No. 2

JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF INDUSTRY AND HANDICRAFTS OF
THE GOVERNMENT OF LAO P.D.R.

FEASIBILITY STUDY
ON
THE NAM NGIEP-I HYDROELECTRIC POWER PROJECT
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC



FINAL REPORT : VOLUME 3

SUPPORTING REPORT (I)
FIRST ENVIRONMENTAL IMPACT ASSESSMENT REPORT



FEBRUARY 2000

NIPPON KOEI CO., LTD.

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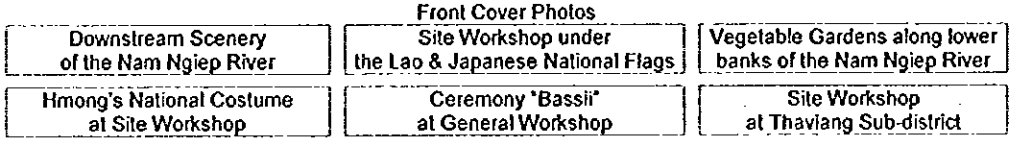
FINAL REPORT

COMPOSITION OF REPORTS

Volume 1	Main Report		
Volume 2	Executive Summary Report		
Volume 3	Supporting Report (I)	:	First Environmental Impact Assessment Report
Volume 4	Supporting Report (II)	:	Preliminary Environmental Management Plan
Volume 5	Supporting Report (III)	:	Preliminary Resettlement Plan
Volume 6	Supporting Report (IV)	:	Sub-Contractor's Field Investigation Report
Volume 7	Supporting Report (V)	:	Records during Field Investigations

Front Cover Photos



VOLUME 3 : SUPPORTING REPORT (I)

FIRST ENVIRONMENTAL IMPACT ASSESSMENT REPORT

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ABBREVIATIONS

Lao PDR agencies

EDL	Electricite du Laos
GOL	Government of Lao PDR
HPO	Hydropower Office (Department of Electricity, MIH)
LWU	Lao Women's Union
MAF	Ministry of Agriculture and Forestry
MIH	Ministry of Industry and Handicrafts
MOH	Ministry of Health
STEA (former STENO)	Science, Technology and Environ. Agencies (Organization)

Foreign organizations

ADB	Asian Development Bank
GOJ	Government of Japan
IUCN	World Conservation Union (Switzerland)
JICA	Japan International Cooperation Agency (Japan)
NTEC	Nam Theun 2 Electricity Company
OECF (JBIC)	Overseas Economic and Cooperation Fund (Japan) Note: Changed organization to JBIC (Japan Bank for International Cooporation) on October 1, 1999.
UNDP	United Nations Development Program
WCS	The Wildlife Conservation Society (New-York)
WHO	World Health Organization

Others

B.	"Ban" Village in Laotian language
BOT	Built-Operate-Transfer
BOOT	Built-Own-Operate-Transfer
CFRD	Concrete Faced Rockfill Dam
EAC	Environmental Assessment Committee
EIA	Environmental Impact Assessment
EMMP	Environmental Management & Monitoring Plan
F/S	Feasibility Study
GPS	Global Positioning System
HEPP	Hydroelectric Power Project
ICB	International Competitive Bidding
IEE	Initial Environmental Examination
IPP	Independent Power Producer
LCB	Local Competitive Bidding
MOU	Minutes of Understanding
NBCA	National Biodiversity Conservation Area
NGOs	Non Governmental Organizations
NK-NBCA	Nam Khading Protected Area
PKK-NBCA	Phou Khao Khouai Protected Area
PPA	Power Purchase Agreement
SPP	Small Power Producer
RAP	Resettlement Action Plan
S/W	Scope of Works
TOR	Terms of Reference

Unit

EL.( ) m	Meters above Sea Level
US$	US Dollar
K.	Kip in Lao PDR
Bht.	Baht in Thailand
MW	Mega Watt (one million watt)
GWh	Giga Watt Hour (one billion watt hour)
B-C, B/C	B: Benefit and C: Cost
EIRR, FIRR	Economic/Financial Internal Rate of Return

CHAPTER - 1

INTRODUCTION

1. INTRODUCTION

1.1. BACKGROUND OF THE STUDIES

The Nam Ngiep 1 Hydropower Project (NNHP) consists of a 185 m rockfill dam with upstream facing located on the Nam Ngiep river about twenty four (24) km upstream its confluence with the Mekong river in Pakxan. The NNHP will create a 156 km² reservoir with a total capacity of about 7 billions m^3. The installed capacity is anticipated to be 440 MW.

The Pre-Feasibility Study for NNHP was carried out in 1989-1990 by Sogreah Ingénierie (France) and HEC (Lao PDR) under a grant from the French Government. The Study aimed to determine the technical and economical viability of the Project in the energy market conditions prevailing in the Lao PDR and in the region.

In 1991-92, a revision of the Pre-Feasibility Study was undertaken. Additional geophysical investigations were carried out to provide more detailed information on the scheme, more especially on the most appropriate dam type and hence on the overall cost of the NNHP.

In 1995, an updating Study was performed. It included a revision of the initial hydrology, on the basis of data collected since 1990, an updating of unit rates for civil works and electromechanical equipment, of electricity tariffs and of the previous economic analysis.

Environmental and social impacts were briefly considered during the Pre-Feasibility Study, but this was limited to deskwork, and the impacts were not the subject of further investigations during revision and updating stages of the Study

Within the context of the present Feasibility Study, which started in August 1998, field investigations were carried out in order to establish the information base line by reference to which potential impacts may be estimated. An Initial Environmental Examination (IEE) was produced in October 1998. Preliminary impact assessment and conclusions was presented as an Interim Report in March 1999. Both documents were subject to public presentation and extensive discussions with the Environmental Assessment Committee (EAC) and the Hydropower Office (HPO) of the Ministry of Industry and Handicraft. The present report provides the results and interpretation of information gathered so far. It must be considered as a first major step in the long process of environmental impact assessment.

1.2. OBJECTIVES OF FIRST EIA REPORT

The objectives of this report is to provide the environmental background for the main purpose of the present Feasibility study which is to recommend the best design option from the technical, economical, social and environmental points of view. In order to achieve this objective at the most reasonable cost, the Governments of the Lao PDR and of Japan have organized the Feasibility Study into two phases:

A **First Phase**, to:

- Identify any major technical or environmental issues which may threaten the feasibility of the NNHP,
- Identify the most appropriate design alternative option that takes full consideration of technical, environmental and economical aspects.

A **Second Phase, conditional on the First Phase findings.** Based on the results of the First Phase, both the Japanese and Laotian governments will mutually agree whether or not the Feasibility Study should be continued to the Second Phase detailed investigation. If it is agreed to proceed, the Second Phase will include further, more detailed, technical studies and investigations, such as geological surveys, aerial photography, and topographical mapping.

The present First Phase of the Feasibility Study includes data acquisition and preliminary analysis to provide the Laotian and Japanese decision-makers with sufficient and reliable information on the technical, economical, social and environmental issues related to the Project implementation. It includes the extension of the existing hydro-meteorological network by installation of additional equipment (one rain gauge and two river gauging stations), additional geological observations at dam site, and environmental field surveys.

As explained in this report, several environmental issues are evaluated at a level which requires improvement in the future, but which are nevertheless described or analyzed with a sufficient accuracy to provide a reliable basis to JICA and to the Government of Lao PDR for decision making about the future of this Project.

Recent experience in Lao PDR and in other countries confirm that the EIA is not limited to a report but is a more comprehensive process which must adapt the several levels of decision making which constitute the life of a Project. This is the reason why this report has been called First Environmental Impact Assessment (First EIA), keeping the reader aware that further work, investigations and reporting is hopefully coming in the future.

This does not mean that the FEA covers only a part of what is generally required in this type of studies. This report is comprehensive and presented in a form which satisfies both the requirements of the JICA and of major international funding agencies.

1.3. ORGANIZATION OF THE FIRST EIA REPORT

The First EIA is only a supporting document of a larger set of reports including a Preliminary Resettlement Plan (PRP) and an Environmental Management Plan (EMP). However, a summary of these specific reports as well as a summary presentation of the Project are included, mainly to make this report self understandable for the reader, but also to follow the recommended content for EIA report as expressed by the World Bank or the Asian Development Bank, both funding organizations which may eventually participate in the development of this Project. Thus the reader will find the following chapters in this report:

1. The institutional and legal framework for environmental management in Lao PDR,
2. A summary description of the Project components,
3. The baseline information on present environmental and social conditions in the region,
4. The analysis of impacts and the presentation of mitigation measures,
5. A summary of the Environmental Management plan,
6. A summary of the Preliminary Resettlement plan, and
7. A summary of the Public Consultation and Participation implemented during the study.

CHAPTER - 2

INSTITUTIONAL AND LEGAL FRAMEWORK

2. INSTITUTIONAL AND LEGAL FRAMEWORK

2.1. GOVERNMENT INSTITUTIONS

The GOL has designated the **National Office of Science, Technology and Environment (STENO)** to serve as the national environmental management agency, reporting directly to the Prime Minister's Office. With six departments and one institute, STENO is envisioned as an umbrella agency to co-ordinate environmental activities at the national level. STENO also has a mandate to develop provincial level representation, to provide the basis for community-based action. STENO is presently considered as the body responsible for the enforcement, control and evaluation of EIA studies related to any infrastructure project developed in Laos.

The **Inter-Ministerial Working Group for Environment and Sustainable Development** coordinates environmental planning and management among line ministries

The **Ministry of Agriculture and Forestry (MAF)** is a key GOL natural resource management agency. It operates at provincial and district levels through the Provincial and District Agricultural and Forestry Offices.

The **Center for Protected Areas and Watershed Management (CPAWM)**, under the Department of Forestry in the MAF, is also an important resource management group, with activities in wildlife, watershed management, NBCA management, and wetland conservation.

In the Ministry of Industry and Handicrafts (MIH), the **Hydropower Office (HPO)** is the focal body for supervision and co-ordination of studies related to hydropower projects, including environmental and social considerations.

2.2. ENVIRONMENTAL MANAGEMENT

2.2.1. ENVIRONMENTAL POLICIES

Current policies of the Government of the Lao PDR and capacity building related to environmental management have undergone rapid development over the last seven to ten years. These originate from the **National Environmental Action Plan (NEAP)** developed in the early 90's and officially implemented in November 1993.

The NEAP assessed the country's major environmental issues and problems, as well as their underlying causes, together with specific strategies and actions required to address them. The NEAP thus has provided the framework for the Lao PDR's environmental policy development and its implementation.

Also of key importance for conservation is the implementation of a **Tropical Forestry Action Plan (TFAP)**. The FAO had encouraged tropical countries to develop their own TFAPs, to maintain the sustainable management and utilization of natural resources and to provide for the well being of their citizens. In 1989, the GOL recognized the importance of preparing its own TFAP; and the First National Forest Conference was held. The TFAP was officially endorsed by the GOL through issuance of the Prime Minister's Decree No.66/PM dated 7/9/91. In the same year, Decree 67/PM established a temporary ban on logging activities nationwide.

In line with this conservation strategy, 20 protected areas, called **National Biodiversity Conservation Areas (NBCA)**, have been created over the last four years, covering more than ten percent (10%) of the country. In this field of conservation, a strategic institutional planning effort is in its early stage. Since 1997, discussions are held to identify issues and options for establishing a watershed management institution, which will have the responsibility for managing and spending the money from hydroelectric revenues that is earmarked for watershed conservation, and regulating all activities in the watershed area that potentially affect watershed conservation.

Watershed management and control is also a key objective in the GOL's environmental agenda. The recent 'Law on Water and Water Resources' (No. 02-90 of 11 October 1996) is intended to assure sustainability in the use of the water resources through a system of policies on ownership, conservation, use and management. In particular, it establishes a basis for setting out requirements for conducting EIAs for large-scale water resource usage, thus including hydropower projects: "*in building a hydropower dam, consideration shall be given to the preservation of the sources of water, forests, the environment, flood protection, water supply, irrigation, water transport, fishing, fishery, aquatic life and others*".

More recently, the **Environmental Law** endorsed by the Parliament in February 1999 and declared for enforcement by Presidential Decree (Letter 09/President Office of 26/4/99) provides the legal framework for environmental management related to development projects, including obligations regarding EIA. More particularly, it supports STENO's role in environmental management of the hydropower sector (supervision, evaluation of EIA, monitoring).

2.2.2. LAWS AND REGULATIONS

Major recent laws and regulations related to environmental management and conservation are listed in the following Table 2.1:

Table 2.1: Selected Laws and Decrees Environment related

Type	Status	Description
Environmental Law	Endorsed by Parliament 02/99 Presidential Decree Letter 09, of 26/4/99	Establishes fundamental principles for environmental protection, conservation and EIA procedures
Forestry Law No. 01/96	Promulgated 11/10/96 Replaces PM Decree No.169 on Management and Use of Forest and Forested Land and PM Decree No. 186 on the Allocation of Land and Forest for Tree Planting and Forest Protection and Conservation	Determines principles, regulation and measures on the use, management, protection, conservation of forest resource
Law on Water and water resources No. 02/96	Promulgated 11/10/96	Intends to assure sustainability of use through policies related to ownership, preservation, use and watershed management
Land Law No. 01/97	Promulgated 12/4/97	Provides principles of land ownership
PM Decree No. 164	Dated 29/10/94	Establishes 18 National Biodiversity Conservation Areas (4 additional NBCA since then)
Council of Ministers (CM) Decree No.185	Promulgated 21/10/91	Defines prohibition of exports of certain species of wildlife

2.2.3. INTERNATIONAL ORGANIZATION POLICIES AND INTERNATIONAL TREATIES

Because official Lao guidelines on conducting EIAs and planning for involuntary resettlement are currently under preparation, the GOL applies the recommendations and guidelines of the World Bank (WB), which are also recognized by the Asian Development Bank (ADB), to large infrastructures projects.

The key references for these Guidelines are:

- WB Operational Directive 4.01 which describes the requirements for Environmental Assessment of Bank's funded projects,
- WB Operational Directive 4.00 Annex B, concerning special requirements for dam and reservoir projects,
- WB Operational Directive 4.30 on Involuntary Resettlement,

- WB Operational Directive 4.20 on Indigenous Peoples.
- Environmental assessment requirements and environmental review procedures of the ADB.

The Lao PDR has already ratified several international treaties related to environment and conservation:

- The International Convention on Important Wetlands (RAMSAR), October 1990,
- The UN Convention on Biodiversity (September 1996),
- The International Convention on Climate Change (April 1994),

The Lao PDR has not yet ratified the CITES Agreement from the International Convention on Trade of Endangered and Rare Wildlife and Plant Species, but the GOL's MC Decree 185 of 1991 provides similar restrictions.

2.3. RESETTLEMENT ORGANIZATION

2.3.1. RESETTLEMENT POLICY

NTEC's examination of the relevant laws and decrees for preparing a Project resettlement policy for the Nam Theun 2 Hydropower Project (NT2) indicated that the Lao people have certain basic rights relative to resettlement. Among these the right to receive compensation for land withdrawn by the State is paramount.[1]

However, while compensation is an important factor in instances that call for resettlement, it is not the only factor. Successful resettlement requires that detailed plans are prepared in advance and that such plans are based on a general set of rules that would apply to the preparation and implementation of plans.

The "Draft National Resettlement Policy for Major Projects in the Lao PDR" prepared on behalf of GOL by NTEC and the NT2 Resettlement Committee is such a set of rules. A first draft of this policy, formulated by the Chairman of the NT2 Resettlement Committee, was discussed at the NT2 Resettlement Policy Workshop in Thakhek in September 1996, attended by more than forty national, provincial, and district government officials and representatives from other organizations. The NT2 Resettlement Committee organized the workshop; subsequently, changes and suggestions resulting from the participants were incorporated into a second draft of the policy.[2]

The second draft was reviewed by a World Bank mission in February 1997 and in March 1997 by the NT2 Study of Alternatives. On March 4 1997, the draft policy was

[1] NTEC, 1998, p. 5-5

the subject of a Vientiane workshop of 32 government officials from a range of ministries. On March 31, 1997, the draft policy was explained and discussed at the Resettlement Action Plan Information Briefing Session in Vientiane. The comments and suggestions on the second draft thus obtained were taken into account by the Resettlement Committee in the preparation of the draft included in the draft RAP of May 1997.

The draft RAP (including the draft national resettlement policy) was the subject of a public consultation workshop in Vientiane in early June 1997. Subsequently, comments on the draft policy were received from the Panel of Experts and the World Bank. GOL is of the opinion that adoption of the national policy should wait until experience has been gained with the implementation of the NT2 Resettlement Policy. However, the policy can be a model for hydro projects within the Lao PDR that wish to meet the standards of international good practice, such as the NNPP. The NT2's own resettlement policy was developed in parallel with the draft national policy. It has been undertaken in large measure by the NT2 Resettlement Committee, which was set up by GOL in 1995.

The text of the *Draft National Resettlement Policy for Major Projects in the Lao PDR* and the Draft Regulations under the *National Resettlement Policy for Major Projects in Lao PDR* drafted by NTEC for the NT2 are found in the NHHP PRP.

2.3.2. LAWS AND REGULATIONS RELEVANT TO RESETTLEMENT

The legal context in the Lao PDR has been changing rapidly over the last few years. A new constitution was introduced in 1991, forestry, water and water resource law in 1996 and land and electricity laws in 1997. This legislation provides a legal foundation for the consideration of resettlement.[3]

An overview of the pertinent articles contained in the above mentioned legislation is provided below. Of particular interest is Article 28 of the Water Resources Law, which states that in the case of hydroelectric projects, the owners shall provide appropriate livelihoods for the resettled population and pay for this out of project funds. The Electricity Act further states that licensees shall pay for any damage to private and/or public properties or rights caused by the project.[4]

2.3.2.1. THE CONSTITUTION (AUGUST 14, 1991)

Article 8: All ethnic groups have the right to protect, preserve and promote their fine customs and culture. All acts of division and discrimination among ethnic groups are prohibited.

Article 13: The economic system objectives are the expansion of production and to transform the subsistence economy into a commodities economy.

[2] NTEC, 1998, p. 5-5.
[3] NTEC 1998, RAP. p. 5-2
[4] NTEC 1998, RAP. p. 5-2

Article 14: The State protects and promotes all forms of State collective and individual ownership.

Article 15: As for the land which is owned by the national community, the State ensures the right to use, transfer, and inherit it in accordance with law.

Article 17: All citizens must protect the environment and natural resources: land, underground, forests, fauna, water sources and atmosphere.

Article 22: Lao citizens are all equal before the law.

2.3.2.2. LAW ON WATER AND WATER RESOURCES, NO. 005 (NOVEMBER 11, 1996)

The law determines the necessary principles, rules and measures related to the administration, exploitation, use and development of water and water resources in the Lao PDR. Articles 17-19 are the requirements for construction of medium and large scale reservoirs for electrical power generation and other purposes – approval, registration, signed agreements. These include feasibility studies and environmental and social impact assessments.

Article 25: The Government promotes the development and use of water resources in small, medium and large scale energy production from water sources with such potential. The use of water resources shall consider its potentials and impacts.

In building a hydropower dam, consideration shall be given to the preservation of the sources of water, forests, and the environment, flood protection, water supply, irrigation, water transport, fishing and fisheries, aquatic life and others.

Article 28: When resettlement is necessary from the area and vicinity of water sources development projects, project owners shall provide assistance in providing appropriate shelters and livelihoods for the resettled population. The funds used to finance resettlement, assistance or compensation to the population shall be included in the project's investment.

Article 25 requires contribution of funds for the quality maintenance of water sources and water resources by those conducting water resource development activities. Requires preservation of water sources, forests and environment, including impacts on fisheries, flooding and irrigation resulting from hydroelectric power dam construction.[5]

Article 28 establishes the legal obligation to resettle and compensate persons involuntarily displaced by the construction of hydropower dams and reservoir impoundments.[6]

2.3.2.3. DECREE ON ENVIRONMENTAL PROTECTION (DRAFT 1996)

Article 2: Environment refers to all nature occurring and man made, directly and indirectly related to humans' living conditions, their existence and

[5] BCEOM. 1999. pp. 1-2
[6] BCEOM. 1999. pp. 1-2.

development, their customs, culture and heritage.

Article 23: Development projects with medium scale investment and above (e.g., hydropower, roads, bridges, mineral exploitation, factories, tourist sites, and tree exploitation) shall require studies and the submission of environmental impact assessment reports as provided by the regulations. The central level environment management agency [STENO] shall review such reports and submit them to the Government for approval. No development project may operate without a certificate of approval of environmental impact assessment.

2.3.2.4. THE LAND LAW (MAY 31, 1997)

Article 3: The Lao PDR land is the property of the national community, and individuals are assigned to effectively use the land. Individuals may not treat land as a tradable commodity.

Article 5: The State protects the legal rights and benefits of those who have effectively received the right to use land, including the right to transfer it.

Article 6: Individuals....have the duty to preserve land in good condition.

Article 17: The State may authorize individuals to use agriculture land:

- For growing rice and raising aquatic animals not to exceed two hectares per one laborer in a family
- For fruit orchards and vegetable farming not to exceed three hectares, respectively, per one laborer in a family

Article 18: The district....may grant the right to use agricultural land within its administration...

Article 21: The State authorizes individuals to use forest lands (defoliated or degraded) not to exceed three hectares per one laborer in a family.

Article 22: The district....may grant the right to use forest land within its administration...

Article 63: The right of an individual to use land shall terminate when the State takes back the land in the public interest.

Article 70: When it is necessary to use an individual's land in the public interest, the State must make appropriate compensation for damages.

Article 71: In determining damages, there must be a Committee comprised of representatives of interested parties to determine the value of the damages.

The law includes elements related to watershed management, such as erosion protection (article 6) and land allocation and tenure rights. Land categories are established including agricultural land, forestry land, construction, access, easement and other land uses (Chapter II). Rights to habitation are guaranteed for multi-ethnic people (Article 3). Tenure rights for possession, use, fruit, transfer (restricted to developed land) and inheritance are also guaranteed (Article 44). Concessionaire use

is protected under the law, and a means for land titling and certification provided.[7]

The Land Act of 1992 stipulates that people deprived from their land are entitled to compensation, and it, as well as the constitution, also recognizes customary land use rights.[8] The World Bank and ADB's resettlement policies similarly recognize customary land rights. Since in rural areas like those in the Nam Ngiep Reservoir Area there are no land titles, identification of properties as well as of customary land use has to be established for and with each family prior to compensation. This will also be necessary for communal use of natural resources, as ADB policies recognize these as eligible for compensation too.

In line with the WB and ADB policies, resettlement is not, however, to be viewed as a simple compensation for land and other properties but is considered as an opportunity for wider regional socioeconomic development. Hydropower projects must not only generate additional revenue for the Government but also direct benefits for the local population, for those displaced by the project, and for resettlement host villages.

2.3.2.5. THE ELECTRICITY LAW NO. 02-97 NA (EFFECTIVE AUGUST 29, 1997)

The law requires a license for the generation and transmission of electricity. Article 14.2 states that "the investor shall submit an environmental impact evaluation which shall include the estimated costs of potential damages and relocation of local residents who may be affected as a result of such electricity production project." Article 18.7 states that "the licensee shall pay for damages to the environment, living conditions and properties of residents, or compensate for costs of relocation of residents.[9]

Requires hydropower projects over 2,000 kW provide full scale environmental and social assessment prior to approval (Article 14). Article 43 (1) duty of MIH to propagate a strategic plan related to the development of electricity enterprises and protection of the environment.[10]

2.3.2.6. PRESERVATION OF CULTURAL HERITAGE

Notice No. 943, implanting Article 19 of the Constitution of the Lao PDR, Decrees No. 99, 174, 194 of the Prime Minister of the Lao PDR (19 December 1992, 13 December 1993 and 12 November 1994 respectively) covers preservation of historical sites, traditional and artistic heritage, traditional architecture and places of worship (more than 50 years old). The regulations prohibit removal, destruction or alteration of these items without authorization of the GOL. It is proposed that objects, sites and structures of significance affected by the Project will be managed under the RAP, as is done for the NT2.[11]

[7] BCEOM, 1999, p 4
[8] James R. Chamberlain, et al. 1996. *Nam Theun 2 Project Area Socio-Economic and Cultural Survey*. Vientiane: Care International. July 30.
[9] NTEC, 1998, p. 5-5
[10] BCEOM, 1999, p 8
[11] NTEC, 1998, pp. 5-4

2.3.2.7. THE FORESTRY LAW, NO. 004 (OCTOBER 11, 1996)

The NT2 RAP has implications beyond the actual Project if it becomes a model for involuntary resettlement within the Lao PDR and perhaps internationally. A key aspect of this model is the use of community managed forests in upland areas, which could for instance become an alternative to moving ethnic peoples from upland areas to lowland regions.[12] For this reason, the NT2 RAP paid close attention to the Forestry Law.

Article 5: Individuals and organizations shall be entitled to possess and use trees, natural forests and forest land only when authorized by the authoritative agencies.

Article 7: Individuals and organizations having received forest and forest land allocations from the State for their preservation and management shall be entitled to compensation and interest, such as the use of wood, gathering of forest produce, etc.

Article 13: The State assigns the use of degraded forest land or bald land to individuals and organizations in accordance to their labor and financial capacity for forestation or revival and to individuals for an area not exceeding three hectares per laborer in the family.

Article 14: Where necessary for the public interest, forests and forest land may be used for other purposes, subject to prior approval from the competent authorities.

Article 16: Forest in the Lao PDR are classified into the following five categories:

1. Protected Forests
2. Reserve Forests
3. Production Forests
4. Regeneration Forests
5. Degraded Forests or Bald Land

Article 30: Traditional use of forest and forest land refers to the long-standing use of forest, forest land and forest produce as acknowledged by the society or law, which includes non-restricted wood collecting for fencing, firewood, forest produce gathering, hunting and fishing of non-restricted species for family consumption, and other traditional uses. Such traditional use shall avoid causing damage to the forests or forest resources, and shall avoid prejudicing the interest of individuals or organizations. The traditional use of forests, forest land and forest produces shall abide by the village forest and forest land regulations.

Article 48: The right to possess and use forests and forest land is acquired through transfer, handover, inheritance.

Article 50: Grant of rights to possess and use forest and forest land is decided by the concerned agencies with authority in allocation of forest and forest land for long term and stable possession and use by individuals and organizations based on contracts and specific regulations.

[12] NTEC, 1998, p. ES-9

Article 51: The right to possess forest and forest land is the right to preserve and use the received forests and forest land for a purpose to meet the requirements for persons enjoying the rights of possession and use.

Article 59: The forest and forestry operations management agencies include the Ministry of Agriculture and Forestry, the Provincial/Municipal Agriculture-Forestry Services, the District Agriculture-Forestry Offices and the Village administrative authorities.

This law provides the basis to formulate management and use plans. It also allows conversion in the public interest and after approval by responsible authorities. For 100-10,000 hectares, approval of the Government is necessary, while the National Assembly must approve conversion of more than 10,000 ha. A conversion fee is charged, and land reclamation and tree planting provided as a compensating measure.[13]

Within the resettlement area, some areas containing forests on slopes greater than 25 degrees may also be classified as Protected Forests with limited utilization of forest products but no logging or other significant physical disturbance.

[13] BCEOM, 1999, p 5

CHAPTER - 3

PROJECT DESCRIPTION

3. PROJECT DESCRIPTION

3.1. GENERAL LAYOUT

As the result of the alternative studies, two (2) dam-scales have eventually been considered, as a Medium-scheme having its FSL at EL.320m (called FSL.320m alternative in this report) and a Large-scheme with FSL at EL.360m (called FSL.360m).

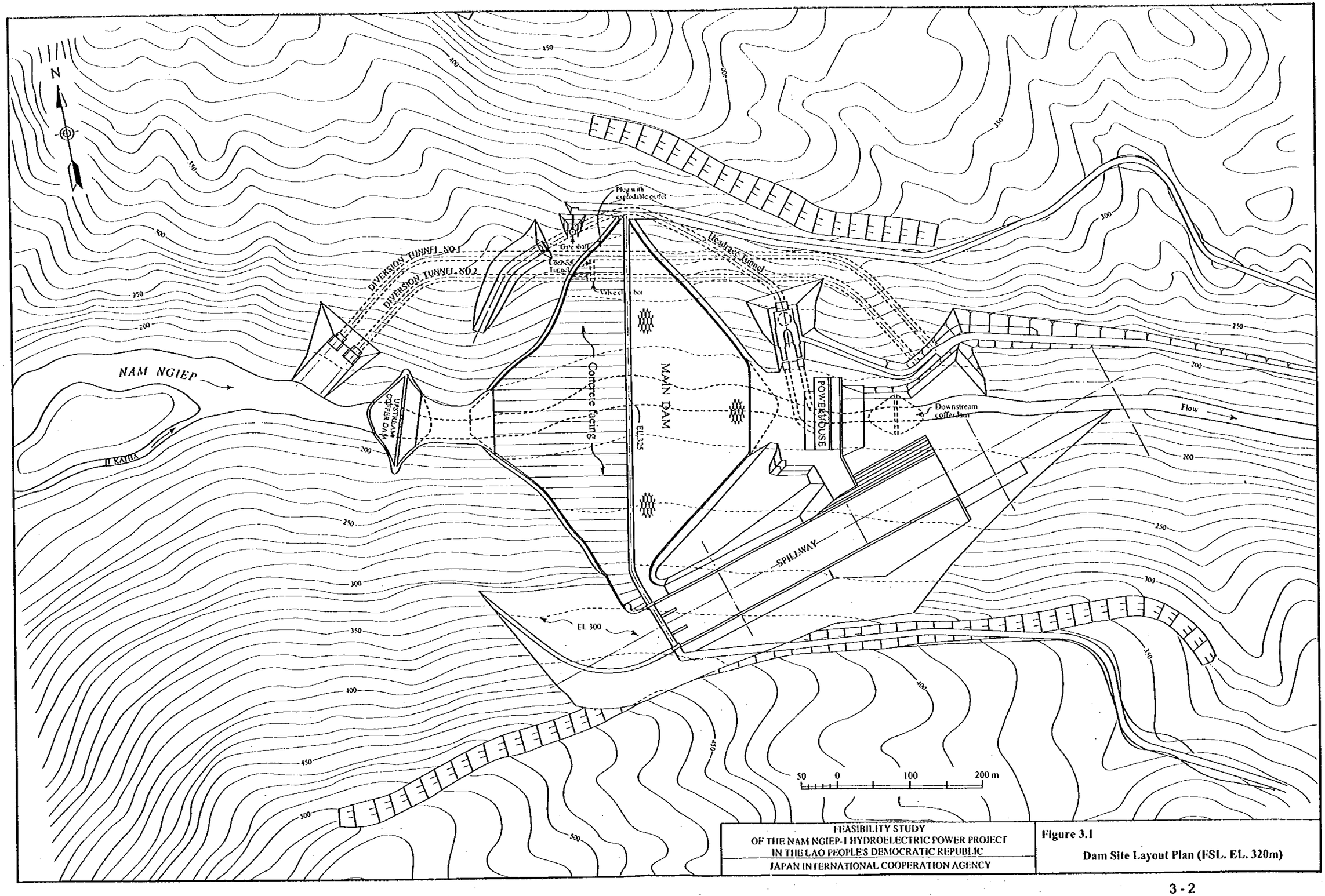
The NNHP is located on the Nam Ngiep River, a tributary of the Mekong River. The proposed Project consists of a concrete faced rockfill dam (CFRD), impounding a 70 to 90km long reservoir depending on the alternative. Water will be turbined through a power plant located at the foot of the dam.

General layouts of dam components are shown in Figure 3.1 and Figure 3.2 for two (2) alternatives FSL.320m and FSL.360m.

Preliminary main features for the alternative schemes are shown in Table 3.1.

Table 3.1 Preliminary Salient Features of Promising Schemes

Structure	Parameter	Unit	FSL.320m	FSL.360m
Reservoir	Catchment area at dam site	km^2	3,700	3,700
	Annual basin rainfall	mm	2,470	2,470
	Annual mean runoff	m^3/s	162.3	162.3
	Annual mean runoff	mill. m^3	5,118	5,118
	Average run-off coefficient	-	0.56	0.56
	Probable max. flood, PMF	m^3/s	15,900	15,900
	Mean annual sediment flow	$t/km^2/yr$	413.4	413.4
	Reservoir area at FSL	km^2	73.9	148.2
	Gross reservoir capacity	10^6m^3	2,279	6,782
	Min. operation level (MOL)	EL.m	284	335
	Draw-down	m	36	25
	Effective storage volume	10^6m^3	1,779	3,092
Dam	Dam type	-	CFRD	CFRD
	Dam height & crest length	m	157, 524	197, 662
	Dam volume	10^6m^3	6.9	12.7
	Dam crest level	EL.m	325	365
Spillway	Spillway crest level	EL.m	306.5	346.5
	Design flood capacity	m^3/s	8,730 (Q=10,000yr)	8,730 (Q=10,000yr)
Waterway	Design discharge	m^3/s	221	224
	Headrace tunnel diameter & length	m	9.0, 420	9.0, 490
Power Plant	Powerhouse type	-	Surface type	Surface type
	Size of powerhouse	m	58(L) 31(W) 58(H)	81(L) 29(W) 52(H)
	Design flood discharge	m^3/s	4,519 (Q=100yr)	4,519 (Q=100yr)
	Rated head	m	131.8	176.8
	Type of turbine	-	Vertical Francis	Vertical Francis
	Plant capacity & nos. of unit	MW	240=2nos@120	360=4nos@90
	Annual energy	GWh	1,349	1,905
Reregulation Structure	Max. pond level	EL.m	173	173
	Required storage capacity	mill. m^3	4.7	4.7
	Design flood discharge	m^3/s	4,519 (Q=100yr)	4,519 (Q=100yr)



FEASIBILITY STUDY
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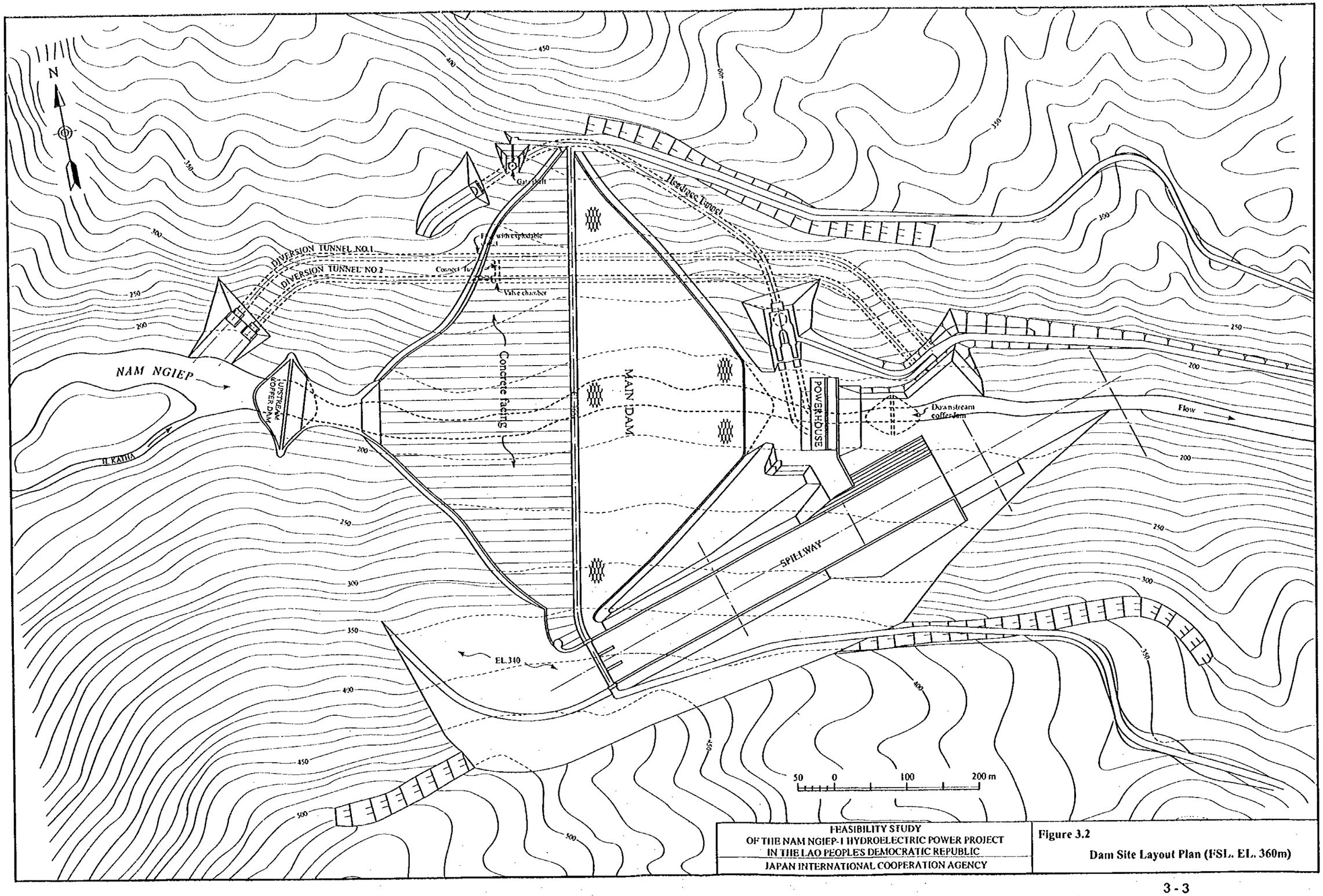
Figure 3.1
Dam Site Layout Plan (FSL. EL. 320m)



FEASIBILITY STUDY
OF THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT
IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
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Figure 3.2
Dam Site Layout Plan (FSL. EL. 360m)

3.2. PROJECT COMPONENTS

3.2.1. DAM AND RELATED FACILITIES

3.2.1.1. DAM AND RESERVOIR

The proposed dam will be of the concrete faced rockfill type (CFRD), with face slope provisionally determined to be 1:1.4 for the upstream slope and 1:1.3 for the downstream slope.

A deep hard rock with velocity of more than 4,000m/s is observed at the dam site especially at both abutments. The weathered rock foundation consisted of alteration of sandstone and mudstone.

The design thickness of the face slab is 300mm at the top, increasing below at some rate in proportion to the head of water. For the Nam Ngiep dam, the face slab is designed by applying the most popular equation 0.3 + 0.003H in meter.

To improve the fractured rock and to seal the open joint under the toe slab to an acceptably low permeability level, low pressure consolidation grouting will be carried out throughout the entire slab foundation. The grouting will be provided in a single stage of 5 and 10m depending on rock quality.

For the deep curtain grouting, the depth of a conservative 2/3H will be taken into account for the Nam Ngiep dam.

All exposed rock slopes resulting from excavation for the plinth, and upstream of it, will be covered with a layer of steel-mesh-reinforced shotcrete to extend somewhat the seepage path in the upstream direction.

The resulting reservoir upstream the dam will flood a maximum of 148.2km^2 for FSL.360m and 73.8 km^2 for FSL.320m. The minimum operation level for the large and medium alternative is respectively of EL.335m and EL.284m (subject to further optimization between EL.280m and EL.284m).

3.2.1.2. RIVER DIVERSION FACILITIES

Tunnel type diversion system will be adopted for the Project. Separate main cofferdam will be provided at the upstream and downstream sides of the main dam.

The Nam Ngiep River will be diverted by two lanes of concrete-lined tunnel. The design discharge was equal to the 25-year recurrence flood of 3,385m^3/s for both schemes.

Tunnel diameter and the required crest level of the upstream main cofferdam were tentatively determined on an assumption that around 20% of the flood peak probably

be regulated due to a reservoir storage function at the upstream of the cofferdam.

Table 3.2 Main characteristics of the river diversion tunnel

No.	Items	Medium-scale (FSL.320m)	Large-scale (FSL.360m)
1.	Tunnel diameter	10.4m	10.4m
2.	Crest of u/s cofferdam	EL.220m	EL.220m
3.	Tunnel Length	1,100m	1,200m

3.2.1.3. OUTLET FACILITY

Outlet facility is usually provided for retardation of reservoir-rise during impoundment, for releasing riparian flow to the downstream reach or emergency draw-down.

The large alternative FSL.360m has a huge storage volume of 6.8 billion m^3. Therefore, it is not realistic to provide a full-scale function for emergency draw-down, which will require extremely large facilities and a high related cost.

Therefore, outlet facilities will be designed with a practical and realistic size mainly to delay the water-rise in reservoir during impoundment. Its discharge capacity is provisionally determined to be 400m^3/s, which is equal to about twice of the basin average run-off and sufficient to control reservoir water level.

For the Large-scale scheme, a fast draw-down in an emergency case cannot be satisfied by the above design. But in the case of the FSL.320m alternative, draw-down from FSL to MOL may be achieved in 50days and the draw-down from MOL to 1/3 depth will needs only about 20 days.

An outlet will be provided in the diversion tunnel No.2, which will be closed after completion of main dam. A valve chamber will be provided at the middle of the stretch in the main tunnel plug.

3.2.1.4. SPILLWAY

The spillway will be designed as a gated overflow type having three 19m wide and 15m high gates, which will be located on the right abutment. The excavated material from the spillway construction will be used for the main dam embankment. Approach bay will be located at EL.300m and EL.340m respectively for FSL.320m and FSL.360m.

Floodwater will be conveyed to the downstream of the dam by an open square concrete chuteway and dissipated by the flat-apron type stilling basin to be located sufficiently away from the dam and its appurtenant structures.

Hydraulic dimensions of the stilling basin will be based on the 100-year flood of 4,519m^3/s and stability of the structure will be confirmed for 1,000-year flood of 6,530m^3/s. Final dimensions of the spillway will be determined by hydraulic model testing.

3.2.2. INTAKE AND POWER WATERWAY

Power intake will be located on the left abutment. Intake sill has to be located above the final sediment level, which was assumed for the Nam Ngiep-1 HEPP to be EL.200m for the project lifetime of 100 years. Size of the intake opening will be so determined that the inlet flow velocities are to be within 1.0m/s at the maximum discharge to minimize destructive vibration, which may be induced on the metal works (gates, trash rack, etc.) of the intake structure.

On the above requirements, an intake opening of 15m(B)x15m(H) divided by a 2m thick center pier will be required for both schemes.

The headrace tunnel will be designed with single lane. Its diameter will be around 9.0m limiting average flow velocity in the tunnel to 3.5m/s.

Penstock line will be designed as an inclined cut-and-cover conduit type, which will be bifurcated at the downstream end of the headrace tunnel and buried in the deep trench excavated behind powerhouse. Penstock lines will be of steel pipe encased for its entire stretch with the reinforced concrete structure.

3.2.3. POWER STATION

Because of the gentle downstream river profile, a surface type powerhouse will be proposed and located immediately downstream of main dam to pass the intake water as simple and short.

To meet 16-hrs power generation, which is a given condition provided by EGAT, the powerhouse will be equiped with two (2) generating units of 120MW for the FSL.320m option and four (4) units of 90MW for the FSL.360m option. Units will be vertical-shaft Francis type for both alternatives.

The particulars, which will be given as the result of the preliminary power plant design, are as follows:

Table 3.3 Major Dimensions of Power Station

Dimensions	Unit	FSL.320m	FSL.360m
Plant Discharge	m^3/s	221	224
Rated Head	m	131.8	176.8
Number of Unit	nos.	2	4
Unit Capacity	MW	120	90
Plant Capacity	MW	240	360

Ground elevation for powerhouse yard will be located at EL.195m, which is 2m above the maximum TWL.193m of the 100-year recurrence flood 4,519m^3/s.

Main transformers will be located on the back-filled open space secured behind powerhouse aiming at economic design. Outdoor switchyard will be also located behind powerhouse for housing indoor type gas insulated metal enclosed switch-gears.

3.2.4. RE-REGULATION FACILITIES

The maximum discharge of the powerhouse will be about 220m^3/s for both schemes. According to the plant operation scenario required by EGAT, power generation will be interrupted daily for 8 hours and entirely on every Sunday and Thai national holidays.

To mitigate detrimental impacts to the downstream area, it was considered compulsory to provide a direct countermeasure, which enables to minimize water level fluctuation by regulating discharges from the powerhouse. A re-regulation reservoir facility is proposed downstream of the main dam site as shown in Figure 3.3 with a tentative operation rule depicted in Figure 3.4. Based on this operation rule, the capacity of the re-regulation pond will be about 4.7 million m^3 with a maximum water level at EL.173m.

The proposed re-regulation facility is a combined structure of a narrow gated section with a broad crest overflow weir section as shown in Figure 3.5. The gated section will have a capacity to release from the two gated bays the maximum plant discharge of 220m^3/s at the normal pond level (NPL) of EL.173m. The overflow section will be designed to flow down the flood discharge of 4,519m^3/s, which is equal to the 100-year recurrence flood at the provisional FWL.180m. Length of the overflow weir will be about 120m and its crest level will be equalized to NPL.

3.2.5. TRANSMISSION LINE

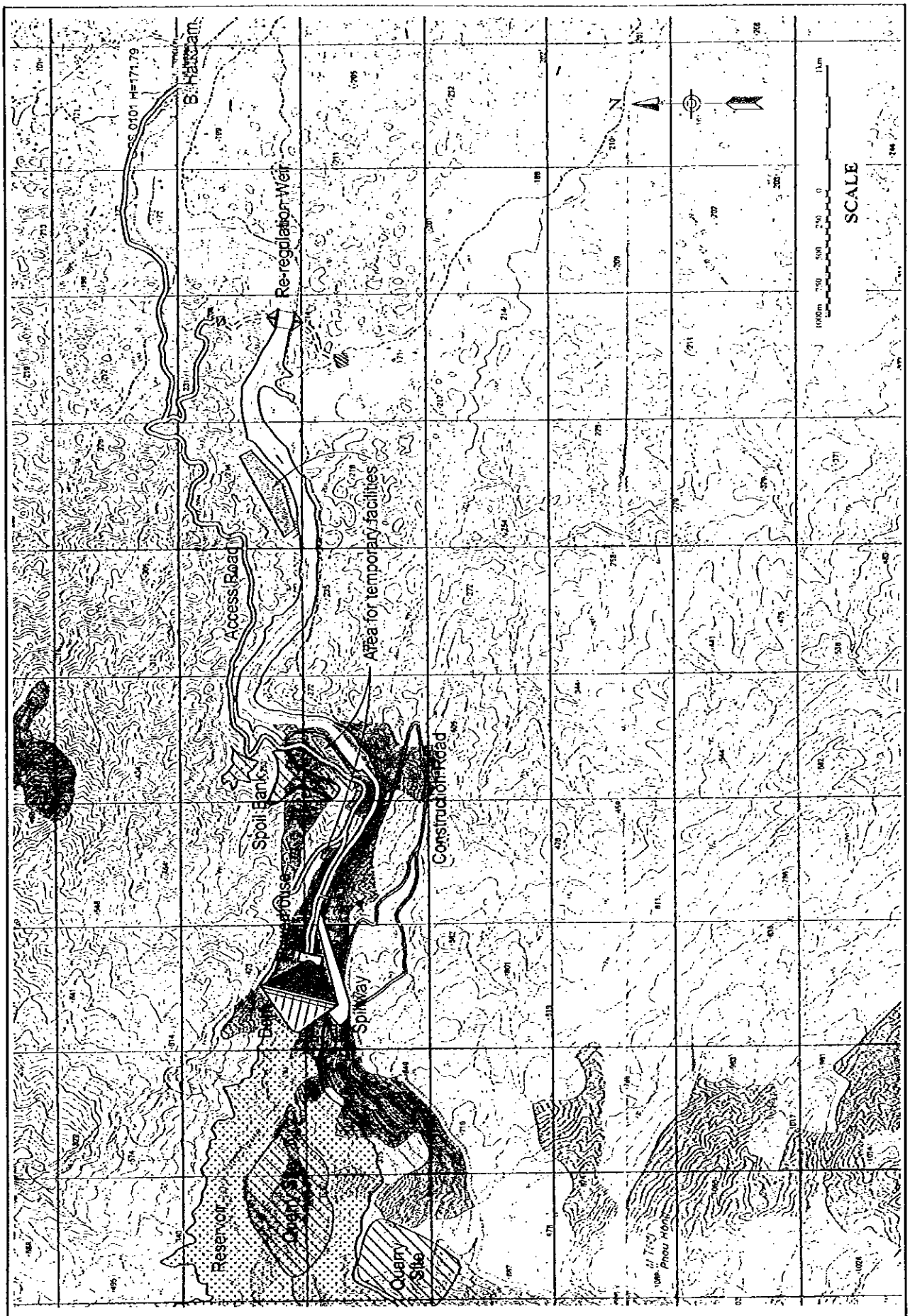
The transmission system development in Lao PDR carries the objectives: (i) to reinforce and extend domestic transmission system, (ii) to receive export power from IPP projects, (iii) wheel it to the appropriate metering point on the border, (iv) to minimize cost, and (v) to minimize environmental impacts.

Domestically, EDL will extend the transmission and distribution lines of voltage below 115kV using concessionaire funding to supply priority centers. For export, a Lao National Grid Company will be established to construct a 500kV national grid connecting with collector substations between B.Nabong 500kV Grid Station (G.S) nearby Nam Leuk power station and B.Sok 230/500kV G.S near Houay Ho power station to wheel the power from IPP projects to the bordering delivery points with Thailand and Vietnam.

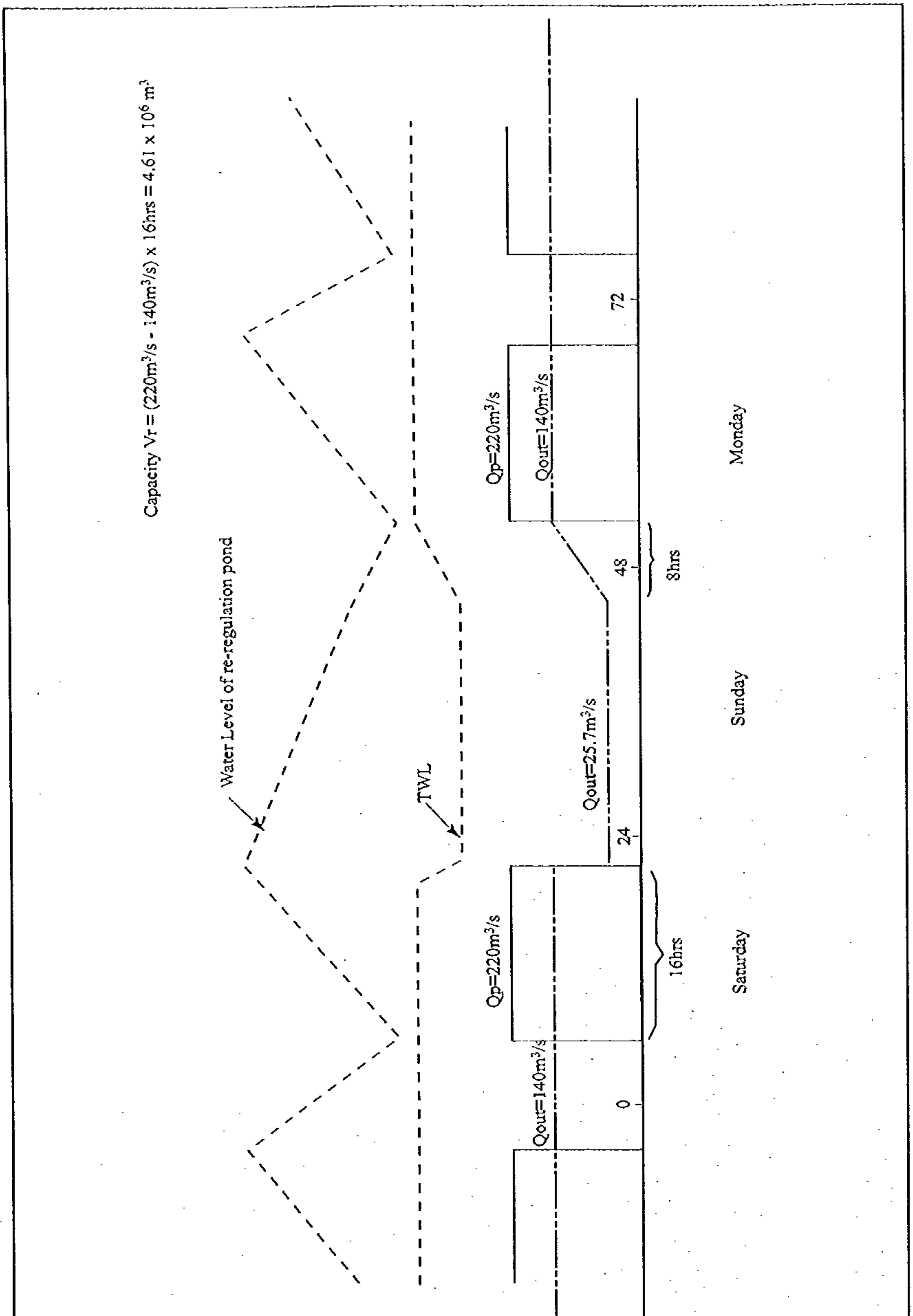
Power transmission line from Nam Ngiep-1 P.S will be a 230kV line connecting the powerhouse to the Nabong Sub-Station with a total length of approximately 110km.

3.2.6. ACCESS ROADS

The dam site is located in Bolikhamxay Province, about 50km from Pakxan, the capital of the Province. Existing road conditions between Pakxan and dam site are as shown below:



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure 3.3** **Temporary Facilities and Access Road**



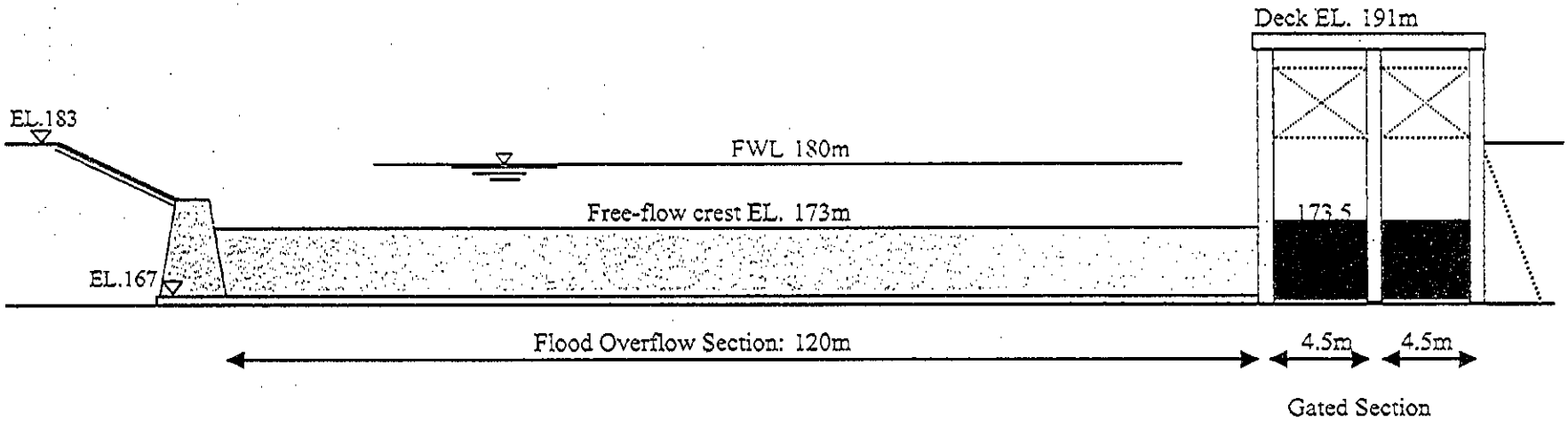
FEASIBILITY STUDY ON THE NAM NGIEP-I HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC	**Figure 3.4**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Tentative Operation Rule of Re-regulation Pond**

Flood discharge capacity

Design flood (100-year flood), Qf_{100}	4,519 m^3/s
Free-flow crest EL.	173 m
Total flow width, Bf	129 m
Flood overflow depth, Hf	7.2 m
FWL	180 m
Minimum hoist deck EL.	191 m

Capacity of sluice gates

Target discharge, Qp	220 m^3/s
Sluice gate bottom EL.	167 m
Total gate width, Bg	9.0 m
Flow depth, Hs	5.9 m
Gate height, Hg	6.5 m
Gate top EL.	173.5 m



Preliminary Design for Re-Regulation Facilities, Nam Ngiep-1 HEPP
No to scale

Figure 3.5 Re-regulation Weir

Table 3.4: Existing road conditions between Pakxan and Dam Site

No.	Existing Road	Road Condition
1	Beginning 3km section from Pakxan (Route No.4)	6.0m wide asphalt paved road
2	Remaining 20km to Borikhan (Route No.4)	6.0m wide laterite paved road
3	20km between Borikhan and B. Thahua (Prov. Road)	3.5m wide non-paved road
4	10km between B. Thahua and B. Hatkham (Prov. Road)	1.5-2.0m wide non-paved road

Minor betterment for the road surface between Pakxan and Borikhan, and widening and paving between Borikhan and B.Hatkham will be required. About 10km of new road are required from B.Hatkham to the dam site, along the left bank of the Nam Ngiep River.

On the existing road between B.Thahua and B.Hatkham, two (2) new bridges will be required, one for crossing the Nan Xao River and a second for crossing a gully near B. Hatkham. The access road from Pakxan to the dam site is depicted in Figure 3.6.

3.2.7. CONSTRUCTION SITES

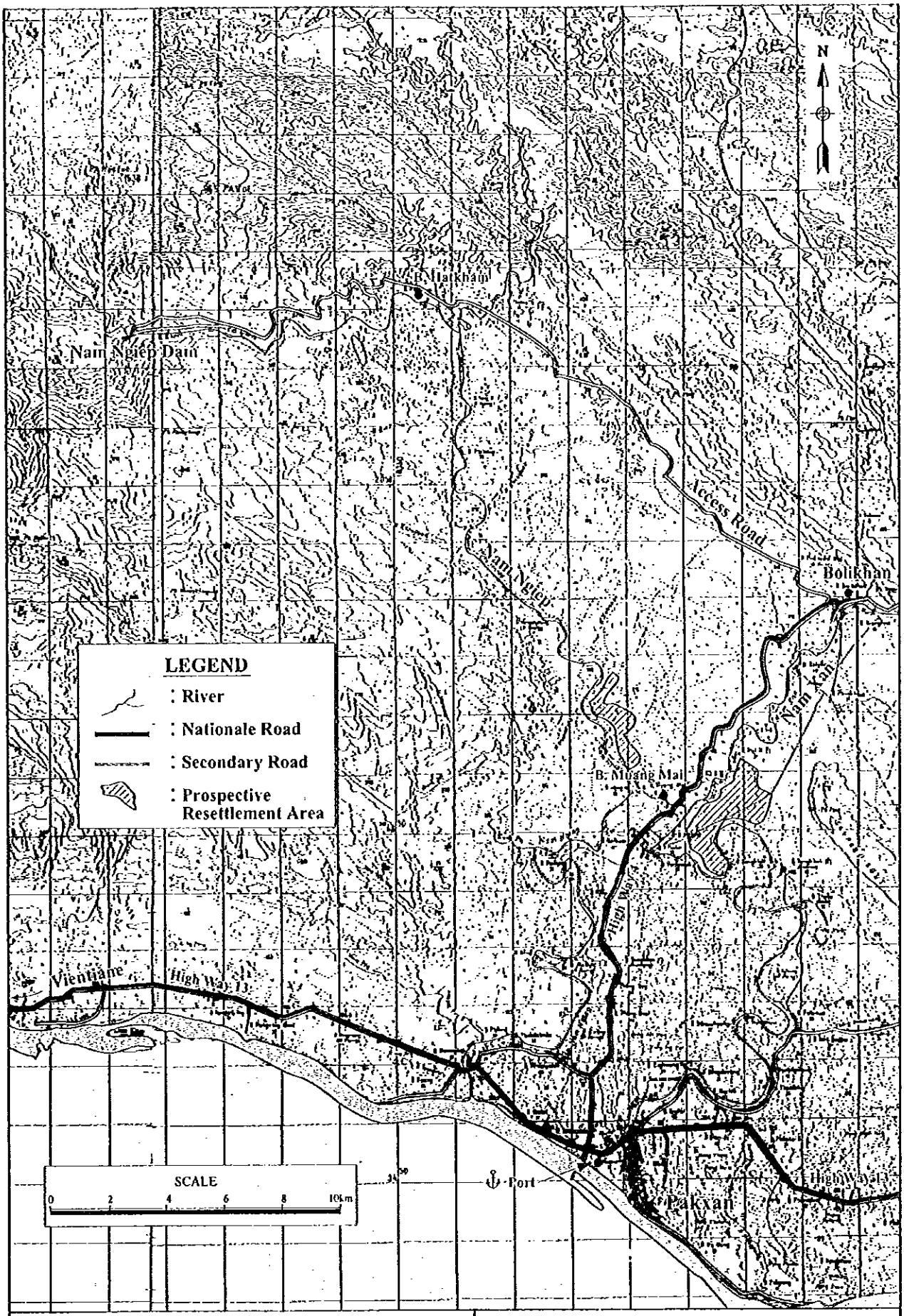
Major temporary facilities for construction will be located at the downstream of the main dam site. There are several possible sites for these facilities between dam site and re-regulation weir, and a preliminary layout is presented in previous Figure 3.3. In these sites, contractor's offices and residential quarters and other temporary buildings (warehouse, motor pool, repair shop, etc.) will be installed.

Two concrete batching plants will be located at the powerhouse site and spillway fore-bay area. Several quarry sites are anticipated for the supply of rock fill, as much as possible located within the boundaries of the future reservoir area. Additional investigations are required. Because of the steep dam abutments, available areas for stockpile and spoil bank are very scarce at the upstream area of the dam site. Therefore, some of the spoil bank may have to be located at the downstream area with proper foundation drainage system and slope protection.

3.2.8. QUARRY AND BORROW AREAS

Conglomerate and sandstone will be used as rockfill material. Conglomerate is located on the hilly cliff top area on both sides on Nam Ngiep River and where the spillway will be implemented. Sandstone is observed at the confluence with H.Katha, on the ridge of the right bank of H.Katha, and downstream of the nam Ngiep gorge.

Other resources for concrete aggregate are from Palaeozoic formations and from Granite intrusive. They are distributed about 12-15km north of dam site, but without access at present. River sand and gravel deposits are distributed along the Nam Ngiep River in the river course, between dam site and B.Hatkham and also downstream of B.Hatkham, but good material, without high silt content, is not expected in large quantities.



FEASIBILITY STUDY
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Figure 3.6
Route of Access Road to Dam Site

Impervious material will be investigated in Quaternary deposits (Terrace deposits) and also in Palaeozoic formations where highly weathered sandstone is expected about 12km north of B.Hatkham.

3.3. PROJECT IMPLEMENTATION SCHEDULE

3.3.1. IMPLEMENTATION PROCEDURE

3.3.1.1. OVERALL IMPLEMENTATION SCHEDULE

The Nam Ngiep-1 HEPP will be implemented in four stages: Phase-1 to Phase-4 of the following events to be accomplished after the feasibility study of the Project.

Table 3.5 Implementation Schedule in Four Stages

Phase	Items	Contents
Phase-1	Financial arrangement for the construction and selection of a consulting firm for the engineering services	Financial arrangement for the implementation of the Project in the Phase-1 will complete by the end of 2001, and start the field investigations and appoint a consulting firm for making a definite plan of the Project with detailed designing
Phase-2	Field Investigations and detailed design of the Project with review of the feasibility studies	The Phase-2 for the filed investigations will start from the beginning of the dry season: the late 2002, and the review of the previous studies and detailed design will start from the end of 2002 and complete by the middle of 2004.
Phase-3	Selection of the contractor with the tendering for construction	The Phase-3 the pre-qualification and tendering for selection of the constructor will start immediately after approval of the project design, and the notice to proceed will be issued to the selected contractor by the end of 2005.
Phase-4	Construction works	The construction works in the Phase-4 is scheduled to start early 2006 and complete by the end of 2011.

3.3.1.2. PRE-CONSTRUCTION ACTIVITIES

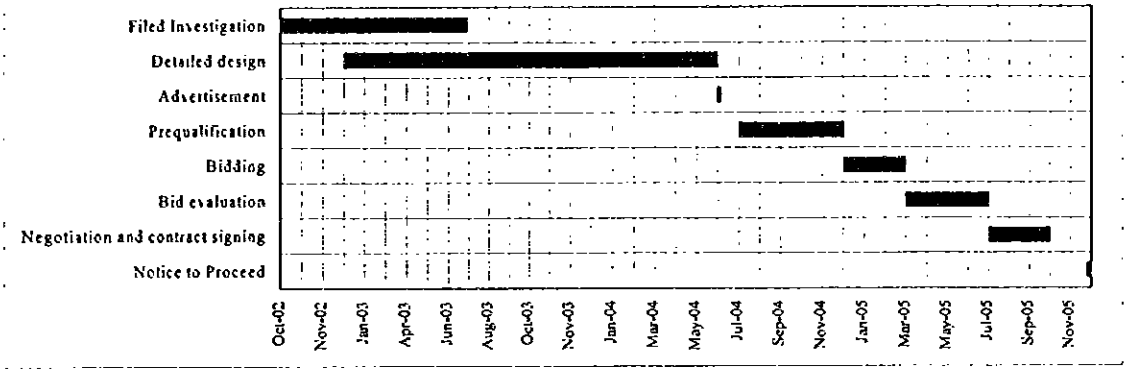
The pre-construction activities may trace the following time schedule:

Table 3.6 Time Schedule for Pre-Construction Activities

No.	Activities	Period	Start	End
1.	Field Investigations	9 months	Oct. 2002	Jun. 2003
2.	Detailed Design			
2-1	Review of previous studies	6 months	Dec. 2002	May 2003
2-2	Detailed design	6 months	Jan. 2003	Jun. 2004
3.	Pre-qualification			
3-1	Advertisement	-	Jul. 2004	-
3-2	Pre-qualification	5 months	Aug. 2004	Dec. 2004
4.	Tendering			
4-1	Bidding	3 months	Jan. 2005	Mar. 2005
4-2	Bid Evaluation	4 months	Apr. 2005	Jul. 2005
4-3	Negotiation and contract	3 months	Aug. 2005	Oct. 2005
5.	Notice to Proceed	-	Dec. 2005	-

Tentative time schedule for the stage of pre-construction is as shown in Figure 3.7 below:

Figure 3.7 Time Schedule for Pre-construction Stage



3.3.1.3. CONSTRUCTION WORKS

After conclusion of the contract between the power-company and the contractor, the notice to proceed (NTP) will be issued to the contractor to start the construction works at the beginning of 2006. The construction time schedule is tentatively planned as follows:

Table 3.7 Construction Time Schedule for Major Works

No.	Structures	Construction Period
1.	Diversion tunnels	Early 2006 to Mid. 2007
2.	Main dam	Mid. 2006 to Late 2009
3.	Spillway	Early 2006 to Mid. 2009
4.	Power waterway	Mid. 2006 to Late 2008
5.	Powerhouse	Mid. 2006 to End of 2011

The construction works will take about 5 years from the NTP, and commissioning will be at the beginning of 2012. Tentative construction time schedule in shown in Figure 3.8.

3.3.2. PROCUREMENT PLAN

3.3.2.1. GENERAL

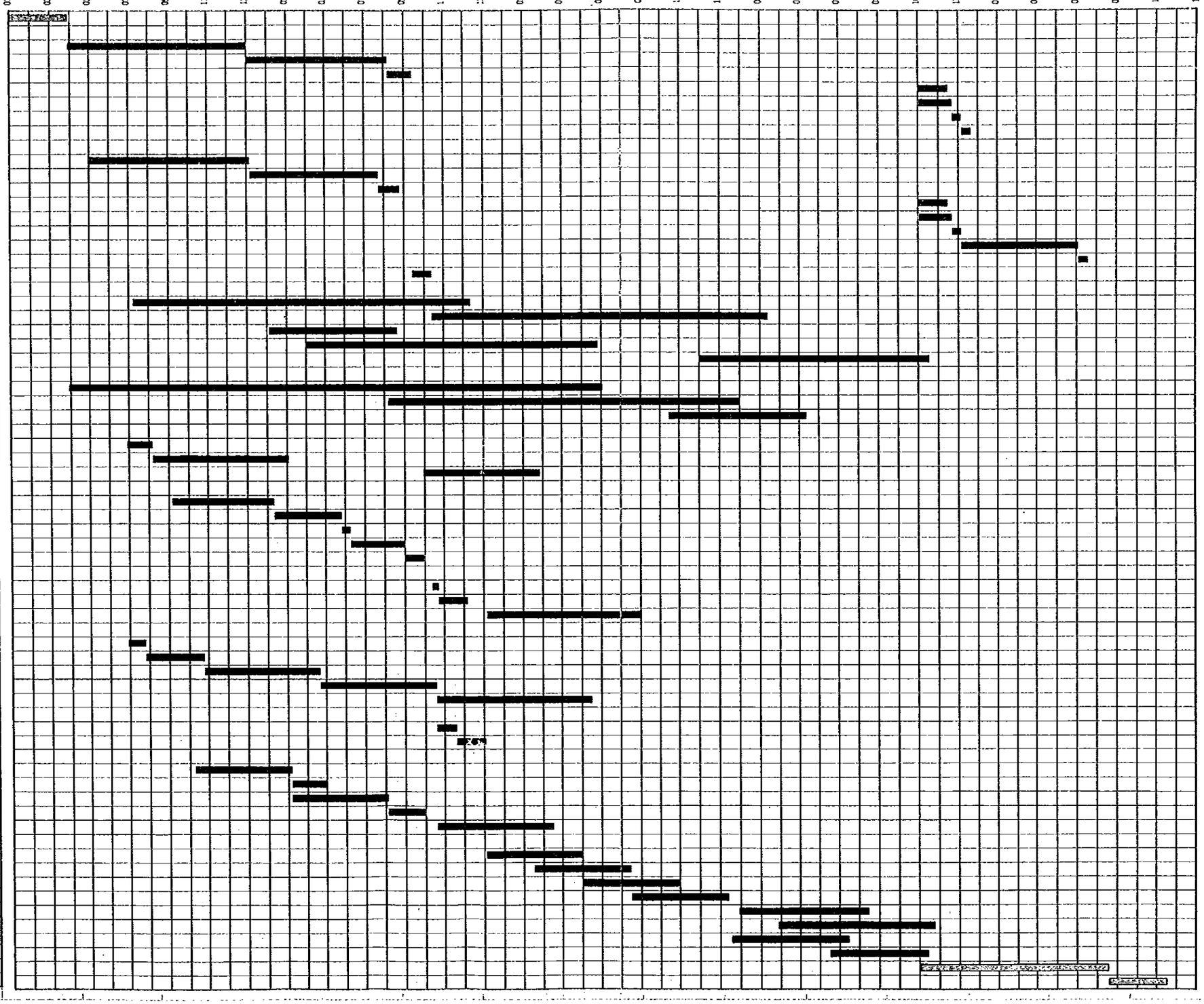
Figure 3.7 and Figure 3.8 show the time allowed for the implementation being only 108 months; 30 months for project design, 18 months for pre-construction procedures and 60 months for construction.

The schedule is very tight taking into consideration the scale of the development and the works/procedures in implementation. Therefore, the detailed design for the Project should be started as early as possible and the contract for engineering services should cover full period from the design stage to the construction stage to reduce risks of delaying the scheduled power commissioning date.

Figure 3.8 Tentative Construction Time Schedule for Nam Ngiep-1 HEPP, FSL 320

Notice to Proceed: January 1, 2006
Power Commissioning Date: November 17, 2010

Work Item	Work Quantity	Start Date	Period (day)	End Date
Mobilization		2006/1/1	90	2006/4/1
Diversion Tunnel No.1				
Tunnel excavation	1,100 m	2006/4/1	275	2007/1/1
Lining concrete	1,100 m	2007/1/1	220	2007/8/9
Backfill grout	1,100 m	2007/8/9	37	2007/9/14
Plug works	9 lift	2009/11/1	45	2009/12/16
Pipe cooling		2009/11/2	50	2009/12/22
Contact grout	20 m	2009/12/22	15	2010/1/6
Portal closure		2010/1/6	15	2010/1/21
Diversion Tunnel No.2				
Tunnel excavation	1,000 m	2006/5/1	250	2007/1/6
Lining concrete	1,000 m	2007/1/6	200	2007/7/25
Backfill grout	1,000 m	2007/7/25	33	2007/8/27
Plug works	9 lift	2009/11/1	45	2009/12/16
Pipe cooling		2009/11/2	50	2009/12/22
Contact grout	20 m	2009/12/22	15	2010/1/6
Valve installation		2010/1/6	180	2010/7/5
Portal closure		2010/7/5	15	2010/7/20
Cofferdams		2007/9/14	30	2007/10/14
Main Dam				
Foundation excavation	638,000 m^3	2006/7/10	522	2007/12/13
Rockfilling	6,856,000 m^3	2007/10/14	517	2009/3/14
Toe slab concrete	20,000 m^3	2007/2/3	200	2007/8/22
Foundation grouting		2007/4/4	450	2008/6/27
Facing concrete	46,800 m^3	2008/12/1	351	2009/11/17
Spillway				
Excavation	4,949,000 m^3	2006/4/1	825	2008/7/3
Concrete	361,000 m^3	2007/6/8	542	2009/1/31
Gate installation		2008/10/15	210	2009/5/13
Power Intake				
Excavation	79,000 m^3	2006/6/30	40	2006/8/8
Concrete	28,000 m^3	2006/8/8	210	2007/3/6
Gate installation		2007/10/1	180	2008/3/29
Headrace Tunnel				
Tunnel excavation	420 m	2006/9/1	158	2007/2/12
Lining concrete	420 m	2007/2/12	105	2007/5/28
Backfill grout	420 m	2007/5/28	14	2007/6/11
Invert concrete	420 m	2007/6/11	84	2007/9/3
Consolidation grouting	420 m	2007/6/3	28	2007/10/1
Penstock Line				
Open excavation	10,000 m^3	2007/10/14	10	2007/10/24
Concrete work	2,200 m^3	2007/10/24	44	2007/12/7
Pipe installation		2008/1/6	240	2008/9/2
Powerhouse, Civil and Architectural Works				
Open excavation	28,000 m^3	2006/6/30	28	2006/7/28
Sub-mass concrete	12,000 m^3	2006/7/28	90	2006/10/26
Sub-struct concrete	6,000 m^3	2006/10/26	180	2007/4/24
Superstructures	3,000 m^3	2007/4/24	180	2007/10/21
Utility works		2007/10/21	240	2008/6/17
OHT Crane				
Rail installation		2007/10/21	30	2007/11/20
Crane installation		2007/11/20	45	2008/1/4
Draft Tubes				
Unit-1,2 setting		2006/10/11	150	2007/3/10
2nd stage concrete		2007/3/10	55	2007/5/4
Unit-3,4 setting		2007/3/10	150	2007/8/7
2nd stage concrete		2007/6/7	55	2007/10/1
Gate installation		2007/10/21	180	2008/4/18
Spiral Casings				
Unit-1,2 installation		2008/1/4	150	2008/6/2
2nd stage concrete		2008/3/19	150	2008/8/16
Unit-3,4 installation		2008/6/2	150	2008/10/30
2nd stage concrete		2008/8/16	150	2009/1/13
Stators / Rotors		2009/1/28	200	2009/8/16
Plant Equipment		2009/3/29	240	2009/11/24
Main Transformers		2009/1/18	180	2009/7/17
G.I.S.		2009/6/17	150	2009/11/14
Impounding to RWL		2009/11/1	291	2010/8/19
Wet Test		2010/8/19	90	2010/11/17
Total construction period : 4.9 years				



3.3.2.2. FIELD INVESTIGATIONS

Prior to the commencement of the detailed design of the Project, the field investigations will start for the following:

Table 3.8 Contents of Field Survey before Detailed Design

No.	Surveyed Contents	Remarks
1.	Topographic Survey	
1-1	Topographic mapping; main dam site, power intake site, diversion tunnel inlets and outlets, up and downstream portals for power waterway, penstock line route, powerhouse site, re-regulation weir site, resettlement sites	
1-2	Longitudinal section surveys along the tunnel routes	
1-3	Cross sectional survey for the Nam Ngiep River downstream of main dam	
1-4	Longitudinal and cross section surveys for material borrowing and quarrying sites	
2.	Geological Investigation	
2-1	Core boring	
2-2	Packer Lugeon test in rock	
2-3	Electrical resistivity prospecting along the tunnels and powerhouse site	
2-4	Seismic refraction survey along dam site and tunnel routes	
2-5	Test pitting and auger boring	
2-6	Property test on embankment materials	
2-7	Test on concrete materials	
3.	Environmental Investigation	
3-1	National policy and legal context developed by GOL.	Through an overall review and examination of the results of the previous EIA, the final environmental investigation for the Project will be performed.
3-2	Present natural and social conditions in and around the Project area	
3-3	Natural and social impacts of the Project	
3-4	Prospective impact mitigation measures	
3-5	Compensation and resettlement plan	
3-6	Environmental management plan including public consultation and participation programs	

CHAPTER - 4

BASELINE INFORMATION ON PRESENT CONDITIONS

4. BASELINE INFORMATION ON PRESENT CONDITIONS

4.1. TYPOLOGY OF STUDY AREA

Hydropower projects generate several types of impacts affecting several components of the environment in different parts of the Project area and at different periods of the Project life. For that purpose, and to facilitate the understanding of the impact analysis, a typology of the Project area has been established. It is based on the division of the Project area into zones, each zone being subject to typical impacts and subsequent categories of environmental impacts. This typology is presented on Figure 4.1, and zones are briefly described below.

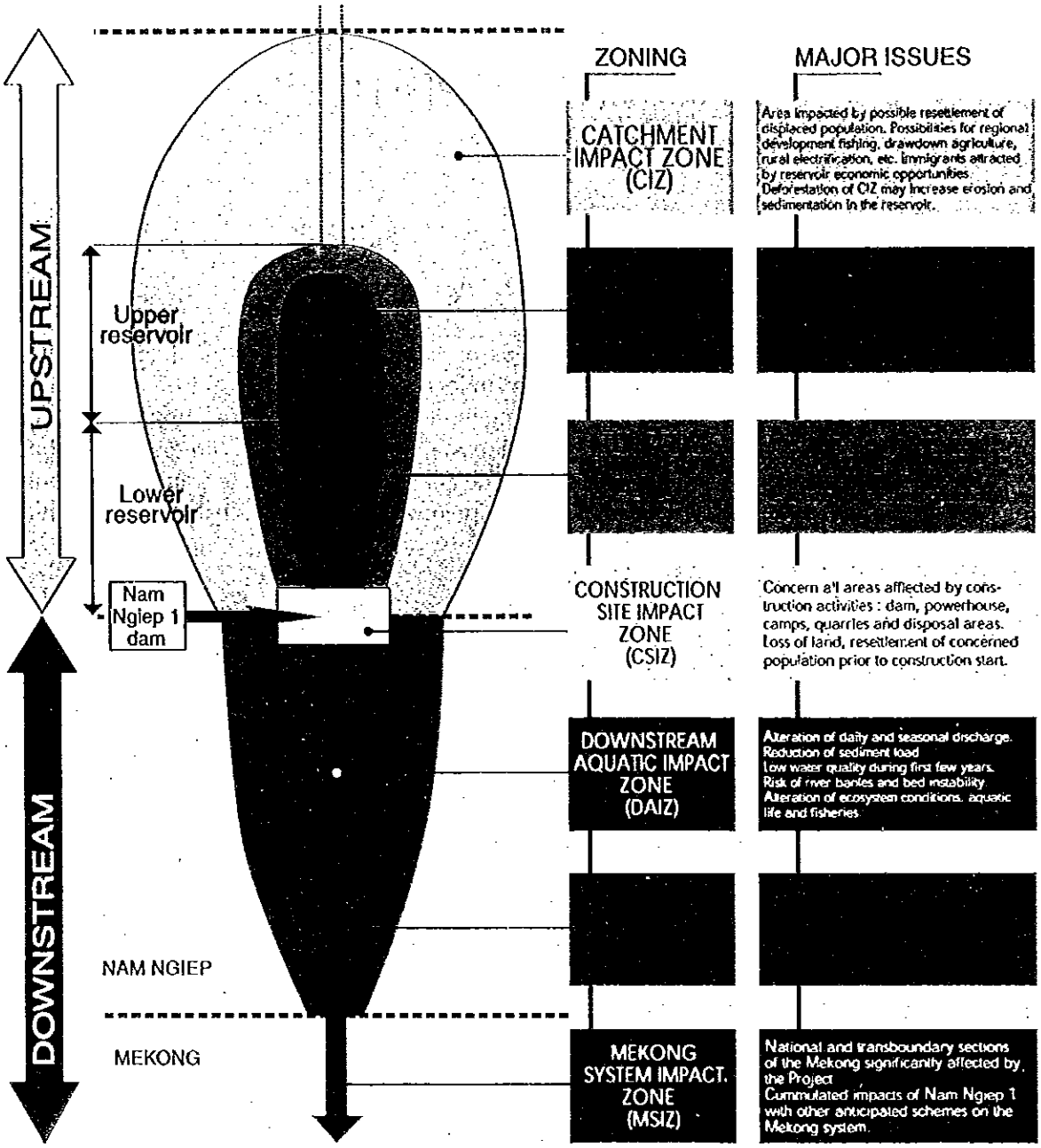
4.1.1. UPSTREAM AREA

This area is subdivided into 3 impact zones:

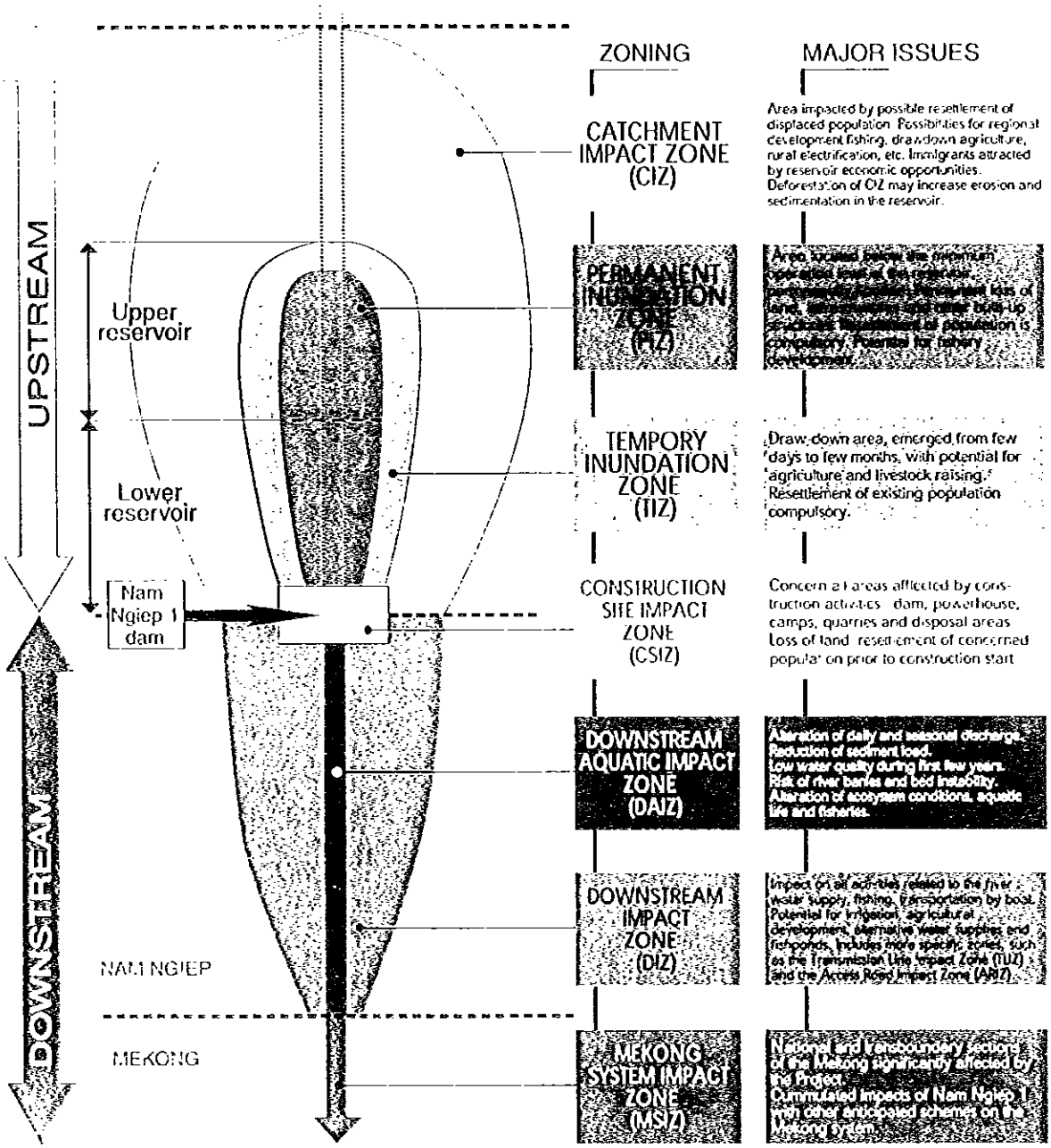
1. **The Catchment Impact Zone (CIZ):** This area is not flooded by the project, but may be impacted in case the displaced population from the reservoir area is relocated within its boundaries, and also if the reservoir acts as a focal point for regional development attracting new settlers in its surrounding. The vegetation cover and the ecological integrity of this catchment may be severely threatened in the long term. Facing this threat, measures for protection of the CIZ are required as uncontrolled development may increase the erosion rate and siltation in the reservoir, reducing eventually the expected life duration of the Project.

2. **The Permanent Inundation Zone (PIZ):** This is the area located below the minimum Operation Level (MOL), which will become a permanent water body. Resettlement of population located presently within its boundaries is compulsory. The PIZ offers generally a good potential for fish production.

3. **The Temporary Inundation Zone (TIZ):** It is located between the Full Supply Level (FSL) and the MOL. This draw down area is flooded part of the year. Emerged lands may offer a potential for development (agriculture, wetlands) depending particularly on the duration of flooding which may range from few days to few months. Resettlement of population living in this area is compulsory.



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC	First Environmental Impact Assessment	Figure 4.1
JAPAN INTERNATIONAL COOPERATION AGENCY	Typologie of The Study Area	



FEASIBILITY STUDY ON THE NAM NGIEP 1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC	First Environmental Impact Assessment	Figure 4.1
JAPAN INTERNATIONAL COOPERATION AGENCY	Typologie of The Study Area	

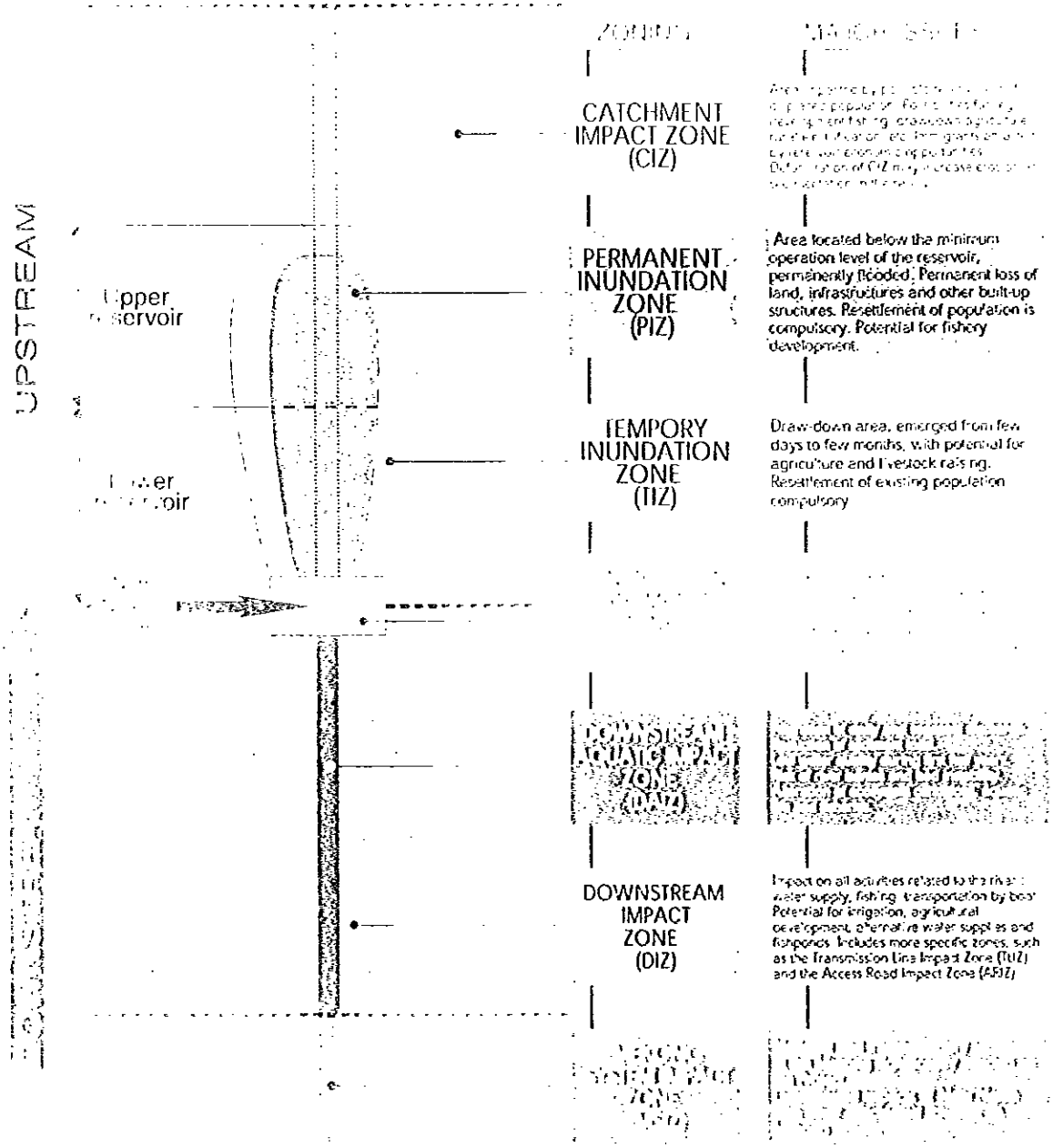


Figure 2.3

Typology of The Study Area

4.1.2. THE DOWNSTREAM AREA

It includes three (3) special Impact zones:

1. **The Downstream Aquatic Impact Zone (DAIZ):** It is constituted of the river system located downstream the dam. Natural water flow and quality is generally severely modified by hydropower project, resulting in significant impacts on aquatic life.

2. **The Mekong System Impact Zone (MSIZ):** This concerns the National or Transboundary reaches of the Mekong which may be significantly affected by the project: Flow changes, water quality or fisheries issues.

3. **Downstream Impact Zone (DIZ):** The DIZ covers the area where modification of the DAIZ may have direct or secondary impacts. It includes generally the villages located along the river, and where water supply, fisheries and river navigation may be affected. It includes also the area where new flow conditions in the river may promote development of irrigation.

4.1.3. THE CONSTRUCTION SITE IMPACT ZONES (CSIZ)

This Zone includes all the areas directly affected by the construction activities: dam and power house, quarries, camps, transmission line and access roads. Land compensation, possibly resettlement are concerned in these zones. A particular point is that mitigation measures in these zones are required at the early stage of project implementation.

4.2. GEOGRAPHY, GEOLOGY, MINERAL RESOURCES AND SOILS

4.2.1. GEOGRAPHY

The NNHP is located on the Nam Ngiep River, a Left Bank tributary of the Mekong.

The Nam Ngiep joins the Mekong at Pakxan, a small city located only 120km by asphalt road from Vientiane. The Nam Ngiep River originates in Xiang Khouang Province and runs for about 160km before joining the Mekong, 1,300m lower in elevation.

The western and northern edges of the basin form a vast cirque with very steep sides due to headward erosion, while only outliners remain of the eastern rim which separates this basin from that of the Nam Sane River. The maximum altitude of the

ridge separating the two basins is 2,819m, in the middle of the western edge of the Nam Ngiep catchment area.

At the confluence with the Mekong, the Nam Ngiep catchment area is 4,510km². The first 55km of river stretch are located in a narrow valley, with a steep slope as the river loses about 1,000m in elevation. Then the valley widens for about 70km, with large, partly cultivated alluvial terraces. Then the valley narrows again over a few km before joining the wide alluvial plain where it eventually joins the Mekong. The dam is located in a narrow gorge just before the river enters this alluvial plain, about 24km upstream from the Nam Ngiep confluence with the Mekong.

Most of the 70km of wide valley, where several villages have been established, will be flooded by the reservoir at EL.360m Figure 4.2 presents a sketch map of the study area.

4.2.2. GEOLOGY AND MINERALS

Most of the rocks forming the substratum underlying the future reservoir in its upper and lower parts are sedimentary. The geology of the reservoir falls basically into five (5) types, each characterizing roughly five (5) sections of the reservoir. They belong to:

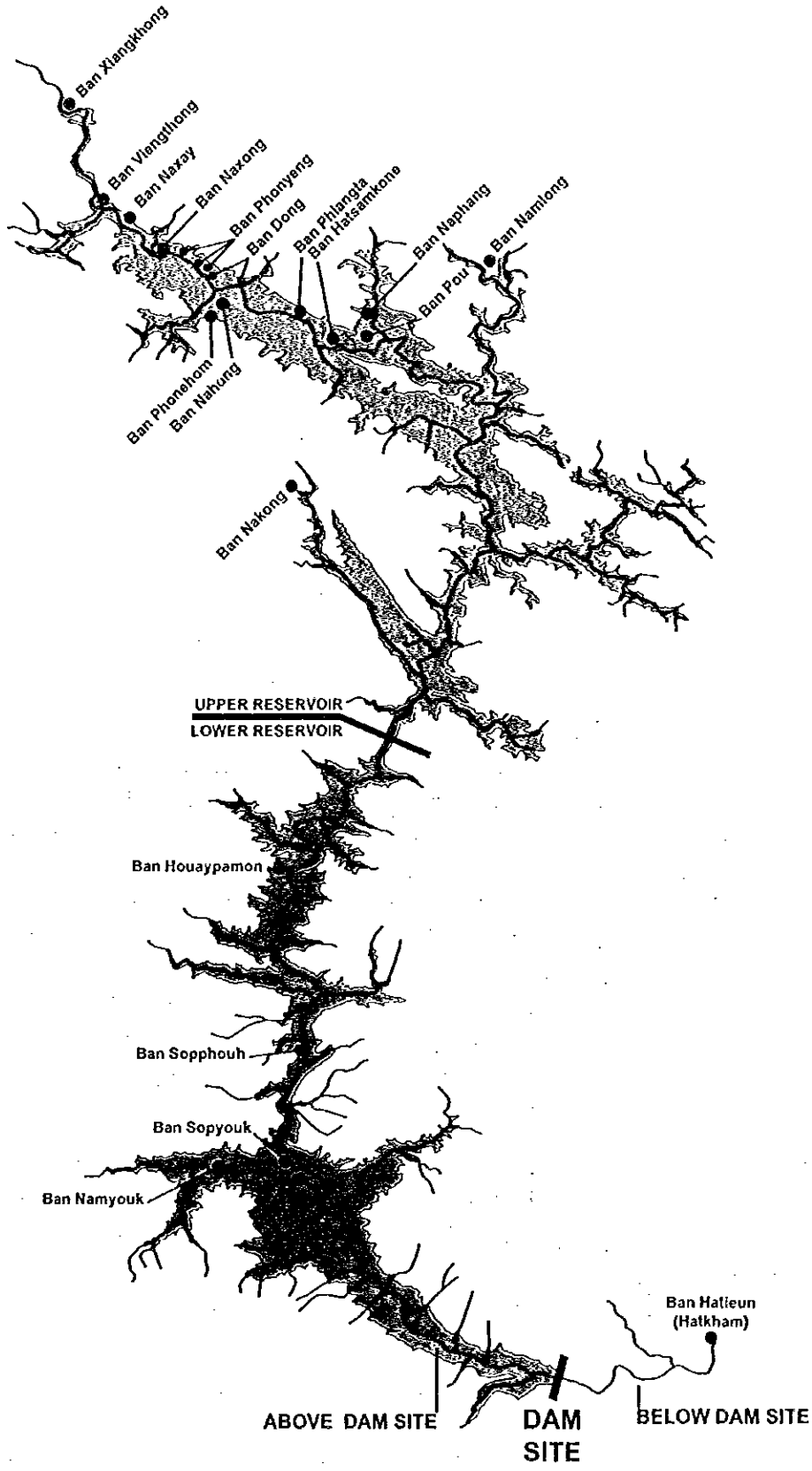
1. The Jurassic or Upper Jurassic-Cretaceous types, with:
   - Pale sandstones and conglomerates, which are very thick, homogeneous and massive, with large beds forming the upper part of these series. These formations are found on the upper slopes where they form the crests and summits.
   - Mudstones with rather thin interbedded siltstones, sandstones and conglomerates.

These formations represent the lower one fifth (1/5) of the reservoir area in a lengthwise direction.

2. Ante-carboniferous granites, characterized by the inclusion of three (3) micas. They are highly fractured and sometimes deeply weathered. The rock is impermeable at depth. Granites on the Right Bank with the next formation (Triassic) on the Left Bank occupy the next one fifth (1/5) of the reservoir.

3. The Triassic types including sandstones, siltstones, schist, marls and conglomerates with seams of coal. All these are consolidated formations alternatively hard or soft. They are hardly permeable and relatively stable, even in places where they form steeply sloping outcrops. The Triassic formations form the third fifth (1/5) of the reservoir.

4. Ante-Norian granites (with 2 micas) outcrops, also highly fractured and deeply weathered, but impermeable in large masses. They form the last but one fifth (1/5) of the reservoir.



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC	First Environmental Impact Assessment	Figure 4.2
JAPAN INTERNATIONAL COOPERATION AGENCY	Reservoir Area Overview	

5. A graben of Jurassic and Cretaceous sandstones and mudstones located between two older sedimentary or intrusive crystalline formations. This provides the substratum of the last upstream fifth (1/5) of the reservoir..

According to the Department of Geology and Mines, no investigation for oil or mineral ore has been, is being, or is anticipated to be conducted, in the reservoir area. Furthermore, due to the geological formations observed along the Nam Ngiep, important economical sources of mineral resources are unlikely to occur.

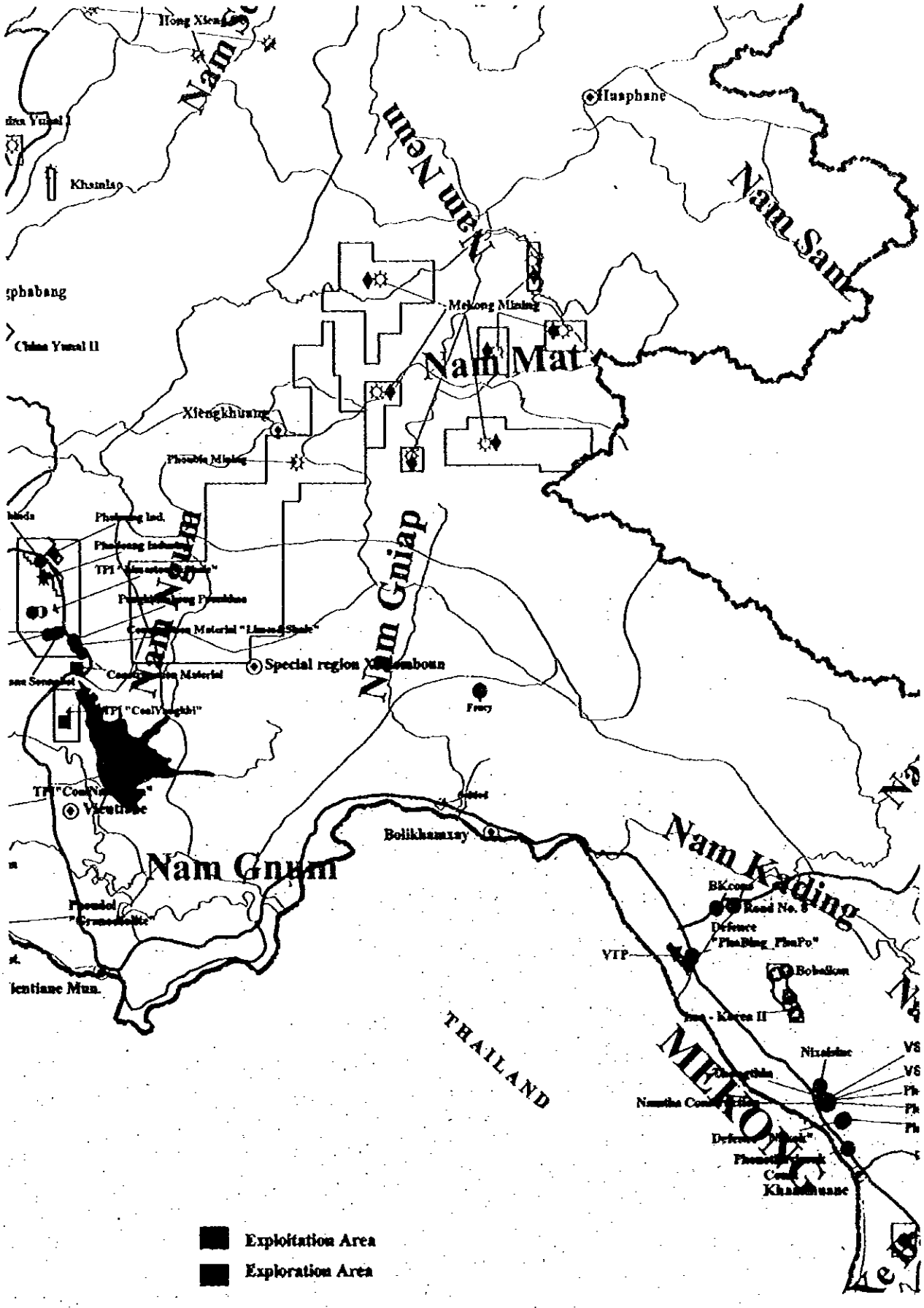
However, some private companies have already received concession from the GOL to explore some areas for iron and gold. As shown in the following figure (from MIH/ Department of Mines), none of the considered zones are located within the reservoir and construction areas or even within the catchment area.

Figure 4.3 shows the exploration areas for mining aroud the Project Area.

4.2.3. SOILS

The following types of soils are likely to be represented in the Project area:

- Lithosols (shallow soils) occur on steeply sloping rock outcrops where soil formation has been limited by natural erosion processes.
- Ferralsols and acrisols (lateritic type soils) form on the upper ridge slopes of the escarpment and plateau areas. The soils are derived from weathered weak sandstone. These soils are characterized by a dark red loamy clay surface horizon overlying a slightly bleached horizon. Clay content increases with depth. They are moderately acid, of low fertility and have poor internal drainage. Due to their low inherent fertility these soils are cropped for no longer than one or two years.
- Luvisols, cambisols and acrisols form lower down slopes where water tables may be variable. The soils have a dark brown loamy topsoil, which changes to a massively structured yellowish brown clay loam with depth. These soils are acidic and depending on their base saturation this determines their classification. In terms of base saturation and inherent fertility the soils are ranked in decreasing order as follows; luvisols > cambisols > acrisols. Small occurrences of these soils would be expected below the ridges and slopes adjacent to watercourses above the Nam Ngiep valley. Some of these soils are utilized for paddy development.
- Fluvisols are young, frequently well drained soils that occur on newly formed terrace areas adjacent to the Nam Ngiep. They are reasonably fertile and may probably be observed in the lower reservoir.



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC JAPAN INTERNATIONAL COOPERATION AGENCY	FIRST ENVIRONMENTAL IMPACT ASSESSMENT	Figure 4.3
	EXPLORATION AREAS FOR MINING	

4.3. CLIMATE AND RIVER HYDROLOGY

4.3.1. REGIONAL CLIMATIC CONDITIONS

The Project area is under the influence of the southwest monsoon, with a wet season from May to October, which yields some 91% of the annual rainfall. The dry season from November to April yields only the remaining 9%. Some of the months may be completely devoid of rainfall.

The particular layout of the catchment explains why rainfall is high in the area. Cyclonic disturbances coming from the China Sea usually run up the Mekong valley. When they reach the Nam Ngiep basin, they cannot pass the high ridges (up to 2,819m) to the west and north and remain stationary until the depression disappears.

Hence, rainfall is close to 2,500mm/year in average, as against less than 2,000mm/ year everywhere else in the region. The showers are concentrated into a short summer period, and run-off is particularly high in spite of the vegetation cover.

Table 4.1 Average Monthly Rainfall Average (mm) in the Project Area

January	59	July	431
February	50	August	591
March	44	September	480
April	41	October	225
May	82	November	119
June	228	December	73
Total : 2,423 mm/year			

(Source: 30 years generated series by Jica Study Team)

No specific data on temperature are available for the Project Area. The range of average temperature indicated for Vientiane should be roughly similar, but warmer than actual temperatures in the Project Area owing to altitude and forest cover.

As a matter of reference, basic meteorological data for Vientiane are given in following Table 4.2.

Table 4.2 Main Climatic Data for Vientiane

Items	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Average rainfall in mm	8	14	34	75	245	272	261	336	310	74	13	2	1,642
Relative humidity (%)	71	69	66	69	78	82	82	84	83	78	73	72	76
Pan evaporation (mm)	127	128	161	164	145	127	123	117	116	136	135	129	1,608
Avg. max. temper. (°C)	28.2	30.3	32.9	34.3	32.9	31.8	31.3	30.8	30.8	30.7	29.7	28.0	31.0
Avg. min. temper. (°C)	16.2	18.5	21.4	23.7	24.5	24.9	24.7	24.6	24.1	22.8	19.1	16.5	21.8
Mean max. temper. (°C)	32.4	35.1	37.2	38.4	36.8	34.9	34.5	34.1	33.6	33.3	32.6	31.5	34.5
Mean min. temper. (°C)	11.5	14.2	16.9	20.3	21.9	22.9	22.7	22.8	22.3	19.4	15.2	11.5	18.5

4.3.2. THE RIVER SYSTEM

At the dam site, the controlled catchment area is 3,700km² or 82% of the total

catchment. Downstream of the dam site, the largest tributary of the Nam Ngiep on its Left Bank is the Nam Xao River, with a catchment area of 310km². The remaining five hundred 500km² catchment consists of a smaller tributary, the Nam Tak, and the drainage of the plain near Pakxan. Total and controlled catchments are presented on Figure 4.4.

As described later in this report, the river is intensively used for fishing and transport of goods and peoples by boat in its lower 50km, until rapids located a few km downstream the dam site impede any navigation.

4.3.3. FLOWS

Results from the Pre-F/S reports (1995) have been revised by the Jica Team during the present Feasibility Study. Mean annual discharge at dam site is now estimated at 161m³/s, based on a run-off coefficient of 0.56. Series of flow at dam site have been generated over a 30 years period. Average for 30 years and typical values for mean, wet and dry years are summarized in the following table.

Table 4.3 Flow at Dam Site (in m³/s)

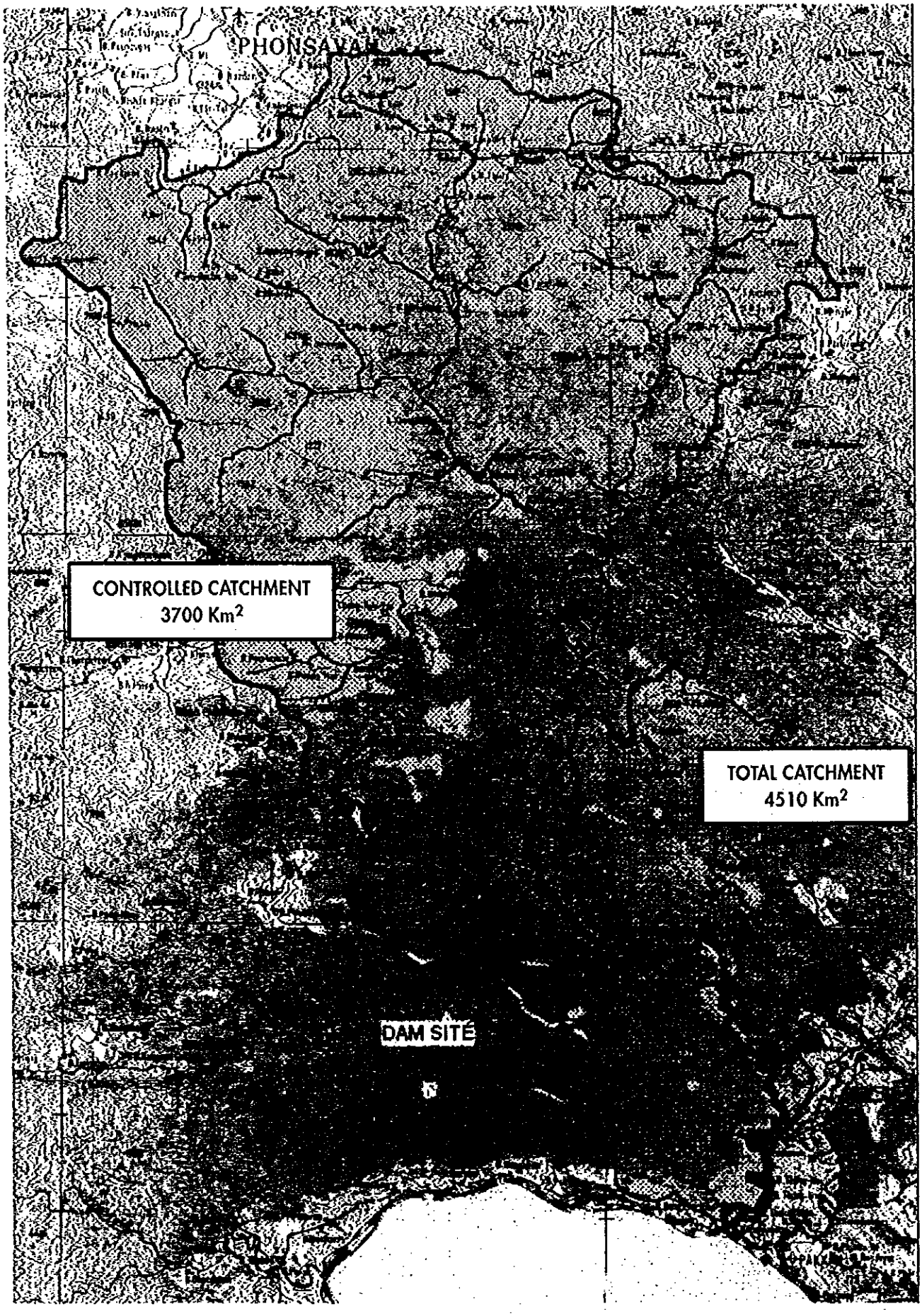
Items	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Ave. (30 yrs)	47	40	35	33	65	182	345	472	384	180	95	58	161
Mean year	59	50	43	40	68	185	236	581	358	168	106	65	163
Wet year	37	33	36	40	91	339	442	850	564	223	122	64	237
Dry year	46	35	30	24	28	71	219	251	173	92	50	40	88

The contrasted discharge between the dry and the wet season is obviously the result of the contrasted rainfall pattern which prevails, but also of the local geology of the watershed. As in many other areas in the Lao PDR, a generally thin weathered layer of high permeability covers the basement rock, which is mainly sedimentary and composed of low dipping sandstone and siltstone. This layer offers probably a very limited water storage capacity, which may result in significantly higher run-off coefficients than generally observed during the rainy season and rapid decrease of the discharge as soon as the rainy season stops. The remaining discharge in the dry season may be mainly the result of a slow drainage of the basement. This phenomenon has recently been observed in the Nam Leuk catchment, geologically comparable and located only twenty to fifty (20 -50) km west of the Nam Ngiep River.

4.3.4. FLOODS

The floods on the Nam Ngiep were investigated during the Pre-Feasibility Study. Computations were based on the Duret formula, to assess the peak discharges for various return periods.

In the following Table 4.4, the results are shown for the hydrological stations of Muong Mai (24km upstream confluence with Mekong) and Ban Hatieun (45km upstream confluence) and for the dam site (54km upstream confluence).



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC JAPAN INTERNATIONAL COOPERATION AGENCY	FIRST ENVIRONMENTAL IMPACT ASSESSMENT	Figure 4.4
	NAM NGIEP CATCHMENT	