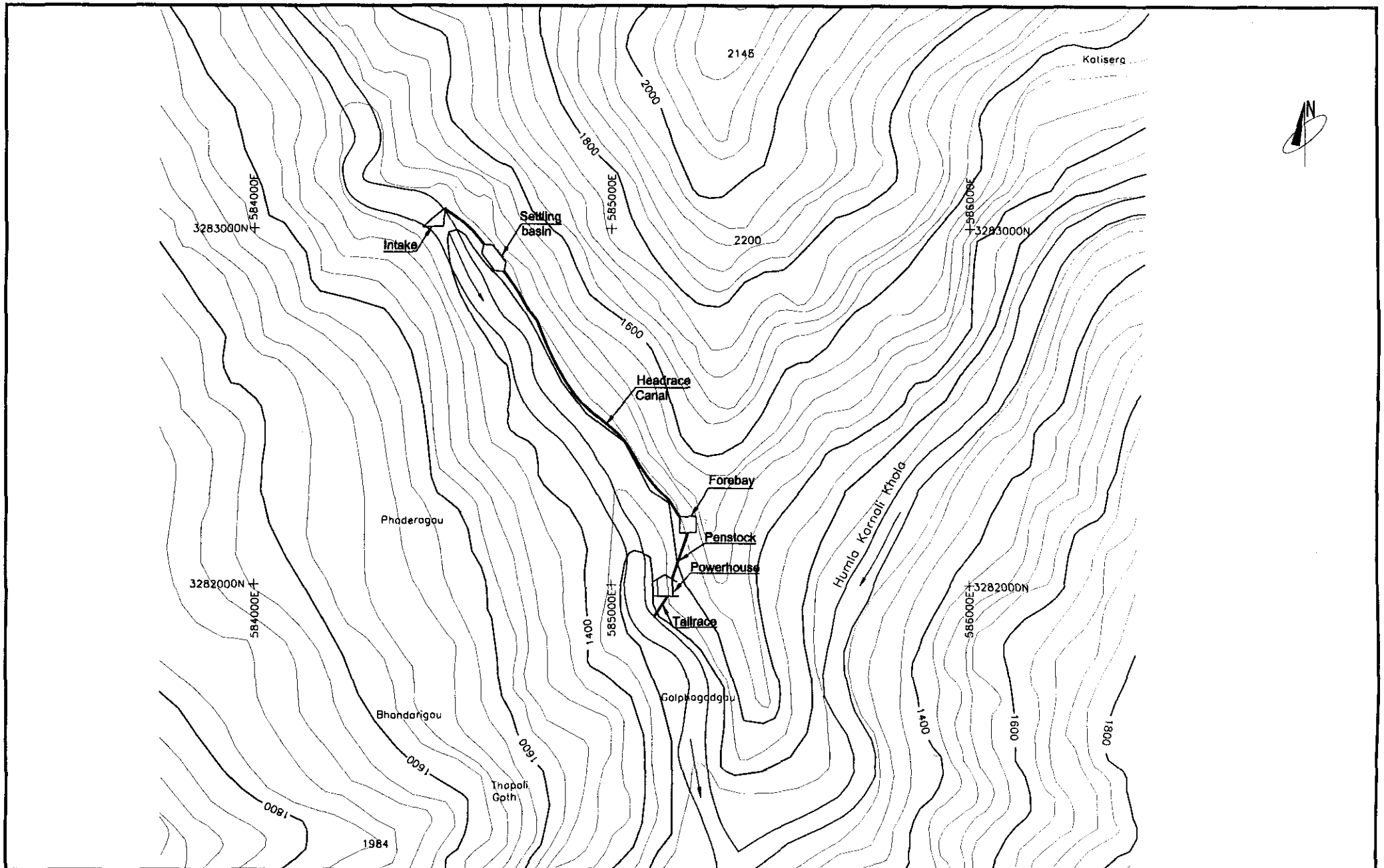
The specific construction cost per kW of Galwa is US$ 9953 and Operation and maintenance cost is 6% of the total cost. The EIRR is estimated –5.2%. The benefit cost ratio is 0.35. The generation cost is US$ 0.18 per kWh and the break-even tariff is US$ 0.24 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 0.77. The ratio of willingness to pay of household with respect to electricity bill per month is 0.81 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0.42.



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	GALWA GAD SHP Humla, MWDR, 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: 493764, Fax 482298 Web site: www.scnet.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	GALWA GAD SHP Humla, MWDR, 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: 493764, Fax 482296 Web site: www.eceef.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.

Load Demand Forecast : Galwa gad SHP

Parameters	Year 2002	Growth rate 2012	Growth rate 2022	Input Parameters	Year 2002	Growth rate 1st Dec.	Growth rate 2nd Dec.
Population	11068	1.70%	1.70%	Public sector growth		2.00%	2.00%
Person per household	5.86	0.00%	0.00%	Commercial sector growth		2.55%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	54%	-0.77%	-0.62%				
Medium income group (%)	47%	1.55%	0.83%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	11%	-0.64%	0.00%	Cons. medium cons. (kWh/a)	360	0.00%	0.00%
				Cons. high consumers (kWh/a)	480	1.00%	1.00%
Household / commercial center	77	-2.96%	-2.78%	Cons. per HH (weighted ave.)	318	0.00%	0.00%
Household / public service	86	-1.90%	-2.00%				
Household / public light	40	-2.84%	-3.97%	Commercial consumption (kWh/a)	750	0.00%	0.00%
				Industrial consumption (MWH/a)	46.8	2.68%	1.34%
El. coeff. low and medium cons.	30%	8.53%	2.61%				
El. coeff. high consumers	60%	4.14%	0.00%	System losses	18%	0.00%	0.00%
El. coeff. commercial centers	30%	5.24%	3.42%	Annual hours of utilization (h)	1314	3.50%	3.50%
El. coeff. public light	30%	5.24%	3.42%				
El. coeff. public services	70%	1.34%	1.18%				

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	11068	1889	306	266	125	697	240	360	480	73	96	60	229
2003	11256	1921	335	298	132	765	240	360	485	80	107	64	252
2004	11448	1953	367	334	139	840	240	360	490	88	120	68	276
2005	11642	1987	402	375	146	923	240	360	495	96	135	72	304
2006	11840	2020	440	420	154	1014	240	360	499	106	151	77	334
2007	12041	2055	482	471	162	1115	240	360	504	116	170	82	367
2008	12246	2090	528	528	170	1226	240	360	510	127	190	87	403
2009	12454	2125	578	592	179	1349	240	360	515	139	213	92	444
2010	12666	2161	633	664	188	1485	240	360	520	152	239	98	489
2011	12881	2198	694	744	198	1636	240	360	525	166	268	104	538
2012	13100	2235	760	834	208	1802	240	360	530	182	300	110	593
2013	13323	2273	788	878	212	1878	240	360	536	189	316	114	619
2014	13549	2312	817	924	216	1957	240	360	541	196	333	117	646
2015	13780	2351	847	972	220	2039	240	360	546	203	350	120	673
2016	14014	2391	879	1023	224	2126	240	360	552	211	368	124	703
2017	14252	2432	912	1077	228	2217	240	360	557	219	388	127	734
2018	14495	2473	945	1133	232	2310	240	360	563	227	408	131	765
2019	14741	2515	980	1192	236	2408	240	360	568	235	429	134	799
2020	14992	2558	1017	1254	240	2511	240	360	574	244	451	138	833
2021	15246	2602	1055	1320	244	2619	240	360	580	253	475	141	870
2022	15506	2646	1094	1389	248	2731	240	360	586	263	500	145	908

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	7	750	6	47	15	14	22	1314	304	55	358	273	0.52	36	237
2003	8	750	6	48	16	16	24	1360	330	59	389	286	0.56	37	249
2004	9	750	7	49	17	17	26	1408	358	64	422	300	0.61	38	263
2005	10	750	7	51	18	19	28	1457	389	70	459	315	0.67	39	277
2006	11	750	8	52	19	21	30	1508	424	76	500	331	0.73	40	292
2007	12	750	9	53	20	23	32	1561	461	83	544	349	0.79	41	308
2008	13	750	10	55	21	25	34	1615	503	90	593	367	0.86	42	326
2009	15	750	11	56	22	28	37	1672	548	99	647	387	0.94	43	344
2010	16	750	12	58	23	31	40	1730	599	108	707	408	1.03	44	364
2011	18	750	13	59	24	34	43	1791	654	118	772	431	1.12	45	386
2012	20	750	15	61	25	37	47	1854	715	129	844	455	1.23	46	409
2013	21	750	16	62	26	41	50	1918	747	134	881	459	1.28	47	412
2014	23	750	17	63	28	45	54	1986	780	140	920	463	1.34	48	416
2015	25	750	19	63	29	49	59	2055	814	147	961	467	1.39	48	419
2016	27	750	20	64	31	54	63	2127	850	153	1003	472	1.46	49	423
2017	29	750	22	65	32	59	68	2201	889	160	1049	476	1.52	50	427
2018	31	750	24	66	34	64	74	2278	929	167	1096	481	1.59	50	431
2019	34	750	26	67	35	70	79	2358	970	175	1145	486	1.66	51	435
2020	37	750	28	68	37	77	86	2441	1015	183	1197	490	1.74	52	439
2021	40	750	30	69	39	85	93	2526	1061	191	1252	496	1.82	52	443
2022	43	750	32	70	41	93	100	2615	1110	200	1310	501	1.90	53	448

ECONOMIC ANALYSIS: GALWA GAD SHP

year	CC	O&M	Total	Generatior	Energy	Benefit	Capacity	Total	Net Cash
	000 US$	000 US$	Cost	Cap (MWh	MWh	000 US$	Benefit	Benefit	Flow
2002	278.9141	0	278.9141	689	0	0		0	-278.914
2003	371.8855	0	371.8855	689	0	0		0	-371.885
2004	278.9141	0	278.9141	689	0	0		0	-278.914
2005		53.7471	53.7471	689	389.3037	27.31961	10.8	38.11961	-15.6275
2006		53.7471	53.7471	689	423.5941	29.63568	10.8	40.43568	-13.3114
2007		53.7471	53.7471	689	461.4031	32.17687	10.8	42.97687	-10.7702
2008		53.7471	53.7471	689	502.6995	34.94146	10.8	45.74146	-8.00564
2009		53.7471	53.7471	689	548.4682	38.00851	10.8	48.80851	-4.93859
2010		53.7471	53.7471	689	598.7788	41.36645	10.8	52.16645	-1.58065
2011		53.7471	53.7471	689	654.3077	45.07384	10.8	55.87384	2.126745
2012		53.7471	53.7471	689	715.3172	49.133	10.8	59.933	6.185898
2013		53.7471	53.7471	689	746.8	51.26273	10.8	62.06273	8.315633
2014		53.7471	53.7471	689	779.7597	53.49118	10.8	64.29118	10.54408
2015		53.7471	53.7471	689	814.1242	55.81472	10.8	66.61472	12.86762
2016		53.7471	53.7471	689	850.4165	58.26716	10.8	69.06716	15.32006
2017		53.7471	53.7471	689	888.6908	60.85231	10.8	71.65231	17.90521
2018		53.7471	53.7471	689	928.5146	63.54272	10.8	74.34272	20.59562
2019		53.7471	53.7471	689	970.4336	66.37377	10.8	77.17377	23.42667
2020		53.7471	53.7471	689	1014.515	69.35018	10.8	80.15018	26.40308
2021		53.7471	53.7471	689	1061.192	72.50089	10.8	83.30089	29.55379
2022		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2023		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2024		217.6525	217.6525	689	1110.033	75.7987	10.8	86.5987	-131.054
2025		217.6525	217.6525	689	1110.033	75.7987	10.8	86.5987	-131.054
2026		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2027		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2028		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2029		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2030		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2031		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2032		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2033		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
2034		53.7471	53.7471	689	1110.033	75.7987	10.8	86.5987	32.8516
NPV	847.4993	457.1747	1304.674	7252.673	5488.145	377.7456		461.8867	-842.787

IRR	-0.05%	
B/C R	0.354025	
BET	0.237726	US$
	18.30489	NRs.
Generation Cost	0.179889	US$/kWh
	13.85143	NRs./kWh
Rev/OM Cost Ratio	0.508299	

Financial / Economic Cost

	US $ (000)	NRs. (000)
Capital Cost	995.313	76639
O&M Cost	59.719	4598
R&R Cost	331.122	25496
Exchange Rate	1	77
Foreign	377.022	29031
Local	618.291	47608
	995.313	

Financial Costs

1st Year	298.5939	0.3
2nd Year	398.1252	0.4
3rd Year	298.5939	0.3
Total	995.313	

Economic Costs

1st Year	278.9141	
2nd Year	371.8855	
3rd Year	278.9141	
Total	929.7137	

Economic Costs

R&R Cost			
327.8108	0.99	373.2518	Foreign
	0.9	556.4619	Local
		53.7471	O&M
	Total	929.7137	

Gandi Gad Small Hydropower Project

FAR WESTERN DEVELOPMENT REGION

GANDI GAD SMALL HYDROPOWER PROJECT (1280KW)

Location

Gandi Gad Small Hydropower Project (GGSHP) is located in Kirsain and Sanagaum VDC of Doti district of the Far Western development region of Nepal. The proposed intakes of the project lies at approximately (81^0 02' 03") 503300E and (29^0 13' 00") 3232700N and at elevation of 625 meters above mean sea level (msl). Likewise the powerhouse is located at (81^0 01' 14") 501025E and (29^0 11' 34") 3230050N. The elevation of the powerhouse is 490 meters above mean sea level (msl).

Access

The distances along the foot track from Dipayal to the intake site and powerhouse site are 18 km and 15 km respectively. It takes about 7 hours to reach to intake site and 5 hours to powerhouse site on foot. A fair weather road from Silgadi, the districts headquarter of Doti District, to Sanfe Bagar of Achham District passes through the upper catchment of Gandi Gad. Santinagar of Phulout VDC is a small bazaar and a bus stop of the Dipayal – Sanfebagar route that is the nearest road- head from the project site. It takes about 2 hours to reach the intake site from Santinagar on foot. The path is difficult and steep. The project is also accessible by mule track from Dipayal, which is linked by air service from Nepalganj and by fair weather road from National East West Highway.

Geology

Regional Geology

Gandi Gad SHP geologically falls in the contact of Lesser Himalayan metasediments (Ranimatta Formation) and the Lesser Himalayn crystallines (Dadeldhura Group) separated by a thrust equivalent to Mahabharat Thrust (MT) of Central Nepal. The project area forms the northern limb of a northwesterly plunging faulted anticline (Seti River Anticline). The rocks of Ranimatta Formation are composed of gritty phyllite, phylitic quartzite, metasandstone and conglomerate with massive quartzite in the lower and upper parts. The rocks of Dadeldhura Group are represented by Budhi Ganga Gneiss (Bu), a member of Kalikot Formation (Kk) which consists of augen and granitic gneiss and felspathic schist. Regional geological mapping of the are in 1"=1 mile scale is carried out by DMG (S. B. Shrestha).

Site Geology

The Gandi Gad SHP is studied to detailed engineering design stage. The projects structure are located along he right bank of the river.

The intake site at its left bank has outcrops of gneiss whereas the right bank is made up of alluvial terrace deposit represented by coarse gravel and sand mixture. The desanding basin is located on alluvial terrace consisting of coarse sandy gravel. The headrace canal alignment passes through different soil deposits (colluvial, alluvial, debris deposit, residual soil etc.) and rocky stretches (gneiss, schist, quartzite). A 20m to 50m wide and 20m to 30m long landslide with tension cracks above the crown is observed. Detailed chainage wise description of the canal alignment is provided in the report. The forbay site is located on the older alluvial terrace deposit predominantly consisting of silt, gravel and cobble with occasional boulders up to 5m diameter, Thickness of the deposit is estimated over 5m. The penstock alignment passes through colluvial soil and medium bedded coarse grained quartzite. The powerhouse and the tailrace sites are located on the Seti river alluvail deposit consisting of varicolored silty sand at least up to 1.5m depth.

The project is studied geologically/ engineering geologically in sufficient detail. Some additional geotechnical investigations (field permeability tests along headrace canal and forbay site) and laboratory test of rock and soil samples, especially for construction material, are recommended during construction phase of the project.

Hydrology

The Gandi Gad is one of the main tributary of Seti River. It meets at a distance of about 15 km South – East from Dipyal. The catchment area of the proposed project site measured calculated from topographical maps 2981 13A, 2981 09C and 2981 09D (produced by Department of Survey, HMGN) is 137.09 sq. km. Average slope of the river is 7%.

Gandi Gad is an ungauged river; therefore direct measurements are not available for this river. Catchment of similar size and characteristic 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: 4.70 m^3/s
Average annual runoff: 1083mm

Flow duration curves:

Probability of exceedance (%)	5	20	40	60	80	90	95
Discharge (m^3/sec)	13.72	7.53	3.43	2.16	1.60	1.36	1.13

HYDEST results

Summary of results is as follows:
Input parameters:
Area of basin below 5000m elevation: 137.01 Km^2
Area of basin below 3000m elevation: 137.01 Km^2
Monsoon wetness index: 1000
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	1.010
10	0.572
20	0.465

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	89	142
10	163	298
20	193	368
50	234	466
100	266	545

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.79	1.50	1.34	1.36	1.81	5.68	17.53	21.1	16.04	7.15	2.96	1.96

Flow duration curves:

Probability of exceedance (%)	0	5	20	40	60	80	95
Discharge (m^3/sec)	39.6	24.1	11.51	3.43	1.68	1.30	0.85

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: 137.01 km^2
Mean monsoon precipitation: 1500 mm
Monsoon wetness index: 1000

Flood flows:

Return period	Flood discharge m^3/s
5	143
20	217
50	271
100	318

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

2.19	1.79	1.64	1.97	2.23	6.93	20.27	24.36	19.08	9.04	4.36	2.82

Flow duration curves:

Probability of exceedance (%)	Max	25	45	65	85	90	95	Min
Discharge (m^3/sec)	133.16	9.40	3.39	2.13	1.38	1.16	0.94	0.23

Previous studies

During the inventory study conducted in June 1998, the following methods were used to compute the hydrological parameters of this project:

The flood discharges are estimated from Envelop Curve Method for Nepal Rivers, Creager's Equation, Dicken's Formula, Ignis's Equation and Rational Formula.
Mean monthly flow was computed by HYDEST (DHM/WECS) method. The result from this method is more appropriate for the catchment. Here the value obtained from HYDEST method is adopted for further study.

Recommended values

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

Layout

Gandi Gad Small Hydro Project is a runoff river project. The available gross head is 135 m and the design discharge is 1.22 m^3/sec (90 % exceedance) giving a total installed capacity of 1280 kW. The headwork consists of approximately 32 m long diversion weir including Side intake with Trash-rock. The length of the weir along its foundation is estimated to be about 35 m and depth of the foundation is about 3 m each. The intake level is proposed at elevation of 625 m above msl.

Headrace canal passes through the Right Bank of the river and the length of the canal will be 4400 m.
A Forebay of 350 m^3 has been proposed at the end of the headrace. The Penstock is about 181 m long. Powerhouse is planned to be of the external type, total area of the powerhouse is estimated to be about 171 m^2. 2 units of Pelton turbine and generator are used. The length of the tailrace canal will be about 80 m long.

The whole structures of the project would be laid on the Right Bank of the river.

Energy

Energy production by the Gandi Gad 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 avg annual Energy (MWh)	Net avg annual energy (MWh)
1	Francis Spiral Case	2	9782	9514
2	Pelton	2	10428	10142
3	Turgo	2	10243	9963
4	Crossflow	2	9237	8984

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

Transmission

Total length of HT lines (11 kV): 20 km
Total length of HT lines (33 kV): 20 km
Total length of LT lines (400v): 8 km

Environmental aspect

The physical environmental impacts of the project are mostly acceptable with no serious threat to the project. Fishing practice will be affected to some extent because, fishing is a part time job for many residents. However, no professional fisherman who sustain only on fishing is reported. The impacts on biological environment are also acceptable since the vegetation clearance is limited to powerhouse and a few other components of the project. No endangered wild life species have been reported. Overall, the environmental condition of the project is favorable.

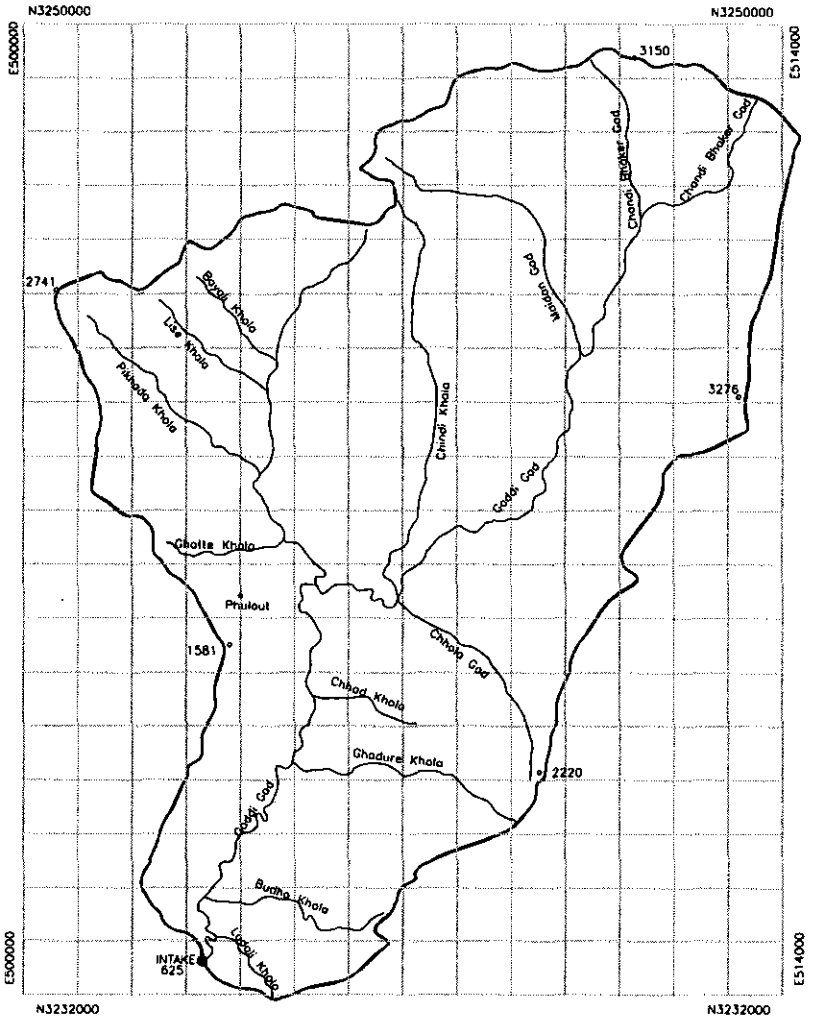
Socio-economic Aspect

Economic Analysis

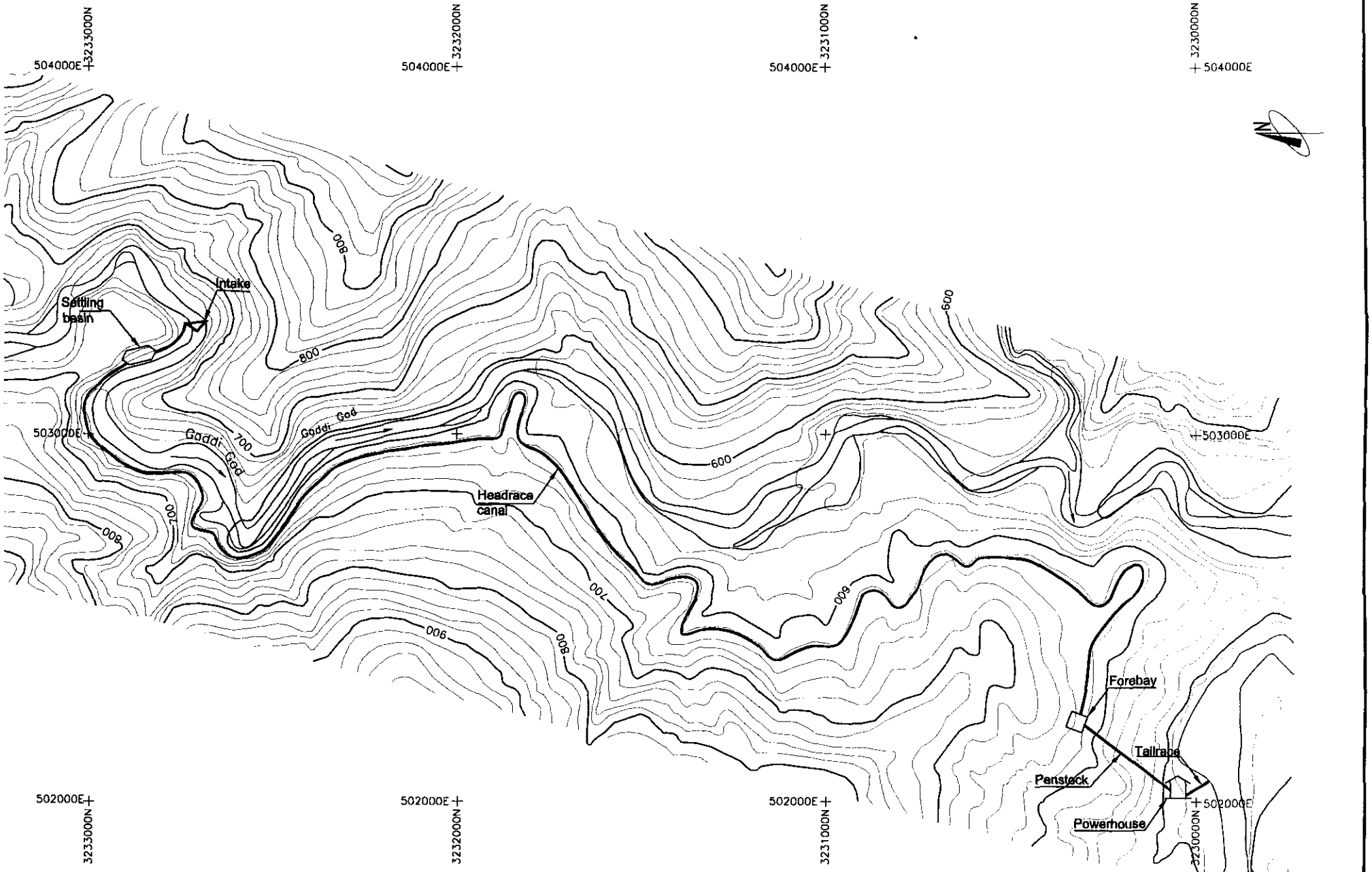
The specific construction cost per kW of Gandi is US$ 2454 and Operation and maintenance cost is 4% of the total cost. The EIRR is estimated –1.0%. The benefit cost ratio is 0.43. The generation cost is US$ 0.03 per kWh and the break-even tariff is US$ 0.56 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 0.65. The ratio of willingness to pay of household with respect to electricity bill per month is 0.52 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0.20.



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	GANDI GAD SHP Doti, FWDR, Nepal	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: 493764, Fax 482298 Web site: www.scsef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535565, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared:	Drawing No.
		CATCHMENT AREA				Checked:	Sheet No.
						Drawn:	



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	GANDI (GADDI) GAD SHP Doti, FWDR, 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 482298 Web site: www.scaef.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 : Gandi gad SHP

Parameters	Year 2002	Growth rate 2012	Growth rate 2022	Input Parameters	Year 2002	Growth rate 1st Dec.	Growth rate 2nd Dec.
Population	14800	3.93%	2.80%	Public sector growth		2.00%	2.00%
Person per household	5.43	0.00%	0.00%	Commercial sector growth		2.50%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	48%	-0.42%	-0.22%				
Medium income group (%)	47%	0.23%	0.22%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	11%	1.06%	0.00%	Cons. medium cons. (kWh/a)	360	0.00%	0.00%
				Cons. high consumers (kWh/a)	480	1.00%	1.00%
Household / commercial center	75	-2.00%	-2.00%	Cons. per HH (weighted ave.)	318	0.00%	0.00%
Household / public service	225	-2.00%	-2.00%				
Household / public light	50	-3.00%	-3.00%	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.	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

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	14800	2723	196	192	180	568	240	360	480	47	69	86	203
2003	15382	2830	219	216	203	638	240	360	485	53	78	98	229
2004	15986	2942	245	243	229	717	240	360	490	59	87	112	258
2005	16614	3057	274	273	259	806	240	360	495	66	98	128	292
2006	17267	3177	306	307	292	905	240	360	499	73	111	146	330
2007	17946	3302	342	345	330	1017	240	360	504	82	124	166	373
2008	18651	3432	382	388	373	1143	240	360	510	92	140	190	421
2009	19384	3567	427	437	421	1285	240	360	515	102	157	217	476
2010	20146	3707	477	492	475	1444	240	360	520	115	177	247	539
2011	20938	3853	533	554	536	1623	240	360	525	128	199	281	609
2012	21761	4004	596	623	605	1824	240	360	530	143	224	321	688
2013	22616	4162	632	664	638	1934	240	360	536	152	239	342	732
2014	23505	4325	670	707	673	2050	240	360	541	161	255	364	779
2015	24428	4495	711	753	710	2174	240	360	546	171	271	388	830
2016	25388	4672	754	802	749	2305	240	360	552	181	289	413	883
2017	26386	4855	799	854	790	2443	240	360	557	192	307	440	939
2018	27423	5046	847	910	833	2590	240	360	563	203	328	469	1000
2019	28501	5245	899	969	879	2747	240	360	568	216	349	500	1064
2020	29621	5451	953	1032	927	2912	240	360	574	229	372	532	1132
2021	30785	5665	1010	1099	978	3087	240	360	580	242	396	567	1205
2022	31995	5887	1071	1170	1032	3273	240	360	586	257	421	604	1283

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	11	750	8	31	8	16	19	1314	261	47	307	234	0.03	24	210
2003	12	750	9	32	9	18	21	1360	291	52	343	252	0.03	24	228
2004	14	750	10	33	10	21	23	1408	324	58	383	272	0.04	25	247
2005	15	750	11	34	11	23	26	1457	363	65	428	294	0.04	26	268
2006	17	750	13	35	12	26	29	1508	405	73	478	317	0.05	26	291
2007	19	750	14	36	13	29	32	1561	454	82	536	343	0.05	27	316
2008	21	750	16	37	14	33	35	1615	509	92	600	372	0.06	28	344
2009	23	750	17	38	15	37	39	1672	571	103	673	403	0.07	29	374
2010	26	750	19	39	17	42	44	1730	640	115	755	437	0.07	29	407
2011	29	750	22	40	18	47	49	1791	719	129	848	474	0.08	30	443
2012	32	750	24	41	20	53	54	1854	807	145	952	514	0.09	31	483
2013	37	750	27	41	21	58	59	1918	860	155	1015	529	0.10	31	498
2014	42	750	31	42	22	63	64	1986	917	165	1082	545	0.11	32	513
2015	48	750	36	42	24	69	70	2055	978	176	1154	561	0.11	32	529
2016	55	750	41	43	26	76	76	2127	1043	188	1231	579	0.12	33	546
2017	63	750	47	43	28	83	83	2201	1113	200	1313	596	0.13	33	563
2018	72	750	54	44	29	90	90	2278	1188	214	1402	615	0.14	34	582
2019	83	750	62	45	32	99	98	2358	1269	228	1497	635	0.15	34	601
2020	95	750	71	45	34	108	106	2441	1355	244	1599	655	0.16	34	621
2021	108	750	81	46	36	118	116	2526	1448	261	1709	676	0.17	35	641
2022	124	750	93	46	39	129	126	2615	1548	279	1827	699	0.18	35	663

ECONOMIC ANALYSIS: GANDI GAD 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	877.222	0	877.222	10142	0	0		0	-877.222
2003	1169.629	0	1169.629	10142	0	0		0	-1169.63
2004	877.222	0	877.222	10142	0	0		0	-877.222
2005		113.0895	113.0895	10142	362.6954	27.51407	138.24	165.7541	52.66457
2006		113.0895	113.0895	10142	405.4988	30.7983	138.24	169.0383	55.9488
2007		113.0895	113.0895	10142	454.0306	34.53571	138.24	172.7757	59.68621
2008		113.0895	113.0895	10142	508.8897	38.76731	138.24	177.0073	63.91781
2009		113.0895	113.0895	10142	570.6936	43.53529	138.24	181.7753	68.68579
2010		113.0895	113.0895	10142	640.2401	48.90855	138.24	187.1485	74.05905
2011		113.0895	113.0895	10142	718.7811	54.98629	138.24	193.2263	80.13679
2012		113.0895	113.0895	10142	807.1592	61.84165	138.24	200.0817	86.99215
2013		113.0895	113.0895	10142	860.2329	65.94818	138.24	204.1882	91.09868
2014		113.0895	113.0895	10142	916.8778	70.34241	138.24	208.5824	95.49291
2015		113.0895	113.0895	10142	977.735	75.06924	138.24	213.3092	100.2197
2016		113.0895	113.0895	10142	1042.989	80.14433	138.24	218.3843	105.2948
2017		113.0895	113.0895	10142	1112.774	85.58063	138.24	223.8206	110.7311
2018		113.0895	113.0895	10142	1187.798	91.42874	138.24	229.6687	116.5792
2019		113.0895	113.0895	10142	1268.515	97.73977	138.24	235.9798	122.8903
2020		113.0895	113.0895	10142	1354.923	104.5031	138.24	242.7431	129.6536
2021		113.0895	113.0895	10142	1447.964	111.8036	138.24	250.0436	136.9541
2022		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2023		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2024		610.6744	610.6744	10142	1547.978	119.6707	138.24	257.9107	-352.764
2025		610.6744	610.6744	10142	1547.978	119.6707	138.24	257.9107	-352.764
2026		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2027		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2028		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2029		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2030		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2031		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2032		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2033		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
2034		113.0895	113.0895	10142	1547.978	119.6707	138.24	257.9107	144.8212
NPV	2665.498	997.7577	3663.256	106758.5	6531.925	501.5214	1303.177	1578.527	-2084.73

IRR	-0.00993	
B/C R	0.430908	
BET	0.560823	US$
	43.18339	NRs.
Generation Cost	0.034313	US$/kWh
	2.642138	NRs./kWh
Rev/OM Cost Ratio	0.243295	

Financial / Economic Cost

	US $ (000)	NRs. (000)
Capital Cost	3141.367	241885
O&M Cost	125.655	9675
R&R Cost	1005.222	77402
Exchange Rate	1	77
Foreign	1076.022	82854
Local	2065.346	159032
	3141.368	

Financial Costs		
1st Year	942.4101	0.3
2nd Year	1256.547	0.4
3rd Year	942.4101	0.3
Total	3141.367	

Economic Costs		
1st Year	877.222	
2nd Year	1169.629	
3rd Year	877.222	
Total	2924.073	

Economic Costs			
R&R Cost			
995.1698	0.99	1065.262	Foreign
	0.9	1858.811	Local
		113.0895	O&M
	Total	2924.073	

Jamadi Gad Small Hydropower Project

JAMADI GAD SMALL HYDROPOWER PROJECT (1300KW)

Location

Jamadi Gad Small Hydropower Project (JGSHP) is located in Gokuleswor VDC of Baitadi district of the Far Western development region of Nepal. The proposed intakes of the project lies at approximately (80^0 34' 00") 458200E and (29^0 38' 13") 3280650N and at elevation of 785 meters above mean sea level (msl). Likewise the powerhouse is located at (80^0 32' 16") 455275E and (29^0 38' 13") 3280650N. The elevation of the powerhouse is 705 meters above mean sea level (msl).

Access

The project site may be supposed to be accessible from motorized vehicles, as the nearest road head Panjugnaya, at the Baitadi-Darchula highway, is only about 3 km far from the Project site. This highway, presently under contraction is expects to be completed in the near future.
Powerhouse and intake sites are accessible by foot trail of 2 km and 4 km panjugnaya respectively. It takes about three and half hours walk from Panjugnaya to intake site and about 1 hour for powerhouse.
Baitadi and Darchula both are accessible by seasonal airstrips at Kathmandu and Gokulesor respectively where as Patan (Baitadi) is also linked by road from the east-west national. It takes about 4 hours to travel from Patan to Panjugnaya village via. Musyachaur by bus or truck.

Geology

Regional Geology

Jamadi Gad SHP area lies in the southern limb of Toligaon - Gokule Syncline and geologically falls within the Lesser Himalayan metasediments and crystallines represented by Ranimatta/ Seti Formation (Midland Group) and Sallyani Gad Formation (Dadeldhura Group) separated by a thrust contact respectively. Ranimatta Formation is composed mainly of gritty phyllite, phyllitic quartzite, metasandstone and conglomerate with massive quartzite in the upper and lower part. Two third of the headrace canal (lower part) and forbay, penstock, powerhouse and tailrace sites are located within this formation whereas the rest one third of the headrace canal alignment and the intake and desanding basin sites are located in the crystallin formation composed of gneissic schist and quartzite. Regional geological mapping of the area in 1"=1mile scale is carried out by DMG (R.R. Shakya).

Site Geology

Reconnaissance visit of the area revealed that the project area mainly consists of loose and hard soil, loose conglomerate with weathered and fresh hard rock outcrops at intervals. Boulder and shingle deposits are scattered on both banks of the river. The project structures are located along the right bank of the river.

The intakes site is composed of river alluvial terrace deposit with big and small boulders. The gravel trap and desanding basin are located on a flat alluvial terrace made up of hard soil mixed with rive left boulders. The headrace canal alignment passes through a terrain with varying slope conditions (5^0 to 60^0) and land use pattern (bushed, thinly forested, cultivated terrace etc.). Geological composition along the headrace canal alignment is not particularly mentioned in the report, probably the geological composition mentioned for the project area also applies to the canal alignment. The surge bay is located on a barren land sloping 7^0. No geological composition is mentioned for the site. The penstock alignment passes through a terrain of 20^0 slope composed of loose rock, boulders and hard soil. The spillway canal passes through a terrain of 22^0 slope with similar geological composition as that of forbay site (which is not mentioned in the report !). The powerhouse and tailrace sites are located on a flat cultivated field composed mainly of gravel mixed loose soil with occasional big boulders.

The reconnaissance report contains poor geological/ engineering geological informations of the project area. Therefore a feasibility stage study for the project is recommended.

Hydrology

The Jamadi Gad is one of the main tributary of Chamelia River. It meets Chamelia at 26 km downstream from the proposed intake site. The catchment area of the proposed project site measured calculated from topographical maps 2980 07A, 2980 07B, 2980 08, 2980 07C and 2980 07D (produced by Department of Survey, HMGN) is 209.34 sq. km. Average slope of the river is 3%.

Jamadi Gad is an ungauged river; therefore direct measurements are not available for this river. Catchment of similar size and characteristic 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: 9.70 m^3/s
Average annual runoff: 1464mm

Flow duration curves:

Probability of exceedance (%)	5	20	40	60	80	90	95
Discharge (m^3/sec)	29.30	15.47	6.79	4.09	2.91	2.42	1.97

HYDEST results

Summary of results is as follows:
Input parameters:
Area of basin below 5000m elevations: 209.34 Km^2
Area of basin below 3000m elevations: 209.34 Km^2
Monsoon wetness index: 1600
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	1.558
10	0.963
20	0.815

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	133	206
10	237	418
20	280	510
50	336	639
100	380	743

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.66	2.26	2.04	2.12	2.87	9.80	30.19	36.31	27.86	12.2	5.34	3.47

Flow duration curves:

Probability of exceedance (%)	0	5	20	40	60	80	95
Discharge (m^3/sec)	70.15	41.32	21.46	6.12	2.96	2.01	1.34

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: 209.34 km^2
Mean monsoon precipitation: 2000 mm
Monsoon wetness index: 1600

Flood flows:

Return period	Flood discharge m^3/s
5	206
20	311
50	388
100	453

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.16	2.60	2.39	2.95	3.36	11.09	33.16	39.32	30.60	14.23	6.85	4.42

Flow duration curves:

Probability of exceedance (%)	Max	25	45	65	85	90	95	Min

Discharge (m^3/sec)	241.44	16.03	5.51	3.12	2.04	1.73	1.41	0.38

Previous studies

During the reconnaissance study conducted in February 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 Baitadi Station and runoff coefficient and retention constants of Surnaya Gad. But the results were unrealistic and inconsistent because only rainfall data are not sufficient to apply this method.

A catchment area ration method was applied to correlate flows with Surnaya Gad river at Patan (catchment area 188 Km^2), however the size and characteristics of this catchment cannot compared.
So, The result of the previous study is 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

Jamadi Gad Small Hydro Project is a runoff river project. The available gross head is 80 m and the design discharge is 2.18 m^3/sec (90 % exceedance) giving a total installed capacity of 1300 kW. The headwork consists of approximately 20 m long diversion weir including Tyrolean intake. The length of the weir along its foundation is estimated to be about 22 m and depth of the foundation is about 2.5 m each. The intake level is proposed at elevation of 785 m above msl.

Headrace canal passes through the Right Bank of the river and the length of the canal will be 4600 m.
A Forebay of 170 m^3 has been proposed at the end of the headrace
The Penstock is about 184 m long.

Powerhouse is planned to be of the external type, total area of the powerhouse is estimated to be about 201 m^2.
2 units of Turgo turbine and generator are used. The length of the tailrace canal will be about 30 m long.
The whole structures of the project would be laid on the Right Bank of the river.
The project general arrangement and layouts are presented in Appendix D.

Energy

Energy production by the Jamadi Gad 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 avg annual Energy (MWh)	Net avg annual energy (MWh)
1	Francis Spiral Case	2	10355	10072
2	Turgo	2	10843	10546
3	Crossflow	2	9778	9510

Considering the discharge and energy output 2 Turgo Turbine units are suggested to use.

Transmission

Total length of HT lines (11 kV): 20 km
Total length of LT lines (400v): 3 km

Environmental aspect

The project report is silent on physical and biological environmental aspects. However, the social impacts are significantly positive. The project is situated in good geological condition. The accessibility of the project is good. The physical environmental impacts during construction and operation phase will be significant due to higher discharge to be diverted and require mitigation measures. A detailed IEE will be required to complete the environmental assessment.

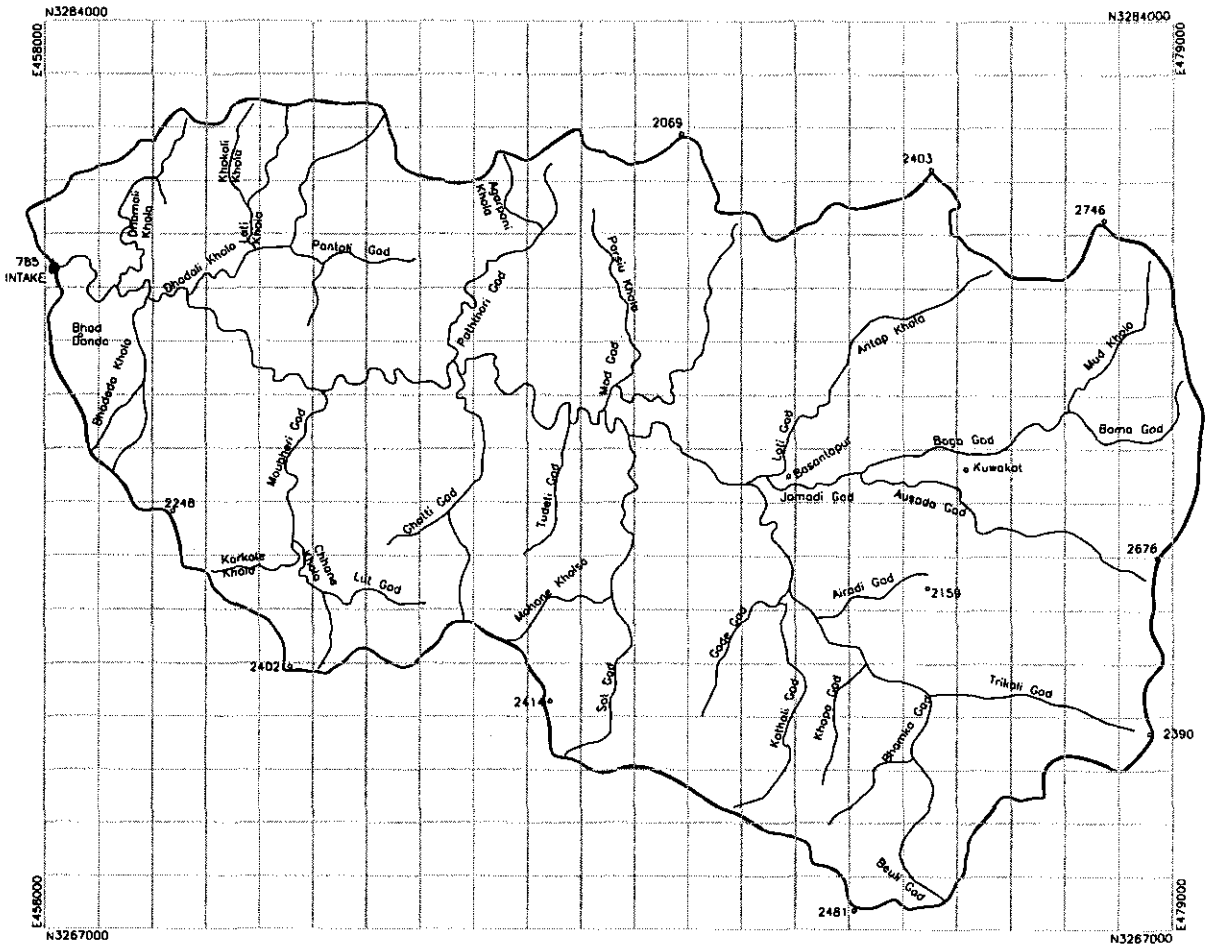
Socio-economic aspect

Economic Analysis

The specific construction cost per kW of Jamadi is US$ 2829 and Operation and maintenance cost is 4% of the total cost. The EIRR is estimated –4.4%. The benefit cost ratio is 0.36. The generation cost is US$ 0.03 per kWh and the break-even tariff is US$ 0.72 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 0.36. The ratio of willingness to pay of household with respect to electricity bill per month is 0.52 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0.21



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	JAMADI GAD SHP Baitadi, FWDR, Nepal	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: 493764, Fax 482298 Web site: www.soaf.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11726, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared:	Drawing No.
		CATCHMENT AREA				Checked:	Sheet No.
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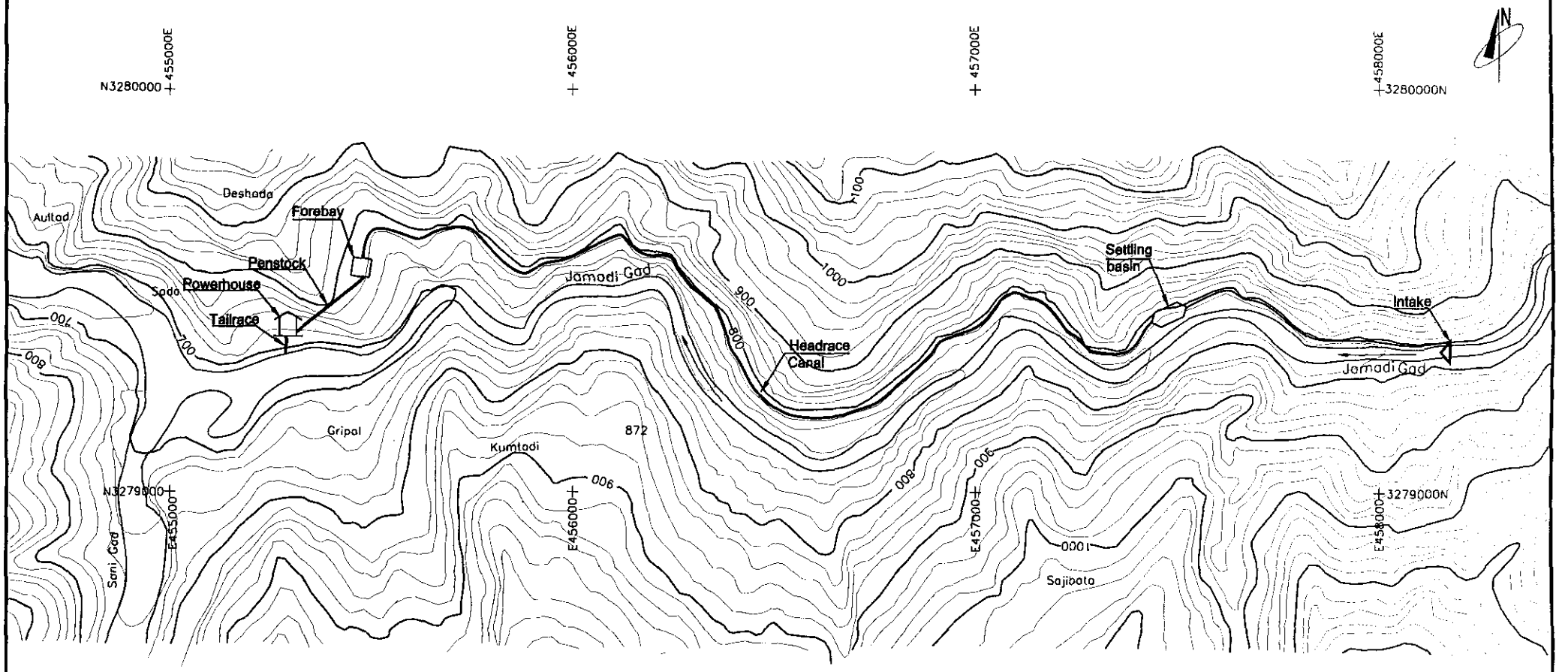


Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	JAMADI GAD SHP Baitadi, FWDR, Nepal	Scale 0 100 200 300(m) 1:10000	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 483784, Fax 482298 Web site: www.scaaf.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535586, Fax 527801 Email: bpc@hydroconsult.com.np	Prepared:	Drawing No.
		GENERAL LAYOUT PLAN				Checked:	Sheet No.
						Drawn:	

Rural Electrification through SHP

Load Demand Forecast : Jamadi gad SHP

Parameters	Year 2002	Growth rate 2012	2022	Input Parameters	Year 2002	Growth rate 1st Dec.	2nd Dec.
Population	18345	2.23%	2.10%	Public sector growth		2.00%	2.00%
Person per household	5.27	0.00%	0.00%	Commercial sector growth		2.50%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	27%	0.00%	0.00%				
Medium income group (%)	47%	0.00%	0.00%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	11%	0.00%	0.00%	Cons. medium cons. (kWh/a)	360	0.00%	0.00%
				Cons. high consumers (kWh/a)	480	1.00%	1.00%
Household / commercial center	75	-2.00%	-2.00%	Cons. per HH (weighted ave.)	318	0.00%	0.00%
Household / public service	225	-2.00%	-2.00%				
Household / public light	50	-3.00%	-3.00%	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.	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

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	18345	3481	141	245	230	616	240	360	480	34	88	110	232
2003	18754	3559	156	271	253	680	240	360	485	37	98	123	258
2004	19172	3638	172	299	278	749	240	360	490	41	108	136	285
2005	19600	3719	190	330	306	826	240	360	495	46	119	151	316
2006	20037	3802	210	364	336	910	240	360	499	50	131	168	349
2007	20484	3887	232	402	369	1003	240	360	504	56	145	186	387
2008	20941	3974	256	444	406	1106	240	360	510	61	160	207	428
2009	21408	4062	283	490	446	1219	240	360	515	68	176	230	474
2010	21885	4153	312	541	490	1343	240	360	520	75	195	255	524
2011	22373	4245	344	597	538	1479	240	360	525	83	215	282	580
2012	22872	4340	380	659	591	1630	240	360	530	91	237	313	642
2013	23382	4437	398	689	613	1700	240	360	536	95	248	328	672
2014	23903	4536	416	720	636	1772	240	360	541	100	259	344	703
2015	24436	4637	434	753	660	1847	240	360	546	104	271	361	736
2016	24981	4740	454	787	685	1926	240	360	552	109	283	378	770
2017	25538	4846	475	823	711	2009	240	360	557	114	296	396	806
2018	26108	4954	496	860	738	2094	240	360	563	119	310	415	844
2019	26690	5064	518	899	766	2183	240	360	568	124	324	435	884
2020	27285	5177	542	940	795	2277	240	360	574	130	338	456	925
2021	27894	5293	567	983	825	2375	240	360	580	136	354	478	968
2022	28516	5411	592	1028	856	2476	240	360	586	142	370	501	1014

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	10	31	11	21	24	1314	298	54	351	267	0.03	24	244
2003	15	750	11	32	12	23	26	1360	327	59	386	284	0.04	24	259
2004	17	750	13	33	12	26	28	1408	359	65	424	301	0.04	25	276
2005	18	750	14	34	13	28	31	1457	394	71	465	319	0.04	26	294
2006	20	750	15	35	14	31	34	1508	433	78	511	339	0.05	26	313
2007	22	750	16	36	15	35	37	1561	476	86	562	360	0.05	27	333
2008	24	750	18	37	16	38	41	1615	524	94	618	383	0.06	28	355
2009	26	750	20	38	17	42	45	1672	576	104	679	406	0.06	29	378
2010	29	750	22	39	19	47	49	1730	634	114	748	432	0.07	29	403
2011	32	750	24	40	20	52	54	1791	697	125	823	459	0.08	30	429
2012	35	750	26	41	21	58	59	1854	767	138	906	489	0.09	31	458
2013	39	750	29	41	22	62	63	1918	805	145	950	495	0.09	31	464
2014	44	750	33	42	23	66	67	1986	845	152	997	502	0.09	32	470
2015	49	750	37	42	25	71	72	2055	887	160	1047	510	0.10	32	477
2016	56	750	42	43	26	77	77	2127	932	168	1100	517	0.10	33	484
2017	63	750	47	43	27	83	83	2201	979	176	1156	525	0.11	33	492
2018	71	750	53	44	29	89	88	2278	1029	185	1215	533	0.12	34	500
2019	80	750	60	45	30	95	94	2358	1082	195	1277	542	0.12	34	508
2020	90	750	67	45	32	103	101	2441	1139	205	1343	550	0.13	34	516
2021	101	750	76	46	34	110	108	2526	1198	216	1414	560	0.13	35	525
2022	114	750	86	46	36	119	116	2615	1261	227	1488	569	0.14	35	534

ECONOMIC ANALYSIS: JAMADI GAD 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	1024.747	0	1024.747	10546	0	0		0	-1024.75
2003	1366.329	0	1366.329	10546	0	0		0	-1366.33
2004	1024.747	0	1024.747	10546	0	0		0	-1024.75
2005		132.3774	132.3774	10546	394.4187	30.64381	140.4	171.0438	38.66641
2006		132.3774	132.3774	10546	433.072	33.66037	140.4	174.0604	41.68297
2007		132.3774	132.3774	10546	475.9303	37.00489	140.4	177.4049	45.02749
2008		132.3774	132.3774	10546	523.6459	40.73624	140.4	181.1362	48.75884
2009		132.3774	132.3774	10546	575.8398	44.81619	140.4	185.2162	52.83879
2010		132.3774	132.3774	10546	633.6189	49.3338	140.4	189.7338	57.3564
2011		132.3774	132.3774	10546	697.107	54.29895	140.4	194.6989	62.32155
2012		132.3774	132.3774	10546	767.4725	59.80545	140.4	200.2054	67.82805
2013		132.3774	132.3774	10546	805.2481	62.78653	140.4	203.1865	70.80913
2014		132.3774	132.3774	10546	845.0842	65.93794	140.4	206.3379	73.96054
2015		132.3774	132.3774	10546	887.4398	69.29224	140.4	209.6922	77.31484
2016		132.3774	132.3774	10546	932.0623	72.83503	140.4	213.235	80.85763
2017		132.3774	132.3774	10546	979.4784	76.60378	140.4	217.0038	84.62638
2018		132.3774	132.3774	10546	1029.409	80.58295	140.4	220.983	88.60555
2019		132.3774	132.3774	10546	1082.354	84.80874	140.4	225.2087	92.83134
2020		132.3774	132.3774	10546	1138.52	89.29855	140.4	229.6985	97.32115
2021		132.3774	132.3774	10546	1198.083	94.06787	140.4	234.4679	102.0905
2022		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2023		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2024		687.6328	687.6328	10546	1261.169	99.12939	140.4	239.5294	-448.103
2025		687.6328	687.6328	10546	1261.169	99.12939	140.4	239.5294	-448.103
2026		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2027		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2028		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2029		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2030		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2031		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2032		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2033		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
2034		132.3774	132.3774	10546	1261.169	99.12939	140.4	239.5294	107.152
NPV	3113.763	1161.552	4275.314	111011.2	5957.959	465.5816	1323.539	1559.415	-2715.9

IRR	-0.04365	
B/C R	0.364749	
BET	0.71758	US$
	55.25369	NRs.
Generation Cost	0.038512	US$/kWh
	2.96546	NRs./kWh
Rev/OM Cost Ratio	0.231488	

Financial / Economic Cost

	US $ (000)	NRs. (000)
Capital Cost	3677.157	283141
O&M Cost	147.086	11326
R&R Cost	1121.728	86373
Exchange Rate	1	77
Foreign	1182.028	91016
Local	2495.128	192125
	3677.156	

Financial Costs

1st Year	1103.147	0.3
2nd Year	1470.863	0.4
3rd Year	1103.147	0.3
Total	3677.157	

Economic Costs

R&R Cost				
1110.511	0.99	1170.208	Foreign	
	0.9	2245.615	Local	
		132.3774	O&M	
	Total	3415.823		

Economic Costs

1st Year	1024.747
2nd Year	1366.329
3rd Year	1024.747
Total	3415.823

Nilgarh Gad Small Hydropower Project

NILGARH GAD SMALL HYDROPOWER PROJECT (240KW)

Location

Nilgarh Gad Small Hydropower Project (NGSHP) is located in Tripurasundari VDC of Baitadi district of the Far Western development region of Nepal. The proposed intakes of the project lies at approximately (80^0 24' 00") 441675E and (29^0 32' 00") 3268025N and at elevation of 980 meters above mean sea level (msl). Likewise the powerhouse is located at (80^0 22' 00") 438650E and (29^0 31' 43") 3267425N. The elevation of the powerhouse is 580 meters above mean sea level (msl).

Access

The project site is accessible by mule track from District Headquarters Baitadi-Khalanga, which is linked by fair weather road to national east-west highway.
Powerhouse site and intake site are accessible by foot trail of 15 km and 9 km from Baitadi-Khalanga respectively. It takes about 4 hours from khalanga to intake site and about 7 hours from powerhouse site.
Baitadi is also accessible by seasonal airstrip at Patan (Baitaki), the roadhead at the Baitadi-Dadeldhura highway, which is linked by road from Dadeldhura to the east-west national highway. It takes about 4 hours to Baitadi-Khalanga from Patan by bus or track.

Geology

Regional Geology

Nilgarh Gad SHP geologically falls within the Lesser Himalayan metasediments represented by Galyang Formation (Gl). Lakharpata Formation (Lk) pinches out just few hundred meters east of the project site. Galyang Formation in the area is represented by dark grey slates with frequently intercalated calcareous slate, sandstone and limestone/ dolomitic limestone.
Regional geological mapping of the area in 1"= 1 mile scale is carried out by DMG (B. M. Jnawali)

Site Geology

During the reconnaissance visit mainly hard rock and hard soil were observed in the project area. Big boulders and shingle deposits were observed along river bed and both of its banks. The topography of the project area is not so favorable especially for the canal and penstock alignments.
The intake site consists of gravel and boulder mixed soil of the river terrace. The gravel trap and desanding basin sites are located on a flat alluvial terrace composed of boulder mixed hard soil. The headrace canal alignment passes through a terrain of mean natural slope of 39^0 which mainly consists of fresh hard rock with weathered varieties at intervals.
The surge bay site is located on a barren land with a mean natural slope of 7.50. No geological composition is provided for surge bay site. The penstock alignment passes through a terrain of mean natural slope of 39^0 which is composed of loose rock, boulders and hard soil. The alignment has some near vertical rock outcrops. The spillway canal passes through a dry gully. No geological description is provided for the spillway. The powerhouse and the tailrace sites are located on a flat cultivated land which is mainly made up of gravel mixed loose soil with occasional big boulders.

The project area topography is not favorable. Most of the stretches along headrace canal alignment have steep (75^0) to vertical hard rock slopes. Therefore prior to carry out further detailed study of the project, economic viability of the project should be considered.

Hydrology

The Nilgarh Gad is one of the main tributary of Mahakali River. It meets Mahakali at 10 km downstream from the proposed intake site The catchment area of the proposed project site measured calculated from topographical maps 2980 06C, 2980 06D and 2980 10B (produced by Department of Survey, HMGN) is 37.27 sq. km. Average slope of the river is 13%.

Nilgarh Gad is an ungauged river; therefore direct measurements are not available for this river. Catchment of similar size and characteristic 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: 1.20 m^3/s
Average annual runoff: 995 mm

Flow duration curves:

Probability of exceedance (%)	5	20	40	60	80	90	95

Discharge (m^3/sec)	4.85	1.84	0.59	0.24	0.13	0.09	0.06

HYDEST results

Summary of results is as follows:
Input parameters:
Area of basin below 5000m elevation: 37.27 Km^2
Area of basin below 3000m elevation: 37.27 Km^2
Monsoon wetness index: 1100
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	0.264
10	0.091
20	0.056

Flood flows:

Return period (yrs)	Flood discharge (m^3/s)	
	Daily	Instantaneous
2	26	46
10	52	107
20	63	136
50	78	178
100	90	213

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.50	0.43	0.38	0.36	0.45	1.59	4.92	6.03	4.63	2.06	0.88	0.59

Flow duration curves:

Probability of exceedance (%)	0	5	20	40	60	80	95
Discharge (m^3/sec)	12.29	7.02	3.34	0.95	0.47	0.34	0.21

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

Input parameters:
Total drainage area: 37.27 km^2
Mean monsoon precipitation: 1750 mm
Monsoon wetness index: 1100

Flood flows:

Return period	Flood discharge m^3/s
5	46
20	72
50	90
100	107

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.71	0.57	0.51	0.57	0.64	2.1	6.45	7.84	6.24	3.01	1.45	0.92

Flow duration curves:

Probability of exceedance (%)	Max	25	45	65	85	90	95	Min
Discharge (m^3/sec)	48.68	2.89	1.04	0.65	0.41	0.34	0.27	0.05

Previous studies

During the reconnaissance study conducted in February 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 Baitadi Station and runoff coefficient and retention constants of Surnaya Gad. But the results were unrealistic and inconsistent because only rainfall data are not sufficient to apply this method.
A catchment area ration method was applied to correlate flows with Surnaya Gad River at Patan (catchment area 188 Km^2), however the size and characteristics of these catchments cannot compare.
So, The result of the previous study is 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

Nilgarh Gad Small Hydro Project is a runoff river project. The available gross head is 400 m and the design discharge is 0.08 m^3/sec (90 % exceedance) giving a total installed capacity of 240 kW. The headwork consists of approximately 12 m long diversion weir including Tyrolean intake. The length of the weir along its foundation is estimated to be about 14 m and depth of the foundation is about 3 m each. The intake level is proposed at elevation of 980 m above msl.

Headrace canal passes through the Right Bank of the river and the length of the canal will be 3700 m.
A Forebay of 20 m^3 has been proposed at the end of the headrace

The Penstock is about 685 m long.
Powerhouse is planned to be of the external type, total area of the powerhouse is estimated to be about 104 m^2.
2 units of Pelton 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 Nilgarh Gad SHP scheme is calculated using HydrA. The annual energy supply from the scheme would be 1938 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	1993	1938

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

Transmission

Total length of HT lines (11 kV): 8 km
Total length of LT lines (400v): 3 km

Environmental aspect

Although the report is silent on environmental impacts, considering the very small discharge to be diverted for the project, the project will cause least physical environmental impacts during construction and operation phase. The socio economic impacts will be significantly positive. A detailed IEE will however be required prior to implementation.

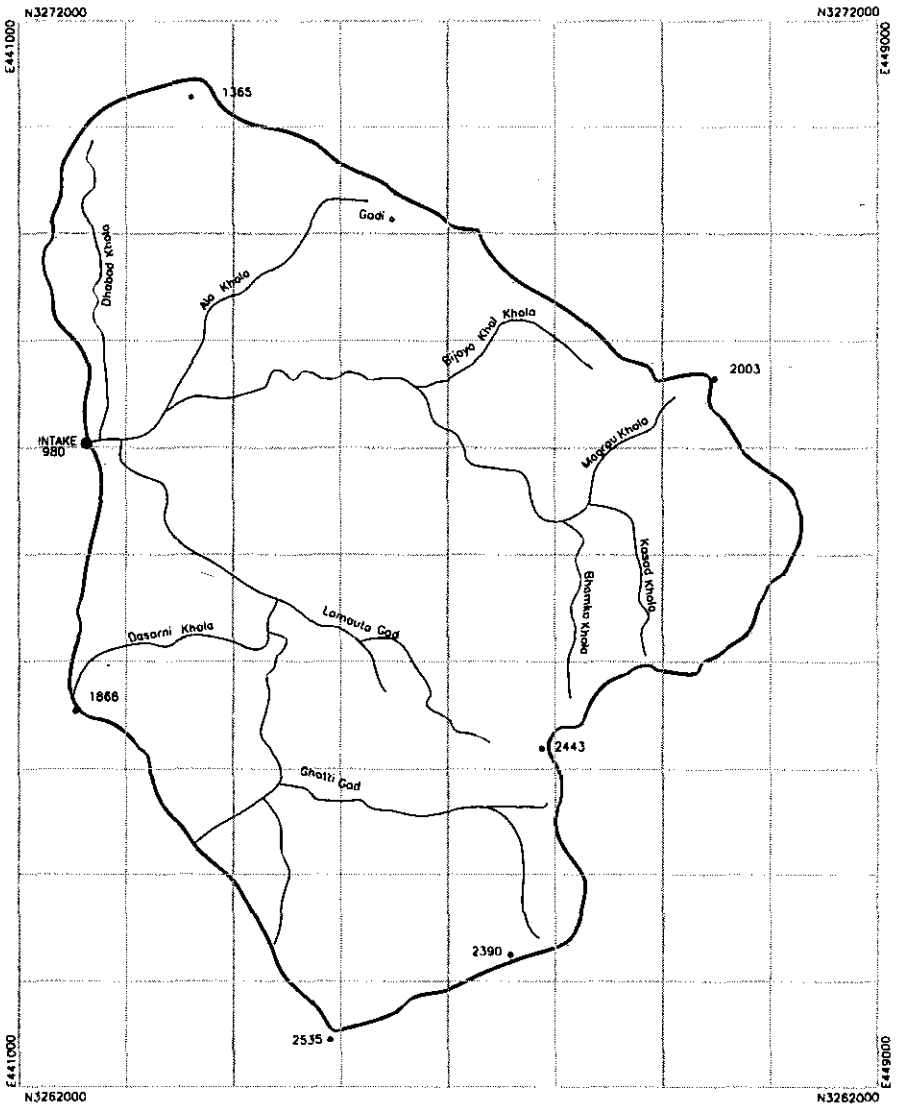
Socio-economic aspect

Economic Analysis

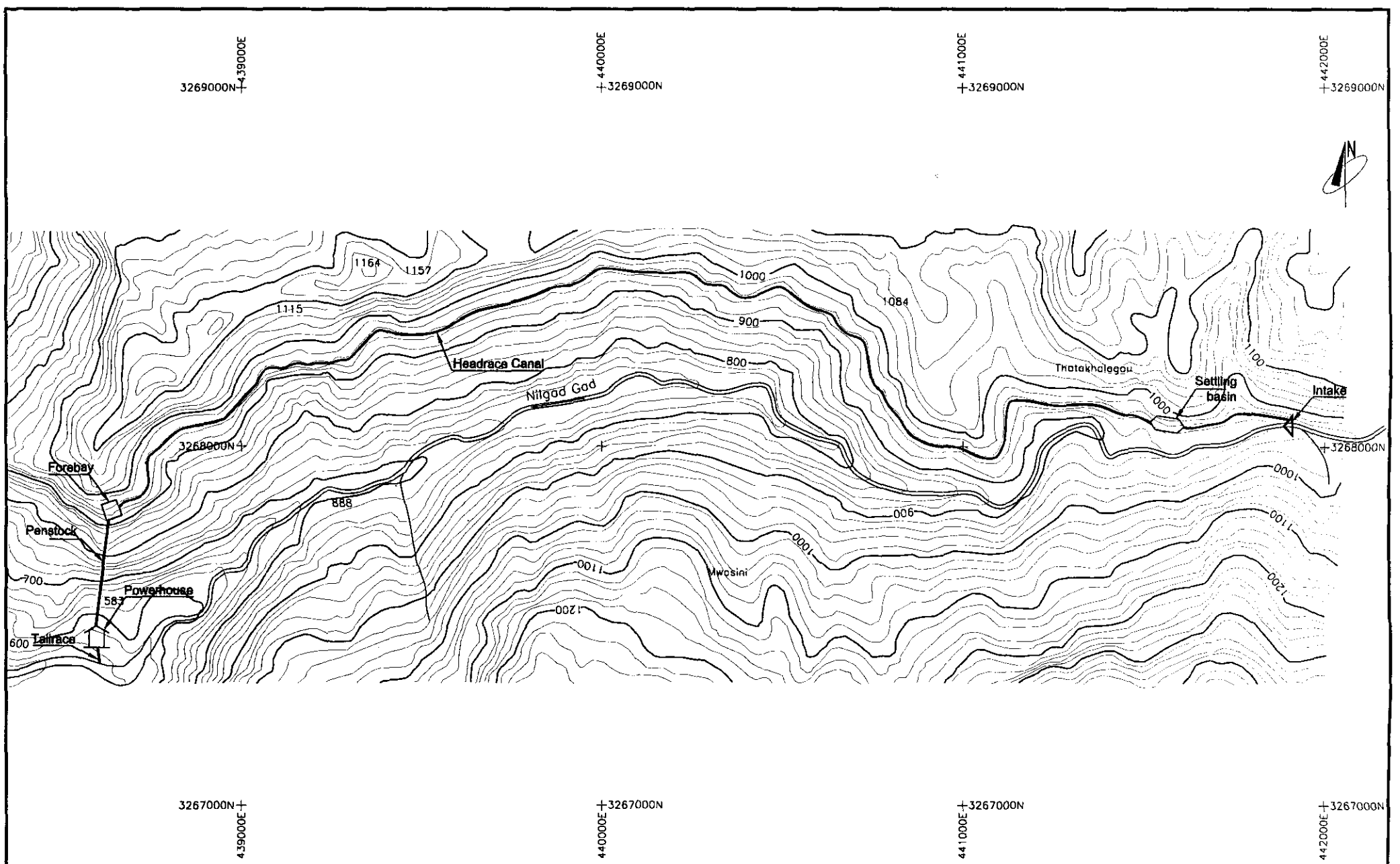
The specific construction cost per kW of Nilgarh is US$ 6108 and Operation and maintenance cost is 6% of the total cost. The EIRR is estimated –8.6%. The benefit cost ratio is 0.34. The generation cost is US$ 0.09 per kWh and the break-even tariff is US$ 0.33 per kWh.

Affordability and Willingness to pay

The ratio of affordability with respect to electricity bill per month is 0.36. The ratio of willingness to pay of household with respect to electricity bill per month is 0.52 The sustainability in terms of ratio of revenue generation with respect to operation and maintenance cost is 0.33.



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	NILGARH GAD SHP Baitadi, FWDR, Nepal	Scale 0 500 1000 1500(m)	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482286 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:	Drawing No.
		CATCHMENT AREA	1:50,000			Checked:	Sheet No.
						Drawn:	



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	NILGARH GAD SHP Baitadi, FWDR, 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: 493764, Fax 482298 Web site: www.ecnet.com/itecompal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535585, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. Sheet No.

Load Demand Forecast : Nilgarh Khola SHP

Parameters	Year 2002	Growth rate 2012	Growth rate 2022	Input Parameters	Year 2002	Growth rate 1st Dec.	Growth rate 2nd Dec.
Population	18345	2.23%	2.10%	Public sector growth		2.00%	2.00%
Person per household	5.27	0.00%	0.00%	Commercial sector growth		2.50%	2.50%
				Agricultural production growth		2.88%	2.88%
Low income group (%)	27%	0.00%	0.00%				
Medium income group (%)	47%	0.00%	0.00%	Cons. low consumers (kWh/a)	240	0.00%	0.00%
High income group (%)	11%	0.00%	0.00%	Cons. medium cons. (kWh/a)	360	0.00%	0.00%
				Cons. high consumers (kWh/a)	480	1.00%	1.00%
Household / commercial center	75	-2.00%	-2.00%	Cons. per HH (weighted ave.)	318	0.00%	0.00%
Household / public service	225	-2.00%	-2.00%				
Household / public light	50	-3.00%	-3.00%	Commercial consumption (kWh/a)	750	0.00%	0.00%
				Industrial consumption (MWH/a)	7.8	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

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	18345	3481	141	245	230	616	240	360	480	34	88	110	232
2003	18754	3559	156	271	253	680	240	360	485	37	98	123	258
2004	19172	3638	172	299	278	749	240	360	490	41	108	136	285
2005	19600	3719	190	330	306	826	240	360	495	46	119	151	316
2006	20037	3802	210	364	336	910	240	360	499	50	131	168	349
2007	20484	3887	232	402	369	1003	240	360	504	56	145	186	387
2008	20941	3974	256	444	406	1106	240	360	510	61	160	207	428
2009	21408	4062	283	490	446	1219	240	360	515	68	176	230	474
2010	21885	4153	312	541	490	1343	240	360	520	75	195	255	524
2011	22373	4245	344	597	538	1479	240	360	525	83	215	282	580
2012	22872	4340	380	659	591	1630	240	360	530	91	237	313	642
2013	23382	4437	398	689	613	1700	240	360	536	95	248	328	672
2014	23903	4536	416	720	636	1772	240	360	541	100	259	344	703
2015	24436	4637	434	753	660	1847	240	360	546	104	271	361	736
2016	24981	4740	454	787	685	1926	240	360	552	109	283	378	770
2017	25538	4846	475	823	711	2009	240	360	557	114	296	396	806
2018	26108	4954	496	860	738	2094	240	360	563	119	310	415	844
2019	26690	5064	518	899	766	2183	240	360	568	124	324	435	884
2020	27285	5177	542	940	795	2277	240	360	574	130	338	456	925
2021	27894	5293	567	983	825	2375	240	360	580	136	354	478	968
2022	28516	5411	592	1028	856	2476	240	360	586	142	370	501	1014

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	10	8	11	21	24	1314	274	49	324	246	0.17	6	241
2003	15	750	11	8	12	23	26	1360	303	55	358	263	0.18	6	257
2004	17	750	13	8	12	26	28	1408	334	60	394	280	0.20	6	274
2005	18	750	14	8	13	28	31	1457	369	66	436	299	0.22	6	293
2006	20	750	15	9	14	31	34	1508	407	73	480	319	0.25	7	312
2007	22	750	16	9	15	35	37	1561	449	81	530	340	0.27	7	333
2008	24	750	18	9	16	38	41	1615	496	89	586	363	0.30	7	356
2009	26	750	20	9	17	42	45	1672	548	99	646	387	0.33	7	379
2010	29	750	22	10	19	47	49	1730	605	109	714	412	0.37	7	405
2011	32	750	24	10	20	52	54	1791	667	120	788	440	0.41	8	432
2012	35	750	26	10	21	58	59	1854	737	133	870	469	0.45	8	461
2013	39	750	29	10	22	62	63	1918	774	139	914	476	0.47	8	468
2014	44	750	33	10	23	66	67	1986	814	146	960	484	0.50	8	476
2015	49	750	37	11	25	71	72	2055	856	154	1010	491	0.52	8	483
2016	56	750	42	11	26	77	77	2127	900	162	1062	499	0.55	8	491
2017	63	750	47	11	27	83	83	2201	947	170	1117	508	0.58	8	499
2018	71	750	53	11	29	89	88	2278	996	179	1176	516	0.61	8	508
2019	80	750	60	11	30	95	94	2358	1049	189	1238	525	0.64	8	516
2020	90	750	67	11	32	103	101	2441	1105	199	1303	534	0.67	9	525
2021	101	750	76	11	34	110	108	2526	1164	209	1373	544	0.71	9	535
2022	114	750	86	12	36	119	116	2615	1226	221	1447	553	0.75	9	545

ECONOMIC ANALYSIS: NILGARH GAD 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	406.274	0	406.274	1938	0	0		0	-406.274
2003	541.6986	0	541.6986	1938	0	0		0	-541.699
2004	406.274	0	406.274	1938	0	0		0	-406.274
2005		79.1649	79.1649	1938	369.0865	28.66	25.92	54.58	-24.5849
2006		79.1649	79.1649	1938	407.0609	31.62339	25.92	57.54339	-21.6215
2007		79.1649	79.1649	1938	449.222	34.91333	25.92	60.83333	-18.3316
2008		79.1649	79.1649	1938	496.2218	38.58862	25.92	64.50862	-14.6563
2009		79.1649	79.1649	1938	547.6808	42.61101	25.92	68.53101	-10.6339
2010		79.1649	79.1649	1938	604.7052	47.06952	25.92	72.98952	-6.17538
2011		79.1649	79.1649	1938	667.4185	51.97399	25.92	77.89399	-1.27091
2012		79.1649	79.1649	1938	736.9884	57.41818	25.92	83.33818	4.173281
2013		79.1649	79.1649	1938	774.3554	60.36727	25.92	86.28727	7.122369
2014		79.1649	79.1649	1938	813.7776	63.48627	25.92	89.40627	10.24137
2015		79.1649	79.1649	1938	855.7137	66.80771	25.92	92.72771	13.56281
2016		79.1649	79.1649	1938	899.911	70.31721	25.92	96.23721	17.07231
2017		79.1649	79.1649	1938	946.8963	74.05222	25.92	99.97222	20.80732
2018		79.1649	79.1649	1938	996.3906	77.9972	25.92	103.9172	24.7523
2019		79.1649	79.1649	1938	1048.892	82.18834	25.92	108.1083	28.94344
2020		79.1649	79.1649	1938	1104.611	86.64304	25.92	112.563	33.39814
2021		79.1649	79.1649	1938	1163.719	91.37677	25.92	117.2968	38.13187
2022		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2023		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2024		434.6482	434.6482	1938	1226.345	96.40224	25.92	122.3222	-312.326
2025		434.6482	434.6482	1938	1226.345	96.40224	25.92	122.3222	-312.326
2026		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2027		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2028		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2029		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2030		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2031		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2032		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2033		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
2034		79.1649	79.1649	1938	1226.345	96.40224	25.92	122.3222	43.15734
NPV	1234.491	700.1303	1934.621	20400.12	5724.585	447.3056		649.2441	-1285.38

IRR	-0.0862	
B/C R	0.335592	
BET	0.33795	US$
	26.02212	NRs.
Generation Cost	0.094834	US$/kWh
	7.302205	NRs./kWh
Rev/OM Cost Ratio	0.362029	

Financial / Economic Cost

	US $ (000)	NRs. (000)
Capital Cost	1466.021	112884
O&M Cost	87.961	6773
R&R Cost	359.074	27649
Exchange Rate	1	77
Foreign	386.974	29797
Local	1079.047	83087
	1466.021	

Financial Costs

1st Year	439.8063	0.3
2nd Year	586.4084	0.4
3rd Year	439.8063	0.3
Total	1466.021	

Economic Costs

R&R Cost			
355.4833	0.99	383.1043	Foreign
	0.9	971.1423	Local
		79.1649	O&M
	Total	1354.247	

Economic Costs

1st Year	406.274
2nd Year	541.6986
3rd Year	406.274
Total	1354.247

SOCIO ECONOMIC RESULTS

SOCIO ECONOMIC RESULTS

- Summary Result of Economic / Financial and Social Analysis
- Socio Economic Data
- Affordability Ratio and Willingness to Pay Ratio
- Energy Consumption in Nepal
- Gross Domestic Product
- Energy Consumption Regional 1995 /1996
- District wise Per Capita Income

SUMMARY RESULTS OF ECONOMIC/FINANCIAL AND SOCIAL ANALYSIS

S. No.	Project Name	Revenue and Power Demand				Economic Analysis				Social Analysis			
		Revene (000 US$)	Revenue / O & M Cost Ratio	Power Demand (MWh/Yr)	Power Factor	Generation Cost (US$/Kwh)	Break Even Tariff (US$/month	Economic Internal Rate of Return (EIRR %)	Benefit Cost Ratio	Affordability and Tariff Ratio	Willingness to pay and Tariff per month Ratio	Sustainability: Revenue per O & M Cost Ratio per Annum	Percentage Ratio of O & M Cost and Total Cost
1	Kabeli Khola - I	27	0.28	904	0.06	0.03	0.69	-1.8	0.44	0.93	0.61	0.61	4.0%
2	Kabeli Khola - II	27	0.18	904	0.06	0.03	1.06	-2.1	0.44	0.93	0.61	0.61	4.0%
3	Maiwa Khola	157	0.82	5878	0.06	0.03	0.18	6.1	0.75	1.21	0.61	0.61	5.0%
4	Leguwa Khola	34	0.58	1351	0.61	0.06	0.24	3.4	0.62	1.11	0.61	0.61	5.0%
5	Sabha Khola	28	0.26	1035	0.1	0.03	0.69	-2.6	0.43	1.11	0.61	0.61	4.0%
6	Rok Khola	16	0.31	582	0.24	0.04	0.42	-7.3	0.40	1.11	0.61	0.61	6.0%
7	Yari Khola	28	0.54	1066	0.84	0.08	0.23	-1.7	0.43	1.11	0.61	0.61	6.0%
8	Molung Khola	118	0.76	4601	0.91	0.06	0.16	3.2	0.61	1.34	0.61	0.61	6.0%
9	Chaunri Khola	22	0.22	729	0.26	0.08	0.66	-ve	0.25	0.88	0.66	0.66	6.0%
10	Tadi Khola	24	0.22	1040	0.15	0.04	0.62	-5.2	0.40	0.7	0.81	0.81	5.0%
11	Khani Khola	20	0.22	805	0.1	0.03	0.77	-2.2	0.42	0.39	0.52	0.52	4.0%
12	Phalankhu - II	25	0.27	1172	0.22	0.05	0.42	10.2	1.01	0.66	0.66	0.66	6.0%
13	Phalankhu - I	25	0.24	1172	0.22	0.05	0.54	10.0	1.00	0.66	0.66	0.66	5.0%
14	Darundi Khola	45	0.30	2079	0.31	0.05	0.41	-3.8	0.38	0.64	0.74	0.74	5.0%
15	Chepe Khola	32	0.23	1460	0.53	0.1	0.48	-ve	0.26	0.77	0.69	0.69	6.0%
16	Charang Khola	43	0.44	229	0.07	0.06	1.78	-ve	0.20	0.8	0.73	0.73	6.0%
17	Jyagdi Khola	20	0.19	1002	0.37	0.08	0.36	-ve	0.27	0.8	0.73	0.73	6.0%
18	Ghami Khola	27	0.27	1224	0.14	0.03	0.58	-1.1	0.44	1.05	0.73	0.73	4.0%
19	Bhim Khola	31	0.31	2305	0.83	0.12	0.43	0.7	0.43	0.75	0.75	0.75	6.0%
20	Chhal gad	17	0.25	829	0.83	0.14	0.4	-17.0	0.26	0.52	0.7	0.7	6.0%
21	Phoi gad	9	0.14	386	0.29	0.1	0.81	-ve	0.19	0.88	0.88	0.88	6.0%
22	Chaudhabise	17	0.17	774	0.15	0.04	0.48	-5.7	0.37	0.36	0.7	0.7	5.0%
23	Jaljala Khola	8	0.13	394	0.51	0.16	0.74	-ve	0.17	0.36	0.61	0.61	6.0%
24	Satya Khola	40	0.30	1922	0.22	0.04	0.48	-1.8	0.39	0.22	0.7	0.7	4.0%
25	Mujkot Khola	56	0.33	3540	0.49	0.02	0.11	11.2	1.04	0.54	0.52	0.52	5.0%
26	Galwa gad	25	0.42	1250	1.81	0.18	0.24	-5.2	0.35	0.77	0.81	0.81	6.0%
27	Gandi gad	25	0.20	1783	0.18	0.03	0.56	-1.0	0.43	0.65	0.52	0.52	4.0%
28	Gadsera gad	8	0.08	544	0.14	0.05	1.14	-ve	0.25	0.6	0.52	0.52	6.0%
29	Kala gad	11	0.21	515	0.54	0.12	0.54	-ve	0.23	0.64	0.52	0.52	6.0%
30	Jamadi gad	31	0.21	1478	0.14	0.03	0.72	-4.4	0.36	0.36	0.52	0.52	4.0%
31	Bhartola gad	15	0.14	678	0.25	0.07	0.78	-ve	0.23	0.97	0.52	0.52	6.0%
32	Nilgarh gad	29	0.33	1445	0.75	0.09	0.33	-8.6	0.34	0.36	0.52	0.52	6.0%

SOCIO-ECONOMIC DATA
Small Hydropower Project

NEPAL	Agriculture land(ha)		Irrig. Status		Area in hectare									Production of Food and Cash Crops in mt.									Food Balance			Literacy %			Health Stastistics										Cottage and Small Industry			Manufacturing Industries			Road(in km)				Govt.	No of Bank					No Of Corp.		
Districts	Cult.	Non-cult	Irri	Non irr.	Rice	Wheat	Maize	Millet	Barley	Suger cane	Oil seed	Tomato	Potato	Paddy	Wheat	Maize	Millet	Barley	Sugerc ane	Oil seed	Tobaco	Potato	Food Supply	Reqmt	Food Surp \ Def	Total	Male	Fem.	Hospital	Bed	Doctors	Nurses	Health Post	Health Assist.	Health Wokers	Pop/B ed	Pop/H Wokers	Water pop	No.	Inv. (Rs. in m)	Emplyment (Person)	No	No of Person	Value Added in Rs.'ooo	Total	Mat	Grav	Earth	Office	NB	RB	ADB	NRB	Other	Tele. Com.	NFC	AIC
Eastern Dev.Reg.																																																						
Taplejung- Mountain	27551	13747	7411	22102	6480	1820	9320	2410	230		350		1900	11860	2180	12510	2530	200		150		13410	17908	22927	-5019	46	62.2	30.5	1	15	2	26	9	13	20	8004	1968	35	51	2.48	47				24			24	47	1		1			1	4	1
Dhankuta-Hill	33105	13711	6495	26797	9610	2730	19000	6980	40	60	520		1200	22780	3550	30310	7000	50	860	270		9450	43967	29673	14294	49	65.6	33	1	15	5	28	13	12	22	9759	2185	48	383	5.22	446	6	108	1221	90	45	27	18	68	2	3	2	1		1	3	1
Solukhumbu-Mountain	21435	11877	1733	17734	700	1200	4330	1200	580		110		2100	1060	1310	6090	1230	530		60		19600	6674	18666	-11992	38.6	56.3	21.3	2	30	4	27	10	12	22	3240	1495	34	153	5.97	156	21	255	3203					45		3	2			4	3	1
Okhaldhunga-Hill	29825	19012	3812	24151	5470	1580	9120	2500	130	20	400		1950	9390	1610	11780	2500	120	330	230		13650	15894	28256	-12362	38.6	55.7	22.8	1	15	1	24	10	12	20	9297	2447	34	137	4.45	286	2	32	207					39	1	2	3			1	1	1
Udayapur-Hill	35065	17328	10978	30773	11700	3480	9680	1100	60	60	4200	40	790	27590	5180	16200	1320	60	1440	2360	30	5250	30312	44701	-14389	38	55	21.4	1	15	3	28	11	13	23	14750	3302	10	239	8.94	766	8	374	5939	154	46	31	77	43	1	3	3			3	1	1
Central Dev. Reg.																																																					
Ramechhap-Hill	40050	19130	3921	32276	4930	3640	16900	2500	340	90	240		1900	4680	3990	16990	2500	310	1180	140		11400	20845	38251	-17406	29.9	48.8	12.7			1	22	13	13	21		3299	32	341	7.64	545	1	19	1306					43	1	4	3			2	1	1
Lalitpur-Hill	12793	4867	5538	11067	4070	4780	5070	1250	40		400		500	18510	8090	13830	1870	40		230		3850	28547	52631	-24084	62.2	76.3	47.8	4	284	25	49	11	13	29	905	2216	46	2630	569.83	28587	617	34343	1314002	210	78	34	98	89	8	3	4		1	1		
Nuwakot-Hill	38997	21155	13410	31783	16870	5550	19700	4140	80	210	380	30	1430	39870	8600	29670	4980	80	3150	110	25	11270	53902	49767	4135	31.4	45.1	17.8	1	25	3	30	11	13	23	9810	3554	18	841	30.7	1383	11	171	3140	138	77		61	53	5	1	3			1		1
Rasuwa-Mountain	6332	4049	751	5201	1070	980	2370	1380	320				2150	2290	1030	3090	1420	300				15260	5046	7092	-2046	22.9	33.7	11.3	1	15	1	22	9	13	20	2450	656	43	56	3.08	179	3	49	2198	108		105	3	38	1		1			1	2	1
Western Dev.Reg.																																																				
Gorkha-Hill	41482	23057	6833	33915	16820	4130	18600	12900	210	20	370		1800	34620	5320	28100	15760	190	450	210		13820	56306	50817	5489	43.3	57.2	30.9	2	40	3	28	13	15	25	6313	3557	30	252	11.07	659	6	347	3443	32	25	5	2	53	3	3	4			1	3	1
Lamjung-Hill	28769	15105	9817	23848	11480	4110	10020	4780	220	30	360		1010	23650	5550	18000	6140	200	480	180		7980	34351	30922	3429	46.8	61.7	33.8	1	15	3	26	10	12	21	10246	2479	52	119	9.37	273				27			27	45	2	2	3			1	1	1
Syanja-Hill	37718	22300	7747	31017	15060	8020	34230	2400	80	160	250		730	33770	11500	48680	28320	80	2400	130		5020	86089	58906	27183	51.1	66.6	38.2			1	22	13	15	23		4812	23	281	52.61	624	3	41	9230	95	82	3	10	46	3	2	4			1	1	1
Mustang-Mountain	4690	777		4221		920	970		1040		40		500		1020	1510		1020		20		3500	2225	2749	-524	48.4	60.7	34.7	1	15	2	27	9	11	21	953	234	21	111	3.47	288	4	47	948					43	1		1			2	3	1
Baglung-Hill	32498	19846	3284	26522	4960	6200	14710	4130	420		300		670	11250	7380	20000	4930	380		180		5450	29465	46965	-17500	40.5	56.5	27.1	1	15	2	28	12	14	24	12059	2660	24	389	12.28	697	19	255	3939					51	3	1	4			2	3	
Mid West Dev.Reg.																																																				
Pyuthan-Hill	28171	14870	4290	23197	5300	8610	10530	2300	580		590		460	9620	8800	12570	2750	540		300		3560	22440	35124	-12684	32.5	51.1	16.9	1	15	2	26	11	14	22	11698	2742	22	167	7.52	335	4	45	2891	64			64	39	2	1	1			1	3	1
Jajarkot-Hill	25751	12471	3314	21114	3080	5880	8050	2100	780		260		570	4650	5880	13620	2570	730		130		4120	18539	23130	-4591	23.5	37.8	9	1	15	2	25	9	12	20	7597	1931	20	67	2.4	150	4	70	1108					35	2		1			1	4	1
Dolpa-Mountain	6008	3333	100	4995	520	570	2010	300	590				480	790	600	2740	360	570				3480	3278	4820	-1542	23.2	37.3	8.4			1	22	10	12	20		455	20	55	0.22	9	1	11	153					37	1		1			1	2	1
Jumla-Mountain	14743	9314	2110	12642	1300	1800	1280	1360	1510		20		550	2410	2020	1810	1460	1490		10		3550	5192	14650	-9458	25.2	41.2	8.4	1	15	3	45	9	11	21	5064	950	21	133	24	131						48		1	2			1	1	1
Humla-Mountain	6066	3231	558	4984	520	610	50	1110	820		60		550	840	610	90	1230	790		30		4150	1740	6879	-4939	19.5	33.4	4.5			1	22	11	14	21		593	21	79	1.79	129						36		1	1			1	2	1
Far-West Dev.Reg.																																																			
Doti-Hill	33463	15904	8699	27562	6730	10100	4200	1940	330	10	670		500	10510	9490	7250	2420	300	150	360		3520	18833	33813	-14980	28.3	48.5	9.8	1	15	6	26	11	13	22	11145	2495	22	654	8.49	228	1	74	3618	50			50	65	1	3	4			2	3	1
Baitadi-Hill	31485	19018	6521	25543	5000	7110	7620	1360	710	20	150		550	8500	7000	11440	1450	640	280	90		4730	16438	40472	-24034	35.3	59.5	13.4	1	15	3	28	12	14	27	13381	2788	27	212	7.56	375				124			124	50	1	1	3			1	2	1
Darchula-Mountain	16053	8911	3241	13201	1650	7280	6100	1500	910		110		610	2950	7020	10150	1500	800		50		3590	14772	19525	-4753	40.9	65	17.7	1	15	2	25	11	14	23	6779	1589	23	94	3.06	190	1	11	551					48	2	1	2			2	2	1

Source: CBS

Affordability Ratio and Willingness to Pay Ration

Region/District	Project	Affordability				Willingness to Pay			
		Low	Middle	High	Ratio	Low	Middle	High	Ratio
EDR		1.27	0.79	0.68	**1.11**	0.63	0.65	0.55	**0.61**
Sankhuwasabha	Sabha								
Taplejung	Maiwa	0.61	0.39	0.31	1.21	0.63	0.65	0.55	0.61
	Kabeli I	1.21	0.81	0.78	0.93	0.63	0.65	0.55	0.61
	Kabeli II	1.21	0.81	0.78	0.93	0.63	0.65	0.55	0.61
Solukhumbhu	Rok								
Dhankuta	Leguwa								
Okhaldunga	Molung	2.03	1.14	0.86	1.34				
Udayapur	Yari								
CDR		0.84	0.56	0.58	**0.66**	0.78	0.65	0.55	**0.66**
Rasuwa	Phlanku I								
	Phlanku II								
Nuwakot	Tadi	0.91	0.58	0.62	0.70	0.94	0.82	0.66	0.81
Lalitpur	Khani	0.56	0.31	0.31	0.39	0.63	0.49	0.44	0.52
Ramechap	Chaunri	1.04	0.79	0.81	0.88				
WDR	Jyagdi	1.00	0.72	0.68	**0.80**	0.77	0.71	0.70	**0.73**
	Ghami	1.36	0.90	0.88	1.05				
	Charang								
Baglung	Bhim	0.94	0.65	0.66	0.75	0.94	0.65	0.66	0.75
	Chepe	1.08	0.67	0.55	0.77	0.75	0.65	0.66	0.69
Gorkha	Daraundi	0.63	0.65	0.63	0.64	0.63	0.82	0.77	0.74
MWDR		0.64	0.49	0.44	**0.52**	0.78	0.69	0.64	**0.70**
Jumla	Jaljala	0.53	0.34	0.21	0.36	0.63	0.65	0.55	0.61
	Chandbise	0.53	0.33	0.21	0.36				
Dolpa	Phoigad	0.94	0.81	0.88	0.88	0.94	0.82	0.88	0.88
Humla	Galwagad	1.00	0.65	0.66	0.77	0.94	0.82	0.66	0.81
Jajarkot	Mujkot	0.58	0.59	0.45	0.54	0.63	0.49	0.44	0.52
	Satya	0.25	0.20	0.20	0.22				
FWDR		0.68	0.60	0.51	**0.60**				
Darchula	Kalagad	0.65	0.67	0.59	0.64				
	Bhartola	1.03	1.00	0.88	0.97				
	Jamadi	0.49	0.34	0.27	0.36				
	Nilgarh	0.49	0.34	0.27	0.36				
Doti	Gandigad	0.75	0.65	0.55	0.65	0.50	0.52	0.53	0.52
	Gadsera								

Gross Domestic Product

Rs. In Million

Description	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
Gross National Product (at Market Price):	144,933	165,350	191,596	209,976	239,388	269,570	289,798	330,018	366,284	393,473	410,493
Agricultural :	65,156	70,090	80,589	85,569	96,896	108,785	112,495	132,373	144,644	149,040	156,384
Non-agricultural:	79,777	95,260	111,007	1,224,407	142,492	160,785	177,303	197,645	221,640	244,433	254,109
GDP at Factor Cost (1994/95 Price):	183,371	188,780	204,397	209,976	221,930	233,040	240,816	251,790	267,473	280,339	282,574
Agricultural:	80,392	79,631	86,356	85,569	88,830	92,706	93,496	96,183	100,856	105,227	107,037
Non-agricultural:	102,979	109,149	118,041	124,407	133,100	140,334	147,320	155,607	166,617	175,112	175,537
Percentage Change:											
GDP at Factor Cost (1994/95 Price):		2.9%	8.3%	2.7%	5.7%	5.0%	3.3%	4.6%	6.2%	4.8%	0.8%
Agricultural:		-0.9%	8.4%	-0.9%	3.8%	4.4%	0.9%	2.9%	4.9%	4.3%	1.7%
Non-agricultural:		6.0%	8.1%	5.4%	7.0%	5.4%	5.0%	5.6%	7.1%	5.1%	0.2%
Average Growth Rate (5 years):											
GDP at (1994/95 Price):	3.95%										
Agricultural:	2.93%										
Non-agricultural:	4.60%										

Source: Economic Survey, MOF, 2002

Energy Consumption in Nepal

	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
Traditional :	**5,691**	**5,811**	**5,933**	**6,059**	**6,185**	**6,269**	**6,403**	**6,540**	**6,681**	**6,824**	**6,960**
Fuelwood	5,084	5,191	5,300	5,412	5,525	5,575	5,694	5,816	5,941	6,068	6,189
Agricultural Residue	228	233	238	243	248	273	279	285	292	299	305
Animal Waste	379	387	395	404	412	421	430	439	448	457	466
Commercial :	**417**	**430**	**483**	**583**	**651**	**674**	**747**	**783**	**1,181**	**1,714**	**1,877**
Electricity	55	56	60	67	72	60	61	61	236	734	790
% Change		1.82%	7.14%	11.67%	7.46%	-16.67%	1.67%	0.00%	286.89%	211.02%	7.63%
Petroleum	306	348	391	449	507	554	625	661	709	246	297
Coal	56	26	32	67	72	60	61	61	236	734	790
Total	6,525	6,671	6,899	7,225	7,487	7,617	7,897	8,106	9,046	10,254	10,714
% Change		2.2%	3.4%	4.7%	3.6%	1.7%	3.7%	2.6%	11.6%	13.4%	4.5%
Total (Millions GJ) :	278	284	294	308	319	325	337	345	386	437	457

Energy Consumption Regional 1995/96

Regional Energy Consumption in the Residential Sector 1995/96

Description	EDR	CDR	WDR	MWDR	FWDR	Mountain	Hill	Terai	TOTAL
Traditional	44,854	83,684	55,030	43,672	31,788	32,377	96,187	130,460	259,028
Fuelwood	38,634	69,916	49,140	41,669	31,751	31,853	90,558	108,696	231,110
Agri Residue	1,155	6,101	1,363	1,693	37	354	5,516	4,478	10,349
Animal Waste	5,065	7,667	4,527	310	-	170	113	17,286	17,569
Conventional Energy	703	5,081	1,269	701	366	362	5,091	2,667	8,120
Coal/Coke	-	12	3	-	-	-	7	8	15
Kerosene	526	3,510	1,057	645	344	326	3,634	2,123	6,082
LGP	26	678	53	25	8		588	202	790
Diesel									-
Petrol									-
Other Oil Product									-
Grid Electricity	151	881	156	31	14	36	862	334	1,233
Non Conventional Energy	134	143	191	61	33	5	201	357	562
Decentralised Electricity									-
Gaseous Fuel	134	143	191	61	33	5	201	357	562
	45,691	88,908	56,490	44,434	32,187	32,744	101,479	133,484	267,710

Regional Energy Consumption in the Agricultural Sector 1995/96

Description	EDR	CDR	WDR	MWDR	FWDR	Mountain	Hill	Terai	TOTAL
Traditional	-	-	-	-	-	-	-	-	-
Fuelwood	-	-	-	-	-	-	-	-	-
Agri Residue	-	-	-	-	-	-	-	-	-
Animal Waste	-	-	-	-	-	-	-	-	-
Conventional Energy	17	334	94	73	63	-	-	-	581
Coal/Coke									-
Kerosene									-
LGP									-
Diesel	17	334	90	73	63				577
Petrol									-
Other Oil Product									-
Grid Electricity			4						4
Non Conventional Energy	-	-	-	-	-	-	-	-	-
Decentralised Electricity									-
Gaseous Fuel									-
	17	334	94	73	63	-	-	-	581

Regional Energy Consumption in the Industrial Sector 1995/96

Description	EDR	CDR	WDR	MWDR	FWDR	Mountain	Hill	Terai	TOTAL
Traditional	574	846	229	1018	967	394	1465	1775	3634
Fuelwood	513	801	189	986	941	385	1400	1644	3430
Agri Residue	61	45	40	32	26	9	65	131	204
Animal Waste	0	0	0	0	0	0	0	0	0
Conventional Energy	1368	6334	516	219	97	80	2185	6271	8534
Coal/Coke	868	1336	175	156	64	67	904	1629	2599
Kerosene	78	206	80	19	1	0	270	113	384
LGP	0	0	0	0	0	0	0	0	0
Diesel	99	3099	172	29	20	10	92	3318	3419
Petrol	0	14	0	0	0	0	5	10	14
Other Oil Product	0	841	0	0	0	0	517	324	841
Grid Electricity	323	838	89	15	12	3	397	877	1277
Non Conventional Energy	0	0	0	0	0	0	0	0	0
Decentralised Electricity									0
Gaseous Fuel	0	0	0	0	0	0	0	0	0
	1942	7180	745	1237	1064	474	3650	8046	12168

Source: WECS, Energy Resources and Consumption Profile

Regional Energy Consumption in the Commercial Sector 1995/96

Description	EDR	CDR	WDR	MWDR	FWDR	Mountain	Hill	Terai	TOTAL
Traditional	160	496	80	198	39	33	548	392	973
Fuelwood	157	496	65	198	39	33	538	385	956
Agri Residue	3	-	15	-	-	0	10	8	17
Animal Waste	-	-	-	-	-	-	-	-	-
Conventional Energy	43	1,441	488	111	53	43	1,530	564	2,137
Coal/Coke	5	1	336	0	24	7	212	147	366
Kerosene	26	936	67	52	14	15	820	261	1,096
LGP	6	47	63	2	1	1	78	40	119
Diesel									
Petrol									
Other Oil Product	-	32	1	48	9	8	54	27	89
Grid Electricity	6	425	21	9	6	12	366	89	467
Non Conventional Energy	-	-	-	-	-	-	-	-	
Decentralised Electricity									
Gaseous Fuel	-	-	-	-	-	-	-	-	
	203	1,937	568	309	92	76	2,078	956	3,110

Regional Energy Consumption in the Transport Sector 1995/96

Description	EDR	CDR	WDR	MWDR	FWDR	Mountain	Hill	Terai	TOTAL
Traditional	-	-	-	-	-	-	-	-	
Fuelwood	-	-	-	-	-	-	-	-	
Agri Residue	-	-	-	-	-	-	-	-	
Animal Waste	-	-	-	-	-	-	-	-	
Conventional Energy	945	5,599	1,369	557	239	-	-	-	8,709
Coal/Coke	-	103	-	-	-				
Kerosene									
LGP									
Diesel	769	3,497	1,033	336	227				
Petrol	154	913	237	122	12				
Other Oil Product	22	1,067	99	99					
Grid Electricity	-	19	-	-					
Non Conventional Energy	-	-	-	-	-	-	-	-	-
Decentralised Electricity									
Gaseous Fuel									
	945	5,599	1,369	557	239	-	-	-	8,709

Total Energy Consumption in Nepal (1995/96) : Regional Distribution

Description	EDR	CDR	WDR	MWDR	FWDR	Mountain	Hill	Terai	TOTAL
Traditional	45,588	85,026	55,339	44,888	32,794	32,804	98,200	132,627	263,635
Fuelwood	39,304	71,213	49,394	42,853	32,731	32,271	92,496	110,725	235,496
Agri Residue	1,219	6,146	1,418	1,725	63	363	5,591	4,617	10,570
Animal Waste	5,065	7,667	4,527	310	-	170	113	17,286	17,569
Conventional Energy	3,076	18,789	3,736	1,661	818	485	8,806	9,502	28,081
Coal/Coke	873	1,452	514	156	88	74	1,123	1,784	3,083
Kerosene	630	4,652	1,204	716	359	341	4,724	2,497	7,562
LGP	32	725	116	27	9	1	666	242	909
Diesel	885	6,930	1,295	438	310	10	92	3,318	9,858
Petrol	154	927	237	122	12	-	5	10	1,452
Other Oil Product	22	1,940	100	147	9	8	571	351	2,217
Grid Electricity	480	2,163	270	55	32	51	1,625	1,300	3,000
Non Conventional Energy	134	143	191	61	33	5	201	357	562
Gaseous Fuel	134	143	191	61	33	5	201	357	562
Total	3,210	18,932	3,927	1,722	851	490	9,007	9,859	28,643

Percentage share of Energy Consumption in Regional : 1995/96

Description	EDR	CDR	WDR	MWDR	FWDR	Mountain	Hill	Terai	TOTAL
Traditional	17%	32%	21%	17%	12%	12%	37%	50%	100%
Fuelwood	17%	30%	21%	18%	14%	14%	39%	47%	100%
Agri Residue	12%	58%	13%	16%	1%	3%	53%	44%	100%
Animal Waste	29%	44%	26%	2%	0%	1%	1%	98%	100%
Conventional Energy	11%	67%	13%	6%	3%	2%	31%	34%	100%
Coal/Coke	28%	47%	17%	5%	3%	2%	36%	58%	100%
Kerosene	8%	62%	16%	9%	5%	5%	62%	33%	100%
LGP	4%	80%	13%	3%	1%	0%	73%	27%	100%
Diesel	9%	70%	13%	4%	3%	0%	1%	34%	100%
Petrol	11%	64%	16%	8%	1%	0%	0%	1%	100%
Other Oil Product	1%	87%	4%	7%	0%	0%	26%	16%	100%
Grid Electricity	16%	72%	9%	2%	1%	2%	54%	43%	100%
Non Conventional Energy	24%	25%	34%	11%	6%	1%	36%	64%	100%
Gaseous Fuel	24%	25%	34%	11%	6%	1%	36%	64%	100%
Total	11%	66%	14%	6%	3%	2%	31%	34%	100%