International Bank for Reconstruction and Development

FOR OFFICIAL USE ONLY

SecM93-460

FROM: Vice President and Secretary

May 12, 1993

NEPAL

ARUN III HYDROELECTRIC PROJECT

ENVIRONMENTAL ASSESSMENT SUMMARY

1. Attached is the Environmental Assessment and Management Executive Summary for Nepal: Arun III Hydroelectric Project. The proposed project provides for financing of the access road; the dam and underground facilities including the powerhouse; evacuation of the project's power to the national grid; an environmental management program; and technical assistance for project supervision and sectoral/institutional reform. Since the executive summary is very detailed, Bank staff have prepared an abbreviated summary of that summary, also attached.

2. The environmental assessment summaries were prepared by Borrower, the Nepal Electricity Authority, and circulation of the summaries does not signify evaluation or endorsement by the Bank. The environmental assessments are subject to review and possible change during the appraisal process.

3. Questions may be referred to Mr. D. T. O'Leary, Ext. 80408. The full Environmental Assessment is available, upon request, from the office of the Director, Country Department 1, South Asia Region.

Distribution:

Executive Directors and Alternates
Office of the President
Executive Vice Presidents, IFC and MIGA
Vice Presidents, Bank, IFC and MIGA
Directors and Department Heads,
Bank, IFC and MIGA

NEPAL ELECTRICITY AUTHORITY
(An Undertaking of His Majesty's Government of Nepal)

ARUN III HYDROELECTRIC PROJECT

ENVIRONMENTAL ASSESSMENT AND MANAGEMENT

EXECUTIVE SUMMARY

KATHMANDU
May 1993

57462

PROJECT DESCRIPTION

The Arun III is a 402 MW "run-of-river" facility that will utilize normal flows in the river, through twin 11.5 km headrace tunnels, rather than depend on water held back in a large reservoir. Development of the project is envisaged in two equal stages of 201 MW. The dam will be a concrete gravity type with a crest length of 155 m and a height of 68 m.

The Arun III power facilities are dependent on the construction of an access road of 122 km that will follow the river valley alignment. The power transmission system required for the full two-stage development of Arun III includes a double circuit 220 kV transmission line of 380-410 km from the Arun III powerhouse to Kathmandu, passing through substations in the Terai; the first stage consists of a 120 km double circuit single tower 220 kV line linking the Arun III Project with the Nepalese national grid and a substation at Duhabi in the Terai..

Project construction is expected to start, with the road, in 1994. The road will take about 40 months, including mobilization. For the bulk of the hydropower components, construction will begin after the provision of road access, post-monsoon 1996. Final design and construction of the complete transmission line system, including substations for Stage 1, could be completed within 43 months from contract award. At the present time, funding is sought for Stage 1 only.

THE SETTING

The Arun Valley contains natural features of recognized international significance, particularly in the Makalu-Barun area north-west of the Arun III site. This area contains one of the few surviving pristine forest areas in the Himalayan range, with very high biodiversity values. Features of high ecological and cultural value have also been identified, through a World Bank and UNDP sponsored regional study, elsewhere in the Valley, which is an international flyway for migrating birds and has a high diversity of aquatic fauna.

The Arun River originates in the Tibet Autonomous Region of China, with approximately 84% of the catchment area lying north of the Himalayan Range. The river pre-dates the uplifting of the Himalayan Range, and its down-cutting has kept pace with the rate of uplift. The catchment area of the Arun at the damsite is approximately 27,000 km2, with that lying within Nepal estimated to be 5028 km2.

The Arun Valley is home to several hundred thousand people from a great variety of ethnic and cultural backgrounds, with different traditions and expectations and different historical roles int he society and economy of the Valley. The population of Sankhuwasabha District, which includes much of the area to be directly affected by the Project, is estimated at some 160,000. Because most of the settlements and arable land are concentrated on the ridges and terraces along the mountain slopes, the access road traverses land which over most of its length is relatively lightly settled and farmed. The same can be said of the hydro project location, as the general demographic pattern is on of decreasing population density from south to north, with only eight persons per km2 in the northern part of the Arun Valley.

Within Nepal, a population of about 450,000 people lives within the catchment area of the Arun River. The access road passes through land occupied by some ten different ethnic groups. The indigenous people are Kirantis, represented by Rais and Limbus (The Arun River is a social dividing line, with the Rais generally to the West and Limbus to the East). Others present in the are Bhotea, Kar Bhote and Gurungs, similar to the Kiranti in their Tibeto-Burman characteristics, and Brahmin-Chetri, occupational castes, and Newars, all of whom have migrated more recently to the valley and are organized along more hierarchical caste lines than the Kiranti.

Most of the Valley's inhabitants live in a rigorous subsistence lifestyle, and some two thirds are functionally illiterate. A main determinant and limitation affecting the economy and lifestyle is that at present virtually all movement of people and goods within the valley is on foot. Consequently, the economy and lifestyle have been largely self-contained and self-sufficient, although the Kiranti have a long tradition of service in the British and Indian Armies, and virtually all ethnic groups depend to varying degrees on seasonal or long term migration out of the valley to India or the Nepalese terai.

Prominent among regional development and conservation efforts has been the Makalu-Barun Conservation Project seeking a combination of sustainable comrnunity development and conservation within a protected area for the Makalu-Barun valley. This has been the outcome of a successful programme mounted by an international NGO, the Woodlands Mountain Institute, which has received Global Environmental Fund support, through collaboration with UNDP and the World Bank.

POTENTIAL ENVIRONMENTAL IMPACTS

The impacts are: direct impacts, resulting from the physical presence of the facilities and the way they are designed, built and operated; indirect impacts stemming from the economic activities surrounding construction; and induced economic effects resulting from improved access. These occur in two main phases, during construction and operation. The area of influence of the project is taken to be the whole Arun Basin within Nepal.

The Arun III Project will have far-reaching social and environmental consequences. Most of these will result from construction of the road rather than from the power project. During construction, the road will require a workforce of an average 6700, peaking at around 9500 during key dry periods, about twice that of the hydropower components requirement of about 3700, or the some 1300 required for transmission line construction. Many of these workers will be from the Arun Valley, since the contractors are obliged to give preference to hire local people. (The approximately 12-14,000 figure for construction workers -- roughly 3% of the Valley's 450,000 population -- will also inevitably include some double counting).

During construction there will be large concentrations of workers and their dependents both at the Contractor's camps at the remote work fronts, plus incomers attracted by economic opportunities. Together, these will create a massive increase in demand for food and fuel with consequent impacts on prices and forests. There will also be some social disruption and pressure on health facilities. Positive impacts will be local employment opportunities with a resulting increase in

per capita incomes and an increased market for local produce.

Since the Arun III Project is a run-of-river scheme, the impacts typically associated with large reservoir hydropower projects not relevant to this project include:

- no resettlement of people or significant loss of agricultural land due to inundation;
- no proliferation of waterborne disease vectors like schistosomiasis or water weeds, due to unsuitable conditions;
- downstream dewatering will not affect agriculture;
- no potential for induced seismicity due to water impoundment;
- limited sediment trapping potential behind dam, minimizing the potential for downstream erosion, with no loss of water-borne sediments to downstream riparian areas;
- project life will not be reduced by reservoir sedimentation since it is a run-of-river facility;
- negligible alterations in water temperature and biochemical oxygen demand due to impoundment, given the minimal water retention time;
- no disruption to navigation, since damsite is located in a non-navigable river stretch;
- minimal danger of destructive downstream flooding in the event of dam failure because of the small amount of water retained behind the dam;
- minimal inundation of riparian vegetation due to steep valley sides and small impoundment (50 ha, extending some 4 km upstream).

Without mitigation, some of the identified negative impacts in the Arun Valley during construction are likely to include:

- clearance of forests within the vicinity of the project, resulting in habitat loss for endangered species of wildlife;
- pressure on fish populations;
- permanent land take of agricultural land, with loss of food production and effects on marginal households (this will be minimal for transmission line Right of Ways (RoWs), although some will occur for substations and tower pads);
- temporary land take and disruption of agricultural activities, with effects on

marginal households;

- hazards to birds (avian hazards) by transmission lines at valley crossings and breeding sites such as Koshi Tappu in the Terai;
- safety hazards to public of transmission lines;
- encroachment onto RoW of transmission lines by landless squatters;
- possibly, health risks from exposure to electromagnetic fields along transmission line Rows.
- marginalization of some project-affected families (PAFs) and of women, despite compensation procedures;
- increased local food deficit;
- food price inflation, with effects on marginal households, especially nutritional status of some women and children;
- development of shanty towns;
- exacerbation of already existing poor health situation and stress on health facilities;
- impact of labour force on local social systems and culture;
- major stresses on all local institutions (in particular local government, schools, and resource management groups).

When the Project is completed, positive impacts during the operational period will be:

- greatly reduced cost of imported food and manufactured commodities;
- greatly reduced transport cost for regional exports;
- better access for current outward seasonal and long term economic migration;
- possibility of expansion of feeder road system;
- rapid growth of new economic centres along the road and for maintenance contract work along transmission line Row;
- increased incomes from livestock;
- increased tourism (and tourism related impacts);

- possible return of educated, successful migrants.

Without comprehensive development programmes in the Valley, negative trends already underway, and likely to be accelerated, will include:

- increased rate of population growth, and consequent demand on resources;
- major reductions in sale prices of locally-produced grain crops, with worsened food balance;
- major reduction in long-haul portering opportunities;
- increased harvesting of forest products to pay for required food and other goods, and forest clearance for cardamom production, with consequent forest degradation and habitat loss, especially through increased construction needs for urbanization;
- further development of shanty towns;
- no reduction in the ongoing processes of impoverishment and marginalization;
- loss of some riverain habitat essential for endangered species;
- loss of forest habitat of other endangered species, and direct threats due to hunting;
- increased disparities in wealth and access to services;
- accelerated erosion of traditional values and culture.

Cumulative impacts can also be expected once the access road is completed, as two other projects, the Upper Arun Hydroelectric Project (UAHP) and the Lower Arun Hydroelectric Project (LAHP) are planned for the Valley. A short discussion of these is found in the main Executive Summary document.

Some quantifiable impacts of the Arun III Project area, according to latest estimates:

	Access Road	**Power**	**Transmission Lines**	**Total**
TOTAL Affected Population-Families (PAFs and SPAFS)	1014	170	576	1760
SPAFs	132	19	4	155
TOTAL Land Take (Ha)	394	117	602	1113
Privately Held Land (Ha)	293	77	312	682

Of the total land take, agricultural land will be 186 ha, which corresponds to about 0.14% of the agricultural land in the Arun Basin.

PROJECT ALTERNATIVES

Internally, Nepal has a major unsatisfied demand for electricity. Externally, the country is in a unique position to supply power to the burgeoning South Asian economy. Nepal has enormous economically feasible hydroelectric power potential, of the order of 25,000 MW. Therefore, the logical choice for some rural and most urban and industrial uses is hydropower. The Arun III Hydroelectric Project was identified as the best major hydropower scheme to be added to the Nepal interconnected System under a least cost generation expansion plan (LCGEP) completed by NEA in 1987 and reconfirmed by an LCGEP Update Study completed in 1990.

HMG/N has now initiated analytical work to improve efficiency in financial resource allocation and to prioritize the expenditure portfolio, so that investment in Arun III will not crowd out other priority projects, particularly those in the social and rural infrastructure sectors. At the same time, HMGN is taking steps to open up the electricity supply system to competition by encouraging private sector participation in power generation.

IMPACT MITIGATION

The Arun III Project has an Environmental Mitigation Plan, which is an integral part of the project and deals with direct impacts including land acquisition, compensation and rehabilitation (ACRP) and a Regional Action Programme, which has grown out of a Management of Basinwide Environmental Impacts Study (MBEIS) by the NGO the King Mahendra Trust for Nature Conservation (KMTNC), sponsored by the UNDP and World Bank (October 1991). This latter addresses the indirect impacts and induced effects, and together the two constitute the "Environmental Management Plan" required by World Bank appraisal procedures (OD 4.01).

The Environmental Mitigation Plan includes design level accommodations, such as avoidance of settlements and buildings wherever possible (a major consideration in choosing the Valley route for the access road over the previous Hill route), minimizing earthworks, and slope stabilization measures as well as various controls on the Contractors, such as on methods of and locations for spoil disposal, strict controls on use of wood for any purpose, and requirements to maximize use of local labor (especially SPAFs). The ACRP, for PAFs and SPAFs includes, as well as socioeconomic surveys prior to acquisition, land for land and employment options for SPAFs, and rehabilitation grants for all PAFs:

- guidelines for leasing land, and restoring it, whenever possible;
- inclusion of informal tenants and squatters in the Land Acquisition Guidelines 2045;
- compensation for any physical damage caused by the Contractor or any

subcontractor operating on the project, according to an agreed and publicized claims procedure

Measures to minimize the indirect impacts of the access road, and to capitalise on the economic opportunities provided by improved access such as tourism, have been identified in the MBEIS the KMTNC. The study listed long-term management options for the area, and proposed an interim management structure, centered on the National Planning Commission (NPC).

The Study's report lists 21 recommended sectoral programmes in six major programme areas (conservation; income generation; institutional strengthening; extension and training; infrastructure and energy; and research, monitoring and information) designed to address both the immediate requirements brought about by the construction process and the longer-term needs for sustainable development within the Arun Valley. In terms of scheduling, five sectoral programmes (strengthening local forest management; helping local communities service construction-related demands, particularly for wood; strengthening government institutions to cope with impacts; training and education for local human resource development; and environmental monitoring) were regarded as priorities for pre-emptive implementation. These activities comprise a "core programme" to be implemented by HMGN as a priority.

Deforestation

As mentioned earlier, the major induced effect of the Arun III Project is the potential serious exacerbation of the ongoing deforestation in the Arun Valley. As a framework, it bears noting that the King Mahendra Trust Study concluded that if existing agricultural practices continued, including the extensive use of 'slash and burn' practices, all the Valley's forest resources would be lost in 5-15 years. The major potential causes of deforestation are the Project workforce during construction and illegal logging once the access road is completed. Among the mitigation steps being taken to address these issues are: requiring contractors to give preference to hiring the local residents (especially SPAFs); instituting strict controls on the use of fuelwood by contractors for any purpose, making contractors responsible for operation of illegal logging control gates during the construction period; locating contractor work camps away from potential environmental 'hot spots,' after consultation with local NGOs and experts in biodiversity; instituting a strict Project Monitoring Plan (see below), as well as an Action Plan for the control of illegal logging, to be managed by HMG/N. In addition to the setting up of the 2,330 km2 Makalu Barun National Park and Conservation Area in the northwest quadrant of the Basin, the Arun Basin's biodiversity resources would also be covered under the Arun Hydroproject through the institutionalization of the Milke Danda Conservation Area along the valley's eastern border.

ENVIRONMENTAL MANAGEMENT RESPONSIBILITIES

The construction team, comprised of the Employer, Engineer and Contractor, have the institutional responsibility for implementing the Project's environmental management strategy, the Environmental Management Plan, which will cope with direct impacts. HMG/N will provide the leadership for setting up an administrative mechanism responsible for the Regional Action

Programme which will deal with indirect impacts and basin-wide change. Both components of the strategy will require new institutions, and therefore will be the subject of institutional strengthening programmes.

Both the Engineer and Contractor will have at least one full time professional environmentalist on their staff for the duration of the works, and the Nepal Electricity Authority will undertake an institutional strengthening programme for its Environmental Unit, which will include the creation of an Arun III Project Environmental Management Unit, working directly with the Engineer's environmentalist and having a professional Resettlement Advisor on its staff.

The NPC has commissioned a Macro-management Study to examine and refine the management recommendations of the Basinwide Impacts Study, to turn agreed proposals into implementable programs in time for the start of road construction after the 1994 monsoon. It is likely that the Regional Action Programme would be carried out by a policy making board (the Arun Basin Interim Management Board) assisted by a multidisciplinary executive unit, the Arun Basin Environmental Management Unit (ABEMU), which would work closely with the District administrations.

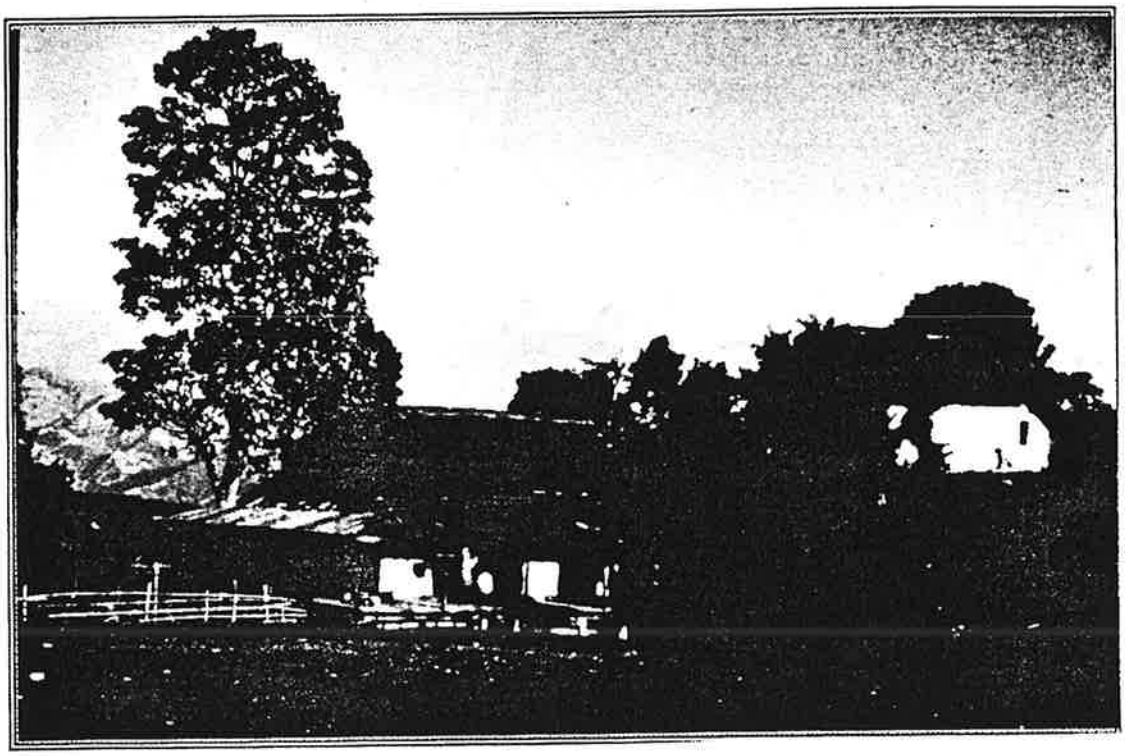
ENVIRONMENTAL MONITORING AND EVALUATION PLAN

The Arun III Project will operate dual environmental monitoring and evaluation programmes, through the Environmental Mitigation Plan for direct impacts, and through the Regional Action Programme for indirect impacts. Both roles envisage a critical role for NGOs, not only within implementation of social programs, but also as critical and objective evaluators of project performance in the environmental (in a broad sense) realm. A post-construction Environmental Impact Audit is part of the overall project planning.

Coordinated by the ABEMU, the Regional Action Programme (RAP) will establish an effective monitoring and evaluation system covering a wide range of issues, reflecting the broad coverage of the Basinwide Impacts Study and the various other environmentally-oriented projects and activities related to the Arun III Project.

NEPAL ELECTRICITY AUTHORITY
(An HMG/N Undertaking)

ARUN III HYDROELECTRIC PROJECT



ENVIRONMENTAL ASSESSMENT AND MANAGEMENT

EXECUTIVE SUMMARY

KATHMANDU
May 1993

NEPAL
ARUN III HYDROELECTRIC PROJECT
ENVIRONMENTAL ASSESSMENT AND MANAGEMENT
ABBREVIATED EXECUTIVE SUMMARY

INTRODUCTION

The Arun III Hydroelectric Project has been subjected to extensive comparative analysis and intensive design studies as well as environmental scrutiny. In this summary report, "environment" is used in its broadest sense to mean the total biophysical, socio-economic and cultural setting within which the people of the Arun Valley live. The various environmental studies are contained in a large number of professional reports totalling several thousand pages. This Environmental Executive Summary attempts to condense under one cover the contents, findings and recommendations of those reports, and the nature of the environmental management systems to be put in place in the Arun Valley as a result.

The major direct environmental impact of the project concerns land acquisition, compensation and rehabilitation, which is, including the access road, the power project, and the transmission lines, estimated to affect some 1,760 families, about 0.18% of the total population of the Arun Valley. Of these families about 155 are seriously affected, i.e. those whose house is taken or who are left with insufficient holdings, assets and prospects to reach their previous living standard. The major induced risk of the project relates to deforestation, for which a detailed mitigation plan is described below.

POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The environmental scrutiny of the Arun III Project has taken place in an institutional and policy environment that has evolved since the project was first conceived. This has included a National Conservation Strategy (NCS) developed with assistance of the World Conservation Union linking sustainable development with conservation; the most recent Five Year Plan (1992-97) stressing the use of environmental assessment as a tool in project design and implementation, the preparation and enforcement of legal provisions emphasizing sustainability, and public and NGO involvement; a series of environmental guidelines developed during the ongoing implementation of the NCS.

Important among legislation relating to the Arun III are the Land Acquisition Guidelines for the Arun Access Road (2045) which have been used to implement a Land Acquisition, Compensation and Resettlement Plan (ACRP) which is to be applied to the Project as a whole, that is, including the access road, the power project itself, and the transmission lines. This has included extensive socioeconomic surveys of the project affected families and application of rehabilitation measures that include land for land and employment options for Severely Project Affected Families (SPAFS) and rehabilitation grants for all PAFs, beyond the normal compensation stipulated by Nepal's Land Acquisition Act.

PREFACE

The Arun III (Access Road/Hydroelectric) Project will be Nepal's biggest development project to date. It has been the subject of a major planning and design effort extending over several years and involving a wide range of organisations and experts.

An important feature of the planning process has been the intensive effort which has been given to the environmental assessment and management components of the project. This has included several major environmental studies by the design team, resulting in significant environmental inputs into the tender documents and engineering designs, and independent study of wider environmental issues related to project implementation. The environmental work has involved government agencies, local and international consultants, international funding institutions, non-governmental organisations, and the people of the Arun Valley.

The various environmental studies are contained in a large number of professional reports totalling several thousand pages. It is not reasonable to expect interested parties to study all these in detail. This *Environmental Executive Summary* attempts to summarise under one cover the contents, findings and recommendations of those reports, and the nature of the environmental management systems to be put in place in the Arun Valley as a result.

Nevertheless, it is not possible in so short a document to do full justice to the vast amount of work that has been done. Therefore this summary should be treated as a guide only. Those wishing to follow up on any issue and obtain greater detail are urged to consult the full reports. These are available at the Nepal Electricity Authority's Arun III Project Office in Kathmandu.

Some of the environmental assessment work has been undertaken with assistance from the United Nations Development Programme, the World Bank and Kreditanstalt fuer Wiederaufbau. Thus the primary source of guidance on methodology has been these institutions. However the final stages of analysis and preparation of this Summary have taken into account the requirements of all the agencies involved in financing the project.

Contact Address:

Dr. J.L. Karmarcharya
Project Director
Arun III Hydroelectric Project
Nepal Electricity Authority
Adwait Marg
P.O. Box 4909
Kathmandu
Nepal

Tel: (+ 977-1) 225973 Fax: (+ 977-1) 226619
Telex: 2633 NEA HO NP Cable: BIDYUT

ARUN III HYDROELECTRIC PROJECT

ENVIRONMENTAL ASSESSMENT AND MANAGEMENT EXECUTIVE SUMMARY

CONTENTS

APPENDICES

TABLES

FIGURES

MAPS

PLATES

ACRONYMS AND ABBREVIATIONS

ABEMU	Arun Basin Environmental Management Unit
ABIMB	Arun Basin Interim Management Board
ACRP	Acquisition, Compensation and Rehabilitation Plan
ADB	Asian Development Bank
ADB/N	Agricultural Development Bank of Nepal
AIDS	Acquired Immune Deficiency Syndrome
APEMU	Arun Project Environmental Management Unit
ARI	Acute Respiratory Infection
CDO	Chief District Officer
CITES	Convention on International Trade in Endangered Species
CIDA	Canadian International Development Agency
DFO	District Forest Officer
DNPWC	Department of National Parks and Wildlife Conservation
DOR	Department of Roads
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Mitigation Plan
FIDIC	Federation Internationale des Ingenieurs Conseils
FINNIDA	Finnish International Development Agency
GEF	Global Environment Facility
GIS	Geographic Information System
GLOF	Glacial Lake Outburst Flood
HEP	Hydroelectric Project
HIA	High Impact Area
HMG/N	His Majesty's Government of Nepal
ICBP	International Council for Bird Preservation
ICIMOD	International Centre for Integrated Mountain Development
IDA	International Development Association
IUCN	The World Conservation Union
JV	Joint Venture Arun III Consulting Services
KfW	Kreditanstalt fur Wiederaufbau
KHDP	Koshi Hills Development Programme
KMTNC	King Mahendra Trust for Nature Conservation
km	Kilometer
KPAs	Key Planning Area
kV	kilovolt
LAHP	Lower Arun Hydroelectric Project
LCGEP	Least Cost Generation Expansion Plan
LDO	Local Development Officer
LDFF	Landslide Dam Failure Flood
LIA	Low Impact Area
m.a.s.l.	meters above sea level
MBCP	Makalu-Barun Conservation Project
MBEIS	Management of Basinwide Environmental Impacts Study
MOFSC	Ministry of Forests and Soil Conservation
MW	megawatt

NCS	National Conservation Strategy
NEA	Nepal Electricity Authority
NGO	Non-Governmental Organization
NPC	National Planning Commission
OD	Operational Directive
ODA	Overseas Development Administration (U.K.)
PAF	Project Affected Family
QNP	Qomolangma Nature Preserve
RAP	Regional Action Programme
RoW	Right-of-Way
RPO	Regional Planning Office
SDC	Swiss Development Cooperation
SPAF	Seriously Project Affected Family
SWK	Scott Wilson Kirkpatrick & Partners
TRRL	Transport and Road Research Laboratory (U.K.)
UAHP	Upper Arun Hydroelectric Project
UNDP	United Nation Development Programme
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
WMI	Woodlands Mountain Institute

1 INTRODUCTION

1.1 BACKGROUND

1.1.1 The Arun III Hydroelectric Project

Following extensive comparative analysis and intensive design studies, the Nepal Electricity Authority (NEA) intends to construct a run-of-river hydroelectric project on the Arun River in eastern Nepal (Map 1). The project is known as the "Arun III Hydroelectric Project" since the site chosen is the third of six potential hydropower sites originally identified on the Arun River in the 1985 Koshi River Water Resources Development Master Plan. In the course of further studies the number of feasible sites was reduced to three, namely the Upper Arun, Arun III and Lower Arun projects.

The installed capacity of the Arun III project will be 402 MW, which compares with Nepal's current installed hydropower capacity of approximately 250 MW. The project has three principal components:

* an access road - the "Arun Access Road";
* a dam, tunnel, powerhouse and associated works;
* a transmission line system for power evacuation.

The first 201 MW stage of the Arun III project is to be funded by a consortium of international lending agencies comprising, among others, the Asian Development Bank (ADB), the Finnish International Development Agency (FINNIDA), the International Development Association, Washington, D.C. (IDA), and the governments of Germany, Japan and Sweden.

It is planned that construction of the access road should commence in 1994, with the first power becoming available in the year 2001.

1.1.2 Environment and Development in Nepal

Nepal is a poor country with a limited capacity to mobilise its natural resources for economic growth. Development of its massive hydroelectric power potential is seen as a strategic necessity to provide electricity for industrialisation to employ the increasing population. In addition to meeting in-country needs, there will be opportunities for sale of surplus power to India.

Given the well-established link between poverty and environmental degradation, the primary environmental issue is not whether infrastructure development should occur. Instead, the need is to ensure that those projects which are implemented are sensitive to the environment and sustainable, and that they bring real and lasting benefits to the people of Nepal. It is also important to balance local and national needs.

In Nepal, it is well recognised that environmental management requires an integrated approach to the physical, biological, social, cultural and economic environment. In this summary report, "environment" is used in its broad sense to mean the total biophysical, socio-economic and cultural setting within which the people of the Arun Valley live.

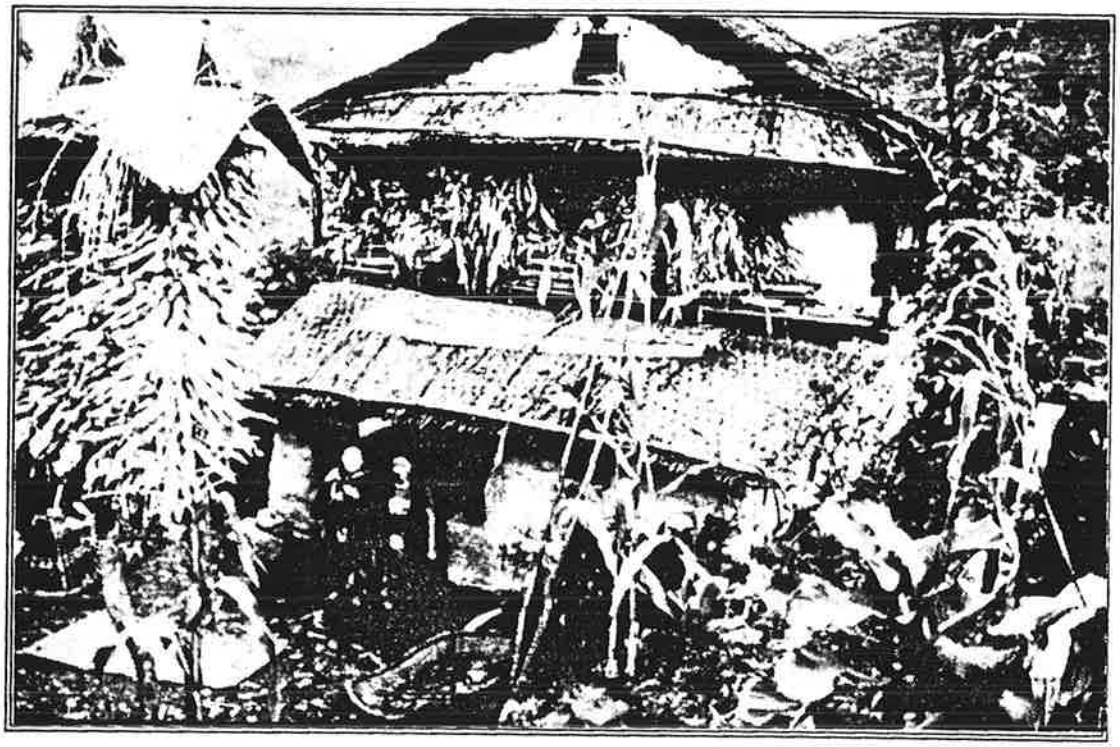


Plate 1 Typical Rai House, Arun Valley
Photo: Charles Ramble

1.2 ENVIRONMENTAL STUDIES IN THE PROJECT PLANNING PROCESS

The general characteristics of the Arun Valley are remoteness, diversity (both natural and cultural), and poverty. A major infrastructure project will bring rapid and irreversible changes to the area. Consequently, the Arun III Hydroelectric Project has been the subject of five different categories of environmental scrutiny:

(1) Recommendations of a variety of independent national and international observers: at least two reports with an overview of environmental management and development ecology in the Valley.

(2) The project design team (NEA, and their national and international consultants): three major environmental impact studies plus this environmental executive summary, as well as input to other project reports, the engineering design and specifications, and the tender documents.

(3) A "Panel of Experts" (independent specialists, including an environmentalist, engaged by NEA to review the design team's recommendations and progress): seven reports to date.

(4) A national conservation and development NGO, the King Mahendra Trust for Nature Conservation, as a consultant to the World Bank: the *Management of Basinwide Environmental Impacts Study*, a major report on management of indirect and induced impacts in the Arun Valley.

(5) Funding agency missions.

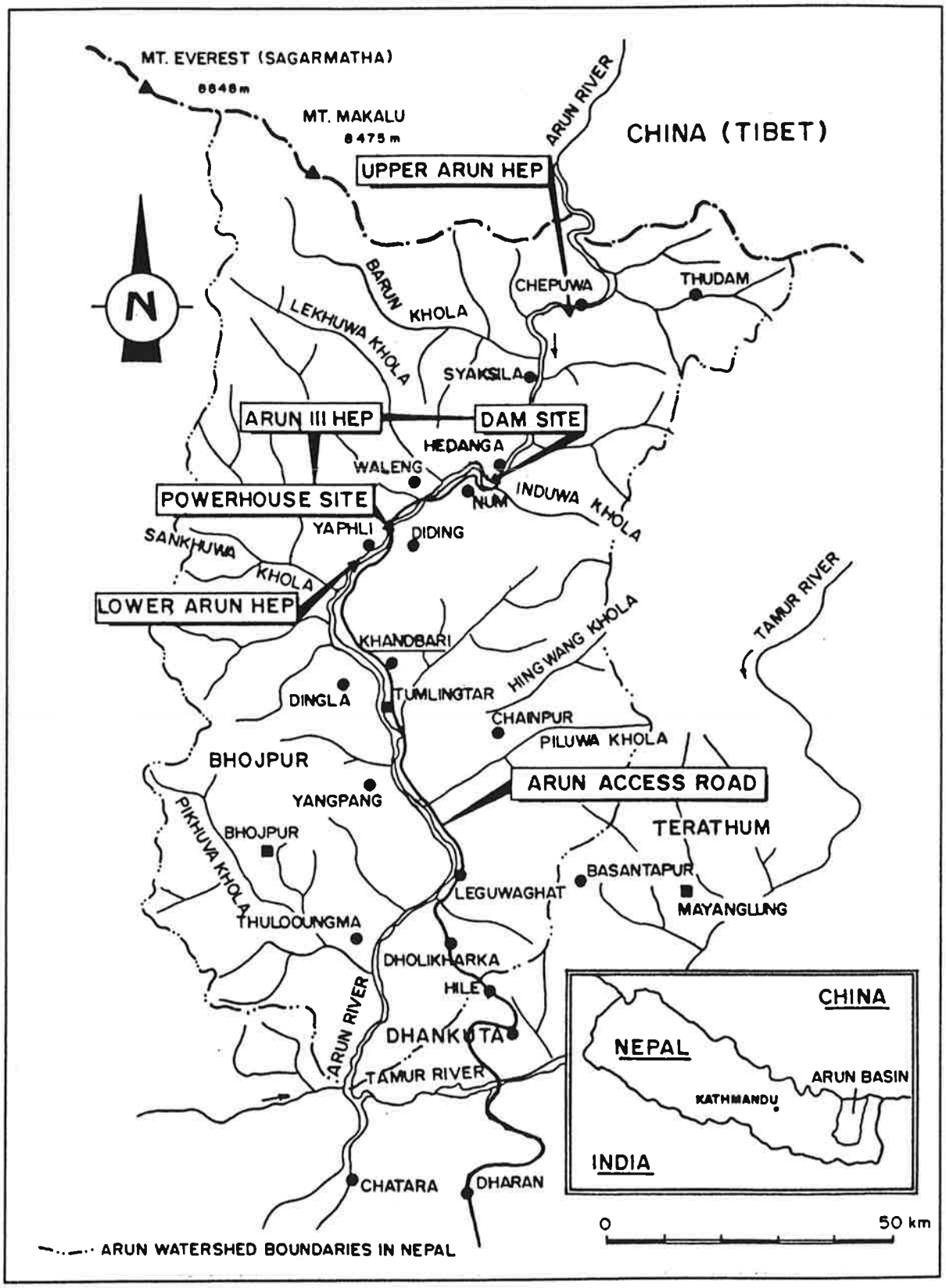
These studies have followed a recognisable sequence: firstly, early independent reports discussing the values at risk in the valley and the need for further analysis relating to management of change (1); secondly, project-specific reports investigating probable direct impacts and appropriate mitigating measures (2, 3, 5); and thirdly, analysis of indirect and induced changes, including economic opportunities, and mechanisms for managing these processes (4, 5).

The consensus of the studies is that the project's direct impacts will be relatively minor when compared with the national benefits of increased electricity availability. However, the indirect impacts and induced effects resulting from the project and opening up the Valley are harder to predict and manage. There will be major economic opportunities, but there will also be increased pressures on natural resources, and the danger of inequitable spread of benefits.

Management of both the direct and indirect effects necessitates a major upgrading of administrative mechanisms and capability.

1.3 THIS REPORT

This Summary's layout follows the format suggested in the World Bank's Operational Directive on Environmental Assessment for a full project-specific EA Report (OD 4.01, 1991).



Map 1 Arun Watershed, Nepal, showing Project Location

2 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 INTRODUCTION

Large infrastructure projects do not occur in a vacuum. They emerge from a particular institutional environment, and operate at a particular moment in the political and socioeconomic history of the partner agencies and countries. Over the period of development of the Arun III Project there have been major changes in national and international policy on environment and development. The Arun III Project was conceived and largely designed under the Panchayat regime. The revolution of 1990 began the process of democratisation in Nepal, with consequent opening up of debate on environment and development, including the role and effects of major projects such as Arun III.

In addition, the 1980's saw rapid advances in both the conceptualisation and acceptance of the necessity for environmentally benign forms of development, culminating in 1992's Earth Summit and the publication of Agenda 21. The establishment of the legal and administrative mechanisms to implement the new policies have resulted in continuous revisions to the Project's environmental provisions and mandate.

2.2 NATIONAL CONTEXT

2.2.1 National Conservation Strategy

National policy on environment and development has developed rapidly in recent years. In the mid 1980's His Majesty's Government of Nepal, with the assistance of IUCN - the World Conservation Union - prepared a National Conservation Strategy (NCS). It was completed in 1987 and endorsed as policy in 1988. The strategy, *Building on Success*, places great stress on the interdependence of conservation and development. The opening sentence of the preface states that:

> "Sustainable development and conservation must be firmly linked if Nepal is to meet the needs and improve the quality of life of its present population and future generations."

The NCS includes a "Conservation Action Agenda" which sets out specific actions and policies. Under the heading "Conservation and Large-Scale Projects" the following policies are stated:

- The terms of reference for feasibility studies related to such projects will include a requirement for the preparation of environmental and socio-economic impact statements, including proposed measures to minimise possible detrimental effects.

- The proponent of any large-scale project, either government or private sector, will be required to:

  - establish a *conservation fund* as part of project capital costs to carry out the necessary social and environmental programmes associated with the project; the purpose of the programmes would be to minimise the detrimental social, economic and environmental effects that may be caused by the project;

  - establish a *conservation section* within the project to manage the social and environmental programmes;

Initial planning for the Arun III Project was undertaken concurrently with development of the National Conservation Strategy, but before it had been confirmed as government policy. Since 1988, NEA's design team has kept abreast of policy developments, and has promoted the incorporation of appropriate approaches and responses in the design process - extensive environmental and social impact work has been carried out, environmental management units will be established both within and outside the project to manage mitigation programmes (Chapter 8), and although the concept of a conservation fund has not been adopted, environmental mitigation costs are being incorporated in project costs.

2.2.2 Eighth Five Year Plan

The most recent statement of government environmental policy is the environmental chapter in the Eighth Five Year Plan (1992-97). Environmental protection and management are seen as important obligations of the State. Eighth Plan policies include, amongst others, the use of environmental assessment as a tool in project design and implementation, the preparation and enforcement of legal provisions emphasising sustainability, and public and NGO involvement.

2.2.3 Environmental Impact Assessment Guidelines

As part of the ongoing implementation of the NCS, Nepal is rapidly developing its own laws, regulations and guidelines for environmental assessment and management. National guidelines for environmental impact assessment were formally endorsed by Cabinet on 18th September 1992, and sectoral guidelines are being prepared. Key documents include:

- *National Environmental Impact Assessment Guidelines.* National Planning Commission/IUCN, 1992.
- *Environmental Impact Assessment Bill* (draft). HMG/N, 1992.
- *Guidelines for the Environmental Assessment of Water and Energy Policies, Programmes and Projects* (draft). Social and Environmental Directorate, Water and Energy Commission Secretariat, March 1992.
- *Guidelines for a National System of Environmental Planning in Nepal* (draft). National Planning Commission/IUCN, 1992.
- *Environmental Impact Assessment Guidelines for the Forestry Sector* (draft). National Planning Commission/Ministry of Forests and Soil Conservation/IUCN, December 1992.

As far as possible, the philosophy of the these guidelines has been incorporated in the ongoing environmental assessment activities of the Project.

2.2.4 Legislation

The acquisition of land for state purposes is governed by the Land Acquisition Act 2034 (1977), and amended for the Arun III Project by the Land Acquisition Guidelines 2045 (1988) declared under the act. Forests and forestry are controlled by the new Forest Act 2049 (1993).

The most important act related to wildlife conservation and protected areas is the National Parks and Wildlife Conservation Act 1973 (2029). It provides for the establishment and administration of protected areas and "the conservation of animals and birds and their habitat". The latest amendment of the Act was in 1989 to allow for the establishment of Conservation Areas.

In addition, Nepal is a state signatory to a number of international conventions relating to wildlife and environmental conservation including:

1956	Plant Protection Agreement for the Asia and Pacific Region
1975	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
1978	World Heritage Convention
1983	International Tropical Timber Agreement
1987	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)

Hunting is regulated by the National Parks and Wildlife Protection Regulations made under the Act (1974, 1975, 1978, 1985). Other acts and regulations relevant to biodiversity include the Wildlife Reserve Regulations (1977), the Himalayan National Park Regulations 2036 (1979), Regulations for the recently gazetted Makalu-Barun National Park and Conservation Area (22nd November 1991), and the Aquatic Life (Conservation) Act, 1961.

Tourism is controlled by the Tourism Act 2035 (1979), mountaineering by the Mountaineering Expedition Regulations 2036 (1980), and trekking by the Trekking and River Rafting Regulations 2041 (1985).

Recent Acts to further the decentralisation process include the Village Development Committee Act, the Municipality Act, and the District Development Committee Act, all of 1991.

2.2.5 Administration of Environmental Policy

Mechanisms for the implementation of environmental policy are at an early stage of development in Nepal, but are evolving rapidly. Endorsement of the NCS in 1988 resulted in the establishment of a high-level umbrella Council for the Conservation of Natural and Cultural Resources. Recently, this has been dissolved and replaced by a powerful *Environment Protection Council*, chaired by the Prime Minister, with a wide-ranging mandate to formulate and implement environmental policy. The Council will be assisted by a new Environment Protection Division under the Secretariat of the National Planning Commission. (At the same time, the name of the Ministry of Forest and Environment was changed back to the Ministry of Forest and Soil Conservation).

One of the Council's main responsibilities will be coordination of the activities of line agencies insofar as they affect the environment (Departments of Irrigation, Roads, Forest etc.). At the same time, the Council will be taking advantage of Nepal's regional development and decentralisation policies to improve the capability of district and village level administrations. These will have an increasing role to play in environmental management as Nepal moves from a centralised bureaucracy controlling development to a decentralised one facilitating local and private sector initiatives.

2.3 INTERNATIONAL CONTEXT

Throughout the 1980's and early 90's donor policy on environment and sustainable development evolved rapidly. All the multilateral and bilateral development agencies now have environmental assessment procedures in place to screen projects throughout the project cycle. For example, the World Bank has environmental assessment policies and procedures

> "to ensure that development options under consideration are environmentally sound and sustainable, and that any environmental consequences are recognised early and taken into account in project design."

Recent World Bank publications on environmental assessment methodology relevant to the Arun III Project include:

- *Environmental Assessment Sourcebook*, Volumes I, II, III. Technical Paper No. 139. Environment Dept., World Bank. August 1991.
- World Bank Operational Directive 4.01 *Environmental Assessment.* October 1991 ("OD 4.01").
- Numerous other relevant World Bank Operational Directives, Operational Manual Statements and Operational Policy Notes, as listed in the Sourcebook.

In addition, there are a number of papers by Bank staff on subjects such as compensation and resettlement which are specific to Nepal.

These comprehensive guidelines are paralleled by similar guidance published by the ADB and other development agencies, for example the ADB's *Guidelines for Social Analysis of Bank Projects* (1991).

As well as considering direct impacts and their mitigation, these international EA procedures are now focused increasingly on indirect and induced effects, and on public participation. For example, the World Bank's OD 4.01 on Environmental Assessment requires that project-specific EAs should normally cover: (a) existing environmental baseline conditions; (b) potential environmental impacts, direct and indirect, including opportunities for environmental enhancement; (c) systematic environmental comparison of alternative investments, sites, technologies and designs; (d) preventive, mitigatory, and compensatory measures, generally in the form of an environmental mitigation or management plan; (e) environmental management and training; (f) environmental monitoring.

Issues that should be addressed include, amongst others, biological diversity, cultural property, indigenous peoples, induced development and other sociocultural aspects, involuntary resettlement, natural hazards, and occupational health and safety. All these topics are covered by Bank Operational Directives. In addition, further Directives or Operational Policy Notes cover Dams and Reservoirs, Projects on International Waterways, Tropical Forests, and Wildlands.

The Arun III Project has responded to this increasingly rigorous analytical atmosphere by extending the scope and coverage of its environmental impact assessment studies, and by assisting other government agencies to develop the programmes necessary for impact mitigation and the enhancement of economic opportunities.

3 PROJECT DESCRIPTION

3.1 ARUN III HYDROELECTRIC PROJECT

3.1.1 Introduction

Arun III is a 402 MW "run-of-river" facility, that is it will utilise normal flows in the river rather than depend on water held back in a large reservoir. Water diverted from the river will flow through a tunnel to an underground powerhouse, and then be discharged back into the river channel.

Key Features of the Project

* High firm river flow due to glacier and snowmelt (78.5 m^3/s 90% dependable flow)
* High head due to steep gradient in loop of river (286 m net head at full load)
* Firm energy of 1558 GWh/annum
* Small area to be inundated (30 ha)
* High energy output per unit of land occupied (MW/ha = 402/430 = 0.93)
* Favourable geology at the locations of almost all major structures
* Access road which can also serve other attractive power projects on the same river (totalling 1045 MW)

Tender design for a staged development (268 MW, 134 MW) was concluded with the April 1991 Engineering Design Report. For financial and macroeconomic reasons NEA and the funding consortium, led by the World Bank, now envisage project development in two equal stages, each of 201 MW.

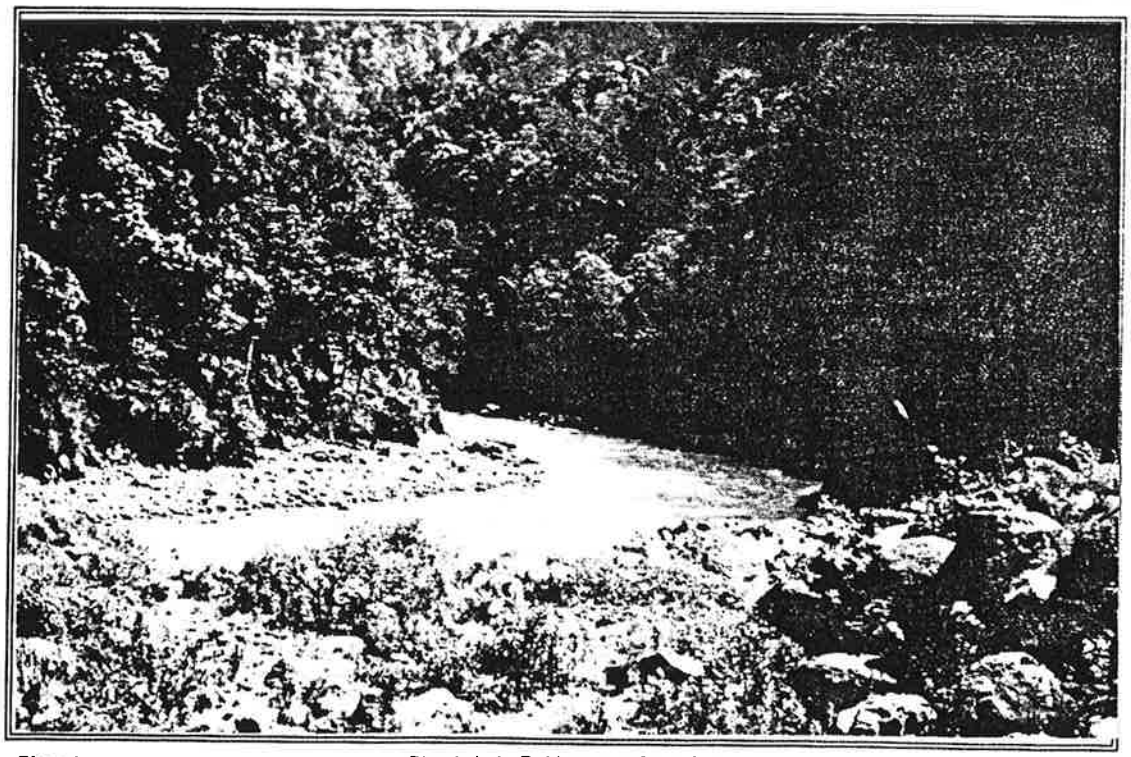


Plate 2 Phyaksinda Dobhan, the Dam Site
Photo: B. D. Joshi

3.1.2 Power Generation Components

The main permanent components (Map 2) will take up some 47.8 ha of land, and will be:

* Dam and reservoir (40 ha inundated), including diversion works
* Power intake, underground desanding basins and flushing system
* Twin 11.5 km headrace tunnels, underground surge tanks and adits
* Underground powerhouse and associated structures
* Permanent offices and housing (5.8 ha)

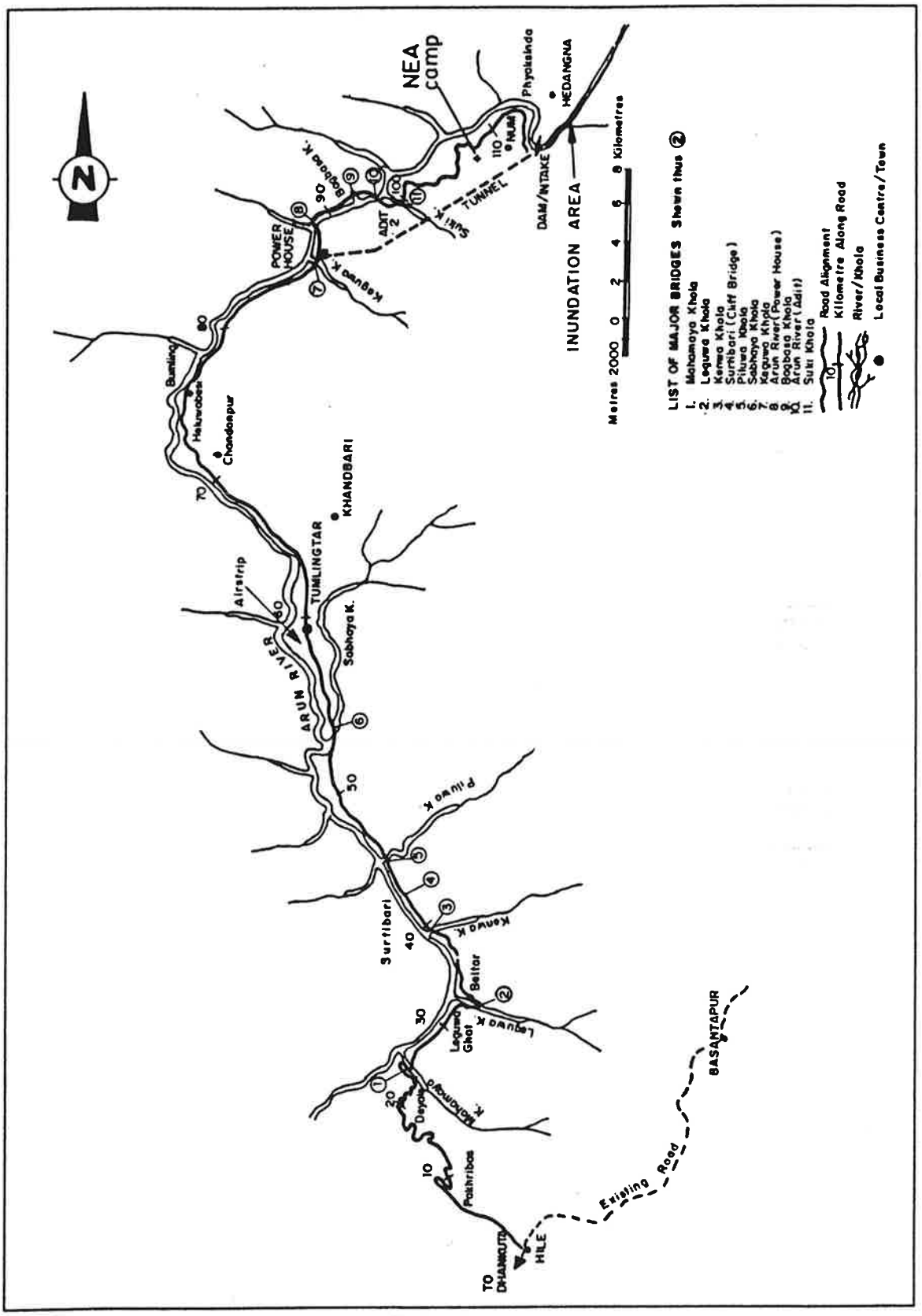
The dam is required to divert water into the headrace tunnel. It will be a concrete gravity dam with a crest length of 155 m and a height of 68 m. Although the reservoir created by the dam will extend some 4 km upstream, it will only have a surface area of some 50 ha.

Temporary facilities will cover some 69.1 ha and will include:

* Quarries, borrow sites and spoil storage areas (16.1 - 32.4 ha)
* Concrete batching and mixing plants
* Work and storage areas (13.5 ha, inc. batching and mixing plants)
* Construction camps, offices and housing (28.5 - 36.5 ha)
* Support facilities, including helipads
* Construction power supply (2.2 ha) and local 33 kV transmission system
* Roads and bridges

Table 3.1 CHARACTERISTICS OF POWER GENERATION COMPONENTS, STAGED DEVELOPMENT

COMPONENT	FEATURES	FIRST STAGE	SECOND STAGE
Dam	concrete gravity with integral spillway, crest length 155 m, height 68 m	to be completed	-
Spillway	3 radial gates, discharge capacity 8100 m^3/s	to be completed	-
Power Intake	4 openings 4 x 13.5 m, trash racks, sediment flushing system, roller gates	to be completed except intake tunnels 1, 2	intake tunnels 1, 2
Desanding Basins	4 underground, 17 x 28 x 110 m	downstream basins 3, 4 and all of flushing system	upstream basins 1, 2
Headrace Tunnels	2 concrete-lined, length 11.51 km, diameter 5.6 m	mountainside tunnel and surge tank	valleyside tunnel and surge tank
High Pressure Waterways	2 steel-lined shafts, 4.3 m diam.	shaft for Units 1-3	shaft for Units 4-6
Power Cavern	underground, space for 6 generating units, 22 x 35 x 161 m	space for Units 1-3, service bay, unloading bay	space for Units 4-6
Turbines	6 x Pelton type, 67 MW each, total 402 MW	Units 1-3, 201 MW	Units 4-6 201 MW
Tailrace System	2 tunnels, 2 surgetanks, 1 outlet structure	one tunnel and surgetank, outlet structure	second tunnel and surgetank



Map 2 Project Layout

3.1.3 Arun Access Road

Construction and operation of the Arun III power facilities is dependent on the construction of an access road to link the site with the existing road system. The direct distance from the nearest road head at Basantapur to the dam site is approximately 50 km (Map 2). However, the difficult terrain necessitates a total length of new road construction of 122 km, including access to the powercavern.

The road will start at the small market town of Hile in Dhankuta District (Plate 3). This is the highest point on the route, at 1920 m.a.s.l. The road descends rapidly past Pakhribas to the Arun River, and then follows the valley throughout (Map 1). Heading north close to the river at 260 - 300 m.a.s.l, five major tributaries are crossed before reaching the Tumlingtar plateau. Between Tumlingtar and the powerhouse site the road continues to follow the left (east) bank of the river, with the terrain becoming much steeper and more difficult halfway, at Bumling.

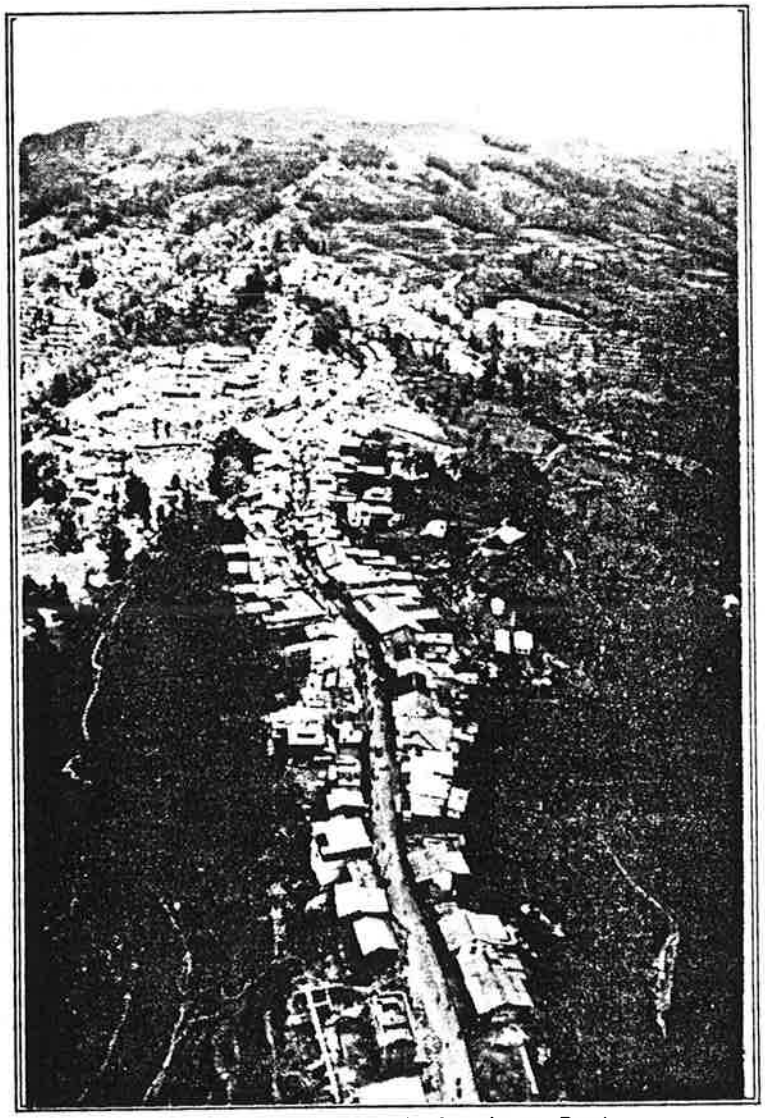


Plate 3 Hile, the Starting Point for the Arun Access Road
Photo: John Henley

At the powerhouse the road crosses the river and proceeds northwards on the right bank near river-level for some 7 km, returning to the left bank immediately below the site of Adit No. 2. Here the road ascends to avoid very steep and difficult ground near the river, and then contours at an elevation of around 1340 m.a.s.l. past Amrang, the site for the permanent camp 17 km north of the powerhouse.

The final descent to the Intake site is made at Phyaksinda, below Num.

11 major bridges will be required, including two over the Arun River itself, one near the powerhouse and one below the site of Adit No. 2 (Map 2).

The road will be single-lane with passing places, with a sealed surface. This will minimise earthworks, slope disturbance, and maintenance costs.

A road maintenance depot will be built at Tumlingtar, an important staging point halfway to the power development sites. Other facilities will include Engineer's camps and resthouses.

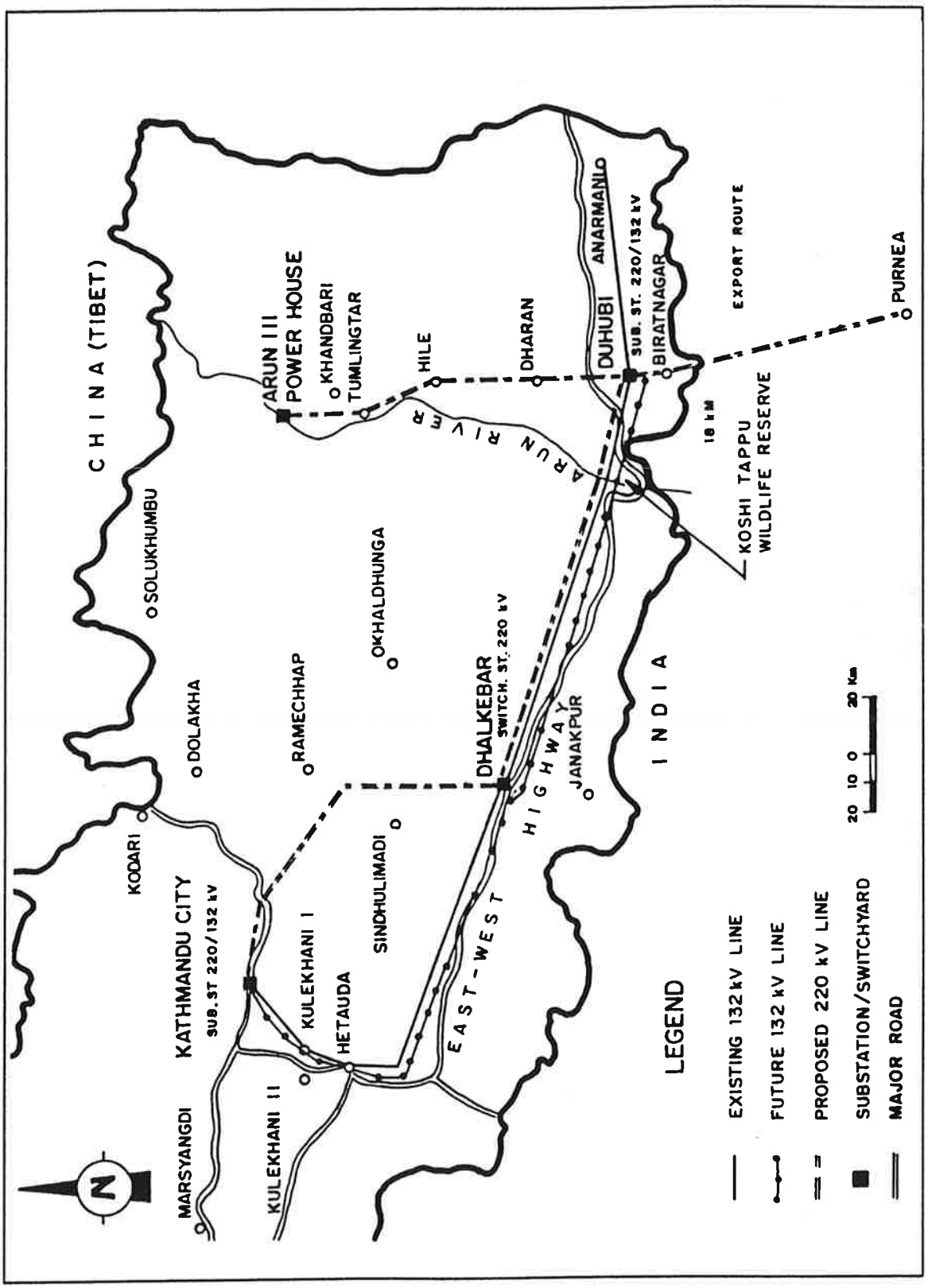
Table 3.2 CHARACTERISTICS OF ARUN ACCESS ROAD	
COMPONENT	FEATURES
Length of new construction	122 km single lane with passing places
Carriageway	4.5 m with 0.5 m shoulders, widening on curves
Right of Way	30 m width taken into government ownership
Gradients	ruling: 7 %, max: 10 %
Wearing surface	double layer surface dressing (stone chip and bitumen spray)
Bridges	11 no, with spans from 30 - 104 m; steel trusses with concrete decks, piers and abutments
Culverts	1100 no, concrete pipe or corrugated steel, variable diam.
Retaining walls	0.57 M m^3 masonry, gabion
Earthworks	soft cut: 1.1 M m^3 rock cut: 0.9 M m^3 fill: 0.95 M m^3

3.1.4 Power Transmission System

The power transmission system required for the full two-stage development of Arun III includes a double circuit 220 kV transmission line from the Arun III powerhouse to Kathmandu, passing through a 220/132 kV substation at Duhubi near Biratnagar, a 220 kV switching station at Dhalkebar in the Terai, and terminating in a 220/132 kV substation near Kathmandu (Map 3). The total length of line will be 380-410 km, depending on final alignment decisions at the Sapta Koshi crossing.

For Stage 1, only the section Arun III - Duhubi will be needed (120 km). The 33 kV transmission system used for the construction power supply at the project site will be retained for local use.

Table 3.3 CHARACTERISTICS OF POWER TRANSMISSION SYSTEM		
COMPONENT	TYPE	DIMENSIONS
System	double circuit single tower,	220 kV
Length	powerhouse - Duhubi powerhouse - Kathmandu	120 km 380-410 km
Right of way	Controlled land use	width estimated at 40-45 m
Towers	standard rigid lattice galvanised steel; possibly wire stay type in Terai	height 40-45 m, footprint 15 x 15 m approx., average span 400 m +
Conductors	twin bundled from Arun III - Duhubi; remainder single	
Substations	220 kV/132 kV	Duhubi, Kathmandu
Switching stations	220 kV	Dhalkebar



Map 3 Transmission Line Routes

3.1.5 Construction Schedule

Construction of the first 201 MW stage of the project is scheduled to commence on 01.01.1994, with commissioning tests of the first turbine on 01.05.2001. The implementation schedule of the second 201 MW stage has yet to be decided. Construction planning studies have resulted in the following key dates and periods for Stage 1 construction:

Letter of Acceptance for Lots C1, C3 (dam, desanding caverns, access road, headrace tunnel, surge tank, NEA camp)	1.11.1993
Start of road construction	post-monsoon 1994
Air support	1.09.1994 - 1.05.1997
First road access to damsite	1.10.1996
Completion of construction power supply	1.10.1996
Completion of permanent camps	1.03.1997
Completion of river diversion tunnel, start of coffer dam	1.11.1997
Spoil disposal to Arun River	monsoon 1998, '99, 2000
Closure of diversion tunnel and filling of waterways	1.03.2001
Completion of transmission line	1.03.2001
Commissioning tests for Power Unit 1	1.04.2001
Demobilisation of contractor(s)	04.2001

Road Construction To meet this schedule, overall construction time for the access road will be limited to 40 months, including mobilisation. Work will start in 1994 and proceed simultaneously on an estimated seven separate workfronts, with extensive air (helicopter) support. The road labour force will average about 6700, peaking at around 9500 during key dry season periods. Camps will be established at Hile, Tumlingtar, and an estimated two points further north. The contractor for the road will also construct the permanent NEA camp at Amrang.

Hydropower Components Construction The hydropower components are divided into civil, mechanical, electrical and hydraulic steel structures lots. The bulk of the work will begin after the provision of road access, in the 1996/97 dry season. Labour force requirements for Stage 1 are estimated at a minimum of 3700, plus at least 140 Employer's/Engineer's supervisory staff, over a period of some four years. Temporary camps will be constructed at two main locations, the powerhouse and the intake. Additional land will be required for storage and assembly areas, concrete batching plants, quarries and aggregate processing, temporary spoil storage, and other facilities including pre-assembly yards at Tumlingtar.

Construction of Stage 2 (remainder of power cavern and 3 further turbines, plus remaining intakes, desanding basins, valleyside tunnel, surge tank, high pressure waterway, outlet tunnel and surgetank) would require a smaller labour force since the road, dam and camps would already be built.

Transmission Line Construction Final design and construction of the complete transmission line system including substations for Stage 1 could be completed within 43 months from contract award. The exact timing of construction of the various elements depends partly on the pattern of growth in demand and the location of intermediate generating facilities. A tentative schedule is:

by 2001	construct 220 kV double circuit system Arun III-Duhubi-Purnea construct Duhubi substation
by 2005	extend 220 kV lines from Duhubi to Kathmandu upgrade Dhalkebar switching station and Kathmandu substations

Each major section of line will require a labour force of some 500, on several workfronts. Substation construction will require about 55 workers.

3.2 OTHER MAJOR HYDROELECTRIC PROJECTS PROPOSED FOR THE ARUN VALLEY

3.2.1 Upper Arun Hydroelectric Project

A detailed feasibility study of this proposed project was completed in 1991. It is another run-of-river scheme, with a projected first stage power output of 335 MW. The underground powerhouse will be sited some 24 km north of the Arun III intake site, linked by a headrace tunnel to a dam site 16 km upstream and approximately 15 km south of the border with the Tibetan Autonomous Region of China (Map 1). It will require extension of the Arun III access road by approximately 47 km. 35 km of 220 kV double circuit transmission line, generally following the access road, would convey power to the Arun III switchyard.

Table 3.4 CHARACTERISTICS OF UPPER ARUN HYDROELECTRIC PROJECT	
Dam/intake	Concrete gravity, radial gated spillway, height 37 m; flow 62.5 m^3/s 90 % dependable
Headrace tunnel	length 7.84 km, diam. 5.5 m, concrete-lined; head 454 m
Powerhouse	underground, 21 x 35 x 105 m
Turbines	Pelton: first stage 4 x 83.75 MW, total 335 MW; second stage 2 x 83.75, total 500 MW
Access road	46.8 km single carriageway, inc. 1.8 km tunnel

3.2.2 Lower Arun Hydroelectric Project

The Lower Arun Hydroelectric Project is another attractive hydropower project on the Arun River. It has been investigated at pre-feasibility level, and would have a power output of 308 MW. The proposed site is downstream from the Arun III powerhouse, immediately northwest of Tumlingtar (Map 1). Desanded water from the Arun III turbine flow would be diverted directly into a headrace tunnel leading to the Lower Arun powerhouse. Two weirs across the Arun would provide supplementary and bypass flows. Additional water would be diverted from the Kaguwa and Sankhuwa Kholas. The whole project site would be very close to the access road already built for the Arun III Project.

Table 3.5 CHARACTERISTICS OF LOWER ARUN HYDROELECTRIC PROJECT	
Diversion structures	concrete fixed crest weir across Arun above Waleng Khola, gated weir at Arun III outlet structure, diversion on Waleng Khola, intake structure and tunnel, and surge tank; max flow 160 m^3/s
Headrace tunnel	length 14.3 - 15.9 km, diam. 8.8 - 9.2 m; head 204 - 235 m
Powerhouse	underground cavern
Turbines	Pelton; installed capacity 308 MW
Access road	single carriageway, very short

4 THE SETTING

4.1 NATURAL ENVIRONMENT

The Arun River rises in Tibet, where over 80 % of its basin lies. The river predates the uplifting of the Himalaya, and in its passage to India has cut a deep and narrow valley for some 155 km through the mountains of Nepal. In Nepal, the northern part of the Valley is remote, extremely rugged, and has few inhabitants. The southern part of the Valley is lower, warmer, and densely populated. Overall the population of the 5000 km^2 Arun Basin in Nepal is about 450,000, from 10 ethnic groups.

The Arun Valley contains natural features of recognised international significance, particularly north-west of the proposed power project sites. Here, the new Makalu Barun National Park and Conservation Area contains one of the few surviving pristine forest areas in the Himalayan range, with very high biodiversity and heritage values, and adjoins Sagarmatha (Mt. Everest) National Park to the west. Features of high ecological and cultural value have also been identified elsewhere in the Valley, which is an international flyway for migrating birds and has a high diversity of aquatic fauna.

4.1.1 Physical Environment

(i) The Dynamic Landscape

The mountains of Nepal are the product of an enormous collision - the Indian continental plate moving north and being forced under the larger Eurasian plate. The Himalaya are the world's highest mountains, and are still rising at a rate of perhaps 1 mm/year. This is extremely fast in geological terms. These high mountains intercept the annual south-east monsoon, resulting in very high rainfall over a short period. 600 mm of rain within 24 hours have been experienced in Darjeeling, immediately east of Nepal. Except at high elevations, temperatures are high, so rock weathering is rapid.

The combination of rapid uplift, weak rock and intense rainfall results in a highly active landscape. Rivers are eroding rapidly, attempting to reach the base level of the Ganges Valley. The lower side slopes of the valleys, undercut by the rivers, are steep. In the Middle Hills gentler terrain is found on the higher slopes, but these are subject to erosive attack by the rivers from below. Along the Arun rapid river erosion combined with bedrock joint orientations dipping into the hillside has created steep rock slopes or rock cliffs. Mass wasting (landsliding) is the norm as slopes attempt to retreat to stable angles. Some of the terrace deposits in the Himalayan valleys result from catastrophic events involving several cubic kilometres of debris - glacial lake outburst or landslide dam failure floods (GLOFS and LDFFS), sometimes triggered by earthquakes

(ii) Climate

Most geographers classify areas of the Valley below 1000 m as being tropical, with a sub-tropical zone from 1000 - 2000 m. The dominant feature of the climate is the summer monsoon. Pre-monsoon rains in April and May trigger vegetative growth, with the full monsoon setting in from early June. Rainfall tends to peak in July, and then tail off to virtually nil in November.

Rainfall totals vary from an average of 1470 mm at Pakhribas (1650 m.a.s.l.) to some 4000 mm at Num (1497 m.a.s.l.). Along the Valley and on north slopes there is a rainshadow effect, with annual totals at Leguwaghat (330 m.a.s.l.) being only 790 mm, and at Tumlingtar (403 m.a.s.l.) 1198 mm.

Temperatures are elevation-dependent. The normal altitudinal decline of 0.6 °C per 100 m is modified by topographical effects, in particular slope aspect. South-facing slopes are markedly warmer and dryer than northern slopes. Cloud cover above 2000 m.a.s.l. limits crop cultivation.

(iii) Geology, Topography and Soils

Arun Access Road The access road runs through the Middle Hills of the Nepal Himalaya. Essentially a line between Heluwabesi (Bumlingtar) and Khandbari separates hilly terrain with extensive soil development and colluvial deposits to the south, from steep, mountainous and rocky terrain to the north.

The Hills generally consist of weakly to moderately metamorphosed rocks with relatively gentle slopes, especially on the weak phyllites. Steeper slopes are associated with harder rock types, particularly schists and quartzites. Elevations vary from 500-2000 m.a.s.l. The Arun is an antecedent river (i.e. it existed in roughly its present course before the Himalaya formed). Consequently the Arun valley is very deep. Tributary valleys are structurally controlled. Terrace deposits, in a few cases extensive and known as *tars*, can be found on the sides of most valleys.

The eastern slopes of the Arun catchment (where the access road is to be located) are drained by a small number of large tributary valleys, many of which have cut deep gorges upstream of their confluences with the Arun. In the southern part of the area, erosion and slope instability in these tributary valleys have resulted in the deposition of extensive fan surfaces at their mouths. The steeper slopes in this area usually occur on the lower valley sides due to stream incision and valley side erosion. Much of the natural drainage pattern on the tributary valley sides has been disturbed by irrigation, which tends to increase catchment storage and leaves many river channels dry, even during the wet season.

Soils on slopes tend to be young, formed in colluvial (gravity-transported) debris. As a general rule, slopes in the hilly, southern portion of the road corridor are less than 35° and are mantled by locally deep (up to 5 m) residual silty, sandy soils on the broad ridge and spur summits, with colluvial soils, also up to 5 m deep, located on the lower valley side slopes. A conspicuous feature along the Valley are areas of red soil (*rato mato*). These old soils occur in areas of greatest landscape stability. The duration of weathering has resulted in soils of low fertility and little agricultural value. They are highly susceptible to accelerated surface erosion.

From a road alignment point of view, the lower valley side slopes are less favourable owing to generally steeper slopes, wetter soils, river scour, and slope failure or soil creep on irrigated farmland. Bedrock at the surface is generally moderately to highly weathered except where it is exposed in structurally controlled cliffs, or where it has been recently exposed by slope failure.

Hydroelectric Power Components The rock mass in the area of the power facilities mostly consists of Pre-Cambrian augen gneiss, granitic gneiss and mica schists. The bedding is regular, and major faults rare. Major structures such as the dam, the desanding caverns, the upstream part of the headrace tunnel, the pressure shafts, the tailrace tunnels and the outlet structure are located in gneiss which is of medium strength. Some 4.15 km of the headrace tunnels pass through an area where variable quality mica schists outcrop.

Transmission Line The lines will run through both the Middle Hills and the alluvial lowlands, the *Terai*. In the hills erosion processes are widespread and demand great care in line routing and tower pad location and design. In the Terai the terrain is flat, but lateral river erosion can be rapid and this again demands care in line routing and tower foundations.

(iv) Seismicity

The area is seismically active, but the power sites are well north of the Main Central Thrust fault. The last major earthquake occurred in 1988, with an epicentre in the eastern Terai. The seismic risk study undertaken for the project in 1990 indicated a low risk of a damaging earthquake at the power sites, and concluded that a horizontal design coefficient of 0.12 would be adequate for important structures.

(v) Hydrology

The Arun River originates in the Tibet Autonomous Region of China, with approximately 84 % of the catchment area lying north of the Himalayan Range. The river pre-dates the uplifting of the Himalayan Range, and its down-cutting has kept pace with the rate of uplift. The catchment area of the Arun at the damsite is approximately 27,000 km^2, of which more than 90% lies in Tibet. The area of the basin lying within Nepal is estimated to be 5028 km^2 (Map 1).

The Arun River flow follows the seasonal variation in rainfall. Minimum flows occur in February, and average 79.5 m^3/s. Highest flows occur during the monsoon season in July and August (average 890 m^3/s and 910 m^3/s, respectively). The flood with an average return interval of 100 years at the damsite is estimated at 4177 m^3/s. The Probable Maximum Flood for the dam and powerhouse sites is estimated as 8100 and 10,780 m^3/s, respectively.

Floods: GLOFS and other Catastrophes In addition to occasional floods due to extreme rainfall, there is a possibility of a Glacial Lake Outburst Flood (GLOF) or Landslide Dam Failure Flood (LDFF) in the Arun Valley. These events are episodic, with a low probability of occurrence, but high damage potential when they do occur. For the Arun III Project, the major potential GLOF hazard is a glacial lake at the head of the Barun Khola, which joins the Arun upstream of the dam site. LDFFs may occur in the main valley or any of its tributaries. The Project's 1993 *Risk Analysis and Insurance Study* concluded that the probability of rain-caused floods and GLOFS capable of damaging the project when under construction (flows of 3600 m^3/s or more) was was once in thirty years for each type of event.

4.1.2 Biological Environment

Nepal, and the Arun Basin in particular, is home to a very large number of different forms of life, both plant and animal. This is due to its remarkable diversity of habitats and to Nepal's location within Asia, where the Himalaya form both a boundary and corridor between different biogeographic provinces (principally Eurasia and South and South-east Asia). The Arun river is itself a distinct ecological boundary for some mammal and bird species.

The biodiversity of the area is under severe pressure due to man's activities. Many species of fauna are forest-dependent. Some 14 endangered or potentially threatened plant species, 14 endangered, threatened or rare mammal species, 2 endangered reptile species, 4 threatened bird species, at least 4 rare and one endangered species of butterfly, and 1 rare species of fish are known or suspected to occur in the immediate vicinity of the Access Road and power sites (Tables 4.1, 4.2). Ecologically sensitive and protected areas within the Valley are shown in Map 4.

(i) Vegetation and Forest Habitat

Within the area of the Arun Valley to be traversed by the access road, a number of distinct habitat types can be recognised. In the Tropical Zone (< 1000 m.a.s.l.) these include Hill Sal Forest, Evergreen Riverine Forest, and Deciduous Riverine Forest. The hill sal forests consist of nearly pure stands of sal (*Shorea robusta*), with few epiphytes or climbers. Trees are some 12-16 m high. Evergreen riverine forest is the narrow strip of dense jungle which occurs on steep slopes adjacent to the river and its tributaries. These forests support many species of tree and shrub, are richly endowed with climbers and epiphytes, contain endangered species of plants such as the tree-fern *Cyathea spinulosa* (Table 4.1), and form important habitat for rare mammals and reptiles (see below).

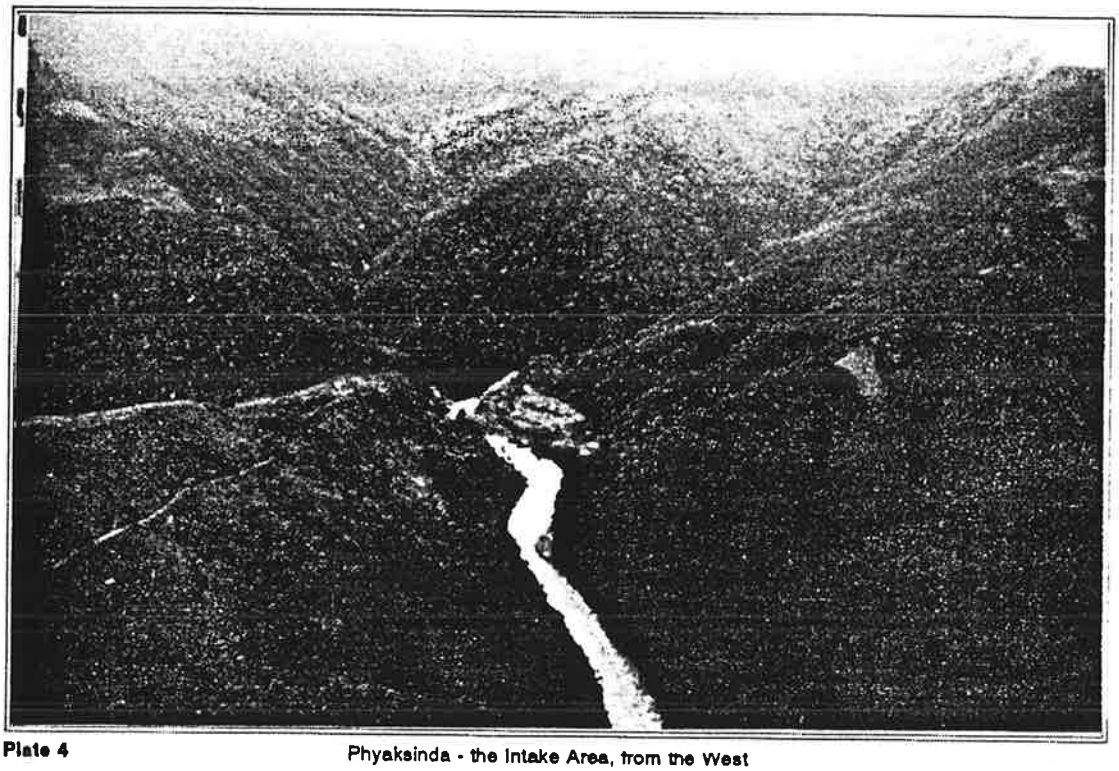


Plate 4 Phyaksinda - the Intake Area, from the West
Photo: James Ramsay

Deciduous riverine forest occurs on dryer southern exposures and along river banks. The most prominent tree is *Acacia catechu*, often on new alluvium as between Diyale and the Sabhaya Khola.

The Subtropical Zone (1000-2000 m.a.s.l.) supports (i) chir pine forest, a type dominated by the single species *Pinus roxburghii* and found on the dry ridge at Salleri between Gorlikharka and Diyale, and (ii) Chestnut (*Castanopsis spp.*) and mixed Chestnut-*Schima* forests. These occur north of the Adit No. 2 site. Natural stands of the higher-elevation chestnut, *Castanopsis tribuloides*, have a closed canopy, with trees as tall as 30 m. Rainfall in this zone is high.

As elsewhere in Nepal, much of the forest in this zone has been destroyed and the land converted to agriculture. The remaining forests are extremely important for wildlife, particularly for deep-forest birds.

(ii) Wildlife

Mammals and Reptiles The riverine forests of the Arun Valley shelter a number of rare and endangered species of mammals, reptiles and birds protected by national law and international conventions. Wildlife-people interactions are at a high level, with very significant economic losses reported due to crop damage and predation on livestock. Hunting for food is widespread, as well as for religious rituals, for medicinal purposes, to control problem animals, and for trade.

Mammals of note include Clouded Leopard, Leopard Cat, Asiatic Golden Cat, Otters, Spotted Linsang (civet), Assamese Macaque, and Pangolin (scaly ant-eater). Reptiles include Python and Indian Monitor Lizard. Population sizes are unknown but are likely to be decreasing, principally due to habitat destruction. 10 mammal and both reptile species are protected under CITES Appendix I as species threatened with extinction (Table 4.2).

Table 4.1 RARE AND ENDANGERED PLANT SPECIES FOUND ALONG THE ACCESS ROAD

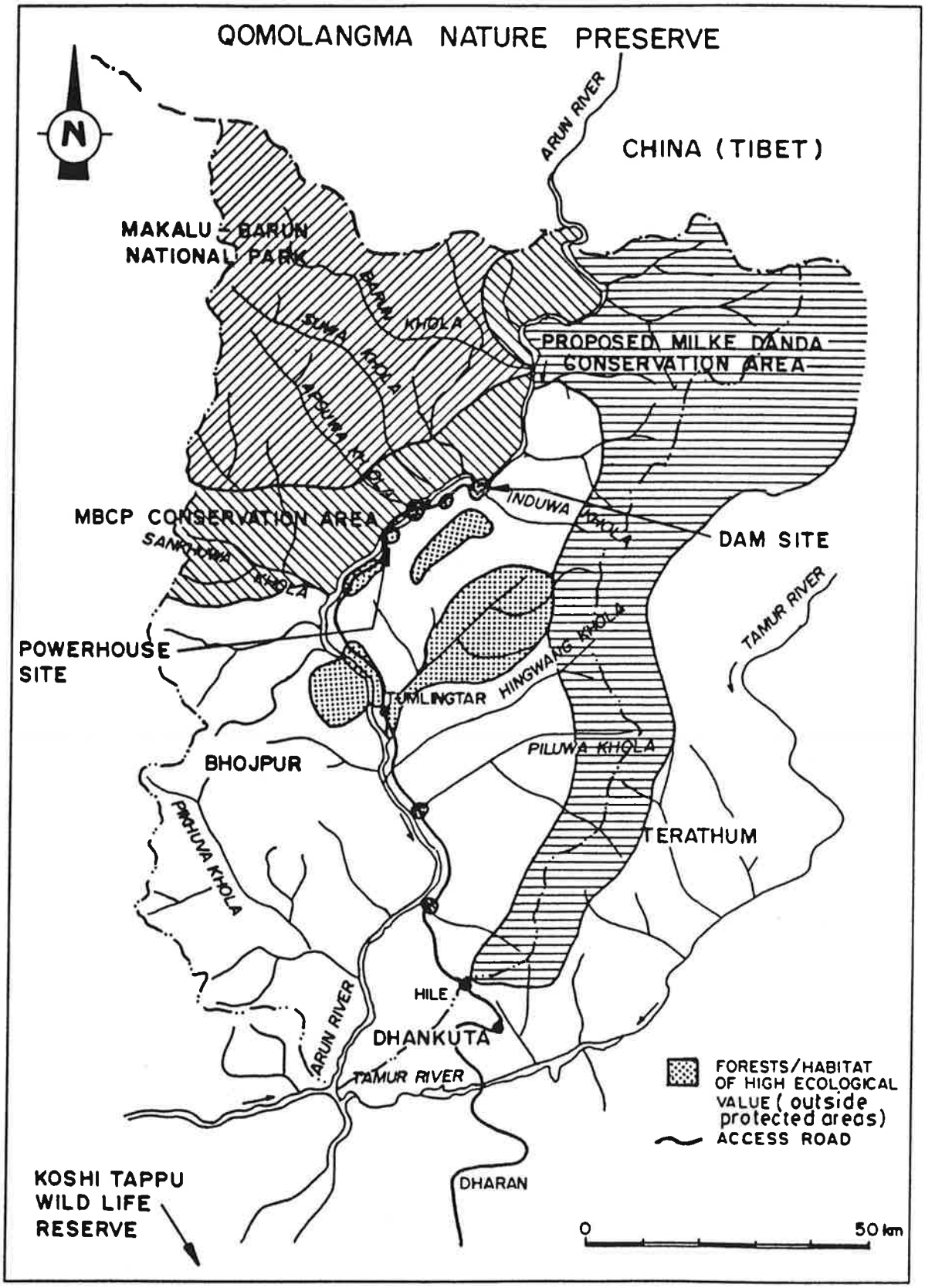
Scientific Name	CITES	HMG/N	MBEIS
Alstonia scholaris	(II)	+	+
Arundina graminifolia			+
Cyathea spinulosa	(II)	+	+
Cycas pectinata	(II)	+	+
Choreospondias axillaris		+	
Dendrobium densiflorum	(II)		
Lycopodium clavatum		+	+
Michelia champaca		+	
Musa sp.			+
Rhododendron arboreum		+	
Shorea robusta		+	
Terminalia belerica		+	
Terminalia chebula		+	
Pandanus nepalensis			+
Total 14	4	10	7

Note: CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora (to which Nepal became a State Party in 1975).
II Appendix II: Species potentially threatened. Nepal has proposed several plants for CITES listing (shown above in parentheses)
HMG/N: Listed in Master Plan for the Forestry Sector (HMG/ADB/FINNIDA 1988)
MBEIS: Considered to be endangered in Nepal by scientific consensus and listed in the Management of Basinwide Environmental Impacts Study

Table 4.2 ENDANGERED, THREATENED AND RARE MAMMALS AND REPTILES KNOWN OR SUSPECTED TO OCCUR IN THE IMMEDIATE VICINITY OF THE ACCESS ROAD

Common Name	Scientific Name	CITES	HMG/N
Mammals			
Asiatic Black Bear	*Selenarctos thibetanus*	I	
Leopard	*Panthera pardus*	I	+
Clouded Leopard	*Neofelis nebulosa*	I	+
Leopard Cat	*Felis bengalensis horsfeldi*	I	+
Asiatic Golden Cat	*Felis temminckl*	I	
Jungle Cat	*Felis chaur*	II	
Otters	*All Lutrinae*	II	
Spotted Linsang	*Prionodon pardicolor*	I	+
Assamese Macaque	*Macaca assamensis*	I	+
Rhesus Macaque	*Macaca mulatta*	II	+
Common Langur	*Presbytis entillus*	I	
Pangolin or Scaly Ant-Eater	*Manis spp*	II	+
Mainland Serow	*Capricornis sumatraensis*	I	+
Goral	*Nemorhaedus goral*	I	
Reptiles			
Python	*Python molurus*	I	+
Indian Monitor	*Varanus bengalensis*	I	

Note: CITES status categories are:
I Appendix I: Species threatened with extinction
II Appendix II: Species not yet threatened with extinction, but which could become so if trade (or other impacts) is not controlled
HMG/N: protected in Nepal under Schedule 1 (Section 10) of the National Parks and Wildlife Conservation Act 2029



Map 4 Ecologically Sensitive and Protected Areas

Birds There are 124 bird species whose breeding distributions are restricted to an area encompassing the Himalaya, north-east India, northern south-east Asia and south-west China, for which Nepal may hold internationally significant populations. A total of 82 of these species have been recorded in the Arun Valley (excluding the Barun valley). The riverine forest bird community is distinct, with 28 species associated only with this forest type. Reconnaissance ecological surveys of the hill sal forests in the lower Sabhaya Khola valley near Tumlingtar have confirmed the presence of 17 species of bird for which Nepal may hold internationally significant breeding populations, and three rare species of Flycatcher.

Four species recorded in the Arun Valley (excluding Barun) have been identified as globally threatened: the Cinereous Vulture, the Lesser Kestrel, the Wood Snipe, and Blyth's Kingfisher.

In addition to resident birds, Nepal is the temporary host to very large numbers of migratory birds. The Nepal Himalaya are pierced by several very deep valleys such as the Arun, and these act as flyways for migratory birds travelling between the Indian sub-continent and the rest of Asia to the north.

Butterflies and Moths The area between Num and Hedangna (the Intake site), is a centre of diversity for *Lepidoptera* (butterflies and moths). More than 20 species of those present are endemic or rare.

Fisheries The Arun is the largest river in the Koshi river system, which is thought to contain 108 species of fish. Of these, 13 species may be endemic. A field study at six sites along the Arun in the project area in 1989 indicated the presence of 17 fish species, in particular the rare migratory Copper Mahseer (Nep. *Katle*: endangered throughout its range in the Himalaya due to dam-building) and resident Mountain Snow Trout (Nep. *Chuche Asala*). Reconnaissance fisheries surveys for the Upper Arun Hydroelectric Project upstream found 25 fish species.

The fish fauna of the river system forms the basis of a complex food chain, involving mammalian predators (including threatened species such as otters), and avian predators (including rare kingfishers). It also supports fisherfolk. Local fishing techniques include cast nets (some now with nylon thread), spears, fishing rods with looped snares, bamboo diversions, herbal toxins, and recently, insecticides and explosives.

Crop Diversity In the project area crop diversity is very high. For example, 59 cultivated varieties of rice have been identified so far. The introduction and use of "improved" varieties has been limited, so that the area remains rich in crop genetic resources.

Ethnobotany Limited data on ethnobotany is available for the Arun Valley. However, of the 630 plants of medicinal value so far recorded in Nepal, 512 have been reported from the east of the country. Field surveys have identified 87 species of medicinal plants in the Arun basin. Of these, about 30 occur at less than 1000 m.a.s.l.

In the Arun Valley, plants and plant products have innumerable uses. In addition to medicinal use, some plants have religious significance and importance for ritual purposes. Despite difficult access, the valley is a major exporter of herbs to the lowland market. The main exported herb is *chiraito* (*Swertia hirayita*). Reportedly, 129.5 tonnes of medicinal plants were exported from the Khandbari area in 1990. The sustainability of existing rates of harvest is questionable.

4.2 SOCIO-ECONOMIC ENVIRONMENT

4.2.1 The People

The Arun Valley is home to some 450,000 people from a great variety of ethnic and cultural backgrounds, with different traditions and expectations and different historical roles in the society and economy of the valley. Project facilities will be located in three districts, Dhankuta, Bhojpur and Sankhuwasabha.

(i) Population

The most recent study of population dynamics in the basin gives an annual population growth rate of 1.62 %, less than the national average of over 2%. The population of Sankhuwasabha District grew by only 0.84 %. The natural growth rate is offset by outmigration of people in search of better economic opportunities than are currently to be found in the Arun Valley. Household size averages 5.4 persons. Almost all settlement is rural - the few towns all have populations of less than 15,000.

The population of Sankhuwasabha District (3840 km^2), which includes much of the area to be directly affected by the Project, is estimated at some 160,000. This gives an overall population density of 42 persons per km^2. This average conceals great disparities since most of the settlements and arable land are concentrated on the ridges and terraces, while most of the rest of the terrain is unsuitable for cultivation or habitation. In 1981 the total population was 129,414. The general pattern is one of increasing population density from north to south, from only eight persons per km^2 in the northern part of the valley to more than 100 persons per km^2 in the south, and with concentrations in the vicinity of Hile and Basantapur, Chainpur and Tumlingtar-Khandbari. The access road traverses land which over most its length is relatively lightly settled and farmed due to its low and previously malarial elevation and to steep terrain.

(ii) Ethnicity

The access road passes through land occupied by some ten different ethnic groups (Table 4.3). The indigenous people are Kirantis. They are represented by two main ethnic groups, Rais (generally found west of the river) and Limbus (generally to the east of the river). In addition, there are other groups who have Tibetan characteristics in their socio-cultural pattern, i.e. Bhotea, who are concentrated in the upper part of the basin, and Gurungs, who resemble the Kirantis in many respects but migrated from mid-Western Nepal. In 1981 40 % of the population of Sankhuwasabha District claimed a non-Nepali mother tongue. 14 separate Rai languages identified in 1880 were still spoken in 1979.

The lower Arun has faced a rapid change of its population composition since Brahmin-Chetri (organised along hierarchical caste lines), Newar, Gurung and occupational castes began to migrate into the area in the late 18th century. While castes from the Hindu society have integrated themselves with the indigenous agriculture orientated society, Newars mainly settled in towns as business and craftsmen. Brahmin-Chhetri penetration of the hills appears to stop at Hedangna (immediately north of the dam site), which is also the northernmost limit for rice cultivation.

Table 4.3 ESTIMATED ETHNICITY IN THE ARUN BASIN (%)	
Rai, Limbu, Gurung, Magar	53
Brahmin, Chhetri	27
Occupational castes	7
Tamang, Sherpa, Tibetan	7
Newar	5
Other	1

Plate 5 Rai Girl
Photo: Rohit Nepali

(iii) Disadvantaged Groups

The largest group to be disadvantaged is women. As elsewhere in Asia, this is a major socio-cultural and developmental issue. Groups particularly disadvantaged by ethnicity and caste include the Kumhals of Tumlingtar and occupational castes, the Kamis of Diding, and a high proportion of Rais throughout the valley. The Kumhals are at the bottom of the economic ladder, and are known to be heavily exploited and massively disadvantaged. They have already lost land at Tumlingtar for the airstrip and the permanent road camp. They will lose more, both to project facilities and to speculators (see Chapters 5, 7).

(iv) Land Tenure

In the Arun Basin, to those who live on it land is much more than simply an economic asset. It provides its occupants with a social and a spiritual home as well as a place to raise crops and animals. The importance of this relationship tends to be greatest among poor and disadvantaged groups. Wealthier and more educated people trade in land as a commodity, and are able to follow economic opportunities wherever they arise. This has important implications for the payment of compensation for land.

Traditionally, the land use and land tenure system especially among Rais and Limbus was based on a communal tenure system known as '*Kipat*'. Members from outside the community had no access to land, while individuals or families belonging to the community had unchallenged rights to use their land, including forests. Shifting cultivation (Nep: *khorea*; Bhote: *so-le*) became deeply rooted in the agricultural system. Primarily this involves poorer families, and for these it is vital as a survival mechanism. Areas for shifting cultivation tend to be named and discrete. Forest conversion for cultivation is a separate, albeit related, process.

When the Government encouraged the migration of high-caste Hindus to the area, th traditional *kipat* land use system became weakened. It was formally abolished by the Land Act of 1964, when *kipat* land became legally convertible to *raikar*. Nevertheless, it is probable that communities still practise their traditional system in areas where no cadastral survey has been undertaken yet.

Land under cultivation along the access road is held under *raikar*, the only legalised form of land tenure which allows cultivation, and which allows the holder buying and selling rights. There is a high level of hidden tenancy. A family's land holdings are often fragmented, though usually one plot is near the house. Average land holdings vary from 0.5 - 1.5 ha depending on the region. The average size of holdings affected by the access road's previous hill alignment was 1.3 ha, with considerable differences from area to area.

Cadastral Survey A cadastral survey, which registers individual title to land, is complete for Dhankuta District. In Sankhuwasabha District it is proceeding northwards, and by August 1992 had covered six Village Development Committees in the district.

(v) Cultural Heritage

The remoteness and difficulty of access of the Arun Valley has enabled the rich variety of local cultures to maintain many of their distinctive features. There are fine local traditions of metal and woodwork, pottery, and of using local plant fibres to weave fabrics.

A major cultural feature is the *Kiranti* cultural heritage of the Rais and Limbus, which is bound up with the natural world. This may be responsible in part for the better preservation of the forests of the Arun Basin when compared with areas further west, as may the related *kipat* land tenure and resource management system.

The access road passes close to a number of shrines, temples and sacred places, which are common to all the region's various ethnic groups. The most important is Manakamana Mai, on the left bank of the Arun immediately north of Tumlingtar. Phyaksinda Dobhan, the Intake site (the confluence of the Arun, Khoktak and Num rivers) is the site of an annual *Mela* (local religious gathering). Every year during the winter month of Magh (Jan-Feb), local people and others from surrounding districts gather here to worship and participate in the Mela, which is a continuation of the larger annual Barun Mela held upstream at the Barun/Arun confluence.

4.2.2 The Economy

Most of the Valley's inhabitants live in poverty in a rigorous subsistence lifestyle that has changed little over hundreds of years. Some two thirds of the population are functionally illiterate. A main determinant and limitation affecting the economy and lifestyle is that at present virtually all movement of people and goods within the valley is on foot. There are no roads north of Basantapur (Map 2), and some settlements are 10 day's walk from the nearest roadhead. Thousands of men (and some women and children) earn a living as porters, transporting goods to and from the remote settlements, carrying loads of up to 100 kg for several days. Apart from the extreme physical demands, the practical limitations, time and costs of porter transport mean that it is difficult for the people of the valley to communicate with and trade with the outside world. Consequently, the economy and lifestyle have to be largely self-contained and self-sufficient.

The main economic activity in the Arun Valley is subsistence agriculture, in which the central feature is dependency on forests as a source of nutrients and biomass for maintaining cropland fertility. Livestock are essential to the system, principally for processing plants into fertiliser, for dairy and other products, and for ploughing. In the southern part of the project area major crops are irrigated rice (below 1700 m), and maize and millet on rainfed terraces. Wheat is grown in winter as a second crop. A few cash crops are of local importance, such as citrus and cardamom. In the higher, cooler, north only 2.8 % of the land is cultivated. The main crops here are barley, buckwheat and potatoes.

Although classified by HMG/N as a food grain surplus area, large parts of Sankhuwasabha District are in food deficit. Most households depend on other sources of income besides farming. Portering, collecting medicinal herbs and other forest products, labour on daily wages, and temporary migration to work in the Terai and India are the main sources of cash income.

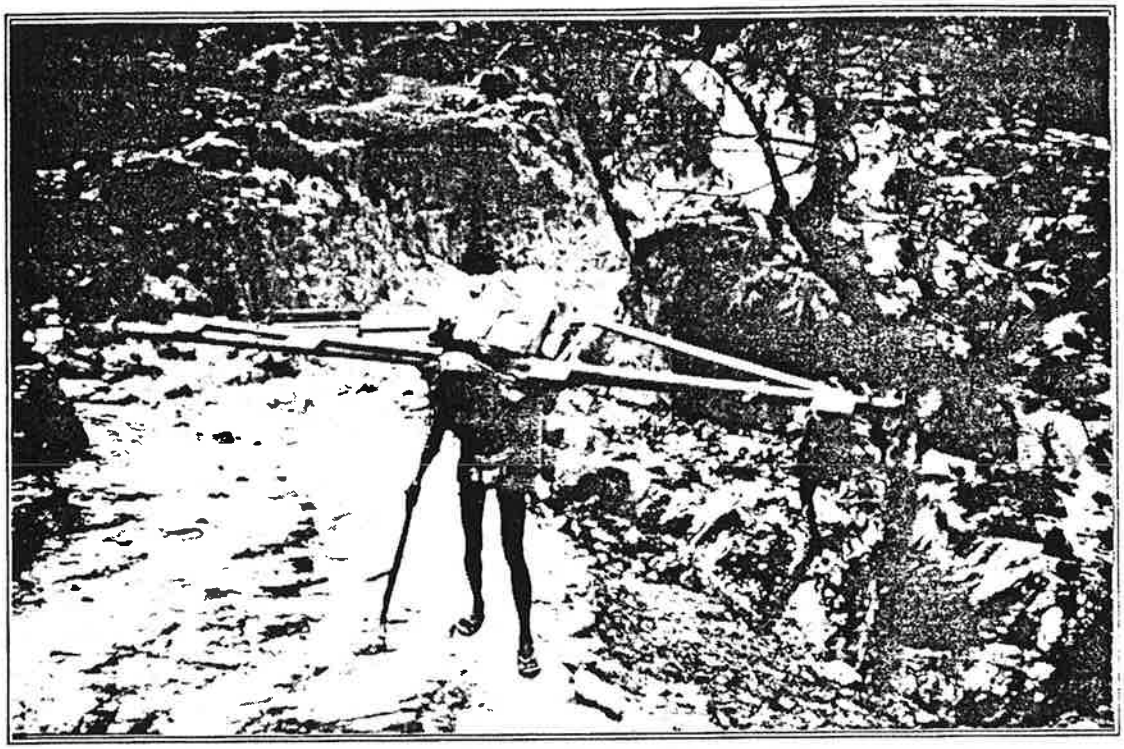


Plate 6 Porter carrying building materials from Hile to Khandbari
Photo: Keith Garratt

Of significance is the interlocking economic and agricultural system of the middle and upper Arun basin. The Kar Bhote peoples north of Hedangna (at the Arun III intake site) depend on a complex set of interlocking economic relationships between different communities which serves to keep the villages of the north Arun viable. These include in particular annual migration of Kar Bhotes to lower elevations in the winter to trade, labour, and generally subsist, and a high level of persistently unequal dependency on middle Arun Gurungs for money supply through loans, tied in with the Gurung utilisation of upper Arun Bhote pastures for sheep.

All sources of information on income data in the Project area show the prevalence of great poverty, with many households in no position to take advantage of the opportunities offered by the Project due to lack of resources and skills for investment, dependency and debt, and illiteracy. Indicators of poverty found by the Basinwide Impacts Study team during their household survey were:

- up to one third of families surveyed had mortgaged land to buy food in the past year (1989/90);
- 58 % of families suffered food deficits in the previous year.

Although agriculture provides over half the income of the population of the Project area, it still falls far short of the subsistence requirements of most farming families. The findings from surveys on average annual income in Sankhuwasabha District by the Basinwide Impacts Study (Table 4.4) are broadly similar to those of the land acquisition studies for the Hill access road, except that gross incomes in the latter averaged NRs 3000-4000. This may be due to a lower level of poverty among families on the ridges, where most economic activity is concentrated.

Table 4.4 AVERAGE ANNUAL FAMILY INCOME BY SOURCE (SANKHUWASABHA DISTRICT: 1990)

Source	NRs	Percent of Total Income
Crops	1507	55
Wages	356	13
Livestock	329	12
Manufacturing	247	9
Portering	192	7
Exports	110	4
Total	2740	100

4.2.3 Health

The food deficit means that some families are unable to meet their main nutritional requirements year-round (usually towards the end of the dry season, March/April/May). Malnutrition affects children in particular. Their lives are further threatened by the three commonest diseases: acute respiratory infection (ARI), measles and diarrhoea. Domestic living conditions plus the extremely variable climate ranging from very cold in the winter months to hot and wet in the summer provides ideal conditions for ARI to develop, and as a result it also the commonest health problem in the area.

Diarrhoeal diseases are second to ARI in frequency. This is due to people having to use springs and small streams to obtain their drinking water. These are often contaminated by open air defecation and lack of latrine facilities common throughout Nepal. Intestinal parasites such as round worm, hookworm, tapeworm, *Giardia*, and *Trichuris* are extremely common. Anaemia due to hookworm is a particular problem.

Having been largely eradicated from the Terai in the 1950's, malaria is a minor health problem in the project area. Below 1200 m.a.s.l. the Arun Valley is low enough for mosquitoes to breed. The main mosquito is *Anopheles fluviatilis* which favours rivulets and small streams shaded by vegetation, and can be a malaria vector. Health posts treat occasional malaria patients, with the assistance of the District Public Health Office, by collecting blood samples and getting them tested in the district hospital.

4.3 REGIONAL DEVELOPMENT

4.3.1 Local Government

The hydropower facilities will be located in Sankhuwasabha District; the access road begins in Dhankuta District, and, where it crosses the Arun north of the powerhouse, passes through Bhojpur District.

The most senior government official in each district is the Chief District Officer (CDO). The district-level activities of the line departments of central government ministries are coordinated by the Local Development Officer (LDO). Village level administration is carried out by elected Village Development Committees and Boards.

A variety of resource management groups and systems exist in the Valley, including informal Rai and Limbu groups operating the traditional *kipat* management of forests, other locally-initiated forest security committees, and government-established groups. The effectiveness and sustainability of these management mechanisms varies widely.

In 1991 the National Planning Commission re-instituted a Regional Planning Office (RPO) in Dhankuta, with UNDP assistance. This is likely to become a focus for regional planning activities.

4.3.2 Makalu-Barun Conservation Project

National and international recognition of the high heritage values of the eastern Himalayan region has resulted in the establishment of three large protected areas around Sagarmatha (Mt. Everest, Qomolangma). These are Sagarmatha National Park, the new Makalu-Barun National Park and Conservation Area, and Tibet's Qomolangma Nature Preserve.

The last two protected areas are the outcome of a successful programme mounted by an international NGO, the Woodlands Mountain Institute (WMI), to assist the governments of Nepal and the Tibet Autonomous Region in developing adjoining mountain protected areas, both of which combine conservation with community development. In Nepal, WMI is working with the Ministry of Forest and Soil Conservation's Department of National Parks and Wildlife Conservation under a 12-year cooperation agreement to build up the new park and conservation area. The project is funded by a consortium of international public and private sector donors, and is independent of the Arun 3 Project.

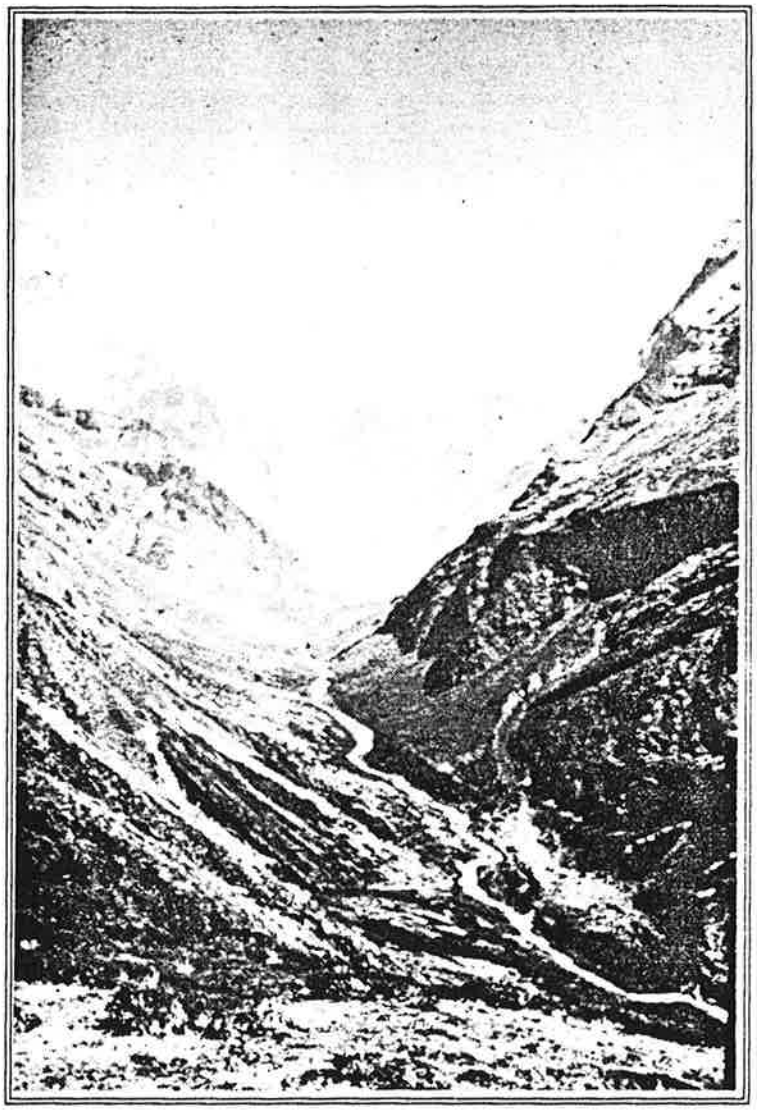


Plate 7 Hinku Valley, Makalu-Barun National Park
Photo: Ang Rita Sherpa

4.3.3 Koshi Hills Development Programme

For a number of years the U.K.'s Overseas Development Administration (ODA) has been sponsoring a rural development programme in Dhankuta and Sankhuwasabha Districts of eastern Nepal. The third phase of this programme ("K3") concentrates on forestry and horticulture. When this phase terminates in mid-1993, the forestry programme will be continued as a component of the larger Nepal/UK Community Forestry Project currently in preparation.

4.3.4 Other Projects and Programmes

Nepal's Agricultural Development Bank (ADB/N) has a Small Farmers' Development Programme which the MBEIS reports as being active and effective in Sankhuwasabha District, having worked with 178 local groups in the agricultural sector. Other projects include the Northern Belt Pasture Development Project and the Pakhribas Agricultural Centre, an agricultural research station near Hile which is supported by the ODA.

5 POTENTIAL ENVIRONMENTAL IMPACTS

5.1 INTRODUCTION

The impacts of major infrastructure projects can be divided into two principal categories. Firstly *direct* impacts, which result from the physical presence of the facilities and the way they are designed, built and operated. Secondly, *indirect* impacts. Indirect impacts stem from the economic activities surrounding construction and the *induced economic effects* resulting from improved access. These impacts occur in two main phases - during *construction*, and during *operation*.

In this chapter, potential impacts identified by the Project's internal environmental assessment exercises and by the KMTNC Management of Basinwide Environmental Impacts Study, are divided into those occurring during the construction phase and the operational phase, and are discussed for each of the major project elements in turn: the access road, the hydropower components, and the transmission line system. A final section discusses *cumulative impacts*.

This summary does not consider the environmental effects of increased electricity availability nationally. The *area of influence* of the project is taken to be the whole Arun Basin within Nepal. In judging significance, relevant factors are the intensity, duration, scale, and reversibility of the impact in question.

Impact matrices are attached at Appendix 5.

5.2 ARUN ACCESS ROAD

5.2.1 Potential Road Impacts: Summary

The Arun III Project will have far-reaching social and environmental consequences. Most of these will result from the road rather than from the power project.

During road construction (1994-1997), there will be large concentrations of workers (max. 9500 plus some dependants) both at the Contractor's camps and at the remote workfronts, plus incomers attracted by economic opportunities. Together, these will create a massive increase in demand for food and fuel along the alignment, with consequent impacts on prices and forests. There will also be some social disruption and pressure on health facilities.

When the road is opened to the public in 1997 there will be rapid short term and far-reaching long term economic adjustments and opportunities. Studies of new roads elsewhere in Nepal show that while roads are a prerequisite for rapid economic development, they are not sufficient to cause development by themselves. There has to be some other major economic impetus to allow roads to liberate the economic potential of an area. Where this is not present a new road does little for the economic welfare of the people in its vicinity, and it may bring disruption to local communities and severe damage to forests and other natural resources due to easier access from outside.

Tables 5.1 and 5.2 overleaf summarise the most significant potential construction period and operational period impacts.

Table 5.1 ACCESS ROAD: MOST SIGNIFICANT POTENTIAL CONSTRUCTION PERIOD IMPACTS	
Positive	Negative (assuming no mitigation)
Local employment opportunities and resulting temporary increase in per capita incomes. Increased market for local produce.	Clearance of forest along RoW and degradation of forest in the vicinity, resulting in habitat loss for endangered species of wildlife. Pressure on fisheries. Permanent take of agricultural land: loss of food production and effects on marginal households. Temporary land take and disruption of agricultural activities: effects on marginal households. Marginalisation of some project-affected families and some women, despite compensation procedures. Increased local food deficit. Food price inflation: effects on marginal households, especially nutritional status of some women and children. Development of shanty towns. Exacerbation of poor health situation and stress on health facilities. Impact of labour force on local social systems and culture. Major stresses on all local institutions (in particular local government, schools, and resource management groups).

Table 5.2 ACCESS ROAD: MOST SIGNIFICANT POTENTIAL IMPACTS WHEN OPEN	
Positive	Negative Impacts, and Existing Negative Trends Likely to be Accelerated if no Mitigation
Greatly reduced cost of imported food and manufactured commodities. Greatly reduced transport cost for regional exports. Possibility of expansion of feeder road system. Rapid growth of new economic centres along the road. Increased incomes from livestock. Increased tourism (and tourism related impacts). Possible return of educated, successful migrants. Enhanced commercial opportunities for women of some ethnic groups , esp. Kar Bhote, Gurung, Kiranti. Increased access to outside for migratory labour, e.g. of Kar Bhote.	Increased rate of population growth due to reduced outmigration and improved health, and consequent demand on resources. Major reductions in sale prices of locally - produced grain crops. worsened food balance. Major reduction in long-haul portering opportunities. Increased harvesting of forest products to pay for required food and other goods, and forest clearance for cardamom production, with consequent forest degradation and habitat loss. No reduction in ongoing processes of impoverishment and marginalisation. Increased slash and burn of high biodiversity forests due to increasing poverty and marginalisation. Loss of some riverine habitat essential for endangered species. Loss of forest habitat of other endangered species, and direct threats due to hunting. Increased disparities in wealth and access to services. Accelerated erosion of traditional values and culture. Further development of shanty towns.

5.2.2 Access Road: Potential Impacts during Construction Phase

This section notes potential direct and indirect impacts of the road construction phase (40 months) on the physical, biological, socio-economic and cultural environments.

5.2.2.1 Impacts of Road Construction on the Physical Environment

(i) Air Quality

The only significant air quality consideration is potential impacts on human comfort and health. Quarry operations and blasting will be localised, with limited, local impacts. However, in Nepal many disease agents around settlements are carried on dust particles. Traffic-generated dust along the road will be an appreciable nuisance and possible health hazard in existing and new settlements, particularly Tumlingtar, for the short period before the new road is sealed.

(ii) Water Quality

Chemical Pollution Limited water pollution could occur due to tanker accidents, accidental spills, or improper disposal. Materials involved would be kerosene, diesel, lubricating and shuttering oils, and possibly petrol (gasoline) and liquid explosives. Overall, chemical pollution is not considered a significant threat to water quality.

Sediment Pollution Sediment pollution arising from construction activities is inevitable. However, any impacts are likely to be limited in scale and duration, and so are considered of low significance. More important is the possible contamination of irrigation water with sediment, and the bacteriological contamination of drinking water supplies (springs, streams and piped systems). Any impacts would be localised and are amenable to mitigation, so this potential impact is not regarded as significant.

(iii) Slopes and Soils

Slope Failure Deep slope failures may be triggered by road construction. The road crosses a number of areas of known instability south of Tumlingtar, and north of Bumling it enters the steep and geomorphologically active gorge area. Here there is a higher risk of large scale slope failure. The road has been designed to cope with these risks. Nevertheless, significant impacts may still occur, particularly for the section of road north of Bumling. Despite the care taken in route selection, road design, and construction methods, it is probable that the access road will be subject to slope failures or other damaging geomorphic events during the HEP construction period over a minimum distance of 2.3 km. These will result in temporary loss of access until cleared.

Spoil Disposal Along the access road, the proximity of the river will give numerous sites where controlled spoil disposal can take place. Between Adit No. 2 and the Intake site strict controls on spoil disposal will be enforced. Without such control spoil disposal could have significant local impacts.

Surface Erosion Sheetwash, rilling, gullying and shallow slope failure are universal problems along roads built in Nepal's hills. Particular difficulties are likely to be experienced in the Arun Valley between Mangma and Tumlingtar (35 km) in areas of erosive red soils. High temperatures, southern exposures, low rainfall and low fertility sites will make establishment of the necessary vegetative slope protection on cut and fill slopes a challenge. Localised slope failures will be experienced until successful bioengineering techniques are developed.

In addition to potential damage to the road, the significance of surface erosion lies in the downstream effects of the eroded sediments on (i) small local irrigation systems; (ii) springs and seeps required for local water supplies; (iii) damage to cultivated areas. Generally these features do not coincide with the most erosion prone areas along the valley bottom, so the overall significance of this impact is regarded as low.

Lack of attention to slope stabilisation causes sediment blockage of drains. Blocked drains and culverts frequently result in washouts and loss of the roadbed. This is a major, significant problem for road maintenance everywhere in Nepal's hills and mountains.

5.2.2.2 Impacts of Road Construction on the Biological Environment

(i) Vegetation

Direct Impacts The direct impacts of road construction on vegetation will include loss of individual plants throughout the Right of Way (RoW) due to the permanent works, and other temporary losses due to land take for ancillary features - quarries and camps. The road will traverse forested areas for about one quarter of its length (approx. 33 km out of 122 km: Table 5.3). The total forest area falling within the 30 m right-of-way is estimated at 106 ha, but vegetation clearance within the RoW will be strictly limited to the area of the Permanent Works.

Areas of vegetation of ecological interest to be directly affected by the access road include, from south to north, Guransedanda ("rhododendron hill"), Salleri, Piluwa river, Sabhaya river, Satighat, Kartikebhir, Simle, Tumbetar, the powerhouse site, the site of Adit No. 2, the permanent NEA camp site, and the descent to the intake site. Most of these areas show high species diversity, presence of rare, endemic and endangered species (e.g. *Pandanus nepalensis*, *Cyathea spinulosa*), orchids, and floristic elements representative of tropical evergreen forest. The best forests in these localities are relatively dense, and are found along river gullies, gorges and rocky cliffs with slopes of 40° or more. North of Tumlingtar there will be direct impacts on the nationally scarce riverine forest, as well as on subtropical forests near the site of Adit No. 2.

Direct impacts on wild vegetation *per se* are considered to be of moderate significance locally, but of little significance in a regional context. However, considered as loss of habitat for vertebrates, the impact could be significant (see (ii) below).

Indirect Impacts Indirect impacts on vegetation during the construction phase will include demands for forest products for the labour force, their dependants, and incomers, plus additional demand created by available cash, and accidental fire. These impacts will be concentrated around (i) Hile; (ii) Tumlingtar; (iii) Heluwabesi; (iv) Pukhuwa (the powerhouse site); (v) Adit No. 2 site below Sholakhani; (vi) Amrang (the permanent camp site); (vii) Phyaksinda (the intake site). Air operations out of Tumbetar, north of Heluwabesi, could also attract a labour force which would affect the nearby forest areas (Plate 8). Except for Hile, there are areas of high botanical value in the vicinity of all these sites.

Potential indirect impacts on forest resources during the construction phase are considered to be highly significant locally.

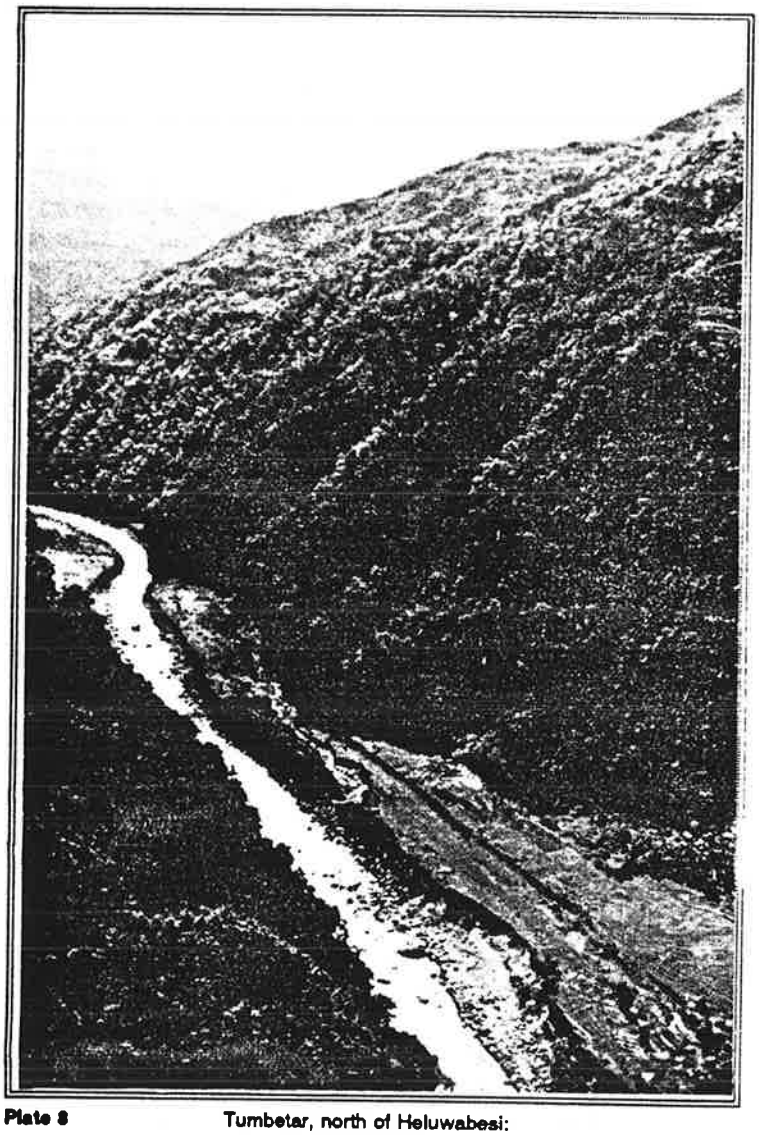


Plate 8 Tumbetar, north of Heluwabesi: possible site for Contractor's facilities
Photo: James Ramsay

(ii) Wildlife

Mammals and Reptiles The road will run close to the Arun River for some 67 km. Construction of the road will have direct impacts on mammalian and reptilian riverine wildlife due to habitat destruction, severance of territory, disturbance (including by helicopter operations over at least 25 months), and increased access for hunting. Quantitative data on wildlife population sizes are not available. The nationally and internationally threatened status of many of the species involved suggest that these losses could be significant nationally.

Birds Habitat loss and ground and air disturbance will also affect birds, particularly territorial breeding birds. In addition, the Arun Valley appears to be a flyway for many autumn and spring migrants, but data are limited. Some of the species involved are endangered and rare. The lower Arun river appears to serve as a resting place for migratory birds during winter and spring. There may be impacts on migratory bird species due to loss of habitat and disturbance. From south to north, sensitive bird habitat areas that could be affected are:

- open mixed forest at Diyale and tropical riverine forest at the Leguwa Khola;
- hill sal forest on the left bank of the Arun river south of Tumlingtar (Sabhaya Khola, Gandhepani, Khahare and Damar);
- evergreen riverine forest and hill sal forest on the left bank of the Arun from Satighat northwards (Jholunge, Betyani, Kartikebhir, Thulo Andhere and Khyutar);
- tropical deciduous riverine forests of Tumbetar, south and north of Tumbetar, Pukhuwa (the powerhouse site) and the area immediately to the north;
- tropical evergreen forest at Phyaksinda, the Intake site.

Impacts on birds and bird habitat during the road construction phase are regarded as being potentially locally significant, and potentially nationally significant for some species.

(iii) Fisheries

During construction, the road will have minimal direct impacts on aquatic biology. However, indirect impacts could be significant locally due to a greatly increased market for fish. Fishing intensity will increase to meet the demands of the labour force and incomers. Detrimental fishing technologies may be used, specifically the ecologically damaging ones of explosives and insecticides.

The ability of the river to sustain higher rates of fish offtake is not known. Reduced fish populations and disturbance associated with fishing could affect shy fish-dependent species such as otters and some predatory birds (raptors). There will also be economic consequences for fisherfolk. Impacts will vary according to the level and sustainability of the catch.

5.2.2.3 Impacts of Road Construction on the Socio-Economic Environment

(i) Land Take

Estimated land take for the road is given in Table 5.3 below. The total permanent land take for the 30 m Right of Way will be approximately 375 ha (plus 19 ha for temporary uses). There will be direct effects on some 1146 households. Of these, approximately 100 stand to lose buildings, either their houses, cattlesheds, or both. Surveys indicate that some 4550 timber trees, 2900 fodder trees, and 500 fruit trees are likely to fall within the RoW when it is pegged out. In regional terms the loss of less than 400 ha of land, of which some 169 ha is cultivated, is of only moderate significance. However, for marginal families including formal and informal tenants, loss of land can be disastrous, triggering a downward spiral into absolute poverty.

Further loss of productive land will be caused by severance and fragmentation, particularly around hairpin stacks such as at Sholakhani (Adit No. 2). Off-site damages may also occur - land and crop damage due to rolling debris, erosion and sedimentation. This impact could be significant locally.

Land will be needed temporarily for pilot tracks, camps, quarries, storage and handling yards, and helipads. These impacts will be particularly significant at Tumlingtar, where the cumulative effect of temporary and permanent land requirements for the road and power components (road reserve 22.5 ha; permanent road camp 3.1 ha; temporary project facilities estimated at 6.9 ha) will take up an appreciable proportion of the agricultural land on the plateau (12 %), without allowing for associated urbanisation.

Table 5.3 LAND USE BY ARUN ACCESS ROAD

Land Use/Vegetation Type	Land Take (ha)	Distance (km)*	Percent
1. Forest	106	33	27
2. Shrub and Grazing	119	37	30
3. Cultivated			
a) Level Terrace	106	33	27
b) Sloping Terrace	63	20	16
Total	394	122	100

* Figures rounded

(ii) Employment and Income

Labour Availability Surveys indicate a high level of labour under-utilisation in the area, of the order of 50 %. Consequently, there should be no knock-on effect on agricultural production. However, women's household workloads may increase further if men are absent on construction jobs.

Employment Income The road contractor will employ on average an estimated labour force of 6720, rising by 50 % during peak dry season periods, falling by 50 % during the monsoon, and spread over some 7 workfronts simultaneously. Assuming a 75/25 % split in labour force employment between local and outside labour, road construction will have a significant impact on average per capita income in Sankhuwasabha District. It is estimated that this will rise by up to 15 % over the 40 month road construction period (1994-1997) due to road-related employment. Some $ 4 to 5 million in wages will enter the Valley's economy each year during this period soley from road construction, a massive figure. Increased incomes will result in increased imports to the area, and consequent increases in employment for porters (until the road opens).

The value of the employment income to the local population will be dependent on hiring practice and construction technology. Assuming a high level of local recruitment for a labour-intensive construction effort, the impact of road construction employment on local cash availability will be highly significant.

(iii) Food Availability, Prices and Nutrition

The hills are a food-deficit area. Currently many farm households in Sankhuwasabha District are not self-sufficient in food production and depend on additional sources of income to purchase food. Virtually all imported food is brought into the district by porters. This will continue until the new road is completed.

An increased per capita income plus an influx of migrant labour plus incomers to supply services will make the food balance situation worse. Modelling indicates an annual food deficit increase for the period of construction from 1.51 kg to 19.35 kg per capita in the project impact zone. Some porters are expected to take up paid jobs on the project, so that the number of available local porters will be reduced while the demand for their services will increase. This is likely to be reflected in increased portering charges, higher food prices, and possibly temporary food shortages. Poor families could face reduced food availability. The nutritional standards of those not able to access the construction-related cash stream are likely to fall further.

For those affected, these impacts could be significant. Surveys for the Basinwide Impacts Study indicate that one third of families in the area have already mortgaged some of their land to buy food.

(iv) Settlements

The impacts of road construction will be felt most immediately in existing settlements along the alignment. Already, land speculation has accelerated greatly and new construction projects have increased. With initiation of the construction programme, the populations of the major roadhead villages and the power facility construction centres will swell with the influx of contractor, engineer and worker populations, their dependants, and incomers.

The most dramatic effects will be at Tumlingtar (Plate 9), which will become a boom town. Other growth points will be Hile, the powerhouse site, and the Num/Phyaksinda/Hedangna area around the dam. These impacts will be highly significant locally.

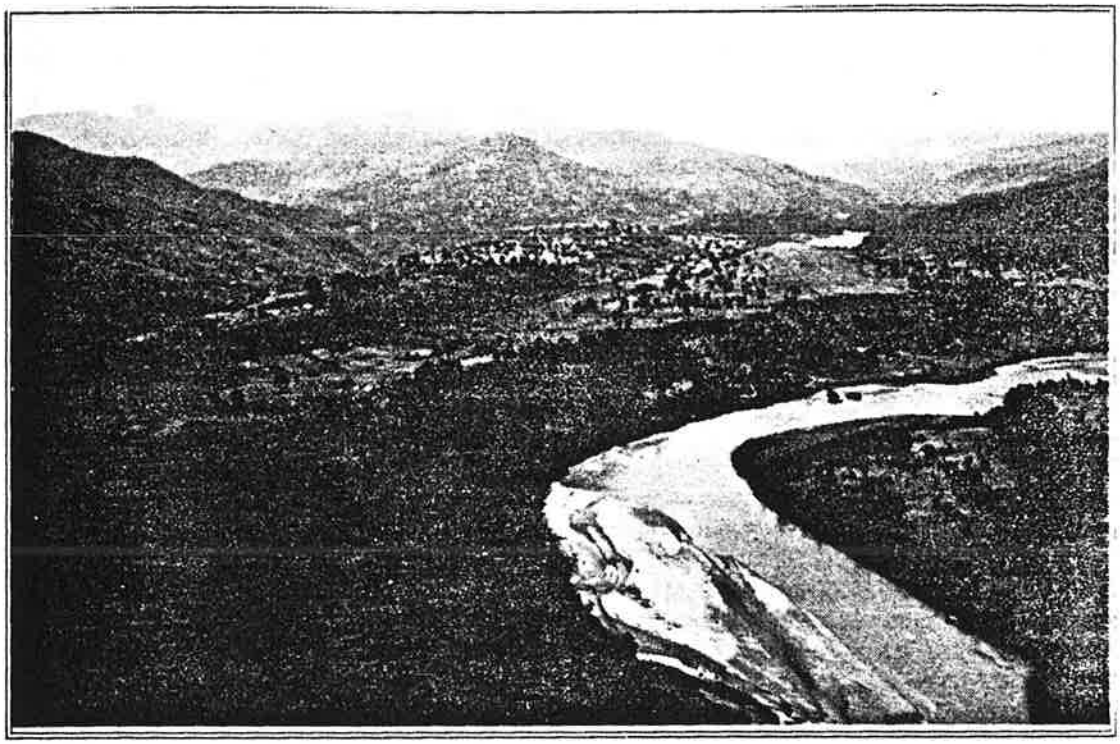


Plate 9 Tumlingtar from the North
Photo: James Ramsay

(v) Health

The concentration of workers and incomers and their dependants will create a greater demand for health care. Existing health facilities have never been sufficient in the area.

The concentration of a labour force of some thousands will encourage prostitution, which will assist the spread of Acquired Immune Deficiency Syndrome (AIDS) and other sexually-transmitted diseases. Particular risk groups are long-distance truck drivers, who are often responsible for disease transmission, and returning Nepali prostitutes from outside the country.

Another health related problem is likely to be malaria, which is prevalent in the Terai despite eradication campaigns. Infected incoming workers could transmit the disease to the vector mosquitoes in the Arun Valley, which could then affect the labour force and local residents. However, although the impact of malaria on individuals is high, the disease is normally treatable and vector control measures are feasible.

The incidence of waterborne diseases and acute respiratory infections is already very high. However, schistosomiasis will not be a problem since it does not occur within Nepal, due to the absence of appropriate conditions. Other diseases likely to be increased are alcoholism, and possibly tuberculosis.

Together with the stress on health facilities, these impacts are considered to be potentially highly significant locally.

(vi) Institutions and Services

Water Supplies An adequate water supply is rare in most areas of the hills. The concentration of road labour will add further pressure to local water systems, particularly in Hile and Tumlingtar. The effects will be felt mostly by women and children, who are normally responsible for supplying families with water. Frequently water sources are polluted, with the result that diarrhoea and other waterborne diseases are common. Pressure on water supply systems will increase the risk of spreading these diseases. These impacts are considered to be of moderate, local significance.

Education Road construction is likely to increase demand for education in the Project area. The main impetus will be provided by increases in the income of families with members employed in construction or ancillary services. To the extent that the contractor's workforce is drawn from local communities, additional demand for school places exerted by incoming workers and their families will be avoided. This impact will be temporary and of relatively low significance.

Government Services The sudden and intensive construction effort and rapid pace of change will place exceptional demands on government services at all levels in the Valley. This will be a highly significant impact locally.

(vii) Women

Some women will benefit from economic opportunities arising from road construction, through both direct labour and the provision of services and commodities to the work force. Women of some ethnic groups are quite independent - Kiranti, Gurung, Kar Bhote, Bhote, Newar - and are likely to take up opportunities offered, especially if assisted by appropriate programmes. Others, particularly from poorer families, will be adversely affected. Numbers on both categories are hard to estimate.

There will be three principal negative impacts on women. Firstly, road construction employment opportunities will be granted mainly to men. They will gain access to the cash economy, and since in most farm families it is the men who control the money while women look after the family and the food, women will tend to remain in the subsistence sector. This is an equity issue. Secondly, male labour absent or occupied on road construction may increase the already high workload of the women and children left at home, particularly on agricultural duties. Thirdly, when compensation is paid for land it is the head of household - the man if there is one - who gets the money. Money paid to the male household heads may be used to pay off loans, purchase consumer goods, or hold expensive rituals such as weddings, rather than for the purchase of replacement land. Women, especially in poorer households, would then be left trying to feed their families on less land.

For the families and individuals affected, these could be significant impacts.

(viii) Vulnerable Groups

In the Valley, some groups of formerly untouchable occupational castes - Kami, Dhamai, Sarki, the Kumhals of Tumlingtar - are characterised by chronic poverty. Their survival depends as much on a set of close social and economic ties with their neighbours and kin, as on individual fluctuations in fortune. If such a group is dispersed through dispossession of its lands, its members become extremely vulnerable. Since they are unused to handling any but the smallest amounts of money, cash compensation seldom enables members of these groups to rehabilitate themselves.

The number of "Seriously Project Affected Families" (see Section 7.3) identified by land acquisition surveys is 132, out of 1146 estimated to be affected by road-related land take.

(ix) Social Fabric and Security

Community Relations Although most areas affected by the road are ethnically diverse, many groups have formed a set of relatively stable relationships. These are normally based on a combination of kinship, residential proximity, economic cooperation and mutuality, and are essential to the subsistence of many households, especially poorer ones. These social relationships and patterns will be disturbed by the influx of the large number of labourers and job seekers expected during road construction.

The intensity and significance of these impacts will be directly proportional to the percentage of labour hired non-locally. Construction of the labour-intensive Dhankuta-Hile road was possible without disruption of existing seasonal agricultural labour inputs since almost all labour was recruited locally and many workers were able to travel home at night. This scenario is likely to be repeated on the southern half of the larger access road project, but will not be possible for the northern sector (north of Bumling) due to low local population densities.

Security The project's large, anonymous and transient workforce is likely to cause an increase in the level of crime and social disturbance: theft, gambling, alcohol and molestation of women commonly occur in these circumstances. Such problems have already been reported from Hile, and can be expected around any establishment comprising single men with money. The capacity of local communities and of the police to cope with an increase in the incidence of crime and social disorder is limited.

Overall, potential impacts on the social fabric are regarded as of moderate, local significance.

5.2.2.4 Impacts of Road Construction on the Cultural Environment

The Valley Route passes through an area of considerable ethnic diversity and near a number of sites of religious importance. The variety and the cultural integrity of local communities has remained largely intact because of their isolation. Road construction would influence indigenous culture by, firstly, introducing more money and therefore more freedom of individual choice into traditionally oriented communities; secondly, introducing new people from other more cosmopolitan cultures.

Cultural change is occurring in any case, and cannot be reversed. The road will greatly accelerate these changes.

5.2.3 Access Road: Potential Impacts after Opening to the Public

These impacts will be the major consequence of the Arun III Project, and so are described at some length.

Direct Impacts Following construction and public opening in 1997, the direct impacts of the road will include (i) continuing impacts on and from water, soils and slopes depending on maintenance inputs; (ii) a continuing risk of accidental fire for roadside vegetation; (iii) disturbance to any remaining wildlife due to traffic noise and night-time lights; (iv) health impacts through accidents; and (v) employment opportunities in road maintenance. These impacts are all localised, but will be long-term. The intensity of the impacts will be largely dependent on management decisions on road design and on maintenance regimes and inputs. The significance of these direct impacts is regarded as moderate, but low in relation to the major indirect impacts that will result from opening the road.

Indirect Impacts The indirect impacts of the road are regarded as much more significant than the direct impacts. Without comprehensive development programmes in the Valley, some existing negative trends are likely to be accelerated.

5.2.3.1 Impacts of Road Operation on the Physical Environment

During operation, the road will be affected by as well as itself affecting the physical environment.

(i) Erosion: Slope Failure and Drainage

Slope failure is a major hazard to all roads in Nepal's hills. Soil creep and slow flow can produce deformation and disrupt drainage. Major slope failures can result in complete blockage of roads and loss of roadbeds. Minor failures, and high rates of sediment and debris production from unstabilised cutslopes, frequently block side drains and culverts. The resulting flow of water over the roadbed can cause damage out of proportion to the scale of the initial blockage.

Major unavoidable geomorphological hazards along the access road are the Dandakharka mudslide between the Leguwa and Kenwa rivers south of Tumlingtar, and a variety of stability problems on the northern section, from debris torrents to rockfall. Periodic road loss due to slope failure is certain over 1.3 km and probable over at least a further 1.0 km. This will necessitate a relatively high level of maintenance input.

(ii) Floods: GLOFS and other Catastrophes

The road design has recognised that a GLOF passing downstream from the dam is a major potential hazard since such occurrences can have devastating effects on both the valley floor and lower slopes, including post-flood failures. JV studies have predicted the magnitude and duration of the GLOF immediately downstream of the dam. Computer modelling predicts that between the Intake/Dam and Powerhouse, a GLOF will cause an increase in water level not exceeding 10 m. Downstream from the Powerhouse and where the widening of the valley is more significant, the rise in water level reduces rapidly, and is negligible about half way between the Kaguwa and Chyawa Kholas. The chosen road alignment is generally well above predicted GLOF levels, dropping only near river crossings. Over the length of the river paralleled by the road, there is a danger of washout by extreme floods over some 7 km.

5.2.3.2 Impacts of Road Operation on the Biological Environment

Once open to the public, and if not mitigated, the access road could result in significant adverse environmental effects through accelerated degradation of natural resources.

(i) Vegetation and Habitat

The road will represent a major new opportunity for earning cash by selling open-access goods, principally forest products such as timber, fuelwood, medicinal herbs and orchids. The increased commercial (non-domestic) demand for biomass for local and external markets will accelerate forest degradation in the vicinity of the access road. Cardamom production is likely to increase, resulting in clearance of some lower temperate forest. Households marginalised by adverse price adjustments, loss of portering opportunities and/or inadequate compensation may expand slash and burn cultivation into forest areas, and will also sell forest products. There will be a continuing risk of fire for roadside vegetation.

These potential indirect impacts are regarded as being highly significant nationally owing to their likely scale, effect on the local economic resource base, impact on biodiversity values, and irreversibility.

(ii) Wildlife and Fisheries

Along the road, remaining wildlife will be disturbed by traffic noise and night-time lights. This is a minor impact compared to the indirect effects of improved access and higher levels of economic activity: wildlife throughout the Valley will be affected directly by increased disturbance and hunting, and

indirectly by loss of habitat arising from accelerated forest degradation and clearance, particularly in the vicinity of expanding settlements along the valley bottom. In addition, fisheries will be more heavily exploited for new markets.

These potential impacts will accelerate the decline of endangered species and are regarded as being potentially significant in the national context.

5.2.3.3 Impacts of Road Operation on the Socio-Economic Environment

(i) Economic Adjustment

Price Adjustment When the Access Road is opened to the public, there will be very large price adjustments. The road will connect the hills with the Terai. Freight costs will no longer be a major factor in separating the economies of the two regions, and prices will rapidly change to reflect this. The price of staples will be greatly reduced, but there will be fewer portering opportunities and lower sale prices for some locally produced goods. There will also be greatly increased demands on the forests of the basin to supply new markets, and changes in settlement patterns and cultural activity. The plains have a relative economic advantage for the production of most commodities, and prices of similar locally produced goods in the hills will drop. The most significant immediate effect will be a dramatic decrease in the price of rice, some other food staples, cement, kerosene and fertilizer. These price reductions will affect sale prices of locally-produced goods. The impact of the adjustment on any family or group will depend on the availability of cash and relative requirements for, and prices of, commodities.

The price of land is likely to rise rapidly, particularly along the right-of-way. Speculative purchases are already occurring in advance of construction.

Production Sectors and Food Balance The road will provide access to southern markets for hill produce. Agriculturally, the most important commodities will probably be livestock products and cardamom, for which the hills have a relative advantage. There will also be a massive demand from the south for forest products from the relatively abundant hill forests. In Sankhuwasabha District, the long run impact of the road is likely to include net reductions in the contribution of the crop sector, and net increases in the contribution of the livestock sector, to total income. Livestock product prices are expected to rise, and livestock exports will increase, enhancing livestock income. Nevertheless, without complementary investments, economic modelling by the Basinwide Impacts Study indicates that the overall food balance scenario will become worse than before the road.

(ii) Employment and Income

Employment Without complementary investments, the overall long run impact of the road on local employment is likely to be negative. This is largely due to two factors: loss of long-haul portering opportunities between Hile and the north, and a road-induced depression in local food prices which reduces cropped area and therefore labour use. Anticipated increases in employment from, e.g., increased cardamom production are not sufficient to offset this decline. Labour use is predicted to decrease from 50 % in 1995 to 47 % in 2010 without the road, and from 58 % (high due to Arun III employment) down to only 38 % with it.

In the upper Arun area portering is a mainstay for many families. Much of the work involves forwarding subsidised rice to Hatiya for the Nepal Food Corporation. For this task, porters' wages are paid in rice, not cash. Road construction will wipe out long-haul portering opportunities, although there will be a continuing low-level need for road maintenance crews. Wages may be paid in cash rather than in kind. Cash may be no substitute for food. There could be increased seasonal outmigration of people looking for work in the Terai and elsewhere. This would occur especially in the northern part of the Project area which is now 5 to 7 days walk from Hile.

Household Income There will be a significant increase in the contribution of the export sector to household income. The livestock sector will replace the crops sector as the dominant contributor to household income. However, the increase in income from livestock is not expected to outweigh the loss in income from reduced sale prices of locally-produced crops and loss of long-haul portering income.

(iii) Poverty and Marginalisation

Economic modelling by the Basinwide Impacts Study indicates that (i) poverty is increasing; (ii) the Access Road Project will not, by itself, halt this process; (iii) small complementary investments in effective income-generating programmes will give major economic benefits to cushion Project impacts. The reasons for these conclusions are complex. They include a predicted increase in population, a decline in cropped area, a reduction in crop prices, an increase in labour surplus, and a marked decline in income from portering.

If the economic model is valid, those who are able to avail themselves of the economic opportunities during and after construction will prosper, while the majority will initially be worse off, and could take twenty years to improve on their present marginal situation. Marginalisation is most often characterised by a household slipping into tenancy, and then attempting to make up for the loss in access to production by employment in the non-farm sector. The landless are likely to seek areas for cultivation by converting remaining forests. Fuelwood sales from open-access forests offer another bright prospect to the poor.

Mortgaging and selling land and other assets is only done as a last resort. In the project area, 30 % of households surveyed had mortgaged their land to meet food needs. *If* mortgaging and selling land is taken as a sign of severe economic stress, and *if* the predicted economic impacts of the project spread throughout Sankhuwasabha, as would happen without mitigation, then in this District about 9,000 families could be too poor to weather the period of economic hardship foreseen following opening of the road. If these findings are correct, and without mitigation, the Project will impose severe costs on the poorest people of the Arun Valley, who already live on the margin of subsistence.

(iv) Settlements

New Settlements The access road will attract increased settlement at many points along its length, especially near footbridges over the Arun. An estimated 60 % of the population increase would be migrants from surrounding rural areas; the remaining 40 % would be incomers, mainly entrepreneurs.

Settlement Form Given the usual desire of landowners to present their faces to the road, traditional forms of village settlements may be radically re-ordered to a roadside ribbon of commercial orientation (Plate 3). Some of the effects would be temporary (i.e., for several years), but many can be expected to be permanent. These impacts will be highly significant locally.

(v) Health

Currently patients have to walk or be carried to hospitals with surgical facilities, or to the roadhead at Basantapur. The presence of the road will greatly improve access to hospital facilities for serious cases. In addition, the road will encourage an upgrading of local health facilities, as well as improved levels of literacy and improved water supplies which both have major impacts on standards of public health. However, there will be a continuing health impact through traffic accidents which would not have occurred in the absence of the road.

(vi) Institutions and Services

Government Road impacts on local government organizations are expected to be both positive and negative. The road will provide easier access to natural resource management and law enforcement agencies, while also increasing demands on the resources. Communication between regional, district

and field offices will be enhanced, as will communication between these offices and local communities, but many field offices will be required to expand their services to keep pace with demands.

Local Groups There will be both direct and indirect impacts on community managed activities. Direct impacts will occur where construction is undertaken in areas currently occupied by irrigation canals, potable water sources, forests and other resources that have been managed by adjacent communities. The migration of village elites to the new road, to take advantage of economic opportunities, could undermine the effectiveness of community organizations in the villages left behind.

(vii) Women and Other Disadvantaged Groups

The immediate effect of opening the road will be drastic price adjustments for both imports and exports from the area (see (i) above). Impacts on women will vary according to the economic condition of each household and its ability to weather the changes and take advantage of new opportunities (e.g. in adapting cropping patterns to exploit new markets) (see discussion at 5.2.2.3 vii above). In the long run, insofar as new wage labour opportunities tend to be taken up by men, there may be increasing absence of males from the home and therefore further increases in already very high homestead work for females. However, the presence of the road will also accelerate the cultural changes that may eventually improve womens' status, particularly through improved educational services and therefore the chance to attain literacy.

(viii) Social Fabric

The road is expected to encourage greater disparity in socioeconomic conditions between communities closest to and farthest away from the road. Households closest to the road will have greater access to new employment and income generating opportunities, transportation to market centres, education, health and other services.

5.2.3.4 Impacts of Road Operation on the Cultural Environment

The road's possible impacts on the cultural heritage of the Valley may be summarised as:

- Erosion in traditional social and religious values, although this is already occurring without the road, and is not all negative.
- Greater invasion of external media and communications, leading to less emphasis on traditional songs and dance forms.
- Invasion of consumer products that may displace traditional crafts and cottage industries.
- Houses will become more substantive, with greater use of non-traditional materials.
- A major growth in construction activity in the market centres.
- Greater use of temples and shrines alongside or close to the road, possibly leading to increased income for effective maintenance.
- Changes in the physical form and social patterns of settlements, including greater economic disparities and stresses on community infrastructure.

5.3 HYDROPOWER COMPONENTS

After listing impacts which will *not* occur, this section describes possible impacts of the hydropower components (dam, intake, desanding basins, headrace tunnels, powercavern, outlet, permanent camp) on the physical, biological and socioeconomic environment during construction and operation. An impact matrix is attached at Appendix 5.

5.3.1 Impacts Which Will Not Occur

The Arun III project is a run-of-river scheme. Therefore, impacts typically associated with large reservoir hydropower projects not relevant to this project include:

* No resettlement of people or significant loss of agricultural land due to inundation.
* Minimal inundation of riparian vegetation (30 ha) due to steep valley sides and small impoundment (50 ha surface area).
* No proliferation of waterborne disease vectors like schistosomiasis or water weeds, due to unsuitable conditions.
* Downstream dewatering will not affect agriculture.
* No potential for induced seismicity due to water impoundment.
* Limited sediment trapping potential behind dam, minimising the potential for downstream erosion. There would be no loss of flood-borne sediments to downstream riparian areas.
* Project life will not be reduced by reservoir sedimentation since it is a run-of-river facility.
* Negligible alterations in water temperature and biochemical oxygen demand due to impoundment, given the minimal water retention time.
* No disruption to navigability, since damsite is located in a non-navigable river stretch.
* Minimal danger of destructive downstream flooding in the event of dam failure because of the small amount of water retained behind the dam.

5.3.2 Hydropower Components: Potential Impacts During Construction

5.3.2.1 Impacts of HEP Construction on the Physical Environment

(i) Air Quality

Locally significant impacts on dry-season air quality are expected from dust over some four years. These impacts will cease following completion of construction and the vegetative stabilisation of slopes and bare ground.

(ii) Water Quality

Leakage of oil and hazardous materials from project construction and operating facilities could have an impact on local water supplies, tributary streams and the Arun River. Concrete batching plant operations at the dam and powerhouse sites will produce liquid wastes from mixers, washing of trucks and other equipment, and solid wastes in the form of sub-standard concrete. Liquid wastes, diesel oil, lubricating oils, grease, paints and other chemical and oil based materials will be used as well as stored in the tunnel shops, fuel storage areas and other operational facilities. These impacts could be significant locally.

(iii) Topography and Soils

Quarry and Borrow Pits Quarry, borrow pit and spoil disposal area requirements are estimated at 23.1 ha at the dam site, 6.0 ha at Adit No. 2, and 14.0 ha at the powerhouse. There will also be requirements for temporary roads, storage and handling yards, and Contractor's camps. Opening quarry and borrow pits and constructing temporary roads will result in changes in local drainage systems, loss of vegetation cover, cutting of slopes, creation of steep highwall sections, erosion hazard, and loss of cultivated land. These impacts will be significant locally in terms of land use and availability, until all construction activities have ceased (Stages 1 and 2) and the land reclaimed.

(iv) Spoil Disposal

Disposal to River An estimated 1.43 million m^3 of excavated rock (spoil) will need disposal at the powerhouse, adit and dam sites during Stage 1 construction. Of this some 490,000 m^3 can be used in the works, as quarry and borrow-pit backfill, and for construction of raised terraces for service buildings at the powerhouse site. The absence of suitable locations for spoil dumps and the high sediment-carrying capacity of the Arun River during the monsoon suggest use of the river for disposal of the remaining 940,000 m^3.

The average annual bedload transport capacity of the Arun for representative debris diameters of 83 and 180 mm is estimated at 35.1 million t/yr and 19.8 million t/yr respectively. The actual load transported is not more than 50 % of the transport capacity. Under-utilised annual capacity is calculated at between 9.9 million tonnes and 1.7 million tonnes, which is well in excess of the total volume of spoil requiring disposal over the entire construction period (about 2.5 million tonnes for Stage 1). The reservoir behind the dam will itself retain more sediment than is to be disposed of during construction. The composition of the spoil is no different to that of the existing bedload. Thus controlled spoil disposal to the river over three monsoon seasons (1998-2000) (max. diameter 500 mm, no dumping when flow is is less than 160 m^3/s) is not considered to be likely to cause significant impacts on either water quality or downstream channel form.

Temporary Spoil Dumps Temporary spoil dumps will be required to store spoils at the dam site, Adit No. 2 and the powerhouse until monsoon flows permit river disposal. These will contain a maximum of 309,000 m^3 of material in 1998, with lesser amounts in 1999 and 2000. Of necessity the temporary spoil dumps are located in both riverine forest and cultivated land. This land take is significant locally, but not in a national context. Reinstatement of the temporary dumps will be a challenge owing to the local topography and infertile substrate; they are likely to be reactivated for Stage 2, after which final reclamation can be carried out.

5.3.2.2 Impacts of HEP Construction on the Biological Environment

Although overall facility impacts on rare or endangered species are not thought to be significant in the national context, data are limited.

(i) Vegetation and Forests

The major direct impacts on natural vegetation cover will occur at the dam site, in the areas selected for quarrying and spoil disposal activities (approx. 30 ha of riverine and sub-tropical forest), in the flooded zone of the reservoir (15 ha of riverine forest), and along access roads on steep slopes. Elsewhere, construction activities will utilise areas of fairly level land which are generally cleared of natural vegetation and have been developed for agriculture. Dust is likely to coat vegetation during the dry season, and there will be fire risks. These direct impacts on forests will be significant locally, at the major construction sites - the dam, powerhouse and adits.

Indirect impacts on forest cover will occur as a result of increased demand for forest products, clearance for new housing and slash and burn by marginalised families. These impacts are considered to be potentially very significant locally.

(ii) Mammals and Birds

During construction, mammals and birds are likely to suffer from disturbance due to construction activities (including air support until road access is provided in 1996), increased hunting and trapping pressure from the work force and incomers, and the creation of more discontinuous forest habitat. Normal movement, feeding and other activities will be disrupted. This will be significant locally, but not nationally.

(iii) Butterflies and Moths

The Arun Valley between the Num and Hedangna ridges (the Intake site) is a centre of *Lepidoptera* diversity and endemism (butterflies and moths). Construction and economic activities in this area are likely to result in major changes in vegetation cover. Impacts could include loss of plants required for insect lifecycles, and problems due to attraction of moths to HEP area lights at night, with subsequent death, disorientation or behavioural changes. In terms of the possible reduction of national biodiversity, these impacts could be significant.

5.3.2.3 Impacts of HEP Construction on the Socio-economic and Cultural Environments

(i) Land Take

Project construction is expected to have a significant impact on local farming communities. The project's permanent facilities at the hydropower sites will require some 48 ha of land (including 16 ha cultivated), with a further 69 ha needed for temporary use by the Contractors (including 46 ha cultivated: Table 5.4). Land acquisition for project use will result in the displacement of approximately 170 households. When combined with the land take for the access road, these impacts will be highly significant locally.

Table 5.4 LAND TAKE BY HYDROPOWER FACILITIES

	Permanent	Temporary	Total
Project Affected Families	21	130	151
Seriously Project Affected Families	19	-	19
Total	40	130	170
Land Take (ha)	47.8	69.1	116.9
Land Use (ha)			
Cultivated	15.7	46.3	62.0
Shrub	8.8	5.9	14.7
Sub-tropical Forest	23.3	16.9	40.2
Land Ownership (ha)	Private: 76.7 Public: 40.2		

(ii) Employment and Income

Labour requirements for the hydropower components are estimated at a minimum of 3700. In general, the skills required will be higher than those for access road construction, and there will therefore be a greater need for skills not available locally. Nevertheless, there will be extensive local employment opportunities over the four and a half year Stage 1 construction period (1997-2000). This will have a substantial effect on local average incomes for males. Further income will be generated by servicing the workforce. These impacts will be highly significant locally.

(iii) Other Socio-economic and Cultural Impacts

During construction, other socio-economic impacts will be similar to those already listed for the access road - price inflation, possible increased food deficits, new housing, stress on health facilities and other government services, Impacts on women and vulnerable groups, stress on community relations, and cultural erosion. These impacts will concentrated around Tumlingtar, the powerhouse, and the intake site, and will be highly significant locally.

5.3.3 Hydropower Components: Impacts during Operation

5.3.3.1 Impacts of HEP Operation on the Physical Environment

(i) Hydrology

During operation a short stretch of the Arun river below the intake site will be dewatered for a short period each dry season (mid-November - mid-May). Flow contributions from tributaries begin within 100 m of the intake, and are estimated to total a minimum of 16 m^3/s at the powerhouse site (about 10 % of the normal dry season flow). Flow reductions will have effects on aquatic life (see 5.3.3.2 below).

During the wet season (June - October) periodic reservoir flushing will cause rapid rises in water level downstream as the sediment sluices in the dam are opened. This is unlikely to cause safety problems downstream since there are few if any river users during the monsoon due to naturally high and dangerous flows.

(ii) Sediments

After the construction of the dam, during an initial period of 3-5 years all of the bed load and part of the suspended sediment will be trapped in the reservoir. Thereafter, the reservoir will be flushed periodically during high flows when sediment levels are naturally high. Full flushing will take about 30 hours. During the wet season there will also be a requirement for about 2 hours flushing of the desanding basins every day. This is not a significant environmental impact.

(iii) Water Quality

A reservoir of approximately 4 km length and 50 ha surface area will be created behind the dam. Water velocity in the reservoir will still be relatively high, and the short retention time will prevent any significant changes to water temperature or other water quality parameters. This is not a significant impact.

5.3.3.2 Impacts of HEP Operation on the Biological Environment

(i) Mammals and Birds

During project operation, there is a remote possibility that lights could cause disorientation to birds migrating at night. Otherwise impacts on mammals and birds during operation will be minimal.

(ii) Fish

The Arun III dam will be a permanent barrier to all fish movement upstream in this section of the river. In the wet season, some fish from upstream populations will move downstream, travelling with released flows through the spillway gates. Some fish will become entrained in the intake, but designed water velocities here are less than typical fish swimming capabilities.

As well as some others, two important species of fish, the threatened *Katle* (Copper Mahseer) and the more common and economically important *Chuche Asala* (Mountain Snow Trout), will be affected by the project. Katle is a migratory species, utilising spawning grounds in the Arun tributaries as far upstream as the Barun River, and is considered to be under threat throughout its range in the Himalaya. The major threats to fish populations and species diversity in all Himalayan rivers are dams and weirs. It is likely that Katle will not remain established upstream of the dam. Katle migrate upstream at the beginning and downstream at the end of the monsoon season. The survival of Katle downstream of the dam, and in particular downstream of the powerhouse, is not considered at risk due to the project because flow between the dam and powerhouse site will not be reduced significantly during the monsoon season, and will remain unchanged downstream of the powerhouse.

Asala is a locally resident fish principally inhabiting upper sections of the Arun, with a small part of the population extending downstream of the dam. Upstream populations of Asala will not be significantly affected by the dam or reservoir.

Further impacts on aquatic life are expected from (i) occasional flushing of sediments, and (ii) periodic reduced flows in the Arun between the intake and the powerhouse during the dry season, a length of some 20 km. Flow from tributaries in this section is some 10 % of the total. However, there will be impacts on nursery habitat and locally significant changes in river biology in this section of the main river channel.

5.3.3.3 Impacts of HEP Operation on Socio-Economic Environment

When operating, the hydropower components will need a small permanent skilled staff (to be based at the permanent camp site at Amrang, midway between the powerhouse and the intake), and an occasional or unskilled labour for maintenance activities. The permanent camp is likely to attract some services, particularly shops, owing to the relatively high spending power of the site. There may be increased demands on local resources, particularly fuelwood, to meet increased demands. These impacts are not considered to be of any wide significance, but local forest management will require strengthening.

5.4 TRANSMISSION LINE SYSTEM

5.4.1 General

The proposed 220 kV transmission line system to link the Arun III development with Kathmandu and other load centres is a major project in its own right. The direct impacts could be significant locally if not mitigated, but overall impacts of the transmission line system will be low. Matrix tables giving details of expected impacts, planned mitigation measures and responsibilities are reproduced at Appendix 5.

Electric power transmission lines are linear facilities. As such, the impacts of transmission lines occur primarily within or adjacent to the right-of-way (RoW). The magnitude and significance of the impacts increases with higher voltages, which require larger structures and wider RoWs.

Eventually, the lines will run for some 390-420 km all the way to Kathmandu through a geographically, ecologically and socially diverse landscape (Map 3). Key features and processes are landsliding in the hills; river erosion in the Terai; forests as habitat for endangered wildlife, for watershed protection, and as a subsistence resource in all areas; the internationally important wetland of Koshi Tappu on the Sapta Koshi River; and ethnic, social and economic diversity ranging from very poor indebted farmers in the hills through large scale land owners in the Terai to the urban settlements of the Kathmandu Valley. However, for Stage 1 power outputs, only the 120 km connection douth from the powerhouse to Duhubi will be required (Map 3).

5.4.2 Potential Transmission Line Impacts During Construction

During construction the principal impacts will be related to permanent and temporary land take, to clearing vegetation in the RoW, and to the construction of access roads, tower pads and substations. Potentially significant impacts of the Arun III transmission line system during construction include:

Physical

- slope stability, erosion and drainage problems from temporary access roads.

Biological

- clearance of forest along the RoW, and consequent effects of habitat loss and disturbance on wildlife, especially (under Stage 2) at Koshi Tappu Wildlife Reserve;

Socio-economic and Cultural

- permanent and temporary land take for access roads, substations, tower pads, and other facilities: effects on farmers (Table 5.5);
- employment opportunities;
- crop and other damage from construction activities;
- impacts of the labour force on food and fuel supply and prices;
- impacts of labour force on local social systems and culture.

Table 5.5 LAND TAKE AND LABOUR FORCE FOR FULL TRANSMISSION LINE SYSTEM		
Permanent Land Requirements		
Right-of-way:		2000 ha approx.
Tower pads:		20 ha
Substations:	Duhubi	4.0 ha
	Dhalkebar	1.0 ha
	Kathmandu	6.0 ha
Temporary Land Requirement		
Access roads and labour camps		Variable
Tower erection, line stringing, storage, distribution centres:		20 ha approx. per 30 km line length
Labour Force	Arun III - Duhubi	450
	Duhubi - Dhalkebar	375
	Dhalkebar - Kathmandu	450
Families	Permanent PAFS	23
Affected by	Permanent SPAFS	4
120 km Stage 1 line	Temporary PAFS	549

5.4.3 Potential Transmission Line Impacts During Operation

When operating, the physical presence of the line, the current flowing through it, the operation of the substations, and line and RoW maintenance procedures are all sources of environmental impact. Potentially significant impacts identified include:

Physical
- none.

Biological
- forest degradation adjacent to RoW;
- hazards to birds (avian hazards) at valley crossings, and at breeding sites such as Koshi Tappu Wildlife Reserve.

Socio-economic
- employment on RoW maintenance
- hazards to aircraft (aviation hazards) at valley crossings and possibly in the Tumlingtar area;
- safety hazards to public;
- property devaluation, especially in the Kathmandu Valley;
- encroachment onto RoW by landless squatters;
- effects on radio and TV reception;
- possibly, health risks from exposure to electromagnetic fields.

Cultural
- none.

5.5 CUMULATIVE IMPACTS

5.5.1 Other Projects

The Arun Access Road and Hydropower Project will be the first element in bringing major change to the Arun Valley. Further projects studied include the Upper Arun Hydroelectric Project (UAHP) and Lower Arun Hydroelectric Project (LAHP). The LAHP, sited between the Arun III powerhouse and Khandbari, would be in an area already "opened up" by the Arun III project. The UAHP is in a region more physically, ecologically and socially sensitive than Arun III. No date has been set for the development of these projects.

5.5.2 Dams, Dewatering and Fisheries

Construction of additional dams and weirs on the Arun would add significantly to the division of fish populations and degradation of aquatic habitat. The Lower Arun Project would probably be more important in this respect, since the stretch of river and tributaries between Tumlingtar and Phyaksinda (the Arun III dam site) is thought to be particularly important in the life cycle of a number of fish species. Dry-season dewatering would add to this impact, which overall could be highly significant for this river system, difficult to mitigate, and irreversible.

5.5.3 Roads

Construction of the Arun Access Road for Arun III will give opportunities for further road connections to (i) Khandbari; (ii) Chainpur; (iii) Bhojpur; (iv) other areas in the Valley. The cumulative impact of these new roads on the Valley would be very large and irreversible

Construction of the access road for the Upper Arun Project would give an opportunity to continue up to the border with China at Kimethanka. This would attract trade from the north, with consequent impacts on the newly established Qomolangma Nature Reserve in the Tibet Autonomous Region.

5.5.4 Transmission Lines

Upper Arun

The Upper Arun transmission lines are likely to follow the eventual access road to the Upper Arun project. Currently this is planned for the right (west) bank of the river in the Makalu-Barun Conservation Area. The lines will cross the river at the Arun III intake site (Phyaksinda), and then take a direct route over the ridge at Num, through the Hurure cloud forest, and then turn west across difficult terrain near the Arun III powerhouse.

RoW clearance for these lines could have significant impacts on both the remaining cloud forests on the Num ridge, and on any remaining butterfly and moth habitat in the Phyaksinda area, a centre of *Lepidoptera* diversity. There could also be a hazard to birds, particularly migrants, at the valley crossings.

The export of nearly 800 MW from the Arun III powerhouse area would necessitate further 220 kV circuit south of the Arun III powerhouse. This line would be built in the same corridor as the original circuits, with consequent increases in impact on biophysical resources, particularly forests. This possible cumulative impact is regarded as moderately significant and long lasting.

Lower Arun

The 308 MW LAHP is expected to require its own power transmission system. When combined with the other two Arun projects, the total power requiring transmission from the Tumlingtar area would be 1045 MW. Again, the added impact would result in a significant cumulative effect, particularly on any remaining hill sal ecotypes.

Overall, potential significant impacts of the transmission line systems will be (i) vegetation clearance and loss of habitat; (ii) construction of access roads; (iii) possible avian hazards; (iv) possible visual impacts in relation to the international tourist trade and heritage.

6 PROJECT ALTERNATIVES

6.1 INTRODUCTION

Internally, Nepal has a major unsatisfied demand for electricity. Externally, the country is in a unique position to supply power to the burgeoning South Asian economy. Nepal has enormous economically feasible hydroelectric power potential, of the order of 25,000 MW. Therefore, the logical choice for some rural and most urban and industrial uses is hydropower.

The Arun III Hydroelectric Project was identified as the best major hydropower scheme for early addition to the Nepal Interconnected System under a least cost generation expansion plan (LCGEP) completed by the NEA in 1987, with the assistance of the Canadian International Development Agency (CIDA) and the International Development Agency (IDA).

The choice of Arun III was reconfirmed by an LCGEP Update Study completed in 1990, again with IDA assistance. This study included estimates of resettlement costs in its comparative analysis of the various projects, but not the costs of other environmental impacts or economic benefits. In reconfirming Arun III, the Update also considered the difficult subjects of "crowding out" (displacement of other development investment by one large project), the recovery of local costs through significant electricity tariff increases, the risk of inflation, and the effects on Nepal's balance of payments, and finally speculated on future debt servicing requirements to pay for the overall power expansion plan (one third of the total annual budget in 1992/93).

HMG/N has now initiated analytical work to improve efficiency in financial resource allocation and to prioritise the expenditure portfolio, so that investment in Arun III will not crowd out other projects, particularly those in the social and rural infrastructure sectors. At the same time, HMG/N is taking steps to open up the electricity supply system to competition by encouraging private sector participation in power generation.

This chapter discusses alternative technologies and sites considered in selecting and designing the Arun III Project.

6.2 ALTERNATIVE TECHNOLOGIES

6.2.1 Energy Supply

Currently fuelwood and other forms of biomass supply 94.7% of Nepal's energy needs. It is widely accepted that harvesting of remaining forests in Nepal's hills is unsustainable, and even so there is massive unsatisfied demand in both rural and urban areas. Given adequate capital and expertise, solar power can substitute for fuelwood for some uses (e.g. water heating), and biogas for others (e.g. cooking in the lowlands). All fossil fuels must be imported, resulting in a drain on foreign exchange and high transport costs. As yet, geothermal electricity generation has not been explored in Nepal, and wind energy has yet to prove a success. Nuclear energy is not a realistic option on cost, seismic safety and institutional capacity grounds. This leaves thermal stations and hydropower as the remaining options.

Nepal has an installed electrical generation capacity of some 250 MW, but the reliable capacity is only about 200 MW. Demand now exceeds this level, and continues to increase. The cheapest form of new supply is usually demand management - load management, energy conservation, energy-efficiency -

and cutting system losses and illegal connections. In conjunction with relevant agencies, NEA is undertaking these tasks, assisted by the World Bank through its "Power Sector Efficiency Project". Allowing for these improvements, projected demand levels still exceed supply, and new generating sources are needed.

The 1987 and 1990 LCGEP exercises looked at the optimal mix of thermal (diesel and gas), run-of-river and storage hydropower projects, and concluded that Arun III should be built as a priority, followed by the Upper Arun scheme. Tested for robustness, the LCGEP analysis confirmed that Arun III should go ahead whether or not intermediate schemes were implemented. The leading candidate for an intermediate project was identified as Kali Gandaki A (102 MW run-of-river), which is now entering its detailed engineering phase with assistance from the ADB, UNDP and Finland.

6.2.2 Access

The sites for the Arun III power facilities are some 50 km north of the nearest roadhead. Alternative access technologies include air (helicopters, fixed-wing short-take off and landing, dirigibles (powered balloons), ropeways, inclined railways, river transport, and a new road.

Helicopters are used widely in the Himalaya, but in general air support is expensive and subject to disruption during the four-month monsoon season. Dirigibles are capable of heavy lifts and precise positioning, but are an untested and therefore risky technology in the region. Inclined railways are only suitable for specific steep sections of the access route, and become redundant if road access can be provided at reasonable economic and environmental cost. The use of jet barges for transport on the Arun River south of Tumlingtar was investigated seriously, but was abandoned as practical constraints became apparent relating to variable flows, obstacles in the river channel, and limited carrying capacity.

The design team concluded that it would not be feasible to build and operate the Project without road access.

6.2.3 Construction Schedules

Currently, the construction period for the 122 km road is projected at 40 months starting in 1994, and for the hydropower components at some 60 months starting in 1996. The speed of construction of a project can have a considerable effect on its environmental impact. Slower construction of the access road would allow a less capital-intensive approach with a higher local labour demand (and therefore local benefits), and modified construction techniques with lower physical impact. Slower construction of the hydropower components of Arun III would reduce the size of the labour force required, reduce the volumes of spoil to be excavated and disposed of annually, and permit more gradual institutional development.

However, the provision of road access is on the critical path for completion of the power components. Delay in opening the road would have unacceptable effects on the commissioning date, and therefore on the project's (and national) economic position. The stringent environmental requirements built into the design, and related mitigation measures, should ensure that the impacts of building to the planned construction schedule are acceptable.

6.3 ALTERNATIVE SITES

6.3.1 Power Site

The merits of the Arun III Project versus other hydropower sites in Nepal were considered in the two LCGEP exercises of 1987 and 1990. On the Arun itself, Arun III has to be built before the Lower Arun scheme since the latter is supplied by water from the former. The Upper Arun scheme will take advantage of the access road already built for Arun III.

6.3.2 Access Road Alignment

The Route Options The road's alignment and specifications are a compromise between (i) the need for minimum disturbance of the fragile landscape, (ii) the benefits of labour intensive methods versus the speed of construction of capital intensive methods, (iii) the relative weighting of higher construction costs versus a lower initial specification and higher maintenance costs, and (iv) connecting existing left bank settlements versus shorter driving times to the project sites and the benefits of a faster axis for future regional development.

The 1986 Arun III feasibility study recommended a route descending from Hile to the river, and then following the Valley throughout to the Intake site. However, in 1987 a detailed feasibility study of possible alignments for the access road was carried out for the Department of Roads. The terms of reference for this study emphasised the objective of maximising economic and social benefits to the region, as well as providing access for the project. It was also stipulated that the road provide access to Khandbari and Chainpur. Within these constraints, all possible routes were considered, and the alignment recommended was the "Hill Route". This ran from the existing roadhead at Basantapur through Mamling to Chainpur, Kharang and Tumlingtar, rising through Khandbari to the Chhyangkuti ridge before descending through Num to the Intake site at Phyaksinda. Detailed designs and tender documents were completed in 1988, in anticipation of an early start to construction, and further refined in the following years. The total length of new construction was 188-197 km (depending on access options to Adit No. 2 north of the powerhouse). The final alignment chosen, designs, and construction methods specified were regarded as environmentally "state-of-the-art" for a major road project in Nepal.

In 1992, following a decision to revise Arun III's development concept and reduce initial expenditure, and given the sole criterion of providing access to the power sites as quickly as possible, the feasibility of a "Valley" route was investigated again. Engineering and construction planning studies have shown that although the construction costs would be similar to those of the Hill Route, there would be a time saving of one year and a total length of new construction of only 122 km. Comparative data on the two routes are given in Tables 6.1 and 6.2.

Land Take The direct social impacts of the Valley Route will be of the order of two-thirds of those of the Hill Route, affecting many fewer families. Project Affected Families (PAFS) are estimated at 1146 compared with 1661 known PAFS for the Hill Route. This is a very significant benefit. Although the number of families affected per kilometre of road is more along the river, the reduced overall length results in a lower total of PAFS. Land take of cultivated land for the Valley Route RoW will be approximately 169 ha, compared with 286 ha for the Hill Route (Table 6.1).

In addition, selection of the Valley Route has also permitted rationalisation of NEA's permanent camp facilities: a single site is now feasible, with consequent reductions in land take and overall impact.

Compensation Compensation payments have already been made for much of the Hill Route. However, the total compensation payable for the Valley Route will be approximately half that payable for the Hill Route. The Hill Route RoW will be retained in government ownership for future road construction purposes. Detailed engineering for a Chainpur-Tumlingtar link road is under way.

Spoil Disposal The disposal of spoil arising from excess cut and from slope failures will be much simpler and less environmentally damaging for the Valley Route, owing to the proximity of the river.

Construction Damage During construction the Valley Route is likely to result in less damage to property and fewer injuries off-site than the Hill Route, owing to its proximity to the river (not far for rocks to roll), and lower settlement density (less to damage).

Construction Materials Construction materials are more easily available along the Valley Route. Consequently there will be less landscape disturbance specifically for construction materials in the Valley.

Table 6.1 ARUN ACCESS ROAD - COMPARATIVE CHART: DISTANCES, LAND USE, LAND TAKE AND FAMILIES AFFECTED

ITEM		ROUTE OPTIONS	
		Valley* (including power cavern access)	Hill
Distance (km)	New construction	121.9***	197.2
	Travel (Hile-Intake)	116.8***	171.4
Land Use (%)	Forest	27	28.5
	Shrub and Grazing	30	16
	Cultivation: Khet	27	41
	Cultivation: Bari	16	15
	Total cultivation	43	56
	Abandoned/Other	-	0.5
	Total	100	100
Land Take (ha)	Forest	106	145
	Shrub and Grazing	119	81
	Cultivation: Khet	106	209
	Cultivation: Bari	63	77
	Total cultivation	169	286
	Abandoned/Other	-	3
	Total Land Take	394****	510
Average Land Take ha/km*****		3.2	2.59
Average Households/km		9.4	8.6
Total Families Affected		1146	1661

* This column from draft ACRP Report, April 1993
** Recommended alignment for adit access along right bank of Arun river
*** This figure is based on preliminary engineering and could increase by 1% to 2% during detailed engineering
**** 375 ha permanent plus 19 ha temporary
***** Hill Route RoW changes from 30 m to 20 m at Chhyangkuti, also powerhouse spur
n.d. No data (available data not disaggregated)

Geomorphological Hazards The Valley Route is more exposed to flooding and debris torrent hazards, including the possibility of GLOFS and landslide dam failure floods. Scour of vulnerable slopes during an extreme flood event could cause failures over some 7 km of the road. Topographical constraints also force the valley alignment to traverse areas at risk from potential deep-seated slope failures. These are likely to give rise to periodic loss of the road over a minimum of some 2.3 km. The corresponding figure for the Hill Route is 0.8 km (the hairpin stacks which are a major feature of the Hill Route are all located on the most stable terrain available and are not liable to severe landslide damage). This 0.8 km distance is made up of two sections of road, at the powerhouse and Adit No. 2, which are common to both routes. From the point of view of geomorphological hazards the Valley Route is feasible, but will require a higher maintenance input over some stretches.

Ecological Impacts Both routes will directly affect areas of high ecological value. The hill sal and lower temperate forests around Tumlingtar and the subtropical forests on the descent to the Intake site will be affected equally by both routes. Therefore the comparison has to be made between impacts on riverine habitats and wildlife and impacts on the three cloud forests on the Chichila Ridge.

Few quantitative data are available to assist this evaluation. Even without the Project, the cloud forests are under severe threat due to unsustainable use. However, there are reasonable prospects for user-group management and conservation, partially owing to their spiritual significance. Although the Hill Route would attract settlements, along the Chichila-Num ridge their size would be constrained by very limited water supplies. The riverine forests north of Tumlingtar are being degraded slowly, but construction of the Valley road and ensuing impacts will accelerate their decline. Prospects for user-group management of these forests could be lower than for the cloud forests owing to lower settlement densities and a greater tendency for open access.

On balance, the significance of long term impacts on ecological values in the Arun Basin will probably be higher on the Valley Route, due to the better regional access provided along the river, and therefore higher levels of future economic activity and demand for forest products.

Indirect Impacts The indirect impacts of both routes will be similar in nature, scale and intensity. Although the Hill Route would directly connect more people and settlements, construction of the road along the Valley would create a relatively short, fast access for future regional development. The Valley Route would also improve access opportunities to Bhojpur as well as to parts of the Makalu Barun Conservation Area. The Tumlingtar stretch is common to both road options.

Conclusion Apart from giving earlier access and being shorter, the principal advantages of the valley Route are socio-economic: the Valley Route will directly affect an estimated 500 fewer families than the Hill Route, and it will also form a better long-term regional growth axis. The disadvantaged Kumhals of Tumlingtar will be affected equally by both routes. Although a relatively high level of maintenance is likely to be required to clear occasional landslides, the lower direct social impacts and long term, strategic benefits of the Valley Route weigh heavily in its favour. This conclusion is supported by the opinion of the Panel of Experts.

The higher direct ecological impacts of the Valley Route should be partially offset by improved management of remaining habitat areas on the right bank by the Makalu-Barun Conservation Project, and indirect impacts minimised by improved user-group management of other areas.

Table 6.2 ARUN ACCESS ROAD: HILL VERSUS VALLEY - A QUALITATIVE ASSESSMENT

Topic	Valley Route	Hill Route
Length:	Shorter	Longer
Physical Impacts: soils, slopes, natural hazards	High	Moderate
Biological Impacts: forests, habitat, wildlife	Direct: Moderate Indirect: High	Direct: Moderate/Low Indirect: Moderate/High
Social Impacts: land take, families affected	Moderate (approx. two thirds Hill Route)	High
Construction: (i) time (ii) costs (iii) construction difficulty (iv) risk of off-site damage/injury	 Shorter Equal High Moderate/Low	 Longer Equal Moderate Moderate/High
Economic Benefits: (i) immediate connectivity (ii) long-term regional access	 Moderate High	 High Moderate
Conclusion: Valley Route is preferable, assuming sound management of impacts and risk		

6.3.3 Transmission Line Routes

Direct Connection to Kathmandu Kathmandu is a major load centre. From the Arun III powerhouse the most direct route to Kathmandu is due west, a distance of some 200 km. However, the terrain is mountainous, geomorphologically active, and largely without road access. The construction of a transmission line across this landscape would be slow, difficult and expensive. Consequently only connections to the existing power transmission system to the south in the Terai have been considered.

Powerhouse to Hile Initial plans were to run two separate single circuit 220 kV lines south from the powerhouse roughly parallel to the access road, along the Hill Route. Shifting the road alignment to the Valley has resulted in a re-alignment of the transmission line over the Tumlingtar-Hile sector, with a saving of 20 km length. Further minor refinements to the alignment can be expected when the design and build contract for the power transmission system is let.

Stage 2 Lines: the Sapta Koshi Crossing Between Duhubi and Dhalkebar the lines pass through the level terrain of the Terai, in general following the line of the East-West Highway. There is one major obstacle, the Sapta Koshi River. Where the Highway crosses the river on top of a long flood control structure, the Koshi Barrage, the riverbed is about 9 km wide. The Indian border is immediately downstream of this structure, so that locating the line further south is not possible. Upstream of the barrage an 18 km length of the river has been set aside as the Koshi Tappu Wildlife Reserve, the most ecologically valuable wetland in Nepal. Between the Barrage and the point at which the river emerges from the Siwalik hills, a distance of about 30 km, the river is heavily braided, and during the monsoon is fast running and unstable. It is confined between two man-made embankments some 12 km apart.

Two crossings are possible, north and south. The southern option runs parallel to the existing 132 kV transmission line from Dhalkebar to Duhubi, which was erected in 1986. It is routed inside the wildlife reserve. The crossing section is approximately 10 km long and comprises 12 spans each of 800 m. This has been in service for 5 years and no structural problems have been recorded. Vegetation clearance here would be limited, but construction of the deep tower foundations needed for this route would involve extensive works over a number of months. The associated disturbance could be significant for wildlife, especially during key breeding and migration seasons. For wildfowl the peak season is February - March, when very large numbers of birds congregate here en route for their summering grounds in the north. In addition, there are resident endangered species, e.g. Black-necked Stork and Swamp Partridge. The direct impacts of the construction process would be short-term, but could have medium term effects on susceptible wildlife populations. During operation, there would be a risk of bird collision damage. There are no data on frequencies of bird collision with the existing 132 kV lines, which are lower than the proposed 220 kV lines.

The northern option runs approximately north-west from Duhubi to intersect with the river where it emerges from the Siwaliks. At this location, the Chatra Gorge, it would be possible to cross the river in a single span of 500-600 m. From the west bank of the river, the line would run south-west until it again intersects the East-West highway, roughly paralleling the embankment. This route (northern alternative) would be approximately 30 km longer than the southern alternative.

Although longer, the northern crossing might be at less risk from hydrological hazards and would avoid disturbance to Koshi Tappu. However, the lines across the entrance to the gorge might pose a hazard to migrating birds, especially in fog and at night (when wildfowl fly). A decision on which crossing to build will include inputs from ornithological surveys to be carried out at both Koshi Tappu and in the Chatra Gorge (see Chapter 9).

Stage 2 Lines: Hetauda versus Sindhuli Between Dhalkebar and Kathmandu (Map 3) two route options were considered. Firstly, following the line of the proposed Sindhuli - Banepa road (130 km). Secondly, following the existing highway and 132 kV line via Hetauda and Kulekhani (215 km). The first route offers substantial cost advantages if the proposed Sindhuli highway is built before the transmission line. However, if the road is not built first, difficult access may make this option less attractive. Construction of the Banepa - Sindhuli highway was approved by HMG/N in February 1993.

7 IMPACT MITIGATION

7.1 INTRODUCTION

The Arun Valley is remote, diverse, and poor. Current trends indicate increasingly unsustainable use of natural resources, particularly forests, and increasing poverty. The Arun III Project, particularly the road, will bring major changes. Without effective intervention, the impacts of the project could be severe, particularly on the poorest families, the forests, and the wildlife. However, if handled sensitively, the project could result in a sustained economic improvement in the lives of many of the people of the Valley, although some negative impacts on the forests, wildlife and fisheries will be irreversible.

Negative impacts identified by the Project's environmental assessment procedures have been dealt with using the following principles: *prevent* where possible; *mitigate* where unpreventable; and for residual effects which cannot be entirely eliminated or mitigated, *compensate*. In many cases, positive impacts can be *enhanced*.

Direct Impacts Direct impacts are best mitigated by refinements to project design and controls and duties laid on the contractors. Direct impacts can be mitigated at three stages of an infrastructure project: during design, by incorporating specific measures in the designs and specifications; during construction, by placing controls on the Contractor; and during operation, by adjusting operating procedures. All three approaches have been used for the Arun III project.

Indirect Impacts Indirect effects of the project largely stem from market forces to be unleashed by project construction and the creation of road access. These indirect impacts are both more important, more far-reaching, and much more difficult to deal with.

Organisationally, the Arun III Project has developed a dual approach to coping with impacts: firstly, an *Environmental Mitigation Plan* (EMP) which is an integral part of the project, and deals with direct impacts including land acquisition and compensation; secondly, a *Regional Action Programme* (RAP) which addresses indirect impacts and induced effects. Together, these constitute the "Environmental Management Plan" required by donor appraisal procedures.

An index to environmentally-related clauses of the tender documents is attached at Appendix 6.

7.2 ENVIRONMENTAL MITIGATION PLAN

Note: NEA will be fully responsible for implementing the Environmental Mitigation Plan, as an integral part of the construction process. The Regional Action Programme will be implemented independently but in coordination with the EMP.

7.2.1 Selection of Competent Contractors

With their tender, each Bidder must submit an *Environmental Protection Statement* and *Health and Safety Statement*. The quality of these statements will affect the final choice of Contractors. The successful Bidders will then develop their statements into a *Full Environmental Protection Plan* and a *Full Health and Safety Plan* covering all relevant aspects of their proposed activities, to be submitted to and approved by the Employer as an enforceable condition of contract.

7.2.2 Mitigation Measures for the Access Road

7.2.2.1 Construction Period

The design of the road draws heavily on lessons learned from the environmentally-sensitive Lamosangu-Jiri road built during the late 1970s and early 1980s with Swiss assistance, and on experience from the Dharan-Dhankuta and Dhankuta-Hile roads. Many aspects of the design details were influenced by this experience, and environmental impact mitigation measures were built in both at the design stage and in the Conditions of Contract (Appendix 6). Specific mitigation measures are noted below.

(i) Physical Environment

Air Quality The road will be sealed, which will prevent dust nuisance as well as reducing maintenance costs and impacts.

Water Quality The Contractor is required to undertake good "housekeeping" which includes a duty to prevent fuel and oil leakage and dispose of used materials properly. The Contractor will also be required to compensate for and reinstate off-site sediment damage to property such as irrigation supplies, and so will have an incentive to avoid this type of impact.

Slopes and Soils The road has been designed to minimise both land take and slope disturbance, by limiting width to a single track with passing places and by careful choice of alignment to avoid unstable slopes wherever possible. Particular attention has been paid to the location of the centre line, with full cut, half cut and full fill sections being specified according to detailed geomorphological investigations. In sensitive sections, strict controls will be placed on the earthworks sequence to minimise off-site damage during excavation of the formation. Earthworks will be minimised by balancing cut and fill as far as possible and by providing economic incentives for the Contractor to use cut material as fill. There are also strict controls on the location and design of pilot tracks, and on the location and methods of spoil disposal.

Surface erosion will be minimised by the use of state-of-the-art bioengineering techniques, principally using indigenous planting stock. The Bill of Quantities includes provision for extensive slope stabilisation measures, including agricultural terracing, special vegetation measures, walling, slope drainage, planting or sowing of seedlings and grass, fencing, and plant nurseries.

The road and headrace tunnel are in one Lot (C-3). After completion in 1997, the road will be maintained by the contractor until completion of the tunnel.

(ii) Biological Environment

Vegetation Direct impacts on vegetation will be minimised by minor adjustments to the final alignment to avoid specific ecologically-valuable sites, strictly limiting the area of vegetation to be cleared to that of the permanent works, and care with fire.

Indirect impacts arising from the Works will be minimised by banning the use of wood to heat bitumen, strict controls on the use of wood for any purpose, the provision of subsidised kerosene to the workforce to minimise demands for fuelwood, and the provision of labour camps using Right-of-Way or out-of-area timber, or non-wood materials, for their construction. Separately, the Regional Action Programme will work to establish and strengthen local forest management groups along the alignment, particularly around Tumlingtar, Heluwabensi, the NEA permanent camp site, and the Phyaksinda/Num/Hedangna area, under a priority Conservation Programme. In addition, the new Makalu-Barun Conservation Project promises improved management and protection of remaining ecotypes on the Arun's right bank.

Wildlife The Contractor is required to instruct and control his workforce in relation to environmentally sound behaviour, including not hunting or harassing wildlife. The Regional Action Programme will be carrying out a biodiversity research programme to which may assist in conservation of remaining wildlife populations, and will also implement conservation awareness activities.

Fisheries Explosives on site will be under the control of the Royal Nepal Army, and therefore should not become available to the workforce for dynamite-fishing.

(iii) Socio-Economic Environment

Land Take Although the width of the road has been minimised, and settlements and buildings avoided where possible, there will still be a need for compensation. Extensive compensation measures have been developed specifically for this project, and are described in Section 7.3 below. Land required temporarily will be leased subject to minimum payment criteria specified in the tender documents. As well as controls on locations for and working methods in borrow pits and quarries, the Contractor will be required to fully reinstate all land used temporarily to a stable and productive use, and pay compensation for and reinstate any damage caused to land and property.

Employment and Income The tender documents contain a detailed statement on the preferential hiring of local labour (Clause 16.4 of the Conditions of Particular Application). Each contractor is expected to hire locally, where appropriate skills are available. The tender documents also note that it is illegal to hire children below the age of 16 in the Kingdom.

Food Availability, Prices and Nutrition Price inflation will be minimised by the provision of subsidised staple food commodities and kerosene to the workforce.

Settlements There are extensive controls on the location, design and operation of Contractor's camps. In addition, RAP will strengthen the administration of settlements such as Tumlingtar to assist them to cope with the rapid expansion caused by the project.

Health The contractors are required to provide health facilities for the workforce, including malaria prophylaxis and control.

Institutions and Services The contractors are required to consult with local communities concerning the design, location and operation of their facilities. This should ensure that both local impacts are minimised, and that the facilities can be handed over to communities later if required.

RAP will implement a priority programme on Strengthening Government Institutions.

Women RAP will undertake specific womens' programmes, including education and training, the establishment of cooperatives and user groups, support for micro-enterprises, health education, and male sensitisation.

Vulnerable Groups "Seriously Project Affected Families" (SPAFs)will receive special attention under the Land Acquisition Guidelines, including permanent employment for one family member by government (see Section 7.3). NEA's Environmental Management Unit will pay particular attention to SPAFS from vulnerable groups. In addition, RAP will implement specific programmes for vulnerable groups not directly affected by the project.

Social Fabric The contractors are required to hire labour locally as far as possible. RAP will implement a priority programme to assist communities to service road construction requirements especially in relation to demands for timber and fuelwood.

(iv) Cultural Environment

RAP will implement a programme specifically for the preservation of monuments, sacred sites and folk heritage.

7.2.2.2 Operational Period

When the road is opened to the public, the major indirect impacts will be dealt with by Regional Action Programmes rather than falling under the project's Environmental Mitigation Plan. However, RAP mitigation measures are noted here to simplify comparison with the impacts identified in Chapter 5.

(i) Physical Environment

The road will require a continuing maintenance input both for normal preventive care (sealing cracks, cleaning drains) as well as adequate equipment on hand to clear periodic landslides and rebuild the formation after major movement.

(ii) Biological Environment

Until demobilisation, the contractor for Lot C3 (access road and headrace tunnel) will maintain check posts on the road to minimise illegal road export of wood. These posts could be continued later if required.

RAP will undertake conservation programmes ranging from environmental education through the conservation of crop genetic diversity, to support for the establishment of a major new conservation area along the unprotected Milke Danda, the ridge which forms the eastern boundary of the Arun Basin and which has exceptional biodiversity values. RAP will also undertake ecological research.

(iii) Socio-economic Environment

Price Adjustments and Food Availability It is not considered feasible to influence the price adjustments that will occur when the road is opened. However, RAP will institute a programme to monitor nutritional levels and determine whether the provision of subsidised rice to the northern areas of the Basin should be continued.

Poverty and Marginalisation RAP will implement a series of programmes aimed at assisting the inhabitants of the Valley to take advantage of new economic opportunities, particularly by revising their cropping programmes and agricultural commodity marketing mechanisms, and participating in the expanded ecotourism industry that is likely to follow road opening.

Health Government will be encouraged by RAP to enhance health provision in the area.

Settlements RAP will discourage communities from abandoning their current locations and moving to the roadside by promoting the construction of access roads to existing settlements, and by supporting the strengthening of Community Development Committees.

Institutions and Services RAP will support local administrative agencies and assist in forming and developing Community Development Committees.

Women and Other Disadvantaged Groups RAP will incorporate specific activities for these groups in all its programmes.

(iv) Cultural Environment

RAP will implement a programme to conserve the built environment, sacred sites, and folk heritage.

7.2.3 Mitigation Measures for the Hydropower Components

7.2.3.1 Construction Period

(i) Physical Environment

Air Quality Air pollution will be mitigated by filters and other pollution control equipment on vehicles and construction plant, and by dust control on roads and at crushing plants.

Water Quality Mitigation measures include:

- conveying of all batching plant operation waste water and truck washdown runoff to settling basins for treatment prior to discharge;
- burying of all concrete waste in pits located at each batch plant site;
- waste water volumes to be treated to remove oil, grease and cement;
- storage areas to be bunded to minimize the potential for surface water contamination in the event of a spill accident;
- hazardous substances from maintenance of mechanical, electrical and air conditioning equipment to be collected and disposed of properly off-site;
- no direct discharge of any potential pollutants to be allowed.

Slopes and Soils Impacts on slopes and soils will be minimised by:

- designing erosion control measures into housing sites;
- controlling the design and location of temporary access roads, and ensuring full reinstatement after use;
- salvage of soil prior to grading;
- revegetation of all disturbed slopes with soil stabilising plant species.

Quarries and Borrow Pits Mitigation measures to be implemented include:

- prior approval of the Engineer needed for the location and working methods of all borrow pits and quarries, including plans for eventual reclamation;
- backfilling borrow pits and quarries with spoil;
- salvage of soil for reclamation purposes if appropriate;
- if in agricultural land, reclamation of pits and quarries to include benches wide enough for later cultivation;
- careful attention to surface drainage at the rear of each bench to ensure that excess run-off is diverted into appropriate structures leading to a natural drainage line;
- all disturbed slopes to be stabilised and revegetated.

Spoil Disposal The Contractors will be required to use suitable spoil for concrete aggregate, road maintenance, coffer-dam construction, and as backfill for quarries and borrow pits. Land disposal of spoil remaining after maximum use for these purposes would cover 18.8 ha to a depth of 5 m. The most environmentally acceptable alternative is to dispose of the excess spoil in the Arun River. Disposal to the river will be limited to the monsoon period of April-November, when the river's transport capacity is highest, and will be carried out to a schedule related to river flows. This will require some intermediate storage of spoil on temporary disposal areas.

(ii) Biological Environment

Vegetation and Forests Mitigation measures to be implemented include:

- provision of subsidised kerosene to the workforce to avoid use of fuelwood;
- promotion of forestry management conservation measures by the Regional Action Programme;

- making the Contractors responsible for the behaviour of their staff and workforce, including fire awareness and control.

Wildlife The Contractors will have a duty to ensure the responsible behaviour of their labour. In addition, RAP will implement a programme of biological research and conservation awareness education.

(iii) Socio-economic and Cultural Environments

Land Take Measures to minimise the impacts of permanent and temporary land take include:

- pre-selection of the temporary construction camp sites;
- Engineer's prior approval required for any alternative and additional sites proposed by contractors;
- leasing land required short-term;
- adit and powerhouse construction camps combined into one;
- reduction of area requirement by specifying two storey buildings wherever possible;
- reclamation of sites to previous land use;
- compensation for and reinstatement of damage to land and property.

Employment and Income The employment of local labour where feasible is stipulated in the tender documents.

Health Mitigation measures will include treatment and surveillance by malaria technicians and provision of adequate health facilities, water supplies, sanitation systems and waste disposal methods.

Other Socio-economic and Cultural Impacts The Contractors for the hydropower Lots will be required to undertake the same socially-related measures as the Contractor for the access road. These will include, for example, provision of logistical support for the work force by the contractors, to minimise price inflation and consequent local hardship. In addition, since the camps may be in place for longer than the more transient road camps, the Contractors will be required to provide adequate recreational facilities and programmes for the workforce to minimise the attraction of off-site activities.

7.2.3.2 Operational Period

(i) Physical Environment

Hydrology Minimum instream flows for the survival of fish fry in the main river could be of the order of 16 - 30 m^3/s. It will not be possible to provide this level of flow between the intake and powerhouse during the dry season without affecting power generation.

(ii) Biological Environment

Birds and Insects If the project's lights prove damaging to insect populations and/or appear to affect birds, the design of the lights will be adapted accordingly.

Fish There are no economically or biologically feasible measures to mitigate the barrier effect of the dam on migratory fish populations.

(iii) Socio-economic and Cultural Environments

NEA Camp NEA's permanent camp at Amrang will become a mini-growth centre owing to the spending power of the employees stationed there. Impacts on the community and surrounding resources will be mitigated by the strengthening of local institutions by RAP.

7.2.4 Mitigation Measures for the Transmission Line System

7.2.4.1 Construction Period

(i) Physical Environment

Slope Stability and Flood Hazards The Tender Documents will include information on geomorphological hazards, and will require the Contractor to carry out geomorphological mapping along the alignment corridor before tower spotting. Special attention will be paid to the Sapta Koshi crossing.

Access Roads The design, location, construction methods and reinstatement of temporary access roads will be subject to the Engineer's approval.

(ii) Biological Environment

Vegetation Wherever possible the lines will be routed across agricultural land and not through forests. Special attention will be paid to line design and location in the vicinity of key ecological areas such as the lower Sabhaya Khola forests near Tumlingtar. Right-of-Way clearance will be closely supervised to minimise unnecessary cutting. Construction crews will be trained in minimum damage techniques for line stringing, and in fire awareness.

Birds Special attention will be paid to line location and design in the vicinity of the Sapta Koshi crossing. The choice of the northern or southern options will take full account of the long-term impacts of the lines on endangered resident and migratory bird species. Visibility aids will be installed at all valley crossings.

(iii) Socio-economic and Cultural Environment

Land Take A variety of mitigation measures will be used:

* Compensation for land acquired permanently will be paid in accordance with the Land Acquisition Guidelines 2045, and all recommendations of these guidelines will be implemented.
* Land required temporarily will be rented, with certain minimum rental criteria.
* Informal tenants and squatters affected by the project will be included in the rehabilitation scheme, which should accord with the Land Acquisition Guidelines 2045.
* A Condition Survey will be carried out along the ROW before construction commences.
* Compensation will be paid for any physical damage caused by the contractor or any sub-contractor operating on the project, according to an agreed and publicised claims procedure.
* Persons affected by the project will be fully informed of their rights in relation to the compensation scheme.

Price Inflation In some areas of the Arun Valley the contractor will supply his labour force with staple foods and kerosene through "fair-price" shops. Supplies for these shops will be purchased in the Terai.

Community Relations and Infrastructure Temporary access roads on public land will be handed over to communities rather than being reinstated, if this is requested.

(iv) Controls on the Contractor

Contractors for the transmission line system will be subject to environmentally-related controls similar to those imposed on the other Arun III contractors. These will include tender evaluation in the light of the bidders' approach and experience in other sensitive areas, requirements for the successful contractor to submit his proposal well in advance of works to allow thorough vetting by the Engineer, use of pre-existing Arun III camps where feasible, and careful working methods including detailed attention to erosion and drainage issues, labour force activities, and site clean-up and reinstatement.

(v) Revisions and Additions to the Draft Tender Documents for the Transmission Line System

Information Before tendering, the existing draft transmission line tender documents will be modified to include the Information section from the Arun III Civil Works Lots, either verbatim with additions to suit conditions in the Terai and central hills, or written afresh and including information on the following four key topics:

* Geotechnical hazards.
* Biodiversity features and issues.
* Social and cultural features and issues.
* Quality-of-life features and issues, particularly visual amenity.

Conditions and Specifications The existing draft transmission line documents will also be modified to include new or expanded clauses on the following subjects:

- a "Full Environmental Protection Plan";
- a "Full Health and Safety Plan";
- the type and scope of surveys required prior to line fixing;
- line location in relation to geomorphological and hydrological hazards, forests, and identified areas of ecological, cultural or visual interest;
- alignment, design and working method variations necessitated by new information becoming available during project implementation;
- incorporation of bird collision hazard mitigation measures, both at the Sapta Koshi crossing and elsewhere;
- the alignment, design and construction of access roads;
- working methods to minimise damage to vegetation, including fire prevention;
- selective ROW clearing, and disposal of timber;
- working methods to minimise disturbance to wildlife during the breeding season;
- ROW condition surveys during the construction period;
- temporary use of land;
- community relations and compensation for damage and crop loss;
- borrow areas and spoil disposal;
- photographic monitoring of key areas;
- tidying of work sites to prevent damage to livestock;
- clean-up procedures;
- ROW reinstatement;
- reinstatement of other areas disturbed by the works;
- access road reinstatement or handover;
- slope treatment techniques;
- labour: engagement, conditions & etc.
- disorderly conduct;
- provision of first aid and health care;
- provision of "fair-price" food shops (in selected hill areas);
- transformer oil constituents;
- transformer oil retention facilities (expand existing paragraph);
- substation sanitation.

7.2.4.2 Operational Period

Physical

* NEA will develop and initiate a regular line inspection programme. including recognition of incipient slope stability problems.

Biological

* NEA will undertake a cooperative monitoring programme with the Department of National Parks and Wildlife Conservation to establish levels of bird collision and identify and implement appropriate responses.
* NEA will develop appropriate ROW vegetation management techniques to ensure safety whilst taking into account social and environmental objectives.

Social

* All towers will be fitted with anti-climbing devices and warning signs; all substations and switchyards will be securely fenced and gated.
* NEA will appoint a Community Relations Officer whose job is to inform the public of the hazards of high voltage electricity. The officer will also have duties in relation to ROW management.

Rural Electrification NEA will provide step-down transformers to allow the 33 kV construction power supply line to be used to supply local communities.

7.2.5 Environmental Mitigation Plan Implementation Schedule and Coordination

(i) Prior to Tendering (1985-1993)

During the project's lengthy design phase, extensive mitigation measures have been introduced through refinements to design aspects and incorporation of appropriate clauses in the tender documents. Also during this period, NEA established its in-house Environmental Unit, and HMG/N began to establish a framework for national-level environmental management and administration, centred on the National Planning Commission.

(ii) Tendering (1993)

During the tender period in 1993, the Bidders will submit their bids which will include Environmental Protection and Health and Safety Statements. These will be evaluated by the Engineer on behalf of the Employer, and contracts awarded on the basis of performance and price.

Following award of the contract, the Contractor(s) will develop and submit for approval their Full Environmental Protection and Health and Safety Plans.

(iii) Construction (1994-2002)

The Arun Project Environmental Management Unit (APEMU) will start operations in 1993, initially drawing its staff from NEA's existing Environmental Unit, and then building up with new appointees. The Regional Action Programme will commence in 1994, with establishment of the Board and Arun Basin Environmental Management Unit (ABEMU), and initiation of the core programme for dealing with priority indirect impacts. Compensation payments for land to be taken will be paid as little in advance of construction requirements as possible, to ensure fair prices.

7.2.6 Costs and Funding

In the Contract, some environmentally-related works such as slope stabilisation are cost items. Others will be absorbed in the Contractors' general estimates. The Bill of Quantities in the tender documents includes an item relating to implementation of the agreed Environmental Protection and Health and Safety Plans.

Supervision of the Environmental Mitigation Plan is a project cost to be borne by the Employer. This will include staffing, training, equipping and operating the project's Environmental Management Unit (APEMU) over the construction period, the provision of specialist environmental staff on the Engineer's

team, contingencies for specialist consultancies and other inputs. Establishment of APEMU will cost around $ 0.265 M including start-up specialist training, with annual running costs for salaries and transport of approximately $ 0.1 M/yr. The Engineer's cost can be expected to run at some $ 0.1 M/yr for the provision of specialist environmental staff. The total cost of supervision of the Environmental Mitigation Plan to the Employer over the eight year construction period will be approach $ 2 M. This expenditure includes a major benefit to the NEA through professional staff training and capacity building. Costs will be borne by NEA if donor assistance is not forthcoming.

A major further mitigation cost is the land acquisition, compensation and rehabilitation programme (ACRP: see next section). The estimated total direct cost of this for the three Stage 1 project components is $ 1.488 M, made up as follows:

- access road: $ 1.224 M
- hydropower components: $ 0.216 M
- transmission line system: $ 0.048 M

The costs of the Regional Action Programme have been tentatively estimated at $ 14.6 M over 10 years. HMG/N is seeking donor contributions to assist this work.

The overall costs of the Environmental Mitigation Plan, ACRP and RAP are estimated at approximatley 3 % of total Stage 1 project costs.

7.3 LAND ACQUISITION, COMPENSATION AND REHABILITATION

7.3.1 Background

The Project's road, hydropower and transmission line components will directly affect a number of families, some of whom will lose their houses. To compensate for such losses, the project has developed and adopted a comprehensive land Acquisition, Compensation and Rehabilitation Plan (ACRP). The ACRP is based on the officially approved Land Acquisition Guidelines 2045. These were developed with World, Bank assistance to guide the land acquisition process for the access road, and are being extended to the hydropower and transmission line components. The plan's procedures are a great advance on any used for previous major infrastructure projects in the Kingdom.

7.3.2 The Acquisition, Compensation and Rehabilitation Plan

Purpose The purpose of the ACRP is stated as:

> "The principal objective is to ensure that the people affected by the property and land takings of the road project will be at least as well off in terms of assets and livelihood after the project as they were before the project. A secondary objective is to assist the communities in the settlements.....to understand the opportunities and hazards arising from the ..... project and to assist them in the development planning of their settlements."

Compensation Measures for *Permanent* and Long-Term Land Take Hardship caused by land acquisition is to be minimised through the following compensation packages:

* A thorough examination of individual household conditions before determining compensation packages, which include a land-for-land option: households are divided into Project Affected Families (PAFs) and Seriously Project Affected Families (SPAFs), depending on the proportion of their income to be lost because of the project and whether the principal residence is to be acquired. This is determined through detailed household surveys.

* Compensation for PAFS will be paid in two tranches: *Normal Compensation* and a *Rehabilitation Grant*. Normal compensation is to be paid 2-4 months ahead of work commencing, and covers the value of the land and buildings affected. Land valuation is done by district Land Valuation officers and under the Guidelines must be based on comparative market values. The Rehabilitation Grant is not paid until the time when the land is actually required and is intended to cover suffering and hardship caused. It includes the value of standing trees and crops, one year's loss of income from fruit and fodder trees, and a small food/hardship allowance for 60 days.

* PAFS will receive Normal Compensation and the Rehabilitation Grant.

* SPAFS (families whose house is taken or who are to be left with holdings, assets and prospects insufficient for regaining their previous living standard) are to be offered (i) equivalent assets to those lost (the land-for-land option); (ii) the Rehabilitation Grant (which will include a 4-month rent allowance); (iii) employment for at least one family member (interpreted as a job on construction or similar for the duration of the project); and (iv) training (as appropriate to undertake the employment offered).

Compensation Measures for Temporary Land Take Land to be used temporarily, for one or two years (e.g. for access road camps, quarries), will be rented. The Conditions of Contract include stipulations on the frequency and minimum level of rent to be paid, and the project will develop standard rent agreement forms. The rent will be based on the land's agricultural productivity, and will be adjusted annually in line with local price variations. Land used temporarily will be fully restored before being returned to its owner.

Procedures Compensation monies are paid to registered landowners, who are almost invariably men. Grievances must be remedied through the local administration and thereafter the courts.

The Project is working urgently to develop mechanisms for dealing with the issues of compensation for formal and informal tenants, common property, *guthi* lands (religious trusts), and land devalued by fragmentation. The Project is also taking steps to (i) develop an information package for PAFS and SPAFS in the vernacular so that these families are clear about their rights and the procedures to be followed; (ii) develop a programme to provide assistance in money management to help affected families re-invest in productive assets rather than use cash for non-productive purposes. NGOs will be contracted to carry out this work. Finally, the Project is investigating reasons for delayed payment of Rehabilitation Grants for land already taken up for road and engineers' camps.

Responsibility for Implementation The land acquisition and compensation process is being undertaken by the Project under delegated powers from specially constituted district Acquisition and Rehabilitation Committees. NEA is recruiting a local Resettlement Advisor to assist in implementation of the ACRP and strengthening the Environmental Management Unit's social wing.

Costs The costs of compensation measures for the access road can be calculated based on work carried out to date and current values. Compensation costs for the hydropower facilities can be calculated based on current values inflated appropriately. The numbers of PAFS for the transmission line component are harder to estimate since the final route of the line will not be fixed until the later part of the decade. Compensation costs for this component can only be estimates at this time.

As noted above, the estimated direct compensation cost for the three project components totals some $ 1.5 M.

Noteon Hill Route Normal Compensation has already been paid for msot of the Hill Route. Government will retain title to this land for future link road construction.

7.4 REGIONAL ACTION PROGRAMME

7.4.1 Background

Measures to minimise the indirect impacts of the access road and hydropower project, and to capitalise on the economic opportunities provided by improved access such as tourism, have been identified by the Management of Basinwide Environmental Impacts Study carried out by the King Mahendra Trust for Nature Conservation for HMG/N (Appendix 3). Together, these measures constitute the *Regional Action Programme.* This major programme will complement the Arun III Project's Environmental Mitigation Plan, and will continue well after the Project has been commissioned.

For the short-medium term, the Basinwide Impacts Study proposed an interim management structure for the Valley centred on the National Planning Commission. HMG/N is now studying these options to determine the most effective implementation system for the Regional Action Programme. It is likely that an Interim Management Board will be established, with RAP activities promoted and coordinated by an executive management unit (see Chapter 8).

7.4.2 RAP Programme Areas

The Basinwide Impact Study's report lists 21 recommended sectoral programmes in six major programme areas (see Table at end of Appendix 3). These programmes are designed to address both the immediate requirements brought about by the construction process, and the longer-term needs for sustainable development within the valley.

The six major programme areas are:

* Conservation
* Income Generation
* Institutional Strengthening
* Extension and Training
* Infrastructure and Energy
* Research, Monitoring and Information

In terms of scheduling, five sectoral programmes were regarded as priorities for pre-emptive implementation ahead of road construction. These relate to:

1. Strengthening local forest management
2. Helping local communities service construction-related demands, particularly for wood
3. Strengthening government institutions to cope with impacts
4. Training and education for local human resource development
5. Environmental monitoring

These activities comprise a "Core Programme" to be implemented by HMG/N as a priority, initially through existing organisations, particularly the Ministry of Forests and Soil Conservation. Local consultants and NGOs will be contracted to expedite the work.

7.4.3 Costs

The total cost of the RAP programmes has been estimated at $ 14.6 M over 10 years. Within this, the cost of the Core Programme for priority implementation is estimated at $ 2.6 M.

8 ENVIRONMENTAL MANAGEMENT RESPONSIBILITIES

8.1 INTRODUCTION

HMG/N has determined that implementation of the Project's overall environmental management strategy will be most effective if separated into two parts: firstly, the construction team comprised of the Employer, Engineer and Contractor, who between them implement the *Environmental Mitigation Plan* which will cope with direct impacts; secondly, under National Planning Commission leadership, the administrative mechanism responsible for the *Regional Action Programme* which will act as an independent monitor of the Environmental Mitigation Plan, deal with indirect impacts during the construction phase, and basin-wide change thereafter.

Both components of the strategy require increased institutional capacity, and therefore will be the subject of appropriate institutional strengthening programmes associated with the project.

8.2 PROJECT ENVIRONMENTAL MANAGEMENT: IMPLEMENTING THE ENVIRONMENTAL MITIGATION PLAN

The Project's arrangements for environmental management during and after construction are shown in Figures 8.1 and 8.2. Administration of the Regional Action Programme is shown schematically in Figure 8.3.

8.2.1 Engineer

On behalf of NEA (the "Employer"), the Engineer is responsible for ensuring that the Contractor builds the project on time, to budget, and in accordance with the Technical Specifications and Conditions of Contract. This includes ensuring compliance with all the environmentally-related clauses of the documents (Appendix 6), and with the agreed Full Environmental Protection Plans and Full Health and Safety Plans to be drawn up by the Contractors and approved by the Engineer.

The Engineer must also (i) evaluate and approve the Contractors' proposals for, e.g., camp siting and design, pilot track routing, working methods for borrow pits and quarries, etc.; (ii) direct that specific techniques and measures be implemented, e.g. for slope treatment and land reinstatement; (iii) analyse monitoring data and order any necessary corrective actions, e.g. for spoil disposal sites.

To do this, the Engineer will include on his team at least one full-time professional environmentalist for the duration of the works. This individual will have full authority to issue instructions to the Contractors to ensure implementation of the specifications and Plans, and will report to the Chief Resident Engineer. In addition to his supervisory function, the environmentalist will have a formal training role for national environmental staff (see below).

8.2.2 Nepal Electricity Authority: Arun Project Environmental Management Unit

Because of the scope of the duties involved and site logistics, the Engineer's environmentalist will not be able to work effectively without a supporting team of professionals. These will be supplied by NEA, on secondment to the Engineer's team (Figure 8.1). The purpose of this arrangement is (i) to supply the professional staff needed to implement the project's Environmental Mitigation Plan; (ii) to development national capacity through both on-the-job training and a more formal series of training exercises, to be developed by the Engineer's environmentalist for the NEA environmental staff.

The *Arun III Project Environmental Management Unit* (APEMU) will have six principal tasks:

(i) With the Engineer, supervise the Contractors' operations to ensure compliance with the contractual provisions and approved Environmental Protection and Health and Safety Plans.

(ii) Work related to land acquisition, including follow up activities such as training for SPAFS, assisting with temporary land take arrangements, dealing with disputes, appeals and claims, and monitoring the progress and effectiveness of the rehabilitation measures.

(iii) Liaison/coordination with concerned District administrations, especially Sankhuwasabha, Village Development Committees, the Regional Action Programme, the Makalu-Barun Conservation Project, NGOs, etc.

(iv) Monitoring impacts on disadvantaged groups, and arranging for needed corrective action.

(v) Undertaking or arranging any further surveys and research, e.g. further work on aquatic biology and the Sapta Koshi bird surveys.

(vi) Community and public relations.

In conjunction with the Regional Action Programme, the APEMU will establish a geographic information system (GIS) for use in impact monitoring and resource management.

The Unit's sociological staff will be assisted by a locally-recruited professional Resettlement Advisor, and will work closely with local NGOs.

8.2.3 Contractor

The Contractors have a duty to carry out their work in accordance with the provisions of the contract, including all its environmentally-related conditions and specifications, and in particular the approved Environmental Protection and Health and Safety Plans. Their staff will include at least one bioengineer or forester, and one environmental monitoring officer. The Contractors for the road and main hydropower components will also have to supply some monitoring data (as specified in the contract documents) to the Engineer.

8.2.4 Environmental Management during Project Operation

After Commissioning, NEA will maintain a small *Field Environmental Unit* at the site to carry out necessary periodic monitoring, and act as a contact point for any local issues. The staff of this unit will be drawn from NEA's strengthened central Environmental Unit in Kathmandu (Figure 8.2).

8.3 REGIONAL ACTION PROGRAMME

8.3.1 RAP Implementation During Project Construction

During the project's construction phase, implementation of the Regional Action Programme will be carried out by an organisation similar to that shown in Figure 8.3. In this, a policy-making board is assisted by a multidisciplinary executive unit. The Board, the *Arun Basin Interim Management Board* (ABIMB), would be comprised of representatives of the principal concerned government agencies (NPC, Forests, Water Resources, and Local Development) and funding agencies, and would include elected local representation from concerned Districts.

The Board's executive arm or *Arun Basin Environmental Management Unit* (ABEMU) will work closely with the District administrations. Its duties will include:

* Provide technical support and professional advice to the Board.
* Coordinate and monitor the implementation of the Regional Action Programme.
* Act as an independent check on implementation of the Arun III Environmental Mitigation Plan.
* Advise the Engineer of matters of environmental concern upon which he should act.
* Gather, evaluate and act on new information.

Because of the diverse nature of its responsibilities, its relationship with ABIMB, and the need to be seen to be independent of the Arun III Project construction organisation, ABEMU will be attached to the National Planning Commission's Environment Protection Division. It will maintain offices in Kathmandu and at the project site.

8.3.2 Confirmation of the Regional Management System

Recognising that ongoing processes of change in the Arun Valley will be greatly accelerated as a result of the project, HMG/N has initiated the process of determining appropriate long-term management structures for the area. The NPC has commissioned a *Macro-management Study* to examine and refine the management recommendations of the Basinwide Impacts Study, and results will be presented in mid-May 1993. Subsequently, further work will be carried out to turn the agreed proposals into implementable programmes, with a reporting date of April 1994. This timetable will give six months in which to establish priority programmes on the ground, in time for the start of road construction after the 1994 monsoon.

8.3.3 Priority Programmes

The five sectoral programmes recommended by the Management of Basinwide Impacts Study for initiation prior to road construction (Table A3.1) will be implemented as follows:

(i), (ii) **Enhancing Community Participation in Forest Management and Conservation** and **Involvement of Local Communities in Servicing Road Construction Requirements** (for wood). These two programmes will be implemented by the District Forest Office with technical support from the Nepal/UK Community Forestry Project, now in preparation. Activities will commence at the latest in early 1994. Total estimated costs over ten years (core programme in first six): $ 0.71 M.

(iii) **Strengthening Government Institutions.** This programme which aims to improve local government capacity to foster community resource management and development will be implemented by the regional planning office (RPO) of the National Planning Commission with technical support from the UNDP-sponsored Strengthening Decentralised Planning Project. Activities will begin in 1994. Costs are estimated at $ 0.47 M over ten years (core activities in the first three).

(iv) **Training and Education.** This important programme will be implemented through a Training and Education Section to be established within the Arun Basin Environmental Management Unit (ABEMU). Activities will begin when the unit is established in 1994. Costs are estimated at $ 0.66 M over ten years (core activities concentrated in years 2-5).

(v) **Environmental Monitoring.** ABEMU will establish a Monitoring Section covering key indicators of the Basin's physical, social, cultural and economic environment, as a management tool. Activities will begin in 1994. Costs are estimated at $ 0.75 M over ten years.

The total cost of these priority programmes is estimated at $ 2.585 M over ten years, or approximately 0.4 % of total Stage 1 project costs.

8.4 INSTITUTIONAL STRENGTHENING

8.4.1 NEA's Project Environmental Management Unit

Effective implementation of the project's environmental management strategy requires a considerable increase in institutional capacity. NEA will set up a new project environmental unit (APEMU) to assist the Engineer in implementation of the Environmental Mitigation Plan. At the same time, and in parallel with strengthening the APEMU, NEA will take steps to improve the capability of its central Environmental Unit to cope with its increasing workload and responsibilities.

Establishment of APEMU will necessitate hiring and training additional staff. APEMU will require a work plan and operating procedures, and new appointees will require orientation to their duties and training to upgrade their professional skills. Since the Unit will be operating on secondment to the Engineer as part of his staff, this work will be done jointly by the Engineer's environmental specialist and the Unit's leader, in a counterpart capacity.

NEA regards it as essential that the organisation benefits as an institution from the project supervision exercise, with an increased corporate capability left behind when the facility is commissioned. For this reason, NEA will ensure that its APEMU staff receive the professional development training they need to carry out their duties effectively.

8.4.2 NPC: Regional Management Structure

Establishment and operation of the regional management structure is a major exercise in institutional development. This aspect of the management process will be recognised in the forthcoming feasibility study, and appropriate measures defined and implemented. Training will be required at a number of levels. UNDP is already assisting the National Planning Commission with an institutional strengthening programme, and has expressed an interest in further assistance in relation to the Regional Action Programme. At the local level, NGOs will be heavily involved in training and monitoring programmes, as well as participatory evaluation of programme performance, and will themselves be eligible for assistance through the Regional Action Programme.

8.4.3 Other Organisations

The Regional Action Programme incorporates a number of projects for strengthening institutions at the local level. These range from line agency programmes to initiate and strengthen user groups in irrigation and forest management, through assistance to Village Development Committees and NGOs to mobilise to cope with local project-related impacts and opportunities.

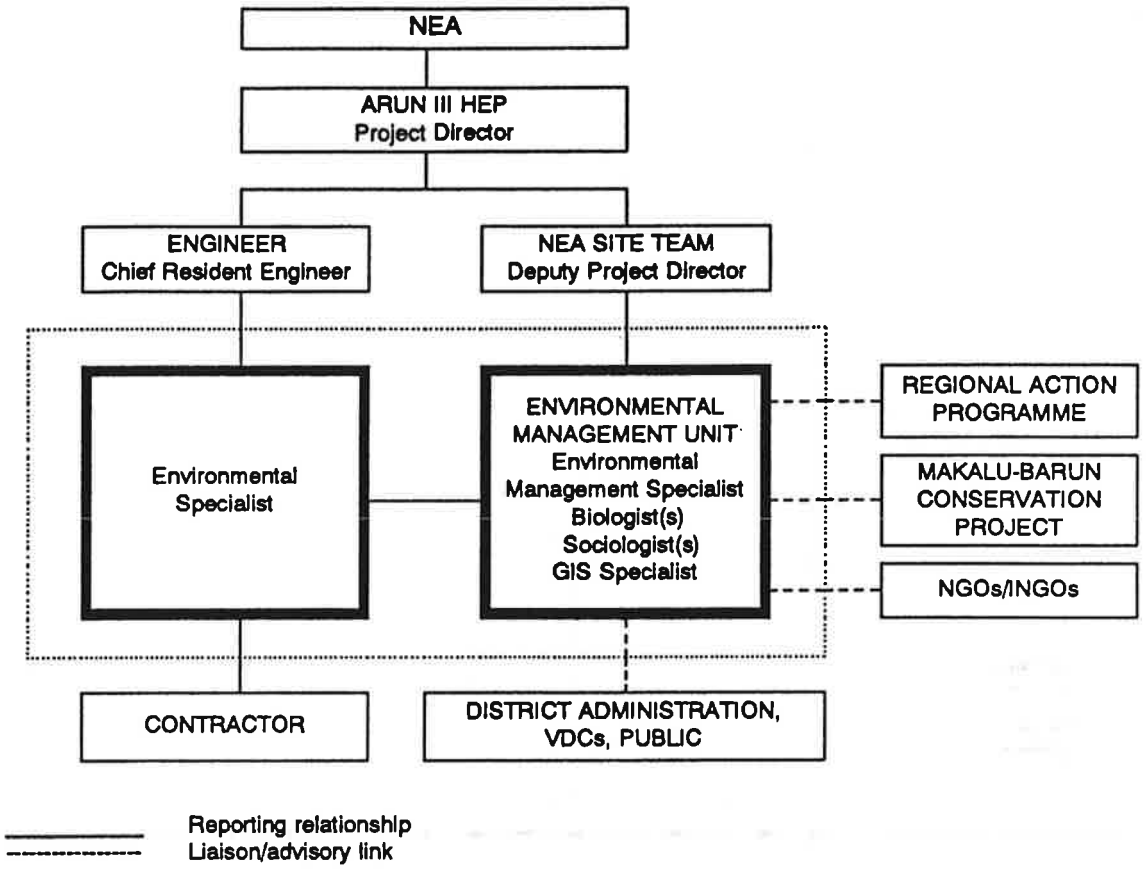


FIGURE 8.1 PROJECT ENVIRONMENTAL MANAGEMENT DURING CONSTRUCTION

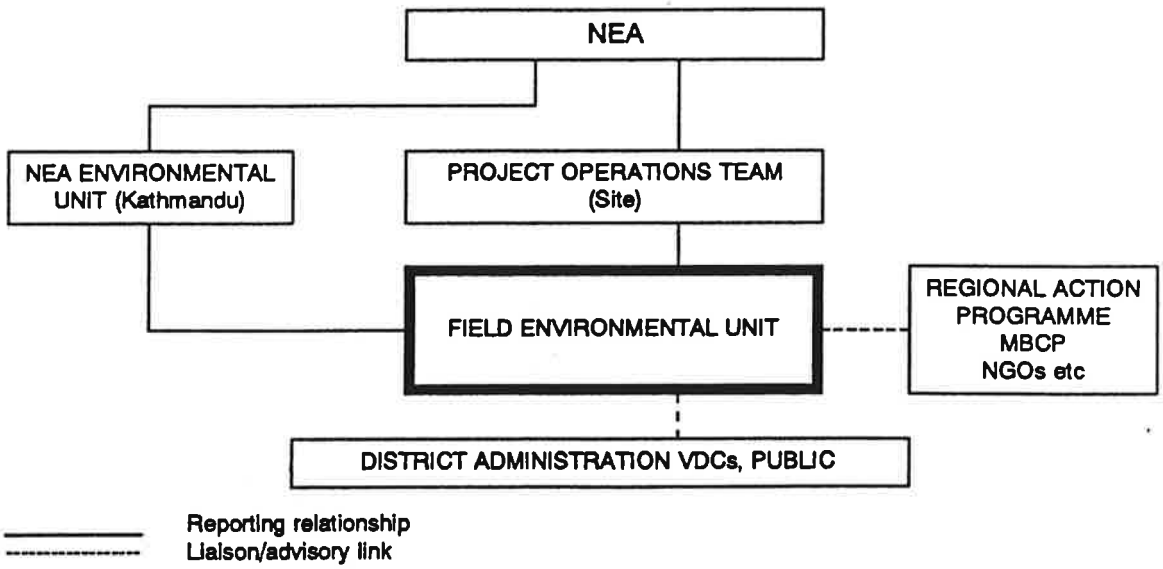


FIGURE 8.2 PROJECT ENVIRONMENTAL MANAGEMENT AFTER COMMISSIONING

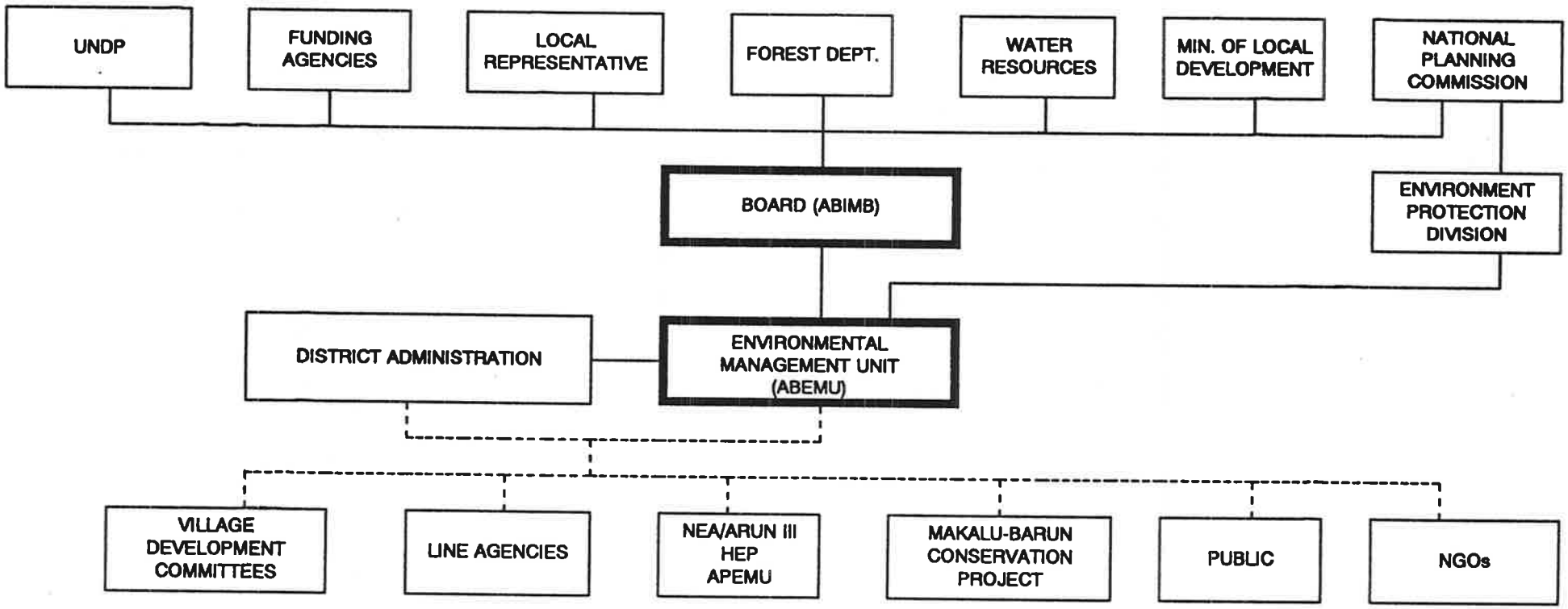


FIGURE 8.3 MODEL FOR ADMINISTRATION OF THE REGIONAL ACTION PROGRAMME

9 ENVIRONMENTAL MONITORING AND EVALUATION

9.1 INTRODUCTION

Monitoring is required during both major phases of the project - construction and operation. Monitoring consists of measuring changes in one or more parameters with time. A parameter may be physical - extent of forests, agricultural production - or less tangible - improved health, changed perceptions. Data that is collected must be evaluated, and appropriate action taken. "Evaluation" refers to, firstly, the periodic evaluation of monitoring data by project management to ensure both Contractor compliance and the effectiveness of mitigation measures, and secondly, to an eventual evaluation by concerned agencies of the success of the environmental components of the whole project from its inception through to the early years of commissioning. Together, monitoring and evaluation are essential management tools.

The Arun III Project will operate dual environmental monitoring and evaluation programmes, through the Environmental Mitigation Plan for direct impacts, and through the Regional Action Programme for indirect impacts.

9.2 ENVIRONMENTAL MITIGATION PLAN: MONITORING AND EVALUATION

9.2.1 Environmental Monitoring and Evaluation during Project Construction

(i) Procedures and Institutions

In addition to the usual checks made by the Employer/Engineer on materials, workmanship, and progress, monitoring, in the form of checks on environmental factors, is required at several stages of construction:

- Firstly, at start-up, to ensure that the designs and working methods proposed by the Contractors have taken account of the environmental constraints specified in the tender documents (geotechnical, ecological, social, heritage features, safety).
- Secondly, to ensure that the Contractors' arrangements regarding temporary use of land are satisfactory.
- Thirdly, during construction, to ensure that the agreed working procedures are followed with respect to, e.g., earthworks, trafficking, vegetation clearance, wildlife disturbance, and similar factors. This will include evaluation of any monitoring data provided to the Engineer by the Contractor under the terms of the contract (e.g. photo-monitoring of sensitive areas).
- Fourthly, during construction, to identify the need for changes to make the mitigation programme more effective, and to dispense with redundant measures.
- Fifthly, on completion, to check that all requirements regarding clean-up and reinstatement have been met, especially with respect to temporary access roads, borrow pits, quarries, spoil tips, camps, and working areas.

Monitoring and evaluation of the environmental provisions of the Contract will be the responsibility of the Engineer, assisted by the Project's in-house environmental unit, APEMU. Some aspects of monitoring will involve local NGOs and user groups, either on behalf of the project or as independent checks on project activities. Major aspects of the monitoring programme are noted below.

GIS for Monitoring The physical data collected under the TRRL project, as well as other environmental and socio-economic data on the Arun catchment area, should be handled and interpreted in an integrated fashion. This can be done most effectively by using a Geographic Information System (GIS). This allows spatial registration of both environmental and economic data, which can then be analysed and interpreted for monitoring and planning purposes. Much of the data collected under the TRRL study, as well as other data related to the access road, has already been entered into the Engineer's GIS database.

(ii) Acquisition, Compensation and Rehabilitation Plan

APEMU will monitor a range of topics relating to land take, compensation and rehabilitation. In relation to permanent land take, which falls under the land acquisition guidelines (Section 7.3), APEMU monitoring (and evaluation and necessary corrective action) will include subjects such as:

- the disbursement of compensation monies and the implementation of related measures such as training and employment for SPAFS;
- the progress and condition of disadvantaged groups within the SPAF category (e.g. the Kumhals of Tumlingtar and other occupational castes);
- the level and nature of disputes and claims relating to compensation;
- perception of the ACRP process by those affected and other members of the public.

For land used temporarily, APEMU will carry out annual fair-rent surveys to fix reasonable rents, and monitor payment of the agreed rentals. APEMU will also monitor ACRP disputes and perceptions, relations with affected communities, and the reclamation and return-to-owner process for land used temporarily.

However, since APEMU will actually be executing ACRP and related procedures on behalf of NEA, independent monitoring will be necessary. This will be carried out by the Regional Action Programme which is likely to contract the field work to appropriate NGOs or local consultancies.

(iii) Access Road

The Project will monitor a variety of physical, biological and social parameters and processes relating to road construction.

Physical Physical factors will include:

- location, design, operation and restoration of temporary facilities - e.g. camps, work areas;
- location, design and impacts of pilot tracks;
- road-induced erosion and sedimentation, including monsoon drainage;
- the implementation and success of slope stabilisation measures, particularly bioengineering;
- the location, operation, stability and reclamation of spoil disposal areas.

For this, the Project will take advantage of relevant work carried out by the U.K.'s Transport and Road Research Laboratory (TRRL), which is involved in road impact studies in the area.

Biological Biological factors to be monitored by APEMU include the condition of vegetation along the right-of-way and in the vicinity of major camps, and intensity of fishing. Vegetation monitoring will be assisted through the contractual requirement for photo-monitoring of sensitive sites by the Contractors. APEMU will also monitor impacts on the habitat and populations of any endangered species directly affected by the road, should these be identified during the course of construction.

Social and Economic Social factors monitored will include adherence to the requirements for recruitment of local labour, camp and other facility "housekeeping" (waste disposal etc.), health and safety conditions, operation of controlled-price shops and local price inflation, and Project/Contractor relations with affected communities.

(iv) Hydropower Components

Environmental monitoring of the construction of the hydropower components will cover the same features as the Access Road, but with particular emphasis on:

Physical
- dust suppression;
- proper disposal of used oils, chemicals and other wastes;
- location and operation of quarries and borrow pits;
- location and design of access roads;
- location, design and operation of spoil disposal sites.

Biological
- vegetation and habitats at the powerhouse, adit and intake sites;
- final design and transmission line alignment of the Construction Power Supply.

Socio-economic
- contractors' camp location and design;
- land rental;
- levels of local employment by the contractors;
- community/contractor relations;
- land reclamation, reinstatement and return.

(v) Transmission Line System

The Arun III transmission line system will be built in stages, reflecting staged installation and commissioning of the turbines at the powerhouse. One or more contractors will be involved at each stage, with the work being carried out on a "design and build" basis. Geomorphological, ecological, social, economic, cultural and land condition surveys will be carried out as inputs to the final design and construction of the system.

During construction, APEMU will monitor each Contractor's compliance with the environmental clauses of the contract, with special emphasis on implementation of the compensation procedures for land used for both permanent and temporary land take, impacts on sensitive ecological and heritage features, and implementation of bird collision hazard avoidance measures. This will be good practice for Stage 2, when the line may cross the ecologically sensitive Koshi Tappu Wildlife Reserve,

9.2.2 Environmental Monitoring and Evaluation during Project Operation

(i) Access Road

Once constructed, monitoring of the physical condition of the road will be carried out by the responsible agency (Department of Roads) in order to plan and implement a cost-effective maintenance programme.

(ii) Hydropower Facility

During project operation NEA's Field Environmental Unit will monitor:

- sediment behaviour in the river (related to desanding and reservoir flushing);
- fish populations, fishing intensity and practices, and the condition of local fisherfolk.

(iii) Transmission Line System

During system operation, NEA will require information on a variety of subjects in order to plan and implement safe, environmentally beneficial and cost-effective working practices. These subjects will include:

- RoW vegetation management techniques;
- bird collision frequency and location (in very limited locations and for limited (but critical) periods);
- social aspects of ROW management, including encroachment by squatters, house construction within clearances, any accidents, and related matters.

9.2.3 Post-Construction Environmental Impact Audit

The Arun III Project is very large infrastructure project. When such large projects have been completed and operated for some time, it is helpful for institutional development purposes and to assist future planning to carry out a post-construction evaluation or audit. This exercise looks at the whole project cycle from initial identification through the pre-feasibility, feasibility, design, construction and early operational stages. Its purpose is to identify areas where improvements could be made, e.g. by improved integration of environmental considerations with engineering and economic analysis at earlier stages, so shortening the project cycle and increasing developmental benefits.
NEA regards this exercise, which will be carried out in conjunction with concerned agencies around the years 2002-2004, as an important input to its corporate strategy for improved efficiency and effectiveness in project design and implementation.

9.3 REGIONAL ACTION PROGRAMME: MONITORING AND EVALUATION

9.3.1 Coverage

Coordinated by the Arun Basin Environmental Management Unit, the Regional Action Programme will establish an effective monitoring and evaluation system covering a wide range of issues, reflecting the broad coverage of the Basinwide Impacts Study and the various other environmentally-oriented projects and activities related to the Arun III Project.

RAP will undertake three types of monitoring. Firstly, *independent* monitoring of Project activities to give an early warning of under-performance. Subjects covered will include the physical, e.g. hydrological conditions in relation to spoil disposal, maintenance of temporary access roads, waste disposal practices; biological, e.g. vegetation condition, harassment or hunting of wildlife; and socio-economic; and socio-economic, e.g. camp locations, labour recruitment practices, adequacy and distribution of compensation payments for all land affected by the project, including construction-related damage.

Secondly, monitoring of project-related impacts not dealt with by NEA's Environmental Management Unit, such as the rate of forest degradation in the vicinity of demand centres such as Tumlingtar and Phyaksinda, as well as elsewhere along the road alignment, rates of urbanisation, impacts on community facilities such as water supplies, the success or otherwise of local management systems (government and community) to cope with the impacts, impacts on vulnerable groups, specifically the Kumhals of Tumlingtar but also other groups identified in socio-economic surveys to date, impacts on

women and children - within Project Affected Families, within families where men have taken up construction jobs, and in marginal families affected by price inflation - community relations.

Thirdly, monitoring of wider issues relating to change in the Basin as a whole. Conditions in the Valley are not static. There are other factors which are causing environmental stress and change. It will not always be practicable to define the boundary between the changes induced by the development projects and those occurring as a result of other forces and circumstances. In practice, there is little reason to attempt to make this distinction. The key issue is that the physical, social, cultural and economic environment of the Arun Basin is and will increasingly be under stress and pressure for change. Basin-wide monitoring by the Regional Action Programme will include:

* watershed condition
* ecosystem conditions
* forest use and productivity balance
* water quality (including Arun River sediment load)
* aquatic biology (to complement and extend APEMU's fisheries surveys)
* wildlife-people interactions (damage to crops and livestock, and consumptive use)
* economic conditions
* tourism
* social and cultural conditions
* movement of traffic and goods
* land use change

Land use change during and after road construction will be inevitable, both along the route corridor and in neighbouring areas. The most appropriate methodology for evaluating this change would be through:

- a consolidation of the existing Acquisition, Compensation and Rehabilitation Programme (ACRP) survey data;
- a second ACRP survey following road construction to identify land use change in the vicinity of the alignment;
- a comparison of air photography taken before and after construction.

1994 will see the establishment of ABEMU, including a monitoring capability with an information storage and retrieval system, and the identification of issues requiring pre-emptive baseline monitoring prior to construction. Also in 1994, pre-emptive monitoring will begin, and details of the long-term monitoring programme developed.

During the main construction period (1995-2001) ABEMU will conduct a full monitoring programme on a regular schedule, and will also undertake periodic reviews of the content and coverage of the monitoring programme.

9.4 FURTHER SURVEYS

9.4.1 Fisheries

The aquatic biology of most Himalayan rivers, including the Arun, is not well known. The river is used by both resident and migratory fish species, and the aquatic life forms the basis of a food chain including reptiles, mammals, birds, and of course man. The increased fish offtake to meet increased demand, the physical presence of the dam and annual flow dry-season flow reductions between the intake and the tailrace will all affect the aquatic ecosystem. Consequently APEMU will undertake further work on fish ecology and related parameters in order to measure impacts and identify feasible mitigation measures. This work will be undertaken cooperatively with local fisherfolk and fisheries specialists, and will commence in 1994 to give least two seasons prior to construction of the coffer dam at the Intake site.

9.4.2 Ornithology

An ornithological survey will be carried out as an input to final transmission line location and design. The information is required to minimise possible negative impacts on the birds migrating along the probable international flyway in the Arun Valley. The survey will cover other areas along the transmission line route where avian hazards might exist, and identify and design appropriate mitigation measures.

For the survey, observers should be in the field at the beginning of the annual spring bird migration. The first season of observations will be preliminary, and will allow the design of more detailed programmes for the next seasons. The surveys are an excellent opportunity to train Nepali nationals in bird identification and other aspects of avian field biology. Staff may be seconded from the Department of National Parks and Wildlife Conservation, from NEA's Environmental Unit, and from interested NGOs such as the Nepal Birdwatchers' Club. Advice on the design and implementation of this work will be obtained from Birdlife International (the new name for the International Council for Bird Preservation, ICBP). Final design of the 220 kV line system will not be carried out until the latter part of the decade. Consequently there is a long lead time in which to carry out appropriate field research.

These surveys will provide excellent training and experience for the more detailed studies which will be needed to determine appropriate line routing and design for the Stage 2 transmission line system. These will need to investigate the current status and breeding behaviour and season of endangered resident bird species in the Koshi Tappu Wildlife Reserve; determine the incidence of bird collisions with the existing 132 kV line at Koshi Tappu; and determine the likelihood of bird/line collisions at the Chatra gorge from observations of resident, locally migrant and internationally migrant species.

9.4.3 Other Surveys

As the project is implemented, APEMU and ABEMU will undertake or initiate any survey work required to improve the effectiveness of planned mitigation and enhancement measures. At this stage it is not possible to identify these, but both units will keep a watching brief on developments in the Valley and will have a mandate to respond appropriately.

An important element of APEMU's further work will be reviewing the effectiveness of the various measures in order to incorporate appropriate clauses in the tender documents for subsequent lots, firstly the construction power supply, secondly the hydraulic, steel structure and electrical lots, thirdly the transmission line system, and fourthly, Stage 2 of the power scheme.

10 CONCLUSION

It is clear that a most unusual and perhaps unique combination of circumstances exists in the Arun Valley. To summarise some of the main points, the Arun Valley is:

* The location for a major programme of infrastructure development.
* The site of natural and biological values of global significance.
* The home for several hundred thousand people of great socio-ethnic diversity, most of whom live in poverty in a rigorous subsistence lifestyle that has changed little over hundreds of years.
* An area where the economy is in decline, and natural resources are already under stress and suffering degradation.
* Possibly the deepest valley in the world, with a unique scenic character and, as the gateway to some of the world's highest mountains, significant tourism potential.

As a run-of-river project, the Arun III hydropower scheme will have comparatively limited and manageable direct environmental impacts. The associated road infrastructure will create significant opportunities for the people of the Valley, in addition to bringing increased pressures on natural resources, accelerated cultural change, and the risks of inequity.

The various environmental studies noted in this document have revealed potential environmental impacts that are sufficiently large to suggest that the project should only proceed with great care and attention to detail. It is essential that effective management and mitigation measures are implemented, firstly, to ameliorate the negative impacts of the project and to ensure that existing negative trends are not exacerbated, and secondly, to ensure that the potential benefits of the project for local people are maximised and distributed equitably.

The proposals and programmes described in this Summary will be implemented with skill and commitment, which will give an opportunity to arrest environmental and economic degradation in the Arun Valley, to protect its unique character and values, and to permanently improve the quality of life of all its people through sustainable development.

A project as large and complex as the Arun III project is bound to have impacts. NEA's response is to treat these as an opportunity, and to begin to develop the national institutional capacity that, in the 21st century, may be called on to implement hydroelectric schemes twenty times as large.

APPENDICES

Appendix 1. REFERENCES

The following three lists of references are an introductory bibliography of environmental matters relevant to the Arun III Project. NEA should be contacted to supply more extensive reference lists.

1. General Bibliography
2. Report of the Management of Basinwide Environmental Impacts Study
3. Publications of the Makalu-Barun Conservation Project

1. GENERAL BIBLIOGRAPHY

Joint Venture Arun III Consulting Services (JV). 1990a. *Arun III Hydroelectric Project: Environmental and Socio-economic Impact Study Report.* Volume 1 - Main Report. Nepal Electricity Authority, HMG, Kathmandu.

Joint Venture Arun III Consulting Services (JV). 1990b. *Arun III Hydroelectric Project: Environmental and Socio-economic Impact Study Report - Volume 2 - Figures and Annexes.* NEA, HMG, Kathmandu.

Joint Venture Arun III Consulting Services (JV). 1992a. *Addendum to the June 1990 Environmental and Socio-Economic Impact Study Report: Volume 1: Environmental Addendum, Final Report.* Jan. 1992. Nepal Electricity Authority, HMG, Kathmandu.

Joint Venture Arun III Consulting Services (JV). 1992b. *Addendum to the June 1990 Environmental and Socio-Economic Impact Study Report: Volume 2: Arun Access Road - Summary of Environmental Information.* Jan. 1992. Nepal Electricity Authority, HMG, Kathmandu.

Joint Venture Arun III Consulting Services (JV). 1992c. *Addendum to the June 1990 Environmental and Socio-Economic Impact Study Report: Volume 3 - EIA of the Transmission Line System.* Jan. 1992. Nepal Electricity Authority, HMG, Kathmandu.

Joint Venture Arun III Consulting Services (JV). 1992d. *Environmental Impact Assessment for Arun Access Road - Valley Route.* September 1992, 2 volumes. Nepal Electricity Authority, HMG, Kathmandu.

2. MANAGEMENT OF BASINWIDE ENVIRONMENTAL IMPACTS STUDY

The following 13 volumes comprise the full report of the 18-month Management of Basinwide Environmental Impacts Study, completed in October 1991:

Volume 1. *Environmental Management and Sustainable Development in the Arun Basin: Summary and Synthesis.* King Mahendra Trust for Nature Conservation as Consultant to the World Bank.

Volume 2. *Action Programs.* KMTNC.

Volume 3. *Management of Natural Resources.* Bhadra, B., S. Sharma, N. Khanal, A. Joshi & B. Sharma.

Volume 4. *Biodiversity.* Giri, M.K., P. R. Shakya, H.S. Nepali, & K.B. Shah.

Volume 5. *Sustainability and Economic Growth.* Banskota, K., M. Upadhya, B. Sharma.

Volume 6. *Cultural Systems and Resources.* Sharma, P.R., D.R. Dahal, & J.M. Gurung.

Volume 7. *Social and Institutional Factors.* Gurung, U.B., I. Neupane, A.R. Pandey.

Volume 8. *Trade and Traffic Survey.* Khanal, N.R.

Volume 9. *Settlement Guidelines.* Kentro, L.

Volume 10. *Role of Women.* Shrestha, I., A. Shrestha.

Volume 11. *Alternative Energy Proposals.* Rijal, K.

Volume 12. *Tourism.* Fleming, W.B.

Volume 13. *Macro Management System.* Dhungel, D.N., S.N. Manandhar.

3. PUBLICATIONS OF THE MAKALU-BARUN CONSERVATION PROJECT

Shrestha, T.B., L.N. Sherpa, K. Banskota, & R.N. Nepali. 1990. *Makalu-Barun National Park and Conservation Area: Management Plan.* Dept. of Nat. Parks and Wildlife Conservation/Woodlands Mountain Institute

This Management Plan was based on the following publications and working reports produced during the planning and field survey phase (1988-1990):

Component Plans

I. *Scientific Research Plan*, by Dr. Tirtha B. Shrestha, Dr. Keshab Raj Rajbhandari, Mr. Rodney Jackson and Mr. Narendra R. Khanal

II. *Park Management Plan*, by Mr. Lhakpa Norbu Sherpa, Mr. Ang Rita Sherpa, and Mr. Jayapal Shrestha

III. *Tourism Management Plan*, by Dr. Kamal Banskota and Mr. Murari Upadhyay

IV. *Community Resource Management Plan*, by Mr. Rohit Kumar Nepali, Mr. Khagendra Sangam, Dr. Charles Ramble and Mr. Chandi Chapagain

Working Papers

Report 1: *Task Force Startup Workshop*, by Mr. Robert Davis

Report 2: *Briefing Seminar: Goals and Current Status of Activities*, by Mr. Murari Upadhyay

Report 3: *Task Force Review Meeting*

Report 4: *Review of National Planning Documents: Seventh Five-Year Plan and Forestry Master Plan*, by Dr. Kamal Banskota

Report 5: *Field Trip Report and Discussion Paper on Conservation and Management of the Makalu-Barun Area*, by Mr. Lhakpa Norbu Sherpa and Mr. Ang Rita Sherpa

Report 6: *Tourism Management and Socio-Economic Survey: Field Report for Sankhuwasabha District*, by Mr. Rohit Kumar Nepali and Mr. Khagendra Sangam

Report 7: *Status of Community Needs, Resources and Development: Sankhuwasabha District*, by Mr. Rohit Kumar Nepali and Mr. Khagendra Sangam

Report 8: *Scientific Report on 1989 Field Survey: General and Phyto-Ecology*, by Dr. Tirtha Bahadur Shrestha, Dr. Puspa Ratna Shakya, and Mr. Hari Saran Nepali

Report 9: *The Effects of Browsing and Other Disturbances on the Forest and Shrub Vegetation of the Hongu, Inkhu and Dudh Koshi Valleys*, by Dr. Chadwick D. Oliver and Lhakpa Norbu Sherpa

Report 10: *Preliminary Notes on the Cultural Dimension of Conservation*, by Dr. Charles Ramble and Mr. Chandi Chapagain

Report 11: *Aspects of Wildlife Protection and Utilization in the Makalu-Barun Conservation Area*, by Dr. Rodney Jackson and Mr. Hari Saran Nepali

Report 12: *Threatened Wildlife, Crop and Wildlife Depredation and Grazing in the Makalu-Barun Conservation Area*, by Dr. Rodney Jackson

Appendix 2. RECORD OF CONSULTATION AND MEETINGS

1. NEPAL ELECTRICITY AUTHORITY

Status Reports

NEA distributes Arun III Project status reports on a regular basis to the following government agencies and industrial organisations in Nepal, for their comments and recommendations:

- Ministry of Water Resources
- Departments of Roads
- Ministry of Finance
- Ministry of Industry
- National Planning Commision
- Ministry of Law and Justice
- Department of Civil Aviation
- Nepal Industrial Development Corporation

Similarly, the Arun III Project office provides relevant information to the following international agencies and embassies:

- The World Bank
- United Nations Development Programme (UNDP)
- Asian Development Bank (ADB)
- Kreditanstalt fur Wiederaufbau (KfW)
- Swedish Embassy
- French Embassy
- British Embassy
- Embassy of Federal Republic of Germany
- Embassy of Japan
- Royal Belgian Embassy
- Embassy of Finland
- Embassy of United States of America

2. THE CONSULTING ENGINEERS:
JV ARUN III in association with SCOTT WILSON KIRKPATRICK & PARTNERS

During the project design studies a variety of government agencies, local and international non-government institutes have been consulted. The reports have been reviewed in draft by IDA and ADB and their comments taken into account in the final versions.

2.1 1990 Environmental Impact Assessment Study (Hydroelectric Power Components)

The following persons and organisations were consulted during preparation of this report (February/March 1989).

1. Buges Watson, R.
   H.M. Ambassador
   British Embassy

2. Chand, Mr.
   Deputy Project Manager
   Marsyangdi Project

3. Cruikshank, E.
Deputy Resident Representative
World Bank, Kathmandu

4. Garbutl, G.
Programme Advisor/Director
Koshi Hills Development Programme

5. Malla, U.M. Prof.
HMG Planning Commission

6. O'Leary, D.
Arun 3 Task Manager
World Bank, Washington

7. Rosser, C. Dr.
Director, ICIMOD

8. Shrestha, J. Dr.
Zoology Department, Tribhuvan University

9. Williams, D.
Environmentalist
World Bank, Washington

2.2 1992 Environmental Impact Assessment Addendum

Organisations consulted on aspects of the EIA Addendum study (June-August 1991):

- Department of Archaeology, HMG/N
- King Mahendra Trust for Nature Conservation: Management of Basinwide Impacts Study team
- Makalu Barun Conservation Project
- Koshi Hills Development Programme, Dhankuta
- Nagar Bikash Samitee (Town Development Board)
- Natural History Museum, Kathmandu
- Support to Special Public Works Programme (Hill Irrigation Project)
- Water and Energy Commission
- Rural Housing Company (formerly the Nepal Resettlement Company)
- Tribhuvan University
- Electricité de France (NEA Twinning Project)
- The World Conservation Union (IUCN), NCS Support Office, Kathmandu
- Overseas Development Administration (Bangkok)
- International Council for Bird Preservation (U.K.)
- National Grid Company plc (U.K.)
- Powerwatch (U.K.)
- World Conservation Monitoring Centre (U.K.)

Tumlingtar: 26 local teachers, businessmen, hoteliers, farmers, and students
Hile: 4 local businessmen and hoteliers
Basantapur: 5 local businessmen and traders, a banker and a forest ranger

2.3 Access Road - Valley Route: Environmental Impact Assessment 1992

Persons and organisations contacted during fieldwork for the revised access road and transmission line alignment (Valley Route) (August 1992):

- Koshi Hill Development Programme
- Regional Statistics Office
- Cadastral Survey Office

Hile: 8 local persons including Village Development Committee members, hoteliers, policement, and shopkeepers
Basantapur: 4 local persons, including businessmen, a banker, and a hotelier

Between Basantapur and Tumlingtar: 8 local persons including a teacher, farmers, hotel keepers and housewives

List of organisations consulted during office work in Kathmandu:

- Water and Energy Commission
- Makalu Barun Conservation Project
- Department of Hydrology and Meteorology
- Rural Housing Company
- Strengthening Decentralised Planning in Nepal (a UNDP project)
- The World Conservation Union (IUCN)
- International Centre for Integrated Mountain Development (ICIMOD)
- Medical Resource Centre
- Malaria Control Division
- Koshi Hills Development Programme

3. MANAGEMENT OF BASINWIDE ENVIRONMENTAL IMPACTS STUDY 1990-1991

This major study involved extensive local consultation for data collection. To assist in defining appropriate mitigation measures, two workshops were held in Dhankuta. Participants included government officers from the four surrounding districts, and representatives of local NGOs.

In addition, two discussion seminars were held for top officials, one in Kathmandu and one nearby, in Dulikhel.

4. PUBLIC CONSULTATION

A public hearing on Arun III was held in Kathmandu on 12 February 1993, organised by the Nepal Forum of Environmental Journalists and other NGOs. Following presentations on the Arun Valley and its features, NEA officials furnished replies to questions from the floor.

Appendix 3. BASINWIDE IMPACTS STUDY

3.1 Introduction

The Arun III Hydroelectric Project is likely to be a catalyst for significant changes in the biological, social and economic environment well beyond the immediate environs of the power facilities and road alignment. Recognising this, in 1989 the United Nations Development Programme (UNDP) funded a major, 18-month study of environmental management and sustainable development in the Arun Basin, intended to complement the more conventional environmental impact studies undertaken by NEA's design team.

Stated in simple terms, the goal of the study was to ensure that negative impacts of the Arun III Project are minimised, and local and regional benefits maximised. The study was not an environmental impact assessment in the normal sense, but was in effect a regional development study which focused on ways in which management of the resources, economy and environment of the Arun Basin might best respond to the processes of regional change brought by the hydroelectric development programme.

The exercise, the *Management of Basinwide Environmental Impacts Study* (MBEIS), was executed by the World Bank, which commissioned a national NGO, the King Mahendra Trust for Nature Conservation (KMTNC) to undertake the work. The team engaged by the KMTNC to undertake the study on its behalf was comprised almost entirely of national experts. The study was completed in October 1991, and its findings presented in English in 13 volumes under the title Environmental Management and Sustainable Development in the Arun Basin.

The team's recommendations are now being discussed by Government, and steps are being taken to translate the recommended measures into implementable programmes. The following notes summarise the approach and main findings of the study, and outline its major recommendations and proposals.

3.2 Approach

In undertaking the study, the MBEIS team identified four "Key Planning Areas" (KPAs) as a basis for organisation. These formed the four main themes within which work proceeded. They were:

* Natural Resources
* Sustainable Economic Growth
* Cultural Resources
* Social and Institutional Factors

In addition, important supporting studies were undertaken in the following subject areas:

* Regional development framework
* Trade and traffic
* The role of women
* Settlement guidelines
* Alternative energy sources
* Monitoring and evaluation
* Macro-level institutional management

For analytical purposes, the basin was divided into "high impact areas" (HIA) and "low impact areas" (LIA), with the HIA defined on the basis of experience elsewhere in Nepal as the area within a half day's walk of the proposed road alignment. (It should be noted that at the time of the study, the proposed road alignment was the old "Hill" route).

The basin was also divided into three zones north to south, the "Upper Arun", "Middle Arun" and "Lower Arun". A comprehensive household survey provided basic data for many components of the study.

3.3 Objectives

The following objectives were identified as guiding principles for the development and implementation of policies and action programmes.

* Mitigation of negative impacts on natural resources.
* Wise use and management of natural resources.
* Protection of biodiversity.
* Maintenance of sustainable supplies of natural resources.
* Achievement and maintenance of sustainable economic improvement and avoidance of economic marginalisation for all resident groups.
* Equitable distribution of benefits among all socio-economic groups and between men and women.
* Alleviation of poverty.
* Provision and maintenance of means by which the people of the valley can participate in and determine decisions affecting their future.
* Maintenance of valued cultural norms, practices, sites and structures.

3.4 Regional Development Framework

A Trade and Traffic Survey predicted the probable future traffic and trade patterns. Settlements and market centres that will suffer as a result of the new road were identified, and likely future growth centres pinpointed. Building on these predictions, the study defined a "growth corridor" with nodal growth points centred on the new road as a framework for regional development, and for the planning and implementation of future development programmes.

3.5 Natural Resources: Land Use Changes and Biomass Analysis

This component of the project analysed land use and land use changes and studied the biomass balance in the impact area, drawing on existing information, forest inventory surveys, the household survey, aerial photography and other sources.

Comparative analysis of 1978 and 1990 aerial photography of parts of the middle and lower Arun Valley revealed that over this period the area of cultivated land grew at a rate of 1.35 % per year, with a total of 773 ha converted to cultivated land from forest, shrub and grazing lands. Expansion of cultivated land into every class of forest cover was observed.

A computer simulation model was developed to facilitate analysis of biomass data and to indicate trends and impacts which would occur as a result of the new hill road. Of great importance is the "destruction at the margin" process whereby users deplete the forests at the edges, rather than travelling further from home and spreading the harvesting impact. The open access nature of the resource exacerbates this process, since users have no incentive to use the forests on a more sustainable basis.

The simulation model pointed towards some important conclusions. In summary, these are:

* Under current and projected demands, the process of biomass depletion in the Middle and Lower Arun HIAs is such that it is presently not on a sustainable path, even without the Arun III project and without the destruction at the margin process.

* With the Arun III project, the increased non-domestic demand for biomass will accelerate biomass depletion, and therefore the deforestation process.

* If the forest use regime in the low impact regions is changed from open access to regulated use, the resource use patterns in these regions can be made sustainable.

* The destruction at the margin process must be eliminated so that the forests can sustain the hill farming system through a steady supply of biomass to the farms.

* For some "hot spots" **high priority pre-emptive programmes prior to the construction period are essential.**

Pre-emptive and longer term action programmes are defined to address these issues. The nature of the forest management systems, tenure and management is seen as the fundamental issue. Consequently, the programmes are based on a general strategy which is:

> "To gradually invest greater property and use rights to forest and pasture resource user communities."

3.6 Biodiversity

The biodiversity component of the MBEIS sought to identify wildlife and plants of significant intrinsic or economic worth, and to develop implementable recommendations for their conservation. The Basin was confirmed as an area of considerable significance for its biodiversity values, with populations of a variety of endangered birds, mammals, reptiles, insects and fish, as well as having a high diversity of traditional crop plants, and high levels of indigenous knowledge of forest product use (ethnobotany). Without effective mitigation, these values are likely to be severely jeopardised by the Arun III Project.

Major recommendations were:

* Establishment of a Milke Danda Conservation Area to cover Milke Danda, Jaljale Himal and Lumbasumbha Himal, with the objective of conserving the Arun Basin's last tract of relatively undisturbed forest east of the Arun River.

* Vegetation and land use mapping of the Arun Valley as a basis for future management, implementation and monitoring.

* Community management of natural forests, including "cloud forests" at Sukepatal, Hurure and Chichila (affected by the "hill" road alignment), sal and subtropical/lower temperate forests at Sabhaya Khola and sal forest at Satighat.

* Conservation of crop genetic diversity.

* Conservation awareness, education and training.

* Biodiversity research, and the creation of a biodiversity database.

3.7 Sustainability and Economic Growth

The objective of this component of the MBEIS was to identify important economic activities and linkages, assess the likely economic impact of the access road on relative prices, identify major problems, assess the comparative advantage of new economic opportunities, and identify ways and means of mitigating negative economic impacts and promoting positive impacts. The study reviewed previous experience of new roads in Nepal, and developed a multi-market computer simulation model for analysis.

Using the simulation model, forecasts of future economic performance and development were made, with and without the new access road. These showed that, without the road, the economy of the valley would face further problems in the future, with a gradual decline in already low real per capita incomes. Mechanisms include, for example, an increasing food and calorie imbalance due to increasing population and decreasing productivity, rising commodity prices relative to prices in the Terai, and a fall in the proportion of utilised available labour from the present 44 %.

The Arun III Project is predicted to have major impacts on the Valley's economy: firstly, during the construction period by generating cash income for locally employed labour, with consequent knock-on effects on local demand and prices; secondly, following the opening of the access road and the cessation of construction, by exposing the Valley to the plains economy, greatly lowering the prices of imported goods, eliminating most long-haul portering opportunities, and increasing access to hill resources. These impacts will not be spread equally between social and ethnic groups, or between the sexes and ages.

The simulation model predicted that real incomes after completion of the Arun III access road will become worse than the baseline scenario (Table A3.1, Figure A3.1). These results confirm experience elsewhere in Nepal that the potential economic benefits of the new road will not be realised unless effective complementary investment programmes are implemented.

Table A3.1 ESTIMATED CHANGES IN REAL PER CAPITA INCOME IN SANKHUWASABHA DISTRICT WITH AND WITHOUT PROJECT AND MITIGATION*

REAL INCOME NRs per capita	YEAR								
	1994	1995	1996	1998	2000	2002	2004	2005	2010
Baseline scenario	2418	2363	2306	2188	2071	1957	1849	1798	1578
With Arun 3 Project	2926	2830	1858	1841	1753	1672	1524	1498	1394
With mitigation programme**	2896	2822	1895	2197	2576	2631	2650	2710	2783

* The model assumed road construction began in 1991, and finished in 1995
** Income Generating Programme - see Table A3.1 for details

The study recommended a range of action programmes to enhance economic opportunities and minimise project-derived hardship and marginalisation. These include employing local persons in construction to the maximum extent possible, importing food grains during the construction period to reduce price inflation, and assisting vegetable production to meet increased demand. In the longer-term, irrigation development, the supply of agricultural inputs such as fertilisers, seed production, promotion of promising crops, strengthening of local cooperatives, vegetable production, and livestock and fruit development are seen as priorities.

3.8 Tourism

This study identified a significant potential for increased tourism in the Arun Basin, following the opening of the new road. However, it stressed the need for good management to avoid the damage that unmanaged tourism has created in other parts of Nepal. Development of tourism infrastructure, designation of management responsibility, and education of local inhabitants and tourists are critical to ensuring a self-sustaining tourism industry.

The study makes a range of recommendations covering issues such as specific sites and activities for tourist use and development, lodge and hotel development, infrastructure for non-trekking activities, facilities to minimise environmental damage from tourism, support for tourism-related income generating activities, and tourism-related education and training.

3.9 Cultural Resources

This component of the study took an in-depth look at cultural variability, the Basin's cultural heritage, and the particular cultural values of the ancient hilltop town of Chainpur, on the "hill" road alignment.

The cultural variability investigation compared the various socio-ethnic groups in terms of distribution, ecological adaptations, traditional economies and other cultural traits. This permitted the assessment of likely differences in individual and group behaviour in response to economic opportunities resulting from the construction of the new road, and of the ability of the different groups to respond positively to the process of change.

The analysis confirmed that there is a likelihood that the economic benefits brought by the new road will be captured by select groups. Some members of groups already disadvantaged will suffer further through loss of land and loss of their current means of livelihood (e.g. portering).

The study recognised that it is difficult and perhaps undesirable to propose direct actions in the cultural field, as the culture of any group evolves and responds to changed circumstances, and any pressure for action must come from the people concerned. The study suggests that the thrust of future programmes must lie not in initiating actions directly, but in empowering and assisting communities to determine and decide the direction they wish to take. It is therefore suggested that the emphasis of future cultural programmes should be on facilitating the development and operation of effective "User Groups" at village level.

In addition, recommendations were made covering preservation or restoration of specified monuments and sacred sites, recording of folk heritage such as crafts, performances, beliefs and rites, preservation of ethnographic cultural items through establishment of an ethnographic museum at Chainpur, and heritage education.

3.10 Social and Institutional Factors

This component of the study focused on the adequacy and effectiveness of institutional arrangements for resource management in the Arun Basin. Information was obtained through case studies of existing resource management systems, interviews with government line agencies and household and community questionnaires.

The analysis revealed serious deficiencies in the ability of government line agencies to handle their current workloads effectively, and throws severe doubt on their ability to cope with the increased and changed demands which will come with the construction process. Case study results indicated that projects which work through properly established and functioning user groups have several advantages over purely government-run projects. The recommendations therefore place strong emphasis on community participation and the establishment of user groups as a means of effective resource

management. This approach capitalises on historical land management systems (*kipat*) and the re-emergence of informal local management groups ("forest security committees").

3.11 The Role of Women

A special study of this subject showed that, in the rural subsistence lifestyle of the Arun Basin, women's total work burden is high compared to that of men, both in production activities and in household chores. Their total contribution to household incomes is higher than males, but they usually do not enjoy formal ownership or legal control of productive resources. In general, they have a smaller role in decision making than men, but this varied considerably among the different socio-ethnic communities.

The study indicated that compensation money paid for land taken by the project goes to male household heads and is not necessarily available to women who, subsequently, have to support their families on a smaller area of land.

Recommended programmes cover issues such as service sector micro-enterprise initiatives, capacity building of self-help and users' groups, agro-processing through improved technology, use of common property land resources, vegetable products, herbs and spices, livestock production, environmental and sanitation education, and male sensitisation to gender issues.

3.12 Settlement Guidelines

This component of the study considered the form and growth of major settlements affected by the new road. It focused primarily on Tumlingtar and Chainpur, and to a lesser extent on Basantapur, Khandbari and Num. Chainpur received particular attention because of the quality and appeal of its architecture and village design.

Recommendations address land use planning, physical infrastructure, environmental concerns such as traffic safety, fire safety, pollution and erosion control, the built environment and settlement planning administration. As in other components of the study, considerable stress was placed on community participation and user group decision making, with a recommendation for the formation of a Community Planning Committee in each settlement.

3.13 Alternative Energy Proposals

This component of the study sought to identify and quantify the benefits and costs of providing energy sources other than fuelwood. It was undertaken because of the likely increased pressures on forests for firewood, the need for new energy sources for programmes to improve socio-economic conditions, and the likely resentment and dissatisfaction among local people if the Arun III project proceeds without provision of electricity to local communities.

The report recommended that the power generation capacity that will be established to meet the construction phase requirements for the Arun III project is later diverted to provide power for major growth centres. Micro-hydro schemes are recommended for more remote centres with smaller power demands.

3.14 Policies and Action Programme

Policy Recommendations

The following policy recommendations were made to address matters of particular concern identified in the course of the study:

* That His Majesty's Government reviews urgently the potential impact of the construction process on the responsibilities of HMG/N agencies, and takes any necessary steps to strengthen resources and personnel in the valley.

* That HMG/N give urgent and serious consideration to establishment of suitable interim and long-term institutional arrangements for environmental implementation and management in the Arun Basin, including the early appointment of an Arun Basin Interim Management Board and establishment of an Arun Basin Environmental Management Unit.

* That resources be allocated to allow the cadastral survey in the valley to be expedited, and that it be completed as soon as possible. (This is because of evidence that forests are being destroyed in anticipation of the cadastral survey).

* That every effort be made to encourage or require the use of the highest possible percentage of local labour in the construction projects.

* That the construction power supply system be located, planned and designed so that it is suitable for use as a permanent power supply to local growth centres when construction is complete.

* That effective negotiation and dialogue be encouraged or required among the Contractor, Engineer and affected settlements about long-term work camp facilities, and what might be agreed to be shared in terms of labour, materials cost, maintenance and inheritance after completion of the project.

Action Programme

The recommendations emanating from various components of the MBEIS have been integrated and re-grouped under a thematic structure. They are presented in the form of detailed and largely self-contained action programmes which are set out in a separate volume of the study report. These are summarised in the table overleaf which is reproduced from the study's summary.

The table also identifies five recommended *pre-emptive programmes* for priority implementation, and gives an indication of the suggested timing and programme for each proposed programme.

Provisional budgets for the recommended programmes are given, totalling US$ 14.6 million. Of this, the pre-emptive measures require $ 2.6 million.

Table A3.1 SUMMARY TABLE OF RECOMMENDED ACTION PROGRAMMES AND PROJECTS, MANAGEMENT OF BASINWIDE ENVIRONMENTAL IMPACTS STUDY

Sector	Major Objectives	Recommended Action	Budget US$ 1000's	Implementation Schedule (years) 1 2 3 4 5 6 7 8 9 10	Lead Participants
A. Conservation Programme					
Enhancing Community Participation in Forest Management & Conservation	Sustainable use of forests; maintain biodiversity levels; minimise soil erosion; better use of highly degraded forest	Establish & support user groups; support private planting; introduce community & leasehold forests; rural development action	690	▒ ▒ ▒ ▒ ▒ ▒ > > > >	DFO
Involvement of Local Communities in Servicing Road Construction Requirements	Meet labor camps' wood needs without severe forest damage; minimize potential social problems during road building	Form local committees to liaise with & provide wood to road labour camps	20	▒ ▒ ▒ > > > > > > >	DFO
Management of National Forests and Plantations	Provide for improved, exclusive HMG/N mngt of selected forests	Link with institutional strengthening project for DFO to improve national forest mgt; establish forest mgt demonstration sites	240	▒ ▒ ▒ > > > > > > >	DFO
Milke Danda Conservation Area	Conserve last extensive forests in the east; protect threatened wildlife spp; promote ecotourism; conserve watersheds	Establish a ca. 500 sq km "Conservation Area"; nature conserv.; pasture mgt; tourism development; rural development	1,325	▒ ▒ ▒ ▒ ▒ > > > > >	Conservation NGO; DNPWC
Conservation of Crop Genetic Diversity	Promote economic benefits from domestic & wild plants for local communities & the nation	Establish short-term crop conserv. plots; short-term preservation of material abroad; establish local conserv. center	805	x x x x x x x ▒ ▒ ▒	National Agriculture Research Centre
Preservation of Monuments, Sacred Sites & Folk Heritage	Preserve the Arun's cultural & folk heritage	Restore/upgrade cultural sites; establish permanent folk heritage record; establish museum; heritage education program	330	x ▒ ▒ ▒ ▒ ▒ > > > >	Dept. of Archaeology; Guthi Samsthan Nat. Museum

*** Projects in *Italics* are recommended for pre-emptive action prior to the road construction phase**

LEGEND
x Planning/preparation period
▒ Core activity
> Continuing routine operation

Sector	Major Objectives	Recommended Action	Budget US$ 1000's	Implementation Schedule (years) 1 2 3 4 5 6 7 8 9 10	Lead Participants
B. Income Generation Programme					
Agricultural Development & Diversification	Improve possibilities for long-term economic sustainability in Sankhuwasabha District	Irrigation development; promotion of cardamom; vegetable production; seed production	1,277		ADB/N; Agr. Inputs Corp.; PAC; DAO
Livestock Development	Minimize degradation of forests, pastures & other resources; improve household incomes	Cow & buffalo milk production; meat production; piggery development; improved breeds	841		DLO; PAC; KHDP
Ecotourism Development	Develop a strategic framework for ecotourism development which is sensitive to env. & culture & provides local benefits	Establish District & Village Tourism Committees; provide infrastructure, training & other support	350		Ministry of Tourism
Small Business Promotion	Promote economically & environmentally viable small business; provide assistance to women entrepreneurs	Establish business promotion office; provide special loan programs, revolving funds, etc.; link with market outlets	120		Ministry of Local Development
C. Institutional Strengthening Programme					
***Strengthening Government Institutions**	Improve forest management; improve implementation of community-based development projects	Institutional strengthening of DFO; support Ilaka agencies with physical facilities & manpower	470		ABIMB
Creation & Strengthening of Community Institutions	Improve community-based resource mngt; initiate & strengthen local economic cooperatives	Form local user groups; form and train Community Development Committees; increase & strengthen cooperatives	530	x x	ABIMB
D. Extension & Training Programme					
***Training & Education**	Promote locally-based action for resource conservation, fund raising; build a cadre of trained local people	Establish Trainig & Education Section; train local HMG/N resource agencies, local people, women; fund-raising	655	x	ABEMU
Forestry Extension	Create attitudinal changes among local people regarding forest conservation	Support DFO in developing effective forest extension programs	30		DFO
Arts Action Groups	Promote effective information dissemination on conservation, health, sanitation & other themes	Support & provide training to district cultural service clubs	30		UNICEF

Sector	Major Objectives	Recommended Action	Budget US$ 1000's	Implementation Schedule (years) 1 2 3 4 5 6 7 8 9 10	Lead Participants
E. Infrastructure & Energy Programme					
Direct Access Road Related Development Project	Discourage tendency for communities to abandon their current locations & move to the roadside	Provide for access road paving & link & spur roads to larger communities along the access road	1,925	x x ▒ ▒ ▒ ▒ ▒ ▒ > >	NEA
Settlement-Related Infrastructure Development	Enable future development of necessary infrastructure within major settlements	Identify funding to support settlement development plans to be prepared by Community Development Committees	1,500	▒ ▒ ▒ ▒ ▒ ▒ ▒ ▒ > >	ABIMB
Alternative Energy Proposals	Improve social, political & economic conditions by tapping local energy resources	Develop rural electrification in high impact zone; develop micro hydropower schemes; study energy substitution	2,500	x x ▒ ▒ ▒ ▒ ▒ > > >	Institution responsible for rural electrification
F. Research, Monitoring & Information Programme					
Biodiversity Research & Database	Provide data to guide biodiversity mngt & monitoring programs	Ethnobotanical research, vegetation & wildlife inventories & transects; wildlife depredation studies	250	▒ ▒ ▒ ▒ ▒ ▒ ▒ ▒ ▒ ▒	ABEMU
Preparation of Trail Network Map	Encourage & support safe & timely travel in the basin	Prepare a trail network map showing settlements, market centers, etc., action plan for upgrading/maintaining trails	15	▒ ▒ ▒ > > > > > > >	Trail & Susp. Bridge Div.; Topographical Survey Dept.
**Environmental Monitoring*	Identify environmental trends & conditions for effective conservation & sustainable development of the Arun's resources	Monitor & evaluate the physical, social, cultural & economic environment of the Arun Basin	750	▒ ▒ ▒ ▒ ▒ ▒ ▒ ▒ ▒ ▒	ABEMU
Total Estimated Budget over 10 Years US $ 14.6 Million					

*** Projects in *Italics* are recommended for *pre-emptive action prior to the road construction phase***

LEGEND

x Planning/preparation period

▒ Core activity

> Continuing routine operation

Appendix 4. MAKALU BARUN CONSERVATION PROJECT

4.1 Introduction

The Makalu-Barun area contains one of the last pristine ecosystems of the eastern Himalaya. Elevations range from 435 m to 8463 m over a distance of some 40 km. The resulting biophysical diversity is of global significance.

Recognising this, and following a five-year planning and preparation period, in 1988 HMG/N signed a 12 year agreement (1988-2000) with the Woodlands Mountain Institute (WMI), an international NGO based in the U.S.A., to establish and manage a new national park and conservation area as an eastwards extension of Sagarmatha National Park. The project, the Makalu Barun Conservation Project (MBCP), covers an area of 2,330 km^2 adjoining the existing 1,148 km^2 Sagarmatha (Mount Everest) National Park to the west and the 35,000km^2 Qomolongma (Everest) Nature Reserve in the Tibet Autonomous Region of China to the north.

4.2 Management Planning

As the first stage of the cooperative programme between the Department of National Parks and Wildlife Conservation (DNPWC) and WMI, a major study of the area was undertaken by a special task force. This was composed of in-country experts supported by WMI specialists.

The study produced a large number of working papers and four management plans. These covered four subject areas: - *Park Management*, *Tourism Management*, *Community Resource Management* and *Scientific Research*. The analyses and recommendations of these four plans were presented and summarised in the *Makalu-Barun National Park and Conservation Area Management Plan*, published in November 1990.

The proposals of the Management Plan incorporate the latest thinking in protected area zonation and community development, including a variety of proposals which seek to integrate conservation objectives with enhancement of economic and social opportunities for the local population. As summarised in the plan itself, they are:

> "The Management Plan calls for the establishment of a new 1,500 km^2 National Park and adjoining 830 km^2 Conservation Area in the northeastern Solukhumbu and northern Sankhuwasabha districts of eastern Nepal. Management Plan objectives are to protect an area of unusual natural beauty and biological diversity, to improve the socio-economic conditions of local people, and to develop models for sustainable conservation and development.
>
> "Implementation will be based upon a participatory model of land management and resource utilisation. This model incorporates the experience, traditional management systems, and recommendations of local people into project policies, strategies, and actions. Additional income-generating opportunities will be developed, particularly for women, through production credit groups. Programmes have been designed to take advantage of the new produce and labour markets that will result from the Arun III Hydroelectric Project and accompanying road construction. Socio-economic improvements will thus be balanced with environmental protection and natural resource sustainability.

"These programmes are based on a participatory planning process and have been developed to engage the local people in a mutually supportive learning process. Thus, while detailed programs and targets have been developed, these are necessarily indicative. They are subject to change through on-going participatory planning and monitoring.

"Both the National Park and the Conservation Area will be managed by HMG's Department of National Parks and Wildlife Conservation (DNPWC). The MBCP is supported through a collaborative agreement between the DNPWC and the Woodlands Mountain Institute, with funding from concerned international and private agencies."

4.3 Current Situation

The project completed its initial planning phase when HMG/N formally gazetted the Park and Conservation Area in November 1991 (Map 4). A Park Warden and WMI Co-Manager were appointed in 1992. 1993 saw the project beginning to establish its presence on the ground, commencing with the establishment of temporary offices in Khandbari, the Sankuwasabha District headquarters.

The project is being co-managed by DNPWC and WMI project staff, with WMI providing firm funding of $ 4.2 million from a variety of sources. National and local cost sharing will be of the order of NRs 1.75 million.

Over the next decade the Department of National Parks and Wildlife Conservation is likely to benefit significantly by way of in-service and on the job training in state-of-the-art mountain park management techniques.

4.4 Relationship of MBCP to the Arun III Project

Protection of the upper watersheds of the Arun River by the MBCP was identified as a benefit to the Arun III Project in the MBCP Management Plan.

The Management Plan also states that major development projects, including hydroelectric schemes, will be prohibited within the National Park, but does not extend this ban to the Conservation Area. As indicated in Maps 2 and 4, the section of river on which the Arun III Project is to be sited forms the eastern boundary of the Conservation Area. However, it is noted that:

> "the Arun III Hydroelectric Project and possible additional Arun projects are of immediate concern and will constitute a focus for MBCP monitoring and consultative activities."

The Management Plan outlines some specific proposed activities related to the Arun III and Upper Arun projects, such as review and critique of studies and assessments, development of recommendations, impact monitoring, and assistance to local people in gaining project employment. Since construction of the Arun III access road will not begin in earnest until after the 1994 monsoon, the MBCP has a lead time of some 20 months to establish appropriate mitigation and enhancement programmes.

The World Bank has proposed that MBCP should be a candidate for additional funding of $ 3.8 million from the Global Environmental Facility (GEF).

Appendix 5. IMPACT MATRICES

This Appendix contains five impact matrix tables, as follows:

Table A5.1 IMPACTS OF ROAD CONSTRUCTION ON HILE

TOPIC	IMPACT	DIRECT/ INDIRECT D: Direct I: Indirect	SIGNIFICANCE H: High M: Medium L: Low	DURATION S: Short M: Medium L: Long	MITIGATION	RESPONSIBILITY
NATURAL RESOURCES	Possible pollution and fires from spills and accidents, sanitation and waste disposal	D	L	S	Normal care and good house keeping. Adequate sanitation facilities; controlled disposal of waste	HMG/ Civil Aviation/ Contractors
	Demand for forest products	I	M	S	Improve forest management	MOFSC
	Disturbance of livestock from helicopter noise	D	L	S	Restrictions on flight paths; compensation	Civil Aviation, NEA
DEMOGRAPHY	Concentration of approx. 450 project employees and labourers	D/I	H	S	Provide extra services	Contractor, RAP
	Influx of job seekers, uncontrolled settlement, social discription	D	M	S	Provide services support local administration	RAP
ECONOMY	Demand for additional food, commodities, fuel, price inflation	D	M	M	Provide goods, kerosene & electricity to workforce	Contractor
	Initial boom; Later loss of trade	D D	H M	M L	Strengthen VDC & local services None	RAP
HEALTH	Pressure on public health services	D	M	S	Establish health facilities for workforce, strengthen local facilities	Contractor, RAP
	Pressure on public water system	D	H	S	Construction of water supply system for project facilities	Contractor
	Additional waste & sewage	D	M	S	Waste to be buried or burned, adequate sanitation	Contractor

Table A5.2 IMPACTS OF TEMPORARY AND PERMANENT FACILITIES ON TUMLINGTAR AREA

TOPIC	IMPACT	CONSTRUCTION/ OPERATION C: Construction O: Operation	DIRECT/ INDIRECT D: Direct I: Indirect	SIGNIFICANCE H: High M: Medium L: Low	DURATION S: Short M: Medium L: Long	MITIGATION	RESPONSIBILITY
NATURAL RESOURCES	Erosion from storm drainage	C/O	D	L	M	Proper design of outfalls	Contractor
	Possible damage from earthquake	C/O	D	H	S	Proper design of structures, foundation	Contractor
	Possible groundwater contamination from fuel spills and sewage	C/O	I	L	L	Bunding around fuel storage	Contractor
	Forest degradation and clearance to meet increased demand for forest products; risk of fire; clearance for cultivation by incomers or displaced persons	C/O	I	H	L	Avoid use of wood as fuel by labour force; supply subsidised kerosene; promote alternatives to wood for construction and heating/cooking; establish user groups; education	Contractor + RAP/NEA/NGO
	Wildlife: loss of habitat; disturbance so reducing breeding success; direct hunting for new markets	C/O	I	H	L	Protect/manage forests; education; extend and enforce hunting regulations; flight path restrictions	Contractor + RAP/NEA/NGO, Civil Aviation
	Increased fishing pressure for new market; use of destructive methods	C/O	I	Uncertain	L	Avoid providing any blasting materials to public. Encourage fishing by non-damaging methods.	Contractor RAP/NEA/NGO.
DEMOGRAPHY/ SETTLEMENT	Displacement of families	C/O	D	H	L	Minimize land requirement; for acquisition of land needed permanently use ACRP	Contractor/NEA
	Concentration of approx. 1000 project workforce	C	D	H	S	Fully serviced camps near workplace	Contractor
	Influx of hundreds of job seekers and entrepreneurs, uncontrolled settlements, urban growth	C	I	H	M	Regulation of settlement on public and private land;Training and strengthening of VDC	RAP/VDC/NGO
	Concentration of approx. 170 road maintenance workforce	O	D	L	L	None required	-
	Further growth as key trading centre	O	I	H	L	-	-

TOPIC	IMPACT	CONSTRUCTION/ OPERATION C: Construction O: Operation	DIRECT/ INDIRECT D: Direct I: Indirect	SIGNIFICANCE H: High M: Medium L: Low	DURATION S: Short M: Medium L: Long	MITIGATION	RESPONSIBILITY
ECONOMY	Loss of arable and grazing land, decrease of agricultural production and fodder resources	C/O	D	M	L	Minimize land requirement; Minimize acquisition of arable land; Acquisition of land only for permanent use; Rent land required temporarily according to recommendations (see.text); ACRP	Contractor/NEA
	Requirement of additional food, commodities, fuel, price inflation	C/O	D/I	H	L	Encourage production of crops & livestock; Provide goods, kerosene, electricity to workforce (fair price shops); Limited use of local fuelwood, prohibit unauthorised felling of trees; Forestry development programmes	RAP/NGO/ Contractor
	Increase of spatial and economic dissimilarities	C/O	I	M	L	Integrated rural development programmes	RAP/NGO
	Additional pressure on infrastructure	C/O	D/I	M	L	Improvement of public infrastructure	RAP/VDC
	Increase of land values	C/O	D/I	M	L	Minimize land requirement. Rent land required temporarily. Minimize delays between property evaluation, compensation and acquisition	NEA/Contractor
	Job opportunities for local people	C/O	D	H	M	Training of local people to fill appropriate positions	NEA/RAP
HEALTH	Additional pressure on public health care system	C/O	D/I	M	L	Improvement of public health services; First aid facilities for project workforce. Information and extension programmes	RAP/Contractor/ NGO/VDC
	Additional pressure on public water system	C/O	D/I	H	L	Water supply for project facilities to be constructed; Improvement of existing water system	Contractor/ HMG/JV
	Additional waste & sewage	C/O	I	M	L	Project waste to be buried or burned, adequate sanitary system; Extension programmes for latrines	Contractor/RAP/ NGO/JV

TOPIC	IMPACT	CONSTRUCTION/ OPERATION C: Construction O: Operation	DIRECT/ INDIRECT D: Direct I: Indirect	SIGNIFICANCE H: High M: Medium L: Low	DURATION S: Short M: Medium L: Long	MITIGATION	RESPONSIBILITY
SOCIO-CULTURAL SYSTEM	Disruption of stable relationships and social patterns in families and communities	C/O	I	M	L	Training and strengthening of VDC; Training and extension programmes, espec. female extention programmes	RAP/NGO
	Unequal income opportunities within families and communities	C/O	D/I	M	L M	Income generation programmes	RAP/NGO
OTHER	Disturbance from helicopter operations, loss of livestock	C	D	M	M	Flight paths, hours of work, siting of noise-sensitive facilities, financial compensation	Contractor/NEA/ Civil Aviation

Table A5.3 IMPACTS OF ARUN ACCESS ROAD

TOPIC	IMPACT	DIRECT/ INDIRECT D: Direct I: Indirect	SIGNIFICANCE H: High M: Medium L: Low	DURATION S: Short M: Medium L: Long	MITIGATION	RESPONSIBILITY
CONSTRUCTION						
NATURAL RESOURCES	Destabilisation of slopes by cut and fill	D	H	L	Care in route alignment, design, construction sequence, drainage, slope stabilisation measures	Engineer/ Contractor
	Damage to slopes, streams and fields from spoil disposal	D	H	M	Balance earthworks; locate and operate disposal sites with care; avoid sidecasting; use rivers for disposal if appropriate	Engineer/ Contractor
	Impacts on forests from land take and demands of workforce and incomers	D/I	H	L	Cut only those trees affected by Permanent Works; specify non-timber construction materials; ban use of wood for heating bitumen; control workforce and supply subsidised kerosene; strengthen forest protection and management	Engineer/ Contractor/RAP
	Severance of wildlife habitat, habitat destruction, disturbance, hunting	D/I	H	M	Route road around key ecological areas; ban Contractor use of key areas; control workforce; education	Engineer/ Contractor/RAP
	Increase in fishing; use of damaging methods	I	?	M	Supply subsidise food to workforce; control explosives; encourage sustainable fishing methods	Contractor/RAP
ECONOMY	Land take for road	D	M	L	Minimise road length and Right of Way width; compensate and rehabilitate	Engineer
	Employment on road construction, and resultant cash flow	D	H	M	Encourage local recruitment	Engineer/ Contractor
	Price inflation, and lowered availability of food to poor	I	H	M	Provide subsidised food for workforce; assist poor in obtaining employment and service opportunities	Contractor/RAP

TOPIC	IMPACT	DIRECT/ INDIRECT D: Direct I: Indirect	SIGNIFICANCE H: High M: Medium L: Low	DURATION S: Short M: Medium L: Long	MITIGATION	RESPONSIBILITY
HEALTH	Accidents at work and on the road	D/I	M/H	S	Safe working techniques; safety clothing; driver training; education	Contractor/RAP
	Possible spread of malaria and other diseases amongst and by workforce	D	H	L	Treat new employees; provide prophylactics; maintain clinics; health education	Contractor/RAP
	Stress on existing health facilities	I	M/H	M	Strengthen health system	RAP
OPERATION: WHEN ROAD IS OPENED TO PUBLIC						
NATURAL RESOURCES	Long-term slope stability problems along some sections of road	D	M	L	Provide adequate resources for effective maintenance programme	HMG
	Greatly increased demand for forest products, resulting in unsustainable harvesting of all products over wider area than at present and retreat of forest	I	H	L	Improve forest management, especially by user groups; target programmes for poor to minimise need for illegal/unsustainable harvesting and slash and burn by poor	MOFSC/RAP
	Loss of habitat of rare and endangered species of mammals, reptiles, birds and insects	I	H	L	Improve forest management; control hunting; education; encourage eco-tourism	MOFSC/DNPWC/ RAP
ECONOMY	Very large price adjustments when road opens, then low prices for imports	I	H	L	None required or feasible	
	Loss of long-haul portering jobs for poor	I	H	L	Income generation programmes to create alternative opportunities	RAP
	Improved incomes from livestock products	I	M	L	Assist with needed inputs, marketing	RAP
	Reduced prices for locally-produced crops	I	M	L	Programmes to intensify/diversify agricultural production	RAP
	Increased tourism	I	M	L	Programmes to maximise local benefit and minimise ecological and cultural impact	RAP
	Growth of settlements near road	I	H	L	Assist with planning and services	VDCs/RAP
CULTURE	Accelerated cultural change	I	H	L	Heritage programmes; education	RAP/VDCs

Table A5.4 IMPACTS OF HYDROPOWER COMPONENTS

TOPIC	IMPACT	CONSTRUCTION/ OPERATION C: Construction O: Operation	DIRECT/ INDIRECT D: Direct I: Indirect	SIGNIFICANCE H: High M: Medium L: Low	DURATION S: Short M: Medium L: Long	MITIGATION	RESPONSIBILITY
AIR QUALITY	Increase of airborne dust from construction traffic and plant during dry season	C	D	L	M	Install dust collectors (filters), water sprays and emission control equipment; Dust control with water in dry season; black top heavy use areas; breathing protection	Contractor
TOPOGRAPHY, SOILS, LANDUSE & VEGETATION	Site road construction impacts on drainage systems, vegetation cover, run off, slopes; loss of cultivated land	C	D	M	M	Road construction methods to be controlled; Reduce to extent possible spoil dumps and associated roads; Combine adit and powerhouse camps; Slope protection measures; Reclaim and revegetate all temporary roads; Salvage soils for use in reclamation	Contractor
	Impacts of quarries and borrow pits on drainage systems, vegetation cover, slopes, and land; creation of steep highwall sections	C	D	M	M	Backfill borrow pits and quarries with spoil; Backfill to stable contours; Provide top soil; Excavate by having benches wide enough for later cultivation; Provide for controlled drainage; Reforest & revegetate disturbed slopes; Make temporary facilities subject to approval	Contractor
	Spoil disposal areas: loss of cultivated land; creation of fill areas; construction of temporary access roads	C	D	M	M	Eliminate spoil dumps by using selected spoil for concrete, road maintenance, and backfill for quarry & borrow pits; Place remainder of spoil in river; Make temporary facilities subject to approval	Contractor
	Contractor's Camps: temporary loss of cultivated lands; effects on drainage systems; loss of vegetation cover; loss of productive forest lands; construction of access roads; waste disposal	C	D	H	M	Pre-select sites. Alternative or additional sites proposed by Contractor to be subject to Engineer's approval; Combine adit and powerhouse construction camps; Implement erosion protection measures; minimise distance between camps & work areas; Salvage soils prior to grading; Replace soils & reclaim as cultivated land; Install drainage control systems for long term use; Revegetate all disturbed slopes Make temporary facilities subject to approval; Reduce space requirements by specifying two storey buildings	Contractor/NEA

TOPIC	IMPACT	CONSTRUCTION/ OPERATION C: Construction O: Operation	DIRECT/ INDIRECT D: Direct I: Indirect	SIGNIFICANCE H: High M: Medium L: Low	DURATION S: Short M: Medium L: Long	MITIGATION	RESPONSIBILITY
	Permanent NEA Camp: loss of cultivated land; displacement of local residents; changes in drainage systems; increase in erosion potential; creation of terraces; cutting of slopes	C	D	L	L	Salvage soils prior to grading; Minimize height of benches; Install drainage control systems; Revegetate slopes; Reduce area needs by eliminating free standing single family structures. Develop two storey buildings where possible to reduce building sizes. Compensation payment and additional measures (see text).	Contractor/NEA
	Indirect Impacts: Demand for fuelwood and other forest products	C/O	I	H	L	Programme of forestry conservation and development; provide canteens for staff; make Contractor responsible for behaviour of his workforce	Contractor/NEA/RAP
HYDROLOGY AND SEDIMENTS	Dam Construction & Operation: changes to hydrological regime; downstream dewatering; reservoir sedimentation and flushing	C/O	D	L	L	Hazard warning system for downstream areas when flushing reservoir	NEA
	Construction Activities: introduction of oil, greases from tunnelling & other activities into water bodies	C	D	M	S	Collection of used lubricants for controlled disposal	Contractor
FISH	Dam Construction and Operation: changes to flow regime & sediment deposition patterns; changes to aquatic habitat; interruption of migratory patterns	O	D	H	L	None yet known to be feasible; further surveys required	NEA: APEMU
BIRDS & MAMMALS	Construction of Project Facilities: loss of habitat; disturbance of breeding sites	C	D	M	M	Minimise land take and forest clearance; controls on workforce; protect forests	NEA/Contractor/RAP
DEMOGRAPHIC	Project Construction: concentration of approx. 3500 hydropower workforce; displacement of approx. 190 households	C	D	H	M	Site camps near workplaces & at a distance from indigenous settlements; ACRP; Rural Development & Training Programme	NEA/RAP
	Project Operation: permanent NEA staff of approx. 203; development of larger economic centre resulting in increased population	O	I	L	L	Strengthen local community organisations and VDC	RAP
	Indirect Impacts: influx of 2-3000 job seekers & entrepreneurs; uncontrolled settlement	C	I	H	M	Regulation of settlement on public and private land; strengthen local organisations	VDCs/NGOs/RAP

TOPIC	IMPACT	CONSTRUCTION/ OPERATION C: Construction O: Operation	DIRECT/ INDIRECT D: Direct I: Indirect	SIGNIFICANCE H: High M: Medium L: Low	DURATION S: Short M: Medium L: Long	MITIGATION	RESPONSIBILITY
SOCIO-ECONOMIC AND CULTURAL	Land take, loss of arable land	C	D	M	M	Intensify production of remainingland; Reclaim arable land after construction.	NEA/RAP/ Contractor
	Loss of forest resources;	C	D/I	M	L	Control deforestation; Forestry conservation & development programme;	NEA/Contractor/RAP
	Displacement of approx. 144 families;	C	D	H	M	Minimize Project land requirements; Compensation & rehabilitation programme;	NEA
1. Project Construction	Interruption of normal farming activities;	C	D/I	M	M	Intensify production on remaining land; Provide skill training for employment on construction;	RAP NEA/RAP
	Requirement for additional food for local people & workforce & immigrants;	C	D	H	M	Encourage production of crops & livestock products for sale to workforce and other outlets; Contractor to provide logistics for his workforce.	RAP/Contractor
	Requirement for additional fuel supplies	C	D	H	M	Contractor to provide kerosene & electricity to workforce, limit use of local fuelwood; Prohibit unauthorised felling of trees and use of open fire; Forestry development programme.	Contractor/ MOFSC/RAP
	Disturbance of traditional social & cultural patterns by large scale immigration	C	D	M	M	Training and strengthening of Village Development Committees; programmes for non-indigenous labour	RAP
2. Project Operation	Some job opportunities for local people;	C/O	D	M	L	Training of local people to fill appropriate positions	APEMU
	Possible availability of electricity in Project area	O	D	M	L	Use proposed 33 kV power line to provide local settlements & small industries with power; Develop rural electrification	NEA

Table A5.5.1 : STAGES 1 AND 2 TRANSMISSION LINE IMPACTS - CONSTRUCTION PERIOD

TOPIC	IMPACT	REGION H=HILL T=TERAI	DIRECT/INDIRECT D=DIRECT I=INDIRECT	SIGNIFICANCE H=HIGH M=MEDIUM L=LOW	DURATION S=SHORT M=MEDIUM L=LONG	MITIGATION	RESPONSIBILITY
PHYSICAL RESOURCES Water Quality	Sediment from earthworks	H	D	L	S	Careful working methods; revegetation.	Contractor
Slopes and Soils	Erosion from earthworks, especially access roads	H	D	M/H	M	Careful design and alignment; controls on borrow areas and spoil disposal	NEA/Engineer/ Contractor
ECOLOGICAL RESOURCES Forests	Vegetation clearance, fire risk	H/T	D/I	H	L	Route line away from forests; minimise ROW width fire precautions	NEA/Engineer/ Contractor
Wetlands	Vegetation clearance, disturbance, fire risk	K. Tappu	D/I	Uncertain	S/M	Alternative line location, good working practices	NEA/Engineer/ Contractor
Wildlife	Disturbance, habitat loss	H/T	D/I	Uncertain	S/M	Avoid wildlife areas and breeding seasons; control workforce	NEA/Engineer/ Contractor
HUMAN USE VALUES Land Take	Permanent loss of arable land; decrease of agricultural production	H/T	D	L (however,for small farmers: H)	L	Minimise land requirement Minimise acquisition of arable land	NEA/Engineer/ Contractor
	Temporary loss of arable land grazing land; decrease of agricultural production and fodder resources	H/T	D	H	S	Acquisition of land only for permanent use according to LAG 2045 and recommendations (comp.text)	NEA/Contractor
	Loss of houses, displacement	H/T	D	L (however, in Kathmandu Valley: M)	L	Rent land required temporarily according to recommendations (comp. text)	NEA/Contractor
	Damage to arable land, crops and facilities	H/T	D	M	S	Reinstatement, compensation	Contractor
Employment	Concentration of approx. 375-450 project workforce	H T	D D	H L	S S	Camps near Workplace	Contractor, Engineer
	Influx of job seekers and entrepreneurs	H T	I I	H L	M M	Control of settlement on public and private land; Training, strengthing VDCs	VDC/RAP

TOPIC	IMPACT	REGION H=HILL T=TERAI	DIRECT/INDIRECT D=DIRECT I=INDIRECT	SIGNIFICANCE H=HIGH M=MEDIUM L=LOW	DURATION S=SHORT M=MEDIUM L=LONG	MITIGATION	RESPONSIBILITY
Health	Additional pressure on public health care system	H/T	D/I	M	M	Improvement of public health services; Provide health facilities for workforce; Information and extension programmes	RAP/Contractor
	Additional pressure on public water system	H/T	D/I	M	M	Water Supply for project to be constructed; Improvement of existing water systems	Contractor/RAP
	Additional waste sewage	H/T	D/I	M	M	Project waste to be buried or burned; Adequate sanitary system	Contractor/RAP
Trade/Infrastructure	Additional pressure on infrastructure	H T	D/I D/I	M L	M M	Improvement of public infrastructure	RAP
	Requirement of additional food, commodities, fuel: inflation	H T	D/I D/I	M L	M M	Provide goods, kerosene, electricity to workforce (fair price shops); Limit use of local fuelwood, prohibit unauthorised felling of trees	Contractor, Engineer
QUALITY-OF-LIFE VALUES Socio-Cultural System	Disruption of community relations	H T	D/I D/I	M L	L L	Not feasible	
	Unequal income opportunities in families and communities	H/T	D/I	M	M	Not feasible (except in the Arun Valley: Income Generation Programmes)	RAP/NEA
	Negative attitudes towards government projects, implications for future development	H/T	I	H	L	Planning rural electrification and roads	HMG

Table A5.5.2 : STAGES 1 AND 2 TRANSMISSION LINE IMPACTS - OPERATIONAL PERIOD

TOPIC	IMPACT	REGION H=HILL T=TERAI	DIRECT/INDIRECT D=DIRECT I=INDIRECT	SIGNIFICANCE H=HIGH M=MEDIUM L=LOW	DURATION S=SHORT M=MEDIUM L=LONG	MITIGATION	RESPONSIBILITY
PHYSICAL RESOURCES Slopes and Soils	Erosion/Sedimentation from access roads	H	D	M	L	Maintenance or reinstatement	NEA, Village Development Committees
ECOLOGICAL RESOURCES Forests	ROW vegetation management	H/T	D	L	L	Vegetation management guidelines	NEA
Birds	Collision hazard	H?/T	D	Uncertain	L	Line location to avoid flyways; design features to minimise collisions	NEA/ContractorDept. of National Parks & Wildlife Conservation
Other Wildlife	Utilisation of/barrier effect of RoW	H/T	D	L	L	None required	
HUMAN USE VALUES Aviation	Collision hazard	Tumlingtar	D	H	L	Line location & design visibility aids	NEA/Dept. of Civil Aviation
Land Values	Decrease in land value in the vicinity of the line	Kathmandu	I	H (in densely populated areas)	L	Compensation payment	NEA
QUALITY-OF-LIFE VALUES Public and Worker Safety	Risk of electrocution	H/T	D	H	L	Security devices; public education; training.	NEA
Visual Amenity and Heritage Sites	Spoiling key views and landscapes; Alien feature near heritage sites: effect on tourism	H	D	M	L	Line location to avoid sensitive sites, camouflage	NEA/Engineer/ Contractor

Table A5.5.3 : SUBSTATION IMPACTS

TOPIC	IMPACT	DIRECT/INDIRECT D=DIRECT I=INDIRECT	SIGNIFICANCE H=HIGH M=MEDIUM L=LOW	DURATION S=SHORT M=MEDIUM L=LONG	MITIGATION	RESPONSIBILITY
CONSTRUCTION PERIOD						
QUALITY-OF-LIFE VALUES Employment	Project Workforce of 40-50	D	L	M	None required	
HUMAN USE VALUES Land Taken	Permanent and temporary loss of arable and grazing land, decrease of agricultural production and fodders resources Loss of houses, displacement	D	H (for small farmers)	L	Avoid land acquisition in densely populated areas Acquisition of land for permanent use according to ACRP; Rent land required temporarily	NEA NEA/Contractors
OPERATIONAL PERIOD						
PHYSICAL RESOURCES Soil and Water	Transformer oil spills	D	L	M	Oil retention sump	NEA/Engineer/ Contractor
QUALITY-OF-LIFE VALUES Health	EMF exposure to nearby residents	D	L	L	Appropriate siting	NEA/Engineer/ Contractor
Safety	Lightning strikes, transformer explosions & etc.	D	H	S	Appropriate design, maintenance, training	NEA/Engineer/ Contractor

Appendix 6. INDEX TO ENVIRONMENTAL SECTIONS OF TENDER DOCUMENTS

Normal good engineering practice includes many measures which qualify as sound environmental practice as well. In addition, in preparing the Tender Documents for the Arun III Project special attention has been given to drafting the Clauses where environmental or socio-economic factors may be involved. As the Project proceeds, this consideration is to be extended to all sections of the documents and for all Lots. While some Clauses may contain only minor references to environmental matters, they are nevertheless important, and where appropriate have been cross-referenced to a more detailed clause.

The principal environmentally-related clauses, taken from Civil Lots C1 and C3 (the first two major lots to be tendered), are as follows:

A FORMS: C1/C3

The FORMS section provides proformas for the Bidders to complete, and allows rapid comparative evaluation of bids.

2.18	Description, Location and Drawings of Construction Facilities and Temporary Camps
2.19	Health and Safety/Environmental Protection
2.20	Muck Disposal

A INFORMATION: C1/C3

This section of the documents provides information about the project to the Bidders.

3.1.1	General
3.2.5	Natural Environment
3.2.5.1	General
3.2.5.2	Climate
3.2.5.3	Hydrology
3.2.5.5	Geology
3.2.5.6	Seismicity
3.2.5.7	Topography, Soils and Land Use
3.2.5.8	Vegetation and Forests
3.2.5.9	Fish
3.2.5.10	Mammals, Birds and Reptiles
3.2.5.11	Other Projects
3.2.6	Population, Social and Cultural Aspects
3.2.6.1	Introduction
3.2.6.2	Population Statistics
3.2.6.3	Education and Skills
3.2.6.4	Labour Force
3.2.6.5	Cultural and Religious Sites
3.2.6.6	Archaeological Sites
3.2.6.7	Health

3.2.7	Rural Economy
3.2.7.1	Introduction
3.2.7.2	Agriculture and Livestock
3.2.7.3	Off-Farm Income
3.2.7.4	Fishing
3.2.7.5	Fuel and Fodder
3.2.8	Institutions
3.2.15	Labour Regulations

B GENERAL CONDITIONS: C1/C3

Together, the GENERAL CONDITIONS and CONDITIONS OF PARTICULAR APPLICATION constitute the CONDITIONS OF CONTRACT.

FIDIC: Standard Federation Internationale des Ingenieurs Conseils Conditions (4th Edition, reprinted 1988 with editorial amendments)

C CONDITIONS OF PARTICULAR APPLICATION: C1/C3

The CONDITIONS OF PARTICULAR APPLICATION qualify the GENERAL CONDITIONS and override both these and the TECHNICAL SPECIFICATIONS.

GENERAL OBLIGATIONS

16.4	Employment of Local Personnel
16.5	Employment of Local Sub-Contractors
20.1	Care of Works
24.2	Insurance against Accidents to Workmen
27.1	Fossils
30.8	Maintenance of the Access Road

LABOUR

34.1	Engagement of Staff and Labour
34.2	Health and Safety Plan
34.3	Rates of Wages and Conditions of Labour
34.6	Housing for labour
34.7	Accident Prevention Officer; Accidents
34.8	Health and Safety
34.9	Measures against Insect and Pest Nuisance
34.10	Epidemics
34.11	Burial/Cremation of the Dead
34.12	Supply of Foodstuff and Fuel
34.13	Supply of Water
34.14	Sanitation
34.15	Alcoholic Liquor or Drugs
34.16	Arms and Ammunition
34.17	Festivals and Religious Customs
34.18	Disorderly Conduct
34.19	Labour Negotiations
34.20	Infringement
34.21	Records to be Kept

34.22 List of Personnel Employed
34.23 Repatriation of Labour

MATERIALS, PLANT AND WORKMANSHIP

36.7 Local Materials

ENVIRONMENTAL PROTECTION

79.1 Environmental Protection Plan
79.2 Environmental Protection and Care
79.3 Permanent Structures and Facilities
79.4 Temporary Structures and Facilities
79.5 Site Roads
79.6 Maintenance of Other Services and Structures
79.7 Spoil Dumps
79.8 Pollution of Waterways
79.9 Wildlife
79.10 Prevention of Illegal Felling and Transport of Timber
79.11 Land Reinstatement
79.12 Archaeological Sites
79.13 Control, Documentation and Monitoring
79.14 Aerial Transport
79.15 Measurement and Payment
79.16 Fire Prevention and Firefighting Equipment
79.17 Restricted Areas
79.18 Waste Collection and Disposal
79.19 Relations with Local Communities and Administrations

80. Liability for Maintenance and Remedial Works

D **GENERAL TECHNICAL SPECIFICATIONS:** **C1/C3** (but not C3-2, the Access Road)

The TECHNICAL SPECIFICATIONS are in two parts: the GENERAL TECHNICAL SPECIFICATIONS, and the PARTICULAR TECHNICAL SPECIFICATIONS, which qualify and override them.

1.1.2 Sites for Site Installation
1.1.3 Removal of Site Installation
1.3.7 Water Supply and Sewage System/Disposal
1.3.8 First-Aid Station
1.3.13 Environmental and Socio-Economic Aspects
1.3.13.1 General
1.3.13.2 Contractor's Operations
1.3.13.3 Contractor's Superintendence
1.3.13.4 Temporary Structures and Facilities
1.3.13.5 Rivers and Streams
1.3.13.6 Waste Collection and Disposal
1.3.13.7 Use of Wood as Fuel
1.3.13.8 Spoil Dumps and Stockpiles
1.3.13.9 Relations with Local Communities and Administrations
1.3.13.10 Health Care and Preventive Actions

E PARTICULAR TECHNICAL SPECIFICATIONS

The following important Clause covers and controls spoil dumping into the Arun River.

Chapter 2 **C1/C2/C3**

2.5.3.4 Dumping

The selection of Clauses below is taken from the Particular Technical Specifications for the Arun Access Road. Similar or identical clauses appear in the Technical Specifications for the other Lots.

Chapter 3 **ARUN ACCESS ROAD** **C3-2-E-3**

100	GENERAL
101	Facilities for the Engineer
105	Privately or Community Owned Services and Structures
109	Land Required for the Works
111	Progress Photographs
200	SITE CLEARANCE
201	Clearing
202	Existing Vegetation and Roots
300	PLANTS AND PLANTING METHODS
301	Plant Materials
302	Planting Methods
303	Fire Prevention
600	EARTHWORKS
601	Definition, Classification and General Use of Earthworks Materials
602	Explosives and Blasting
603	Excavation of Cuttings
611	Earthworks to be Kept Free of Water
612	Soiling and Revegetation
618	Environmental Protection
619	Borrow Pits and Quarries
620	Spoil Disposal
900	SURFACE DRESSING
901	Materials
2000	MISCELLANEOUS PROTECTION WORKS
2003	Slope Treatment
2004	Rip-Rap
2600	MATERIALS
2615	Fertilizer
2616	Grass Seeds
2800	MAINTENANCE