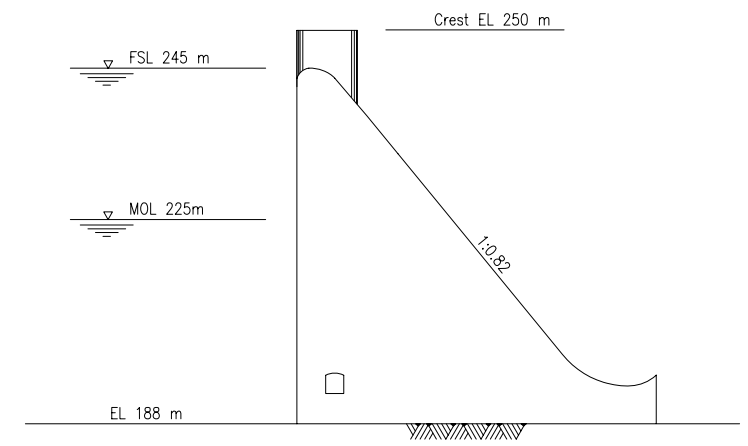
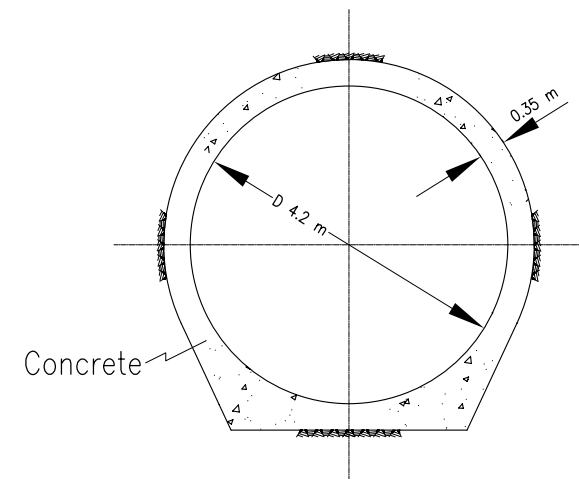
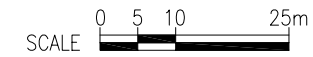


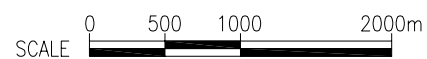
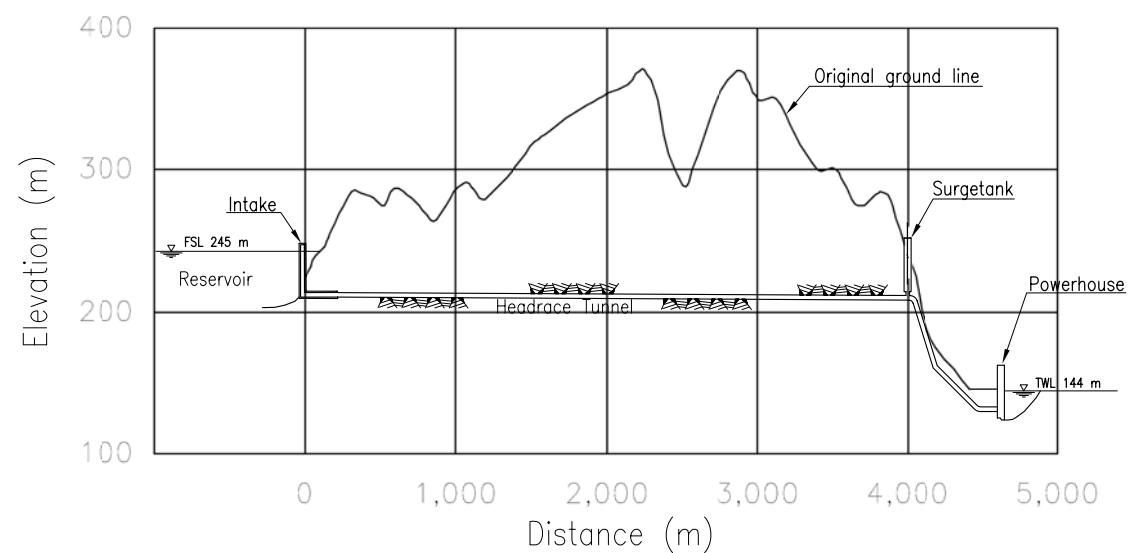
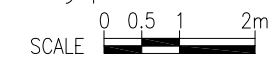
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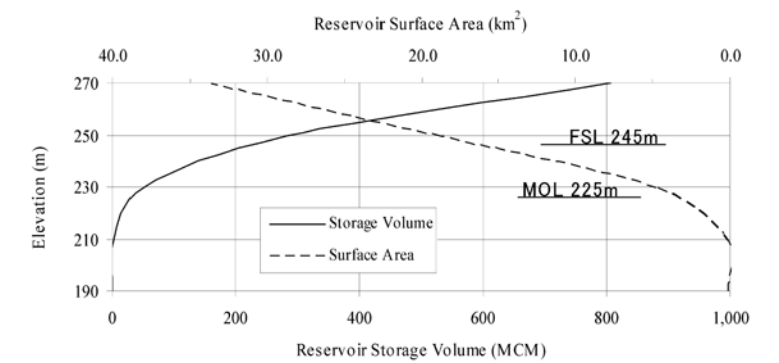
Typical Section of Dam



Typical Section of Headrace Tunnel



Profile

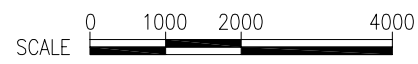
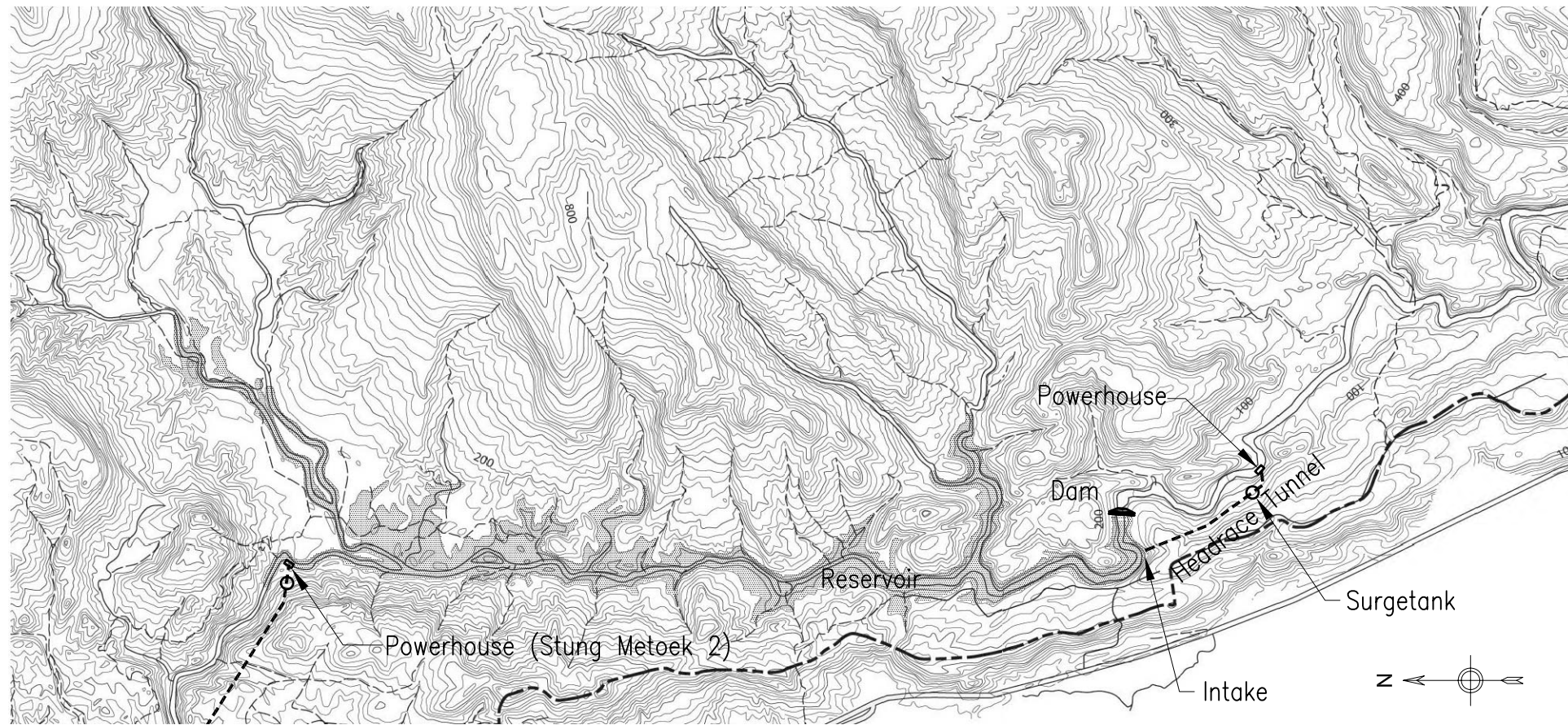


Reservoir Area-Storage Curve

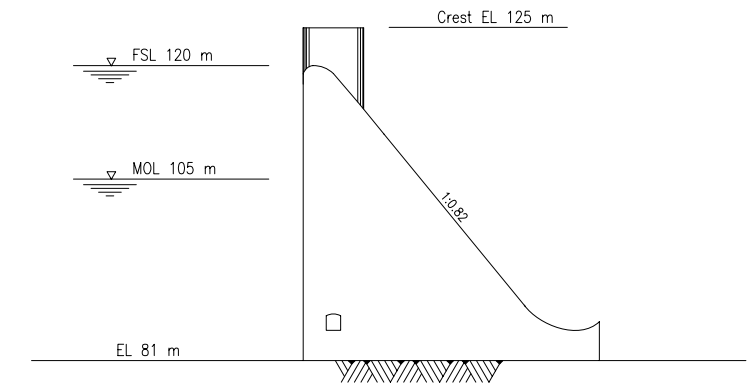
The Master Plan Study of
Hydropower Development in Cambodia

NIPPON KOEI CO., LTD. DWG. NO. A-5

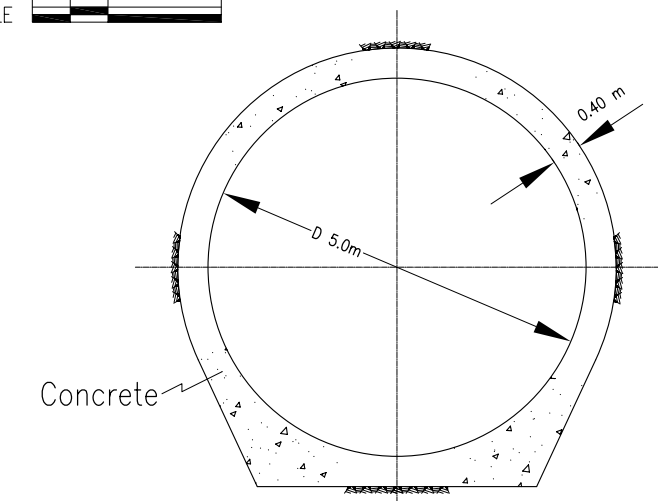
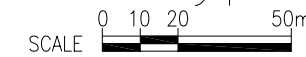
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Upstream Powerhouse Alternative



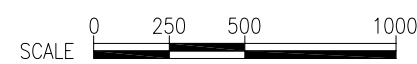
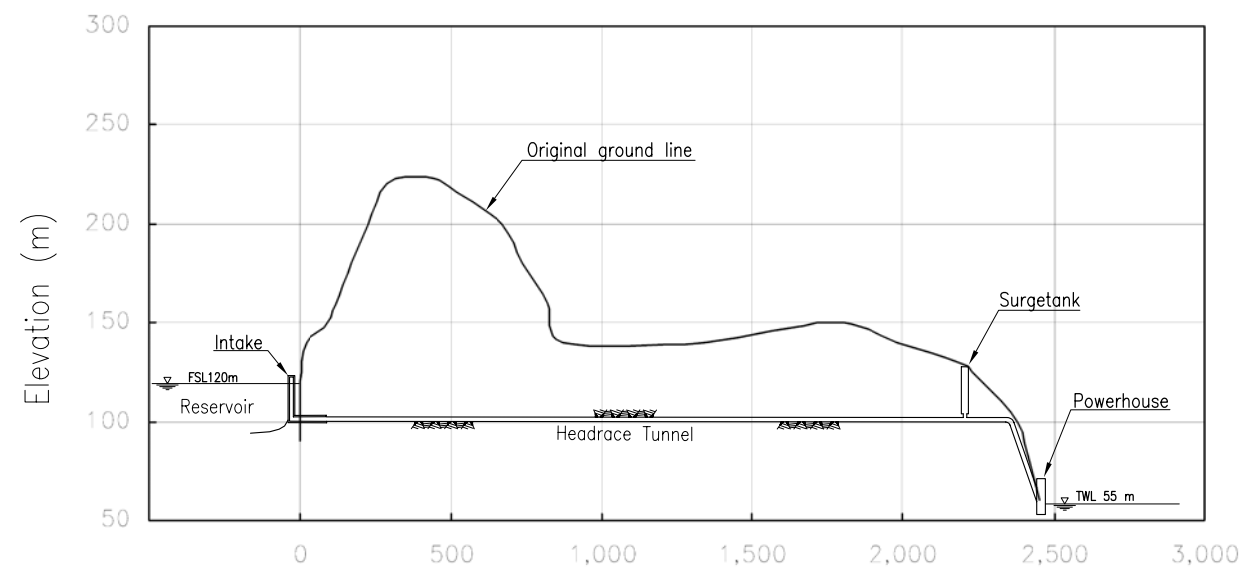
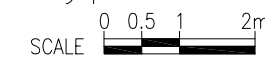
Plan



Typical Section of Dam

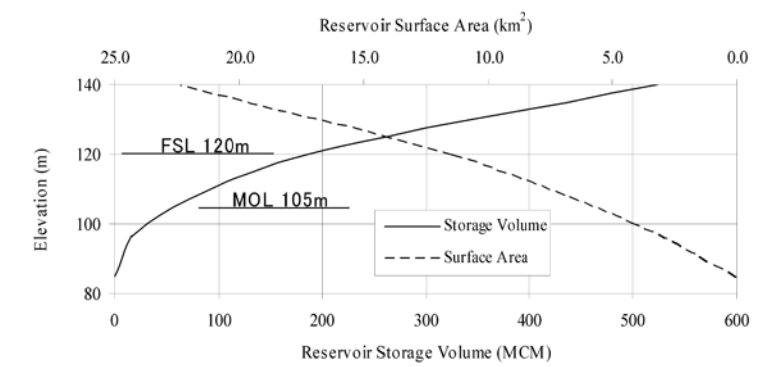


Typical Section of Headrace Tunnel



Distance (m)

Profile



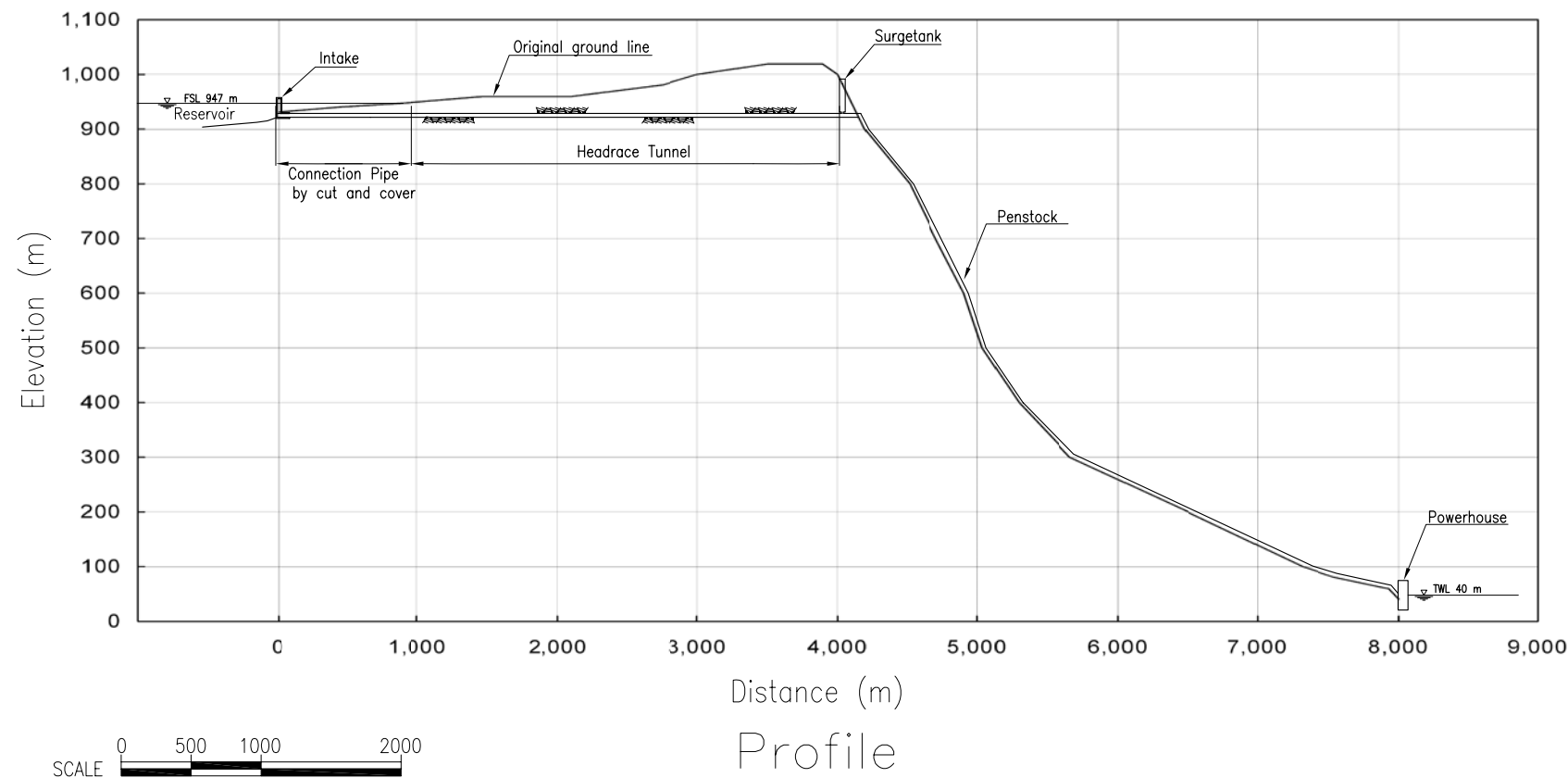
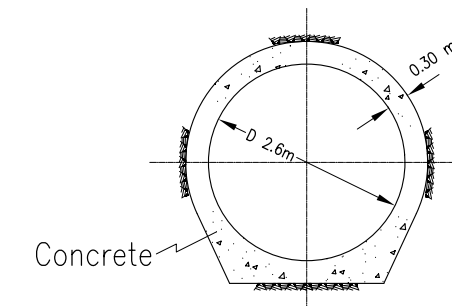
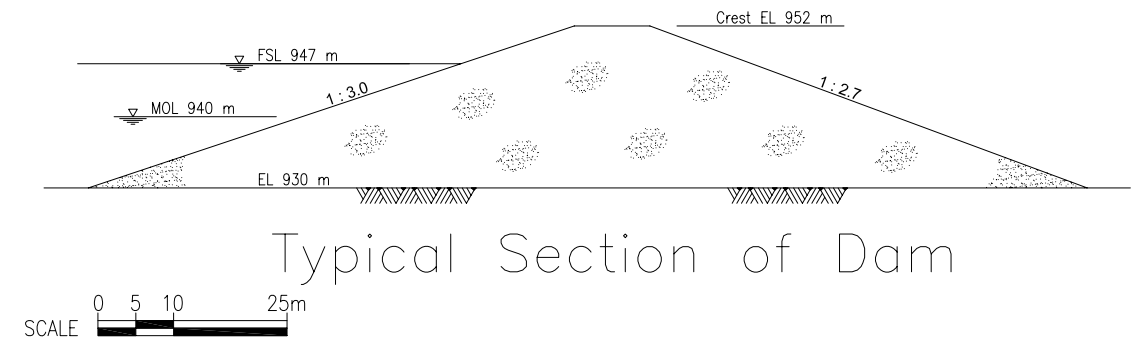
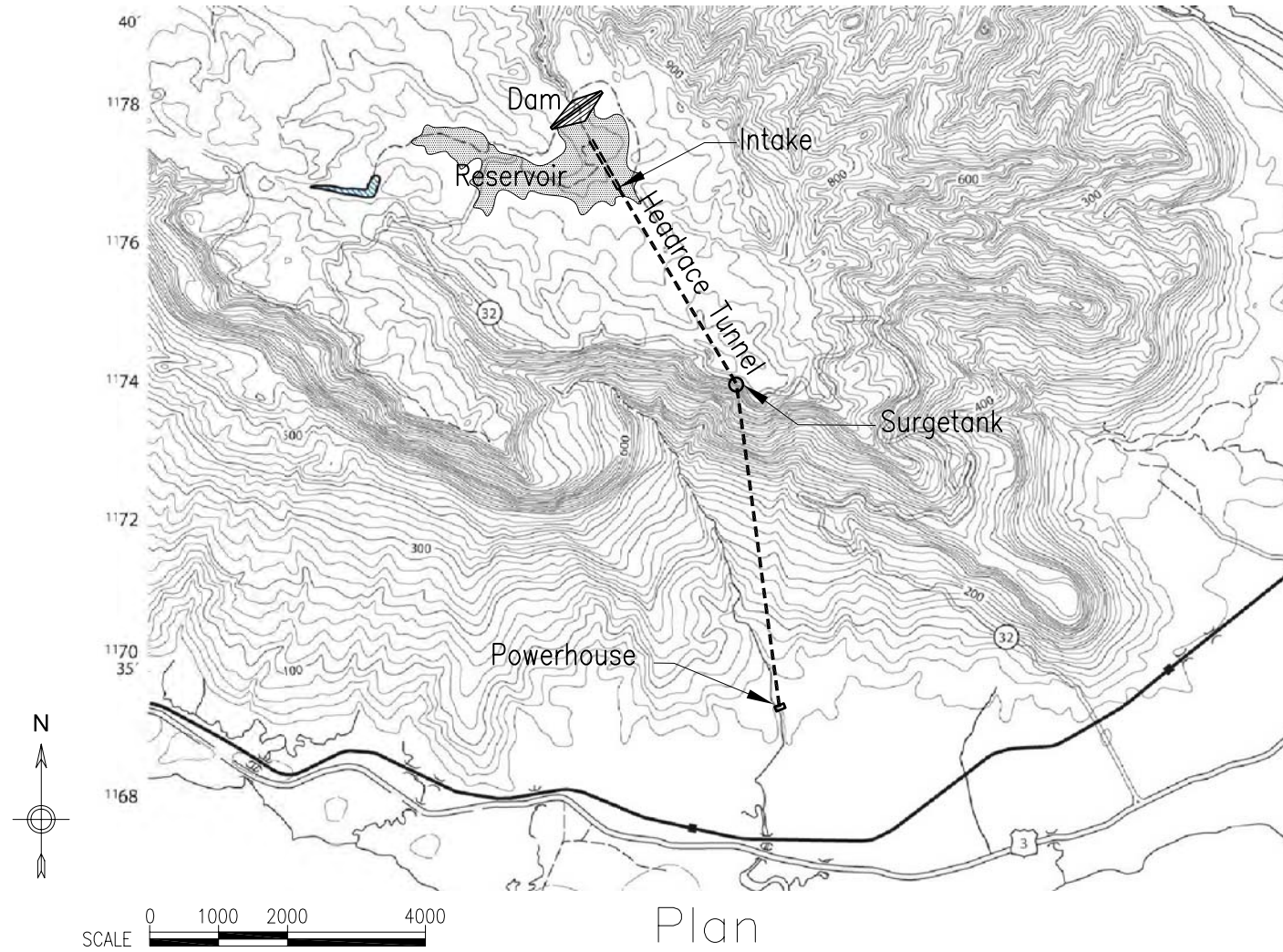
Reservoir Area-Storage Curve

The Master Plan Study of
Hydropower Development in Cambodia

NIPPON KOEI CO., LTD. DWG. NO. A-6

TITLE

Stung Metoek 3 Hydropower Project



The Master Plan Study of Hydropower Development in Cambodia		
NIPPON KOEI CO., LTD.		DWG. NO. A-7
TITLE Bokor Plateau Hydropower Project		

APPENDIX-B RESULTS OF NATURAL ENVIRONMENT SURVEY BY SUBCONTRACTOR

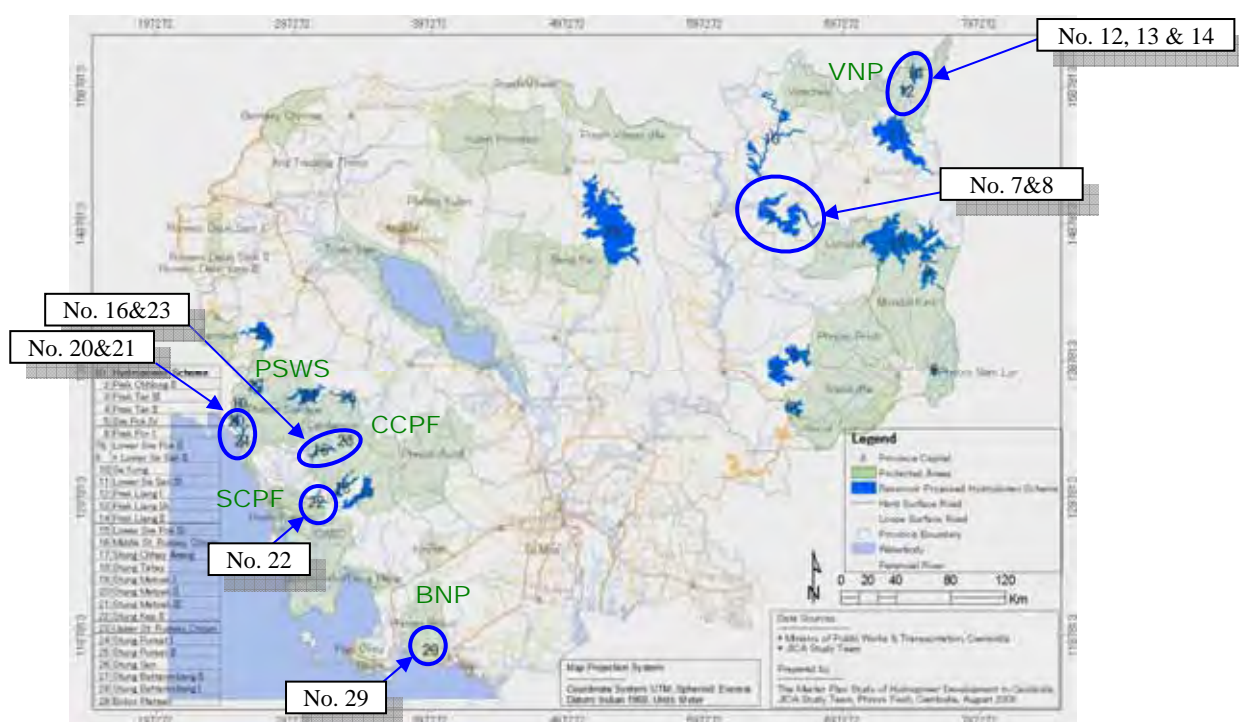
NATURAL ENVIRONMENT

The rapid economic growth of Cambodia in recent years drives a huge demand for electricity. A power sector strategy 1999–2016 was formulated by the government in order to promote the development of renewable resources and reduce the dependency on imported fossil fuel. The government requested technical assistance from Japan to formulate a Master Plan Study of Hydropower Development in Cambodia.

The objective of this paper is to survey the natural and social environment of 10 potential hydropower projects in Cambodia that can be grouped into six sites as listed below. This survey constitutes part of the Master Plan Study of Hydropower Development in Cambodia. The objective of the survey is to gather baseline information on the current conditions of the sites, which will be used as input for a review and prioritisation of the selected project sites.

This report indicate the natural environment of the following projects on 6 basins.

	Original Site No.	Name of Project	Province	Protected Area (Abbreviation)
1	No. 12, 13 & 14	Prek Liang I, IA, II	Ratanak Kiri	Virachey National Park (VNP)
2	No. 7 & 8	Lower Se San II & Lower Sre PokII	Stung Treng	-
3	No. 29	Bokor Plateau	Kampot	Bokor National Park (BNP)
4	No. 22	Stung Kep II	Koh Kong	Southern Cardamom Protected Forest (SCPF)
5	No. 16 & 23	Middle and Upper Stung Russey Chrum	Koh Kong	Central Cardamom Protected Forest (CCPF)
6	No. 20 & 21	Stung Metoek II, III	Pursat & Koh Kong	Phnom Samkos Wildlife Sanctuary (PSWS)



LOCATIONS OF HYDROPOWER PROJECT AND PROTECTED AREA

1. PREK LIANG I, IA, II

1.1 VILLAGES CLOSE TO THE SITES

The hydropower projects Prek Liang I, IA and II are located on the Prek Liang river, which flows into the Ou Ta Bouk river. The latter is a main tributary of the Se San. The selected survey areas focus on one of the two communes of Ta Veng district of Ratanak Kiri province. Three villages of Ta Veng Leu commune were selected for field surveys: Bangket, Ta Bouk and Ta Veng. The majority of the population in these villages are ethnic hill tribes, Brao and Lun (3SPN 2007).

The three villages are located on the Se San River, and the livelihoods of the local people are related to the river. They have experienced the same changes in water flow patterns in the river as the villages in the Lower Se San-Lower Sre Pok area.

1.2 ACCESSIBILITY OF TARGET VILLAGES

There are no village observed in the Prek Liang I, II Sites. The closest communities in the district of Ta Veng is located 53 km north of the Ratanak Kiri provincial capital. Access is via a small clay road in fair condition during the dry months that can be used by cars and small trucks. Access to this district must be worse during the wet months. Ta Veng village is located within the Ta Veng district centre, while Bangket and Ta Bouk are located about 6 km and 12 km north of Ta Veng district, respectively. The 6 km section of road between Bangket and Ta Bouk village crosses the forest area. Motorbikes are used because cars can not drive from the district centre to the two target villages.



Photo 1-1: Road to Ta Veng District, Bangket and Ta Bouk village

1.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

In the three target villages, a water and sanitation programme has been offered to the people by German Agro-Action since 2005. It has included an awareness campaign on sanitation, the construction of hand wells and distribution of water filters. The most extensive projects were conducted by the River Coalition. Its work is similar to that it has done in the Lower Se San-Lower Sre Pok area.

Recently the government approved mineral exploration within Virachey National Park, upstream from the target villages. The three projects are planned to be located in this park. The mineral exploration zone overlaps with the project sites.

1.4 PROTECTED AREA : VIRACHEY NATIONAL PARK (VNP)

1.4.1 History and geography

It is hard to clarify the environmental conditions of the Prek Liang I and II's project sites. Since there is no specific information of the project sites, the general information of the Virachey National Park is stated as the references.

Virachey National Park was created under a royal decree on the creation and designation of protected areas, issued on 1 November 1993, and is managed by the Ministry of the Environment. The park is one of the top priority conservation areas in south-east Asia. Located in Ratanak Kiri and Stung Treng provinces, it covers an area of 3325 sq km and protects flora and fauna of international significance. The

streams from the mountains of the park contribute significantly to the flow of the Mekong. A high percentage of people living around the park are ethnic minorities.

Since 2000, the World Bank has financed a Biodiversity and Protected Area Management Project (BPAMP) within Virachey National Park. The project aims to improve the capabilities of the Ministry of Environment to plan, implement and monitor national protected areas. This includes developing and testing proactive measures to minimise unsustainable exploitation and degradation of biodiversity of national and global significance. There are four components: 1) national policy and capacity building, 2) park protection and management, 3) community development and 4) project management. The extension of this conservation project (2008–12) is expected to be approved soon by the World Bank.

The people living close to the National Park seem to live in harmony with nature. An ethnic minority, they rely on slash and burn agriculture and collection of non-timber forest products. Forest product trading is a minor problem.



Photo 1-2: Ou Chul river in Ta Veng villag (left), forest cover in Bangket (centre) and Ta Bouk villag (right)

Most of the forest is close to the villages. However, forest hunting and gathering occur further away. The main non-timber forest products harvested are rattan, bamboo and malva nuts. Hunting for food and for trade occurs in Virachey National Park, and although a consistent decline in wildlife populations has been observed, reports indicate that tigers, Himalayan black bears, Malayan sun bears, gaurs, sambar deer, muntjac and civet are still being hunted. Turtles, monitor lizards and pangolin are the most commonly traded animals. Rabbits, forest rats and other smaller animals are usually hunted for subsistence closer to the villages.

1.4.2 Flora

Dense semi-evergreen lowland and montane forest, upland savannah, bamboo thickets and occasional patches of mixed deciduous forest predominate in the vegetation of Virachey National Park. Hills and low mountains dominate the topography, with most areas lying higher than 400 m above sea level, and elevations reaching more than 1500 m along the border with Laos and Vietnam. Grassland and shrubland as well as marshes are found in isolated areas.

The literature describes two broad vegetation formations in the park as the following, found in seven landscapes, each with its own predominant vegetation (BPAMP 2005):

- Humid medium elevation formations (above 600 metres) with montane slopes and montane peneplain.
- Humid low elevation formations with middle valley reaches, valley floors, western lowland, isolated granite outcrops and wetlands.

Logging and timber collection are prohibited within the park, and there is no reported timber production. Non-timber products are widely collected by indigenous people to exchange for necessities such as rice, salt and medicine. These products include wild vegetables (more than 60 species), wild fruits (30 species), dry and oil resin (three kinds), honey, rattan and bamboo (BPAMP 2000).

Forest management within the protected area aims at conservation. Patrols are launched from the three ranger stations to prevent or record offences. A tree nursery has been created for future restoration of degraded areas within the park (BPAMP 2007).

1.4.3 Fauna

The first major survey of the forest and biodiversity within Virachey National Park was conducted in 1998 (Ashwell 1998). The latest survey was conducted by Conservation International in 2007, but the

report is not yet available. A previous survey by CI was conducted in June 2006, involving a rapid assessment of mammals, reptiles, amphibians and fish. The biological research focused on selected sites within Ta Veng district in the eastern part of the park, along the Ou Ta Bouk river downstream from the Prek Liang project site. Those areas are well known for biodiversity and are relatively unfragmented and large enough to accommodate viable populations of animals (Emmett 2006).

The surveys indicate that there may be as many as 156 vertebrate species in the park, of which 43 are of international significance. Of these, bovids, cats, small carnivores and primates are threatened. Globally threatened primate species occurring in the park include the slow loris, pygmy loris, pig-tailed macaque, long-tailed macaque, douc langur and yellow-cheeked crested gibbon. Species of particular concern include elephants, tigers, gaurs and bantengs (BPAMP 2007).

(1) MAMMAL

Emmett (2006) used the camera traps to confirm the presence of large and small mammals. Three camera traps were set in suitable places in an attempt to photograph medium-sized and large mammals. The traps were set for five days only. They were baited with fresh pork and “Hawbakera Wildcat Lure no 2” to attract most animals species. The threat to wildlife comes from cross-border hunting and wildlife trade from Vietnam. Table 1-1 shows the list of species from camera trap results.

Table 1-1: List of species from Camera trap results

Common Name	Scientific Name	IUCN Redlist
Elephant	<i>Elephas maximus</i>	EN
Tiger	<i>Panthera tigris</i>	EN
Leopard	<i>Panthera pardus</i>	LR/nt
Clouded leopard	<i>Pardofelis nebulosa</i>	VU
Fishing cat	<i>Prionailurus viverrinus</i>	VU
Marbled cat	<i>Pardofelis marmorata</i>	VU
Leopard cat	<i>Prionailurus bengalensis</i>	LC
Sun bear	<i>Ursus malayanus</i>	DD
Gaur	<i>Bos gaurus</i>	VU
Pig-tailed macaque	<i>Macaca nemestrina</i>	VU
Long-tailed macaque	<i>Macaca fascicularis</i>	LR/nt
Stump-tailed macaque	<i>Macaca arctoides</i>	VU
Sambar deer	<i>Cervus unicolor</i>	LR/nt
Red muntjac	<i>Muntiacus muntjak</i>	LR/nt
Wild pig	<i>Sus scrofa</i>	
East Asian porcupine	<i>Hystrix brachyura</i>	VU
Large Indian civet	<i>Viverra zibetha</i>	LR/nt
Large-spotted civet	<i>Viverra megaspila</i>	VU
Small Indian civet	<i>Viverricula indica</i>	LR/tn
Owston's palm civet	<i>Hemigalus owstoni</i>	LR/nt

EN= Endangered, DD= Data Deficient, LC= Least Concern, LR/nt= Near Threatened VU= Vulnerable
Source: Emmett 2006.

(2) BIRDS

It is estimated that as many as 100 bird species of international significance are present in Virachey National Park. This is one of only two areas in Cambodia known to support Germain's peacock pheasant, a restricted-range species. In addition, the park supports a number of globally threatened and at-risk species, including Siamese sirebacks, red-collared woodpeckers and great hornbills (BPAMP 2005). A number of significant records have been made (Mlicovsky 1999), including three species recorded for the first time in Cambodia: the white-browed piculet (*Sasia ochracea*), Eurasian woodcock (*Scolopax rusticola*) and Japanese paradise-flycatcher (*Terpsiphone atrocaudata*). In the park's aquatic environment, fresh-water crocodiles, otters, fresh-water tortoises and some fish are of conservation significance.

Virachey National Park is one of only two areas in Cambodia known to support Germain's peacock pheasant *Polyplectron germaini*, a restricted-range species. In addition, the park supports a number of globally threatened and near-threatened species, including the Siamese fireback *Lophura diardi*, red-collared woodpecker *Picus rabieri* and great hornbill *Buceros bicornis*. Virachey remains one of the most ornithologically unexplored parts of Cambodia. However, survey work in neighbouring areas of Laos and

Vietnam indicates that higher elevations are likely to be of particular importance for globally threatened species such as the black-hooded laughing thrush *Garrulax milleti* and black-crowned barwing *Actinodura sodangorum* (BirdLife 2007).

Other regionally significant bird species are: the little cormorant, Indian cormorant, grey heron, purple heron, woolly-necked stork, black-necked stork, cotton pygmy-goose, brahmyn kite, white-bellied sea-eagle, great-thick knee, river tern, little tern, orange-breasted green pigeon, green imperial pigeon, alexandrine parakeet, pied kingfisher, streak-throated woodpecker, great slaty woodpecker, yellow crown woodpecker, broad-and-red broadbill and white-bellied woodpecker.

(3) REPTILES AND AMPHIBIANS

The Global Amphibian Assessment in 2004 found 43 species (three endemic) for Cambodia (Emmett 2006). Emmett's 2006 survey use timed diurnal and nocturnal searches and pitfall trapping with straight-line drift fences to collect the sample. Based on preliminary identifications, Emmett recorded at least 23 reptile and 18 amphibian species. Up to three reptile species and four amphibians may be undescribed species, but they have not been included in the total numbers of species unless there is no doubt that they are distinct species. Each species is listed in Table 1-2 below.

Table 1-2: Reptiles and amphibians species found in the 2006 survey

Reptile Common name	Reptiles Scientific name	Amphibians Common name	Amphibians Scientific name
Reticulated python	<i>Python reticulatus</i>	Leaf-litter frog	<i>Leptolalax sp1</i>
Banded krait	<i>Bungarus fasciatus</i>	Leaf-litter frog	<i>Leptolalax sp 2</i>
Plumbeous water snake	<i>Enhydris plumbea</i>	Litter frog	<i>Leptobrachium sp</i>
Red-necked keelback	<i>Rhabdophis subminiatus</i>	Horned frog	<i>Megophrys sp</i>
Common mock viper	<i>Psammodynastes pulverulentus</i>	Toad	<i>Bufo galeatus</i>
Unknown snake	(possibly juvenile water snake)	Striped spadefoot toad	<i>Calluella guttulata</i>
Green cat snake	<i>Bioga cyanea</i>	Striped sticky frog	<i>Kalophrynus interlineatus</i>
Unknown slender-toed gecko	<i>Cyrtodactylus sp</i>	Dark-sided chorus frog	<i>Microhyla heymonsi</i>
Tockay gecko	<i>Gekko gekko</i>	Painted chorus frog	<i>Microhyla pulchra</i>
Horned tree lizard	<i>Acanthosaura nataliae</i>	Kuhl's frog	<i>Limnonectes kuhlii</i>
Unknown horned tree lizard	<i>Acanthosaura sp</i>	Unknown frog	<i>Limnonectes sp 1</i>
Forest crested lizard	<i>Calotes emma</i>	Unknown frog	<i>Limnonectes sp 2</i>
Barred gliding lizard	<i>Draco taeniopterus</i>	Marten's puddle frog	<i>Occidozyga martensii</i>
Indo-Chinese water dragon	<i>Physignathus cocincinus</i>	Chantaburi stream frog	<i>Rana montivaga</i>
Long-tailed lizard	<i>Tachydromus sexlineatus</i>	Dark-sided frog	<i>Rana nigrovittata</i>
Many-lined sun skink	<i>Mabuya multifasciata</i>	Taiwanese frog	<i>Rana taipehensis</i>
Streamside skink	<i>Sphenomorphus maculata</i>	Green-sided frog	<i>Odorrana morafki</i>
Rough-scaled skink	<i>Tropidophorus sp</i>	Common tree frog	<i>Polypedates leucomystax</i>
Bowring's supple skink	<i>Lygosoma bowringii</i>		
Leaf-litter skink	<i>Scincella sp</i>		
Impressed tortoise	<i>Mnouria impressa</i>		
Giant Asian pond turtle	<i>Heosemys grandis</i>		
Asiatic softshell turtle	<i>Amyda cartilaginea</i>		

Source: Emmett, 2006

(4) FISHES

For a fish survey, Emmett (2006) found at least 39 different species were caught in five different places.

Table 1-3: Fish Species Discovered during Emmett's 2006 Survey

Scientific name	Common name	Scientific name	Common name
<i>Osphronemus exodon</i>	Elephant ear gourami	<i>Garra cambodgiensis</i>	
<i>Raiamas guttatus</i>		<i>Pristolepis fasciata</i>	
<i>Xenentodon cancila</i>		<i>Hampala macrolepidota</i>	
<i>Barbodes schwanefeldi</i>	Tinfoil barb	<i>Channa gachua</i>	
<i>Hypsibarbus sp. Cf. vernayi</i>		<i>Balitora cf. annamitica</i>	
<i>Parambassis apogonoides</i>	Iridescent glassy perchlet	<i>Poropuntius laoensis</i>	
<i>Annamia normani</i>		<i>Danio gibber</i>	
<i>Mystus albolineatus</i>		<i>Hypsibarbus vernayi</i>	
<i>Rabora pavi</i>		<i>Schistura obeini</i>	
<i>Poropuntius laoensis</i>		<i>Schistura personata</i>	
<i>Mystus atrifasciatus</i>		<i>Lobocheilos rhabdoura</i>	
<i>Pristolepis fasciata</i>	Catopra	<i>Sineleotris namxamensis</i>	
<i>Epalzeorhynchus frenatum</i>		<i>Pareuchiloglamis nebulifer</i>	
<i>Hampala macrolepidota</i>		<i>Pseudecheneis sympelvicus</i>	
<i>Rasbora urophthalmoides</i>	Least rasbora	<i>Garra cyrano</i>	
<i>Xenentodon cancila</i>		<i>Rasbora aurotaenia</i>	
<i>Mystacoleucus greenwayi</i>		<i>Hypsibarbus vernayi</i>	
<i>Rasbora myersi</i>	Silver rasbora	<i>Glossogobius giuris</i>	
<i>Rasbora paviei</i>		<i>Rasbora steineri</i>	
<i>Poropuntius normani</i>			

Source: Emmett, 2006.

2 LOWER SE SAN, LOWER SRE POK

2.1 VILLAGES ALONG THE SITE

The Lower Se San-Lower Sre Pok II project site is on the Se San River, immediately downstream from where it is joined by the Sre Pok River. The selected survey areas focused on one commune in Ratanak Kiri province (Hat Pak) and four communes in Stung Treng province (Kbal Romeas, Srae Kor, Ta Lat and Phluk). In total, 11 villages were selected for the field survey. Five upstream villages will be completely flooded once the hydropower station is operational: Kbal Romeas, Krabei Chrum, Srae Sranok, Srae Kor Phum 1 and Srae Kor Phum 2. Two villages upstream of the dam will not be flooded: Hat Pak and Veun Hay. Ta Lat and Rumpoat villages will also be flooded once the dams are built, according to the people. Two villages downstream of the dam were also selected: Phluk and Ban Bung. The majority of the population in these villages is ethnically Lao.

There are six target villages of the interview survey located on the Se San River whose populations' livelihoods are related to the river: Hat Pak, Veun Hay, Srae Kor Phum 1 and Srae Kor Phum 2, Rumpoat and Ta Lat. They have experienced changes in water flow patterns in the river during the past 10 years (since the Yali dam was built). There is reason to believe that the Yali dam has seriously impacted fish stocks and species diversity. It is estimated that fish yield has been reduced to 10–30 percent of what it was previously (SWACO 2006). The impact on incomes and other tangible losses could be about USD2.3 million from 1996 to 1999 (Oxfam America 2001). An earlier report stated that flooding on the Se San River in 1996 raised the water level in the Sre Pok River as far upstream as Kbal Romeas commune (Baird *et al.* 2002).

2.2 ACCESSIBILITY OF TARGET VILLAGES

The district of Veun Sai is located about 40 km north of the provincial capital of Ratanak Kiri. Access is via a clay road in fair condition. Hat Pak commune is located on the bank of the Se San River and could be reached only by boat from Veun Sai district.



Photo 2-1: Road to Hat Pak commune, Hat Pak and Veun Hay villages



Photo 2-2: Road to Kbal Romeas, Krabei Chrum and Srae Sranok villages

All the three target villages in Kbal Romeas commune are located on the Sre Pok riverbank. Newly built earth roads provide easy access to them. The extension of the built road from Stung Treng town to Se San district provides many difficulties for travellers to Phluk commune.



Photo 2-3: Road to Phluk commune, Phluk and Ban Bung villages

2.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

The most extensive projects were conducted by the River Coalition, which involves the NGO Forum, 3S Rivers Protection Network (3SPN), Culture and Environment Preservation Association and Oxfam America. Its work is focused on environmental and human rights issues related to hydropower projects. Many documents have been produced related to people's livelihoods, fisheries and the impact of hydropower projects on the Se San and Sre Pok rivers.

Ta Lat commune: Recently the government approved coal exploration at three places in Ta Lat commune (Ou Chongkal, Srae Kambot and Srae Phachang). Two forest communities have been established. Three economic land concessions were also licensed by the government and timber cutting has operated since 2005.

Kbal Romeas and Srae Kor communes: Several newly established economic land concessions are in full operation. Trees are being cut. The forest concessions limit villagers' activity. Twelve forest communities have been established in Srae Kor commune. Their forest areas overlap with the economic land concessions.

There is no protected area related to the potential project sites of Lower Se San and Lower Sre Pok II. All the forests in the target villages there have been awarded to private concessions. There are very few surveys of natural resources in Sesan district. There was an environmental impact assessment of the economic land concessions within Stung Treng province, but the author could not obtain them from the companies, which claimed the reports were confidential.

2.4 NATURAL ENVIRONMENT AND POPULATION

The Lower Se San II and Lower Srepok II are seldom covered by the National Conservation Area so that there is no previous report of a natural environment survey in the area of the target villages of the interview survey. The people seem to live in harmony with nature. An ethnic minority, they rely on agriculture and collection of non-timber forest products. Forest product trading is a minor problem. A boat trip was made to the project site, where workers employed by the company that will build the hydropower project had been active for months exploring the area.

Most forest is relatively close to the villages, but forest gathering and hunting occur further from the villages because the nearby forests were given to the economic land concessions. The riparian vegetation is quite dense.

The main non-timber forest products harvested are two kinds of resin. In the past, logging provided a major part of household income for the population of the target villages. Nowadays, all forest areas surrounding the target villages of Stung Treng province were switched to economic land concession schemes. The owner of those concessions does not allow local people to collect timber and non-timber product in the forest area. In each economic land concession, a tree nursery was established. The reservoir will affect those concessions.



Photo 2-4: Project site work, demarcation milestone and camp

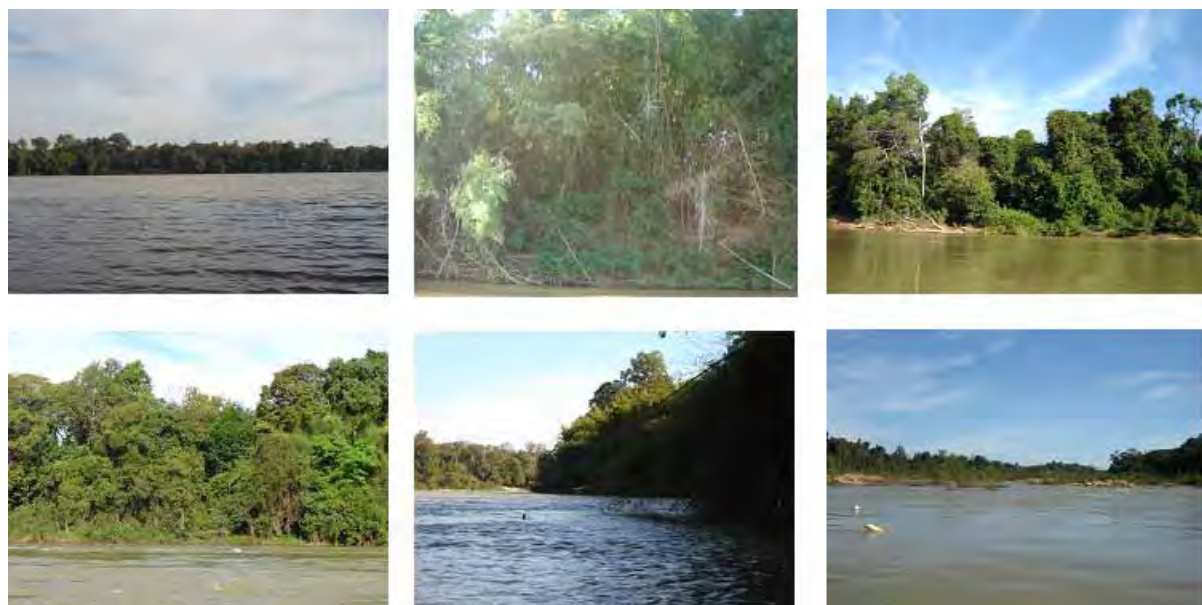


Photo 2-5: Riparian vegetation along Se San River from Phluk village to the project site



Photo 2-6: Forest area close to the project site (Project No. 7-8)



Photo 2-7: Forest cover around the Kbal Romeas commune

3. BOKOR PLATEAU

3.1 SURVEY AREA

The Bokor Plateau hydropower project site is located on a small river on Bokor mountain, about 2000 m downstream from the Popok Vil water fall. This river is one of several tributaries of the Prek Toek Chou river. The Kamchay hydropower project that is being built (193 MW) and it relies on water resource from the Prek Toek Chou river.

The selected survey areas focus on one of the 16 communes of Kampot district in Kampot province. Three of the four villages of Koh Touch commune were selected for field surveys: Kandal, Prek Ampil and Prek Chek. The majority of the people in these villages are ethnically Khmer. The three target villages are located along National Road No. 3 and are situated outside the catchments area of the Prek Toek Chou river. Local livelihoods come from wet season rice production and marine fishing.

3.2 ACCESSIBILITY OF TARGET VILLAGES

Koh Touch commune is located about 14 km south-west of the provincial capital. The access road is paved and in good condition. The roads to the three village centres are of clay and in fair condition during the dry months. These villages are located between National Road No. 3 and the sea.



Photo 3-1: Roads to Prek Ampil, Prek Chek and Kandal

3.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

The three villages of Kandal, Prek Ampil and Prek Chek in Koh Touch commune are involved in the Environmental Management of the Coastal Zone in Cambodia project.

The NGO Korphey Express has conducted awareness campaigns on natural resource conservation in the three villages. The Danish Red Cross offered sanitation facilities, wells and water storage facilities. The ASAC (Assistance on Curbing Small Arms) programme of the European Union built a school. The NGO Racha built a hospital and provided medical supplies.

3.4 NATURAL ENVIRONMENT AND POPULATION

There is no previously reported natural environment survey in the area of the three villages. In Kampot province, the forest area was reduced up to 12 percent in the period between 1993 and 2005. Protected forest represents up to 51 percent of total forest cover land (CZM 2007). The annual fish, squid and shrimp catch has continually decreased since 1995. This statement is corroborated by people's perceptions in the three villages. Most forest is now relatively far from the villages, mostly located within Bokor National Park (BNP).



Photo 3-2: Rice field in Prek Ampil village (left), Ou Koh Touch river (centre), overview of target villages from Bokor mountain (right)

3.5 PROTECTED AREA: BOKOR NATIONAL PARK (BNP)

3.5.1 History and geography

Bokor National Park (BNP) was created under a royal decree on the creation and designation of protected areas, issued on 1 November 1993, and is managed by the Ministry of Environment. BNP lies in the southern half of the Elephant Mountains, near the coast. It was first developed as a well-known resort during the French Protectorate.

It is one of the largest national parks of Cambodia, with a surface area of about 1400 sq km. Its elevation ranges from 30 to 1079 m. The park is undulating to hilly in the north-east, with a mountain plateau in the west and south-west. BNP is an important water catchments area for several rivers, in particular the Prek Toek Chou, which flows through the provincial capital (Sorensen 1998).

One of several tributaries of the Prek Toek Chou has its source in the highest level of BNP, and it is the water of this tributary that the Bokor Plateau hydropower project will rely on. BNP has suffered lots of pressure on resources. Illegal logging is a major threat. It is estimated by Global Witness that perhaps 80 percent of the park has been logged since 1997 (Sorensen 1998).

Six previous studies have been carried out in or about BNP. These were a study of vegetation (Dy 1970), a survey of tigers (Robinowitz 1999) park management requirements (Sorensen 1998), a primary bird survey (Goes *et al.* 1998), a localised but detailed study of forest vegetation (Ashwell *et al.* 1999) and a wildlife survey (WCS 2001).

In 1995, BNP was believed to have UNESCO World Heritage potential. But then, most species-rich forest areas were converted to species-poor shrubland. A newly approved project to create a large resort in the former town has ended the World Heritage attempt. The new resort, involving a USD2 billion investment, is under construction.

A delineation of the resort is being undertaken, but the BNP managers do not yet know the total area dedicated to the resort. At present, forest encroachment, illegal logging and charcoal production are considered the major threats to BNP. Numerous trails in the shrubland and forests have been made by collectors of non-timber forest products.



Photo 3-3: Damaged water intake (left), hill where this small river begins (centre), downstream flow to Bokor project site (right)



Photo 3-4: Damaged water intake (left), pump house (centre), water pipeline support pier (right)



Photo 3-5: Several pictures of the natural environment close to the Bokor Plateau project site

3.5.2 Flora

BNP is a biologically rich area. It contains several types of montane ecosystem and includes humid lowland evergreen forest in the south and semi-deciduous dipterocarp forests in the north. In middle of the Park are palm groves, hill and sub-montane forests, interspersed in the east with many gallery forests and humid sub-montane with drier sclerophyllic montane vegetation type, then interspersed in the west with fens and bogs in the highlands. On the upper slope are many Fagaceae and Lauraceae and on the plateau several formations of Myrtaceae and Vacciniaceae and also *Sphagnum* bogs (Sorensen 1998).

The southern part is lowland evergreen forest. In the north is deciduous and semi-evergreen forest (WCS 2001). Sorensen (1998) reported that the park harboured more endemic plant species per unit area than any other location that had been studied in Cambodia. Areas of high plant endemism within BNP can be found on the entire plateau along the west and south-west and in the gallery forest.

Few biological surveys have been conducted in the area, and these appear to have concentrated mainly on the lower elevations of the Elephant Mountains and the southern plateau. More complete plant survey information is found in Dy's (1970) analysis of the vegetation of south-west Cambodia. The southern gradient (1–1050 m) of the range of Dy's study is inhabited by a rather diverse and endemic biota of at least three major vegetation zones:

- Tropical evergreen forest is dominated by Dipterocarpaceae from sea level to 500 m.
- Tropical evergreen Oak—Tree Fern (*Cibotium*) forest from 500 to 800 m, and
- Short montane evergreen forest above 800 m that is dominated by gymnosperm (*Dacridium* and *Podocarpus*), Myrtaceae and Ericaceae (*Vaccinium*) interspersed with occasional and often extensive sphagnum bogs or fens.

Dy (1970) enumerates 35 species of trees and shrubs and 20 species of lower stratum. Species groups occupying the upper stratum of the vegetation include Myrtaceae (two genera, seven species) Fagaceae (two genera, five species) and Lauraceae (three genera, four species). The prominent families of the lower stratum include Myrsinaceae (two genera, four species) and Rubiaceae (three genera, four species). The most species-rich groups of herbaceous families include the Cyperaceae and Rubiaceae.

Of the 35 species that Dy (1970) recognised as endemics of south-west Cambodia, 30 are known to occur solely in the Elephant Mountains). This justifies the view that the plant endemism is centred on Bokor hill and environs (Sorensen 1998). The 1998 survey found 38 timber species, of which the majority are rare, and 47 species of non-timber forest plants (Sorensen 1998).

Logging is prohibited within it, and there are no reports on timber production. However, forest clearance and encroachment have occurred since the early 1990s, exacerbated by migration from outside the province (Sorensen 1998). This view was supported by the household survey. Wood is collected for fuel and fence posts and also for selling.

Non-timber forests products are widely collected by poor households. They include bamboo, rattan, lianas, wild edible fruit (13 species), medicinal plants (19 species) and material for handicrafts (10 species) (Sorensen 1998).

Management of the protected area aims at conservation. No timber collection is allowed. Patrols have been launched regularly under the WildAid programme since 2000 to prevent and record violations of the ban. Community development is also brought under this programme.

3.5.3 Fauna

There was no survey of the mountain birds or mammals prior to 1998. The 1998 survey was done with support from the WWF. The bird survey provided some interesting results. The southern part of the BNP has 27 percent bird species recorded that are not found elsewhere in the other part of the Park. Approximately 300 bird species are expected here, although only 226 have been recorded (Sorensen 1998).

(1) MAMMALS

The 2000 survey by WCS identified 29 mammal species by direct observation, specimen or phototrap picture (WCS 2001). Nine of the them are globally threatened: the Sunda pangolin *Manis javanica*, pig-tailed macaque *Macaque nemestrina*, pileated gibbon *Hylobated pileatus*, Asian golden cat *Catapuma temminckii*, tiger *Panthera tigris*, Asian elephant *Elephas maximus*, gaur *Bos gaurus*, southern serow *Naemorhedus sumatraensis* and East Asian porcupine *Hystrix brachyuran*.

Evidence of Asian elephants was found in the south-west of BNP (Srae Muoy Roy) and both elephants and gaurs were found in the north-central area of the park (Boeng Thom and Ou Kaseap). Tiger tracks were found in the south-west (Srae Muoy Roy) and north-central (Ou Kaseap) areas.

Phototrap pictures of the Sunda Pangolin, sun bear *Ursus malayanus*, marbled cat *Pardofelis marmorata*, Asian golden cat, leopard cat *Prionailurus bengalensis* and East Asian porcupine were taken (see Appendix D for more detail).

The survey indicated that most abundant boreal species were (in descending order) red muntjac, lesser mouse deer, common palm civet, leopard cat, Asian brush-tailed porcupine, wild pig, Berdmore's squirrel, sun bear, East Asian porcupine and yellow-throated marten.

(2) BIRDS

Goes *et al.* (1998) reported that there are approximately 300 bird species in BNP, at least eight of them globally significant.

A 1998 survey in BNP found globally threatened species including the green peafowl, chestnut-headed partridge, rufous-winged buzzard and grey-headed fish-eagle. The first recordings for the country included the blue-cared kingfisher, crow-billed drongo and several warblers. BNP is the only place in the region where the great hornbill still thrives (Sorensen 1998).

A 2000 survey within the BNP was conducted by the Wildlife Conservation Society (WCS 2001). A total of 249 species were recorded. BNP is home to a number of globally threatened and near-threatened species, of which the green peafowl *Pavo muticus*, silver oriole *Oriolus mellianus*, spot-bellied eagle owl *Bubo nipalensis*, rufous-winged buzzard *Butastur liventer*, oriental darter *Anhinga melanogaster*, blue-rumped pitta *Pitta soror*, Swinhoe's minivet *Pericrocotus cantonesis* and chestnut-headed partridge *Arborophila cambodiana* are important records.

(3) REPTILES AND AMPHIBIANS

During the WCS survey, four main sites were visited to collect amphibians and reptiles. Most emphasis was on the southern plateau and the Prek Koh Touch, which flow past the three target villages. Eleven amphibian species of and nine reptile species were recorded (WCS 2001).

The poorly known Cardamom endemic gecko *Cytodactylus intermedius* was found to be abundant on the plateau. Two specimens of *Trimeresurus* tree-viper were collected that have brown tails instead of the typical red tail and were expected to be described as a new species or subspecies (WCS 2001).

There may be a peninsular Thailand element at Bokor in that the *Acanthosora* lizards at Bokor were more like *A. armata* (a peninsular Thailand species) than the expected *A. capra* (a southern Annamite species) (WCS 2001).

(4) FISHES

There is no record or survey regarding the fish species within BNP.

4. STUNG KEP II

4.1 SURVEY AREA

One of the proposed Stung Kep II dam site (right site) is located on Stung Kep river in Russey Chrum commune, Thma Bang district of Koh Kong province. The other proposed dam site of Stung Kep II (left site) is located on the Stung Tatay river in Trapeang Rung commune, Koh Kong district of Koh Kong province. The nearest village is located about 18 km from the proposed dam site (left site), but only about 3 km from National Road No. 48. The Stung Kep flows into the Stung Tatay about 8 km downstream from the right site, before the Stung Tatay flows into the sea at Koh Kong Bay.

The selected survey areas focus on the two villages of Tatay Kraom commune in Koh Kong province (Anlong Vak and Koh Andaet). The majority of the population of these villages is ethnically Khmer. The two proposed dam sites are located within the southern Cardamom Protected Forest, managed by the Ministry of Agriculture, Forestry and Fisheries. The two target villages are located within the Peam Krasaob Wildlife Sanctuary (PKWS), which is managed by the Ministry of Environment.

There is no previously reported natural environment survey in the area of the two villages. Increased population and land speculation seemed to favour encroachment on the forest of the PKWS. Non-timber forest products were collected by the local population, especially rattan, resins, wild fruits and traditional medicinal plants. Charcoal is being produced at large in this area. The “buried kilns” are usually found behind houses or in farmland. Wooden materials such as poles and planks are collected for family use.



Photo 4-1: Natural environment of the target villages

4.2 ACCESSIBILITY OF TARGET VILLAGES

Tatay Kraom commune is located about 19 km south-east of the provincial capital of Koh Kong. The access road (National Road 48) is paved and in good condition. The two villages are located on the Stung Tatay riverbank.



Photo 4- 2: Stung Kep river and a road in Tatay Kroam commune

4.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

Two existing projects are being conduct within the study area that are the mangrove forest management project run out by the Ministry of Environment funded by International Development Research Centre and, the Environmental Management of the Coastal Zone in Cambodia with the fund from DANIDA.

4.4 PROTECTED AREA: PEAM KRASOAP WILDLIFE SANCTUARY (PKWS) AND RAMSAR SITES

The PKWS was created under a royal decree on the creation and designation of protected areas, issued on November 01, 1993. The sanctuary is situated in Mondol Seima, bordering Smach Meanchey and Koh Kong districts, and covers an area of 237 sq km. The PKWS boasts a unique mangrove ecosystem. Within the same area is Koh Kapi and associated islands which earned a nomination as Wetlands of International Importance under the Ramsar Convention. The PKWS and Koh Kapi Ramsar site have some of the best remaining examples of mangrove forests in the Gulf of Thailand, because many other areas have been cleared for intensive shrimp aquaculture and large-scale charcoal production (Marschke *et al.* 2001).

Although the coastline is relatively unpopulated, there has been a rapid increase in migration into the province, especially in the PKWS, due to improved security and short-term economic opportunities. Population pressures and access to markets place greater pressure on the mangroves and aquatic resources within and surrounding the PKWS.

The PKWS is a lush ecosystem replete with mangroves, aquatic species and wildlife. It spans parts of three districts and is home to around 10,000 people. Intertidal levels and water from highland areas both influence the PKWS. The estuarine areas are affected by the interaction between freshwater and saltwater, especially during the rainy season. The PKWS provides such favourable conditions for fishing and other resources that many people have settled there and depend upon its natural resources for their livelihood (Marschke *et al.* 2001).

The Stung Kep II dam site is located within the southern Cardamom Protected Forest. This important forest is proposed to be the south-west elephant corridor. It is located within the Phnom Samkos Wildlife Sanctuary, Central Cardamom Protected Forest and Peam Krasaob Wildlife Sanctuary. This forest has an essential role in the Cardamom biodiversity conservation corridor identified by the Asian Development Bank.

4.4.1 Flora

The 2003 dry season survey conducted by WildAid (Daltry *et al.* 2003) of the southern Cardamoms and the Botum Sakor Peninsula, where the proposed Stung Kep II project site is located, confirmed that in spite of heavy logging and hunting pressures in recent years, this area still contains nationally significant biodiversity, including important populations of endemic and endangered plants and animals. It should be a high priority for conservation.

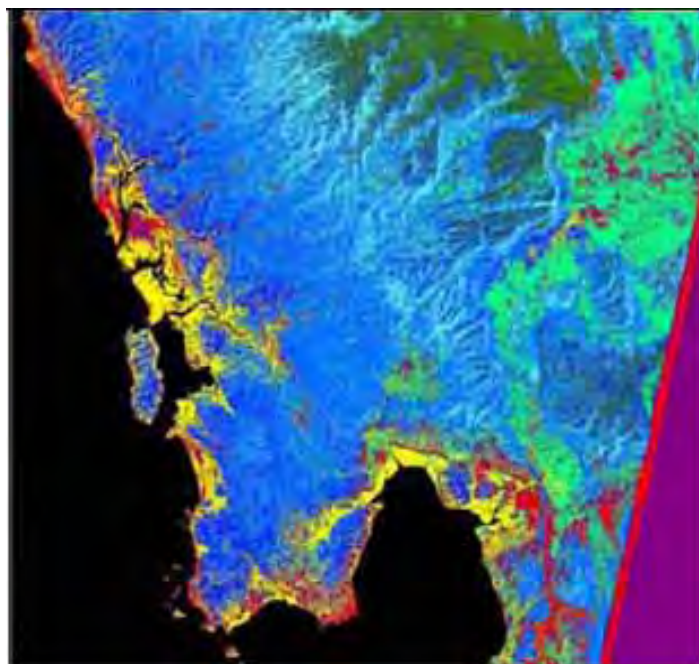
By April 2003, 251 species of epiphytes, vines and lianas were identified, and fertile specimens were taken from well more than 200 species of vascular plants. These inventories are undoubtedly far from complete, and future surveys are predicted to yield more species among all taxonomic groups. Many of the plants have yet to be positively identified, and it is likely that at least some are new to science (Daltry *et al.* 2003). The tall evergreen forest is of fairly high diversity on a global scale, and has the highest tree diversity of any forest in Cambodia.

The forest cover in the southern Cardamoms includes:

- Evergreen tall sandstone forest: Dipterocarp species, high densities of species from the Clusiaceae, Sapotaceae, Lauraceae and Myrtaceae families make these forests reminiscent of dipterocarp forest.
- Short evergreen sandstone forest: Dipterocarp trees are less abundant than in the evergreen tall forests, often being represented only by various *Hopea* species, and poor/acid soil groups become more abundant.
- Tall evergreen basalt forest: The canopy is dominated by giant *Ficus* trees, *Nageia wallichianus*, *Irvingia malayana*, *Heritiera javanica*, and various *Syzygium* spp., *Elaeocarpus* spp., *Garcinia* spp. and *Lauraceae* spp., including the valuable *Lauraceae* sp¹ at its densest in these forests.
- Upland forest and deciduous forest.

¹ *Lauraceae* sp in Khmer mreah prew” that is a wood that could be extracted for essential oils

- Freshwater swamp forest was dominated by just a few species, including *Polyalthia* sp., *Syzygium* sp., *Cinnamomum* sp., *Nephelium* sp., *Aglaia* sp., *Myristica* sp.,
- Open dipterocarp woodland, open *Melaleuca* woodland, open pine woodland, grassland, riparian forest, lowland river swamp, mangrove swamp, bamboo groves.



Classified Landsat image. Colour codes:

Black: water (25.0%);

Yellow: mangrove/swamp (6.1%);

Dark blue: tall evergreen forest (12.0%);

Mid-blue: medium and short evergreen forest (20%);

Pale blue: disturbed evergreen forest (8.4%);

Dark green: upland forest (6.3%);

Pale green: open woodland (9.7%);

Purple: grassland (8.5%);

Red: bare earth/ road (4.0%).

Source: Daltry & Traeholt 2003.

Figure 4-1: Classified landsat image of forest cover in the Southern Cardamom Region

Non-timber forest products known to be collected from the southern Cardamoms include: rattan (*Korthalsia* spp.) stems, for cane and wicker (common); aloewood (Chan Krisna, or gaharu; *Aquilaria crassna*) for essential oil; samraang (*Scaphium macropodum*) fruit, for whose boiled seeds there is large market; *vour romiet* (yellow vine, *Coscinium* sp.) stem, for chemical products; *tep porou* (*Cinnamomum tetragonum*) bark; *preah prew* (*Lauraceae* sp.) wood, for extraction of essential oils; *kuy* (*Willoughbeia edulis*) fruit; and antplant (*Myrmecodia* sp. or *Hydnophytum* sp.; epiphytes) roots, for medicine (Daltry *et al.* 2003).

4.4.2 Fauna

There are many previous biological surveys within the Cardamoms. This report takes into account the most recent survey by WildAid in 2003.

(1) MAMMALS

The 2003 survey by WildAid (Daltry *et al.* 2003) found that the southern Cardamoms contain 28 species of large mammals, but most of them in very small numbers. The list includes globally threatened species such as the clouded leopard *Neofelis nebulosa*, Asian elephant *Elephas maximus*, gaur *Bos frontalis* and Malayan sun bear *Helarctos malayanus*. There were no verifiable reports or observations of any of the large cats or Asiatic wild dogs. Signs of tigers *Panthera tigris*, were notably absent, in spite of alleged sightings by local people. These large predators are most likely present in very small numbers or possibly locally extinct. There were also no observations of hog deer *Axis porcinus* or Eld's deer *Cervus eldii*, despite several reports from villagers claiming that they used to be relatively common.

A total of 11 species of small and medium-sized mammals were documented in the southern Cardamoms Protected Forest (Daltry *et al.* 2003). One hundred and fifty-six small and medium-sized mammals

representing six species, from the orders Scandentia, Carnivora and Rodentia, were captured during 2192 trap nights. Five species of small mammals, from the orders Scandentia and Rodentia, were observed occasionally but not captured.

(2) BIRDS

The WildAid survey (Daltry *et al.* 2003) identified 137 species. Many of the birds were winter migrants, but most were residents. They included a number of species and subspecies that are endemic to the Cardamom Mountains eco-region, which encompasses the mountains of south-west Cambodia and south-east Thailand. It is anticipated that many more species will be found in future surveys.

Nineteen species were new records for the Cardamom Mountains. These were: white-winged duck, laced woodpecker, streak-throated woodpecker, Alexandrine parakeet, pompadour green pigeon, an unidentified crane, a greenshank (probably common), milky stork, woolly-necked stork, blackheaded stork, racket-tailed treepie, vinous-breasted starling, forest wagtail, Richard's pipit, blue-eared barbet, arctic warbler, Siberian blue robin, ruby-cheeked sunbird and thick-billed flowerpecker (Daltry *et al.* 2003).

(3) REPTILES AND AMPHIBIANS

The short survey by WildAid (Daltry *et al.* 2003) documented 59 species of reptiles, including 46 within non-protected parts of the southern Cardamoms. Most species were identified without difficulty or the need to sacrifice specimens, but one lizard (a skink) and one snake (a kukri *Oligodon* sp.) could not be positively identified in the field and were therefore collected for closer study. It is possible that these are species or subspecies new to science.

At least 23 species of amphibians were confirmed in the southern Cardamoms during the WildAid survey. Several have not yet been positively identified, however, and voucher specimens were collected for closer examination at the Muséum Nationale d'Histoire Naturelle in Paris. The confirmed checklist included frogs that are used locally for human consumption (e.g., *Hoplobatrachus chinensis*) as well as important prey for other animals (e.g., *Limnonectes limnocharis*). There is some evidence that the mangrove frog *Fejervarya cancrivora* inhabits mangroves and swamps on the coastal southern Cardamoms and Botum Sakor Peninsula.

The WildAid survey confirmed that the presence of Siamese crocodile is obvious in the Stung Ta Tai. The first indication that crocodiles were present came from a series of interviews with local hunters in 1999, but the species could not be identified from their descriptions alone. Between 25 February and 7 March 2000, several rivers in Koh Kong and Pursat Provinces were visited on foot (Daltry 2000). Three clear sightings of live crocodiles were made in the upper Stung Kep and Stung Krau rivers, confirming that the species was *Crocodylus siamensis*. There were also numerous observations of tracks, trails and dung: up to 23 crocodile scats were recorded.



Photo 4-3: Siamese crocodile prints (left) and its habitat (right) in Stung Kep

In 2003, the FFI conducted a survey of Siamese crocodiles along 357 km of waterways, or 25 percent of the watercourses draining the southern slopes of the central and southern Cardamom Mountains, including the Stung Tatay (Daltry *et al.* 2003). Much of this river is remote and difficult to reach. Seventy km of Stung Tatay stretches were surveyed, and three distinct sites confirmed to contain crocodiles, including a number of juveniles. One of these sites is located immediately upstream from the location of the proposed project site.

5. MIDDLE & UPPER STUNG RUSSEY CHRUM

5.1 SURVEY AREA

The hydropower project Middle and Upper Stung Russey Chrum (No. 16 & 23) is located on the Stung Russey Chrum river in Tatay Leu commune, Thma Bang district, Koh Kong province. The nearest village (Kien Chongruk) is about 13 km from the proposed project sites but is located in Veal Veng district of Pursat province. There are two project sites, both located within the Central Cardamom Protected Forest, which is managed by the Ministry of Agriculture, Forestry and Fisheries with technical assistance from Conservation International.

The selected survey areas focus on Koh Pao village in Bak Khlang commune of Mondol Seima district and two villages of Dang Tong commune of Smach Meanchey district (Phum Ti Buon and Phum Ti Pir) in Koh Kong. In two of the three villages, the population is urban and located about 70 km downstream from the project sites. Most of the population in these villages is ethnically Khmer.



Photo 5-1: Marine fishing in Koah Pao (left), Phum Pir (centre) and Phum Buon (right) villages

5.2 ACCESSIBILITY OF TARGET VILLAGES

Two of the three villages are located within the provincial capital of Koh Kong province. Koh Pao could be reached only by water.

5.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

With support from the International Development Research Centre, a group of researchers at the national level and in Koh Kong province are taking a new approach to managing mangrove resources—one that involves the leadership of local people. And the group is having success: people who were destroying the mangroves are now helping to protect them. Based in part on these results, the Cambodian government has also modified its policy on the environment.

In the three target villages, there is currently a project run by the Ministry of Environment with DANIDA funding called Environmental Management of the Coastal Zone in Cambodia. It aims to provide assistance for the protection, conservation and management of coastal and marine resources (CZM 2007). The project's components include:

- Policy, legal and institutional framework: produce reports on the status of Cambodian coastal areas, coastal and marine environment issues, law and regulation in the coastal zone, etc.
- Cambodian shoreline management strategy: produce reports on the local area coastal resource management plan, the state of environment, the strategic environmental assessment, the state of the coastal environment and the socio-economy, etc.

The Fauna and Flora International (FFI) in cooperation with the Ministry of Environment and Forestry Administration, with undertakes three components of conservation: (1) community-based protection for the endangered Siamese crocodile and its habitat, (2) conserving the Cardamom Mountains by tackling human-induced threats and (3) building Cambodia's capacity for conservation by establishing education courses throughout the country.

The Cambodian Crocodile Conservation Programme has a special emphasis on the central and southern Cardamom Mountains, where most of the world's critically endangered Siamese crocodiles remain. Within this area, the project includes community-based initiatives that link livelihood assistance with crocodile protection and habitat preservation.

The Cardamoms Biodiversity Conservation Corridors in Cambodia, a pilot project financed by the Asian Development Bank, was prepared based on the following criteria: (1) located within the Greater Mekong Sub-region economic corridors or their zone of influence, (2) reducing ecosystem fragmentation by linking two or more protected areas, (3) areas of international biodiversity importance, (4) areas of high poverty incidence and population growth, (5) area of a transboundary protected nature and (6) area have institutional capacity that is currently active in implementing one or more projects.

The Forestry Administration's Wildlife Protection Office was selected to implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) programme on monitoring the illegal killing of elephants (MIKE) in Cambodia. One of the two national MIKE sites covers the Cardamom Mountains, with the main emphasis on the southern Cardamoms Protected Forest.

5.4 PROTECTED AREA: CENTRAL CARDAMOM PROTECTED FOREST (CCPF)

5.4.1 History and geography

The both Upper and Middle Russey Chrum are inside of the CCPF.

The CCPF was gazetted and given a formally demarcated boundary in 2002. It is managed by the Cardamoms Conservation Programme, which is a partnership between Conservation International and the Forestry Administration. The area has now been designated a protected forest, and all logging concessions within its boundaries have been cancelled. The CCPF covers more than 4,000 sq km of evergreen forest, dry dipterocarp forest, pine forest, grasslands and wetland habitats, at elevations ranging from 50 to 1,500 m. The area contains a wide variety of lowland and mid-altitude habitats surrounding a core central plateau, of which about 60,000 ha have an elevation over 1,000 m (Emmett and Olson 2005). The CCPF been recognised as internationally important for biodiversity conservation. It forms part of the Indo-Burma Biodiversity Hotspot and represents one of the largest, most diverse and least developed forest regions in mainland south-east Asia.

Biological research in Cambodia has been extremely limited in scope, and there is a paucity of data for almost all taxa. A few conservation organisations have conducted biological surveys in south-west Cambodia. These include:

- A preliminary wildlife survey in the Cardamom region—FFI, 1999.
- Cardamom Mountains Biodiversity Survey—FFI, 2000.
- Social and Ecological Surveys of Phnom Oral Wildlife Sanctuary—FFI, 2002.
- Mini-RAP Assessment of the Silver Road Logging Concession, Cardamom Mountain area, Cambodia—CI, 2003.
- Biodiversity Assessment of the Southern Cardamoms and Botum-Sakor Peninsula—WildAid, 2003.

5.4.2 Major flora in the CCPF

The CCPF contains some of the most important hill river systems and swathes of contiguous evergreen forest in Cambodia. Habitat destruction within the CCPF is occurring at a comparatively low rate. Current levels of logging, land clearance for agriculture and charcoal production are low, and the evergreen forests appear to be in good condition. Collection of non-timber forest products is causing minimal damage except for activities that focus on globally threatened plant species such as the critically endangered agar tree *Aquilaria crassna*. Alteration to natural fire regimes is having an unknown but possibly detrimental impact on biodiversity in four grassland and pine forests (Emmett and Olson 2005).

The lowland wetlands on the eastern side of the Areng valley and the upland marshes to the east and north of Ou Saom represent the most significant still-water bodies in the CCPF, in terms of both size and biological importance. Of particular critically endangered species, the largest populations are in these wetlands. Wetlands within the Areng Valley are threatened by over-fishing or conversion to agriculture, but the upland marshes around Ou Som show fewer signs of disturbance (Emmett and Olson 2005).

5.4.2 Fauna

CI's 2004 survey found a very high diversity and abundance of threatened species. Twelve mammal species, two birds, seven reptiles, one amphibian and one fish recorded during this survey are classified as globally threatened, and many others are classified as near threatened or data deficient. Potentially undescribed species were discovered, including a rodent (*Rattus* sp.), at least one species of shrew (*Crocidura* sp.), a snake (*Oligodon* sp.), several frogs (e.g., *Philautus* sp. and *Polypedates* sp.), a skink (*Scincella* sp.) and a caecilian (*Ichthyophis* sp.) (Emmett and Olson 2005).

There are few previous biological surveys within the Cardamom Mountains region. This report takes into account the most recent survey by the Conservation International in 2004. Additional description of fauna and flora of previous surveys was documented in the report on hydropower projects Chapter 4: Stung Metoek II & III (No. 20-21) and Chapter 5: Stung Kep II (No. 22).

(1) MAMMALS

In total, 57 mammal species were recorded for the CCPF, for which there were voucher specimens, camera-trap photographs or confirmed observations. Of these, twelve are classified as globally threatened. This takes the total number of mammal species recorded for the Cardamom Mountains to approximately 79 (Emmett and Olson 2005). CI's 2004 survey failed to record the presence of fishing cats. Fishing cats and otters are dependent on wetland habitats where their main food source, fish, is plentiful. Previous camera trapping has not focused on the periphery of wetlands (Emmett and Olson 2005).

The statuses of the dhole *Cuon alpinus* and otter have recently been revised from vulnerable to endangered on the IUCN red list. Otter tracks were found on sandbanks along the Russey Chrum River and the Areng River. Photographs and casts were taken. Up to four species of otter could occur in the Cardamom Mountains: the Eurasian otter *Lutra lutra*, smooth-coated otter *Lutrogale perspicillata*, Asian small-clawed otter *Aonyx cinerea* and the hairy-nosed otter *Lutra sumatrana*. *L. lutra* has been tentatively confirmed in the CCPF by previous surveys (Daltry and Traeholt 2003), whereas *Aonyx cinerea* and *Lutrogale perspicillata* were only predicted to occur.

Lutrogale perspicillata is IUCN-listed as vulnerable due to hunting for skins, over-fishing and habitat alteration. *Aonyx cinerea* and *Lutra lutra* are classified as near threatened and *L. sumatrana* as data deficient, indicating trends similar to *L. lutra* and *Lutrogale perspicillata* (Emmett and Olson 2005).

Wild cattle tracks were frequently observed on the upland plateau in pine forest, montane evergreen forest and grassland. The gaur is vulnerable, and these observations and records are important and positive signs for the conservation of this species. Elephant dung was found in and around a large cave in the Knorgl Strol mountain area. Two species of bear inhabit this region: the Malayan sun bear *Helarctos malayanus* and the Asiatic black bear *Ursus thibethanus*. Both species are widespread in Asia, but are threatened by hunting and habitat loss throughout their range (Emmett and Olson 2005).

Large cat droppings were found in the Russey Chrum Valley. Their size and consistency indicate either a leopard or a tiger. The survival of these species in the region is dependent on high levels of direct protection and improved enforcement of Cambodia's wildlife law. Camera trap photographs recorded Asian golden cats and clouded leopards (vulnerable species), although only in fairly low numbers. Camera traps have recorded only two pangolins in four years, and the research team made no observations. Pileated gibbons were recorded at all surveyed sites. This species is classified as vulnerable and appears to be very abundant in the region (Emmett and Olson 2005).

The CI survey recorded two species of tree shrew and at least eight rodent and two insectivore species. Of these, 10 species are new records for the Cardamom Mountains, and six are new records for Cambodia. Several voucher specimens from the rodent genera *Maxomys* and *Niviventer* are externally different to previously recorded species for the country and may be new records for Cambodia, or even new to science (Emmett and Olson 2005).

Eleven species of bat were recorded during the survey. Two species, *Myotis horsfieldi* and *Rhinolophus lepidus*, are new records for Cambodia. Both are found throughout the CCPF. Another species, *Rhinolophus shameli*, is listed as near threatened by the IUCN. Very few individuals of *R. shameli* have been found in Cambodia (Emmett and Olson 2005).

(2) BIRDS

Long & Swan (in Daltry & Momberg, 2000) reported 82 species from the Central Cardamoms, including the endemic Cambodian Laughingthrush, *Garrulax ferrarius*. Long et al. (2002) recorded 91 species at Veal Veng, of which the most significant were the globally threatened (Vulnerable) Lesser Adjutant, *Leptoptilos javanicus*, and the near-threatened Grey-headed Fish Eagle, *Ichthyophaga ichthyaetus* and Great Hornbill, *Buceros bicornis*. Pierce & Pilgrim (2003) observed 107 bird species including 18 new records for the Cardamoms and two species of conservation concern: the Silver Oriole (*Oriolus mellianus*, Vulnerable) and Great Hornbill (Near Threatened). Daltry & Kuy (2003) reported 39 species from the upper Areng Valley, including White-winged Duck (*Cairina scutulata*, Endangered), Green Peafowl (*Pavo muticus*, Vulnerable) and Black-necked Stork (*Ephippiorhynchus asiaticus*, Near Threatened).

A total of 93 bird species were recorded in and around the CCPF during these surveys (eight of those could be identified only as to genus. Two additional but unconfirmed sightings are worth mentioning because of their potential significance: one of a duck consistent with the white-winged duck was made in the Russey Chrum Valley and an observation of a hornbill consistent with the White-crowned Hornbill was made near O'Som village (Emmett and Olson 2005).

Fifteen of the species represented new records for the CCPF, three also being new for the Cardamom Mountains. The new species for the Cardamom Mountains were the black-browed reed warbler, Chinese sparrowhawk and common moorhen. The additional new species for the CCPF are the lesser fish eagle, oriental bay owl, black-headed bulbul, changeable hawk eagle, common tailorbird, oriental darter, long-tailed broadbill, osprey, rackettailed treepie, cattle egret, oriental reed warbler and green imperial pigeon. Perhaps the most significant of these is the oriental darter, a globally near-threatened species for which the only record from the Cardamoms dates back to the 1930s (Emmett and Olson 2005). If confirmed, the potential record of the white-crowned hornbill would represent an expansion of the known distribution of this globally near-threatened species. Two globally threatened and five near-threatened bird species were documented during this study.

(3) REPTILES AND AMPHIBIANS

CI's 2004 survey recorded at least 55 reptile and 29 amphibian species. Up to four reptiles and five amphibian species may be undescribed, but were not included in the total numbers unless there was no doubt that they are distinct species (Emmett and Olson 2005).

A large number of the reptile species found in the CCPF have been classified as globally threatened. The Siamese crocodile *Crocodylus siamensis* is critically endangered and the elongated tortoise *Indotestudo elongata* is endangered. The Asiatic soft-shell turtle *Amyda cartilaginea*, Asian giant pond turtle *Heosemys grandis*, black marsh turtle *Siebenrockiella crassicollis*, impressed tortoise *Manouria impressa* and Asian box turtle *Cuora alboinensis* are classified as vulnerable. The Asian leaf turtle *Cyclemys atripons* is near threatened. One of the amphibian species, the spiny-breasted giant frog *Paa fasciculispina*, is classified as vulnerable, and Mortensen's frog *Rana mortenseni* is near threatened (Emmett and Olson 2005). The survey confirmed the presence of at least nine reptile and seven amphibian species that had not been previously recorded in the Cardamoms. Of these, at least three reptiles and three amphibians (over seven percent of the total species found) are also new records for Cambodia (Emmett and Olson 2005).

(4) FISHES

Forty-three species of fish in 14 families (five orders) were found by the CI survey, 33 of which were new records for the Cardamom Mountains. These results bring to 54 the total number of fish species recorded from drainages originating in the Cardamom Mountains. The family Cyprinidae (carps, minnows and barbs) dominated the collections with 20 species, more than three times as many as the next most abundant group, Balitoridae (hill stream loaches). Three or fewer species were observed in the other 12 families, with six families being represented by only one species (Anabantidae, Cobitidae, Gobiidae, Osteoglossidae, Pristolepididae and Sisoridae).

The highest priority for fresh-water fish conservation in the CCPF, and indeed in south-west Cambodia, is the endangered Asian arowana or dragon fish *Scleropages formosus* and blackfish *Tor* sp. At least one species from the genus *Tor* was found in the Cardamom Mountains. Over-collection of the dragonfish is seriously threatening the survival of remaining populations.



Photo 5-2: Asian arowana or dragonfish *Scleropages formosus* and unknown species of 'blackfish' *Tor* sp

6. STUNG METOEK II, III

6.1 SURVEY AREA

The hydropower project Stung Metoek II (No. 20) is located on the Metoek River in Thma Da commune, Veal Veng district, Pursat. The nearest village is located about five kilometres from the proposed project site. Stung Metoek III (No. 21) is located on the Metoek River in Bak Khlang commune, Mondol Seima district, Koh Kong province.

The selected survey areas initially given to the team focus on four villages of Thma Da commune (Aekpheap, Kandal, Sangkom Thmei and Thma Da). In reality, Thma Da village does not exist and only three villages were taken into account. All the villages are located upstream of the dam site and will be completely flooded once the dams are operational. The majority of the people in these villages are ethnically Khmer. The two proposed dam sites and target villages are located within the Phnom Samkos Wildlife Sanctuary, which is managed by the Ministry of Environment. The population experienced catastrophic flood during 1988 and most recently in 2006. Many household assets, livestock and crops were destroyed.

6.2 ACCESSIBILITY OF TARGET VILLAGES

The district of Veal Veng is located about 195 km south-west of the provincial capital of Pursat. The access road (National Road No. 56) is a clay road in fair condition during the dry months. This road is built as far as Thma Da commune and will be extended to the Thai border.



Photo 6-1: Road to Thma Da commune and Veal Veng district.

6.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

Four existing projects are being conducted within the study area that are the Ministry of Environment project funded by Fauna and Flora International (FFI), the Cardamoms Biodiversity Conservation Corridors in Cambodia project funded by the Asian Development Bank, Cambodian Crocodile Conservation Program is now implemented by FFI and the Forestry Administration and the (MIKE) program of the Forest Administration's Wildlife Protection Office. The detail of these projects was described in the Chapter 3.

6.4 NATURAL ENVIRONMENT AND POPULATION

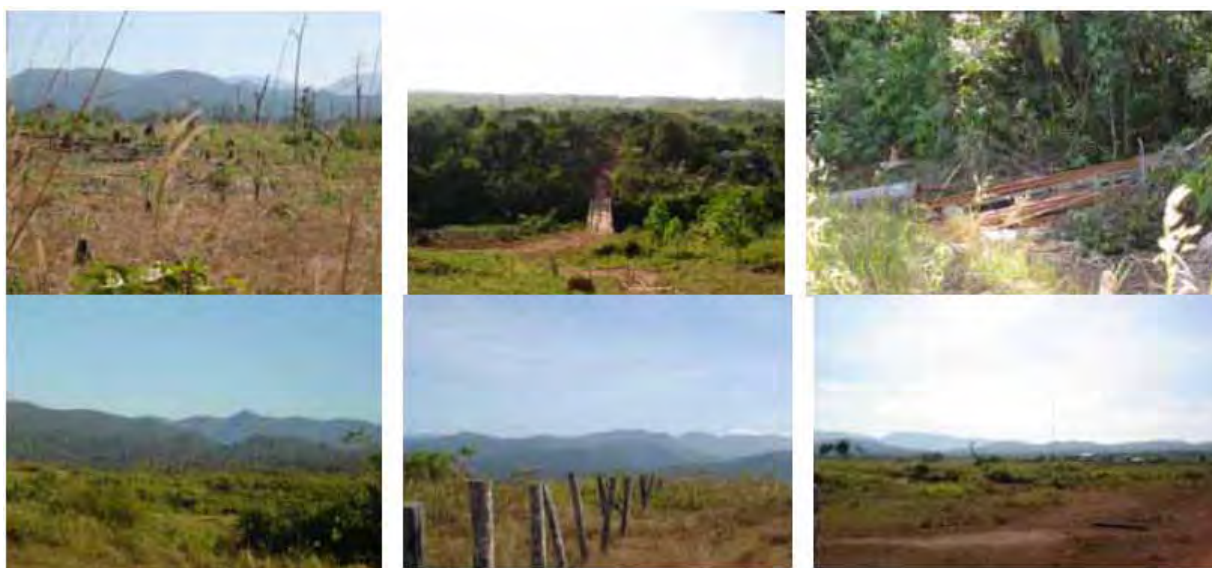


Photo 6-2: Natural environment of Kandal village (top centre, bottom left), Sangkom Thmei village (top left, bottom centre), Aekakpheap village (top right, bottom right)



Photo 6-3: Subsidiary activities include making thatch and brooms and growing vegetables in the dry season

There are no reports of earlier natural environment surveys in the area of the three target villages. Increased population, expectation of a new border crossing and land speculation seem to favour encroachment on the Phnom Samkos Wildlife Sanctuary (PSWS).

Observations during the field investigation in December 2007 indicated that the forest around the target area of Thma Da commune is typically characterised by semi-dense and dense evergreen mountain forest. The Ministry of Environment has handed over about 5,000 ha of forest land to Thma Da commune. Within the 5,000 ha, there are no remaining patches of forest except for sparse bamboo stands on the banks of streams and the Stung Metoek river bank.

The people in the village perceive that the forest and wildlife is abundant in the sanctuary. Landmines are also a major problem in the target villages. Firewood and charcoal are significant energy sources for cooking. Most people still depend on natural resources for subsistence. However, better off households may convert farmland into rubber plantations.

Fauna and Flora International have been supporting the management of PSWS in order to strengthen law enforcement. Nevertheless, it is expected that the new law on protected areas² may lead to some changes in levels of conservation. Discussions with representative of the PSWS and rangers revealed some key concerns:

- Cooperation levels with local authorities,
- Awareness among local communities

² The new law on protected areas was enacted by the National Assembly on 27 December 2007.

- Consideration of the PSWS management plans and the basic needs of livelihoods to meet conservation targets,
- Limited financial support.

These villages are similar in geographical features and are located on gentle slopes at an elevation of 240–250 m. They are not built on the banks of the Metoek River.

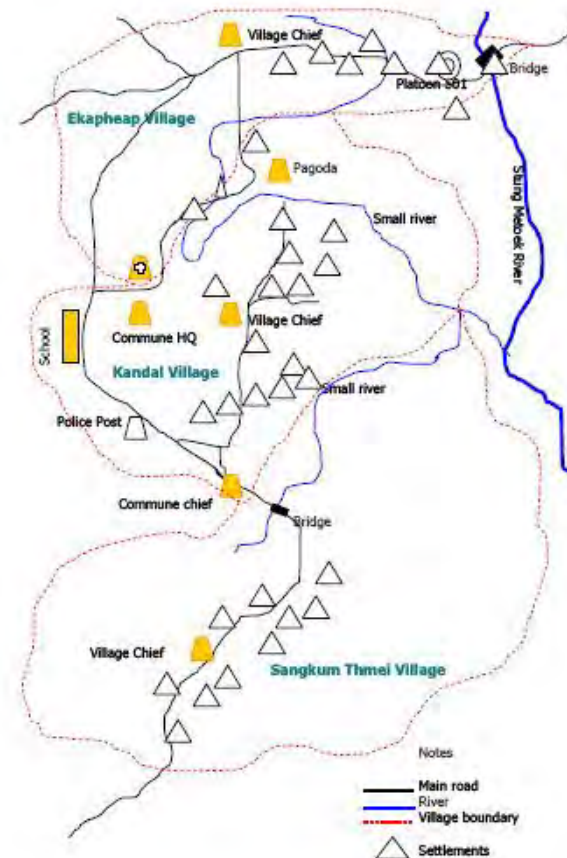


Figure 6-1: Thma Da commune map

6.5 PROTECTED AREA: PHNOM SAMKOS WILDLIFE SANCTUARY (PSWS)

6.5.1 History and geography

There are also sizeable areas of natural marshes and grassland. Human density is very low, and settlements are almost wholly confined to lowland areas near rivers (Momberg and Weiler 1999). The PSWS is located in Pursat and Koh Kong provinces and covers an area of 3,338 sq km, protecting flora and fauna of international conservation priority. The Metoek River and its catchments area are one of the most important rivers of the Cardamom Mountains. Its water contributes significantly to the survival of mangrove forest in its delta region (Koh Kong Bay).

FFI currently finances the Cardamom Mountain Wildlife Sanctuaries Project, which aims to ensure the long-term conservation of a landscape of global importance and its biodiversity while reducing poverty and ensuring essential national development. The focus is on establishing and maintaining management systems in two protected areas: Phnom Samkos Wildlife Sanctuary and Phnom Oral Wildlife Sanctuary. The Phnom Samkos Wildlife Sanctuary (PSWS) was created under a royal decree on the creation and designation of protected areas, issued on 1 November 1993, and is managed by the Ministry of Environment with financial and technical support from the Fauna and Flora International.

The PSWS is one of the three parts of the Cardamom Mountains region,³ which covers 1.87 million hectares. Ranging up to 1,771 metres (Mount Oral), the mountains are cloaked with a variety of natural forest types according to altitude, aspect, geology and hydrology: dry deciduous forest, semi-deciduous forest, lowland evergreen forest, hill evergreen forest, bamboo thickets and pine forest.

6.5.2 Flora

This is a very high diversity of habitats, some of which occur nowhere else in Cambodia, such as large expanses of fire-regulated ferns, upper montane forest, high elevation marshes and blackwater rivers (FFI 2007). The Cardamoms host more than half of Cambodia's known 2300 species of plants. Of about 230 species that are endemic to Cambodia, more than 100 are from the Cardamom forests (ADB 2005).

The Cardamom Mountains, with their 1.87 million hectares of dense forest cover, intricate network of rivers, coastal wetlands and mangrove forests, are also the key watershed for western Cambodia, providing water supply, climate regulation and abundant fisheries for hundreds of thousands of people (ADB 2005). The coastal Cardamoms are the only source of fresh water to the Bay of Koh Kong, where the mangrove forest is widespread.

The FFI survey in 2000 (Daltry & Momberg 2000) indicated that the Phnom Samkos Wildlife Sanctuary harbours high plant diversity and many endemic species. The specimens collected include species that are new to science or to the national record. The vegetation can be broadly separated into zones: the lower slopes are covered by mixed deciduous forests that grade into dry evergreen forest at an elevation of about 400 m above sea level. At around 1000 m, the evergreen forest becomes conspicuously wetter, with many palms, tree ferns and a greater diversity of trees, including *Pinus merkusi*. Above about 1300 m, the forest undergoes another transformation into a moist montane/cloud type. Here the trees become stunted (about 15 m maximum canopy height), encrusted with mosses, lichens and epiphytes. *Quercus* species (oaks) appears in this zone. The forest on the high plateaus is punctuated by clearings of bare rock and grasses, with Zingerveraceae (wild gingers) and *Rhododendron* spp. at the margins (Daltry & Momberg 2000).

The plant survey team's parataxonomist was able to identify only about 40 percent of the trees at the highest elevations, so dozens of unidentified specimens were collected and preserved. Many commercially important plants were recorded, such as *Calamus* spp. (rattan, widely used as a building material) above 300 m, and kresna wood (*Aquilaria* sp., exported for perfume production).

The FFI survey in 2000 (Daltry & Momberg 2000) was primarily intended to produce baseline biodiversity data in order to identify priority species and habitats for protection. Plants were also surveyed and their conservation needs assessed. The survey team believed that some of the vegetation communities are unique to the Cardamom Mountains. Recent botanical surveys have recorded seven genera of conifer from Cambodia: *Amentotaxus*; *Calocedrus*; *Cephalotaxus*; *Dacrydium*; *Nageia*; *Pinus*; *Podocarpus* (Tomas *et al.* 2007).

There have been many biological surveys within the Cardamom Mountains region. This report takes into account the FFI survey in 2000. Additional descriptions of fauna and flora by previous surveys are documented in Chapters 3 and 5.

6.5.3 Fauna

The Cardamom Mountains are now known to contain almost all the country's known mammals, birds, reptiles and amphibians. They are part of the most significant Indochina habitat of the tiger (*Panthera tigris*) and Asian elephant (*Elephas maximus*) and most significant global habitat for the Siamese crocodile (*Crocodylus siamensis*). They are one of the very few sites in Asia with white-winged ducks, black-necked storks and Asian arowana (ADB 2005).

The Cardamom Mountains and adjoining corridors contain significant populations of at least 59 globally threatened species and are crucial to the conservation of these species. The elephant population appears to remain highest in the Cardamom Mountains regions and is thought to be one of the largest in Indochina. The forests have been recognised the Ministry of Agriculture and Forestry and Fishery as a level I tiger

³ The Cardamom Mountains region constitutes three main massifs: Mount Samkos, the Central Cardamom Mountains and Mount Oral.

conservation unit. Other important species include the Asiatic wild dog, gaur, pileated gibbon, Eld's deer, elongated tortoise, spiny mountain frog, chestnut-headed partridge, Cambodian laughing thrush, silver oriole, great hornbill, lesser adjutant stork, Asian arowana, green peafowl, eaglewood and Siamese cycad (ADB 2005).

The FFI survey was primarily focus on larger mammals and their habitats, a wide range of other taxa, including plants, bats, other small mammals, reptiles, amphibians and insects, were also surveyed and their conservation needs assessed.

Although the FFI survey is the most extensive and detailed to have been conducted in the Cardamom Mountains, the species checklists are still far from complete. The fact that so many plants and animals were discovered in a short period in a relatively small area is testimony to the extraordinary biodiversity and pristine condition of the Cardamom Mountains. Further work is bound to yield more species and surprises.

(1) MAMMALS

The FFI survey found at least 34 species of large mammal, confirmed from tracks, droppings, visual searches, bushmeat remains and camera trap photographs (Daltry & Momberg 2000). Sixteen of them are classified as threatened or near threatened and 23 are listed by CITES. The project rated the Cardamoms as outstanding in density and diversity of large mammals. Confirmed species included globally threatened mammals such as gaur (*Bos frontalis* or *Bos gaurus*), Asian elephant (*Elephas maximus*), Asiatic wild dog (*Cuon alpinis*), smooth-coated otter (*Lutra perspicillata*), Asiatic black bear (*Ursus thibetanus*), pileated gibbon (*Hylobates pileatus*) and the rare Indochinese subspecies of tiger (*Panthera tigris*).

Carnivore specialists concluded that the Phnom Samkos Wildlife Sanctuary constituted "model habitat" for tigers. While certain large mammals, notably serow (*Naemorhedus sumatraensis* or *Capricornis sumatraensis*), were recorded only at high elevations, lowland habitats appeared to be especially important for elephants, tigers, sambars (*Cervus unicolor*) and wild dogs. Local people reported that there had been little or no decrease in large mammal populations during their lifetimes; elephant numbers were said to be on the increase (Daltry & Momberg 2000).

The FFI survey found 15 species of rodents had been captured by the middle of the survey, but the final total would not be known until voucher specimens had been fully examined in specialist museums. The mammalogists predict that some of these will be new to science. Fourteen bat species were captured using harp traps and mist nets on Phnom Samkos. Eight were new records for Cambodia, including the globally threatened *Harpiocephalus mordax*.

(2) BIRDS

The FFI survey recorded well more than 100 species of forest birds in the PSWS alone, with 15 new national records confirmed. As well as hosting many resident species, the Cardamom Mountains provide an important staging post for migrants. No new bird species were captured, but new subspecies may be described. While the mountain peaks were found to support fewer montane specialists than other, higher, parts of Indochina, the Cardamom foothills are notable for their exceptionally high bird diversity and biomass.

Certain IUCN red list and CITES-listed species such as the green peafowl (*Pavo muticus*) and wreathed hornbill (*Rhytoceros undulatus*) which have become rare in other parts of their range, appeared to be fairly common in the Cardamoms. Two known endemic birds, the Cambodian laughing thrush and chestnut-headed partridge (*Arborophila cambodiana*), were found to be abundant in the higher evergreen forests. A number of resident bird species are taken as bush meat for personal consumption, notably silver pheasants (*Lophura nycthemera*), partridges and hornbills (Daltry & Momberg 2000).

Eames *et al.* (2002) surveyed two hitherto unexplored mountains in the PSWS. A total of 166 bird species were recorded by either trapping or direct observation, including two threatened species (chestnut-headed partridge *Arborophila cambodiana* and green peafowl) and 15 species new for Cambodia. In total, 52 skins, one wing, 28 complete and 35 incomplete alcohol specimens and 35 tissue samples were collected. The collection included two specimens of the chestnut-headed partridge intermediate between the two known subspecies *A. c. cambodiana* and *A. c. diversa* and therefore distinctive enough to be described as a new subspecies. The occurrence of two restricted-range species (chestnut-headed partridge and

Cambodian laughing thrush (*Garrulax ferrarius*) means that the area should be considered to be of elevated conservation concern (Daltry & Momberg 2000).

(3) REPTILES AND AMPHIBIANS

The confirmed checklist includes a large number of endangered reptiles, such as the giant soft-shell turtle (*Pelochelys cantori*) and the Burmese python (*Python molurus*), as well as other species of economic, ecological, cultural and medical importance. Many of the reptiles were morphologically distinct from populations across the border in Thailand and could be described as new subspecies (Daltry & Momberg 2000).

Perhaps the most significant finding of the survey was the discovery of apparently intact populations of Siamese crocodiles (*Crocodylus siamensis*) in many of the larger rivers and marshes in the Central Cardamom Mountains. This critically endangered species was believed to be virtually extinct in the wild and has disappeared from most other parts of its range. This species was common and widespread in the wetlands and waterways of south-east Asia less than a century ago, but hunting and habitat loss have reduced its distribution to barely 1 percent of its former range. Based on surveys since 2000, it is estimated that fewer than 250 adults survive in the wild in the Cardamom Mountains (Daltry & Momberg 2000).

Grismer *et al.* (2007) described a new species of rhacophorid frog of the genus *Chiromantis* from Phnom Samkos. This new species is the eighth potential endemic from the Cardamom Mountains and underscores the need for continued field work there.

Thirty species of amphibians were found in the Cardamoms within the first month of the survey by Grismer *et al.* (2007). At least eight were new national records for Cambodia. A further 11 species, chiefly from high elevations, have not yet been identified and probably include several species new to science. The confirmed checklist includes frogs that are locally used for human consumption (e.g., *Rana raja*) as well as important prey for other animals (*Rana limnocharis* or *Limnonectes limnocharis*). From work elsewhere in Cambodia and neighbouring countries, there are probably well over 50 species of amphibians in the wider Cardamom Mountains.

The survey conducted by Daltry and Wüster (2002) found a new species of wolf snake of the genus *Lycodon* in the Cardamoms. Visually, the new species is most similar to *Lycodon subcinctus* from eastern Thailand and elsewhere in Cambodia.

(4) INSECTS

The FFI survey selected a single super-family of Lepidoptera, the Pyraloidea, to provide a measure of insect diversity and endemic species within different types of forest. Preliminary analyses suggest that the Cardamom Mountains harbour exceptional species richness: 1973 pyraloid moths were collected using light traps within just three weeks, of which one-fourth to one-third were estimated to be species new to science. Probably most are new national records for Cambodia. In addition, 100 flies, 15 dragonflies, 200 caddis flies, 20 wasps and 200 beetles were collected for identification by specialists (Daltry & Momberg 2000).

(5) FISHES

The FFI survey recorded 11 species of fish. Many are still awaiting identification. It is possible that more species could be found in this area. The species of special conservation concern, especially bonytongue *Scleropages formosus* of the dragon fish family Osteoglossidae, is reportedly found in the Cardamoms (Daltry & Momberg 2000).

APPENDIX-C WORKSHOP CORRESPONDENCES

During the course of the study, two major workshops were held to release the contents of the Master Plan Study and to organizations concerned to exchange information and opinions. In addition, as MIME had keen attention on the contents of the Interim Report, power sector internal discussions were made three times in total. This appendix introduces the contents of these correspondences including the interim report to the NGOs by the Study Team.

1. The First Internal Workshop

- (1) Date: November 13, 2007 (Tuesday)
 (2) Venue: MIME conference room (Phnom Penh)
 (3) Outlines:

- ① At first, it was intended to hold an open workshop to the public. After discussions and coordination with MIME, the workshop was held as an internal one, with strong request from MIME.
- ② The Study Team selected explained on the 10 priority projects for further examination. The 10 priority projects were approved by MIME.

- (4) Attendants: As per the attached attendants list

(5) Program:

Time	Program	Presented by
08:30-08:45	Keynote address	H.E. Secretary of State, Dr. Ith Praing
08:45-09:00	Introduction of study team members	JICA-MIME C/P Team
09:00-09:45	Section 1 Introduction	JICA team
09:45-10:50	Section 2 Project screening	JICA team
10:50-11:10	Tea break	
11:10-11:50	Discussion	
11:50-12:00	Concluding remarks	H.E. Secretary of State, Dr. Ith Praing

(6) Major comments and response from the Study Team

No.	Comments	Response/Opinions of the Study Team etc.
1.	<p>MIME</p> <ul style="list-style-type: none"> ◇ What is the reason of the necessity for Open Workshop of the Master Plan Study? ◇ It is ok to make dissemination but it is difficult to make discussion on the Master Plan. The Master Plan has not been 	<ul style="list-style-type: none"> ◇ Hydropower development is now ongoing in Cambodia. Everybody is looking at such development. Explanation of the government policy is necessary. ◇ Hydropower development is not only the issue of the government but also the issue

No.	Comments	Response/Opinions of the Study Team etc.
	<p>prepared yet. For discussion with the people concerned with a project, public hearing would be necessary to project-affected people (PAP) of individual project area on the resettlement program, etc.</p> <p>◇ The Master Plan is a policy matter, which is difficult or not suitable to discuss but could be disseminated at the Open Workshop. Public may not be interested in the technical matters of Hydropower Master Plan.</p>	<p>for the national citizens of Cambodia. To avoid unnecessary conflict with NGOs etc., explanation is required.</p> <p>◇ Today's presentation material is good enough to explain to NGOs. If MIME does not disclose such information, it would be a big issue in the later stage.</p> <p>◇ It is necessary and important for MIME to explain the progress of the Master Plan Study, and to disseminate the Power Policy.</p> <p>◇ The study team considers it is important to disseminate not only the Final Master Plan but also to explain on the process and interim progress of the Master Plan Study.</p>
2.	<p>MIME</p> <p>◇ In a normal way, master plan studies are discussed only among the concerned ministries. Information disclosure or public awareness program to the public is made during the implementation stage.</p> <p>◇ Resettlement is one of the big issues. When a development plan is disclosed to the public, some people would try to migrate into and settle in the project areas illegally.</p> <p>◇ It is not necessary for NGOs to join in the discussion at this stage of the Master Plan Study.</p>	<p>◇ Explanation of progress and dissemination is important to hear on their concerns and needs and to get feedback to the Study.</p>
3.	<p>MIME</p> <p>◇ Today, the ministry listened to the study team's request. Today's discussion results will be reported to the Minister and we wait for his decision on the dissemination at the Open Workshop.</p>	<p>◇ NGOs have already known about the Hydropower Master Plan Study, and there are already many inquiries on the Study to JICA Cambodia Office.</p> <p>◇ Site survey would start even from the day after tomorrow (15th Nov.). Can we get approval only on the selection of the 10 projects so that we can start field survey and further in-depth review?</p> <p>◇ In the study team's schedule, it is already in the Second Stage to make field survey at the sites. During the field survey, the study team needs to explain the background and necessary information to the local people as required.</p> <p>◇ The study team needs approval to proceed to the field survey. If the approval is not obtained and is disapproved in the future, the study cannot be preceded further.</p>
4.	<p>MIME</p> <p>◇ MIME basically agrees to the study result</p>	<p>◇ The study is being carried out in accordance</p>

No.	Comments	Response/Opinions of the Study Team etc.
	<p>presented by Mr. Katayama.</p> <ul style="list-style-type: none"> ◇ For #7&8 Lower Sre Pok 2 + Lower Se San 2 Project (LL2), now feasibility study (FS) is ongoing by Vietnam. What will be the outcome or contribution of the study team to this project for example? ◇ In the Master Plan Study, it seems that ongoing projects are not considered. It should be included in the Master Plan. 	<p>with the Scope of Works (S/W) concluded between MIME and JICA. In the selected 10 projects, there are three projects which have MOU with private companies for study. The field survey by the study team in the LL2 site is not to help the FS but for study on the necessary Institutional Recommendations to be elaborated in Stag 3 of the Study towards implementation of the Master Plan Projects.</p> <ul style="list-style-type: none"> ◇ The Master Plan Study aims at formulating the input sequences of hydropower projects into the National Generation Expansion Plan, in which the ongoing projects will be integrated.
5.	<p>MIME</p> <ul style="list-style-type: none"> ◇ The selection of 10 projects for field survey is ok. Discussion is necessary on which sites to be surveyed because some of the projects are already under study by other companies. ◇ In our opinion, #7&8 Lower Sre Pok 2 + Lower Se San 2 (LL2) is not necessary to conduct field survey as FS is ongoing by Vietnam. 	<ul style="list-style-type: none"> ◇ The study team needs to conduct sample field survey because we should review and give Institutional Recommendations for implementation of the Master Plan Projects. ◇ LL2 has really significant environmental impacts and needs careful EIA. The recommendations would help MIME in appraising projects.
6.	<p>MIME</p> <ul style="list-style-type: none"> ◇ From the results of this study, almost of the selected projects are of reservoir type. There is no run-of-river type development. That means a reservoir type is much better than run-of-river type. We would like to confirm the selection criteria. ◇ For sedimentation problem, there should be a technical solution by sand flushing for example. So, such projects should not be excluded from the candidates for implementation. ◇ For power density of 500kW/km², how the study team arrived at this value? 	<ul style="list-style-type: none"> ◇ For run-of-river type development, as was discussed during the inception stage in July 2007, in the northeastern part of Cambodia, a dam is required to create head in the gentle topography, for hydropower generation. In the southwestern part, head for power generation is available in general on the steep river courses, but due to the low discharge in the dry season, a dam is required for augmenting the dry season discharge for power generation from the stored water in the reservoir. Alternative options for run-of-river type was examined during the inception stage, however, due to the situation, such alternative could not be adopted in general. (Note: Prek Liang IA project is of run-of-river type to be directly connected to the tailrace outlet of the upstream Prek Liang I project.) ◇ For sedimentation problems there are cases of Three-Gorge Project in China, Miwa dam in Japan, and so forth, which practice sand flushing. The Mekong mainstream projects have disadvantage in sand flushing such as low hydraulic head available for flushing, wide river course/reservoir area that would result in local flushing along certain water courses only. Detailed study and examination are essentially required not

No.	Comments	Response/Opinions of the Study Team etc.
		<p>at future DD stage but at the FS and EIA stage to prove the technical feasibility of the sand flushing or other mitigation measures.</p> <p>✧ For the power density threshold at 500 kW/km², the study team proposed the figure for achieving the balanced development of hydropower resources and environmental conservation throughout the Cambodia. By employing the threshold at 500 kW/km², about one half of the technical potentials except for the Mekong mainstream projects could be developed. This is to aim at a Win-Win solution between the two positions.</p>
7.	<p>MIME</p> <p>✧ We would like to confirm whether Lower Se San III or Lower Sre Pok III can be changed to run-of-river type or not.</p>	<p>✧ By changing from reservoir type to run-of-river type, the study team has a concern whether we can develop a hydropower greater than 10 MW or not.</p> <p>(Ref. item No. 6)</p>
8.	<p>MIME</p> <p>✧ The selected 10 schemes are acceptable. It is ok to start the field survey. The survey team can contact people and NGOs as required. MIME needs the survey report.</p> <p>✧ The study team may explain to the window of NGOs with the materials distributed today for explanation and discussion at the Internal Workshop.</p>	<p>✧ The Study Team conducted the field survey for formulation of the Master Plan based on the selected 10 priority projects.</p> <p>✧ During the field survey, the Study Team contacted the residents or NGOs to collect necessary information.</p> <p>✧ The Study Team explained the contents of the study to NGO forum on November 19, 2007.</p>

List of Attendants for the First Workshop (November 13, 2007)

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	K. Suzuki	Director of Electric Power and Energy Team	JICA Headquarter
2	S. Kobayashi	Program Officer	JICA Headquarter
3	Shigeki Miyake	ARR	JICA Cambodia Office
4	Nozomi Saito	Intern Trainee	JICA Cambodia Office
5	Akihisa Haraguchi	Project Formulation Advisor	JICA Cambodia Office
6	Takahashi Washizawa	JICA Expert to MIME	JICA Cambodia Office
7	Hitoshi Kanetsuki	Member of JICA Mission	Chugoku Electric Power
8	Hideki Narumi	Member of JICA Study Team	JEPIC-ICC
9	Atau Kishinami	Member of JICA Study Team	IDEA
10	Akio Katayama	Leader of JICA Team	NK
11	Yuichi Ueda	Hydrologist of JICA Team	NK
12	Mika Matsumura	Social Env./JICA Study Team	KRI
13	Takeshi Okamura	Hydropower Engineer	NK
14	H.E. Dr. Ith Praing	Secretary of State	MIME
15	H.E. Mr. Tun Lean	General Director	MIME
16	Dr. Bun Narith	Deputy General Director	MIME
17	Hul Kunnak Vuth	Executive Director	EAC
18	Victor Jona	Deputy General Director	MIME
19	Much Chhun Horn	Director	MIME
20	Praing Chulsa	Deputy Director	EDC
21	Chea Narin	Chief Office	MIME
22	Mak Thorn	Deputy Chief Office	EDC
23	Cheap Sour	Director	MIME
24	Heav Chanvisal	Chief of Construction	EDC
25	Nong Sareth	Deputy Director_HED	MIME
26	He Sam Ol	Deputy Chief Office	MIME
27	Hean Veasna	Staff_HED	MIME
28	Sok Sophorn	Staff of mapping	MIME
29	Pan Narith	Deputy chief, Hydro Dept	MIME
30	Horn Naren	Staff of HED	MIME
31	Oung Vuthy	Chief Office	MoE
32	On Vuthy	Deputy Director, HED	MIME
33	Heang Bora	Chief Office, DET	MIME
34	Pen Sameth	Staff, HED	MIME
35	San Vibol	Chief Office	MIME
36	H.E. Keo Rottanak	Director of Minister's Cabinet	MIME

2. The Second Workshop (Open)

- (1) Date: September 15, 2008 (Monday)
 (2) Venue: Cambodiana Hotel (Phnom Penh)
 (3) Outlines:

- ① For the presentation of the Study results up to the 2nd field survey and the contents of the Interim Report.
 ② MIME organized the workshop and the Study Team assisted MIME.
 ③ Discussions, Questions and Answers on the result of the study

- (4) Attendants: As per the attached attendants list
 (5) Program:

Time	Program	Presented by
08:00-08:30	Registration	
08:30-08:35	Welcome Remarks	Katayama
08:35-08:45	Opening address	H.E. Dr. Ith Praing
08:45-09:00	Introduction of Hydropower Master Plan Study	Okamura/Much Chhun Horn
09:00-09:30	Section 1 Master Plan Projects	Katayama/Dr. Bun Narith
	Q&A, Discussion	
09:30-10:10	Section 2 Hydropower Planning	Okamura/ Much Chhun Horn
	Q&A, Discussion	
10:10-10:30	Tea break	
10:30-11:10	Section 3 Social and Environmental Considerations	Yamashita/Heng Kunlearnng
	Q&A, Discussion	
11:10-11:40	Section 4 Economic Assessments	Yamashita/Heng Kunlearnng
	Q&A, Discussion	
11:40-12:10	Section 5 Institutional Arrangements	Katayama/Dr. Bun Narith
	Q&A, Discussion	
12:10-12:20	Concluding remarks	H.E. Dr. Ith Praing

(6) Major comments and response from the Study Team

No.	Comments	Response/Opinions of the Study Team etc.
1.	World Bank ✧ The Study Team should consider the plant factor from the current 40% to more than that.	✧ As a standard plant factor of hydropower plants in the power grid, the Study Team has recommended 40%, which enables 9.6 hour peaking power a day. The seven hydropower projects planned by the Study Team have a target Capacity-Inflow Ratio (CIR), 20% in the northeastern region and 30% in the southwestern region. Accordingly, except for LL2 which has a CIR of 5% and is a run-of-river scheme in terms of flow regulation capacity, the other projects can generate significant firm power throughout the year. Their power output similar to the installed capacity could be generated for 9.6 hr even during the dry season. It will not drop like a run-of-river project.

No.	Comments	Response/Opinions of the Study Team etc.
2.	<p>MIME</p> <ul style="list-style-type: none"> ◇ The Study Team's definition on Power Density should be carefully considered. There could be such arguments that some of the reservoir area is forest but some are not. Some may be bamboo vegetation. 	<ul style="list-style-type: none"> ◇ As for the power density, the Study Team introduced one threshold criteria of 0.5 MW/km² of reservoir area. All the selected projects cleared this criterion. (Supplementary Note: The threshold criteria are to be applied to single purpose projects for energy generation. If a dam project is of multi-purpose and the project has such economic benefits as flood control, development of water resources for irrigation and municipal water supply, the threshold criteria could not be applied.)
3.	<p>MAFF</p> <ul style="list-style-type: none"> ◇ In the five aspects comprehensive assessment (FACA), for natural and social environmental aspects, there seems to be less discussion on fishery. Migratory flow of fish on the river will be affected. I am very much concerned about fishery. 	<ul style="list-style-type: none"> ◇ In general, on the rivers situated in the northeastern region, it is reported there are fish migration between Tonle Sap and 3S Rivers. Installation of fish pass is one of the options. Fish culture using reservoir should also be studied. (Supplementary note: Forecast of the impacts on fish catch is a difficult task. WWF reports the risk of Mekong River is at over-fish catch. Fishing industry like hunting culture in the ancient time could not be continued in the 21st century but fish culture should be promoted as has been practiced in China.)
4.	<p>MOPWT</p> <ul style="list-style-type: none"> ◇ About building hydropower dam, Lower Sre Pok 2 + Lower Se San 2 will submerge the road between Ou Pou Mon and Banlung. There have been several discussions on the road between the Ministry of Interior and Ministry of Public Works and Transport. We got a draft layout of the road from EVN. However, I am not very sure about the size of the reservoir. I would like to know the specific plan of the reservoir. 	<ul style="list-style-type: none"> ◇ We are doing the Master Plan study including field survey. Much more detailed feasibility study is undertaken by EVN. For the reservoir area, EVN could tell you more accurate figures. Planning and relocation of the road should be studied in the feasibility study, and it is beyond our scope of works of the study. (Supplementary note: The layout of relocation road shown in the presentation was our assumption for rough cost estimate since the layout of EVN was not available to the study team.)
5.	<p>EAC</p> <ul style="list-style-type: none"> ◇ As for social environment and economic analysis, it is necessary to consider from construction stage to operation stage. How much does the Study Team take into consideration the environmental cost and compensation cost? ◇ There are two major ways of investment. One is public investment and the other is private investment. Private investment normally gives us higher tariff, but for the government, much tax revenue is expected from such 	<ul style="list-style-type: none"> ◇ For the compensation costs, \$3,500 per household is considered for the compensation of houses and \$11,000 per hectare is considered for the compensation of farmlands. ◇ Environmental protection cost is set at 3% of the total civil construction cost commonly for all the projects studied. ◇ Differences in the financial revenue and expenditures of the Government are not considered in the financial analysis for the

No.	Comments	Response/Opinions of the Study Team etc.
	<p>private investment. In the case of private investment, government is still able to control the investor's activities including compensation or environmental countermeasures. It is necessary to compare public investment and private investment to select the best way for the fastest implementation. Economic and financial evaluation may differ by such cases of public investment and private investment. I would like to know whether such considerations on financial structures are made for the analysis.</p>	<p>Master Plan study. It was intended to compare the projects on the same basis. After decision of the project implementation mode, either public or private, financial structures would be considered in the feasibility study level.</p>
6.	<p>World Bank</p> <p>◇ Stung Metoek project indicates its development cost of 10 cent/kWh. How can we export the electricity?</p>	<p>◇ In the Master Plan, Stung Metoek 2 and Stung Metoek 3 are reformulated to locate respective power stations on the Cambodian side. The electricity is planned for domestic supply. Because of the topography, heads for power generation are small and thus the cost will be more than 10 cent/kWh. However, the water released after power generation still has a significant economic value as water resources in the region where severe water shortage has been experienced. If we consider developing the Stung Metoek 2 and 3 as multi-purpose projects, the power tariff (10 cent/kWh) can be lowered through cost sharing.</p>
7.	<p>EAC</p> <p>◇ Water may be supplied to Thai side while the dam and turbine are situated on the Cambodia side. About 500 MCM of water would be available every year at an altitude of 50 m above sea level. There may be two options: one is to supply all the water to Koh Kong city, and the other is to export some water to Thai land.</p> <p>◇ Apart from the revenue from water export, we have much macro economic benefit for our economy.</p>	
8.	<p>MOPWT</p> <p>◇ By the construction of hydropower dams, not only fish migration but also people's boat navigation will be affected. MOPWT should consider the change of people's ways of transportation. MOPWT requests the JICA Study Team to consider navigations. About building</p>	<p>◇ Navigation lock will be included as one of recommendations in the Master Plan.</p>

No.	Comments	Response/Opinions of the Study Team etc.
	<p>hydropower dam, Lower Sre Pok 2 + Lower Se San 2 will submerge the road between Ou Pou Mon and Banlung. There have been several discussions on the road between the Ministry of Interior and Ministry of Public Works and Transport. We got a draft layout of the road from EVN. However, I am not very sure about the size of the reservoir. I would like to know the specific plan of the reservoir.</p>	
9.	<p>EAC</p> <ul style="list-style-type: none"> ◇ In the slide No. 7 of the presentation, it is mentioned “about 0.4 cent/kWh for surcharge on power tariff...”. Some of the projects are good and but for some other projects, costs are high. If we adopt the same surcharge on power tariff (0.4 cent/ kWh) for all hydropower projects. While hydropower projects with high financial performances are affordable for paying such surcharge, the projects with lower profitability don’t have enough capability for paying the surcharge. In charging the surcharge, it is better to consider potential profitability of each project. ◇ In slide No. 8, there is an item of “Infrastructure project such as road, electrification” as sub item of “4. Village development with Surcharge/SEF”. Many ministries will be involved to such infrastructure project. I would like to know from experiences in Japan that whether such Surcharge/SEF can be returned to the project or such budget will go under MEF. 	<ul style="list-style-type: none"> ◇ Surcharge may be imposed on all the grid users., Contribution by IPP to SEF (Social and Environmental Fund) may depend on economic performance of individual project, some are difficult to bear such cost. ◇ However, logical basis of such levy is to require IPP to bear external non-economy costs of the project due to environmental impacts like forest submersion and to add these to the project cost. The project cost including environmental costs should be evaluated. If environmental cost is too high, it means the project is not economic. ◇ There will be a new study team coming in November for technical assistance to EAC. You can consult that study team on the surcharge practiced in Japan if necessary.

List of Attendants for the Second Workshop (September 15, 2008)

LIST OF ATTENDANTS

No.	Institution	Name	Organization	Post/Title
1	MIME	H.E. Dr. Ith Praing	MIME	Secretary
2		H.E. Mr. Khlaout Randy	MIME	Secretary
3		Dr. Bun Narith	MIME	Deputy Director General
4		Much Chhun Horn	MIME	Director of HED
5		Heng Kunleang	MIME	Director of EDD
6		Nong Sareth	MIME	Deputy Director of HED
7		Chiv Hour	MIME	Deputy Director of HED
8		On Vuthy	MIME	Deputy Director of HED
9		So Veasna	MIME	Deputy Director of ETD
10		Chea Narin	MIME	Chief of Office, HED
11		San Vibol	MIME	Chief of Office, HED
12		Kimnhan Chan Amrin	MIME	Deputy Chief
13		Pan Narith	MIME	Vice chief of Office, HED
14		He Samol	MIME	Vice chief of Planning Office
15		Pen Sameth	MIME	HED staff
16		Horn Naren	MIME	HED staff
17		Hean Veasna	MIME	HED staff
18		Bun Vichet	MIME	HED staff
19		Chea Piseth	MIME	HED staff
20		Sun Davin	MIME	HED staff
21		Chi Chanraksmeay	MIME	HED staff
22		Sok Sophom	MIME	Staff of Geology Dept
23	DIME	Chhun Hin	DIME Kampot	Director of DIME Kampot
24		Say Hay	DIME Koh Kong	Chief of Energy Office
25		Seng Bunthol	DIME Pursat	
26		Hem Vanthorn	DIME Ratanakiri	Director of DIME Ratanakiri
27		Pheng Chea	DIME Stung Treng	Director of DIME Stung Treng
28	Provincial Authorities	Sales Sen	Kampot Provincial Office	Vice Governor Kampot
29		Ean Savan	Koh Kong Provincial Office	Vice Governor Koh Kong
30		Keo Thy	Pursat Provincial Office	Vice Governor Pursat
31		Kong Sipha	Stung Treng Provincial Office	Vice Governor Stung Treng
32	Government Institutions	H.E. Dr. Ty Norin	EAC	Chairman
33		Mak Thorn	EdC	Vice chief of Office
34		Heav Charvisal	EdC	Vice chief of Section
35		Kang Chanthan	MOWRAM	
36		Oum Borith	MLMUPC	Deputy Director Department
37		Chea Nareth	Forestry Administration	Staff of Forestry Administration
38		So Sophort	CNMC	Director of Department
39		Hong Sinara	Ministry of Public Works and Transport	Deputy Director General
40	Prum Somany	Ministry of Agriculture, Forestry and Fisheries	Fishery Department	
41	International Donor Agencies	Shigeki Miyake	JICA Cambodia Office	
42		Meng Chanvibol	JICA Cambodia Office	
43		T. Washizawa	JICA in MIME	JICA Expert
44		Veasna Bun	WB	Operations Officer
45		Nida Ouk	ADB	Senior Project Officer
46		Toch Sovanna	UNIDO	Representative
47	JICA Study Team	A. Katayama	JICA Study Team	
48		T. Okamura	JICA Study Team	Hydropower Engineer
49		T. Yamashita	JICA Study Team	
50		Ung Chanpisey	JICA Study Team	Secretary
51		Ches Sophy	JICA Study Team	Assistant
52		Kao Vannak	Raffle Hotel Le Royal	
53	Media	Ken Son	TVK	
54		Mak Renita	TV Bayon	
55		Nov Kunthea	Reaksmey Kampuchea Newspaper	
56		Ty Uysong	Koh Santepheap Newspaper	
57	Interpreter	Sok Leang	Go Translation Service	Interpreter

3. Other internal meetings, explanation to NGO etc.

Other than the two major Workshops, the following three internal meetings were held among power sector government officers. In addition, the Study Team briefed the contents of the Second Workshop to NGOs to exchange opinions. Details are as follows:

(1) The first internal power sector meeting on Interim Report

- 1) Date: August 21, 2008 (Tuesday) 8:40-12:00
- 2) Venue: MIME conference room (Phnom Penh)
- 3) Program;

Time	Program	Presented by
08:30-08:40	Opening address	H.E. Mr. Tun Lean
08:40-09:00	Section 1 Master Plan Projects	Katayama
09:00-09:45	Section 2 Hydropower Planning	Okamura
09:45-10:15	Section 3 Social Impacts	Matsumura
10:15-10:30	Tea break	
10:30-11:00	Section 4 Environmental Impacts	Sah
11:00-11:30	Section 5 Economic Assessments	Katayama /Okamura
11:30-11:45	Section 6 Institutional Arrangement	Katayama
11:45-12:00	Concluding remarks	H.E. Mr. Tun Lean

4) Attendants:

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	H.E. Mr. Tun Lean	Director General	MIME
2	Dr. Bun Narith	Deputy Director General	MIME
3	Much Chhun Horn	Director of HED	MIME
4	Heng Kunleang	Director of EDD	MIME
5	Nong Sareth	Deputy Director of HED	MIME
6	Chea Narin	Chief Office	MIME
7	San Vibol	Chief Office	MIME
8	Kimnhan Chan Amrin	Deputy Director of HED	MIME
9	Pan Narith	Deputy Director of HED	MIME
10	Mok Phoumy	Deputy Chief	EdC
11	Heav Chanvisal	Chief of Construction	EdC
12	Nong Chhavyvann	Staff	MIME
13	Sok Sophorn	Staff of Geology Dept	MIME
14	Miyake Shigeki	ARR	JICA Cambodia
15	Meng Chan Vibol	Program Officer	JICA Cambodia
16	Takeshi Washizawa	JICA Expert to MIME	JICA
17	A. Katayama	JICA Study Team Leader	Nippon Koei
18	Y. Miyagawa	JICA Study Team	Nippon Koei
19	B. P. Sah	JICA Study Team	PASCO Corporation
20	T. Okamura	JICA Study Team	Nippon Koei
21	M. Matsumura	JICA Study Team	Koei Research Institute
22	Ung Chanpisey	Secretary	JICA Study Team

5) Major comments and response from the Study Team

No.	Comments	Response/Opinions of the Study Team etc.
1.	<p>MIME</p> <p>◇ As a result of the selection of priority projects, ten schemes were selected and then the number was reduced to seven. Is there any idea of selecting three more to make it ten again?</p>	<p>◇ The study team has selected, in Stage 1 of the Study, 10 priority projects from the 29. Thereafter three projects were excluded: one reduced for the integration of PL1 and PL1A into PL1; one for discarding USRC for its low economic performance; and the one was reduced by excluding from Master Plan projects but treating as a committed project since implementation agreement was concluded in June 2008 with a Chinese developer.</p> <p>◇ The TOR of the present Master Plan require to select and study 10 priority projects as subjects for preparing the Hydropower Master Plan. If we try to maintain the number at ten, we need to redo the past process from the beginning. Such is a task beyond the Scope of Work (the number of total priority projects might decrease even during such additional work due to commitment of some projects for implementation). If you do wish to increase to ten, our counterpart team would be required to undertake such tasks.</p>
2.	<p>MIME</p> <p>◇ How the study team concludes on the Mekong mainstream projects of Sambor and Stung Treng?</p>	<p>◇ Unless otherwise the technical feasibility of sand flushing of deposited material in the wide and flat reservoir is confirmed, Mekong Mainstream projects should not be implemented. To confirm such technical feasibility, it is necessary to (i) survey and analyze suspended solid (SS) on its particle size distribution, concentration, mineral components (especially for clay), and (ii) confirm with model tests and simulation, whether it is possible to secure the necessary tractive force in the major part of the reservoir.</p> <p>◇ In the wide and flat reservoir area of Sambor project, it will not be easy to secure the necessary tractive forces.</p> <p>◇ MIME hopes the development of Mekong Mainstream even it is of the run-of-river type development. There would be a possibility of run-of-river type development using small channels in the river course.</p>

(2) The second internal power sector meeting on Interim Report

- 1) Date: August 29, 2008 (Friday) 8:45-12:20
- 2) Venue: MIME conference room (Phnom Penh)
- 3) Program: The same as the meeting on August 21.
- 4) Attendants:

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	H.E. Dr. Ith Praing	Secretary	MIME
2	H.E. Mr. Khlaut Randy	Secretary	MIME
3	H.E. Dr. Ty Norin	Chairman	EAC
4	H.E. Mr. Tun Lean	Director General	MIME
5	H.E. Mr. Keo Ratanak	Managing Director	EdC
6	Dr. Bun Narith	Deputy Director General	MIME
7	Cheap Sour	Director of Minister's Cabinet	MIME
8	Much Chhun Horn	Director of HED	MIME
9	Heng Kunleang	Director	MIME
10	Theng Marith	Director of Regulation	EAC
11	Nong Sareth	Deputy Director of HED	MIME
12	So Veasna	Energy Technique	MIME
13	Chea Narin		MIME
14	San Vibol		MIME
15	Oung Vuthy		MoE
16	Kimnhan Chan Amrin	Deputy Chief	MIME
17	Pan Narith		MIME
18	Mok Phoumy	EdC staff	EdC
19	Mak Thorn	EdC staff	EdC
20	Heav Chanvisal	EdC staff	EdC
21	Sok Sophorn	Staff of Geology Dept	MIME
22	Y. Miyagawa		JICA Study Team
23	B. P. Sah		JICA Study Team
24	T. Okamura	Hydropower Engineer	JICA Study Team
25	M. Matsumura		JICA Study Team
26	T. Yamashita		JICA Study Team
27	Ung Chanpisey	Secretary	JICA Study Team

5) Major comments and response from the Study Team

No.	Comments	Response/Opinions of the Study Team etc.
1.	EDC ✧ What will be the strategy and concrete measures for social impact mitigation?	✧ Details will be examined during this study stage. The rough ideas of the Study Team are as follows: ① Cross subsidy from grid users to be used for rural electrification and community development project = Surcharge on electricity tariff ② Request IPP developers for establishment of Social Environmental Fund (SEF) ③ Consensus formation among people on the balance between hydropower development and environmental conservation

No.	Comments	Response/Opinions of the Study Team etc.
		④ Careful preparation of resettlement plan, considerations on livelihood, resettlement of community as a whole, compensation of “land for land” and “house for house”
2.	<p>EAC</p> <p>✧ The Study Team’s proposal on one project by the government force account with human resources development and technical transfer as major objectives, may contradict with the government’s policy to open the project to private sector.</p>	<p>✧ EDC as an implementing agency, with financial assistance from MDB or JBIC, the project can be implemented and capacity building and human resources development of the government staff can be expected. The Study Team understands that the government policy to open the project to private sector does not mean exclusion of power development by EDC. If the government takes up all of the prospective projects for implementation, it may contradict with the government policy. However, for the promotion of hydropower projects, if the government can get financial assistances, implementation of one project as a model case will contribute to the national benefit.</p>
3.	<p>EAC</p> <p>✧ Tendering is recommended from the Study Team for the selection of IPP developers, however, there are not much concrete examinations.</p>	<p>✧ The Study Team does not insist that all the projects should be by tender. For example, as for Prek Liang project, field investigations and topographic maps preparation were done for the first time by the Study Team to propose concrete plans. As a result, the project was realized as one of the precious hydropower resources in Cambodia. In other words, additional values were created by the Study Team.</p> <p>✧ For priority projects identified/proposed by public surveys as above, it is normal practice that such projects should either be implemented by the government or selection of IPP developers by tender in case of development by private sector.</p> <p>✧ For concrete ideas on IPP tendering, there is a prior study by the World Bank, however formulation of concrete idea is out of the TOR of the Study.</p>
4.	<p>EAC</p> <p>✧ The Study Team only focuses on hydropower, but thermal power should also be included for a comprehensive examination.</p>	<p>✧ The Study Team understands such opinion, but the Study is being implemented based on the agreed TOR.</p>

No.	Comments	Response/Opinions of the Study Team etc.
5.	<p>EAC</p> <p>✧ For Bokor Plateau project, it has some impact to ongoing Kamchay project but ranked as No. 4. What is the reason?</p>	<p>✧ Effective head of Bokor Plateau project is 912 m, on the other hand, that of Kamchay stays at 122 m. As a result of river diversion by Bokor Plateau project located upstream most of Kamchay basin, Kamchay hydropower project's inflow will decrease, resulting about 13 GWh of power generation decrease per year. However, even Bokor Plateau project compensate such power generation decrease, due to the high head of Bokor Plateau project, it is still a good project and ranked as No. 4.</p>
6.	<p>EAC</p> <p>✧ The Study Team recommends underground powerhouse for Prek Liang hydropower projects as they are located inside the national park. However, considering the financial affordability of Cambodia, it is questionable whether such idea is appropriate or not.</p>	<p>✧ Development type of the powerhouse is normally determined through comparison among underground, open, or semi-underground types.</p> <p>✧ One thing the Study Team can advise is that underground powerhouse is not as costly as generally supposed. In case of open type powerhouse, it is necessary to set the foundation elevation deep enough to satisfy the required draft head and stability of the powerhouse with the foundation rock. As a result, slope excavation volume behind the powerhouse may become quite large, thereby often requires the related slope protection works. For underground powerhouse, such large quantity of slope protection works will not be necessary. Therefore, there would not be so many differences in construction cost as is normally supposed.</p> <p>✧ Further for Prek Liang 1 project, the underground type powerhouse would be the only realistic layout of the project. Suppose the topography allows open type powerhouse, underground type powerhouse has a merit of applying non-pressure tailrace tunnel which is less costly, but open type powerhouse needs a long pressure tunnel and a large surge tank, which will be more expensive.</p>
7.	<p>EDC</p> <p>✧ The Study Team recommends Prek Liang project as a government own project with force account system with financial assistance from multi-lateral development bank (MDB). But to apply to World Bank or ADB, it may take four to five years to realize the</p>	<p>✧ The Study Team recommends a government force account project as a model project for (i) capacity building, and (ii) hydropower development inside national park. This concept is not against the government policy for power sector liberalization, but to recommend the</p>

No.	Comments	Response/Opinions of the Study Team etc.
	<p>project. It is questionable that such implementation is realistic. Now the power sector is liberalized. If the Study Team still recommends such force account system, there should be some wayout from the Study Team to synchronize force account and liberalization policy of the government in a reasonable way.</p>	<p>capacity building of the government staff in parallel with the promotion of hydropower development.</p> <p>✧ The Study Team supposes that “Wayout” means the provision of public fund. The Study Team is not able to promise the provision of the fund. For the provision of fund, it is necessary for the government to take initiative. (Refer to item No. 2)</p>

(3) The third internal power sector meeting on Interim Report

- 1) Date: September 5, 2008 (Friday) 8:45-11:30
- 2) Venue: MIME conference room (Phnom Penh)
- 3) Program:
 - (i) Explanation on the Outline of the Hydropower Master Plan Study
 - (ii) Q&A
- 4) Attendants:

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	H.E. Dr. Ith Praing	Secretary	MIME
2	H.E. Mr. Khlaut Randy	Secretary	MIME
3	H.E. Mr. Tan Kim Vin	Secretary	MIME
4	H.E. Dr. Ty Norin	Chairman	EAC
5	H.E. Mr. Tun Lean	Director General	MIME
6	Dr. Bun Narith	Deputy Director General	MIME
7	Victor Jona	Deputy Director General	MIME
8	Cheap Sour	Director of Minister's Cabinet	MIME
9	Much Chhun Horn	Director of HED	MIME
10	Heng Kunleang	Director of Energy Development	MIME
11	Theng Marith	Director of Regulation	EAC
12	Nou Sokhon	Director of Transmission Dept	EdC
13	Nong Sareth	Deputy Director of HED	MIME
14	On Vuthy	Deputy Director of HED	MIME
15	Chiv Huor	Deputy Director of HED	MIME
16	So Veasna	Energy Technique	MIME
17	Chea Narin	Chief of Hydro Planning Office	MIME
18	San Vibol		MIME
19	Oung Vuthy		MoE
20	Kimnhan Chan Amrin	Deputy Chief	MIME
21	Houng Chantha	Technical Manager	EdC
22	Mok Phoumy	EdC staff	EdC
23	Mak Thorn	EdC staff	EdC
24	Heav Chanvisal	EdC staff	EdC
25	He Samol	Deputy Officer HED	MIME
26	Pen Sameth	Staff of HED	MIME
27	Horn Naren	HED	MIME
28	Hean Veasna	HED	MIME
29	Chy Chanrasmey		MIME
30	Seng Kimrithy	Planning Office	MIME
31	Bun Vichet		MIME
32	Chea Piseth	HED	MIME
33	Son Davin		MIME
34	Takeshi Washizawa	JICA Expert to MIME	JICA
35	T. Okamura	JICA Study Team	Nippon Koei
36	T. Yamashita	JICA Study Team	Nippon Koei

1) Major comments and response from the Study Team

No.	Comments	Response/Opinions of the Study Team etc.
1.	MIME ✧ Royal Government of Cambodia (RGC) has already revised and prepared a new demand forecast/ generation expansion plan, which were already approved by	Issue-1 As a result of review of demand forecast of MIME's power development plan (PDP), it was realized that the PDP does not satisfy the

No.	Comments	Response/Opinions of the Study Team etc.
	<p>the Prime Minister in January 2008. MIME request the Study Team to prepare hydropower development plan based on the latest demand forecast/ generation expansion plan for formulation of the master plan.</p>	<p>demand. The review result shows that PDP can not satisfy the required reserve margin (15%). Further, during the period of 20 years up to year 2024, supply capacity is always below the demand except these three years of 2009 (reserve margin: 11.6%), 2013 (12.2%), and 2020 (1.9%).</p> <p>By applying MIME-PDP as a base, even with all the input of hydropower projects, it is not able to satisfy the demand. As a result, it becomes necessary for the Study Team to apply additional thermal power plants for master plan formulation. However, TOR of the JICA Study is to review the hydropower part of the existing KEPCO's power development plan including generation expansion plan and transmission extension plan, which were formulated in 2006. It is out of the scope to formulate a power development plan including thermal power plant.</p> <p>In the minutes of meeting in January 25, 2007, it is mentioned that the Study Team should use the KEPCO's study report result.</p> <p>Issue-2 As is separately proposed by MIME-EAC, this hydropower MP is as a part of generation expansion and transmission extension plans. If the Study Team formulate the hydropower master plan study with MIME-PDP as presented, it will be not possible to maintain the consistency of with the power development plan originally proposes.</p> <p>Issue-3 MIME-PDP presented to the Study Team on August 28, applies the method which is different from the common ways of formulation of generation expansion plan. That is, the assumed power generation of hydropower project is ambiguous. There is a big difference with the normal estimate method checked by the Study Team. There will be drastic modifications required if we apply the MIME-PDP.</p>
2.	<p>MIME</p> <ul style="list-style-type: none"> ◇ The Study Team can suggest the ideas of Social Environmental Fund (SEF). 	<ul style="list-style-type: none"> ◇ The Study Team heard that EAC was also considering such idea. It will be proposed in the Draft Final Report.
3.	<p>MIME</p> <ul style="list-style-type: none"> ◇ MIME requests to remove the threshold values of Power Density. 	<ul style="list-style-type: none"> ◇ Threshold values of power density (0.5 MW/km²) was explained and discussed during the first workshop on November

No.	Comments	Response/Opinions of the Study Team etc.
		<p>13, 2007, and MIME once approved the idea.</p> <ul style="list-style-type: none"> ◇ However, this value is the Study Team's recommendation value. Final application will be dependent on the government decision. ◇ Past samples of dam development in the world related with power density is shown in sub-section 9.4.2 (3) of the report. There are six projects reported in the past samples. ◇ During the first screening stage of this MP study, LSS3 and LSP3 projects were excluded for further examination because of the power density, numbers of household for resettlement, and area of inundated farmland. In Figure 9.4.2 of Chapter 9, these two projects are located in the upper right. It can be seen from the figure that those two projects have particularly significant environmental impacts in terms of inundated area and resettlement, though there are several other examples. ◇ For reference, CDM Board accepts application of simplified constant as a unit reservoir emission of CO₂ if power density is greater than 4.0 MW/km² ◇ Detailed descriptions are given in sub-section 9.4.2.(3).
4.	<p>MIME</p> <ul style="list-style-type: none"> ◇ How MIME should promote Mekong Mainstream projects in the future? 	<ul style="list-style-type: none"> ◇ Refer to Record of Meeting on August 21, 2008, item No. 2. ◇ In case the feasibility of sand flushing is judged to be unsolved. There would be a possibility of run-of-river type development using a part of small river courses on the river..
5.	<p>MIME</p> <ul style="list-style-type: none"> ◇ If the Study Team explains to NGO on the study progress/result, that will be the responsibility of the team and MIME is not particularly against. 	<ul style="list-style-type: none"> ◇ The Study Team explained the progress and interim result of the study to NGOs on September 15.

(4) Report to NGOs on the study results up to Interim Report

- 1) Date: September 15, 2008 (Monday) 15:00-16:30
- 2) Venue: Conference room in NGO Forum
- 3) Program:
 - ① Explanation of the study outline

Section 1 Electricity and Hydropower**Section 2 Master Plan Study****Section 3 Way Forward**

- ② Q&A

4) Attendants:

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	So Socheat	SCFO	WWF Greater Mekong
2	Mann Vuthy	Coordinator	Community Legal Educational Center
3	Tonn Kunthel	Project Officer	NGO Forum
4	WASHIZAWA Takeshi	JICA Expert	JICA in MIME
5	Meng Chanvibol	Program Officer	JICA Cambodia Office
6	Yamashita Akira	Project Formulation Advisor	JICA
7	MIYAKE Shigeki	A.R.R	JICA Cambodia Office
8	Ame Trandem	Advisor, Mekong Project	NGO Forum
9	Brian Lond		Oxfam
10	Seng Bunra		Conservation International
11	Bun Chantrea	Program Coordinator	NGO Forum
12	Akio KATAYAMA	JICA Study Team	JICA in MIME
13	Takeshi OKAMURA	JICA Study Team	JICA in MIME
14	Takeshi YAMASHITA	JICA Study Team	JICA in MIME
15	Ches Sophy	JICA Study Team	JICA in MIME

5) Major comments and response from the Study Team

No.	Comments	Response/Opinions of the Study Team etc.
1.	<ul style="list-style-type: none"> ◇ How the Study Team's MP will affect to the development plans of Chinese developers and MIME? For example, is it possible for the government or Chinese developers to implement the project which is not in the MP? 	<ul style="list-style-type: none"> ◇ The MP by the Study Team is prepared with assistance from the government. But the official MP will be prepared referring to the Study Team's MP. It is government decision whether to prepare an official MP along with JICA MP or not. There is no legal force on the JICA MP.
2.	<ul style="list-style-type: none"> ◇ Stung Chhay Areng is not included in the MP's Priority projects, but the Chinese developer and the government seem that they have never given up the development. People living in the region have been living in the region for 500 years or more, and they are tribes who keep the traditional ways of life. ◇ Unlike projects with rather small reservoir like Stung Tatay or Stung Metoek, Stung Chhay Areng has rather flat area and thus formulates a large scale reservoir. We have significant 	<ul style="list-style-type: none"> ◇ With the five aspects comprehensive assessment (FACA) by the Study Team, Stung Chhay Areng is ranked as No. 11. As the project formulates the reservoir using wide and flat area which is rather rare in this region, the reservoir will be large. As there are several villages, there will be a resettlement issue.

No.	Comments	Response/Opinions of the Study Team etc.
	concerns on the environmental impacts on flora and fauna.	
3.	<p>✧ Lower Sre Pok II + Lower Se San II (LL2) has broad area of the reservoir, and the construction cost is high. From socioeconomic survey, there are quite number of people against the dam construction and resettlement. However, in the Study Team ranked the project as No.1. What are the reasons?</p>	<p>✧ When prioritizing projects, LL2 had low scores on social environment aspect and natural environment aspects, but had high scores on technical and economic aspects, thus the total score was high to be the No. 1.</p>
4.	<p>✧ In case the reservoir area is quite wide, it is supposed that there may be cases where CO₂ emission will increase by the implementation of the project. Please explain the method of estimating CO₂ emission reduction effect.</p>	<p>✧ Effect of CO₂ emission reduction is estimated with the following three aspects:</p> <ol style="list-style-type: none"> 1) CO₂ emission reduction effects by replacing diesel power generation 2) Reduction of CO₂ absorption by forest inundation 3) Increase of CO₂ emission from the reservoir <p>✧ Of the 29 candidate sites, which were not selected as priority projects, there were a few projects with large reservoir and inundated forest area, resulting the estimate of CO₂ emission increase.</p>
5.	<p>✧ How social and natural environment aspects are evaluated in the economic evaluation?</p> <p>✧ For example, project sites in the northeast region, people live with inland fishery. How the Study Team evaluates the fact that people will not be able to catch fish as a result of dam construction?</p>	<p>✧ On social and natural environmental aspects, costs for resettlement, and contributions to social environmental fund (SEF) are taken into consideration. However those costs as were pointed out are not considered for evaluation.</p> <p>✧ For such estimate, data and analysis are necessary on the current fish catch, selling price of the fish, and anticipated decrease amount of fish catch due to dam construction. It is difficult to collect such data and analyze such aspects in the master plan study level.</p> <p>✧ In the Study, such impacts are not quantified, but envisaged items for impacts and their general mitigation measures are indicated. Detailed examination will be done during the FS stage.</p>