DON SAHONG HYDROPOWER PROJECT, LAO PDR

ENVIRONMENTAL IMPACT ASSESSMENT

FINAL

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Prepared for:

MEGA FIRST CORPORATION BERHAD

Prepared By:

National Consulting Company
Vientiane, Lao PDR

ENVIRONMENTAL IMPACT ASSESSMENT - DON SAHONG HYDROPOWER PROJECT

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ABBREVIATIONS AND ACRONYMS

AECOM	An international infrastructure engineering and consulting firm, author of the Final Feasibility Study and Engineering Status Report
APW	Australian Power and Water an author of the 2007 Draft EIA
ASEAN	Association of South East Asian Nations
CESVI	Cooperazione e Sviluppo (World Aid from Italy)
CIA	Cumulative Impact Assessment
CMPE	Centre of Malariology, Parasitological and Entomology
DAFEO	District Agriculture and Forestry Extension Office
DOE	Department of Electricity
DPRA	Development Project Responsible Agency
DSHPP	Don Sahong Hydropower Project
ED	Essential Drugs
EDL	Electricité du Laos
EIA	Environmental Impact Assessment
EMO	Environmental Management Office
EMMP	Environmental Management and Monitoring Plan
ESR	DSHPP Engineering Status Report (supersedes Final Feasibility Study (FFS))
EU	European Union
FCZ	Fishing Control Zone
FFS	Final Feasibility Study
FishMAP	DSHPP Fisheries Monitoring and Action Plan
FS	Feasibility Study
GFL	Great Fault Line
GMS	Greater Mekong Sub region
GOL	Government of Lao People's Democratic Republic
GWh	Gigawatt hours
ha	Hectare
HC	Health Center
IEE	Initial Environmental Examination
IPP	Independent Power Producer
IUCN	International Union for Conservation of Nature
JMP	Joint Monitoring Program for Water Supply and Sanitation by WHO/UNICEF
MA95	Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin made in 1995
MAF	Ministry of Agriculture and Forestry of Lao PDR
MDG	Millennium Development Goals
MEM	Ministry of Energy and Mines of Lao PDR
MFCB	Mega First Corporation Berhad
MIH	Ministry of Industry and Handicrafts of Lao PDR
MOH	Ministry of Health of Lao PDR
MoNRE	Ministry of Natural Resources and Environment of Lao PDR (formerly WREA)
MOU	Memorandum of Understanding
MRC	Mekong River Commission

MW	Megawatt (1 million watts of power)
NAFRI	National Agriculture and Forestry Research Institute of Lao PDR
NBCA	National Biodiversity Conservation Area
NCC	National Consulting Company
NEAP	National Environmental Action Plan
NGPES	National Growth and Poverty Eradication Strategy
NTFPs	Non-Timber Forestry Products
PAP	Project Affected Persons
PEC	PEC Konsult Sdn Bhd
PRC	People's Republic of China
RAP	Resettlement Action Plan
RESDALAO	Renewable Energy for Sustainable Development Association
SIA	Social Impact Assessment
SMMP	Social Management and Monitoring Plan
SOW	Statement of Work
STD	Sexually-transmitted disease
TBA	Traditional Birth Attendant
TOR	Terms of Reference
UNICEF	United Nations Children Fund
VHK	Village Health Kit
VHV	Village Health Volunteer
WHO	World Health Organization
WREA	Water Resources and Environment Administration (now MoNRE)

GLOSSARY OF COMMON LAO WORDS FOR GEOGRAPHICAL LOCATIONS

Don (e)	Island
Hang	tail / downstream tip (of the island)
Hou	River Channel
Hua	head or upstream tip (of the island)

EXECUTIVE SUMMARY

Background

Mega First Corporation Berhad (MFCB) signed a Memorandum of Understanding with the Government of Lao PDR (GOL) on March 23, 2006, giving MFCB exclusive rights to investigate the technical, environmental and economic feasibility of the Don Sahong Hydropower Project (DSHPP). The figure at right shows the general location of the Project.

A number of studies dealing with environment and social issues were completed on behalf of MFCB. These include an Environmental Impact Assessment (EIA, which incorporated a Social Impact Assessment or SIA), an Environmental Management and Monitoring Plan (EMMP), a Social Management and Monitoring Plan (SMMP), and a Resettlement Action Plan (RAP). Subsequent to these studies, MFCB signed a Project Development Agreement with GOL on 13 February 2008 to develop the Don Sahong Hydropower Project to a point where construction can begin.

Comments on the EIA 2007[1] were received from the MRC, WREA (now MoNRE), the Department of Electricity and some NGOs. These comments were addressed in draft updated environmental and social documents, which were submitted to the GOL (MoNRE) in October 2010. This document (hereafter called (EIA 2013) is the improved and finalised version of that draft EIA and reports the current information on the Project at this date.

Description of the DSHPP

The DSHPP is a run-of-river project situated entirely within the Hou Sahong, a 5 kilometre long channel between the islands of Don Sadam and Don Sahong (see figure below). The project layout envisaged is a concrete box-like structure comprising the dam and powerhouse to be constructed about 130 meters upstream of the downstream junction of the Hou Sahong with the main channel. The foundations for this structure will be about 15 m below the existing channel bed and will extend from bank to bank across the Hou Sahong channel. The structure will contain four bulb-type turbine generators and associated control and protection equipment. Three-phase transformers will be located on the downstream side of the powerhouse, with cables taking the high voltage power to an adjacent substation to the left of the powerhouse.

[1] Prepared by APW and PEC (2007). Don Sahong Hydropower Project, Lao PDR. Environmental Impact Assessment Report. Volumes 1 and 2, December 2007.

Construction of the dam and powerhouse will cause water to back up in Hou Sahong, creating a small headpond, the level of which will vary with the level of the Mekong upstream. The crest of the barrage is set at RL 76.9m, which exceeds the maximum level of the Mekong at the upstream entrance to the Hou Sahong. Because the topography of the two islands that form the banks of the Hou Sahong reservoir is below this level, embankments will be built on both sides and roughly parallel with the channel to retain the water.

At present the bed levels in the upper reaches of the Hou Sahong restrict flow into the channel during periods of low flow. To improve flow through the Hou Sahong the river bed will be excavated to an average of 3 m and 1.5 m depth at the upstream and downstream ends of the channel, respectively. A limited area will also be excavated downstream of the powerhouse. Excavated material will be used for concrete aggregate and to construct the retaining embankments. Any excess rock will be disposed of at carefully pre-selected locations on Don Sadam and Don Sahong. Excavation and other channel modifications are also proposed in Hou Xang Pheuak and in Hou Sadam to provide alternative fish migration routes to replace the Hou Sahong, which will be blocked to upstream movement of fish. This will be a vital component of the DSHPP fish migration mitigation program.

Potential Environmental and Social Concerns of the DSHPP

While hydropower dams can provide a significant impetus to regional and national economic growth and development, it is well known that they may also cause economic, environmental and social concerns. This EIA (and the associated Social Impact Assessment (SIA)) have identified and assessed the important potential impacts of the Project. In particular these were:

- impacts on the flow of the Mekong River;
- impacts on fish migration and implications for fisheries in the vicinity of the DSHPP and in the wider Mekong basin;
- social impacts in terms of displacing people and their resettlement;
- social impacts on the livelihoods of directly affected communities; and
- social impacts on the health and nutrition of affected communities.

The specific studies and analyses reported here, have been used to inform a comprehensive mitigation program, which is reported in other documents in the EIA package, namely the Environmental and Social Management and Monitoring Plans and the Resettlement Action Plan.

Legal and Institutional Framework

Key organizations and agencies involved in the environmental assessment process for hydropower projects include: the Government of Lao PDR (GOL); the Prime Minister's Office (PMO); Ministry of Natural Resources and Environment (MoNRE); the Ministry of Agriculture and Forestry (MAF); the Water Resources Committee; the Ministry of Energy and Mines (MEM); the Environmental Management Unit of MEM Hydropower Department; the Ministry of Finance; the Department of National Land-use and Planning; the Ministry of Education and Culture; and the District Governor(s) of the Project location. Measures for monitoring and managing potential environmental and socio-economic impacts have been developed based on Lao PDR legislation, regulations, decrees, standards and guidelines.

The 1995 Mekong River Commission Agreement (MA95)

The Mekong River Commission's (MRC) Agreement on Cooperation for the Sustainable Development of the Mekong River Basin has guided the development of the Project and the associated environmental and social documentation. This process is ongoing.

The MRC has indicated the following general principles for planning Hydropower development in the Mekong Basin:

- Development must be equitable and sustainable;
- Hydropower development in the Mekong Basin should be seen in context of the regional energy sector, in particular realistic future energy demands; and
- Fisheries and navigation are integral elements of hydropower dams, it is necessary to find optimal solution to conjunctive hydropower generation, navigation lock operation and fish migration.

Other Relevant International Agreements

The DSHPP is very close to the international border between the Lao PDR and Cambodia. Construction and operation of the project will have no significant direct impact on Cambodian Territory *per se*. The EIA and the associated Cumulative Impact Assessment (CIA) address this potential issue, as well as all Mekong flows downstream of the Project. Creation of a Ramsar Site in the Si Phan Don Wetland has been proposed. However, in May 2010 Lao PDR designated the Xe Champhone Wetlands (Savannakhet Province) and the Beung Kiat Ngong Wetlands (Champasak Province) as their first two Wetlands of International Importance..

Impacts and Mitigation

The EIA includes a summary of all potential impacts and mitigations related to the DSHPP (see Table 5-1). The following is a summary of the principal issues.

Fish Migration and Fisheries

The potential impacts of the proposed DSHPP on the sustainability of both local and regional fisheries have been identified as the most important environmental consideration for this EIA. This has been raised as a major issue in all discussions with concerned agencies such as MRC, IUCN, WWF and LNMC in Vientiane and in discussions with local stakeholders downstream in Cambodia. The relative significance / importance of the Hou Sahong as a year-round pathway for fish migration is still being investigated and monitoring will continue for ten years of the Project's life. A detailed analysis of the potential impacts and proposed mitigation measures is presented in two specialized reports on the fisheries (attached as Annex C and D). The results of those studies are summarised here.

The long-term sustainability of fisheries in the Mekong River that depend on migratory fish populations face a number of threats. The creation of man-made barriers across mainstream channels is one which is directly applicable to the DSHPP and this problem has been addressed carefully in this impact assessment. Other significant threats to migratory fish

include alteration of the natural river flow regime, altered sediment loads and loss of critical habitat especially from reduced connectivity between river and floodplain. As the DSHPP will not significantly increase any of these threats, no mitigation or management actions have been proposed for them by this Project[2].

Another significant and growing threat is the over-exploitation of migratory fish populations during critical life history stages. This is an area where the Project proposes to assist in more active resource management, by encouraging community co-management of the fisheries within the immediate Project footprint. This would be achieved by working with local villages and GOL resource managers to protect areas where fish may accumulate from over exploitation.

The first step, for the Project will be to create non-fisheries related livelihood income systems to compensate for direct Project related impacts arising from the permanent loss of fish-traps in the Hou Sahong and to reduce fishing pressure on alternate fish migration pathways created by channel modification in the Hou Xang Pheuak and the Hou Sadam.

Fish and Dolphins of the Lower Pools

Excavation of a tailrace channel in lower Hou Sahong is required as part of the project. This would have the same impacts as the upstream activities and would require the same precautionary and warning safety measures. The proposed operations also raise a concern regarding the potential impact on a residual population of "conservation sensitive" Irrawaddy dolphin, resident in the pools of the Mekong River. The main area where dolphins are usually seen is some 2-3 km from the tailrace channel. As dolphins are sensitive to underwater percussion charges, underwater blasting will not be permitted at any location below the GFL with connectivity to the known dolphin area.

The fish passage mitigation measures to be applied, together with the fisheries management program will ensure that the food supply in the dolphin area downstream of the DSHPP will be maintained.

Resettlement, Social Impacts and Livelihoods

Only eleven (11) households will need to be relocated and a resettlement action plan (RAP) has been developed and submitted to the GOL, to resettle these families and to provide for their future welfare. In addition a Social Management and Monitoring Plan (SMMP) has been prepared that will improve infrastructure (water supply, sanitation, education, health facilities and electric power) to the population of those villages whose livelihoods will be directly affected. The implementation of the Project will be of considerable economic benefit to Lao PDR and will provide improved infrastructure and stimulation for growth in the Champasak Province.

Health and Nutrition

The health risks facing people living in the Lao PDR are higher than for those living elsewhere in the region, based on current assessment of public health indicators like child mortality rates. People living on the islands in the Project area also face additional health problems due to their isolation from health services on the mainland and because of specific local diseases like schistosomiasis, which is due to contact with river water.

The hydropower project can improve this situation and reduce the risk from these diseases to both locals and temporary workers by implementing mitigation plans outlined in the SMMP.

[2] Negligible Project impacts on sediment transport and flow have been demonstrated by 1D and 2D modeling studies reported in AECOM (2011b).

At the same time, the Project is mindful that hydropower project camps can potentially aggravate local public health situations because of the concentration of external labor forces in temporary camps.

Numerous mitigating actions appropriate for the DSHPP management in relation to public health are proposed and discussed in the SIA and SMMP associated with this EIA. The DSHPP plans to assist local and regional health agencies to maintain and improve the existing public health standards and will implement its own programs to educate the workforce and local population alike of potential health risks, change dangerous behaviours and to improve the standards of sanitation and potable water quality within the Project area.

The DSHPP will engage a medical consultant to prepare a detailed plan for the construction operation. The medical plan for the DSHPP project should be pro-active, detail the exact role of DSHPP and contractor health and emergency response facilities with relation to local communities and should be a priority for the Project. Such a program is commonly linked with the overall safety program but in this case warrants special and early attention.

Climate Change

The DSHPP may have small but positive impacts on global climate change by providing electricity that does not involve the burning of fossil fuels. Because it is a run-of-river project there will be very little submerged biomass that would emit methane or other greenhouse gases, as has happened with projects that include large reservoirs.

Mitigation Measures

At the project level, MFCB and the DSHPP planners have designed a process to avoid and/or mitigate environmental or social impacts. These include:

- A comprehensive study of fish migration and fisheries was undertaken in 2010 to develop a mitigation strategy (see Annex C). The outcome was the DSHPP Fisheries Monitoring and Action Plan (FishMAP), which is a programme designed to fully mitigate the potential impacts to the fisheries resource and to fish migration through the Project area.
- Another important issue is the effect of the DSHPP on regional flows in the Mekong River. For that analysis, detailed computer models of the river were elaborated. The models demonstrate that the impacts of the DSHPP (a run-of- river scheme) on river flows will be insignificant, and will not affect downstream locations such as the Tonle Sap or the Mekong delta
- The replacement of the initially-proposed barge operations with a bridge that will provide a road link between the mainland and the islands of Don Sadam and Don Sahong.
- A smaller footprint for the reservoir and the other project components than was originally proposed.
- The use of more “fish-friendly” horizontal bulb type turbines instead of the preferred vertical Kaplan type, which are easier to maintain.
- The potential use of the dried river bed for construction laydown areas and camps instead of taking land on the two islands.
- Engineering aspects of the embankments design to reduce impacts and to provide alternative ways of providing irrigation water to villages on the two islands. Although a gravity irrigation system is preferred, the Project would provide pumps if necessary.
- Minimization of noise and vibration from blasting. A warning siren will be sounded and daily blasting will be done as much as possible all at once rather than spreading out many individual blasts over the day.

- The blasting for the downstream excavations will only be done after the coffer dams are constructed, so blasting will be on dry land and will avoid impacts to dolphins or fish that would occur with underwater blasting.
- The construction company will be selected based on their experience, expertise, and financial strength to make sure that the project is built according to plan and that there is little or no danger of the project being abandoned due to contractor's problems.
- Unlike Nam Theun 2 which emphasized "livelihood restoration", DSHPP will strive for "livelihood betterment". This may include the appointment of "wealth-creation" advisors, who would work with the local people to help them maximize the Project's local economic benefits (such as increased land values) and help create opportunities to add value to existing agricultural and fishery products or switch to other higher-valued forms of agriculture).

Consultation

Extensive consultation with stakeholders has been carried out in Lao PDR and Cambodia. This has included discussions and workshops with concerned government agencies, NGOs, and the affected people.

Conclusions and Recommendations

The results of the studies carried out for this assessment indicate that the DSHPP will not have significant local or cumulative impacts on the Mekong River flows, fish migration, or fisheries. This assumes that the FishMAP programme of mitigation actions is implemented successfully, including the ten-year program of monitoring and adaptive management that is described in detail in Annexes C and D to this EIA[3]. Other impacts, such as the requirement to resettle eleven households, or the effects on health and nutrition, etc. have been demonstrated to be more than compensated by the benefits to local communities that will flow from the project in terms of in terms of improved health and infrastructure services, better access to education and markets and other development opportunities expected to come from the effective implementation of the mitigation measures specified in the EMMP, the SMMP and the RAP.

In terms of the flows in the Mekong, the cumulative impact assessment studies have determined that large mainstream Mekong dam projects already under construction in China or planned in Lao PDR or China could produce major changes in flow. The DSHPP will not contribute to these changes, due to its location on one of 17 channels of the Mekong in the Si Phan Don area and because it is a run-of-river project with essentially no storage unlike many of the larger upstream projects. Hydrologic studies have determined that the DSHPP will not affect downstream flows in Cambodia or in the Mekong delta and so the Project will not affect the ecology or economy of the Tonle Sap or the rate or extent of saline intrusion in the Mekong delta.

[3] These Annexes are issued as separately bound reports

1 Introduction and Background

This document addresses the environmental and social impacts of the DSHPP in response to requests by the Government of Lao PDR (GOL) to update the original Environmental Impact Assessment (EIA 2007) (PEC&APW 2007). Within this document, reference is made to the Appendices of EIA 2007, which are included as a separately bound Annex E to this report (EIA 2013, Annex E).

This report shall be read in conjunction with the Engineering Status Report (AECOM 2011a), which supersedes the Final Feasibility Report (AECOM 2009). Further hydrological and sedimentation investigations are detailed in (AECOM 2011b), which supplements the information on these topics in AECOM (2011a).

The original EIA was based on reference data and fieldwork done by technical experts between October, 2006 and March, 2007. Questions on the EIA 2007, raised by the Water Resources and Environment Administration, WREA (now MoNRE), and the Mekong River Commission (MRC) are addressed in this report.

Little previous environmental information directly relevant to DSHPP was available other than that contained in preliminary engineering scoping studies and numerous publications on fisheries in the Lower Mekong Basin, largely published by the Mekong River Commission (MRC) or its predecessor. While there is considerable interest in the general area with an evolving tourism trade based primarily on sight-seeing visits to Khone Phapheng, a waterfall located east of the site, the Government of the Lao PDR (GOL) is also encouraging development of the DSHPP.

This updated EIA has been compiled based on data gathered, according to the environmental legislation and guidelines of MoNRE and the Ministry of Energy and Mines (MEM) and its Department of Electricity. The original field work and supplementary environmental and social data collection in 2009 have been carried out in consultation with both these agencies.

1.1 Project Location

The DSHPP is a run-of-river scheme, rated at 260 Megawatts (MW), located in the middle reach of the Mekong River in the southern area of Khong District, Champasak Province 150 km downstream of the provincial capital, Pakse (Figure 1-1). It is situated on Hou Sahong, a channel between the islands of Don Sadam and Don Sahong, just above the Lao PDR and Cambodian border.

This area is generally known as Si Phan Don (Four Thousand Islands), a complex of islands along about 10 km of the Mekong lying of the upstream (Lao) side of the Great Fault Line (GFL), formed by a sequence of volcanic and sedimentary processes. The whole series of layers of sedimentary rock has been folded and thermally metamorphosed, then eroded to form a relatively flat and level land surface, into which the Mekong River has eroded seven main channels and numerous smaller channels. These channels include two major waterfalls – Khone Phapheng on the eastern bank and the Lippi or Samphamit Falls further west, as well as numerous smaller channels and cascades, most of which flow only in the wet seasons when the river level is high.

Figure 1-1 Project Location

In the vicinity of the Project, the Cambodian border lies on the west bank of the Mekong and crosses the river about 2.5 km downstream of the proposed power station site, just beyond the Lao village of Veunkham.

The Project itself is located on the Hou Sahong (Figure 1-2), the third largest of the perennial water courses that traverse the Si Phan Don (Four Thousand Islands) area. The two larger watercourses are the main stream of the Mekong that cascades over the Phapheng Falls and the Hou Det, leading to the Tad Samphamit. During the high flow season other branches, particularly the channels closer to the right bank of the Mekong carry higher flows, but Hou Sahong is the largest branch without a major waterfall between the upstream and downstream sections of the Mekong; it has a relatively even fall from upstream to downstream with only a small series of rapids.

Figure 1-2 Don Sahong Hydropower Project Vicinity

1.2 Purpose of the Project

At present, there are a number of hydropower projects existing or planned in the country and the development of the DSHPP in Champasak Province is consistent with the Lao government policy to encourage economically, socially, and environmentally sound development of the country. It is also a part of the government policy to eradicate poverty and achieve 90 percent electrification throughout the country by 2020. Once the DSHPP is completed, it will increase national revenues by exporting power and supply power to Don Sahong, Don Xang Pheuak and Don Sakoun, thereby facilitating and promoting tourism, and agriculture in the region, and improving the quality of life of people living in those areas.

1.3 Project Need and Rationale

Lao PDR is a land-locked country with an agricultural economy and is classified as a “least developed country” where the annual Gross Domestic Product (GDP) per capita of the country in 2008 was only US$ 810. Most of the population lives in the country side, have very little income and only basic health care. In 1996, at the sixth Party Congress, the GOL set a national poverty reduction program (now changed to the National Growth and Poverty Eradication Strategy (NGPES) with a goal to lift the country from the list of least developed countries by 2020. NGPES emphasizes that the social and economic development of the country must occur in a sustainable and environmentally sound fashion.

Achieving and securing sustainable and environmentally sound economic development of the country can be facilitated through developing environmentally socially and economically

sound hydropower as less than 2% of the potential capacity of some 26,000 MW (excluding the main stream of the Mekong River) has been developed.

The DSHPP will not only contribute to the national growth and poverty eradication strategy of the government but it will also make a significant contribution to the reduction of global green-house gas production. Further, the direct and indirect benefits for the local communities and the nation resulting from the proposed Project include:

- provision of a bridge to Don Sadam from the mainland, with continuing road access to Don Sahong across the dam and embankments
- general improvement of road access to the Project area
- creation of employment opportunities for local people during the construction and operation
- a social action plan to improve livelihoods and foster wealth creation in the Project area
- facilitation of improvements to rural electrification, health care and education facilities
- establishment of water supply and irrigation to the villages
- promotion of tourist businesses in the area, and
- promotion of trade and services of small and medium businesses

1.4 Institutional, Policy and Legal Framework

1.4.1 Lao Regulatory Framework

Key organizations and agencies involved in the EIA process include: the Government of Lao PDR (GOL); the Prime Minister's Office (PMO); Ministry of Natural Resources and Environment (MoNRE); the Ministry of Agriculture and Forestry (MAF); the Water Resources Committee; the Ministry of Energy and Mines (MEM); the Environmental Management Unit of MEM Hydropower Department; the Ministry of Finance; the Department of National Land-use and Planning; the Ministry of Education and Culture; and the District Governor(s) of the Project location.

Measures for monitoring and managing potential environmental and socio-economic impacts have been developed based on Lao PDR legislation, regulations, decrees, standards and guidelines. The following legislation now in force, and supporting regulations (promulgated or in draft) in Lao PDR are relevant to ensuring environmental and socio-economic issues are addressed during design, construction, and operation of the Project.

1.4.2 Relevant Laws

The following Lao laws are pertinent to the DSHPP:

1. The **Lao PDR Constitution** (1991) acknowledges the need for natural forests as well as environmental protection in Lao PDR and requires that Environmental Assessment give particular attention to the assessment of potential positive and negative socio-economic impacts of project development and to prevention and/or mitigation of harmful impacts.

2. The **Environmental Protection Law** No.02/99/NA, (1999) assigns to the Science, Technology and Environmental Agency (now MoNRE) the rights and primary responsibilities for protection, mitigation and restoration of the environment in Lao PDR. The law defines the environmental conservation responsibilities of other GOL agencies such as the Department of Electricity, Department of Forestry, etc. It directs that environmental management and monitoring units (EMMUs) be established at all levels of government, with responsibilities to include such things as: establishing and enforcing sector environmental plans; taking action to mitigate environmental

damage; issuing orders to adjust, suspend, remove or close down activities that cause negative impacts. The overriding principles promulgated by the law are that:

- Environmental conservation comes before mitigation and restoration
- Those who generate an environmental impact are responsible for the resulting damage caused

3. The **Water and Water Resources Law** (1997) classifies all catchment areas for various uses and promotes protection and rehabilitation of forests, fishery resources and the environment. It suggests that EIA should be carried out on large-scale water development projects, and requires that funds be provided for protecting and enhancing catchment area resources, and for resettlement compensation.

4. The **Electricity Law** (1997) provides the basis for developing a concession agreement to construct and operate a hydropower project (Article 11), and provides the requirements for construction of transmission lines. In both cases, the Electricity Law provides for minimal damage to the environment that is to be monitored by the Environmental Management Unit (EMU) in the Hydropower Department of the Ministry of Industry and Handicrafts (MIH). The law requires that EIA's be prepared, particularly for large-scale hydropower projects (Articles 6, 12). The EIA is required to incorporate mitigation measures and provide for compensation for damages to the environment, people's livelihoods and if necessary, relocation of affected people (Articles 14, 18).

5. The **Amended Forestry Law**, No 06/NA (Dec. 2007): determines basic principles, regulations and measures on sustainable management, preservation, development, utilization and inspection of forest resources and Forestland, promotion of regeneration and tree planting, and increase of forest resources in the Lao People's Democratic Republic aiming for maintaining the balance of nature, making forest and Forestland a stable source of living and use of people, ensuring sustainable preservation of water sources, prevention of soil erosion and maintenance of soil quality, conserving plant and tree species, wildlife species as well as environment and contributing to the national socio-economic development.

6. The **Wildlife and Aquatics Law**, No 07/NA (Dec. 2007) determines principles, regulations and measures on wildlife and aquatic life, promotes husbandry and breeding; specifies utilization of wildlife and aquatic life in sustainable manner, without harmful impact to natural resources and habitats; restricts the decrease and extinction of wildlife and aquatic life; encourages people to understand and recognize the value and significance of wildlife. The law requires the management, monitoring, conservation, protection, and utilization of wildlife and aquatics in sustainable manner. To guarantee plenteousness and richness of ecological natural equilibrium system, to contribute in upgrading livelihoods condition of the multi ethnic people, which is the potential in the development of the national society and economy.

7. **Land Law** (1997) Land within Lao PDR is the property of the national community, and individuals are assigned to effectively use the land, but not treat it as a tradable commodity. The law sets out the rights of those who have been allocated land, including the right to transfer that land, are protected by the State.

8. **Road Law** (1999) Environmental protection is required during road activities. National and provincial authorities of the Ministry of Communications, Transport, Post and Construction are responsible for environmental protection on road projects. Reasonable compensation must be paid to individuals whose land is expropriated for road rights-of-way, relocation of replacement structures, and loss of trees and crops.

1.4.3 Decrees, Regulations and International Conventions

The following are relevant to the DSHPP:

1. **Prime Minister's Decree No. 164/1993** established eighteen protected areas and required that the government develop management plans for each area. Two additional protected areas, referred to now as National Biodiversity Conservation Areas (NBCAs), have since been added and now one more additional NBCA as Nam Kane NBCA has been established making the total 21 NBCAs nationwide. The current area totals 3.4 million hectares or 14.3% of the country's area. In addition, provinces and districts have also designated their own conservation areas and protection forests bringing the overall national total to 5.3 million hectares or 22.6% of the total land area.

2. **Decree on the Preservation of Cultural, Historical and Natural Heritage** requires that in order to prevent exploitation of relics and antiquities, any person who discovers archaeological relics or a cultural site must inform the provincial and district offices within three days.

3. **PM Decree No. 102/PM on the Implementation of the Environmental Protection Law (2001)** specifies that:
   Development projects and all development activities that related to the environment shall be conducted as follows:
   - All development projects, including State and private owned, shall have an environmental impact assessment (EIA) before the establishment and operation of those projects. They shall also have method and protecting or mitigating measures to protect social and natural environment that can be approved by the government.
   - The owners of the development projects shall have an obligation to bear the cost occurred in any process of EIA.

4. **PM Decree No. 192/PM on the Compensation and Resettlement (2005)**
   The decree comprises six sections and nineteen articles.
   - Section I is the general section sets out the objective and fundamental principle for compensation, and relocation of Project affected people. It also provides instructions and measurement procedure for mitigation and compensation for all potential negative impacts on socio-economic and livelihood of the affected people within or in the vicinity of the Project areas. Defines and classifies affected groups e.g. the vulnerable and ethnic groups of affected people.
   - Section II states and defines the right of affected person in receiving compensation.
   - Section III states and defines the compensation requirement and procedure, assistance measure during the relocation, settlement and livelihood development.
   - Section IV defines resettlement and compensation components which states and emphasizes the significant of local culture and tradition, community participation in the process, grievance measure and budgetary consideration.
   - Section V refers to enforcement procedures for both violator and complier, and
   - Section VI sets out the implementation procedure as well as sets out the institutional frame work of responsibility.

   All electricity projects in Lao PDR that fulfill the following criteria are required to develop and implement a full Resettlement Action Plan (RAP):

- All Electricity Projects involving the necessary relocation of 200 or more individuals.
- All Electricity Projects involving the loss of land, community structures, services and/or livelihood (income) for 200 or more individuals.
- All Electricity Projects that result in the loss of housing, land, community structures, resources, habitat and/or livelihood for 100 or more individuals that are disadvantaged, including vulnerable ethnic groups, isolated communities, households headed by women and the poorest communities.

All electricity projects with fewer than 200 individuals affected (100 individuals from disadvantaged groups, requiring relocation, loss of community structures, services, livelihoods, housing and land) by project activities do not require a separate RAP, however, resettlement plans for those individuals that fall into this category shall be included in the Social Management and Monitoring Plan (SMMP) and Environmental Management and Monitoring Plan (EMMP) that is required for the Environmental Assessment Process. In doing so the resettlement plans included in the SMMP shall incorporate the relevant requirements of the Environmental Management Standard.

5. **MAF Regulation Nº 0360/MAF.2003, on Management of National Biodiversity Conservation Areas, Aquatic Animals and Wildlife** provides guidelines on NBCA establishment and zoning and also on restricted activities and development fund establishment and the rights and duties of state agencies in NBCA management.

6. **Regulation on Environment Assessment No: 1770/WREA dated 3/10/2000**
   Each Development Project Responsible Agency (DPRA) must ensure that any development project in the Lao PDR carries out Environmental Assessment (EA) in accordance with the content determined in this Regulation, and any regulation of its own line ministry.
   The Environment Assessment must include at least a Project Description to enable DPRA to perform a project environment screening under Article 7 of this Regulation. If the project is not exempt under Article 8 of this Regulation, the EA must include an Initial Environment Examination (IEE) as specified in Article 9 of this Regulation. For some projects, through the findings of the IEE, an Environmental Impact Assessment (EIA) is required as specified in Articles 11, 12, 13, and 14 of this Regulation.

7. **Regulation on Implementing EA for Electricity Projects No. 447/MIH, dated 20th November 2001**
   The following noteworthy information is contained in the Regulation regarding development and review of an IEE for electricity projects. The Department of Electricity is required to ensure that environmental assessment is included in its decision to approve, finance or undertake any type of electricity project in Lao PDR.

8. **Prime Minister Decree No. 112 dated 16/02/2010 on Environmental Impact Assessment (2010)** A new decree of the prime minister was approved in 2010, which provides an update of the GOL environmental assessment study and approval process. In parallel with this decree, WREA (now MoNRE) issued a decision notice that lists the types of development projects that must prepare and submit IEE and EIA reports for their approval. According to this decree the DSHPP is required to prepare a full EIA.

9. The **Environmental Management Standard for Electricity Project No.0366/ MIH.DOE, (2003)** states that:
   Environmental screening is a preliminary assessment of a project's potential environmental impact. It is normally completed at a project identification stage.

Screening is used to decide whether a project's impacts are of a significant nature to warrant further environmental assessment. The IEE will determine the scope of the EIA. This will include the scope and plan for conducting the study to meet the requirements of an SIA. The IEE shall identify the expected social impacts of the project, and a plan to obtain the necessary information for determining the magnitude of the impact and the potential measures to avoid, minimize, mitigate or compensate for the effects.

The IEE shall include the following information related to SIA:

- Discussion of consistency with governmental regulatory requirement.
- Brief description of the social conditions in the project area including an estimate of the number of people to be relocated, distribution of population in project area, a brief discussion of the local economy and primary source of income, the presence of significant cultural and infrastructure facilities that will be affected and a list of issues to be discussed in the SIA relative to the social conditions.
- Preliminary plan for relocating the affected persons (Preliminary Resettlement Plan-PRP). The PRP may provide budget and technical feasibility proposals (availability of relocation sites, etc.) for more than one technical design.
- A preliminary assessment of land acquisition requirements and a determination of whether the land required for the project fall into forest/tribal or other special areas.
- Description of indigenous groups in the project area (if any) to include status of the population from the perspective of the GOL, significant unique characteristics of the cultural tradition of the groups, special economic resources of the group.

In the case of the DSHPP, screening carried out at the time of the project identification indicated that a full EIA would be required, together with an EMMP, SIA, SMMP, and RAP. Further, individual IEEs would be required by WREA (now MoNRE) and MIH-DOE to cover the transmission line and access road and bridge.

1.4.4 Best Practice

The following is a summary of best international practice in the development of hydropower projects. They form the basis for the DSHPP development and its environmental documentation.

World Commission on Dams – Criteria and Guidelines

The World Commission on Dams (WCD), having considered the multiple and diverse impacts and interests in dams, have identified five critical decision points within dam planning as having the strongest influence on the performance of projects.

- The first two key decision points refer to water and energy planning , leading to decisions on a preferred development plan: 1) Needs assessment: validating the needs for water and energy services; and 2) Selecting alternatives: identifying the preferred development plan from among the full range of options.

These activities are most useful in very early stages of resource development. This project specific ESIA does not have the resources to carry out a comprehensive identification and comparison of all development options, although a CIA is attached which summarizes the results of the broad strategic studies which led to the identification of the specific project which is the subject of the EIA and assesses the impact of the project within that overall framework.

The "within project" options / alternatives considered in planning the DSHPP are detailed in Section 1.3 of this EIA.

After a project emerges from this process as a preferred development alternative, three further critical decision points occur: 3) Project preparation: verifying that agreements are in place before tender of the construction contract; 4) Project implementation: confirming compliance before commissioning; and 5) Project operation: adapting to changing contexts.

This EIA outlines approach and plans to fulfill the requirements at each of these decision points and the developer is presently working with GoL authorities and international agencies to ensure the requirements of all 5 decision points are fulfilled.

Similarly the Project is aware of and working to meet the specific environmental and socio-cultural standards and guidelines imposed on HPP development by the MRC and the GoL. Particularly including the following suggestions from WCD for reviewing the social aspects of the Project:

- Stakeholder analysis based on risks and rights and resulting in the formation of a stakeholder forum;
- Supporting vulnerable and disadvantaged stakeholders to participate in an informed manner;
- Understand the distribution of costs and benefits across stakeholders;
- Agree measures to promote development of, and ensure benefits to Project affected and displaced people; and
- Include recourse and compliance mechanisms.

World Bank Environmental Criteria for Site Selection of Hydropower Projects (Good Dams and Bad Dams)

A recent World Bank initiative to assess the environmental impacts of dams found the most effective environmental mitigation measure is good site selection. The paper developed a schedule of Environmental Criteria designed to use to rate and rank proposed new hydroelectric projects in terms of their likely adverse environmental impacts (Ledec and Quintero 2003).
With respect to the DSHPP, the table below lists the WB criteria for the Project and highlights the major risks. The principal potential risks are to aquatic biodiversity/ endangered species and the affected human population (Table 1-1).

Table 1-1. Criteria to rate likely adverse environmental impacts from new hydropower projects

Indicator	Unit	DSHPP	Guideline for assessment of the risk
Area inundated (FSL)	km^2	2.2	The lower the better (limits loss of natural habitat/wildlife and displacement of people)
Number of people displaced	Persons/ MW	66/260 =0.25	The lower the better as there is less disruption to communities
Likelihood of reservoir stratification	Froude No.	>1	Stratification unlikely for F>1
Water Residence time	days	0.2	At this very short retention time there is little likelihood of change in water quality & the impoundment is easy to flush
Number of protected aquatic organisms in the area	Number	**2**	The presence of endangered species will require special studies and management plans

Indicator	Unit	DSHPP	Guideline for assessment of the risk
	r o f s p p		
Number of protected terrestrial species	Number of spp	5+	Birdlife within the Si Phan Don region
Power/Area of Inundation	W/m^2	116	The higher the better; Note that at ratio above 0.5, Hydro power becomes more greenhouse gas efficient than thermal power
Flood Area/Installed power	Ha/MW	0.9	The lower the better - note the global average for Hydropower dams is 60 (Ledec and Quintero, 2003)

A- The endangered aquatic species known from the area are the Giant Mekong Catfish and other endangered fish species, plus the Irrawaddy dolphin.

While focusing on physical and biological environmental considerations, the paper also notes:

- impacts due to displacement and the need for participatory decision making with resettlers and hosts, and for income restoration assistance in contributing to successful resettlement
- the importance of determining downstream releases for managing disease vectors and maintaining downstream human uses.
- the role of access roads in facilitating major land use changes (positive and negative), and hence the need for locating them in the least environmentally and socially damaging corridors.

A Cumulative Impact Analysis (CIA) has been carried out to estimate the relative impacts of the DSHPP and other hydropower projects in the Lower Mekong region. There were over 130 major dams either existing, under construction, or planned in Lao PDR, Cambodia, Vietnam, and Thailand in 2010.

The CIA compares these projects based on World Bank indicators to screen in very general terms the environmental impacts of different types of dams. Indicators most useful for comparison are “Reservoir Surface Area (ha) per MW” and “Number of displaced people per MW”. For the DSHPP these two indicators show low potential impacts: the flooded reservoir area / MW is <1 compared to worldwide average of 60; and only 0.25 person displaced /MW (Table 1-1).

Lao PDR Policy on Watershed Protection

A Watershed Management approach was endorsed in 2002 by the National Agriculture and Forestry Conference. The approach complements the national planning framework by improving the understanding of the natural resource base and socio-economic situation in a given watershed and agreeing among the key stakeholders at the local level to more effectively address poverty alleviation, and future conservation and development of upland watersheds.

The strategic vision for watershed management is similar to the National Poverty Eradication Programme. The aim is to bring more collective and collaborative efforts across concerned line agencies and with the provinces in order to ensure that the action plans and resource

allocations are harmonized and are focused to agreed target areas. The Government commitment to develop and implement a major watershed management component is part of its overall land use zoning and planning approach. All districts are required to develop watershed plans either by themselves or together with neighboring districts depending on the biophysical boundaries of the watershed.

1.4.5 Relevant International Agreements

While the DSHPP is very close to the international border between the Lao PDR and Cambodia construction and operation of the Project will have little direct impact on Cambodian Territory *per se.* The EIA and Section 4 of the CIA discuss the effect of the Project on all Mekong flows downstream of the Project as well as the marginal indirect effects on Cambodia's fisheries in the long term.

Creation of a Ramsar Site in the Si Phan Don Wetland has been proposed but is unlikely to occur. Lao PDR has completed the accession formalities with UNESCO and had joined the Ramsar Convention, as of May 2010, with entry into force occurring on 28 September 2010. Lao PDR has designated the Xe Champhone Wetlands (Savannakhet Province) and the Beung Kiat Ngong Wetlands (Champasak Province) as their first two Wetlands of International Importance[4].

Although the obligations of DSHPP under the environmental policies and guidelines of the two international conservation organizations operating in Laos, IUCN-Laos and WWF-Laos, are uncertain these organizations would certainly be involved in administration of the Si Phan Don Wetland.

1.4.6 MRC and Hydropower Planning in the Mekong Basin

The Mekong River Commission's (MRC) **Agreement on Cooperation for the Sustainable Development of the Mekong River Basin (1995)** includes a number of articles that will apply to the DSHPP. These include: **Article 3** – on the need to protect the environment and natural resources; **Article 5,** requiring prior notification to, and agreement by, the MRC's Joint Committee. **Article 6** relating to changes in natural flows and **Article 7-** specifying the need to avoid, minimize and mitigate harmful effects on the environment, especially on water quantity and quality, the aquatic (ecosystem), and ecological balance of the Mekong River system.

The Mekong River Commission has indicated the following general principles for planning Hydropower development in the Mekong Basin:[5]

- Development must be equitable and sustainable
- Hydropower development in the Basin should be seen in context of the regional energy sector, in particular realistic future energy demands.
- Fisheries and navigation are integral elements of hydropower dams, it is necessary to find optimal solution to conjunctive hydropower generation, navigation lock operation and fish migration.

The MA95 agreement and its requirements have guided the development of the Project and the associated environmental and social documentation. This process is ongoing.

Mainstream Dams: While 1995 Mekong Agreement does not preclude mainstream dams, their impacts must be environmentally and sociologically acceptable. MRC should act as

[4] Please refer to http://www.ramsar.org/cda/en/ramsar-news-lao-celebration/main/ramsar/1-26%5E24738_4000_0

[5] http://www.mrcmekong.org/download/programmes/hydropower/presentations/6.2%20-%20Summary%20of%20national%20hydropower%20consultations.pdf#search=%22mainstream%22

main dialogue facilitator to promote cooperation and best practices. There must be agreement to prioritize mainstream dams and fisheries issues.

As stated in their web site (Initiative on Sustainable Hydropower (ISH)), the MRC position on proposed mainstream hydropower dams[6] is as follows:

> *Eleven hydropower dams are currently being studied by private sector developers for the mainstream of the Mekong. The 1995 Mekong Agreement requires that such projects are discussed extensively among all four countries prior to any decision being taken. That discussion, facilitated by MRC, will consider the full range of social, environmental and cross-sector development impacts within the Lower Mekong Basin. So far, none of the prospective developers have reached the stage of notification and prior consultation required under the Mekong Agreement. MRC's position is that it supports sustainable hydropower development implemented within the framework of the 1995 Mekong Agreement and which serves the joint interests of its member countries. MRC has already carried out extensive studies on the consequences for fisheries and peoples livelihoods and this information is widely available, see for example a report of an expert group meeting on dams and fisheries. MRC is undertaking a Strategic Environmental Assessment (SEA) of the proposed mainstream dams to provide a broader understanding of the risks and opportunities of such development. Dialogue on these planned projects with governments, civil society and the private sector is being facilitated by MRC and all comments received will be considered.*

The SEA is due to report its findings in late 2010. It aims to assess and make recommendations on alternative mainstream Mekong hydropower development strategies, including the regional distribution of costs and benefits with respect to economic development, social equity and environmental protection and among different affected interests and sectors. Particular emphasis is given to the importance of looking at the proposed dams as a group and the cumulative impact from an integrated basin-wide perspective through the Basin Development Plan scenarios and other methodologies.

Unfortunately, at the time document was prepared, the MRC SEA report was not available. However, the CIA was developed to the extent possible taking into consideration the vast amount of information available through MRC, and in particular to be guided by the general objectives of the SEA. For example, the MRC has developed a preliminary set of design criteria for assessing the impacts of mainstream dams to address the following issues [7]:

- Effects on the fisheries resources of the Mekong, the world's largest inland fisheries, especially with respect to migratory species, fish biodiversity and consequences for peoples' livelihoods;
- Effects on sediment and river morphology, with associated risks to the life of mainstream impoundments, safe operation for dam safety, and effects on long-term bed stability, river bank erosion and channel stability in the downstream reaches.
- Effects of unexpected and possibly rapid changes in water surface level and flow rates downstream due to peaking operations, and
- Potential water quality changes, especially with regard to water pollution, both in the impoundments above the dams and localized effects downstream.

The DSHPP environmental studies investigated each of these. In particular, the fish migration and fisheries approach described later in this EIA is in substantial agreement with the preliminary MRC recommendations.

[6] http://www.mrcmekong.org/ish/ish.htm (accessed 2 September 2009)

[7] MRC 2009. Preliminary Design Guidance for Proposed Mainstream Dams in the Lower Mekong Basin. Mekong River Commission.

1.5 DSHPP Environmental and Social Reports

1.5.1 Environmental and Social Documents

The DSHPP environmental and social assessment consists of the following documents:

1. Environmental Impact Assessment (EIA) (this report),
2. Environmental Management and Monitoring Plan (EMMP),
3. Social Impact Assessment (SIA),
4. Social Management and Monitoring Plan (SMMP),
5. Resettlement Action Plan (RAP),
6. Cumulative Impact Assessment (CIA).

Background and supporting documents of the environmental and social assessment include:

1. DSHPP Engineering Status Report (ESR) (AECOM, 2011a),
2. DSHPP Hydrology, Hydraulics and Sedimentation Studies Report (AECOM, 2011b)

1.5.2 Objectives of this Updated EIA Report

The main objectives of this updated EIA are to:

- Examine the available environmental information as well as baseline investigation on the existing environmental situation in the Project areas and the identification of proposed affected areas in which the Project construction and operation will cause noticeable environmental and social impacts of any kind,
- Report all potentially significant Project-related, physical, biological and social issues with regards to the Project,
- Identify expected or potential direct and indirect impacts caused by the Project and adequate mitigation measures; and
- Prepare the environmental management plan to be implemented by the Project.

1.5.3 Scope and Structure of this EIA Report

The scope of this Environmental Impact Assessment includes the assessment of all significant potential impacts, both positive and negative, on the Project areas including:

- Identification and analysis of the existing National and International legal frameworks and policy related to environmental impact assessment and management to ensure the significant impacts of the Project are managed in compliance with national and international safeguards.

- Assessment of environmental impacts: predict and evaluate the adverse and beneficial impacts for each stage of the Project, and assess the risk of significant deterioration in the physical, biological, and social wellbeing of the Project affected environment.

- Formulation of an environmental management plan to make sure that all impacts by the Project are identified and appropriate procedures defined to manage those potential effects / impacts.

Consequently the EIA study of the DSHPP covers the following aspects:

- Identification and analysis of the existing national and international legal frameworks and policies related to environmental impact assessment and management to ensure the significant impacts of the Project are managed and taking into account in compliance with national and international safeguards.

- Study Area Identification and Justification
- Project description and environmental description
- Identification of potential physical, biological and socio-cultural Impacts
- Assessment of impact significance
- Formulation of the Environmental Management and Monitoring Plan (EMMP), as a separate report
- Recommendation of mitigation measures

The original EIA (PEC & APW, 2007) has been used as a starting point for this document. Numerous comments were received from WREA (now MoNRE), MRC and DOE on that document (See Annex A) and the original EIA has been updated to take into consideration: these comments, changes in the project design during the Final Feasibility Study (AECOM 2009), and recently gathered and updated environmental and social information. In addition, certain aspects of the original EIA have been redone, particularly the screening / scoping process.

1.6 Name and Address of the EIA Report Author

On May 10, 2009, Mega First Corporation Berhad signed a contract with National Consulting Company to perform additional environmental studies and update the original EIA. The author of this EIA report is:

National Consulting Company.
No. 012 Khaisone Road,
Ban Phonsay, Xaysettha District,
Vientiane Capital, Lao PDR
Tel : (856-21) –264 389
Fax :(856-21) 261 882

2 Project Scope and Components

2.1 Background

The Don Sahong Hydropower Project (DSHPP) is a run-of-river hydroelectric power project situated in the Khong District of Champasak Province, southern region of Lao PDR, several kilometers upstream of the Lao–Cambodia border.

The scheme utilizes a natural fall of about 20 m in the Mekong River formed by a tectonic feature known as the 'Great Fault Line'. The gross head on the scheme varies from about 13m to 21m depending on the seasonal variation in flow and relative variations in the depth of flow upstream and downstream of the falls. The Mekong River is substantially braided in Southern Lao, with about seven main channels and many more sub-channels flowing across the fault. The Don Sahong Project is located on the 5 km long Hou Sahong channel, which runs parallel to, and about 2 km west of, the Phapheng channel (the main channel of the Mekong). .

On 23 March 2006, Mega First Corporation Berhad (MFCB) signed an agreement with the Government of Lao PDR (GOL) to conduct an 18-month feasibility study for the Don Sahong hydropower project in Lao PDR. The feasibility study (FS) and an environmental impact assessment (EIA) were completed in December 2007 by PEC Konsult Sdn Bhd and APW Ltd. On 13 Feb 2008, MFCB signed a Project Development Agreement (PDA) with the GOL, to develop the project to the point where construction can begin. During this period, the parties agreed that they will prepare/deliver the range of technical, environmental/social, financing and contractual documents necessary to implement the Project to international industry standards.

2.2 Power Generation

The power plant is proposed to have a nominal installed capacity of 260 MW, developed by discharging the design flow of 1600 m^3/s operating at the rated head of 17.0m. Power output will vary with the seasonal flow variation, as in general terms a particular headwater/tailwater condition will correspond to a particular river flow, thus a particular power output.

2.3 Project Features

As shown on Figure 2-1, the layout is similar to that proposed in the original 2007 FS, except that a bridge from the mainland is proposed for both construction and permanent access to the islands of Don Sadam and Don Sahong and the new facilities, instead of a barge arrangement.

The scheme comprises a 260MW power station in the form of a reinforced concrete barrage structure at the downstream end of the Hou Sahong channel, with embankment sections returning along the islands of Don Sadam and Don Sahong that border the Hou Sahong, all of which will form a small reservoir or headpond contained within the embankments on these two islands.

The powerhouse barrage spans the 100m wide (approx.) Hou Sahong with a maximum height of about 30m, and is located about 130 m upstream of the outlet of the Hou Sahong. The generating plant will comprise 4 x 65MW Bulb turbine generating sets

The impounding embankments are approximately 7 km length in total, with height varying from 22.5m at the downstream end to 0m at the upstream end. Based on a design flood

level for the 1000 year ARI flood of RL 76.0, the crest level of the barrage and impounding embankments will be RL 76.9 masl. The total foot print of the impoundment plus embankments is 263 ha. There are no hydraulic control structures at the Hou Sahong inlet, and the water level in the headpond is therefore entirely governed by the natural water level in the Mekong River at the Hou Sahong inlet, and the flow through the power station. Accordingly the volume of water impounded and the impoundment surface area vary with water level, and time of year.

The embankment will incorporate an emergency overflow section for controlled flood release in the unlikely event of an extreme event greater than the 1000 year flood. The emergency overflow will comprise a slightly lowered section of the crest extending over a length of about 700m, with sufficient drainage and protection works downstream to channel any spill to the Hou Xang Pheuak. It is stressed that this provision is provided mainly to meet internationally accepted dam safety practice by providing a fail-safe means of preventing embankment failure in the event of a flood of any foreseeable magnitude, which in this case means that safety would be provided even for an event over and above the 1:1000 year design standard identified as appropriate under the relevant design standards.

Power will be transferred to the National grid from a 230kV switchyard located adjacent to the power station and a 230kV double circuit transmission line, running generally north toward the Ban Hat substation some 20km distant from the station (see Section 2.5.3).

Figure 2-1 DSHPP Layout

Shows Dam Location, Site Access Road Alternatives, Embankments, and Excavation Sites (Cross-hatched)

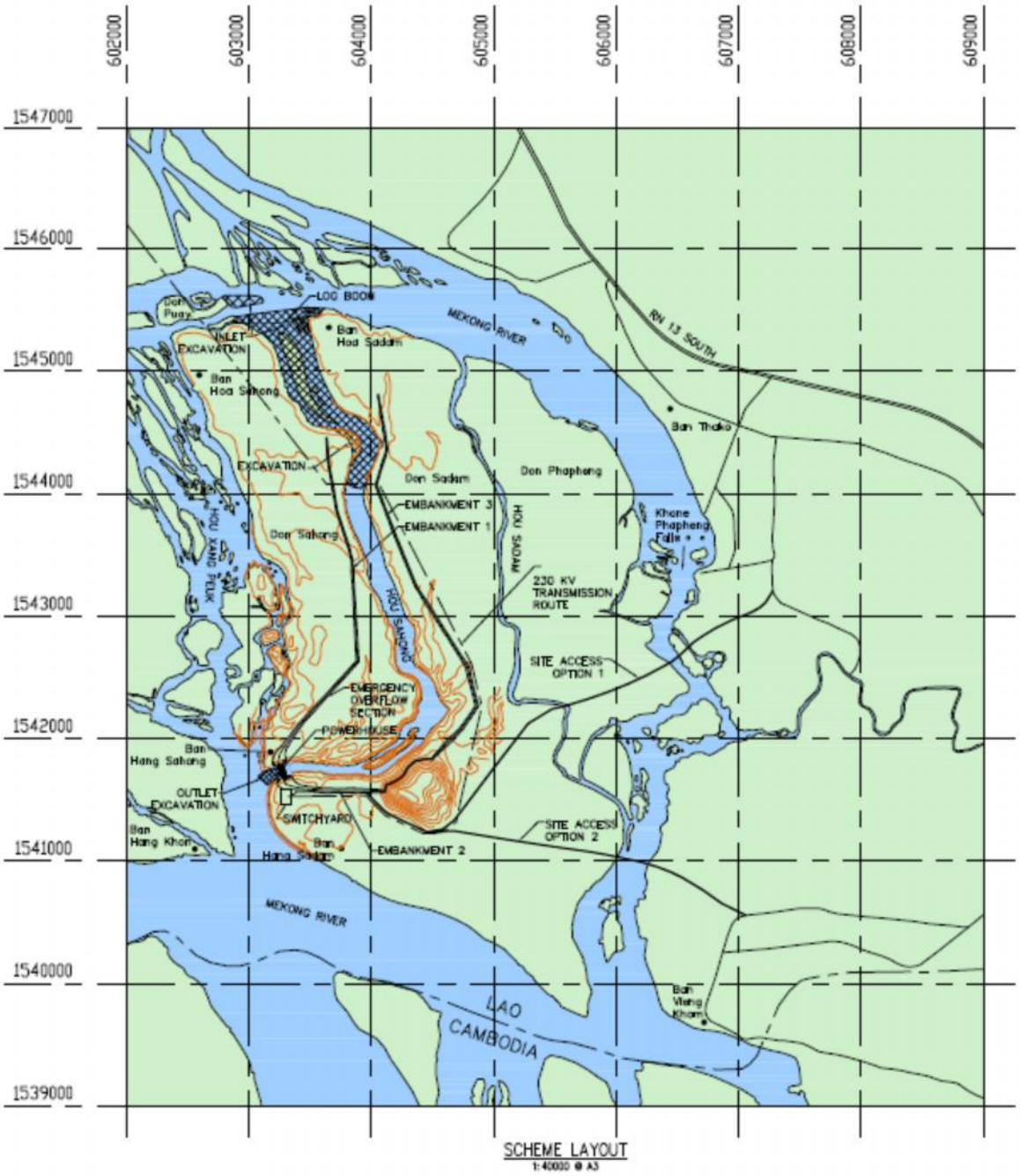
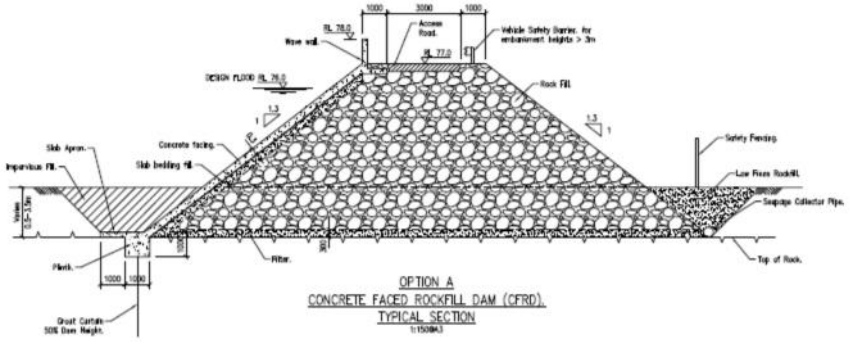
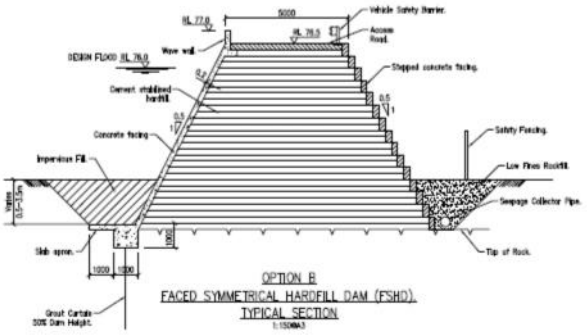
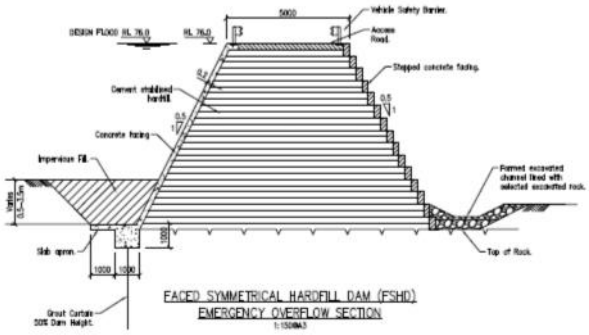


Figure 2-2 Typical cross-sections of the embankments







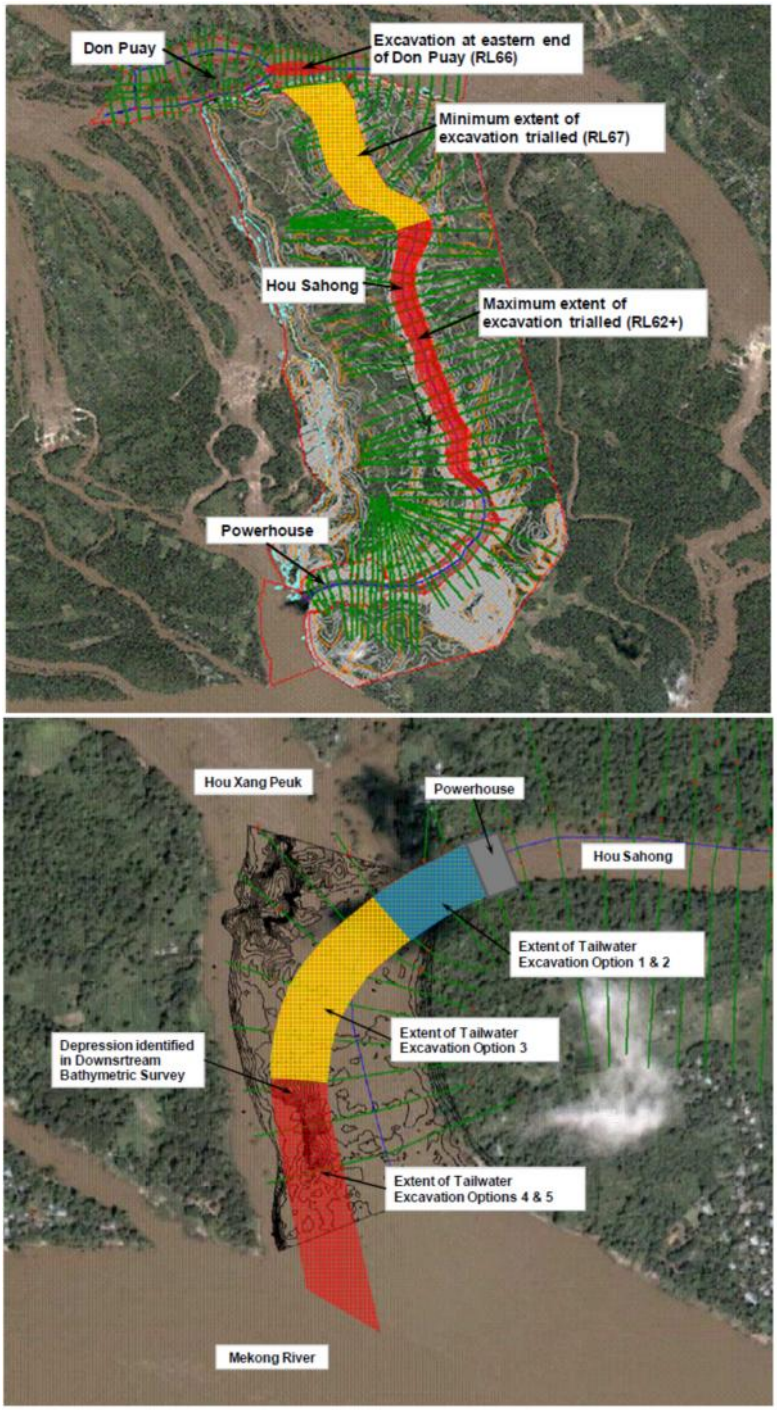


Figure 2-3 Locations of excavation in the Hou Sahong

At present the channel bed levels in the upper reaches of the Hou Sahong restrict flow into the channel during periods of low flow. In order to improve flow through the Hou Sahong the river bed will be excavated a maximum of 5 m in depth at the upstream and downstream ends of the channel. There will also be excavation downstream of the powerhouse, as shown on Figure 2-3. The figure indicates the maximum extent of excavation investigated in the FS. Final design will dictate the actual required extent of excavation.

Excavated material will be used for concrete aggregate and to construct the retaining embankments. Any excess rock will be disposed of at carefully pre-selected locations on Don Sadam and Don Sahong.

Excavation and other modifications are proposed in Hou Xang Pheuak and in Hou Sadam to provide alternative low flow period migration routes to replace the Hou Sahong which will be blocked for upstream movement of fish. These modifications are detailed in Annex C. This will be a vital component of the DSHPP fish migration mitigation program.

Although downstream excavation in the mainstream Mekong is not proposed, cognizance was taken of the presence of a small pod of Irrawaddy Dolphin some 2km distant from the powerhouse site, the Project provides for excavation to be undertaken without the use of explosives.

2.4 Project Study Area

Potential impacts of hydro projects may occur both upstream and downstream of the dam. While upstream impacts may result directly and indirectly from flooding of the reservoir, downstream impacts may result directly and indirectly from changes in the timing and volume of flows in the river during operation of the hydro project. Moreover, there are impacts that can occur on a larger scale, such as effects on fisheries in the lower Mekong.

The “study area” will not necessarily be the same for all disciplines and resources. For example, the study area for socio-economic impacts will be larger than the impact area for vegetation. Similarly, the study area for the CIA will encompass most of the lower Mekong basin whereas the EIA study area is much more concerned with detailed local impacts.

With these limitations in mind, the DSHPP EIA study area is defined to be sufficiently large and oriented to include both the direct and indirect environmental and social impacts of the DSHPP. Figure 1-2 shows the vicinity of the DSHPP where local impacts may be expected.

2.5 Project Components

2.5.1 General

The DSHPP will produce electricity for domestic consumption and export and thereby sustain and enhance social and economic development in the region. The main components, and features of the Project are illustrated in Table 2-1 and Figure 2-4. The following paragraphs provide a brief description of the main Project infrastructure. More detailed information is found in the Engineering Status Report (AECOM 2011a).

2.5.2 Dam and Powerhouse

The powerhouse will have a base dimension of 88m by 79m and house four 65 MW bulb type turbines.

Table 2-1 Main Features and Components of the DSHPP

Component	Feature	Details
Main Dam	Main Dam Type	Concrete Faced Rockfill, Geomembrane Rockfill or Roller Compacted Concrete
	Maximum Height	22.5 m
	Embankment Crest Length	7 km
	Crest Elevation	76.9 m RL
Spill way	Emergency Spillway type	Emergency overflow section in the west embankment to the Mekong River. (see Figure 2-4)
	Crest elevation	75.45 m RL
	Crest Length	700 m
Powerhouse	Turbine Type	Bulb
	Installed Capacity	4 X 65 MW = 260 MW
	Powerhouse Dimension	88m X 79m
Reservoir	Maximum storage level	75.45 m RL
	Maximum reservoir area	263 ha
Transmission line (see note below)	230 kV length	126 Km
	500 kV length (by Owner)	51 km
	500 kV length (by EGAT)	~ 45 km
Road access	Access road and bridge from mainland	Approximately 3-4 km long depending on final design

Note: Location of transmission line not yet determined.

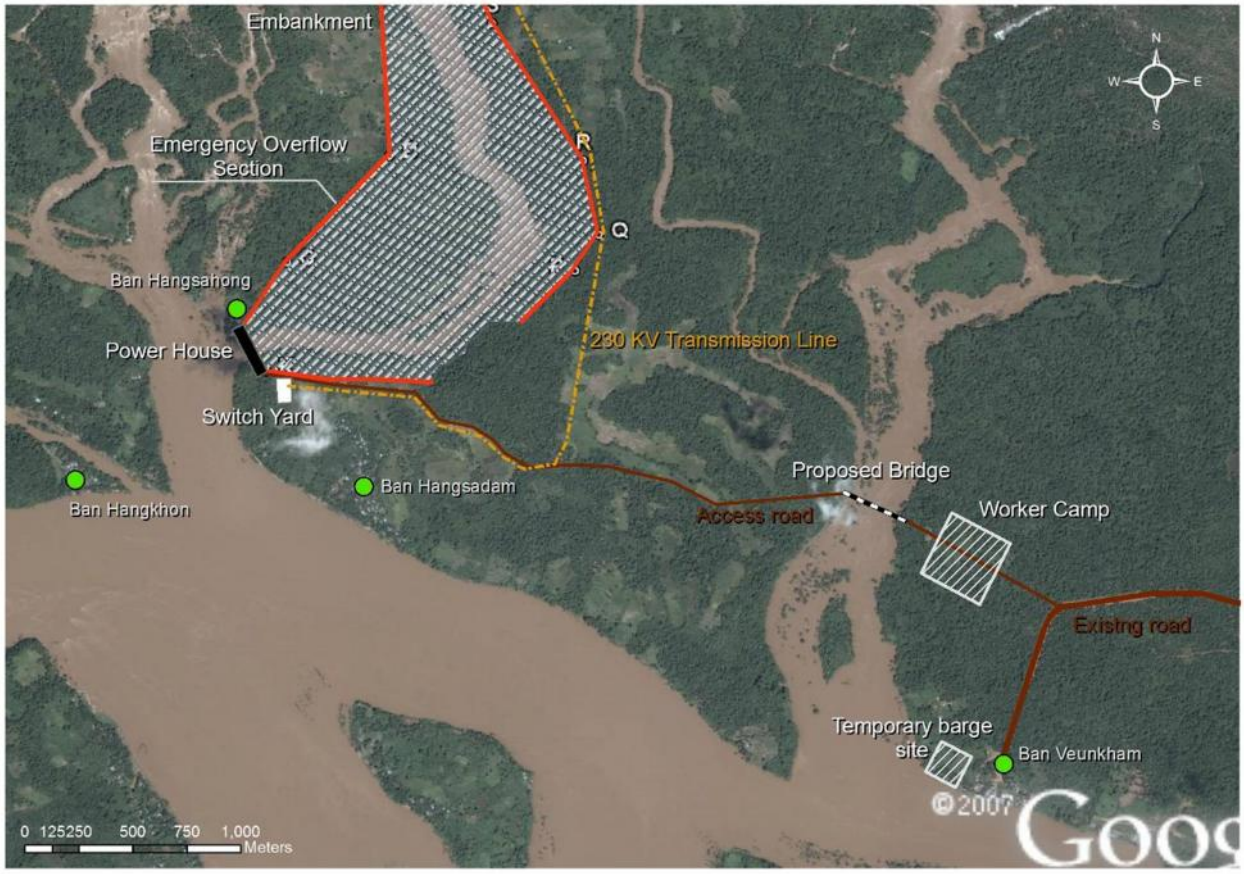


Figure 2-4 Main Components and Infrastructure of the DSHPP

From the substation a 230 kV double circuit transmission line will run from the switchyard on Don Sadam, north across Don Sahong and Don Tan before reaching the mainland in the vicinity of Ban Nakasang and continuing to Ban Hat substation (see Photographs 2-1 and 2-2). At Ban Hat energy for EdL will be fed to the existing Southern Lao Grid (115 kV). The majority of the energy generated will, however, be exported and the primary targets for export are Thailand and Cambodia. The potential terminal in Cambodia, Stung Treng, is only 60 km from Ban Hat, considerably closer than the Thailand delivery point, Ubon (250 km), and so would be the logical destination because of lower capital costs and transmission losses, but the projected demand in Cambodia will not be large enough to accommodate the full output from Don Sahong for many years. Although no negotiations have taken place with either EGAT or EDC regarding purchase of the energy, it is likely that export will be to both utilities. The transmission to Ubon would be via a 230 kV double circuit line, which is proposed to run beside the existing 115 kV line to Pakse, and then parallel to the existing Pakse-Ubon 115 kV line.

2.5.4 Access Roads

Access to the Project area is direct along Highway No.13, 150 km south from the provincial capital, Pakse. The highway was reconstructed in 2001 and has a 7 m double flush seal pavement on a 9 m carriageway. The numerous bridges on the highway are designed to AASHTO HS-25. Pakse can be reached by Highway 13 south from Vientiane or along Highway 10 from the Thailand border crossing 45 km west at Vang Tao /Chong Mek and the Lao Nippon Bridge across the Mekong River. Pakse is also served by multiple daily flights from Vientiane, Phnom Penh and Siam Reap and less frequent flights from Bangkok.

The construction of the DSHPP will require considerable upgrading the road access and construction of a permanent bridge from the mainland to Don Sadam and new roads on Don Sadam and Don Sahong via the top of the dam as shown on Figure 2-4.

2.6 Construction Camp

It is proposed that a major temporary construction facility be located on the mainland near the bridge site and upstream from Veunkham (see Figure 2-4). This facility would contain offices, accommodation, workshops, storage and holding areas so that only immediately required equipment and materials will need to be transported to the Project site and impacts to the local populations are reduced. With the main facility on the mainland, there will be only limited storage areas at the Project site, with rock crushing, concrete batching and basic workshops located at or near the switchyard and powerhouse.

2.7 Excavation, Borrow and Spoil Disposal Sites

2.7.1 Raw Material

The DSHPP will require approximately 130,000 m^3 of concrete, which will include 33,000 m^3 of sand and 52,000 m^3 of aggregate (gravel). It is likely that some of the gravel may need to be transported from sources that are presently being exploited along the Mekong upstream of the Project. This will be decided during final design.

There is no need for borrow sites for rock fill as all rock for the dam and embankments will come from the excavations for deepening of the Hou Sahong entrance and power house. Sand for concrete and filters will be dredged from the Mekong River upstream where the deposits are large and currently being used on a small scale for construction purposes (Photographs 2-1 and 2-2).

Photograph 2-1 – Dredged Material Being Unloaded at Ban Nakasang

Photograph 2-2 – Unloading Gravel at Ban Hat Ferry

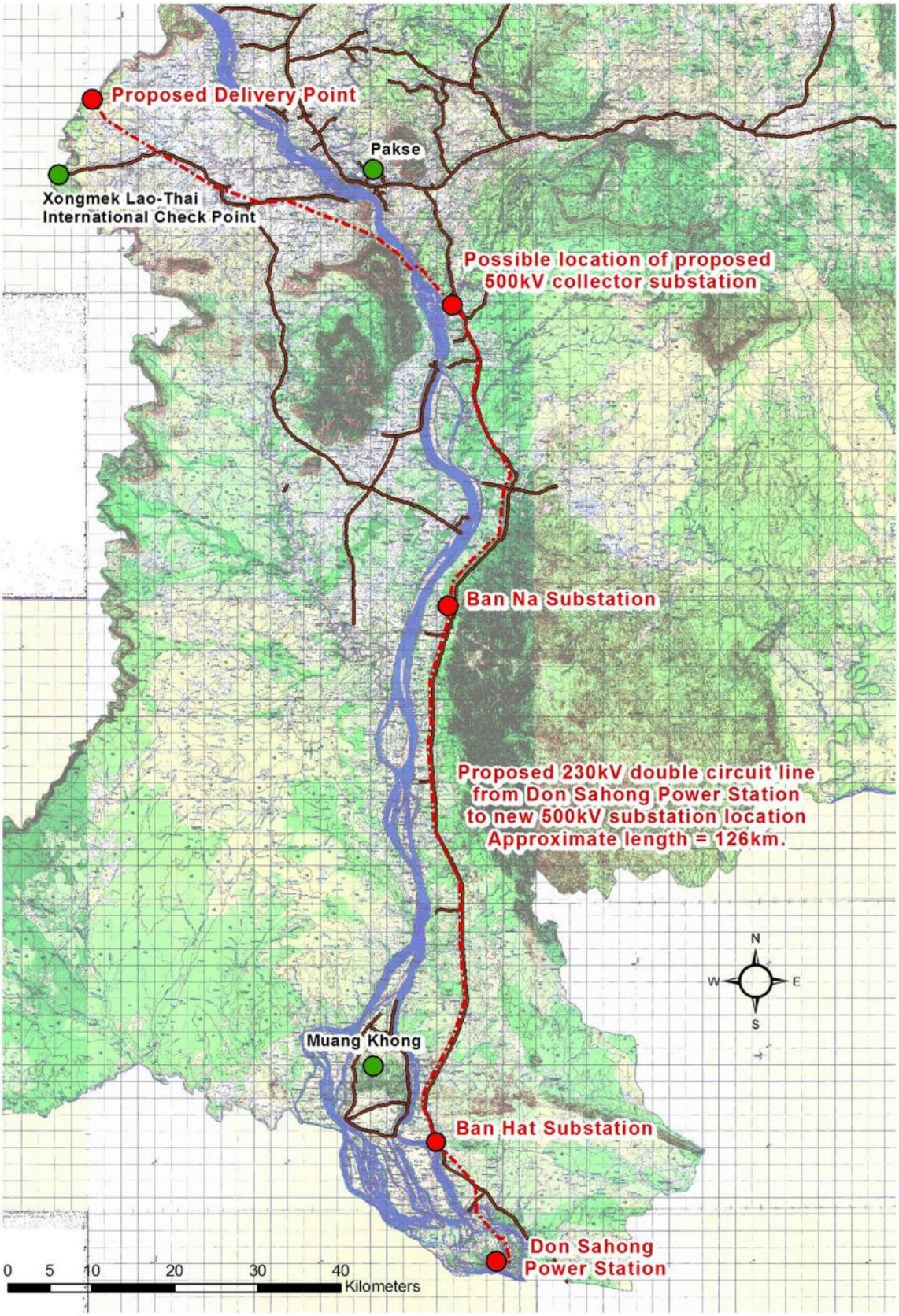


Figure 2-5 Proposed Transmission Line Route

2.7.2 Disposal of Waste

The total excavation required in the upstream portion of Hou Sahong will be approximately 2.4 million m^3 while downstream of the dam excavation will be approximately 0.072 million m^3. While a significant portion of this will be used in the dam and embankments, approximately a million m^3 of surplus rock from the excavations will be available and used for the construction of access roads, and other Project infrastructure. Any surplus excavation materials will be disposed of in carefully selected disposal sites approved by environmental authorities and the Project Engineer.

Prior to clearing of the Dam, power house, road and transmission lines commercial trees will be identified, and sold to the contractor, provincial government or local businesses. Vegetation which has no commercial value will be made available to local residents for fuel, charcoal production, or construction.

2.8 Project Operations

The DSHPP will cause water to back up in Hou Sahong, creating a small headpond, the level of which will vary with the level of the Mekong upstream. The top of the dam is set at RL 76.9m, which is above the maximum level that the Mekong will achieve at the upstream entrance to the Hou Sahong. Based on daily water levels recorded at Thakho since 1995, the average level of the reservoir is expected to vary about 3.2 meters, with its highest level in August-September and its lowest level in late April-early May, each year. The projected water surface elevations upstream and downstream of the dam are shown on Figure 2-6.

The variation in the inundated area within the embankments during normal operations of the DSHPP is illustrated in Figure 2-7, indicating the relatively small difference between low water and high water conditions.

2.9 Scoping of Potential Environmental and Social Impacts

In order to guide the update of the EIA and focus the assessment on key environmental and social concerns and issues, a scoping exercise was undertaken by the environmental and social impact specialists. This process identified and provided a preliminary estimate of the potential impacts of the principal activities and infrastructures of the DSHPP on a wide range of Physical Biological and Social (environmental) components and processes. The Impact Identification Matrix resulting from the scoping exercise is shown in Table 5-1.

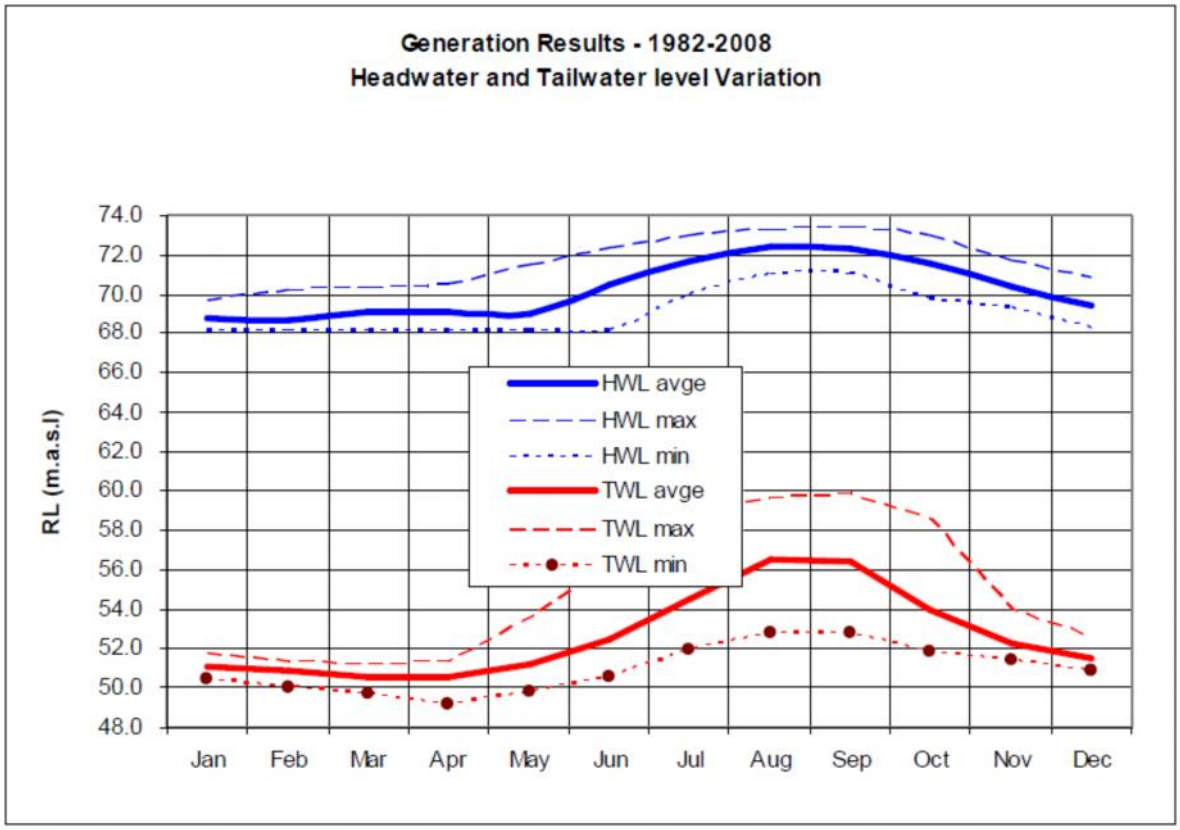


Figure 2-6 Monthly Variation of Water Surface Elevations Upstream (HWL) and Downstream (TWL) of the DSHPP Dam

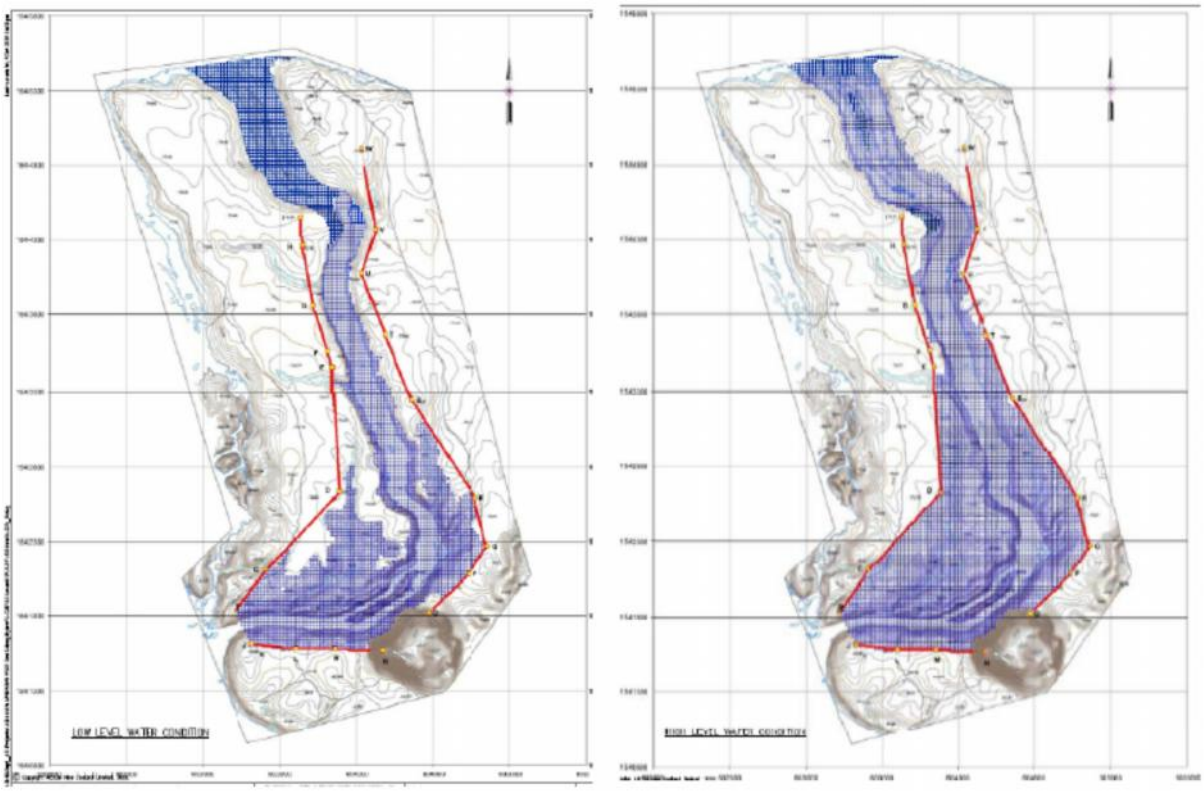


Figure 2-7 Inundated Areas during DSHPP Normal Operations
(Low Water at left and High Water at right)

			PRE-CONSTRUCTION			CONSTRUCTION							OPERATION						ANCILLARY DEVELOPMENT			DECOM-MISSIONING		
		Notes: ***N*** = Potential major negative impact n = Potential minor negative impact, can be mitigated -- = No impact anticipated p = Potential minor positive impact ***P*** = Potential major positve impact MI = more information needed	Survey and Investigation	Land Acquisition	Clearing	Resettlement	Diversion Works	Construction	Labor Force	Reservoir Filling	Waste Disposal	Hazardous Materials/ Activities (blasting)	Presence of Dam & Reservoir	Reservoir Fluctuation/ Change in flows	Sediment Management	Weed Control	Hydropower production	Dam Failure	Transmission Lines	Illegal/Unplanned	Bridge / access roads	Dam	Roads, Bridge	Transmission Lines
PHYSIOCHEMICAL	LAND	Landforms	--	--	--	n	n	n	--	n	n	n	n	--	n	--	--	**N**	--	MI	--	**N**	n	p
		Soil Profile	--	--	--	n	--	--	--	--	n	n	--	--	--	--	--	**N**	--	MI	--	n	--	--
		Soil Composition	--	--	--	n	--	--	--	--	n	n	--	--	n	p	--	**N**	--	MI	--	n	--	--
		Slope Stability	--	--	n	--	n	n	n	n	--	n	n	n	--	--	--	**N**	n	MI	n	n	--	--
		Subsidence and Compaction	--	--	--	--	n	n	n	n	--	n	n	n	n	--	--	**N**	--	MI	--	n	--	--
		Seismicity	--	--	--	--	--	--	--	--	--	n	n	n	--	--	--	n	--	MI	--	n	--	--
		Flood Plains/Swamps	--	--	n	--	n	n	n	n	--	--	n	--	n	p	--	**N**	--	MI	--	p	--	--
		Mineral Resources	--	--	--	--	--	--	--	--	--	--	n	--	n	--	--	n	--	MI	--	--	--	--
		Buffer Zones	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**N**	--	MI	--	--	--	--
	SURFACE WATER	Shore Line	n	--	n	--	n	n	--	n	--	n	n	n	--	--	--	**N**	--	MI	n	p	p	--
		Bottom Interface	--	--	--	--	n	n	--	n	--	n	--	n	p	p	--	**N**	--	MI	n	p	p	--
		Flow Variation	--	--	--	--	n	n	--	n	--	--	n	n	--	--	--	**N**	--	MI	--	p	--	--
		Water Quality	--	--	n	--	n	n	--	n	--	n	--	--	n	p	--	**N**	--	MI	n	p	p	--
		Drainage Pattern	--	--	--	--	n	n	--	n	--	--	--	--	--	--	--	**N**	--	MI	--	--	--	--
		Water Balance	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	MI	--	--	--	--
		Flooding	--	--	--	--	n	n	--	n	--	--	--	n	--	p	--	**N**	--	MI	--	--	--	--
		Existing Use	--	--	n	n	n	n	--	n	--	--	n	n	--	--	--	**N**	--	MI	--	--	--	--
	GROUNDWATER	Water Table	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**N**	--	MI	--	--	--	--
		Flow Regime	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**N**	--	MI	--	--	--	--
		Water Quality	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**N**	--	MI	--	--	--	--
		Recharge	--	--	n	--	--	--	--	p	--	--	p	--	--	--	--	**N**	--	MI	--	n	--	--
		Aquifer Characteristics	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	MI	--	--	--	--
		Existing Use	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	n	--	MI	--	--	--	--
	ATMOS-PHERE	Air Quality	n	--	--	--	--	n	--	--	--	n	--	--	--	--	p	--	--	MI	n	--	p	--
		Air Flow	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	MI	--	--	--	--
		Climatic Changes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	p	--	--	MI	--	--	--	--
		Visibility	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	MI	--	--	--	--
	NOISE	Intensity	n	--	n	n	n	n	--	--	--	n	--	--	--	--	--	--	--	MI	n	--	p	--
		Duration	n	--	--	--	n	n	--	--	--	n	--	--	--	--	--	--	--	MI	n	--	p	--
		Frequency	n	--	--	--	n	n	--	--	--	n	--	--	--	--	--	--	--	MI	n	--	p	--
																				MI				
BIOLOGICAL / ECOLOGICAL	SPECIES AND POPULATIONS	Terrestrial Vegetation	--	--	n	n	--	n	--	n	n	n	--	--	n	p	--	**N**	n	MI	n	--	p	p
		Terrestrial Wildlife	--	--	n	--	--	--	--	--	--	--	--	--	--	--	--	**N**	n	MI	n	--	p	--
		Other Terrestrial Fauna	--	--	n	n	--	--	--	n	--	--	--	--	--	--	--	**N**	--	MI	n	--	p	--
		Aquatic/Marine Flora	--	--	n	--	--	n	--	--	--	--	n	n	n	p	--	**N**	--	MI	n	n	p	--
		Fish	--	--	n	n	--	n	--	**N**	--	**N**	n	n	n	n	--	**N**	--	MI	n	n	p	--
		Endangered Species	--	--	n	n	--	n	--	**N**	--	**N**	n	n	n	n	--	**N**	--	MI	n	--	p	--
	HABITATS AND COMMUNITIES	Terrestrial Habitats	--	--	n	n	--	n	--	n	n	n	--	--	n	p	--	**N**	n	MI	n	p	p	p
		Terrestrial Wildlife	--	--	n	--	--	--	--	--	--	--	--	--	--	--	--	**N**	--	MI	n	p	p	--
		Aquatic Habitats	--	--	n	n	--	n	--	**N**	--	**N**	n	n	n	p	--	**N**	--	MI	n	p	p	--
		Aquatic Communities	--	--	n	--	--	--	--	**N**	--	**N**	n	n	n	--	--	**N**	--	MI	n	p	p	--
		Wetlands	--	--	n	n	--	n	--	**N**	--	**N**	n	n	n	--	--	**N**	--	MI	--	p	--	--
		Estuarine Habitats	--	--	--	--	--	--	--	MI	--	--	MI	MI	--	--	--	**N**	--	MI	--	MI	--	--
		Estuarine Communities	--	--	--	--	--	--	--	MI	--	--	MI	MI	--	--	--	**N**	--	MI	--	MI	--	--
		Marine Habitats	--	--	--	--	--	--	--	MI	--	--	MI	MI	--	--	--	**N**	--	MI	--	MI	--	--
		Marine Communities	--	--	--	--	--	--	--	MI	--	--	MI	MI	--	--	--	**N**	--	MI	--	MI	--	--
HUMAN	HEALTH AND SAFETY	Physical Safety	n	--	--	n	n	n	**N**	--	n	**N**	n	n	--	--	--	**N**	n	MI	n	n	p	n
		Psychological Well-Being	--	--	--	n	n	n	p	--	n	n	p	--	--	--	p	**N**	--	MI	p	--	n	--
		Parasitic Disease	--	--	--	--	--	--	n	--	n	--	--	--	--	p	--	n	--	MI	--	--	--	--
		Communicable Disease	--	--	--	n	n	n	n	--	n	--	--	--	--	--	--	n	--	MI	n	--	--	--
		Physiological Disease	--	--	--	--	--	--	n	--	n	--	--	--	--	--	--	**N**	--	MI	--	--	--	--
		Water Borne Disease	--	--	--	--	--	--	n	--	n	--	n	--	--	p	--	**N**	--	MI	--	p	--	--
	SOCIAL AND ECONOMIC	Employment	--	--	--	p	**P**	**P**	**P**	--	p	**P**	**P**	--	p	p	**P**	**N**	p	MI	p	n	n	n
		Fisheries	--	--	--	n	n	n	n	--	--	n	n	--	--	p	n	**N**	--	MI	p	p	--	--
		Housing	--	--	--	**P**	--	--	n	--	--	--	**P**	--	--	--	**P**	**N**	p	MI	p	--	n	n
		Education	--	--	--	**P**	--	--	--	--	--	--	**P**	--	--	--	**P**	--	p	MI	p	--	n	n
		Utilities	--	--	--	**P**	--	--	--	--	--	--	**P**	--	--	--	**P**	n	p	MI	p	--	n	n
		Amenities	--	--	--	**P**	--	--	--	--	--	--	**P**	--	--	--	**P**	n	p	MI	p	--	n	n
		Property & Settlement	--	--	--	**P**	--	--	--	--	--	--	**P**	--	--	--	**P**	**N**	--	MI	--	--	--	--
		Indigenous people	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**P**	n	--	MI	--	--	--	--
		Vulnerable people	--	--	--	p	--	n	n	--	--	--	**P**	--	--	--	**P**	**N**	--	MI	p	--	n	--
		Padi Land Use	--	--	--	p	--	n	n	--	n	--	--	--	--	--	--	**N**	--	MI	n	--	--	--
		Other agricultural Land Use	--	--	--	p	--	n	--	--	n	--	--	--	--	--	--	**N**	--	MI	n	--	--	--
		Transboundary Impacts	--	--	--	--	--	p	p	--	--	--	n	n	p	p	p	**N**	p	MI	p	--	n	n
	AESTHETIC / CULTURAL	Landforms / Landscapes	--	--	--	--	--	--	--	--	n	n	--	--	--	n	--	**N**	**N**	MI	n	p	p	p
		Biota	--	--	--	--	--	--	--	--	--	--	--	--	--	n	--	**N**	--	MI	--	--	--	--
		Wilderness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**N**	--	MI	--	--	--	--
		Atmospheric Quality	--	--	--	--	n	n	--	--	--	--	--	--	--	--	--	--	--	MI	n	--	--	--
		Climate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	MI	--	--	--	--
		Tranquillity	--	--	--	n	n	n	--	--	n	n	--	--	--	--	p	**N**	--	MI	n	--	--	--
		Sense of Community	--	--	--	n	--	n	n	--	--	--	--	--	--	--	p	n	--	MI	--	--	--	--
		Man-Made Objects	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**N**	--	MI	--	--	--	--
		Historic Places or Structure	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	n	--	MI	--	--	--	--
		Religious Places or Structure	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	n	--	MI	--	--	--	--

Figure 2-8 Environmental and Social Impact Scoping Matrix

3 Environmental Setting

3.1 Physical Environment of the Project Areas

This section briefly outlines the main physical, biological and social features of the DSHPP area. There is considerable general information and some new data collected for this updated EIA which are contained in the Appendices and are referred to throughout this section. Also there is considerable data relating to the Mekong River hydrology and DSHPP site geology contained in the Engineering Status Report.

Figure 3-1 DSHPP Site on the Hou Sahong

3.1.1 Physical Features of the Project Areas

The DSHPP is located on the Hou Sahong, a 5 km long channel that flows year-round between the islands of Don Sadam and Dong Sahong (Figure 3-1). These islands are of relatively low relief with the only prominent features being a hill at the south end of Don Sahong. The islands support three communities and approximately one-third of the land area is agricultural, primarily rice paddy. The Hou Sahong remains a dominant feature of the local landscape as its levels vary by approximately 2.5 to 3.0 m between the dry season and the wet season. It is also a fundamental

environmental element and very important to the population, productivity and ecology of the two islands and the greater Si Phan Don Wetlands complex.

3.1.2 Topography and Setting

The topography of Don Sadam and Don Sahong rises from an elevation of 48 m at the lower end of the channel to 78 m on the north ends of the islands, except for the single prominent hill near Hang Sadam, which has an elevation of some 115 m. The fall in the Hou Sahong channel is about 20 m over its 5 km length. The relative elevations would be less in the wet season and greater in the dry season. There are no major barriers in this channel, only rapids and rocks, unlike most of the other channels across the Greater Mekong Fault Line, which have waterfalls of varying heights. Its upper entrance is characterized by a rocky outcrop for 300 m downstream and Hou Sahong has three main islands, one at each of the top, central and lower ends. The islands are relatively flat land not subject to flooding, generally at 74 to 77m elevation, and much has been cleared as paddy land.

3.1.3 Geology and Geomorphology

The geology and geomorphology of the dam site and surrounding area summarized below is further described in the Engineering Status Report. This is based on the work of the DSHPP Project Geologist and detailed field investigations including drilling of boreholes and digging test pits in the immediate area of the dam site by ASA Power Engineering Co., Ltd of Vientiane.

General Geomorphology

The single course of the Mekong divides into a series of small channels between numerous islands in the area is known as Si Phan Don (Four thousand Islands), approximately 45 km north of the Cambodian border.

The geomorphological basis for this braided channel seems most likely to be a metamorphic rock unit that strikes across the river in this area[8] and which is especially resistant to erosion. The erosion resistant unit has caused a natural damming effect above and then a steep bed gradient as the river passes across the harder rock then descends in a series of rapids and /or waterfalls. Here, approaching the Cambodian border, the bed level falls from elevation 80m to elevation 50m. Previous work has claimed this abrupt fall is due to a tectonic feature described as “The Great Fault”. However, the DSHPP has found no evidence for such a tectonic feature either from field inspection or on any published geological maps of the Project area (AECOM 2011).

Within the Project area, much of the river flow is across planar rock surfaces rather than alluvial soils, especially in the west. The flow is perpendicular to the rock beds and crosses numerous lithologies.

In the dry season, the flow is confined to several well defined channels which are characterized by abrupt changes in direction as shown on the aerial photographs of the region. The geological control of the stream courses is demonstrated in the lower reaches of the Hou Sahong, where the final bend in the stream is dictated by a change in strike of the rock and stream flow is along a series of weaker sedimentary rocks. The natural rock surface slopes gently to the south, at much the same gradient as the river channels.

One aspect of this unusual geomorphology is that normal valley profiles have not developed and river bank heights do not increase along channels such as the Hou Sahong. A second is the presence of former erosion channels on either side, as either dry or infilled channels which are evidence of earlier stream paths. Former channels have affected the choice of the dam site which is downstream of all such features.

[8] Comprising interlayered meta- tuff and meta-sedimentary rock (AECOM 2011a)

Dam Site Geology

Geological maps at the scale of 1:1,000,000 provide a general picture of the geological conditions, with folded Mesozoic rocks striking east-west. More recent geological records available for southern Laos indicate an east-west trend in the geological sequences. Extrapolation from these maps, aerial photographs and field observations suggest the land between the Phapheng Waterfall, to the east, and the waterfall near Sipheng, to the west (see Figure 1-2), comprise Triassic Age rocks ranging from massive metavolcanics (rhyolites) to thinly bedded sedimentary rocks (shales, siltstones, sandstones and some limestones). While the massive rhyolites tend to dominate the Project area there are sedimentary rocks along the left bank of the Hou Sahong at the proposed dam site. The general strike of the rocks is east-west and the dip is consistently to the south at around 30 - 50°. Although shales represent continuous planes of weakness in the rock mass, the geometry of the beds does not make their presence a problem of major concern for the proposed dam structure.

At the upstream entrance to the Hou Sahong channel, a wide bar of massive rhyolite is present as seen on the aerial photographs. This also strikes east-west across the entrance and dips to the south. Drilling has confirmed its massive and hard nature. Further zones of hard rock are indicated along the length of the channel by the presence of rapids and intermittent rock outcrops.

Geotechnical Investigations

The geotechnical investigations were undertaken by ASA Engineering and seismic sub-contractors. The drilling work was supervised by a drilling engineer and a geologist. Local labor was used for the test pit excavations and the laboratory testing was carried out at Khon Kaen University in Thailand. Details of this work are contained in Section 2 of the Engineering Status Report (AECOM 2011) which describes the results of the following activities:

- Geological and geomorphological traverses
- Drilling, both vertical and inclined boreholes
- Seismic traverses of both banks
- Test pit excavations
- Laboratory testing of both soil and rock samples.

Preliminary estimates of the quantities of rock to be excavated from the various worksites, and volumes of materials to be extracted from borrow areas and disposed of in approved sites are provided in the Project description section of this EIA.

In summary the geotechnical investigations confirm a solid dam site, the need for substantial excavation at the dam site and entrance to Hou Sahong and additional geotechnical work during the design phase of the DSHPP.

3.1.4 Sources of Materials

i. Clay Materials

Test pits were excavated on the lowermost slopes of the small hill, upstream of the dam site on the left bank in search of impervious core material for the embankments. This material was found to be limited in extent and unsuitable due to its potential for “piping” and so the concept of clay cores for the embankments was abandoned in favor of a concrete lining on the interior surface of the embankments.

ii. Alluvial Sands

Small sporadic pockets of alluvial sands occur along most of the channels of the Mekong River. In the dam site area, these are of fine, uniform grading, with a mica content of perhaps 5%. The broad sand deposits, located at the upstream end of Khong Island are coarser in grain size, rounded, and reasonably well graded, with a mica content of 2 - 3%. While sands in the vicinity of the Project should be suitable for concrete, quantities are unknown at this stage. Most of the river

alluvium in the area of the dam site is coarse silt and its distribution pattern alters each year with rising and falling of wet season water levels.

iii. Rockfill

Large volumes of rock excavation will be required for the DSHPP. Rock excavated from the entrance of the Hou Sahong would be composed largely of hard quartzite. Potential quarry sites were also identified on both banks of the Hou Sahong, at the upstream end of the first major bend above the dam site. The isolated ridge on the right bank would provide a source of hard rock within the reservoir area and would be used for construction of the lower dam site. Excavation of the channel downstream of the dam will generally encounter more bedded rock strata, is likely to generate smaller rock fragments but could be used for the outside layers of any rock fill embankments.

iv. Coarse Aggregates

Two major lithologies, rhyolite and quartzite, are identified as possible sources of aggregate in the immediate Project area. Samples taken from the quarry sites at the upstream end of the channel, from the entrance of the Hou Sahong, and from the dam site demonstrated that both rock types are hard to extremely hard and eminently suitable for use in the embankments.

v. Soils of the Islands

As noted above the underlying geology of Don Sadam and Don Sahong is planar and is quite hard. The soils are essentially thin layers of silty sands and are of low natural fertility. These soils have very low moisture retention capacities, which further decrease their productivity. Because of this no soils maps were available or were drawn. There is little variation in the distribution of soils on both islands and the crops are only grown during the wet season. In most of the area dry season use is limited to grazing. Wet season cropping of rice is characterized by low yields and expensive chemical or organic fertilizer applications would be required to increase yields.

3.1.5 Hydrology of the Mekong River

Detailed analysis of the Mekong River's hydrology is critical to the planning of the DSHPP. The Mekong river Commission have compiled 82 years of flow data at Pakse and these data have been compared with a more recent 6 year data set from Stung Treng, Cambodia. The complicating factor is the relative distribution of flows between the various channels through the island and cascade complexes from Khong Island southwards. The percentage flow down any one channel also varies seasonally. For instance flows over Khone Phapheng are estimated at 25% for peak flows (i.e. 16,000 m^3/s), 75% for average flows (i.e. 2500m^3/s) and >90% for low flows (i.e. 1570 m^3/s) of the corresponding Pakse flow rates. The flow in the Hou Sahong was measured at 79 m^3/s (4% of the 2,000 m^3/s average flows in the Mekong River at Pakse) in January, 2007 and at 40 m^3/s (2.5% of the 1,622 m^3/s low rate flows) in March, 2007.

The analysis of hydrology and related flow rates for the Hou Sahong are explained in detail in the Engineering Status Report, which also contains hydrological information pertinent to the design of the Project. The description of the Mekong River flow regime presented here highlights the main aspects which affect the DSHPP.

The most important aspect is the proposal to divert flow from the main channel into the Hou Sahong to generate electricity. The rate of diversion will be managed to ensure a minimum flow in the main river channel downstream of the Hou Sahong inlet so "environmental flows" are maintained in the Hou Sadam, Hou Som Yai / Noi and over the Khone Phapheng falls. "Environmental flow" allocations from 600 m^3/s to 1,000 m^3/s were considered and the economic evaluation of the Project is based on a minimum flow of 800 m^3/s, which is the lowest flow recorded in the extreme dry season of 2010. The additional quantum of flow diverted into Hou Sahong is of little importance during the high flow season, when the flow at Thakho is well in

excess of 800 m^3/s and only a small proportion of the total flow would be diverted (1600 m^3/s maximum). However, in the low flow season, the diversion would reduce the flow at Thakho compared to the base case (no DSHPP) (Table 3-1). It is expected that the visual appearance of the falls will still be maintained by a minimum flow of 800 m^3/s.

The long-term average monthly flow data for Pakse is presented in Table 3-1. This data has been used to estimate the flows over Khone Phapheng for the low flow period and comparing that with the anticipated environmental flows used for engineering estimates in the Engineering Status Report (Table 3-2).

While it is recognized that the Khone Phapheng waterfall is best viewed at lower flows, the amount of reduction in low season flows, the peak tourism months, is critical. Photograph 3-1 on the following pages shows the waterfall at various discharges and, visually, there is little difference in appearance.

Table 3-1 Long Term Average Monthly Flow (m^3/s) at Pakse 1924-2006

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Average	2805	2156	1815	1781	2870	8648	17215	27137	27536	16435	8136	4266	10156
Maximum	4350	3096	2425	2492	7202	17551	28706	42477	40031	27423	15366	6262	14306
Minimum	1756	1812	1163	1068	1313	3210	9236	16150	16327	7400	4458	2705	6836
Median	2854	2211	1834	1754	2666	8502	17090	27481	27000	15971	7821	4110	10103

Table 3-2 Estimated Discharge over Khone Phapheng with Varying Environmental Flows

	Jan	Feb	Mar	Apr	May
Flow at Pakse					
- Average Flow Rate	**2805**	**2156**	**1815**	**1781**	**2870**
- Minimum Flow Rate	**1756**	**1812**	**1163**	**1068**	**1313**
Estimated flow at Khone Phapheng (Thakho)					
- Average Flow Rate	**2075**	**1595**	**1670**	**1639**	**2129**
- Minimum Flow Rate	**1616**	**1667**	**1070**	**approx. 800**	**1104**
Environmental Flow at 800 m^3/s					
- Ave Flow Diverted to DSHPP	**1275**	**795**	**870**	**839**	**1329**
- Min Flow Diverted to DSHPP	**816**	**867**	**236**	**183**	**375**

27 May 2006 – Pakse flow = 2,100 m^3/s

13 June 2007 – Pakse flow = 4,130 m^3/s

27 November 2006 – Pakse flow = 3,600 m^3/s

19 January 2007 – Pakse flow – approx. 2,300 m^3/s

19 April 2006 – Pakse flow = 1,450 m^3/s

Photograph 3-1- Khon Phapheng at Various Discharges

3.1.6 Water Quality of Mekong River

The Mekong River is a very clean and unpolluted river by international standards [9]. Baseline water quality data has been collected for the Mekong River at Pakse (Site ID: H013900) by the Mekong River Commission (MRC). These data from July 1985 to December 2006 are summarized in Table 3-3, including monthly averages as well as mean, median, minimum and maximum. The available baseline water quality data for the Mekong River at Pakse generally falls within acceptable limits for both drinking water and ambient surface water quality (with the exception of dissolved oxygen concentrations) as presented Table 3-3. The key results are summarized below:

- The pH was slightly alkaline (7.5-8.0) but remained within acceptable limits for both drinking water and ambient surface water.
- The presence of approximately 65-102 mg/L $CaCO_3$ alkalinity throughout the year was consistent with the slightly alkaline pH values observed, and the high calcium levels (18-29 mg/L) relative to other major ions.
- The river was characterized by low salinity, with electrical conductivity (EC) values less than 300 µS/cm. The salinity was highest during the dry season months of December to May (200 -230 µS/cm) and lower in the wet season (130-180 µS/cm), due to the effects of dilution.
- Total suspended solids (TSS) varied seasonally, with substantially higher concentrations during the wet season months of July to September. The monthly TSS peaked in August (474 mg/L). Turbidity data are not available, but would be expected to exceed the drinking water limit of 10 NTU, even during the dry season.

[9] Table 1 of Attachment A of Appendix G of Annex E provides summary water quality data for the Mekong at Pakse between 2000 and 2005 (from MRC); Table 2 provides data from the Hou Sahong in February 2007 (this project); and Table 3 compares the Mekong water quality data with other international records.

- The average values of dissolved oxygen (DO) fell below the minimum level required for the protection of aquatic fauna (6 mg/L;GOL, 1999) from May to November. Lower dissolved oxygen values (4.7-5.5 mg/L) were associated with higher chemical oxygen demand (COD 1.4-2.1 mg/L) and vice versa (DO 6.0-7.1 mg/L; COD 0.6-1.1 mg/L). Chemical oxygen demand (COD) values peaked at 2.1 mg/L in September.
- Nitrate-nitrogen levels (0.06 to 0.22 mg/L) were considerably higher than ammonium nitrogen (0.03-0.08 mg/L). On some occasions, ammonium nitrogen exceeded the ambient water quality guideline of 0.06 (pH < 7.5).
- Phosphorus concentrations were low in comparison with nitrogen, with total phosphorus ranging from 0.02 mg/L (February) to 0.07 mg/L (August).

In 2009, water samples were collected, handled and conserved according to "Standard Methods for the Examination of Water." Water samples were collected at five stations in the Mekong River and in Hou Sahong, upstream of the dam site (see Table 3-5). Table 3-4 presents surface water quality as measured on August 28-30, 2009. The analyses followed Standard Methods of Government of Lao PDR, Ministry of Health Drinking Quality (GOL 2004) and the World Health Organization (WHO 2004). The key results are summarized below:

- The pH levels in the Mekong River ranged from slightly acidic to near-neutral pH (7.64 to 7.84). The pH at all sampling cross sections was within the ambient surface water quality limit (GOL 2009; 5-9).
- The river had electrical conductivity (EC) values ranged from 60.3 to 103.3 µS/cm.
- The dissolved oxygen concentration in the Mekong River and Hou Sahong ranged from 5.9 to 7.5 mg/L, generally above the level required for the protection of aquatic fauna (6 mg/L; GOL, 2009).
- The Mekong River and Hou Sahong had total dissolved solids (TDS) ranging from 87 to 262 mg/L.
- Total phosphorus concentrations ranging from 0.08 - 0.12 mg/L and total nitrogen ranged from 0.48 -1.75 mg/L.
- Total coliform counts ranged from 19-41 (Most Probable Number/100mL).

Table 3-3 Baseline water quality data for the Mekong River at Pakse
(July 1985 – December 2006)

Parameter	Unit	Water Quality Guidelines		Month												Statistics			
		Drinking water [A]	[(a)] Ambient Surface water [B]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Min	Max	Mean	Med-ian
pH	-	6.5 - 8.5	5 - 9	7.8	7.9	8.0	7.8	7.8	7.7	7.6	7.5	7.5	7.6	7.8	7.7	7.5	8.0	7.7	7.7
total suspended solids (TSS)	mg/L	-	-	32	17	17	17	44	178	333	474	438	268	211	124	17	474	179	151
Electrical conductivity (EC)	µS/cm	1000	□2000-2500 (TDS 1000 mg/L)	203	227	234	236	226	182	155	135	137	160	189	202	135	236	190	195
Temperature	°C	-	-	24.8	26.5	27.5	28.2	28.4	28.1	27.8	27.0	27.3	27.0	26.4	25.1	24.8	28.4	27.0	27.2
Dissolved oxygen (DO)	mg/L	-	≥ 6	7.1	6.2	6.4	6.1	5.3	5.5	4.9	4.7	4.8	5.5	6.0	6.6	4.7	7.1	5.8	5.8
Chemical oxygen demand (COD)	mg/L	-	-	0.99	1.11	0.64	1.07	1.40	1.75	1.83	1.68	2.07	1.45	1.09	0.87	0.64	2.07	1.33	1.26
Alkalinity ($CaCO_3$)	mg/L	-	-	95.9	99.4	101.9	96.5	90.6	70.2	68.9	66.2	65.0	74.3	84.9	92.9	65.0	101.9	83.9	87.8
Ca	mg/L	-	-	25.6	27.1	29.0	27.7	26.5	21.0	20.3	18.6	18.0	20.4	23.4	25.3	18.0	29.0	23.6	24.3
Na	mg/L	-	-	6.5	7.5	8.0	9.0	8.8	6.9	5.1	3.5	3.9	4.6	5.7	6.2	3.5	9.0	6.3	6.34
Mg	mg/L	-	-	6.1	5.5	5.8	5.5	5.2	3.7	3.3	3.5	3.8	4.0	5.2	5.0	3.3	6.1	4.7	5.09
K	mg/L	-	-	1.3	1.2	1.9	1.6	1.6	1.5	1.8	1.6	1.3	1.4	1.5	1.5	1.2	1.9	1.5	1.53
Cl	mg/L	-	-	8.5	10.0	9.9	11.3	10.6	10.1	6.3	3.6	4.0	5.8	8.2	9.0	3.6	11.3	8.1	8.75
SO_4	mg/L	-	-	17	19	22	21	23	17	13	10	10	14	16	15	10	23	16	16.29
NO_3-N	mg/L	□9 (40 mg/L NO_3)	10	0.114	0.086	0.088	0.064	0.149	0.217	0.183	0.176	0.146	0.163	0.173	0.131	0.064	0.217	0.141	0.148
NH_4-N	mg/L	-	0.06 (pH<7.5); 0.4 (pH>7.5)	0.030	0.025	0.031	0.033	0.041	0.037	0.045	0.031	0.038	0.082	0.032	0.043	0.025	0.082	0.039	0.035
Total-P	mg/L	-	-	0.038	0.022	0.023	0.025	0.042	0.063	0.057	0.068	0.066	0.058	0.051	0.045	0.022	0.068	0.046	0.048
PO_4-P	mg/L	-	-	0.020	0.016	0.015	0.014	0.034	0.049	0.049	0.042	0.040	0.037	0.038	0.028	0.014	0.049	0.032	0.035
Fe	mg/L	1	-	0.192	0.210	0.184	0.133	0.313	0.207	0.543	0.267	0.243	0.365	0.240	0.171	0.133	0.543	0.256	0.225
Si	mg/L	-	-	7.091	6.245	6.378	6.120	5.292	5.516	4.864	4.681	4.835	5.496	5.987	6.593	4.681	7.091	5.758	5.751

A – *GOL Ministry of Health Guideline (2004)*
B – *GOL Ambient Surface Water Quality Standards (2009).*

Table 3-4 Surface water quality at DSHPP Project area, 2009

Parameters	Unit	Drinking Water Quality Guideline		Location					Test method
		GOL(2004)	WHO(2004)	MK10003	MK10060	MK10070 (Sene)	MK10070 (Khong)	MK10081	
Physical									
pH	-	6.5 - 8.5	5-9	7.84	7.75	7.64	7.78	7.75	pH probed by Session meter
Electric Conductivity	µS/cm	1000	-	60.3	82.8	103.3	96	90.5	Conductivity probed by Session meter
Dissolved Oxygen(DO)	mg/L	-	> 6	6.8	5.9	7	7.5	6.5	Dissolved Oxygen by Azide modification
Total Dissolved Solids (TDS)	mg/L	-	1000	134	125	262	186	87	Dry at 105^{o}C
Chemical									
Total Phosphorus(T-P)	mg/L	-	-	0.083	0.118	0.121	0.123	0.11	Ascorbic Acid
Total Nitrogen(T-N)	mg/L	-	-	0.503	0.478	0.802	0.978	1.747	Cadmium reduction
Micro-biological									
Total Coliforms	MPN/100mL	-	-	41	28	27	37	19	Multiple Tube Fermentation

3.1.7 Erosion and Sedimentation

Additional measurements of water quality were taken in 2009 to gauge suspended sediment concentrations at various locations upstream of the DSHPP in the watershed area. These locations were identified and marked with GPS along Mekong River and Hou Sahong as presented in Table 3-5. Methods and standards for the sediment sampling are shown in Table 3-6. Results of the sampling are found in Table 3-7.

Table 3-5 2009 Sampling Locations for Suspended Sediments

Stations	Name of Villages	Coordinate		Elevation (m)
		48 N	UTM	
01	MK10003@Pakse	0585952	1671089	90.50
02	MK10060@Ban.Deuateu	0593475.80	1580282.08	89
03	MK10070@Ban.Meuangsene	0584889.92	1558658.02	87
04	MK10070@Ban.Khangkhong	0592046.43	1558928.44	86
05	MK10081@Hou Sahong upstream dam	0603771.13	544567.13	54.79

Table 3-6 Analytical Methods and Standards for Suspended Sediments

No.	Parameters	Unit	Standards values	Analysis Methods
1	Sediment solid	$cm^3/dm^3/h$	N'	Imhoff cone
2	Sediment Suspended	mg/L	20 - 80	Photometric
3	Total solids	mg/L	N'	Dry at 105^oC

Table 3-7 Results of Erosion and Sedimentation concentration in Rainy season

No.	Name of Villages	Water level (m)	Sediment solid ($cm^3/dm^3/h$)	Sediment Suspended (mg/L)	Total solids (mg/L)
1	MK10003@Pakse	90.50	1.4	166	300
2	MK10060@Ban.Deuateu	89	1.5	171	296
3	MK10070@Ban.Meuangsene	87	1.3	102	364
4	MK10070@Ban.Khangkhong	86	1.6	190	376
5	MK10081@Hou Sahong upstream dam	54.79	2.8	313	400

3.1.8 Climate and Meteorology

Climate is not a factor of any consequence to the impact assessment or feasibility of DSHPP. Rather these studies are focused on the water flows in the Mekong River and Hou Sahong, in particular. General climatic data is available for nearby locations such as Pakse, in Laos and Stung Treng, in Cambodia. Daily variations in rainfall, evaporation rates, sunshine hours or wind speed and direction will not influence the Project; and because the DSHPP headpond is relatively small the effect on local climate will be insignificant.

The climate in the Project area is characterized by a pronounced wet season from May to October. However, the rain generally falls in relatively short, heavy storms, which are expected to cause only minor disruptions to most construction activities.

The DSHPP may have small but positive impacts on global climate change by providing electricity that does not involve the burning of fossil fuels. Because it is a run-of-river project there is expected to be little submerged biomass that would emit methane or other greenhouse gases as has happened with projects that include large reservoirs.

3.2 Biological Environment

3.2.1 General

The biological and ecological aspects of the Project area and transmission line route are among the most important aspects of the DSHPP. The aquatic environment and the fish of the Hou Sahong are an integral part of the Mekong River and Si Phan Don ecosystems. The land environments along the proposed transmission line between the dam site, across the Mekong River and to Ban Hat are comprised of a mixture of paddy land and disturbed forest.

3.2.2 Vegetation in the Project Area

The investigations of terrestrial vegetation covered both the areas affected on Don Sadam and Don Sahong as well as along the general route of the proposed transmission line from the dam site to Ban Hat substation, as shown on Figure 2-5. The original study was carried out by Dr. Sengdouane Wayakone of the Faculty of Forestry, National University of Laos and officers from the Champasak Province Department of Forests [10]. Those investigators then undertook another evaluation of the wildlife resources of these two areas to update the report in 2010, with the assistance of the EIA team's Birdlife Expert.

The Forest Department maps forests according to a specific classification in Lao PDR. The relative areas of these forest types for Khong District and for the Project Affected Areas including the transmission line are summarized in Table 3-8. This table shows that the Project could affect some 0.9% of the Khong District forests.

Table 3-8 Forest Type Comparison between Khong District and the Project Areas

Land Use and Forest Types		Khong District	Indicated Project Areas	
		Area (ha)	Area (ha)	%
Land Use and Forest types within the Headpond and Transmission line	Mixed Deciduous Forest (MD)	27,491.0	63.88	0.23
	Gallery Forest (G)	1,247.8	11.38	0.91
	Unstocked Areas (T) incl. Agriculture	10,281.8	346.39	3.37
	Swamp Forest (S)	2,902.8	320.40	11.04
	Dry Dipterocarp Forest (DD)	47,227.2	77.49	0.16
	Total	**89,150.6**	**819.54**	**0.92**

According to forest cover maps, the field reconnaissance survey and villagers' interviews, many areas of Don Sahong and Don Sadam have been disturbed already by:

- Use of forests near villages and along Hou Sahong for activities such as firewood and making of fish traps; and
- Conversion of forest land into agricultural land use types and burning for hunting, especially within and around the proposed pondage.

The remaining Mixed Deciduous Forests (MDF) occur on the upper slope of Don Sadam and some on the two small islands of Don Kieu and Don Khouak, in Hou Sahong.

Within these relatively undisturbed areas the main tree species with commercial value include Mai Dou (*Pterocarpus macrocarpus)*, Mai Pouya (*Lagerstromia balansae*), Mai Deang (*Xylia kerrii craib*), Mai Te (*Aszelia x*), Mai Khao (*Adina cordifolia*), Mai Sanen (*Dalbergia hupeana var. laccifera*) and Mai Tieu (*Cratoxylon formosum*). Some Mai Nhang (*Dipterocarpus alatus*) remain in the paddy fields and on private lands. Many of the big trees have been removed by local residents for timber for housing construction and only small diameter regenerated trees remain.

[10] See Annex E, Appendix H

3.2.3 Wildlife and Aquatic Animals

The islands are small and have been inhabited for at least 60 years. The status of the terrestrial wildlife resource in the DSHPP area was assessed as poor, largely due to the lack of interconnected habitats, and the human disturbance and exploitation of the existing natural habitats and wildlife.

Discussions with local residents confirmed the relatively poor status of wildlife habitat and species in the Project area. There were no reports from Hou Sahong of the Smooth–coated otter, a protected species,. Only occasional visiting wildlife other than common small mammals, amphibians and reptiles as listed in Annex F.

1). Birdlife

The assessment of birdlife completed in conjunction with the Forestry aspects, included the same areas, and was undertaken by Mr Sengrath Phirasack of the Division of Forest Resource Conservation. For the purposes of this study the DSHPP study area was divided into three parts: transmission line; Mekong River Banks and Don Sahong and Don Sadam islands including the Hou Sahong. A list of birds from nearby Xe Piane National Biodiversity Conservation Area (NBCA) is included for comparison[11].

Photograph 3-2 Intermediate Egrets (*Egretta intermedia*) at Ban Hua Sadam

Field work was executed with a representative of the Provincial Agriculture Forestry Office (PAFO), by interviews with local village headmen and onsite surveys of birds with a local hunter. The survey team slowly walked along the transmission line, Mekong River bank and affected areas of Don Sahong and Don Sadam observing and recording birds and noting any signs thereof. There were also interviews with local people during evenings and survey stops.

Bird identifications were based on A Guide to the Bird of Thailand (*Lekagul et al. 1991*). There were 48 species of birds observed or reported to occur in the general DSHPP area (including five (5) species listed as Endangered Species[12]. Some 41 of these species were found or reported from Don Sahong and Don Sadam, 38 species from the transmission line corridor and 19 species from the Mekong River areas. To some extent this reflects the effort put into the observation periods with only limited time spent at the river areas. No Protected Species were observed or indicated in the DSHPP area on the islands of Sadam or Sahong. A list of the animals and birds observed and/ or indicated to occur in the Project areas is provided as Annex F.

3.2.4 Aquatic Ecology including Fisheries

General Mekong River

A review of previous studies on Lower Mekong Basin (LMB) fisheries show that a large amount of information already exists on the importance of fisheries; in both subsistence and

[11] Appendix I of Annex E

[12] Regulation No. 360, the Dept. of Forestry Regulation on Species Listed for Conservation Purposes in Lao PDR. Classifies Category I species as endangered.

commercial terms, for the 60 million people who live in the four main LMB countries (Hortle, 2007 and 2009). In particular, studies by Vietnam, Cambodia, Thailand and Laos fisheries departments, working in co-operation with the MRC, have shown that the Great Fault Line (GFL) forms a boundary between the two most productive fisheries systems in the Mekong River. The lower fisheries system is based on the Mekong Delta, Tonle Sap Lake and the interconnecting mainstream Mekong channel upstream to the GFL. The middle fisheries system is based from the GFL to an area just upstream of Vientiane, and the third system extends north upstream of Vientiane (Poulsen et al., 2004).

The productivity of these systems depends on many dynamics, but is greater in the lower systems which are more hospitable to flora and fauna in terms of temperature, habitat availability, flow rate, and nutrient loads (Kang et al., 2009). The relative importance of the tributaries and floodplains associated with these mainstream systems is less well known, but is assumed to play a highly significant role in maintaining the fisheries production within the systems (Poulsen, et al., 2002b). In general, the fish migration patterns within these systems are determined by the spatial separation between dry season refuge habitats and flood season spawning, nursery and growth-out habitats within each system (Poulsen, et al., 2004).

The Mekong River basin is host to an estimated 1,300 described species of fish. The number of species appears to be increasing with each passing year, as taxonomic experts reclassify existing fishes and find new species in mountainous areas of Mekong tributaries. This is reduced to 300 plus for the exclusively freshwater sections of the middle Mekong, most of them of commercial, social and economic importance. Most of these are definitely migratory to some degree. Some move only 100 m from mainstream habitats to floodplains to breed and others move hundreds of kilometers to reach critical habitats.

The migratory cues that control these migrations are complex (MRC TAB, 2007), but for the majority of species are based on changes in river flow. The deeper water bodies in the mainstream act as refuges for fish during the dry season (Poulsen et al., 2002a), with many species undertaking lateral migrations onto the floodplain in the wet season, and which may involve some longitudinal migration upstream and downstream depending on life history stages (Poulsen et al., 2002b). The majority of species in the LMB that only undertake short-distance migrations do so within one of these three systems that makes up the LMB.

However, some long distance migratory fish move between the one or more systems, though the interconnectivity is generally stronger between the lower of the two systems (Kang et al, 2009) a small number of species may cross all three system (Hurwood et al ., 2008). The scale of these fish population migrations is an important factor to take into consideration when attempting to manage extractive fisheries or mitigate the impacts of infrastructure development (Hurwood et al., 2008). If a discrete population of migratory fish is impacted in one geographic area, then that impact can extend across the whole of that population's habitat range. The main aspects of fish migration are complex and migration is being studied over a long periods of time[13]

Fisheries Migration Perspective on Hou Sahong

The zone of interconnectivity between the lower and middle zones is through a system of braided channels across the GFL, which though in the dry season have substantial waterfalls or rapid sections forming barriers to fish movement, as river levels rise in the wet season become inundated and fish are able to move more freely. This system of falls is a zoogeographic barrier for many fish species, in particular species of marine origin (Sverdrup-Jensen, 2002).

[13] Additional information can be found in Annex C and Section G.3 of Appendix G in Annex E

The number of species that require free passage past the GFL to complete their lifecycles and sustain their present population levels is not fully known, but 201 fish species have been recorded to inhabit the area, and at least 90 species are thought to be involved in distinct migrations (Baran et al., 2005). The MRC have identified 58 species of significant subsistence and commercial importance that annually migrate upstream across the GFL.

Other studies in the area have shown that 50 species dominate the fisheries in the area that target migratory fish (Baran et al., 2005). Of these 50 species, 85% of the biomass comprises fish less than 25cm, though 61% of the species recorded exceed 25cm (Baran et al., 2005). A further 26 species that spawn on floodplains are known to have a downstream larval drift stage (Halls and Kshatriya, 2009).

Considerable research has been devoted to determining the life history and migratory cues important for fish movement in the Mekong River (MRC, 2001; Van Zalinge et al,2004; Warren, et al, 1998; Baird, 1996; Baird, et al, 2003; Baird, et al, 2004; Roberts and Baird, 1995; Baird et al., 2001. Information relevant to the Project area is summarized in Figure 3-2.

The DSHP Project is sited on the Hou Sahong, which has been described as the only viable pathway for upstream migratory fish in the late dry season (as illustrated in the figure below, from Baran and Ratner (2007). That conventional wisdom that all upstream fish migrations during the first rise in river at the end of the dry season (usually in April) must pass through the Hou Sahong is not supported by any categorical evidence, and household catch data from this project does show that migratory fish also occur in an adjacent channel with similar flow volume (Hou Xang Pheuak) during the late dry season.

However, there are natural barriers and choke points in that channel which would limit its viability as an upstream migration route at the lowest river levels. The objective of the FishMAP channel modification program is to remove those barriers and initial trial results indicate this is feasible (see Annex D to this EIA).

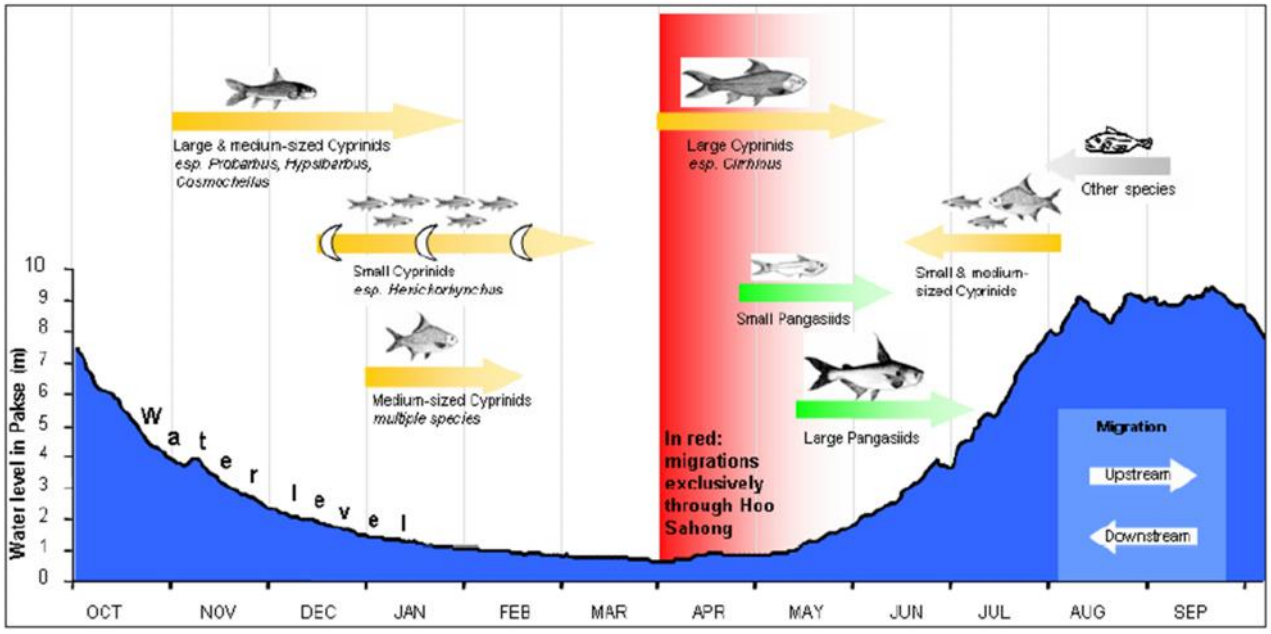


Figure 3-2- Fish Migration Patterns at Great Fault Line
Main Fish Species Migrating through Hou Sahong

It is difficult to delineate the exact fish species migrating through Hou Sahong at various times of the year. A basic listing of the major species and the time of each species migration is presented in Table 3-9. This includes nine (9) species in the dry season (upstream migration). However all 35 species will use the channel to some degree.

Table 3-9 Main Fish Species Migrating though Hou Sahong

Scientific Name	Lao Name	Major Species
Dry Season Upstream Migration – 4 Months December to April		
Cyprinidae		
Scaphogenus bandanesis	Pa Pien 9	+
Scaphogenus steinegri	Pa Pien 13	+
Cirrihinus microlopis	Pa Pawn	+
Cirrihinus nolitrrella	Pa Geng	
Labeo erythropterus	Pa Wa Soong	
Bengana behri	Pa Wa Na Noor	
Erythopterus melangira	Pa Srae	
Hysibarbus sp.	Pa Pak Nout	+
Numerous Small Cyprinids	Pa Saew	+
Gyrinoichelidae		
Gyrinoichelius pennolri	Pa Goh	
Wet Season Upstream Migration – 3 Months – mid-May to mid July		
Pangasidae		
Pangasius conchophilus	Pa Por / Gae	+
Pangasius larnaudii	Pa Beung	+
Pangasius krempfi	Pa Sooai Hang Leuang	+
Heicophagus waandersii	Pa Noo	+
Pangasius macronema	Pa Nyawn	+
Pangasius pleurotaenia	Pa Nyawn Tawng Khom	+
Bagnidae		
Hemibagrus filamentosous	Pa Kot	+
Hemibagrus wyckiodes	Pa Kung	+
Siluridae		
Belodonthicthys dinema	Pa Khop	+
Hemisilurus mekongensis	Pa Nang Deng	+
Micronema spp	Pa Nang	+
Kryptopterus spp.	Pa Peekgai 1 & 2	+
Ompok hypothalamus	Pa Peekgai 3	+
Ompok bimaculatus	Pa Seum	+
Sisoridae		
Bagarius yarrelli	Pa Khe Yai	+
Bagarius bagarius	Pa Khe Noi	+
Cyprinidae		
Cyprinus carpio	Pa Nai	
Downstream Migration - 6 Months – June to December		
Cyprinidae		
Henichorychus lobatus	Pba Soi Hua Lem	+
Henichorynchus siamensis	Pba Soi Hua Bo	+
Labiobarbus spp.	Pba Lang Khon	+
Paralabuca spp.	Pba Dtep	+
Lobocheilus melanotaenia	Pba Kiang	+
Crossocheilus sp	Pba Tok Toi	+
Probarbus jullieni	Pba Eun	+
Labeo erythropterus	Pba Wa Soong	
Minimum Total Estimate – At Least 35 Major Species		

For many years, the GFL was considered to be a zoo-geographical barrier to fish movement (migration). This is true for about eight fish species which are not found above the GFL. There are a very large number of migratory fish species that make bi-directional movements (migrations) up and over the GFL and back down again on an annual basis. Hou Sahong is the most important fish migration route of any channel at the GFL, mainly because of its physical dimensions, and bi-directional fish migrations during both the dry and wet seasons.

Fishing Perspective

Fishing in all sections of the Mekong River, and its tributaries and inter-island channels, takes place using a vast range of equipment and methods during every month of every year. It is mainly during the periods of fish migration that fishing operations intensify, when often special types of gear are deployed to intercept fish on their migratory pathways through Hou Sadam, Hou Sahong and Hou Xang Pheuak. This is exemplified by the different fish traps employed throughout the year (Photograph 3-3). Most of the families resident on the islands of the Si Phan Don region are involved in fishing to some extent and the various methods used are described in Appendix G of Annex E.

Photograph 3-3 – Fish Traps in lower Hou Sahong (top) and Hou Sadam (bottom)

It is commonly reported in the Lao media, and in discussions with local fishers and members of this study, that fisheries resources are now threatened by overfishing, in part to meet increasing demand but also through increased access to markets and the use of more sophisticated fishing practices. This situation has been evident in the GFL area since 1993, when a community co-management initiative was implemented to reduce fishing pressure on the resources of the Si Phan Don area as a whole, and the channel across the GFL in particular (Daconto, 2001). Though these measures were reported at the time to have a

positive effect on the areas fisheries, but these do not seem to have has a lasting impact and most local fishers are now worried again about the long-term sustainability of their livelihoods which depend heavily on the fishery (Nai Ban from six villages. personal communication, see Table 3-10). This is evident in a recent shift in the last five years from using large-meshed gill nets for catching species such as *Probarbus*, to targeting smaller species using gill nets with smaller mesh-sizes (15-25mm). This is an example of the 'fishing down' of a Mekong fish community, in which large long-lived species, and higher valued fish, are the first to be affected by heavy fishing, leading to increased targeting of lower valued species (Baird, 2006).

There has been considerable discussion on the issue of threats to and declines in the fisheries resources of the LMB (Allen et al., 2005; Baran, et al., 2001 Hogan et al., 2004; Baird & Flaherty, 2005, Baird, 2006), with the MRC pointing to the decline of larger long-lived species as be a possible indicator of over fishing (MRC 2003). However, studies have shown that in some areas the overall catch has not declined; it is just that the numbers of people accessing the fishery, amongst other factors, has increased, resulting in a diminished catch per fisher, along with an increase in the proportion of smaller lower-valued fish being caught (Baran and Myschowoda, 2008). However, this is cold comfort to individual household's dependent on wild fisheries resources, as they are required to invest more resources to catch the same or less fish, to the detriment of the long-term sustainability of their livelihood systems.

Table 3-10 Fisheries Trends in the DSHPP Area from Interviews with Village Leaders
(Nia Ban from six villages in the Project Area)

Name of Village	Reference Year When Fishery Most Productive per HH/Fishing	Percentage Decline in Fishery to Today Levels	Change in Village Population	Main Reasons Given for Changes in Productivity	Other Observations
Phapheng	1999	50%	1990 - 25 HH 2009 - 27 HH Relatively steady	A lot more fishing being done and illegal fishing gear being used, plus since 2006 water levels have fluctuated a lot more in dry season, which impacts migration as rising water in dry seaon prevents migration	Dry season migrations of fish have declined faster than wet season migrations, and gill net use has increased up to 5 fold
Hou Sadam	1992-95	70%	1990 - 60 HH 2009 - 90 HH = 1.5 fold increase	Fish caught in Cambodia first, Tonle Sap is blocked all the time now, change in dry season flows with more water now and it fluctuates up and down daily now	Dry season migrations of fish have declined faster than wet season migrations.
Hou Sahong	1995-96	70%	2000 - 55 HH 2009 - 70 HH = 1.3 fold increase	Population in area increase and fish not coming up from Camboia, also maybe natural as river levels are higher in dry season now.	50 % of the overall decline occurred after 2005, decreases in wet and dry season catches are the same
Esom	2000	90%	2000 - 55 HH 2009 - 90 HH = 1.6 fold increase	A lot of fishing gear is being set now and some illegal methods are being used now in Sipandone area as a whole	Wet season fish catches decrease faster than dry season catches.
Hang Khone	1990	80%	2009 - 44 HH No Significant Change	A lot more fishing gear is now being being set in Cambodia and some illegal methods are also being used	Wet season fish catches decrease faster than dry season catches, mostly non-scales species such as catfish, and in 2000-02 most big fish dissapear
Hang Sadam	1992-95	70%	1990 - 20 HH 2009 - 96 HH = 4.8 fold increase	Avaliablity of modern fishing gear and increased access to markets	Since 95, in some years fish catch was high on occasion, such as 2002 when famous photo taken for poster, but still that year fish catch lower than 92-95

3.2.5 The Mekong (Irrawaddy) River Dolphin

Distribution of River Dolphin Populations

The most recent detailed scientific research on the Irrawaddy dolphin in the Mekong river is from an investigation between 2001 -2005 (Beasley 2007), which is summarised and updated in (Beasley, Marsh et al. 2009). Except where otherwise noted, those two reports form the basis for the data and commentary presented here.

Small and declining populations of the Irrawaddy dolphin *Orcaella brevirostris* occur in coastal and large inland riverine systems of SE Asia, distributed from the eastern coast of India to Vietnam. The sub population in the Mekong River is one of five known freshwater populations (three occur in major SE Asian rivers).

The earliest records from the Mekong suggest several thousand individuals were present historically, distributed throughout the lower river, from the bottom of Khone Falls to the delta and including the Tonle Sap. There are no historical or contemporary records of dolphin occurrence in the Mekong Basin above the Khone Falls.

A survey In 1996 estimated the entire population of the river at about 200 individuals (Baird and Beasley 2005). The most recent detailed survey (from 2001- 2005) reported around 127 individuals remaining, and classified the population as critically endangered.

Localised Occurrence Based around Deep Pools

Irrawaddy dolphins occur in small, isolated populations, which are apparently highly localised, not ranging far from their preferred habitat, which is are river pools, usually more than twelve (12) metres in depth (Baird and Beasley 2005). Detailed river surveys made between 2001 and 2005, reliably recorded dolphins at twelve (12) deep water pool locations in the Mekong between Stung Treng and the Khone Falls, although dolphins rarely occurred downstream of Kratie. On average, an individual range was only 16 km^2 in the dry season, increasing to more than 70 km^2 in the wet season.

Dolphin-watching tourism is currently centered on two pools, where dolphins are reliably present throughout the year. In 2005, the largest population in the river was at Kampi Pool in Kratie Province, Cambodia, with a second, smaller population at the Chiteal Pool (known as “Vern Nyang,” or “Boong Pa Gooang” in Lao). This pool is immediately downstream of the DSHPP. The Chiteal pool population is reported to have declined significantly in the past twenty years, from 20-30 individuals in 1991 to nine individuals in April 2005 (Beasley, 2007) and most recently to six (6) individuals (Dr Victor Cowling, WWF, Vientiane, December 2012).

High mortality rates

Human activities appear to be the main causes of mortality of adult dolphins, which die due to entanglement in gill nets or through destructive fishing practices (e.g. dynamite fishing). Probably the most important threat to the current populations is the continuing high frequency of death in newborn dolphin. The cause of these mortalities is still unknown, despite ongoing investigations.

Potential indirect causes of dolphin mortality include habitat degradation, contaminants, disease, boat collision, harassment and noise, reduced fish stocks, and inbreeding depression. As of April 2005, the Irrawaddy annual rate of decline of the dolphin population in the Mekong River was estimated at 4.8% or more.

Other factors affecting river dolphin survival are: their slow maturation rate (7-9 years); long calving interval (2-3 years); and most importantly, their close proximity to human activities in freshwater ecosystems. Beasley et al (2009) state that “If the Irrawaddy dolphin population inhabiting the Mekong River has any chance of survival, the primary management goals must be to (1) determine the cause(s) of newborn mortality and subsequently mitigate the

causative factors, and (2) reduce anthropogenic mortality to zero (ideally in cooperation with local communities)".

Dolphin-watching Tourism
The dolphin-watching tourism industry has been identified as one of the greatest challenges to the conservation of the animal, particularly at Chiteal Pool, where until recently few restrictions were imposed on the boats involved with dolphin-watching tourism.

3.3 Social and Cultural Aspects

The community and cultural aspects of the DSHPP have been studied[14] in several ways including:

- Undertaking a household socio-economic survey of the main communities affected by the Project – refer to Annex E (Appendix A);
- Preparing a detailed Resettlement Action Plan (RAP) for the moving of 11 families from Ban Hang Sahong and Ban Hang Sadam;
- Preparing a preliminary Social Management and Monitoring Plan (SMMP);
- Completion of a Public Health Survey for the main communities in the DSHPP area – refer to Annex E (Appendix D);
- Undertaking investigations and reporting on the Unexploded Ordinance (UXO) – refer Annex E (Appendix F); and
- Undertaking investigations and reporting on tourism in the surrounding areas of DSHPP – refer Annex E (Appendix E).

In addition the EIA Study Team undertook discussions and research investigations with the staff of international NGOs including MRC, IUCN and WWF relating to the communities and natural resources likely to be affected by the DSHPP.

A detailed report on the social investigations made in 2007 and 2009 is presented in the Social Impact Assessment (SIA), bound separately. Impacts and mitigations are addressed in the Social Management and Monitoring Plan (SMMP) and the Resettlement Action Plan (RAP) documents.

3.3.1 Unexploded Ordnance (UXO) in the Project Area

Some parts of Lao PDR were very heavily bombed by the USA military during the Indochina War. A general description of the distribution of these bombs and the potential UXO risks is provided in Annex E, Appendix F.

The Project commissioned a review of the likelihood UXO contamination in the Khong District. The report (dated 19/2/2007) considered the Khong District to be low to non-contaminated and recommended that earthworks in the Project area could be undertaken without any requirements for specialized surface or subsurface UXO clearance.

3.3.2 Tourism in DSHPP Project Area and Surroundings

This summary of tourism activities around the Project area is based on information collected in 2007. This involved discussions with all operators of tourist facilities in the DSHPP area; collection of information from Lao and Thai authorities and discussions with tourists. Additional tourism information is attached in Appendix E of Annex E.

[14] See also: "Don Sahong Hydropower Project, Lao PDR - Social Impact Assessment" April 2010

Due to its unique and impressive waterfalls, extensive wetland areas, natural diversity, fishing activities and historical sites dating back to colonial times and livelihood of communities, the Si Phan Don area is a major tourist attraction of Champasak Province.

Taking advantage of the bridge over the Mekong in Pakse, Thai tourists come to visit the area in large numbers on day-trips by vans, tourist coaches via the Vang Tao /Chong Mek crossing of the Lao/Thai international border. In the past 5 years, the area has also become a destination for western backpackers searching for simplicity of life, authentic local livelihoods, nature and the traces of the colonial period. Don Det and Don Khone are recommended destinations for the backpackers' holidays.

Tourist Attractions
The popular tourist attractions of the area are:

1. Khon Phapheng (water fall)
2. Li Phi / Somphamit waterfall
3. Irrawaddy dolphin watching
4. Don Det
5. Don Khon
6. Bung Ngam and Cambodia border
7. Bridge and remnants of first locomotive in Laos dating from colonial times
8. Mosaic of natural islands and wetland areas

Don Sadam and Don Sahong are not primary destinations for tourists of any type but are a small part of the tourist resource base of the area.

Boat Landings
Tour operators take tourists to the island areas through many boat landing points: Bung Ngam, Don Song Hang, Tha Muang, Nakasang and Phiangdy. Bung Ngam landing point is controlled by Phou Doi Travel Company. Under the arrangement, Phou Doi pays an annual fee to Khong District with the condition that all boat services to visitors are exclusively to be provided by Phou Doi Travel Company. In similar arrangements, Tha Muang is run by Pakse Travel, Phiangdy by Lanexang Travel but Nakasang is co-run as a shared facility by Phou Doi, Lanexang and Indochina Travel companies.

Main Tour Operators
Five tour operators are operating in the areas surrounding the DSHPP, mainly:

1. Phou Di Travel
2. Lanexang Travel
3. Indochina Travel
4. Pakse Travel
5. Xedon Travel

These are Lao companies of which Phou Doi Travel and Lane Xang Travel companies have their headquarters in the capital, Vientiane.

Tourist attractions (clockwise from top left) Khone Phapheng, colonial rail bridge at Don Det/Don Khone, Tad Samphamit Falls, Dolphin Watching

Jetty at Tha Muang and tourist party departing for Don Det

Guesthouse Associations

Two guesthouses associations are organized in the area, north of the DSHPP:

1. Don Det guesthouse association
2. Don Khon guesthouse association

Tourism Activities in Villages of Area

The villages offer different tourists activities at different levels. The tourism activities are more intense on the main land in the area of Khone Phapheng water fall and on the linked islands of Don Det and Don Khone.

Don Sahong and Don Sadam so far are visited only by a few foreign tourists and present an undeveloped potential tourist attraction due to its pristine natural environment, authentic village life, fishing related activities along Hou Sahong, Hou Sadam and Hou Xang Pheuak. A guesthouse is currently being built at Hua Sadam.

Basic descriptions of the individual tourist facilities and attractions in the area are presented in Section 2.6 of Appendix E of Annex E. This region is also part of an ADB major project on "Tourism in the Mekong River Region" and this study is ongoing.

Information on Tourists and Visitors

Champasak Province Level

The tourist flow in Champasak Province has increased dramatically since 1999 with the National Lao Tourism Year Campaign. The number has further jumped to a record high with the completion of construction of the bridge over the Mekong River in Pakse two years ago, allowing Thai tourist coaches easy access to Champasak Provinces tourist areas.

In 2006, it is estimated that 113,684 tourists visited Champasak Province an increase from 63,963 in 2004 and 99,044 in 2005. Data from the Thai immigration authority shows that the number of visitors from Ubon Ratchatani to Southern Laos passing through Chong Mek Border is currently more than 140,000 and has increased by about 12% from 2005 to 2006 (Table 3-11). Approximately 70% of the total visitors from Thailand visited Khon Phapheng Waterfalls as the main attraction.

Table 3-11 Total Visitor Arrivals from Thailand at Chong Mek Border crossing

Category	2005	2006
1) Passport	41,024	57,283
2) Border pass	84,550	84,102
Total	**125,574**	**141,185**

Source: Ubon Immigration Office at Phibun (Mangsahan, 2006)

As expected the peak season for tourists in the province was recorded in November through February. Thai tourists represented some 68% of incoming tourists corresponding to 66,124 persons, followed by westerners (including New Zealand and Australian) and Lao visitors, both at 16% and corresponding to 16,181 persons (Figure 3-3).

Among westerners, French tourists were the highest corresponding to 25% of the total of 16,181 or 4,045 persons .It is to be noted that these figures for westerners are conservative, as many backpacker tourists visit the area individually and might not be recorded in the official statistics.

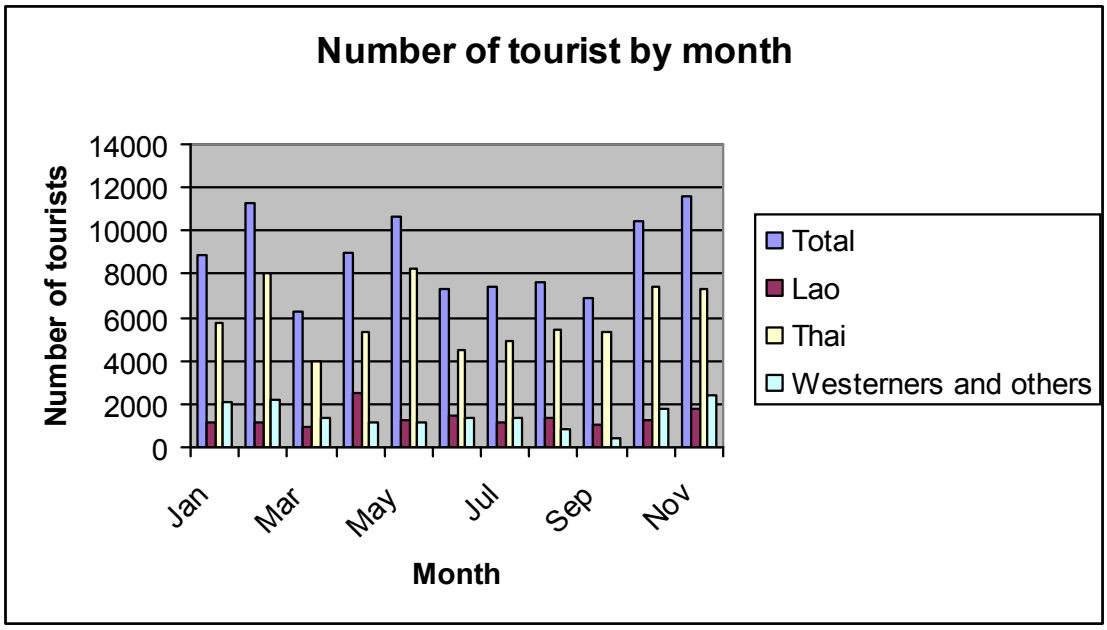


Figure 3-3 Tourist Arrivals

At the Project Area Level
It is difficult to get exact information of number of all types of tourists visiting the lower Si Phan Don Wetland area in general and the individual islands in particular. It is assumed that over 90% of foreign tourists coming to Champasak Province visit at least Khone Phapheng waterfall. Under this assumption, over 80,000 foreign tourists have visited the general DSHPP area in 2006 but few have visited Don Sadam or Don Sahong, most being restricted to the Khone Phapheng area and a few dolphin watching.

Preferences of Tourists
Though the main groups of foreign tourist have different preferences and levels of service offered, they all share common views that the rich natural diversity, the impressive waterfalls, the pristine nature, the authentic simple village life, hospitality of the local villagers and the peaceful life are the main attractions for them.

3.4 Conservation Issues

Conservation NGOs, such as the IUCN and WWF have promoted the declaration of the Si Phan Don Wetlands as a Ramsar site and its declaration would permit their interest to be further pursued and the site would include the DSHPP site. The DSHPP would be viewed as a critical aspect in the planning of the Si Phan Don Wetlands. At this time the GOL has not decided to nominate this as a Ramsar site and it appears unlikely to do so in the near future. Lao PDR has completed the accession formalities with UNESCO and had joined the Ramsar Convention, as of May 2010, with entry into force occurring on 28 September 2010. Lao PDR has designated the Xe Champhone Wetlands (Savannakhet Province) and the Beung Kiat Ngong Wetlands (Champasak Province) as their first two Wetlands of International Importance[15].

The Si Phan Don Wetland proposal (see Figure 3-4) is about conservation and sustainable resource management for a 486 km^2 area which is upstream of a similar area, already declared on the Cambodian border and embracing the Mekong River. It includes all of the

[15] Please refer to http://www.ramsar.org/cda/en/ramsar-news-lao-celebration/main/ramsar/1-26%5E24738_4000_0

Mekong River below Khong Island, its numerous channels and a 1 km wide buffer zone on the banks of the Mekong River including a 40,000 ha central zone.

IUCN intends to inventory the Si Phan Don Wetland when and if it is declared. This is a preliminary step to preparing a development plan for the area and would involve consultation with the local communities on Don Sahong and Don Sadam. Of particular interest for the Si Phan Don Wetlands would be the role of fishing management in the long-term development plans for the area. This is a key issue for consideration and rationalization of approval of DSHPP by the GOL.

The Ramsar Convention legislation (see Appendix J of Annex E), does not exclude hydropower proposals from being included. IUCN has a “vision” for the future whereby the established Stung Treng Ramsar site and the proposed Si Phan Don Ramsar site would merge, leading to a trans-boundary Ramsar site - one of only a few worldwide.

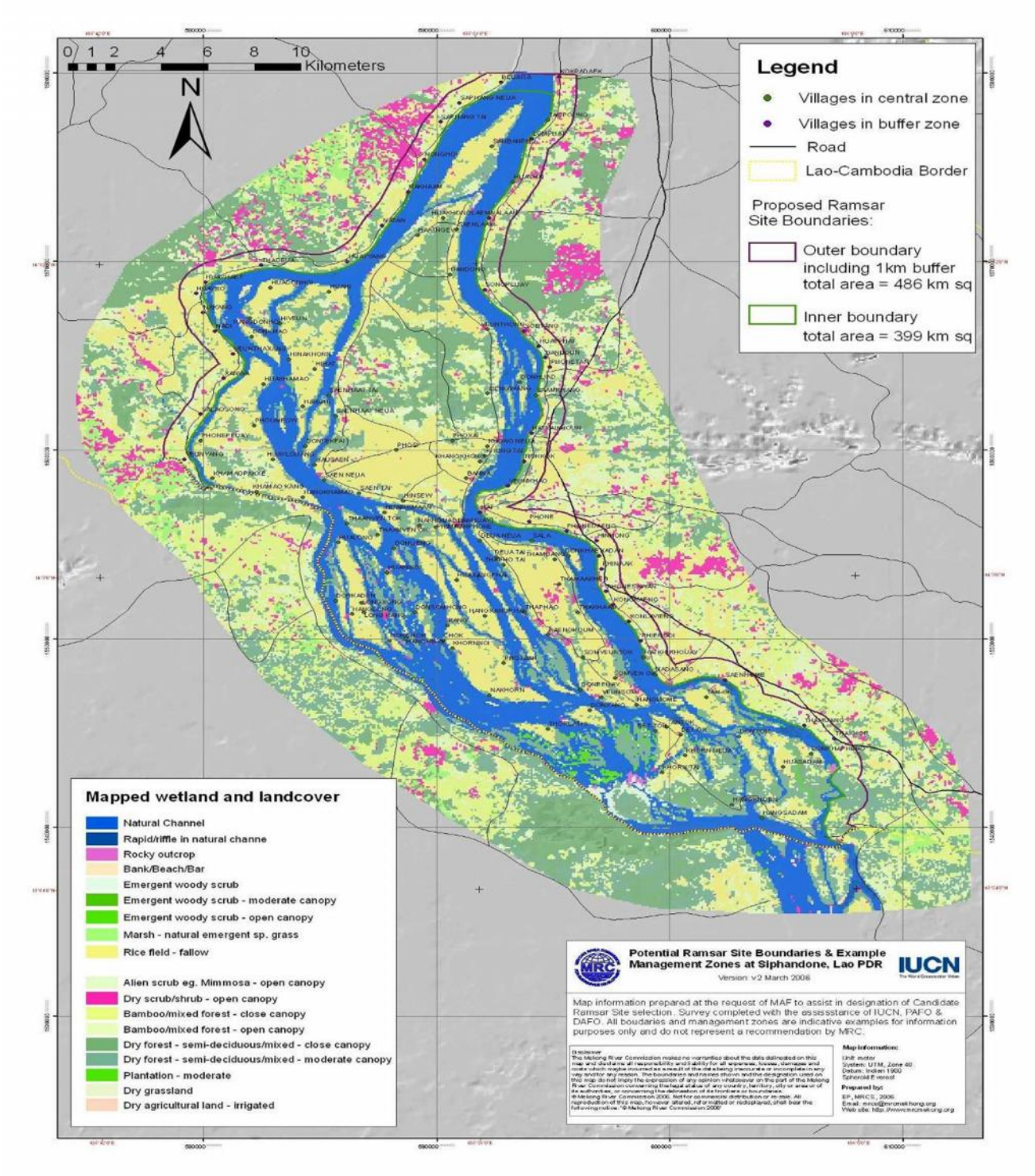


Figure 3-4 Map of the proposed Ramsar site in Southern Laos
(the border with Cambodia lies to the south).

4 Project Rationale and Alternatives

4.1 Rationale

Lao PDR is a land-locked country with a population of around 6.3 million, most of which is rural, without access to electricity and relatively poor. Lao PDR has abundant and high potential resources for hydropower development. Theoretically, its hydroelectric potential is about 26,500 MW; of this about 18,000 MW can be exploited. Hydropower plays a significant role in the socio-economic development of the country. It is a major contributor to the national GDP, and the government's revenue. However, through 2008, only 671.3 MW of capacity has been installed. In 2007, only 58.8% of all households in the country had access to electricity.

With the aim of supporting national growth and poverty eradication, the Lao government plans to become the "battery of ASEAN" and to increase the number of households with access to electricity to 90% in 2020 (EDL, Ministry of Energy and Mines, 2008).

In accelerating and facilitating power development, the key challenges that need to be addressed by the government are:

- A better and a more transparent integration of social and environmental concerns.
- Curtailing possible over-dependency of the economy on hydropower development.
- Increasing domestic tariffs to cover financial production costs, at least in urban areas, with a transparent subsidy scheme for poor rural areas.
- More effective sub-regional cooperation in producing and distributing electricity.
- Prioritisation of proposed hydropower projects and development of suitable financing.
- Improvement of the regulatory framework and encouragement for increased private sector investment, and
- Institutional strengthening, especially in financial planning, management, and negotiation capacity with developers.

(National Growth and Poverty Eradication Strategy -NGPES)

NGPES states that the average consumption of energy in the economic sector is increasing 10% every year. It is therefore required that the government: 1) expand electrification networks in the rural areas by extending the grid to easily accessible areas, 2) provide off-grid supplies to remote areas where the expansion of the grid is difficult for environmental and economic reasons, 3)complete construction of small and medium-scale projects (up to about 60 MW) for domestic utilization using government investment funds, 4) construct a 500 KV high voltage electric transmission system and 5) Continue mini-developments (micro-hydropower, solar and wind energy projects for off grid power supply in remote areas.

4.2 Hydro Power Potential and Demands

Hydro power is the most abundant and cost effective energy source in Lao PDR. Of the 18,000 MW that is technically exploitable about 12,500 MW is found in the major Mekong sub-basin and the remainder in minor Mekong or non-Mekong basins[16]. RESDALAO showed that in 2005, of the total installed hydropower capacity in Lao PDR, EDL owns 45.5%, 52% are Independent Power Producers (IPPs), and the remaining belong to the provinces and communities.

4.2.1 Domestic Market Power Demand

[16] Renewable Energy for Sustainable Development Association (RESDALAO)

The power demands of the country have been increasing steadily every year and will continue to do so. While in 2000, only 35% of households in Lao PDR were electrified the number has increased to 58.8 % in 2007. The government has committed to increase the number to 90% by 2020. Increasing the population's access to electrification will also increase the power demands of the country. Due to the increase in manufacturing in the country, by the year 2013, the domestic power demand is expected to reach 1992MW.

Table 4-1 Forecast of Domestic Power Demand of the Lao PDR

Items	2006	2007	2010	2015	2020
Power demands, GWh	1,400.6	1,711.4	5,013	13,370.8	14,783.6
Growth rate		22%	43%	22%	2%
Peak Load, MW	349.4	415.6	945.4	2223.2	2493.8
Growth rate		19 %	32%	19%	2%

Source: Ministry of Energy and Mines

4.2.2 Regional Market Power Demand

Lao PDR belongs to the Greater Mekong Sub region (GMS), comprising Cambodia, Lao PDR, Myanmar, Thailand, Vietnam and the Yunnan Province of the PRC. The GMS countries have diverse energy resources that are unevenly distributed among the member countries. Lao PDR, Myanmar, Vietnam and Yunnan are energy self-sufficient but Thailand and Cambodia rely on imported power.

Thailand's energy consumption and demands keep increasing. In 2005, the nation's peak load demand was about 20,500 MW. In 2007, the power demand jumped by 7.2% to about 22,600 MW. Over the next 15 years, Thailand expects its electric power demand to increase by almost two and half times or about 56,500 MW and the Thai government is planning to increase its own installed capacity to just above 58,000 MW by 2020.

Based on the concessions and power purchase agreements that have been signed with the Thai government, it is apparent that the power demand in Thailand will increase and accommodate much of any power produced for export in Lao PDR.

4.3 Project Alternatives

While the Project Proponent only has a mandate to investigate the DSHPP in detail, there are three alternatives in the vicinity as shown on Figure 4-1. The three alternatives are:

- Thakho Project, based on a diversion around Khone Phapheng
- Development of a hydropower project on the Hou Xang Pheuak
- Development of the Tad Somphamit hydropower project

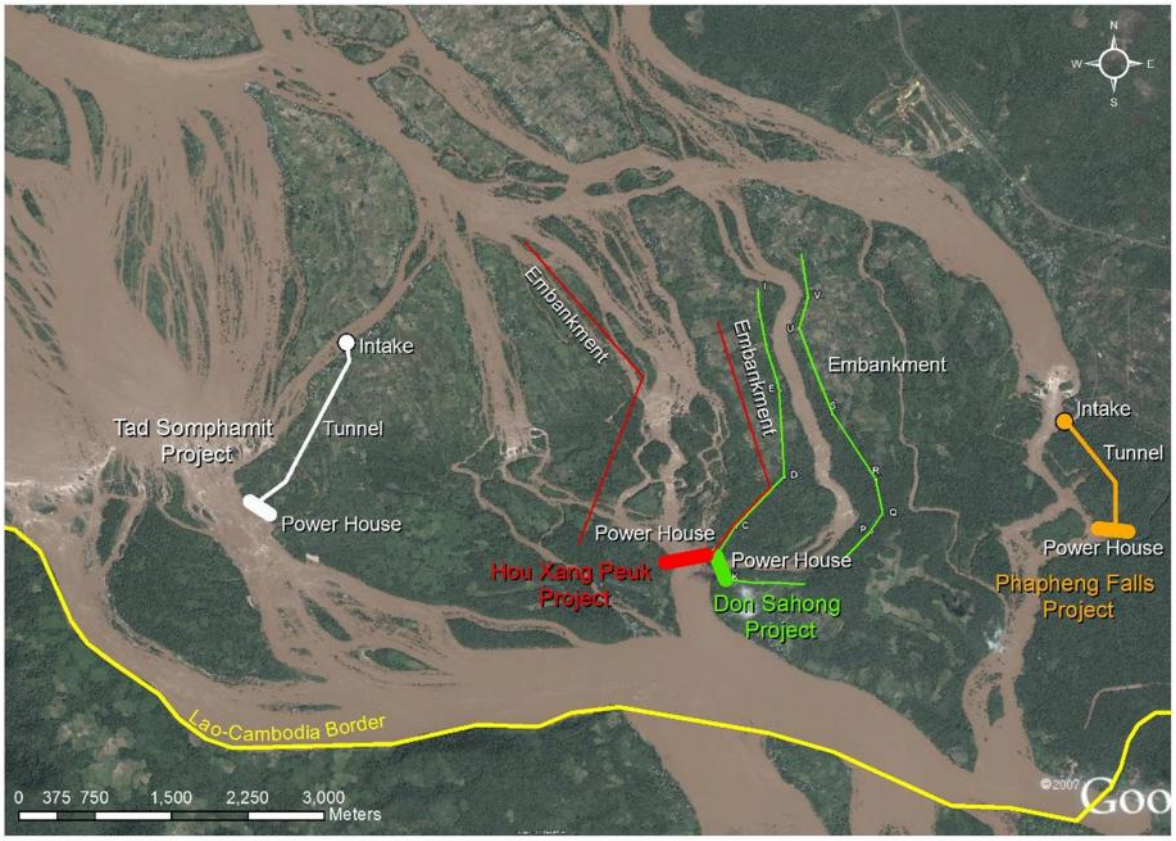


Figure 4-1 Alternative Power Station Sites at the GFL

Several different sized operations for DSHPP were based on diverting different quantities of Mekong River flow down the Hou Sahong channel, and include diversions of 800 m^3/s through to 1600 m^3/s, and power station installed capacities from 180 MW to 360 MW. Details of the capacity optimisation for DSHPP are included in the Engineering Status Report.

4.3.1 Khone Phapheng Alternative Concept

This alternative was listed in the "Power System Development Plan for Lao PDR" (PSDP) completed for the GOL by Maunsell/ Lahmeyer in August, 2004 (Figure 4-2). The PSDP study of the project, done only at desk level with no site visit, was based on an intake upstream of the falls, a single 12 m diameter headrace tunnel, and underground power station with two 30 MW units and tailrace tunnel. The works, apart from the intake, would not be visible to the general public visiting Khone Phapheng waterfall. Other advantages of this option include:

- Benefits to the ecological consequences on fish migration which is limited at Khone Phapheng compared with the blocking of the Hou Sahong year-round fish migration channel and no impacts on the normal roles of all other channels with respect to fish migration
- Advantages during construction and operational phases, of a mainland-based operation rather than an island-based operation, although the proposed bridge to the DSHPP will reduce this advantage.

Figure 4-2 Khone Phapheng (Thakho) Power Station Concept

Subsequent feasibility studies for this option were carried out, with significant changes to the original concept proposed in the PSDP (2004). The final concept is shown in Figure 4-2 above. Rather than an underground tunnel, this design involves excavation of a headrace channel that bypasses the Khone Phapheng falls, with a powerhouse barrage at its downstream extent housing 4 x 43MW bulb turbines resulting in a rated capacity of 172MW. While the power output is significantly greater than that proposed in the PSDP (2004) concept, associated impacts are also increased. The Khone Phapheng falls are a significant tourist attraction in the area. The major access to the falls is from its eastern side where the project is located. Visitors to the site would pass directly over the headrace channel.

This project has a significantly lower installed capacity than the DSHPP (172 MW vs 260 MW) and a consequently lower annual energy production (1010 GWh vs 2044 GWh).

The Thakho project would create an additional waterway that bypasses the Khone Phapheng falls. Water for power generation would be directly diverted from the falls, reducing its flow during station operation. A minimum environmental flow over the falls of 800m^3/s is also proposed for the Thakho project.

The Don Sahong project will also affect flows to Khone Phapheng falls, but the project would use an existing waterway, whose maximum flow will be similar to the natural maximum flow. Therefore the Don Sahong project will not reduce the maximum flow over the Khone Phapheng falls.

4.3.2 Hou Xang Pheuak Alternative

The Hou Xang Pheuak alternative (Figure 4-3) is unexplored at this time. However it would raise a number of environmental issues as it would require enlargement of the channel entrance and have adverse impacts on fish migration especially during the wet season.

Figure 4-3 Hou Xang Pheuak Power Project Concept

This concept would locate the power station just above the confluence of Hou Xang Pheuak with Hou Sahong, with the left abutment adjacent to Ban Hang Sahong (the hamlet would have to be relocated as for the Don Sahong project) and the right abutment on Don Khone. No topographic survey has been carried out on the area west of Don Sahong but there would be considerable excavation at the entrance to Hou Xang Pheuak and on the water falls mid-way down (Haew Xang Pheuak Nyai, Haew Xang Pheuak Noi and Khone Larn) to provide a waterway capable of carrying the required flow to the power station. Substantial embankments would be required on the western side.

While there has been no detailed study of this alternative it is likely that the power station capacity and output would be comparable with DSHPP, the cost of excavation and retaining embankment will be more costly than for DSHPP. Construction would be difficult because of

the many braided channels in the area west of Don Sahong and the construction period would be at least one year longer.

4.3.3 Tad Somphamit Alternative

The Tad Somphamit alternative (Figure 4-4) is also unexplored at this time. Information on this alternative comes from the Power System Development Plan and does not include field work or feasibility analysis. The project would raise similar environmental issues regarding the downstream migration and would be complicated by its relative inaccessibility. However, no detailed fisheries information is available.

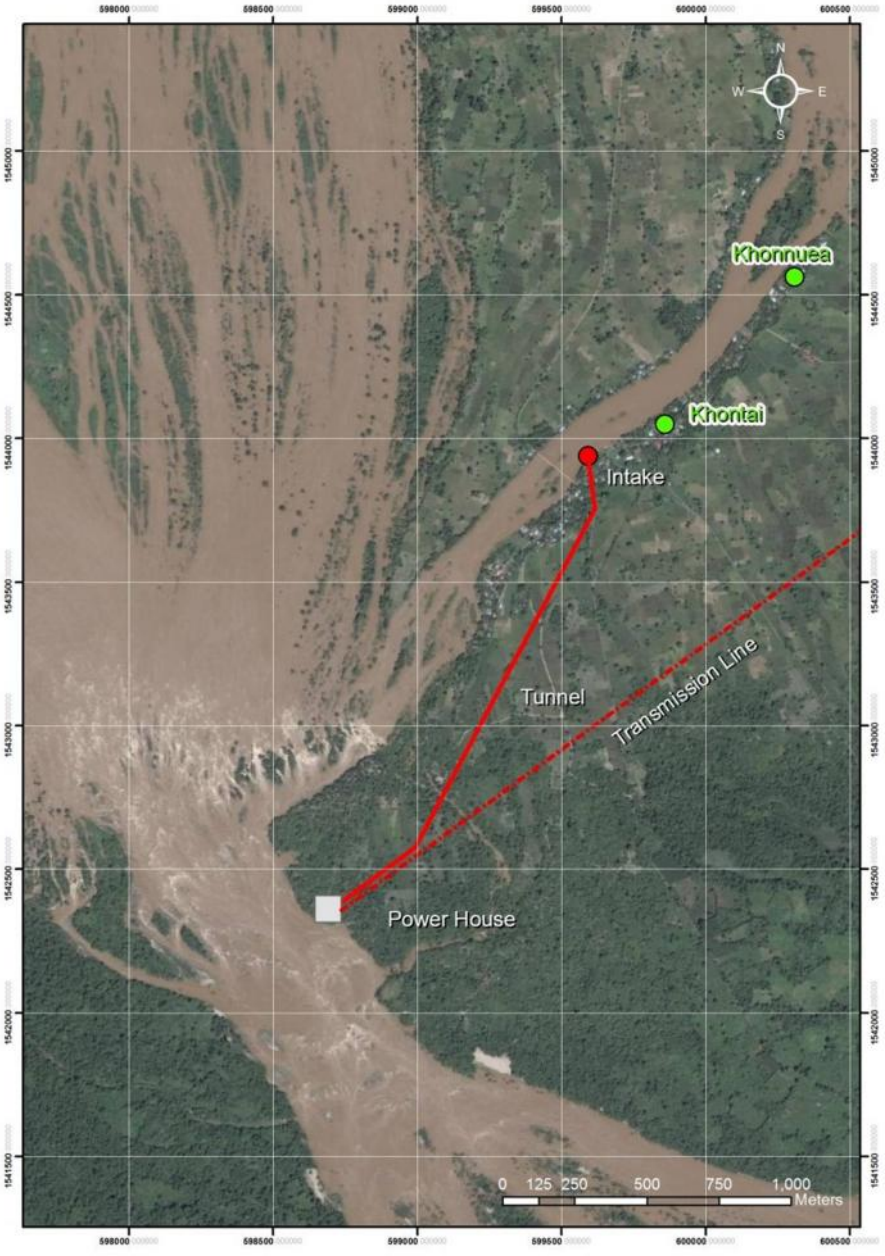


Figure 4-4

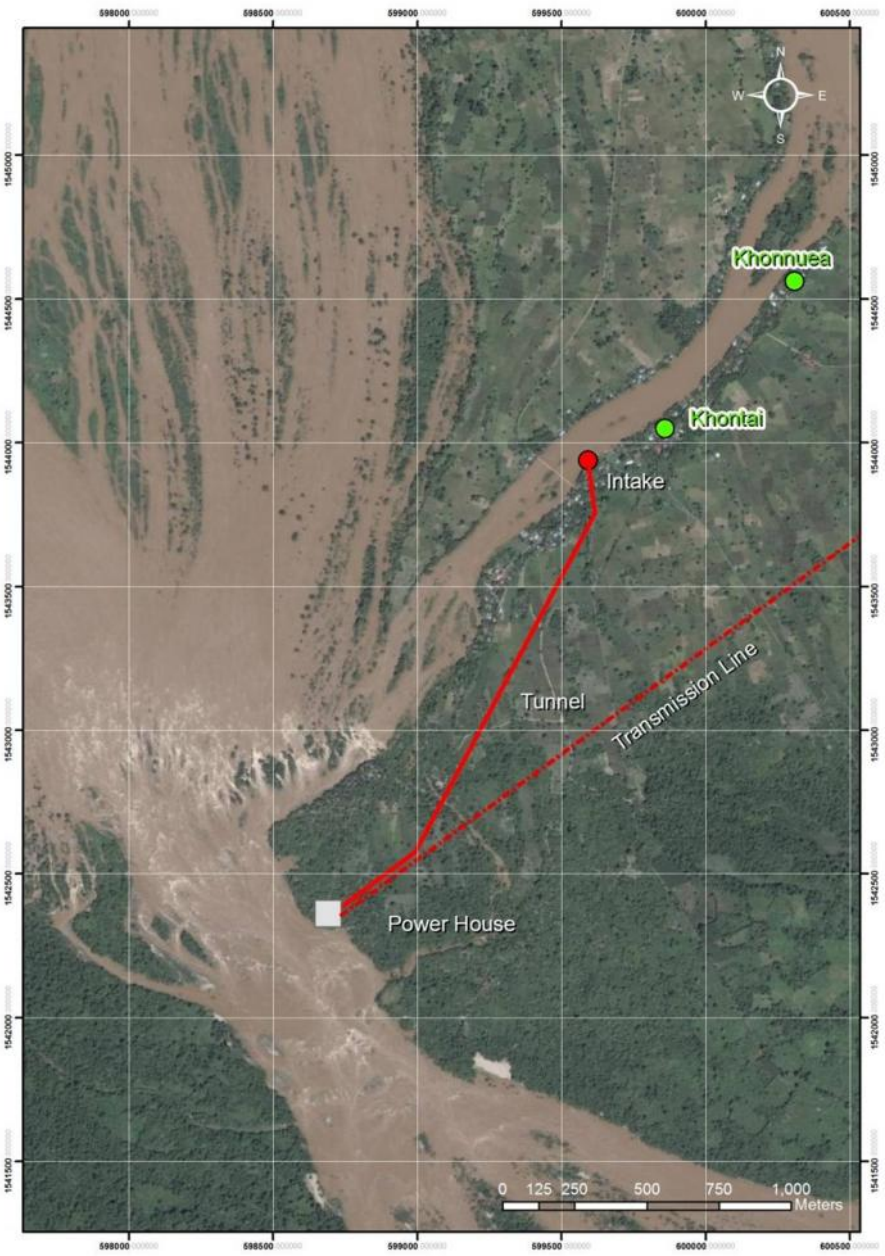


Figure 4-4 Tad Somphamit Hydropower Project

The concept would locate a weir and intake between the islands of Don Det and Don Khon near the villages of Ban Khon or Ban Khon Tai, with the powerhouse at the outlet of the Tad Somphamit channel. Since there is no analysis of this project available, it is not possible to ascertain the amount of resettlement that would be needed. However, satellite imagery indicates that the banks of the Tad Somphamit channel contain significant population on both sides (see Figure 4-5).

Figure 4-5 Tad Somphamit channel showing heavily populated banks

4.3.4 Within-Project Options

As previously introduced, the Project Proponent only has a mandate to investigate the DSHPP in detail. The engineering feasibility study investigated a range of alternatives for the DSHPP that are detailed in the Engineering Status Report, showing the impacts on installed capacity and annual average energy of, among other variables:

- number, size and type of units,
- varying degrees of channel improvements at the Hou Sahong mouth,
- quantum of environmental flows,
- effects of peaking generation,
- effects of reduced inflows to pondage (due to upstream development).

Apart from the impact on fish migration and its effect on the local inhabitants on Don Sahong, Don Sadam and surrounding islands, the most sensitive aspect of the development is the level of the "environmental flow", the water that is left in the Mekong downstream of the Hou Sahong entrance, its effect on the streams downstream (Hou Sadam, Hou Som Nyai and Hou Som Noi) and the visual impact of the Khone Phapheng waterfalls. A minimum environmental flow of 1,000 m^3/sec was initially suggested in the 2007 Feasibility Study Report by APW/PEC. This level of discharge would be more than the minimum historical flow over the falls, as interpreted from the historical minimum recorded flow at Pakse.

Subsequently in 2008 MFCB engaged AECOM to review and extend the 2007 Feasibility Study (APW/PEC). Additional hydraulic, topographical and geotechnical investigations were carried out to develop an optimized concept design and powerhouse arrangement. The optimum installed capacity and corresponding inlet and outlet excavation levels selected for the three alternative environmental flows studied by AECOM are presented in Table 4-2.

Table 4-2 Results of the FFS Optimization Studies

Environmental Flow (m^3/s)	Installed Capacity (MW)	Inlet level (m a.s.l.)	Tailwater excavation level
1000	260	65	46
800	260/280	65-64	46
600	280	63	46

For the purposes of the Final Feasibility Study an installed capacity of 260MW, an inlet excavation level of RL 65 m and an outlet excavation level of RL 46 m have been selected. This selection assumes an environmental flow of approximately 800 m^3/s will be applicable. This environmental flow of 800 m^3/s corresponds approximately to the driest (recorded) flow over the Phapheng Fall in the dry season of 2010.

4.3.5 No Project Option

The No Project option will not cause any change to the current migration patterns of the Mekong fish or affect the dolphin population. As discussed elsewhere in this report, the Irrawaddy dolphin populations are under significant threat, under current conditions, from a number of causes including overfishing in the area and the use of banned fishing gear. Experts indicate that the remaining populations may not be viable.

The no-project option would result in reducing the potential power export earnings of the GOL, thereby reducing the government's ability to alleviate poverty countrywide, and especially in parts of the southern area which will otherwise remain without access to electricity. The no-project option would also limit the ability of GOL to attract electricity dependent industries to the Southern Laos region.

The DSHPP will contribute to improving the regional infrastructure. It will enable social, livelihood and public health improvements to the six villages directly affected by the Project and will boost economic and tourism development through the extension to surrounding areas of a reliable electricity network. As specified in this document and in the SMMP, the implementation of the DSHPP will provide the following benefits to the area that will be foregone if the Project is not implemented:

- provision of a bridge to Don Sadam from the mainland, with continuing road access to Don Sahong across the dam and embankments
- general improvement of road access to the Project area
- creation of employment opportunities for local people during the construction and operation
- a social action plan to improve livelihoods and foster wealth creation in the Project area
- facilitation of improvements to rural electrification, health care and education facilities
- establishment of water supply and irrigation to the villages
- promotion of tourist businesses in the area,
- promotion of trade and services of small and medium businesses

Furthermore, construction of the Project has been welcomed by the inhabitants of Don Sadam and Don Sahong, who see this as a means to improve their living standards. While conceding their livelihoods may be affected, they anticipate net benefits from the Project through the proposed livelihood restoration programs. Consultation with people downstream in Cambodia indicates support for the Project, especially if the Project will provide tangible benefits to the local people.

4.3.6 Comparison of Alternatives

Table 4-3 provides a comparison of the alternative projects in the vicinity of the DSHPP, including an indication of the key impacts, with and without mitigation, of each project alternative. It must be recalled that the Project Proponent only has the mandate to develop the DSHPP. As such, their responsibility is to ensure that the DSHPP applies all reasonable measures to reduce or eliminate negative impacts and enhance positive effects from the Don Sahong project. Assuming appropriate and effective mitigation as described in this document, the DSHPP provides the most benefits in terms of power generation, and will have generally similar environmental and social impacts to the other alternatives.

Table 4-3 Alternatives Comparison Matrix

Alternative		Capacity (MW)	Average Generation (GWh/ yr)	Type	Displaced people	Key Potential Impacts with and without mitigation				
						Fish Migration Impact	Dolphin Impact	Tourism Impacts	Social Impacts / Benefits	Livelihood Impacts
1	DSHPP	260	2044	Run of river	63	Significant potential negative impact, but mitigation possible and may improve migration. Would involve modifications to Hou Xang Pheuak and Hou Sadam. Implementation of the FishMAP program could actually improve the current situation.	Potential negative impact. Fish migration mitigation will reduce negative impact. Construction impacts necessary. Viability of dolphin population is questionable with or without the Project.	No impact to Khone Phapheng falls. Project may improve tourism potential by providing bridge access to Don Sadam and Don Sahong	Significant social benefits to local people, including on Cambodia side. Resettlement will be minor and resettlers will be better off than now.	Potential serious negative impact to fisheries without mitigation measures. Fish migration mitigation and fisheries management program will improve fisheries. SMMP describes other livelihood programs.
2	Xang Pheuak	?	?	Run of river	60+	Significant potential negative impact to downstream migration. Mitigation possible through Don Sahong	Potential negative impact. Fish migration mitigation will reduce negative impact. Construction impacts necessary. Viability of dolphin population is questionable with or without the Project.	No impact to Khone Phapheng falls. Access to Project site unknown, probably by barge rather than bridge.	Significant social benefits could accrue to local people, including on Cambodia side. Resettlement will be similar to DSHPP and resettlers will be better off than now.	Potential serious negative impact to fisheries without mitigation measures.

Alternative		Capacity (MW)	Average Generation (GWh/ yr)	Type	Displaced people	Key Potential Impacts with and without mitigation				
						Fish Migration Impact	Dolphin Impact	Tourism Impacts	Social Impacts / Benefits	Livelihood Impacts
3	Thakho	172	1010	Run of river	Unknown (SIA only covers 50MW concept with underground tunnel). Few households in immediate Project footprint, but Khone Phapheng market would require relocation.	May negatively impact Hou Sadam. Impacts to fish entering turbines.	None, but viability of dolphin population is questionable.	Reduction of flows over Khone Phapheng may affect views in dry season.	Significant social benefits could accrue to local people, but may be offset by impacts to tourism and local fisheries.	Loss of jobs if tourism negatively affected because of impact to the falls. Impacts on fisheries at Thakho and Khone Phapheng villages. Some downstream impacts in the Soung Pho/ Kachevian area
4	Tad Somphamit	56	357	Run of river	Significant	Significant potential negative impact to downstream migration without mitigation. Minor impacts to upstream migration.	None, but viability of dolphin population is questionable.	No impact to Khone Phapheng falls, but may affect other falls on the west side of the river. Access to Project site unknown but would likely involve barges.	Significant social benefits could accrue to local people. Access issues may be complicated by proximity to Cambodia. Unknown amount of resettlement needed.	Unknown impact on fisheries, but probably minor. Could negatively affect tourism in Cambodia side.
5	No Action	0	0	N. A.	0	none	None, but viability of dolphin population is questionable.	none	none	none

Note: Capacity and Average Generation from: "Power System Development Plan for Lao PDR", Maunsell/Lahmeyer, August 2004

5 Potential Impacts

5.1 Introduction

This chapter identifies potential negative and positive environmental and social impacts which may occur during the construction, operation and decommissioning of the Project. An outline summary of the major potential impacts during the construction and operation of the Project are as follows:

- Potential impacts on land use and local Infrastructure
- Impacts of air, noise and water quality on villages and particularly villagers living close to construction areas
- Potential impacts on resources use, forestry, and wildlife
- Impacts on cultural and island communities
- Potential Impacts on public health
- Impacts on hydrology and downstream flows
- Potential impacts on livelihoods, archaeology and cultural of communities
- Environmental issues associated with transportation on roads.
- Impacts on tourism and Ramsar Site management

Potential impacts of the Project during the construction and operation may also result in indirect and direct impacts on land and resource use. Indirect impact includes induced population growth which could increase pressure on local resources use and agriculture land. The population growth related to the Project may also result in increasing impacts on timber and non-timber forest products. The construction and establishment of the Project's switchyard, transmission line, and powerhouse, access road and bridge will permanently affect land and resource use.

Because of the importance of the potential impacts on aquatic life and fisheries, these are discussed separately in Section 5.7. Similarly, the impacts of the DSHPP on the hydrology and flows of the Mekong River are discussed in Section 5.8.

This EIA does not cover the impacts of the access road and bridge. These are covered in a separate document, IEE (Initial Environmental Examination) – Access Road and Bridge, as requested by MoNRE and MEM.

5.2 Impact Significance

Environmental and social impact significance can be determined on the basis of an impact's magnitude, duration, and compliance with accepted standards. Application of the appropriate mitigation as described in the EIA and EMMP aims to reduce significant negative impacts to a less-than-significant level. If reasonable mitigation cannot sufficiently reduce the negative impact's significance the EIA reports that the impact remains after mitigation and is significant.

5.2.1 Magnitude of impact

An impact can be characterized by its magnitude:

- Minor: environmental impacts characterized by no or small, potentially measurable change; for social impacts, no or small adverse changes and more beneficial potentially measurable impacts; standard siting, construction/ operational norms and standards and practices can address such impacts.

- Moderate: environmental impacts include measurable loss or system disruption, system able to continue without mitigation but at a lower level; social impacts: measurable socio-economic changes, but individuals and communities would be able to function quite well but at a different level; standard siting, construction norms and standards and practices to take care of these impacts, but some mitigation measures may also be required

- Severe: environmental impacts consist of substantial or major losses or system disruptions; systems unable to function without considerable mitigation or major compensation; social impacts: substantial changes to existing conditions or major socio-economic loss or disruption; individuals and communities unable to function traditionally without mitigation or major compensation; alternatives to the proposed action have to be considered and a well-budgeted EMMP needed with strict monitoring and capacity strengthening.

5.2.2 Duration

An impact can be of short duration (for example noise during construction only), or long lasting or permanent such as the taking of private lands for the project, or destroying a wetlands. Long lasting or permanent impacts are generally significant. For example, an impact that is minor in magnitude but permanent in nature may be classified as significant. An irreversible impact will also normally be significant.

5.2.3 Compliance with Standards

A project causes a significant impact if it does not comply with accepted norms, such as air, noise or water quality numerical standards, requirements of accepted Lao environmental guidance and standards, the MRC guidance, or other standards accepted for the impact assessment such as WHO or European environmental standards.

5.3 Impact Summary

A summary of the potential environmental and social impacts and possible mitigation during the project construction, operation and decommission periods is shown in Table 5-1. Details are provided in the subsequent sections.

Cumulative impacts of the DSHPP have been addressed in a separate Cumulative Impact Assessment (CIA). The scope of the CIA includes physical, biological, and human impacts from the DSHPP when considered in the context of the hydropower development process in Lao PDR. While dams have provided significant impetus to growth it is well known that dam developments present a number of economic, environmental and social concerns. In the case of mainstream dams on the Mekong such as the DSHPP these issues need to be addressed, and in particular the following aspects require careful analysis and are addressed in the CIA:

- Mekong River Flows, and downstream impacts from their modification
- Fish Migration and Fisheries in the Lower Mekong
- Resettlement of displaced people
- Social and livelihoods impacts, and
- Health and Nutrition

Table 5-1 Impact Matrix

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
Construction Phase					
Physiochemical					
Noise and vibration due to construction and transportation	Construction areas; movement of vehicles, blasting, excavation, construction activities	During the construction	Potential minor negative impact, can be mitigated	Adopting International standards on occupational Health and safety as well as noise minimization program (in Contractor's EMMP). Acceptable noise levels to be specified.	**No Significant Impact**
Air Pollution; dust due to the construction and transportation	Construction areas and surrounding villages	During the construction	Potential minor negative impact, can be mitigated	Develop site management program prior the construction Appropriate road engineering; good compacting and runoff design, reduce speed limits, developing watering schedule for all roads (in Contractor's EMMP)	**No Significant Impact**
Water Pollution; soil erosion and siltation	Construction areas, And embankment areas subjected to drawdown.	During the construction and operation	Potential minor negative impact, can be mitigated	Develop best management practice on soil erosion and sedimentation at all constructed areas as well as pollution control technique -Maximize the use of excavated rocks, develop runoff system , installing sediment traps, rehabilitate construction areas by planting shrubs and trees Develop appropriate monitoring program (in Contractor's EMMP)	**No Significant Impact**
Handling and Storage of Fuel and Explosive materials	Mainland and island sites	Temporary/ During the construction	Potential minor negative impact, can be mitigated	Develop specific policy, safety, emergency response and SOP which comply to international standards, install oils and grease aggregators and separators and appropriate storage facilities (in Contractor's EMMP)	**No Significant Impact**
Disposal of earth, rock spoils	Construction areas and dump sites	Temporary/ During the construction	Potential minor negative impact, can be mitigated	Identify earth rock disposal sites and develop best practice management program (in Contractor's EMMP)	**No Significant Impact**
Solid wastes	Construction sites and workers camps	Temporary/ During the construction	Potential minor negative impact, can be mitigated	Constructing approved-offsite disposal facilities and develop management program. (in Contractor's EMMP)	**No Significant Impact**

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
Biological					
Terrestrial Vegetation: Loss of forest, plantation trees and wild life	Power house, switch yards, camps, embankments, transmission lines, building access roads and resettlement	Temporary and Entire project life	Potential minor negative impact can be mitigated: 29.4 ha of paddy land, 169.9 ha of forest	Mapping and inventory of impacted areas including village areas, project works areas, spoil disposal, quarry and temporary land use Consulting with local villagers and forestry provincial government to minimize impact Setting reforestation and wildlife life conservation program	**No Significant Impact**
Impact to Irrawaddy Dolphin	Downstream of the DSHPP	During the construction	Potential minor negative impact can be mitigated	Excavation not to include underwater blasting. Fish food supply to be maintained Mekong flows and water quality essentially unchanged in dolphin areas	**No Significant Impact**
Reduced fish migration	Hou Sahong water channel	During the construction	Potential major negative impact can be mitigated	Implement FishMAP	**No Significant Impact, with FishMAP**
Human (Health and Safety)					
Unexploded Ordnance	Constructed areas	During the construction	Very low incidence of UXO	Develop appropriate technical measure for safe infrastructure development and resettlement	**No Significant Impact**
Parasitic, water borne and communicable, sexual transmitted disease due to influx workers, project employees	DSHPP area	During the construction	Potential minor negative impact can be mitigated	Establishing health care system to prevent, control and provide medical treatment Screening and medical surveys of all employees before engagement Provide education on health and hygienic Working closely with local and provincial health Department	**No Significant Impact**
Safety hazards for villagers, workers and project employees at work places	Workers, project employees, surrounding villagers	During the construction	Potential minor negative impact can be mitigated	Develop or adopt the international best practices on occupational Health and safety at the work place (in Contractor's EMMP and Health and Safety Plan) Establish local and village security committee	**No Significant Impact**
Social and Economics					
Employment opportunities	Project areas, and surrounding villages	During the construction	Positive major positive impacts	Required by RAP	**Positive Impact**
Housing and Resettlement need	Project areas; 11 families & houses on	Entire project life	Potential minor negative impact	Implement resettlement program and provide compensation per RAP	**No Significant Impact, with RAP**

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
	DSH and Don Sadam need to resettle		can be mitigated	Establish grievance and other committees as per the RAP	**and SMMP**
Loss of infrastructure	Project areas, and surrounding villages		Potential positive impact. Infrastructure will be improved by Project.	Inventory all existing infrastructure, developing management program prior the construction. Carry out DSHPP infrastructure improvements	**Positive Impact**
Loss of fishery	Hou Sahong, Hou Sadam, Hou Xang Pheuak	Entire project life without mitigation	Potential major negative impact that can be mitigated	Implement FishMAP and SMMP Dependency on fishery will be replaced with alternative livelihood systems	**No Significant Impact, with FishMAP and SMMP**
Loss of paddy lands	29.4 hectares	Entire project life	Potential minor negative impact can be mitigated	Establish committees to identify measures and options for compensation	**No Significant Impact, with SMMP**
ROW for Access roads	Affected and surrounding villages	Entire project life	Potential major positive impacts; having new access roads	Covered in the separate IEE – Access roads and bridge	**Positive Impact**
Power supply	Affected and surrounding villages	Entire project life	Potential major positive impacts on local and surrounding villages	Required by RAP and SMMP	**Positive Impact**
Aesthetic and cultural					
Landscape and visual impacts	Hou Sahong and constructed areas	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Impacts to Religious places and Structures	Constructed areas	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Operations Phase					
Surface Water					
Flow variation	Mekong River	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Water Quality	Mekong River	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Water Balance	Mekong River	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Flooding	DSHPP area	Entire project life	No Impact anticipated	None required	**No Significant Impact**

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
Existing Use	DSHPP area	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Biological/Ecological					
Impacts to fish migration and aquatic habitats	Mekong River at the GFL	Entire project life without mitigation	Potential major negative impact that can be mitigated	Implement FishMAP	**No Significant Impact, with FishMAP**
Impact to Irrawaddy Dolphin	Downstream of the DSHPP	Entire project life	Potential minor negative impact can be mitigated	Fish food supply to be maintained by implementing the FishMAP Programme Mekong flows and water quality essentially unchanged in dolphin areas	**No Significant Impact, with FishMAP**
Human					
Aesthetic and cultural	DSHPP area	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Landscape and visual impacts	Hou Sahong	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Dam failure	Mekong River downstream	May never occur	Major impact, but unlikely to occur	No major impoundment. Dam failure plan for maximum flood based on overflow of western embankment into the Mekong.	**No Significant Impact**
Decommissioning Phase					
Physiochemical					
Land					
Flood plain/swamp	Hou Sahong	After decommissioning	Potential minor positive impact	None required	**No Significant Impact**
Seismic	Hou Sahong	During and after decommissioning	Potential minor negative impact	Minimize the potential effects of seismic events in the design of the decommissioning	**No Significant Impact**
Surface Water					
Flow Variation	Mekong River	After decommissioning	No change anticipated	None required	**No Significant Impact**
Noise					
Increasing traffic level	Project areas and nearby villagers	During decommissioning	Potential minor Negative impact	Adopting International standards on occupational Health and safety as well as noise minimization program	**No Significant Impact**
Blasting and removing dam and concrete infrastructure	DSHPP area	During decommissioning	Potential minor Negative impact	Blasting may affect aquatic animals. Other methods to be used.	**No Significant Impact**

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
Air quality					**No Significant Impact**
Increasing dust and air emission level due to the truck movements, removing dam and concrete infrastructure	Project areas and nearby villagers	During decommissioning	Potential minor Negative impact	Develop site management program for dust suppression prior to decommissioning.	**No Significant Impact**
Increasing transport network	Project areas and nearby villagers	During decommissioning	Potential minor Negative impact	Appropriate road engineering; good compacting and runoff design, reduce speed limits, developing watering schedule for all unpaved roads	**No Significant Impact**
Biological/Ecological					
Fish migration	Hou Sahong	During decommissioning	Potential minor positive impact	Restore fish ability to move freely through the channel. Short-term negative impacts possible during dam removal until natural conditions are restored	**Positive Impact**
Terrestrial vegetation and wildlife	Project areas	After the project decommissioning	Potential Minor Positive Impact	Restore original plant communities. Short-term negative impacts possible during dam removal until natural conditions restored	**Positive Impact**
Endangered species	Mekong River	After the project decommissioning	No Impact Anticipated	None required	**No Significant Impact**
Aquatic habitat	DSHPP area	After the project decommissioning	Potential Minor Positive Impact	Restore aquatic habitat.	**Positive Impact, with FishMAP**
Human					
Fisheries	DSHPP area	After the project decommissioning	Potential Minor Positive Impact	Restore fishery activities	**Positive Impact, with FishMAP**
Employment	Project areas and nearby villages	During decommissioning	Potential Minor Positive Impact	Creating work and job opportunity	**Positive Impact**
Employment		After the project decommissioning	Potential Minor Negative Impact	Apply the SMMP during construction and operation	**No Significant Impact, with long-term results of the SMMP**
Landscape	DSHPP area	After the project decommissioning	Potential Minor Positive Impact	Restore/rehabilitate visual landscape	**Positive Impact**
Tourism	Project areas and nearby villages	During, after the project decommissioning	No Impact Anticipated	None required	**No Significant Impact**

5.4 Impacts during Project Construction

5.4.1 Impacts on Land Use and Local Infrastructure

Land use and local impacts may be associated with the requisition of land for establishment of the power house, switch yards, camps, workshop, offices, and access road and bridge. The Project will result in both temporary and permanent loss of access to land and some local infrastructure.

Approximately, 359.2 hectares of land will be required for the construction of ancillary project components, of which, about 290.7 hectares of agriculture and forestry land of the two islands will be affected by the DSHPP. Of this only 29.4 ha of paddy land and 169.9 ha of forest lands will be affected by the Project. Regarding impacts on local infrastructure and land use on the two islands of Don Sadam and Don Sahong, there is very little infrastructure existing in the Project area other than road access provided by Highway 13 South on the mainland. Land use on the two islands of Don Sadam and Don Sahong is traditionally held but untitled and agricultural land is relatively scarce, so spoil dump locations are critical to local residents and will be located so as to avoid damage to the extent possible. The actual impacts of actions such as access roads are difficult to assess except in general terms. Similarly, the interference with local transport on Highway 13 appears to be limited except during peak periods of moving major equipment to the DSHPP site.

With the application of mitigation such as the SMMP the residual impact of the Project on Land Use will not be significant. Positive Impacts are expected on Local Infrastructure.

5.4.2 Land Clearing, Embankment and Road Construction

The areas required for land clearing and their status as of 2007 are listed in Table 5-2. This table is representative of the land needs required under the plan evaluated in the Feasibility Study No new estimate of land acquisitions was available at the date of publication of this report.

The table shows that approximately 300 ha of lands will be required permanently for the DSHPP on Don Sadam and Don Sahong. This includes some 29.4 ha of paddy land and 169.9 ha of forest lands of which about 40% are degraded. This figure does not include any lands for spoil dumps either temporary or permanent.

The clearing of lands for the Project is an issue that requires negotiation with the three local Village Committees and the relevant District authorities and payment of compensation. This will include the following:

- Compensation for loss of lands indicated as being within the respective village areas
- Compensation for loss of trees within the respective village areas
- Compensation for loss of trees outside the village areas but within areas managed by Khong District and Champasak Province forestry authorities.
- Negotiations for spoil disposal areas and their restoration.

Resettlement and compensation issues are discussed in detail in the RAP and SMMP, which are submitted as separate documents.

Table 5-2 Estimates of Project Land Requirements and Landuse in Affected Areas

(All areas in ha)

Project Features	Location	Village Area & Household (HHs)	Rice Paddy Lands		Forestry Lands		Island Rock & Vegetation & Water	Total Area
			In Use	Grazing Disused	Good	Degraded		
A. Right Bank – Working & Reservoir Areas								
1. Dam, Works & Switchyard	Hang Sahong	1.5 (10 HHs)	-	-	0.5	2.7	-	**4.7**
2. Embankments 2.1km x 10m	Don Sahong	-	-	-	1.5	0.6	-	**2.1**
3. Land Flooded at EL 75m	Don Sahong		4.5	1.5	54.3	35.5		**94.8**
B. Left Bank – Working & Reservoir Areas								
1. Dam, Plant Sites & Facilities	Hang Sadam	0.3 (1 HHs)	2.3	2.8	-	2.7	-	**8.1**
2. Lower Embankment 2.4 km X 10m	Hang Sadam	-	1.1	0.7	-	0.6	-	**2.4**
3. Land Flooded at EL 75 m	Don Sadam		3.1	6.3	45.2	23.2		**77.8**
4. Island Barge Landing	Hua Sadam	-	1.5	-	-	-	-	**1.5**
5. Road to Dam site (10mx5,700 m)	Hua Sadam to Hang Sadam	-	2.9	0.8	1.6	0.4	-	**5.7**
6. Access Site at Coffer Dam	West of Hua Sadam	-	1.2	-	-	0.7	-	**1.9**
7. Upstream Coffer Dam & Islands for Flow Channels	Hua Sadam to Hua Sahong	-	-	-	-	-	3.2	**3.2**
Subtotal Don Sahong & Don Sadam		**1.7 ha & 11 HHs**	**16.6**	**12.4**	**103.1**	**66.5**	**3.2**	**203.3**
C. Mainland Barge Landing								
1. Nominated Landing site	North of Resort	0.3	0.4	-	0.2	0.4	-	**1.2**
D. Reservoir Water Areas – Nominal not Official								
1. Community Fishing Zone	Hou Sahong		-	-	-	-	29.2	)
2. Traditional Lee Traps	Hou Sahong		-	-	-	-	10.0	) **76.3**
3. Other Fishing Zones	Hou Sahong		-	-	-	-	37.1	)
4. Two Island Flooded	Hou Sahong		-	-	-	-	11.3	**11.3**
5. Aquatic Habitats in Downstream Channel	Mekong River		-	-	-	-	5.0	**5.0**
Subtotal			**-**	**-**	**-**	**-**	**92.6**	**92.6**
D. Total DSHPP Areas		**2.1 11 HHs**	**17.0**	**12.4**	**103.3**	**66.9**	**92.6**	**296.7**
E. Transmission to Ban Hat Substation								
1. On Don Sahong (30m x 2,980m)	Don Sahong	-	4.4	2.3	-	3.2	-	**8.9**
2. On Don Tan Tok (30m x 2,400 m)	Don Tan Tok	-	2.6	2.9	1.0	0.7	-	**7.2**
3. Over Mekong River Channel (30 x 1,200 m)	2 Channels	-	-	-	-	-	3.6	**3.6**
4. On Mainland – Nakasang To Ban Hat Substation (30m x 15,300 m)	East of Road No. 13	-	11.8	18.7	6.3	9.1	-	**45.9**
T/L Subtotal – 20,680mx30m	**Don Sahong to Ban Hat**	**-**	**18.8**	**23.9**	**7.3**	**13.0**	**3.6**	**65.6**
TOTALS		**1.3 ha (11 HHs)**	**35.8**	**36.3**	**110.6**	**79.9**	**96.2**	**359.2**

Source: Map interpretation and ground surveys by EIA Team, January to April 2007

The impacts of the DSHPP pondage and associated works are identified in Table 5-3. In summary:

- Some 26% of the land systems of the two islands are affected including over 32% of their forests and between 5 and 22% of their agricultural lands
- A total of approximately 300 ha are directly affected, out of a total of 876.5 ha or 32.2%; this is considered a potentially significant impact in terms of the local environment of Don Sadam and Don Sahong.
- It is impossible to define these land takings in terms of effects on registered village lands lost as registered plans are not available or approved by District authorities.

Table 5-3 Land Use Areas Required for DSHPP Pondage and Works
(Agricultural and Forestry Lands on Don Sadam and Don Sahong)

Location & Land Use	Natural Conditions ha	Affected by DSHPP Ha	Percentage of Area Affected
Don Sadam – Agricultural	139.9	7.1	5.1%
- Forestry/ Other	334.1	95.1	28.5%
- Subtotal	**474.0**	**102.2**	**21.6%**
Don Sahong – Agricultural	104.2	23.3	22.4%
- Forestry / Other	211.3	77.6	36.7%
- Subtotal	**315.5**	**100.9**	**32.0%**
Two Island Land Systems	**789.5**	**203.1**	**25.7%**
Hou Sahong - Small Islands	11.3	11.3	100%
Hou Sahong - Water	76.3	76.3	100%
Total Ecosystem of Islands	**876.5**	**290.7**	**33.2%**

The necessary mitigation actions are discussed in the Social Management and Monitoring Plan (SMMP) and the Resettlement Action Plan (RAP)**.** Mitigation measures are also outlined in Table 5-1.

With these measures in place impacts from land clearing and embankment construction will not be significant.

5.4.3 Coffer Dam Construction, Channel Excavation and Spoil Dumps

The construction and operation of the DSHPP's cofferdams and channel excavation are complicated works which last for the entire construction period. They are integrally linked with spoil disposal either in the embankments or in separate locations. Also the upper coffer dam requires temporary dams to effectively excavate the required channel and a sloping entrance into the Mekong River. The estimated quantities of materials to be excavated to RL 66 and for approximately 2 km downstream of the entrance and to be disposed of are:

- Stage 1 - 700,000 cu. m.- Extending downstream from the main upstream cofferdam and can proceed after completion of the dam
- Stage 2 - 250,000 cu. m – involving excavation in the area between the main cofferdam and initial cofferdam and to be done during a period of low-flow
- Stage 3 - 60,000 cu. m – involving excavation of the river occupied by the main cofferdam and also done in a period of low flow and after the Power Station has reach "water-tight" stage
- Stage 4 - 20,000 cu. m – involving the removal of the upstream cofferdam and excavation of under-lying rock to provide a transition from RL 60 into the main stream of the Mekong River

- Downstream of power station - 70,000 cu m – involving excavation to reduce the headloss through the station and increase energy.

This totals some 1.35 million cu m of mostly hard rhyolite rock of which approximately 250,000 cu m of the total excavated can be used for construction of the Containment Dams and Saddle Dam and for rip-rap protection and streamlining of the entry into Hou Sahong. Nevertheless there are over 1.05 million cu m of waste excavated rock to be disposed. Locations for this will require detailed negotiation with local village officials.

The mitigating actions required in respect to coffer dam and channel excavation will include discussions and negotiations based on definite plans for the spoil disposal sites with local village administrations as is discussed in the SMMP and RAP. This is essential in order to avoid conflict and ensure good local planning. Any spoil areas will have adequate drainage and will be designed with restoration in mind. The possibility of disposing of all this material within the embankment of the Project's pondage will be considered during final design.

With these measures in place impacts from cofferdam construction will not be significant.

5.4.4 Impacts on Air and Water Quality

The effects and amelioration measures required for the DSHPP during construction phase with regard to air and water quality protection are described in the following sections.

Dust Suppression

Extensive quantities of excavation materials will have to be moved during the construction period and vehicle traffic will be an obvious source of dust during this period. Also there would be other sources of dust at the worksites on Don Sadam, Don Sahong and the mainland camp and storage area. With its embankments and roads (including ancillary access roads) minimizing dust in the dry season will be a requirement for all contractors. The dam site and main works area are very close to all three villages so controlling of speed limits and wetting of all traveled surfaces should be imposed on all operations and to ensure that the Project activity complies with the national and international standards. Adequate DSHPP policy for this matter will include a "dust suppression plan" before the implementation.

With these measures in place, the impacts from airborne dust will not be significant.

Transport, Handling and Storage of Fuel and Explosives

Another important aspect relates to the transport, handling and storage of fuels and explosives. With a split between mainland and island sites and then again with work ongoing at several sites simultaneously on the islands, detailed attention will be given to these matters, not only to protect the environment but also from the public safety viewpoint. The DSHPP and its contractors will have policies, safeguards and emergency response plans in place. This will receive priority in Tender Documentation and Project planning during detailed design.

With these measures in place impacts will not be significant.

Water Quality Protection

Little information is available on specific sites where water quality protection is required. However with multiple construction works proceeding on and around the pondage, which is enclosed by coffer dams, it will be possible to plan a runoff control system. Any site releases will have sediment traps installed and operating to protect the Mekong River, particularly in the dry season when clear water prevails. Bunding of vulnerable zones outside the pondage will also be applied as required. Monitoring of releases of onsite water bodies and releases

will be the responsibility of the main contractors and will be reported by the DSHPP monitoring authority which will carry out independent oversight.

The need for comprehensive mitigation action required for air and water quality protection are obvious as the DSHPP is in close proximity to existing villages, particularly Hang Sadam. This community also draws water from the Mekong River downstream of the dam site and this aspect needs to be considered in mitigation. The main mitigation measures envisaged include:

- Development of dust suppression systems including watering schedules for all roads and works areas within 1 km of these villages
- Each contractor to devise a comprehensive fuels and explosives transport, handling and storage plan including bunding of tanks and an emergency response plan with DSHPP responsible overall
- Preparation and implementation of an overall water quality protection plan based on using the pondage area to collect, treat and release all waste waters and to include a detailed monitoring program.
- Provision of water supply systems for affected communities.

This is an important aspect and one in which the contractors and DSHPP will need to liaise with the Champasak Provincial office of MoNRE, both for planning and during operational stage for construction**.**

With these measures in place impacts on water quality will not be significant.

Climate Change

Large reservoirs can emit substantial amounts of methane, which is a potent greenhouse gas (GHG). Methane is emitted from reservoirs that are stratified and where the bottom layers are anoxic, leading to degradation of biomass through anaerobic processes. The largest proportion of GHG emissions from a dam is caused by the decay of flooded biomass. Large, shallow, forested reservoirs tend to generate the most methane.

On the other hand, hydropower dams serve to reduce emission of carbon dioxide as hydropower offsets thermal power generation, thereby reducing overall GHG emissions of the electricity sector. GHG resulting from the manufacture of the dams cement and steel, plus the energy used in the construction amount to less than 10% of the annual carbon dioxide emissions of the fossil fuel equivalent.[17]

The DSHPP reservoir during operations will not be significantly larger than the existing river footprint, as shown in Figures, and the water through the Hou Sahong will be fast moving and well aerated, thereby discouraging the formation of methane from biomass. GHG emissions for the DSHPP will be minimal in comparison to the annual CO_2 emissions of thermal power plants producing equivalent amounts of power.

Impacts on climate change by the DSHPP are expected to be positive.

5.4.5 Impacts and Mitigating Actions on Forestry and Wildlife

The impacts and mitigating measures related to forests and forestry in the context of the DSHPP are largely preventative and remedial to compensate for the losses to the island / channel ecosystem, and particularly of trees of use to the local communities. These forest resources include bamboo and suitable species for poles and firewood. There are no

[17] **"Climate Change and Dams: An Analysis of the Linkages Between the UNFCCC Legal Regime and Dams" United Nations Environment Programme (**UNEP) and World Commission on Dams, November 2000

indications of any endangered species but, depending on village plans, some compensation may be payable to District or Provincial forest authorities.

Forest Resources

Generally, the clearance of vegetation within the dam site, powerhouse and reservoir can lead to further fragmentation of already diminishing areas of natural forests and wildlife habitats. Based on the land use and forest map and conducting field survey, most vegetation types covered within the Project area are swamp and unstocked forest. However, there are some Mixed Deciduous Forest and Gallery Forest, although severely degraded, in the Hou Sahong riparian zone. All forest lands below RL 75m are likely to be affected and it is probable that vegetation below this level would be destroyed through flood damage during the wet season.

Table 5-4 shows the total area of forest types and the indicated affected areas on Don Sadam and Don Sahong. Swamp Forests (56%) are the most seriously affected and the other three categories range between 12.6 and 17.1%. However it would be necessary to confirm these figures by compiling a more detailed inventory of all forests during the detailed design phase.

Table 5-4 Forestry Landuse area and type affected by the DSHPP

Land Use and Forest Types	Don Sahong	Don Sadam	Total (Ha)	Total Affected Areas excl. Trans Line	
	Area	Area	Area	Area	%
Mixed Deciduous Forest (MD)	-	145.5	145.5	22.8	15.6
Gallery Forest (G)	-	66.6	66.6	11.4	17.1
Unstocked Areas (T) incl. Agricultural	253.5	185.0	438.5	55.4	12.6
Swamp Forest (S)	62.4	80.6	142.8	80.0	56.0
Total	**315.9**	**477.7**	**793.3**	**169.6**	**21.3**

Note: * Affected areas exclude transmission line

The effects of the DSHPP pondage and associated works are listed in Table 5-2 and Table 5-3. There is no feasible way of reducing these effects as all areas are required for various infrastructure and the pondage.

Photograph 5-1 – Secondary growth on right bank, lower Hou Sahong

In addition to these effects on local vegetation is the proposed transmission line. The 20.7 km long transmission line right-of-way (ROW) (30 m) has a total land area of some 62.0 ha, including 42.7 ha of agricultural land and 16.3 ha of forestlands This right-of-way has not been decided and would involve tower locations and selective clearing in some forests. As with the effects of the impacts on forests of Don Sadam and Don Sahong this aspect requires detailed inventorying in the design phase of the Project.

Overall the impacts on forest resources will not be significant but some resources may be affected by the cumulative adverse impact of the Project.

Wildlife Resources and Mitigation Measure

Wildlife and wildlife habitat assessment involved field surveys, local villagers' interviews and discussions with authorities concerned and showed that the only significant habitats remaining occur on the steep slopes of the Don Sadam conservation area. In other more accessible lower slopes where forests have been destroyed, wildlife and wildlife habitat have also been disturbed by human interventions including the taking of logs, poles and bamboo over the years. All the fauna communities within the flooded areas will be lost once the DSHPP is initiated and would change once the Project becomes operational when the dam site is completed.

The mitigation measures required to protect the remaining forest and wildlife resources during construction are indicated to include:

- Undertake a complete forest inventory of the two islands, highlighting forest losses, any compensation to traditional owners and a plan for salvage of forest resources by local communities
- Completion of a detailed survey focused on the DSHPP pondage area of wildlife resources and any necessary plans for rescue prior to clearing of riparian vegetation
- Prepare a plan for selective planting of forest species in consultation with the representatives of the three local communities and forestry authorities and to include bamboo and other suitable pole species, in particular. None of these mitigation actions have been costed in detail and this is considered as a separate pre-construction forestry sub study. The total estimated costs of such a program are estimated as a lump sum at USD 300,000.
- Invoke controls on all workers through the contractors to be aware of the limited wildlife resources of the islands' ecosystem, to refrain from exploiting these resources and to actively support co-operation in protection and preservation of these resources.

With these measures in place impacts on wildlife resources will not be significant.

5.4.6 Impacts and Mitigating Actions for Island Communities

Physical Impacts on Villages

The villages of Ban Hang Sadam, Ban Hua Sadam and Ban Hua Sahong would bear the direct and indirect impacts of the DSHPP. The hamlet referred to as Ban Hang Sahong and one outlying household of Ban Hang Sadam would need to relocated. These communities comprised of a total of eleven (11) households. No relocation is anticipated on the mainland. This is discussed in detail in the RAP. All communities are close to some of the construction activities, for example:

- Hang Sadam is within 1.0 km of the main dam site and has agricultural lands directly affected by the construction facilities and by the downstream dredging for the tailrace channel.
- Hua Sadam is within 0.3 km of and directly affected by the main barge landing site, its agricultural lands will be affected by the main road and traditional use and cultural areas will be affected by the eastern upstream coffer dams and channel excavations.
- Hua Sahong is within 0.5 km of and will be directly affected by construction of the barge landing and the western upstream cofferdam and channel excavation.

It is proposed to relocate the Hang Sahong hamlet approximately 1km to the north of its current location. Works such as forest clearing and channel excavation will affect the

northern part of Don Sahong, and will require an access road from the dam site to the northern extent of the island. This is in addition to the access road-cum-embankment on Don Sadam. While these roads would be assets beneficial to the local communities it is envisaged that separation of village traffic and DSHPP traffic may be necessary on Don Sadam. Also the drainage arrangements for all Project access roads needs to be planned to be compatible with local villagers' drainage needs in their agricultural fields. Otherwise these issues will be a source of local complaints.

Other mitigating actions that need to be resolved through consultation with local communities include:

- Water supply sources, both temporary during construction and permanently because many villagers use the Hou Sahong as their water source.
- Noise emissions and their effects on community activities, such as the operation of the Wat at Hua Sadam that fronts Hou Sahong.
- Policies on use of roads by local residents and appropriate warning signals by DSHPP and contractors' vehicles and public warning signs where appropriate along access roads.
- Arrangements and use of DSHPP emergency health facilities and vehicles for local residents.

With these measures in place, and implementation of the RAP, physical impacts on villages will not be significant.

Social Impacts on Villagers

Refer to Section 5.1.1.2 of the Social Impact Assessment (SIA) for details of social impacts.

5.4.7 Impacts and Mitigating Actions for Public Health

Refer to Section 5.1.2 of the Social Impact Assessment (SIA).

5.4.8 Impacts and Mitigating Actions for Mainland Operations

The location of the 20ha mainland camp area, as shown on Figure 2-4 has been approved by the relevant district and provincial authorities. Development of a fenced-off main camp at this location would not require relocation of households.. There are several considerations concerning the mainland camp, including;

- It is likely to generate considerable uncontrolled land occupation on the periphery by "camp followers", due to the relatively low-income levels and standards of development, water supply, and sanitation of the local residents;
- It would generate significantly increased traffic accessing Highway 13;
- Re-use of the construction camp facilities should be considered in camp layout, including the possibility to use the location for the permanent operators village;
- Possibility of using redundant barging facilities for tourism and local fishing operators.

The impacts and required mitigating actions for mainland camp operations are incomplete and need review based on final decisions on the Project, It is suggested that this aspect be re-addressed during the DSHPP design stage. However, detailed management measures for the camps will be required of the Contractors, as explained in the Environmental Management and Monitoring Plan (EMMP).

With these mitigating measures in place, including implementation of the EMMP which provides for special specifications for the management of camps, the impacts of mainland operations will not be significant.

5.5 Impacts during Operation Phase

In general, the impacts during the operational phase of DSHPP would be considerably less than those imposed by construction on the ecosystem of the two islands and experienced by the three communities directly involved. This section outlines the nature of some of the operational phase impacts and mitigating actions. The reader is also referred to the results of the Fisheries Study and the Hydrological Model, Sections 5.7 and 5.8.

5.5.1 Impacts and Mitigating Actions on Land Use

Once the construction phase is finished, the DSHPP and its contractors would have to consolidate and clean up their land holdings on Don Sadam and Don Sahong. This condition may also apply to land used in the camp and outside for temporary works on the mainland. Site rehabilitation and re-use of any facilities or salvage of building supplies for local communities will be priority items. Similarly scarification and planting with trees of any temporary worksites negotiated by the contractors should be undertaken. It is considered advisable that as much land as possible should be returned to the local village authorities in as good a state as possible. To effect this, DSHPP will make site clean-up and rehabilitation a condition of engagement for all contractors onsite.

With these mitigating measures in place, including implementation of the EMMP by the Contractors that provides for rehabilitation, the impacts on land uses will not be significant.

5.5.2 Impacts and Mitigating Actions for Island Communities and Livelihoods

Refer to Section 5.2.1 of the associated Social Impact Assessment (SIA).

5.5.3 Impacts and Mitigating Actions on Public Health

Refer to Section 5.2.2 of the associated Social Impact Assessment (SIA).

5.5.4 Impacts & Mitigation Actions for Tourism and Ramsar Site Management

Tourism Aspects

The negative impacts of the DSHPP on tourism for both the construction and operational phases will be minimal. Don Sadam and Don Sahong are not presently tourist destinations and unlikely to be so in the immediate future. The improvements of the accessibility to the two islands would improve slightly their possibility of becoming tourist areas for:

- The attraction of the hydropower station and pondage.
- Development of a circuit nature trail from Ban Hang Sadam across Hou Sahong to Don Phapheng and to the west side of Khone Phapheng waterfall and back to Ban Hua Sadam.

Such a development would tend to focus on Don Phapheng and accommodation there, closer to the waterfall. The implications of this may need to be considered by Department of Tourism authorities as part of the long-term development plans of the Khone Phapheng area. The DSHPP will result in a potential for increased tourism development in the region.

Negative impacts will not be significant, and some positive impacts may occur.

Ramsar Site Management
As noted in Section 3.4 the declaration of a Ramsar site for the Si Phan Don Wetland is not imminent, and two other wetlands have been designated. Development of DSHPP is not excluded by the potential future designation of the Si Phan Don wetlands as a Ramsar site. However, in the long term the presence of the Project would have some implications for the overall management plan of the Si Phan Don Wetlands, including:

- Direct positive impacts on fisheries management;
- A need to accurately assess the forestry, wildlife and fisheries losses associated with DSHPP, so that data is available to conservation groups and MRC on the full implications of in-stream hydropower development on the Mekong River. This is an environmental issue required for future reference in Lao PDR;
- Potential uncontrolled tourism developments on Don Phapheng that might affect the visual quality of the falls.

As the preparation of long-term sustainable management plans for the Si Phan Don Wetland include community consultation including stakeholders' meetings to formulate the plans, these will be integrated with the actions and objectives of DSHPP. The Developer intends to cooperate with and support the appropriate groups in their development of the Si Phan Don management plan. Exchanges of information and ideas on optimizing the long-term benefits to the local communities should be the prime objective of this consultation process.

No negative impacts on Ramsar management are expected, and some positive impacts may occur through support by the DSHPP of the Ramsar site management, if it is officially declared in the future.

5.6 Impacts during De-commissioning

The present MoU indicates that the concession period will be 27 years from commercial operation, after which the power station will be handed over to the GOL and they will continue to operate the facility. Hydropower stations, such as the DSHPP, have useful lives of decades – there are hydropower stations still operating more than 100 years after first commissioning - so there is no technical reason why the power station should ever be decommissioned. On the other hand, there are small power stations that have been removed from streams in the United States and other countries, specifically to restore aquatic ecological balance.

If decommissioning and removal of the power station were required, the basic actions required would involve the following:

- Restoration of the natural control at the entrance of the Hou Sahong and dumping rockfill (taken from the water retaining embankments) into the stream to replace the rock removed during lowering of the upper reaches
- Removal of electrical/ mechanical plant at the base of the powerhouse
- Demolition of the concrete structures (although this would not be absolutely necessary as the turbine waterways, once the mechanical and electrical equipment is removed, will allow fish to pass freely and the structure will provide permanent access from Don Sadam to Don Sahong).
- Extensive tree planting program for the sides of the channel to restore vegetation to these zones

Negative impacts of decommissioning would not be significant given the mitigation proposed.

5.7 Aquatic Ecology and Fisheries Impacts and Mitigation Actions

The potential impacts of the proposed DSHPP on the fisheries are by far the most important aspects of the Project. These have been raised as a major issue in all discussions with concerned agencies such as MRC, IUCN, WWF and LNMC in Vientiane and the issue has dominated the discussion at all the Stakeholders' Meetings. The main results of studies to evaluate the impacts and the mitigations are summarized here below. The details of all fisheries studies are presented in Annex C and in Annex E (Appendix G).

5.7.1 Impacts to Migratory Fish

The long-term sustainability of migratory fish populations in the Mekong River is threatened by a number of human actions. These include: alteration of natural river flow regimes and sediment loads; loss of critical habitats and reduction in floodplain connectivity; the over exploitation of fishery resources; and the creation of barriers to fish migration across mainstream channels.

The DSHPP dam will be a barrier to fish movement through the Hou Sahong. Therefore activities to mitigate this impact will be a major focus for the Project. As the Project will not have a material impact on the other issues listed above, no mitigation or management actions for those issues have been proposed, except in relation to over exploitation of the fisheries resource.

In the Si Phan Don area, over exploitation is a sensitive issue, because local fisheries rely heavily on harvesting fish making spawning migrations. This is one area where active resource management can be undertaken and the Project proposes to assist the GOL to improve fisheries sustainability by developing model fisheries management systems within the immediate Project footprint.

This could be achieved by working with local villages and GOL resource managers to declare Fishing Control Zones (FCZ) to protect areas where fish may accumulate from over exploitation.

As a first step, the Project will concentrate on creating non-fisheries related livelihood income systems as compensation for direct Project related impacts relating to the construction of the dam on the Hou Sahong and permanent loss of fish-traps in that channel.

DSHPP's overall strategy for mitigating direct fisheries migration impacts is guided by the MRC requirement to provide "safe passage for 95% of the target species under all flow conditions"[18]. In developing the strategy the following factors and constraints have been taken into consideration:

- the unique attributes of the Project site which include:
    - the presence of many major and minor parallel channels crossing the Great Fault Line, which can provide natural connectivity around the Hou Sahong barrage, as distinct from a bank to bank barrage that would completely sever upstream and downstream connectivity;
    - the opportunity to modify existing natural parallel channels adjacent to the Sahong channel to create or enhance alternative natural migration pathways, as opposed to providing artificial fishway structures integrated with the powerhouse;
- the importance of the Sahong channel as a key fish migration pathway across the GFL;

[18] MRC (2009). Preliminary Design Guidance for Proposed Mainstream Dams in the Lower Mekong Basin, Mekong River Commission.

- the limited information available on Mekong fish migration patterns including the range of species and their specific migratory patterns/requirements;
- the opportunity to monitor and better understand fish migration patterns by extended data collection over the four-year construction period;
- the need to incorporate an adaptive/flexible approach to mitigation which allows for modifying passage design parameters after analysis of monitoring results during the operation period. Such monitoring results can be shared with other organizations;
- facilitation of efficient Project construction without delays and potentially unwarranted cost overruns;
- the use of large, low-head bulb turbines which are known to be "fish friendly";
- the provision of specifications in contract documents that will require the turbine supplier to carry out a testing program on blade strike based on the actual turbine to be adopted. As a criterion of compliance, the turbine supplier will be encouraged to demonstrate and design for as high a performance target for avoidance of blade strike as possible. The results from this, including the ability to demonstrate compliance with the 95% criteria for a range of fish sizes, will be used to develop and implement any further measures found necessary;
- the need to establish an agreed, statistically robust methodology for determining rates of fish mortality due to passage through turbines; and
- the commitment by DSHPP to implement a fish exclusion screen and bypass system in the upstream section of the Sahong channel to reduce the number of fish passing through the turbines.

5.7.2 Upstream Fish Migration Impact Mitigation

The following procedure will be used to address impacts on upstream fish migrations:

1. The main alternative upstream pathway for fish will be the Hou Xang Pheuak, as it is closest to and similar in width to the Hou Sahong and has the capacity to allow fish movement. The Hou Sahong and Hou Xang Pheuak join to form one channel close to the power station, which due to increased flow discharge with the Project, will be the peak attraction point for fish migrating upstream (particularly during peak fish migrations in the dry and early wet season);

2. Before construction starts, while Hou Sahong is still functioning as the main fish migration pathway, the steep banks either side of the Xang Pheuak channel at the main constriction points will be excavated to a shallower angle, which will improve wet season migration conditions when the channels is normally full of water and fish passage is restricted to each bank where bed roughness and vegetation create slower flows and provide the main migratory pathways. The excavated rock will then be back filled below each of the three steeper sections in the constricted channels bed to reduce overall bed gradient and improve fish passage during the dry season;

3. Also before construction starts, the bedrock bar across the middle section of the Hou Xang Pheuak (Khone Larne), which forms an almost completed barrier to fish movement during low flow conditions, will be modified to create a defined low flow channel on the western side and the vertical fall on the eastern side will be back filled downstream to improve the overall bed gradient and improve fish passage;

4. During construction a low partial-width flow control rock-wall will be built to span the entrance to Hou Xang Pheuak with an opening on the eastern or Hou Sahong side of the Hou Xang Pheuak, this will improve fish attraction in the first instance directly into Hou Xang Pheuak, and secondly after fish have moved upstream to the discharge from the power station in the Hou Sahong and then returned downstream to loiter at the channel junction;

5. Rock excavated from the Hou Sahong will also be available at this time for placement in the Hou Xang Pheuak to fix any problems identified during the first fish migration season after preconstruction modifications have been made and their effectiveness assessed;

6. Also before construction, while Hou Sahong is still functioning as the main fish migration pathway, the Hou Sadam will be modified by excavating the upstream inlet to provide greater dry season water depth through the channel and have its downstream outlet cleared to improve attraction flows for fish moving up the eastern most channel complex below Khone Falls;

7. If at any stage during construction any unusual fish accumulations are found in the Hou Xang Pheuak or adjacent channels, then FCZ (as mentioned above) will need to be implemented to protect against overfishing of migratory fish that might occur until the alternative migration pathways have been demonstrated to be effective;

8. During the preconstruction, construction and operational phases, to ensure that large fish species such as the Mekong Catfish are provided with the highest level of protection possible, the Project will setup the following systems:
   - Any large fish caught alive below any of the three channel complexes will be purchased on site by the Project's fisheries monitoring team and physically transported over the GFL and released upstream (after biological characteristics and genetic samples have been taken and tracking transmitters attached); and
   - A trap-and-transport system will be installed at the base of the power station in the Hou Sahong, based on large-mesh large-volume fish-traps (which allow smaller species to escape capture) placed at both banks which will be cleared daily and all large fish physically transported over the GFL and released upstream (after biological characteristics and genetic samples have been taken and tracking transmitters attached).
   - The trap-and-transport system will be actively monitored both within and without the trap with fish sensing devices to evaluate their success and allow modifications to be made if required.

9. In order to ensure the successful implementation of the above measures to provide adequate fish passage through the alternative migration pathways, and as maintaining the overall sustainability of the migratory fish community passing through this point of the river is the objective, the following additional measures and programs will be undertaken:
   - The Project will directly fund, but jointly manage with GOL district, provincial and national fisheries line agencies, a major 10-year monitoring program to study migratory fish and localized area density in the three channels (Sahong, Sadam and Xang Pheuak) in accumulation zones adjacent to these channels, to identify causes of delay, increased mortality and barriers to successful fish passage;
   - In that 10-year period, the Project will undertake continual modification of the alternative migration pathways (Hou Xang Pheuak, Hou Sadam and the trap-and-transport on Sahong) to improve fish passage as shown by the above monitoring;
   - Support if required the establishment and operation/enforcement of Fish Control Zones to protect migratory fish in areas immediately downstream of the three channel complexes across the GFL in co-operation with all stakeholders (including villages, district, province and GOL line agencies) so that fish accumulations downstream are minimized and exploitation of migratory fish populations at these locations are minimized.

5.7.3 Downstream Fish Migration Impact Mitigation

The following section outlines the adaptive management procedures that will be used to mitigate potential impacts on downstream fish migration.

Turbine design

No structures will be placed to physically exclude fish from entering the upstream end of Hou Sahong. The DSHPP has applied the results of recent theoretical studies on fish blade strike of low head, low speed turbine designs and taken account of recent fish catch data in the Project area. On the one hand this analysis suggests that there is a reasonable likelihood that during power plant operations the 95% safe passage performance target could be achieved without the need of a downstream fish screen and bypass channel.[19] On the other hand there is a need to ensure that the target can be met. The Project has made provision for a fish screen diversion and bypass structure that can be easily implemented should monitoring results during power plant operations indicate that such a structure is necessary. Thus an adaptive and flexible approach will be adopted that recognizes the current status of available information but ensures a commitment for implementing additional structural mitigation measures if and when they are needed.

This approach is also prudent from a cost effectiveness point of view given the current status of information. The barrage and powerhouse can be constructed without the need to integrate costly screens and bypass systems that may not be necessary and could be less effective than screens and a bypass system located further upstream in the Sahong channel and not structurally connected with the power plant.

This adaptive approach is described as follows:

Incorporate specifications in the mechanical and electrical EPC contract documents that require the turbine supplier to carry out physical testing of the effect on fish based on the actual turbine to be adopted. As a criterion of compliance, the turbine supplier will be encouraged to demonstrate and design for as high a performance target for avoidance of blade strike and other fish damage as possible. This will include the design of specific 'fish-friendly' measures into the turbine water passage (e.g. minimum blade gap, minimization of cavitation, etc.). These results will be used to develop and implement any further measures found necessary.

- Targeted fish exclusion devices are currently being considered; this is principally a fish screen and bypass system in the upper Sahong channel, but behavioral or electric barriers may also be tested if appropriate, prior to commissioning of the Project.
- Establish a monitoring program that with reasonable confidence is able to quantify survival rates for downstream passage through the DSHPP turbines. The monitoring program will be implemented before commencement of the turbine operation phase. It will include an action plan which specifies performance targets and triggers for implementation of the selected fish exclusion device(s) including detailed specifications thereof.
- Prepare preliminary criteria, parameters, and designs for a fish screen and bypass channel for implementation at a later stage in the event it is found to be required from the results of the monitoring program. The proposed location is at the elbow bend near the upstream end of the embankments. Preparation of a preliminary design will include trials of diversion screen designs in the Hou Sadam:
    - Detailed specifications for the fish screen including bar spacing which will depend on the analysis of monitoring results.
    - The screen will be designed so that it can be cleaned and repaired without the loss of function.

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    - The screen will be appropriately angled leading fish to a proposed bypass channel adjacent to the left abutment of the bridge.
    - A constructed bypass channel to lead fish into either the Hou Sadam or the Hou Xang Pheuak.
- Construct the minimum necessary civil works for a possible future fish diversion screen during the construction period when the river bed is dry.
    - The civil works will incorporate a bridge across the Hou Sahong impoundment at the preferred location identified above with provision in its structure for the attachment of a pre designed fish screen.
    - The bridge will facilitate community access between Don Sahong and Don Sadam thereby providing additional transport infrastructure for the local community.
- Make provision for a behavioral or electrical barrier to deter fish from entering the Sahong channel. The proposed location of this barrier is at the inlet to the Sahong (see Figure 5-2). Implementation of the behavioral barrier will be triggered by the monitoring results and may be implemented either along with or instead of a fish screen and bypass structure depending on the monitoring outcomes.

The Project's interpretation of the MRC guidelines for effective fish passage suggests mortality of fish eggs and larvae passing downstream of a mainstream hydro power project should not exceed 30%. Therefore larval drift will be monitored regularly, and turbine operation will be curtailed during critical larval drift periods if monitoring demonstrates this is required to meet the MRC guidelines.

5.7.4 Dolphins of the Lower Pools: Threats from Dam Construction

The population of Irrawaddy dolphins in the Mekong is critically endangered, mainly due to human activities (See section 3.2.5). The construction of dams along the mainstream lower Mekong River (particularly southern Laos or Cambodia), is reported to pose a substantial additional risk to their ongoing survival (Beasley, Marsh et al. 2009). That argument was apparently based on the potential for such dams to affect i) the dolphins deep water habitat "Dolphins rely on deep-water areas during the dry season" and / or ii) their food supply "Dolphins rely on ….annual fish migrations to replenish fish stocks".

The Project will not significantly alter the level in the Chiteal Pool (dolphin habitat below the dam) because the dam has minimal storage in comparison to the Mekong flow and it only blocks one of seven main channels of the braided Mekong River at that location. The Project will not alter the water quality downstream of the dam because the maximum residence time in the headpond is only 4 hours, which is insufficient to alter water quality.

The depletion of fish stocks is not anticipated because of the mitigation measures proposed in the FishMAP programme (ANNEX C). In summary the dam will be only a partial barrier to fish migration and the Project will develop alternative pathways for both upstream and downstream fish migration.

5.7.5 Project Activities to Mitigate Impacts on the local Dolphin population

During Construction

A range of measures will be employed to prevent the construction at the DSHPP site from impacting the dolphin population of the Chiteal Pool. The DSHPP has made a firm commitment that all construction activities, except for the initial construction of the cofferdam, will be isolated from the river. At the downstream end of Hou Sahong, excavation will only occur within the bounds of the cofferdam. No underwater blasting will be permitted, in order to protect the sensitive dolphin population.

During Operation

The sediment flux through the Hou Sahong channel will not change significantly during Project operation. The small portion of suspended sediment that settles in the headpond will be flushed past the DSHPP dam during high flow periods, to match the natural sediment flux as closely as possible.

Regardless of changes in sediment flux due to the DSHPP, the discharge from the DSHPP into the Hou Sahong will bypass the deep pool dolphin habitat. At low water levels, the emergence of the natural rock bar at the outlet of the combined Hou Sahong and Hou Xang Pheuak channels diverts the flow from these channels downstream of the dolphin habitat (see Figure 5-1). This rock bar, combined with the flows from the western branches of the Mekong, forces the flow and suspended particulates coming from Hou Sahong and Xang Pheuak to bypass downstream and away from the dolphin habitat. This effect is most significant during the dry season when the cofferdam will be constructed. At this time dolphin movements close to the Project location are more limited. During high flow periods the discharge from the DSHPP dam will be dominated by the relatively greater flow down the western branches which pass through the Chiteal pool.

The DSHPP construction contract also specifies that during construction of the cofferdam, rock fill materials will be selected, and fabric screens will be used, to minimize the deposit and transport of suspended particulates from the immediate area of the cofferdam. So that no significant changes in sediment flux are expected in the area of the dolphin habitat either during construction or operation of the Project.

Figure 5-1 below illustrates the location of the DSHPP in relation to the Chiteal Pool in the Mekong downstream of the Hou Sahong. The upper panel is an aerial photo of the site during the dry season (deep pools are in dark blue and shallow rock bars within the river are the lighter shade. The lower panel shows the same photo, overlaid by the river flow patterns as constrained by rock bar formations.

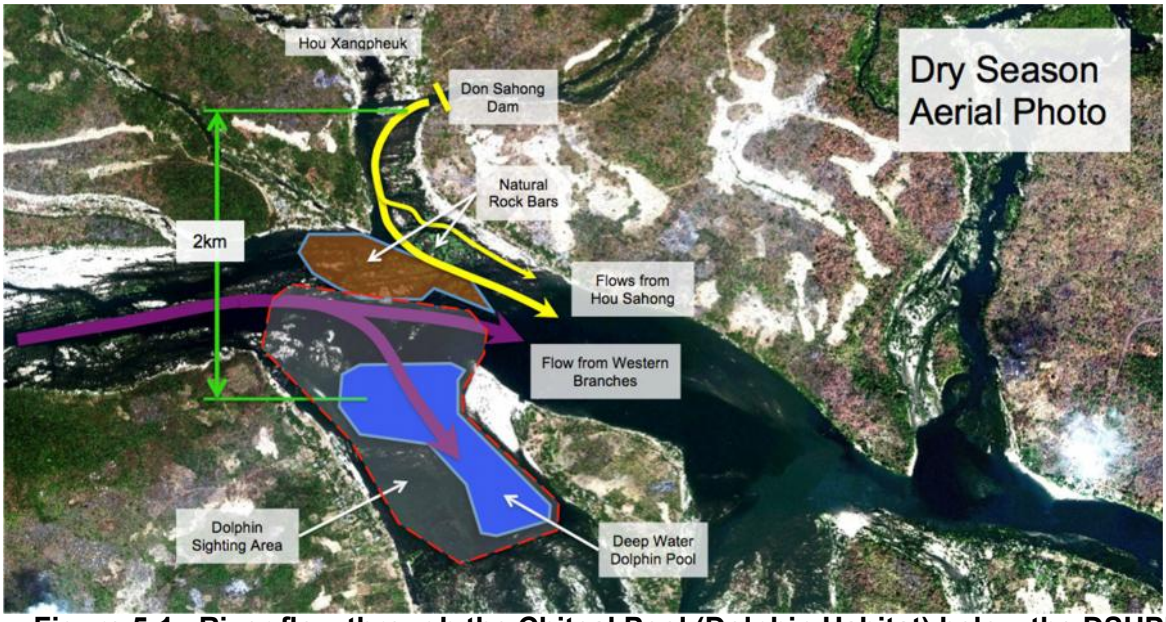


Figure 5-1 River flow through the Chiteal Pool (Dolphin Habitat) below the DSHPP
Main flow from western branches in wet season (pink)
Discharge from Hou Xang Pheuak / Sahong channelled by rock bars to north of Chiteal Pool (yellow)

A reduction of fish prey for the dolphins due to the Project construction and operation has also been reported as a threat.

While the Project is in the vicinity of the dolphin habitat, flows from the Hou Sahong channel do not pass directly through the dolphin habitat. During periods of upstream migration that generally occur outside of the peak flow period, prey fish are expected to enter the dolphin habitat from the channel directly south of the deep pool. Flow in this channel will not be affected by the construction or operation of the Project. During the high flow periods, typically associated with downstream fish movements, the greater flow of the western Mekong branches, which are also not affected by the Project, will carry the typical volume of fish prey into the area of the dolphin habitat.

To mitigate the impact of blockage of the Hou Sahong channel, the two adjacent channels, Hou Xang Pheuak, and Hou Sadam will be modified to improve their fish migration viability. When the Project is operating, the increased dry season flows through the Hou Sahong will attract fish migrating upstream. While not expected to pass directly through the dolphin habitat, it is expected that a greater proportion of upstream migrating fish will be attracted to the northern extent of the dolphin habitat.

Gill nets and Illegal fishing
The use of gill nets is a major risk to the sustainability of migratory fish populations and to the river dolphin. An important aim of the Project's fisheries management program is to reduce this type of over exploitation of the fish stocks, through a variety of means. The development of alternate livelihoods for the local population is a major social development commitment of the Project to reduce the dependency of the local communities on fishing. The Project hopes these efforts will also reduce the risk to the dolphin population.

In this work the Project will take note of and learn from the well-meaning but ill-advised efforts of Cambodian fisheries authorities to protect the dolphin by banning gill netting over 190 kms of river. As that effort was made without consultation with local community or the implementation of any alternative livelihoods or replacement income activities, it created resentment and disquiet amongst the local communities who bore the burden of loss of income and livelihoods, and was unsuccessful (Beasley et. al., 2009).

5.7.6 Other Project Initiatives to Aid to Dolphin Conservation

Given the sensitivity and importance of the local dolphin population, DSHPP will facilitate the monitoring and management of the dolphins in the Mekong River by supporting:

- monitoring the dolphin population in the immediate area downstream of the Project;
- research into the serious ongoing problem of mortality of new born dolphin calves which threatens the entire river dolphin population of the Mekong River; and
- the management of illegal destructive fishing activities and restrictions on the use of gill nets in sensitive areas including dolphin habitat in and around the Project area.

Concerns for the impacts of the Project on the dolphin population are two-fold:

1) Disturbance of dolphin habitat - during the construction phase a tailrace channel will be constructed downstream of the Hou Sahong for less than 1 km (as shown in Figure 2-3). This excavation would have the same impacts as the upstream activities and would require the same precautionary and warning safety measures. However as dolphins are sensitive to underwater percussion charges, as an additional precaution, no underwater blasting will be permitted below the downstream coffer dam. During operations the water quality of the discharge from the DSHPP is expected to be very similar to the mainstream flow because residence time in the head pond will be less than 4 hours. The natural channel bathymetry downstream of Project is expected to direct the discharge flow through the channel on the left bank and not through the dolphin pool on the right bank.
2) Food supply - the fish passage mitigation measures to be applied, together with the fisheries management program will ensure that the food supply of the dolphin population downstream of the DSHPP will be maintained during the construction and operational phases.

5.8 Construction Phase Mitigation

In summary, the main mitigation measures proposed to prevent impacts on the aquatic ecosystem and particularly the sustainability of the fisheries are:

- Commencing remedial actions on the Hou Sadam and Hou Xang Pheuak prior to construction, to facilitate a year round fish migration capacity. This work is to be completed prior to the construction of the coffer dams on the Hou Sahong.
- Put in place on the two (2) adjacent waterways of Hou Sadam and Hou Xang Pheuak, year round pro-active “controls on fishing” during the construction and operational period, either year round (preferable) or during critical migration periods, as determined from the monitoring program

5.8.1 Estimates of Number of Fishers Affected by DSHPP

As discussed in the SMMP, before estimates of compensation can be made, the number of fishers indirectly and directly affected, have to be assessed. While the number of fixed traps on Hou Sahong can be determined, determination of exact numbers of mobile and seasonal traps is more difficult. Preliminary data has been collected but it is incomplete and inconclusive. The main problems are in determining the place of residence of the fishers and the extent of actual use of traps in Hou Sahong and in the other channels, during the dry and wet seasons and thus the extent of impact on fishers livelihoods in the area. It is proposed that the mitigation actions should also include Hou Sadam and Hou Xang Pheuak as these areas and resident fishers are directly affected by DSHPP through mitigation actions noted above.

The fishing families of Hang Sadam, Hua Sadam and Hang Sahong village areas will be directly affected by the Project. The fishers of Don En and Don Tan will be affected by the

barging activities and some of the fishing families of Ban Hang Khone and possibly Veunkham, would be directly affected by the downstream dredging of their traditional fishing grounds.

As the mitigation measures are proposed to replicate the function of Hou Sahong in the other channels, it is assumed that there will be no significant impacts on the fishing industry beyond the immediate Project area.

The results of estimates of the number of fishers and their families or other households directly and indirectly affected are summarized in Table 5-5. Of course these preliminary estimates will be confirmed prior to commencing any negotiations on fisheries compensation.

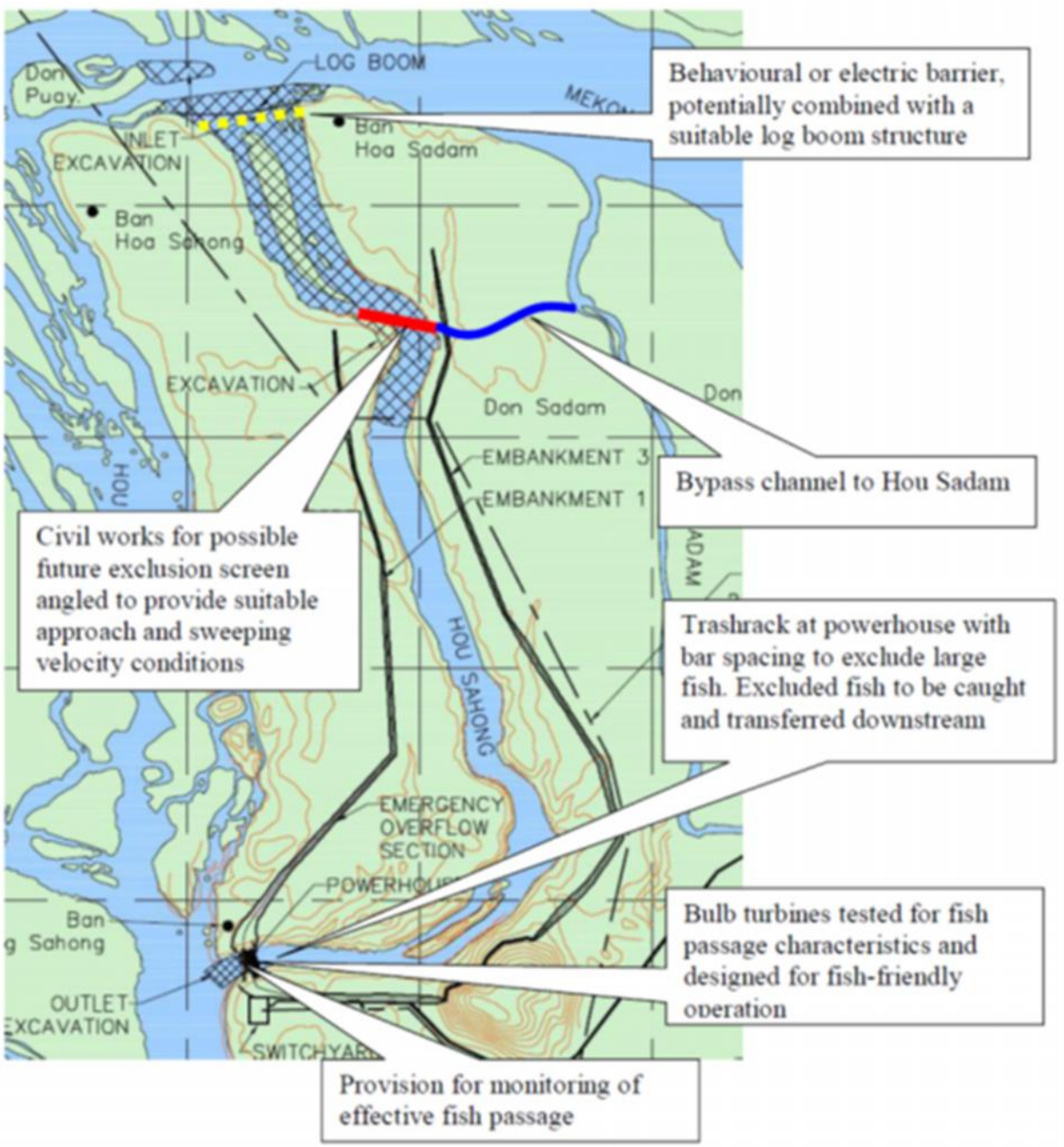


Figure 5-2 Concept Design of Proposed Downstream Mitigation Measures

Table 5-5 – Estimates of Number of Fishers Affected by DSHPP (2007)

Area of Project	Directly Affected Fishers	Indirectly Affected Fishers or Others	Reasons for Inclusion
Don Sadam & Don Sahong [1]	243	280	Resident in impacted area & included in HH Survey
Miscellaneous users along Hou Sadam & Hou Xang Pheuak [2]	50	10	Estimates only
Totals Affected	293	290	Directly & indirectly affected by DSHPP

Notes: (1) Total population of 3 villages and 20% of total population of 1,400
(2) Based on estimated population migrating to areas to work including traditional owners of fish traps

5.8.2 Evaluation of Fish Mitigation Options

The impacts of a barrier across Hou Sahong on fish migration are summarized as follows:

- The impacts are independent of the height of the coffer dams and the final DSHPP dam height
- Damage would be done to the fish species migrating if permanent mitigation actions are not implemented
- Modifications to other channels such as Hou Xang Pheuak and Hou Sadam are proposed as the primary mitigation measure
- A capture and transfer program should be introduced during the construction period as a further mitigation measure for large fish species such as Giant Mekong Catfish.
- Controls are to be introduced on fishing in the Hou Sadam and Hou Xang Pheuak and in any areas downstream of the works that are identified as being unusual fish accumulation zones associated with Project construction.

Table 5-6 Assessment of Effects of DSHPP on Fish Migration at the Great Fault Line

	Dry Season	Wet Season	Comments
Case 1 – No Project on Hou Sahong			
Upstream migration of fish	No effects on migration patterns	No effects on migration patterns	Fisheries management and controls are necessary to prevent over fishing
Downstream migration of fish	No effects on migration patterns	No effects on migration patterns	
Case 2 – DSHPP - No Mitigation Measures			
Upstream migration of fish	Seriously affected	Moderately affected	Considered probable that dry season upstream migration would be affected severely in dry and moderately in wet season
Downstream migration of fish	Moderately affected	Low effects	Downstream larval drift of fish would be affected severely in the dry and moderately in the wet season
Case 3- DSHPP Mitigation – Improvements to Hou Xang Pheuak and/or Hou Sadam for Fish Migration			
Upstream migration of fish	No significant effects on migration patterns	No significant effects on migration patterns	Dry season migrations dependent on replicating Hou Sahong type channel

	Dry Season	Wet Season	Comments
			on Hou Xang Pheuak Fisheries management and controls are also necessary to prevent over fishing
Downstream migration of fish	No significant effects on migration patterns	No significant effects on migration patterns	Limited problems in wet season as several other channels cater under present regime Fisheries management and controls are also necessary to prevent over fishing

5.8.3 DSHPP Fisheries Monitoring and Action Plan (FishMAP)

The DSHPP Fisheries Monitoring and Action Plan (FishMAP) proposed here for inclusion in the EIA, includes the alternative fish passages and fish pass described in detail above plus initiatives to improve fisheries management in the Project area and its immediate vicinity through the introduction of alternative non-fisheries dependent livelihood systems to reduce fishing pressure on the three channels.

Annex A of the DSHPP EMMP provides a summary and budget for the actions to be taken as part of FishMAP.

5.9 Impacts on Hydrology and Downstream Flows

Impacts of the DSHPP on flows can be seen in terms of the immediate vicinity of the Project and in regional effects. The DSHPP is a run-of-river project with negligible storage, so there will not be changes to downstream flows, as discussed below in Section 5.9.4. In terms of the local effects, two dimensional modeling was provided by the feasibility study consultants[20]. This model reflects flow series simulations covering the years 1982 to 2009. Future flows with the DSHPP in operation reflect an environmental flow downstream of the Hou Sahong (toward Hou Sadam and Khone Phapheng) of 800 m^3/s, and the MRC "Definite Future" scenario.

The DSHPP will affect only the Hou Sahong, Hou Sadam, and the Khone Phapheng channels of the Mekong River. All other channels in the vicinity of the Project have inlets upstream of the DSHPP area of influence and so will not be affected by the Project. This includes Hou Somphamit, Hou Xang Pheuak, and other channels to the west of the Project. As such, the detailed modeling was restricted to the Sahong, Sadam, and Khone Phapheng channels.

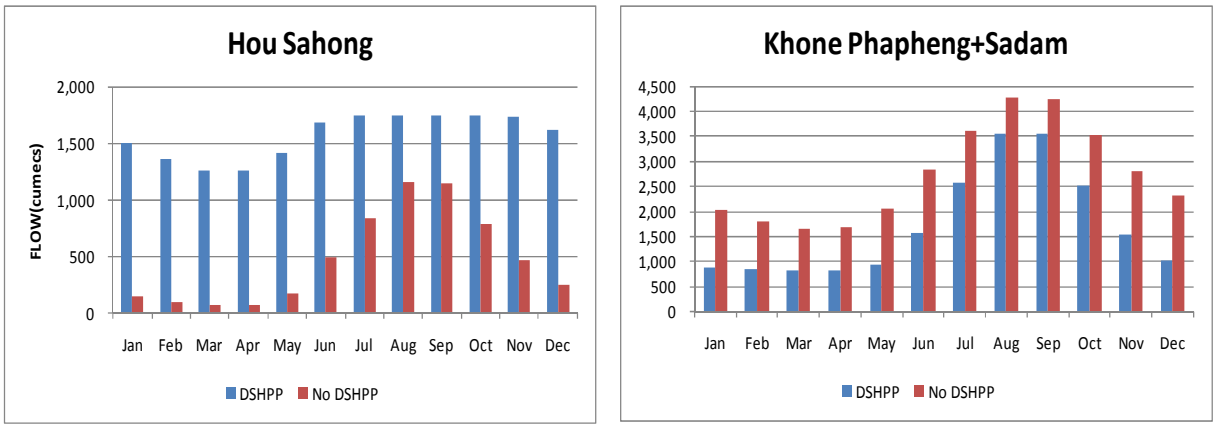
Cumulative impacts of the DSHPP are not expected, as discussed in the Cumulative Impact Assessment report.

[20] AECOM, September 6, 2010

5.9.1 Average Flows in Affected Channels

Average modeled monthly flows are anticipated to be as shown on Figure 5-3.

Figure 5-3 Effect of DSHPP on Average Monthly Flows

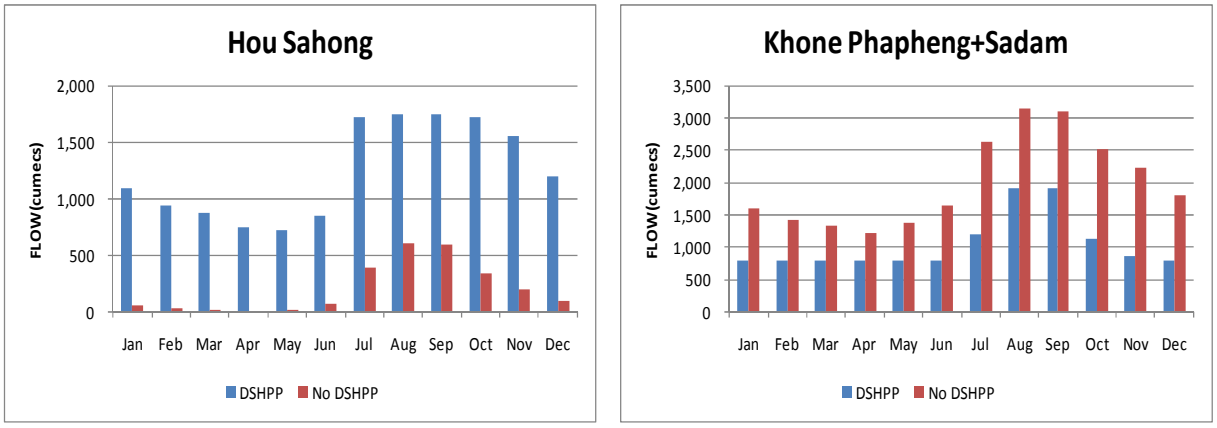


As can be seen, this model shows that flows will be diverted into the Hou Sahong but still maintain a minimum average flow of 800 m^3/s in the Sadam and Khone Phapheng channels.

5.9.2 Minimum Flows in Affected Channels

Minimum modeled monthly flows are anticipated to be as shown on Figure 5-4.

Figure 5-4 Effect of DSHPP on Minimum Flows

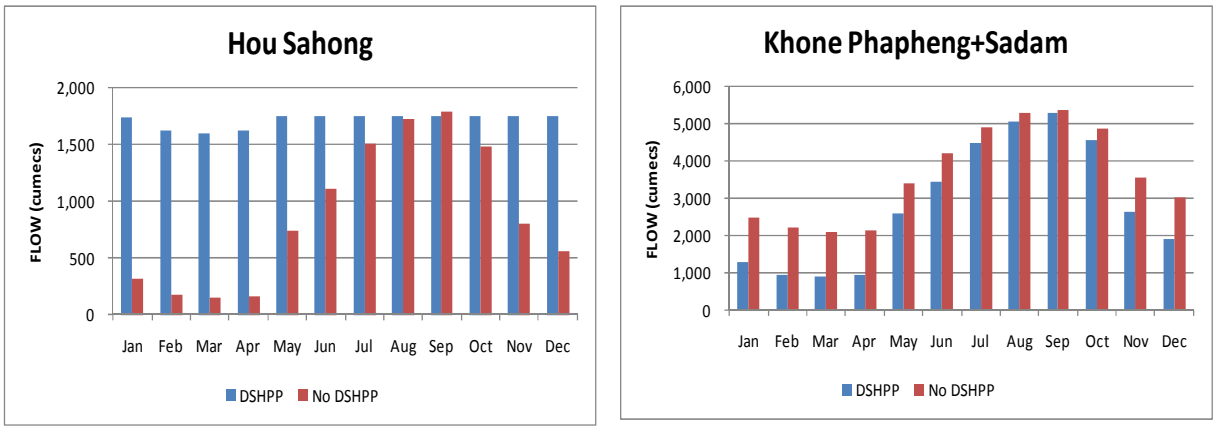


The modeling of minimum flows indicates that the DSHPP will divert some flow into the Hou Sahong while still maintaining a minimum environmental flow of 800 m^3/s in the Sadam and Khone Phapheng channels.

5.9.3 Maximum Flows in Affected Channels

Minimum modeled monthly flows are anticipated to be as shown on Figure 5-5.

Figure 5-5 Effect of DSHPP on Maximum Flows



The modeling of maximum flows indicates that the DSHPP will divert some flow into the Hou Sahong while still maintaining a minimum environmental flow of 800 m^3/s in the Sadam and Khone Phapheng channels.

5.9.4 Effect of DSHPP on Downstream Flows

As introduced above, the DSHPP is a run-of-river project that is not expected to have effects on flows other than in the immediate vicinity of the Project. The DSHPP generates energy using flows that are directly available from the river system upstream. The retention time of flows in the small headpond is in the order of 1-2 hours and there is no capability to store water for later use. Accordingly operation of DSHPP will only influence or change flows in the parts of the river system that are directly affected by the diversion of additional water at the Hou Sahong inlet. Otherwise the river flows upstream of the Hou Sahong inlet and downstream of the Hou Phapheng (Khone Phapheng Falls) outlet will remain unchanged when DSHPP is operating.

Figure 5-6 illustrates this situation. The major flow branches of the southern Si Phan Don region around the Project area are indicated schematically with arrows, overlaying the March 2010 (dry season) satellite image. The blue arrows indicate flows that do not change as a result of DSHPP. The pink arrows represent flows that will change.

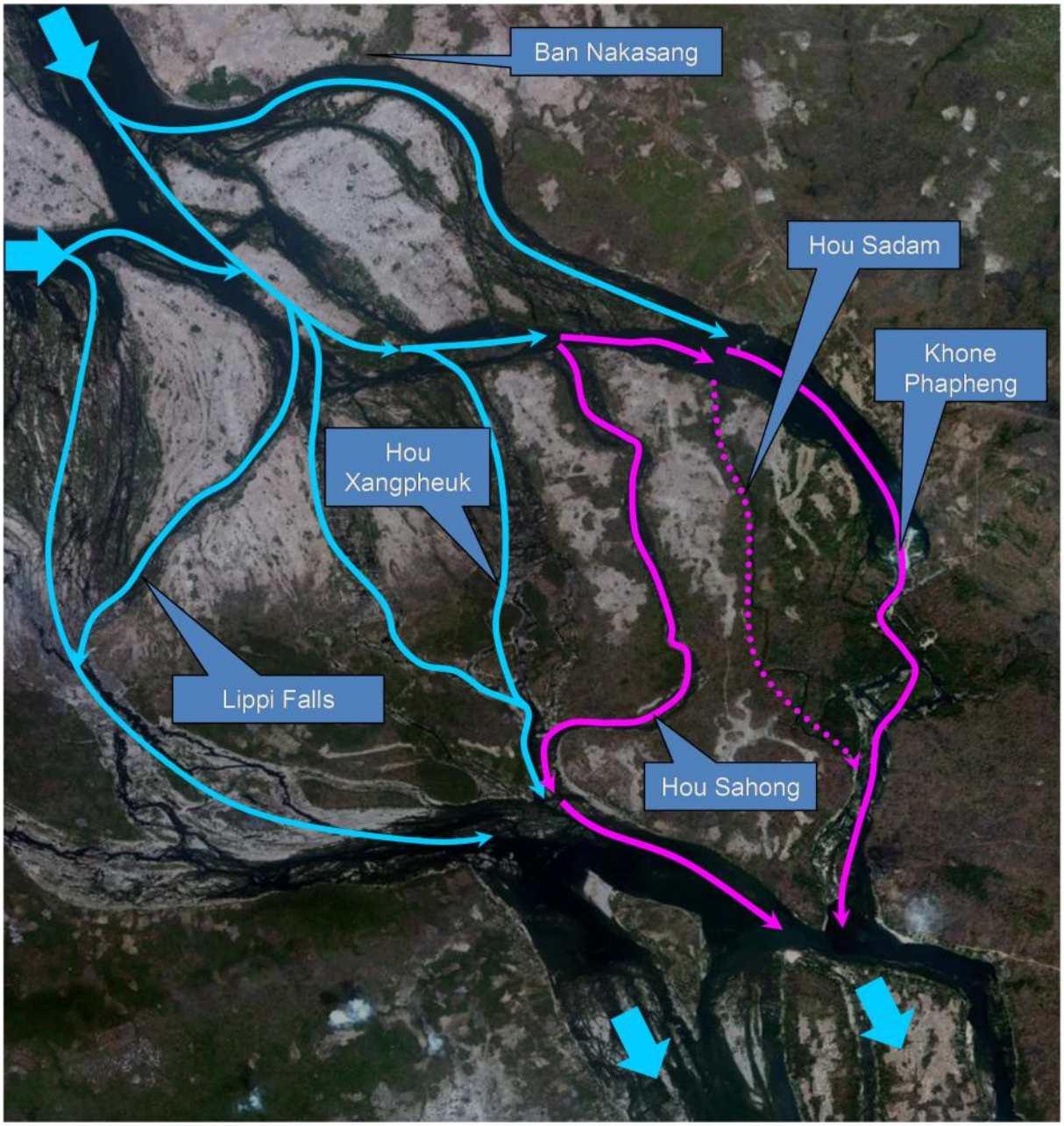


Figure 5-6 Schematic Diagram of flows affected by the DSHPP

The effect of the DSHPP is represented by a simplified conceptual diagram of the channels in Figure 5-7. The relevant branches of the River are represented by numbers as follows:

(1) Flow coming in to the Si Phan Don region
(1a) Northern-most branch upstream of Ban Thakho passing Ban Nakasang
(1b) Main branch passing between Don Tan and Don Det
(1c) Western and Southern-most branches including Lippi falls
(2) Hou Sahong
(3) Branch downstream of Sahong inlet and north of Don Sadam
(4) Main branch over the Khone Phapheng falls including Hou Sadam which represents less than one percent of this total
(5) Main branches entering Cambodia

Figure 5-7 Schematic Diagram of Channels in the Project Vicinity, and their annual monthly average flows, with DSHPP & without DSHPP

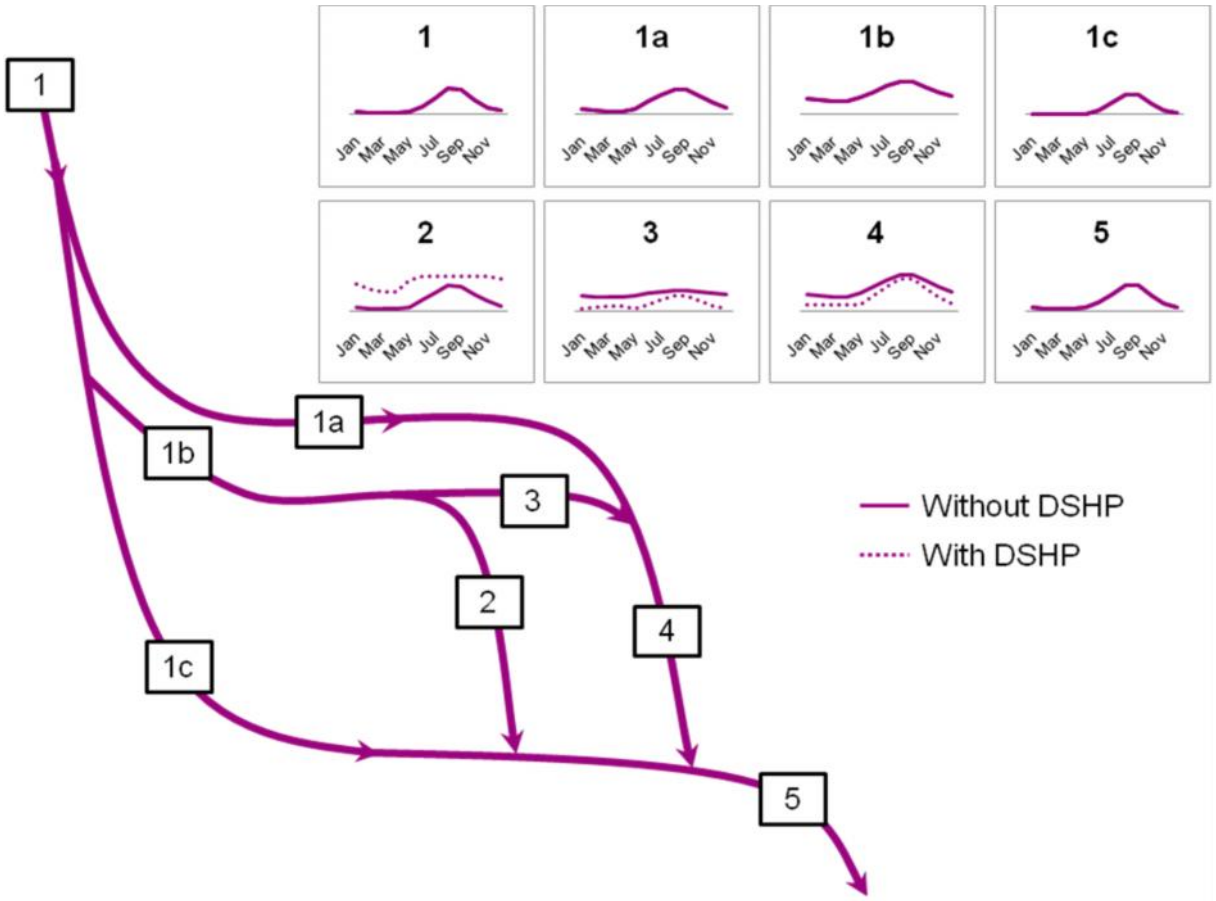


Table 5-7 and Table 5-8 provide flow data (in m^3/s) on the changes that will occur in the various branches represented in Figure 5-7 without (before) and with DSHPP, for a range of flows from the 1% exceeded to the 99% exceeded values. Measured flows were used during the modeling deliberately to avoid the influences of future upstream storage schemes.

Table 5-7 Natural Flow Durations - without DSHPP

% Exceeded	1	1a	1b	1c	2	3	4	5
1%	37,400	3,100	3,700	30,700	1,620	2,070	5,130	37,400
5%	29,900	2,700	3,400	23,800	1,380	2,060	4,760	29,900
10%	25,600	2,500	3,300	19,800	1,260	2,040	4,510	25,600
20%	18,000	2,000	2,900	13,000	960	1,970	4,010	18,000
30%	12,400	1,700	2,600	8,200	730	1,880	3,540	12,400
40%	7,800	1,300	2,300	4,300	510	1,750	3,010	7,800
50%	4,700	860	1,900	1,900	300	1,650	2,510	4,700
60%	3,200	600	1,700	900	180	1,550	2,150	3,200
70%	2,500	510	1,600	400	130	1,440	1,950	2,500
80%	2,200	430	1,500	300	100	1,380	1,810	2,200
90%	1,900	340	1,400	200	70	1,310	1,650	1,900
95%	1,700	270	1,300	100	50	1,270	1,540	1,700
99%	1,500	190	1,300	40	30	1,220	1,410	1,500
Annual Average	9,600	1,200	2,200	6,200	510	1,680	2,880	9,600

Table 5-8 Estimated Flow Durations with DSHPP

% Exceeded	1	1a	1b	1c	2	3	4	5
1%	37,400	3,100	3,700	30,700	1,750	1,950	5,000	37,400
5%	29,900	2,700	3,400	23,800	1,750	1,690	4,390	29,900
10%	25,600	2,500	3,300	19,800	1,750	1,530	4,000	25,600
20%	18,000	2,000	2,900	13,000	1,750	1,180	3,220	18,000
30%	12,400	1,700	2,600	8,200	1,750	870	2,520	12,400
40%	7,800	1,300	2,300	4,300	1,750	520	1,770	7,800
50%	4,700	860	1,900	1,900	1,720	230	1,100	4,700
60%	3,200	600	1,700	860	1,530	200	800	3,200
70%	2,500	510	1,600	440	1,280	280	790	2,500
80%	2,200	430	1,500	280	1,110	370	800	2,200
90%	1,900	340	1,400	160	920	460	800	1,900
95%	1,700	270	1,300	90	790	530	800	1,700
99%	1,500	190	1,300	40	640	610	800	1,500
Annual Average	9,600	1,200	2,200	6,200	1,500	690	1,880	9,600

The following observations are made from the results:

- Flow in to the region (1) is always equal to flow entering Cambodia (5) without or with DSHPP.
- The post construction effects on the river system are localized with only flows in branch 2, 3 and 4 and the short reach between the Sahong outlet (2) and the Phapheng outlet (4) experiencing change.
- The changes in the short reach between the Sahong and Phapheng outlets are not tabulated, but can be taken as the difference between the without and with flows in columns 2 and 4.
- The flow change associated with branch 4 can be attributed to the extra flow that is diverted into the Hou Sahong (2) for generation.
- Minimum flow passing through branch 4 is in accordance with required minimum environmental flow of 800m^3/s
- Maximum diverted flow into the Hou Sahong is 1750 m^3/s which represents the maximum overall turbine discharge.
- The annual average flow in the Sahong channel will increase by approximately 1000 m^3/s, and the annual average flow over the falls reduces by a corresponding amount.

In summary, the DSHPP is only expected to have an effect on flows on the Hou Sahong, Hou Sadam, and Hou Phapheng. The Project will not affect downstream flows.

6 Conclusions and Recommendations

6.1 Conclusions

The detailed Final Feasibility Study (FFS) for the DSHPP has indicated that a power station with an installed capacity of 260 MW and exporting a majority of its energy production to Thailand or Cambodia, with the remainder for domestic consumption, is economically viable.

A comprehensive study was undertaken of the social and environmental issues associated with the Project and reported in an EIA and related documents in 2007, as required by the various regulations of the Ministry of Natural Resources and Environment (MoNRE) and Ministry of Energy and Mines (MEM). That information was subsequently updated with additional surveys in 2009 and new information from the FFS.

In terms of resettlement impacts, only 11 households will need to be relocated and an updated Resettlement Action Plan (RAP) has been prepared to resettle these families in a new village on Don Sahong. In addition the Social Management and Monitoring Plan (SMMP) is designed to improve infrastructure (water supply, sanitation, education, health facilities and electric power) in the affected villages and develop and promote alternative livelihoods to compensate for the social impacts arising from inundation of arable land and loss of the Hou Sahong fishery, due to the creation of the headpond.

The most critical issue identified by the environmental study was the potential for the Project to disrupt fish migration by blocking the Hou Sahong, which is a major migration route, particularly for fish moving upstream in the low flow season. Mitigation measures have been recommended that will minimize the impact of this closure by enhancing migration pathways in two adjacent channels that will replicate the conditions in the Hou Sahong in both low and high flow seasons, so that the residual impact on upstream and downstream migrations will not be significant. The design and implementation of these mitigation measures will be based on field studies to determine effective solutions, and performance will be monitored and designs adapted as necessary during the first ten years of the Project life. The Project aims to improve the success rate of fish migration upstream through the Si Phan Don area, thereby improving fisheries sustainability in the area.

Another important issue is the effect of the DSHPP on regional flows in the Mekong River. For that analysis, detailed models of the river have been elaborated. The models demonstrate that the impacts of the DSHPP (a run-of- river scheme) on river flows will be insignificant, and will not affect downstream locations such as Tonle Sap and the Mekong delta.

The issue of cumulative impacts of this Project with other hydropower projects that are being planned or under construction has been covered in a separate Cumulative Impact Assessment (CIA). In general the CIA indicates that the DSHPP will not be the main source of impacts along the Mekong.

6.2 Evaluation of Impact on Mekong River Fisheries

The impact on Mekong River fisheries is a complex issue. There is no question that the fish industry based in the lower, middle and upper Mekong River is a huge resource with a value of hundreds of millions of dollars annually. It is also acknowledged that the Hou Sahong, while not the only route for upstream and downstream migration of fish, is a major route.

If the Hou Sahong were blocked with no mitigation measures there would undoubtedly be a severe impact on the fish population and those that depend on the fishery. However, the

DSHPP includes measures that will provide passages for fish that will replicate the Hou Sahong so that there will be no significant adverse effect on the resource. These measures will be closely monitored over a ten-year period and modifications made as necessary to ensure that they maintain the migration patterns if not improve them.

There are a number of parties involved in these issues. This includes the GOL, its various fisheries departments at the national, provincial and district levels, the Mekong River Commission (MRC) and the associated Lao National Mekong Committee (LNMC) with extensive interests in the management of the river's resources and the various conservation groups including IUCN and WWF, which have a vested interest in long-term plans for natural resource and sustainable management of these resources.

The DSHPP Fisheries Monitoring and Action Plan (FishMAP) will address both social and environmental impacts within the immediate Project footprint, based on the three channels and their adjacent villages. In addition, the FishMAP will also target fisheries management activities within the Project footprint. With the successful implementation of the FishMAP, which aims to improve overall fish passage through the Si Phan Don area, no negative impacts are expected either upstream or downstream in the wider Mekong system.

6.3 Si Phan Don Wetlands Ramsar Declaration

The GOL has considered establishing a Ramsar site covering the Si Phan Don Wetlands. Current indications are that this is not likely to happen in the near future, and the first Lao Ramsar sites have been declared at the Xe Champhone Wetlands (Savannakhet Province) and the Beung Kiat Ngong Wetlands (Champasak Province). While declaration of the Si Phan Don wetlands as a Ramsar site would not preclude the implementation of the DSHPP, its development would have to be managed within the overall objectives of the Ramsar Convention. It is recommended that the DSHPP undertakes the following actions:

- Cooperation with the GOL and authorities such as LNMC if and when the Si Phan Don Wetland is designated as a Ramsar site by providing requested information on the engineering and environmental findings of the Project
- Permitting the appointed planning organization for the Si Phan Don Wetland to review and comment on any specific proposals by DSHPP to undertake monitoring and management of the natural resources of the affected areas.

6.4 Recommendations

The DSHPP is a hydropower project that is of concern to many, mainly because of its potential to reduce the rate of successful fish migration through the Si Phan Don area, and possible diversion of dry season flows away from the Khone Phapheng falls. The basis of both these concerns are discussed and feasible mitigating actions are proposed in this report.

Notwithstanding the potential impacts, the implementation of the Project will be of considerable economic benefit to the Lao PDR and will provide improved infrastructure and stimulation for growth in the Champasak Province.

Implementation of the numerous suggestions and recommendations contained in this EIA Report as well as in the studies and documents identified below will effectively minimize the residual environmental and social impacts of the Project.

- The Resettlement Action Plan (RAP) as finally determined for relocating communities in Ban Hang Sahong hamlet and others affected by DSHPP

- The Social Management and Monitoring Plan (SMMP) as revised in consultation with GOL including Khong District authorities and representatives of villages within the Project area.
- The Environmental Management and Monitoring Plan (EMMP), as approved by MoNRE and MEM, Department of Electricity.
- The FishMAP program, which includes adaptive monitoring and management of the fisheries in the DSHPP area during the first ten-years of the Project life.

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ANNEX A

Response to Comments Received on the Don Sahong Hydropower Project 2007 EIA Documents

Comments Received from the Mekong River Commission

MRC Comment	Summary of MRC Comment	Response
	Project Description	
11	Section 2 Project Description Add good quality maps and drawings	Project Description was updated with information from the Final Feasibility Study (FFS). New satellite imagery maps and drawings have been incorporated in the EIA and CIA
12	Clarify that this is a run-of-river project with no significant storage	The EIA clarifies that the dam will have no significant storage or regulation.
13	Better description of excavation needed	The EIA clarifies the location of excavation, borrow, and spoils disposal areas (from FFS)
14	Installed capacity – different parts of the report mention or imply different numbers: 300 MW, 180-480MW, 360 MW	The EIA clarifies that the correct installed capacity from the FFS is 260 MW
14	No description of how environmental flows will be controlled to feed the bypass channels, Khone falls, Li Phi falls	The EIA provides a description (conceptual design) from the FFS. Included is a discussion of results of the DSHPP Mekong River model that was developed for the updated EIA and CIA. The proposed changes in flow will direct more fish to successfully pass through the alternative fish passage channels and away from the Khone Falls which is a dead end.
15	Channel modifications and their effects not described	The EIA provides a description from the FFS. Channel modification is unavoidable due to the Project's nature and fish passage upstream through Hou Sahong will be lost however, modifications will be done to improve passage in two alternative channels which fish now have difficulties ascending.
16	Switchyard location; transmission lines impacts not addressed	The EIA addresses this based on the FFS. A separate IEE will be developed for the transmission lines
17	More information needed on construction site access	The EIA addresses this based on the FFS. A separate IEE will be developed for the new bridge and access roads. The bridge will cause some changes to flow patterns in the Sompandon channel just downstream of the Hou Sadam and may impact fish accessing the Hou Sadam, but improvement to the downstream channel (cleared and more water released to improve attraction flows) will overall improve fish passage.
18	More detail needed on alternatives of logistic support areas	The EIA provides a description from the FFS.
	Institutional and Legal Framework	
19	MRC only reviewed the 1995 Mekong agreement	Comment noted. No response needed

MRC Comment	Summary of MRC Comment	Response
20	MRC did not review Lao PDR laws and policies	Comment noted. No response needed
21	Ramsar issues not reviewed by MRC	Comment noted. No response needed
22	Summary of MA95 issues	Comment noted. No response needed
23	There are information gaps and inconsistencies regarding MA95. Information scattered throughout the EIA report. Consolidate in one section and ensure it is in the Executive Summary	A new section dealing with MA95 was developed, checked for consistency with rest of report, and added to the Executive Summary.
24	Interpretation of some MA95 articles not correct. Some reference needed to updated parts of MA95	Addressed in new MA95 section
25	Interpretation of some MA95 articles not correct. Inconsistencies on this issue in the EIA	Addressed in new MA95 section
26	Interpretation of some MA95 articles not correct. Inconsistencies on this issue in the EIA	Addressed in new MA95 section
27	MA95 provisions have not caused project delays on other projects to date.	Addressed in new MA95 section
28	MRC Trans-boundary EIA guidelines not yet ratified by MRC JC, but these would only be applicable if a Member State wanted to use them.	Addressed in new MA95 section
29	EIA not complete or accurate re: MA95. EIA should cite national and international commitments on part of GoL	Addressed in a revised legal section
30	EIA should be appraised against TOR. The EIA admits that there is a lack of information in some areas, but says that there is enough to approve project.	Comment noted. This comment referred to the 2007 EIA effort. The most important additional information developed for the 2010 EIA comes from the hydrologic modeling of the Mekong and the various affected channels and from the year-long fisheries study. The modeling indicated that the DSHPP will not have a significant local or regional effect on flows. Although the project may alter some of the natural values currently present in the proposed Ramsar area, improvements in fisheries management and less fishing pressure on fish should balance any loss in the Ramsar area.
31	EIA should address trans-boundary and cumulative impacts	A separate Cumulative Impact Analysis was developed to address this issue.
32	GoL has experience with CIA and SIA in Hydropower projects (implies that this should be used to strengthen the EIA)	Comment noted. A CIA was developed.
	Baseline Information on Project Area	
	General Physical Features	
33	Topography, geology, soils, climate adequate. More info needed on materials sourcing and construction seasonality	Addressed based on information from the FFS
	Hydrology	

MRC Comment	Summary of MRC Comment	Response
34	Explain methodology for transferring Pakse discharges to project site	This issue was addressed using the new DSHPP Mekong River models
35	Distribution of Mekong flows through the channels is complex. Flows for the scheme could be highly variable	Comment noted. Flows through all the nearby channels assessed in the Mekong model. The information was also used to verify that the channel modifications will closely replicate the existing fish migratory routes in terms of flows.
36	Simulation and hydrodynamic modeling needed	This issue was addressed using the new DSHPP Mekong River models. The regional model showed no effect from the DSHPP.
37	Need detail on flows in all 17 channels, Technical challenges to distributing flows in dry season.	This issue was addressed using the new DSHPP Mekong River model, as mentioned above.
38	Turbines would operate well below installed capacity in dry season	Addressed based on the FFS. Because Don Sahong will have multiple turbine units the number of units operating will reduce as overall flows reduce through the dry season. The remaining turbines will operate at equal flows at as high a capacity as possible, as this is the most efficient way to operate. Analysis indicates that the turbines will operate at in excess of 90% flow capacity for 70% of the time, and above 75% capacity for 99% of the time. At these operating positions the turbine guide vanes are relatively open and provide conditions similar to those in the full-flow condition.
39	Turbines would operate well below installed capacity in dry season	Addressed based on the FFS.
40	Turbines would operate well below installed capacity in dry season. Loss of revenue depending on environmental flow selected	Addressed based on the FFS.
41	Loss of revenue depends also on flows in other 16 channels	This issue was addressed using the new DSHPP Mekong River model. The model shows that the DSHPP does not affect any channels except Hou Sahong, Hou Sadam, and Hou Phapheng.
42	EIA should explain how flood hydraulics will be influenced	This issue was addressed using the new DSHPP Mekong River model and the FFS, in the sense that this run-of-river project will not affect overall flood hydraulics.
	Aquatic Ecology and Fisheries	
43	EIA underestimates the geographic extent of the fisheries migrating through the fault line	Addressed in the new Fisheries Study. The geographic extent of the fisheries has been recognized in the FishMAP, with enhanced protection of migratory fish pathways and an alternative livelihood program improving longitudinal passage over the GFL.
	Dolphins	
44	Summarize Appendix G.8 in the main EIA report	Addressed in the EIA – with detailed discussion in Section 3.2.5 and Section 5.7.
45	The Irrawaddy dolphin is Critically Endangered	Comment noted.

MRC Comment	Summary of MRC Comment	Response
46	Dam is <1 km from Veun Gnang pool. Tailrace excavation will approach pool	Comment noted. EIA and FFS discuss this.
	Terrestrial vegetation, wildlife and bird life	
47	Expand discussion of habitats for birds	Addressed in the EIA as appropriate
48	Use EU and CESVI info on Si Phan Don Wetlands	Addressed as appropriate
	Communities and Cultural Aspects	
49	Socio economic assessment is good but too narrowly defined, focusing only on immediate area. Need to look upstream and downstream	The SIA has been updated. Additional information beyond the immediate DSHPP can also be found in the CIA. Areas upstream and downstream should benefit immediately from reduced fishing in the immediate area of the Project, and extension of the alternative livelihood program through local institutional strengthening and a focal point for sustainable development will provide medium to long-term socio-economic benefit.
	Public Health	
50	Expand public health assessment of all villages in DSHPP area	Addressed in the EIA and SIA
	UXO	
51	EIA addresses this adequately. Additional info available as needed	Comment noted. No response needed
	Tourism	
52	EIA recognizes importance of tourism	Comment noted. No response needed
53	Lao National Tourism Administration specified Khone falls for eco-tourism	Comment noted. No response needed
54	Tourism #2 source of revenue for Lao PDR. Si Phan Don area #5 most popular destination	Comment noted. No response needed
55	EIA reports major growth in tourism	Comment noted. No response needed
56	EIA should report strong support for Ramsar site in Champasak	Comment noted. Programs to protect migrating fish, promote sustainable management and long-term support for the initiative will support the Ramsar nomination.
	Impact Analysis and Mitigation Measures	
	Environmental Flows	
57	Need much more detailed discussion of environmental flows	This issue was addressed using the new DSHPP Mekong River models and the FFS.
58	More precise info on flows over Khone falls needed in EIA, not later during design.	This issue was addressed using the new DSHPP Mekong River models. An environmental flow of 800 m^3/sec will be maintained.
	Excavation and Water Quality	

MRC Comment	Summary of MRC Comment	Response
59	Various forms of excavation, including underwater blasting mentioned in the EIA as major short-term impacts	Comment noted. Excavation will be by mechanical means and strictly controlled blasting. Under water blasting upstream will be approximately 8-10%. Controlled blasting uses just sufficient charge to fragment the rock to a size suitable for excavation, but not to pulverize it. This means that additional fine particles are not formed and turbidity from the excavation process will be (if anything) minor and rapidly diluted. No underwater blasting at the downstream end will be permitted.
60	Further detail needed for: (1) underwater excavation especially impact on dolphins and other aquatic life; (2) long term impacts of morphological changes (especially bed and bank stability); and (3) emissions of toxic substances	This issue was addressed based on information from the FFS. The FFS indicates that underwater blasting will not be done. Blasting will be carried out where needed on the "dry" river bed after the placement of the coffer dams upstream and downstream of the project. The modifications that will be carried out on the Xang Pheuak channel will seek to replicate the existing morphology of the Hou Sahong. Banks will be made less steep so as to provide fish passageways during various flows. No toxic substances are anticipated to be released as part of the excavation efforts.
	Fisheries	
61	(1) channel modifications need to be shown effective prior to dam construction; (2) ways to reduce "fish-attractant feature of outflow from turbines is needed	Addressed in the Fisheries Study. 1)Channel modification will be done and assessed before dam construction, and improvements made as Required. 2)As the alternative channel is adjacent, and its attraction flow will be improved this should not be an issue, and there are other means to control this if monitoring identifies it to be an issue.
62	Address downstream fish movement	Addressed in the Fisheries Study. Downstream fish movement will be mitigated through the use of low head, low speed turbines for which recent theoretical studies on fish blade strike indicate the potential impacts on downstream migrating fish through Hou Sahong are likely to be low and generally within the MRC target guideline. Larger fish may still need to be excluded to meet the criteria. The project will monitor the mortality rates closely during operations. A fish screen and bypass channel system will be implemented upstream of the barrage. An additional behavioral or electrical barrier at the entrance to the Hou Sahong will also be considered, should such additional measures prove necessary.

MRC Comment	Summary of MRC Comment	Response
63	Fish / egg / larvae mortality through turbines will be high	This should not be an issue as bulk of the river flow remains in the natural river down other channels. The turbines to be installed are low head and low speed bulb turbines. See also mitigation mentioned in the previous comment response.
64	Address cumulative impact of losing 30% of fish eggs and larvae through turbines	Addressed as above.
65	Fisheries mitigation addressed in EIA. Research program particularly good.	Comment noted. Additional results available in the Fisheries Study, which is considered by the DSHPP as an essential part of the Project.
66	Need further discussion on: (1) geographic / economic impact on fisheries underestimated, (2) proposed mitigation for upstream movement cannot be proven prior to the dam (3) mortality of fish through turbines overlooked	Addressed in the Fisheries Study including a set of recommendations for final design. 1) the geographic/economic impacts are discussed above, 2) Channel modification will be done and assessed before dam construction, and improvements made as required. However by using the naturally occurring channel morphology in the Sahong channel as a template, the DSHPP aims to maximize the likelihood of getting it right first time, but the Project is prepared to undertake refinements over time; 3) discussed above.
	Dolphins	
67	Expand impact info in the report (from Appendix G.8)	Addressed
68	Mitigation possibilities limited	Comment noted. This will be emphasized in the EIA
	Communities and Cultural Aspects	
69	EIA acknowledges social impacts	Comment noted. No response needed
70	More thorough vulnerability mapping and consultation needed	This issue was addressed through additional field work and the updates to the SIA, SMMP, and RAP
	Tourism	
71	Wider impacts should be researched: (1) damage to Lao PDR as eco-tourism site, (2) long term decline if dolphin tourism stops, (3) short term losses due to construction emissions	Addressed
	Ramsar Issues	
72	More work on compatibility of DSHPP to Ramsar	This issue was addressed through consultations with IUCN. However, IUCN informs that the GoL has not made a decision to go forward with the Si Phan Don Ramsar site.
	Trans-boundary and Cumulative Impacts	
73	A stand-alone chapter on transboundary and cumulative impacts needed	A separate Cumulative Impact Analysis addresses this issue, and it is also addressed at a more localized level in the EIA
	Resettlement and Social Action Plans	
74	A RAP and SMMP presented in the EIA	Comment noted. No response needed. These documents have been updated

MRC Comment	Summary of MRC Comment	Response
75	A Resettlement Policy Framework is needed	This issue was addressed in the RAP
76	3-year livelihood transition may not be enough	This issue was addressed in the updated SMMP and RAP, and also in the Fisheries Study. The SMMP and RAP propose four years, and FishMAP will provide at least ten years of fisheries monitoring and management (which may include alternative livelihoods) .
	EMMPs for the Project	
77	Add standard measures to the EMMP even if detailed info not available	Addressed, including the development of special specification clauses for contracts
	Alternatives	
78	Effects of different options not discussed in EIA	Addressed in the EIA based on the FFS. Discusses effects of different installed capacities and other sites. Alternatives Impact Matrix developed
79	Discuss impacts of Thakho project	Thakho improvements to ferry and barge landings have been canceled due to new bridge and road. Thakho (Phapheng) hydro project impacts discussed based on FFS
80	Discuss impacts of Hou Xang Pheuak Alternative in more detail	Addressed in Alternatives Impact Matrix
81	No Project Alternative discussion is adequate.	Comment noted. No response needed. Additional “No Project” definitions were developed for the CIA
82	Discuss impacts of Tad Samphamit project	Addressed in Alternatives Impact Matrix
83	EIA has mandate to investigate the DSHPP only, but more systematic screening of alternatives needed	Addressed in Alternatives Impact Matrix

Comments Received from Social and Environmental Management Division, Department of Electricity, Ministry of Energy and Mines

DOE Comment	Summary of DOE Comment	Response
	General Comments	
1	DOE appreciates the work of the developer to develop EIA, SIA, SMMP, RAP, and EMMP. However, the impacts on the biologic environment, especially fish need to be revised	This is addressed in the updated EIA, based on a year-long fisheries study. A detailed set of recommendations for mitigation are proposed as part of the final design. These mitigation measures will be monitored and enhanced as needed over a ten-year period.
2	According to Lao regulations, the following separate reports are required: EIA, EMMP, SIA, SMMP, and RAP	Separate reports have been prepared
3	The EMMP, SMMP, and RAP shall indicate responsible agencies, budget and schedule	These issues are covered in the indicated documents
4	The monitoring program shall cover all phases of the development	Addressed in the EMMP

DOE Comment	Summary of DOE Comment	Response
5	Ensure that abbreviations are explained and easy to understand	Addressed in all the revised documents
6	Improve the map legends for legibility	All maps and figures have been revised
	Specific Comments	
	EIA	
1	There is missing baseline data, including location of quarries, temporary and permanent residential camps, and solid waste disposal sites. Also, provide baseline data on fisheries and Irrawaddy dolphins. Impacts on all these to be properly predicted and mitigation proposed	The revised EIA addresses these issues. The fisheries issue is covered in the Fisheries Study which is annexed to the EIA
2	Impacts of the transmission lines not clear. Ensure that they are covered in the EMMP and SMMP, with budget and implementation arrangements.	The transmission line impacts are covered in a separate Initial Environmental Examination (IEE) document. The specific routing of the transmission lines is not yet known, pending definition and location of the market demand.
3	*Physical Environment* Provide adequate hydrological and hydro-climatic data Identify impacts and mitigation for: waste from camps and other activities; traffic during construction; borrow and disposal areas and their rehabilitation after construction	Addressed in all the revised documents, particularly the EIA and EMMP
4	*Biological Environment* Identify baseline, impacts and mitigation regarding the Irrawaddy dolphins	The revised EIA addresses this issue. The fisheries issue is covered in the Fisheries Study, and this is used to predict some of the impacts to the nearby dolphin population
	EMMP Report	
	The EMMP must be a separate report	A separate EMMP report has been prepared
	The EMMP must contain a matrix showing project activities, existing situation, management plan, agency responsibilities and budget	Addressed in the EMMP
	RAP Report	
	The RAP must be a separate report	A separate, updated RAP report has been prepared
	Livelihood restoration for the resettled people not clear. Must have their consent to this before moving.	Addressed in the RAP
	Culture and traditions of the affected people must be studied and discussed with local authorities to prevent conflicts	Addressed in the RAP
	Host community impacts and mitigation measures must be addressed	Addressed in the RAP. There is no host community since the resettlement village is on nearby presently vacant land belonging to the resettled persons.
	The relocation budget of $2000 per house is too small. New houses should be better than old. $5,000 to $10,000 may be needed	Addressed in the RAP, using current costs and with consultation with affected people. Costs will be nearly $15,000 per house plus additional costs for infrastructure and livelihoods restoration.
	SMMP Report	
	The SMMP must be a separate report	A separate SMMP report has been prepared

DOE Comment	Summary of DOE Comment	Response
	The SMMP must contain a matrix showing project activities, existing situation, management plan, agency responsibilities and budget	These issues are addressed in the SMMP

Comments Received from the Lao Mekong Secretariat

LMRC Comment	Summary of Lao Mekong Secretariat Comment	Response
1	**General**	
	The Lao Mekong Secretariat commented on issues affecting implementation of the 1995 Mekong River Agreement, especially Articles 5 and 7	Comment noted
	The agreement cites three interrelated issues: economy, social aspects, and environment. All three must be addressed and none is more important than any other	Comment noted
2	**Article 5 – reasonable and rightful use of water**	
	MRC Joint Committee must be informed of dry season water use by the project, and MRC must approve. Downstream members (Cambodia and Vietnam) must also approve before construction	Comment noted. A "Notification, Prior Consultation and Agreement" document in accordance with the 1995 agreement has been prepared and will include attachments such as the EIA.
	The project must not cause problems to Tonle Sap during the wet season	Comment noted. A detailed model of the Mekong has been developed and the results demonstrate that the project will not cause these problems
	The project must not cause salt water intrusion at the Mekong delta during the dry season	Comment noted. A detailed model of the Mekong has been developed and the results demonstrate that the project will not cause these problems
	Normal water levels in the Mekong must be maintained.	Comment noted. A detailed model of the Mekong has been developed and the results demonstrate that the project will not cause these problems
	The issues above are not covered in the 2007 EIA. Developer should carry out the necessary further studies	The hydrologic model study has been used to address these issues.
3	**Article 7 – riparian countries must protect the water and prevent harmful development of the Mekong basin.**	
	a). Hou Sahong is a year-round fish migration route. DSHPP will stop that and will negatively affect the dolphins. The DSHPP will also destroy an important tourist site.	The hydrologic model study in combination with the Fisheries Study has been used to address these issues. These impacts can be avoided.
	b). solving the fish migration issue by excavating the Hou Xang Pheuak and Hou Sadam will destroy those waterfalls and it is uncertain that the fish will use these routes.	The revised EIA addresses these issues. The fisheries issue is covered in the Fisheries Study which is annexed to the EIA
	c). augmenting energy production from 250 MW to 360 MW by excavating 5 meters at the entrance to Hou Sahong may not be feasible	The Final feasibility Study has determined that the project will be rated at 260 MW. The excavation will ensure stable flows into the Hou Sahong inlet
4	All the above will affect flows at Khone Phapheng and Lippi falls. This is not clearly addressed in the EIA. Detailed studies must be carried out	The hydrologic model study has been used to address these issues.
	Recommendations to developer	

LMRC Comment	Summary of Lao Mekong Secretariat Comment	Response
	Carry out in-depth study of fish migration on Hou Sadam and Hou Xang Pheuak, as well as dolphins	The fisheries issue is covered in the Fisheries Study which is annexed to the EIA
	Carry out in-depth study of low flows over Khone Phapheng and Lippi falls to protect tourism.	The hydrologic model study has been used to address these issues.

Other Comments Received

Comment	Summary of Comment	Response
1	Lao PDR's current proposal for accession to the Ramsar International Convention on Wetlands is threatened under the proposed DSHPP	This is addressed in the EIA. However, as of this time, the Government has not made a decision to declare the Si Phan Don Wetlands a Ramsar site and the best information available is that it is unlikely to do so.
	The EIA should present a comprehensive "No Project" option	Addressed in the EIA
	The EIA should assess possible impacts against criteria that are required for the potential Si Phan Don Ramsar site.	See comment response to item 1 above
2	DSHPP is a serious threat to fish migration	The fish migration and fisheries issue is covered in the Fisheries Study which is annexed to the EIA
3	DSHPP is a threat to the viability of the Irrawaddy dolphin population in the Mekong River	Addressed in the EIA. Dolphin populations in the vicinity of the DSHPP as well as further south in Cambodia are under significant decline. Mitigation measures for the DSHPP are planned, but the population may not survive even if there is no DSHPP
4	The DSHPP will affect hydrology at Khone Phapheng which will have considerable ecological impacts	Flows over the falls were studied using the detailed hydrological model. The Fisheries Study has investigated the ecological impacts at Khone Phapheng
5	There will be considerable negative impacts on livelihoods of local communities	This issue is addressed extensively in the SIA and SMMP, as well as in the Fisheries Study
6	The credibility of the information and recommendations provided in the EIA has been compromised by lack of transparency in the EIA process.	All environmental and social documents produced for the DSHPP will be in the public domain. Extensive consultation has taken place with local authorities, affected people and other stakeholders, including those on the Cambodia side.

ANNEX B

DSHPP Environmental Studies Project Team

#	Designation	Name
1	Team Leader	Dr. Armando BALLOFFET
2	Project Coordinator	Mr. Videth VISOUNNARATH
3	Assistant Project Coordinator	Ms. Phetmany SANASISANE
4	International Independent Advisor	Dr. Greg WEARY
5	EIA	Mr. Virasack CHUNDARA
6	Hydrologist	Dr. Khamfeuane SIOUDOM
7	Hydrologist	Mr. Graeme BOYD
8	Public Health Specialist	Dr. Bounsouane PHOMSOUPHA
9	Land Use Specialist	Dr. Sengkham INTARATVONGSY
10	Terrestrial Ecologist	Dr. Sengdeuane WAYAKONE
11	Social and RAP Specialist	Mr. Bounma MOLAKHASOUK
12	Fisheries Expert	Dr. Oudom PHONEKHAMPHENG
13	Fish Passage Consultant	Mr. Garry THORNCRAFT
14	Engineering Support	AECOM

ANNEX C -- DSHPP Fisheries Study in Hou Sahong, Hou Sadam and Hou Xang Pheuak (2010) (SEPARATELY BOUND)

ANNEX D -- DSHPP Fisheries Study Report (2013) (SEPARATELY BOUND)

ANNEX E -- Appendices to the 2007 EIA (SEPARATELY BOUND)

ANNEX F -- Lists of Wildlife observed or recorded in the Project Areas

Wildlife Status within and around the DSHPP Project Area

N0	Common Name	Scientific Name	Local Name	Sahong Sadam	River Bank	Tran Line	Remark
1	Slow Loris	*Nycticebus coucang*	ลิงลีม				✓
2	Sunda Pangolin	*Manis javanica*	ลิ่น				✓
3	Long-tailed Macaque	*Macaca fascicularis*	ลิงแสม				✓
4	Smooth-coated Otter	*Lutrogale perspicillata*	นากขี้นอุย				✓
5	Eurasian Wild Pig	*Sus scrofa*	หมูป่า				✓
6	Sambar	*Cervus unicolor*	กวาง				✓
7	Red Muntjac	*Muntiacus muntjak*	ฝางหำมะดา				✓
8	Small Indiancivet	*Viverricula Indica*	เหี้ยมขี้ม				✓
9	Water Monitor	*Varanus bengalansis*	เห้ย				✓
10	Bangal Monitor	*Varanus Bengalensis*	แลน				✓
11		*Physignathus cocincinus*	กะต้าง				✓
12	Monocled Cobra	*Naja Kaouthla*	งูเห่า				✓
13	King Cobra	*Ophiophagus hannah*	งูจงอาง				✓
14	Reticulated Python	*Python reticultus*	งูเหลือม				✓
15	Rat snake	*Ptyas mucous*	งูสิง				✓

✓ Evidence of presence based on literature review and interview

Status of Birdlife within and around the DSHPP Project

N0	Common Name	Scientific Name	Local Name	Sahong Sadam	River Bank	Tran Line	Remark
1	Chinese Francolin	*Francolinus pintadeanus*	นกกะตาตีง	*		*	✓
2	Bar-backed Partridge	*Arborophila brunneopectus*	นกกะตาสีน้ำตาน	*		*	❖
3	Red Junglefowl	*Gallus gallus*	ไก่ป่า	*		*	✓
4	Green Peafowl	*Pavo muticus*	นกยูง	*			✓
5	Lesser Whistling-duck	*Dendrocygna javanica*	นกเป็ดแดง		*		✓
6	White-winged Duck	*Cairina scutulata*	นกเป็ดน้ำ		*		✓
7	White-bellied Woodpecker	*Dryocopus javensis*	นกโพระดสีน้ำตาลดาง	*		*	✓
8	Grey-headed Woodpecker	*Picus canus*	นกโพระดหัวสีเทา	*		*	✓
9	Greater Yellownape	*Picus flavinucha*	นกโพระดตอนเหลือง	*		*	✓
10	Common Flameback	*Dinopium javanense*	นกโพระดหลังคำ	*		*	✓
11	Lineated Barbet	*Megalaima lineata*	นกกะถิกคำมะดา	*		*	✓
12	Green-eared Barbet	*Megalaima faiostricta*	นกกะถิกหูเขียว	*		*	❖
13	Oriental Pied Hornbill	*Anthracoceros albirostris*	นกแก๊ง	*			✓
14	Great Hornbill	*Buceros bicornis*	นกกก	*			✓
15	Indian Roller	*Coracias benghalensis*	นกตะขาหลังตีง	*		*	❖
16	Common Kingfisher	*Alcedo atthis*	นกจะเต็นน้อยสีน้ำตาน		*		❖
17	Dollarbird	*Eurystomus orientalis*	นกตะขาหลังงิว	*		*	✓
18	Common Kingfisher	*Alcedo atthis*	นกจะเต็นน้อยสีน้ำตาน		*		❖
19	Indian Cuckoo	*Cuculus micropterus*	นกกุกกู่ยิบเดย	*		*	❖
20	Asian koel	*Eudynamys scolopacea*	นกกาเม้า	*		*	❖
21	Drongo Cuckoo	*Surniculus lugubris*	นกกุกกู่แขวนแขว	*		*	❖
22	Greater Coucal	*Centropus sinensis*	นกกิด	*	*	*	❖
23	Lesser Coucal	*Centropus bengalensis*	นกกิดน้อย	*	*	*	❖
24	Vernal Hanging Parrot	*Loriculus vernalis*	นกแวดปากน้อย	*		*	❖
25	Barn Owl.	*Tyto alba*	นกเค้าแมว	*		*	❖
26	Oriental Bay Owl	*Phodilus badius*	นกเค้าสีน้ำตาน	*		*	❖
27	Collared Scops-Owl	*Otus lempiji*	นกเค้าหู	*		*	✓
28	Brown Fish Owl	*Ketupa zeylonensis*	นกเค้าปาสีน้ำตาน		*		✓
29	Brown Wood Owl	*Strix leptogrammica*	นกฮี้ตุ๋	*		*	✓
30	Spotted Dove	*Streptopelia chinensis*	นกเขาตู้	*	*	*	❖
31	Red Collared Dove	*Streptopelia tranquebarica*	นกเขาหอง	*		*	✓
32	Emerald Dove	*Chalcophaps indica*	นกเขาปากแขวน	*		*	✓
33	Yellow-footed Green Pigeon	*Treron phoenicoptera*	นกเปล้าตีนเหลือง	*		*	✓
34	Pin-tailed Green Pigeon	*Treron apicauda*	นกเปล้าหางแหม	*		*	✓
35	Green Imperial Pigeon	*Ducula aenea*	นกเปล้าพะยาแขวน	*		*	✓
36	White-rumped Vulture	*Gyps bengalensis*	แขงค่ยาว	*	*	*	✓
37	Red-headed Vulture	*Sarcogyps calvus*	แขงหัวแดง	*	*	*	✓
38	White-rumped Falcon	*Polihierax insignis*	แขงน้อยก้นขาว	*		*	✓
39	Great Egret	*Egretta alba*	นกยางใหย่	*	*	*	❖
40	Intermediate Egret Plumed	*Egretta intermedia*	นกยางกาง	*	*	*	❖
41	Black Drongo	*Dicrurus macrocercus*	นกแขวดำ	*	*	*	❖
42	Lesser Racket-tailed Drongo	*Dicrurus remifer*	นกแขวดหางบังเหย	*	*	*	❖
43	Oriental Magpie Robin	*Copsychus saularis*	นกเต้นขาบ		*		❖
44	Common Myna	*Acridotheres tristis*	นกอ้องโม่ง	*		*	❖
45	Hill Myna	*Gracula religiosa*	นกสาลิกา	*		*	❖
46	Stripe-throated Bulbul	*Pycnonotus finlaysoni*	นกขอกค่ลาย	*		*	❖
47	Oriental Darter	*Anhinga melanogaster*	นกค้อ		*		❖
48	Streak-eared Bulbul	*Pycnonotus blanfordi*	นกขอกแดงหูแขก	*		*	❖

Notes: ✓evidence of bird present in literature review and interviews
❖ Observed in field survey
★ Not evident in field survey