SUMMARY ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

PROPOSED NAM THEUN II HYDROELECTRIC PROJECT

IN THE

LAO PEOPLE'S DEMOCRATIC REPUBLIC

November 2004

MINISTRY OF INDUSTRY AND HANDICRAFTS

NAM THEUN II POWER COMPANY LTD.

CURRENCY EQUIVALENTS
(as of 14 November 2004)

Currency Unit	–	Kip (KN)
KN1.00	=	$0.000093
$1.00	=	KN10,773

ABBREVIATIONS

ADB	–	Asian Development Bank
AFD	–	Agence Française de Développement
CIA	–	cumulative impact assessment
EAMP	–	Environmental Assessment and Management Plan
EDL	–	Electricité du Laos
EGAT	–	Electricity Generating Authority of Thailand
EMO	–	Environmental Management Office
EMU	–	Environmental Management Unit
HCC	–	head construction contractor
HCCEMMP	–	Head Construction Contractor's Environmental Management and Monitoring Plan
HIV/AIDS	–	human immunodeficiency virus/acute immunodeficiency syndrome
IUCN	–	International Union for the Conservation of Nature and Natural Resources
Lao PDR	–	Lao People's Democratic Republic
MRC	–	Mekong River Commission
NNT	–	Nakai Nam Theun
NPA	–	national protected area
NTFP	–	nontimber forest product
NTPC	–	Nam Theun 2 Power Company Limited
RMU	–	resettlement management unit
ROW	–	right of way
SDP	–	Social Development Plan
SEMFOP	–	Social and Environment Management Framework and First Operational Plan
SESIA	–	Summary Environmental and Social Impact Assessment
SIA	–	Strategic Impact Assessment
STD	–	sexually transmitted disease
STEA	–	Science, Technology and Environment Agency
WMPA	–	Watershed Management and Protection Authority

WEIGHTS AND MEASURES

µg	–	microgram
cm	–	centimeter
El	–	elevation above sea level in meters
ha	–	hectare
kg	–	kilogram
km	–	kilometer
km^2	–	square kilometer
kV	–	kilovolt

l	–	liter
m	–	meter
m^3	–	cubic meter
m^3/s	–	cubic meter per second
masl	–	meters above sea level
mg	–	milligram
MW	–	megawatt
ºC	–	degree Celsius

NOTES

(i) Throughout this report, the Lao words *Nam*, *Xe*, and *Houay* are used to mean “river” and *Ban* to mean “village”. To avoid repetition, the English word is not repeated after the Lao name, i.e., “Nam Theun” is used rather than “Theun River.”

(ii) The fiscal year (FY) of the Government ends on 30 September.

(iii) In this report, "$" refers to US dollars.

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I. INTRODUCTION

A. Background

1. The potential for hydropower development on the Nam Theun and Nam Kading systems in central Lao People's Democratic Republic (Lao PDR) was first identified by the Mekong Secretariat in the 1970s. The studies undertaken by the Government of Lao PDR identified a series of potential sites for hydropower development on the Nam Theun, which were given numbers for reference purposes, including the Nam Theun 2 site. In 1991, following initial studies, the Government of the Lao PDR, with support from the World Bank and the United Nations Development Programme, commissioned the Snowy Mountain Engineering Corporation to undertake a Feasibility Study for the Nam Theun 2 Hydroelectric Project (the Project). A number of detailed studies were subsequently completed, including the investigation of alternative options and economic evaluations. Since 1994, the Nam Theun 2 Electricity Consortium has been responsible, with support from the Asian Development Bank (ADB), Agence Française de Développement (AFD), World Bank, and the Government, for development of the project design. On 1 January 2004, the responsibilities of Nam Theun 2 Electricity Consortium to develop the Project were transferred to Nam Theun 2 Power Company Limited (NTPC), which is wholly owned by four companies: Electricité de France International (35%), Electricité du Laos (EDL, 25%), Electricity Generating Public Company Limited (25%), and Italian-Thai Development Public Company Limited (15%).

2. The Project will dam the Nam Theun, a tributary of the Mekong, generating 1,070 megawatts (MW) of electricity for supply to the Electricity Generating Authority of Thailand (EGAT) (93%) and EDL (7%). The Project is forecast to generate approximately $1.9 billion in revenues (in nominal terms) for the Government over the 25-year project concession period. In so doing, the Project is expected to be one of the largest sources of foreign currency income for the Government over its lifetime, a very important contributor to the Lao PDR's gross domestic product, and a significant source for the Government's fiscal revenues after repayment of the commercial debt. The Project is recognized by the Government as an essential part of the country's development framework to reduce poverty.

B. Purpose and Scope of this Report

3. This Summary Environmental and Social Impact Assessment (SESIA) presents the baseline conditions, then summarizes the key environmental and social impacts of the Project and the approach and methods proposed for their resolution. It draws on the work presented in a series of separate reports submitted to the Government, ADB, AFD, and World Bank as shown in Table 1. These studies were undertaken to meet the safeguard policies and requirements of these four entities, and are available on the NTPC's web site (www.namtheun2.com). They reflect several additional studies and analyses that were undertaken to improve the impact assessment and management approaches documented in earlier drafts. They also reflect comments received during stakeholder consultation carried out in the project area and internationally between May and September 2004.

Table 1: Documents Used in the Preparation of the Summary Environmental and Social Impact Assessment

Document	Version	Purpose
Environmental Assessment and Management Plan	Final draft, November 2004	Presentation of the baseline condition and assessment of the environmental impacts associated with the Project and development of plans to minimize, mitigate, or compensate for these impacts.
Social Development Plan	Final draft, November 2004	Plan to manage social impacts including those related to resettlement, health, and downstream impacts in the Xe Bang Fai area and to manage special issues related to ethnic minorities.
Social and Environment Management Framework and 1st Operational Plan	Final draft, November 2004	Plan to manage the Nakai-Nam Theun National Protected Area and its corridors. Its funding is provided by the Project as a compensation for the environmental impacts related to the Project.
Cumulative Impact Analysis and Nam Theun 2 Contribution	Final report, November 2004	Environmental and social analysis of combined impacts of a number of development projects in the Mekong basin including effects of other (future) developments on Nam Theun 2 impacts and developments in other sectors that are induced by Nam Theun 2.
Lao PDR Hydropower Strategic Impact Assessment	Draft final report, November 2004	Assessment of combined impacts of 21 hydropower projects planned for implementation in the Lao PDR before 2020 with recommendations on the management of environmental and social impacts within the sector.
Environmental and Social Cost/Benefit Analysis	Draft final report, June 2004	Provides estimates of the environmental and social costs and benefits of the Project for those impacts that can be valued. Final results are being used for the overall project economic analysis.

Lao PDR = Lao People's Democratic Republic
Source: Environmental Assessment and Management Plan, November 2004.

C. Scope of Environmental and Social Studies for the Project

4. The environmental and social studies carried out to date address different needs. Scope of the environmental assessment is discussed in the Environmental Assessment and Management Plan (EAMP); issues related to the compensation for project-related environmental impacts provided through the management of the Nakai-Nam Theun National Protected Area[1] (NNT NPA) are dealt with in the Social and Environment Management Framework and First Operational Plan (SEMFOP); the SEMFOP also includes an Ethnic Minority Development Plan (EMDP) and a Resource Access Restriction Process Framework. Scope of the social issues including resettlement, ethnic minority, and health issues are addressed in the Social Development Plan (SDP). This includes a number of subcomponents as follows:

[1] National biodiversity conservation area and national protected area (NPA) have the same meaning and are transposable in the Lao PDR.

(i) Resettlement Action Plan and Ethnic Minorities Development Plan for the Nakai plateau/reservoir resettlement area;
(ii) Downstream Areas Ethnic Minorities Development Plan and Resettlement and Compensation Framework for areas affected along the Xe Bang Fai and Nam Theun; the Framework is being updated to a Resettlement Plan;
(iii) Project Lands Resettlement (acquisition and compensation) Framework, which is being updated to a Resettlement Plan(s); and
(iv) Public Health Action Plan.

5. The social and environmental studies have involved extensive surveys of the existing environmental and social conditions in the project area, followed by subsequent identification and assessment of potential environmental and social impacts. Mitigation and compensation measures have then been developed where impacts cannot be avoided. Monitoring actions have also been identified to be undertaken during project implementation.

6. The EAMP, SEMFOP, and SDP consider the construction and operation of the Project and to a lesser extent, its decommissioning. Their geographic scope covers an area of approximately 6,700 square kilometers (km^2) including some 4,025 km of river. Only a portion of this area (approximately 1,306 km^2) is, however, likely to be affected by the Project. In addition, approximately 3,950 km^2 covering the NNT NPA and its adjoining corridors will be supported by the Project through implementation of the SEMFOP. While the Project has minimal adverse impacts on this area, it is considered part of the Project because its conservation under the SEMFOP will be used as compensation for a portion of the environmental impacts related to the Project. Recognizing that this project can have impacts beyond this immediate study area, particularly when combined with impacts of other development projects, a Cumulative Impact Analysis (CIA) has been completed. The CIA considers the Project in the context of development projects in the hydropower and other sectors across the whole Mekong Basin and over a 20 year time frame. Also recognizing Nam Theun 2 is a large project that may have sector wide implications, a Strategic Impact Assessment for the Lao Hydropower Sector (SIA) was prepared. The SIA identifies, at the sector level, the numerous strategic opportunities to avoid impacts and improve environmental and social management. It is intended to complement the Power System Development Plan by providing recommendations to Lao PDR Government institutions, donors, private investors and other stakeholders, to further improve decision making, develop mitigation measures and improve policy, legal and institutional aspects of the sector. The findings of these studies are summarized in Section VII.

7. While the environmental and social studies undertaken to date identify potential impacts, some of these impacts, particularly during operation, have only undergone preliminary assessment within the current studies. This is because exact downstream impacts will be known only during operation of the Project (a full list of construction and operation plans is given in Appendix 1).

II. DESCRIPTION OF THE PROJECT

A. Description of Project Scope

8. The Project plans to dam the Nam Theun near Ban Sop Hia, Khammouane province, impounding some 195 km of the river and its tributaries and creating the Nakai reservoir on the Nakai plateau. The reservoir will have a surface area of approximately 450 km^2 at full supply level and a total storage capacity of 3,910 million cubic meters (m^3). Water from the reservoir

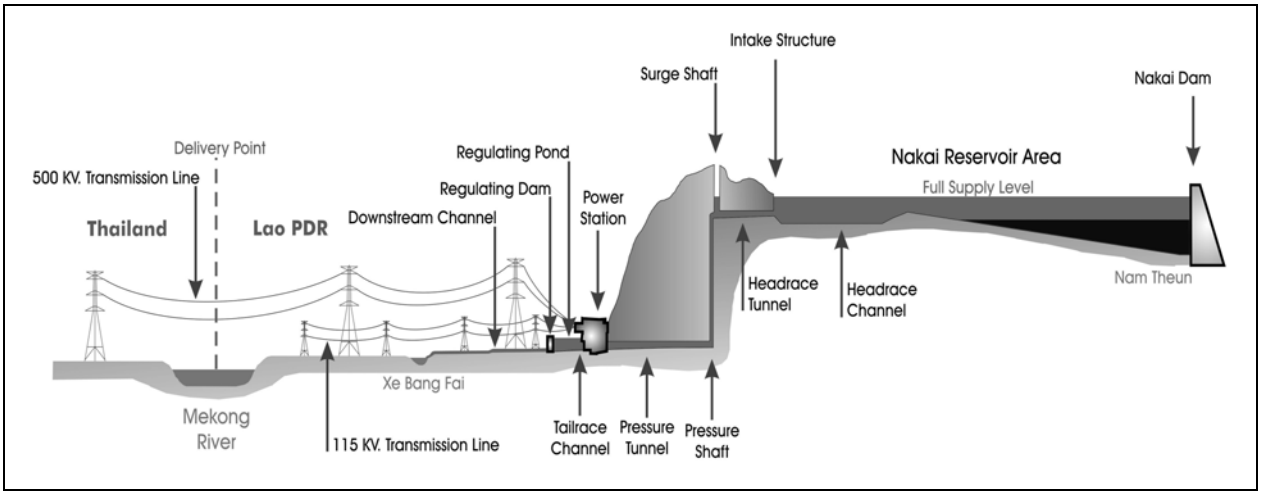
will fall about 350 meters (m) through a tunnel to a power station located at the base of the Nakai escarpment, taking advantage of the difference in elevations between the Nakai plateau and the Gnommalat plain. From the power station, water will then flow into a regulating pond and then via a 27 km downstream channel into the Xe Bang Fai. The Project will therefore transfer an average annual flow of 220 m^3 per second (m^3/s) from the Nam Theun into the Xe Bang Fai. Water from the power station will also be released into the Nam Kathang below the regulating dam at a rate equivalent to current natural inflows.

9. The power station will have a generating capacity of 1,080 MW (net 1,070 MW), 995 MW of which will be for EGAT's demand via a 138 km-long 500-kilovolt (kV) double-circuit transmission line. EDL will receive 75 MW for use in the Lao PDR via a 70 km-long, 115 kV transmission line to Thakhek, although approximately 20 MW of this can be directed via existing and project-built 22 kV transmission lines to the local area including the resettlement sites. The total estimated cost of the Project is $1.3 billion (including a $0.1 billion contingency).

10. The main Project components, illustrated in Figure 1, are as follows:

(i) a 48 m high dam on the Nam Theun, and 13 saddle dams to create the Nakai reservoir;
(ii) 4.25 km headrace channel and intake structure on the Nakai plateau, approximately 35 km southeast of the Nakai dam to divert water from the Nakai reservoir to the power station;
(iii) a power station with six electricity generating units and accompanying administration, operating, and control rooms;
(iv) a regulating pond (to control downstream flows) and a 27 km long, excavated channel to direct the diverted flows from the power station into the main channel of the Xe Bang Fai near the town of Mahaxai;
(v) 500 kV, 115 kV, and 22 kV transmission lines to interconnect the power station switchyards with the EGAT and EDL power transmission systems; and
(vi) ancillary works such as access roads, bridges, and operators' residences to enable construction, operation, and maintenance of the Project and to meet other obligations of NTPC.

Figure 1: Nam Theun 2 Project Components



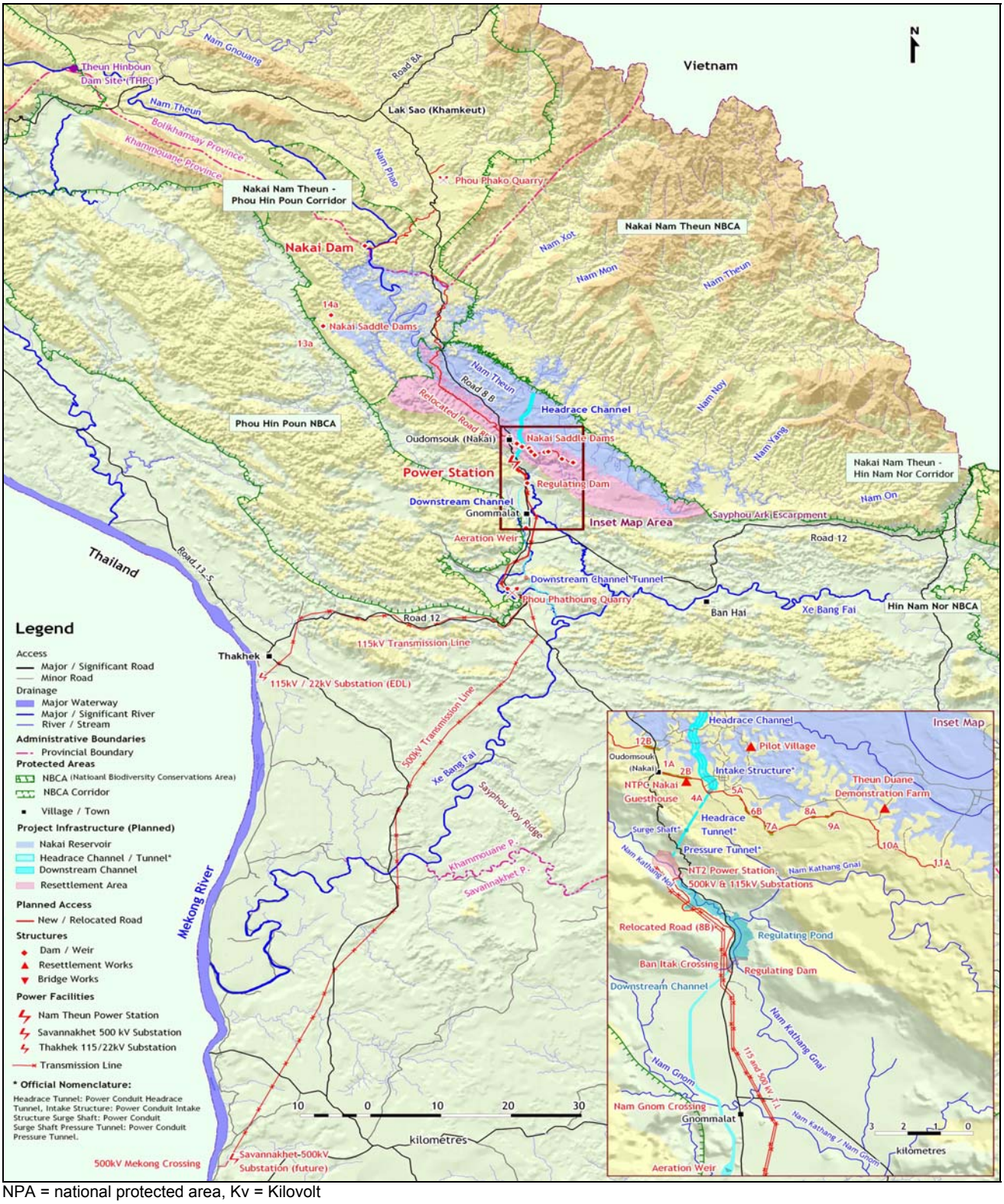
Kv = Kilovolt, Lao PDR = Lao People's Democratic Republic
Source: Environmental Assessment and Management Plan, November 2004.

11. The project area with key project features is shown in Figure 2. Construction activities will also require road construction and upgrading, sourcing of limestone for aggregate production, disposal of spoil, and establishment of construction camps. Possible locations for these are illustrated in Figures A4.1 to A4.3 of Appendix 4.

B. Project Location

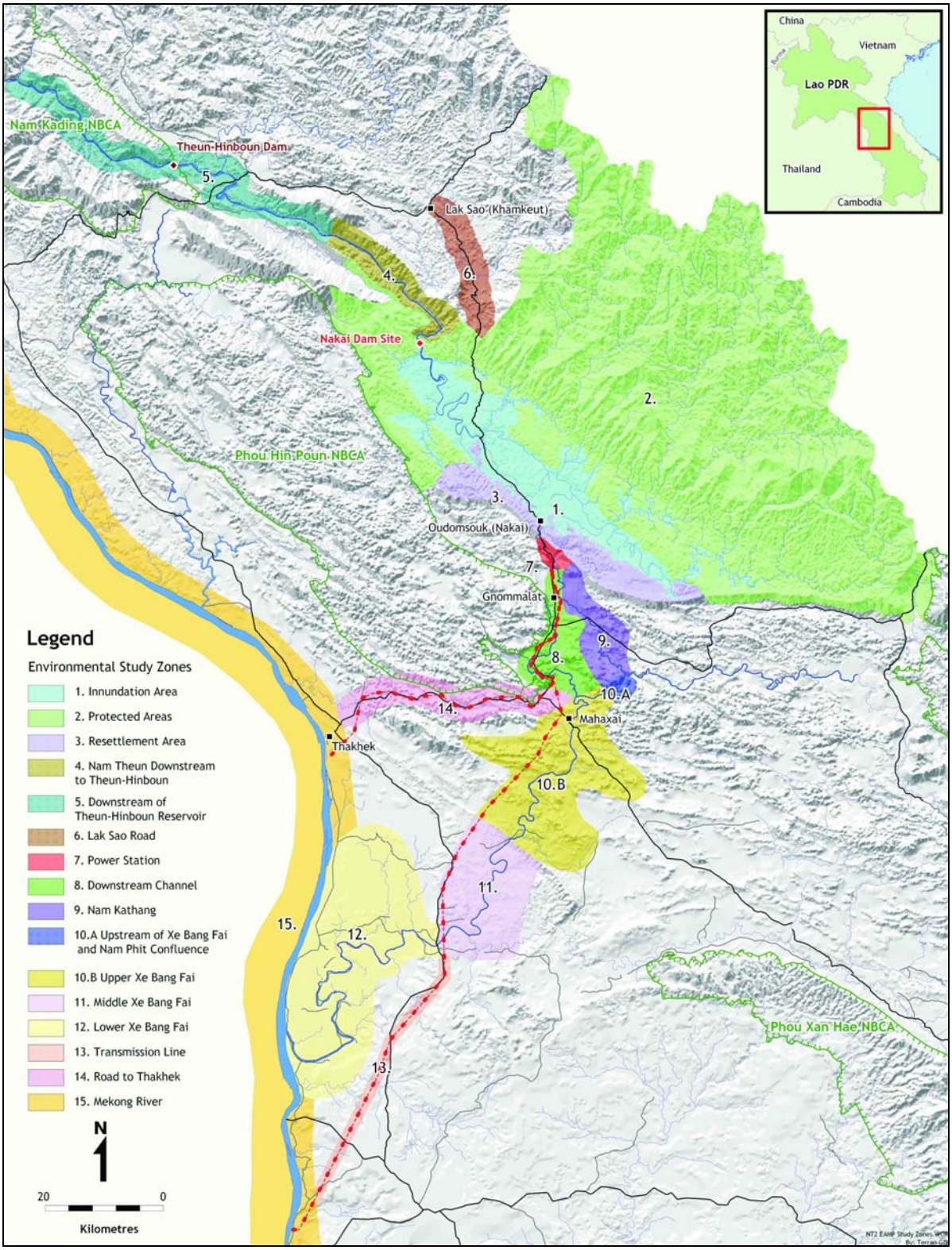
12. The main area to be affected by the Project is the Nakai plateau. The Project will also impact areas between the plateau and the Mekong river, along the Xe Bang Fai and Nam Theun and along the alignment of transmission lines. Figure 3 divides the project area into 15 zones whose characteristics are then summarized in Table 2.

Figure 2: Principal Project Features



NPA = national protected area, Kv = Kilovolt
Boundaries are not necessarily authoritative
Source: Environmental Assessment and Management Plan, November 2004.

Figure 3: Study Areas



Lao PDR: Lao People's Democratic Republic, NPA = National Protected Area
Boundaries are not necessarily authoritative
Source: Environmental Assessment and Management Plan, November 2004.

Table 2. Summary of Characteristics of Study Zones

Zone	Area	Overview of Key Characteristics	Key Issues
1	Inundation area	• Area below 538 meters above sea level (masl) on the Nakai plateau to be inundated by the reservoir—approximately 450 km^2 at full supply level (538 masl) and 108 km^2 at minimum operating level (525.5 masl)	• Impacts primarily attributable to impoundment of river creating the reservoir, including inundation of land, water quality, plants and animals, and human settlements. Construction activities will also affect this area
2	Protected areas	• Includes NNT NPA (area 3,500 km^2) and two corridor areas (approximately 770 km^2) that connect the NNT NPA with the Phou Hin Poun NPA to the west and the NNT NPA with the Hin Nam No NPA to the south	• Poor land use practices in NNT NPA (forms 88% of the Nam Theun catchment for the Nakai reservoir) would result in increased sedimentation, shortening the life of the reservoir • Management of the NNT NPA is to focus on conservation of internationally recognized biodiversity and recognition of customary rights of ethnic minorities, together with support for livelihood activities
3	Resettlement area	• 208 km^2 area along southern rim of Nakai reservoir selected for resettlement following consultation with affected households • Vegetated with mixed broadleaf and coniferous forest, dry evergreen forest, and agricultural areas • Existing population in resettlement area primarily in villages of Nakai Tai and Nakai Neua, district headquarters, and Ban Oudomsouk • 2 Nakai Plateau villages have chosen to move down off Plateau to Bolikhamxay	• Efficient implementation of resettlement and development program • Carrying capacity of land and optimum sustained use of land • Movement of wild elephants through the zone and potential for human-elephant conflict • Construction activities (including construction camps) will affect host population • Coordination with host community population in Bolikhamxay
4	Nam Theun from Nakai Dam downstream to Theun Hinboun reservoir	• Riparian land along Nam Theun from Nakai dam to start of Theun Hinboun reservoir approximately 32 km downstream • Much of zone is included in the NNT-Phou Hin Poun corridor • Nam Phao discharges into Nam Theun approx 11.7 km downstream of the Nakai dam • No established villages or permanent settlements in the zone, though some use of the river by villages for fishing	• Effects on riparian habitats, riparian releases from Nakai dam and the plants and animals that inhabit the area • Amount of riparian release will influence fish populations in the Nam Theun and the fisheries of nearby villages • Most of current fish population will disappear • 1 construction work camp at Nakai dam site (800 workers)

Zone	Area	Overview of Key Characteristics	Key Issues
5	Downstream of Theun Hinboun reservoir	• Includes Theun Hinboun reservoir and a riparian area along the Nam Kading that potentially stretches to the Mekong	• For a larger portion of the year the flow in the Nam Kading in the 36 km reach between the Theun Hinboun reservoir and the Nam Mouan will be limited to the minimum riparian release from the Theun Hinboun project.
6	Lak Sao road	• Includes Road 8b south of Ban Lak Sao to about the intersection of Road 8b and the border of zone 2. • Includes quarry to be opened at Pha Phen (Phou Phako) to provide aggregate for construction	• Issues are associated with construction including noise, air pollution, and water-related issues such as run-off and drainage • Construction of a workforce camp will create issues related to waste disposal, health impacts, resource use, and cultural issues
7	Power station	• Small area immediately surrounding the power station • There are no residents in this area although there are some gardens	• Issues are associated with construction and operation of power station • Water quality and quantity, diversion of flow into surrounding rivers, and rerouting of the natural stream drainage • 1 construction work camp (800 workers)
8	Downstream channel (DC)	• Includes 27 km length of the downstream channel from the regulating dam to the Xe Bang Fai confluence • Includes adjacent areas that will be modified as part of construction of the downstream channel	• downstream channel will impact rice paddies and will require modification of the Nam Phit channel • 2 construction work camps (2,600 workers) • Location of spoil disposal sites, placement of embankments and bridges along the downstream channel, and elimination of some wetland areas at the lower end of the downstream channel • Approximately 200 households who either use or occupy land on the downstream channel alignment will be affected
9	Nam Kathang	• Covers Nam Kathang and riparian land from the regulating pond to its confluence with the Xe Bang Fai • Includes approx 1,632 households within 23 villages • 2 villages upstream of downstream channel	• Zone will not be affected by any increase in discharge • Environmental issues include the quality of water released from the regulating dam

Zone	Area	Overview of Key Characteristics	Key Issues
10	Upper Xe Bang Fai	• Zone extends from the confluence of the downstream channel (Nam Phit) and the Xe Bang Fai to the Sayphou Xoy ridge about 25 km downstream of Mahaxai • 12 villages are located along the river reach	• Primary issues related to increase in discharge in the Xe Bang Fai, changes in discharge regime, erosion of river banks, changes in water quality, effect on land use along river bank, effects on fisheries and restrictions on crossing the river
11	Middle Xe Bang Fai	• Area between Sayphou Xoy Ridge and Road 13 crossing; includes 5 mainstream villages and 7 backwater villages (on the Xe Noy, a tributary of the Xe Bang Fai) • 12 villages are located along the river reach	• Will experience increase in dry-season discharge that may facilitate navigation and improve irrigation potential • Some villages have initiated dry-season irrigation; this may improve with additional water in the Xe Bang Fai • Other issues in this zone are similar to Zone 10 (Upper Xe Bang Fai) but severity of impact expected to be less due to distance from downstream channel and larger size of channel
12	Lower Xe Bang Fai	• Covers approximately 500 km^2 from its confluence with the Mekong up to the Road 13 crossing: includes approximately 70 km of river • Area is fairly densely populated with some 53 villages and approximately 400 km^2 of rice paddy fields; it is a major area of rice production for Khammouane province • Zone experiences natural flooding almost every year and is hydraulically controlled by the Mekong.	• Area will experience higher dry-season flows facilitating increased dry-season irrigation
13	Transmission lines	• Zone extends from bridge over the Xe Bang Fai on Road 13 to Savannakhet along the route of the transmission line that will deliver electricity to Thailand	• Primary issues are social, including land acquisition, compensation, restoration for lost assets • Some loss of forest
14	Road to Thakhek	• Consists of area along the road between Mahaxai and Thakhek along which 115 kV Transmission line passes	• Habitat loss and human occupancy issues
15	Mekong river	• EAMP and SDP consider the Mekong between its confluences with the Nam Kading and Xe Bang Fai, plus consideration of the 500 kV • Transmission line crossing immediately north of Savannakhet. • The CIA looks at the wider impacts along the Mekong downstream of Savannakhet	• Flood stage levels of the Mekong are key issue for EAMP and SDP. Migration of fish through the area, navigation, and flooding

EAMP = Environmental Assessment and Management Plan, NNT = Nakai Nam Theun, NPA = national protected area, SDP = Social Development Plan
Source: Environmental Assessment and Management Plan, November 2004.

C. Project Construction and Operation

13. Construction of the Project is estimated to take 54 months (including commissioning). A single HCC, namely Electricité de France, will be responsible for overseeing all construction contracts. Current plans are for the Project to begin delivery of electricity to EGAT and EDL in December 2009.

14. Construction of the Project is expected to employ approximately 4,000 workers. Four potential zones have been identified for the development of construction work camps: at the Nakai dam site (approximately 800 workers), at Ban Oudomsouk on the Nakai plateau (approximately 800 workers), at the power station (approximately 2,200 workers), and downstream of the power station, between Ban Gnommalat and Mahaxai (approximately 400 workers). Operation and maintenance of the Project is estimated to employ 150 staff. An operator's village will be constructed near the regulating dam to accommodate these employees.

D. Project Owners and Developers

15. The Project is to be developed on a build-own-operate-transfer basis by NTPC. NTPC will be responsible for designing, constructing, and operating the Project for the concession period of 25 years from the commercial operating date, after which it will be transferred to the Government for continued operation and maintenance.

E. Policy Context and Project Rationale

16. The Lao PDR is currently recognized as a least developed country and relies heavily on external aid. Almost half of its 5.4 million people live in poverty. The country has few options to secure sustainable environmentally and socially sound development and the Government has recognized hydropower as a key element in achieving the macroeconomic foundation from which poverty will be tackled (within its economic development strategies and its National Growth and Poverty Eradication Program). Other key revenue generating options for the Lao PDR are tourism (which continues to grow), mining (which has been initiated in several locations and whose potential is still under investigation), and timber harvesting (which historically has been unsustainable). The Government and EGAT entered into a memorandum of understanding in 1996 for the development and supply of up to 3,000 MW of electricity from the Lao PDR to Thailand.

17. The Project is expected to generate around $1.9 billion in revenues (in nominal terms) for the Government over the 25-year project concession period. This is based on agreements signed for the purchase of electricity between NTPC and EGAT. In this respect, it will be a very important contributor to the Lao PDR's gross domestic product (as discussed above). The Government intends to use its share of revenues to develop programs that will contribute to the reduction of poverty through the promotion of economic and social development. Additionally, NTPC has committed to providing $31.5 million ($6.5 million before commercial operations and $1 million for each year of the concession period) to finance the management and protection of the NNT NPA under the framework provided in the SEMFOP. This and other direct and indirect benefits of the Project are described in more detail in Section V.

III. DESCRIPTION OF THE PHYSICAL, BIOLOGICAL, AND SOCIAL ENVIRONMENTS

A. Physical Environment

18. The project area, illustrated in Figure 2, covers two river systems in central Lao PDR—the Nam Theun and the Xe Bang Fai—and extends from the lowlands along the Mekong river to the rugged Annamite mountain range along the Lao PDR–Viet Nam border. Midway between the Mekong river and the Lao PDR–Viet Nam border lies the Nakai plateau, located approximately 350 m above the adjacent plain to its south and southwest. The power station is located at the base of the escarpment beneath the Nakai plateau, while the proposed dam is located at the northwestern edge of the Nakai plateau.

19. The Nam Theun itself originates at an elevation of 2,286 m in the Annamite mountains and is joined by three tributaries on the Nakai plateau (Nam On, Nam Noy, and Nam Xot). Together these form the project watershed, which is protected under the NNT NPA. The watershed is characterized by mountainous, mainly forested, terrain and is remote and sparsely populated. The plateau itself lies at an elevation of 520–550 m. Sandstone peaks of elevations of 1,100–1,300 m form its northeastern margin while to the southwest, it is surrounded by a sandstone lip at an elevation of 600–700 m. The Nam Theun meanders across the relatively flat Nakai plateau. Downstream of the proposed dam, it cuts through heavily forested hills where additional tributaries (e.g., Nam Phao) join before reaching the headpond of the Theun-Hinboun Hydroelectric Project and then the Mekong river, approximately 96 km further downstream.

20. The Project will transfer water from the Nam Theun into the Xe Bang Fai, with the water entering the Xe Bang Fai just north of Mahaxai. In this area, the Xe Bang Fai meanders through sandy banks in a karstic limestone plain. Approximately 25 km downstream of Mahaxai, the Xe Bang Fai passes through the Sayphou Xoy ridge, which acts as a hydraulic control and can cause water to back up upstream during flooding. From the ridge, the river flows through low-lying plains to its confluence with the Mekong. Flooding in this area is common during the wet season (May–October) caused by backwater from the Mekong moving up the Xe Bang Fai. Flooding of up to 1.5 m can occur over low-lying areas.

21. The project area experiences a tropical monsoon climate with distinct wet and dry seasons. River discharges are directly related to precipitation with approximately 85% of annual runoff typically occurring between June and October while low flows occur in April. Mean annual and monthly discharges in the main rivers to be affected by the Project are summarized in Table 3.

Table 3. Summary of Mean Annual and Monthly Flows
(m^3/s)

Monitoring Site	Data Series	Mean Annual Discharge	Mean Monthly Discharge	
			Driest Month	Wettest Month
Nam Theun at Ban Thalang (Nakai plateau)	1986–2002	205.6	24 (Apr)	653 (Aug)
Nam Theun at Dam Site	1950–2002	238	31.9 (Apr)	734.7 (Aug)
Nam Kathang at Regulating Dam Site	1994–2002	10.2	0.3 (Apr)	38.5 (Sept)
Xe Bang Fai at Mahaxai	1989–2002	265.4	12.7 (Apr)	921.2 (Aug)
Mekong at Nakhon Phanom (upstream of Xe Bang Fai)	1924–1999	5,865	1,493 (Apr)	19,879 (Aug)
Mekong at Mukdanhan (downstream of Xe Bang Fai)	1922–1992	6,960	1,552 (Apr)	21,453 (Aug)

Source: Environmental Assessment and Management Plan, November 2004.

22. The average annual discharge in the Mekong at Nakhon Phanom has decreased by over 10% in the past 75 years. Seasonal flood magnitudes have also decreased while annual minimum monthly flows have increased. This could be the result of withdrawal or storage of water in the upper Mekong for irrigation or other uses, climatic changes, and/or changes in vegetative cover and land use.

23. Measured water quality in the Nam Theun is good, reflecting the fact that the river is located in a relatively undisturbed catchment with a small population and no industry. Water quality in the Xe Bang Fai basin is similarly good, although orthophosphate and total phosphorus are somewhat higher. Groundwater is used for domestic supply in the Gnommalat area. Groundwater is also available in the proposed resettlement area and its quality is good. A water quality monitoring program starting in late December 2004 will extend the existing baseline data before the start of construction and operation.

B. Biological Environment

1. Aquatic Habitats and Fish Diversity

24. The diversity of fish species in the Nam Theun is low compared with the Mekong mainstream and the adjacent Xe Bang Fai basin. A total of 131 species of fish have been observed in the Xe Bang Fai and 68 in the Nam Theun basins. All fish species currently observed in the project area exist either in other basins or outside the area of direct project impacts. Habitats that are important to fish populations in the Nam Theun and Xe Bang Fai include riverbank terraces and floodplains—the floodplains at the confluence of the Xe Bang Fai with the Mekong river are particularly important for Xe Bang Fai fisheries. Flooded areas serve as nursery grounds and refuges for juvenile fish. Habitats in the Xe Bang Fai are more diverse and the river has direct communication with the rich Mekong fauna. Furthermore, the presence of only juvenile fish at some locations in the Nam Theun suggests locally intense fishing activity.

25. Seasonal fish migrations between the Mekong river and the Xe Bang Fai are important components of the economic livelihoods of communities on and adjacent to the Xe Bang Fai. Fish are harvested in the rivers either as a source of protein or for sale in local markets. A comprehensive baseline study of aquatic resources in the Xe Bang Fai river has been on-going since 2001 and will continue through operation of the Project. Framework for mitigation, compensation, resettlement, and livelihood restoration has been prepared. Based on the framework the preparation of a resettlement plan is underway.

2. Terrestrial Biodiversity

26. Climate and the diversity of geological conditions in the area have led to an extraordinarily high diversity of species, isolation, and endemism. The Annamite mountains that form the border between the Lao PDR and Viet Nam are recognized as an area of global significance in terms of biodiversity. The distribution of vegetation and land use in the project area is illustrated in Figure 4.

27. In the northern Annamite rain forest ecoregion, within which the NNT NPA is situated, 19 mammal and bird taxa[2] are considered near or strict endemic. These currently include langurs, crested gibbons, saola, large-antlered muntjac, Annamite muntjac, Indochinese wartypig, Annamite striped rabbit, crested argus, Edward's pheasant, and the orange-necked partridge. Three forest species (Fokien Cypress—*Fokienia hodginsii*, Yunnan youshan/May kinh—*Keetelaria evelyniana*, and Tenasserim pine—*Pinus latteri*) and the habitats they provide will also need special measures directed toward their conservation. While they occur in other parts of the region, their precise extent is uncertain and natural populations may be limited.

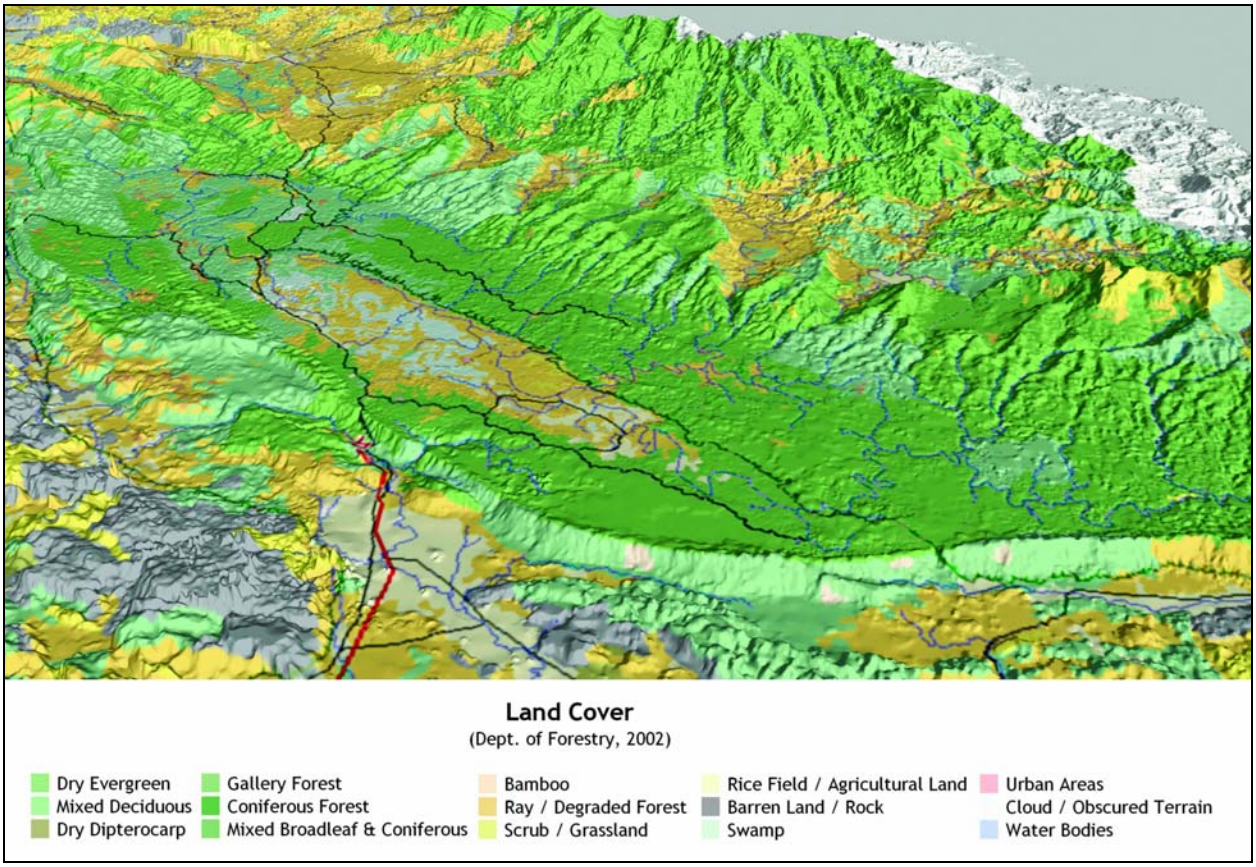
28. Currently, of the 106 mammal, 403 bird, 38 reptile, and 25 amphibian species recorded on or in the Nakai plateau, NNT NPA, and the Nam Theun corridor, 38 mammal, 17 bird, and 10 reptile species are classified as globally threatened according to the Red List of Threatened Animals of the International Union for the Conservation of Nature and Natural Resources (IUCN). Some 115 species are considered nationally at risk in the Lao PDR. A summary of the most threatened species identified in the NNT NPA is given in Appendix 2.

29. In terms of the NNT NPA, since most of the Nam Theun catchment is remote, sparsely populated, and difficult to access, a large portion remains in near pristine condition and contains a wide variety of wildlife of global and national conservation significance. Threats to this area include hunting, collection of nontimber forest products (NTFPs) focusing on tree species with fragrant bark/wood and medicinal properties, and logging, most notably in the area of the NNT NPA on the Nakai plateau. Commercial logging in the NNT NPA has, however, ceased.

30. The area on the Nakai plateau to be inundated by the reservoir contains secondary, dry deciduous, evergreen, and conifer forest habitats, a large portion of which has been degraded. Logging reduced forest cover in the inundation area from 61% to 48% between 1973 and 2003. The Nakai plateau was once inhabited by an outstanding density and diversity of wildlife species. These species have come under increasing pressure over the last 30 years from settlement expansion, logging, and hunting.

[2] Groups of organisms that are considered distinct enough to be treated as a separate ecological unit.

Figure 4: Forest Types and Land Use within the Project Area



Source: Environmental Assessment and Management Plan, November 2004.

31. Of the endangered species in the project impact area, two have been identified as requiring special management attention because of the threat posed to their populations by reservoir inundation and because, if well managed, they can help conserve other wildlife species using the same habitats. These are the Asian elephant and white-winged duck; their status in the project area is summarized in Table 4.

Table 4: Asian Elephant and White-Winged Duck in the Project Area

Species	Key Characteristics in the Project Area
Asian elephant	Two distinct subpopulations have been recorded: one in the northwest, the other in the southeast of the Nakai plateau. Estimates put the northwestern population at 90–120 individuals and the southeastern population at 100–400 individuals. These populations are currently threatened by poaching, by snares (meant for other large mammals), and by habitat reduction associated with agricultural encroachment. Human-elephant conflicts exist due to agricultural expansion and the elephants' acquired taste for agricultural crops. Elephants frequently visit mineral licks located on the Nakai plateau indicating the importance of these resources. During peak rains, groups from both subpopulations have also been observed to congregate along the Nam Theun, apparently to socialize and mate. An elephant program has been initiated by NTPC to identify, among other things, the actual size of elephant populations and habitats likely to be affected on the Nakai plateau.

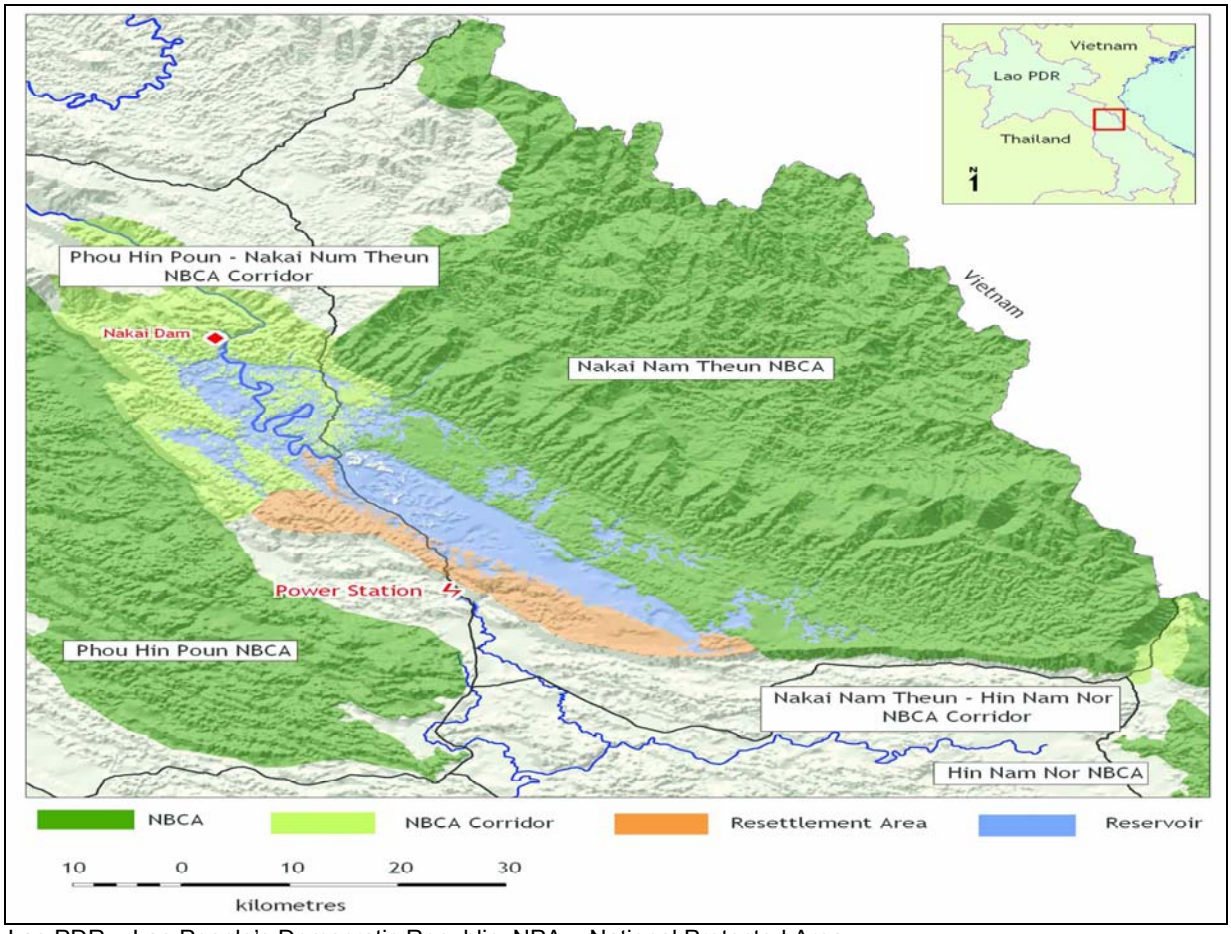
Species	Key Characteristics in the Project Area
White-winged duck	Wildlife Conservation Society (1995, 1996) identified a population of five to 10 pairs of white-winged ducks at the western end of the Nakai plateau. Its habitat is stagnant or slow-moving natural and artificial wetlands, within or adjacent to evergreen, moist, deciduous, or swamp forests. They are relatively intolerant of human disturbance, potentially abandoning an area after only a single contact. Their population has experienced a dramatic decline in South and Southeast Asia, such that in 1997, the global population was estimated at 450 individuals, and the total population for Cambodia, Lao PDR, Thailand, and Viet Nam was estimated at 130 individuals (World Bird Database: the site for Bird Conservations, BirdLife International, 2003). It continues to decline, largely attributable to widespread lowland deforestation, compounded locally by drainage and conversion of wetlands. The resultant small, fragmented populations are facing extinction.

Sources: Environmental Assessment and Management Plan, November 2004; Investigations into the Territorial Ecology of Area Affected by the Nam Theun 2 Hydropower Scheme (1995), Additional Surveys and Recommendations on Birds and Mammals for the Nam Theu 2 Hydropower Project (1996).

3. Protected Areas

32. Three NPAs surround the immediate project area: NNT NPA, which constitutes 88% of the drainage for the project reservoir; Phou Hin Poun NPA, a region of karst limestone; and Hin Nam Nor NPA, located to the south of the NNT NPA (Figure 5). Prime Ministerial Decree No. 193 of 2001 established a series of corridors to connect the three NPAs to enable wildlife to migrate between them. The Project itself is expected to have minimal negative impact on these NPAs. The NNT NPA will be conserved through financing provided by the Project.

Figure 5: National Protection Areas and Protected Wildlife Corridors



Lao PDR = Lao People's Democratic Republic, NPA = National Protected Area
Boundaries are not necessarily authoritative
Source: Environmental Assessment and Management Plan, November 2004.

33. Each NPA, including the NNT NPA, is noted for the presence of several threatened and endangered species. IUCN/Wildlife Conservation Society surveys also identified three new mammal species inhabiting the NPAs including the Saola (a new species of muntjac) and a new rabbit species. Fish studies have also identified numerous new species. The habitats of these species may extend onto the plateau. Unsustainable types of shifting cultivation has also affected, and continues to degrade, the forests and habitats of the NNT NPA, and the Government does not currently have adequate personnel or resources to control this degradation.

C. Existing Human Settlements, Livelihoods, and Infrastructure

34. For purposes of describing social characteristics, the project area has been divided into five key areas as follows: (i) NNT NPA; (ii) Nakai plateau; (iii) Xe Bang Fai; (iv) Nam Theun; downstream of the Nakai dam; and (v) project lands.

35. In general terms, population densities in the NNT NPA, on the Nakai plateau, and along the Nam Theun downstream of the Nakai dam are low, and characterized by pronounced ethnicity, dependence on subsistence livelihoods with household income levels well below the

national poverty line, and limited or no access to infrastructure and services such as education, health, electricity, and water supply. This is in contrast to the Xe Bang Fai basin within which (when moving toward the Mekong river) population numbers gradually increase, together with income and education levels; ethnic identity becomes less pronounced; livelihoods more secure; and connections to electricity and water supply more common. A comparison of key social characteristics currently available for areas 1–3 is presented in Table 5. The social characteristics in the Nam Theun downstream of the Nakai dam and in project lands are discussed in Sections III.C.1 and III.C.2, respectively.

1. Social Characteristics of the Nakai Plateau

36. The population that will need to be resettled by the creation of the Nakai reservoir represents a mix of cultures as a result of numerous inward and outward migrations over the last couple of centuries. Despite this, several characteristics qualify the original population and those ethnic groups that have migrated to the area over the last couple of centuries, as "indigenous" according to ADB and World Bank safeguard policies. These include a definite sense of belonging to the Nakai plateau, economic disadvantage of the people on the plateau, prevalence of traditional institutions, and a primarily subsistence-oriented livelihood production system.

37. In 1998, average household income on the Nakai plateau (of $450 a year) was well below the national poverty line of $800. While agriculture (mainly rice) dominates the economy of this area, productivity is constrained by low yields under rain-fed conditions, poor soils, adverse weather conditions, and lack of modern technology. Only 17% of families can produce sufficient rice for the year and 50% have a rice deficiency for more than 6 months of the year. To make up for this deficit, these communities traditionally depend on maize, starchy roots, and general gathering in the forest to supplement their food, as well as the sale and barter of NTFPs and livestock (mainly buffalo). Men in general are considered as the heads of households and have most dealings with organizations and government outside the village. Women tend to be more active in the economic sphere and in domestic and child-rearing chores. The Lao Women's Union is active in this respect, assisting women throughout the country with economic development opportunities.

2. Social Characteristics of the Downstream Xe Bang Fai

38. The Xe Bang Fai areas are typical of many lowland areas in the Lao PDR where the population is dependent on paddy cultivation, fishing, and some degree of nonagricultural income with only a few ethnic minorities distinct from the Lao-Tai ethnic group. The Government has previously supported major irrigation developments along the lower Xe Bang Fai and has requested that this Project contribute toward extending this to include other areas along the Xe Bang Fai by providing additional water in the Xe Bang Fai. Dry-season riverbank gardens supply most of the vegetables for local consumption and riverine forests and wetlands are an additional source of edible plants, aquatic animals, NTFPs, and herbal medicines. Most communities fish in the river at different times of the year. Fish is the main source of protein and most fish are consumed locally. On average, households also catch several kilograms of nonfish aquatic products monthly; the rainy season from April to October provides the highest production. Each household also raises on average two or three head of cattle, one pig, and 10 chickens. Cattle are a form of saving and are sold for cash to meet household expenditures.

Table 5: Key Social Characteristics of the Project

Characteristic	Nakai Nam Theun National Protected Area	Nakai Plateau	Xe Bang Fai
Population	Approximately 5,800 people in 31 enclave villages will participate in management and protection of the NNT NPA, and will benefit from village and livelihood development. 22,500 people in 54 villages in the peripheral impact zone who enter in or use resources of the watershed are also included in the SEMFOP	A total of 6,783 people in 1,298 households (2003 Census), of which 970 households will be fully eligible for the housing and livelihood program (i.e., full impact) while 94 households will be eligible for housing and a further 130 eligible for the livelihoods programs only (i.e., partly affected households).	Approximately 40,600 people in 7,096 households along Xe Bang Fai riverbanks (2001) below the Nam Phit confluence. About another 3,300 persons living in about 1,700 households in hinterland villages seasonally travel to catch fish or collect aquatic products in the Xe Bang Fai.
Ethnicity	Diverse mix comprising three main ethno-linguistic groups: Brou (53%), Vietic (25%), and Tai Kadai (16%).	Five main ethno-linguistic groups: Brou (40%), Tai Bo (40%), Upland Tai (11%), Vietic (6%), and Sek (1%). However, distinctions between groups are blurred.	Mainly Lao Tai but also several communities of Brou.
Livelihoods	Shifting cultivation, livestock raising, hunting, fishing, collection of NTFPs, and some sedentary cultivation. Most households only able to grow rice for sustainable consumption for 2–6 months a year. They supplement this through cash or barter sale of NTFPs, livestock, and fish.	Swidden rice, fish, livestock raising, hunting and gathering forest products—all primarily for household use and for sale/barter for rice. Only 17% of families produce sufficient rice for the full year.	Secure livelihoods, based on agriculture (mainly paddy rice), animal husbandry, and fishing. Some 84% of villages have irrigation pumps. Off-farm income is more important (relative to other areas), including shops and services.
Income	Estimate of annual average cash income per household was $87 in 1996, with total annual average income estimated to be double this per household (i.e., includes imputed income).	The National Statistics Office survey of 1998 gave annual average cash income of $225 per household and total average annual household income of $450 (cash and imputed income).	The 2001 socio-economic survey by NTPC, National Statistics Center and Ministry of Health, gave annual average household income of $664. Forty percent of the population live below the poverty line.
Infrastructure	Remote, with access limited to footpaths and river transportation. Limited access to electricity (some micro-hydro) or water supply. Water tends to be sourced from groundwater and rivers, and collected from rainwater.	Ban Oudomsouk has electricity but most households are without electricity. Some use batteries. Sixty percent of the population use river/stream water as only domestic water source. Boiling is uncommon. Roads are unsealed and of poor quality.	Most villages along Xe Bang Fai are, or will soon be, connected to the electricity grid. Forty percent of the population relies on the river for domestic water supply; 20% of the population has some form of sanitary facility. Access roads (Roads 12, 13, and 8b) are gravel surface and subject to degradation in the wet season. Access tracks to villages in middle Xe Bang Fai are of poor quality.

Characteristic	Nakai Nam Theun National Protected Area	Nakai Plateau	Xe Bang Fai
Education	Few single-room primary schools teaching 1 or 2 grades, although this number has recently been increased following World Bank assistance. Teachers are paid irregularly by the Government.	Schools only function in larger villages. Attendance is low; 63% of the population report no schooling at all; 31% had primary school education (1998). A small percentage of villagers are literate in the Lao Language; none of the ethnic languages of the plateau are written. Literacy levels are higher among men than women.	Education status is reportedly better than Nakai plateau but schools often do not function due to lack of resources. Approximately 31.6% of adults literate, 12.4% attended secondary school, and 6% progressed beyond. Education levels are highest in lower Xe Bang Fai.
Public Health	No sustained health care. People are reliant on ritual specialists. Malaria, respiratory diseases, and gastro-intestinal diseases are found throughout. Drinking water is rarely boiled.	Average distance to nearest hospital (located at Ban Oudomsouk) is 11 km—for most only accessible by walking. Some 3.9% of communities surveyed reported visiting a doctor in 1998. Most villages have a designated village health volunteer but they seldom have the necessary medicines or skills. Fever, malaria, diarrhea, and respiratory infections are prominent.	Access to medical facilities, use of mosquito nets, and nutritional status are in most respects better than on Nakai plateau.

NTFP = nontimber forest product
Source: Based on data presented in the Final Draft SDP (November 2004).

3. Social Characteristics of the Downstream Nam Theun (below Nakai Dam)

39. There are no permanent or established villages located along the Nam Theun from below the Nakai dam until some 50 km downstream (Ban Katok), and no land is cultivated from the Nakai dam to the headpond of the Theun-Hinboun Hydroelectric Project. Approximately 215 fisherfolk and hunters from nearby villages do, however, use this stretch of the Nam Theun. A detailed study has been conducted to reconfirm the populations in this downstream zone and the extent to which they depend upon the river for their livelihoods. Fish and aquatic animals are an element of livelihood strategies and in surveys, ranked second or third in terms of household food security after rice and vegetable cultivation or other forms of natural resource exploitation (hunting and gathering NTFPs). Communities were found to collect flora and fauna species from the forest habitats in the riparian zone, although collection tended to be away from river banks.

4. Social Characteristics of the Project Lands

40. The fifth main zone comprises project lands, which include areas for the construction of the Nakai dam, Nakai saddle dams, headrace channel, power conduit intake structure, power station, regulating pond and dam, operator's village proposed quarry areas, and construction work camps, as well as corridors for transmission lines, the downstream channel, and roads to be upgraded or constructed. The concession agreement defines an area of about 5,500 hectares (ha), excluding transmission lines, within which the NTPC and its HCC may choose to design and construct the above infrastructure. The actual area required, however, is considerably less: about 2,565 ha during the construction phase and 760 ha during the operation phase.

41. Communities in several different areas with a diverse range of social characteristics will be affected by project lands. A first phase in baseline data collection involved the review and interpretation of remote sensing data of the area covered in the concession agreement. This indicated that for 37 of the 57 project lands, approximately 37% of the area affected is characterized by disturbed forest, 35% by swidden plots (either fallow or in use), 11% by little-disturbed forest, and 7% by rice paddies. The route of the 500 kV transmission line traverses paddy fields in the Gnommalat plain, mixed paddy and forest around Mahaxai, sparsely populated farming in degraded forested areas just after crossing Road 13, and then a medium-dense populated area before reaching the Mekong. Some 36 villages with approximately 2,700 households are located close to the route of this transmission line. Ethnicity, income levels, and other social indicators also vary throughout the project lands. Broadly, project lands associated with the Pha Phen (Phou Phako) quarry and dam site are populated with Tai Meuy, Hmong, and Vietic groups while along the transmission lines there are some villages and land belonging to Brou (Makong) (especially around Gnommalat and Mahaxai) and Lao Loum (further south).

42. A second phase of baseline studies, involving more detailed ground and household surveys and covering all project lands, began in June 2004. It will be complete in January 2005.

D. Physical cultural resources

43. Two surveys undertaken in the project area in 1991 and in 1994–1995 indicate that few items of historical or archaeological importance are likely to exist in the area affected by the Project. An additional field-based physical cultural resources survey was carried out in the first half of 2004 for the whole project area (including project lands). This included lands not previously covered due to changes in project design. It involved a detailed inventory of all sites and artifacts and identified a number of sites of prehistoric, historic, spiritual, religious, and palaeontologic significance, cemeteries, and other cultural sites within the project area including:

(i) Sites of spiritual significance, cemeteries, an abandoned Buddhist temple near Ban Nakai Tai (believed to be approximately 200 years old), and the foundations of a royal hunting lodge built in the 1940s on the Nakai plateau;
(ii) A number of historic Buddhist temples, a prehistoric cave, and territorial spirit sites in the downstream channel area (although outside project lands);
(iii) An important religious site (Wat Sen Sayalarm), historic limestone kilns, and a cemetery on the banks on the Xe Bang Fai;
(iv) Historic sema stones (believed to predate the 18th century) adjacent to the transmission line corridor plus other territorial, religious, and cultural sites in other project lands; and
(v) Evidence of prehistoric human occupation (possibly Neolithic and Palaeolithic) in a number of limestone rock shelters and caves in the Pha Phen (Phou Phako) region.

IV. ANALYSIS OF ALTERNATIVES

A. Consideration of Options

44. The Government commissioned a comprehensive Study of Alternatives in 1999 updated in 2000 with the Power Sector Strategy Study[3], and again in 2004 with the Power Sector Development Plan[4] in order to determine whether the Nam Theun 2 Hydroelectric Project was indeed the most attractive option for power export to Thailand. Among other things, these studies aimed to determine how the Project compared to other power export schemes and whether the proposed configuration of the Project was optimal. Three major workshops, attended by an average of 150 participants including representatives from ministries, nongovernment organizations, development partner and embassy representatives, and various experts were held as part of the 1997–2000 studies.

45. Nineteen candidate independent power projects were examined in the Study of Alternatives and compared against technical, economic, financial, environmental, and social criteria. The study found that incorporating additional design features, such as multiple-level intakes and regulating ponds, could achieve a significant reduction in the environmental impacts of several of the proposed independent power projects. The scale of social impacts was also found to relate directly to the scale of resettlement; all projects were evaluated to determine whether resettlement could be reduced or eliminated. In most cases, however, projects would need to be reduced to run-of-the-river status to achieve a significant reduction in resettlement, as populations tend to live close to riverbanks. Both the Power Sector Strategy Study (2000) and preliminary results from the Power Sector Development Plan rank Nam Theun 2 first against other potential hydropower developments in the Lao PDR. Table 6 presents a preliminary ranking and characteristics of the 10 highest-ranked projects.

[3] ADB. 1999. *Technical Assistance to the Government of Lao People's Democratic Republic for the Power Sector Strategy Study.* Manila.

[4] Assisted by the World Bank.

Table 6: Preliminary Ranking and Characteristics of Hydropower Projects

Rank	Project	Project Type	Installed Capacity (MW)	Annual Energy Output (GWh p.a.)	Adjusted Weighted Generation Cost[a] (¢/kWh)
1	Nam Theun 2	Storage/transfer	1,074	5,922	1.6
2	Theun Hinboun Expansion	Storage/transfer	105	686+	2.4
3	Thakho	R-of-R/Mekong	30	214	2.6
4	Nam Mo	Storage	125	603	2.7
5	Xe Kaman 3	Storage	250	1,369	2.8
6	Xe Kaman 1 (u/s reg.)	Storage	470	2,086	3.1
7	Nam Ngum 2 (u/s reg.)	Storage	460	1,901	3.2
7a	Nam Ngum 2B	Storage	140	196	8.7
8	Xe Kong 5	Storage	400	1,795	3.2
9	Nam Sane 3	Storage	60	283	3.3
10	Nam Ngiep 1 (+ reg dam)	Storage	330	1,537	3.8

GWh = gigawatt hour, kWh = kilowatt hour, MW = megawatt, p.a. = per annum, R-of-R = Run of River, u/s = upstream.
The economic weighted average cost of generation has been calculated using economic, social, and environmental evaluation software. It takes into account economic and financial costs and revenues of developing each scheme weighted against monetary valuations of environmental and social impacts. It attempts to provide a more objective analysis of environmental and social costs and benefits.
Source: Meritec/Lahmeyer International (2004 – preliminary results) Power Sector Development Plan undertaken for the World Bank.

46. Preliminary overall findings of the analysis of alternatives conclude that:

(i) The growth in demand for electricity in Thailand, even with moderate economic growth and a well-established program of energy conservation, is strong enough to accommodate at least the Nam Theun 2 Project plus other hydropower projects in the Lao PDR, depending on their cost; and

(ii) The tariff negotiated with EGAT for the Nam Theun 2 Project is very close to the least-cost alternative supply source—combined-cycle gas turbine (CCGT)—when taking into account the impact on projected natural gas prices of forecast world oil prices, the capital cost of recent CCGT plants in southeast Asia, and the base project cost. Additionally, the Lao PDR hydropower projects provide the Thai system with a useful diversification of supply close to an area (northeast Thailand), which is currently underserved.

B. Without-Project Scenario

47. The Study of Alternatives also assessed the tradeoffs between the best alternative scenario to the Project and implementation of Nam Theun 2. The tradeoffs were $320 million less income to the Government; 2,430 fewer people to be resettled; 286 km^2 less area flooded by reservoirs; and 138 km less river inundated.

48. Furthermore, an economic impact study[5] and an environmental and social management plan[6] for the Project concluded that the consequences of adopting a without-project alternative would be:

(i) continued low gross domestic product rates and high poverty levels in the Lao PDR;
(ii) forgone direct economic benefits, including improvement of infrastructure, health services, etc.; and
(iii) accelerated exploitation of forests and biodiversity in the NNT NPA.

C. Alternative Configurations

49. The Study of Alternatives also considered alternative configurations for the Project. Three parameters were identified as critical to the overall environmental and social impacts, namely the size of the Nakai reservoir; the flow pattern in the Xe Bang Fai; and the flow pattern in the Nam Theun, downstream of the Nakai dam. The options considered and conclusions reached are summarized in Table 7.

Table 7: Comparison of Alternative Configurations for Nam Theun 2 Project

Alternative Configuration	Options Assessed	Conclusions
Reduce size of Nakai reservoir	Seven alternatives were considered in relation to the size of the reservoir. Following public consultation, it was agreed that three options would be examined further. These were a dam at Nakai, a dam further upstream at Ban Thalang, and developing the Project as a run-of-the-river scheme.	Generation capacity decreases and relative cost per unit energy generated increases as reservoir size is reduced. For example, if reservoir is reduced to run of the river, 3,220 gigawatt-hours per year less power will be generated and the relative generation cost would be 236% compared to the Nakai dam option of the Nam Theun 2 Project.
Reduce effects of discharges into the Xe Bang Fai	The following means were investigated: (i) Divert power station releases into the Nam Thon, a tributary of the Nam Hinboun (ii) Deepen the river channel of the Xe Bang Fai at strategic locations (iii) Provide regulation upstream of where the Xe Bang Fai receives water from the Project, so as to reduce the	Of these options (i) to (v) were found to have either no marked impact, were prohibitively expensive compared to their beneficial impacts, or were technically not feasible. Furthermore, a subsequent mitigation measure agreed with EGAT is to enable electricity generation to stop and therefore stop discharge into the Xe Bag Fai when this river is close to flooding.

[5] Louis Berger International, 1997, Economic Impact Study of Nam Theun 2 Dam Project Study 1997.
[6] IUCN, 1998, Environmental and Social Management Plan for the Nakai Nam Theun Catchment and Corridor Areas.

Alternative Configuration	Options Assessed	Conclusions
	(iv) natural flood hydrograph (v) Build a reservoir in the Nam Se Noy tributary, which could then possibly be diverted to the Nam Phong river system for irrigation use (vi) Divert the upper Xe Bang Fai (vii) Increase the size of the regulating pond to enable a more consistent discharge into the Xe Bang Fai during periods when the power station is not operating; and Shut down the power station when the Xe Bang Fai floods to reduce the potential for increased flooding.	Options (vi) and (vii) have been incorporated into the scheme.
Reduce the impacts in the downstream Nam Theun	Three options are available to reduce the impact of a limited riparian release into the Nam Theun: (i) Increase in mandatory riparian release; (ii) Aeration of riparian release; and (iii) Partial diversion of a natural stream into the Nam Theun to increase its flow.	These options were not considered in the Study of Alternatives. The Project already provides for the riparian release to be aerated through a cone valve in order to increase the levels of dissolved oxygen in the released water. Means of optimizing the release for environmental and social benefits are being considered under the riparian flow study. The diversion of another stream into the Nam Theun immediately downstream from the Nakai dam would increase the cost of construction and may not have a significant effect on the quality of discharge.

Source: Environmental Assessment and Management Plan, November 2004.

V. ANTICIPATED ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION

A. Physical Environment

50. Key impacts of project operation on the physical environment are associated with changes to hydrology, water quality, erosion rates, and to a lesser extent climate and groundwater. Impacts during project construction are discussed in more detail in Section V.F. Table 8 presents a summary of key impacts on the physical environment.

Table 8: Summary of Key Impacts on the Physical Environment and their Mitigation

Impact Receptor	Project Induced Physical Environmental Changes	Proposed Mitigation
Hydrology	• Impoundment of 195 km of Nam Theun • Diversion of 220 m^3/s from Nam Theun to Xe Bang Fai (annual average) • Significant reduction in flow of Nam Theun downstream of Nakai dam • Almost doubling of annual average flow in Xe Bang Fai • Average 3% reduction in Mekong flow between Nam Kading and Xe Bang Fai • Potential reduced risk of flooding along Nam Theun and Mekong (Mekong approximately 18cm lower at times of flood at confluence of Xe Bang Fai)	• Project will provide minimum 2 m^3/s (weekly average) of flow into Nam Theun downstream of Nakai dam to help sustain the riparian environment • Inclusion of regulating pond into the project design to enable a more constant and controlled release of water into Xe Bang Fai • Project has committed to restrict outflow from regulating dam in periods when Xe Bang Fai is in, or threatened by, flooding
Water Quality	• Periodic episodes of low dissolved oxygen concentration in parts of the reservoir and downstream rivers • Increased nutrient concentrations in initial years • Wastewater discharges from construction sites and work camps and sedimentation from construction sites (see Section V.F.)	• Removal of some biomass in inundation area prior to reservoir filling • Discharge into Nam Theun will come from the epilimnion (warmer oxygen-rich upper water layer) of the reservoir • Discharge into Nam Theun will be through an aerating structure (a cone valve) • Construction of an aeration weir in the downstream channel • Aeration structures incorporated into Nam Kathang release • Solid waste and wastewater management • Erosion and sedimentation management on the construction sites. • Effective catchment management
Erosion and Sedimentation	• Sedimentation in the reservoir and reduced sedimentation in the downstream Nam Theun • Reduced riverbank erosion in Nam Theun downstream of Nakai dam • Increased riverbank erosion in Xe Bang Fai below confluence with the downstream channel • Potential erosion in downstream channel	• Restrict construction to dry season to the extent possible • Implement soil protection measures in construction areas • Riverbank protection/stabilization in Xe Bang Fai • Monitoring of erosion in Xe Bang Fai. • Protection of exposed sections of downstream channel and its confluence with Xe Bang Fai • Inclusion of an erodible section in the downstream channel to reduce the erosion potential in Xe Bang Fai • Inclusion of regulating pond in design facilitating more constant and controlled release of water into Xe Bang Fai • Asset and livelihood compensation and restoration for any land/assets/livelihood lost

Source: Environmental Assessment and Management Plan, November 2004.

1. Hydrological Impacts

51. Averaged over a year, the Project will divert 220 m^3/s from the Nakai reservoir, through the power station to the Xe Bang Fai. As a consequence, discharge in the Nam Theun downstream of the Nakai dam will be reduced to a minimum of 2 m^3/s (averaged over 1 week) plus the spills of the rainy season and a complementary release of 5 million m^3 over a period of 12 months. This compares with calculated mean annual flows of 238 m^3/s at the Nakai dam site at present. This will permanently alter inhabitants and disfavor species adapted to existing conditions. Impacts below the Nakai dam will primarily be felt in the first 12 km section to the confluence with the Nam Phao. Thereafter, the impact will be moderated by the flows from the Nam Phao. Flows in the Mekong between its confluences with the Nam Kading[7] and the Xe Bang Fai will be reduced by an annual average of 302 m^3/s with an average 220 m^3/s and 82 m^3/s being diverted by the Nam Theun 2 and Theun Hinboun hydroelectric projects, respectively (the latter is already operational and located approximately 50 km downstream of the Nakai dam, also on the Nam Theun). The diversion induced by the Nam Theun 2 Project represents only 3% of total flows (as an annual average) in this area of the Mekong and therefore is not expected to significantly affect navigation or fish populations in this area.

52. Discharge into the Nam Kathang will be equivalent to its natural flow with no resultant hydrological impact. From the power station, discharge into the downstream channel will be controlled by the regulating dam. Flows into the Xe Bang Fai will, however, increase by an average (over the year) of 220 m^3/s and a maximum of 315 m^3/s compared to current calculated mean annual flows of 265 m^3/s at Mahaxai. Changes in water levels are expected to be greatest at Mahaxai, the first major settlement downstream of the Xe Bang Fai/downstream channel confluence, and will be more prominent in the dry season, with increases in water levels of 5.8 m in April (dry season) compared to an increase of 1.5 m in August (wet season). The effects of this increased flow will on average diminish progressively downstream as the contributing catchment increases. Discharge into the downstream channel from the regulating dam on Sundays will be lower (about 80 m^3/s) to reflect less power demand in both Thailand and the Lao PDR.

53. The Nakai reservoir is expected to significantly reduce flooding immediately downstream of the Nakai dam, retaining floods completely or attenuating them, depending on the extent of rainfall and resultant levels in the Nakai reservoir. Hydrological modeling indicates that flood levels at the Xe Bang Fai–Mekong confluence will fall by approximately 0.18 m. However, modeling suggests that overall flood levels in the Xe Bang Fai and its floodplain could increase by approximately 0.5 m, 0.4 m, and 0.2 m in the upper, middle, and lower reaches of the Xe Bang Fai, respectively, when combined with floods that exceed the bank and a maximum release from the regulating pond (i.e., worst case situation). The resulting flooded area (when natural Xe Bang Fai flows reach 1,970 m^3/s) is estimated to increase by 3.75% (from 324 km^2 without the Project to 335 km^2 with a maximum project discharge of 315 m^3/s). For such an extreme case, flood depths in the lower Xe Bang Fai are estimated to increase by between 0 m and 0.55 m. The largest changes in depth are expected to occur close to Road 13, diminishing toward the Mekong confluence.

54. **Mitigation**. Negative hydrological impacts will be mitigated through operational management of the Project, and specifically operation of the regulating dam. To prevent additional flooding caused by the Project, outflow from the regulating dam will be restricted

[7] The Nam Theun becomes the Nam Kading downstream of the Theun Hinboun dam.

when flows in the Xe Bang Fai approach 1,970 m^3/s and outflow will cease before the natural flow reaches 2,270 m^3/s (the point at which flooding currently occurs in Xe Bang Fai). The regulating dam will limit the rate of increased discharge into the Xe Bang Fai to a maximum of 20 m^3/s/hour.

55. The hydrological changes caused by the Project provide significant opportunities to enhance the economies and livelihoods of downstream Xe Bang Fai populations. Higher dry-season flows will provide an increased and guaranteed water resource for irrigation and reduced irrigation water pumping costs; these benefits are discussed further in Section V.D.5.

2. Water Quality

56. Changes in water quality during filling and storage of water in the Nakai reservoir could affect water quality in the Nam Theun (downstream of the Nakai dam), Xe Bang Fai, Nam Kathang, and possibly the Mekong. Fish, other aquatic life, and people who depend on the rivers for their domestic water consumption and aquatic products could in turn be affected. Factors affecting water quality in the reservoir include solar radiation of the reservoir surface, mixing of the water column (and nutrients therein), the volume of biomass inundated, growth of aquatic weeds, sedimentation, and use of agricultural chemicals.

57. It is expected that the Nakai reservoir will be thermally stratified each year from the late dry season through the first few months of the wet season. Maximum water temperatures at the reservoir surface could be 30ºC compared to bottom temperatures of 20–25ºC. Under these conditions, periodic episodes of low dissolved oxygen (<2 milligrams per liter [mg/l]) are predicted to occur in deeper waters. These anoxic conditions are expected to last for 1–3 months. Because of the shallow nature of the reservoir, anoxic conditions will affect less than 3% of reservoir volume. Modeling predicted that dissolved oxygen concentrations in the dry season through the power station and the Nakai dam were above 5 mg/l (generally acceptable to sustain aquatic life) and low in nutrients. Nutrient levels will be higher during the initial years of reservoir inundation (due to decomposition of organic matter in the reservoir). Modeling did, however, predict that levels of dissolved oxygen in the Nam Kathang and the Xe Bang Fai would be affected and would require specific measures to protect fish populations.

58. Peak concentrations of 25 micrograms per liter (µg/l) of ammonia are predicted to occur in the Nakai reservoir during the wet season after thermal destratification. This is in line with baseline values for the receiving waters and is not expected to impact on fish. Predicted pH levels in the Nakai reservoir also fall within the desirable pH range for good fish production (6.5–9). Suspended sediment concentrations into the reservoir are expected to be quite low given the relatively undisturbed nature of the catchment. However, agricultural activities in the resettlement area may lead to an increase in the use of pesticides. These are extremely toxic to fish and can bioaccumulate to levels harmful for human consumption.

59. **Mitigation**. The identified impacts on water quality in the Nakai reservoir and downstream in the Nam Theun and Xe Bang Fai will be mitigated by the following measures:

(i) Good catchment management to protect the Nakai reservoir from sedimentation;
(ii) Reduction of biomass in the inundation area. The removal of some biomass prior to flooding will be encouraged, including firewood collection and salvaging timber;

(iii) Drawing riparian releases from the epilimnion[8] and aeration by a cone valve. This will help improve water quality and conditions for fish populations in the downstream Nam Theun;

(iv) Drawing the power station water from the majority of the water column, thereby ensuring that water discharged into the downstream channel consists of a mix of potentially anoxic hypolimnion and oxygenated epilimnion;

(v) Aerating the water released into the Nam Kathang. The Nam Kathang release of the regulating dam will incorporate two aeration structures, including a hydraulic jump and a weir;

(vi) Aerating the water in the downstream channel before its release into the Xe Bang Fai. An aeration weir in the downstream channel will improve dissolved oxygen concentrations in the flow. Bacterial and algal buildup, which could diminish the efficiency of the aeration weir, will be cleared during periodic low discharges on Sundays;

(vii) Managing aquatic weeds by reservoir drawdown. The annual seasonal drawdown and refill of the Nakai reservoir will control aquatic weeds;

(viii) Managing the use of fertilizer, pesticides, and other synthetic chemicals through the implementation of a pest management plan; and

(ix) Ensuring strict compliance with the existing construction schedule. NTPC will ensure that the HCC strictly complies with the construction schedule so that waters in the reservoir do not build up for a longer period than planned (e.g., before water is drawn down and thereby mixed through operation of the power station). Such a delay could result in fish kills because of anoxic conditions in the Nakai reservoir.

60. NTPC is also committed to maintaining the existing beneficial uses of water in the project area. It is therefore prepared to support the development of other sources of domestic water supply in those villages that depend partly or fully on the Xe Bang Fai and Nam Kathang for their water. Water quality in all concerned water bodies will also be subject to monitoring during construction and operation. A baseline water quality monitoring program is to begin in late December 2004.

3. Erosion and Sedimentation

61. Increased erosion is only expected to be a significant impact in the Xe Bang Fai as a result of the considerably higher flows, lower sediment load of project waters entering the Xe Bang Fai, and the pore pressure in river banks resulting from weekly changes in discharge. This could affect about 40,000 inhabitants living along the Xe Bang Fai river. It is estimated that the Xe Bang Fai channel could widen on average between 10.7 m and 15.9 m along the length of the river with maximum widening of no more than 20 m before the river adjusts to its new regime and morphology. This new morphology is not expected to reach equilibrium until at least 2 years after the new flow regime in the Xe Bang Fai. The extent of widening will decrease as the distance from the confluence with the downstream channel increases, so that by the time the river reaches the bridge on Road 13 the loss of land is predicted to be negligible. Erosion will result in damage or loss of land used for local cultivation. The adjustment to river width is likely to be slow and obvious, giving communities time to adjust without unpredicted losses to property or injury. In contrast, erosion in the Nam Theun downstream of the Nakai dam is not expected to be a problem due to the low flow and the existence of rocks and vegetation.

[8] The warmer oxygen-rich, upper layers of the water column within which most biological activity occurs.

Infrequent spills could result in some minor, locally restricted erosion. The downstream channel will be protected from erosion at critical locations. No significant increase in the erosion rate is expected in the Nam Kathang due to maintenance of natural flow levels.

62. Sedimentation of the Nakai reservoir is anticipated to be minimal due to very low rates of topsoil loss in the largely undisturbed forested catchment that consists of the NNT NPA. It is not expected to affect the reservoir's storage capacity or hydropower generating potential. Management of the NNT NPA will be needed to maintain the current low level of erosion.

63. **Mitigation.** Several project components have been designed to minimize erosion impacts in the Xe Bang Fai. These include the controlled and consistent release of water from the regulating dam, limiting the rate of increasing and decreasing discharge into the Xe Bang Fai, and strengthening the downstream channel and the Xe Bang Fai confluence to prevent erosion. Erosion levels along the Xe Bang Fai are currently being monitored; the Xe Bang Fai, together with the downstream channel, will also be monitored during Project operation. Remedial mitigation measures, such as bank protection, stabilization, and asset and livelihood compensation (or a mix of these), will be considered on a case-by-case basis. Villagers will be able to alert district compensation committees of any abnormal erosion rates or affected infrastructure/livelihoods. The SEMFOP details plans to manage land use activities in the NNT NPA to avoid excessive erosion and therefore prevent sedimentation of the Nakai reservoir.

4. Other Impacts on the Physical Environment

64. The creation of the Nakai reservoir is expected to generate minor micro-climatic changes on the plateau (in air temperature, relative humidity, winds, etc.). However, these changes are only expected to exist for short periods due to the overpowering dominance of the monsoon. Minor seismic impacts are possible as a result of river impoundment and dam construction, though the height of the dam (48 m) is well below the size at which such impacts are known to be probable (100 m). Reduced amounts of water in the Nam Theun downstream of the Nakai dam are not expected to significantly affect groundwater levels due to steep valley sides preventing the river from being a major source of aquifer recharge. Increased water flows in the downstream channel and the Xe Bang Fai will result in higher groundwater levels, reducing the energy requirements for abstraction for use by communities. No further mitigation efforts for these issues are considered necessary.

B. Biological Environment

65. The Project's principal impacts on the biological environment are on aquatic and terrestrial habitats, species diversity, protected areas, and endangered species. Key impacts and their mitigation are summarized in Table 9.

Table 9. Summary of Key Impacts on the Biological Environment and their Mitigation

Impact Receptor	Direct and Indirect Impacts of the Project	Proposed Mitigation
Aquatic Habitats and Fish Diversity	• Transformation of 195 km of the Nam Theun into the Nakai reservoir will permanently alter habitats and disfavor species adapted to fast-flowing conditions • The Nakai dam will represent a barrier to migration between the lower Nam Theun and its headwaters	• Diversion of the river away from the Nakai dam site during construction • Stabilization of road sides and other areas to reduce erosion • Clearing of some vegetation in the inundation area to remove

Impact Receptor	Direct and Indirect Impacts of the Project	Proposed Mitigation
	• Large seasonal fluctuations in water level in the reservoir and changes in water quality (anoxic conditions) are likely to lead to unfavorable conditions for some fish and other aquatic species • Changes in water flow, quality, and temperature in the Xe Bang Fai might alter the species composition and productivity of the river • Work in or along rivers might increase the sediment load causing damage to fish (gills), destroy spawning areas, and reduce productivity of the river	biomass and reduce the likelihood of adverse water quality developing (see also *Table E.1.* and Section V.A.2) • Construction of retention tanks around areas where liquid and solid fuels and chemicals are to be stored • Implementation of a pest management plan • Ban on fishing with explosives by project workers
Terrestrial Biodiversity	• 1,170 km^2 of land and associated vegetation are affected by the Project (construction phase). Areas of broadleaved and coniferous forests, swamps, and gallery forests are most affected • 450 km^2 will be permanently lost by impoundment of the reservoir • Improved accessibility to NNT NPA (due to the reservoir) and increased human population on the plateau, stimulating increased hunting pressure and trade in wildlife	• Designation of NNT NPA and provision (by NTPC) of $31.5 million toward its management and protection (through SEMFOP) • Compensatory forestry program covering 28,000 ha of degraded forest • Alternative livelihood systems combined with conservation for inhabitants of NPA • HCC must also assure a ban on hunting among construction workers
Endangered Species	• Disturbance to catchment and corridor areas could threaten habitats of a wide range of animals including endangered species such as the Asian elephant, tiger, macaques, dhole, gaur, banteng, and white-winged duck	• Conservation programs for the Asian elephant and the white-winged duck • Survey of 16 key wildlife species and development of management programs if these species are found to be present • Management and financial support to NNT NPA • Research and associated planning to minimize impacts of inundation on wildlife

Source: Environmental Assessment and Management Plan, November 2004.

1. Aquatic Habitats and Fish Diversity

66. Aquatic habitats are likely to be affected by activities during project construction and operation. Impacts during construction could be generated by sedimentation caused by work in the riverbed, clearing of vegetation in the inundation area, and erosion at construction sites; water pollution caused by oils, fuels, and chemical use; and use of explosives. Increased sediment loads can directly affect fish downstream through damage to or accumulation in their gills leading to death or sublethal effects. Increased sediment loads will also indirectly affect fish through modification of habitats (e.g., rocky river bed to mud-covered), destroy spawning sites, and reduce primary production and therefore fish food. Spills of fuels and chemicals may directly affect aquatic fauna or humans and animals feeding on aquatic products. Use of

explosives in water can either instantly kill fish or severely damage their internal organs, an impact that can occur at a considerable distance from the explosion site.

67. Once construction is complete, long-term impacts on aquatic habitats and fish biodiversity in the project area will be felt. In the Nam Theun headwaters (in the NNT NPA), impacts are unlikely if the area is properly and successfully managed. However, species that migrate between the headwaters and the middle and lower Nam Theun will be affected. The impoundment of 195 km of the Nam Theun and creation of the Nakai reservoir with few distinct habitats, plus the changes in water quality in the reservoir (see Section V.A.2) will displace many species that cannot adapt to the new conditions. Sedimentation as the reservoir fills will further remove distinct habitats favored by some species. The Nakai dam will block possible migration routes between the plateau and downstream areas. Of the 68 fish species recorded in the Nam Theun basin, estimates suggest that 35% will not adapt to the changed conditions and a further 17% are unlikely to adapt. Only 21% are expected to adapt without difficulties. Downstream of the Nakai dam, reductions in water flow will reduce the carrying capacity of the river, both in terms of fish diversity and abundance. Some species may adapt to these changes while others may disappear. Baseline studies indicate, however, that all species currently recorded in the Nam Theun basin exist either in other basins or outside the area of direct project impacts.

68. In the Xe Bang Fai, several habitats will disappear due to increased water levels, some will be displaced, while others will be altered. Water temperatures will also drop in the Xe Bang Fai, perhaps by up to 3.5ºC; in synergy with other changes (such as sedimentation, increased discharge, discharge fluctuations, and water quality), this could increase the stress on the aquatic community. While the impacts in the Xe Bang Fai will be significant, the impact of changed hydrological conditions and fish populations in the Mekong mainstream is negligible. Tributaries are of utmost importance for Mekong mainstream fish as spawning and nursery grounds. It is possible that increased flows in the Xe Bang Fai may instigate spawning migrations into the river. The dynamics and possible impacts remain uncertain.

69. **Mitigation**. During construction, strict management and regulation of construction activities, including measures to minimize sedimentation, prevent and control fuel/chemical spills, banning the use of explosives underwater or for fishing (by project workers), and scheduling of sediment-generating construction activities to occur during the dry season, will be implemented to mitigate construction related impacts. A number of the operational impacts (e.g., impacts caused by impoundment and creation of the reservoir environment and preventing migration) cannot be mitigated. Management of the NNT NPA should, however, ensure the survival of most fish species that are present elsewhere in the river system, compensating for this impact. Populations of critical species will be monitored in order to detect possible declining populations and to help provide recommendations for appropriate support measures (e.g., restrictions or ban of captures, establishment and use of captive stock for stocking and supporting the wild population, and increase in areas of protected pools). No new fish species will be considered for potential introduction into the reservoir for 10–15 years to allow existing species to stabilize in the new conditions. To mitigate the impact of reduced, but even, flows along the Nam Theun downstream of the dam, adjustments to the river morphology will be considered for purposes of sustaining water flows and depths in critical areas. There are no plans to provide fish ladders as these have proven ineffective elsewhere in the tropics. (Mitigation of water quality impacts was discussed in Section V.A.2.) NTPC is currently monitoring baseline fisheries in the Xe Bang Fai, which will continue after the commercial operating date.

2. Terrestrial Biodiversity

70. Direct impacts on terrestrial biodiversity will occur as a result of clearing land for construction works and for reservoir inundation, and as a result of degradation and disturbance to ecosystems. Approximately 1,170 km^2 of land (including approximately 28,000 ha of forest), primarily on the Nakai plateau, will be affected in this way. Indirect impacts on terrestrial biodiversity are expected to occur as a result of increased population and improved access to the area. The reservoir will make some areas, including the NNT NPA, more easily accessible, particularly for hunting, increasing the vulnerability of wildlife.

71. On the Nakai plateau, all forests, savannah, grasslands, and wetlands within a 450 km^2 area (40% of the plateau) will be inundated and vegetation will be lost. Of this land cover, 57% is considered disturbed habitat. In the remaining area, 50% of forests are in relatively good condition. No endangered or endemic tree species are, however, expected to be lost and from a provincial and national perspective, the impact of lost forest species and habitats is not considered significant. As waters rise, resident and visiting wildlife, including birds, will need to find new habitats and territories. A large number of islands will form on the western end of the Nakai reservoir and some animals might find refuge on these islands. However, these habitats will not be large enough to accommodate all animals. Some animals, including some mammals and reptiles, might become stranded and so vulnerable to hunting. The seasonal migration of large mammals, such as elephants, from the NNT NPA to the Phou Hin Poun NPA will be disturbed by the presence of the reservoir, resulting in potential conflicts between animals and the local human population.

72. Other areas of vegetation that will require clearance include 0.1–0.15 km^2 to facilitate construction of the Nakai dam, 27 km^2 for construction of the new alignment of Road 8B, and 1.5 km^2 for the regulating pond. All vegetation will also be removed along the 27 km length of the downstream channel affecting rice paddies, secondary forests, and a small wetland. Habitats along the 12 km stretch of the Nam Theun below the Nakai dam until the Nam Phao confluence will be affected as a result of reduced discharge and there will be encroachment of vegetation into the river channel. The nearby forest should not be affected but the reduced flow may impact terrestrial wildlife that depends on fish in this stretch of the river. Impacts on terrestrial biodiversity in the Xe Bang Fai are mainly attributable to increased discharge and associated loss of land, particularly riverine forests. Increased discharge, particularly during the dry season, may also affect the migration of mammals and other wildlife across the river. Finally, the main impact of the transmission lines will be from the clearance of vegetation for towers and maintenance access tracks. The transmission lines pass through a mixture of agricultural land, scrub, and degraded forest; 62 km of the 500 kV line pass through lowland dry evergreen forest, secondary succession mixed deciduous forest, and dry dipterocarp forest.

73. **Mitigation.** Mitigation of impacts on terrestrial biodiversity includes a wildlife management and protection program in the NNT NPA to compensate for the losses caused by the Project. NTPC will provide $6.5 million during construction and a further $1 million for each year of its operating concession to support this management (total $31.5 million). This management program will also restore a similar area of currently degraded forest under a compensatory forestry program. The program will focus on forest areas where crown cover is less than 20%, including areas within the NNT NPA, areas earmarked for sustainable forestry in the Nakai plateau resettlement area, and forest areas on the plateau outside the area affected by inundation. Degraded forest areas will be improved through a combination of natural regeneration, enrichment planting (using native species), and other techniques as necessary, supported by detailed surveys of degraded areas, consultations with local people, development

of management plans and a tree nursery, and monitoring. Furthermore, a plan will be developed for the management of animal relocation from the Nakai plateau to reduce potential conflicts with the local population and reduce wildlife vulnerability to hunting. An elephant program currently under development will assess elephant population size, migratory patterns, and resource use to help provide recommendations on management strategies to prevent elephant-human conflict. Construction areas and associated vegetation clearance will be minimized to the area needed for efficient activity. In the Nam Theun downstream of the Nakai dam, mitigation will be based on management of the riparian flow. An analysis of riparian release and its impact on downstream ecosystems has been conducted to support this. Impacts associated with the transmission lines will be mitigated primarily through the selection of alignments that minimize the amount of vegetation disturbed or cleared.

3. Threatened Species

74. Threatened species may be affected as a result of increased human populations on the Nakai plateau, destruction of habitats as a result of construction and reservoir inundation, and increased access to habitats where species occur. The increased human population on the Nakai plateau, particularly during construction, will engender hunting pressure on wildlife. The value of wildlife for communities on the plateau is considerably greater than that of domestic livestock. Clearance of vegetation and reservoir inundation will remove habitats and cause species to drown, be displaced, or be stranded on islands. Some habitats of the Asian elephant will be lost through inundation of their mineral licks and forage areas. The white-winged duck is likely to disappear from the area, if no appropriate attention is given to it. The reservoir will improve accessibility to the NNT NPA and with it, the potential for increased hunting pressure and trade in endangered species in the NPA.

75. The Nakai reservoir will only inundate 40% of the Nakai plateau. The remaining area, within which 50% of forests are in relatively good condition, may be sufficient habitat to maintain viable populations of most of the plateau fauna. Elephants move seasonally between different parts of the plateau and therefore require special impact mitigation efforts.

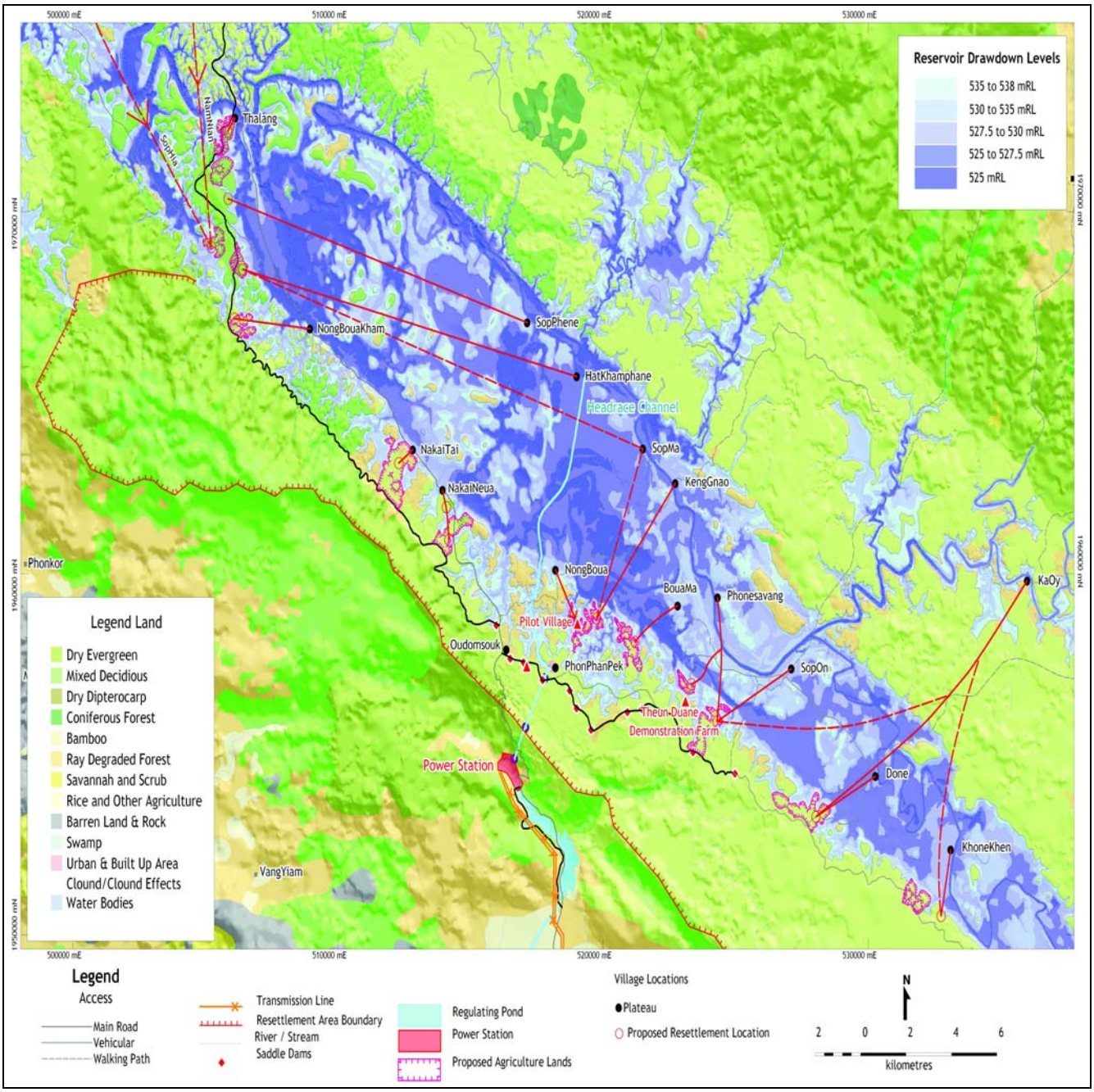
76. **Mitigation**. Specific conservation programs for the Asian elephant and white-winged duck will be established. Furthermore, a survey of wildlife on the Nakai plateau will be conducted during the construction phase. If any of 16 key bird and mammal species[9] are determined to be present on the plateau during this survey, a full-scale study of these species will be arranged in order to develop management programs through, for example, the protection of key habitats, resources, and population dynamics on the plateau and in the NNT NPA. In addition, wildlife (particularly indicator species such as elephants, primates, and hornbills) will be monitored to detect actual changes and trends in population and enable further management. Construction impacts will be minimized through careful location of work camps and implementation of Head Construction Contractor Environmental Management and Monitoring Plans (HCCEMMP).

[9] Six mammal species (Sunda pangolin, sun bear, Asian small-clawed otter, clouded leopard, tiger, and Asian elephant) and 10 bird species (Siamese fireback, white-winged duck, wreathed hornbill, tawny fish owl, wood snipe, gray-headed lapwing, black kite, small pratincole, greater spotted eagle, and gray heron) have been selected based on research by WCS and IUCN as key species for protection. Their presence on the plateau is not currently known. If their populations are well managed, other species will also be protected because of the habitats they share.

C. Environmental Impacts Associated with Resettlement Sites

77. The proposed resettlement area for the 17 Plateau resettlement sites of approximately 210 km^2 lies on the southwest side of the proposed reservoir (Figure 6*)*. Two of the plateau villages (Sop Hia and Nam Nian) prefer to relocate to a resettlement site in the Bolikhamxay village from which they originated. The establishment of these resettlement sites and the livelihood activities of the resettled people may result in various impacts on existing land and natural resources including: (i) loss and disturbance of natural habitats; (ii) erosion and degradation of soil; (iii) overexploitation of wildlife and aquatic resources and human-wildlife interactions; (iv) deterioration of water quality resulting from fertilizer use and poor wastewater disposal; (v) solid waste disposal and waste water drainage; (vi) landslide, flooding and water logging; (vii) unexploded ordinance; and (viii) increase in population attracted by new infrastructure and economic opportunities.

Figure 6: Proposed Resettlement Area and Its Environmental Characteristics



mRL : meter reservoir level
Source: Environmental Assessment and Management Plan, November 2004.

78. **Mitigation.** Necessary measures will include a range of infrastructure services and management controls in the resettlement villages, such as proper waste treatment facilities and disposal, prohibiting shifting cultivation in the resettlement area, protection of susceptible soil surfaces with seeding and/or mulch, clearance of unexploded ordinance, and sustainable management of 100 km^2 of the resettlement area by the Nakai Plateau Forest Association.

D. Impacts on Social Environment

79. Social impacts are anticipated in five key areas, namely the Nakai plateau, downstream Nam Theun below the Nakai dam, in the NNT NPA, along the Xe Bang Fai and in project lands (e.g., power station, regulating pond, downstream channel, operator's village, work camps, quarries, spoil disposal sites, transmission lines, and roads). Social impacts in each of these areas and proposed mitigation are summarized in Table 10 and discussed in Sections V.D.1–V.D.8. Social impacts associated with construction works (e.g., health effects) are examined in more detail in Section V.F. All affected persons will be appropriately compensated and rehabilitated for any adverse impacts. The intention is that they should be better off than they were before the Project.

Table 10: Summary of Social Impacts and their Mitigation

Direct and Indirect Impacts of the Project	Key Areas Affected					Proposed Mitigation (General – not directly associated with the impacts)
	1	2	3	4	5	
Relocation of estimated 1,128 households (approximately 6,224 people)	√					Full compensation and restoration for lands, resources, and livelihoods lost or changed with the aim that they should be better off than before the Project
Loss of land and changed livelihoods	√	√		√	√	Livelihood packages, and fisheries and forestry development
Resource access restrictions and altered livelihood	√	√	√	√		Improved land tenure
Social stress caused by resettlement and displacement	√					Improved institutional capacity for local, regional, and national institutions for implementing resettlement and livelihood development plans
Potential in-migration leading to competition for resources (infrastructure and natural resources), reduced capacity of local authorities, and marginalization of ethnic groups	√					Exclusive rights for resettlers in relation to natural resource management Health, education, and community development initiatives for resettlers
Influx of people (during construction and operation) could create price increases, and shortages of essential goods and services due to increased demand	√			√		Monitoring of erosion along Xe Bang Fai and provision of compensation as needed Specific measures to ensure benefits for women and potentially vulnerable groups
Changes in ecology and accessibility to rivers for people dependent on aquatic resources for nutrition	√			√	√	Culturally sensitive consultation and mitigation for ethnic minorities
Changes in water quality and water flow resulting in the introduction or elimination of water-borne disease	√	√			√	Mitigation framework for monitoring and implementation of measures to enhance project benefits in Xe Bang Fai and other downstream areas (e.g., irrigation potential and capacity building)
Health impacts including increased STDs (especially spread of HIV/AIDS), drug use, alcoholism, poor sanitation, spread of other communicable diseases, and human trafficking (see further under Section V.F)	√	√		√		Human trafficking, HIV/AIDS, drug-use awareness and preventive education programs for communities, workers, and spontaneous settlers (a public health plan and a human trafficking awareness plan have been prepared)
Improved access to markets, schools, and health facilities	√	√				
Increased irrigation potential	√			√	√	
Loss of protein and nutritional impact		√	√	√		

HIV/AIDS = human immunodeficiency virus/acquired immune deficiency syndrome. STD = sexually transmitted disease
Five Key Areas: 1 = Nakai Nam Theun National Protected Area, 2 = Nakai plateau, 3 = Xe Bang Fai, 4 = Nam Theun downstream of the Nakai dam, and 5 = Project Lands.
Source: Environmental Assessment and Management Plan, November 2004.

1. Nakai Plateau

80. The key social impacts in this area will be relocation of approximately 1,128 households; loss of 560 ha of rice fields, 139 ha of other crops and vegetables, forest land, and fishing grounds; associated social stress; and the changes in lifestyles and livelihoods that these will cause. Residents of the plateau will also be affected by construction activities including disturbance, increased pressure on resources and services, possible inflation due to increased demand, health risks (e.g., HIV/AIDS), human trafficking risks associated with an influx of workers and camp followers (approximately 800 workers with perhaps an additional 3,200 followers), and marginalization of vulnerable ethnic minorities. Construction impacts are examined in more detail in Section V.F.

81. **Mitigation.** The proposed resettlement area is situated on the southwest shore of the Nakai reservoir as shown in Figure 6 above. Efforts have been made to select resettlement sites within existing traditional and spiritual territories and to ensure cultural continuity and familiarity. Of the 17 villages to be moved, 10 will be relocated 3.5 km or less from their existing site. One will be moving 4.8 km while four villages will move 10–15 km. Two villages will remain at their present location: in Ban Oudomsouk, only a third of houses will need to be relocated while in Phonphanpek, only agricultural land and no houses will be affected. The plateau resettlement sites comply with village desires to be near the future reservoir, an all-weather road, their present locations, the forest, and land that can be used to grow rice. Approximately 650 ha of land will be converted to sustainable, irrigated agricultural land. The Tai resettlers from Sop Hia and Nam Nian will relocate from the plateau back to their original village (Nam Pan) in Bolikhamxay province. Consultation with the host village of Nam Pan is ongoing. The Vietic people from Sop Hia prefer to remain on the plateau. The ways in which project-affected people have influenced the resettlement process through consultation and participation are indicated in Chapter 4 of the SDP.

82. The Resettlement Action Plan for the Nakai plateau (contained in the SDP) has been designed to ensure that all resettled families are significantly better off after relocation: the target if for all households to be above the National Rural Poverty Line, which in 1998 was equivalent to $837 for an average family of 5.5 persons, within 4 years after relocation. NTPC is also committed to ensuring that all relocated villages achieve the National Average Rural Income target, which was equivalent to $1,200 in 1998, within 7 years after relocation. Provisions will include livelihood options for agriculture, commercial forestry, reservoir fisheries, and animal husbandry. Each relocated family will be provided with at least 0.5 ha of cleared land for crops, vegetable gardens, fruit trees, and some rice fields plus seedlings, tools, and agricultural and labor training (among other things). A full range of infrastructure will also be provided, including irrigation supply, domestic water supply, electricity, schools, and community facilities. The legal entitlements of affected people are laid out in the STP and in NTPC's concession agreement, an extract of which is presented in Appendix 3. The Concession Agreement will be revised to reflect the final SDP. The EMDP (contained in the SDP) describes issues associated with the relocation of ethnic groups, particularly those more vulnerable to the change, and details the mitigation measures to be adopted.

83. The Project will fund a health program for the benefit of resettled people. This is discussed in Section V.D.8.

84. A pilot village was established in 2002–2003 to demonstrate some actions to the plateau villagers after the long drawn-out preparation period. It was not intended as a pilot for the full resettlement and livelihood program, because the fisheries and forestry livelihood components

are not yet in place. The pilot village has been beneficial for developing viable solutions for physical relocation, resettlement site infrastructure, and agricultural development.

2. Nam Theun below Nakai Dam

85. No permanent villages lie along the Nam Theun from below the Nakai dam until Ban Katok some 50 km downstream, and no land is cultivated up to the headpond of the Theun-Hinboun Hydroelectric Project. Fisherfolk and hunters from nearby villages do, however, use this stretch of the Nam Theun. Fish diversity and abundance is expected to be affected by reduced flows in this stretch of the Nam Theun with consequent impact on fishing practices, catches, and local livelihoods. The extent of such impacts is currently being assessed in a riparian release study and results will be incorporated into the final EAMP and SDP. During construction, villages along Road 8b will be affected by increased disturbance from construction traffic (traveling between quarry sites for example) and social and health impacts associated with approximately 800 construction workers and perhaps an additional 3,200 followers (see further in Section V.F.).

86. **Mitigation**. The riparian release study is being finalized to help better assess impacts and develop a strategy for appropriate management, compensation and restoration in this section of the river (results are expected late December 2004). Compensation for lost fisheries will be implemented in the fishers' villages, which are somewhat distant from the river. Construction management plans will be implemented to mitigate impacts during construction.

3. Nakai Nam Theun National Protected Area

87. As described in Section III.C, the communities living in the NNT NPA are the most impoverished in the project area. Improvement of their livelihoods is currently hampered by their remoteness. Although the Project will not directly impact these communities, significant social implications are likely. Creation of the Nakai reservoir will improve access for communities living in the NNT NPA, and access to the NNT NPA for outsiders. Without careful management, this could increase pressure on timber and wildlife resources and also encourage increased agricultural production to supply the demand on the plateau from construction workers and their followers. If sustainable utilization of resources can be achieved, the reservoir will, however, enable better access to markets, health facilities, and other services for NPA communities, so contributing to an improvement in their livelihoods. In the absence of sustainable land management in the NPA, increased sedimentation could affect the operations of the Project.

88. **Mitigation**. The Project has committed to provide $31.5 million of financial assistance and management support for the conservation of biodiversity and improvement of livelihoods of the communities residing in the NNT NPA. A total of $6.5 million will be provided during the construction period and a further $1 million a year throughout NTPC's operating phase of 25 years. The Government has prepared SEMFOP for the NNT NPA. This will be implemented, and funds administered by, the Watershed Management and Protection Authority. The coverage and implementation of this plan is described in further detail in Section IX, but essentially, its objectives are to effectively protect the watershed, wildlife, and biodiversity values; safeguard the well-being, traditional livelihoods, and culture of its human inhabitants; and improve their livelihoods by focusing on poverty reduction through environmentally sustainable development.

4. Xe Bang Fai

89. Impacts on the Xe Bang Fai will largely be restricted to project operation. A total of 7,096 households in 89 mainstream villages lie in areas potentially affected. Of these, however, 19 villages are only impacted by backwater effects, and approximately 66 villages lie in the Xe Bang Fai hinterland from which residents seasonally travel to fish in the Xe Bang Fai. Adverse impacts can be divided into four zones:

(i) **Upstream of Upper Xe Bang Fai***.* Project impacts are limited but 12 villages with 537 households in the area may experience higher water levels as a result of backwater effects.

(ii) **Upper Xe Bang Fai***.* This area, containing 12 villages with 852 households, will experience the greatest impacts of additional discharges including loss of riverbank gardens, erosion of riverbank impacting fixed assets and other productive lands, and impacts on fisheries.

(iii) **Middle Xe Bang Fai***.* Twelve villages with 704 households will experience similar impacts to those in the Upper Xe Bang Fai, but to a lesser extent.

(iv) **Lower Xe Bang Fai***.* Fifty-three villages in 5,003 households live in this area. Negative impacts include flooding of lower riverbank gardens and possible changes to fisheries.

(v) **Hinterland Xe Bang Fai.** On the Nam Phit/Houay Khama, 66 villages with 1,708 fishing households have been identified as possibly affected by the Project.

90. Communities along the Xe Bang Fai also have the potential to derive considerable benefits from the Project, including increased potential for dry-season irrigation and reduced pumping costs. Annual flooding currently results in damage to wet-season crops, which is pushing communities toward dry-season irrigation and the food security that it provides. The Project will supply an additional 7 billion m^3 of water to the Xe Bang Fai, facilitating the expansion of irrigated land.[10] The benefits from this additional flow are potentially greater for communities in the middle and upper Xe Bang Fai because their pumps currently run dry in the dry season. Other positive benefits resulting from higher flows include a reduction in vertical pumping distance from the river to irrigated fields (estimates suggest that this represents a less than 28% saving in pump costs during the dry season), higher groundwater levels with consequent reduced abstraction costs, and improved river transport during the dry season. Women also view the easier access to water due to the high water levels and large flows as a benefit.

91. **Mitigation**. The approach to compensation and livelihood restoration has been defined within a Downstream Areas Resettlement and Compensation Framework (part of SDP), which is being upgraded into a resettlement plan. All project-affected people will be fully compensated and restored for impacts on property and/or livelihoods. Erosion levels along the Xe Bang Fai will be monitored during operation and mitigation, and compensation will be agreed on a case-by-case basis. Villagers will also be able to alert district compensation committees to any abnormal erosion rates or affected infrastructure/livelihoods. A comprehensive baseline survey of fish stocks began in 2001 and will continue through project operation to determine project impacts on fisheries and any mitigation needed.

[10] This indirect project impact will require further investment, outside the Project, to realize the agricultural productivity potential. A World Bank rural development project is currently assessing this potential.

5. Project Land Resettlement, Acquisition, and Compensation

92. The Project will require exclusive use of up to 2,565 ha for the construction of project infrastructure, including the power station site, regulating dam and pond, downstream channel, quarries, spoil disposal sites, Nakai saddle dams, access roads, and transmission lines. Of this, 519.8 ha comprise productive assets that will be permanently lost and 842.61 ha that will temporarily be used during construction. Only limited acquisition of houses is expected for project lands (mainly in Ban Oudomsouk on the Nakai plateau due to saddle dams). When a household is displaced, relocation will only be a short distance and within village boundaries. Other land, buildings, and productive assets in the project lands will need to be acquired with associated compensation to current owners and users.

93. Few productive assets exist at the Nakai dam site and its access roads, although some swidden fields and NTFP collection activities will be interrupted. Approximately 13 ha of paddy and productive gardens will be affected at the Pha Phen (Phou Phako) quarry site, including its access roads. For other project roads, neither resettlement nor significant compensation is anticipated. Similarly, construction of transmission lines is expected to result in loss of very few, relatively small parcels of land required for the towers with appropriate compensation. The Nakai construction camp, intake structure, and saddle dams will mainly impact Oudomsouk village and associated assets as indicated above, and households affected in this way will be eligible for the resettlement, compensation, and livelihood programs described for the Nakai plateau in the SDP.

94. The water release from the power station was originally planned to flow into the Nam Kathang. Baseline studies and consultation, however, indicated that this could result in erosion and water quality impacts, large-scale resettlement, and loss of land and assets. The downstream channel, regulating dam, and regulating pond were therefore integrated into the project design to prevent and minimize these impacts. As a result, there are no villages located on the actual alignment of the downstream channel or in the area to be inundated by the regulating pond. Assets belonging to households in the corridor of the spoil disposal locations, access roads, and the 115 kV and 500 kV transmission lines may be affected. For example, the regulating pond will inundate a number of vegetable gardens and banana plantations, fields, and some huts; the regulating dam and proposed operator's village also lie directly next to the village of Ban Keovilay and its fields. The downstream channel will traverse productive rice paddy land for approximately 8 km of its 27 km length. Households along the route will, however, benefit from increased potential irrigation and higher groundwater levels (requiring less pumping energy) due to higher dry-season flows.

95. **Mitigation**. NTPC is making every effort to minimize the need for direct resettlement, and land or asset acquisition and compensation in project lands. Significant social impacts have already been avoided through the inclusion of the regulating dam and downstream channel. Routes and locations of other project lands are currently being carefully planned so as to minimize social disturbance. To this effect, a detailed on-the-ground survey has been under way since June 2004 to confirm all potentially affected land, buildings, and assets previously identified through interpretation of satellite imagery. The survey also includes consultation with potentially affected people to identify land uses and assets and determine appropriate compensation measures. The approach to compensation has been defined within a Project Lands Resettlement (Acquisition and Compensation) Framework (part of the SDP), and resettlement plans are being prepared. In principle, compensation will be in replacement of assets or livelihoods of equal value if the direct impacts are significant (in-kind replacement for land or assets, or direct replacement to enable the project-affected person to achieve the same

level of imputed income). Where assets or livelihoods lost are only a relatively small percentage of a family's total livelihood or income, or when specifically requested by the project-affected person, cash compensation will be given as an alternative.

6. Vulnerable Populations

96. The 1998 Census found that approximately 23% of affected households on the Nakai plateau fell into the vulnerable category. Households may be vulnerable for a variety of reasons, including poverty levels, ethnicity (e.g., the adaptability of particular ethnic groups to sedentary agriculture), and household characteristics (e.g., households headed by a widow, female, handicapped person, or male over 60 years of age; single-person households; and households with a handicapped person). The majority of households to be resettled live below the official poverty line.

97. **Mitigation**. All vulnerable households will be monitored and given special consideration in the resettlement, compensation and rehabilitation process. Income levels will also be closely monitored during implementation, and economic vulnerability will be considered in the overall livelihood planning process. To ensure that ethnic minority concerns are addressed, constant interaction between minority groups and the resettlement management unit (RMU) and other agencies will be necessary and will be encouraged. Specialist international and national professional support will be used. A gender analysis is under preparation, and a gender action plan will be prepared and integrated into the SDP and SEMFOP.

7. Social Stress

98. The social impacts described have the potential for causing social, psychological, and physiological stress among affected people, particularly those to be relocated. This in turn can lead to problems such as alcoholism and drug abuse and place stress on social, cultural, and family structures. The sources of stress may include:

(i) problems associated with the resettlement process and potential community discord;
(ii) risk of impoverishment relating to difficulties in adapting to new livelihood systems;
(iii) potential exploitation by others in the relocation/compensation process; and
(iv) possible conflicts within or between communities, or with government agencies.

99. Ongoing measures will continue to mitigate these potential causes of stress. A key aspect of this has been the adoption of a participatory approach to resettlement, compensation, and rehabilitation. Studies show that close involvement and understanding of the process minimize the likelihood of negative consequences. Participatory rural appraisal techniques have been employed to familiarize village leaders and the community at large with the Project and to find out their opinions and expectations.

100. The strengthening of community institutions will also play an important part in minimizing social disruption and discord. Responsive and accessible village administration is essential in ensuring that affected households have the community support they need in times of stress. A detailed program will be put in place for the establishment of appropriate village committees and for the transition of some settlements from informal hamlets to official administrative units.

8. Health and Human Trafficking

101. A health impact assessment was conducted for the five key areas: (i) NNT NPA; (ii) Nakai plateau; (iii) Xe Bang Fai; (iv) Nam Theun, downstream of the Nakai dam; and (v) project lands. The major and most immediate adverse health impacts are expected in areas where construction and camps of workers and camp followers (families of workers and service providers) are concentrated. These impacts would consist mainly of communicable diseases (food and water-borne, sexually transmitted disease and HIV/AIDS) and road traffic and construction related accidents. The increased risk of human trafficking has also been investigated and research cited by United Nations Development Programme and International Labor Organization indicate very little research on human trafficking issues in relation to large projects. Nevertheless, an awareness and preventive education program is being prepared.

102. **Mitigation.** The Public Health Action Plan has been prepared and includes two health programs that are responsible for preventing and mitigating the adverse health effects of the Project. They are the Resettlement Health Program for the Nakai plateau, and the Regional Health Program. The two programs each have their own objectives, budget to be financed by the Project, target groups, activities and time frame, and will be implemented through the public health institutions. The objectives of the Resettlement Health Program are to (i) prevent and mitigate effects of resettlement on the resettled population, (ii) improve the health situation of the resettlers, and (iii) build the capacity of the public health institutions for addressing their target populations' needs. The Regional Health Program is intended to (i) prevent and mitigate significant adverse health effects resulting from the immigration of construction workers and construction camp followers, (ii) mitigate significant adverse health effects due to the construction works and increased traffic, (iii) prevent and mitigate significant adverse health effects resulting from changes of water levels and flows, and (iv) improve the health situation of the local population. Detailed implementation plans are being prepared for the Resettlement and Regional Health Programs. There will also be a Health Monitoring and Surveillance System, which will include an Infectious Disease Detection System. A Project Staff Health Program is also being prepared by the HCC to: (i) ensure preventive and curative measures safeguarding health and safety of the workers and their families, and (ii) prevent and mitigate health effects due to construction works and the influx of project staff on the local population. HIV/AIDS and human trafficking awareness and prevention programs are also being prepared and will each include a monitoring and surveillance system.

E. Impacts on Physical and Cultural Resources

103. The Nakai reservoir will affect a number of physical cultural resources within the inundation area, including sites of spiritual significance and 26 cemeteries. These resources are part of the cultural traditions of the villages in this location and will require appropriate spiritual ceremonies prior to any impact. Methodologies will be agreed with communities, relevant government authorities, and an internationally recognized specialist. Construction activities in project lands also have the potential to impact a number of physical cultural resources, including disturbance religious sites; physical damage to religious structures, historic sites (e.g., temples, historic lime kilns), and cemeteries; and theft of moveable objects and artifacts (e.g., from within temples). Special care will also need to be taken to protect sites of prehistoric and spiritual value around the Pha Phen (Phou Phako) quarry site.

104. **Mitigation**. The results of the most recent physical cultural resources survey (carried out in mid 2004) have been used to develop a management plan that includes (i) community awareness programs, (ii) relocation of physical cultural resources, (iii) appeasement

ceremonies, (iv) securing moveable physical cultural resources, (v) archaeological salvage operations, (vi) additional risk assessments, and (vii) a procedure for dealing with chance finds. Survey results and management measures are also being integrated into resettlement plans.

F. Environmental and Social Impacts during Construction Works

105. In addition to land acquisition described in Section V.D.5 above, physical construction works in all project lands could lead to environmental and social impacts if mitigation measures are not appropriately implemented. Because exact locations, specific designs, and precise techniques and work methods have not yet been finalized, any detailed, quantitative assessment of many construction impacts is not possible at this stage. HCC is developing an HCCEMMP that would form the basis for carrying out more detailed analyses and implementing appropriate management plans as these issues become better defined (see Appendix 1 for a list of subplans contained in the HCCEMMP). A preliminary identification of impacts and their mitigation is, however, presented in Table 11. Construction impacts associated with quarry sites, work camps, road construction or upgrading, and transmission lines are discussed in more detail thereafter.

Table 11: Summary of Key Impacts during Construction and their Mitigation

Impact Type	Source of Impact	Proposed Mitigation
Environmental Impacts		
Biological Diversity	• See Section V.B	• See Section V.B
Water Quality	• Erosion from areas disturbed by construction activities • Wastewater discharges (from construction sites and construction camps) • Spills and leakage of fuels and chemicals • Pesticides and herbicides used in site clearance • Contamination as a result of inappropriate waste disposal	• HCC is required to prepare several plans, including an erosion and sediment control plan and a water quality monitoring plan • Good site-management practices • Treatment facilities to remove oils and grease from water to be discharged • Prevention and control of spills • Provision of wastewater treatment facilities for all wastewater from construction camps and other construction facilities • Strictly controlled use of synthetic chemicals for vegetation clearance
Air Quality	• Emissions from vehicles and equipment operating at construction sites and passing through settlements • Dust generated by construction activities at quarry sites, concrete batch plants, construction sites, dust on roads, and passing traffic • Burning of waste • Quarry sites	• Maintenance of vehicles and stationary equipment in good working order • Spraying of water on roadways to control dust • Limiting of area where dust could be generated through good site-management practices and work scheduling • Burning of waste will only be carried out in designated areas away from settlements • Burning of materials that could cause toxic fumes will not be allowed • HCC will prepare an emissions and dust control plan

Impact Type	Source of Impact	Proposed Mitigation
Noise	• Excavation and other construction activities including quarrying, concrete batch plant, and crushers • Explosives used for dam construction and tunneling • Vehicle noise • Associated impacts on wildlife and human populations • Quarry sites	• Maintenance of vehicles and stationary equipment in good working order • Installation of noise mufflers on all engines • Explosives will only be used during daylight hours when wildlife is less active • Little or no explosives used underwater so as to prevent harm to fish/aquatic species • HCC will prepare a noise control plan
Disposal of Spoil	• An estimated 15 million m^3 of spoil will be generated during construction of e.g., downstream channel, headrace channel, and intake tunnels • Disposal could destroy habitats, generate dust, and affect surface water quality	• Where possible, spoils will be reused in construction of roads, rim bunds, sediment traps, landscaping, and resettlement village construction • Final sites for disposal to be determined through environmental studies and consultations, and incorporated into HCC spoil disposal plan
Social Impacts		
Disruption to Livelihoods	• Materials sourcing • Noise • Traffic through settlements • Closure or restrictions to use of land or transport routes	• Development and implementation of HCCEMMP to include management of noise, traffic, dust, and interactions with local people • Account will be taken of social impacts when identifying materials sourcing locations, such as land acquisition, which will be mitigated through the SDP
Health and Safety	• Increased likelihood of accidents (human and livestock) as a result of increased traffic • Contamination of drinking water • STDs and communicable diseases • Pestilence • Reduced food availability in markets due to large numbers of workers and camp followers. • Trafficking	• Implementation of a project staff health management program • Appropriate waste and wastewater management and disposal • Traffic control measures • Minimize breeding grounds for pests in the HCC construction camps • Construction workers fed on site with imported food • Trafficking and safe migration awareness program • Minimize camp followers

HCC = head construction contractor, HCCEMMP = Head Construction Contractor's Environment Management and Monitoring Plan
Source: Environmental Assessment and Management Plan, November 2004; Social Development Plan, November 2004.

1. Quarry Sites

106. Limestone aggregate, sand, laterite, and sandstone are needed for the road base and concrete structures (e.g., dams, power station, intake structure, tunnels, and downstream channel). Fifteen potential quarry sources have been identified, although final sites will be determined based on a closer comparison of environmental and social impacts. These impacts include visual intrusion because of removal of a significant part of some hills, noise (and its associated impacts on wildlife and people), sedimentation (and associated impacts on water quality), impacts on physical cultural resources, and impacts associated with the transport of material to work sites.

107. **Mitigation** will include protection against erosion, sedimentation, poor air quality, and noise as laid out in Table 8 and preparation (by the HCC) of a quarry management plan as part of the HCCEMMP. Environmental impact assessments of quarry sites will be undertaken 6 months prior to the start of construction. At the end of exploitation, the quarries used will be rehabilitated.

2. Work Camps

108. Four work camps are under construction to accommodate the anticipated 4,000 workers the Project will require (see Figure 3 in Appendix 4). Based on experience from the Theun Hinboun Hydroelectric Project, these camps could attract up to four times as many camp followers. The total number of additional people in the area could therefore reach 20,000. Potential impacts arising from the workforce and the spontaneous development it will attract include pressure on land and natural resources (e.g., hunting), generation of solid and liquid wastes, and increased public health risks (including an increase in prevalence of sexually transmitted diseases such as HIV/AIDS). Without treatment, wastewater could cause water quality problems in adjacent water bodies, which could affect fish populations and human health. Inappropriate solid waste disposal could lead to contamination of soil, groundwater, and rivers, and the spread of pests and communicable diseases.

109. **Mitigation** of impacts will be outlined in the HCCEMMP and construction work camps plan including bans on construction worker hunting, fuel gathering, and collection of NTFPs, implementation of a project staff health management program to educate and provide health services to the workforce, and appropriate waste and wastewater management. In addition, the Government will implement strict regulations to prevent hunting and will strictly license new businesses conditional on their appropriate disposal or wastewater, waste, and sanitary conditions. Solid waste collection and proper disposal outside the reservoir area will be established. NTPC is currently investigating how impacts could be further reduced by minimizing the number of camp followers. Experience from other recent projects in the area is being used to examine options for NTPC, e.g., maximizing employment from settlements in the project area and bussing workers to work sites.

3. Construction or Upgrading of Roads

110. The Project will upgrade approximately 106 km of existing public roads and construct 56 km of new roads. In addition, access roads and tracks (some temporary) will be needed for construction, operation, and maintenance. Neither resettlement nor significant compensation is anticipated. Potential impacts include clearance of vegetation; erosion and sedimentation; dust during construction; car interactions with people, livestock, and wildlife; induced development and increases in population; and increased access. These could generate negative impacts through increased hunting of wildlife and timber extraction but will also benefit affected populations by providing them with better access to markets, schools, health, and other services.

111. **Mitigation** will include construction controls as detailed previously, e.g., on erosion, air emissions and noise, design alignments to minimize impacts on vegetation, provision of road signage, and enforcement of maximum speeds.

4. Transmission Lines

112. Impacts from the three project transmission lines (500 kV, 115 kV, and 22 kV) will occur predominantly during construction and will include clearing of vegetation for easements and access roads. (This is discussed in Sections V.B.2 and V.D.5.) During operation, impacts will be limited to electromagnetic radiation, visual impacts, and impacts associated with access and maintenance of the lines. Electric and magnetic field calculations for the transmission lines have been compared to guidelines endorsed by the International Commission on Non-Ionizing Radiation Protection. Electric and magnetic fields are expected to be within the guidelines, for all exposure characteristics with the exception of the "up to 24 hours per day" exposure category, which is exceeded by the predicted electric field of the 500 kV transmission line only.

113. **Mitigation** during construction will be incorporated into the HCCEMMP and its vegetation clearing plan. The pest management plan also limits the use of herbicides for site clearance. For health impacts associated with electromagnetic radiation, mitigation measures will ensure no human habitation is within the easement of the transmission line. No public health impact is therefore anticipated.

VI. ENVIRONMENTAL AND SOCIAL ASSESSMENT OF THE THAI TRANSMISSION LINE

A. Introduction

114. NTPC is responsible for delivering electricity to the Lao PDR–Thai border north to the town of Savannahket (138 km, 500 kV transmission line). To supply the electricity into the EGAT system, an additional double-circuit 500 kV transmission line, approximately 165 km in length, including about 300 towers, will be constructed from the Lao PDR–Thai border to the new Roi ET 2 substation, Thailand. The project will also include reconstruction of the about 20 km of the existing 230 KV Roi Et—Roi Et2 double circuit lines, and installation of 2 transformers at the Roi Et 2 substation. Planning and construction of this additional transmission line is the responsibility of EGAT. EGAT is not receiving any financial support from ADB or the World Bank for the construction of this transmission line, which is necessary for the transmission of the power generated by the Nam Theun 2 Project.

115. The Thai National Environmental Quality Act (1992) requires an environmental impact assessment for transmission lines that pass through an area of Class 1B watershed and an initial environmental examination (IEE) to be prepared if the line passes through a forest reserve. EGAT has confirmed that no environmental impact assessment or IEE is required under Thai law as the route of this transmission line has been changed to avoid any sensitive areas such as watershed, forest reserve, cultural and historic heritage sites, or tourism spots. However, since part of the transmission line (about 10 km) will go through the "reserved forest category E," EGAT will need to secure permission from the Royal Forestry Department on its clearance.

116. With respect to social issues, EGAT has powers under the EGAT Act of 1968 to purchase, occupy, and use land or property to construct transmission lines under, above, along, or across land belonging to any person. For this, EGAT pays fair and just compensation at prevailing market rates for land acquired or used. EGAT's corporate plan explicitly requires public participation and seeks public acceptance of projects.

117. The transmission line is scheduled for approval by the Thai Cabinet in late 2004. EGAT indicated that land acquisition and any further environmental surveys (e.g., detailed forestry survey, land survey, and IEE study) would commence thereafter.

118. For the purpose of funding agency due diligence, ADB and World Bank missions visited the proposed alignment in June 2003 and October 2004, respectively. The route will require a 60 m wide right of way (ROW) along its 165 km length, amounting to 9.7 km^2 of land. Eighty percent of the proposed ROW is currently under paddy with some other crops under cultivation. The remaining 20% is under fruit orchards (mainly mango and coconut), eucalyptus plantations, and some areas of forest (both public and private) between Moei Wadi and Amphur Wan Yai of Mukdahan (Mekong crossing). The line passes close to villages but only one house currently lies on the alignment.

119. Construction of around 300 transmission line towers will require permanent acquisition of 12 ha of ROW land with an estimated 2,000 plots in private ownership. Only land under towers is permanently acquired. The EGAT Act 1968 requires this land to be compensated at full replacement value. Remaining land in the ROW remains the property of the land owner but with restricted use (no structures or trees over 3 m in height). Any loss of trees are compensated for at a rate that takes into account the disruption in income associated with the trees. Environmental impacts are likely to be associated with some clearance of natural vegetation and habitats, but are expected to be limited in scope, and localized. Construction across rivers may require special management for erosion control and slope stabilization. Health impacts on people living or working in the vicinity of the cable line associated with electromagnetic radiation will also need to be considered.

120. The ADB and World Bank missions concluded that they were satisfied that EGAT has the capacity and experience to prepare and implement satisfactory plans associated with resettlement and environmental impact assessments, and a copy of such plans will be requested by ADB for review when available. With respect to environmental impacts, ADB and World Bank will continue to monitor the final decision from the Royal Forestry Department and the Ministry of Natural Resources and Environment regarding the requirement for an IEE. Should an IEE be prepared, ADB will request a copy and at the same time will urge EGAT to engage in early consultation with the Royal Forestry Department, the stakeholders, and local community.

VII. CUMULATIVE IMPACT ASSESSMENT

A. Introduction and Scope

121. Given the potential for project impacts to have wider implications when considered in the context of other development trends, a CIA has been conducted to analyze the combined impacts of a raft of projects, either implemented together or in a sequence, and of future developments and plans, in relation to the Nam Theun 2 Project. The scope of the CIA includes the effects that other (future) developments have on the type and magnitude of Nam Theun 2 impacts (added impacts), and the impacts of development in other sectors that are induced by the Nam Theun 2 Project (induced impacts).

122. The geographic coverage of the CIA includes the Mekong Basin, Nam Theun/Nam Kading, Xe Bang Fai, and Hinboun basins, as well as the linear development zone of transmission lines and roads. In addition, border areas are covered in relation to social development, transport, and biodiversity.

123. Two development scenarios have been assessed based on 5-year and 20-year planning horizons. These scenarios cover several sectors by examining the present situation, existing plans, and development trends. Sectors covered are: hydropower, transport, irrigation, water supply and sanitation, urban development, fisheries, forestry, industry, social development (including ethnic minorities, health, education, and social disparity), and conservation (biodiversity issues). Of all these sectors, hydropower is the most planned and has the greatest potential to affect the whole Mekong basin in terms of active (seasonal) storage of water. This results in increased dry-season and decreased wet-season flows. Other assumed sector developments which in combination form the social-economic development scenario at both national and regional levels are discussed in more detail in Appendx 5.

B. Cumulative Impacts of Anticipated Regional Development

124. A preliminary summary of anticipated cumulative impacts of Nam Theun 2 when combined with the anticipated developments in other sectors described above over 5-year and 20-year planning horizons are presented in Table 12.

Table 12: Cumulative Impacts of Anticipated Regional Developments, including Nam Theun 2 Project

Impact Zone	Five-Year Scenario	Twenty-Year Scenario
Nakai plateau	Impacts are dominated by Nam Theun 2 project activities. Some additional impacts are envisaged due to improved access following the construction phase and temporary population increase. Key impacts will be: increased pressure on wildlife (e.g., from hunting and logging due to an influx of people and better access to the area), increased health risks (STDs including HIV/AIDS), and increasing frequency and severity of vehicle accidents.	The situation is stabilized but significantly changed from the current baseline. Transport communications will be significantly improved and new activities will have been attracted to the reservoir (e.g., commercial fisheries and tourism). The anticipated situation is: (i) Sanitation and water supply improved; (ii) Oudomsouk population higher than during the project construction period by some 140–150%; (iii) Commercial fisheries established; (iv) Health conditions improved with reduced incidence of malaria and food- and water-borne diseases, and shift from communicable toward noncommunicable diseases; (v) Health and education services improved but struggling to keep up with demand due to population increase; (vi) Increased employment in service sector including tourism; and (vii) Increased cultural integration on the plateau with blurring of ethnic identities.
Nakai Nam Theun National Protected Areas	(i) Reservoir will affect fish migration in the Nam Theun; (ii) Better protection of biodiversity and forest resources through SEMFOP but also increased threats linked to road construction and population increase on the Vietnamese side of the border; (iii) Improved delivery of social services including access to education, availability of medicines, and	(i) Change in fish biodiversity and production dependent on type of fish population that establishes itself in the reservoir; (ii) Increased threat to biodiversity due to population increase on the Vietnamese side of the border and increased exploitation of the NPA; (iii) Further improvements in social services including immunization coverage, hygiene and nutrition, health centers, and functioning village schools;

Impact Zone	Five-Year Scenario	Twenty-Year Scenario
	possible reductions of malaria and nutritional problems; (iv) Some integration of ethnic minorities but not to the same extent as on the plateau; (v) Some improvement in poverty reduction; and (vi) Improved management and enforcement efforts in the NNT NPA may increase pressure on other NPAs.	(iv) Considerable out-migration and labor migration to urban areas due to natural population increase; (v) Process of integration with lowland Lao culture will have proceeded further and led to assimilation of small Vietic groups; and (vi) Significant reduction in poverty in terms of food security, better market access, and employment.
Xe Bang Fai Basin and Surrounding Districts	Impacts of Nam Theun 2 Project operation have started to be felt. New Road 12 will also have significant impacts. Cumulative impacts are likely to be: (i) Increased untreated wastewater due to higher population around Gnommalat and Mahaxai; (ii) Commercialization and intensification of agriculture in Mahaxai and Gnommalat, but only moderate expansion in irrigated rice area; (iii) Increased logging in undisturbed forest and other areas; (iv) Considerable expansion of Gnommalat and Mahaxai settlements characterized by lack of planning; (v) Increased prevalence of STDs (including HIV/AIDS) and vehicle accidents more common; (vi) Capacity of the various district services considerably strengthened due to Nam Theun 2 Project support.	No new large-scale hydrological changes are foreseen, but the transport corridors and accompanying urbanization will be a significant development in relation to cumulative impacts. The situation is likely to be: (i) Reduced problem of oxygen depletion due to less organic matter in the reservoir and improved wastewater treatment; (ii) Localized eutrophication and increased levels of pesticides in rivers and fish due to intensified agriculture; (iii) Reduced biodiversity and fish production due to disturbed spawning cycles caused by changed hydrological regime. However, increased flooding may increase floodplain and back swamp production of fish; (iv) Improved sanitation, health services, and awareness of health issues. Water-borne illnesses and intestinal parasitic infestations substantially reduced and mortality from malaria and dengue fever sharply reduced; (v) Substantial growth of Mahaxai and Gnommalat (perhaps by 200%) and of Thakhek (by 140–150%). Growth in services sector including tourism and expansion of cement industry in Mahaxai creating employment; (vi) Some assimilation of ethnic minority groups in urban areas, but cultural identity will be retained in rural areas
Nam Theun, Nam Kading and Nam Hinboun basins and surrounding districts	Nam Kading and Nam Hinboun will experience the combined impacts of Nam Theun 2 and Theun-Hinboun Extension projects, in addition to the developments caused by improvement of Road 8 corridor, and increased cross-border trade and population movement. Predicted impacts are: (i) Reduced discharge in Nam Kading (below Theun Hinboun dam) in the flood season. With the Theun-Hinboun extension, the cumulative impact will be a diversion of a larger part of the flood into the Nam Hinboun, further reducing flows in the Nam Kading; (ii) Reduced flood periods affecting fish migratory behavior;	No further hydropower expansion planned in the basin. Development will be dominated by increase in transport-related activities and impacts and developments on the plateau. The situation is likely to be: (i) Increased pressure experienced in Nam Kading NPA, Phou Hin Poun NPA, and Nam Chat/Nam Pan Provincial Conservation Forest due to increased pressure of cultivation, logging, and hunting and as a result of improved protection of NNT NPA; (ii) Rural-urban migration trend reinforced and size of Lak Xao increased to 27,000–28,000; (iii) Full assimilation of smaller ethnic groups, in or near Lak Xao (including some Vietic groups), losing their ethnic identity; and (iv) Hmong cultural traditions and language

Impact Zone	Five-Year Scenario	Twenty-Year Scenario
	(iii) Increased threats to biodiversity due to population increase and increased transborder traffic. The Wildlife Conservation Society project will, however, tend to counteract this; (iv) Remaining and limited forested areas increasingly encroached upon but participatory village forestry introduced; (v) Increase in irrigated areas and irrigation schemes along Nam Hinboun; (vi) Population of Lak Xao increased to 17,000–18,000, partially due to in-migration; Gradual integration of ethnic groups into mainstream economy will be accelerated slightly due to Nam Theun 2-related activities, population influx, increased urbanization, improved infrastructure, and growth in services sector. Vulnerable Vietic groups will be under particular pressure of integration.	likely to continue despite changes in socioeconomic conditions.
Mekong River Basin (scenarios include all hydropower developments in the basin including Yunnan)	The dominant factor will be some additional development of hydropower in Yunnan (People's Republic of China) and Lao PDR. The impacts are calculated to be: (i) Dry-season discharge at Savannakhet may increase by 45%. During floods, discharge reduced by 7%; (ii) Water levels at Phnom Penh will be lower during floods and increased during the dry season. Average annual maximum level of Tonle Sap will also be reduced; (iii) Changes in flow pattern will have an insignificant negative impact on floodplain and Tonle Sap fisheries as these are favored by high wet-season water levels; (iv) Changes in flow pattern will, however, have a small positive impact by damping damaging flood incidents and by increased dry-season water level that will support irrigation and reduce salt intrusion in the Mekong delta.	Dominant impact will be further development of hydropower in Yunnan (People's Republic of China) and Lao PDR. Impacts are calculated to be: (i) Dry-season discharge at Savannakhet may increase by 135%. During floods, discharges may reduce by 22%; (ii) Water levels at Phnom Penh will be lowered further during floods and increased further during the dry season. Average annual maximum level of Tonle Sap will be further reduced; (iii) Changes in flow pattern will have a significant negative impact on floodplain and Tonle Sap fisheries; and (iv) Changes in flow patterns will, however, have a significant positive impact by damping damaging flood incidents and by increasing dry-season water levels that will support irrigation and reduce salt intrusion in the Mekong delta.

HIV/AIDS = human immunodeficiency virus/acute immunodeficiency disorder syndromw, Lao PDR = Lao People's Democratic Republic, NNT = Nakai Nam Theun, NPA = national protected area, SEMFOP = Social and Environmental Management Framework and First Operational Plan, SDP = Social Development Plan
Source: Cumulative Impact Analysis and Nam Theun 2 Contribution, Final Report, November 2004.

125. The CIA also examined the specific contribution of the Nam Theun 2 Project to the downstream changes in the Mekong described above. The Nam Theun 2 Project alone is predicted to result in an increase (of about 8%) in dry-season discharge at Savannakhet while

reducing flood discharges by 2%. The Nam Theun 2 reservoir is also expected to cause only minimum retention of sediments.

126. The CIA concluded that the Nam Theun 2 Project alone will have an insignificant[11] negative impact on the Mekong floodplain and on all aspects of the Tonle Sap including fish production. It recommends several best practice actions to mitigate and compensate for impacts of developments and predicts the results of these actions on the 5-year and 20-year scenarios. Other recommendations include (i) establishing staffing and training needs in connection with Nam Theun 2, improving coordination and strengthening RMU and District Resettlement Working Groups, (ii) strengthening integrated planning institutions at all levels and the role of government as regulator, (iii) developing comprehensive NPA plans, (iv) establishing legal arrangements among the neighboring countries, and (v) implementing an equitable Basin Development Plan. These recommendations will be considered by the Government and jointly discussed and implemented with development partners and international agencies such as the Mekong River Commission.

C. Strategic Impact Assessment of the Hydropower Sector

127. The Power Sector Development Plan was developed based on a series of studies on the power sector undertaken over the last 10 years. Many of these studies have incorporated environmental and social criteria in choosing alternative hydropower development plans and discussed the environmental and social issues related to development in the sector. A Strategic Impact Assessment has been undertaken to consolidate, update and expand this previous work in order to clarify the broader issues faced by hydropower development in Lao PDR and develop strategic priorities for use by government institutions, donors, private investors and other stakeholders in improving the management of environmental and social issues within the sector. The study reviewed the planning legal, regulatory and institutional framework in Lao PDR; reviewed experiences from several environmental impact assessments undertaken in Lao PDR; estimated the environmental and social impacts of 21 hydropower projects that, based on plans, are the most likely projects to be built in the next 15 years, and provided recommendations for improvement of the management of environmental and social issues within the sector.

128. The major conclusions of the report included that the legal and administrative framework in place was comprehensive and modern, however, implementation is dependent on the capacity and power of the regulatory agencies; and although environmental impact assessment reports in Lao have assisted in planning better projects and identifying needs for mitigation and compensation, they at times have lacked in quality and effectiveness and, have not been timed properly. Of the 21 hydropower projects likely to be developed in Lao in the next 15 years, 12 are anticipated to involve resettlement affecting an aggregate of >16,000 people; the headponds and reservoirs of the projects are anticipated to inundate an aggregate area of 1,200 km^2 with 17 of the 21 projects inundating relative small areas (0-70 km^2; average of 17 km^2) and 4 of them inundating larger areas (113-450 km^2; average of 228 km^2); 10 of the 21 projects may potentially impact NPAs and most of the sites are in areas where there are ethnic minorities.

129. The Strategic Impact Assessment provided recommendations to improve environmental and social management in the sector including: (i) recommendations for construction and

[11] Significance is based on whether or not the induced impacts of Nam Theun 2 are within the range of normal fluctuation.

operation including mitigation measures for improved water quality, reducing erosion impacts and including environmental flow assessment; (ii) developing improved management programs using Nan Theun 2 as a model; (iii) implementing integrated water resource management including using work on the Nam Ngum watershed as a demonstration, building capacity and undertaking assessments for an intact river protection program; (iv) improving the planning process including upstreaming environmental and social concerns in the early steps of engagement with developers; (v) improving enforcement of regulations; (vi) identifying criteria and developing guidelines and standards for resettlement; (vii) clarifying zonation within NPAs for different uses; (viii) defining impact zones for EA analysis; (ix) strengthening monitoring by developing standardized indicators and a national database; (x) developing standardized guidelines for consultation; and (xi) ensuring funding, capacity building and training of regulatory agencies.

VIII. ECONOMIC ASSESSMENT

130. In terms of environmental and social impacts, the most significant project impacts are the inundation of the Nakai plateau and trans-basin transfer of 220 m^3/s of water (annual average) from the Nam Theun into the Xe Bang Fai. The diversion of water will significantly alter the discharge regime in both the Nam Theun (flow reduction) and the Xe Bang Fai (flow increase). These characteristics imply a significantly different distribution of the environmental and social costs and benefits across the impact areas of the Project.

131. For the purpose of economic valuation, project-impact areas have been divided into five distinct areas, namely the Nam Theun downstream of the Nakai dam, the NNT NPA, the Nakai plateau, the Xe Bang Fai, and the Mekong river. The economic assessment also distinguishes between costs and benefits that are strictly local or national in nature and those of global significance (e.g., expected benefits from the maintenance of forest coverage and biodiversity in the NNT NPA).

132. Preliminary estimated costs and benefits of project impacts in each area are presented in Table H.1. These are based on an environmental and social cost-benefit analysis being completed for the Project. The concept of total economic value has been used, which includes both use and nonuse values. The results indicate that the environmental and social impacts of the Project are estimated to yield significant positive benefits both at the local and global levels, in the range of $15 million–30 million at the local level, to approximately $85 million at the global level.

Table 13: Preliminary Economic Assessment of Environmental and Social Impacts
(present value terms using 10% discount rate, $ million)

Areas	Local ($ million)		Global ($ million)		Remarks
	Cost	Benefit	Cost	Benefit	
Nam Theun downstream of the Nakai dam	N.I.	N.I.	N.I.	N.I.	• Costs result from potential loss of fisheries • Results from a riparian release study are expected in December 2004.
Nakai Nam Theun National Protected Area	N.I.	17.0–36.0	N.I.	50	• Local benefits result from improved and maintained income levels due to better resource management and development of new economic activities (e.g., ecotourism). • Global benefits arise from maintenance of the carbon sink value of the NPA
Nakai plateau	4.4–5.4	8.5–11.5	0	35	• Local costs result from loss of existing economic activities on the plateau. Local benefits result from the higher levels of income expected from the livelihood programs • Global benefits result from reduced emissions of greenhouse gases from the Project compared to the best alternative energy source (gas combined-cycle)
Xe Bang Fai	6.8–9.4	0.25	0	0	• Local costs mainly derive from the estimated loss of fisheries. Results of hydrology study are still to be incorporated. • Benefits do not include potential for significant increase in irrigation and agricultural production. To be realized, these benefits require additional investments not supported by the Project.
Mekong river	N.I.	N.I.	N.I	N.I.	• Analysis will incorporate the finding of the CIA study.
Total	**11.2–14.8**	**26–48**	**N.I.**	**85**	

N.I. = none identified or quantified at the time of report preparation, NPA = national protected area.
Sources: Environmental Assessment and Management Plan, November 2004; Social Development Plan, November 2004, and Social and Environment Management Framework and First Operational Plan, October 2004.

133. As indicated in Table 13, the values presented remain preliminary in nature and do not reflect all costs and benefits. Results from three significant studies (Nam Theun riparian release study, Xe Bang Fai hydrology study, and CIA) are to be included. The expected considerable irrigation potential along the Xe Bang Fai is not included either. This indirect project impact will require further investment, outside the Project, to realize the agricultural productivity potential. A World Bank rural development project is currently assessing this potential. Finally, there remains some uncertainty on whether livelihood programs will be able to deliver the targeted income levels for resettled households; however, NTPC will extend the duration of the livelihood programs, if it becomes clear that income targets are not met.

IX. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

A. Introduction

134. The management of environmental and social impacts and measures to mitigate them are encompassed in a set of plans prepared under the Project. The three key plans are the draft

EMP (contained within the EAMP), draft SDP, and draft SEMFOP. Their scope and objectives are summarized in Table 14. A list of all mitigation programs and plans to be implemented during project construction and operation is presented in Appendix 1.

Table 14: Overview of Environmental and Social Management Plans

Plan	Objectives	Content
Environmental Management Plan (EMP)	To ensure effective implementation of mitigation, management, and monitoring measures to address all identified environmental impacts, during construction and operation.	(i) Detailed breakdown of mitigation requirements, responsibilities, schedules, and costs; (ii) Determines obligations of the head construction contractor and the required contents of the HCCEMMP; and (iii) Describes responsibilities and mechanisms for implementation and monitoring.
Social Development Plan (SDP)	To present a detailed analysis of the social implications of the Project on affected people and lay out in detail necessary mitigation measures including the resettlement plans and EMDPs for project-affected people on or along the Nakai plateau, downstream Xe Bang Fai, and Nam Theun, and project lands.	(i) Detailed baseline of households, livelihoods, assets, and lands to be affected by the Project and projection of the number of households likely to be eligible for resettlement, compensation and rehabilitation packages during the resettlement period; (ii) Detailed baseline and analysis of ethnic groups, trends, livelihoods, and vulnerabilities; (iii) Detailed description of the proposed resettlement, livelihood, and compensation packages including how affected people have contributed toward their design through participatory planning; and (iv) Definition of timing, responsibilities, and costs for each package and entitlement. The SDP presents the above information for three affected areas: Nakai plateau, downstream Xe Bang Fai and Nam Theun, and project lands. For each area, an Ethnic Minority Development Plan and a Resettlement Action Plan are being developed.
Social and Environment Management Framework and First Operational Plan (SEMFOP)	To provide a management framework and first operational plan for effective protection of the Nam Theun watershed area,[a] NNT NPA, NNT HNN corridor, and NNT PHP corridor. Management activities include wildlife and biodiversity, safeguarding the well-being, traditional livelihoods, and culture of human inhabitants, and improving livelihoods by focusing on poverty reduction through environmentally sustainable development.	(i) Consolidated baseline data on the environmental and social (including livelihood and ethnic) characteristics of the watershed; (ii) Detailed description of the institutional and management framework and operational plan for the WMPA for its first 6 years of operation (from 1 February 2004 to 30 April 2010); (iii) Technical and management activities to mitigate and manage any impacts including: • Forest and land use planning, allocation, and management • Participatory Protected Area Management • Resource access restriction and livelihood development for conservation • SEMFOP inclusion of an EMDP and a Resource Access Restriction Process Framework to address possible impacts from access restrictions to resources.

EMDP = Ethnic Minority Develoment Plan, HNN = Hin Nam Nor, NNT = Nakain Nam Theun, NPA = national protected area, PHP = Phou Hin Poun, WMPA = Watershed Management and Protection Authority.

[a] The Nam Theun 2 watershed area consists of the NNT NPA, NNT Hin Nam Nor corridor, and NNT Phou Hin Poun corridor.

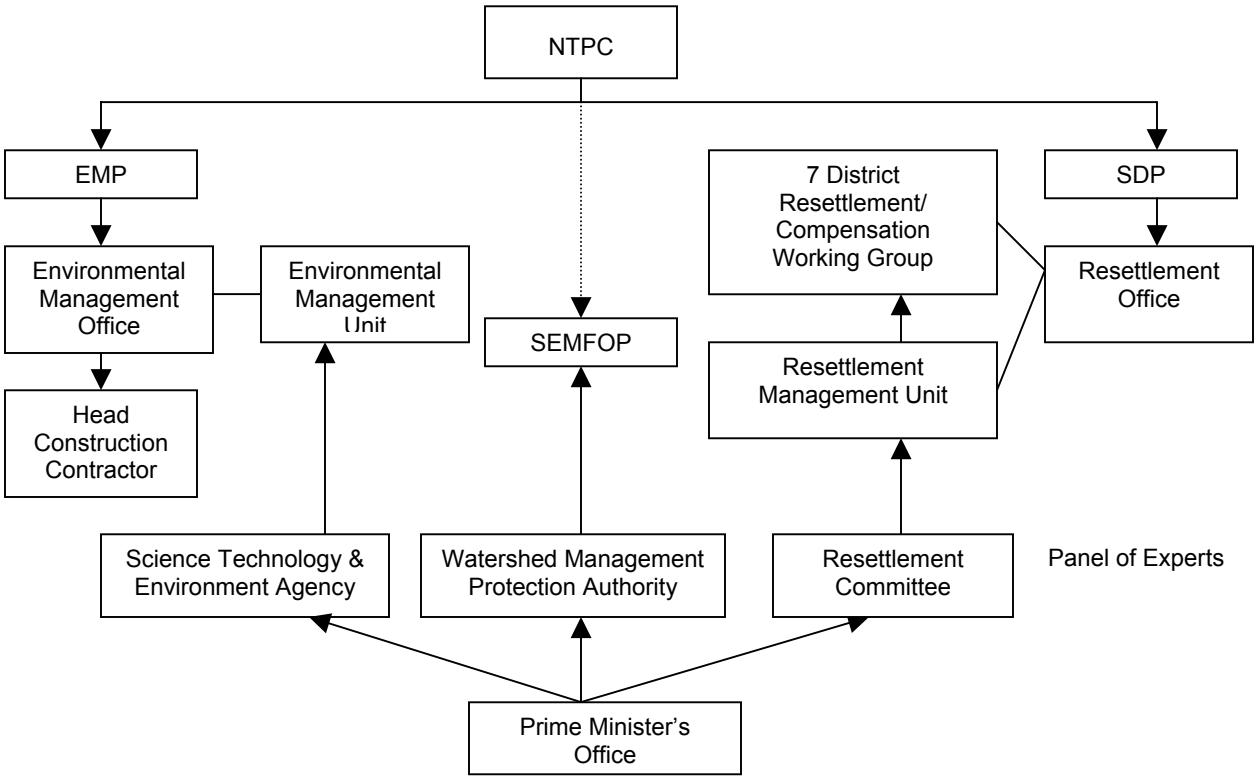
Source: Environmental Assessment and Management Plan, November 2004; Social Development Plan, November 2004; and Social and Environment Management Framework and First Operational Plan, October 2004.

135. In addition, the environmental and social management and mitigation requirements for the Project are laid out in Schedule 4 of the concession agreement that was signed on 3 October 2002 between the Government and NTPC. The concession agreement acknowledges that the above environmental and social plans that were existing at that time were developed and agreed to by the Government and NTPC. Schedule 4 outlines the social and environmental obligations of NTPC and the Government for social and resettlement impacts (Part 1); for management of project-related environmental impacts (Part 2); and for environmental and social management in the NNT NPA (Part 3). The contents of the three management plans described in the concession agreement will be updated by the end of the appraisal process to incorporate any changes in the plans made in response to ongoing studies, consultation, and the appraisal process of international financing institutions. The concession agreement will also be revised to reflect the final EAMP, SDP, and SEMFOP.

B. Institutional Responsibilities

136. The overall framework of institutional responsibilities for implementing the social and environmental management plans is presented in Figure 7. Implementation responsibilities are then discussed.

Figure 7: Overview of Institutional Responsibilities



EMP = Environment Management Plan, NTPC = Nam Theun 2 Power Company Limited, SDP = Social Development Plan, SEMFOP = Social and Environment Management Framework and First Operational Plan

1. Key Organizational Responsibilities for EMP Implementation

137. The key organizations responsible for implementation of the EMP are the Environmental Management Office (EMO) of NTPC, HCC, and the Environmental Management Unit (EMU) of the Government. EMO is responsible for technical planning, implementation, and monitoring of all environmental mitigation and compensation measures under NTPC's responsibility. EMO is also responsible for ensuring that the HCC fully meets its contractual and environmental management obligations. EMO will report to EMU on a monthly basis and will work in close cooperation with EMU and other government agencies as necessary. The HCC will be responsible for implementing measures to avoid or minimize environmental, social, and health impacts during construction, including definition and implementation of the detailed management plans (HCCEMMP). The HCC will also be required to apply international standard quality assurance procedures and an environmental management system in full compliance with International Organization of Standardization 14001. This will be subject to the monitoring by the panel of experts and the international advisory group (see Section V.4 and 5 below).

138. Under the direction of the Science, Technology and Environment Agency (STEA) of the Prime Minister's Office, the Government has established EMU, which is responsible for implementing and managing the environmental components of the concession agreement. EMU is designed specifically for the Project and consists of representatives from the Ministry of Industry and Handicraft's Hydropower Office, EDL, Khammouane Provincial Office, and the district offices of Nakai and Gnommalat. EMU is responsible for implementing some of the mitigation measures outside the NNT NPA, e.g., promoting the removal of biomass from the Nakai reservoir prior to inundation, strictly enforcing hunting and wildlife trade regulations on the plateau, and ensuring good environmental management at spontaneous settlements. EMU will also review reports of monitoring programs during construction and operation.

2. Key Organizational Responsibilities for Social Development Plan Implementation

139. The Project is the largest and most complex development involving resettlement with which the Government has been involved. In response, a comprehensive resettlement organization structure has been established comprising the following:

(i) **Resettlement committee**. Established by the Prime Minister's Office, its members include representatives from all three affected provinces and is chaired by the governor of Khammouane province (where most resettlement and related activities will occur) with NTPC as co-chair. It has overall responsibility for guiding and managing the resettlement and compensation process.

(ii) **Resettlement management unit**. Under the overall responsibility of the resettlement committee, the RMU is responsible for working with NTPC and, among other things, planning and implementing the resettlement process; organizing public consultations; carrying out socioeconomic surveys; ensuring the allocation of resettlement budgets and provision of guidance and training to district resettlement working groups; ensuring the participation of the Lao Women's Union; and participating in the grievance procedure. The RMU has seven technical and administrative units, with responsibility for infrastructure, livelihoods, training, social services, consultation, land asset surveys and titling, and compensation monitoring and evaluation.

(iii) **District resettlement (or compensation) working groups**. These have been established in the seven districts to be affected by the Project and are responsible for implementing, in cooperation with villagers and under the technical supervision of the RMU and resettlement organization, the relocation, rehabilitation, compensation, and development activities specific to their districts. Staff are drawn from local district staff.

(iv) **NTPC resettlement organization (resettlement organization)**. Working in close cooperation with the RMU and the resettlement committee, NTPC has established this organization to be responsible for all social and resettlement activities of NTPC including the development and implementation of the resettlement and compensation actions described in the SDP. The resettlement organization will be responsible for providing sufficient human and financial resources to ensure the objectives and targets of the SDP are met, for providing prompt and adequate compensation and mitigation of social effects, ensuring appropriate consultation and participation methods are used, and providing housing and community infrastructure.

3. Key Organizational Responsibilities for Social and Environmental Management Framework and First Operation Plan

140. The Prime Minister's Office has established and mandated the Watershed Management and Protection Authority (WMPA) to implement the SEMFOP, using funds provided by NTPC. WMPA will be responsible for coordinating and managing all activities in the watershed area, including:

(i) Conservation, maintenance, and promotion of biological diversity coupled with the development of a national park appropriate for scientific research and tourism;

(ii) Building and strengthening the capacity of the WMPA;

(iii) Facilitating improved livelihoods for inhabitants of the Nam Theun 2 watershed area to reduce poverty through environmentally sustainable development; and

(iv) Protecting and rehabilitating forest cover in the Nam Theun 2 watershed area to assure adequate water discharge with low suspended sediment.

4. Panel of Experts

141. An environmental and social panel of experts is mandated to provide independent review of and guidance on the treatment of environmental and social issues associated with the Project. Among other duties, as provided in the concession agreement, the panel of experts will provide reports to NTPC and the Government stating whether environmental and social safeguards and funding agency guidelines have been complied with. The panel of experts will recommend remedial action if it determines any noncompliance with these guidelines.

5. International Advisory Group

142. An international advisory group (IAG) was appointed by the president of the World Bank in 1997 to provide independent review of and guidance on the overall aspects of the Project, including environmental and social issues. Among other duties, the IAG will provide reports to the president and board of executive directors of the World Bank concerning the preparation and implementation of the Project. The IAG made its first visit to the Lao PDR for

Nam Theun 2 in May–June 1997 with subsequent visits in 1998, 2001, and 2004. A member of the IAG also visited the Lao PDR in 2003.

6. Institutional Capacity

143. A high level of responsibility has been vested with the various government organizations and special units outlined above. The EMP, SDP, and SEMFOP therefore incorporate measures (including financing) to support and strengthen these organizations. Emphasis will be placed on training and skill development in core environmental, natural resource protection, social, ethnic minority, and community participation disciplines as well as development and training of relevant government officials in management skills, finance and accounting, English language, monitoring, data collection and analysis, and management information systems. Capacity building under this Project will have medium- and long-term benefits for environmental management and resettlement procedures in the Government generally. A detailed capacity-building program has been prepared and its implementation initiated as a result of an institutional capacity assessment supported by ADB.

C. Financing

144. NTPC has agreed to comply with, implement alone or jointly with another party, and bear the cost of the environmental and social commitments laid out in the concession agreement. NTPC is therefore responsible for covering the cost of all mitigation and management measures, including the financing of government agencies established for the purpose of the Project. NTPC has committed to provide about $89 million for the implementation of environmental and social mitigation and management measures. This does not include the further $60 million that NTPC has committed in order to include the regulating dam, the downstream channel, and the aeration weir into the project infrastructure to prevent extensive resettlement and environmental impacts. A budget breakdown for construction and operation is summarized in Table 15 below. NTPC has to provide letters of credit to the Government as security should, for example, the panel of experts deem that NTPC has failed to comply with the environmental and social commitments, and to mitigate or compensate for any unforeseen project impacts.

Table 15: Summary of Environmental and Social Budget Commitments[a]

	Budget Commitment (million $)[b]		
	Construction and Commissioning (up to about 2010)[c]	**Commercial Operation**	**Total[b&c]**
Social Measures Includes resettlement and compensation measures, livelihood programs, and institutional capacity building on Nakai plateau, project lands, and Xe Bang Fai	35.5	18.2[d]	53.7
Environmental Measures Includes fish studies, water quality monitoring, wildlife programs, public education, and institutional strengthening	2.9	0.9[e]	3.8
Watershed Management (SEMFOP)	6.5	25	31.5
Total	**44.9**	**44.1[d&e]**	**89.0[c&d]**

Source: Environmental Assessment and Management Plan, November 2004; Social and Environment Management Framework and First Operation Plan, October 2004.

[a] The budget presented reflects an increase of approximately $54.8 million from the budget presented in the 2002 concession agreement. Additional social measures for Nakai plateau and Xe Bang Fai have been added.

[b] Figures have been rounded for ease of reference and therefore do not sum exactly in the total column.

[c] This budget excludes (i) construction of regulating dam, downstream channel, and aeration weir to mitigate environmental and social impacts of using the Nam Kathang (approximately $60 million); and (ii) Nam Theun 2 Power Company Limited environmental and social staff costs (approximately $6 million–8 million).

[d] An amount of $7.5 million is to be provided over the 25-year concession period toward a social and environment remediation fund.

[e] Differential Construction Cost of the HC for implementing environmental activities ($55.5 million) is not included.

D. Monitoring

145. Monitoring will determine whether the mitigation measures undertaken by NTPC and other agencies responsible for implementation of activities are respecting the agreements reached by all parties. Monitoring will be carried out both internally and externally in accordance with Schedule 4 of the concession agreement.

146. For environmental impacts, external monitoring will be undertaken during construction and operation periods. NTPC and the HCC will have an internal monitoring system. The HC will adopt an International Organization for Standardization 14001 quality management plan for monitoring construction activities and associated environmental mitigation measures. In addition, internal monitoring will be managed and implemented by EMO, which will regularly review the status of project impacts and make recommendations to NTPC to rectify any failure in meeting its environmental obligations. EMO will also report regularly to EMU. EMU will monitor the performance of the HCC and NTPC. It will make recommendations to the Government on any steps needed to rectify problems. Furthermore, the Government, in consultation with NTPC, will engage an independent monitoring agency (funded by NTPC) to externally monitor and evaluate the environmental measures implemented. This will be done on an annual basis and at other times as required by the Government. The agency will report its findings to the Government and NTPC. The NNT-NPA will be managed by WMPA and monitored by EMU and the panel of experts.

147. For social impacts, internal monitoring by NTPC (resettlement organization) will focus on the physical progress of resettlement plan implementation on the Nakai plateau, downstream Xe Bang Fai and Nam Theun, and project lands, against the schedule in the SDP. The resettlement

organization will be responsible for monitoring the construction of infrastructure associated with resettlement and will report quarterly to the RMU and the resettlement committee. A set of indicators will be developed for affected households and villages including income levels, sources of income, food sufficiency, basic health and education conditions, and women's status. The well-being of ethnic minority groups on the Nakai plateau and in the Xe Bang Fai and Nam Theun areas will be closely monitored. Such external monitoring will be carried out for the duration of SDP implementation. External monitoring on behalf of all lenders and guarantors will be carried out by the Lenders Technical Advisors for both social and environmental mitigation activities.

148. To ensure that the basic rights of project-affected peoples are protected, concerns are adequately addressed, and entitlements are delivered, a grievance procedure will be implemented. A senior provincial official will head a project grievance committee, which will also include members from the Justice Department, Lao Women's Union, Ethnic Council, and resettlement committee. If an affected person is not satisfied with the compensation package or if, for any reason, the compensation does not materialize according to the agreed schedule, he or she has the right to make a claim to the project grievance committee, which has the capacity to deal with such complaints.

E. Adaptive Management

149. NTPC recognizes that changes may need to be made to the methods used to address and implement the impact management and monitoring objectives determined for the Project. An adaptive management approach will therefore be adopted for environmental and social management components. Generally, adaptive management involves the monitoring and evaluation of actual performance of a particular management program or activity and responds to that evaluation with appropriate changes. This is an iterative process, repeated for as long as it takes for an environmental or social system to stabilize after an impact. Adaptive management will be applied to all project-impact areas and for all project impacts. Examples of major applications of the adaptive management approach include the riparian release from the Nakai dam into the Nam Theun, the management of wildlife populations on the Nakai plateau, and the establishment of the pilot village on the plateau. Lessons learned from the pilot village have already been integrated into the resettlement, compensation, and rehabilitation approach laid out in the SDP.

X. PUBLIC CONSULTATION AND DISCLOSURE

A. Overview

150. The public consultation and disclosure process has been guided by the requirements of ADB, AFD, World Bank, and the Government. Its overriding goals have been to ensure transparency in decision making and to provide for stakeholder involvement in selecting resettlement sites, designing the Project, and determining appropriate remedial measures for affected people and communities. More specifically, the objectives are to:

(i) ensure stakeholder concerns are incorporated in project design and planning;
(ii) increase public awareness and understanding of the Project; and
(iii) enhance positive development initiatives through the direct involvement of affected people.

B. Public Consultation activities

151. Stakeholder consultation activities for this Project began in 1995 and by October 2004 there had been almost 400 public consultation and participation meetings and briefings. This Project was the first time that a large-scale public consultation process had been undertaken in the Lao PDR and substantial capacity and understanding of stakeholder involvement in decision making has been built and strengthened as a result.

152. Since early 2004, independent consultation experts were engaged to assist the Government of Lao PDR and NTPC in undertaking a new round of the local consultation process. In this process, the risks and mitigation plans outlined in the draft documents have since been discussed with a wide group of stakeholders through a series of local consultations with Project affected communities in the major impact zones: Nakai Plateau, downstream Xe Bang Fai, downstream of the dam, and NNT-NPA. Information on the compensation and resettlement plans was presented by facilitators through the appropriate medium the various stakeholders could understand including radio broadcasts in minority languages, visual materials together with verbal explanation, site visits to proposed and pilot resettlement areas, and open discussions and feedback proposals, concerns and preferences. The latest round of consultations has included all households and given women a greater voice, improved the district level understanding about ethnic minorities and capacity and attitude towards participatory processes, increased the villagers' technical knowledge of the mitigation measures and has resulted in some design changes. The EAMP, SDP, and SEMFOP have been revised following consultations at local, national, regional, and international levels in 2004. Regional and international public meetings were held in Vientiane, Bangkok, Tokyo, Paris, and Washington D.C. in August–September 2004, and the draft results of the EAMP, SDP, and SEMFOP were discussed by a range of interested parties including funding agencies, international nongovernment organizations, and other stakeholders. A summary of the concerns and issues raised during the international stakeholder workshops and related responses is presented in EAMP and SDP. Full records of consultation meetings are available in moderators' reports.

153. The public consultation and disclosure program continues to progress in a three-step approach:

(i) **Step 1: Information collection and dissemination.** This step has aimed to raise awareness. First, data were collected on the human and physical characteristics of the current environment in order to predict project impacts. Thereafter, information has been disseminated to stakeholders regarding project features and potential changes to the social and physical environment.

(ii) **Step 2: Eliciting stakeholder concerns.** Comments have been sought from stakeholders in response to information gathered and disseminated during Step 1. Discussions on alternatives and proposed mitigation measures have been encouraged throughout the public consultation and disclosure process. Issues for stakeholders that may previously have been overlooked or are outstanding are given a forum for review. This Step has represented a needs assessment and has provided a basis from which decisions have been made and will continue to be made.

(iii) **Step 3: Active involvement in project design and implementation.** Based on the discussions held in Step 2, stakeholder input has been sought in determining mitigation measures to address project impacts. The process of stakeholder involvement and identification will continue during project implementation. This

process provides for cyclical feedback, so as to improve project design and its proposed implementation based on the views of stakeholders.

154. Techniques used have reflected the diversity of individuals and groups involved. They include:

(i) use of visual representations including pictures, diagrams, and posters;
(ii) face-to-face communication including small group and general village meetings, as well as participatory rural appraisal techniques, especially where levels of literacy are recognized as low;
(iii) the translation into the Lao language of project documents and summaries;
(iv) use of local NTPC project information centers at Vientiane, Thakhek, and Nakai; and
(v) direct contact with stakeholders through electronic or written media, group and individual briefings, radio and television interviews, distribution of detailed project information, organization of symposia and forums, and site visits for international stakeholders.

155. Efforts have been made to remain sensitive to language, gender, and ethnicity issues. While the majority of ethnic groups residing in the project area can speak Lao, language checks are made before discussions, especially for women and the elderly; the consultation team also includes members from local ethnic minorities speaking local languages. The participation of women in the consultation process has received special attention because they tend to be less educated than men or have less exposure to the outside world. The participation of women has been encouraged by, for example, organizing women's only groups; the Lao's Women's Union has played a central role in such local consultations. To ensure that all ethnic groups, including vulnerable minorities, can fully participate in and actively influence project design, separate discussions have been held for different ethnic groups to enable small groups to speak freely. Traditional and local religious leaders have also been engaged to ensure that local beliefs are respected and taken into consideration in project design and mitigation.

C. Public Disclosure

156. Throughout project planning, copies of key reports and draft project environmental and social documents in English and Lao languages have been made available. Information has been, and continues to be disseminated, via the project web site at www.namtheun2.com, including the Study of Alternatives, EAMP, SDP, and SEMFOP (upon which this SESIA is based). The first draft of the EAMP, and its subsequent updates, have for example been disclosed to the public since 1997. The advance draft of the EAMP, SDP, and SEMFOP were made available on the project web site in April 2004 and an advance draft of this SESIA was posted there in July 2004 in preparation for preappraisal consultations.

157. The EAMP, SDP, SEMFOP, and this SESIA are being made available for public review before appraisal by international financial institutions, including ADB, World Bank and project web sites. They are being made available for 120 days before the boards of executive directors of ADB and World Bank begin consideration of the Project for approval. The Government of Lao PDR will have a translation of the revised documents. Disclosure to local affected people will be through an information and outreach program with documentation in Lao being made available and using appropriate tools for illiterate and ethnic minority members of affected communities. After appraisal and board decisions by ADB and the World Bank, any required revisions will be made, after which the final documents will be made available to the various stakeholders. Of

particular importance are the Government and project-affected people who will receive a full Lao translation and partial Lao translations, respectively. The project-affected people will also have the services of an information and outreach program.

D. Project Planning Responses to Stakeholder Concerns

158. Feedback from stakeholders has influenced or been incorporated into project planning and design. For example, the following project design features are attributed to public consultations:

(i) location of the power station to avoid any resettlement;
(ii) inclusion of the downstream channel as an alternative to channeling water down the Nam Kathang and routing the channel to minimize resettlement and social impacts and maximize development potential. As a result of consultations with directly affected people, the channel is designed partly above ground level; helping to minimize width and land requirements. Irrigation outlets from the raised channel will also enhance gravity-fed irrigation opportunities in the Gnommalat area;
(iii) construction of the regulating pond to minimize fluctuations in daily discharge into the Xe Bang Fai to minimize erosion;
(iv) bank protection at the confluence of the downstream channel and the Xe Bang Fai to reduce erosion;
(v) inclusion of aeration structures to improve water quality in regulating pond and downstream channel;
(vi) guaranteed minimum flow in the downstream channel to help sustain fish populations that may develop;
(vii) commitment to shut down operation before natural over bank flooding in the upper Xe Bang Fai; and
(viii) location and composition of resettlement areas, house designs, compensation measures, and village composition and livelihood models to ensure that affected people are appropriately compensated and better off than they were before the Project.

159. Feedback received during village consultations and the international stakeholder workshops in 2004 has also been used to improve project design and implementation planning. Village consultations on the Nakai plateau and in the Xe Bang Fai area completed in late December 2004 revealed that the majority of concerns and requests had already been addressed in the SDP. However, several other important issues were also raised that had not previously been included, for example, requests for larger agricultural areas, modifications to house designs, location of gardens, supplying toilets for villages (Xe Bang Fai), and bridges over the Xe Bang Fai and dyke protection (Xe Bang Fai). NTPC is currently investigating the feasibility of these additional requests and they will be considered if they are feasible and in accordance with government and NTPC policy. A summary of how stakeholder views have influenced project planning is given in the EAMP and SDP.

XI. CONCLUSION

160. Generating approximately $1.9 billion in revenues (in nominal terms) for the Government over the 25-year concession period, the Project is considered to be an essential element of the Lao PDR's development framework to reduce poverty.

161. The EAMP and SDP conclude that the net benefits of the Project justify the impacts and their corresponding economic value. The safeguard documents acknowledge that the Project is expected to have significant, and in some cases irreversible, adverse environmental and social impacts including loss of biological diversity, inundation of the Nakai plateau, changed hydrological regime in several rivers, riverbank erosion, resettlement, changed livelihoods, and health implications. These adverse impacts have, however, been reduced to the extent possible through project design, and extensive participation of project-affected people in the development of resettlement and compensation plans. The extent of these adverse impacts will be further managed and mitigated through implementation of the EMP, SDP, and SEMFOP and other related programs.

162. Not withstanding these negative impacts on the environment and on people, the Project is however expected to bring benefits, including dedicated protection of the globally significant biodiversity in the NNT NPA; improved access to markets, education, and health care for the populations of the Nakai plateau and NNT NPA; and significantly increased dry-season irrigation potential in the area surrounding the downstream channel and Xe Bang Fai. The overall aim of the Project's social mitigation strategy is to ensure that all affected persons are better off than before the Project. Long-term and potentially nationwide indirect benefits are anticipated as a result of enhanced capacity and skills that the Project will develop as a result of its capacity-building programs and direct employment of staff.

163. NTPC is committed to ensuring that adverse impacts are minimized, direct project benefits maximized, and all relevant funding agency and government safeguards fully applied. It is also committed to enhancing national and international best practice in hydropower development, impact prevention, mitigation, and management, upon which future projects in the Lao PDR and worldwide can draw. There is a risk that the environmental and social mitigation measures designed under the project may not yield desired results due to uncertainties associated with potential impacts. Therefore, the project proponents have developed flexible plans, for providing adjustments where needed. The Project proponents are developing internal and external monitoring mechanisms to ensure effective implementation of the Project.

ENVIRONMENTAL AND SOCIAL MITIGATION MEASURES AND MANAGEMENT PLANS DURING CONSTRUCTION AND OPERATION

Construction Management and Mitigation Plans	Mitigation Programs during Construction and Operation	Mitigation Programs during Operation
(i) Erosion and Sediment Control Plan	(i) Control of Synthetic Chemical Use for Pest Management	(i) Control of riparian release into Nam Theun
(ii) Spoil Disposal Planning and Management Plan	(ii) Water Quality Management and Monitoring Program	(ii) Management of the reservoir and associated fish populations
(iii) Quarry Management Plan	(iii) Resettlement Action Plan and Ethnic Minorities Development Plan for the Nakai plateau	(iii) Aeration of water downstream of power station in downstream channel and Nam Kathang
(iv) Water Quality Monitoring Plan	(iv) Resettlement Action Plan and Ethnic Minorities Development Plan for Xe Bang Fai and downstream Nam Theun	(iv) Protecting downstream channel fisheries
(v) Chemical Waste/Spillage Management Plan	(v) Project Lands Resettlement Action Plan	(v) Prevention of Increased Flooding at Mahaxai on Xe Bang Fai
(vi) Emergency Plan for Hazardous Materials	(vi) Social and Environment Management Framework and First Operational Plan (SEMFOP)	(vi) Monitoring and control of scouring and erosion of river channel in Xe Bang Fai
(vii) Emissions and Dust Control Plan	(vii) Public Health Action Plan	(vii) Protection of downstream channel
(viii) Noise Control Plan	(viii) Human Trafficking and Safe Migration Awareness Program	(viii) Wildlife Management and Protection Program
(ix) Physical cultural resources		(ix) Management of endangered and threatened species
(x) Landscaping and Revegetation Plan		(x) Control and enforcement of access and hunting
(xi) Vegetation Clearing Plan		(xi) Public education concerning environmental issues
(xii) Waste Management Plan		(xii) Plantation forestry program on Nakai plateau
(xiii) Reservoir Impoundment Management Plan		(xiii) Restrictions to unsustainable forms of shifting cultivation
(xiv) Environmental Training for Construction Workers Plan		(xiv) Funding support for implementing agencies
(xv) On-site Traffic and Access Management Plan		
(xvi) Explosive Ordnance Survey and Disposal Plan		
(xvii) Construction Work Camps		
(xviii) Manual of Best Practice in Site Management of Environmental Matters		
(xix) Project Staff Health Plan		

Sources: Environmental Assessment and Management Plan, November 2004; Social Development Plan, November 2004.

MOST THREATENED WILDLIFE SPECIES RECORDED IN THE NAKA NAM THEUN NATIONAL PROTECTED AREA

Scientific Name	Common Name	Global Threat Status		At Risk in Lao PDR
		Critically Endangered	Endangered	
Amblonyx cinereus	Oriental small-clawed otter			√
Arctictis binturong	Binturong			√
Bos gaurus	Gaur			√
Bos javanicus	Banteng		√	√
Cuon alpinus	Dhole			√
Elephas maximus	Asian elephant		√	√
Felis chaus	Jungle cat			√
Lutrogale perspicillata	Smooth-coated otter			√
Manis javanica	Sunda pangolin			√
Manis pentadactyla	Chinese pangolin			√
Miniopterus schreibersii	Common bent-winged bat			√
Neofelis nebulosa	Clouded leopard			√
Panthera pardus	Leopard			√
Panthera tigris	Tiger		√	√
Pseudoryx nghetinhensis	Soala		√	√
Pygathrix nemaeus	Douc langur		√	√
Rhinoceros sondaicus/ Dicerorhinus sumatraensis	Rhinoceros	√		
Ursus malayanus	Sun bear			√
Ursus thibetanus	Asiatic black bear			√
Aceros nipalensis	Rufous-necked hornbill			√
Aceros undulates	Wreathed hornbill			√
Anser anser	Graylag goose			√
Buceros bicornis	Great hornbill			√
Cairina scutulata	White-winged duck		√	√
Ciconia nigra	Black stork			√
Ducula aenea	Green imperial pigeon			√
Ichthyophaga humilis	Lesser fish eagle			√
Ichthyophaga ichthyaetus	Gray-headed fish eagle			√
Milvus migrans	Black kite			√
Pavo muticus	Green peafowl			√
Rheinardia ocellata	Crested argus			√
Vanellus duvaucelii	River lapwing			√
Cuora galbinifrons	Indochinese box turtle	√		√
Cuora trifasciata	Chinese three-striped box turtle	√		
Indotestudo elongata	Elongated tortoise		√	√
Manouria impressa	Impressed tortoise			√
Platysternon megacephalum	Big-headed turtle		√	√
Pyxidea mouhotii	Keeled box turtle		√	√
Sacalia quadriocellata	Four-eyed turtle		√	

Note: Species falling into International Union for the Conservation of Nature and Natural Resources (IUCN) categories "Vulnerable" or "Near Threatened" are not marked or included in this summary table. Details of these and other species of national conservation significance are listed and discussed in the Environmental Assessment and Management Plan.

Sources: Global Threat Status is recorded in IUCN 2003 Red List of Threatened Animals. National status follows *Duckworth et al. 1999.*

LEGAL ENTITLEMENTS FOR AFFECTED PEOPLE ON THE NAKAI PLATEAU

1. Project-affected people on the Nakai plateau are entitled to the following entitlements according to Schedule 4, Part 1 of the concession agreement of Nam Theun 2 Power Company (Concession agreement will be revised to reflect the final SDP.)

(i) Housing
- (a) The labor and transportation cost associated with the dismantling of existing house and constructing new one
- (b) Provision of new materials for construction of new house
- (c) Electrical wiring and basic fixtures
- (d) Minimum housing area not less than existing area or 42 square meters (m^2), whichever is the greater
- (e) Households of seven or more persons containing two families have the option to have two houses
- (f) Sheds, other outbuildings, and fencing will be provided to the household

(ii) House/Farm Land
- (a) 0.5 hectares (ha) per household
- (b) Up to 0.15 ha of riceland per household in off-village location, to be developed/allocated on a community basis. In the event less land is available, other livelihood options will provide replacement
- (c) Land provided with survey, and joint title to husband and wife
- (d) House to be constructed in location acceptable to owner

(iii) Infrastructure
- (a) Irrigation water to the house/farm lot boundary and distribution system
- (b) Irrigation to rice lands
- (c) Year-round household water supply
- (d) Electricity to the house
- (e) Road access to house/farm lot
- (f) School access within 3 kilometers (km)
- (g) Clinic access within 5 km

(iv) Services
- (a) Transportation of all household assets to new location
- (b) Health check of all household members prior to and after move
- (c) Access to the resettlement management unit (RMU) for advice
- (d) Access to grievance procedures for complaints

(v) Cash
- (a) One-time allowance to cover moving time, disturbance of $15/person
- (b) Compensation for fruit trees lost at district prevailing market prices in case no acceptable replacement trees provided, compensation for standing crops at market prices

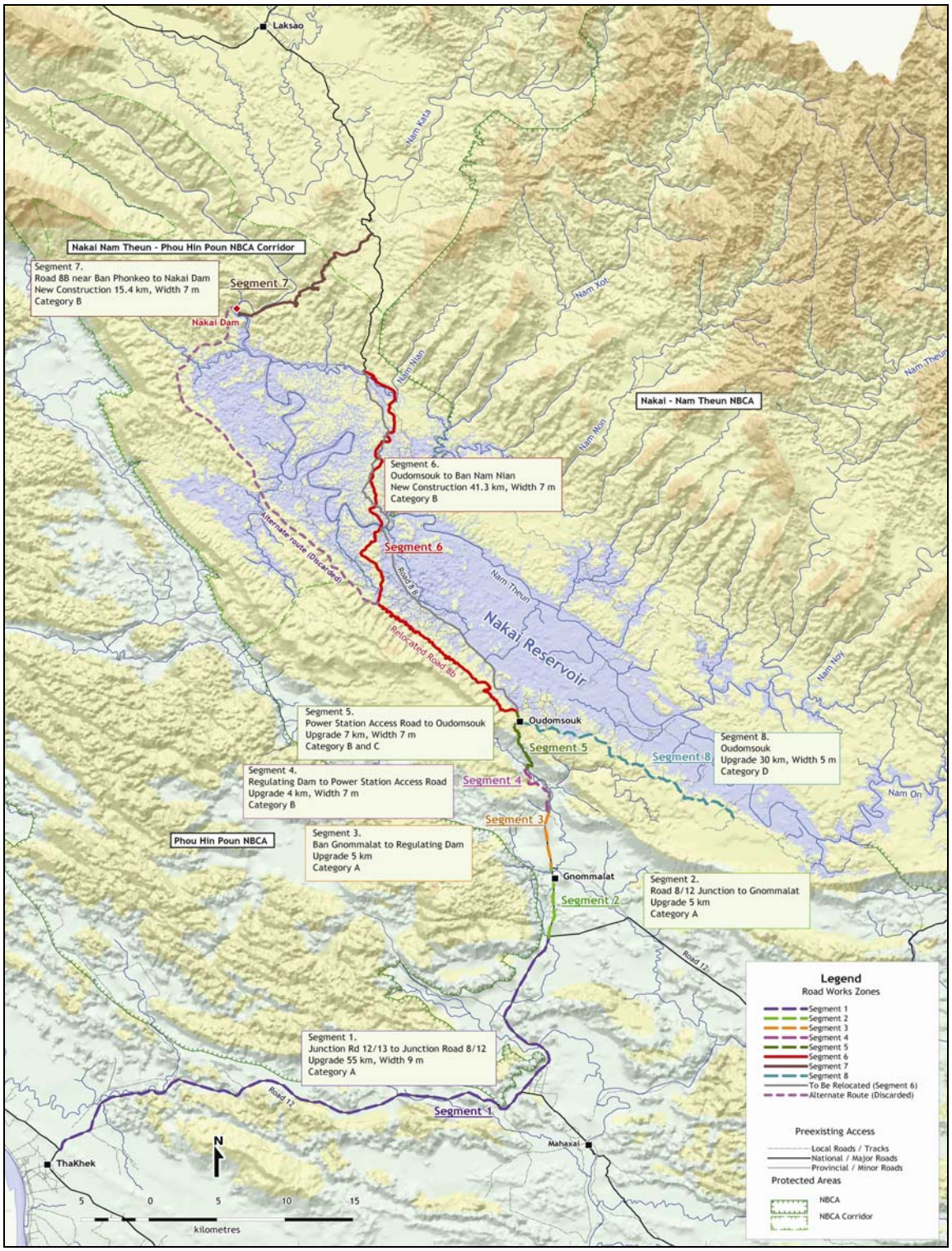
(vi) Production Assistance
- (a) Effective access to a range of feasible production and income generation options to meet predetermined household income target, including production forest and reservoir fisheries
- (b) Tools to work the farm and forest land

(c) Planting materials for 3 years after preparation of farm lot, including fruit tree saplings
(d) Fertilizer and other agro-chemicals for 3 years after preparation of farm lot
(e) Training in farming, forest management, and fisheries techniques
(f) Agricultural advice for 5 years after preparation of farm lot
(g) Access to identified forests for collection of nontimber forest producst
(h) Access to identified reservoir drawdown areas
(i) Skills training for wage labor jobs
(j) Household budgeting training
(k) Income support program during implementation period at 440 kilograms (kg) of rice per person
(l) Households with economically inactive members and other vulnerable households to participate in the production benefits from communal forests through provision of a basic needs allowance as determined by the village

(vii) Departees: Those wishing to permanently leave the district and not move to a resettlement site will receive a one-time payment for the value of land, trees, production, and structures lost, plus transportation and disturbance allowances.

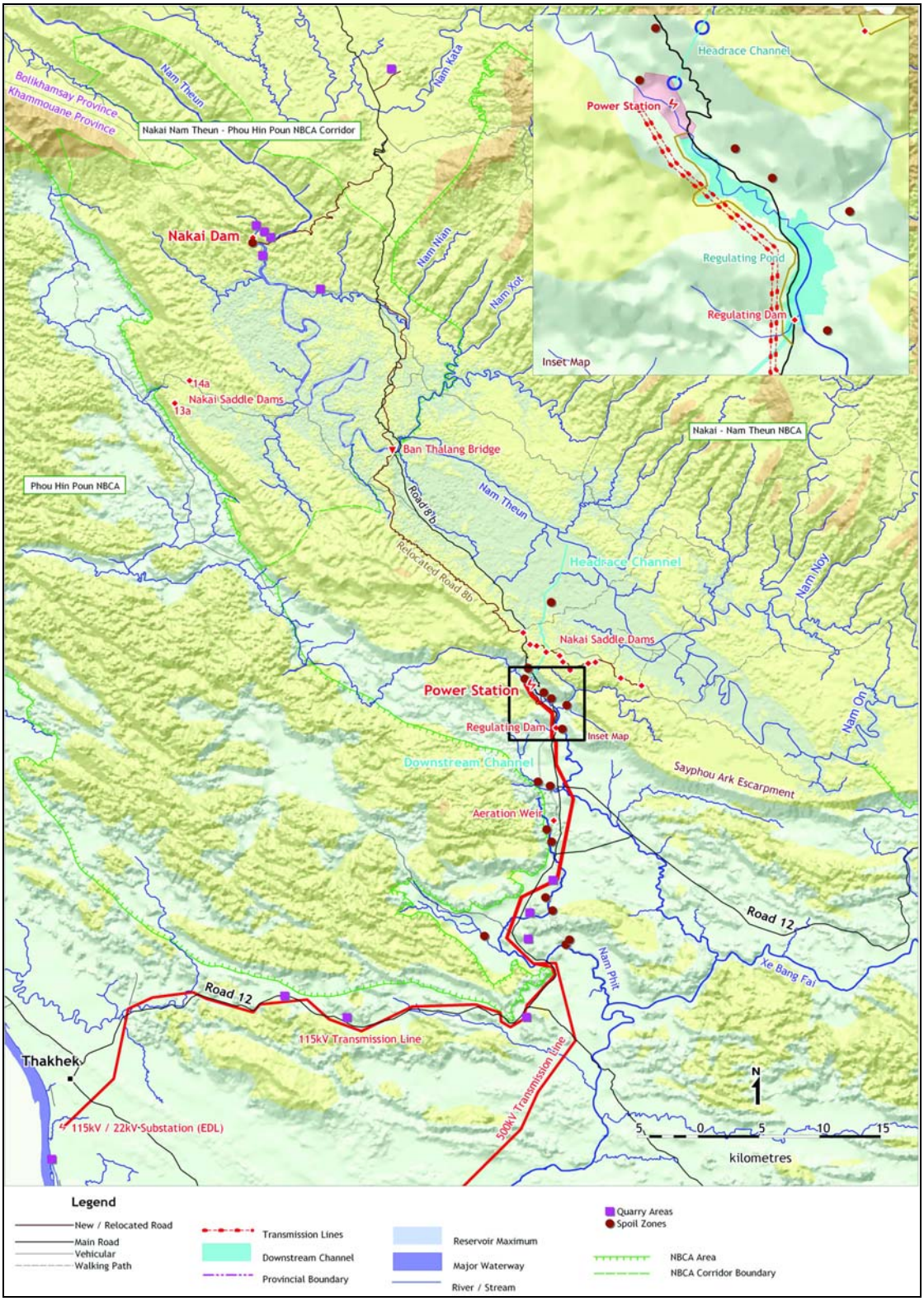
MAPS OF CONSTRUCTION WORKS AND ASSOCIATED SITES

Figure A4.1: Road Construction and Improvements



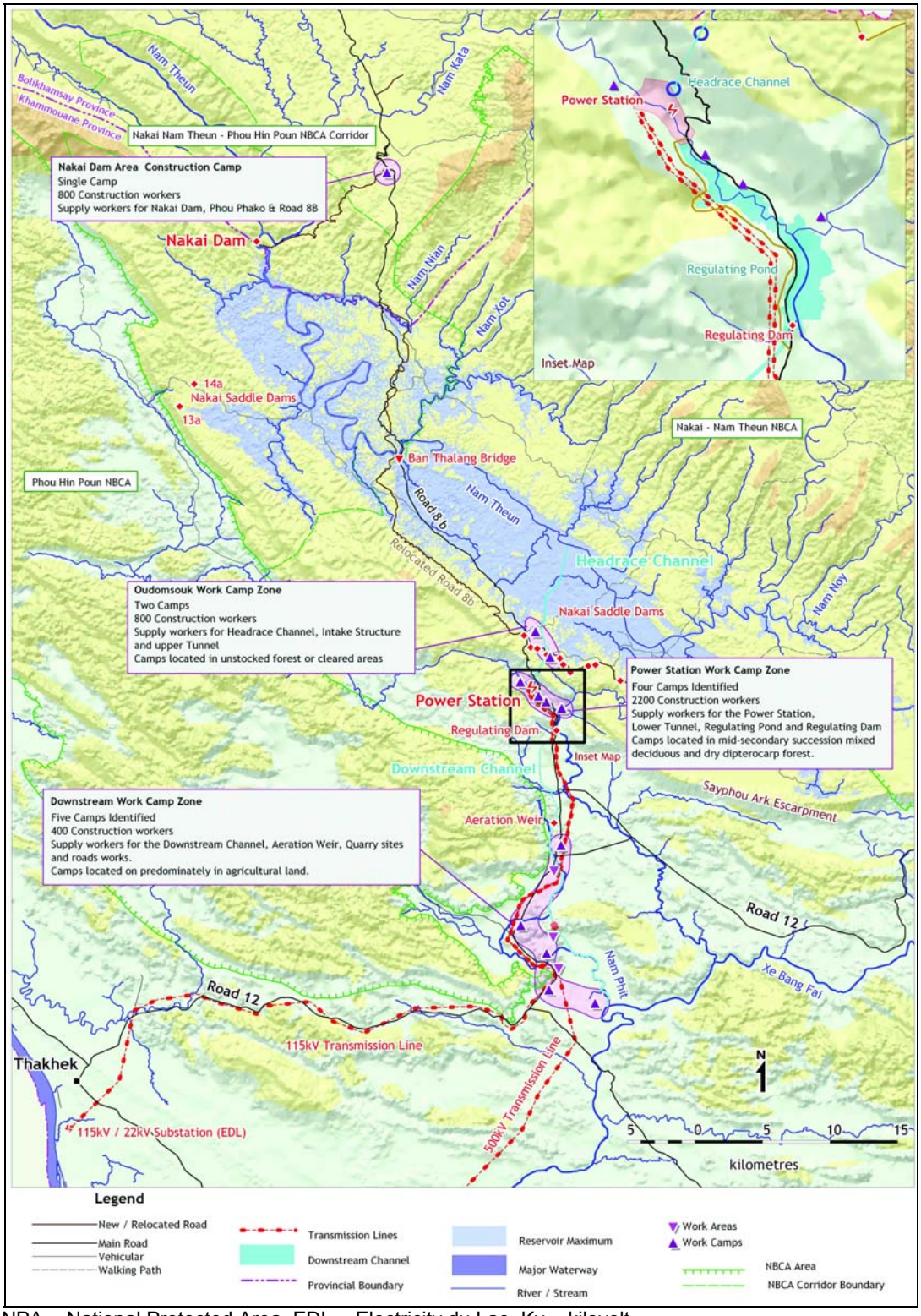
NPA = National Protected Area
Boundaries are not necessarily authoritative
Source: Environmental Assessment and Management Plan, November 2004.

Figure A4.2: Location of Quarries and Spoil Disposal Areas



NPA = National Protected Area
Boundaries are not necessarily authoritative
Source: Environmental Assessment and Management Plan, November 2004.

Figure A4.3: Location of Construction work camps and work areas



NPA = National Protected Area, EDL = Electricity du Lao, Kv = kilovolt
Boundaries are not necessarily authoritative
Source: Environmental Assessment and Management Plan, November 2004.

ASSUMED SECTOR DEVELOPMENTS USED IN THE CUMULATIVE IMPACT ASSESSMENT

1. Sector developments are based on an analysis of existing development trends and plans with an emphasis on aspects that may combine with impacts caused by the Nam Theun 2 Project.

2. **Hydropower** is the most planned sector with long-tem development plans for the region. Hydropower development in Yunnan province, People's Republic of China (PRC), is likely to have the greatest impact on hydrology in the Mekong basin with a potential installed capacity of 15,600 megawatts (MW) and active storage of 23,200 million cubic meters (m^3) by 2025. A number of projects are planned in the Lao People's Democratic Republic (Lao PDR), of which Nam Theun 2 is the largest. The most important parameter for the downstream flow changes is active (seasonal) storage which results in increased dry-season flow and decreased wet-season flow. No significant hydropower development is planned for Thailand. It is unlikely that Cambodia will develop larger projects in the Mekong basin in the next 20 years and only a few projects are planned on tributaries in Viet Nam. The predicted development is shown in Table A6 together with predicted active storage volume. Nam Theun 2 is expected to account for 12% of active storage capacity in the Mekong basin in 2010 and for 7% in 2025.

Table A6: Existing and Predicted Active Storage Volume in the Mekong Basin
(million m^3)

Year	PRC	Lao PDR	Thailand	Cambodia	Viet Nam	Total	NT2-portion (%)
2004	257	5,194	4,606	—	779	10,836	
2010	10,524	12,949	4,606	—	789	28,868	12
2025	23,193	22,608	4,606	—	3,480	53,887	7

— = not available, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Environmental Assessment and Management Plan, November 2004.

3. **Transport** is a dynamic growth sector in the region. Considerable funds are being channeled into this sector with the goal of linking all major towns in the country. There are plans for several important transportation corridors linking the Lao PDR to Thailand and Viet Nam, including the East-West Corridor (Road No. 9) with a bridge at Savannakhet, Road No. 8 in Bolikhamxai to the Vietnamese border, and Road 12 in Khammouane. Many of these roads link up with roads to be upgraded by the Nam Theun 2 Project.

4. **Irrigation** by far the largest and most intensively cultivated irrigated dry-season rice areas are found in the Mekong delta. By 2000, these double-cropped areas constituted around 87% of the total area of dry-season irrigated rice in the Mekong basin. The Lao PDR and Cambodia have the largest percentage-wise expansion potential for dry-season irrigated rice (could be doubled). From the local perspective, the Xe Bang Fai basin is the most promising in terms of irrigation potential.

5. **Water Supply and Sanitation**. Estimates for increased water consumption show a need for three times the existing supply by 2025 when up to 80 million people may inhabit the lower Mekong basin (55 million at present). In the Nam Theun 2 project area, several towns have plans to expand or establish water supply and sanitation projects to cope with growing demand.

6. **Urban Development**. Trends in the local context are concerned with population increase due mainly to in-migration from rural areas or from outside the project area to the towns of Thakhek, Mahaxai, and Gnommalat in Khammouane province and Lak Xao in Bolikhamxai province. Along with urbanization come the challenges of town planning, water supply, and sanitation.

7. **Fisheries.** This is a key development sector both locally and in the Mekong region. Future hydropower development and subsequent changes in water flow and quality will affect this sector in the short and long-term. At present in the lower Mekong basin, fish and aquaculture yields are increasing but this may not be sustainable with present methods and technology. The Nakai reservoir is expected to give rise to new fisheries.

8. **Forestry** includes both commercial logging and utilization of forests by local communities for harvesting of nontimber forest products and traditional products. Forest cover in the Mekong basin is dwindling with an estimated total cover of 34.4%, the Lao PDR having approximately 40%, which is likely to decline to 30% given present trends. Commercial logging in the project area has been extensive and there is currently overcapacity in the timber-processing industry. A number of plans deal with reforestation and the establishment of plantations.

9. **Industry** as a sector, industry is concentrated in towns, the most important in the project area being Savannakhet where there are a number of light industries established. Wood processing is presently the most important industry in Bolikhamxai and Khammouane provinces. Establishment of a cement factory at Mahaxai is the most important industrial development planned in the project area. Other potential industries include oil refineries, textiles, canning, and construction materials.

9. **Mining**. The development of the mining sector is part of the economic growth pattern but is also a potential source for local water pollution through waste and processing water discharges. Tin, zinc and lead are being extracted in the Nam Pathen valley on a tributary of the Hinboun and this may be contributing to increased turbidity and heavy metal concentrations in the water. Some gypsum mining in Donghene district and large-scale mining of gold and copper are taking place in Xepon district, Savannakhet province. Further developments in the future may prove to be economically viable.

10. **Social Development** covers a number of subsectors or themes: health, education, ethnic minorities and social disparity. In terms of health and education, the existing services are weak in terms of lack of skills, materials, equipment and funding. The spread of HIV/AIDS and other sexually transmitted diseases is of concern as mobility, urbanization, and immigration increase. There is also a trend toward increased social disparity between households in communities (advantages of human, material, and financial resources lead to advantages in employment opportunities), between rural and urban areas (growing gap in services and wealth), and between men and women (trends favor men). In addition, ethnic minorities are being integrated and assimilated as a result of socioeconomic change, cultural contact, and loss of traditional livelihoods.

11. **Conservation**. Several areas in the project area are classified as having very high biodiversity value for Southeast Asia in particular the Naka Nam Theun national protected area and the Vu Quang National Park in Viet Nam. There have been a number of positive developments in terms of policy, ratification of international agreements and conventions, the establishment of 20 national protected areas in the Lao PDR and the development of

conservation management plans. However, there are clear trends that illegal hunting and trading in wildlife is seriously threatening many endangered species and the biodiversity of many national protected areas as enforcement of regulations is currently weak.