



Photo 1

Footpath to the Upper Reservoir



Photo 2

Outcrop of slightly fractured shale



Photo 3

Small hill in the Reservoir



Photo 4

Right side of the Reservoir
Steep slope of the limestone outcrop



Photo 5

Left side of the Reservoir



Photo 6

Small stream in the left side of the
Reservoir
(geological boundary of limestone
and sedimentary rocks)

JN-3 Geological issues (Upper dam site)



Photo 7

Fractured zone in the Road



Photo 8

Cave in the limestone along the road



Photo 9

Fractured zone along the road to
Phu Yen



Photo 10

Topographical condition in the Lower Reservoir
(Around the outlet, near the geological boundary on D1st and D2ebn as clayish shale)



Photo 11

Condition of the outcrop (shale) in the riverbed to the Dam axis
(Clayish shale with no limestone, hard and massive)



Photo 12

Outcrop of the shale near the Dam axis (thin beds of selective erosion in the clayish shale with limestone)

JN-3 Geological issues (Lower dam site)



Photo 13

Saddle of the left side hill
(No features of the structural weak zone)



Photo 14

Condition around the bottom of the Reservoir



Photo 15

Topographical condition around the upstream of the Reservoir
(Clayish shale)

Checklist of Environmental Parameters: JN3

NOTE: The remarks are made based on the current plan. The assessments are based on the information obtained during the survey and should be reviewed and corrected, if necessary, at the next stage.

	Expected negative impacts			Remarks
	Major	Unknown or can be mitigated	No significant impact	
A. Environmental Problems Due to Project Location				
A-1. Social Environment				
1. Effects on ethnic minorities	×			<p>Upper dam / reservoir People from Lan village use the site for agriculture and grazing buffalo. Lan village comprises Muong and Thai minorities.</p> <p>Lower dam / reservoir The site is occupied by Thung Lang village which comprises Muong and Thai.</p>
2. Resettlement	×			<p>Upper dam / reservoir There is a small farming house within the site. An approach road from the closest national road is planned. The road is long and goes through several villages, which may lead resettlement.</p> <p>Lower dam / reservoir The entire households of Thung Lang village (c. 37 households) may have to move out from the site. An approach road from the closest national road is planned. The road is long and goes through several villages, which may lead resettlement.</p>
3. Loss of land (e.g. agricultural land)	×			<p>Upper dam / reservoir Rice field and grazing land will be lost. An approach road from the closest national road is planned, which may lead lost of agricultural lands.</p> <p>Lower dam / reservoir Rice field of Thung Lang village will be lost. An approach road</p>

				from the closest national road is planned, which may lead lost of agricultural lands.
4. Encroachment into watershed			×	Upper dam / reservoir Intact large forest remains close to the site but it will not be impacted directly by the project. The approach road may affect the good secondary forest around the reservoir. Lower dam / reservoir The watershed is expected not to be affected.
5. Encroachment on historical and cultural values			×	There is no historical and cultural site in both areas.
6. Impairment of navigation			×	Upper dam / reservoir There is no shipping traffic. Lower dam / reservoir There is no shipping traffic.
7. Inundation of mineral resources			×	There is no mineral resource in both areas.
8. Decline of fisheries			×	Upper dam / reservoir Fishery is not practised in the area. Lower dam / reservoir Small-scale fishery for people's own consumption is practised in the area.
9. Downstream impacts			×	Upper dam / reservoir There are small streams from the sites. The social environment of the downstream is expected to be small and limited. Lower dam / reservoir The downstream of Mua river has not been studied however significant impacts are not expected.
A-2. Natural Environment				
1. Encroachment into precious ecosystem		×		The terrestrial ecosystem at upper and lower dams / reservoirs has already been degraded due to human activities. Some secondary forests are left, and they need to be conserved as much as possible. Although the aquatic ecosystem of both areas is not fully understood, the impacts can be limited because of small size of the basin.
2. Encroachment into existing protected			×	Both areas are not in the national protected areas.

areas				
3. Migrating fish species		×		<p>Upper dam / reservoir There are small streams from the site and the system is limited and small. Although precise impact is not known, the impact is expected to be limited.</p> <p>Lower dam / reservoir One tributary of Mua river system is destroyed. The tributary river system is small. Although precise impacts are not known, the impact is expected to be limited.</p>
4. Effects on scenic value			×	Impact on scenic value is limited.
5. Downstream impacts			×	<p>Impacts on the terrestrial ecosystems of both sites are limited and are expected small.</p> <p>Impacts on the aquatic ecosystems of both sties are not fully understood. However, the scale of the impacts on the ecosystem of the upper dam / reservoir is expected to be limited due to its size.</p>
A-3. Physical Environment				
1. Watershed erosion / silt runoff		×		<p>Upper dam / reservoir Since the site consists of limestone and page, severe erosion and landslide are not expected.</p> <p>Lower dam / reservoir Details of its geological character are not studied yet. It seems that weathering has been progressing. A detailed study needs to be undertaken.</p>
2. Effects on groundwater hydrology			×	<p>Upper dam / reservoir Impact on groundwater hydrology is expected to be limited and small.</p> <p>Lower dam / reservoir Impact on groundwater hydrology is expected to be limited.</p>
3. Downstream water flow variations			×	Once the reservoirs are filled with water, the water flows from the dams are regulated to the same amount as before. It means that there will be no change in water flow variations.
4. Change of sedimentation transportation balance		×		The sedimentation transportation balance is expected not to change significantly.

B. Environmental Problems Associated with Construction Stage		×		<p>All the items in this section should be carefully considered and technical specifications must be given to contractors to conduct all necessary mitigation measures.</p> <p>Route of the approach road should be carefully planned in order to avoid villages and agricultural areas as much as possible and to prevent soil erosion and landslides as much as possible.</p> <p>Workers' camp is expected to be big and its social impacts are to be carefully assessed and fully mitigated.</p> <p>Careful consideration should be paid to select disposal area to prevent secondary impacts. It is ideal to site the disposal area within the reservoir areas.</p> <p>Poaching and introduction of alien species must be well controlled to prevent disturbance to the local ecosystem and biodiversity (even if they are already degraded). Especially at the upper dam / reservoir site, the biodiversity of the surrounding forests should be protected.</p>
B-1. Construction Monitoring				
1. Construction monitoring				
B-2. Construction				
1. Soil erosion / silt runoff				
2. Toxic wastes from equipment and cement factory				
3. Environmental degradation at quarry site				
B-3. Workers				
1. Safety of workers				
2. Sanitation at workers' camp				
3. Dust/ odors / fumes / noise / vibrations				
4. Quarrying hazards				
B-4. Social Environment				
1. Negative perception of local people				
2. Traffic accidents				
3. Traffic congestion and damage to road and bridge				
4. Environmental aesthetics				

B-5. Natural Environment				
1. Poaching by workers				
2. Firewood collection				
3. Introduction of alien species				
C. Environmental Problems Related to Project Operations		×		<p>All the items in this section should be carefully considered and necessary mitigation measures must be undertaken by operation organisation to reduce impacts as much as possible.</p> <p>Insect vector / waterborne diseases are at the moment not prevailing in the areas. The water levels of reservoirs of PSPP change everyday, which may not make insects (e.g. mosquito) actively breed. It is therefore likely that the diseases will not prevail. However, necessary caution should be given to the local people.</p> <p>Impacts on the natural environment should be carefully assessed and necessary countermeasures should be undertaken.</p>
C-1. Operation Monitoring				
1. Operation monitoring				
C-2. Operation				
1. Warning system				
2. Downstream erosion				
3. Eutrophication of the reservoir				
4. Downstream water quality				
5. Reservoir bank stability				
C-3. Social Environment				
1. Insect vector / waterborne diseases hazards				
2. Estuarine and marine fisheries impacts				
C-4. Natural Environment				
1. Poaching due to new access methods				
2. Illegal logging due to new access methods				
3. Encroachment due to new access methods				
D. Additional Consideration for Hydropower Projects		×		<p>All the items in this section should be carefully considered and necessary mitigation measures must be undertaken.</p>

				<p>At the moment, it is unlikely that avian hazards from transmission lines and towers occur. This is because large birds such as <i>Ciconia</i> spp. do not migrate in the region.</p> <p>At the moment, it is unlikely that aircraft hazards from transmission lines and towers occur. This is because there is not an airfield in the region.</p>
D-1. Transmission Lines				
1. Encroachment on precious ecosystem				
2. Impairment of wildlife movement				
3. Avian hazards from transmission lines and towers				
4. Impairment of environmental aesthetics				
5. Soil erosion from construction and areas left exposed				
6. Inviting new encroachment				
7. Aircraft hazards from transmission lines and towers				
8. Induced effects from electromagnetic fields				



Photo 1

The upper reservoir site was seen from the southwest point. The site is flat and is used for agriculture and grazing buffalo.



Photo 2

The mountain located west of the upper reservoir site is covered with good secondary forest.



Photo 3

There are rice fields in Thung Lang village at the lower reservoir site.

APPENDIX 4-6-2

Results of the second site reconnaissance ; JN5

The features of promising potential sites for PSPP

Site Name	JN 5
Location (Name of River)	Upper dam/reservoir : Son La Province/ Phu Yen Dostrict/Kim Bon Commune(Suoi On River) Lower dam/reservoir : Son La Province/ Left Bank Phu Yen Dostrict/ Sap Xa Commune Right Bank Bac Yen Dostrict/ Hong Ngai Commune (Suoi Sap River)
Project Parameter	Installed Capacity P(MW) 1,000 Design Discharge Qd(m ³ /s) 240 Effective Head He(m) 525 Peak Duration Time T(hrs) 7

Field	Point of second field survey	Findings
Topography and Geology	(Overall geological condition)	<ul style="list-style-type: none"> • Regionally, NW-SE system of folding of Devonian-Permian Triassic sedimentary rocks as schist-shale or basalt porphyry is alternatively found in P2-T1 vn. Bedding of the sedimentary rocks has N70-80W strikes and nearly vertical dip. Some schistosity of the schist have N10-20W strike and nearly vertical dip. Rock condition is generally hard and massive. Weathering in the surface is 10-20m depth. • Some outcrops are fractured strongly along the access road. Limestone bed as D2-D3bc is inter-bedded within the P2-T1 vn, Some eroded holes exist in the limestone bed along the river elevations.
	(Upper dam/reservoir)	<ul style="list-style-type: none"> • Hard and massive green schist / basalt porphyry (P2-T1 vn) and clayish shale / limestone (T2 lmt) is around the Upper Reservoir and Dam area. The NW-SE system of the boundary of these rocks crosses the reservoir. • The rock around the geological boundary are limestone/shale and schist, there are no weak zone along the boundary. Some hard and massive schist and porphyry outcrop on the riverbed. • Narrow ridge in the left side of the reservoir, corn firm was found behind this narrow ridge on the higher elevation than bottom of the reservoir, the top of this field or form has probably spring points but no seen. Some hard rock outcrops of schist and porphyry were found in the reservoir.
	<ul style="list-style-type: none"> • Site geology • Checking the weathering grade along the geological boundaries through the Dam Axis • Checking the Spring point, strike and dip of the bedding of the outcrops 	<ul style="list-style-type: none"> • Basically, no spring points were found but water level is expected to be near the bottom of the reservoir in view of the agricultural conditions. The permeability of rock may be low. • Quite hard and massive porphyry and schist was found in the riverbed around the Dam axis. Weathering in the slope of the valley seems about 5-15m depth.
	<ul style="list-style-type: none"> • Checking the permeability of the Reservoir • Checking the Geology and strength of the rock around the Dam axis 	<ul style="list-style-type: none"> • Intake located under the relatively gently slope, the depth of the weathered zone is probably 20-30m or more and no outcrops (T2 lmt or P2-T1 vn).
	(Intake)	<ul style="list-style-type: none"> • Checking the Geology and the strength of the rock around the Intake
(Waterway • Surge Tank)	<ul style="list-style-type: none"> • Checking the condition around the fault zone 	<ul style="list-style-type: none"> • Designed waterway route runs under the boundary of limestone and basalt porphyry / schist zone, the conditions of these rocks are massive and hard with some open joints in the limestone, The permeability of rock seems probably high. • No features of the fault zone is not identified in the surface.
(Underground Power Station)	<ul style="list-style-type: none"> • Checking the Geology and the strength of the rock around the Underground Power House 	<ul style="list-style-type: none"> • No outcrop in the limestone area was found.

Legend : ☉ high priority, ○ important issue • general point

	<p>(Lower dam/reservoir)</p> <ul style="list-style-type: none"> • Site geology <p>◎ Checking the Permeability of the Reservoir</p> <p>○ Checking the Geology and the strength of the rock around the Dam axis</p> <ul style="list-style-type: none"> • Checking the condition around the fault zone through the Lower Reservoir 	<ul style="list-style-type: none"> • Geology is mainly limestone (D2g-D3bc2) area around the Lower Reservoir and dam site. The NW-SE system of structural line along the river is reported in the published map. Both side of the slope beside the river is steep of limestone. <p>◎ Hard and massive limestone as D2g- D3bc with many open joints are found around the lower Dam site, dips of the bed are 20-35 degrees. The permeability of rock is probably high.</p> <p>○ Strength of the massive limestone is not so low, generally same as fresh sedimentary rock.</p> <ul style="list-style-type: none"> • Structural NE-SW fault probably crosses from the lower reservoir to the Na Nay village. Some small gullies along the road are easy to collapse.
	<p>(Outlet)</p> <ul style="list-style-type: none"> • Checking the geological conditions 	<ul style="list-style-type: none"> • Geological condition of limestone area is generally same as the lower dam site.
	<p>(Others)</p> <ul style="list-style-type: none"> • Checking the condition around the fault zone through the Lower Reservoir 	<ul style="list-style-type: none"> • No features of the structural fault zone was identified. Not only the big one reported in the published map, but also the cohesive weak zone probably exists around the lower dam site.
	<p>(Overall)</p> <ul style="list-style-type: none"> • Checking the geological conditions 	<ul style="list-style-type: none"> • Bottom level of the lower dam is planned between high and low water level of Hoa Binh Lake. Therefore two cofferdams are necessary. • Since small valleys are developed in the upper reservoir area and elevation of some cols are lower than that of topographic map, a saddle dam and curtain grouting will be required as a countermeasure.
Design	<p>(Upper dam/reservoir)</p> <ul style="list-style-type: none"> • Property of the proposed dam axis <p>• Checking the thin ridge of the left valley</p>	<ul style="list-style-type: none"> • There is a waterfall at the dam site, which is about 5 m height. The slope of the riverbed becomes steep downstream from this waterfall. Topography of the upstream of the waterfall is wide and flat, where are used for crop field, and outcrops were not found. • Therefore, the dam axis will be selected at the major ridge in the downstream of the waterfall. • The ridge of the right bank of the planned dam site is a thin and slope is rather gentle. The ridge of left bank has a sufficient width and slope is rather gentle. • Fill-type Dam is not suitable in view of topographic conditions such as steep river slope in the downstream of the waterfall. • The watershed of the upstream of a planned reservoir is 740 m high. • There is a highly weathered col, whose elevation is as low as around 720m, in a series of mountain of the left side of the reservoir. • Therefore countermeasures for stop the leakage ,such as saddle dam /grouting, will be required.
	<p>(Intake)</p> <ul style="list-style-type: none"> • Checking the topographical conditions at intake post. 	<ul style="list-style-type: none"> • The location of the intake is planned in the ridge, which has a sufficient width and a gentle slope.
	<p>(Waterway • Power Station)</p> <ul style="list-style-type: none"> • Selecting the position for access tunnel 	<ul style="list-style-type: none"> • Since the approach tunnel to the underground powerhouse is planned in secondary sediments, it is necessary to move to the downstream of the ridge. • Therefore the planned underground powerhouse will be moved to the downstream.
	<p>(Lower dam/reservoir)</p> <ul style="list-style-type: none"> • Selecting the dam site, evaluating the topo. Condition <p>• Selecting the position of cofferdam</p>	<ul style="list-style-type: none"> • Hard outcrops were found at both sides of the upstream (about 500 m) of the planned dam site. Therefore dam axis will be moved. • Since topography of the site is steep and narrow, concrete gravity type is suitable for the lower dam. • In view of the topographical condition, the planned location for the upstream cofferdam is appropriate. • As per movement of the dam site to the upstream of about 500 m, the downstream cofferdam will be moved to the previous dam site (upstream of about 1.6 km).

Legend : ◎ high priority, ○ important issue • general point

	<ul style="list-style-type: none"> • Selecting the position of diversion • Confirming the sedimentary quantity • Issues related to temporary structure and disposal areas 	<ul style="list-style-type: none"> • As a result, diversion tunnel can avoid crossing the deep valley and its length is reduced about 1.3 km shorter. • Although a planned dam site is located in the backend of Hoa Binh Lake, little sediment volume was seen. • Temporary structure area is available around Phieng Luohg village. • Disposal area will be planned inside of the lower reservoir in order to minimize the environment impact.
	<p>(Outlet)</p> <ul style="list-style-type: none"> • Selecting the candidate positions of outlet 	<ul style="list-style-type: none"> • Since the outlet is planned in a secondary sediment area, it is necessary to move to the downstream of the ridge.
	<p>(Approach)</p> <ul style="list-style-type: none"> • Selecting the approach route for dams and powerhouse • Confirming the validity of connecting route between the lower dam site 	<ul style="list-style-type: none"> • Approach route to the upper dam site will be planned from the lower dam site. However, It is necessary to construct a new road about 8.0 km long from Na Nay village. • Approach route to the lower dam site will be planned to access along the Suoi Sap River from Route 379, which route is easier than improving existing road from Route 379 to Na Nay village..
	<p>(Others)</p> <ul style="list-style-type: none"> • upper and lower reservoirs 	<ul style="list-style-type: none"> • The river flow at the upper dam site is less than 0.1 m³/s and the catchment area of the site is as small as about 3.5 km².
Natural and Social Environments	<p>(Ecosystem)</p>	<ul style="list-style-type: none"> • The terrestrial ecosystem at upper and lower dams / reservoirs has already been degraded due to human activities. However some secondary forests are left, and they need to be conserved as they are. • The aquatic ecosystem of both areas is not fully understood. Especially the aquatic ecosystem of Sap river needs to be studied and necessary mitigation measures should be undertaken.
	<p>(Resettlement / Loss of assets)</p>	<p>RESETTLEMENT</p> <p>Upper dam / reservoir</p> <ul style="list-style-type: none"> • A couple of families of Suoi Let village need to be resettled. <p>Lower dam /reservoir</p> <ul style="list-style-type: none"> • Although precise number of the resettling families is not identified yet, resettlement is expected to occur. • An approach road is planned from the closest national road to go through 8 villages, and resettlement may occur. • People of Phieng Luong had been moved to this place by Hoa Bin dam project. They may be badly impacted by the project because the village is very close to the dam site. Careful assessment of the impacts and consultation with the people need to be undertaken. <p>LOSS OF ASSESTS</p> <p>Upper dam / reservoir</p> <ul style="list-style-type: none"> • Rice field and grazing land will be lost. <p>Lower dam / reservoir</p> <ul style="list-style-type: none"> • Rice field along Sap river will be lost. • An approach road is planned from the closest national road to go through 8 villages, which may lead loss of agricultural lands. • Secondary impacts by lost of the rice fields need to be carefully assessed. After the project, people are supposed to buy rice, which may lead more cultivation on steep slopes for cash crops. It may lead severe erosion of these slopes.



Photo 1

The ridge of the right bank of the planned dam site is a thin and slope is rather gentle. The ridge of left bank has a sufficient width and slope is rather gentle.



Photo 2

There is a waterfall at the dam site, which is about 5 m height, and outcrop is tuff.



Photo 3

Topography of the upstream of the waterfall is wide and flat, where are used for crop field, and outcrops were not found.



Photo 4

There is a highly weathered col, whose elevation is as low as around 735m, in a series of mountain of the left side of the reservoir.



Photo 5

The thin ridge of 35 m long exists in the east part of the reservoir.



Photo 6

The watershed of the upstream of a planned reservoir is 740 m high.



Photo 7

The location of the intake is planned in the ridge, which has a sufficient width and a gentle slope.



Photo 8

The approach tunnel to the underground powerhouse is planned in secondary sediments.



Photo 9

It is necessary to move to the downstream of the ridge.



Photo 10

Hard outcrops were found at both sides of the upstream (about 500 m) of the planned dam site. Therefore dam axis will be moved.



Photo 11

Right bank with steep slopes at the position of the dam site.



Photo 12

There are outcrops in the left bank of the dam site.