

## CHAPTER VIII

### 8. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The Environmental Management Plan (EMP) provides guidance for inspection, mitigation measures and monitoring for implementation during pre-construction, construction, and operation of the project. The EMP consists of institutional arrangements, summary of mitigation measures, and monitoring programs. The mitigation measures and monitoring programs will include the frequency schedule, institutions, and budget.

#### 8.1 Institutional arrangement

Implementation of the EMP for the project will be carried out by the project owner in cooperation with professional institutions such as the General Department of Energy (GDE) of MIME, Provincial Department of Environment (PDoE), District Forestry Administration, District Fishery Administration, Provincial Department of Water Resources and Meteorology (PDWRAM), 3S Rivers Network (a NGO), Culture Environmental Protection Association (CEPA) (a NGO), Provincial Department of Land Management Urbanized Planning and Construction (PDLMUPC), Department of Public Works and Transportation, local authorities, particularly Commune Councils, the Involuntary Resettlement Committee (IRC), and from the central level there will be cooperation with the Ministry of Industry Mines and Energy (MIME), Department of Environmental Impact Assessment and Department of Pollution Control of Ministry of Environment (MoE), Forest Administration and Fishery Administration of Ministry of Agriculture Forestry and Fishery (MAFF), Department of Hydrology and River Works of Ministry of Water Resources and Meteorology (MoWRAM), and Ministry of Economics and Finance (MEF).

The GDE of MIME and the construction & operation company (Design engineer and Operation Engineers of the Project Owner) have the overall responsibility for ensuring that all the construction and operation activities which will harm the environmental and social resources should follow the environmental standards in the EMP for the project. Daily, weekly and/or monthly inspection and monitoring in and around the project site during the construction and operation phases is required to ensure the contractors are in compliance with engineering design and operation and EMP. This will need to be included as a condition in construction contract documents.

The contractor will be responsible for daily implementation of the EMP and other environmental safeguards that are stipulated in construction contract documents to ensure construction and operation activities are in compliance with environmental protection standards.

The project owner/project investor is responsible for all expenditure for all impact compensation, environmental mitigation and monitoring costs during the entire project investment period. Good cooperation and collaboration with project stakeholders is



strongly required for ensuring smooth and successful implementation of all stages of the project.

The Department of Environmental Impact Assessment (DEIA) and Department of Pollution Control (DPC) of MoE is responsible for monitoring and investigation of all environmental impacts that will occur in the project area as well as in the regional area. Monthly and annual inspections and monitoring or emergency checking is required. Environmental quality management and mitigation procedural advice shall be provided to the project owner as well as the construction and operation agency to make sure no serious environmental impacts occur in the project area.

The Inter-ministrial Resettlement Committee (IRC) of MEF together with line ministries and local authorities are responsible for approving on the resettlement action plan and compensation rate in collaboration with the project owner in the arrangements for relocation and resettlement of the affected people (AP) by the project activities and assist the project owner to solve and comply with Government policy, compensation rates, and the procedure of the resettlement action plan. IRC will also work closely with the Land Management and Urban Planning and Construction institution and Local Authorities to ensure the compensation will be correct and accepted by the APs.

The Forestry Administration, Fishery Administration, and other conservation agencies in the project area will be responsible for the inspection and monitoring of the impacts on aquatic wildlife and territorial fauna & flora in the project area.

Local authorities and police will be responsible for the facilitation, controlling, and solving of any social conflicts that may happen in the project area. They will also assist the project owner to protect drug trafficking and illegal activities in the project area.

## **8.2 Potential Environmental Impacts and Mitigation Measures**

The project will impact the natural and social resources in and around the project area due to project activities during pre-construction, construction and operation phases. The proposed mitigation measures to reduce the negative impacts are identified for each environmental item in the different project phases and summarized in table 64.



Table 64: Summary of Environmental Impacts and Proposed Mitigation Measures

Issue	Potential Environmental Impacts	Degree of Impact			Proposed Mitigation Measures	Respon- sibility Institution	Cost Estimate
		Small	Moderate	High			
<b>Pre-Construction phase</b>							
<b>Project site</b>	<p>The reservoir site will submerge agricultural land, forest areas, grasslands, shrubland, and other land uses in the Sesan district. The resettlement areas will also impact forest areas.</p> <p>The reservoir site and proposed resettlement areas will cover some existing land and forest concessions in the Sesan district.</p> <p>Moreover the project site risk with the earthquake due to the result of geology and seismology study.</p>				<p>Reduce the reservoir size by reducing the height of the dam as much as possible to minimize the flooded forest area, agricultural land, existing land concessions, and existing settlement areas of the four communes in Sesan district.</p> <p>The dam site shall be built in alternative site 1, 1.5km downstream from the confluence of the Sesan and Srepok rivers.</p> <p>Resettlement areas shall be located where there is no conflict/harm to the social and environmental resources in the area.</p> <p>The design shall include the protection factor to the earth quake in the area. Planning and budgeting for emergency aid and compensation to the affected people, if dam collapse by such natural disaster.</p> <p>The project design shall be minimized to reduce the flood level in order to reduce damaging forest, agricultural land, households, and land and forest concessions.</p> <p>Detour road and new bridge construction is required to compensate for the stretch of road and bridge lost by the project.</p> <p>The alignment of the detour road of the</p>	<p>DE/PO, and GDE</p> <p>None (DE/PO are responsible)</p>	<p>None (DE/PO are responsible)</p>
<b>Design</b>	<p>The project will flood 305.74km<sup>2</sup> areas within four communes (Phluk, Srekor, Talat, and Kbal Romeas), 7km of national road #78 and Srepok bridge, and 7086ha of forest will be damaged due to the resettlement areas. It will also flood five land concession areas and one forest concession area</p>						



						national road and resettlement areas shall be located in areas where they do not adversely impact to natural and social resources in the area.			PO are responsible and the cost shall be included in the investment cost
						The company is responsible for all expenditure for compensatory road, bridge, and resettlement area construction and the quality of the road and bridge shall be similar or better than the existing ones.	DE/PO, DPWT, and IRC		
						Compensation to communities for the fisheries lost in the both the Sesan and Srepok Rivers is provided to support the livelihoods of the local people living along the rivers		DE/PO, Fishery Administrative	Compensation budget is to be included in project investment cost.
						Provide agricultural programs such as (i) animal raising such as cattle, chicken, duck, and other animal; (ii) agricultural extension projects including rice, vegetables, and other crop production.			
						The company shall select appropriate access road alignments and design to avoid/reduce damage or risk to natural resources such as forest, wildlife, aquatic fauna and flora, and to avoid any risk to social resources in the area. The access road must connect directly with national route 78 and not pass through any villages		DE/PO, DPWT	Construction and operation budget is included in project investment cost.
						The project executive company together with MIMC shall cooperate with the responsible owners of the land concession and forest concession to solve the land conflict before the commencement of project construction.		DE/PO, MAFF, MLMUPC, and local authority,	No cost for the land, but compensation cost for the plantation
<b>Dam</b>	High impact on fish movement/migration up and down the sesan and Srepok rivers. Dam across the Sesan River will impact not only the fisheries in the area but also the fishery in the Mekong downstream, Mekong delta, as well as in the Tonle Sap Lake.								
<b>Access road construction</b>	Impact on natural resources caused by construction activities such as clearing forest for the new access road to the project site, borrow pit, noise, vibration, water supply, water quality, and drainage systems.								
<b>Land conflict</b>	The proposed reservoir of the Lower Sesan 2 HPP will submerge some land concessions and a forest concession in the area which are licensed and in operation. The name of the land and forest								



	<p>concessions are:</p> <ul style="list-style-type: none"> <li>- Pheapimex</li> <li>- Grand Land Company</li> <li>- Siv Geach Agro-Industrial</li> <li>- Phumady Investment Group</li> <li>- Sopheak Nika Investment Agro-Industrial</li> <li>- Sal Sophear Trade</li> </ul>				<p>seed and product.</p> <p>The compensation cost is included in project investment cost.</p>
<p><b>Resettlement</b></p>	<p>With FSL of 75m and dam site 1, the project will resettle of 1059 HH within 332HH of Srekor commune, 453HH of Kbal Romeas commune, 267HH of Talat commune, and 7HH in Phluk commune. This will result in the resettlement of around 5000 people.</p>		<p>The resettlement need to be appropriately located and have an appropriate size for the PAH or APs to meet the equivalent or better living conditions to what they have at the present.</p> <p>The new resettlement site shall be selected in where there are no adverse impacts on natural and social resources.</p> <p>The resettlement activities shall be done with peaceful discussion with APs, proper measurement of the affected properties, and reasonable compensation in accordance with the real costs in the local market.</p> <p>A resettlement action plan is required and the effective compensation date shall be agreed before the commencement of construction activities.</p> <p>Moreover the compensation and resettlement activities shall be carried out exactly as described in the Resettlement Report (separate report that prepare by PECC-1 study team).</p>	<p>DE/PO, PECC-1, IRC/MEF, MLMUPC, and local authority</p>	<p>The compensation cost is to be included in project investment cost.</p>



<b>B. Construction phase</b>							
<b>Impacts on hydrological regime</b>	The construction of main dam and access roads to project site will cause blockage of natural drainage and change river flow in the area and downstream of the project site.	✓			The construction of a diversion canal at dam sites shall be provided with adequate capacity to release water to downstream avoiding big changes of flow in the river. Adequately provide drainage systems along the access road to the project site.	CE/PO and Contractor	Include in contractor contract cost
<b>Impacts on water quality</b>	The water quality downstream of the dam site in Sesan river will be reduced at construction stage due to cutting of forest, earth works, potential disposal of waste into the river course or on the open spaces nearby, especially the spilling of fuel, lubricants, and other toxic materials from construction machinery/vehicle and construction work.		✓		The cutting of forest and earth works shall be done in the dry season. Appropriate erosion and sediment control measures shall be put in place to avoid sediment laden discharges from the site during the wet season.	CE/PO and Contractor	Include in contractor contract cost
<b>Impact on ambient air</b>	Emissions causing air pollution, dust, noise and vibration from cutting/burning forest/vegetation in construction site and in the reservoir areas, construction machinery, blasting rock, and transportation of construction materials will impact on ambient air quality.  Forest fires caused by careless project staff, wildlife hunter, and land reclamation for occupation or plantation in the area will also pollute the atmosphere in the	✓			Provide adequate waste management facilities including sanitation latrines in the construction sites and camps.  Water quality examination in downstream of construction site	CE/PO and Contractor	Include in contractor contract cost  3000\$
					The company will cooperate with the Forestry Administration to collect and improve wood for use for some purpose or sale to the market rather than burning it, in order to reduce air pollution.  Good quality of construction machine with lowest possible air pollution shall be used.  The company will use appropriate blasting material and techniques so no high pollution is emitted to the air.	CE/PO and Contractor	None



	<p>project area as well as in the region.</p> <p>At least four faults are present in and around the project site. One earthquake occurred near the project site in 1978 with magnitude <math>M_s = 5.2</math> degree Richter. Therefore the Lower Sesan 2 HPP implementation is at risk from seismic activities due to dam construction and reservoir with millions of cubic meters storage capacity.</p>			<p>The main dam of the Lower Sesan 2 HPP shall be built where there a favorable geological conditions which is alternative dam site 1.</p> <p>All physical structures including the main dam shall be designed with high protection from seismic activity in the region.</p>	DE/PO	None
<p><b>Impacts on forest and wildlife habitat</b></p>	<p>With the FSL of 75m, the project will damage 23093ha of deciduous forest, 3516ha of semi-evergreen forest, 248ha of evergreen forest, and thousand hectares of other forest and grassland. Many hectares of forest will damage/lost by project construction including the access road and detour to route 78. Loss of wildlife habitat in the proposed reservoir area, along the access road and detour road, and other construction sites of the project will occur.</p> <p>The proposed resettlement sites also will affect forest and wildlife habitat. Based on the project lay out the proposed resettlement sites are located in about 4,618ha of deciduous forest, 1,556ha of semi-evergreen forest, 102ha of evergreen forest, and hundreds of hectares of other forest will be damaged/lost.</p>			<p>The reservoir shall be minimized as much as possible.</p> <p>The cutting of forest shall be done only within areas of the project site where construction activities are required.</p> <p>Strictly ban construction workers from encroaching into the forest for hunting or cutting forest.</p> <p>Reforestation in open space nearby the project area or in area selected by FA shall be undertaken during the project construction and operation stages to compensate for the area of forest lost due to the project.</p> <p>The company shall also make a contribution to strengthen the forest and wildlife habitat conservation program in the area including incorporation and contribution budget to the FA and other relevant conservation agencies to protect the forest and wildlife in and around the project area. One forest-seeding-station shall be provided near the reservoir site.</p>	CE/PO	<p>The cost for reforestation and supporting the forest and wildlife habitat conservation program will put in annual environmental fund that PO will responsible for paying in whole period of project investment(*)</p>



<p><b>Impact on wildlife</b></p>	<p>The project will impact on sandbar birds, bulbuls, woodpeckers, hornbills, sunbirds, and mynas. And the project construction activities will affect to terrestrial wildlife such as Eld's Deer, Dhole, Banteng, and Vultures in the project area. Many of these are rare and endangered species.</p> <p>Indirect impact on the large wild-animals such as Banteng (Bos javanicus), Gaur (Bos gaurus), Bears, Elephants and Gibbon which are still at large elsewhere in the northeast and eastern Cambodia will occur due to the loss of the forest/habitat in the Sesan and Srepok catchments.</p>		<p>The cutting of forest shall only be done in areas required for construction activities.</p> <p>Blasting rock and operating of construction machinery shall be done within limits of noise and vibration and only during day time for the whole construction stage.</p> <p>Strictly ban construction workers from entering the forest for hunting or cutting forest.</p>	<p>CE/PO and Contractor</p>	<p>None</p>
<p><b>Impacts on aquatic biology and fishery</b></p>	<p>The laden water and sedimentation /siltation from the construction activities will damage the river bottom aquatic life. The lower dissolved oxygen, potential high content of oil and grease, and toxic parameters in the water will impact aquatic wildlife and fish because they can not grow, breed, and survive.</p> <p>Some time project staff and workers may do illegal fishing in the rivers and cause impact on the fishery in the area too.</p>	<p>✓</p>	<p>Appropriate erosion and sediment control measures shall be put in place to avoid sediment laden discharges from the construction site particularly during the wet season.</p> <p>The project construction company shall educate the workers do not dispose waste into the water course, and provide adequate waste management facilities including sanitation latrines in the construction sites and camps.</p> <p>Illegal fishing activities from the project staff and workers shall be prohibited.</p>	<p>CE and Contractor</p>	<p>Include in contractor contract cost</p>



<p><b>Impact on water supply</b></p>	<p>The project will impact on the water supply of the community downstream including Phluk community water supply and Stung Treng town water supply during construction activities and will reduce the water quality of the Sesan river. The treatment costs of the town water supply will increase.</p>		✓		<p>Appropriate erosion and sediment control measures shall be put in place to avoid sediment laden discharges from the construction site particularly during the wet season. Provide adequate waste management facilities including sanitation latrines in the construction sites and camps. The PO shall provide potable water/pay compensation costs to downstream water users if water quality is seriously deteriorated by project construction activities</p>	<p>CE and Contractor</p>	<p>Include in contractor contract cost</p>
<p><b>Impact on roads</b></p>	<p>During the construction period the project will impact on the existing road and bridge in the area especially the national road #78 and bridges along the road.</p>	✓			<p>Improvement of existing roads and bridge that will be used for the project is required. Frequently maintain the existing and access roads that will be used for the project, to make sure good functioning during the whole construction period. Improve the stretch of the national road #78 that will be used for the project, if it not yet improved before commencement of project construction</p>	<p>CE/PO, DPWT and Contractor</p>	<p>Included in project investment cost.</p>
<p><b>Impact on Navigation</b></p>	<p>The project will disturb navigation of some small engine boats that the local people frequently use for transportation from village to village and sometimes to Stung Treng town.</p>	✓			<p>Provide navigation route for the small engine boats in the diversion canal that proposed by the project in construction stage. Confirm to the boat operator/villagers the navigation route at dam site during the construction stage through the diversion canal. Navigation signs at of the entry and exit of the diversion canal shall be provided. Minimise the size of the reservoir area.</p>	<p>CE/PO, DPWT and Contractor</p>	<p>Include in contractor contract cost</p>
<p><b>Impact on</b></p>	<p>The project will damage and</p>		✓		<p>Minimise the size of the reservoir area.</p>	<p>CE/PO,</p>	<p>None</p>



<p><b>land use</b></p>	<p>change the land use condition in the area due to the project construction such as dam construction, reservoir flood area, resettlement area clearing/construction, detour road and other project component construction.</p>				<p>Limit the size of the resettlement areas based on the PHA and community requirements. Extra land reclamation near by the resettlement area is strictly prohibited.</p>	<p>DPWT, IFC/MEF, and Contractor</p>	
<p><b>Impact on agricultural development</b></p>	<p>During construction of the Lower Sesan 2HPP especially when the reservoir water level reaches 75m (m.s.l), the total flooded area will be 33563ha which comprises agricultural land of 1290ha which is equal to 24.7 % of the agricultural land of the Sesan district as a whole. The project will adversely impact to the agricultural development during the period of the construction and the period of resettlement of the PAH/APs.</p>				<p>The reservoir shall be filled after harvesting of agricultural products in the reservoir site. The company shall arrange the agricultural land in the resettlement areas in time for the PHA/APs to continue rice plantation in next season after finishing agricultural activities in the previous places.</p>	<p>CE/PO, DPWT, IFC/MEF, and Contractor</p>	<p>None</p>
<p><b>Impact on local culture</b></p>	<p>The project may have cultural conflict if the project recruits staff from the outside with different culture to work for the project construction. Some activities from the project staffs such as noise, encroachment into worship forest/places, and bad faith/against to the local believe/culture can cause impact on the local people and ethnic group culture in the project area.</p>				<p>Educate the project workers and staff to respect and obey the culture of the local people as well as the regulation and law of RGC on religious beliefs and other disciplines concerning culture, tradition, and civilization. Strictly discipline any project workers or staffs who do illegally activities with the local people or who do not respect and obey the ethnic culture in the project area.</p>	<p>CE/PO, and Contractor</p>	<p>None</p>
<p><b>Impacts on Public Health</b></p>	<p>Deforestation/burning, transportation of construction material, blasting noise and vibration may affect the health of</p>				<p>Construction works shall follow all safety working standards. Tools and equipment shall be provided to protect against any dangers to project staff as well as to local</p>	<p>CE/PO, policemen, and Contractor</p>	<p>Include in contractor contract cost</p>



	<p>workers and people in the community, especially Phluk and Chrop community.</p> <p>Poor water quality in the Sesan river that cause by the construction activities will affect to downstream communities health.</p> <p>Outside workers/staffs of the project may affect to local people's health through transmission of social diseases such as HIV/AIDS, syphilis, etc., and also drugs using and trafficking.</p>			<p>people.</p> <p>Provided health facilities, medicines, and medicine/doctor for examination and treatment of project staff and local people to avoid the spread of disease to people.</p> <p>Good collaboration with health institutions in Sesan district, Stung Treng province and central levels to protect any transmission of disease in and around the project area.</p> <p>Cooperate with police and local authorities to protect against drug use and drug trafficking in the project area.</p>		
<p><b>Blasting</b></p>	<p>Blasting rock for dam and access road construction may affect people, wildlife and ambient air quality due to emission of noise, vibration, and air pollution.</p> <p>Blasting may cause danger to villagers or wildlife which go to/near the blasting area.</p>	<p>✓</p>		<p>Blasting must be undertaken within limits taking consideration of the area to avoid high risk to wildlife and human beings in the area.</p> <p>Adequate broadcast to local authority as well as community about blasting schedule (date and time) to avoid any dangers to people and domestic animals.</p> <p>Blasting shall only be done in day time.</p>	<p>CE/PO, and Contractor</p>	<p>Include in contractor contract cost</p>
<p><b>Traffic</b></p>	<p>Traffic congestion and traffic accidents may happen on the national road #78 and access road to the project site due to transportation of construction materials.</p>	<p>✓</p>		<p>Adequate traffic signs shall be provided along the national road #78 and project access roads.</p> <p>Educate project drivers in order to limit speeds in settlement areas or dense population places.</p>	<p>CE/PO, DPWT, and Contractor</p>	<p>Include in contractor contract cost</p>
<p><b>UXO and Toxic chemical</b></p>	<p>Risk with remains of bomb/UXO and toxic chemical used by the US air-force in war. Risk to the worker and local people will be occurred in construction period</p>		<p>✓</p>	<p>De-mining shall be done before earth work, especially in construction site , resettlement area and quarries.</p> <p>The project owner shall do good cooperation with local de-mining authority CMAC or other local de-mining agency to</p>	<p>CE/PO, Local Authority, and CMAC</p>	<p>Included in project investment cost.</p>



		deal on this issue.					
		Treated of soil where founded the toxic chemical remain.					
<b>C. Operation phase</b>							
<b>Impacts on hydrological regime</b>	The water flow in Sesan river downstream of the project site will be changed due to project operation. The design discharge of proposed project is 2119.2m <sup>3</sup> /s and the firm discharge is 466.7 m <sup>3</sup> /s.					None	
<b>Water quality</b>	During the first 1-3 years of operation the water in the reservoirs may be poor due to decay of forest or vegetation and small animals that are trapped in the flooded reservoir area. Disposal of waste into the river course or on the open space nearby the water course from operation staff can pollute the water of Sesan river too. Low dissolved oxygen, high pollution of biological and nutrient parameters, or eutrophication phenomena will occur. Some time high breeding of pathogenic					Include in contractor contract cost	
						OE/PO	
						Include in contractor contract cost	
						OE/PO	
						Include in contractor contract cost	



	<p>bacteria, virus, and host or vector related diseases (snail, mosquito, etc.) are happened. The indirect affect to the wildlife and human beings can be caused by disease transmission such as malaria, dengue fever, Shistosomiasis, etc.</p>				
<p><b>Impacts on wildlife habitat and wildlife</b></p>	<p>The large and deep water (1-7km width, 30-50km length, and 20-35m depth) in the reservoirs is an obstacle to wildlife migration in the area. New settlement areas for Srekor village, Sresranok village, and for Krabei Chrum village will add pressure to the wildlife habitat and wildlife near by area due to the encroachment from the villagers.</p>		<p>Strictly ban the encroachment to the forest/habitat of the wildlife in terms of new reclamation for land occupation or hunting.</p> <p>Ban hunting wildlife in the area.</p> <p>Cooperation with wildlife protection agencies for the development of wildlife protection programs at the local and national level. Contribute in technical and budgetary terms to protect the wildlife habitat and wildlife in and around the project area.</p>	<p>OE/PO, Forest Administrative , and conservation agencies</p>	<p>The cost for reforestation and supporting the forest and wildlife habitat conservation program will put in annual environmental fund that PO will responsible for paying in whole period of project investment(*)</p>
<p><b>Impacts on aquatic biology/ fishery</b></p>	<p>The Lower Sesan 2 HPP project will impact to the movement of aquatic biology especially fisheries in Sesan and Srepok river due to the dam construction across the river and the project operation. All aquatic fauna and fish will not be able to migrate up and down of the dam.</p>		<p>Provide appropriated mean to maintain fish and other aquatic life re-appearance as existing by creating fish research center near by the reservoir site of the project.</p>	<p>OE/PO, Fishery Administration</p>	<p>USD 0.5 million per year for construction of fish research center **</p> <p>USD 0.1 million per year for production of baby fish and operation the center **</p>



<p><b>Impact on rare or endangered species</b></p>	<p>The project will adversely damage the aquatic rare species especially fish namely Mekongina erythrospila (Trey Pasi Ee), Bangana behri (Trey Pawa Mok Pir) and Probarbus species (Trey Trawsak), and will completely interrupt the fish movement route in both rivers as well as water regime change, and deep water in the reservoir.</p> <p>Due to the big/long/deep reservoir, the project will impact not only on the aquatic fauna and flora rare species but also on the rare and endanger species of terrestrial wildlife in the area as well as in the Northeast Plateau of Cambodia which is one of the main wildlife habitats in the country. The impact on the rare and endanger terrestrial wildlife and bird species include Kouprey, tiger, Asian elephant, Banteng, wild buffalo, golden cat, fishing cat, black bear, gibbons, Greater Adjutant (Leptoptilus dubius), White-shouldered Ibis (Pseudibis davisoni), Green Peafowl (Pavo muticus), Cinnereous Vulture (Aegyptius monachus).</p>			<p>Cooperation with FA/MAFF to produce as the same fish species as presently exist in the area for consumption up and down stream of the project site with the equivalent or more quantity than presently or use other methodologies that can protect the rare and endangered fish species in both rivers.</p>	<p>OE/PO, Fishery Administration</p>	<p>include in above column</p>
<p><b>Impacts on downstream and upstream livelihoods</b></p>	<p>The people living along Sesan and Srepok rivers are depending on farming, fishing, collecting forest by-products and animal raising (buffalo and cattle). These activities play very vital role in their daily</p>	<p>✓</p>		<p>Cooperation with wildlife conservation agencies and contribute the budget to protect bird habitat near by the project area including bird habitat (existing and new habitat) in Stung Treng, Ratanakiri, Mondul kiri, and Kratie province territory.</p>	<p>OE/PO, Forestry Administration</p>	<p>USD 0.5 million per year for supporting conservation program in and around area (whole project operation period will be applied)**</p>
				<p>Appropriate training course or new skilled and income restoration shall be provided to PHA and APs (boat operators and fishermen). The cost for training and income restoration will be borne from the project executive company. The number of</p>	<p>OE/PO, IFC/MEF</p>	<p>USD 0.473 million **</p>



<p><b>Impact on water supply</b></p>	<p>The releasing of water from the project in operation stage may affect to the water supply</p>	<p>✓</p>		<p>livelihood in the project areas, but fishing activity now has become vital for villagers in the project area, upstream and downstream.</p> <p>The project will affect to livelihoods of the community downstream also in terms of health affect (poor water quality), decreasing fishing production, destroying vegetable gardens on the river bank or shoreline of the river, and some time damaging of properties or killing animals and villagers because of changing flow regimes and sudden flooding caused by water releasing from dam in operation phase.</p>	<p>PHA and APs are counted based on the resettlement study result in separate report, by PECC-1.</p> <p>The project executive company will responsible for compensation to indirect PHA (in upstream of the project area, communities along the both rivers in Ratanakiri and Mondulakiri province). The compensation can be provided in strengthening livelihood program such as new career capacity building, small business fund providing, agricultural support programs such as (i) animal raising; (ii) agricultural extension program. The company will responsible for all budget for technical training and providing seed in the appropriate period that all the villagers who living along the both river can adopt with changing of food supply (fish) and their daily livelihood and that the practices employed are sustainable.</p> <p>Regularly control the water quality in the reservoir to avoid adverse affect cause by aquatic weed bloom or grey algae bloom, pathogenic bacteria and virus breeding in the reservoir.</p> <p>Adequately and timely disclose water releasing schedule to downstream community to avoid any risk to health, properties, and live.</p> <p>Regularly control the water quality in the reservoir to avoid adverse affect cause by aquatic weed bloom or grey algae bloom,</p>	<p>OE/PO, MAFF</p>	<p>USD 1.8 million every year for agricultural support program (the period of mitigation proposed in 10 years)**</p>
					<p>OE/PO</p>		<p>None</p>
							<p>USD 1000/year (apply entire)</p>



	downstream especially Phluk community and Stung Treng town, if the water quality in reservoir was contaminated.				pathogenic bacteria and virus breeding in the reservoir. Take an action in time to protect any high risk of water quality happened in the reservoir. Cooperation with local authorities and tourism department of Stung Treng to find other tourism places near by the project area and improve/develop to subsidize the cascade lost by the project.		investment (period)
<b>Impact on tourism facility</b>	The project will impact on the tourism facilities in downstream, especially cascades in Phluk commune.	✓				OE/PO	Included in project investment cost.
<b>Impact on public health</b>	The project may affect community health in operation stage such as transmission of the social disease such as HIV/AIDS, syphilis from the project staffs. Drug injection and trafficking from project staff in the local community can also adversely affect the people. When the power house starts to run again the water flow and water level downstream of power house will quickly rise up and can be a danger to humans and animals.				Ban project staffs do not spread or transmit disease into the local community, health care post may be provided in community near by the project site, regularly examination the project staffs health and treatment if found any health problems. Adequately capacity tailwater pool to reduce the peak water flow from the powerhouse during project operation stage. Adequate disclosure the operation schedule (water release from the project) to the community downstream to avoid any harmful to the properties and live.	OE/PO	None

**Note:** (\*) The annual environmental fund is proposed USD 0.5 million; and the project owner will pay in yearly to the MoE and Forestry Administration of RGC to compensate to the forest and wildlife habitat lost by the Lower Sesan 2 HPP project. The MoE and FA of RGC will use this fund to support forest and wildlife conservation program in the area (Stung Treng and Ratanakiri province)

\*\* Detail proposed mitigation cost was described in Annex 6.



### 8.3 Monitoring Program with monitoring cost

Monitoring on some parameters of the environmental impacts caused by the project pre-construction, construction and operation is required. The responsible institution and costs for conducting monitoring are included in the monitoring program, see table 65. Detail cost estimation attached in annex 6.

Table 65: Environmental monitoring program

Mitigation measure	Parameters to be Monitored	Location	Frequency	Institutional Responsibility	Cost, US\$
<b>Pre-construction phase</b>					
Reduce the project size to minimize the flooded forest area, agricultural land, existing land concessions, and the settlement area of the four communes in Sesan district.	Check the final engineering design and lay out of the project.	Project office	One time for draft final design, and one time for final design	DE/PO, GDE, DoE, IRC, and Local authority	No cost
The dam site shall be built in site 1, at 1.5km from confluent point of the Sesan and Srepok rivers.	Check drawing lay out, make sure dam site is at 1.5km from confluent point.	Project office			No cost
New settlement area shall be selected where is not conflict/harmful to the social and environmental resources in the area	Investigate new settlement area to screen the impact on social and environment in place.	Project office and field visit at proposed site			1320
The alignment of the detour road, access road, and new resettlement place shall be selected in where is not adversely impact to natural and social resources in the area.	Check the alignment of detour road, access road, and new resettlement area	Project office and field visit at proposed site	One time for draft final design, and one time for final design	DE/PO, DPWT, and DoE	160
Fish passage structures or other approach shall be provided to allow fish and other aquatic fauna migrate upstream and downstream of the dam.	Check the final engineering design or proposed fish research center or compensation to support the livelihood of the local people living along the rivers.	Project office	One time for draft final design, and one time for final design	DE/PO, GDE, Fishery Administrative, and DEIA/MoE	No cost



<p>Or fish research center is one option to balance fishery up and down stream in both river.</p> <p>Or compensation to the fishery lost in the both rivers (Sesan and Srepok) is provided to support the livelihood of the local people living along the rivers.</p>					
<p>The project executive company together with MJME shall cooperate with the responsibility institution on the land concession and forest concession to solve the land conflict before the project construction.</p>	<p>Check the detail project report to make sure the solving committee for the land conflict ready established and work effectively with affected land and forest concession companies</p>	<p>Project office and field visit at proposed site</p>	<p>One time for draft final design, and five time for final design and completed solving</p>	<p>DE/PO, IRC/MEF, MAFF, DLMUPC, and DEIA/MoE</p>	<p>4400</p>
<p>New resettlement places arrangement with appropriate location and size for the PAH or APs.</p> <p>The resettlement activities shall be done with peaceful discussion with PAH/APs, and reasonable compensation as real cost in the local market.</p> <p>The effective compensation date shall be done before the construction activities.</p> <p>Moreover the compensation and resettlement activities shall be carried out with exactly result of the study which is described in Resettlement Report.</p>	<p>Check the compensation and resettlement action plan implementation are effective as real result on the resettlement study</p>	<p>Project office and field visit at proposed site</p>	<p>One time for draft final design, and 10 time for final design and completed solving</p>	<p>DE/PO, IRC/MEF, Local Authority, NGOs (3S rivers, CEPA), and DEIA/MoE</p>	<p>7260</p>
<b>Construction phase</b>					
<p>The construction of a diversion canal at dam sites shall be provided with adequate capacity to release water to</p>	<p>Inspect on release flow, dimension of diversion canal that can do navigate of small boat.</p>	<p>At diversion canal construction site</p>	<p>two times in first construction stage and quarterly in whole</p>	<p>CE, DWRAM, DPWT, and DoE</p>	<p>3080</p>



downstream avoiding big changes of flow in the river, flood upstream, and can be used for temporary navigation route.	Check the canal functioning	Along the road construction and other construction site	construction period		
Adequately provide drainage systems along the access roads to project site.	Check drainage system make sure project implementing company and contractor adequate provide	Along the road construction and other construction site	Quarterly in whole construction period	CE, DWRAM, and DoE	1600
Appropriate erosion and sediment control measures (retention pond and blue fine mesh cloth/plastic) shall be put in place to avoid sediment laden discharges from the site during the wet season.	Inspect on the erosion and sediment laden protection facilities/method, make sure the mitigation measure are properly applied	At construction site	Monthly in raining season, through the construction period	CE, DWRAM, and DoE	1600
Provide adequate waste management facilities including sanitation latrines in the construction sites and camps.	Check waste management facility and its functioning use for project	At construction site and worker/staff camps	Quarterly in whole construction period	DoE	800
Water quality examination upstream and downstream of the project site shall be done regularly to ensure the quality of water during construction does not seriously impact aquatic wildlife and human beings.	Control/check water quality. <i>10 parameters will take for examination such as pH, Conductivity or Total dissolved solid (TDS), DO, BOD<sub>5</sub>, COD, Tot-N, Tot-P, NO<sub>3</sub>-N, PO<sub>4</sub>-P, Tot-Coliform.</i>	At 6 stations in both rivers same/near by the location that taken in baseline study	Quarterly through construction phase	DPC and DoE	20000
Good quality of construction machine with lowest possible air pollution shall be used. Appropriate blasting material and techniques so no high pollution is emitted to the atmosphere, and day time blasting only.	Control/check air quality that emitted from the construction activities, to make sure not harmful to human health as well as the wildlife in the project area. <i>Parameters to be measure: TSP, NO<sub>2</sub>, SO<sub>2</sub>, CO, and Noise.</i>	At very active construction site and quarry, two sample are recommended	Every 6 month	DoE and DPC	15120



<p>The cutting forest shall be done within areas of the project site where construction activities are required.</p>	<p>Inspect on forest cutting for the project is exactly in the limit of project site required</p>	<p>At construction site and within reservoir area</p>	<p>Weekly or Monthly in clearing for the construction site and clearing in reservoir area</p>	<p>District Forest Administration, Forest Community member</p>	<p>6000</p>
<p>Strictly ban construction workers from encroaching into the forest for hunting or cutting forest.</p>	<p>Inspect in the project area to make sure there is not illegal reclamation or hunting from the project staff</p>	<p>Near by construction site and camp</p>	<p>Yearly</p>	<p>Local authority, community forest committee</p>	<p>None</p>
<p>Contribution to strengthen the forest and wildlife habitat conservation program in the area including incorporation and contribution budget to the Forestry Administration and other conservation agency to protect the forest and wildlife in and around the project area.</p>	<p>Check the budget for the strengthen the forest and wildlife habitat conservation program are regularly paid</p>	<p>In project office, in Phnom Penh</p>	<p>Yearly</p>	<p>MEF, MAFF, MoE, and conservation agencies</p>	<p>None</p>
<p>Appropriate erosion and sediment control measures (retention pond and blue fine mesh cloth/plastic) will install in place to avoid sediment laden discharges from the construction site during the wet season.</p>	<p>Inspect on the protection method and facilities</p>	<p>In construction site</p>	<p>Weekly or Monthly in construction period</p>	<p>DoE and DWRAM</p>	<p>6000</p>
<p>Illegal fishing activities from the project staffs and workers are banned.</p>	<p>Control illegal fishing activities from project staff</p>	<p>In project area</p>	<p>Monthly in construction period</p>	<p>District Fishery Administration and commune council</p>	<p>4800</p>
<p>Frequently maintain the existing and access road that will be used for the project, to make sure good functioning in whole construction period.</p>	<p>Inspect on the existing and access road that use by the project</p>	<p>On road way that use by project</p>	<p>Quarterly in construction period</p>	<p>DPWT, DoE</p>	<p>1600</p>
<p>Adequate traffic signs shall be provided along the national road #78 and project access roads.</p>	<p>Check traffic arrangement and sign</p>	<p>In construction site and along the road way</p>	<p>Quarterly in construction period</p>	<p>DPWT, DoE</p>	<p>1600</p>
<p>Educate project drivers in order to limit speeds on settlement area or dense population places.</p>	<p>Check traffic condition</p>	<p>Along the road way in project area</p>	<p>Quarterly in construction period</p>	<p>DPWT, DoE</p>	<p>1600</p>



**Operation phase**

<p>Adequately confirmation the operation and pose or peck-flow release schedule to the community downstream, to avoid any harmful to the properties on the river bank and life of human being as well as animal.</p>	<p>Check the operation schedule are properly set up and adequate disclosure to the community downstream</p>	<p>In project operation office</p>	<p>Quarterly</p>	<p>DWRAM, CEPA, 3S River Network</p>	<p>No cost</p>
<p>Monitoring on aquatic fauna and flora in downstream of the project area will carried out during operation stage.</p>	<p>Check any research on fauna and flora are carried out</p>	<p>In project office and downstream of dam site</p>	<p>Yearly in first 5 years of operation period</p>	<p>Fishery Administration, District Administration</p>	<p>2500</p>
<p>Strictly ban the encroachment to the forest/habitat of the wildlife in term of new reclamation for land occupation or hunting.</p>	<p>Inspect in the project area to make sure there is not illegal reclamation or hunting from the project staff</p>	<p>In project area and around the new resettlement by the project</p>	<p>Quarterly</p>	<p>Forest Administration, local authority, and conservation agency in the area</p>	<p>Use the environmental fund that provide in above</p>
<p>Regularly control the water quality in the reservoir to avoid adverse affect cause by aquatic weed blood or grey algae bloom, pathogenic bacteria and virus breeding in the reservoir.</p>	<p>Control/check water quality. 10 parameters will take for examination such as pH, Conductivity or Total dissolved solid (TDS), DO, BOD<sub>5</sub>, COD, Tot-N, Tot-P, NO<sub>3</sub>-N, PO<sub>4</sub>-P, Tot-Coliform.</p>	<p>In riservoir</p>	<p>Every 6 month through operation phase</p>	<p>DPC and DoE</p>	<p>60000</p>

**Note:** The above cost estimation exclude cost of staffs/engineers of project executive company



## CHAPTER IX

### 9. ECONOMIC ASSESSMENT

#### 9.1 Hydro-energy and energy economic calculation for dam site alternatives

Basing on document of mean monthly flow to dam site and curve  $Q=f(H)$  at downstream of powerhouse of each dam site alternative, energy calculation results of dam site alternative are as follows:

Table 66: Main parameters

No.	Parameters	Unit	Value
1	Catchment area	Fiv	km <sup>2</sup> 49200
2	Mean annual discharge	Qo	m <sup>3</sup> /s 1306
3	Full Supply Level	FSL	m 75
4	Minimum Operating Level	MOL	m 74
5	Gross storage	Wtb	10 <sup>6</sup> m <sup>3</sup> 1792.5
6	Dead storage	Wc	10 <sup>6</sup> m <sup>3</sup> 1459.3
7	Active storage	Whi	10 <sup>6</sup> m <sup>3</sup> 333.2
8	Reservoir surface area corresponding to FSL	Fmh	km <sup>2</sup> 334.4
9	Max discharge through powerhouse	Qmax	m <sup>3</sup> /s 2037.5
10	Max head	Hmax	m 28.5
11	Minimum head	Hmin	m 18.9
12	Rated head	Htk	m 21.8
13	Installed capacity	Installed cap.	MW 400
14	Firm capacity	Firm capacity	MW 104
15	Mean annual energy	Eo	10 <sup>6</sup> kWh 1953.9
16	No of hour used installed capacity	hsd	Hour 4885

Table 67: Result gained from estimating the project salient features

Parameters	Unit	Alt.,1	Alt.,2.1	Alt.,2.2
<b>Reservoir</b>				
Dam site		Dam site 1	Dam site 2.1	Dam site 2.2
FSL	m	75	75	75
MOL	m	74	74	74
Wtb	10 <sup>6</sup> m <sup>3</sup>	1792.5	2296.5	2296.5
Wc	10 <sup>6</sup> m <sup>3</sup>	1459.3	1917.1	1917.1
Whi	10 <sup>6</sup> m <sup>3</sup>	333.2	379.4	379.4



<b>Powerhouse</b>				
Powerhouse location		At dam	At dam	At dam
Qmax	m <sup>3</sup> /s	2037.5	2054.6	2058.5
Hmax	m	28.5	29.2	31.3
Hmin	m	18.9	20.0	24.3
Htk	m	21.8	22.7	26.2
Installed capacity	MW	400.0	420.0	480.0
Firm capacity	MW	104.0	109.0	97.0*
Eo	10 <sup>6</sup> kWh	1953.9	2030.9	2235.0*
Tmax	hour	4885	4835	4656
No. of resettled	household	1579	1590	1590
No. of resettled person	person	6507	6540	6540
Investment capital	10 <sup>9</sup> VND	11010.682	11717.855	13452.101
<b>Financial properties</b>	Foreign Loan: 6%/year; Local Loan: 13%/year			
Power Selling Price	USc/kWh	6.30	6.41	6.59
FNPV	Mil.USD	69.34	69.34	69.34
FIRR	%	12.42	12.27	11.98
B/C	-	1.12	1.12	1.10

\* Energy deducted Qenv = 100m<sup>3</sup>/s

## 9.2 Selection of dam site

After consideration of dam site alternatives, it can be as herein:

In terms of economic efficiency: Calculation results of financial indicator based on view of keeping NPV unchanged for all alternatives. The dam site alternative 1 showed that it is the best in term of financial point of view, FIRR is higher compared to alternative 2.1 and 2.2 as 12.42%, 12.27% and 11.98% respectively. However, in consideration of indicator B/C, it is also the highest one. In case of the alternative 2, if selected, it will make investment cost increased about 2400 billion VND (143.7 Mil. USD) in comparing with alternative 1 but making energy output being increased only 282.5 million kWh. This added investment cost does not bring economic effectiveness as compared to alternative 1.

In term of engineering geological condition: At riverbed, dam site alternative 1 has better geological condition but geological condition of alternative 2 also meets requirements for structure of concrete spillway, grouting is necessary for both two alternatives. Abutment side is homogeneous earthfill dam so two dam sites have the same condition.

In construction condition, dam site alternative T2.2 is more favorable because of waterway is constructed independently on the right bank, but geological condition is not good as one in T1 but diversion is only required in flood season so cost for



diversion is reduced, besides construction organization is also more advantage because construction layout of items are rather separate, not concentrated in a area as same as Site T1, nature depend level is also lower thus reliability on schedule is also high.

In terms of operation in the future: Dam site alternative T1 and T2.1 has disadvantage on operation of spillway, it can effect directly to normal operation of powerhouse because of these structures are arranged closely, in order to annul this effect a side wall is necessary to arrange to divide into two areas so that disturbance of downstream water level at spillway won't impact to downstream area of powerhouse.

From the above mentioned calculations and analysis, dam site alternative T2.2 is proposed to be proposal alternative to carry out the following studies.

*Selection of dam site alternative as well as other parameters of project are depend on economic and financial indicators of the alternatives, however input data served for this calculation is now being suppose of consulting agency in normal levels at Vietnam nowadays and investment form of project is also supposed to be BOT during 30 years, thus in the next step (Feasibility Study) when Investor has more corrective information on capital, investment form... parameters of project (including dam site) will be calculated and adjusted.*

Two alternative dam sites were originally considered for the dam at 1.5km (Site 1) and 5km (Site 2) respectively downstream of the confluence of the Sesan and Srepok Rivers. After consideration of geological and some social issues Site 1 has been chosen as the preferred site. It has much better geology than Site 2 for the dam's foundations, reduces the reservoir area by around 4500ha (from 38,000 to 33,500ha) and does not require any resettlement of Phluk village. In addition it means that some cascades below Site 1 are not flooded.

### **9.3 Selection of Full Supply Level**

#### **9.3.1 Limits on elevation of design water level**

A number of alternatives for the height of the dam have also been considered from between 80m and 70m m.s.l. With FSL of 75m m.s.l is the preferred height to minimise the reservoir area while keeping the project financially viable.

In principle, parameters on design water level (FSL and MOL) are selected basing on technical- economic comparison for alternatives combination of design water level, with consideration of silt standard in reservoir. For reservoirbed of Lower Sesan 2 HPP, upper limit of FSL is not available, selected FSL is water level with the best economic and financial indicators on basic of benefit analysis taken from energy and compensation cost for damage – resettlement caused by water filling.

Considered lowest MOL is determined according to sediment standard of reservoir. Basing on Vietnamese Construction Standard TCXD VN-285-2002, silt volume of



reservoir seems to be filled up when elevation of sediment surface in front of pressured site is reached to sill elevation of main intake. Also basing on regulation in TCXD VN-285-2002, for Lower Sesan 2 HPP sediment accumulated time for full fill is not under 100 years. Studies on geology at reservoir show that large slide in reservoir is not possible to happen, only small slides are possible to happen. Therefore, sediment volume in reservoir will mainly be suspended silt in flow. Reservoir of Lower Sesan 2 is spreaded the end of reservoir has two main tributaries, bottom slope is small, flow velocity will reduce when flow is got into reservoir abdomen, widen at downstream so most of silt will deposit at this area. Calculations on deposit silt in reservoir show that after 100 years sediment elevation of silt is at elevation of 53m. According to this condition, sill of intake won't be less than elevation of 55m. With designed discharge for generation of Lower Sesan 2 HPP at different alternatives of capacity, inundation of intake sill under minimum operating level (MOL) is about 15m. Therefore, in order to insure sediment requirement basing on TCXD VN-285-2002 elevation of lowest MOL of Lower San San 2 HPP is not under elevation of 71m when considering and selecting of design parameters of reservoir.

From the above analysis, limits in consideration of design water level of Lower Sesan 2 HPP are determined as follows:

- Full Supply Level: Basing on optimum calculation of water level
- Minimum Operation Level: is not under elevation of 71m.

### **9.3.2 Basic parameters in calculation and selection of FSL**

Annual flow series: In calculation and selection of design water level, annual runoff series used in calculation is runoff series from 1977 to 2006 with mean annual runoff  $Q_0 = 1304 \text{ m}^3/\text{s}$ . Determination basics for calculated annual runoff are mentioned in Meteo- Hydrological Study.

Storage volume of reservoir: During preparation of Pre- Feasibility Study report, aerial photograph map of scale 1: 10000 of whole reservoir area is measured with contour correction of 2m, from that reservoir volume is measured and determined with different elevations and relation curve between reservoir volume and elevation ( $W, F = f(z)$ ) is established.

Calculation of back water in reservoir: basing on river cross profile system prepared by PECC1 and PECC4 during hydro-dynamic calculation at downstream of Sesan river and Srepok river on Cambodian territory in 2004, combined with aerial photograph map of scale 1:10000 for whole reservoir area, basing on annual track investigation documents and history flood on both two tributaries topography, roundness of reservoir area are modeled to calculate back water corresponding to flood frequency 5% in consideration with reservoir silt after 50 years. Details for reservoir silt calculation see in Appendix Volume, result with FSL of 75 Sesan tributary with back water to upstream at position being the end of back water (39km from dam site 2) is +1.2m, Srepork tributary with gentler slope of riverbed so effected range of back water is longer (60 km from dam site 2) back water level is +2.3m.



Damage of reservoir corresponding to water levels: During implementation and study, boundary line of reservoir-bed is set up corresponding to different elevations (difference of 1m). Basing on this mark system, damage investigation group will list number of household, number of resident, damage on residential land, garden land, slashed and burnt land, forestry land, tree types, agricultural crop... corresponding to each water level from that damage and cost for compensation and resettlement are calculated for each FSL alternative in consideration of back water.

### 9.3.3 Quantity of main work for FSL alternative

Basing on arrangement alternative in selection of design water level mentioned in section "V.2.3" and studied range for design water level is given in section "V.2.1", calculation for construction quantity for alternatives of FSL are done.

Table 68: quantity of FSL alternatives

Work	Unit	FSL=74	FSL=75	FSL=76
Excavation	m3	14,179,327	14,249,250	14,321,079
Embankment	m3	8,921,295	9,629,070	10,910,220
Concrete	m3	644,414	645,696	647,013
Hydro-mechanical equipment	Ton	8,781	8,808	8,836
Hydraulic-mechanical equipment	MW	460	480	500

Table 69: Cost of FSL alternatives

Parameters	Unit	Option 1	Option2.1	Option2.2
Total investment capital	MUSD	592,79	618,18	665,38

### 9.3.4 Quantity of main works and cost of MOL alternatives

Based on the above mentioned arrangement alternative, quantity of construction and investment cost for MOL alternatives are calculated.

Table 70: Cost of MOL alternatives

Parameters	Unit	Alternative			
		75	75	75	75
FSL	m	75	75	75	75
MOL	m	74	73	72	71
Total investment capital	MUSD	618.19	619.36	620.31	621,06



## 9.4 Natural resources in social value

### 9.4.1 Annual total livelihood obtain from natural fish

Annual total livelihood obtain from the natural fish, especially for the people living upstream of the dam site, will be counted based on the number of population and local market price of the fish. From the environmental view point can be predicted that the people living in downstream of the dam site can continue their fishing activities even some affected to the fish production (increase or decrease) in project construction and operation.

The total catch of the Sesan and Srepok River in Ratanakiri Province was calculated based on CPUE and Hour catch per year of result KCC fish study team in dry season during Feb-May 2008, and the total population living along the rivers in year 2007.

Cost value of annual livelihood depending on the natural fish resources (100% loss)

No	Location to the project area	Yield per year (t)	Local market price of the fish (USD/kg)	Cost per year (USD)	Value of catch per family per year (USD)
1	Phluk village to Svay Rieng village (Ranak Kiri border) and Srepok Bridge to Krabei Chrum village (Ratana Kiri border)	244.960	2.5	612,400.00	400.26
3	In Sesan river, Upstream of Svay Rieng village (Ranak Kiri border) to Vietnam border	350.933	3	1,052,799.00	287.34
4	In Srepok, Upstream of Krabei Chrum village (Ratana Kiri border) to Vietnam border	51.473	3	154,419.00	113.46
<b>Total:</b>		<b>647.37</b>		<b>1,819,618.00</b>	

Cost value of annual livelihood depending on the natural fish resources (66% loss\*)

No	Location to the project area	Yield per year (t)	Local market price of the fish (USD/kg)	Cost per year (USD)	Value of catch per family per year (USD)
1	Phluk village to Svay Rieng village (Ranak Kiri border) and Srepok Bridge to Krabei Chrum village (Ratana Kiri border)	161.67	2.5	404,175.00	264.17
2	In Sesan river, Upstream of Svay Rieng village (Ranak Kiri border) to Vietnam border	231.62	3	694,860.00	189.65
3	In Srepok, Upstream of Krabei Chrum village (Ratana Kiri border) to Vietnam border	33.97	3	101,910.00	74.88
<b>Total :</b>		<b>427.26</b>		<b>1,200,945.00</b>	



**Note:** \* According to the fish movement results

- The fish price in community base in Stung Treng in average USD 2.5/kg (Jan.-May 2008)
- The fish price in community base in Ratanak Kiri in average USD 3/kg (Jan.-May 2008)
- Exchange rate USD 1 = 4000 Riel (April, 2008)

#### 9.4.2 Annual total livelihood obtain from the forest products

Refer to 502 households interviews in the research study "Natural Forest Benefit and Economic Analysis of Natural Forest Conversion in Cambodia" published by CDRI, Dec. 2006, specified that the livelihood value of the local value of consumption and sale of forest products, non-timber forest products, obtained from natural forests in four provinces in Cambodia (Kampong Thom, Kratie, Mondul Kiri, and Pursat) in period of one year varies from province to other province, see result value below:

- USD 265 / HH in Kampong Thom province
- USD 424 / HH in Kratie province
- USD 167 / HH in Mondul Kiri province
- USD 314 / HH in Pursat province

Anyway based on the social-economic survey result in the five communes of the project area (Stung Treng province) with 191 Households interviews, by EIA study team of KCC in Feb.-Apr 2008, found that 13.6% of 191HH had main income from non-timber products, and their monthly income is USD 72/HH or USD 864/HH/year. This value can not be applied for the whole communities.

Assume of annual total livelihood obtain from the forest products in project area equal to average of data result in Mondul Kiri (USD 167 / HH / year) and Kratie (USD 424 / HH/ year), due to both province is have border with the project site and the forest condition is similarly.

Annual total livelihood obtain from the forest products in the project area will be equal to the total number of households in the project area 1677 HH multiply with ((USD 167 + USD 424) /2) /year = **USD 494,715** per year.

#### 9.5 Natural resources in environmental value

Due to the reservoir site with FSL of 75m (m.s.l) and proposed resettlement areas for the Lower Sesan 2 HPP project, the forest in the area will damage or lost as described in following:

Forest Type	In reservoir site with FSL 75m	In resettlement areas	Total affected area
	(ha)	(ha)	(ha)
None Forest	5831.461	580.404	6,411.87
Woodland Evergreen	42.070	226.651	268.72
Woodland Deciduous	832.629	1.499	834.13
Deciduous Forest	23,093.027	4,618.677	27,711.70
Semi Evergreen Forest	3,516.545	1,556.919	5,073.46
Evergreen Forest	248.192	102.652	350.84
Total	33,563.924	7,086.802	40,650.73



Use the result of the research study "Natural Forest Benefit and Economic Analysis of Natural Forest Conversion in Cambodia" published by CDRI, Dec. 2006, for the value of sustainable management of natural forest at a 10% discount rate as following:

- USD 112/ha/year for deciduous forest
- USD 247/ha/year for semi-evergreen forest
- USD 375/ha/year for evergreen forest

#### Forest area will submerge in reservoir site

Forest type	In reservoir site, ha	Covered by forest and land concession (30%), ha	Total affected area, ha	Annual value in USD	Total in USD
Deciduous Forest	23,093.027	6927.9081	16,165.12	112	1,810,493
Semi Evergreen Forest	3,516.545	1054.9635	2,461.58	247	608,011
Evergreen Forest	248.192	74.4576	173.73	375	65,150
<b>Total</b>	<b>26,857.76</b>	<b>8,057.33</b>	<b>18,800.43</b>	<b>734</b>	<b>2,483,654</b>

#### Forest area will damage in resettlement site

Forest type	In resettlement areas, ha	Covered by forest and land concession (60%), ha	Total affected area, ha	Annual value in USD	Total in USD
Deciduous Forest	4,618.68	2771.21	1,847.47	112	206,917
Semi Evergreen Forest	1,556.92	934.15	622.77	247	153,824
Evergreen Forest	102.65	61.59	41.06	375	15,398
<b>Total</b>	<b>6,278.25</b>	<b>3,766.95</b>	<b>2,511.30</b>	<b>734</b>	<b>376,138</b>

#### Summary natural resources value per year that will be lost by the project

No.	Description	Annual lost, in USD
1	Fish products	1,200,945.00
2	Non-timber product	494,715.00
3	Sustainable management of natural forest in reservoir areas	2,483,654.00
4	Sustainable management of natural forest in resettlement areas	376,138.00
	<b>Total:</b>	<b>4,555,452.00</b>



The value of forest loss in the reservoir area can be determined as following:

Reservoir Area (with Water Level 75m)				Biomass calculation		Cost estimation		
Forest Type	Area (ha)	30% in land and forest concession, ha	Forest loss in reservoir area, ha	Above ground Biomass for Various Tropical Forest (Ton DM/ha)*	Total Biomass (DM), ton	Assume 1ton of DM=1m <sup>3</sup> timber	Unit price of Forest (**), USD/m <sup>3</sup>	Amount, USD
Woodland Evergreen	42.070	12.62	29.45	70	2,061.43	2,061	43	88,641
Woodland Deciduous	832.629	249.79	582.84	85	49,541.43	49,541	43	2,130,281
Deciduous Forest	23,093.027	6,927.91	16,165.12	120	1,939,814.27	1,939,814	43	83,412,014
Semi Evergreen Forest	3,516.545	1,054.96	2,461.58	200	492,316.30	492,316	54	26,585,080
Evergreen Forest	248.192	74.46	173.73	300	52,120.32	52,120	81	4,221,746
<b>Total</b>	<b>27,732.463</b>	<b>8,319.74</b>	<b>19,412.72</b>		<b>2,535,853.74</b>			<b>116,437,762</b>

**Note:** \* Source: IPCC Guideline for National Greenhouse Gas Inventories, 1996  
 \*\* Forest price for each type: Luxury forest 151-283 \$/m<sup>3</sup>; Class I forest 81\$/m<sup>3</sup>; Class II forest 54\$/m<sup>3</sup>; Class III forest 43\$/m<sup>3</sup>; and other forest 43\$/m<sup>3</sup>

The value of forest loss in new settlement area can be determined as following:

Settlement Area				Biomass calculation		Cost estimation		
Forest Type	Area (ha)	50% in land/ forest concession, ha	Forest loss in resettlement area, ha	Above ground Biomass for Various Tropical Forest (Ton DM/ha)*	Total Biomass (DM), ton	Assume 1ton of DM=1m <sup>3</sup> timber	Unit price of Forest (**), USD/m <sup>3</sup>	Amount, USD
Woodland Deciduous	226.651	113.33	113.33	85	9,632.67	9,633	43	414,205
Woodland Evergreen	1.499	0.75	0.75	70	52.47	52	43	2,256
Deciduous Forest	4,618.677	2,309.34	2,309.34	120	277,120.62	277,121	43	11,916,187
Semi Evergreen Forest	1,556.919	778.46	778.46	200	155,691.90	155,692	54	8,407,363
Evergreen Forest	102.652	51.33	51.33	300	15,397.80	15,398	81	1,247,222
<b>Total</b>	<b>6,506.398</b>	<b>3,253.20</b>	<b>3,253.20</b>		<b>457,895.45</b>			<b>21,987,232</b>

**Note:** \* Source: IPCC Guideline for National Greenhouse Gas Inventories, 1996  
 \*\* Forest price for each type: Luxury forest 151-283 \$/m<sup>3</sup>; Class I forest 81\$/m<sup>3</sup>; Class II forest 54\$/m<sup>3</sup>; Class III forest 43\$/m<sup>3</sup>; and other forest 43\$/m<sup>3</sup>

### Summary of cost estimation for the forest loss by the project

Description	Loss area, ha	Total Biomass (DM), ton	Cost Estimation, USD
Forest loss in reservoir site	19,412.72	2,535,853.74	116,437,762.00
Forest loss in resettlement site	3,253.20	457,895.45	21,987,232.00
<b>Total:</b>	<b>22,665.92</b>	<b>2,993,749.20</b>	<b>138,424,994.00</b>



Through analysis of the proposed financial alternatives show that the present market change trend (interest rate of banks is started to reduce), when electricity selling and buying negotiation between Cambodia and Vietnam is not clear, loan borrowing contracts with banks are not available, the Study showed the following financial indicators:

- Total investment capital: 816.235 million USD
- Interest rate of loan in foreign currency: 6%/year
- Interest rate of loan at commercial bank: 13%/year
- Exempted profit tax of Cambodia: maximum period is 9 year
- Discount rate: 10%

### Financial and Economic Analysis for Environmental Cost Alternatives

There are three alternatives of environmental cost being taken to account as follows:

- Alternative 1: Environmental cost measured by PECC1
- Alternative 2: Environmental cost measured by KCC
- Alternative 3: Environmental cost currently applied in Vietnam

Parameters	Alt.,1	Alt.,2	Alt.,3
Installed Capacity (MW)	400.00	400.00	400.00
Firm Capacity (MW)	104.00	104.00	104.00
Energy generation (million kWh)	1953.87	1953.87	1953.87
Net energy generation ( million kWh)	1944.10	1944.10	1944.10
<b>Capital Structure</b>			
Total investment capital – (million USD)	816.235	814.464	816.235
Total investment capital (without IDC) (million USD)	676.174	674.737	676.174
Owner's equity (million USD)	206.962	206.531	206.962
Loan in foreign currency (million USD)	169.099	169.099	169.099
Loan from Commercial Bank	300.113	299.107	300.113
Interest rate of loan in foreign currency	6%	6%	6%
Interest rate of loan in Vietnam dong	13%	13%	13%
<b>Financial indicators</b>			
Selling Price (USc/kWh)	6.3	6.4	6.25
NPV (million USD)	64.002	65.425	62.600
FIRR%	12.18%	12.22%	12.13%
B/C	1.11	1.11	1.11
Cost Price (USc/kWh)	5.59	5.68	5.56
Payback period (year)	17	17	17
<b>Economic Indicators</b>			
NPV (million USD)	60.749	56.011	63.210
EIRR%	13.27	11.35	11.23
B/C	1.19	1.17	1.20

\* Net energy generation is annual energy generation minus losses and self consumption of plants

Based on the financial and economic analysis mentioned on table above, the Study showed that the project is economical and financial for investment. However, taking into account the target of 17 year payback period, the environmental cost measured by KCC will lead to the highest of electricity selling price at 6.4 USc/kWh, the environmental cost measured by PECC1 will give the lower electricity selling price at 6.3 USc/kWh, and the last (the environmental cost currently applied in Vietnam) will give the lowest electricity selling price at 6.25 USc/kWh.



## CHAPTER X

### 10. CONCLUSIONS AND RECOMMENDATIONS

#### 10.1 Conclusions

Though the proposed Sesan 2 HPP will produce a large amount of energy (1953.9 GWh) per year for Cambodia and exporting to surrounding countries, and will assist with the development of the Nation, the project will cause some significant environmental and social impacts which must be balanced against the economic benefits of the project when the decision is made whether this project is to proceed or not. But given the relatively flat landscape of the area where the dam is proposed - which will result in the inundation of 27,723 hectares of land including forest, which serves as habitat to a range of rare and endangered species, and agricultural and village lands, the involuntary resettlement of around 5000 people and the blocking of fish movement upstream of the dam site which currently provides around 30,000 people with a large part of their fish supply and main food source - significant economic argument is required to justify the project proceeding.

However it is not the intention of this EIA to make the decision on whether the project should proceed or not along with the consequences - that is for the relevant decision makers to decide - but rather to show what the impacts of this development will be and what mitigation measures should be undertaken to minimize the significant impacts should it be decided that the project should proceed. Any non-conformance with the mitigation measures will likely result in highly significant environmental and social impacts resulting from the dam for many years affecting the future generations of Cambodia. It will be the responsibility of the relevant decision makers, dam company and other institutions to ensure that the mitigation measures are complied with in order to ensure the significant impacts of the project are minimized as far as possible.

The project is in the feasibility study stage at the moment and the detail design, construction, and operation stages will be undertaken in the coming years (2009 – 2014), refer to project schedule in feasibility study report. The total investment cost is about **USD 816.23 Million**.

The natural resources in the project area currently include a reasonable abundance of forest and wildlife with good air and reasonable water quality. Some forest areas contain high environmental value for wildlife habitat. It is part of the Lower Mekong Dry Forest Eco-system which is internationally recognized as containing valuable wildlife habitat and a range of rare and endangered species.

There are many people, some of them are ethnic group, living in the project area as villages have existed there for many years. No known archaeological sites or artifacts are present in the area. However a few cascades downstream of the project site have potential for ecotourism.

During construction and operation of the project some significant negative impacts to natural and social resources in the area will occur. About 30,000 hectares of land will be flooded which includes areas of forest, agricultural land and settlements. The



project will affect to 1059 families with 4785 persons (people in 2007) OR 1579 families with 6507 persons (focus 2011). The impact on the hydrological regime of the Sesan River will be moderate due to the water releasing design. Impact to aquatic fauna is high, and impact to territorial wildlife is moderate due to the dam construction and operation. The water quality in the Sesan River will change. Low water quality is expected particularly during construction due to cutting of the forest, earth works, disposal of waste and spilling of fuel and lubricants from the construction machinery into the river course or onto the open space nearby. The air emissions from the construction machinery, dust and smoke from blasting rock, and burning forest & vegetation in reservoir will also reduce air quality. Noise and vibration from construction activities may be short term but may affect wildlife and human health. Mitigation measures are however recommended in the EMP for the project which should reduce these impacts to some extent.

Impact on public health may occur at the construction site (malaria) and along the roads leading to the project site (traffic accident), or from transmission of social diseases such as HIV/AIDS, syphilis, etc., and also drugs and alcohol by the workers or project staff taking them into the local community. Mitigation measures are recommended in the EMP to reduce these impacts.

Cumulative impacts will also occur during the construction and operation stages from the combination of hydropower plants in the Sesan and Srepok River catchments. The cumulative impacts include climate, hydrological regimes, forest, fish, wildlife habitats, and wildlife. It is strongly recommended all the power companies with dams in the catchment areas coordinate and cooperate in managing and reducing the cumulative impacts as far as possible.

However the project will give a positive impact to the Cambodian nation such as providing energy to Cambodia and its neighbors, and jobs for up to a few thousand workers and local people in the community during the construction stage, increase income to some local people, and the project will improve other development activities to support of increasing economic in Cambodia.

It can therefore be concluded that there will be some significant negative impacts on environmental and social resources and through implementing the mitigation measures recommended in the EMP the negative impacts should be offset to some extent. The project will also bring benefits to the local and regional economy.

## 10.2 Recommendations

In anticipation that the project will have significant affects on the environmental and social resources in the area it is recommended that:

- The size of the reservoir is reduced as much as possible to reduce the area of land that will be flooded and all the consequent impacts.
- Adequate compensation/resettlement is provided to those people who will be directly and indirectly affected by the project particularly for the villages that will be flooded by the reservoir and for the villages along the rivers that will suffer from reduced fish stocks.
- Research on aquatic fauna and flora and ways to replace the loss of migratory fish upstream of the dam.



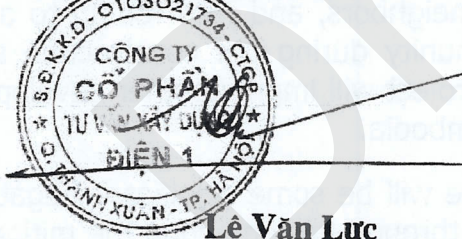
- At least 100 m<sup>3</sup>/s of water is continually released from each dam, in case of pause operation, to keep the downstream ecosystems alive and water flow from the dam is continuously monitored.
- Water quality in the reservoir and downstream of each scheme is regularly monitored and appropriate action taken where water deterioration is being caused by the dam.
- Valuable trees in the reservoir areas are cleared and use for other purpose before reservoir filling.
- Reasonable environmental fund shall be setting to ensure the effective on environmental compensation and management.
- Important remaining areas of wildlife habitat are protected as much as possible.
- De-mining the requiring construction places and quarries before implementation is required.
- All mitigation measures recommended in the EMP are fully implemented.

EVNI Request to MoE and other relevant ministries as well as RGC to support and provide license in according with the investment law and law on Environmental Protection and Natural Resource Management.

Phnom Penh 29/12/2008

PECC1 Company  
General Director

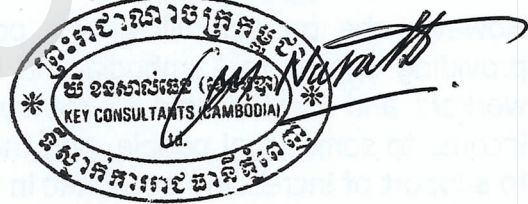
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**Lê Văn Lực**

Phnom Penh 29/12/2008

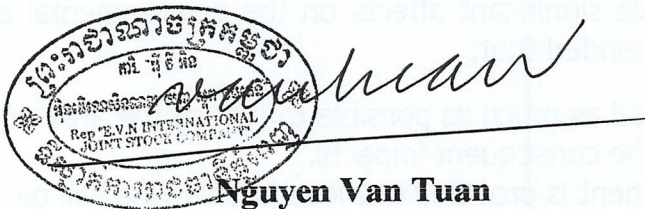
EIA study company  
General Director



**Som Mithonarath**

Phnom Penh 29/12/2008

Investment company  
Chief Office of EVNI in Phnom Penh



**Nguyen Van Tuan**



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