JAPAN INTERNATIONAL COOPERATION AGENCY

NEPAL ELECTRICITY AUTHORITY
ENGINEERING SERVICES
PROJECT DEVELOPMENT DEPARTMENT

THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL

FINAL REPORT

VOLUME I

MAIN REPORT

FEBRUARY 2003

NIPPON KOEI CO., LTD.
TOKYO, JAPAN

This Report consists of

EXECUTIVE SUMMARY

Volume I	*Main Report*
Volume II	*Supporting Report (1)*
	(Engineering Study)
Volume III	*Supporting Report (2)*
	(Environmental Impact Assessment)

The Cost estimate is based on the price of December 2002 and the exchange rates in December 2002 are:

US$ 1.00 = NRs. 77.0 = Yen 120

PREFACE

In response to a request of His Majesty's Government of Nepal, the Government of Japan decided to conduct the Upgrading Feasibility Study on the Development of the Kulekhani III Hydropower Project in the Kingdom of Nepal, and entrusted the study of Japan International Cooperation Agency (JICA).

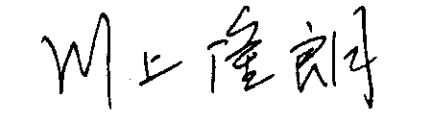
JICA sent a study team, led by Mr. Tsutomu Kodama of Nippon Koei Co., Ltd. to the Kingdom of Nepal five times from September 2001 to February 2003.

The team held discussions with the officials concerned of the Majesty's Government of Nepal, and conducted related field surveys. After returning to Japan, the team conducted further studies and compiled the final results in this report.

I hope this report will contribute to the promotion of the plan and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of His Majesty's Government of Nepal for their close cooperation throughout the study.

February 2003



Takao KAWAKAMI
President
Japan International Cooperation Agency

February 2003

Mr. Takao KAWAKAMI
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit you the Final Report of the Upgrading Feasibility Study on the Development of the Kulekhani III Hydropower Project in the Kingdom of Nepal.

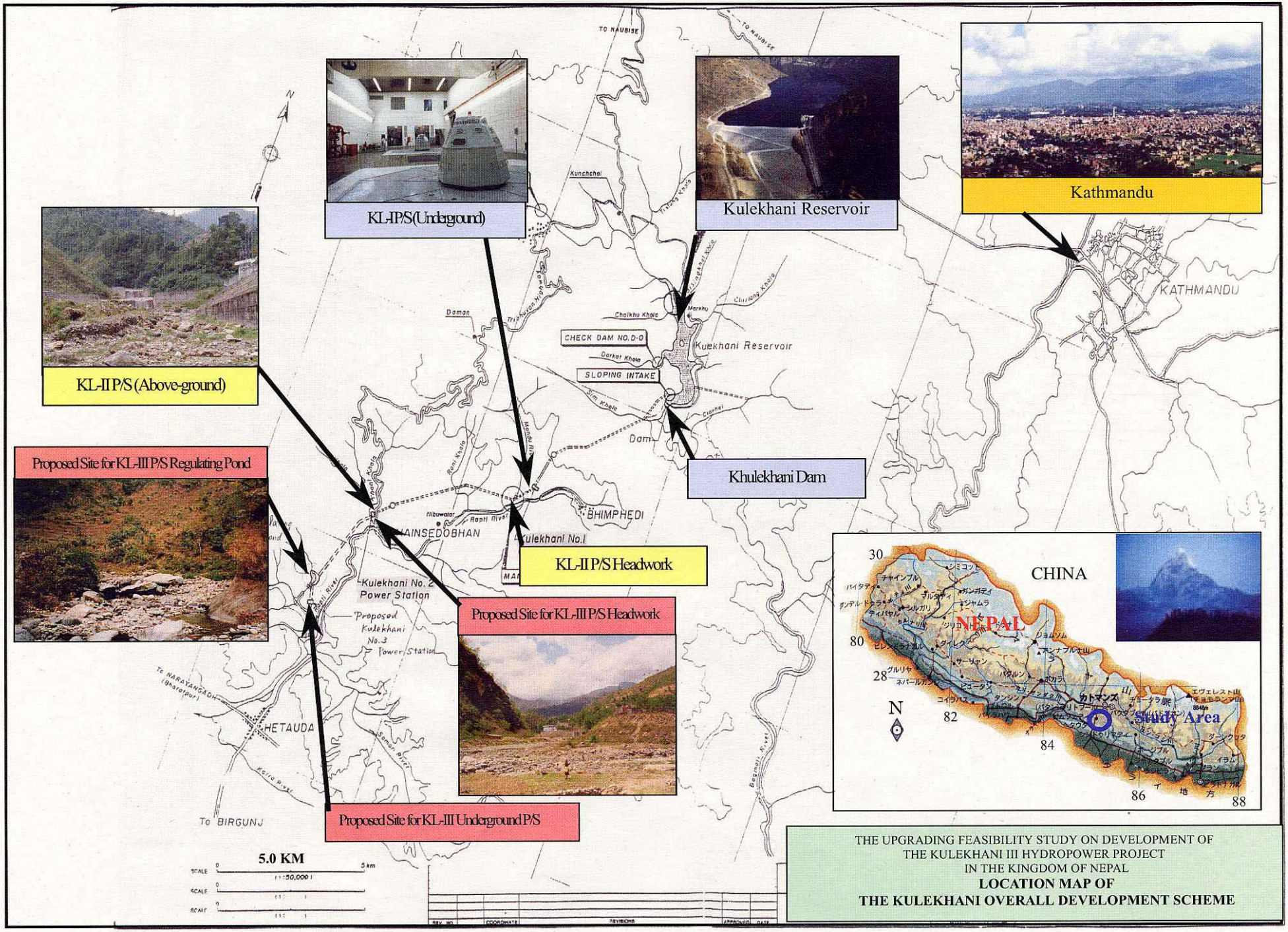
The main objectives of the Upgrading Feasibility Study is to formulate the optimum development plan of the Kulekhani III Hydropower Project which is planned to be built in the Rapti River about 40km southwest of Kathmandu in liner distance. To attain the purpose, the Study Team performed the survey, investigation and studies during the period from September 2001 to February 2003. In conclusion, the Upgrading Feasibility Study proposed to develop a peak power station of regulating pond type with an installed capacity of 45MW from technical, environmental and economic/financial viewpoints. It was also recommended to implement the Project as early as possible by proceeding to the detailed design following this Study in order to supply the reliable peak power in the dry season in the fiscal year of 2007. The implementation of the Project contributes to the development of the national economy in Nepal and the regional development around the Project by effective utilization of the water resources in Nepal.

The Report consists of four Volumes, Main Report, Executive Summary and two Supporting Reports. The Main Report covers all the investigation and study results including field investigation and results, plan formulation, environmental impact assessment and resettlement action plan, cost estimates and project evaluation. The Executive Summary presents main outputs of the Study. The Supporting Reports give additional and supporting information and data to the Main Report.

We would like to express our grateful acknowledgement to the personnel of your Agency, your Branch Office in Nepal, and the Embassy of Japan in Nepal, and also to officials and individuals of His Majesty's Government of Nepal and Nepal Electricity Authority for their assistance and advice extended to the Study Team. We sincerely hope that the results of this Study would contribute to the national and regional development of the country.

Yours sincerely,

Tsutomu Kodama
Team Leader
Upgrading Feasibility Study
on
Kulekhani III Hydropower Project



THE UPGRADING FEASIBILITY STUDY ON DEVELOPMENT OF
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LOCATION MAP OF
THE KULEKHANI OVERALL DEVELOPMENT SCHEME

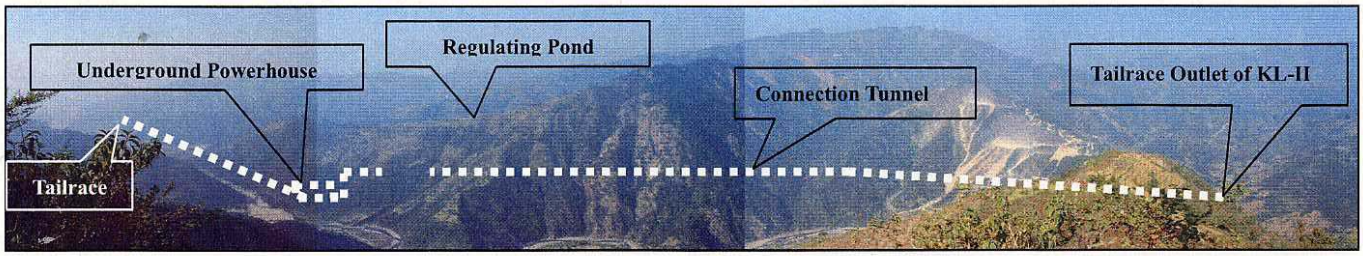

Photo 1 Distant View of the Kulekhani III Project

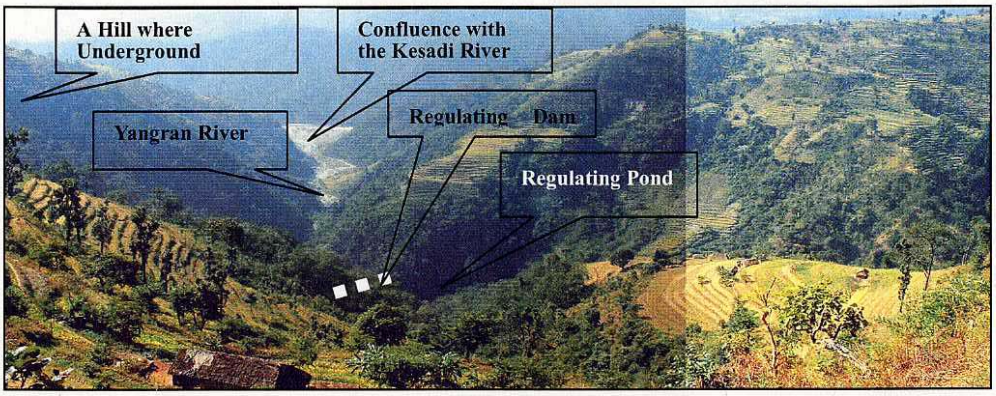

Photo 2 Distant View of the Proposed Regulating Pond Site on the Yangran River

Photo 3 General View of Sanutar Village for Access Road Site

Photo 4 Irrigation Canal in Yangran River

Photo 5 Water Supply Point

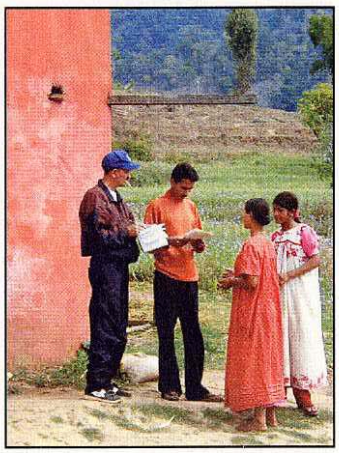

Photo 6 Interviewing Sanutar Women's Savings Group

Principal Features of Kulekhani III Hydropower Project

1. Hydrology and Regulating Pond

Catchment Area	: 8.1 km^2
Full Supply Level (FSL)	: EL.597.0 m
Minimum Operation Level (MOL)	: EL.577.0 m
Gross Storage Capacity	: 652,000 m^3
Effective Storage Capacity	: 475,000 m^3
Surface Area	: 0.049 km^2
Surface Length	: 650 m
Design Flood of Regulating Dam	: 280 m^3/sec
Design Flood of Khani Headwork	: 470 m^3/sec
Sedimentation	: 19,000 m^3/yr

2. Power Output

Installed Capacity	: 44.8 MW (22.4 MW × 2 units)
Maximum Plant Discharge	: 43.1 m^3/sec
Rated Head	: 117.8 m
Annual Average Energy	: 47.3 GWh
Firm Peak Energy	: 29.5 GWh
Secondary Energy	: 17.8 GWh

3. Main Structures

(1) Khani Headwork

Maximum Intake Discharge	: 2.0 m^3/sec
Normal Operating Water Level	: EL. 601.0 m

(2) Connection Tunnel

Type	: Concrete lined horseshoe section, free flow tunnel
Diameter	: 3.25 m
Length	: 3,500 m

(3) Regulating Dam

Type	: Roller compacted concrete dam (RCC)
Crest Elevation	: EL.600.0 m
Foundation Elevation	: EL.548.0 m
Crest Length	: 110.0 m
Sand Flush Gate	: 3.0m wide × 2.0 m high × 1 no, High pressure slide gate
Spillway Type	: Non gated spillway

(4) Headrace Tunnel

Type	: Concrete lined circular section, Pressure tunnel
Diameter	: 4.1m
Length	: 350 m

(5) Penstock

Type	: Tunnel type
Diameter	: 3.4 m-2.2m
Length	: 190 m

(6) Powerhouse

Type	: Underground type
Building Dimension	: 17 m wide × 31 m high × 74 m long

(7) Tailrace Tunnel

Tunnel Section

Type	: Concrete lined vertical leg horseshoe section, Free flow tunnel and conduit
Diameter	: 4.4 m
Length	: 1,750 m (tunnel) and 350 m (conduit)

(8) Turbine

Type	: Vertical shaft Francis, 2 nos.
Rate Speed	: 500 rpm

(9) Generator

Type	: Conventional (Suspended), 2 nos.
Rated Capacity	: 26.4 MVA
Frequency	: 50 Hz

(10) Main Tramsformer

Type	: Indoor, Special 3-phase, 2 nos.
Voltage Ratio	: 11 kV/132 kV

(11) 132 kV Switchgear :Indoor GIS with single bus for incoming

4. Transmission line

Length	: 1.7 km
Number of Circuit	: Double circuit
Voltage	: 132 kV
Conductor	: ACSR 260 mm^2

5. Construction Period : 3.5 years

6. Construction Cost

(US$ Million as of November 2002)

Direct Construction Cost	:	62.1
Administration Cost	:	1.6
Engineering Service Cost	:	4.7
Environmental Cost	:	1.8
Physical Contingency	:	6.0
Price Contingency	:	1.5
Total Cost	:	77.7

THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL FINAL REPORT

Preface
Letter of Transmittal
Principal Feature of the Project

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LIST OF DRAWINGS

MAIN ABBREVIATION

Table of Terms (1/4)

Abbreviation	Terms
Nepal Agencies	
DHM	Department of Hydrology and Meteorology
DSC	Department of Soil Conservation
EEC	European Economic Community
GON	Government of Nepal
HCIL	Hetauda Cement Industries Limited
MOAC	Ministry of Agriculture and Cooperatives
MOF	Ministry of Finance
MOFSC	Ministry of Forest and Soil Conservation
MOPE	Ministry of Population and Environment
MORFD	Ministry of Foreign Affairs and Defense
MORPA	Ministry of Royal Palace Affairs
MOWR	Ministry of Water Resources
NEA	Nepal Electricity Authority
NEA-ED	NEA Environmental Department
NEC	Nepal Electricity Corporation
NEPECON	Nepal Engineering Consultancy Services Center Limited
NESS	Nepal Environmental & Scientific Services (P) Ltd.
Foreign Organization	
ADB	Asian Development Bank
CITES	Convention on International Trade in Endangered Species
CRIEPI	Central Research Institute of Electric Power Industry
DANIDA	The Danish Agency for Development Assistance
EPRI	Electric Power Research Institute
GOJ	Government of Japan
IDA	International Development Association
IMF	International Monetary Fund
IUCN	International Union for Conservation of Nature and Natural Resources
JBIC (Former: OECF)	Japan Bank for International Cooperation (Overseas Economic and Cooperation Fund)
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
KF	Kuwait Fund
KfW	German Development Bank
KOICA	Korea International Cooperation Agency
MIT	Massachusetts Institute of Technology
SIDA	Swedish International Cooperation Agency
UNDP	United Nation Development Program
USAID	The United States Agency for International Development
WB	World Bank
WCD	World Commission on Dams
WDS	The Wildlife Conservation Society
WHO	World Health Organization
Others	
ACRS	Acquisition, Compensation and Resettlement Section
AIDS	Acquired Immunodeficiency Syndrome
AP	Affected Person

Table of Terms (2/4)

Abbreviation	Terms
APP	Agriculture Perspective Plan
B/C	Benefit per Cost
BOD	Biochemical Oxygen Demand
CBO	Community Based Organizations
CCV	Community Consensus Valuation
CDC	Compensation Determination Committees
CDE	Community Development Expert
CDO	Chief District Officer
CF	Community Forest
CIF	Cost, Insurance, and Freight
CIWEC	Canadian International Water and Energy Consultants
CNPS	Central Nepal Power System
CO_2	Carbon Dioxide
CPI	Consumer Price Index
D/D	Detailed Design
DFO	District Forest Office
DG	Diesel Generator
DMD	Deputy Managing Director
DMS	Detailed Measurement Survey
DO	Dissolved Oxygen
DoF	Department of Forest
DP	Dynamic Programming
DSM	Demand Side Management
EGEAS	Electric Generation Expansion Analysis System
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EM	Environmental Manager (Project side)
EMP	Environmental Management Plan
EO	Environmental Officer (Contractor side)
ESMS	Environmental and Social Monitoring Section
F.S.L.	Full Supply Water Level
F.W.L.	Flood Water Level
F/S	Feasibility Study
FC	Foreign Currency
FEM	Finite Element Method
FIRR	Financial Internal Rate of Return
FUG	Forest User Group
G.S.	Gauging Station
GDP	Gross Domestic Product
GIS	Global Information System
GIS	Gas-insulated Switchgear
GNP	Gross National Product
H.W.L.	High Water Level
HFT	Himalayan Front Thrust
HH	Household
HIV	Human Immunodeficiency Virus
HMG/N	His Majesty's Government of Nepal
HSD	High Speed Diesel

Table of Terms (3/4)

Abbreviation	Terms
ICB	International Competitive Bidding
IDC	Interest during Construction
IEE	Initial Environmental Examination
INGO	International Non-governmental Organization
INPS	Integrated National Power System
IPP	Independent Power Producer
IRR	Impoverishment Risks and Reconstruction
KESMU	Kulekhani III Hydropower Project Environmental and Social Management Unit
KGA	Kali Gandaki A Hydropower Project
KL I, II and III	Kulekhani I, II and III Hydropower Project
LAA	Land Acquisition Act
LC	Local Currency
LCG	Local Consultative Group
LDC	Overhead Travelling
LOLP	Loss of Load Probability
LRMC	Long Run Marginal Cost
LRO	Land Revenue Officer
M.O.L.	Minimum Operation Level
MBT	Main Boundary Thrust
MCT	Main Central Thrust
MF	Multi-fuel Diesel Generator
MIC	Most Impacted Communities
MOU	Minutes of Understanding
MT	Mahabharat Thrust
MUV	Manufacturing Unit Value
MWSP	Melamchi Water Supply Project
NEMP	Natural Environmental Mitigation and Monitoring Plan
NGO	Non Governmental Organization
NH_3	Nitrogen Trioxegen (Ammonia)
NO_2	Nitrogen Dioxide
NO_3	Nitrogen Trioxide
NPV	Net Present Value
NRF	National Reserve Forest
O&M	Operation and Maintenance
ODA	Official Development Assistance
OFWF	Forced-oil-circulation Water-cooled
OHT	Overhead Travelling
OPGW	Optic Overhead Ground Wire
P/H	Powerhouse
P/S	Power Station
PAF	Project Affected Family
PC	Public Consultation
PIC	Project Impacted Communities
PICS	Project Information and Co-ordination Section
POE	Panel of Experts
PPA	Power Purchasement Agreement
PROR	Peaking Run-of-River

Table of Terms (4/4)

Abbreviation	Terms
PS	Pre-stressed
PTS	Plane Table Survey
RCC	Roller Compacted Concrete
RCP	Resettlement and Compensation Planner
RF	Resettlement Framework
ROR	Run-of-River
RP	Resettlement Plan
RSP	Resettlement and Social Specialist
S/S	Substation
S/W	Scope of Works
SAP	Social Action Plan
SAPS	Social Action Plan Section
SAPS	Special Assistance for Project Sustainability
SCF	Standard Conversion Factor
SEMP	Social Environmental Mitigation and Monitoring Plan
SIA	Social Impact Assessment
SPAF	Seriously Project Affected Family
ST	Storage Type
STD	Sexually Transmitted Diseases
T/L	Transmission Line
TLO	Tole/Lane Organization
TKN	Total Kjeldahl Nitrogen
TOR	Terms of Reference
TP	Total Phosphorus
TSS	Total Suspended Solids
VAC	Village Advisory Committee
VAG	Village Advisory Group
VDC	Village Development Committee
WASP III	Wien Automatic System Planning Program
WECS	Water and Energy Commission Secretariat
YWMP	Yangran Watershed Management Program
EL.( ) m	Meters above mean sea level
NRs	Nepal Rupees
IRs	Indian Rupees
US$	US Dollar
US ¢	US Cent