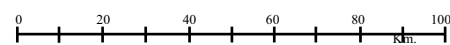
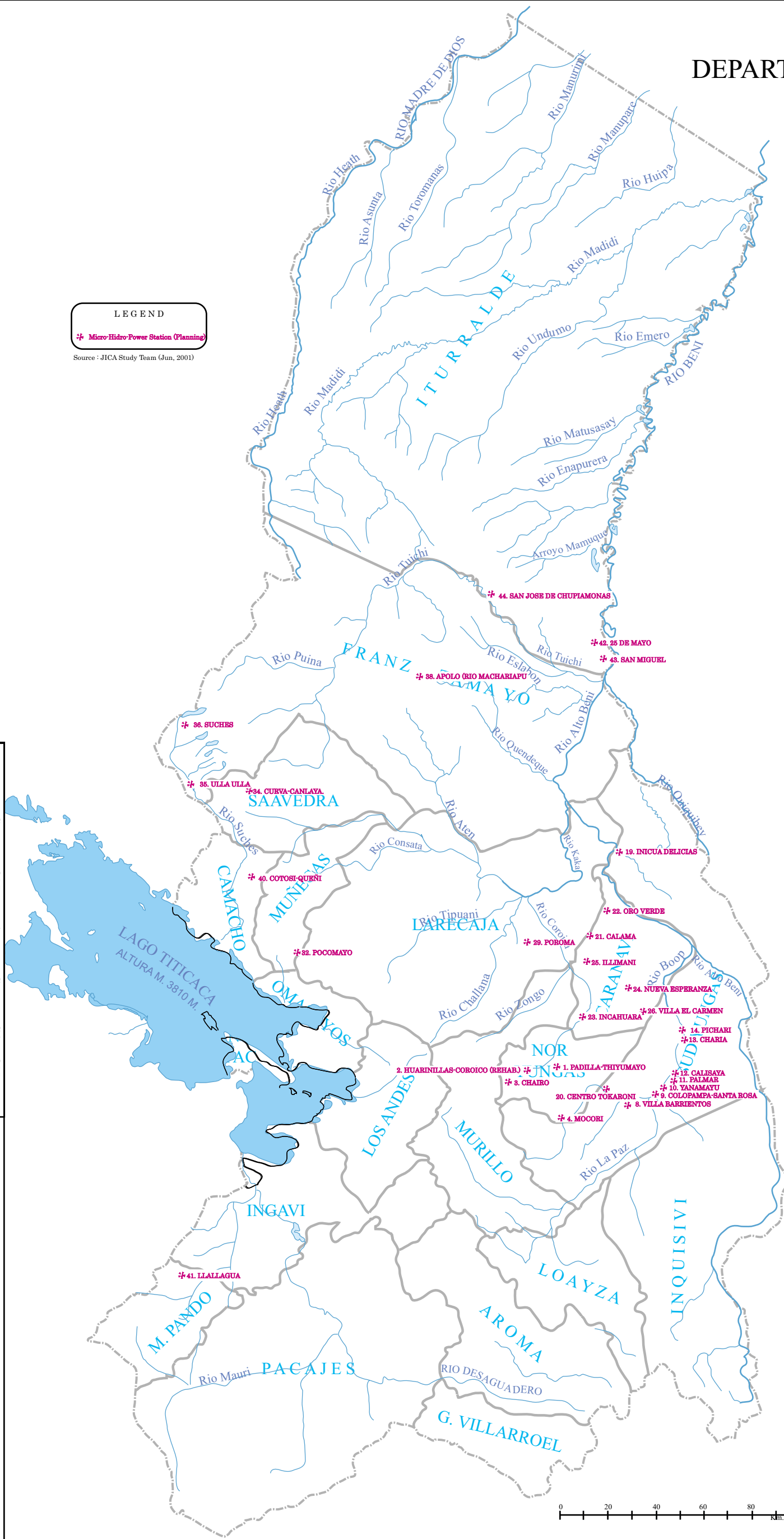


DEPARTAMENTO DE LA PAZ



LEGEND
 ✦ Micro-Hidro-Power Station (Planning)
 Source : JICA Study Team (Jun, 2001)



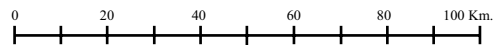
THE STUDY ON RURAL ELECTRIFICATION IMPLEMENTATION PLAN BY RENEWABLE ENERGY IN THE REPUBLIC OF BOLIVIA
 JAPAN INTERNATIONAL COOPERATION AGENCY
 Figure 4.5
 Selected Priority Micro-Hydro Power Project (2002-2006, 2007-2011)
 (La Paz)

DEPARTAMENTO DE ORURO



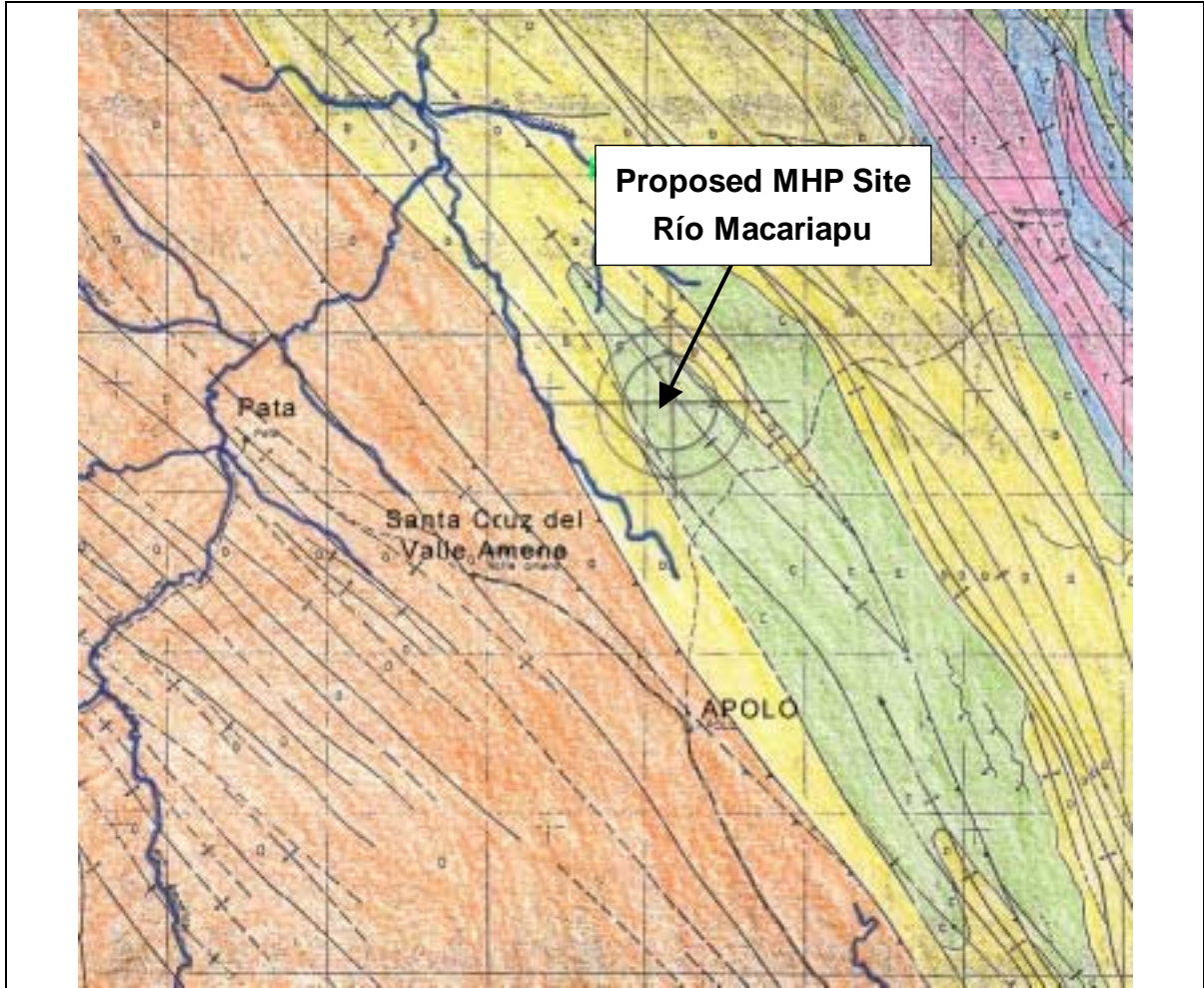
LEGEND

⚡ Micro-Hidro-Power Station (Planning)



THE STUDY ON RURAL ELECTRIFICATION
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Figure 4.6
Selected Priority Micro-Hydro Power Project
(2002-2006,2007-2011) (Oruro)



Source: Centro de Investigacion y Aplicacion de Sensores Remitos Ciaser - Geobol", Estudio Integrado de Los Recursos Naturales del Departamento de La Paz, Geologia, Interpretado y Compilado por: Ing. Raul Ballon Ayllon, Apolo, (1985)

LEGEND

- C** **Carboniferous [Carbonifero]** (3.5 ~ 2.7 hundreds million years ago)
 - a) Gritty, limelight with thin diamictitas intercalations. (Altiplano and Oriental Mountain range)
[Areniscas, limolitas con delgadas intercalaciones de diamictitas. (Altiplano y Cordillera Oriental)]
 - b) Diamictitas, limelight, gritty, gritty conglome resides and diamictitas with intercalations of gritty and conglomerates in the superior part. (Subandino North)
[Diamictitas, limolitas, areniscas, areniscas conglome radicas y diamictitas con intercalaciones de areniscas y conglomerados en la parte superior. (Subandino Norte)]
- D** **Devonian [Devonico]** (4.0 ~ 3.5 hundreds million years ago)
Shale, gritty and limelight [Lutitas, areniscas y limolitas]
- O** **Ordovician [Ordovico]** (4.9 ~ 4.3 hundreds million years ago)
Shale, gritty and limelight [Lutitas, areniscas y limolitas]

Figure 5.1 Geological Map of Apolo

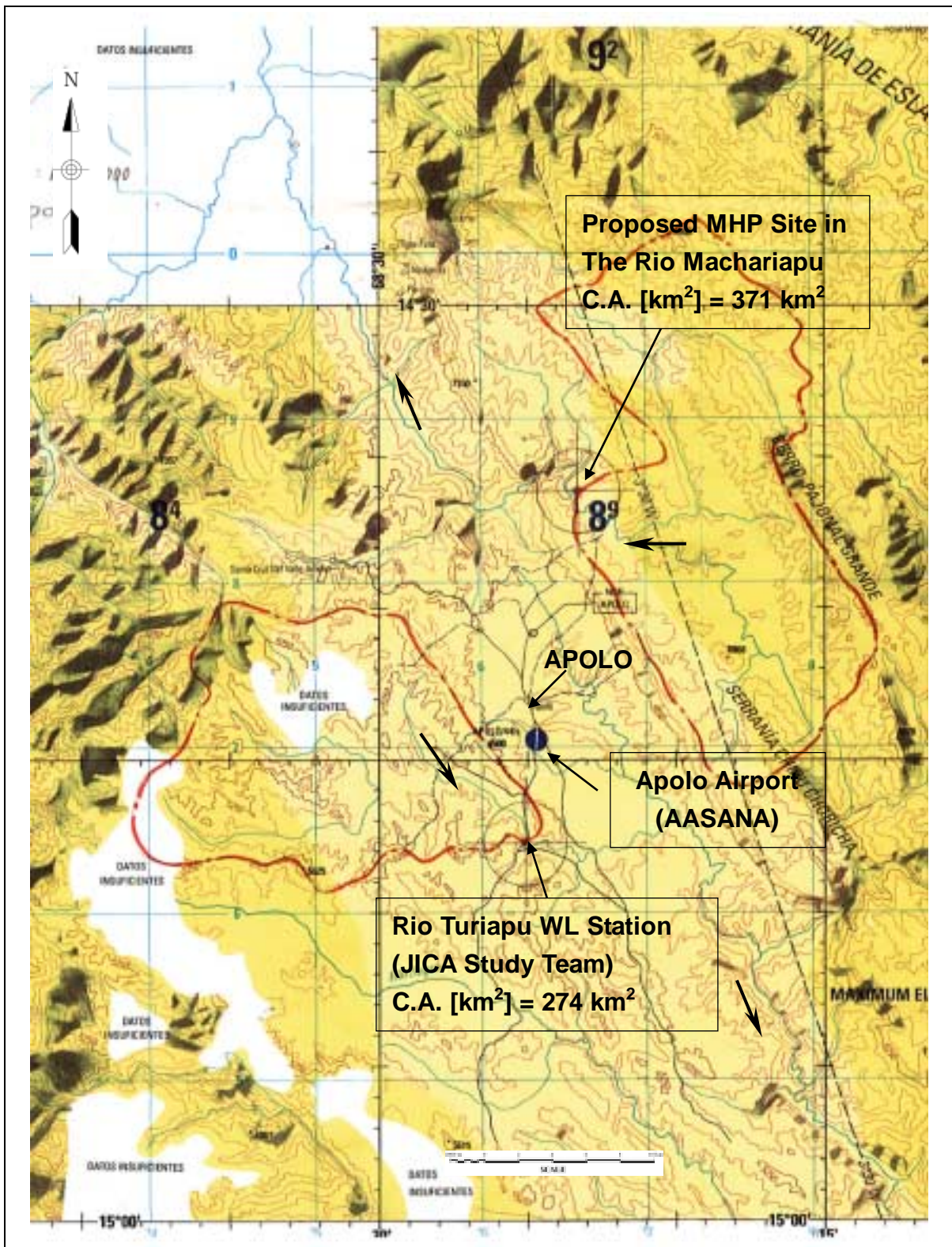


Figure 5.2 Catchment Area of the Turiapu River W.L. Station and Proposed MHP Intake Site at the Machariapu River in the Apolo

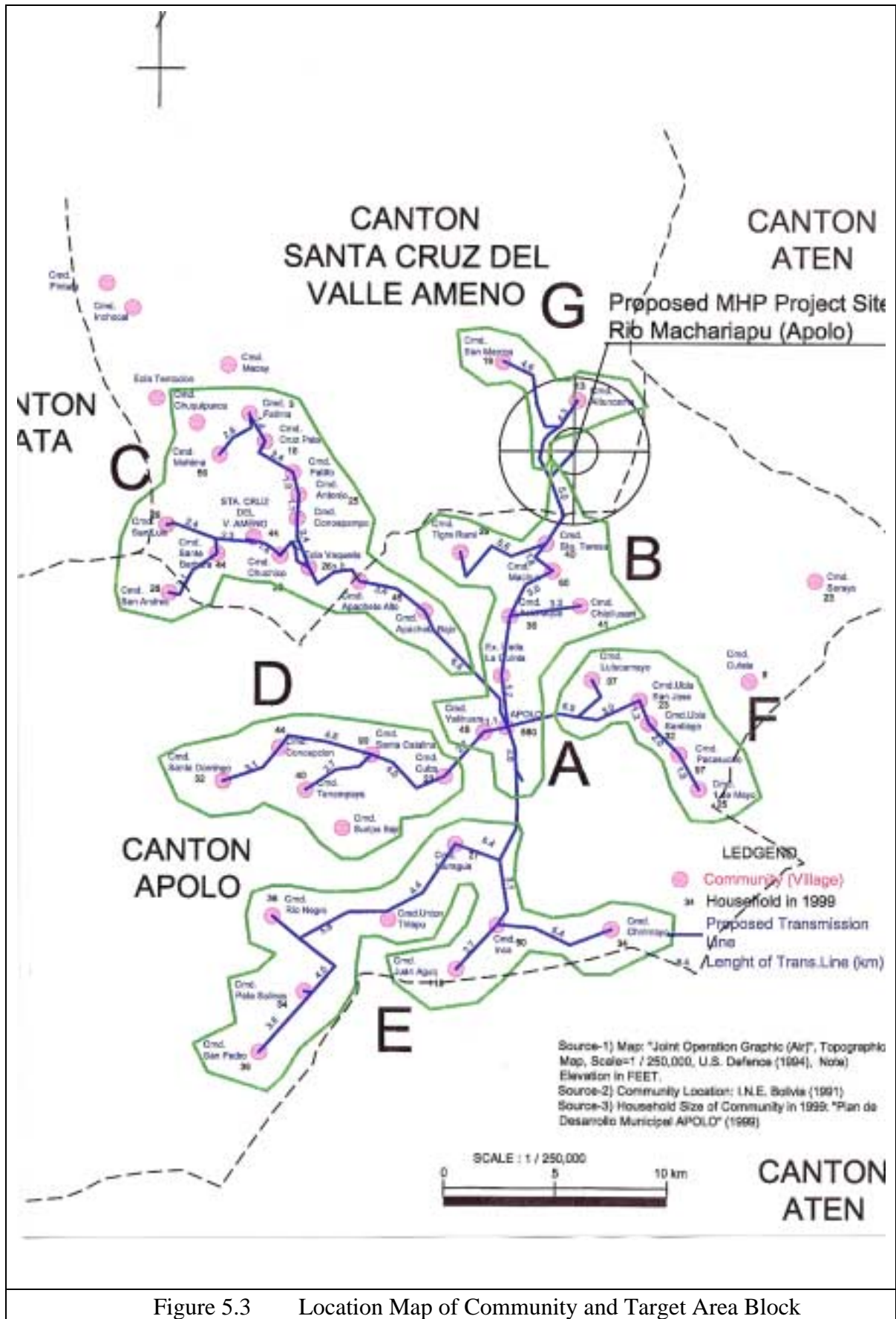


Figure 5.3 Location Map of Community and Target Area Block

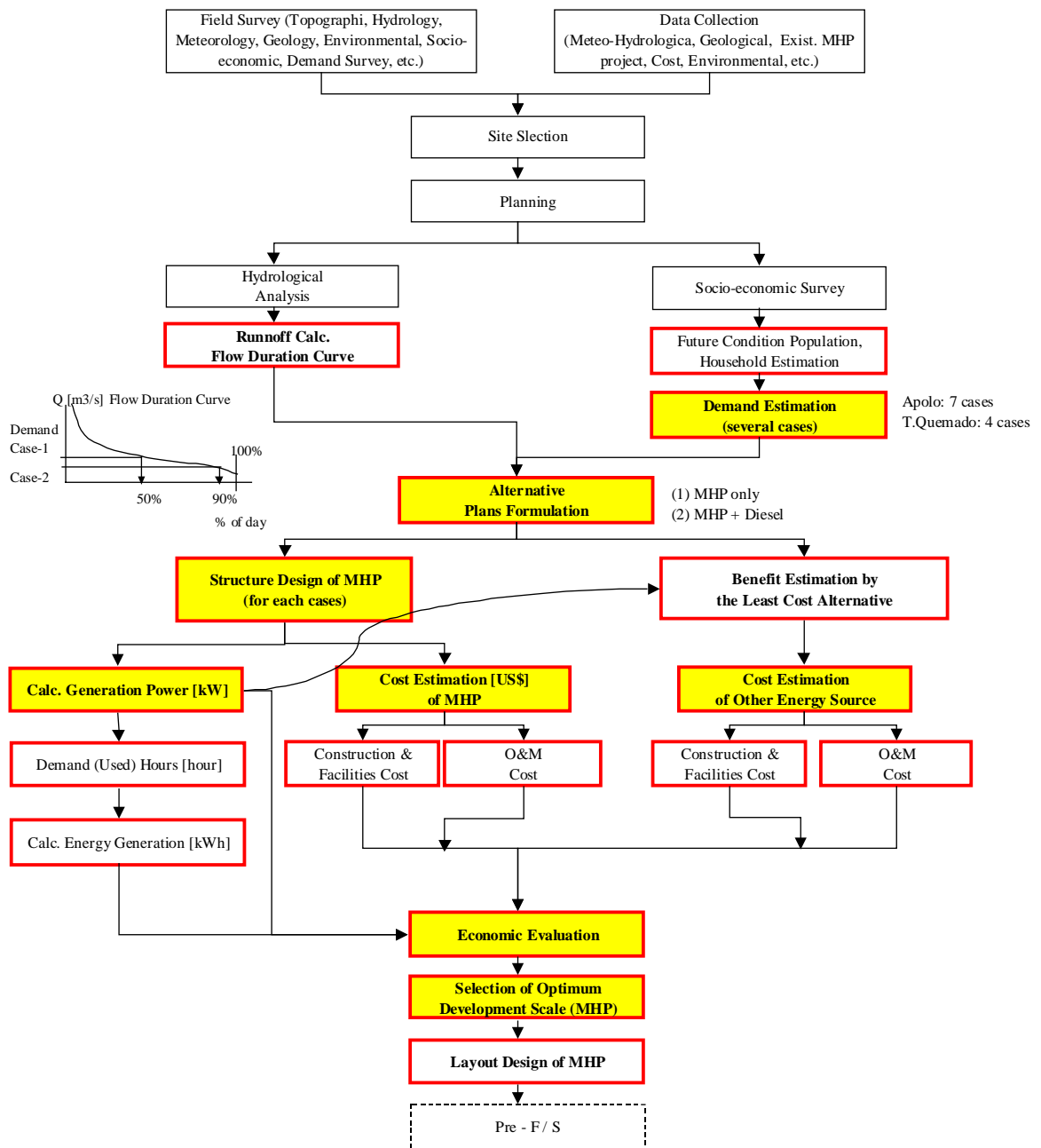
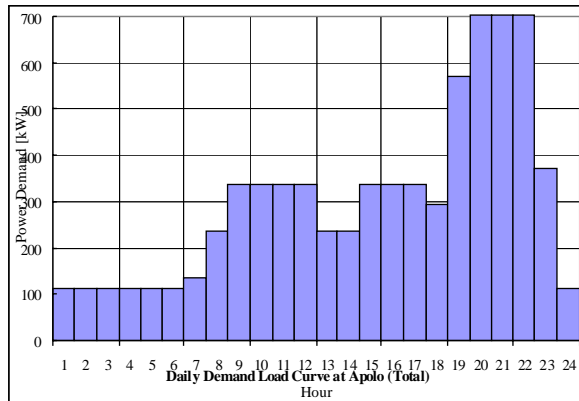
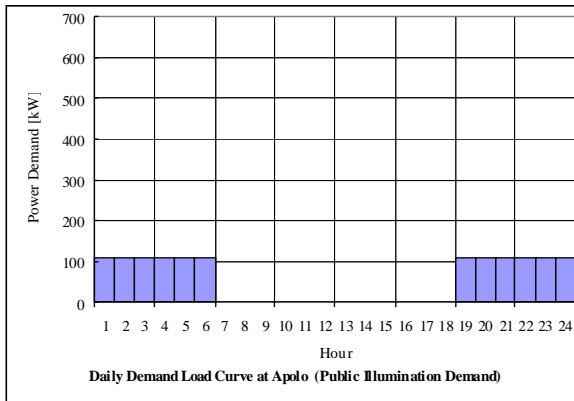
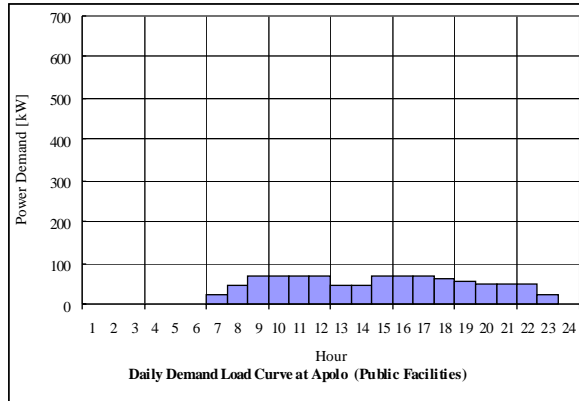
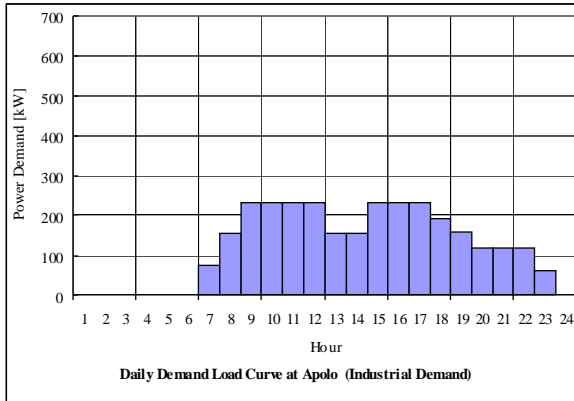
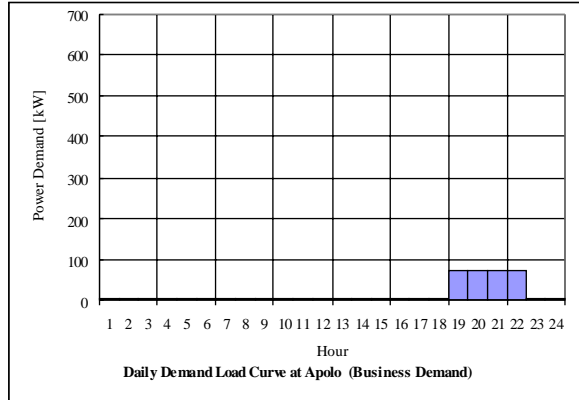
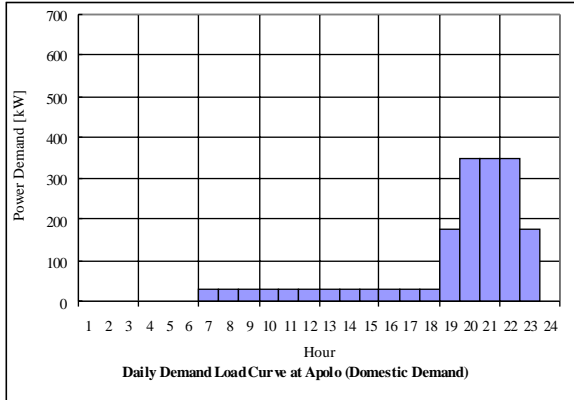


Figure 5.4 Work Flow of Formulation of Optimum Micro-Hydro Power Development Scheme

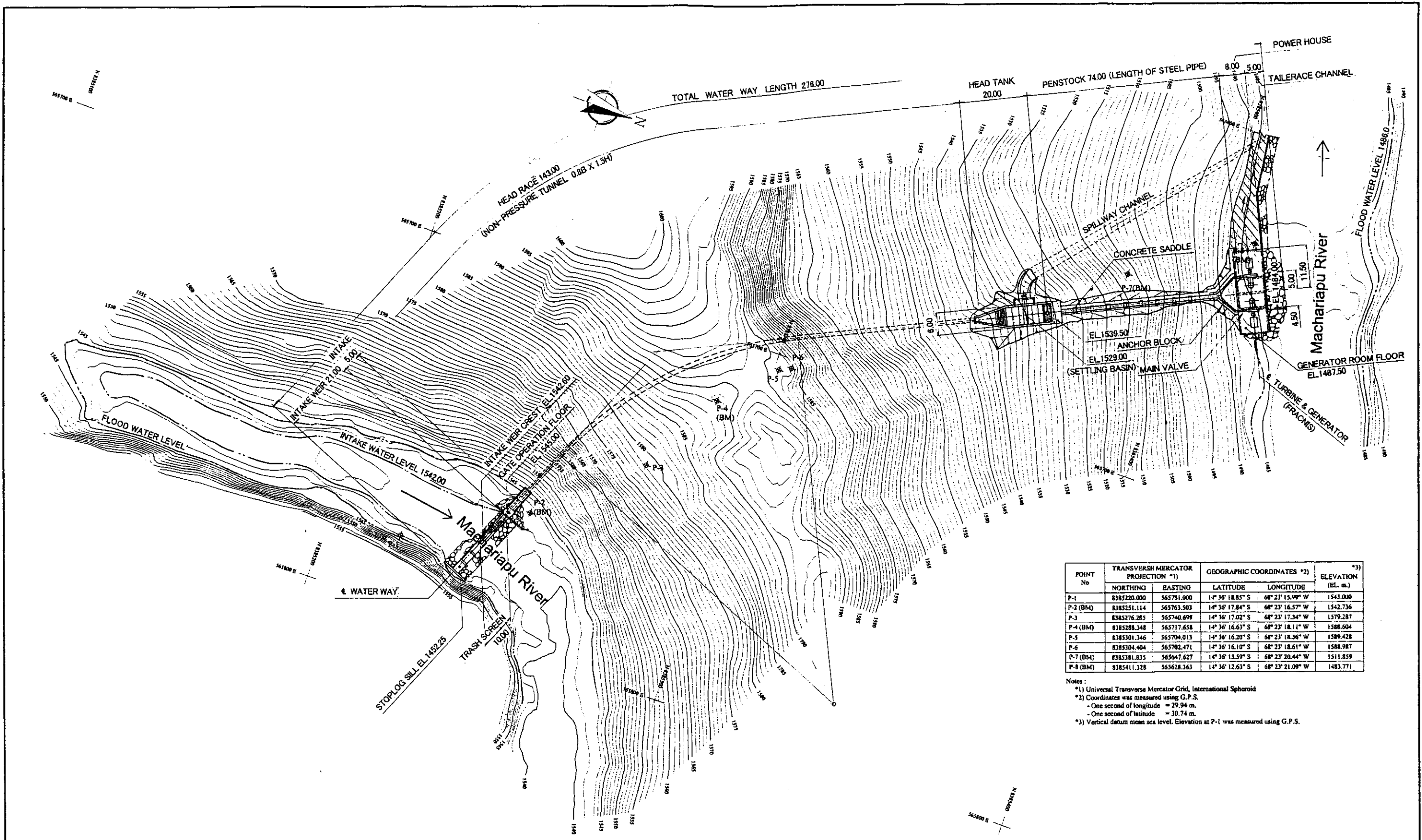
Estimated Demand for Apolo MHP (2005)
[Case-7, Peak=700kW]

	Midnight						Daytime												Evening				Midnight		Daily Total Energy Demand (kWh/D)	Monthly Total Energy Demand (kWh/M)	Annual Total Energy Demand (kWh/Y)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			
	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00			
1) Domestic	0	0	0	0	0	0	30	30	30	30	30	30	30	30	30	30	30	30	175	350	350	350	175	0	1,760	52,800	642,400
2) Business	3	3	3	3	3	3	7	7	7	7	7	7	7	7	7	7	7	73	73	73	73	3	3	400	12,000	146,000	
3) Industry	0	0	0	0	0	0	77	153	230	230	230	230	153	153	230	230	230	193	157	120	120	120	60	0	2,917	87,500	1,064,583
4) Public (Public Facilities)	110	110	110	110	110	110	23	47	70	70	70	70	47	47	70	70	70	63	167	160	160	160	135	110	2,268	68,050	827,942
(Public Illumination)	0	0	0	0	0	0	23	47	70	70	70	70	47	47	70	70	70	63	57	50	50	50	25	0	948	28,450	346,142
	110	110	110	110	110	110	0	0	0	0	0	0	0	0	0	0	0	0	110	110	110	110	110	110	1,320	39,600	481,800
Total	113	113	113	113	113	113	137	237	337	337	337	337	237	237	337	337	337	294	571	703	703	703	373	113	7,345	220,350	2,680,925



(Case-7, Peak Demand = 700kW)

Figure 5.5 Estimated Daily Load Curve for Apolo MHP Project

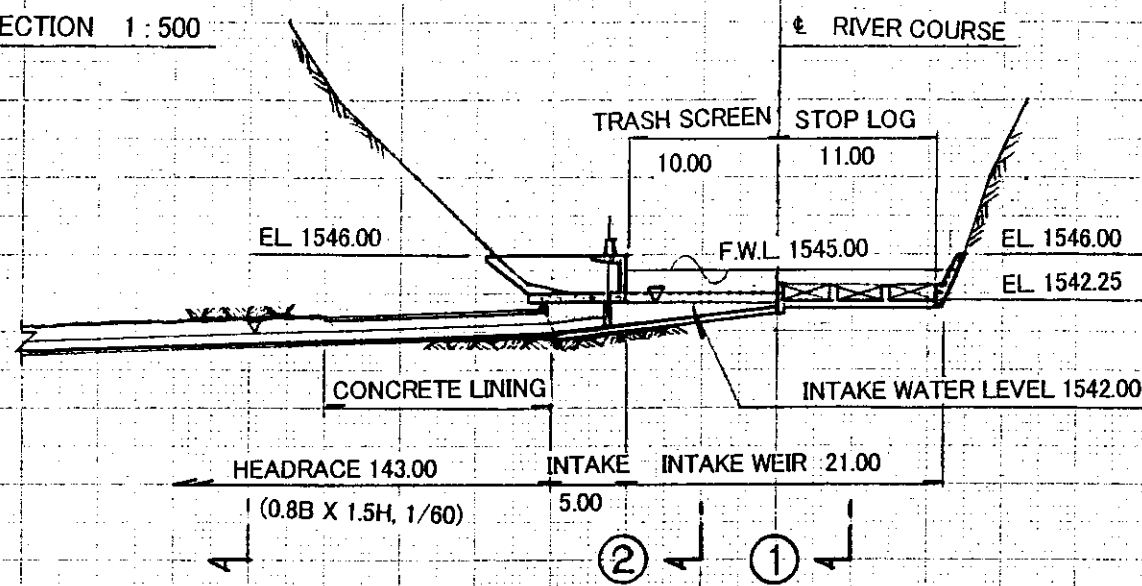


POINT No	TRANSVERSE MERCATOR PROJECTION *1)		GEOGRAPHIC COORDINATES *2)		ELEVATION (BL. m.) *3)
	NORTHING	EASTING	LATITUDE	LONGITUDE	
P-1	8385220.000	565781.000	14° 36' 18.85" S	68° 23' 15.99" W	1543.000
P-2 (BM)	8385251.114	565763.503	14° 36' 17.84" S	68° 23' 16.57" W	1542.716
P-3	8385276.285	565740.698	14° 36' 17.02" S	68° 23' 17.34" W	1579.287
P-4 (BM)	8385288.348	565717.658	14° 36' 16.63" S	68° 23' 18.11" W	1588.604
P-5	8385301.346	565704.013	14° 36' 16.20" S	68° 23' 18.56" W	1589.428
P-6	8385304.404	565702.471	14° 36' 16.10" S	68° 23' 18.61" W	1588.987
P-7 (BM)	8385318.835	565647.627	14° 36' 13.59" S	68° 23' 20.44" W	1511.859
P-8 (BM)	8385411.328	565628.363	14° 36' 12.63" S	68° 23' 21.09" W	1483.771

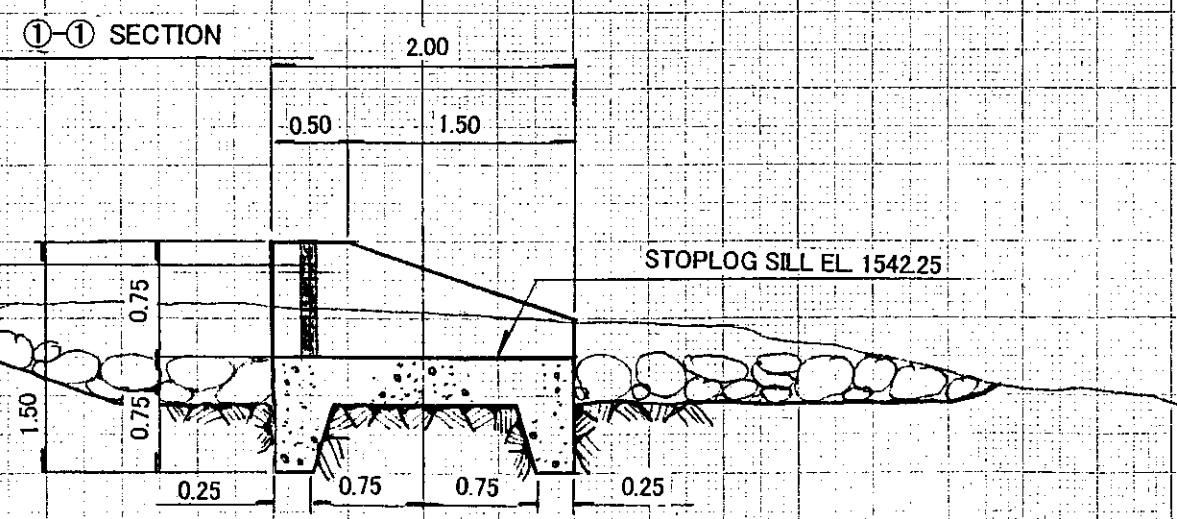
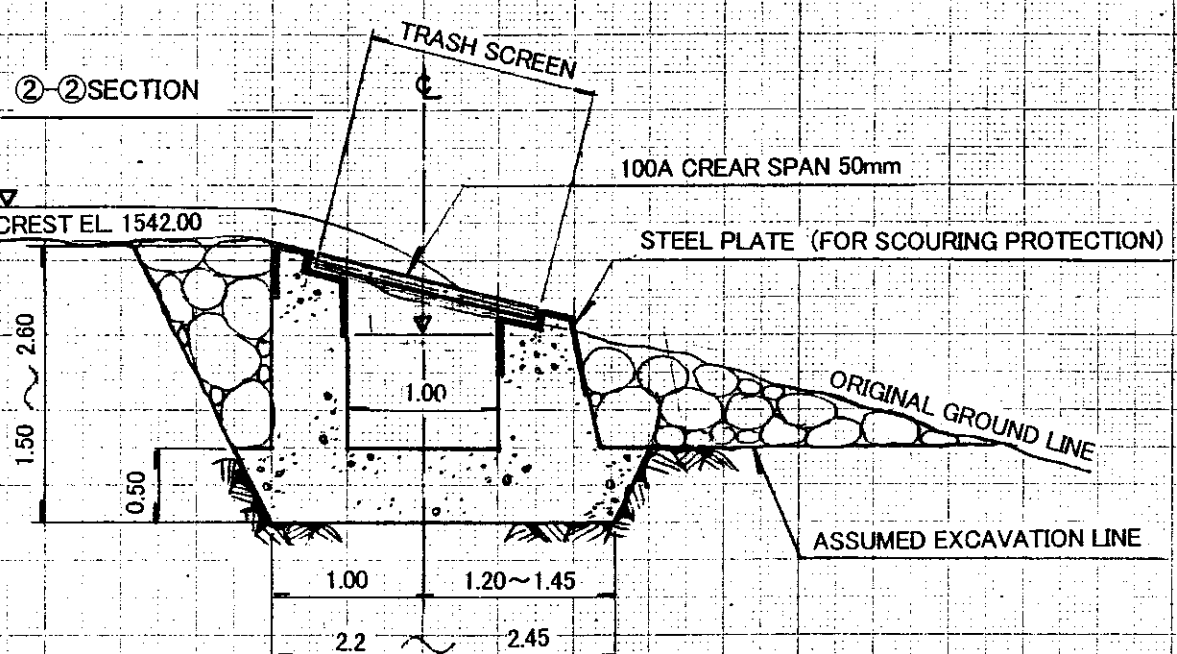
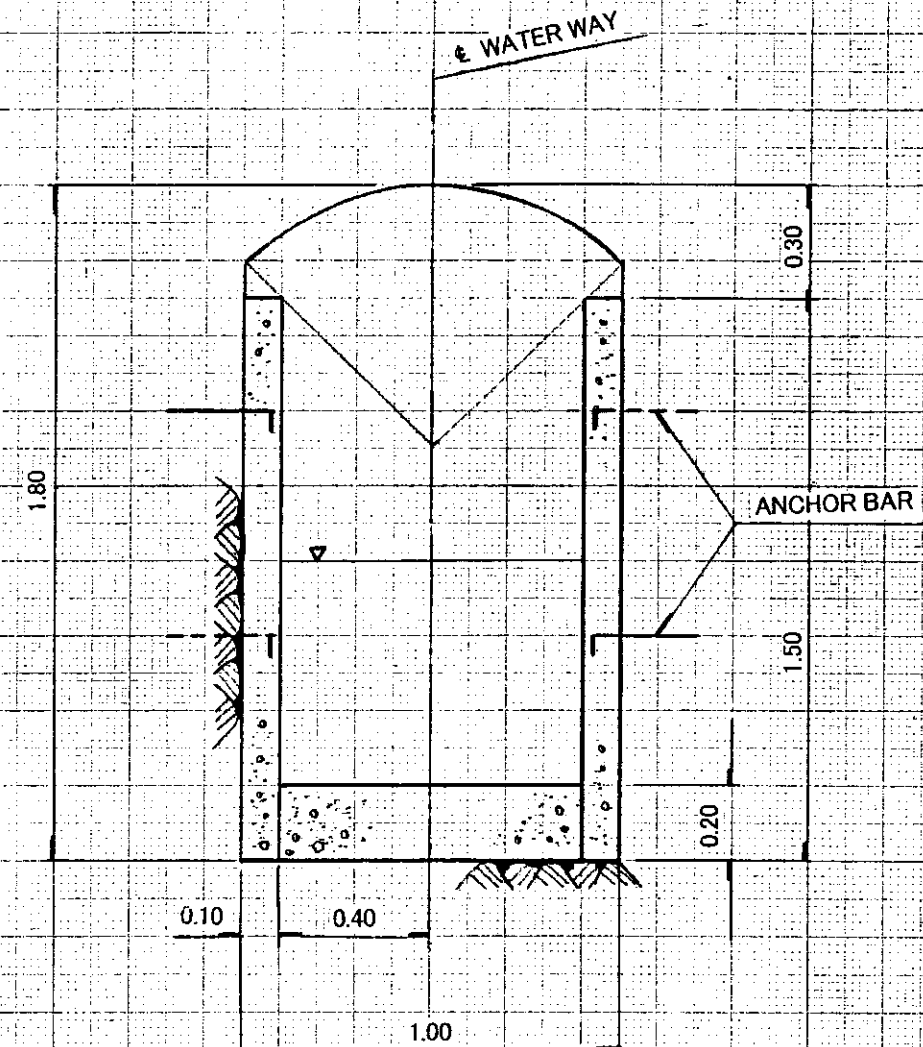
Notes:
 *1) Universal Transverse Mercator Grid, International Spheroid
 *2) Coordinates was measured using G.P.S.
 - One second of longitude = 29.94 m.
 - One second of latitude = 30.74 m.
 *3) Vertical datum mean sea level. Elevation at P-1 was measured using G.P.S.

CONTOUR INTERVAL 1.0 METERS
 ELEVATION UNIT IN METERS (m) FROM SEA LEVEL
 HORIZONTAL UNIT IN METERS (m).

INTAKE LONGITUDINAL SECTION 1 : 500



HEADRACE TYPICAL CROSS SECTION 1 : 20



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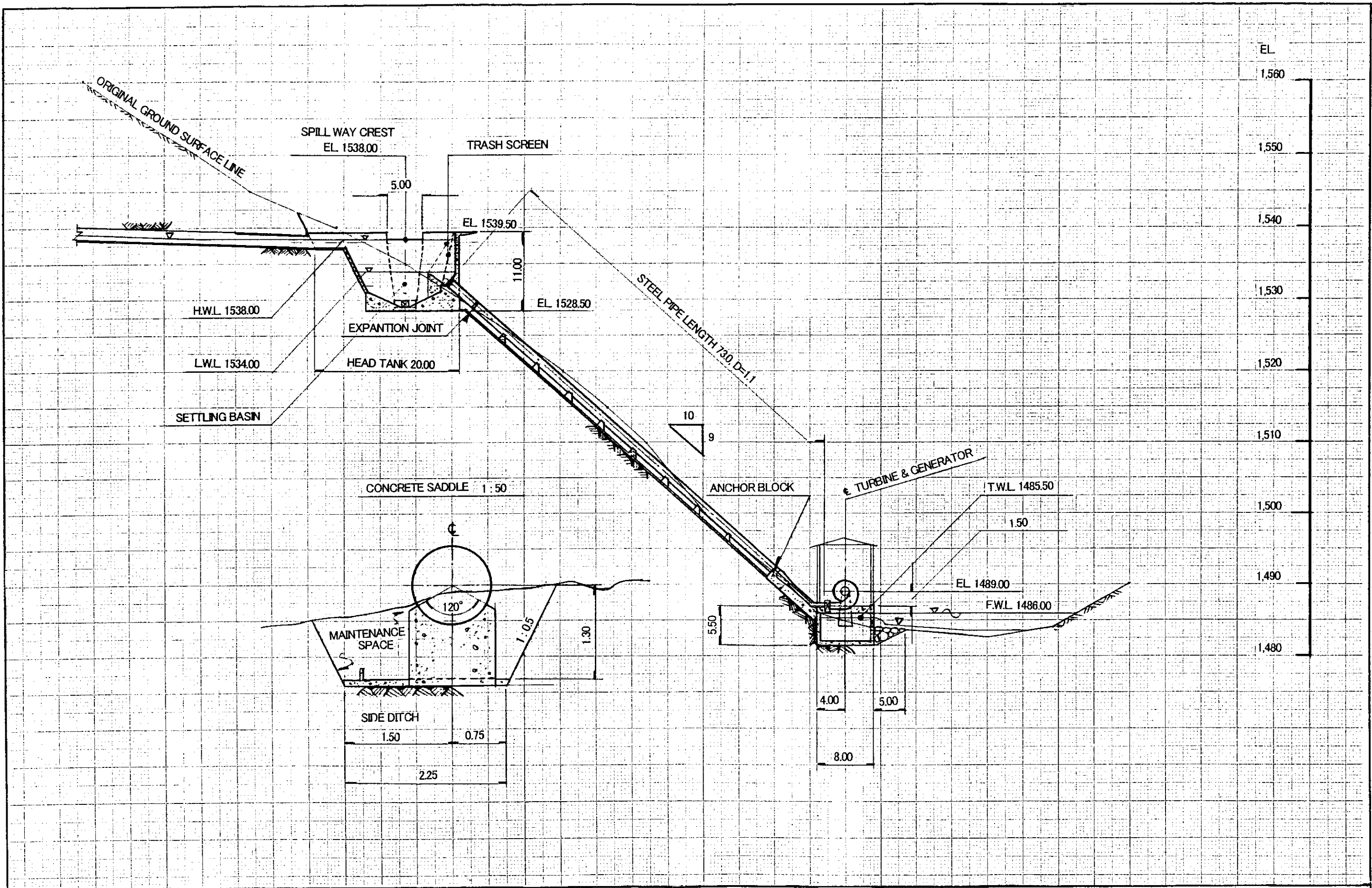
LOCATION: APOLO / FRANZ TAMAYO PROVINCE LA PAZ DEPARTMENT MACHARIAPU RIVER

Figure 5.6 Layout Plan of Apolo MHP (2/3) (Río Machariapu)

SCALE: Intake 1: 500 Headrace 1: 20

DATE: JULY - 2001

SHEET: 1 / 1



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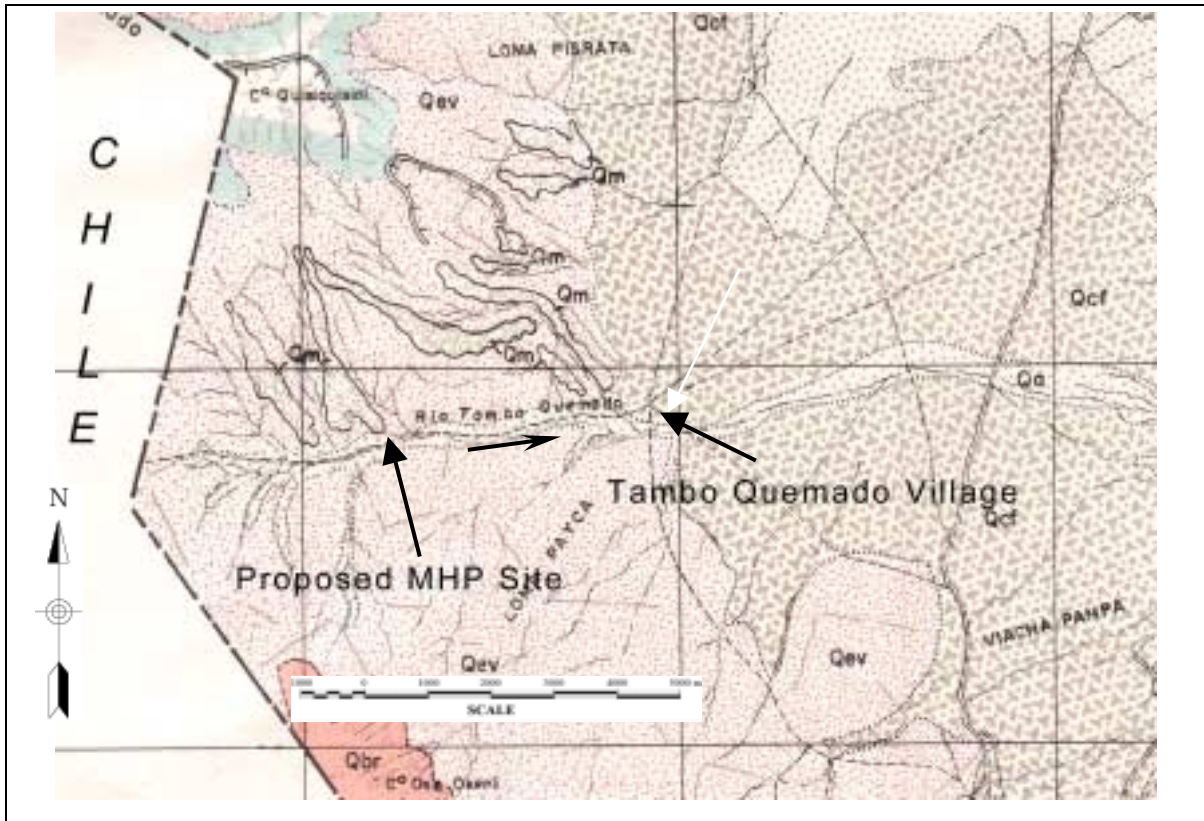
LOCATION:
APOLO / FRANZ TAMAYO PROVINCE
LA PAZ DEPARTMENT
MACHARIAPU RIVER

Figure 5.6 Layout Plan of Apolo MHP (3/3)
(Río Machariapu)

SCALE:
1: 500

DATE:
JULY - 2001

SHEET:
1 / 1



Source: Sajama, Republica de Bolivia
 Ministerio de Minas y Petroleo,
 Departamento Nacional de Geologia,
 Hoja No. 5839 (1963)

LEGEND

Qa	Depositos aluviales
Qa	Depositos coluvio-fluviales
Qaa	Abanicos aluviales
Qt	Terrazas
Qm	Morrenas
Qve	Volcanes en escudo
Qcl	Consos de lava
Qh	Hornitos volcanicos
Qbr	Brechas volcanicos
Qev	<u>Estratovolcanes [Volcanic stratums]</u> Andesite - daciticas associated with clastic rocks [Lavas andesitico - daciticas asociadas con rocas piroclasticas]
Qgp	Glaciales de piedras
Qlt	Form. Taracollo
QI	Intrusiones cuaternarias
Tpe	Form. Perez (Ignimbritas blancas y rosadas de compacion riodiacitica)
Tma	Form. Mauri (Sedimentos tobaceos con lavas intercaladas)

Figure 6.1 Geological Map in Tambo Quemado

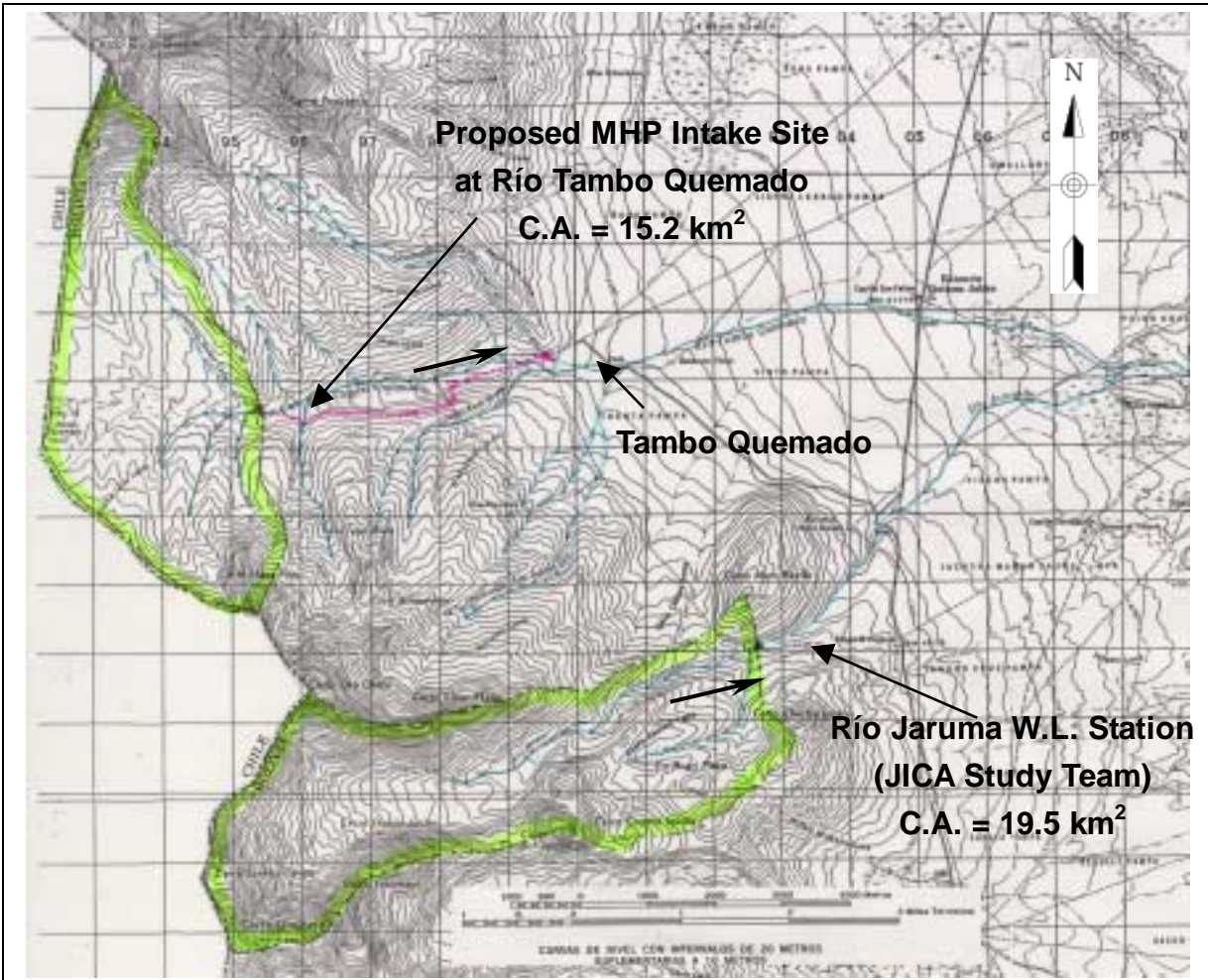


Figure 6.2 Catchment Area of the Jaruma River W.L. Station and Proposed MHP Intake Site at the Tambo Quemado

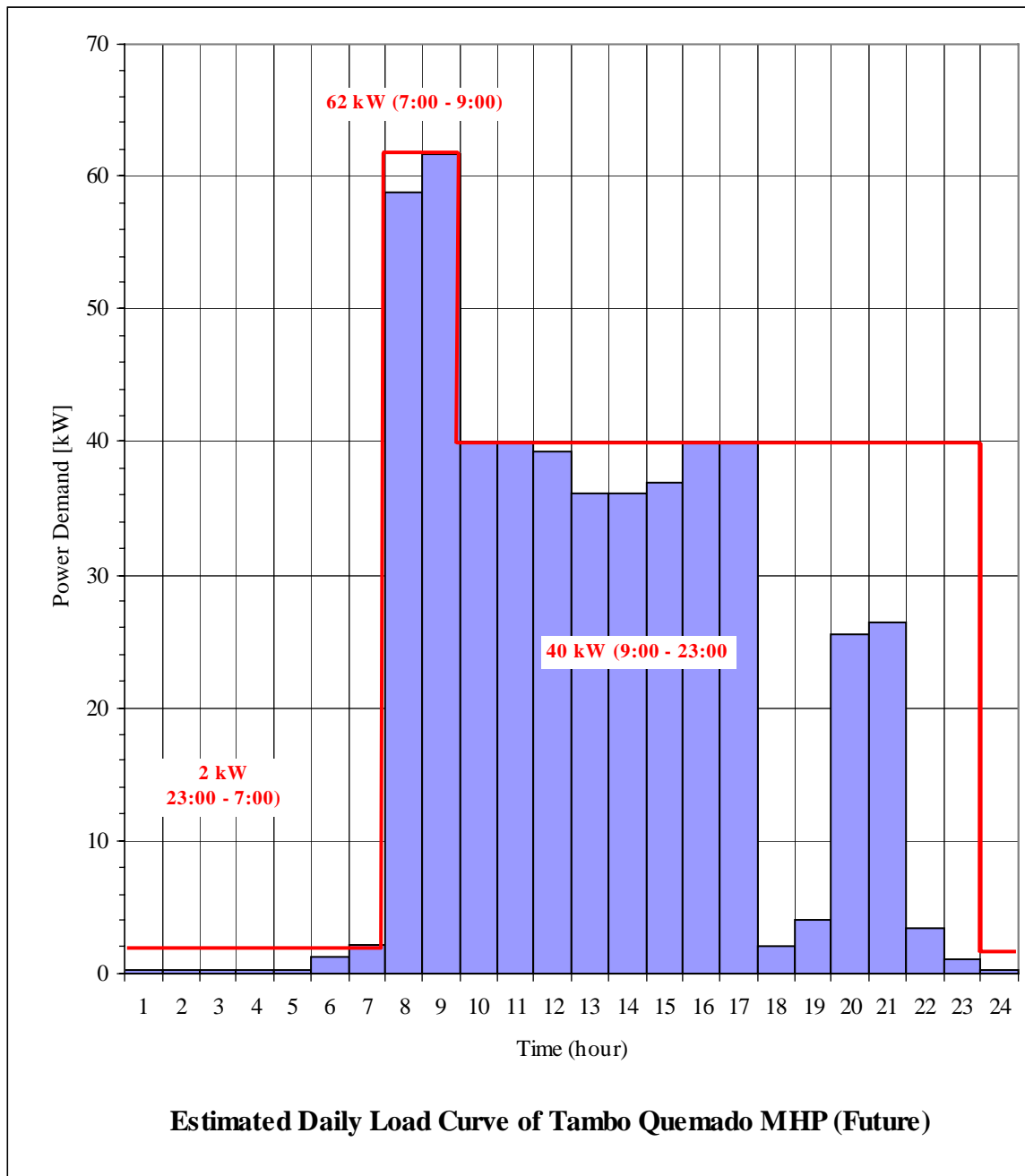
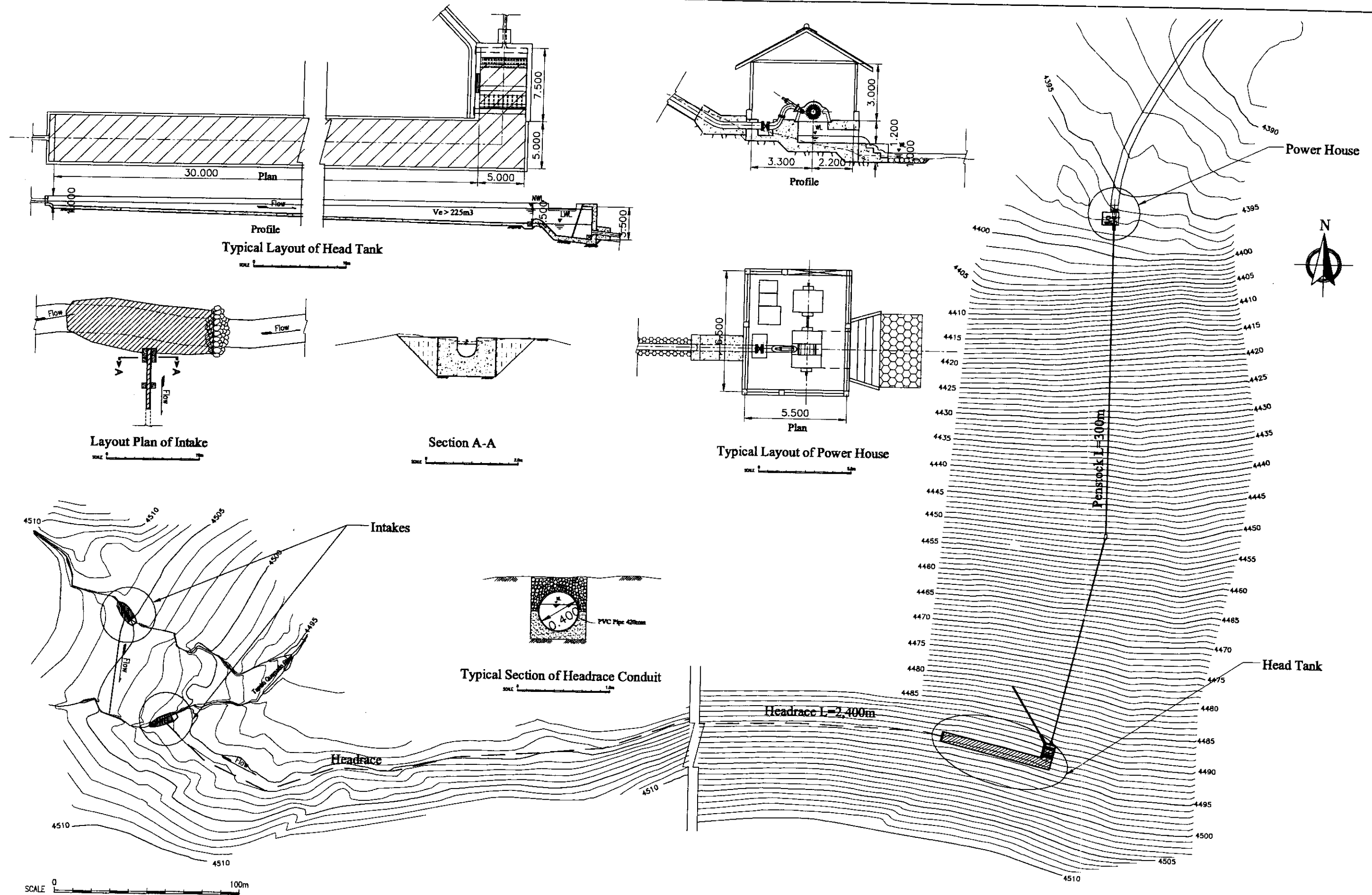


Figure 6.3 Assumed Daily Load Curve for Tambo Quemado MHP Project



THE STUDY ON RURAL ELECTRIFICATION
 IMPLEMENTATION PLAN
 BY RENEWABLE ENERGY
 IN THE REPUBLIC OF BOLIVIA

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION:
 TAMBO QUEMADO / SAJAMA PROVINCE
 ORURO DEPARTAMENT

Figure 6.4
 Layout Plan of Tambo Quemado MHP

SCALE :
 H = 1 : 2000

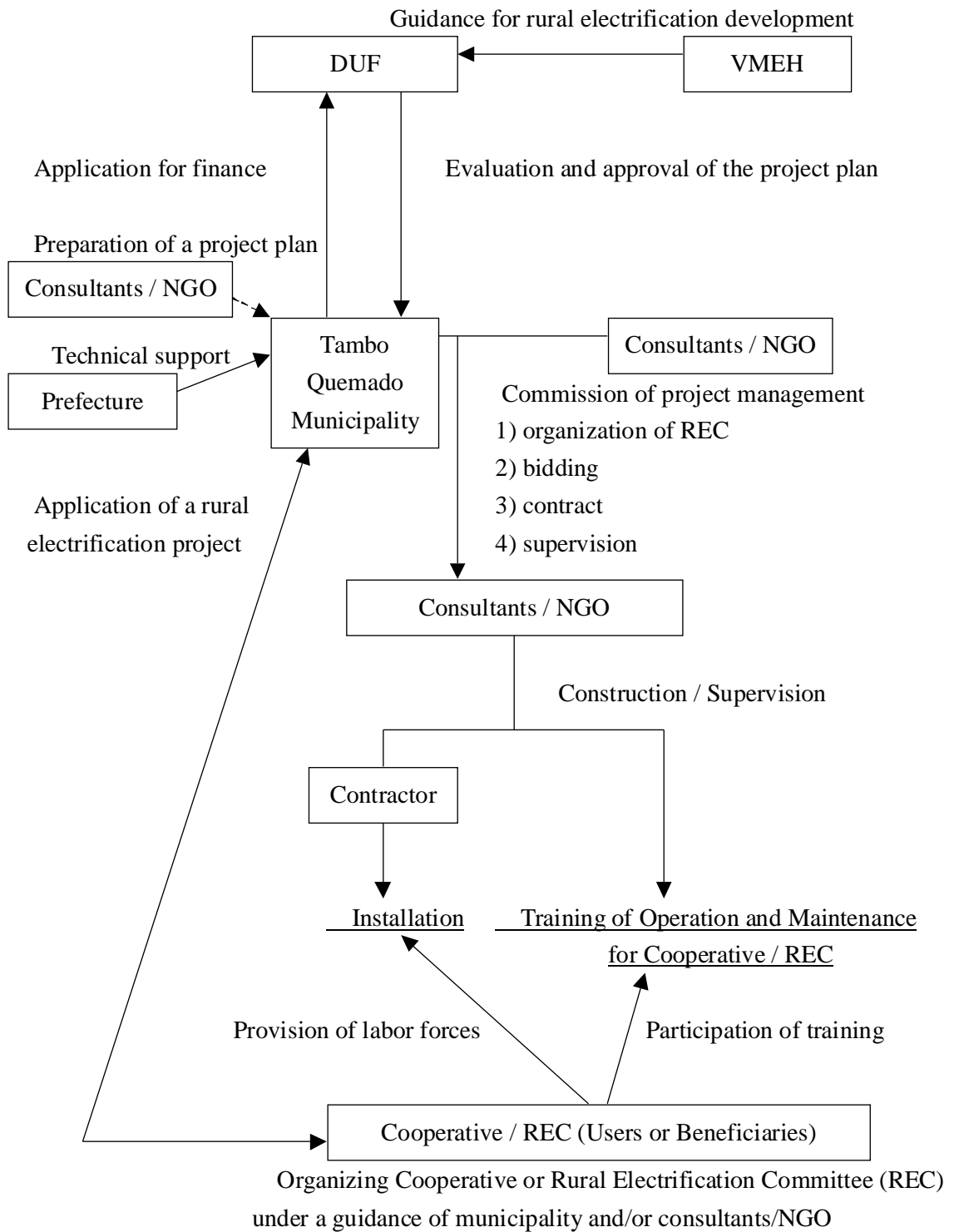
DATE :
 Feubary- 2001

SHEET :

Work Item	Year	1st year											
	Month	1	2	3	4	5	6	7	8	9	10	11	12
	Season	Rainy Season				Dry Season						Rainy Season	
	Tot.mon	1	2	3	4	5	6	7	8	9	10	11	12
1. Design													
1.1 Review of Pre F/S	0.5	0.											
1.2 Survey Investigation	0.5	0.											
1.3 Basic Design	1.0		1.0										
1.4 Detailed Design	1.5			1.5									
1.5 Preparation of Tender Document	0.5				0.								
2. Stage-1 Construction													
2.1 Tendering	0.5				0.								
2.2 Evaluation of Tender	0.5				0.								
2.3 Contracting	0.5					0.							
2.4 Construction Work	4.0						4.0						
1) Preparation Works	1.0						↔						
3) Intake	0.5						↔						
4) Headrace Channel (PVC)	3.0						↔						
5) Head Tank & Spilway	1.0						↔						
6) Penstock	1.0							↔					
7) Power House	1.0							↔					
8) Tailrace	0.1									↔			
9) Installation of Turbine & Generator	0.5									↔			
10) Transmission Line	2.0						↔						
11) Distribution Line	0.2									↔			
2.5 Test and Commissioning	0.5										0.		
2.6 Completing											▲		
3. Environmental Study													
3.1 EIA	3.0		3										
3.2 Environmental Monitoring													to be continue →

JICA Study Team

Figure 6.5 Proposed Implementation Schedules for Tambo Quemado MHP Project



Source: JICA Study Team

Figure 6.6 Proposed Project Implementation fo Tambo Quemado MHP Project