



Photo 1

Upper Reservoir



Photo 2

Upper Reservoir



Photo 3

Upper Reservoir

JN5— Geological issues (Upper dam site)



Photo 4

Narrow ridge in the left side of the reservoir



Photo 5

Behind the narrow ridge



Photo 6

Outcrop of schist
(Schistosity; N8W75W)



Photo 7

Outcrops of basalt porphyry near the Dam axis



Photo 8

Outcrop of basalt porphyry
Near the Dam Axis
(Bedding N24W80SW, joints N80E80E)



Photo 9

Fractured zone of the schist in the road near
the village
(Some valleys in the slope is easy to collapse)



Photo 10

Lower Reservoir
(Weathered limestone, angle of slope is 30-40degrees)



Photo 11

Lower Reservoir
(Limestone outcrops, bedding is nearly horizontal, angle of slope is 40-50degrees)



Photo 12

Riverbed in Lower Reservoir
(Wide and flat area around the riverbed, few hundred meters upstream of Dam axis)



Photo 13

Condition near the Lower Dam axis
(Steep slopes as 45-50 degrees on the both
side of the river, same as photo JN5L-3)



Photo 14

Left side of the slope in the reservoir
(Limestone outcrops below higher water level
of Hoa Binh Lake, including some eroded
holes)



Photo 15

Close up of eroded holes in the limestone
outcrop
(as photo above)

Checklist of Environmental Parameters: JN5

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 A couple of families from Suoi On village (Hmong minority) have temporary houses, and a couple of families from Suoi Let village (Dao) live in the area.</p> <p>Lower dam / reservoir By the present plan of the high water level of the dam, 4 villages will be affected directly. They are Phieng Luong village (Dao) and the others (Thai). People of Phieng Luong had been moved to this place by Hoa Binh dam project. They may be severely 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>
2. Resettlement	×			<p>Upper dam / reservoir Households of Suoi Let at the site need to be resettled.</p> <p>Lower dam /reservoir Although precise number of the resettling households is not identified yet, resettlement is expected to occur. An approach road is planned from the closest national road to go through 7 villages, and resettlement may occur.</p>
3. Loss of land (e.g. agricultural land)	×			<p>Upper dam / reservoir Rice field and grazing land will be lost.</p>

				<p>Lower dam / reservoir Rice field along Sap river will be lost. An approach road is planned from the closest national road to go through 7 villages, which may lead loss of agricultural lands. Secondary impacts by lost of rice fields need to be carefully assessed. After the project, people who lose their rice fields are supposed to buy rice, which may lead more cultivation on steep slopes for cash crops and may lead severe erosion of these slopes.</p>
4. Encroachment into watershed			×	<p>Upper dam / reservoir An approach road may affect the forests around the reservoir. Lower dam / reservoir Watershed of Sap river is not expected to be affected.</p>
5. Encroachment on historical and cultural values			×	There is no historical and cultural site in both areas.
6. Impairment of navigation		×		<p>Upper dam / reservoir There is no shipping traffic. Lower dam / reservoir There is seasonal shipping traffic from Na Lay and Phieng Luong villages to markets down Hoa Binh lake. However, it will be replaced by the approach road.</p>
7. Inundation of mineral resources			×	There is no mineral resource in the both areas.
8. Decline of fisheries		×		<p>Upper dam / reservoir Fishery is not practised in the area. There are two aquacultural ponds owned by the families from Suoi On village, however these are not directly impacted by the reservoir. Lower dam / reservoir Fishery is actively practised and the local people consume the catches. The affect is not precisely predicted.</p>
9. Downstream impacts			×	<p>Upper dam / reservoir The social environment of the downstream of On river is not studied. However, social impacts are predicted to be limited if they happen because the river is short and flows into the lake. Lower dam / reservoir The downstream of Sap river (c. 2 km from the dam) is Hoa Binh</p>

				lake, and no significant impact is 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. 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.
2. Encroachment into existing protected areas			×	Both areas are not in the national protected areas.
3. Migrating fish species		×		Upper dam / reservoir On river system is limited and small. Although precise impact is not known, the impact is expected to be limited. Lower dam / reservoir Although Hoa Binh dam already disturbs Sap river system, the river system is relatively big and a comprehensive study is recommended.
4. Effects on scenic value			×	Impact on scenic value is limited.
5. Downstream impacts			×	Impacts on the terrestrial ecosystems of both river systems are limited and are expected to be small. Impacts on the aquatic ecosystems of both river systems are not fully understood. However, the scale of the impacts on the ecosystem of On river system is expected to be limited due to its size.
A-3. Physical Environment				
1. Watershed erosion / silt runoff			×	Both areas of dams / reservoirs are not prone to severe erosion. There is a narrow ridge in the left side of the upper reservoir which has experienced several small-scaled landslides.
2. Effects on groundwater hydrology			×	Upper dam / reservoir It is unlikely that there is severe impact to groundwater hydrology. Lower dam / reservoir Severe impact to groundwater hydrology is not expected. However, since it is in limestone area, some unexpected impacts may occur. More detailed geological survey will be conducted in the next stage (feasibility study stage) and the results should be reflected in the plan.
3. Downstream water flow variations			×	Once the reservoirs are filled with water, the water flows from the

				dams are regulated to the same as before. It means that there will be no change in water flow variations.
4. Change of sedimentation transportation balance		×		The sedimentation accumulation mechanism and its amount are under study and the details will be reflected to the study in the next stage.
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).</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

An interview survey was conducted at Suoi On village close to the upper reservoir site.



Photo 2

There are a two houses close to the upper dam site. They have rice field in the upper reservoir site.



Photo 3

There are rice fields along Sap river, the lower reservoir site. This rice field belong to Keo Lan village.

APPENDIX 4-6-3

Results of the second site reconnaissance ; P5

The features of promising potential sites for PSPP

Site Name	P5
Location (Name of River)	Upper dam/reservoir : Son La Province/ Moc Chau District / Song Khua Commune (None) Lower dam/reservoir : Son La Province/ Moc Chau District (Hoa Binh Lake)
Project Parameter	Installed Capacity P(MW) 1,000 Design Discharge Qd(m ³ /s) 250 Effective Head He(m) 510 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"> • Geology around P5 site is Silurian-Devonian NS to NNW-SSE system of sedimentary folding zone mainly limestone, structural line is NW-SE system along the river in the published map. Top of the limestone hill consists of a lot of the irregular topography such as depression grounds and flat area. • Limestone as itself is hard and massive, including many eroded holes. Generally underground water level is probably nearly same or a bit higher than Hoa Binh Lake.
	(Upper dam/ reservoir) <ul style="list-style-type: none"> • Site geology 	<ul style="list-style-type: none"> • The rock of upper Reservoir is mainly composed of limestone as Cambrian-Silurian-Devonian sedimentary rocks (O3-Ssv/C2-O1?bk/S2-D1bh). The limestone in this area makes the topography irregular such as flat, steep valley and depressed ground. The condition of limestone is hard and massive but with many open holes.
	<ul style="list-style-type: none"> ⊙ Checking the Permeability of the Reservoir 	<ul style="list-style-type: none"> ⊙ Many open joints are found between the beddings of the limestone and vertical in some places. Dips of the lime stone bed is generally 30-40 degrees, dips of joints are nearly vertical. The permeability of rock is probably quite high.
	<ul style="list-style-type: none"> • Checking the condition of the fracture zone through the Reservoir(in Hoa Binh) 	<ul style="list-style-type: none"> • Some fractured zones as E-W system are found both side of the Hoa Binh Lake, this fractured zone probably is extended from the P5 Upper reservoir. Most of the fractured zones are not clear because of being covered by the secondary sediments or weathering surface.
	<ul style="list-style-type: none"> • Checking the weathering grade around the geological boundary 	<ul style="list-style-type: none"> • Topographical anomaly (valley) along the rock boundary is reported in the published geological map.
	(Intake) <ul style="list-style-type: none"> ○ Checking the Geology and the strength of the rock around the Intake 	<ul style="list-style-type: none"> ○ Strength of limestone (O3-Ssv) is massive and hard around the Intake area.
(Waterway • Surge Tank) <ul style="list-style-type: none"> • Site geology 	<ul style="list-style-type: none"> • The geology around the waterway to Lower Reservoir is mainly gently bedding as 20-30 degrees of limestone as C2-O1?bk, granite vein (γ PR3bn) is outcrops near the waterway line. The condition of limestone is hard and massive with many open holes. 	
<ul style="list-style-type: none"> ○ Checking the strength of the rock around the tunnel 	<ul style="list-style-type: none"> ○ Hard and massive limestone with open joints or strongly weathered granite around the waterway site. A fresh and massive 100-200m width of the granite outcrop (γ PR3bn) was found in the left side of the Hoa Binh. The condition of the granite in the left bank is rather granodiorite than granite. Granite in the right bank of the river was not found clearly due to strong weathering. 	
<ul style="list-style-type: none"> • Checking the conditions of the open cracks in the limestone 	<ul style="list-style-type: none"> • As for gently sloped limestone, small caves and eroded open joints along the Hoa Binh Lake were found. 	
(Underground Power Station) <ul style="list-style-type: none"> ○ Checking the Geology and strength of the rock around the tunnel • Checking the weathering grade around the boundary of the granite and the other rocks 	<ul style="list-style-type: none"> ○ The conditions and the rock mass permeability around the Underground Power Station are gently inclined bedding as 20-30 degrees of limestone with many eroded holes as relatively high permeability. • The condition around the boundary of granite and limestone is not clear by the strongly weathered surface and secondary sediments. 	
(Tailrace) <ul style="list-style-type: none"> • Checking the geological conditions 	<ul style="list-style-type: none"> • The condition around the Tailrace may be mainly gently sloped limestone with small caves (open joints) along the Hoa Binh Lake. 	

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

	<p>(Outlet)</p> <ul style="list-style-type: none"> • Checking the geological conditions 	<ul style="list-style-type: none"> • The condition around the Outlet is mainly gently sloped limestone with small caves (open joints) along the Hoa Binh Lake.
	<p>(Approach)</p> <ul style="list-style-type: none"> • Checking the geological conditions 	<ul style="list-style-type: none"> • There is no difficulty for the construction of the road.
	<p>(Others)</p> <ul style="list-style-type: none"> • Checking the geological conditions 	<ul style="list-style-type: none"> • Limestone along with the Hoa Binh Lake includes a lot of void and cave eroded by underground water flow.
Design	<p>(Overall)</p>	<ul style="list-style-type: none"> • The outlet is planned in the gently sloped small gully, and outcrops were not found around there. Also, secondary sediment was found up to H.W.L. of Hoa Binh Lake. • Therefore, the location of the outlet should be changed. • As an alternative, the ridge of the downstream (about 750 m) of the previous plan could be available for the location of the outlet due to little sediment.
	<p>(Waterway • Power Station)</p> <ul style="list-style-type: none"> • Considering the construction method 	<ul style="list-style-type: none"> • Entrance of approach tunnel to the underground powerhouse and waterway should be relocated to the downstream as well as the outlet. • Since the base rock of a proposed site is composed of limestone with many eroded holes, there will be some risk of encountering sudden sump water during its excavation.
	<p>(Tailrace)</p> <ul style="list-style-type: none"> • Considering the construction method 	<ul style="list-style-type: none"> • Entrance of the approach tunnel to the tailrace will be selected at the downstream of the outlet. • Since the base rock of a proposed site is composed of limestone, there will be some risk of encountering sudden sump water.
	<p>(Outlet)</p> <ul style="list-style-type: none"> • Considering the construction method • Sounding 	<ul style="list-style-type: none"> • Before construction of the outlet, it is necessary to excavate the downstream of the ridge and wall off the water of Hoa Binh Lake. • It is necessary to design the cofferdam and the underwater excavation method for the outlet. • As a result of sounding, the depth of Hoa Binh Lake, which is away from the right bank of 70 m, was 42.5 m.
	<p>(Approach)</p>	<ul style="list-style-type: none"> • The upper dam site can be accessed by a vehicle though Route 6 & 37 about 45 km long from Moc Chau and through the un-paved road about 20 km long from Men village. • It is necessary to construct a new road about 2.5 km long from Ben Khua village to the outlet.
	<p>(Others)</p>	<ul style="list-style-type: none"> • The water level of Hoa Binh Lake was 95 m (20 m lower of H.W.L.).
Natural and Social Environments	<p>(Ecosystem)</p>	<ul style="list-style-type: none"> • The terrestrial ecosystem at the upper and the 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, however the impacts are expected to be limited.
	<p>(Resettlement / Loss of assets)</p>	<p>RESETTLEMENT</p> <p>Upper dam / reservoir</p> <ul style="list-style-type: none"> • Although precise number is not identified, some households of Song Hung village need to be resettled. Since they had been moved to this place by Hoa Bin dam project, careful assessment of the impacts and close consultation with the people need to be undertaken. <p>Lower dam /reservoir</p> <ul style="list-style-type: none"> • Resettlement is expected to occur by the approach road and the outlet construction. • There are several households at the planned outlet site, and one person was interviewed. There was a village and the rest of the villagers had been resettled by the Hoa Bin dam project to the planned upper reservoir site (Song Hung). A careful assessment of the impacts and close consultation with the people needs to be undertaken. <p>LOSS OF ASSESTS</p> <p>Upper dam / reservoir</p> <ul style="list-style-type: none"> • The cropland of Song Hung village will be lost. <p>Lower dam / reservoir</p> <ul style="list-style-type: none"> • The slope is steep and the area of agricultural lands is expected to be small. The impacts are expected to be limited.



Photo 1

The outlet is planned in the gently sloped small gully.



Photo 2

The water level of Hoa Binh Lake was 95 m (20 m lower of H.W.L.). Secondary sediment was found up to H.W.L. of Hoa Binh Lake.



Photo 3

Outcrops were not found around there. Therefore the location of the outlet should be changed.



Photo 4

The ridge of the downstream (about 750 m) of the previous plan could be available for the location of the outlet due to little sediment.
(View from the previous outlet)



Photo 5

This is the alternative site of the outlet.
(View from the boat)



Photo 6

It is necessary to construct a new road about 2.5 km long from Ben Khua village to the outlet.