TRUNG SON HYDROPOWER PROJECT MANAGEMENT BOARD

ENVIRONMENT IMPACT ASSESSMENT REPORT

TRUNG SON HYDROPOWER PROJECT

(Edited pursuant to the statement in the meeting by the Appraisal Board for Environment Impact Assessment Report to Trung Son Hydropower Project dated 19/4/2008)

THE PROJECT OWNER	THE CONSULTING FIRM
TRUNG SON HYDROPOWER PROJECT MANAGEMENT BOARD	POWER ENGINEERING CONSULTING COMPANY No.4
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Thanh Hoa, May 2008

This EIA was prepared by Power Engineering Consulting Joint Stock Company No. 4 for Trung Son Hydropower Project Management Board and approved by the Ministry of Natural Resources and Environment by its decision 1257/QD-BTNMT of June 17, 2008. By this document, Trung Son Hydropower Project meets applicable Vietnamese regulations. This report should be read in conjunction with the Supplementary Environment and Social Impact Analysis and an Environmental Management Plan, which have been prepared by Trung Son Hydropower Project Management Board.

Báo cáo Đánh giá tác động môi trường (EIA) do Công ty Cổ phần tư vấn Xây dựng điện 4 thực hiện theo yêu cầu của Ban Quản lý Dự án Thủy điện Trung Sơn và được Bộ Tài nguyên và Môi trường phê duyệt theo Quyết định số 1257/QĐ-BTNMT ngày 17 tháng 6 năm 2008. Báo cáo này của Dự án Thủy điện Trung Sơn đáp ứng các quy định hiện hành của Việt nam. Báo cáo này phải được đọc cùng với Báo cáo Bổ sung Phân tích Tác động Môi trường và Xã hội và Kế hoạch Quản lý Môi trường do Ban Quản lý Thủy điện Trung Sơn lập.

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1. GENERAL VIEW OF TRUNG SON HYDROPOWER PROJECT

As Hydropower Development Master Plan for Ma River has been approved by Ministry of Industry (MOI) in the decision 1195/QD-NLDK dated March 31, 2005. According to the Master Plan, Trung Son hydropower project (previous name was Ban Uon hydropower project) was recommended in Ma river. Pre-feasibility study for the project has been approved by the prime Minister in decision 865/TTg-CN. The proposed dam site of the project is at Trung Son commune, Quan Hoa district, Thanh Hoa province. The project site is about 195 km west north of Thanh Hoa city; its reservoir tail is about 9.5 km from the border between Vieam and Laos. The total area of the reservoir in the proposed alternation (alternative 4) is 13.175 km2.

Trung Son hydropower project is a multipurpose project. In addition of its main purpose is to provide about 260 MW to the national power network, the project will also mitigate flood for its downstream area with its flood control volume of 112 million m3 and supplement water for irrigation for downstream area of Ma river, contributing to reduce salt penetration process in dry season. The project reservoir will also provide favorable condition for development of waterway transportation, aquatic production and fishery to support socio-economic development of the mountainous districts in two provinces Thanh Hoa and Son La. Construction and operation of the project will create impacts on natural environment and socio-economic situation of the area as well. The impacts are considered in both positive and negative impacts.

Governmental organization to approve the investment project is Ministry of Industry and Trade (MOIT)

2. LEGAL AND TECHNICAL BASIS FOR ENVIRONMENT IMPACT ASSESSMENT.

- Law on Environmental Protection, number 52/2005/QH11 approved by the National Assembly XI, meeting 8th on November 29, 2005; became effective July 2, 2006.
- Land Law of Vietnam in 2003; became effective July 1, 2004.
- Law on Water Resource approved by the National Assembly X, meeting 3rd on May 20, 1998; became effective January 1, 1999.
- Law on Forest Protection, number 29/2004/QH11 approved by the National Assembly on December 03 20, 1998; became effective April 01, 2005.
- Decree number 80/2006/ND-CP dated August 09, 2006 issued by the Government to instruct implementation of clauses of Law on Environmental Protection.
- Circular 08/2006/TT-BTNMT dated September 08, 2006 issued by Ministry of Natural Resources and Environment (MONRE) providing guidance on strategy environmental impact assessment, environmental impact assessment and environmental protection commitment.
- Decision number 22/2006/QD-BTNMT dated December 18, 2006 issued by MONRE on mandatory using of Vietnamese standard on environment.

- Decision of Minister of Industry approving hydropower development master plan for Ma river; number 1195/QD-NLDK dated March 31, 2005.
- Instruction of the Prime Minister allowing preparation of investment project for Ban Uon hydropower project, number 865/TTg-CN dated June 28, 2005 on pre-feasibility study of Ban Uon hydropower project, Thanh Hoa province.
- Decision number 907/QD-EVN-HDQT of Vietnam Electricity Group (EVN) dated November 02, 2007 on establishment of Trung Son hydropower project management board (TS HPMB).

3. PREPARATION OF ENVIRONMENT IMPACT ASSESSMENT FOR THE PROJECT

The EIA report for Trung Son project in investment project phase is prepared by Power Engineering Consulting Company Number 4, JSC (PECC4); administrated by Trung Son HPMB.

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List of people contributing to preparation of EIA report for the project is in below table:

No	Full name	Title, Responsibility
I	**Project owner**	**Trung Son hydropower project management board**
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2	Dang Quoc Quang	Staff of Trung Son HPMB
II	**Consultant**	**Power Engineering Consulting Company 4, JSC**
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4	Dang Phuong Hao	Hydraulic engineer, in charge of mapping
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6	Pham Huyen	Master on Environmental technology, member
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CHAPTER 1
PRELIMINARY DESCRIPTION OF THE PROJECT

1.1 PROJECT NAME

Project name: Trung Son Hydropower Project

Location: Trung Son commune, Quan Hoa district, Thanh Hoa province

1.2. NAME OF PROJECT IMPLEMENTATION AGENCY

Name of project implementation agency: **Trung Son Hydropower Project Management Board**

Address: **25A – Quang Trung – Ngoc Trao ward – Thanh Hoa City**

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1.3 PROJECT LOCATION

According to the master plan on Ma River approved by Ministry of Industry in Decree No. 1195/QD-NLDK dated March 31, 2005, project location is on Ma River with site at Uon Village.

In investment report phase (pre-feasibility study phase), the project was studies on 4 different lines on site of project by PECC4; headwork is located in Trung Son commune, Quan Hoa district. Decision No 865/TTg-CN of Governmental Prime Minister passed pre-feasibility study for project and authorized planning Trung Son Hydropower Investing Project of which proposed dam site is at Trung Son commune, Quan Hoa district, Thanh Hoa province.

In investment project phase, apart from approved idea, other locations were continuously perfected by PECC 4 and solution at downstream in Trung Son commune, Quan Hoa district chose is distant 2km from approved one in investment report. High water level of Trung Son reservoir is 160 m (to meet the requirements of national defense on security of border between Vietnam and Lao).

Location of project:

Geographic co-ordinates:

- X= 2 279 739.48
- Y = 482 791.16 (VN2000)

The project's headwork is located in Trung Son commune, Quan Hoa district, Thanh Hoa province. The project's headwork is 95 km west south of Hoa Binh town and 195 west north of Thanh Hoa city. There is a road to the project site on the left bank of the river. The road on the right bank is in poor condition.

High water level of Trung Son reservoir is 160 m; The reservoir with its tail water level in accordance with flood frequency of 1% (Q = 9,100 m3/s) will inundate about 1,538.95 of land.

Field surveys show that there is no important religious, cultural or historical structures will be affected by the project.

Trung Son Hydropower Project location is presented in the Ma River Hydropower ladder system (figure 1).

1.4 MAIN COMPONENTS OF THE PROJECT

Objectives of the project:

- Supply power to the national grid: The project with installed capacity of 260 MW will provide 1,044.12 million kWh to the national grid. The project will lighten power shortage in the country.
- Flood mitigation for downstream: The reservoir will provide a volume of 112 million cubic meters for flood control purpose.
- Supplement of water to downstream in dry season: Besides the project will supplement water to downstream in dry season contributing to decrease of saltination to downstream.
- Constructions of the project will contribute to infrastructure and socio-economic development of the mountainous districts of Thanh Hoa, having important political meanings in poverty reduction, improvement of local people's culture, strengthening union among ethnics in Vietnam.

Legal components of the project:

(i) The following components are legally included in the project: reservoir, main dam, and spillway, power headrace (intake gate, power plant, discharge cannel, diversion structure during construction, and power distribution system of the plant), construction material mines (soil, rock and sand mines), auxiliary structures (construction camps, operation houses, storages, and disposal fields), access road Co Luong – Co Me and resettlement areas.

(ii) Components are not legally included in the project: Transmission lines from plant's transformer to national system.

The study carries out environmental impact assessment for the components under the category (i) – Legal project components. Study for components under the category (ii) will be carried out under other projects.

1.4.1 Scale and technology of the project components

Components belong to the project

The project comprises following components:

1.4.1.1 Main project components

❖ **Headwork:**

1. Reservoir

The area of reservoir is 13.175 km^2, at high water level of 160 m, the reservoir surface's area is 13.13 km2; its total volume (Wbt) is 384,53 million m^3, and its dead volume is 236.40 million m^3, and active volume is 112.13 million m3.

2. Main dam

The main dam is RCC dam including spillway. Its crest length including spillway is 530.3 meters; crest elevation is 167.3 meters; crest width is 10 meters, maximum height of the dam is 86.7 meters, slope of dam roof at upstream is 0 and downstream is 0.8.

3. Spillway

Spillway is designed as part of the main dam including 6 spilling sections. It is made from reinforced concrete with valves. Its energy dissipation is designed as flip bucket form. Elevation of spillway sill is 145 meters; spilling aperture 14 m x 15 m; Dimension of radial gate 14 m x 15.5 m.

Designed flood spilling capacity is 8,841 m3/s at flood frequency of 0.5%; checking flood capacity is 12,046 m3 at flood frequency of 0.1%.

❖ **Power headrace:**

1. Intake gate

Elevation of intake gate sill is 138 m; dimension of trash-rack 8 m x 5.5 m x 10.5 m; dimension of emergency weir is 4 m x 5.5 m x 5.5 m.

2. Tunnel

Tunnel diameter is 5.5 m; total length of a tunnel is 235. 5 m; thickness of tunnel shell is 16 – 21 mm; slope of tunnel is 29.83%.

3. Power house

The project will be installed with 4 Francis turbines with total capacity of 4 x 65 MW. There will be also 3 three phase, 220 V generators and control and auxiliary equipments.

4. Discharge cannel

Discharge cannel's bottom width is 70 m; slope of channel bottom is 0.001; length of discharge canal is 80 m.

Table 1.1: Main parameters of the project

No	Parameter	Unit	Baseline
I	**Basin**		
1	Basin area F_{lv}	Km^2	13.175
2	Average rainfall of many Years X_0	mm	1 420
3	Yearly average discharge Q_o	M^3/s	244
4	Total yearly flow W_o	10^6m^3	7.695
II	**Water reservoir**		
1	Normal rising water level	m	160
2	Dead water level	m	150
3	Pre-flood water level	m	150
4	Flood control capacity W_{pl}	10^6m^3	136
5	Capacity equivalent to normal rising water	$10\ m^3$	348.53
6	Useful flood control capacity W_{pl}	10^6m^3	112.13
7	Capacity W_{pl} equivalent to control water	10^6m^3	136.00
8	Dead capacity W_c	10^6m^3	236.40
9	Reservoir area equivalent to normal rising	km^2	13.13
	Flood peak discharge equivalent to		
	- P= 0,1 %	M^3/s	13 400
	- P= 0,5 %	M^3/s	10 400
	- P= 1 %	M^3/s	9 100
	- P= 5 %	M^3/s	6 200
III	**Main dam**		
1	Dam crest elevation	m	163.7

2	Length of dam crest ($L_đ$)	m	353.0
3	Elevation of peak (greatest) dam	m	88,0
4	Width of the peak (b)	m	10
5	Upper roof (m)		0.4
6	Lower roof (m)		0.4-0.8
IV	**Spillway**		
1	Elevation of spillway sill	m	145
2	Number of spilling section		6
3	Spilling aperture BxH	m	14x15
4	Dimension of radial gate BxH	m	14x15,5
5	Design flood discharge P=0,5%	M^3/s	8 841
6	Control flood discharge P=0,1%	M^3/s	12 046
7	Energy dissipation form		flip bucket
V	**Energy line**		
A	***Intake gate***		
1	Elevation of intake gate sill	m	138
2	Dimension of trash-rack n x B x H	m	8x5.5x10,5
3	Dimension of emergency weir n x B x H	m	4x5.5x5,5
4	Dimension of flat valve n x B x H	m	4x5.5x5,5
B	***Tunnel /Pressure pipe***		Pipe
1	Tunnel diameter/ pipe AL	m	5.5
2	Total length of a tunnel/ 1 pipe	m	235.5
3	Slope of tunnel/ pipe	%	29.83
4	Thickness of tunnel shell/ Pipe shell	mm	16-21
E	***Plant's specificity***		
1	Type of turbine		PO
2	Number of power generator set		4
3	Installed capacity N_{lm}	MW	250
4	Ensured capacity $N_{bđ}$	MW	41.84
7	Peak water column H_{max}	m	71.10
8	Lowest water column H_{min}	m	54.20
9	Medium water column H_{tb}	m	62.79
10	Calculated water column H_{tt}	m	56.50
11	Q_{max} through the plant	M^3/s	503.84
VI	**Electricity output**		
1	Yearly electricity output E_0	10^6	1029.47
2	Hours used for installed capacity	hour	4176
VII	**Discharge canal**		
1	Bottom width (b)	m	70
2	Roof coefficient (m)		1
3	Slope of channel bottom (i)		0.001
4	Length of discharge canal (L)	m	80

	VIII	**Mức đầu tư**			
VIII	1	Suất đầu tư cho 1 KWh		10^3VNĐ	4,774
1	2	Suất đầu tư cho 1 KW công suất lắp máy	10^3	10^6VNĐ	19,941
2	For 1 KWh			4,774	
	For capacity machine installed		10^6	19,941	

1.4.1.2 Auxiliary components

Scale of each production area, worker camp and other auxiliary units is defined based on overall implementation schedule of the main components, intensity and time of use of equipments and others. Number of workers working in the construction site is defined based on worker norms for the each constriction work which has been applied for other hydropower projects in Vietnam.

Almost of the auxiliary components and houses will only be used during the construction period. Therefore, except some components which will be used in project operation period, auxiliary components will be constructed as temporary structure, being easy to install and uninstall.

It is expected there are two types of houses: Administrative houses (type 1) and factory house (type 2).

- Type 1 house will be brick structure with steel roof frame, tole roof, foundation covered by cement.
- Type 2 houses are used for factories and stores with steel frame, tole roof and wall.

  There re three types of stores: in house, roofing and open.
- In house stores are used to keep valued materials and equipments which are affected by temperature or humidity such as cement, electrical equipments, spare parts of construction equipments, etc. In house stores are made from brick; foundation covered by cement, being roofed by tole.
- Roofing house stores are used for materials or equipments which are not affected by temperature but humidity and sunlight such as wood, steel, etc.
- Open stores are used for materials, which are not affected by temperature nor humidity such as sand, rock. The store will be founded with mixed macadam.

Besides the mentioned store types there will be other types for petrol, explosive, etc which are designed as appropriate.

List of auxiliary components is in table 2.1

Table 1.2: List of auxiliary components

No	Item	Technical parameter	Area (hectare)
1	Macadam grinding and sieving factory	800000 m^3 per year	7.55
2	RCC and normal concrete factory	300 m^3/h + 60m^3/h	3.72
3	Normal and prefabricated concrete factory	100 m^3/h	0.51
4	Steel rod factory	14 T/shift	0.48
5	Wood casing factory	4.17 thousand m^3/year	0.23
6	Steel casing factory	86.26 tons	0.19
7	Parking and maintenance unit	420 units	7.86
8	Assemble lines	3300 T/year	1.34
9	Explosive store	2 x 40 T	2 x 0.25
10	Lap	-	0.21
11	Fire station	2 unit	0.06
12	Lubricant and oil store	350 T	0.26

No	Item	Technical parameter	Area (hectare)
13	Spare part store	-	0.48
14	Specific hydraulic unit	-	0.23
15	Water and electricity unit	-	0.26
16	Stand by power supply station	2 x 500 KVA	2 x 0.05
17	Pumping station and water technical treatment station	100 m^3/h	0.06
18	Pumping station and water treatment	30 m^3/h	0.06
19	Rock store	40000 m^3	1
20	Sand store at sand mine	209000 m^3	3.49
21	Dumping ground at right bank	2161000 m^3	14.40
22	Dumping ground at left bank	3287000 m^3	21.91
23	Office of contractors	330 persons	0.67
24	Worker camps	3600 persons	5
25	Office of PMB	50 persons	0.29
26	Office of consultants	50 persons	0.27
27	School and kindergarten	-	0.11
28	Health clinic	30 beds	0.1
29	Post office	-	0.03
30	Public cultural house	-	0.71
31	Market	-	0.2
32	Bus station	-	0.1
33	Rubbish damp	-	0.15
34	Cemetery	-	0.3

(Source: Main report prepared by PECC4)

a. Roads in the construction site

Based on the natural condition, layout of project components and transportation requirements, road system in the construction site is designed as below:

- Operation road 1 is road for construction of main dam, spillway and intake gate with the length of 2.1 km. In phase 1, the road is 7.5 m wide, paved by macadam of 5 m. The road will be covered by biennium with 5.5 m wide in the phase 2.
- Operation road 2 is road for construction of power house with the length of 0.9 km. In phase 1, the road is 7.5 m wide, paved by macadam of 5.5 m. The road will be covered by biennium with 5.5 m wide in the phase 2.
- Construction road is about 10.4 km length including road to material mines, auxiliary infrastructures, dumping ground, store ground and other locations. The road is 7.5 m wide, paved by macadam of 5.5 m.

b. Water supply system:

Water for domestic use of workers in the construction site is expected from surface water. Drinking water will come from under ground water exploited via drilled wells. Water from the wells will be distributed to worker camps and offices through a pipeline system.

Water for construction is taken from survey water at streams near the project site or will be pumped from the river.

c. Telecommunication system:

Communication for the project is intended based on the vibrant protocol installed for 220 kV line to Hoa Binh hydropower plant and Nho Quan 500/220/110 kV substation. In addition, telecommunication equipments allowing the project to connect to the existing system of telecommunication sector will also be installed.

d. Transportation of equipments and materials to the project site:

Because the project site is at mountainous area therefore materials and equipments will be mainly transported to the project site via existing road system and new operation road to be built in the project site. Other construction materials such as steel, cement, etc will be transported from Hoa Binh town to the project site.

e. Construction materials naturally exploited

- **Quarry**: Quarries with total capacity of 8 million m3 are at both right and left sides of Ma River, about 8 km upstream from the dam site and above the water level of the reservoir. There are tracks to the quarries but in very poor condition. Stone quality at the quarries in of good quality under a thin cover layer could be used for concrete and materials for rock-fill dam as well.

- **Sand mines**: There are three sand mines near to the project site with total capacity of about 225,000 m3, of which pebbles accounts for about 34,250 m3. The mines can be access to by trucks with current roads. Of the three sand mines, the one at Thanh Xuan communes is of good quality and nearest to the project site.

- **Earth mines**: There is a surveyed earth mine at the right bank of the river, 10 km for the project site with capacity of 4 million m3. The quality of materials is considered as good quality however the mine is far from the project site therefore it will be complicated to transport earth from the mine to the project site.

1.4.1.3 Clearance of mines, explosive and poisonous chemicals

Clearance of mines, explosive and poisonous chemicals will be implemented at the dam site area, power house, discharge cannel, construction materials mines, construction and operation roads and other locations, whether it is expected that there is still mines or explosive remaining from the war.

OB chemical searching and clearing will be implemented in the reservoir area to reduce the impact of the chemical caused by storing water into the reservoir.

1.4.1.4 Construction volume of main project components

Table 1.3: Construction volume of main project components

TT	Work item	Unit	Main components		Total
			Head work	Power race	

			RCC and spillway	Intake gate	Tunnel	Power house and discharge cannel	
	Earth excavation						
1	Excavation of class II earth and transport to dumping ground	10^3m^3	770,77	-	238,33	158,89	1.167,99
2	Excavation of class II earth for foundation	10^3m^3	330,33	-	102,14	68,09	500,57
3	Excavation of class III earth and transport to dumping ground	10^3m^3	966,64	-	200,59	133,73	1.300,96
4	Excavation of class III earth for foundation	10^3m^3	414,27	-	85,97	57,31	557,55
	Rock excavation						-
5	Excavation of class II rock by normal mine explosion	10^3m^3	104,10	-	153,94	102,63	360,67
6	Excavation of class II rock by explosion for foundation	10^3m^3	44,61	-	65,97	43,98	154,57
7	Excavation of class II rock by small explosion	10^3m^3	26,24	-	38,81	25,87	90,92
8	Excavation of weathered rock	10^3m^3	212,91	-	186,84	124,56	524,31
	Damping						
	Earth fill						
9	Earth fill grade II dam core	10^3m^3	28.11	-	-	-	28.11
10	Earth fill grade III from borrow area	10^3m^3	112.44	-	-	-	112.44
11	Earth fill grade III, re-used from excavation	10^3m^3	-	-	1.10	92.72	93.82
12	Earth fill grade III to cofferdam, re-used from excavation	10^3m^3	-	-	-	-	-
13	Earth/rock fill, re-used from excavation	10^3m^3	-	-	-	-	-
14	Earth fill to project's component base, soil of grade II	10^3m^3	-	-	-	-	-
15	Earth fill to project's component base, soil of grade III	10^3m^3	-	-	-	4.88	4.88
	Rock fill						-
16	Rock fill, aggregates from borrow area	10^3m^3	5.56	-	-	-	5.56
17	Rock fill, aggregates re-used from excavation	10^3m^3	-	-	-	-	-
	Filter						
18	Filter embankment by vehicle,	10^3m^3	2.01	-	-	-	2.01

TT	Work item	Unit	Main components				Total
			Head work	Power race			
			RCC and spillway	Intake gate	Tunnel	Power house and discharge cannel	
	aggregates from quarry						
19	Filter embankment by manual, aggregates from quarry	10^3m^3					-
20	Fine filter by sand	10^3m^3	2.01				2.01
	Construction and pavement						-
21	Masonry, mortar, rock from quarry	10^3m^3	2.77	-	0.88	-	3.65
22	Riprap (rock from quarry)	10^3m^3	0.27				0.27
	Other works						
23	Grassing	10^3m^2	1.81		9.90		11.71
24	Bulb rubble joint	10^3m d	0.95				0.95
	Concrete works						
	Foundation concrete						
25	Foundation concrete M150 aggregates 4x6	10^3m^3	-	-	0.12	-	0.12
	Concrete to foundation						-
26	Foundation concrete M150 (aggregates 4x6)	10^3m^3	41.88	17.92	-	-	59.80
27	Roller Compacted Concrete (RCC) M150	10^3m^3	679.61				679.61
28	Foundation concrete M200 (aggregates 2x4)	10^3m^3					
29	Concrete to support, anchor abutments M200 (aggregates 2x4)	10^3m^3	-	-	31.69	-	31.69
30	Foundation concrete M250 (aggregates 2x4)	10^3m^3	43.34	1.93	-	-	45.27
31	Concrete to unit pit M250 (aggregates 1x2)	10^3m^3				19.71	19.71
	Concrete to wall						
32	Reinforced concrete M200 (aggregates 2x4)	10^3m^3	39.63	-	-	1.60	41.23
33	Reinforced concrete M250 (aggregates 2x4)	10^3m^3	6.11	21.48	-	46.00	73.59
34	Reinforced concrete M300 (aggregates 1x2)	10^3m^3	109.64				109.64
	Reinforcement						
35	Fabrication, installation of	ton	5176.48	859.32	1584.5	3365.45	10985.80

TT	Work item	Unit	Main components				Total
			Head work	Power race			
			RCC and spillway	Intake gate	Tunnel	Power house and discharge cannel	
	reinforcement to concrete				5		
36	Anchorage bar	ton	6.07	-	13.45	35.87	55.40
	Grouting works						
37	Consolidation grouting M300	10^3m^2	-	-	13.20	-	13.20
39	Drainage drilling	10^3md	11.53				11.53
40	Anchor drilling	10^3md	1.49	-	3.30	8.80	13.59
	Equipment						
41	Hydro-mechanical equipment	T	264.39	93.86	-	341.41	699.66
42	Local fabricated equipment	T	869.70	400.58	2526.00	65.48	3861.76
43	Unit equipment	T				250.00	250.00

Table 14: Land dig and filling volume according to the quarter in construction year for each work item

Unit: 10^3m^3

No	Work item	Construction year I		Construction II				Construction III			
		Quarter I	Quarter II	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV
1	Main dam + spillway	531.8	531.86	531.9	531.86	177.29	177.3	0	0	0	0
2	Pipe pressure	0	116.49	174.7	174.73	58.24	0	0	0	0	0
3	Intake gate	0	104.85	157.3	157.27	104.85	0	0	0	0	0
4	Plant + Tunnel flow	0	99.86	149.8	49.93	0	0	16.3	24.5	24.51	74.4
5	Flow construction	0	309.60	0	27.46	0	74.43	0	0	0	0
6	Resettlement size										

No	Work item	Construction year IV				Construction year V				Total	
		Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV		
1	Main dam + spillway	101.2	33.75	0	0	0	0	0	0	2617.01	
2	Pipe pressure	0	0	0	0	0	0	0	0	524.19	
3	Intake gate	0	0	0	0	0	0	0	0	524.24	

4	Plant + letting water out	0	0	0	0	0	0	0	0	439.38	
5	Flow construcion	0	0	0	0	0	0	0	0	411.49	
6	Resettlement size									669,24	

Table 1.5. Stone volume according to construction work item in quarter in construction year

Unit: 103m3

No	Work item	Construction year I		Construction year 2				Construction 3			
		Quater III	Quater IV	Quater I	Quater II	Quater III	Quater IV	Quater I	Quater II	Quater III	Quate IV
1	Main dam + spillway	0	21.29	102.8	122.19	100.90	40.73	0	0	0	0
2	Pipe pressure	0	0	50.76	154.84	154.84	26.23	0	0	0	0
3	Intake gate	0	0	50.76	112.87	186.32	36.73	0	0	0	0
4	Plant + channel flow	0	0	98.29	159.50	0	0	0	0	0	0
5	Flow construction	0	112.4	95.88	0	0	8.13	0	0	0	0
TT	Resettlement size **Work item**	**Construction year 4**				**Construction year 5**				**Total**	
		Quater I	Quater II	Quater III	Quater IV	Quater I	Quater II	Quater III	Quater IV		
1		5.31	1.77	0	0	0	0	0	0	394.94	
2	Main dam + spillway	0	0	0	0	0	0	0	0	386.67	
3	Pipe pressure	0	0	0	0	0	0	0	0	386.68	
4	Intake gate	0	0	0	0	0	0	0	0	257.79	
5	Plant + letting water out	0	0	0	0	0	0	0	0	216.41	
	Flow construcion										
	Resettlement size										

1.4.1.5. Main construction methods

❖ **Sand exploitation**

Natural sand material will be exploited by dredger, hauling to stock pile by truck, where it will be screened and hauled to batching plant and construction site.

❖ **Soil excavation**

This kind of work will be done mainly using excavator 2.3m3 combining with bulldozer 110cv, 140cv loading into truck 12T to transport to planned stock-pile areas, disposal areas.

❖ **Rock excavation**

Rock will be excavated mainly using large drilling, blasting method with borehole diameter is up to 105mm, except the foundation area where close to concrete structure or the case of rock slope, which will be excavated using small blasting with hole diameter of

56mm and manual. Rock resulted from excavation will be haled to stockpile area for latter using or to disposal area planned in upstream.

Surface resulted from rock excavation to be foundation of concrete structures shall be excavated in at least 2 layers, in which the final layer (including layers on inclined slopes) shall be protective layer whose thickness shall not less than 2.0m. The excavated layers on top of the protective layer shall be excavated by large blasting with hole diameter not exceed 105mm. The protective layer shall be excavated in 2 sub-layers: the upper sub-layer shall be excavated using blasting but borehole shall have diameter not exceed 56mm, bottom of such boreholes shall be not less than 30cm from the designed excavation limit. The lower sub-layer (the rock lift left closed to the structure foundation) shall be excavated by hammer, no blasting shall be allowed.

Faults, joints exposed on rock surface as resulted from excavation which will be foundation of concrete structure, shall be enlarged by excavation to create a slope of 4 :1 or more gentle all along the fault, joints, loosen rock shall be taken out and excavated down to the depth at least as deep as twice of the fault/joint width. Following the preparation, such fault/joint shall be filled by concrete up to designed foundation level.

Rock excavated from foundations of dam, spillway, intake, powerhouse, tailrace channel shall be classified right at the excavation site before any transportation to stockpile or disposal areas. Good and hard rock excavated from layers IIA, IIB under such mentioned components shall be transported to stockpile for using as material dumping the cofferdam, or using as rock in riprap or being crushed into concrete aggregates. Rock excavated from IB layer or mixed between IB and IIA will be transported to disposal areas because it will not satisfy the Specifications.

❖ **Concrete placement method**

* Concrete placement on spillway, powerhouse:

Spillway and powerhouse are complicated structures with lots of reinforcement and embedded parts inside concrete. Reinforced concrete works in spillway and powerhouse shall be furnished by tower crane, crawler crane. Some complicated structures shall be placed using concrete pumping.

* Roller Compacted Concrete (RCC) placement:

A 300m3/h RCC batching plant will be located above elevation 163.7m on left dam abutment. Concrete mixture will be hauled from batching plant to the dam by a conveyor system locating along the dam foundation on left bank. Dumping truck will be loaded with concrete mixture at the end of conveyor system at discharging point and then transporting concrete to placement point on the dam surface. Bulldozer will be used to spread the dumped RCC mixture in to 30cm layers before using 10T roller with steel drum to compact concrete.

❖ **Rock-soil works**

Rock-earth fill will be implemented at upstream, downstream cofferdams, and backfill to powerhouse foundation...

Earthfill material at cofferdams will be re-used from foundation excavation or from soil borrow area, earthfill work underwater will be dumped directly within the earthfill vicinity of the cofferdam, and the inland embankment shall be done in each 30cm layers and compacted by compactor until it reaches to the designed density.

Rockfill works at cofferdams shall be taken from material resulted from foundation excavation or from quarry. The underwater work will be dumped directly, the inland part will be embanked into layers whose thickness shall not exceed 1.5m and it shall be compacted until it reaches to designed density.

❖ **Masonry works**

Rock masonry will be furnished in areas protecting slopes, drainage gutter, downstream cofferdam protecting powerhouse, etc... Masonry work shall be done manually.

Rock using for masonry work, for riprap shall be material resulted from excavation including rock from layers IIA and IIB or being taken from quarry.

❖ **Concrete works**

The exposed conventional vibration concrete (CVC) shall be placed using conventional method: mixing at station batching plant, hauling by mixing-dumping truck, dumping by crane combined with pump. On the chute of spillway, concrete will be placed using sliding formwork and pump. At intake and powerhouse, which are complicated structure existing with lots of reinforcement and embedded parts, concrete work as well as formwork and reinforcement shall be done using tower crane, crawler crane, in some very complicated structures, concrete pump will be used.

❖ ***Curtain grouting to dam foundation***

As has been designed, foundation of the concrete dam will be furnished with a curtain grouting comprises of 3 rows. Boreholes of curtain grouting shall be drilled right after placing the dam base so as it will not cause any interferences to the concrete placement in the dam body. Drilling of holes for curtain grouting on the dam base shall be done using compressed air or self-propelled drilling machine.

The grouting on dam base will be done in 5m stages, depending on each holes, it will be done using two grouting procedures which are ascending and descending procedures.

Drainage holes will be drilled only after completing grouting works in each dam sections.

❖ ***Installation of hydro-mechanical equipment***

Hydro-mechanical equipment such as gates, trash rack, rotational joints, hydraulic lifting machine, etc... will be supplied to erection bases at headwork area, then being re-assembled before hauling to installation location by special wagon. Equipment will be hauled into erection position using crawler crane or gantry crane. Embedded parts inside concrete will be transported to placement block using tower crane or crawler crane then will be localized, adjusted and fixed before any concrete placement.

❖ ***Installation of hydraulic mechanical equipment***

Hydraulic mechanical equipment as spiral case, draft tube will be re-assemble at erection bases at waterway, then being transported to erection location by special vehicle. Such equipment will be hauled into its locations before localizing, adjusting and fixing using crawler crane and tower crane. Main equipment inside powerhouse such as rotor and stator will be delivered to powerhouse and being re-assembled on erection floor inside powerhouse and will be hauled into its location by overhead traveling crane before adjusting. Beside, other equipment will transported to erection floor inside powerhouse by truck or flatfoot car, unloading by overhead traveling crane using auxiliary hook and

dropping down to the lower floor through equipment access shaft. Equipment will be transported to its location by roller, trolley, winch, or monorail crane which will be equipped at suitable locations inside powerhouse.

❖ ***Installation of technical electric equipment***

Installation of electric equipment in powerhouse and switchyard will be commenced from the third construction year and will be completed basically before commissioning of unit 1. Transformer will be transported by trafooc to erection ground, using crane capacity 50T to lift the transformer from trafooc and unloading on erection ground. Then the transformer will be hauled into workshop for necessary adjustment, calibration. Having been calibrated, adjusted, the transformer will be transported to its operational location.

1.4.2. The supplying electricity line for construction implementing

Based on the construction ground, local site supplying for construction, workers villages, construction amount of supplying electric power for construction implementing will include:

-Implementing option in using concrete dam with the first construction year is 2,5 MV and later years is 8MV, the detail electricity supplying option as follows:

Establishing a new line with two branches 110 kV (3A CSR-185), the connecthead is devided on 110kV Hoa Binh-SonLa line with 0,5 km long.

-Building a new line with Electric generator is 110/35/22 kV-25A –Mai Chau.

-Building a new line with one branch 35 kV (3AC-95), from TBA 110/35/22kV-25MVA Mai Chau to Trung Son hydropower plant is 38 km long, these branches will devided with 35 kV and Electric generator 35/0 kV for construction implementing

1.4.3 Resettlement alternatives

As the result of research of PECC4, the total of resettlement households is 472 households , 2353 persons, estimated at the time of researching in 2005 corresponding to 160m selected water level+ overflow of 1%, expected to 526 households in 2011. The number of resettlement households is 507 with 2520 persoons. The affected households are mainly Thai, Muong People (amount 98 %), the rest is H'Mong People. The resettlement approach is defied as follows:

<u>In Thanh Hoa province</u>: Affected HH from three communes Trung Son, Muong Ly and Trung Ly will be resettled in three resettlement areas as below:

- Resettlement area number 1 - Trung Son commune: The area of 3540 ha will be for resettlement of 216 HH, 1030 persons from two villages (Ta Ban 190 HH, 910 people and Xuoc 26 HH, 120 people
- Resettlement area number 2 – Muong Ly commune: Total area is 1910 ha. This is for resettlement of 85 HH, 461 people from two villages (Nang village 47 HH, 225 people and Tai Chanh village 38 HH, 206 people).
- Resettlement area number 3 – Trung Ly commune: Total area is 1050 ha. This is for resettlement of 36 HH, 195 people from two villages (Lin village 18 HH, 107 people and Chieng village 18 HH, 88 people
- **<u>In Son La province</u>**:

Resettlement area number 4 – New Xuan Nha commune. There will be 170 HH, 834 people from Dong Ta Lao and Tay Ta Lao villages being resettled to the resettlement point.

1.5.TOTAL INVESTMENT CAPITAL

Total investment capital of the project as estimated with loan from local commercial bank taking into account the supporting budget from Government to be: **5,337.234** billion VND.

Table 1.6: Total investment capital for construction

No	Discribtion	Value excluded Tax(VND10^6)	Output VAT (VND10^6)	Value included tax (VND10^6)
	Total expenses of construction	**5.080.798,15**	**256.435,89**	**5.337.234,04**
1	**Construction expenses**	**1.903.667,94**	**190.366,79**	**2.094.034,74**
2	**Devices expenses**	**1.306.450,09**	**9.884,19**	**1.316.334,27**
a	Devices Buying expenses	*1.193.825,08*	*9.884,19*	*1.203.709,26*
b	Installed devices expenses	*112.625,01*		*112.625,01*
3	**Compensation and resettlement expenses**	**203.631,10**		**203.631,10**
4	**Other expenses**	**1.103.972,60**	**22.736,75**	**1.126.709,34**
a	Project management expenses	*63.348,61*	*6.334,86*	*69.683,47*
b	Other expenses (excluding loan interest)	*276.745,07*	*16.401,89*	*293.146,96*
c	Interest	*763.878,92*		*763.878,92*
5	**Saving expenses [15%(1+2+3+4a+4b)]**	**563.076,42**	**33.448,16**	**596.524,58**

1.6 CONSTRUCTION SCHEDULE OF THE PROJECT

The project will be constructed in five years including one year of preparation and 4 years for constructing main civil works. Herein is the construction flow:

Preparation year:

Constructing access road, water/power supply systems, housing, worker camp and auxiliary works; implementing compensation, resettlement process.

Early July: Starting excavation to main dam foundation, part on land.

In dry and flood season, the natural flow will be diverted on natural river channel.

Construction year 1:

Early November: excavating foundations of powerhouse, intake, and penstock.

Constructing diversion culvert on left bank above elevation 86.0m, completing by May.

In dry and flood seasons the discharge will be diverted by natural river channel.

Construction year 2:

Dry season: early December, start to close the river, the maximum average discharge in 5 days period, Qclosure5% = 212m3/s.

Discharge in period (XII-V), QP=5%=400m3/s, water level in upstream 93.12m. Elevation of upstream cofferdam 93.70m. Discharge will be diverted through culvert (nxbxh=3x5x6) on left bank, culvert bottom elevation 86.0m.

Starting to treat the dam foundation part in river bed in 2 months.

Placing RCC on main dam by the end of May, dam section in river bed will be placed up to elevation 105.0m, on left/right bank up to elevation 115.0m.

By the end of quarter III: completing concrete works at intake, starting to install equipment to intake structure.

In construction year 2: placing concrete in powerhouse up to erection floor elevation.

The dry season discharge is diverted by culvert at elevation 86.0m, in flood season, diverting the discharge by culvert and overtopping the dam at elevation 105.0m; B = 50m.

Construction year *3:*

Completing equipment installation at intake by the end of June.

Completing concrete work at spillway, main dam. In September, installing gates to spillway.

Completing concrete work to tailrace channel. Hydro mechanical equipment of powerhouse will be installed from quarter II and hydraulic mechanical equipment will be started with installation from quarter III.

The discharge in dry season will be diverted by culvert at elevation 86.0m; the flood discharge will be diverted by culvert and the completed permanent spillway.

Construction year 4:

May: early this month, plugging the culvert to fill the reservoir.

Installation of equipment to spillway will be completed by July.

July: comprehensive trial test, in August putting unit 1 in commissioning.

By the end of October: completing the whole project, generating the left units.

The dry season discharge will be diverted by culvert, the flood season discharge will be spilled by permanent spillway system and powerhouse as stipulated by operational regime.

CHAPTER 2:

NATUAL CONDITIONS, ENVIRONMENT, AND SOCIO-ECONOMIC SITUATION AT TRUNG SON HYDROPOWER PROJECT AREA

2.1 Natural conditions and environment situation

2.1.1 Geographical and geological features

2.1.1.1 Geographical features

Trung son hydropower project is located at Ma river, at territory of Trung Son commune, Quan Hoa district, Thanh Hoa province. The project site is about 195 km north west of Thanh Hoa city; its reservoir tail is about 9.5 km from border between Laos and Vietnam. Total reservoir area at the PA4 selected alternative is 13.175 km2.

2.1.1.2 Topography, geomorphology and landscape of the project area

a) Topographical features:

Trung Son hydropower project is at Ma River basin in territory of Thanh Hoa and Hoa Binh provinces. This is the high mountainous area of Vietnam comprising high mountain ranges with west north – south east direction. The mountains are significantly separated with high slope from 10-30 decree. Mountains lining along the river have small slope with absolute elevation of hundred meters.

Based on analysis of geological structural features, petrographical constituent, orography, hydrographic network and topographical form, the studied area is divided into 15 forms of topography in 5 mail groups (topographical forms created by denudation process, temporary flow, regular flow, caster activities and human activities).

b) Geomorphologic characteristics:

1. The remaining of the surface smoothed and denuded imperfectly.

Chiefly disposes in the forms of main watershed surface of the basin (such as Bu Hu Luong mountain) with the height over 1000m and the popular surface sloping level 3-8o, some regions up to 10-15o. The surface covering layer is thinly created (below 0.5m), or origin stone inert, with the weather Saprolit cover. The dominant exogenous process on these surfaces mainly is away-washing, and away-washing under the surface

2. The remaining surface of pediment basin

Being shown in the form of high hill surface along the main river basin. The surfaces have the average height of 700-800m, less divided than the above mentioned surfaces. The covering layer eluvia is 0.5-1m thick, with the weather Saprolit cover. The dominant exogenous process is away-washing, away-washing on the surface and under the surface.

3. *Quick gravity slope*

Stretching major area in the high mountainous region in the basin, especially in Muong Lat penetrating block, and in the area of limestone mountains (despite the terrain energy is great, the durability of the limestone causes the gravity slope process here to not happen strongly). The slope has straight forms, with the sloping level up to 30o, some areas reaches 45-50o in forms of collapsing wall. The slope cover is created thinly, with the thickness under 0.5m, even with inert origin stones in some places. The dominant exogenous process in these slopes is breaking and collapsing

4. *Slow gravity slope*

Being the terrain form of large area in the research zone. These slopes have sloping level 15-30o, with slope side face rough, sub-staging, weakly divided. The creation components of the slope cover include macadam, grit with 0.5-1m thickness. The major exogenous process is washing sloping, defluxion.

5. *Away-washing slopes*

Stretching on limited area in the research basin. They are shown in forms of slopes with sloping level 8-15o, with side face straight sunken, being medium divided. The slope cover includes macadam, grit mixing with blocks of 1-1.5m average thickness. The major exogenous process is ditch erosion.

6. *Deluvi- Coluvi Agglomerating slope*

Counting rather modest portion of area in the zone, in forms of slopes at ends of mountains and hills. In forms, they are slopes with sloping level 8-12o, with straight side-face, the foot of slope is a bit prominent, little divided. The slope covering layer has mixed components with the thickness over 1.5m. The main exogenous process on these slopes is away-washing.

Group of terrain forms created by temporary flow activities

7. *Erosion sunken spout bottom*

Popularly disposing on the quick and slow gravity slopes in forms of interstice and alley with horizontal side face in V form and sub-staged vertical side face. At these sunken spouts, the deep erosion happens strongly, so there often appears an inert origin stone on their surface.

8. Erosion-agglomeration sunken spout bottom

Usually disposing in the area of slow gravity slope, with the horizontal side face in V form which has been widened in comparison with erosion sunken spout. The vertical side face is rough and sub-staged. The surface creation on the vertical side face is often unstable with the mixing of inert origin stone area and the small raw material agglomerating area. The dominant exogenous process includes both deep erosion, with some horizontal erosion, and agglomerating ‘bed’, and sometimes there happens mud-stone flood.

9. *Proluvi agglomerating plot*

Usually disposing at the end of sunken spout of temporary flow in forms of sloping surfaces, a bit prominent, at sloping level 5-8o, some places 10-15o. The creation of the surface covering layer includes macadam, grit, pebble, rolling stones, with unstable thickness. The main exogenous process is agglomeration and away-washing.

Group of terrain forms created by regular flow activities

10. Lower alluvial ground

The surface is smooth, develops not continuously along the river. The approximate height is 0.5-1m, greatly changing according to seasons. The creation components of the surface covering layer includes sand, pebble, with clay powder. The dominant exogenous includes agglomeration, buried agglomeration and flood.

11. Undivided terrace complex

The terrain form is shown by rather smooth surface with the average sloping level 3-8°, mainly in the places where the big streams in the region meet.. Creation movement and exogenous process effects cause changes and inability to analyze the terraces by creation

periods, so we temporarily arrange them in the form of terrace complex without division. The creation components of the covering layer include powder sand, pebble mixed with carved stones. The main exogenous process includes away-washing, washing and flooding agglomeration. *12. Erosion-agglomeration basin bottom*

Mainly developing in the widened basin of the main river, and the flow is smoother than other river parts. The horizontal side face of this terrain form is widened in U letter form, the vertical side face is sub-staged and there are usually chutes and waterfalls. The surface creating components are mainly pebbles, sand powder mixing. The main exogenous process is agglomeration, sloping and sometimes away-washing.

❖ ***Group of terrain forms created by Karts activities***

13. The surface of denudation – away washing

Disposing in the north of the lake bed with the average height 1300-1400m. The surface is divided by interstices, alleys, basins, karts hollow, causing the terrain with obstacles with group of tower and half-tower shaped peaks, connecting in square network, with the surface lengthening within the watershed between Ma river and Da river.

❖ ***Group of terrain forms created by human's activities***

14. Man-made reservoir

Until now in the research scale, there has been no reservoir built with remarkable area, or in other words, the reservoir system building is out of care here. But in the future, when building Trung Son hydro electric dam, a reservoir of medium area, about 14.7 km2 , is to be built (according to Electricity Consultant Construction Company No.4). This reservoir shall have the bed in basin of Ma river and its auxiliary streams, from the spillway line to upper water source with code 160m high. Then the main exogenous process in the reservoir area shall be agglomeration-accumulation and bank blowing.

15. The system of traffic roads and their cut and fill slopes

Although the map cannot show perfectly, this is the important terrain form due to people's activities because it can cause very quick influences on the traffic activities, and the economic development in the region. With this terrain form, especially on the cut and fill slopes at the gravity slope, the blowing-collapsing process will happen even more strongly. Besides, the traffic routes across the river and stream opening will be threatened by blowing flooding.

c) Landscape of project area

The area of reservoir and workhead has been significantly affected by human activities. This area is dominated by agricultural plants (dry rice and corn), industrial plants (bamboo), and residential areas. Stream areas mainly covered by small trees, unused land and rock banks.

2.1.1.3.Geological conditions

1. General geological setting

a) Genaral geological structure

The studied area in particular and NE region in general is located within a tectonic structure zone where is impacted by clashing and sunken suction actions caused by Indian-Australian part and below the European-Asian part about 50 million years ago creating a compressive status and uneven stretching within the our country's hydrosphere; together with that are hand differential movements which have created the topography and new

tectonic structure of Vietnam in general and of the studied area in particular where are characterized by being cut into blocks and in the trend of going down toward East and South East.

b) Fault systems

The studied area is located between two grade I active faults namely Song Ma and Son La, these both faults are seismic generation faults. The Son La fault is some 16km far from dam site 3 alternative. Song Ma fault is some of 19-19.5km from the dam site. Right at the dam site area, there are faults of grade IV and V developing in NW-SE, NE-SW directions.

c) Rock and soil permeability

Referring to topographical, geological, engineering geological and hydrological characteristics, considering the Full Supply Level of 160m assigned to the proposed reservoir it has been understood that the watershed where the reservoir will be created is distributed with bedrock formations characterized with watertight features. The watershed elevation of the reservoir is much higher than FSL, width of watershed's top is rather large therefore no potentiality of losing water from the reservoir to other catchments area is found.

2. Engineering geological conditions at selected dam site option

a) Dam site

Left bank and river bed at dam site 4A alternative fall within area distributed with sericite quartz foliated rock of member 2 of Song Ma formation. The right bank belongs to the upper part of member 1 comprising of mica quartz schist rock, the could be possibility that the rock is weakly foliated therefore having higher strength. In general the bedrock is strongly weathered, uneven, surface of hard rock of IIA layer has serrated shape and deeply located.

The dam will be 88m high, 455m long, both dam abutments are rather gentle, left bank and right bank are 25o and 30osloping respectively. Generally, dam site 4A has rather thick weathering zone, surface of IIA rock on left bank is some of 40m beneath the ground, and down to 50m on right bank, at river bed, thickness of the to be excavated layer of sand and gravel is 3-6m on top of IIA rock layer, foliated rock found here is of weak and strongly foliated rock.

b) Spillway

Spillway IV will be located at a hill on left bank of dam site IV alternative, strata distributed at spillway downwardly comprising of edQ, IA1, IA2, IB, IIA of mica quartz schist, sericite quartz. In the design, the spillway sill, top of chute and plunge pool are all located on mica quartz schist, sericite quartz of IIA layer, medium hard, rock sample under saturated state has compressive strength of 200kg/cm2, which means the spillway is ensure with stable operation.

c) Waterway

Waterway 4A comprises of intake, tunnel, and powerhouse. The whole alignment is located on a hill, left bank of Ma river, being within area distributed with schist of Song Ma formation. In general strata found in tunnel alignment comprises of edQ, IA1, IA2, IB, IIA, IIB layers. As revealing from document resulted from physo-geology investigation, from drilling work provided at tunnel alignment, the surface of hard rock is rather shallow

located but being interfered by two faults of grade IV. As showing in the design, the tunnel alignment is located exposed on ground, founded on layers of IA2, IB, and IIA.

There are three faults namely IV-6, IV –7 and IV-9 crossing waterway alignment. Since rock has dipping angle of 40-50o, dipping toward NE, the weathered soil layer is rather thick, suitable support methods shall be applied to maintain long-term stability of slopes, particular the slopes on right banks of waterway foundation.

3.Geological condition of basin

According to the document of BU36, BU40, BU41 borehold, the layer includes basin alluviums with components of clay, rust and limestone with 3-6m thick on the above. The below is sericit, mica IIA, IIB. According to experiement of water pressure, in the IIA basin, it losses 16,7 lugoen, IIB losses lesser 1 lugoen.

2.1.2 Climate and hydrographical features

2.1.2.1 Available data and records

List of meteorological-gauging stations and period of recording in ma river basin in presented in table 2.1

Table 2.1: List of meteorological-gauging stations and recorded parameters

N^o	Station	Recorded parameters	Recorded
1	Tuần Giáo	Rainfall, evaporation, temperature and wind	1961-2007
2	Điện Biên	Rainfall, evaporation, temperature and wind	1959-2007
3	Sơn La	Rainfall, evaporation, temperature and wind	1961- 2007
4	Sông Mã	Rainfall, evaporation, temperature and wind	1962-2007
5	Mộc Châu	Rainfall, evaporation, temperature and wind	1961-2007
6	Mai Châu	Rainfall, evaporation, temperature and wind	1961-2007
7	Lạc Sơn	Rainfall, evaporation, temperature and wind	1961-2007
8	Hồi Xuân	Rainfall, evaporation, temperature and wind	1956-2007
9	Nho Quan	Rainfall, evaporation, temperature and wind	1961-2007
10	Yên Định	Rainfall, evaporation, temperature and wind	1965-2007
11	Bái Thượng	Rainfall, evaporation, temperature and wind	1961-2007
12	Như Xuân	Rainfall, evaporation, temperature and wind	1964-2007
13	Tĩnh Gia	Rainfall, evaporation, temperature and wind	1964-2007
14	Thanh Hoá	Rainfall, evaporation, temperature and wind	1955-2007

(Source: Report on climate and hydrographical conditions made from Centre of Applying Technology KTVT – MoNRe, prepared by PECC4)

2.1.2.2 Climate conditions

The project area has climate characteristic of west north area of Vietnam at the west side of Hoang Lien Son mountainous range; indirectly affected by monsoon leading to its temperature in winter season higher than that of east north area. Climate of the area is clearly divided into two seasons:

+ Rain: Rainy season lasts 6 months, starting from April and ending in October with average rainfall accounting of 79 – 85.2 total annual rainfall. This creates favor conditions for growth and development of many plants. In contrary, the dry season is featured by small rainfall and drought having negative impact on development of plants.

+ Wind regime: Hot and dry wind coming from the west often occurs in Thanh Hoa and Son La provinces during April to September, especially during April – May leading to low humidity during the period, which has negative impacts on development of plants.

+ Temperature: The average temperature of the area is 18.6 C degree. The hottest months are May, Jun and July with average temperature of 23-34 C degrees and the coolest months are December, January and February with average temperature of 15.9 C degree.

+ Humidity of air: Annual average humidity is in range of 84 – 89%

Overall assessment: The area could be considered as a dry area in Vietnam with total annual rainfall below 1,600 mm and long dry season (5 – 6 months). The most difficulty in the area is the shortage of water during dry season. Therefore, construction of the project reservoir besides purpose of power generation is a positive factor to improve climate condition of the area and supplement water to the area during dry season.

Table 2.2: Monthly raining amount in representative stations in Ma River Basin (mm)

Month/ Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Năm
Tuần giáo	23,5	28,9	56,5	128	212	304	303	279	134	69,1	39,7	20,7	1597
Điện Biên	22,8	31,8	50,7	105	190	264	301	303	148	66,3	33,8	22,5	1538
Sơn La	18,9	29,2	49,4	112	195	254	266	271	131	67,0	34,8	15,5	1443
Sông Mã	13,2	17,6	36,1	90	155	216	217	230	111	40,9	24,8	13,5	1165
Mộc Châu	22,4	22,4	41,7	100	179	242	262	319	261	125	38,2	15,4	1628
Mai Châu	14,3	11,7	29,5	94	197	264	311	332	289	169	37,0	11,1	1760
Lạc Sơn	29,7	29,1	50,6	97	222	269	300	358	308	210	84,7	25,3	1984
Bản Khá	33,1	34,0	44,3	125	185	224	253	337	151	78,0	40,6	20,6	1525
Sốp Cộp	19,2	19,7	43,2	107	162	212	229	234	114	61,8	31,9	20,1	1253
Yên Châu	10,8	14,9	39,0	97,5	148	210	218	246	133	59,5	20,8	11,5	1210
Hồi Xuân	14,5	16,6	33,9	92,3	222	257	337	338	276	145	40,4	15,7	1788
Nho Quan	25,1	25,9	51,1	90,5	189	239	261	343	344	232	88,4	24,7	1914
Yên Định	16,5	18,2	32,6	63,9	162	197	175	258	319	201	75,9	16,2	1535
Bái Thượng	27,0	26,1	46,8	91,8	249	258	242	321	346	238	95,8	25,1	1966

2.1.2.3 Hydrological conditions

a) General features:

Ma river is originated from Pu Huoi Long mountainous area (Lai Cau province) at elevation of 2.179 m. This area is featured by mountain peaks and highland area. Average elevation of the river catchments is 760 m with highest peak at above 2,000 m.

Ma river's catchments area is located between two high mountainous ranges in west north – east south direction. The first range is on the left of the river spreading from Tuan Giao to Trung Son and the second range is at the right side of Ma and Chu rivers. A distinguished feature of the area is highland area, which is easy to observed in up and middle of the basin.

The main dam area is expected located in the middle stream in Ma River. The river is in Vietnam territory, apart from main river, there is Quanh river branch which has its origin from Yen Chau mountain in Son La Province flowing into Ma River with Ban Nhuc river section is 0.7km far from the alternative 3 on upstream.

The branches level 2 and level 3 of Ma river has its quite high destiny, with fishbone- form with 2-3 km long. The most typical character of river system has meridain approach and strong winding. The longtidue of rivers is quite low in downstream and sudden shift in upstream.

Table 2.3: Features form of Ma river basin to the project site

Dam site alternative	Catchments area (km2)	Length of the river (km)	Width of the basin (km)	River network density (km/km2)	Average elevation of the basin (m)	Slope of river (%0)
A 4A	13175	239	55	0.68	760	4.51

(Source: Report on climate and hydrographical conditions prepared by PECC4)

b) Annual flow:

Total annual rainfall in the river basin to project site is low, about 18.7 billion m3 in average equivalent to rainfall of 1420 mm, Total annual flow to the dam site is 7.7 billion m3, equivalent to flow module of 18.5 l/skm2 and flow level of 584 mm. Flow factor at the area is low at 0.41 liter. Because the river bed is at basic erosion level therefore water flow from under ground to the reservoir is 4.38 l/skm2, accounting for 26.7% of total flow to the reservoir. Dry and hot climate, high level of evaporation of the reservoir, which is 400 mm higher than actual evaporation of the basin present the feature of the area.

Table 2.4: Water feature of Trung Son reservoir's basin

P	R	U		E	W	α
(mm)	*(mm)*	*(mm)*	*%*	*(mm)*	*(mm)*	
1,420	584	156	26.7	836	992	0.41

(Source: Report on climate and hydrographical conditions prepared by PECC4)

❖ **Flood season:**

Flood season is not the same for the whole basin of Ma river. Upstream and middle stream area is far from the sea. Flood season in the area is from June to October with average flow module of 34 l/skm2, accounting for 74% of total annual water flow. Flood season in the downstream area, which is close to the sea, is a month later than that in upstream and middle stream areas. Starting from July and ending in November. The flow module in the area is 50 l/skm2, accounting for 75% of total annual flow. In Chu river, flood season starts in July to October with flow module of 35.4 l/skm2, which accounts for 61.9% of total annual flow. Month, in which the largest flows often occur is sooner in upstream compared to downstream. In upstream, the largest flow is often occurs in August with average flow module of 47 – 52 l/skm2, accounting up to 20% of total annual flow. The highest flow occurs in November with average flow module of 80 – 100 l/skm2, accounting for 24 – 25% of total annual flow. In Chu river, the largest flow occurs in September with flow accounting for 19.6% of total annual flow.

Table 2.5: Flow distribution at Cẩm Thủy gauging station

Features	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	Ave
Q *(m^3/s)*	140	118	104	108	156	**365**	**620**	**876**	**821**	**408**	250	328	360
%	3.23	2.72	2.4	2.49	3.62	8.43	14.3	20.3	19	9.43	5.78	7.58	

The big floods on the Ma River Basin are caused by that the storms, the tropical low-pressure, or the cool-air makes big rains. The month with the highest flow is month IX

– this is the time of the highest frequency of storms, tropical low pressure. The consequence is the crest of flood module of Ma River Basin is not so high, about 450 l/skm2 on the main stream, and about (1.000÷2.000) l/skm2 on the small rivers and the flood period is long.

The downstream of Ma River flowing into the plain which has the small slope of the river (below 10/00), the river is winding and on the area of radius 50km far from the river mouth, there are two contributories Buoi and Chu rivers joining into Ma River. There is some difficult with the flood drainage and made the waterlogged problem to the plain. If the total of rainfall is about (300÷400)mm, there is the waterlogged problem to about 10.000ha in the lowland. According to the data of the Irrigation Management and Plan Institute, the area of Ma River which usually is in the waterlogged problem is about 44,000ha each year.

❖ **Dry season:**

Dry season in the basin lasts about 7 to 8 months with total flow according for less than 30% of total annual flow; flow module of dry season is approximately 1/4 module of that in flood season. The period of three consecutive months, which has lowest flow, is often from February to April with the total flow of about 7.6% the total annual flow. The average flow module in this period is only 6.29l/skm2. The month of which the flow is smallest is March with the flow amount is only 2.4% the total annual flow. The average module of the stream is 5.94l/skm2.

According to calculation of Power Energy Consultation Company 4, the average annual flow at Trung Son is 244m3/s. The distribution of flow by season, monthly flow, and flood peak flow for various frequencies were also calculated and presented in below tables.

Table 2.6: The statistical parameters of yearly flow at dam site

F (km2)	N (year)	Qo (m3/s)	Cv	Cs	Qp (m3/s)		
					10%	50%	90%
13.175	47	244	0.25	2Cv	325	239	172

(Source: Report on Climate and Hydrological conditions prepared by PECC4)

Table 2.7: Distribution of flow by season in correspondent to designed frequencies

Frequency	**Flood Season (VI-X)**		**Dry Season (XI-V)**		**Year**
	α (%)	**W (10^6m^3)**	**α (%)**	**W (10^6m^3)**	**W (10^6m^3)**
P=10%	81.0	7,543	19.0	1,779	9,322
P=50%	71.1	5,238	28.9	2,130	7,368
P=90%	72.1	3,821	27.9	1,478	5,299

(Source: Report on Climate and Hydrological conditions prepared by PECC4)

Table 2.8: Distributions of monthly flows in typical years.

Year/month	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**Year**
Years with abundant water volume 1960-1961, p=10%	226.6	567.8	1082.9	633.9	351.1	194.8	148.2	83.4	70.5	58.3	51.5	68.3	294.8
Years with average water 1981-1982, p=50%	291.2	307.4	594.9	515.7	287.3	195.1	136.1	103.0	95.26	83.3	99.5	99.3	234.0
Years with small volume of water 1968-1969, p=90%	168.3	164.9	487.1	361.3	200.6	133.5	90.1	70.6	56.1	48.5	64.6	71.4	159.7

(Source: Report on Climate and Hydrological conditions prepared by PECC4)

Table 2.9: Results of calculation of flood peak discharge at dam site

Unit: m^3/s

Calculated site	F*(km^2)*	P%				
		0.1	0.5	1	5	10
Cẩm Thuỷ Station	17,500	14,900	11,600	10,200	7,050	5,730
Dam site	13,175	13,400	10,400	9,100	6,200	5,000

(Source: Report on Climate and Hydrological conditions prepared by PECC4)

It could be concluded that water flow to Trung Son reservoir is not abundant and unequal distributed by season. Flood season usually lasts from June to October with total flow accounting for 70% of the annual total flow. The biggest flow appears in August and the smallest flow occurs in March. The biggest flow may be 7 to 18 time bigger than the smallest flow depending on water flow to the reservoir is big, small or average.

c) Total sediment of the reservoir:

Sediment of Trung Son reservoir is calculated based on the muddy level of water at Cam Thuy station. Sediment of the reservoir comprises two components: river bed and suspended sediments. River bed sedimentation is estimated at about 20% of suspended sediment.

Total annual sediment accumulated at Trung Son reservoir in selected alternative is 1,301,000 m3.

Table 2.10: Calculation results of accumulated sediment at Trung Son reservoir

N_o	Feature	Value
(A)	Average muddy level,δ (g/m^3)	222
(B)	Suspended sediment volume, R_o (kg/s)	54.2
(C)	Accumulated sediment ratio, E	0.75
(D)	Weight of suspended sediment, γ_{ll} (ton/m^3)	1.182
(E)	Weight of river bed sediment, $\gamma_{dđ}$ (ton/m^3)	1.554
(F)	Total accumulated volume of suspended sediment, V_{ll} (m^3/year)	1084047
(G)	Total accumulated volume of river bed sediment, $V_{dđ}$ (m^3/year)	216810
(H)	Total annual accumulated sediment (10^6m^3/year)	1.301
(I)	Total annual accumulated sediment in 00 years (10^6m^3)	130.1

2.1.3 Current situation of natural environment, its sensitivity and absorption capacity

2.1.3.1 Current condition of air:

The project area is located at high mountainous area of western region of Thanh Hoa province. This is the resident place of ethnic minorities, whose main activities is agriculture (planting rice and subsidiary crops) and forestry. Industry has not yet been developed in the area. Therefore, air in this area is of good quality and has not been polluted by industrial gas emission. In addition, its forest area is also in good condition and having low population density therefore it still remain the environment balance due to self clean mechanism of nature.

In order to assess the quality of air at project area, PECC4 and Center for Environmental Research and Community Development has conducted surveys and colleted analytical samples in August 2007 at project site.

Comparison the analytical results presented in table 2.10 and Vietnamese standard it could be concluded as below:

+ Noise level: compared to Vietnamese standard TCVN 5949 : 1998 the current noise level is at acceptable level.

+ Air quality: compared to Vietnamese standard TCVN 5937 : 2005 all of measured factors are below the permitted value in the standard . It is concluded that air environment is very good condition.

a) The current condition air in the river bed

Table 2.11: Analytical results of quality of air at project area

Samples	Indicators						
	Hanging dust (mg/m^3)	Dust PM10 (mg/m^3)	Dust Pb (mg/m^3)	NO_2 (mg/m^3)	CO (mg/m^3)	SO_2 (mg/m^3)	Noise (dBA)
Chiềng Nam village	0.097	0.070	0.00068	0.002121	0.298948	0.011156	29.8
Co Me village	0.088	0.061	0.00062	0.001937	0.363936	0.010527	30.4
Applied standard	0.20	0.15	0.0015	0.20	30	0.35	75
	TCVN 5937-2005						**(TCVN 5949-1998)**

(Source: Center for Environmental Research and Community Development)

***b)* The current condition air in the beginning area and lowland**

Table 2.12: Analytical results of quality of air at the beginning area and lowland

Samples	Indicators						
	Hanging dust (mg/m^3)	Dust PM10 (mg/m^3)	Dust Pb (mg/m^3)	NO_2 (mg/m^3)	CO (mg/m^3)	SO_2 (mg/m^3)	Noise (dBA)
Co Me village	0.088	0.061	0.00062	0.001937	0.363936	0.010527	30.4
Bản Tạo (School)	0.114	0.083	0.00091	0.001895	0.489310	0.010678	45.9
Near bridge Chiềng	0.114	0.083	0.00091	0.001895	0.489310	0.010678	45.9
Co Lương village	0.138	0.100	0.00091	0.003828	2.598459	0.017143	59.0
Applied standard	0.20	0.15	0.0015	0.20	30	0.35	75
	TCVN 5937-2005						**(TCVN 5949-1998)**

c) The current situation of air in the resettlement area

The construction area is located in the river bed and its has the same air in the construction area, therefore, the document has also has the nature of air invironment as in the resettlement area.

Observation and monitoring of environmental quality will be continued implementing during project construction to control the poisonous substance in the air to ensure the level of the poisonous substance will not exceed the permitted level to prevent negative impacts to people and natural environment.

2.1.3.2 Current situation of water environment

In order to assess the quality of water resource at project area, PECC4 and Center for Environmental Research and Community Development has conducted surveys and colleted analytical samples in August 2007 at project site.

No	Sample code	Place whether samples were collected	Date of collection
1	**At the river bed area and resettlement size**		
	NTS 1	Near Lát village - Mường Lát	31/08/2007
	NTS 2	100m from Lat stream- Mường Lát	31/08/2007
	NTS 3	100 downstream of Chà Lan stream	31/08/2007
	NTS 4	Chiềng Nưa village	31/08/2007
	NTS 5	Quanh stream - Tà Pán village	31/08/2007
2	**At the beginning and lowland size**		
	NTS 6	Trung Sơn commune	31/08/2007
	NTS 7	Between two villages Dồn and Chói	31/08/2007
	NTS 8	Xia stream - Co Lương	31/08/2007
	NTS 9	Mã river - Co Lương	31/08/2007

Compurgation of analytical results with Vietnamese standard TCVN 5942 : 1995 shows that all of tested indicators are below the permitted level of the standard, except the hanging solid substance indicator, which is 8 time higher than standard in volume A and two time in volume B. It may be because the sample was taken during raining so that hanging solid substance indicator is higher than permitted level.

Table 2.13. Analytical results of water quality at the project area

No	Indicators	Unit	Sample codes									TCVN5942-1995	
			NTS 1	NTS 2	NTS 3	NTS 4	NTS 5	NTS 6	NTS 7	NTS 8	NTS 9	Vol A	Vol B
1	pH	-	7.32	7.36	7.35	7.66	7.48	7.50	7.68	7.41	8.12	6-8.5	5.5-9
2	BOD_5	mg/l	4.9	4.9	5.1	5.3	5.4	5.2	5.5	6.0	5.6	<4	<25
3	Colour	(Pt-Co)	76.211	68.471	62.047	62.296	66.490	59.754	43.218	30.769	45.041	-	-
4	Smell	-	No smell	No smell	No smell	No smell	No smell	No smell	No smell	No smell	No smell	-	-
5	Taste	-	No	No	No	No	No	No	No	No	No	-	-
6	COD	mg/l	8	9	9	8	8	9	10	10	9	<10	<35
7	DO	mg/l	6.43	6.51	6.59	6.79	6.73	6.60	6.51	6.44	6.83	≥6	≥2
8	Hanging solid substance	mg/l	197	189	152	180	160	165	178	140	196	20	80
9	Fe^{2+}	mg/l	0.124	0.122	0.010	0.012	0.017	0.016	0.029	0.015	0.111	1	2
10	Fe^{3+}	mg/l	0.020	0.021	0.018	0.021	0.022	0.020	0.025	0.023	0.027	1	2
11	NH_3	mg/l	0.678	0.725	0.790	0.796	0.811	0.823	0.860	0.785	0.925	0.05	1
12	NO_3^-	mg/l	2.079	3.011	2.246	2.325	2.405	2.487	3.034	3.322	4.065	10	15
13	NO_2^-	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0.285	0.287	0.126	0.132	0.139	0.143	0.152	0.738	0.174	-	-
15	Total mineral level	mg/l	80	86	82	86	88	92	98	177	95	-	-
16	Coli form	MNP/100ml	290	290	230	240	250	280	300	320	360	5000	10000

Note: TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

2.1.3.3 Current situation of soil

❖ **Classification of soil in the reservoir area**

According to land map of Thanh Hoa province revised in 2004 by Institute of Planning and Agricultural Design and supplement survey results of PECC4, there are following types and categories of soil in the project area:

Table 2.14: Types of soil in the reservoir area

Vietnam classification	FAO-UNESCO classification
I - Alluvium 1. Ma River Alluvium	**I- Fluvisols** 1. Umbric Fluvisols
II- Black soil 2. Black soil on withered products of limestone	**II- Luvisols** 2. Calcic Luvisols
III- Worn-out grey soil 3. worn-out grey soil on withered products of axit magma	**III- Haplic Acrisols** 3. Arenic Acrisols
IV- Yellowish red soil (Feralit) 4. Brown and red soil on medium magma and base 5. Brown and red soil on limestone 6. Brown and red soil on clay and degenerated stones 7. Brown and red soil on granite.	**III- Ferralsols** 4. Rhodic Ferralsols 5. Rhodic Ferrasols 6. Rhodi-Leptic Acrisols 7. Chromic- Leptic Acrisols
V- grayish yellow Humus (Feralit) 8. Mountainous Yellowish red humus and grayish yellow humus	**IV- Humic Acrisols** 8. Humic Acrisols , Humic Ferralsols
VI – Mountainous Alit Humus 9. Mountainous Alit Humus	**V- Aplitic Humic Acrisols** 9. Aplitic Humic Acrisols
VII- Splitting soil 10. Splitting soil	**V- Mixed Gley Sols** 10. Mixed Gley Sols

1. Alluvial land *(P)*

Alluvial land is distributed into narrow lines along Ma river and subsidiary streams in Quan Hoá, Mường Lát districts (Thanh Hoá province) and Vạn Mai, Mai Châu communes, Hoà Bình province. Alluvium of this basin has a reasonable fertility, concentrated mainly in alluvial ground by the river, most of them would be strengthened yearly, which is suitable for farming products, bean, and mulberry.

2.Wornout grey soil *(X)*

Worn-out grey soil generates from withered products of granite or antique alluvium and flood reserves, being distributed here and there at diluvia steps at the foot of slopes

developing on granite, interpolating with diluvia flats at the foot of granite mountains or on the antique alluvium floors which are 8-12m in height in communes of Muong Lat district, Quan Hóa, Thanh Hoá province.

Worn-out grey soil has a grey layer of farming soil, poor in clay percentage of which is usually less than 10%. The soil has a light component, being sour and low percentage of fertility. The land is developed in small pieces to raise rice, farming products, vegetables, beans and peas, fruit trees, etc.

***3.Black soil** (R)*

There is only one type of Black soil in the basin, which generated from the withered products of worn-out limestone and accumulated in basins or narrow chinks between limestone mountains in some fields of the limestone basins in Mai Châu district (Hoà Bình), Vạn Mai limestone mountains and the nearby of Quan Hoá, Thanh Hoá province.

The Black soil has a black colour, with an average 0.6-1.0 m layer in depth and high percentage of clay, mainly more than 60%, and containing mineral clay monmoriloit. Its caption absorb capacity is high (60-80mili unit/100g soil). The ground is not very slope, full of organic (4-5%), and very high volume of fertility, therefore it is used in rice raising, farming products etc... with high productivity.

4. Yellowish Red soil (Feralit)

Yellowish red soil (Feralit or Ferrasols) is usually distributed at the height of less than 100m and the largest area of covering ground in the basin.

There are 4 types of Yellowish red soil of the Ma river basin in Trung Son Project area:

+ **Reddish brown soil on medium magma and base (Fk)**

Soil generated from medium rocks and base being distributed in Quan Hoa, Thach Thanh (Thanh Hoa) is very rich. Therefore it is deeply used to develop cafe, tea, fruit trees, corns, potatoes and beans and peas, etc. with high and stable productivity.

+ Reddish brown soil on limestone (Fv)

Reddish brown soil generating from the withered products of limestone is often distributed in Moc Chau (Sơn La); Cô Lương, Mai Châu, Hoà Bình province and limestone mountains a long with Ma river near Quan Hoa town, Thanh Hoa province. These are some main features of the reddish brown soil:

Reddish brown soil generating from withered products has a high volume of fertility so it is suitable to many kinds of plants. Therefore, local people have established permanent fields to plant corn, tomatoes, vegetables and beans and peas which gain high and stable productivity.

***5. Reddish brown soil generating from clay and withered rocks** (Fs-Fj)*

Reddish brown soil generating from clays and withered rocks has a golden and red colour at all section, being distributed in Xuân Nha, Mộc Châu (Sơn La), Mai Châu (Hoà Bình) and the low hills and mountains of Quan Hoá, Mường Lát of Thanh Hoá province, therefore the covering soil of red and brown has a average depth of 1.5-2.0m. It has strong cutting topography, 15-20° slope, some of them is 30-35°. Because of the subclass of schist and slope topography, soil on the slope side and line would be easy to fall down in rain and flood reasons. People in Mai Chau, Quan Hoa have used the reddish brown soil for planting

bamboo, material forests for manufacturing papers, and used under 15o slope for planting food plants and industrial plants and fruit.

6. Reddish yellow, grayish yellow soil generating from granite (Fa)

Reddish yellow and grayish yellow soil generating from granite is distributed mainly in Muong Lat, Thanh Hoa, which has difficult slope and very slope terrain, layer is usually from 0.7 to1 m in depth, which is thinner than those generating from clay and withered rocks, in order to maintain the water providing of the basin, there is no better way than strictly protecting all the riverhead forests because most of them are able to reproduce and develop quite well on all areas of yellowish red and grayish yellow soil generating from very slope granite(Fa)

7. Reddish yellow humus and grayish yellow humus (Humus-Feralit) *(HFs -HFa)*

Reddish yellow humus (humus-Feralit) generates in the height of 900-1800m of the medium mountain peaks in the boundary of Thanh Hoa- Son La, Thanh Hoa- Hoa Binh provinces and the medium and high mountains at the Viet Lao borders (Phu Quan- 1,888m, Pu Si lung- 1,287 m, Phu Luông- 1,676 m, Chòm Pan- 1,700 m)...;

Many parts of this land are covered by forests, the soil is rich in organic, the speed of water soaking is high, capacity of water storing is high, and this is also a land of the riverhead biological water environment of most rivers in the basin. Therefore, forests of this land should be protected strictly.

8. Mountainous Alit Humus (HA)

Research on soil and tropical humidity of Vietnam show that the withered Alit layer generates and develop on the high band of 1800-2800 m in height. (1,888m). However, because of the high volume of protein and the thick rotten layer, soil is able to preserve and establish riverhead flow for many rivers and streams. Therefore, protecting forests is the important measure to protect the ability of frequent water supply to the Trung Sơn water reservoir.

9. Splitting soil *(D)*

Splitting soil generates and develops along with washed-up products of various kinds of mountainous and hill soils preserved at the foot of less slope sides or narrow slope slits, therefore it is distributed diversified. The volume of fertility and structure of splitting soil depend a lot on the soil features of the nearby mountainous and hill soil. This is also a main region of planting farming products and food of residents of the mountainous Mai Chau and Quan Hoa, Muong Lat.

*** Land use situation in the total area**

Total natural area of the project region is 78,823.51 ha, of which forestry production and agricultural land is 62,471 ha, accounting for 79.25% of total natural area. Of the land, agricultural land is 10,407.67 ha, accounting for 16.66% and remaining is forestry land of 52,045.78 ha, accounting for 83.31%.

Table 2.15: Current land use situation in project area's communes

Unit: ha

Land type	Thanh Hoa province	Son La province

	Total	Quan Hoa district	Muong Lat district				Moc Chau district
		Trung Son commune	Total	Trung Y commune	Tam Chung commune	Muong Ly commune	Xuan Nha commune
Total natural land	78,823.51	7,934.13	40,846.82	19,290.32	13,048.11	8,508.39	30,042.56
1. Agricultural land	62,471.19	6,311.99	36,071.37	17,876.59	10,590.85	7,603.93	20,087.83
1.1. Agricultural production land	10,407.67	738.99	5,707.65	3,045.72	1,092.01	1,569.92	3,961.03
1.1.1. Annual plant land	10,065.02	726.71	5,667.85	3,036.86	1,075.07	1,555.92	3,670.46
1.1.2. Long term plant land	342,65	12.28	39.80	8.86	16.94	14.00	290.57
1.2. Forestry land	52,045.78	5,572.30	30,351.98	14,830.67	9,491.80	6,029.51	16,121.50
1.3. Aquatic product land	17.74	0.70	11.74	0.20	7.04	4.50	5.30
2. non-agricultural land	1,496.47	456.80	825.18	317.90	268.44	238.84	214.49
2.1. Residential land	162.40	26.80	75.60	22.50	27.60	25.50	60.00
2.2. Specific purpose use land	263.14	34.00	179.55	79.90	44.00	55.65	49.59
2.3 Cemetery land	17.54	9.00	8.54	8.50	0.04		
2.4 Streams and rivers	1,053.39	387.00	561.49	207.00	196.80	157.69	104.90
3. Unused land	14,855.85	1,165.34	3,950.27	1,095.83	2,188.82	665.62	9,740.24

(Source : Land office and statistic office of Quan Hoa, Muong Lat, Moc Chau districts and estimated areas based on current land use situation maps, scale of 1 :10,000)

Non-agricultural land is 1496.47 ha, representing 1.9% of total natural area including: Residential land of 162.4 ha, accounting for 10.85% of non agricultural land; specific purpose land of 263.14 ha, accounting for 17.58%; other no-agricultural (streams and rivers, cemetery land, etc) is 1,070 ha, accounting for 71.56%.

Unused land is 14,855.85 ha, accounting for 18.85% of total natural area, of which flat area is only 266 ha, the remaining is hilly and mountainous area or streams and rives surface.

Almost of production land in the project area has been allocated to the local households including currently unused and rotational cultivation land. According to the statistical record, in average each household has 2.4 ha of production land excluding production land which is not registered with local authorities. The figure is highest Nha communes with 2.62 ha/HH and lowest in Trung Son commune with 1.4 ha/HH.

- **Current land use situation in riverbed and in project site**

According to the researching result of PECC4, the current land use situation in riverbed and in project site is divided into the diffent types as follows:

Table 2.16: Current land use situation in riverbed and in project site

Unit: ha

No	Names	Residential land	Long term plant land	Annual plant land	Forestry land	Streams and rivers, rocks	Cemetery land	Total
1	**Thanh Hoá Province**	**10,24**	**7,78**	**88,29**	**702,09**	**127,13**	**0,03**	**935,55**
	Quan Hoá District	5,76	4,20	73,32	410,96	19,80	0,03	514,07
	Mường Lát District	4,48	3,58	14,97	291,13	107,33	0,00	421,48
2	**Sơn La Province**	**5,04**	**8,59**	**204,52**	**367,26**	**15,50**	**2,50**	**603,4**
	Mộc Châu District	5,04	8,59	204,52	367,26	15,50	2,50	603,4
3	**Total**	**15,28**	**16,37**	**292,81**	**1069,35**	**142,63**	**2,53**	**1538,95**

(Source: Report of Contruction Damage Research prepared by PECC4)

- **Current land use situation in the expected resettlement areas**

According to the researching result of PECC4, the current land use situation in the resettlemnt areas is divided into the diffent types as follows:

Table 2.17: Current land use situation in resettlement areas

Unit: ha

No	Land type	Total natural land	Agricultural land						
			Agricultural land	.Agricultural production land				**Production forest land**	
				Aquatic product land	Non-aquatic product land	. Annual plant land	**long term plant land**	**Forest land**	**Natural forest land**
	Total	**6021**	**688**	**19.0**	**148.0**	**516.0**	**5.0**	**660.0**	**1165**
I.	**Thanh Hoá Province**	**4919**	**526**	**17.0**	**148.0**	**356.0**	**5.0**	**660.0**	**1165**
1	**Resettlement Area 1**	**2639**	**229.2**	**8.8**	**51.0**	**168.0**	**1.4**	**627.0**	**281**
	Tà Bán village	2076	204.4	5.0	51.0	147.0	1.4	452.0	0.0
	Xước village	563	24.8	3.8	0.0	21.0	0.0	175.0	281
2	**Resettlement Area 2**	**1604**	**228.6**	**5.0**	**68.0**	**153.0**	**2.6**	**0.0**	**558**
	Nàng village	986	105.0	3.0	25.0	76.0	1.0	0.0	420

	Tài chánh village	618	123.6	2.0	43.0	77.0	1.6	0.0	138
3	**Resettlement Area 3**	**676**	**68.2**	**3.2**	**29.0**	**35.0**	**1.0**	**33.0**	**326**
	Lìn village	419	34.2	3.2	7.0	23.0	1.0	30.0	225
	Chiềng village	257	34.0	0.0	22.0	12.0	0.0	3.0	101
II.	**Sơn La Province**	**1102**	**162**	**2.0**	**0.0**	**160.0**	**0.0**	**0.0**	**0.0**
1	**Resettlement Area 4**	**1102**	**162**	**2.0**		**160.0**	**0.0**	**0.0**	**0.0**

(Resource: The report of resettlement general plan prepared by PECC4)

*** Current land use situation for tranmission line for implementing construction**

Transmission line supplying power for construction implementing with 22kV, 35kV, according to power supply alternative, the transmission line is established in 15A National Road and expected services road. The expected current area crossed by transmission line is residential land and vegetable land and forestry plant land of local people and unused land. As regulations proposed, under the 22, 35kV transmission line, it should not move houses, the small land area is used for foundation constructing location.

❖ **Soil erosion**

Soil erosion does not only reduce the thinness of soil resulting the reduction of fertility of soil, its productivity but also result to serious land slide along river banks, surrounding dam and road; degradation of flow in rivers and streams, cannels; reduction of lifetime of reservoir, water pollution; deterioration of ecological and water environment system.

Results of soil erosion are rock, gravel, sand and mud, remaining parts of fertilizers (both chemical and organic), plants protection substances such as pesticides, herbicide, mouse killing, etc, animal carrion, and other nutritive in dissolvable forms. These items would be washed and flowed to downstream areas and become one of the key factors causing pollution to the environment.

Main factors affecting to soil erosion in Trung Son area are considered including:

- Soil type: Soil types in the area are on the stable structures, which help to reduce the erosion of soil causing by surface water and win. Of the soil types in the area, the light yellow soil, this is at surface of high slope sand rock, light and not in stable structure, is the most early eroded type.
- Slope level: The area is featured with high slope level that results to large surface flow causing soil erosion and landslide.
- Rain: Rainy season starts from May and ends by September in upstream area and October in downstream area, Total rainfall in rainy season accounts for 700 – 90% of total annual rainfall. The period of three consecutive months, which has largest rainfall is June to August or July to September. During the period, during the heavy rain it is often creates floods, erosion, and land slide especially in areas having high slope level.
- Land coverage level: vegetation cover has significant impact on soil erosion. The survey results show that the land coverage in the project area in good quality, the lowest area of the proposed reservoir is covered by replanted forest. In addition,

natural resources in the areas are protected. The vegetation cover is mainly natural and planted forests. Proportion of annual trees is low therefore, the land is sufficiently protected from erosion.

2.1.3.4. Natural calamity in the area

The calamity in the construction and resettlement areas, the calamity phenomenon may occur sweeping flood, rainstorm, big flood in Ma river, and Southern west hot-dried wind.

- According to research result documents, the research of sweeping floods in Vietnam made by Professor, Ph Mr.Vũ Văn Tuấn – Deputy Director of Institute of Environmental and Science Meteorological hydrology and following to Maps of area divisions on the swept foods, the reason causes sweeping flood is because of large rain in basins, strongly affects to economic activities of people or breaks equality ecology (change of cover level, flow regime, flow or character of the basins...). Based on the map of the research of swept flood area division, there does not occur the phenomena of swept-flood in construction, riverbed and in resettlement areas. In the natural condition on the cover of these areas is very good, the mainly cover is plant forests (Luong, Bamboo) of the local people, therefore, the occurrence of sweeping flood is rarely happened.
- Annually, the local people face usually with natural calamities like floods on Ma river, rainstorm, southern west hot wind. The local people are familiar with these phenomena and prepare measures preventing these.

2.1.3.5 Current situation of ecological environment at project and surrounding area

a) Natural floristic

+ Plant species:

According to survey data taken by the Institute of Ecological and Biological resources, Institute of Geography under the Vietnam Institute of Science and Technologies in February 1988 and January 2005, and other materials published by botanists, it initially has been counted up 1873 species belonging to 152 families of high grade botanical species with vessel. (appendix 1). The number of the botanical species will be likely higher if more detailed survey to be conducted.

The identified 1873 species belong to 6 botanical branches:

1. Psilotophyta : 1 family, 1 species
2. Lycopodiophyta: 2 families, 9 species
3. Equisetophyta: 1 family, 2 species
4. Polipodiophyta: 15 families, 153 species
5. Pinophyta: 7 families, 16 species
6. Magnophyta: 126 families, 1692 species

There are 10 families with the largest number of species (more 30 species in each family) as follow:

- Euphorbiaceae : 127 species
- Fabaceae : 112 species
- Lauraceae : 83 species
- Poaceae : 59 species
- Orchidaceae : 49 species
- Fagaceae : 46 species

- Rubiaceae : 67 species
- Moraceae : 60 species
- Scrophulaceae : 33 species

There are 14 families with the smallest number of species (1 species)

- Psilotaceae
- Gnetaceae
- Bombaceae
- Caricaceae
- Chloranthaceae
- Convalariaceae
- Hippocastaneaceae
- Ixonanthaceae
- Sargentodoxaceae
- Bromeliaceae
- Polygonaceae
- Stemonaceae
- Taccaceae
- Trilliaceae

2. *Botanical resources:*

Within 1873 species, which have been counted up:

- Plants providing wood	319 species
- Plants providing medicine	592 species
- Plants providing foods	239 species
- Plants providing resin, fat oil	44 species
- Plants providing essential oil, and scent oil	15 species
- Plants providing fiber	25 species
- Plants providing tannin, dyeing material	25 species
- Plants providing foods for cattle	34 species

Within the botanical system, there are many wooden stem liana and grass stem liana, of which the most popular families are as below:

- Creepers with wooden stem: Celastraceae, custard apple (Annonaceae), grapes (Vitaceae), Gnetaceae, fragnant cynanthe (Asclepiadaceous), Myrsinaceae

- Creepers with grass stem: goldthread (Berberidaceae), Menispermaceae, Stemonetuberosa (Stemonaceae), sweet potato (Convolvulaceae), calabash (Cucurbitaceous)...

Plants providing medicines mainly belong to families of Polypodiaceae, Araliaceous, Aristolochiaceae, Euphorbiaceae, Fabaceae, Loranthaceae, Menispermaceae, Myrsinaceae, Sargentodoxaceae, Simaroubaceae, Symplocaceae, Thymeleaceae, Araceae, etc.

Plants providing woods mainly belong to families of Pinaceae, Cupressaceae, Podocarpaceae, Annonaceae, Betulaceae, Dipterocarpaceae, Ebenaceae, Elaeocarpaceae, Euphorbiaceae, Fabaceae, Fagaceae, Lauraceae, Meliaceae, and Sapindaceae...

Medlar-trees are also popular belonging to family of Orchidaceae.

❖ **Vegetation cover**

1. Ordinary tight forest with wide-leaved trees generating from soil withering from different kind of mother rocks except for limestone

Forest has a structure of 3-4 layers, including 1-2 wooden tree layer, bush layer and grass layer. The wooden tree layer is about 15-20m high with diameter of trees is about 20-25 cm. The most popular species in the layer including: Alphonsea, Polyalthia (Annonaceae), Alnus nepabensis, Betula alnoides (Betulaceae), Hopea, Vatica (Diptercarpaceae), Ficus (Moraceae).

Bush layer including small wooden trees and bush, which are normally less than 7m high. The most popular species are Diospyros (Ebenaceae); Elaeocarpus (Elaeocarpaceae); Aporusa, Bridelia, Glochidion, Macaranga (Euphorbiaceae); Litsea, Cinnamomum, Beilschmiedia, Actinodaphne (Lauraceae); Ficus (Moraceae); Catanopsism, Lithocarpus, Qnercus (Fagaceae) Manglietia, Mechelia, Magnolia (Magnoliaceae); Aglaia, Chisocheton, Dysoxylum (Meliaceae), and some species of Myrtaceae, Rosaceae, Rutaceae, Sapindaceae, etc.

Grass layer includes Adiantaceae, Dennstaedtiaceae, Dryoteridaceae, Gleicheniaceae, Poaceae, Araceae, Cyperaceae, and Zingiberaceae...

2. Ordinary tight forest with wide-leaved trees generating from withered rocks from limestone

This type of forest used to have a structure of 4 - 5 layers with many precious wooden trees with high economic value. That is why they become a subject of utility of residents, which reduces the quality and size of forests. At the moment, this type of forest is distributed here and there with about 2-3 ha in area, 3 layers of structure including 1 layer of wooden trees, 1 layer of bush and the grass layer.

The wooden tree layer has an average height of 10-15m, diameter of which is about 20cm including Hopea chinensis, Vatica chevalieri, Parashorea chinensis (Dipterocarpaceae), chi Dillenia (Dilleniaceae), Nageia fleuryi, Podocarpus pilgeri (Podocarpaceae), Mitrephora calearea (Annonaceae), Madhuca pasquieri, Allospondias lakonensis, Stroblens tonkinensis, Syzygium bonii, Pterospermum heterophyllum, Celtiss japonica, Pometia pinata, Clausena anisata, branch Ficus, and some species of Fagaceae, Lauraceae, Ebenaceae, Sterenculiaceae...

The bush layer includes small wooden trees and bushes with a height of less than 5m, which have: Apocynaceae, Arliaceae, Ebenaceae, Euphorbiaceae, Fagaceae, Lauraceae, Meliaceae, Moraceae, Myrtaceae, and Sapindaceae...

The grass layer includes Gleicheniaceae, Adiantaceae, Aspleniaceae, Poaceae, Arceae, Cyperaceae, Fabaceae, Zingiberaceae...

3. The sexual-reproduction forest between wide-leaved trees and bamboo

The dominant botanical species here are bamboos such as Arundiaria sp, some species of branch Bambusa, Dendrocalamus, Neohouzeauna dulooa.

The popular wide leaved trees include Alphonsea (Annonaceae), Elaeocarpus (Elaeocarpaceae), Macaranga (Euphorbiaceae), Dillenia (Dilleniaceae), Michelia (Magnoliaceae)...

4. Bamboo forest

This type of forest is quite popular with pure types of Bambusa, Dendrocalamus.

5. The wide leaved trees and needle-shaped sexual-reproduction forest

This kind of forest is distributed on the height of 900m. It has a structure of 3-4 layers, including 1-2 layers of wooden trees such as Cephalotaxus (Cephalotaxaceae);

Cycas (Cycadaceae); Keteberia evelymiana, Pinus kwangtangensis (Pinaceae); Dacrycarpus imbricatus, vageia fleuryi (Podocarpaceae); Acer (Aceraceae); Castanopsis, Lithocarpus, Quercus (Fagaceae)... These wooden trees are about 15-20 m in height.

The bush layer includes small trees of the big wooden trees such as Rubiaceae, Magnoliaceae...

The grass layer includes Ericaceae, Poaceae, Cyperaceae, Aralliaceae, Araceae.

6. Bushy plot

Including bushes or inferior wooden trees such as with a height of less than 5m such as; Desmos chinensis, Desmos cochinchinensis, Fissistigma (Annonaceae); Ilex (Aquifoliaceae); Acalypha, Alchornea, Mallotus, Antidesma, Bridelia (Euphorbiaceae), Rhamnus (Rhamnaceae); Rubus (Rosaceae); Randia (Rubiaceae); Helicteres (Sterculiaceae); Callicarpa (Verbenaceae)... as well as Imperata cylindarinca, Eupatorum odoratum.

7. Grass plot

This plot is established on the farming land after years of wearing out because of washed up process, including (Poaceae); Chrysopogon aciculatus, Cynodon dectylon, Echinochloa frumentacea, Eleosine indica, Imperata cylindrica, Saccharum setaria...

Asteraceae: Blumea gardneri, B. hieracifolia, B. lanceolaria, B. martiniana, Eupatorium odoratum, Artemisia annua, A. roxburghiana

Cyperaceae: Bulbostylis, Kllinga.

B)Artificial floristic composition

1. Planted forests

Planted forests account for a small percentage in the area of the floristic composition. The planted forests have some species. Bamboo forest accounts for the largest area compared with other kinds of trees such as acacia confusa Merr, eucalyptus, pinus merkussi jungh.J de Vriese. In particular, Dendrocalamus membranaceae is planted dominantly because they are suitable for the ecological condition here with high economic impact for the people.

2. Industrial plants : Sugar-cane, tea...

3. Fruit plants: Pineapple, Orange, grapefruit, longan, litchi

4. Short-term plants: Vegetables, beans, peas...

5. Food plants: Rice, Corn, potato, sweet potato.

❖ ***Rare and precious botanical species***

Within the area of the project, natural forest has been destroyed significantly because exploiting woods, fire woods and other products, within which are many rare, precious and economic-valued botanical species.

- Emergency (E):
- Very urgent (V):
- Rare (R):
- Threaten (T):

- Not available (K):

Apendix 2.28: List of rare and precious plants at the basin

No	Scientific name	Vietnamese name	Status
1	*Acanthopanax gracilistylus* W.W.Sm.	Ngũ gia bì hương	K
2	*Acanthopanax trifoliatus* L.	Ngũ gia bì gai	T
3	*Adina cordifolia* (Roxb.) Hook.f.ex Brandis	Gáo	T
4	*Aquilaria crassna* Pierre ex Lecomte.	Trầm hương	E
5	*Amentotaxus argotaenia* (Hance) Pilg.	Dẻ tùng sọc trắng hẹp	R
6	*Ardisia siluestris* Pit.	Lá khôi	V
7	*Burretiodendron tonkinensi* (A.Chev.) Kosterm.	Nghiến	V
8	*Caesalpinia sapan* L.	Tô mộc	T
9	*Carya tonkinensis* Lecomte.	Mạy chân	V
10	*Camellia pleurocarpa* (Gagnep.) Sealy	Chè lá mỏng	T
11	*Calamus platyacanthus* Warb	Song bột	V
12	*Calocedrus macrolepis* Kurz	Bách xanh	E
13	*Cephalotaxus hainanensis* H.L.Li	Đinh tùng	R
14	*Cibitium barometz* (L.) Sith	Cẩu tích	K
15	*Cinnadenia paniculata* (Hook.f.) Kosterm.	Kháo xanh	K
16	*Cinnamomum balansae* Lecomte	Gù hương	R
17	*Cinnamomum parthenoxylon* Meissn	Vù hương	K
18	*Chukrasia tabularis* A.Juss.	Lát hoa, Lát da đồng	K
19	*Colona poilanei* Gagnep.	Xuân liên thanh hoá	R
20	*Coptis chinensis* Franch	Hoàng liên trung quốc	E
21	*Cunninghamia konishii* Hayata	Sa mộc quí phong	R
22	*Delavaya toxocarpa* Fr.	Dầu choòng, Mắc rạn	R
23	*Dendrobium nobile* Lindl.	Hoàng thảo dẹt	R
24	*Dioscorea colletii* Hook.f.	Vần nghệ	R
25	*Dioscorea menbranacea* Craib	Nần đen	R
26	*Docynia indica* (Wall.) Decne	Táo mèo	R
27	*Drynaria fortunei* (O. Kuntz ex Mett.) J. Smith	Bổ cốt toái	T
28	*Fallopia mutifora* (Thunb.) Haraldson	Hà thủ ô đỏ	V
29	*Fokienia hodgisii* (Dunn) A. Henry et Thomas	Pơ mu	K
30	*Illicium ternstroenioides* A.C.Smith	Hồi chè	r
31	*Itoa orientalis* Hemsl.	Cườm đỏ	R
32	*Ketelecria evelymiana* Mast	Du sam	V
33	*Goniothalamus chinensis* Merr. & Chun.	Giác đế trung hoa	R
34	*Goniothalamus macrocalyx* Bân	Màu cau trắng	R
35	*Hopea hainanensis* Merr. et Chun	Sao hải nam, Sao lá to	E
36	*Leparis petelotii* Gagn.	Nhẫn diệp Petelot	R
37	*Madhuca pasquieri* (Duybard) H.J. Lam	Sến mật	K
38	*Mahonia nepalensis* DC	Mã hồ	V

No	Scientific name	Vietnamese name	Status
39	*Manglietia fordiana* (Hemsl.) Oliv.	Vàng tâm	V
40	*Markhamia stipulata* (Roxb). Seem	Đinh	V
41	*Melientha suavis* Pierre	Rau sắng	K
42	*Mouretia tonkinensis* Pit	Mua re bắc bộ	T
43	*Nageia fleuryi* (Hiekel.) de Laut	Kim giao	V
44	*Panax pseudoginseng Wall.*	Tam thất	E
45	*Parashorea chinensis* Wang S.Hsieh	Chò chỉ, mạy kho	K
46	*Paris polyphylla* Smith	Bảy lá một hoa	R
47	*Pauldopia ghorta* (Buch.-Ham.ex G.Don) Steenis	Đinh vang	V
48	*Pvieasia annamensis* Pierre ex Lecomte.	Chông, Cò kén	R
49	*Pinus kwangtungensis* Chun ex Tsiang	Thông pà cò	V
50	*Polygonatum kingianum* Collettet Hemsl	Hoàng tinh hoa đỏ	V
51	*Podocarpus pilgeri* Foxw	Thông tre lá ngắn	R
52	*Podophyllum tonkinense* Gagnep.	Bát giác liên	E
53	*Psilotum nudum* (L.) Griseb	Không hạt lá thông	K
54	*Rauvolfia verticillata* (Lour.) Baill.	Ba gạc	V
55	*Smilax glabra* Roxb.	Thổ phục linh	V
56	*Taxus chinensis* (Pilg.) Rehder	Sam hạt đỏ lá ngắn	R

Remarks:

- Emergency (E):
- Very urgent (V):
- Rare (R):
- Threaten (T):

Not available (K):

b) fauna

❖ ***Species components***

Investigations and scientific studies show that the project area has a abundant fauna system with some value species. The initial surveys also show that the area is not only abundant in term of number of species but also animal density.

Table 2.19: Fauna species

Animal Class	lineages	Family	Species
Mammals (*Mammalia*)	8	22	65
Birds (*Aves*)	15	41	169
Reptiles (*Reptilia*)	2	13	25
Amphobinans (*Amphibia*)	1	4	12

Total	**24**	**80**	**265**

❖ ***The diversity of the animal system***

- In thick tropical and subtropical forests, there usually occur migration animal like monkeys, gibbons, gayals, lions, *Pardofelis nebulosa, and Trachypithecus crepusculus* ect. Especially, *Trachypithecus delacouri* the most typical one need to be protected.
- In the bamboo forests, there have *Ursus thibetanus, Manis pentadactyla, Naemorrhedus umatraensis* often lives in green forests .
- In the grass and brush areas, there are *Macaca assamensis, Cuon alpinus, Prionodo, pardicolor and Lutra lutra, ect.*

❖ ***Species distribution***

In terms of distribution of forest animals in the basin of Trung Son hydropower, most of them are widely distributed in almost every part of the country; some of which that are distributed along the Truong Son forest are present at this basin also.

Those with big size and wide acting area such as monkeys, malayan bears, tibetan bears, fire panther, spotted panther, tiger, bull are mainly distributed at proteozoic and inferior forests far away from residences. Those which are distributed near residential areas such as deer, muntjac, wild pigs, civet usually perform in inferior forests, edges of forests, fields or along rivers and streams.

Big birds such as white pheasants, white-tummied cataplasm, persimmons, .. usually perform at low forests; those living near the water such as otter, birds belonging to the heron family Ardeidae, Water chicken family Rallidae, Kingfisher Alcedidae, Varan Varanidae and amphobians usually surround ambyss, river banks. Most of the small mammals, birds, lizards, snakes often live in inferior forests, bushes, grass fields or fields.

However, the number of subjects in this area has been reduced dramatically due to the frequent destroying of living environment and the exceeding use of animals.

Regional people use forest animals for different purposes. The main utility of these animals are: foods, medicine, commercial purpose…

❖ ***Rare and precious animals to preserved:***

There are 23 species of which:

- Emergency (E): 6 species
- Rare (R): 3 species
- Threaten (T): 12 species

Table 2.20: List of rare and precious animals at the basin

No	Vietnamese name	Scientific name	Status	
			Vietnam	International
1	Tê tê vàng	*Manis pentadactyla*	V	
2	Cu ly lớn	*Nycticebus bengalensis*	V	
3	Cu ly nhỏ	*Nycticebus pygmaeus*	V	VU

4	Khỉ đuôi lợn	*Macaca nemestrina*	V	VU
5	Khỉ mốc	*Macaca assamensis*	V	VU
6	Khỉ mặt đỏ	*Macaca arctoides*	V	VU
7	Voọc mông trắng	*Trachypithecus delacouri*	E	CR
8	Voọc xỏm (1)	*Trachypithecus crepusculus*	V	CR(1)
9	Sói đỏ	*Cuon alpinus*	E	VU
10	Gấu ngựa	*Ursus thibetanus*	E	VU
11	Gấu chó	*Ursus malayanus*	E	
12	Triết chỉ lưng	*Mustela strigidorsa*		VU
13	Rái cá thường	*Lutra lutra*	V	VU
14	Cầy gấm	*Prionodon pardicolor*	R	
15	Cầy mực	*Arctictis binturon*	V	
16	Cầy vằn bắc	*Hemgalus owstoni*	V	VU
17	Beo lửa	*Catopuma temminckii*	E	VU
18	Báo hoa mai	*Panthera pardus*	E	
19	Báo gấm	*Pardofelis nebulosa*	V	VU
20	Sơn dương	*Naemorrhedus umatraensis*	V	VU
21	Sóc bay lớn	*Petaurista philippensis*	R	
22	Sóc bay lông tai	*Belomys pearsonii*	R	
23	Nhím đuôi ngắn	*Hystrix brachyura*		VU

National preservative current E: Emergency species; V: Vulnerable;
R: Rare (pursuant to Anon. 2000).
International preservation current CR: Threatened ; EN: Emergency
VU: Lo
Note: (1): According to Nadler *et al. (2003)*

c) Aquarium

Results of analysis of quarium in the reseirvoir there are 25 species in the 3 algae species including *Bacillariophyta*, *Cyanophyta*, *Chlorophyta*. The above species component is low and it may calculate not much samples and there is not verious species in th aquarium . In the foating plant, *Bacillariophyta* and *Chlorophyta are outstanding most in the quantity of species*, the typical species in the aquarium in the mountainous rivers is simple algae with its branches including *Navicula*, *Nitzschia*, *Diatoma*. In *Cyanophyta* and *Chlorophyta*, *there are Oscillatoria* of *Cyanophyta*, *Spirogyra* of *Chlorophyta* occuring in the most time. These species adapt in fresh water in natuaral river.

+ Floating animals

In the basin, it is calculated of 29 species belonging to *Copepoda*, *Cladocera*, *Rotatoria*, *Ostracoda* and insect larva. Within which, the highest number of species belongs to *Cladocera*, then *Copepoda and Rotatoria.* The last are Ostracoda and insect larva. Most of them appear in natural flows which are not influenced by human activities.

+ Bedding animals and Aquarius insects

Results of bedding animal's analysis show that there are 10 species of bedding animals including snails (*Gastropoda*), oyster (*Bivalvia*), shrimp (*Crustacea - Macrura*) and crab (*Crustacea - Brachyura*). In the species components, snails have the largest number (7 species). The others have few number with small density. Calculated aquarium insects consist of 16 species which are frequent at natural mountainous flows such as *Ephemeroptera*, *Plecoptera*, *Tricoptera*, dragon flyers (*Odonata*), *Hemiptera* and *Diptera*. Within these insects, *Ephemeroptera and* dragon flyers (*Odonata*) have the largest number of species. Others have few number of species. Most of them live in clean water flows. Insects at streams have the largest number of species and frequent density.

+ Fish and fishery

At River Ma basin and the nearby regions, in Sep. 2004 it is calculated of 60 species of sardine (Clupeiformes), Carp (*Cypriniformes*), (*Cyprininodontoformes*), cuttle fish (*Oliocephaliformes*), Eel (*Synbrachiformes)*, bass (*Perciformes*) and loach(*Mastacembeliformes*). Within them, carp *(Cyprinidae*) have a largest number of species and have the highest economic value. There are 17 species of economic value in the Ma river basin. There are 3 rare and precious species recorded in the Vietnam Red Book: spinibarbus caldwebli, Chien and hemibargus.

Within these, the most frequent farmed and natural hunted are chubs, carps, hemibargus, etc. Surveys and interviews of local people show that fishery is not frequent and often taken at dry season when the water is not too strong. There are a dozen boats frequently exploiting in the river by nets, hook. etc. Each boat can fish about 2-3 kilos of fish a day. Fish caught here also consist of those running from farming ponds due to overflows. Those farmed in the regions are carps, tilapia, ctenopharyngodon ideleus etc. The areas of farming are not large because of blocking hollows. The productivity is not high and products are for within the area only. It is impossible to calculate pond area of breeding fishes because of the unstable location of farming.

In the total of 132 species in the researched area, there are 8 species listed in Vietnam Red Book, they are clupanodon thrissa tor (folifer) brevifilis, Spinibarbus hollandi, Varicorhinus laticeps, Sinilabeo lemassoni, Cranoglanis multiradiatus, Hemibagrus guttatus, Bagarius yearrelli). They are in V level. There is not any specie listed in the dicision No.48/2002/NĐ – CP and Red list of IUCN 2002.

On the obove 8 species, the cranoglannidaed, hemibagrus guttatus, Bagarius yearrelli is econimic purpose in the researched area, it is rarely to meet in the five of rest one.

Table 2.21: List if fishes in ma River , Thanh Hoa Province

No	Vietnamese	Sciencentific name	Situation
			Vietnam
	Bộ cá Trích	**Clupeiformes**	

	Họ cá Trích	**Clupeidae**	
1	Mòi Cờ	Clupannodon thrisa L	V
	Họ cá trỏng	**Engraulidae**	
2	Lành canh trắng	C.grayii Richardson	
	Bộ cá chép	**Cypriniformes**	
	Họ Cá Chép	**Cyprinidae**	
3	Cá Cháo	Opsariichthys bidens Gunther	
4	Mại Sọc	Rasbora cephalotaenia Bleeker	
5	Trắm đen	Mylpharyngodon piceus Richardson	
6	Trắm cỏ	Ctenopharyngodon idellus (C&V)	
7	Chày mắt đỏ	Squaliobarbus curriculus Richardson	
8	Măng	Elopichthy bambusa Richardson	
9	Dầu hổ bằng	Toxabramis swinhonis Gunther	
10	Mương Xanh	Hemculter leucisculus Basilewsky	
11	Mương nâu	H. Songhongensis Hảo & Nghĩa	
12	Mương dài	H. elongatus Hảo & Vân	
13	Thiểu bắc	Ancheyrythroculter erythropterus Basil	
14	Dầu sông thân mỏng	Pseudohemiculer dispar peters	
15	Dầu sông gai ngắn	P.hainanensis Nichols&Pope	
16	Mương gai	Hainania serrata Koller	
17	Vền	Megalobrama skolkovii Dybowsky	
18	Ngựa Bắc	Tor (folier) brevifilis Peters	V
19	Ngão gù	Culter recurvirostris sauvage	

20	Cá cầy	Parator macracanthus Pell&Chew	
21	Cá Bống	Spinibarbus denticulatus Oshima	
22	Chày đất	S.hollandi Oshima	V
23	Đòng dong	Capoeta semifasciolataGunther	
24	Cá Sỉnh	Varicorhinus (O) gelarchi Peters	
25	Sỉnh gai	V. (O) laticeps Gunther	V
26	Rầm xanh	Sinilabeo lemassoni Pell&Chev	V
27	Trôi	Cirrhina molitorella C&V	
28	Cá Mrigan	C.mrigala Hamilton	
29	Dầm đất	Osteochilus salsburyi N&P	
30	Cá Đo	Garra pingi Tchang	
31	Cá sứt môi	G.orientail Nichols	
32	Cá Diếc	Carassius auratus Linnaeus	
33	Cá Chép	Cyprinius carpio Linnaeus	
	Họ cá chạch Đồng	**Cobitidae**	
34	Cá chạch Đồng	Misgumus anguillicaudatus Nich	
35	Cá chạch Hoa	Cobitis taenia dolychorhynchus	
	Họ chạch vây bằng	**Balitoridae**	
36	Cá chạch suối	Nemachilus pulcher	
37	Cá chạch đá sọc	Barbatula fasciolata	
38	Cá chạch đá đuôi bằng	B.orthrocauda Yen	
39	Cá chạch đá chợ đồn	B.uniformis Yen	
40	Cá Vây bằng vẩy	Balitora brucei Gray	
	Bộ Cá nheo	**Siluriformes**	

	Họ cá nheo	**Siluridae**	
41	Cá nheo	Silurus asotus linnaeus	
	Họ cá Trê	**Clariidae**	
42	Cá Trê đen	Clarias fuscus	
	Họ cá Ngạnh	**Cranoglanidae**	
43	Cá Ngạnh	Cranoglanis multiradiatus	V
	Họ cá lăng	**Bagridae**	
44	Cá Lăng chấm	Hemibagrus guttatus	V
45	Cá mịt	Leiocassis virgatus	
	Họ cá chiên	**Sisoridae**	
46	Cá chiên sông	Bagarius yearrelli	V
47	Cá Chiên suối con	Glyptothorax minutum	
48	Cá Chiên suối Hải Nam	G.hainanensis N.&P	
49	Cá Chiên suối	G.sp	
	Họ cá úc	**Ariidae**	
50	Cá Úc	Arius sinensis	
	Bộ cá ngần	**Osmeriformes**	
	Họ cá ngần	**Salangidae**	
51	Cá ngần	Salanx longianalis Regan	
	Bộ cá kim	**Beloniformes**	
	Họ cá Nhái	**Belonidae**	
52	Cá Kim Trung Hoa	Hyporhamphus sinensis	
	Bộ mang liền	**Synbranchiformes**	
	Họ Lươn	**Monopteridae**	
53	Cá Lươn	Monopterus albus	
	Bộ cá Vược	**Perciformes**	
	Họ cá chạch sông	**Mastacembelidae**	
54	Cá Chạch sông	Mastacembelus armatus	

	Họ cá chẻm	Centropomatidae	
55	Cá chẻm	Lates calcarifer	
	Họ cá rô phi	**Cichlidae**	
56	Cá rô phi vằn	Oreochromis niloticus	
57	Cá rô phi đen	O.mossambicus	
	Họ cá bống đen	**Eleotridae**	
58	Cá Bống cáu	Butis butis	
59	Cá Bống Vân	Tridentiger trigonocephalus	
60	Cá Bống đen	Eloetris fusca	
	Họ cá bống suối	**Odontobutidae**	
61	Cá Bống suối đầu ngắn	Percottus chalmersi	
62	Cá Bống suối bắc bộ	P. tonkinensis Yen	
	Họ cá bống trắng	**Gobiidae**	
63	Cá Bống đá	Rhynogobius hadropterus	
64	Cá Bống than	R.leavelli	
65	Cá bớp	Botrichthys sinensis	
66	Cá bống đối	Mugilogobius abei	
	Họ cá rô đồng	**Scombridae**	
67	Cá rô đồng	Anabas testudineus	
	Họ cá sặc	**Belontidae**	
68	Cá cờ	Macropodus opercularis	
	Họ cá chuối	**Channidae**	
69	Cá chuối	Channa maculata lacepede	
70	Cá quả	C.striata Bloch	
	Bộ cá Hồng Nhung	**Characiformes**	
	Họ cá hồng nhung	**Characiidae**	
71	Cá Chim trắng nước ngọt	Colossoma brachipomus	

	Bộ cá bơn	**Pleuronectiformes**	
	Họ cá bơn cát	**Cynoglossidae**	
72	Cá Bơn sọc	C. Trigrammus Gunther	

(Source: Basic resesrches in science, Science and Technical Publisher 2004)

2. Ecology system in the resettlement area

Besides the common feature in the ecologic system in the basin on the resettlement area, there is typical feature that is ecology made by human. There are following features such as:

+ Plant

1. Forest Plant

Inundated construction is mainly in bamboo area, inwhich Luong bamboo is most planted, additionally, there is some wood plants such as Cunninghamia konishii, makhamia stiplulata, podocarpsu….

2.Fruice plant:orange, lemon,litchi,longan trees, jacqfriut,ramuitan, banana....

3. Shorterm -tree: Vegetable

4. Food trees: rice, pean, potato...

+ Animals: Hệ động vật

Animal in the epected resettlement area remains the common feature of animal in the basin but it is not diversified, it is mostly buffolo, bigs, chicken …

+ Aquarium

In the expected resettlement area, the rivers and stream flow into Ma River, high slope so that the aquarium has little differrence from the last and the aquarium doesn't its preserves.

2.1.3.6 Natural preserved zone

Natural preserved zone in the construction site

1. Pù Hu preserved zone

The Pù Hu preserved zone is situated in the administrative territory of Xuân Hoa commune, Mường Lát district, Thanh Hoá province with 35,089ha in area, within which forest has 23,849 ha in area. This zone is situated in the basin of Trung Son Hydropower and 30km to the South.

Geographic landmark: 20o23'-20o35' North latitude, 104o44'-105o01' Eastern longitude

Biological diversity: This zone consists of two main types of forest: ordinary green forest at the lower ground distributed at the height of 200m with main botanical species such as Fabaceae, Meliaceae, Sapindaceae; ordinary green forest at the lower ground distributed at the height of more than 700m with main botanical species of Fagaceae, Moraceae, Lauraceae. Early statistics provides information of 509 high graded botanical species with vessels.

This zone has several preserve-valued animals such as Tibetan bear Ursus thibetanú, Malayan bear H. malayamus, Panther Panthera pardus, Bull Bos gaurus and Gobbins. Though birds have not been surveyed in details, it is recorded that there are two species with preserved value including Yellow-beaked climber Sitta solangiae, which is globally in

very urgent condition, and Van Nam Flat-beaded laughing-thrush, which is globally threaten. (Lê Trọng Trải, Institute of Forest investigation and planning). The most important point is the discovery of the yellow-beaded climber because this is a very narrow-distributed species. (Sources: Information about existing preserved zones and recommendations in Vietnam - International Birdlife Program and Institute of Forest investigation and planning, Hanoi, 2-2001)

2. Xuan Nha preserved zone

Xuan Nha preserved zone: 38,069 ha in area, belong to Moc Chau District, West South of Son La province, 20-25km East from Trung Son Hydropower

Geographic landmark: 20o36'-20o48' North latitude, 104o29'-104o50' Eastern longitude.

Biological diversity: This zone has 22,172 ha in area of natural forest, within which the ordinary green forests accounts for the most.

Briefly, 456 botanical species have been calculated, within which are several rare and precious ones recorded in the Vietnam Red Book such as Podocarpus neriifolius, Chukrasia tabularis, Markhamia stipulata. We also recorded 48 mammal species, 160 bird species, 44 reptiles and 19 amphibians (Sources: Information about existing preserved zones and recommendations in Vietnam - International Birdlife Program and Institute of Forest investigation and planning, Hanoi, 2-2001)

Productive area of forest in the basin is distributed mainly in the Xuan Nha preserved zone and belong to the restricted area with a quite abundant and diversified components of species, within which are many precious and huge trees. Shade volume of this kind of forest is more than 60%, most of the trees are more than 15m in height, some of them are more than 30m, the forest is structured in 5 layers. It is also a habitat for many animals such as mammals, birds and reptiles. This is the forest ecology with the highest value of precious gene sources in the region and the good capacity of water regulation, which can reduce the volume of soil worn out, preventing from catastrophes and increase the life of this construction.

Once the water reservoir begins to accumulate water, a part of this zone which belongs to mountain villages West Ta Lao, East Ta Lao, Pu Lau would be flooded. The flooded area consists mainly artificial forests (bamboo, chukrasia tabularis A.Juss...) and natural forests. The flooded area with 367.26ha in area accounts for 0.9% of the total area of natural forest. The flooded natural forest is about 5.30ha in area while those planting ones of people in those villages are 361.96ha in area.

The preserved zone is next to the construction site

3. Pà Cò - Hang Kia preserved zone

Pà Cò - Hang Kia preserved zone is situated on the administrative territory of Pa Co commune, Hang Kia, Bảo La and Piềng Ve, Mai Châu district, Hoà Bình province. It has 7091 ha in area, within which 2681 ha belongs to restricted zone and 4410 ha belongs to the ecological preserved area. A part of this area is situated in the hydropower basin and 40km to the North of the foot of the dam.

Geographic landmark: 20o41'-20o46' North latitude, 104o51'-105o01' Eastern longitude.

Biological diversity: there are three new species of orchid described in this area. There has not been any information about biological diversity of this zone. (Sources:

Information about existing preserved zones and recommendations in Vietnam - International Birdlife Program and Institute of Forest investigation and planning, Hanoi, 2-2001)

Although the productive natural forest of this zone is situated out of the borders of the construction, the protection should not be ignored. Once the construction is completed, the transport would be easier and more convenient. Therefore, forest protection is needed to prevent illegal hunting and exploitation of animals and botanical species.

4. Pù Luông preserved zone

Pù Luông preserved zone located in Quan Hoa and Ba Thuoc Districts, Western Thanh Hoa, Vietnam Northern Centre. The preserved area includes the West of Pu Luong –Cuc Phuong limestone mountain and ist North is border to Mai Chau, Tan lac and Lac Son of Hoa Binh Province. Geographic landmark

- 20^0 21'- 20^0 34' North latitude;

- 105^0 02'- 105^0 20' Eastern longitude.

The preserved area includes area of 9 communes such as Phú Lệ, Phú Xuân, Thanh Xuân, Trung Sơn, Phú Nghiêm in Quan Hoá District and Thành Sơn, Thành Lâm, Cổ Lũng and Lũng Cao in Bá Thước District; with total area is 17.662 hectare, in which including seriously preserved area with 13.320 hectare and reecologic zone is 4.342ha.

Proteozoic forests in Pù Luông preserved area is considered as a thick proteozoic forest in rainy tropical season.

According to the result of Institute of Forest Research and Plan in 1997 on animal in Pu Luong presevered zone, there is recorded 59 species of animals, 162 species of birds, 28 species of reptiles and 13 species of amphibian (Lê Trọng Trải and Đỗ Tước 1998; BirdLife and FIPI, 2001). In which *Trachypithecus delacouri is seriously threatened* .

The reseacher team including Lê Trọng Trải and Đỗ Tước (1998) defined the existance of *Trachypithecus delacouri with* about 40-60 componants in 8-9 groups, and *Nycticebus bengalensis* and *Macaca mulatta*. Additonally, the research about monkey in Pù Luông was carried in 1999 by Association of Frankfurt Animal (Baker, 1999), the result shows that there is as existence of *Macaca arctoides*, *Macaca mulatta*, *Macaca assamensis Trachypithecus crepusculus*.

According to the research result of Pù Luông preserved zone of Đặng Ngọc Cầm researcher, there is total of 43 species of animals in 17 families 6 series is recognized.

The diversity of animal in the Pù Luông preserverd zone may be equal to other limestone mountains in the North of Vietnam. However, some species is completely disappeared in this area, several species was existed in the past like forestry Buffalos, Monkeys and Liones. Some others is in this case including *cuon alpinus*, *Lutra lutra* and *Ursus malayanus*, if these species are existing, they will be in danger. Unless of forestry Buffalos, Monkeys and Liones and 23 species of animals is protected and 14 species of which is surely existed.

As the result of Mai Đình Yên, Nguyễn Hữu Đức and Dương Quang Ngọc researchers on Pù Luông preserved zone, there is 55 species of fishes in total in 45 generations and 18 họ families defiend. In which there are 50 local species and 5 external species..

These 5 species listed in Vietnam Red Book in "V" level are recognized including *Onychostoma laticeps*, *Bangana lemassoni*, *Spinibarbus hollandi*, *Bagarius rutilus* và *Cranoglanis henrici* (Anon. 2000). Especially *B. Rutilus is in large* and *B. Lemassoni is recognized in* Pù Luông.

2.2. SOCIO-ECONOMIC AND ENVIRONMENTAL STATUS

2.2.1 Population, group, labors

According to a survey in 2006, there are 4,058 households, 22.263 habitants living in five communes: Trung Son (Quan Hoa), Muong Ly, Trung Ly, Tam Chung (Muong Lat) and Xuan Nha (Moc Chau). The population growth rate of the area is about 3%, higher than that in other areas in two provinces Thanh Hoa and Son La.

Labor force in the area is 11,394 people accounting for about 51% of the area's population. Of which, 98% work in agricultural sector and only 2% work in non agricultural sector. The feature should be taken into consideration in preparing plan for restoration of likelihood for affected HH.

Main ethnic minorities in the area are Thai and Mong. There are some Kinh HH in the areas, which are running small business. In general, there is no conflict among HH and ethnics in the area.

Table 2.22: Features of population of the project area in 2006

No	Items	Number of HH	Number of people	Ethnics		Labor force
				Thai	Mong	
	Total	***4058***	**22263**	**8489**	**13774**	**11349**
A	**Thanh Hoa province**	**2813**	**15587**	**5922**	**9665**	**9260**
I	***Quan Hoa district***	***561***	***2529***	***2529***	***0***	***2504***
1	Trung Son commune	*561*	2529	2529	0	2504
II	***Muong Lat district***	***2252***	***13058***	***3393***	***9665***	***6756***
1	Muong Ly commune	*745*	4617	1154	3463	2235
2	Trung Ly commune	*955*	5517	1655	3862	2865
3	Tam Trung commune	*552*	2924	584	2340	1656
B	**Son La Province**	***1245***	**6676**	**4109**	**4109**	**2089**
I	***Moc Chau district***	***1245***	***6676***	***4109***	***4109***	***2089***
1	Xuan Nha commune	665	3259	1956	1956	968
2	Tan Xuan commune	580	3417	2153	2153	1121

(Source: survey in March 2007)

In Moc Chau, Muong Lat and Quan Hoa, proportion of labor force working in agricultural and forestry sectors is about 75%. In communes in the project area, the rate is significantly higher, about 95%. Labor force working in other sectors such as industry and commerce accounts for a very small proportion.

2.2.2 Economic activities

2.2.2.1. Agricultural production

a) Cultivation:

Agricultural cultivation activities are still the main production activities in the area. Income from agricultural cultivation accounts for about 40% - 60% of total income of HH in the area. Cultivation activities including paddy rice and dry rice, and other cultivated crops such as corn and cassava.

Paddy rice cultivation: There are two paddy rice crops per year in the area. In area belong to Thanh hoa province with high slope topographical condition is not suitable for paddy rice cultivation. There are few belt of land in the size of several ha being cultivated by local HH with one or two crops per year, some of the land belt is only several hundred meters. Cultivation of paddy rice in the area is considered at low standard, much depending on natural condition and having low productivity due to lack of water and investment for intensive cultivation. An exception case is in Xuan Nha commune, where has flat area and abundant water resources. A irrigation system was built to provide water for irrigation of about 60 ha of paddy land.

Paddy area in each commune in the area is as follow: Trung Son commune 21 ha; Trung Ly commune 42 ha, of which 5 ha of two crops and 37 ha of one crop per year; Tam trung commune 117 ha, of which 28.9 ha of two crops and 89 ha of one crop per year; Muong Ly commune 16 ha, of which 7 ha of two crops and 9 ha of one crop per year; Xuan Nha commune 236 ha, of which 85 ha of two crops and 151 ha of one crop per year.

Annual paddy yield in each of these commune as follow: Trung Son 63 tons, Trung Ly 125 tons, Tam Chung 1310 tons, Muong Ly 45 tons and Xuan Nha 730 tons.

Dry land cultivation: this type of cultivation is popular in the area. In average, each HH has 2 to 3 ha of dry land. Normally, local HH cultivate dry rice, corn and cassava to meet their demand. Due to significant relying on natural condition, plant production is low and not stable.

Annual cultivation area at milpa is as below:

- Trung Son commune: Dry rice 58.5 ha, corn 135 ha, cassava 264; respective yield is 46.8 tons, 405 tons and 1,848 tons.
- Trung Ly commune: Dry rice 323.7 ha, corn 475 ha, cassava 29.7; respective yield is 259 tons, 1425 tons and 207.7 tons.
- Tam Trung commune: Dry rice 108.7 ha, corn 246 ha, cassava 45; respective yield is 87 tons, 738 tons and 315 tons.
- Muong Ly commune: Dry rice 380 ha, corn 220 ha, cassava 45; respective yield is 304 tons, 660 tons and 312 tons.
- Xuan Nha commune: Dry rice 200 ha, corn 400 ha, cassava 110; respective yield is 200 tons, 1240 tons and 825 tons.

Table 2.23. Total food yield and food volume per head in 2006

Item	unit	Trung Sơn	Trung Lý	Tam Chung	Mường Lý	Xuân Nha
1. Total rations converted into rice	ton	514.84	1,808.43	1,134.84	1,009.00	2,169.70
Of which: - Rice	Ton	109.84	383.43	396.84	349.00	929.70
- Other foods converted to rice	Ton	405.00	1,425	738.00	660	1,240.00
2. Rations per head	kg/head/year	203.58	327.79	388.11	218.54	219.27

Beside the mentioned plants, local HH also cultivate peanut, various bean and veritable types and fruit trees such as plum, jack-fruit and custard-apple to meet their daily demand. In general, productivity of the trees is low due to lack of sufficient investment and modern cultivation technologies.

Table 2.24: Area, productivity and yield of various types of tree in the communes

Unit: area (ha); productivity:(quintal/ha); yield:(ton)

Item	Food trees					Food grains and foodstuff trees		
	Paddy rice		Dry land rice	Corn	Cassava	Peanut	Vegetables	Beans
	Winter crop	Spring crop						
1.Trung Sơn								
- Area	19.7	1.2	58.5	135.0	264.0		19.5	74.7
- Productivity	30	28	8	30	70		120	20
- Yield	59.6	3.4	46.8	405.0	1,848.0	0.0	234.0	149.4
2.Trung Lý								
- Area	37.0	5.0	323.7	475.0	29.7	3.0	7.0	1.0
- Productivity	30	27	8	30	70	7	120	20
- Yield	111.0	13.5	258.9	1,425.0	207.7	2.0	84.0	2.0
3.Tam Chung								
- Area	88.7	28.6	108.7	246.0	45.0		1.5	0.5
- Productivity	27	24	8	30	70		20	20
- Yield	241.3	68.6	86.9	738.0	315.0	0.0	3.0	1.0
4. Mường Lý			0					
- Area	8.5	7.5	380.0	220.0	44.7	0.0	0.5	0.5
- Productivity	30	26	8	30	70	0	120	20
- Yield	25.5	19.5	304.0	660.0	312.7	0.0	6.0	0.0

Source: Departments of Agriculture and Statistic of Quan Hoa and Muong Lat districts

Table 2.25: Area, productivity and yield of various types of tree in Xuan Nha commune, Moc Chau district, Son La province in 2006

Unit: area (ha); productivity:(quintal/ha); yield:(ton)

Item	Food trees					Food grains trees		foodstuff trees
	Paddy rice		Dry	Corn	Cassava	Vegetables	beans	Fruit trees
	Winter crop	Spring crop	land rice					
- Area	151	85	200	400	110	4	6	170
- Productivity	32	29	10	31	75	120	20	51
- Yield	483,2	246,5	200	1240	825	48	12	868

Source : Departments of Agriculture and Statistic of Moc Chau districts

b) Livestock

Livestock is developed without any plan and has not been considered as main resources of income in the area. Due to low technical technology and using local breeds which are normally small and sow growth and especially hardly being protected from desires all result to low economic efficiency of livestock sector. Most of fowls, cattle and poultries are left unbridled.

Currently, in average each of households has 1-2 cows or/and buffalo, some households have 3-4 cows or/and buffalos, 1-2 pigs and 10-15 poultries.

Table 2.26: Cattle and poutry of communes in the project area

unit: unit

TT	Province / districts	Buffalos		Cows		Pigs		Goals		Poultries	
		Total	Of which being reproduced	Total	Of which being reproduced	Total	Of which being reproduced	Total	Of which being reproduced	Total	Of which being reproduced
	Total	**3.396**	**1.358**	**4.549**	**1.365**	**13.580**	**2.431**	**469**	**28**	**79.870**	**11.981**
1.	Trung sơn commune	248	99	854	256	1.098	187	278	28	7.280	1.092
2	Trung Lý commune	368	147	317	95	2.012	698			16.200	2.430
3	Tam Chung commune	507	203	520	156	2.400	205	91		13.790	2.069
4	Mường Lý commune	203	81	488	146	2.420	317			17.600	2.640
5	Xuân Nha commune	2.070	828	2.370	711	5.650	961	100		25.000	3.750

Departments of Agriculture and Statistic of Moc Chau, Quan Hoa and Muong Lat districts

c) Forestry:

Forestry is one of the main activities in the area. According to statistical data, the four communes in Thanh Hoa province has 35,924.28 ha of forestry land, accounting for 73.64% of total their natural land, of which production forestry land is 15,243.58 ha (accounting for 42.43% of total forestry land). Total of specific forestry is 12,165 ha (accounting 33.86%) and basin protection forestry is 8,515 ha (accounting for 23.7%). Xuan Nha commune, Son La province manages 16,121 ha of forestry land of which 25 ha is re-planted, accounting for 0.165; specific and basin protection forestry is 16,096 ha, accounting for 99.84% of forestry area.

d) Aquatics

The studied communes in the mountainous districts have little water surface area to breed aquatics, thus, aquatics branch does not have advantages to develop. At present, the project districts have 181.8ha of water surface area to breed aquatics, in which Mộc Châu district has 126.1ha, Quan Hoá district has 39.9ha, Mường Lát district has 15.8ha, mainly breeding freshwater fish. The aquatic products in the project districts occupies small rate compared to the total production value of other economic sectors in the districts. However, freshwater fish breeding has begun developing in recent years, the area of ponds and lakes has increased.

In the future, when Trung Son lake is constructed with rather large water surface area, it will create good conditions to develop aquatics at locals.

2.2.2.2 Industry, handicraft and services.

These area mountainous districts so industry branch in the project districts nearly does not have conditions to develop. The industry in the project districts are mainly processing and exploiting industries. The processing industry in Moc Chau district occupies 80.5% of the industrial output value in the whole district, in Quan Hoa district occupies 67.3%, in Muong Lat district – 61.5%. They are mainly small private industry and handicrafts foundations. Main industrial products in the project districts are materials (stones, sand, grave, brick, tile, enameled tile...), processed products (food, beverage, weaving products, clothes, products made of leather and imitation leather, wooden products, forest products, products made of paper), mechanical products (equipment, machines, motored vehicles), and other recycled products.

In the project communes, industrial and small-industrial foundations meet only demands on processing services and minimum repair such as husking, food processing, hand-held tool repair.

Besides, based on their capability, the electricity branch in the project districts has effectively exploited National Electricity Network, small hydropower to serve inhabitants' life and production.

The industrial production foundations are mainly at households so labor forces are at locals, mainly manual laborers in the families with limited production level.

Because of difficult transportation condition, trade activities here are mainly to sell retail commodities for inhabitants. In 2003, the whole Moc Chau district had 1738 trade and service foundations, in which there were only 12 State's foundations. The number of people doing business and services were 2141 people, in which 147 persons were State's personnel. In 2003, the whole Muong Lat district had 177 trade and services foundations (4 were State's organizations). The working people in this field were 177 ones. In 2003, Quan Hoa district had 675 foundations with 802 persons doing business and services.

Up to now, tourism nearly does not have chances and conditions to develop in the project districts.

2.2.3. Culture and society and traffic in the project area

a) Culture

None of historical relics have been found in the project communes through surveys and investigation in the area. People living in Trung Son hydropower project area are mainly ethnic minorities including Thai, Muong, H'Mong... having different usages and customs. This creates colorful cultural pictures of the ethnic communities in Vietnam. Thai and Muong ethnic groups have customs that people often live with others who have blood relationship with them or in communities. They often settle in lowland areas, plain area near to water resources, especially fertilized areas along the streams, where have suitable conditions for paddy rice cultivation and fishing in ponds.

b) Education

At present, all communes in Thanh Hoa province have primary and secondary schools. These schools are in good condition. There are school classrooms in all main villages. In general, the rate of children going to school is low; number of children giving up their schooling is high in villages. Primary and secondary school in Xuan Nha commune is well invested (classrooms are constructed as class III) including accommodation for teachers and pupils from far villages.

All districts have completed their programs on illiteracy eradication. Data on educational situation of the area in 2005 is summarized in table below:

Table 2.27: Some criteria on education of communes in the project are

Seq.	Criteria	Unit	Moc Chau	Quan Hoa	Muong Lat
I	Number of schools	School	63	36	16
1	Primary schools	-	25	18	9
2	Primary and secondary schools	-	12		
3	Secondary schools	-	21	17	6
4	Secondary and high schools	-	3		
5	High schools	-	2	1	1
II	No of classrooms	Room	1123	548	325
III	Number of teachers	Person	2301	640	331
1	Primary teachers	-	1341	375	238
2	Secondary teachers	-	796	234	75
3	High teachers	-	164	31	18
IV	No of pupils	-	33653	11181	6222
1	Primary pupils	-	18413	5752	4286
2	Secondary pupils	-	11756	4394	1449
3	High pupils	-	3484	1035	487

Resources: Statistical Yearbook of the district in 2005

c) Public health care:

There is health care clinic and physician and 1-2 nurses, which are all local people in each of these communes in the project area. Public health care and family planning

programs have been implemented effectively and contributed to reduce some diseases such as malaria, bronchoscope, etc. However, these clinics are poorly equipped so that all serious cases have to be sent to district hospitals.

d) Communication

According to statistical data of Thanh Hoa and Hoa Binh in 2005, proportion of households who have telephone is very low. The number of telephone in Quan Hoa district was 820 and that figure in Mai Chau was 1460. Telephone service is still not available in some communes resulting difficulties in communication with outside.

e) Radio and television

Some of communes are still out of radio and television cover.

f**) Traffic situation in the project area**

The province, district and commue affected by the construction is inNorthern difficultly mountainous areas so that it is so difficult to access to affected areas including National Road No.06 and 15. Additionally, the road system through commute is so difficult but sand-based road, its stabitity is low.

CHAPTER 3: ENVIRONMENTAL IMPACTS ASSESSMENT TO TRUNG SON HYDROPOWER PROJECT

Table 3.1: Source, objects, extent of environmental impacts caused by the project construction

No	Activities	Source of impacts	Object of impacts	Extent		Impact
				By space	By time	
I	Preparation stage					
1	- Land acquisition for the project construction - Compensation - Construction of resettlement sites	- Land acquisition, losing house, public infrastructure and other public works - Cutting tree, clearing site, preparing ground in resettlement sites, dividing field into plots - Constructing public infrastructures in resettlement sites (schools, domestic water supply, access road, power supply system, irrigation system…)	- Affecting life, economy, career, resident, cultivation location and habit of project affected household (PAH) and communes, districts in the project area	- Dam site, powerhouse areas - Resettlement sites - Access road from Co Luong – Co Me.	Medium term	Strong
			- Affecting to the using land status in the project area and causing impacts to land resources in the reservoir area.			Medium
			- Declining the terrestrial ecosystem in the resettlement sites, losing partially resident of fauna, scaring away terrestrial animal, affecting to the protective function of the forest.			Strong
			- Biomass left from vegetation cutting will increase volume of wastes, taking land area because of disposal areas, causing pollution to land, underground water in the disposal areas and Ma river.			KĐK
			- Leveling, preparing ground, land reclamation, constructing of public infrastructures in resettlement sites, making soil to be easy to erosion, increasing dust, exhausted gas, wastes, wasted water making pollution to air, water, land erosion.			KĐK
			- The displacement of population living within Xuan Nha protected area and other locations to resettlement sites far from protected area will help minimizing negative impacts to those protected areas			Small
2	- Vegetation management, ground preparation - Vegetation	- Cutting tree - Mine, explosion left from the war - Chemical poison OB - Ground preparation	- Declining terrestrial ecosystem in the project area, access road Co Luong – Co Me and reservoir area, taking partially resident of animal scaring away terrestrial animal by noises.	- Dam site, powerhouse areas, - Reservoir area	Long-term	Strong
			- Changing landscape in the project area, access road Co Luong – Co Me and reservoir area.			KĐK

	management in reservoir area		- Biomass left from vegetation cutting will increase volume of wastes, taking land area because of disposal areas, causing pollution to land, underground water in the disposal areas and Ma river.	- Access road from Co Luong – Co Me.		KĐK
			- Mine, explosive left from the war which may cause dangerous to human lives.			Strong
			- OB chemical poison which can pollute the water environment, affecting aquatic life and objects using water from reservoir.			Strong
3	Constructing auxiliary works	- Constructing access road - Constructing power supply system, water supply system, communication system… - Constructing houses and other auxiliary works (clinic, post office, school, bus stop…)	Increasing dust, noise, exhausted gas causing pollution to air environment	- Dam site, powerhouse areas - Access road from Co Luong – Co Me.	Short-term (during preparation and construction periods)	KĐK
			Taking land for disposal area (wasted soil, rock) causing pollution to land, underground water area in disposal area, Ma river.			KĐK
			- People is benefited from public infrastructures			KĐK
II	During construction period					
1	Impacts caused by construction of project components : - Constructing diversion works	- Operation of transporting vehicles - Operation of vehicles, equipment (excavator, bulldozer…) - Blasting in foundation excavation - Up/downstream cofferdam failure	- Impacting to environment by generating dust, exhausted gas	- Dam site, powerhouse areas. - Xuan Nha, Pu Hu protected areas and surrounding areas, - Access	Short-term (during construction period)	Medium
			- Affecting to environment by causing noise.			Small
			- Affecting to living custom of animal, particular to noise sensitive species, affecting to health of workers, local resident			Strong
			- Blocking the migration of fish and other aquatic life between upstream and downstream of Ma river			KĐK
			- Impacting properties and works on land owned by Project owner, local resident in the project area and downstream area. Threatening lives of workers, local resident and downstream			Strong

	(up/downstream cofferdam, diversion culvert) - Constructing main dam, spillway - Constructing powerhouse + switchyard, intake, penstock, tailrace channel	- Land sliding during construction. Accident on access road because of transportation - Dropping construction material during construction period (aggregates, cement, concrete, soil, rock, packages, sawdust, …)	area due to potential failure of diversion works, accident by blasting during foundation excavation, transportation accident, and accident during work, land sliding,…	road Co Luong – C Me.		
			- Increasing volume of wasted rock, taking land area for disposal areas.			KĐK
			- Causing pollution to land, underground water table in the vicinity of disposal area. Increasing turbidity, suspended sediment, etc... Polluting Ma river because of surface water flowing crossing the project area taking with loosen material, or dropped material during construction period.			KĐK
			- Creating job opportunities to local resident			KĐK
			- Developing tourism in the local			KĐK
			- Increasing volume of transportation passing along the road, particularly the access road Co Luong – Co Me and National Road (NR) 15A, affecting to the movement of local resident and the quality of those road system (settlement along the road alignment,...)			Medium
2	Exploiting construction material (soil, rock, sand borrow areas)	- Excavating overburden - Exploiting soil, rock, sand for construction - Activities of vehicles transporting soil, rock sand to project sites and other machinery vehicles (excavator, bulldozer, drilling machine,)	- Impacts to air environment because of dust, exhausted gas	- Rock quarry, soil borrow area, sand borrow area - Disposal areas	Short-term, during construction period	Small
			- Impacts to environment by noise.			Small
			- Impacts to living custom of fauna, particular to noise sensitive species			Medium
			- Threatening lives of workers, local resident by transportation accident, land sliding, blasting during rock exploitation			Strong
			- Taking land area for disposal area of cut tree, biomass, excavated soil, rock			KĐK
			- Making pollution to soil, under water in disposal area where dumping cut tree, biomass, rock, soil. Polluting Ma river because surface water from rain will flow crossing the quarry, borrow areas, disposal area, stockpiles of Trung Son HPP.			KĐK
			- Making use natural resources (material as soil, rock, sand)			KĐK

			available in the region, reducing cost for Project owner.			
3	Activities in auxiliary works and worker camp					
3.1	Operation of various plants, such as: - Crushing plant, batching plant - Reinforcement fabrication bases - Timber fabrication bases	- Operation of vehicles, equipment (crusher, concrete mixer, sawing machine,…) - Dropped material, aggregates, cement package, wasted log…)	- Impact to air environment by dust and exhausted gas - Impact to noise environment. - Increasing turbidity, suspended sediment in water due to rainfall flowing across these areas taking together wasted material, dropping material,…	Crushing plant, timber processing base, steel processing base,...	Short-term, during construction period	Small (except crushing plant)
3.2	Activities in workshops	- Changing oil - Water released from washing car	- Polluting soil, underground water and Ma river	Workshop where maintaining, repairing equipment, vehicles	Short-term, during construction period	Small
3.3	Oil, lubrication, petroleum, explosive warehouse and storages	Due to concentration of inflammable matters, explosion, petroleum, oil, explosive	- Exposure with high risk of firing, explosion affecting to surrounding forest - Threatening lives of workers and local resident during transportation, keeping and using process - Affecting to air environment in case of leakage (because organic matters are easy to evaporate) or explode	- Explosive warehouse - Petroleum warehouse	Short-term, during construction period	Small
3.4	Sand, soil,	- Operation of	- Causing pollution to air environment	Soil, rock, sand	Short-	Small

	rock stockpile	transportation vehicles transporting soil, rock, sand to and from stockpiles	- Causing pollution to water environment due to erosion matter flowing with the flow	stockpile areas	term, during construction period	Small
3.5	Housing of worker, officer, camp follower, clinic, post-office, market, bus stop, kinder garden…	- Due to operation of workers, officers, camp follower,... - Due to health examining activities	- Generating wastes: wasted water, wastes (domestic wastes, clinic wastes), taking land as dumping and disposal area	- Worker camp - Protected areas, surrounded vegetation - People in Xuan Nha commune, Moc Chau district, Trung Son commune, Quan Hoa district, Muong Ly and Trung Ly communes of Muong Lat district and surrounding communes, districts	Short-term, during construction period	KĐK
			- Polluting soil, underground water in disposal area. Polluting Ma river			KĐK
			- Cutting tree, exploiting firewood, hunting, trading, keeping wood, illegal hunting affecting to forest protection in protected areas, project areas, and surrounding areas			Strong
			- Increasing population density, making disturbances to normal live, culture, social; changing custom, social evil, conflict between workers and local resident... affecting to national defense, security and management of local authority			Medium
III	Operation period					
1	Concentration of project staff (130 people)	- Living of operators	- Generating wasted water, domestic wastes	In powerhouse area, Xuan Nha commune, Moc Chau district, Trung Son commune, Quan	Long-term	KĐK
			- Increasing population density in project area, causing disturbance to economic-cultural-social life of local resident affecting to national defense, security and management of local authority			TB

				Hoa district, Muong Ly and Trung Ly communes of Muong Lat district and surrounding areas		
2	Reservoir impoundment	- Changing hydrological regime - Biomass submerged in reservoir area - Natural mineral resources submerged in the reservoir - Chemical poison being submerged	- Changing hydrological regime: the flow regime of the river is converted into reservoir flow regime.	- Reservoir area - Downstream area of Ma River	Long-term	Strong
			- Increasing underground water table surrounding reservoir area			KĐK
			- Changing topographical conditions in the reservoir: increasing water surface area			KĐK
			- Changing micro climate conditions surrounding reservoir area			KĐK
			- Causing pollution to water environment because biomass is disintegrated when filling water into reservoir and land under bottom of reservoir is being muddy			Strong
			- Causing pollution to water environment due to chemical passion left causing impacts to aquatic life and water using objects			Strong
			- Causing submergence to mineral resources			KTĐ
			- Forming new ecology: reservoir aquatic ecology.			Strong
			- The reservoir impoundment will create barriers to movement of some animal			KĐK
			- Changing landscape: forming reservoir, pushing tourism activities			KĐK
			- Developing fishery in reservoir			Small
3	Project operation	- Due to operation activities of equipment housed inside	- Making impacts by creating noises due to the operation of vehicles, equipment housed inside powerhouse	- Powerhouse area - Ma river,	Long term	KĐK
			- Releasing wasted oil, lubrication			KTĐ

		powerhouse - Maintenance, repairing duration of equipment installed inside powerhouse - Due to discharge and flood discharge regimes - Due to dam failure situation - Energy is generated from powerhouse - Load connected operation regime	- Protecting downstream area of Ma river from flood (reducing and slowing down the flood flow during flood season, reducing the flooding area) and increasing the flow volume during dry season (using flood storage of 112m3).	downstream of the dam		Strong
			- Causing impacts, and loss of lives and properties in downstream area of Ma river in the case of dam failure and emergency situation during operation period, during discharging and controlling flood			Strong
			- Enlarging budget of local by tax amount paid by the power plant			Small
			- Changing economic structure in the local, helping pushing the industrialization process, modernization of rural agriculture			KĐK
			- Changing flow regime in downstream part of Ma river			Small
			- Affecting to erosion regime, sedimentation regime in reservoir and in Ma river, section in downstream			Strong
			- Losing land nearby the reservoir banks because it will be semi-submergence land and because of erosion along river banks in downstream part			Small
			- Affecting to water sources used for irrigation and domestic use, navigation, socio-economic life, local resident living in downstream area of Ma river			Medium
			- Affecting to biological environment (terrestrial flora, fauna, aquatic life)			Medium
			- Affecting to Hoi Xuan hydropower project in downstream			KĐK

3.1 Environmental Impacts Assessment During Construction Period

3.1.1. Activities during preparation period

During preparation period, the project will be furnished with following activities:

- Land acquisition for project construction.
- Compensation.
- Damage survey, OB chemical poison finding, ground preparations , resettlement site and reservoir area.
- Construction of auxiliary works: access road system, construction power supply system, water supply system, drainage system, worker camp, clinic, post-office, warehouse, stockpiles, etc...

3.1.2. Impacts to natural environment

3.1.2.1. Impacts to topography, geomorphology and landscape in the area

The clearing and cutting of vegetation as well as ground preparation, construction of access road (construction-operation road system) in the areas of dam site, powerhouse, resettlement sites and in reservoir area will take out the vegetation, change topographical surface and therefore create severe process (erosion, land sliding) and making changes to landscape in the region.

During ground preparation, cutting slopes to construct access road, it will destroy structure of land making it so easy to land sliding, therefore during construction period there should be warning signs providing at areas highly potential to sliding. Particularly to the case of access road, this is the only one access road connecting the project area to National Road (NR) 15A, in addition to necessity warning about land sliding to prevent damages during transportation of vehicles from happening it should be suitable measure to ensure the transportation flow of vehicles during the construction period. See mitigation measures in chapter 4.

To the access of transmission line, there is a big construction implementation, the main direction is along access road and therefore it has some unremarkable changes.

3.1.2.2. Impacts to air and noise environment

Activities generating dust, exhausted gas and noise are mainly come from operation of various vehicles, equipment used in the construction, ground preparation. Since those activities will be existed with unremarkable intensity with limited number of vehicles, equipment operating scattered it can be said that impacts by such activities are unremarkable.

3.1.2.3. Impacts to ecological environment and functions of forest

Potential impacts affecting ecological environment and protective functions of forest could be:

- To be ready for the construction of various project components, the Contractor has no other way but constructing access road to bring in vehicles, equipment, material to the project site, such job will cause impacts to forest, cultivated land areas.
- The implementation of vegetation cutting, clearing, leveling, preparing ground as required for the construction of resettlement sites, worker camp, material warehouse,

stockpiles, car parking area, disposal areas, etc... will surely take forest area and cultivated land areas.

3.1.2.4. Impacts to water environment

- Disturbance on land surface and the cutting of tree, vegetation will increase the eroded matter increasing turbidity, organic matter and suspended solid in water making pollution to water and therefore affect to aquatic life.

- Ma river, rivers and streams in the resettlement sites, water table and soil in disposal areas could be polluted.

3.1.3 Impacts on socio, culture and economics

1. Impacts by researches of livehood population in riverbed and in expected resettlement areas

When carrying out researching, it causes disorder in affected areas, the local people will not concentrate in manufacturing. Any wonder of the local people will raise to the project owner on compensation, resettlement alternatives to local people, the responsibility of authorities in compensation, allowance and resettlement.

2. Impacts on community health

- Dust, gas emission from the site clearance, construction of auxiliary facilities, resettlement areas will have negative impacts on health of workers and local communities.

- Mines, explosives left from the war in construction site (dame site and power house area), materials mines need to be cleared to avoid danger of explosives to workers and local people.

3. Impacts on socio-economic and culture

a) Economics, incomes and livelihood of households and communes in the project area will be affected

Land acquisition will also has impacts on assets, trees and other structures in the land of households, communes.

b) Changes in residential and production locations of affected households (Resettlement and livelihood restoration for affected households)

Construction of the project will require land acquisition of households living in reservoir area, construction site and construction materials mines. It is necessary to find other land recourses for resettlement and production restoration for the affected households.

c) Local people benefits from the construction of infrastructures for the project

The construction of the project will require a huge number of workers in the construction site. That will result to overload for infrastructure in the area especially schools, hospitals, health care clinic, restaurants and entertainment services.

A high density of trucks, cars and other equipments will also result to over load of transportation system, power supply and water supply system, etc.

It is necessary to upgrade or build additional infrastructure facilities to meet the demand. The newly built infrastructure will not only meet the demand for the project implementation but also bring benefit to local people. The new transportation system will allow local people to exchange with outside and the market easier supporting for the socio and economic development in the area.

3.2. Impacts during construction period

3.2.1. Activities during preparation period

The project has activities during construction period:
- To implement the main divisions including dam, dike, plant construction, foundation. To exploit in quarries of land, soil, sand spilling, wastes in dumping ground
- To level the ground, resettlement areas construction
- To cut vegetables, cleaning, mine and explosive disarming, OB poisonous chemical, construction site ground level (dam, plant), resettlement areas, and river bed area.

3.2.2. Impacts to natural environment

1. Impacts to air and noise environment

a) Air environment

During construction period, air environmental will be polluted by dust and exhausted gas: CO, SO2, NO2,… generating from various activities during construction of project components.

It can be classified pollution sources as follows:

- Due to activities of vehicles, equipment operating during ground preparation, leveling, excavating, hauling, loading and unloading soil, rock and other material (truck, excavator, bulldozer, drilling machine, roller, compactor, etc....).

- Due to blasting activities during foundation excavation, exploitation of material.

- In addition are exhausted gas generated from domestic activities of workers.

** Pollution generated from blasting activities during excavating foundations of project components and rock exploitation*

In average, when blasting to excavate 1m3 of rock there will be 0.4 kg of dust generated. According to the design document, the rock volume to be excavated by this mean or other will be 1,610.740x103m3 in total, quantity of rock exploited from quarry will be 1,641,530 m3, volume of dust generated will be 644.296 ton and 656.612 ton respectively.

** Pollution generated by activities of vehicles, equipment during leveling, preparing ground, embanking, excavating, transporting rock, soil and other material (truck, excavator, bulldozer, drilling machine, compacter, roller, etc...) at the site.*

- Exhausted gas:

Herein is volume of rock, soil excavated in various project components:

Notes: the above tables have excluded volume of rock, soil exploited from borrow areas. These borrow areas are far from project area (>10km) and far from population areas therefore the dust, exhausted gas emission can be said within small range, unremarkable impacts.

Basing on document available at NATZ about poison exhausted gas emission when using one ton of oil for internal combustion engine (Table 3.15) it can forecast the volume of exhausted gas from operation of vehicles and equipment used during embankment, excavation of main civil work, as follows:

Table 3.1: Coefficient of exhausted gas emission

Used oil factor (kg/ton	Factor of exhausted gas (kg/ton oil)

soil, rock)	SO2	NO2	CO
0.1	2.8	12.3	0,.5

Table 3.2: Volume of CO gas generated during operation of vehicles, equipment required by excavation, embankment at main civil works

No	Components	Construction year 1		Construction year 2				Construction year 3		
		Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III
1	Main dam + spillway	2.6593	2.7658	3.173	3.2703	1.391	1.0901	0	0	0
2	Penstock	0	0.5825	1.127	1.6479	1.0654	0.1312	0	0	0
3	Intake	0	0.5243	1.04	1.3507	1.4559	0.1837	0	0	0
4	Powerhouse+tailrace	0	0.4993	1.24	1.0472	0	0	0.082	0.1226	0.1226
5	Diversion works	0	2.11	0.479	0.1373	0	0.4128	0	0	0

No	Components	Construction year 4				Construction year 5				Total
		Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV	
1	Main dam + spillway	0.533	0.178	0	0	0	0	0	0	15.06
2	Penstock	0	0	0	0	0	0	0	0	4.56
3	Intakes gate	0	0	0	0	0	0	0	0	4.56
4	Powerhouse+tailrace	0	0	0	0	0	0	0	0	3.49
5	Diversion works	0	0	0	0	0	0	0	0	3.14

Table 3.3: Volume of SO2 gas generated during operation of vehicles, equipment required by excavation, embankment at project components

No	Components	Construction year 1		Construction year 2				Construction year 3			
		Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV
1	Main dam + spillway	148.92	154.88	177.7	183.13	77.893	61.046	0	0	0	0
2	Penstock	0	32.617	63.14	92.28	59.662	7.3444	0	0	0	0
3	Intake	0	29.358	58.25	75.639	81.528	10.284	0	0	0	0
4	Powerhouse+tailrace channel	0	27.961	69.46	58.64	0	0	4.575	6.8628	6.8628	20.843
5	Diversion works	0	118.16	26.85	7.6888	0	23.117	0	0	0	0

No	Components	Construction year 4				Construction year 5				Total	
		Quart	Quarter	Quart	Quart	Quart	Quart	Quart	Quart		

		er I	II	er III	er IV	er I	er II	er III	er IV		
1	Main dam + spillway	29.83	9.946	0	0	0	0	0	0	843.35	
2	Penstock	0	0	0	0	0	0	0	0	255.041	
3	Intake	0	0	0	0	0	0	0	0	255.06	
4	Powerhouse+tailrace channel	0	0	0	0	0	0	0	0	195.21	
5	Diversion works	0	0	0	0	0	0	0	0	175.81	

Table 3.4: Volume of NO2 gas generated during operation of vehicles, equipment required by excavation, embankment at project components

No	Components	Construction year 1		Construction year 2				Construction year 3		
		Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Q II
1	Main dam + spillway	654.19	680.37	780.6	804.48	342.17	268.16	0	0	0
2	Penstock	0	143.28	277.4	405.37	262.09	32.263	0	0	0
3	Intake	0	128.97	255.9	332.27	358.14	45.178	0	0	0
4	Powerhouse+tailrace channel	0	122.83	305.1	257.6	0	0	20.1	30.147	30
5	Diversion works	0	519.06	117.9	33.776	0	101.55	0	0	0
No	Components	Construction year 4				Construction year 5				
		Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV	T
1	Main dam + spillway	131.1	43.69	0	0	0	0	0	0	37
2	Penstock	0	0	0	0	0	0	0	0	11
3	Intake	0	0	0	0	0	0	0	0	11
4	Powerhouse+tailrace channel	0	0	0	0	0	0	0	0	85
5	Diversion works	0	0	0	0	0	0	0	0	37

The tables above show that exhausted gas emission will concentrate mainly at the dam site. Total volume of gas emission in the project area is remarkable but since the construction period is quite long (4 years and a half, long but not continuous) impacts caused will be reduced remarkable.

- Dust:

+ Dust generated during excavation, embankment processes:

In accordance to Environmental assessment sourcebook, volume II, sectional guidelines, environment, World Bank, Washington D.C 8/1991), the dust pollution factor during leveling, excavating, embanking soil/rock will be as follows:

E = k x 0.0016 x (U/2.2)1.4 / (M/2)1.3

In which: E: pollution factor (kg/ton); k: grain structure, average value 0.35

U: average velocity of wind; M: average humidity of material to be 20%

Basing on that result, the average pollution factor in the region will be 0.00654kg/ton.

Volume of dust emission into the air due to activities during excavation, embankment at various main civil work components are as follows:

Table 3.5: volume of dust generated from excavation, embankment at main civil work components

No	Components	Construction year 1		Construction year 2				Construction year 3		
		Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Q I
1	Main dam + spillway	3.4784	3.4784	3.478	3.4784	1.1595	1.1595	0	0	0
2	Penstock	0	0.9371	1.814	2.6511	1.7141	0.211	0	0	0
3	Intake	0	0.6857	1.029	1.0285	0.6857	0	0	0	0
4	Powerhouse+tailrace channel	0	0.6531	0.98	0.3265	0	0	0.107	0.1603	0
5	Diversion works	0	2.0248	0	0.1796	0	0.4868	0	0	0
No	Components	Construction year 4				Construction year 5				T
		Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV	
1	Main dam + spillway	0.662	0.221	0	0	0	0	0	0	1
2	Penstock	0	0	0	0	0	0	0	0	7
3	Intake	0	0	0	0	0	0	0	0	3
4	Powerhouse+tailrace channel	0	0	0	0	0	0	0	0	2
5	Diversion works	0	0	0	0	0	0	0	0	2

+ Volume of dust generated due to activities of transportation vehicles when hauling soil, rock, and material.

Number of truck running on the site at peak time will be about 404 trucks (5-12T). Average transporting length will be 70km/truck/day.

Basing on coefficient of dust pollution (kg/1.000km) mentioned in handbook of emission, non industrial and industrial source, Netherlands; US Environmental Protection Agency (USEPA); World Trade Organization (WTO), it can forecast the volume of dust emission from operation of vehicles during hauling rock, soil, material on the site using the length of transportation and capacity, as follows:

Table 3.6: Dust volume generated from transportation vehicles at the site by capacity

Truck type (ton)	Emission factor (kg/1000km)	Total volume of dust generated (kg/day)
< 3.5	0.2	-
3.5 - 16	0.9	25.452

During construction period, the Project Owner, Contractor and sub-contractors will implement mitigation measures to control dust pollution generated during transportation of

material (dripping soil, rock, dust running with trucks) as well as during excavation, leveling, embankment by means of covering during transportation, watering in construction areas and access roads where transportation activities are available, impacts from such a source will be limited.

b) Sound environment

The sound environment in the project area will be affected by noises created from blasting activities required for the excavation, exploitation of material, by transportation vehicles, equipment, and machines available at the site. Besides sound from talking of workers.

+ Noise from blasting: such a noise will be created by blasting during excavation of foundations of various project components and noise from blasting to exploit rock.

Noise created by blasting will create vibration from exploitation area (quarry) or the construction site. Instantaneous intensity of noise created by blasting could reach to 95 - 100dB, even up to 115dB. Comparing to the allowable level (TCVN3985-1999) the duration exposed to noise allowable for worker during a day shall not exceed 1 hour. However, blasting duration is short, normally within 11h30 to 12h and 17h30h to 18h (when other activities have been stopped), moreover the blasting vicinity is normally at the dam site location, powerhouse location and quarry area (quarry is 8km from the project area), therefore impacts will be unremarkable.

+ Noise created from transportation vehicles, from equipment (excavator, bulldozer, mixer, drilling machine, air compressor, ...) at the site.

Table 3.7 Noise created by some vehicles, equipment during construction period at the site from 15m distance

Equipment	Noise (dB)	Equipment	Noise (dB)
Heavy trucks	70-96	Sawing machine	80-82
Bulldozer	77-95	Drilling machine	76-99
Compacter	72-88	Concrete mixer	74-88
Air compressor	69-86	Excavator, loader	75-86
Flexible crane	75-95	Vibrating roller	70-80

(Source: from FHA (USA))

Since the construction site is existed with lots of sources and activities generating noise, in fact noise will be created large due to resonance between them. The required additional noise is listed in table 3.18.

Table 3.8: The required additional noise when lots of activities occurring at the same location

Difference between noise (dB)	Required additional noise (dB)	Difference between noise (dB)	Required additional noise (dB)
0	3.0	7	0.8
1	2.6	8	0.6
2	2.1	10	0.4
3	1.8	12	0.3
4	1.5	14	0.2
5	1.2	16	0.1
6	1		

(Source: Le Trinh – Environmental Impacts Assessment – Procedures and application – Scientific and Technique Publisher)

Thus, in the case of maximum resonance of noise created by various vehicles, equipment at the site could be as follows:

Table 3.9: Noise from vehicles, equipment with maximum resonance at 15m distance

Equipment	Noise (dB)	Equipment	Noise (dB)
Heavy truck	73-99	Sawing machine	83-85
Bulldozer	80-98	Drilling machine	79-102
Compactor	75-91	Concrete mixer	74-88
Air compressor	72-89	Excavator, loader	75-86
Flexible crane	78-98	Vibrating roller	73-83

Table 3.10: Noise exposure standard (TCVN 3985-1999)

Maximum allowable duration exposing to noise	Allowable noise (dB)
24 h	70
8 h	85
4 h	90
2 h	95
1 h	100
30 minutes	105
15 minutes	110
	Maximum allowable noise: 115

Comparing with the allowable noise exposure duration (table 3.23 the noise level created by operation of vehicles, equipment, machine in distance of 15m is higher than 70dB (Table 3.22). Within such limit, worker is not allowable to work continuously in 24 hours. Other areas like worker camp, dumping ground, expected resettlement areas, amount of machine storage is not large and it locates scattered so that the impacts by noise is not high.

2. Impacts to water environment

The water environment will be impacted mainly by liquid wastes created by construction activities at various project components and domestic life of workers.

- Impacts by domestic wastes generated by workers:

Table 3.11: Demand on domestic water supply from workers

Construction year	Standard (litter/capita/ day)	Number of people (person)	Demand on domestic water supply (m3/day)			Wasted waster (m3/day)
			Domestic water use	Other demand (10%)	Total	

Construction year 1 (1/2year	110 litter (in which, 100 liters at worker camp, 10 liters at construction site)	1850	203.5	20.35	223.85	179.08
Construction year 2		4030	443.3	44.33	487.63	390.10
Construction year 3		3140	345.4	34.54	379.94	303.95
Construction year 4		2830	311.3	31.13	342.43	273.94
Construction year 5 (10months)		1480	162.8	16.28	179.08	143.26

(Source: calculation for worker camp and auxiliary works of Trung Son HPP prepared by PECC4)

Notes: number of people here means number of workers, officers of Contractor, Engineers, Management Board and camp followers.

Composition of domestic wasted water is organic matters, suspended solid, washing matter, micro-organism, etc... When being discharged into Ma River will increase content of matter existed already in the water causing pollution to water environment and therefore affecting to aquatic life. According to some document the typical characteristics of domestic wasted water will be as follows:

Table 3.12: Typical composition of domestic wasted water

Pollution matters	Unit	Concentration		
		Weak	Medium	Strong
1. Total solid waste	mg/l	350	720	1200
Dissolved	mg/l	250	500	850
Suspended	mg/l	100	220	350
2. Deposited solid	mg/l	5	10	20
3. BOD5	mg/l	110	220	400
4. COD	mg/l	250	350	500
5. Total organic carbon	mg/l	80	160	290
6. Total Nitrogen	mg/l	20	40	85
(estimating by N)	mg/l	8	15	35
Organic	mg/l	12	25	50
Free amoni	mg/l	0	0	0
Nitrit	mg/l	0	0	0
Nitrat	mg/l	4	8	15
7. Total phosphorus	mg/l	1	3	5
(estimating by P)	mg/l	3	5	10
Organic	MNP/100ml	106-107	107-108	108-109
Inorganic				
8. Total Coliform	μg/l	<100	100-400	>400
9. Evaporated organic carbon				

(Source: Wastewater Engineering. Treatment, Disposal, Reuse)

Pollution level of domestic wasted water caused by activities of workers at the project site is forecasted as medium level of the said above table. Basing on that, it can be estimated the typical pollution composition of wasted water released in the project area, as follows:

Table 3.13: Typical composition of wasted water during peak construction year

Composition	kg/day
1. Total solid	280.872
- Suspended solid	85.822
2. Deposited solid	3.901
3. BOD5	85.822
4. COD	136.535
5. Total organic carbon	62.416
6. Total Nitrogen (estimating by N)	15.604
7. Total phosphorous (estimating by P)	3.121

Thus, during construction period, composition of pollution matters inside wasted water is high, moreover the construction period is lasting longer than 4 years, the design and construction of wasted water treatment system in the construction site is required. Details are included in "Mitigation measures" section.

With the volume of wasted water of 390.1m3/day (equivalent to 142,386.5m3/year), total solid waste discharged into the river will be 280.872kg/day. In which volume of suspended solid is 85.822kg/day (equivalent to 31,325.03 kg/year), with that the average concentration of suspended solid in wasted water when being discharged into reservoir will be 0.003631 mg/l. This means that the domestic wasted water will increase suspended solid content in Ma river 0.003631 mg/l, very few (total annual flow Wo of river water will be 7685x106 m3). On the other hand the domestic wasted liquid will be collected for treatment before discharging into river (see section on mitigation measures) therefore not many impacts will be posed on river water quality.

- Industrial wasted water:

Industrial wasted water will be generated from construction activities such as washing car, changing oil, lubrication, maintenance of vehicles and transporting equipment, etc...

+ Under the design, the demand on water for construction activities will be:

Table 3.14: Water demand for construction activities

No	Work items	Demand (m3/day)
1	Water volume required at the site for various vehicles, equipment, concrete curing	453.1
2	Water required for auxiliary works	273
3	Crushing plant	25
4	Batching plant	47
5	Mechanical workshop and car parking area	50
6	Precast concrete base	30
7	Steel formwork base	15
8	Aggregates washing station	93
9	Water, power supply bases	5
10	Laboratory	5

11	Petroleum warehouse	3
Sub-total		999.1
Contingency for other demands (10%)		99.91
Total		**1099.01**

Wasted water released from construction activities, processing material, washing truck, car, vehicles, maintenance other equipment, etc... will contain lots of suspended matter, oil, lubrication and not excluding some other heavy metal causing pollution to Ma river if such wasted water will be discharge directly to the river without any collection, deposition measures.

+ Volume of lubricant used in average will be 18 liter/time/truck, the number of changing in average per year will be 4 times/truck/year. In the peak year, there will be some 404 trucks, car, vehicles of all types, when the lubricant discharged out will equivalent to some 29.088 liter/year (excluding lubricant discharged from other vehicles, equipment). This will be potential sources impacting to the quality of surface water and underground water in the region if no suitable treatment measures will be furnished.

- Rainfall flowing in construction site:

Rainfall water flowing on construction site, borrow areas, disposal areas, wasted dumping areas will contain loosen rock, soil, mineral salt on surface, leakage oil, lubrication, wastes, material (sand, cement, package, timber log, etc...) increasing the content of suspended solid wastes, organic matter, increasing turbidity, etc... of the water helping reducing the water quality, spoiling the view (in the case of matter having long time of disintegration or enable to disintegration such as package, clout, etc...).

Particularly, disposal areas are all located nearby the river, stream therefore creating higher possibility of polluting the water environment, in the case of flash flood, the volume of rock, soil going together with the flow will be remarkable, therefore the arrangement of disposal areas shall be suitable and in conforming to standard and regulations and the method of dumping, leveling and compaction shall be strictly applied. In addition, water flowing out from domestic wasted dumping area containing lots of organics and harming bacterium shall be furnished with mitigation measures and there also should be close supervision furnished otherwise the water environment of river, stream and underground water table will be exposed with high possibility of pollution.

3. Impacts to natural resources and soil environment

a) Taking land for dumping area, disposal areas:

+ Taking land area for wasted soil dumping area: during construction of project components, rock, soil material excavated from foundations of powerhouse, tailrace channel, penstock, etc... will be reused partially, most of them will be dumped in disposal areas. Volume of rock, soil dumped into disposal areas on right bank will be 2,160,669 m3, on left bank will be 3,286,974.79 m3. Total land area taking for disposal area will be 36.32ha.

Volume of soil, rock excavated during construction of access road Co Luong – Co Me will be: 720,614 m3.

In addition, the volume of rock, soil excavated during exploitation of quarry, borrow area, leveling, preparing ground in resettlement sites will be remarkable.

+ Taking land for domestic waste dumping area:

Volume of domestic waste released by domestic life of workers will be as follows:

Table 3.15: volume of domestic wastes released by workers

Construction year	Number for worker (people)	Waste volume (m3)
Construction year 1(6 months)	1850	337.63
Construction year 2	4030	1,470.95
Construction year 3	3140	1,146.1
Construction year 4	2830	1,032.95
Construction year 5 (10 months)	1480	444.0
Total		**4,431.63**

Land area taking by disposal area, some 0.15 ha (including management building, access road,…).

Comparing to the disposal rock, soil volume, the domestic waste volume is not so large but with main component of organic matter the domestic wastes will be favorable environment for micro-organism to develop, particularly those creating diseases to human and cattle. Therefore methods as collection and treatment shall be furnished.

- Causing pollution to soil, underground water table in the area of disposal areas.

- Pushing soil erosion:

Construction activities furnished at project components will cause loosen to soil pushing erosion, washing nutrient of land.

- In addition, the operation of vehicles, equipment could change the physo-mechanical properties of land (compactiveness, grain structure, etc...) or causing pollution to soil environment (pollution by oil, heavy metal, etc...) due to oil, lubrication leakage during maintenance.

b. Impacts by land acquision and riverbed cleaning up

Impacts to ecology environment and to the function of forest preservation and prevention including:

-Carrying out vegetation cutting, cleaning up, leveling the ground to construct dam site, resettlement areas, material storage dumping, dumping ground, and construction of transmission line power supply for the project ….cause losses of forest land area and cultivate land area.

- The riverbed will be cleaned up before filling water into the reservoir including vegetation cover cutting and cleaning. The cleaning area: 1538,95ha in different types.

According to the result of researching, a part of reservoir is in the area of ecology recovery in the management scale of Xuan Nha natural preservation zone. Xuân Nha preservation zone area is occupied approximately 301,7ha in river bed area, occupied 1,8% of total area of preservation zone (based on Xuan Nha Preservation Zone Area after having revised three types of forests with 16316,8ha, Decemeber, 2006).

Therefore, land acquisition for project construction not only causes to lose vegetation cover (due to ground cutting, traffic road, field exploitation, resettlement sites construction and wood for fire), to narrow and split habitats of animals (degree, dustes, noise, people,…), to affect to mirigation and existence of animals, to ecological environement, and to the function of forest preservation and protection, to increase the risks of swept flood. ***However, the occupied area of riverbed is not in the area of seriously protection of Xuan Nha natural preservation zones***, it is only in the area of ecologic recovery and surrounding environment in Tà Lào Đông, Tà Lào Tây

and Pù Lầu villages. It is discribed in detail: of which 603,4 ha occupied land of the preservation zone, there is 213,11 ha agricultural land, only 367,26 ha forestry land including: 5,3 ha natural forest and 361,96 ha for Luong planted by the local people, and a number of other trees is reduced remarkably. In order to mitigate impacts to ecologic environement, to ensure the function of forest protection, it is proposed to afforest to fulfill the occupied forest area, and give this area to the local people of resettlement no.04 keep this protection forest area (see in the mitigation measures – chapter 4).

The construction surrounding environment in the serious protected zones of the two natural preservation zones, Xuan Nh and Phu Hu, a quite good forest cover is an ideal resident for animal moving out of construction area.

4. Impacts to ecological environment

a) Impacts to plants and forest natural resources

As the researching result of PECC, the affected area to vegatation in the areas as follows:

- Impacts to the vegetation in the reservoir area. Types of area are presented in the following table:

Table 3.16: Affected area of vegetation cover and reservoir
Unit: ha

No	Name	Land for Permanently plant	Land for annually tree	Natural and planted forest	**Total affected area**
1	**Thanh Hoá province**	**7,78**	**88,29**	**702,09**	**798,16**
	Quan Hoá District	4,20	73,32	410,96	488,48
	Mường Lát District	3,58	14,97	291,13	309,68
2	**Sơn La province**	**8,59**	**204,52**	**367,26**	**580,37**
	Mộc Châu District	8,59	204,52	367,26	580,37
3	**Total**	**16,37**	**292,81**	**1069,35**	**1378,53**

(Source: Report of damaged construction survey by PECC4)

- Impacts to the vegetation the resettlement and tranmission line supply power to construction and types of vegetation are presented in the following table:

Table 3.17: Area of vegetation cover in resettlement area and connect transmission line

Unitị: ha

No	**Name**	**Land for water-rice**	**Land for cultivated rice**	**Land for other annual tree**	**Land for annual tree**	**Planted forest**
	Total	**19.0**	**148.0**	**516.0**	**5.0**	**660.0**
1	Thanh Hoá province	17.0	148.0	356.0	5.0	660.0
1.1	Resettlement area 1	8.8	51.0	168.0	1.4	627.0
1.2	Resettlement	5.0	68.0	153.0	2.6	0.0

	area 2					
1.3	Resettlement area 3	3.2	29.0	35.0	1.0	33.0
2	Sơn La province	2.0	0.0	160.0	0.0	0.0
2.1	Resettlement area 4	2.0		160.0	0.0	0.0

According to researching data, mainly vegetation cover is planted area (lat tree, around, bamboo tree..) and annual tree of local people (rice,maize, manioc…), there is not rare species in danger.

Demand on firing, foodstuff of workers will increase the exploitation of firewood, hunting, trading, and keeping timber and illegal animal, causing bad impacts to fauna in surrounding area. Within protected areas, the Hang Kia – Pa Co protected area is far from the project area therefore the possibility of timber cutting and illegal hunting will not occur. Only Xuan Nha, Pu Hu protected areas will be suffered with strong impacts and therefore suitable measures shall be furnished to prevent such impacts from happening.

- Explosive, petroleum warehouses will be existed with high flammable possibility:

Serving the construction of Trung Son HPP, there will be one petroleum warehouse of 350T, on an area of 0.26 ha; and two explosive warehouse 40T with area of 0.5ha constructed.

Surrounding the project area will be mainly productive forestry land (bamboo, textured wood, china-tree, eucalyptus, etc...) and special used forest (Xuan Nha protected area) and productive natural forest, in the case of fire, the impacts extent will be very large. Regulations

b) Impact to terrestrial biodiversity

+ Hunting animal: the concentration of large number of workers at the project site will attract some people from other areas to be here to live, to do trading and service. Eating service will not except the case of using speciality from wild animal. Market to such thing will encourage local resident to enter into forest for illegal hunting.

- Impacts to living habits of animal by noise:

Animal are noise sensitive species. Therefore when the project is under construction, animal living surrounding the project area will move out this area to high and quite mountains to live.

Vegetation and forest in the surrounding area is rather well developed to be good resident for animal when they are moving from the project area, animal will spread to surrounding area or to nearby protected area to live (moving to nearby protected areas will mostly be flying species like birds).

Except the case of Xuan Nha protected area, since the reservoir area will submerge an area within the ecological restoration area, the project dam site is more than 10km from this protected area, noise created during construction will cause impact to fauna. However since surrounding construction area are mainly high mountains, these impacts will be limited.

Pu Hu protected area is 10km from the project areas, noise created during construction will impact to this area within a limited level.

Animal species especially those sensitive to noise, fast moving with large living extent as monkey, gibbon, bear, panther, gayal, etc... will move themselves to dense forest in the core of the projected area or surrounding area to live and find food, this will increase density of species and there may be new species moved to areas where migrant species are available to avoid noise caused during project construction, leading to unbalanced ecology and existing conflict among fauna will be stronger, there may be species die. Species have no adoption to new living conditions may be died.

Species living nearby population area such as deer, muntjac, wild boar, etc... in early stage will move out, far from the project area, normally to forest in valley or low, quite mountain to love then they will be bank to forest, slash and burn area nearby the project area for living. Smaller species, birds, reptile will only display from submerged areas or spreading from the project area to live. Species depends on water environment as otter, water bird species (heron family, kingfisher family), variant species, grass snake species, water turtle species and amphibians species will move to bank edges to live. The movement, but not so far, by small animal, bird, amphibians, reptile will be the cause exciting the animal hunting of local resident living nearby such areas. But when the project is under official operation, noise created during construction period will be stopped, species will gradually come back to the region. However, some small animal like squirrel, rat, lizard having no ability to displace themselves far, when the reservoir is filling, they may be die in water. However such phenomenon will be very limited, and creating less impact to the local fauna because they are species with large distribution, existed in lots areas, fast birth viding, the left will develop and fill back the gap in quantity.

c) Impacts to aquatic life

- Making barrier to movement of fish and aquatic life from upstream and downstream of Ma river:

The construction of a dam on Ma river at Trung Son will impact to aquatic life and aquatic sources, affecting to fish activities of local resident.

The project area is found with some migration fish including Hemibagrus, elopichthys bambusa, etc... the construction of Trung Son dam will impact to migration habit of such fish. However, downstream of Trung Son HPP will be Hoi Xuan HPP, however this dam will constructed or not, the movement between upstream and downstream of migration fishes and aquatic life will be affected. So far in Vietnam no irrigation system or hydropower project had proposed any feasible method to mitigate impacts to migration fish.

5. Impacts to water natural resource

Impact due to barring Ma flow affecting to natural flow and to usage in the construction downstream.

- Preventing small rivers to supply for domestic and productive water in resettlement areas , mitigating water flowing into Ma river.

3.2.3. Impacts to cultural – socio – economic environment

1. Impacts to health, lives of workers, resident living in the project area and downstream area

- Impacts from dust, exhausted gas:

Dust, exhausted gas will impact to the respiration affecting to health conditions of workers working at the site and local resident living around the site.

According to forecast from some projects in which the Consultant has involved, the area having concentration of pollution exceeding the allowable limit and therefore causing bad impacts to human heath is within radius of 300-500m, the radius affected by blasting is larger, within 2000-3000m. However, blasting activities are normally occurred when other activities have been stopped. Moreover the project area is quite far from worker camp which is arranged at the beginning of wind direction (North from dam site, the main wind directions in this region is NE, SW) therefore the impacts by dust, gas to human health will be reduced. In the case of soil, rock borrow areas which are quite close to population area, suitable measures including warning shall be provided in the case of blasting to ensure safety of lives, health and properties of surrounding population.

Mitigation measures to minimize impacts from dust, exhausted gas to health of workers, officers and local resident have been mentioned and described in chapter 4. In the cases of access road VH1, VH2 crossing population centers (Co Me, Co Luong villages, etc...) mitigation measures shall be furnished to minimize impacts from dust, noise, exhausted gas by covering the truck under transportation, watering at least twice a day (during hot, windy, dry days this frequency shall be 3-4 times per day), trucks shall be regulated for suitable.

- Impacts by noise:

As same as dust, exhausted gas, and noise will impact directly to health of workers and local resident living surround the project area, causing hearing related diseases.

To estimate the radius impacted by noise, the following equation has been applied (U.S department of transportation, 1972):

$M1 - M2 = 20\log (R2/R1)$

In which:

M1: Noise at location 1; M2: noise at location 2; R1: distance from source to location having noise 1; R2: distance from source to location having noise 2.

Table 3.29: Noise generated by blasting activities and vehicles/equipment by distance to source

Equipment	Distance (m)							
	15	30	60	120	240	450	600	3000
Heavy truck	73-99	93.0	87.0	80.9	74.9	69.5		
Bulldozer	80-98	92.0	86.0	79.9	73.9	68.5		
Compactor	75-91	85.0	79.0	72.9	66.9	61.5		
Air compressor	72-89	83.0	77.0	70.9	64.9	59.5		
Flexible crane	78-98	92.0	86.0	79.9	73.9	68.5		
Sawing machine	83-85	79.0	73.0	66.9	60.9	55.5		
Drilling machine	79-102	96.0	90.0	83.9	77.9	72.5	70.0	
Concrete mixer	74-88	82.0	76.0	69.9	63.9	58.5		
Excavator	75-86	80.0	74.0	67.9	61.9	56.5		

Equipment	Distance (m)							
	15	30	60	120	240	450	600	3000
Vibrating roller	73-83	77.0	71.0	64.9	58.9	53,5		
Blasting	95-115	109.0	103.0	16.9	90.9	85.5	8.5	9.0

Results mentioned in the above table show that when the distance is twice longer, noise will be reduced by some 6dB. It means within 450m from noise generating source from vehicles, equipment, machine, noise is less than 70dB.

The arrangement of worker camp and population centers as present, impacts from noise to health of worker and local resident are evaluated as limited.

Health of worker will be impacted by noise, dust, exhausted gas only during working time.

In the case of areas along access road Co Luong – Co Me where some population centers are located, to minimize impacts from noise to human health, the construction of this road and the transportation of material, equipment as required by the construction of the dam and powerhouse during day time, avoid to implement such a job during off time of population. If construction is done during night time, it shall be agreed by local resident and local authority in writing document.

- Impacts from concentration of huge workers:

+ Workers concentrated at the site could bring new diseases and transmit to local resident.

To reduce pressure to local health care services (posing on equipment, examining tools, drug, doctor, nurse staff, examining, etc...) the Project owner will construct clinic at auxiliary work with 30 beds serving the health examination, checking, keeping records of workers, officers.

+ With the concentration of huge workers at the site, the generation of pollution matters will create conditions for micro-organism to develop, to be high risk to generate and transmitting germs. Temporary latrine, if not being well managed, the environment quality in the region will be reduced. If the environmental sanitation conditions are not good, it may create diseases affecting to health conditions of workers.

- Impacts during construction period:

Accidents due to working could be occurred during construction period if workers do not only regulations on working safety and safety method applied to the project including traffic accident, accident during blasting to excavate rock, electric shock accident, etc.....

In some cases, during construction period, sources of pollution (dust, exhausted gas, noise, etc...) will cause badly impact to human health making them tired, dizzy, and unconscious and no more be active in work leading to accident.

Industrial accident during construction period could cause injury or life losing to the case of workers working at the site. In addition, if no safety methods are applied, or suitable warnings are not furnished during working period, it may cause life losing and injury to local resident living and/or acting nearby the construction site.

- Impacts by environmental failures:

+ Impacts by land/rock sliding: the occurring of land/rock sliding may cause injury to people directing traffic vehicles, workers working in foundation pit, headrace channel, borrow area, etc.....

+ Impacts by firing at petroleum warehouse, explosive warehouse:

The occurring of fire could endanger the human lives. Safety radius of blasting is some 184.2m, within this limit, human is not allowed for any activities during blasting.

The explosion and fire hazard in vicinity of explosive, petroleum warehouses are high, therefore safety methods to such warehouses shall be taken with cares and seriously implemented.

+ Impacts from failures of up/downstream cofferdams:

Following are possible causes causing failures of cofferdams:

+ Discharge and maximum water level of construction flood higher than designed discharge and maximum water level.

+ Cofferdam may be failed due to quality of construction material which is not ensuring the quality as specified by standard.

+ Under construction, but the component has not been reached to the designed elevation when premature flood higher than the design value.

+ The cofferdam failure may be also caused if the Contractor does not construct it as the designed elevation or quality of construction material, coefficient of compactiveness do not satisfy the standard.

Impacts: the up/downstream cofferdams failure will not only cause losing to properties or economy of the Project Owner, of people living in downstream area but it may also cause injury or lives losing of workers and of population living along both banks of Ma river, in downstream area.

2. Affecting to security order in the local, management of local authority, culture, custom, habit of people living in the project area

- Affecting to national security, security order in the local area and management of local authority:

The concentration of workers at the site (mainly male), camp follower, emigrator may lead to the fact of illegal land transferring, conflict between working groups, conflict between Contractors, conflict between officers, workers with local resident, causing social evil (drug, prostitution, ...) causing difficulties in controlling national defense, security order, social management.

Officers, workers, camp follower (family: wife/husband, children, etc...) and free emigration to the construction site will cause changing in the project area, increasing temporarily population density, number of people staying in this area, all will cause difficulty to the management of population, social security, etc... of authorities in communes, districts of the project area.

- Impacts to culture, custom, habit of local resident:

The project area is living mainly by Thai minority people, a small number of H'Mong people who lives united by family, tribe, in villages. They have high community characteristics and lots of unique custom, belief.

Workers working at the site come from different areas, of various ethnic people, having different culture, custom, thus making interfering and mixing between various culture threatening the losing of culture characteristic existed in this area.

3. Impacts to traffic:

- The implementation of the project, with large number of transportation vehicles mobilized to transport equipment, material from somewhere else to the site and within the construction area, will increase the density of vehicles affecting to traffic conditions of various access road alignments and therefore will cause settlement to incoming road as well as inter village, inter commune road alignments. Road in the region is now earth road, path, therefore during rainy season the operation of vehicles will cause worse conditions to them.

To minimize impacts cause by traffic in the region, there shall be suitable car regulation regime, large, huge equipment, machine shall be transported by special used truck and shall be done during day time, transpiration of vehicles, and equipment during rainy season shall be limited.

4. Impacts to economy, careers of local resident living in project area

Impacts to number of resettlement people :

Number of affected households due to land acquisition for the project construction in selected alternation is as below:

Table 3.19: Summary of households/individuals to be affected both houses and production land in the reservoir area

No	Location	Number of households	Number of persons	Affected households and percentage of total households in commune
1	**Thanh Hoá province**	**277**	**1587**	
1.1	***Quan Hoá district***	**152**	**915**	
	Trung Sơn commune	**152**	**915**	**34.2%**
	Tà Bán village	119	769	
	Xước village	23	107	
	Quán Nhục village	10	39	
1.2	***Mường Lát district***	**125**	**672**	
	Mường Lý Commune	**80**	**433**	**10.7%**
	Tài Chánh village	34	183	
	Nàng village	42	227	
	Muống 2 village	4	23	
	Trung Lý Commune	**36**	**201**	**3.7%**
	Lìn village	16	95	
	Chiềng Lý village	16	78	
	Pa Búa village	4	28	
	Tam Chung Commune	**9**	**38**	**1.6%**

	Poom Khuông village	4	22	
	Kha Ni village	5	16	
2	**Sơn La province**	**155**	**766**	
2.1	***Mộc Châu district***	**155**	**766**	
	Tân Xuân commune	**151**	**741**	**26.3%**
	Tà Lào Đông village	100	455	
	Tà Lào Tây village	51	286	
2.2	**Xuân Nha commune (new)**	**4**	**25**	**0.15%**
	Pù Lầu village	4	25	
	Total	**432**	**2353**	

(Source: Resettlement Master Plan prepared by PECC4)

Economy: Land acquisition will also has impacts on assets, trees and other structures in the land of households, communes. The lost volume is estimated as below:

Table 3.20: Lost inventory of reservoir area

TT	Item	Unit	volume	note
I	Number of affected households/people			
1	Number of HH/people to be affected on both their houses and lands	HH/person	432/2353	
1.1	Thanh Hoá province	HH/person	277/1587	
a	Quan Hoá district	HH/person	152/915	
b	Mường Lát district	HH/person	125/672	
1.2	Sơn La province	HH/person	155/766	
a	Mộc Châu district	HH/person	155/766	
2	Number of HH/people to be affected on production land only	HH/person	75	
2.1	Thanh Hoá province	HH/person	28	
a	Quan Hoá district	HH/person	11	
b	Mường Lát district	HH/person	17	
2.2	Sơn La province	HH/person	47	
a	Mộc Châu district	HH/person	47	
II	Assets, houses, infrastructures and public assets			
1	Houses			
1.1	Mộc Châu district			
	Xuân Nha commune (old)			
	Category IV house	m2	171	
	House on stilts	m2	8426.13	
	Thatched cottages	m2	239.5	
	Kitchen, store and breeding facilities	m2	3113.7	
1.2	Quan Hoá district			
	Trung Sơn commune			
	Category IV house	m2	186.75	
	House on stilts	m2	7142.14	
	Thatched cottages	m2	1076,6	
	Kitchen, store and breeding facilities	m2	3541.37	

1.3	Mường Lát district			
	Trung Lý commune			
	House on stilts	m2	1428.47	
	Thatched cottages	m2	43	
	Kitchen, store and breeding facilities	m2	904.58	
	Mường Lý commune			
	Category III houses	m2	180.95	
	Category IV houses	m2	138.4	
	House on stilts	m2	3734.17	
	Thatched cottages	m2	30.36	
	Kitchen, store and breeding facilities	m2	1787.47	
	Tam Chung commune			
	House on stilts	m2	55	
	Thatched cottages	m2		
	Kitchen, store and breeding facilities	m2	73.5	
2	Tombs			
	Toms	Unit	20	
3	Public buildings, transportation and irrigation facilities			
	Inter commune roads	Km	10.5	
	Inter village roads	Km	32.0	
	Suspension bridges	M	50	
	Schools	m2	737.89	
	Houses for teachers	m2	61.25	
	Cultural houses	m2	77	
	Health clinic	m2	73	
	Ta Com forest protection station	m2	42	
III	Trees and crops			
4.1	Thanh Hoá province			
a	Wood trees, special trees			
	Eucalyptus trees, casuarinas trees, etc.	Tree	426	
	Bamboo	Tree	2247789	
b	Fruit trees and crops			
	Jack fruit tree	Tree	347	
	Pamela trees	Tree	652	
	Plum trees	Tree	345	
	Longan trees	Tree	2737	
	Custard-apple trees	Tree	116	
	Chinese pig trees	Tree	60	
	Sugar cane	Ha	3.2	
	Potato	Ha	60.14	
	Rice	Ha	28.15	
4.2	Sơn La province			
a	Wood trees, special trees			
	Wood trees (normal)	Tree	335	
	Bamboo - Tre, bương (not yet reach to crop scale)	Tree	607019	
b	Fruit trees and crops	Tree		

	Longan, litchi and mango trees	Tree	1680	
	Jack fruit tree	Tree	457	
	Plum trees	Tree	58	
	Rice	Ha	85.332	
	Vegetables	Ha	119.2	

(Source: Inventory survey conducted by PECC4)

The concentration of workers at the site will increase demand on food, entertainment and therefore pushing up the trading and services in the region to develop. Services established will satisfy demand of normal life and livelihood of workers, officers working at the site. This will help solving the demand on job and increasing income to local resident.

Site investigation concentrating on material and resources in the region has found soil, sand, rock borrow areas with acceptable storage and quality as required by the project construction. The exploitation of such borrow areas locally has helped making use local material, reducing cost to the project.

- Creating job opportunities to workers and changing labor structure in the local area:

The construction of Trung Son HPP will be initial background to change labor structure in the local area through satisfying the demand on working force of the project.

Depending on the ability of local working force, they will be selected to work at some project component and get paid. At project components where requiring simple work or work will be done by manual method: cutting tree, transporting rock, soil material by simple vehicle, watering to cure concrete, preparing the foundation excavation, grassing at dam abutments, etc... the Contractor and sub-contractors shall be allowed to hire local labor to perform such a work. People who is hired to work at the site, will have chance to learn new technology, get familiar and know how to operate machine and vehicle. Gradually their knowledge will be improved and they will be positive and efficient factor affecting to knowledge, to cultural, spirit life of local resident.

5. Impacts of resettlement

- Number of household to be resettled:

According to the implementation plan of the project prepared by PECC4, Resettlement plan should be completed in 2011. Number of resettlement households is projected to each affected village to the time of completion of the resettlement plan based on the natural and mechanical population growth rate, which is 3% per year for the area.

In some villages, not every households in the village will be inundated by the reservoir but will be isolated due to inundation of the access roads and the cost to build infrastructure facilities for the remaining HH is higher than the cost to resettle the HH and from the social aspect of ethnic minority it is better to remote all HH in these villages.

Total resettled HH at survey time in 2005 in selected water level option of 160 m taking into account the tail water at flood frequency of 1% was 472 HH, 2353 persons. The figure is projected in 2011 is 526 HH. The affected HH are mainly Thai (account for about 98%), the remaining are Mong.

Table 3.21: Projected HH and persons to be resettled in selected option

No	Item	Year 2005		Year 2011		Resettlement option
		household	Person	household	Person	

	Total	**472**	**2353**	**527**	**2630**	
A	**Thanh Hoá province**	**317**	**1587**	**351**	**1768**	
I	**Quan Hoá district**	**192**	**915**	**216**	**1030**	
1.	**Trung sơn Commune**	**192**	**915**	**216**	**1030**	
	- Tà Bán village	159	769	179	866	Concentrated
	- Quán Nhục village	10	39	11	44	Concentrated
	- Xước village	23	107	26	120	Concentrated
II	**Mường Lát district**	**125**	**672**	**136**	**738**	
1	**Mường lý Commune**	**80**	**433**	**90**	**487**	
	- Tài Chánh village	34	183	38	206	Concentrated
	- Nàng village No1	42	227	47	255	Concentrated
	- Muống village No. 2	4	23	5	26	Self arrangement
2	**Trung Lý Commune**	**36**	**201**	**41**	**226**	
	- Pa Búa village	4	28	5	32	Self arrangement
	- Lìn village	16	95	18	107	Concentrated
	- Chiềng village	16	78	18	88	Concentrated
3	**Tam Chung commune**	**9**	**38**	**5**	**25**	
	- Pom Khuông village	4	22	5	25	Self arrangement
	-Suối Kha Ni	5	16			Resettled
B	**Sơn La province**	**155**	**766**	**174**	**862**	
I	**Mộc Châu district**	**155**	**766**	**174**	**862**	
1	**Tân Xuân commune**	**151**	**741**	**170**	**834**	
	- Đông Tà lào village	100	455	113	512	Concentrated
	- Tây Tà lào village	51	286	57	322	Concentrated
2	**Xuân Nha commune**	**4**	**25**	**5**	**28**	
	- Pù Lầu village	4	25	5	28	Self arrangement

(Source: Resettlement Master Plan prepared by PECC4)

- Proposed resettlement areas

Based on the lost inventory survey, area and legal status of affected land, land availability of land in the area, desire of the local people and proposals of local authorities (moving and coming locations) and representatives of resettlement HH and investment alternative to support resettlement HH to recover their income, promote the socio-economic development of the areas and ensure the security and national defense of the border area the Resettlement Master Plan for Trung Son hydropower project has been prepared and agreed with the local people, related commune people committees and district people committees of Quan Hoa, Muong Lat and Moc Chau with signed agreement (attached to the report in annex section).

Through investigation and analysis in the area, four resettlement areas have been identified for Trung Son hydropower project located in four affected communes, which are able to receive all resettlement HH (507 HH, 2520 persons). They are Resettlement area number 1 in Trung Son commune to resettle 190 HH, 910 people from Ta Ban village and 26 HH, 120 people from Xuoc village; the resettlement area number 2 in Muong Ly commune for resettlement of 47 HH, 255 people in Nang 1 village and 38 HH, 206 people in Tai Chanh village; Resettlement area number 3 in Trung Ly commune for resettlement of 18HH. 107 people in Lin village and 18 HH, 88 people in Chieng village ; and resettlement area number 4 in Xuan Nha commune for resettlement of 113 HH, 512 people in Dong Ta Lao village and 57 HH, 322 people in Tay Ta Lao village.

3. 3. Impacts assessment during operation period

5.1.1 Impacts to natural environment

1. Impacts to air, sound environments and micro-climate conditions

a) Impacts to air and sound environment

- Impacts by noise:

The powerhouse has been studied and proposed with updated equipment, machine, moreover the walls will be installed with soundproof devices therefore noise generated will mainly affect to the powerhouse itself.

- Impacts from exhausted gas (CH4, H2S, CO2, NH3,....) generated when biomass and organic matters disintegrating.

During initial time of reservoir impoundment from 3 to 6 months, biomass and organic existed in soil within reservoir area will be disintegrated under fastidious conditions and release gas as CO2, H2S, CH4 and a small volume of N2O, NH3,… with bad smell causing pollution to air environment.

b) Impacts to micro-climate conditions surrounding the reservoir

When the reservoir is filling, the climate conditions surrounding this area will be changed.

Trung Son reservoir is a narrow lake, running along the river channel therefore the reservoir formation will impact unremarkably to climate regime in the catchment. However, in area nearby the reservoir, some climate typical characteristics will be changed, it can be forecasted that:

* *Thermal regime:* when Trung Son reservoir is completely filled and under its operation regime, temperature fluctuation during day and during year will be reduced. The maximum value will be reduced, the minimum value will be increased.

* *Relative humidity*: the absolute minimum humidity will be increased during every months of the year. The average humidity is almost unchanged, increasing by some 1% of hottest dry months.

Independently, micro-climate conditions will be improved in small scale but putting in the whole hydropower project cascade on Ma river (Trung Son HPP and Hoi Xuan HPP in downstream) the improving extent of micro-climate will be larger.

Thus, when the reservoir is created, special climate phenomenon and extreme values of humid – heat conditions are in the trend of reducing and being more gentle. This will have both negative and positive impacts. Such as:

- To human, differences between water/soil temperature will create wind, particularly during dry season, the reservoir climate will create good results to sleeping, nervous system, blood pressure system, good conditions to health of workers.

- When humidity in the reservoir area will increase harming insect, disease causing insect will also have good conditions to develop. This is negative impact to the growing of tree, plant, and crop.

2. Changing hydrological regime of surface and underground water table

a) Hydrological regime of surface water under normal operation regime

** Upstream of the dam site (reservoir area)*

When the reservoir is constructed, a 32 km river section in upstream of the dam site will be created into reservoir, the flow regime of the river will be instead by reservoir hydrological regime. The inflow velocity into reservoir will be headed with sudden reduced limiting the sediment load interring the reservoir, but most of sediment load will be trapped here, reducing the reservoir storage, limiting project benefits.

** Downstream area*

- **In the case if Trung Son HPP is not constructed**, Ma river flows from Viet-Lao border to downstream part under natural hydrological regime (because it is less impacted by irrigation structures). In the dry season, discharge Q and water level H recorded at Hoi Xuan gauging station fluctuates under natural rule with average discharge of 120m3/s, average water level of 52.01m, environmental problems as joining between rock, soil along banks has been stable, habit of people living along banks familiar to natural flow,…

- **In the case Trung Son is constructed (annual regulation)**, Hoi Xuan HPP is not constructed: with operational regime of the powerhouse operating at peak load will cause large changing to the flow, showing in fluctuation of water level and daily discharge…

Table 3.24: Water regime in lowland when having pond without Trung son Hydropower's reservoir

Month	Qotb (having not reservoir yet in Trung Son) (m3/s)	Qotb (reservoir is avalable in Trung Son) (m3/s)
VI	268,5	268,0
VII	451,1	450,5
VIII	620,5	619,9
IX	548,1	505,0
X	273,6	272,7
XI	179,6	178,8
XII	127,6	127,2
I	98,6	57,5
II	83,8	94,3
III	78,9	94,0
IV	84,0	94,7
V	119,4	121,8
TB	**244,5**	**240,4**

Daily discharge during dry season at Hoi Xuan gauging station is estimated with 24 hours in day, the maximum discharge 69,14 m3/s. According to the Trung Son discharge in the daily discharge condition like Hoi Xuan, the maximum discharge will be 83,1m3/s equal to 34,06%. This will cause negative impact to ecology; life and activities of people living along two banks; irrigation; fishing; erosion, sliding and therefore threatening safety of lives, properties and works constructed on land,…

Therefore, there is not Trung Son HHP, the flow on Ma river from Viet-Lao border to downstream is natural.

In summary, in the case Trung Son HPP is constructed but not Hoi Xuan HPP, the operational regime under peak load chart will cause unremarkable damages on economy, environment in downstream area in long-term.

If Hoi Xuan HPP is available in daily discharge, the flow regime (flow, water level)in downstream in dry reason is increased and more stable.

b) Hydrological regime in operation condition of flood season

Basing on hydrological calculation results, peak flood volume corresponds to design frequency of Qp=1%=5378m3/s in the case without project. In the case with Trung Son HPP, flood volume will be kept a part in reservoir up to FSL, a part will be discharged through spillway, other part will be through powerhouse (Qmax = 83.31 m3/s) before discharging to downstream so it will have effect to slow down and reduce flood discharge at downstream of dam.

c) Underground water table

When reservoir is created it will create some underground water table at shallow layer, especially it will be low land areas near reservoir.

Underground water level and humidity of land surrounding reservoir increasing is supply source, water will be added for excavation round, drilling shaft, make contribution to resolve domestic water supply and irrigation water in dry season and being favorable condition for plant grow.

3.3.1.3. Impact to topographical and morphological processes

- *Topography, morphology at reservoir bed area:*

When reservoir belonging to submerged land terrain is extended (reservoir surface area corresponding to FSL is 13.13km2), local basic cavitations water level will increase and in fact energy of water will reduce causing sediment and mud deposit process at reservoir bed and surface erosion process intensity will reduce. But here, the most interesting one is phenomenon of humidity store increasing in covering layers on the slope, it is possible to exceed static friction causing sliding phenomenon and changing bank line. Here is to determine effective scope, scale and level of this process. Basing on design, bank line of reservoir is a semi-submerged range near bank, calculated from surge water level to minimum operating level (150m-160m). Because terrain of Ma river valley, reservoir area has narrow type so area of this semi-submerged zone is unremarkable. Moreover, it is observed that Ma riverbed at the present is cut too depth on general terrain surface, flow presents its young development period in which bedrock is exposed at riverbed, sometimes there are small sand bars along bank, and there are gravel and pebble banks at some confluence positions of large streams.

In terms of reservoir bank regeneration capacity, basing on preparation of calculation diagram, damage and recreation of reservoir bank is forecasted for hydropower projects. Basing on load regulations and force acted on irrigation project (QP.TL-C-1-78) issued in 15 th September 1979. Basing the above procedures, Xolotariep method is used for specific section and its calculation results are as follows:

Table 3.25: Calculation results forecasted for reservoir bank sliding of Trung Son HPP

Sloping	Length of	Width of regeneration (m)	Erosion volume (m3)

	regeneration (km)	After 10 years	After 100 years	After 10 years	After 100 years
>15o	30	57.9	90.1	13,789,230	22,100,827

Basing on the above basic, when reservoir putting into operation, sliding and bank regeneration will happen to be balance status and suitable with local erosion level that is determined with intensity at weak level to average.

Sliding volume after 100years is about 22.106m3, occupied 9.35% dead storage of reservoir, it won't affect to life of reservoir.

Now reservoir backshore exists still hamlets with erosion speed as forecasted that will effect to these residential area (residential areas often distribute at low terrain with ground and loose weathered layer, so geological foundation is weak).

Otherwise, now along Ma River section from project layout to upstream has traffic road system connected from hamlets in the region. Traffic system in studied range up to now is still at low status, mainly is soil road. Sliding phenomenon of reservoir bank will effect directly to the existing traffic road system. Basing on the above calculation results, width of regeneration of reservoir bed after 10 years is 57.9m and after 100 year is 90.1m in average . Distance from the existing road to reservoir water level with average length is 50-60m. Thus, powerhouse operation & management board must observe closely for sliding speed and level of reservoir area to have preventation measures and overcome problem in time. Cost of observation, consequence overcome will be born by powerhouse operation and management board.

+ Sediment at reservoir bed:

Erosion at surface of catchment is source to create sediment flow in river thus reservoirs are constructed on river, sediment at reservoir bed relates to silt flow, it is necessary to assess appropriately to insure the life of the project.

Basing on calculation of PECC4, silt flow on Trung Son reservoir area is 54.2kg/s in average corresponding to river water turbidity of 222g/m3. Total annual sediment amount caused deposit at reservoir is 1.301x106m3, in which suspended sediment is 1,08.106m3, bed load amount is 0.217.106m3. Results of calculation are as follows:

Table 3.26: Results of sediment calculation

No	Characteristics	Values
1	Annual turbidity,δ (g/m3)	222
2	Suspended sediment load, Ro (kg/s)	54.2
3	Coefficient of deposited sediment, E	0.75
4	Suspended sediment yield, γll (ton/m3)	1.182
5	Transported sediment yield, γdđ (ton/m3)	1.554
6	Total volume of annual deposited sediment, Vll (m3/year)	1,084,047
7	Total volume of transported sediment, Vdđ (m3/year)	216,810
8	Total volume of annual deposited sediment (106m3/year)	1.301
9	Total volume of sediment deposited in 100 year (106m3)	130.1

Deposited silt amount at reservoir bed includes sediment of river getting into reservoir in flow and sediment due to bank erosion.

Basing on the above calculation results, total deposited sediment in reservoir bed after 100 year is 152,2.106m3, occupied 62.53% of dead storage of reservoir. By rapid calculation

method, with dead storage of Trung Son reservoir of 236,4.106m3 life of reservoir will reach over 150years. Therefore, impact assessment can be at not high level, silt retaining in reservoir bed deposit is not effect to the project life.

- *Topography, morphology of river bank line and river bottom at the downstream:*

Reservoir has long term regulated regime. It only generates in peak hours so daily water level fluctuation is high, moreover a main part of mud and sediment retaining in reservoir occupies about 80% . Total sediment flowing to reservoir increases sediment deposit of water causing excavation capacity at reservoir bed and erosion that changing shape of bank line and Ma river bottom at the downstream is high, therefore impact caused erosion and sliding at bank due to water level difference and shortage of sediment. However, if Hoi Xuan HPP is constructed at downstream of the project it will limit this impact.

3.3.1.4. Causing exciting earthquake

Up to now, there is not detail studies about this field and determination of exciting earthquake potential now is still depend on the statistic data. However, UNESCO had progress in this field. Through static on exciting earthquake happened in many large reservoirs in over the world, it can conclude that necessary and enough condition to arise exciting earthquake such as:

+ Geological structure at reservoir is not stable, cut through fracture tectonic faults;

+ Max head height of reservoir is over 90m;

+ Storage volume of reservoir is over 1.109 m3.

Comparing these conditions with real of project design show that:

+ Geological structure at reservoir area effected by two faults of divided zone of Ma River structure and Son la (grade I) they are faults causing earthquake (Son La fault is about 16km far from project site, Ma river fault is 19km far from project site) thus project area where is strongest earthquake activity. However, faults in the range of reservoir present discontinuous and weak action. Thus they are resonant factor caused exciting earthquake at the average - weak level.

+ Height of design head: Hmax= 71.1m, lower than head height so exciting earthquake will cause.

+ Storage of reservoir: 348.53 x 106 m3, equal to ≈ 40% storage level that happens exciting earthquake.

Due to 2/3 factor is not possible to cause exciting earthquake so it can conclude that: when reservoir is put into operation, exciting earthquake is impossible to happen. However, the project locates in region with tectonic activity regime with strong potential earthquake grade sometimes exciting earthquake is possible to arise thus it is necessary to have more detail studies about this problem to bring out appropriate treatment option.

3.3.1.5. Water environment

- Impact due to liquid waste is raised during operation of powerhouse:

+ due to oil and lubricant:

For turbine of hydropower plant, powerhouse has now selected the state of art equipment and determined during operation process without causing oil seepage.

Oil and lubricant of turbine bearing if is not replaced it will be purified or filtered to reuse. Moreover, waste oil and lubricant collection system is arranged in the powerhouse,

seepage during maintenance of turbine bearing, lubricate equipment ball-bearings to treat and pour into stipulated position so environmental pollution is not happened.

+ Due to domestic waste water of operator of powerhouse: In design, operator of powerhouse includes about 130 persons. Thus waste amount caused by domestic use of worker is very little in comparing with construction time. Moreover, powerhouse has designed enough sanitary system based on design standard for civil works so wastes do not discharge directly to natural environment, thus it is confirmed that domestic use waste of operator and worker does not effect to water environment.

- Impact caused by submerged biomass in reservoir bed area. This is waste source with high effect to water quality of reservoir.

When reservoir is put into operation, some land areas are submerged in water and series of substances existed on them will create a part of organic source, available oxygen content will be consumed. Organic source arising in artificial reservoirs is mainly from humus layer of surface zone of land and vegetable covers. Equation for consumed oxygen content calculation is as follows (according to A.I, Denhinova):

$$\sum O_2 = \frac{K_{oDat} \; x \; S_{Dat} \; + \; K_{tv} \; x \; D_{tv}}{1000} \quad \text{(ton)}$$

In which: $\sum O_2$: necessary oxygen content to oxidize organic substances disintegrated from plant and land submerged in reservoir bed (ton).

KoDat: Experiential coefficient presented oxygen content (kg) is necessary to oxidize organic substances disintegrated from 1ha land (kg/ha).

Kotv: Experiential coefficient presented oxygen content (kg) is necessary to oxidize organic substances disintegrated from 1 ton dry biomass (kg/ton).

SDat : Land area submerged in reservoir bed (ha).

Dtv: absolute dry biomass in reservoir bed (ton).

Total submerged area in region is 1538.95ha. In which, forestry area is 1.069,35ha (planting forest of 1.001,01ha, natural forest of 68.34ha). Retaining is stream, river, rock stockpile, residential land and agricultural plant cover. Before filling water into reservoir, inhabitant has take advantage of agricultural products and planting forest cover (jet, bamboo tree, bead-tree, eucalyptus etc...). Thus vegetation cover is submerged in reservoir bed mainly of natural forest; root and small leaf and branches of planting forest cover because of inhabitant left after taking advantage.

Biomass calculation result in reservoir bed is as follows:

Table 3.27: Biomass of vegetation cover at reservoir bed

	Area (ha)	Body	Branch	Root	Leaves	Grass	Total
Coefficient of biomass in poor forest (ton/ha)		17.78	5.149	2.699	0.851	0.516	
Coefficient of biomass in bamboo forest (ton/ha)		12.0		2.4			
Coefficient of biomass in planted bamboo forest after	993.35	0.00		2,384.04			2,384.04

collected by people (ton)							
Biomass of planted textured, china-tree forest after collected by people (ton)	7.66	0	39.44	20.67	6.52	0	66.63
Biomass of natural forest (ton)	68.34	1,215.09	351.88	184.45	58.16	35.26	1.844.84

(Sources: Agricultural products and planting forest are collected before filling water into reservoir, retaining part in reservoir includes tree root and small leaves and branches).

Table 3.28: Retaining biomass in reservoir

In clearance methods (ton)

Alternative	Total biomass	Reused biomass, clearing			Biomass left in reservoir					
		Collected	Clearing	Total	Not collected	Branch	Root	Leaves	Grass	Total
P1	4,295.51	0.00	0.00	0.00	1,215.09	391.32	2,589.16	64.68	35.26	4,295.51
P2	4,295.51	1,215.09	0.00	1,215.09	0.00	391.32	2,589.16	64.68	35.26	3,080.42
P3	4,295.51	1,215.09	491.26	1,706.35	0.00	0.00	2,589.16	0.00	0.00	2,589.16

Notes: P1: Without clearance

P2: Collecting from natural forest (all round wood of tree body, bamboo etc.. are collected)

P3: Collecting+ cleaning all biomass of reservoir bed (all round wood of tree body, bamboo; retaining grass, leaves and branches are burn out, submerged biomass in reservoir is tree roof, recycle grass, organic substances, animal live in and on ground surface).

By experiential equation of A.I. Denhicova, we calculate necessary oxygen content to oxidize organic substances of plant and land in reservoirbed and forecast oxygen content dissolved in reservoir water for the above alternatives.

If dissolved oxygen content flowing to reservoir in flow is 6.43 – 6.83 mg/l, with total water content flowing to reservoir in many years is 7685 million m3 in average, oxygen content dissolved in reservoir is 49414,55 – 52488,55ton. Consumed oxygen content and dissolved oxygen content retaining in reservoir is given in Table:

Table 3.29: Total consumed oxygen content and dissolved oxygen content retaining in reservoir in alternatives

	Alternative			TCVN 5942 - 1995	Vietnamese standard TCVN 6774:2000 (mg/l)
	P1	P2	P3		
Consumed oxygen content (ton)	179,98	101,28	91,61		
Oxygen content retaining in reservoir (ton)	from 49234,57 to 52308,57	from 49313,27 to 52387,27	from 49322,94 to 52396,94		
Oxygen content retaining in reservoir	from 6,4066 to	from 6,4168 to	from 6,4181 to	≥ 6	> 5

(mg/l)	6,8066	6,8168	6,8181		

These results show that after filling water into reservoir, submerged biomass does not change water quality much in comparing with natural river, in all cases of clearance water quality insures life of aquatic, water supply for production and water supply for domestic usage, in principle it is not necessary to clear. However, to take full advantage of resources, increase benefit for local authorize, combustibles for inhabitant at surrounding area and insure requirement on hydraulic and good-looking for the project, valuable forest trees are collected and exploited before filling water into reservoir and clear all vegetation cover in the range of 2km before dam.

Otherwise, to limit impact of wave, wind for bank line to mitigate erosion of bank line, collection and vegetation cover near reservoirbed are not done near residential areas (including planting forest cover).

3.3.1.6. Impact to land resources and environment

- Land resources will be submerged when filling water into reservoir. Submerged area is 1538.95 ha.

Basing on study at the site and data, submerged land types are presented in table 3.37.

Table 3.30: Area of submerged land types

	Soil P, X, D, R	Soil X, Fv, Fs, Fj	Soil Fv, Fs, Fj	Soil P, X, D	Soil D, Fs, Fj...	Granite rock	Total
Thanh Hoa province	88.29	7.78	702.09	10.24	0.03	127.13	935.55
Quan Hoa district	73.32	4.20	410.96	5.76	0.03	19.80	514.07
Muong Lat district	14.97	3.58	291.13	4.48		107.33	421.49
Son La province	204.52	8.59	367.26	5.04	2.50	15.50	603.40
Moc Chau district	204.52	8.59	367.26	5.04	2.50	15.50	603.40
Total	292.81	16.37	1.069.35	15.28	2.53	142.63	1.538.95

(Source: Institute of Geography)

After 3-6 months submerged, not only trees, plants, bodies of lived creatures living at the ground (worm, cricket etc.,.) be decomposed but soil at the reservoir's bottom also be broken its structured, lost its bond, and be wetted, that resulting in formation of muddy sediment at the bottom of the reservoir.

- Land losing due to slope erosion at the downstream area:

Based on above analysis, erosive possibility at the slope and digging at the channel of the river is high, resulting in land losing at the adjacent area at D/S of the power plant. However, about 7km from the dam site is location of the tail of Hoi Xuan reservoir therefore mitigated remarkably impact.

Table 3.31: Summary of land by soil type in the proposed resettlement areas

Symbol	Soil type	ha
Fs	brown red soil on degenerated stones	710
Fa	yellow red soil on magma	900
Fq	light yellow soil on sand	96,2
Land area could be used for production (agriculture and forestry)		**1706.2**
Non agriculture land area		21,8
Total natural area		**1728**

(Source: Resettlement Master Plan prepared by PECC4)

- When impounding and going into operation, the moistured content at soil surrounding the reservoir shall be increased (assumed to be 10-15%).

3.3.1.7. Impact to natural mineral resources

Within the reservoir of Trung Son HPP, mineral investigation and survey have been conducted with the compilation of the map in scale of 1:50,000. The results shown that within the scale of the reservoir area, no mineral with industrial developed value has been found. – Curently, there is not exploiting activities and mineral survey in riverbed and surrounding areas.

- it is discovered throught surveying and registered 8 sites – mineral quarries on the map, in which 2 mineral quaries of quartz and 6 sites of constructive material.

The scale of quartz sites is small, content of quartz is low and not valuable. .

The scale of urmalin quartz is wide but exluding SnC -W-Mo mental.

Constructive quarries including granitC, limstones and dolomit is large potential, meets enougn demands of available rock for construction.

- There is several unsual radioactivities, without symbols of valuable radioactivities storage in riverbed area.

General conclusion: for available documentations, up to now, there has not discovered valuable minerals in Trung Son riverbed and surrounding environement.

(quoted according to the **report of mineral nutural resources survey in riverbed prepared by Fedaration of rare radioactivity geologists)**

3.3.1.8. Impact to ecological environment

a) Impact to ecological environment, forest natural resources, and in-land biological diversity

- Impoundment of the reservoir shall obstruct movement of some animal species.

- Partly of the forest land, grass-plots, brushes at resettlement area shall be replaced by ecological system of agricultural plant.

- Improvement of ecological environment, fauna, flora:

+ After constructed completion of the project, temporary land occupied areas, disposal areas shall be planted with forest for recovering ecological system and many areas of bared hills and abundant land shall be supplemented by forest plantation that has been taken (particularly deserted lands at population areas surrounding the reservoir). Hence, vegetation and ecological environment shall be improved remarkably (forest plantation area refers to Chapters 4, 6).

+ Impoundment at the reservoir shall, in one hand extending water coverage area (reservoir surface area corresponding with FSL of 160 is 13.13km2) and make increase of surface water level, underground water level; on the other hand shall improve climatic conditions, which is a favor condition for flora species (both planted trees and natural trees) that favor wet condition to develop.

+ To assure water source for the reservoir and protecting environment, forest protection and plantation must be pushed to strengthen, that is a factor helping to maintain and develop the fauna.

b) Aquatic livings and fishery

- When the reservoir is impounded, body, leaves, small roots of remained plants, remains of animal, plants and species living at the soil shall be disintegrated which shall be a rich food source for aquatic organisms. Therefore, density and living mass of plankton at beginning time shall be very high. Shrimp species at Atyidae branch shall develop with fairly large amount at areas nearby the slopes.

- During the time forming muddy sediments at the bottom of the reservoir, bottom animal species, particularly soft body animal shall be reduced remarkably in term of numbers of species, as well as quantity of individuals as un-stable bottom yet.

After a couples of years when the bodies of creatures have been broken up totally, nutritional quantity in the reservoir also reduced, foundation of reservoir's bottom is rather stable then density and living mass of planktons reduce, and soft body species shall increase.

- Large reservoir area shall be an essential factor for fish species developed, prolonging with the appearance of fish breeding job at the region.

- Construction of the project has changed the flow regime of the river into the reservoir regime, reservoir's ecology in accompanied with aquatic system area typically for this aquatic region shall be formed, and living space of aquatic creature system is enlarged. Component of species, quantity of individuals and volume of aquatic creatures increase of which, increasement on quantity of fish, shrimp, crab and some other species thanks to breeding process of human is essential.

In the first years of submerge, aquatic living system area of the Trung Son HPP basically is the region of reservoir aquatic living system. Instructed creature groups for reservoir in Vietnam such as: Microcystis blue algae, Melosira algae; Bosmina, Diaphanasoma (branched beard- Crustacean; giáp xác râu ngành), Mongolodiaptomus, Vietodiaptomus, Microcyclops, Mesocyclops, Thermocyclops (row-leg crustacean; giáp xác chân chèo), Conchostraca leave-leg crustacean (giáp xác chân lá) shall appear with dominant quantity in term of plankton at the reservoir.

Fish species eating plant and organic mud adapted with still water living develop in both quantity and number of species. Fish species that adapted with aquatic basin living in form of flowing water rivers are reduced. At the beginning time, natural explored quantity is high, many individuals with large size appear such as: carps, hypohthamichthys, mud carp.

During usage process, almost reservoirs shall have to experience to 4 periods. Each period has typical features in term of structure, components and aquatic livings under the direct impact of water environmental factors. Ecological developed scheme of the reservoir is as below:

+ Mixtured period: this period occurs right after formation of the reservoir and might be prolonged up to 10 years. This period is sub-divided into 2 successive stages: high nutrional stage (first stage of impoundment - about 5 years) and nutrional reduced stage.

+ Stable period: is a successive stage after the mixture ones.

+ Fertilized period: is the successive stage of the stable ones.

+ Marshing period: is the last period of the reservoir, starting when the accumulated mud volume reach to minimum operated water level.

In brief, change in aquatic ecological system in river flown pattern into reservoir still water ecological system has resulted in increment of species, numbers of individuals of aquatic livings systems. Simultaneously the appearance of some new species thanks to breeding activity of human beings shall also increase ecological diversity of the aquatic ecological system, increasing explored quantity, and also increasing nutrition for population.

Ecological diversity of the reservoir aquatic ecology altered by periods of the reservoir, depending on ecological development of the reservoir. In detail, the numbers of species, quantity of high aquatic creatures in high nutrional stage and decreasing gradually in the nutrional reduced stage, heading to stability in the stable period and increasing gradually at the marshing period.

- In addition, aquatic living creatures, fauna, flora nearby the slope at the D/S of the reservoir also are affected by changing of the flow regime, as below:

Though Trung Son HPP has long term regulated regime generating electric power in accordance with load chart, the flow regime of Ma river at the D/S of the dam site altered so much between generated hours and ingenerated hours, affecting to living of aquatic creatures and nearby slope flora, impacting to aquatic product source at the D/S area. However, at the D/S of the Trung Son dam site is the reservoir of Hoi Xuan project therefore it impacts, in accordance with operation by load chart, to ecological environment remarkably.

3.3.3.9. Landscape

After impoundment of the reservoir, and it goes to operation, landscape patterns have been formed as presented below:

+ After project completion, surrounding the reservoir shall form a nice view: landscape of the Trung Son reservoir, in connection with landscape of Hoi Xuan reservoir.

+ Community landscape: when having electricity, on the 2 side road of the operation and surrounding the control compound shall form new living communities.

+ Areas of temporary occupied land, disposal areas shall be covered by forest.

+ Resettlement area: landscape of rural community and agricultural plants.

3.3.2. Impacts to social-economic environment

3.3.2.1. Health of labor workers, population community at the project and D/S of the project

- Gases, stinking smell generating when disintegrating living masses at the reservoir area has polluted atmosphere, affecting to health of people living surrounded the reservoir.

- Impact due to dam broken down:

Reasons causing to dam failure when operating:

+ Water volume of water level of the reservoir exceeding the volume and highest water level by design (PMF).

+ Due to the fault of discharging outlet gate system: stuck the outlet gates.

+ Due to inaccuracy of flood forecasting therefore operation of the power plant is not in time when flood occurs.

+ Due to induced earthquake:

The project area is situated at the region which has intensively seismic level: the dam site has seismic grade of 8 (according to MSK-64 scale), maximum earthquake has magnitude of 6.153, acceleration of maximum earthquake at the dam site corresponding to MCE is a=0.24g. According to above analysis, the project area still has risk of induced earthquake.

Impact: Dam failure may cause to injury or causing casualties to workers at the site, local people at hamlets, villages on 2 backsides of the river and projects at D/S, which in this case directly are Hoi Xuan HPP and villages nearby the Co Me, Co Luong dam sites.

3.3.2.2. Flood control for D/S

Economics at Ma river basin is under and in the process of development and in the flow of economic structural movement. Region where having high speed of economic development and strong economic structural movement is the one which situated at the D/S on the territory of Thanh Hoa province. Large industrial parks are being formed there, cities, towns are being extended. This is also a place where requires to water source and requirement of mitigating natural disasters resulting from water source.

Due to feature of climate there, that normally occurs disasters such as: waterlogged, drought, salty water penetrated, flash flood and column flood, that obstructing the process of social economic development.

To have background for development of the water resource work for social economic development at the basin. At Decision No 4506 QH/BNN – KH dated 25/10/2002, Minister of Agriculture & Rural have assigned to Plant Institute of Water Resource organized the research for compiling the report of “Plan for general usage and protection of water resource at basin of Ma river”.

Studied result of the plan has defined to anti-flood for the D/S of Ma river for selection solution:

- Strengthening and improvement the dyke system at the D/S and

- Constructing multi-purpose reservoirs which have capacity for D/S flood control

Flood control volume in each reservoir was allocated in maser plan as follow:

No	Reservoir	River	Province	Flv (km2)	Gross storage (106m3)	Flood storage (106m3)
1	Hua Na (M. Hinh)	Chu	Nghe An	5178	523	300
2	Cua Dat	Chu	Thanh Hoa	5708	1374	300
3	Pa Ma	Ma	Sơn La	3460	896	300
4	Ban Uon	Ma	Thanh Hoa	13175	342	200

(Sources: Assessment report for flood cutting at downstream, Trung Song HPP prepared by Hanoi Water Resource Plan Institute)

Flood control system at D/S of Ma river presently is mainly of dyke. Dyke of Ma river has been built in many periods, quality of its body and its foundation are not affirmed in term of safety; culvert under the dyke is shorter than dyke's body therefore there're risks that need to be improved, strengthened to affirm meeting the targeted task of anti flood.

As dye of Ma river is too high, and in addition, it crosses to so many population areas, the task of raising higher its elevation is difficult that needs to have proper solution for the dyke system. To anti flood at D/S of the Ma river on the plan of general usage of water source, proper solution for the dyke in combination with U/S reservoir for flood control is suitable and appropriate with total explored policy at the basin of the river.

To control flood for the D/S of Ma river, it's required the anti flood capacity at the Chu river are: at Cua Dat 300 x 106m3, at Hua Na (Muong Linh) 300 x 106m3. At Ma river side, it's required flood control capacity of Ban Uon (Trung Son) is 112 x106m3 and Pa Ma 350 x 106m3. With such capacity, it's affirmed for controlling flood for the Chu river with flood frequency of 0.6% and Ma river with flood frequency of 1% reaching water level according to decision No 2534 of the Ministry of Agriculture & Rural Development.

According to orientation of social economic development of the Thanh Hoa province up to year 2020, dyke system of Chu river must be able to control flood with flood frequency of 0.6%, and dyke system of Ma river is able to anti flood with frequency of 1%. After the year 2020, due to economic development, affirmed frequency for flood control might be have other requirement therefore D/S flood option needs to have essential safety level for later stages is 150 millions m3.

With the capacity level for anti flood of Ban Uon of 112 x106m3, it's met requirement of anti flood according to present standard. However, in the arrangement of the project structure, it's necessary to arrange in such way that reservoir can be operated for controlling flood with water level of 150x106m3 with higher flood control criteria compared with present ones.

3.3.2.3. Economy of Project owner, local resident and communes in project area and downstream area

- The investment in construction of Trung Son HPP will change economic structure of communes in project area in a positive trend, helping pushing industrialization process to rural agriculture in the region. In this case of a mountainous area where agriculture-forestry to be key point taking high proportion, the investment in project construction will surely increase proportion of industry and basic construction field. Then, the power generated by the plant will be an important condition on which the local resident or other investors invest in construction of small size agricultural product processing bases, assembly base, mechanical workshop, electronic workshop, etc...

- Cool environment, reservoir view together with typical cultural characteristics of minority ethnic people living here (Thai people) will be an attractive point calling for tourism, both local and foreign to be here.

Together with Trung Son reservoir, Hoi Xuan reservoir, protected area and other tourism locations: the ecological tourism location Hang Kia – Pu Luong, Pu Hu protected area, Hang Ma cultural – archaeological site, etc... the formation of this reservoir will push tourism activities, commercial services will develop in this region. Trading bases will be created to satisfy demand fro tourism as well as local. In this area, there may be developed with various tourist forms as

sailing, fishing, adventure tourism, cultural tourism, ecological tourism, etc... However suitable exploitation plans shall be proposed to make use this strong point to develop the economy but on the other hand to protect the ecology and biodiversity, archaeological protection, protecting the unique characteristics of each ethnic people's culture.

The tourism-service development will contribute to the changing of economic structure and career to areas surrounding reservoir. The tourism development will create job opportunities to local working force, increasing income through service as renting boat, guiding tourism, restaurant, entertainment,…

- The creation of a reservoir with quite large surface area and storage (13.13km2) will create good conditions to aquatic cultivation sector in the project area.

Comparing to natural river, the aquatic cultivation will be increased productivity of fish, shrimp, etc... helping improving economic efficiency, improving nutrient quantity of local resident. If the investment and management are good, the aquatic cultivation will bring back high economic efficiency.

- Enlarging local budget from tax paid by Trung Son HPP, increasing investment capital to other sectors.

- In the case discharging of flood from the reservoir, there may be loss on lives, land, properties and other structures on land owned by local resident living in downstream area if no warning methods or displacement are provided promptly. Therefore during flood discharging the Trung Son Management board shall inform to the Hoi Xuan HPP management board about discharge, regime so as they can propose alternative to prevent the Hoi Xuan dam from potential damages and failure and local resident will be ready for displacement if necessary. In the case if flood discharge from Trung Son HPP cause impacts, it is expected that they shall have to pay for compensation and any cost required for overcoming the results.

- Other economic objects

In addition to Project owner, local resident, communes, districts in the project area and downstream area, there will be other economic objects which may be impacted by Trung Son HPP, such as:

+ Hoi Xuan HPP, dyke system and economy in downstream area

According to the design, Trung Son HPP will have flood storage of 112m3, together with other hydropower projects to be constructed on Ma river system, Trung Son reservoir will help protecting downstream area from flooding. This will be provided by cutting flood discharge flowing down to downstream, reducing the dam failure hazard to Hoi Xuan dam, reducing stress posing on dyke system in downstream area.

Downstream area of Ma river concentrates with lots of population, large urban area, there fore the flood control role of Trung Son will be remarkable.

+ Hoi Xuan reservoir: Trung Son reservoir is the upstream cascade of Hoi Xuan reservoir, outflow from Trung Son reservoir will be inflow of Hoi Xuan reservoir, so as a results, between the upstream and downstream reservoir, the following will be characterized:

Hoi Xuan reservoir will have a more stable hydrological regime that that of Trung Son reservoir.

Since part of sediment load will be trapped in Trung Son reservoir, Hoi Xuan reservoir will have longer lifetime.

+ Beneficiaries from energy source:

When Trung Son HPP is connected to the Grid there will be some of 1044.12million kWh generating from this power plant. This will be a remarkable energy source supplying to the National Grid.

The generated energy will not only satisfy demand of local but also meet the raising demand of the whole region and the country. This hydropower project when being operated will be an important factor in changing the view of rural life in lots of communes, districts of Thanh Hoa and Son La provinces in general and districts, communes in project area in particular.

+ Other beneficiaries of water using:

The operational regime in the load chart during dry season of Trung Son HPP will not only impact to the aquatic life but also to benefits of other water using objects. To mitigate such impact, prevent conflict between water using objects from happening, particularly water using objects in downstream (from dam site to the end of Hoi Xuan reservoir), when the project is under commercial operation, the management board shall disclose to public the operational regime of the powerhouse, maximum discharge, minimum discharge so as the local resident and all of other water using objects will be informed.

Since sediment will be trapped in the reservoir, sediment feeding low land areas along Ma river in downstream part will be reduced therefore the natural nutrient sources will be limited affecting to the development, growing and productivities of plant. The sediment volume trapped in the reservoir will take about 80% of total sediment load arriving to the reservoir.

In addition, the construction of Trung Son HPP will play an important role in salinity washing in downstream.

3. National security, order in the local, management of local authority, custom, habit, culture, belief of local resident living in the project area

- National security: according to missive number 1808/QP dated 26/04/2004 the Ministry of National defenses in which stipulating that “to combine as the best the socio-economic development with the national defense, preventing the access road from Trung Son, Trung Thanh to Muong Lat, Hoa Binh from submergence, it is proposed that Electricity of Vietnam should furnish alternative with Full Supply Level of 160m at which the distance from the end of reservoir to Vietnam –Laos border will be 9.5km and somehow directing during construction to have close co-operation between agencies of Ministry of National Defense available in the region so as not to make any impacts to the National Defenses task”.

On the basic of this missive, PECC4 has recommended to select water level of 160m as Full Supply Level of the reservoir so as to ensure the national security at the border of Vietnam-Laos as has been committed by the Ministry of National Defense and Project Owner. During the project implementation stages, close co-operation between various units, agents under the Ministry of National Defense to ensure the national security in the region.

- The concentration of the project’s staff operating the power plant will increase population density in some communes in the project area and it may create problems in regards to social, order, security such as arising conflict between local resident and project’s staff, drug dependence, prostitution, etc... affecting to the management of population, social, national defense and the social order in the local as well.

- Number of staff required at the powerhouse will be limited (about 130 people only), but since they will come from various regions with different cultural custom, different level of

knowledge, habit while staying and working here for long time, there will be something like coexist between various ethnic minority, mixing culture, habit, custom, belief between local resident and the project's staff. The project's staff is normally those having a curtain level of knowledge, culture, and hopefully that they will enhance the knowledge of the local resident by means of daily communication.

- When the project is completed with its construction, the energy generated by the project will help enhancing domestic power supply (lighting, TV, radio) which will improve living standard, cultural life of the local resident. This is meaningful to communes, districts in mountainous area of Thanh Hoa and Son La provinces.

CHAPTER 4: PREVENTION AND MITIGATION MEASURES TO NEGATIVE IMPACTS ON ENVIRONMENT

4.1. Mitigation measures against negative impacts on environment during construction stage

4.1.1. Mitigation measures to environmental impacts caused by waste matter

4.1.1.1 Mitigation measures to impacts caused by gas emission, dust and noise

a) Air pollution mitigation measures

- All trucks and mechanical equipments to be used in the construction site should meet standard on technical safety and environment issued by Register department.
- Regular check, maintain all transportation means, mechanical equipment working in the construction site
- Regular the number of trucks and mechanical equipment in accordance with implementation schedule and intensity to reduce working number of equipments working in the construction site.
- Using simple, easily implemented and feasible measures plus previously verification and reasonable regulation of trucks and equipments will allow meeting the standard on gas emission in the project site.

b) Measures to mitigate dust

- All automobiles must be covered on their top when transporting materials. All trucks should be load ed with designed capacity to avoid strewing of materials during transportation.
- Using water irrigation twice a day during land levelization and transportation of construction materials. Based on whether condition, especially in sunny and windy days in dry season, density of mechanical working at the site, it may be needed to apply moisturizing measures regularly to roads and construction sites near worker camps or resident areas.
- Watering to reduce dust in areas of dringing and screening of materials and concrete stations.
- These measures could be able to reduce significantly dust created by construction activities but it is very difficult to reduce dust created by explosion during construction and exploitation of construction materials.
- Covering and watering measures during construction and transportation easily implemented and feasible.
- At the resettlement size, the local human resources are used to build the pipe, cannal constructions, ground clearance,… the using machine is limited to use in the simple works to reduce dusts, smoke in the project area.

c) Measure to mitigate noise impacts

- To schedule a reasonable working period and suitable regulation of number of machines and equipments working at the construction site. This is a simple and feasible measure.

- Regulation of the number of machines and equipments working at the construction site will reduce resonance of voice causing by too many machines and equipments working at the same time.

The cost for mitigation measures to impacts caused by gas emission, dust and noise will be included in general cost for contractors.

All the measures will be stated in the bidding documents as a mandatory clause to contractors to ensure the air environment of the project area to meet standard TCVN 5937-2005: Standard on air quality; TCVN 5939-2005: standard on industrial gas emission concerning to dust and inorganic substances; TCVN 6438-2001: maximum limitation of transportation means in land and TCVN 5948-1999: Standard on environment concerning noise

4.1.1.2 Mitigation measures to impacts caused by liquid waste

❖ **Mitigation measures:**

- Waste water collection and treatment:

+ During construction, waste water is mainly discharged from daily activity of people such as egested water, cleaning and showering, etc. Substances in the waste water are in the forms of drift such as small pieces of paper, plastic, nylon, etc or other solid substances in the from of glue, solution and bacterium.

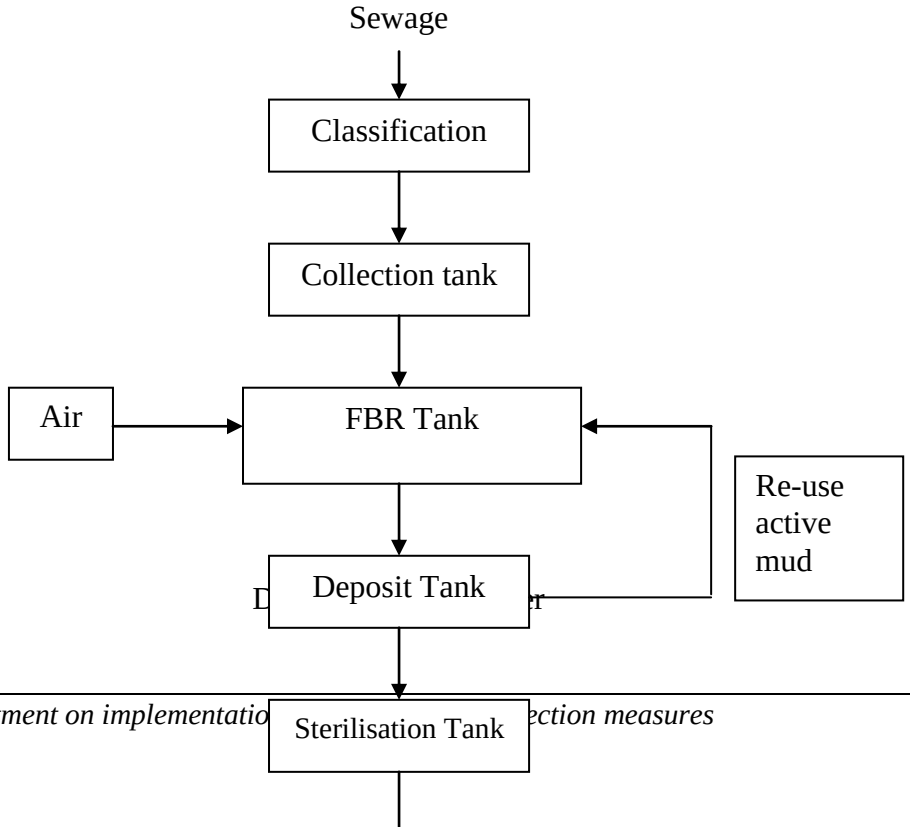
+ Waste water treatment area is located in construction camping areas, concrere complex,

+ All water from lavatory should be collected and treated in anaerobic method.

+ All waste water from other activities such as cooking, disc cleaning, house cleaning, shower, washing, etc) will be collected and treated to meet the environmental standard before releasing. Water normally will be released to Ma river.

+ For the convenient purpose, water treatment facilities will be located near to offices of the PMB and contractors (number 17 in the construction layout). All waste water from the offices and worker camp area will be collected and treated at the area.

+ Domestic sewage is normally collected, treated and released in accordance with following procedure:



Operation principle:

Domestic use waste water is collected by culvert pipe, through trash rack, into collection tank. From collection tank, waste water through gas biological septic tank (fix buffer type). Here, air is scoured continuously in waste water condition, aerobic microorganisms adhered on buffer material surface will disintegrate organic substances in waste water. Then, waste water is flowed to deposited tank to deposit mud, active mud is returned to septic tank to reuse. Waste water after depositing is taken to room sterilized by Chlorine, then discharged through pipe to Ma River. Waste water after treating is grade II of Vietnamese standard TCVN 6772-2000.

- *Waste lubricant from construction means:*

This is liquid waste, discharged from machines operated at the site (truck, excavator, bulldozer, vibrating car...).Thus, all lubricant volume after replacing are collected absolutely at maintenance and repair workshop.

Lubricant wasted of project actions is transported to industrial zone to reuse or be material for other production process.

- *Advantage, disadvantage and effect*

- This is simple waste water collective and treatment method, easy to use and still meet requirement for environmental protection.

- Construction and operation of treatment system will increase investment cost.

- Waste water collection and treatment system is only used in short time (construction time - 4years 4 months).

- Technological, technical process for collection and treatment is not complicate, possible to implement.

- With aerobic treatment method by active mud to treat with normal domestic wasted water, the treatment efficiency BOD from 85%÷95% (main pollution component of domestic wasted water), with the content of chlorine used to kill bacterium in wasted water will not impact to pH of water.

- The method applied give good results, domestic wasted water after treatment ensure the allowable standard to release to environment.

4.1.1.3. Mitigation measures to reduce solid wastes

- *Mitigation measures*

In the workers's camps and construction area.

- *Domestic wastes:*

+ Contractors during construction period, shall furnish wastes bins as a means of wastes collection.

+ The Contractor shall implement regulation on general sanitary for the site area; waste rubbish is taken to stipulated area. Other solid domestic wastes are buried in holes.

+ Workers will be trained and campaigned to raise their awareness in dam site to put wastes in the stipulated area. Proceeding the imposement economically on person, organization violating the regulations.

Number of worker at the site during construction time varies from 1.480 to 4.030 persons. With domestic waste volume is about 0.5kg/person/day in average and density of solid waste is 500 kg/m^3, daily domestic waste volume at the site may be about 1.48 to 4.03 m^3. Thus, it is estimated that after 4 construction years the project will eliminate about 4,437.79 m^3 of domestic waste (Table 4.1).

Table 4.1: Domestic waste volume during construction time of project

No	Schedule	No of person at the site	Daily waste volume (*m^3/day*)	Annual waste volume (*m^3/construction year*)
1	First construction year (*6months*)	1.850	1.85	337.63
2	2nd construction year	4.030	4.03	1,470.95
3	3rd construction year	3.140	3.14	1,146.10
4	4th construction year	2.830	2.83	1,032.95
5	5th construction year (*10months*)	1.480	1.48	450.18
Total waste volume (*m^3/4years 4months*)				4,437.79

Therefore, in order to collect all the above rubbish, it is necessary to construct a rubbish dump with the following scope: rubbish dump is designed with the depth of 5m; buried waste rubbish is compressed to specific quantity of 700 kg/m^3 and 4 covering times by soil with thickness of 10cm.

Volume of rubbish dump: 4,437.79 x (5/7) = 3,169.85 m3

Area of buried square of rubbish dump will be: 3,169.85 : (5-0.4) = 689.1 m2

Area of rubbish dump plan is: 689.1 : 0.75 = 918.8 m2 ≈ 0.0918 ha

- Construction area of buried hole: is arranged as stipulated, waste dump is located in non-submerged area and non-effected by flood discharge.

- Treatment method of domestic waste: rubbish buried hole shall be constructed in the sanitary regulations. To prevent from effect of rubbish hole caused underground water pollution, foundation of rubbish hole is designed to prevent from seepage, to insure permeability of hole foundation of 10^{-7}cm/s. Waste rubbish is compacted carefully and dredged by lime power before covering with soil. Barrier wall is constructed to prevent raining water from overflowing through rubbish hole.

- *Construction solid waste:*

Construction and industrial wastes are mainly is waste soil and rock, collected into separate soil/rock waste dumps to prevent environmental issues such as: erosion, soil sliding, and flood in flood season. It includes waste dump on right bank (2.161.000m^3), waste dump on left bank (3.287.000m^3).

- Waste dumps are arranged at favorable position during construction time and insure environmental issues: waste dump on right bank must have area about 14.4 ha, is arranged near transportation road TC3B (*Site 33 - General construction plan of the project*); waste dump on left bank has area about 21.91ha, arranged along transportation road TC10 (*site 34 - General construction plan of the project*).

- Terrain at Cu stream is rather flat in comparing with region, otherwise this is most favorable position during construction time to arrange waste dump on left bank.

- To stabilize edge of waste rock/soil block; prevent material wash and drift from stream, river and reservoir; limit pollution water sources; protect landscapes... Because dams are not constructed surrounding waste dump thus when pouring soil and rock that must have large size at surrounding of deposal area. It will be action as cofferdam to prevent disposal rock/soil that has loosed structure, swept in water flow to river when raining. Rock/soil types with loosed structure are poured into middle of disposal area. Basing on waste pouring process, waste is poured in each layer, leveled carefully before pouring next layers. Contractor shall comply with waste pouring process and shall level, compact and plant green tree when disposal area is full to prevent sliding, erosion from disposal areas in water flow running to river. Especially, disposal area on left bank shall be arranged near stream so Investor requires Contractor and construction units to monitor closely waste pouring as stipulated.

- Investor has responsibility to supervise waste discharge of Contractor and environmental risks caused by waste dump.

- Total area of two solid waste dumps in construction is 46.31ha.

- Solid wastes arise from other activity plants (packing cover), however it is not much but it is collected fully.

- Whole construction wastes are transported to the above mentioned waste dumps, compacted as stipulated. But for waste dump on right bank (near Ma River) and waste dump on right bank (near Cu stream) because it is distributed near water source so Investor and Contractor must supervise closely for waste discharge and treatment method when emergency is happened.

- To concrete wastes from construction activities in the resettlement area such as infrastructures ground, clearance, cannal system constructions. These can be used to build cannal and dams, domestic traffic roads in the lowlands.

In the construction areas of electricity transmittion line for implementation

+There is only about 20 workers for implementing the transmittion line construction for the whole line, the distribution of wastes is applied so that these wastes will be collected at the stipulated area.

+ Amount of solid wastes in construction of 22, 35 kV is unremarkable, this is used to fill, pressure concrete pillars, the amount of surplus will be filled at this place.

- *Advantage, disadvantage and effect of method*

- Good implementation of the above mentioned mitigation methods meets target of environmental protection, high feasible level.

- Construction of buried dump and waste treatment are same as very complicated technology and cost for construction of waste buried dump is rather high, especially is waste rubbish dump.

- Domestic waste rubbish of project is collected, transported and treated as regulation that pollution is limited due to disintegration of organic substance and action of micro organic harmful for person and cattle (epidemic disease spread), and collection and treatment of construction waste limited loosed rock./soil amount from erosion and drifted in flow because of rain at disposal areas.

4.1.2. Impact mitigation measure not related to waste

4.1.2.1. Impact mitigation measure for impacts from reservoir bed occupation, project layout, material sources.

- *Mitigation measures*

- For effected persons due to land occupation of project area:

To limit effect of land occupation for project construction and effected persons, Investor will implement well compensation, support and resettlement:

+ During resettlement and agricultural settlement, the Owner will cooperate with local authority to set mind resettlement people and help them to integrate in the native people life.

+ Execute compensation and timely support affected households to early stabilize their life. The reservoir bed and project layout has 432 households/2353 persons are affected in terms of housing and production land; in which Thanh Hoa province has 277 households/1587 persons, Son La province has 155 households/766 persons. 75 households are affected in production land term; in which Thanh Hoa province has 28 households and Son La province has 47 households.

+ Suitable compensation, assistance and resettlement shall be done for affected households so that they have sufficient conditions for resettlement.

Table 4.2: economic criteria in project area in before and after resettlement plan

Items	Unit	Current	Plan	QH/HT comparision (time)
1. Gross products of foods for rice	ton	1.061,43	1828,41	1,72
In which: - Rice	ton	346,86	630,36	1,82
- Reference	Ton	714,57	1199,00	1,68
2. Average food/person/year	Kg	260,00	759,75	2,92
- gained rice	Kg	86,00	502,17	5,84
3. Total income of project area	VND million	3058,48	8949,14	2,93
4. Average income household/year	VND million	6,82	15,15	2,22
5. Agricultural land area average/household	ha	2,48	1,80	0,73
In which: - Aquatic argricultural land	ha	0,08	0,15	1,97
- Rich soil land	ha	2,30	1,50	0,65
6. Average big domestic animal/household	per	1,96	3,00	1,53

+ Prior to filling water into reservoir, households shall be permitted to collect farming products, fruits and trees in the reservoir bed. Expenses of removal cleanness of housing

facilities, production works, and enclosure for manure and cemetery for affected households shall be supported. Additional expenses for newly housing construction are also given.

+ Besides compensation of land and property damage for people at the project area, support of production, health care, education is also executed to ensure resettled households.

+ Involvement in solving claims from pe

ople during compensation, support and resettlement

+ Execution of monitoring activities in compensation, support and resettlement in compliance with specified regulation.

+ Doing social research prior to and after compensation, support and resettlement (6 months or 1 year later) to have timely support policies and limit unexpected issues.

+ Total investment of compensation, support and resettlement of Trung Son hydropower project is about **304,561,28** million VND...

- *For Infrastructure*:

Construction of Trung Son hydropower project will affect to 32.0 km road of inter-village, 10.5km road of inter-commune, 50m of suspension bridge at the reservoir bed area. In order to overcome such impacts, the project will reconstruct traffic infrastructure in the resettlement areas.

The project will also execute upgrading of 20.8km of construction, operation road from Co Luong to Co Me. This is important road connecting communes and being the unique road for local people transport in the area. Therefore, in order to ensure traffic condition of the road, specified construction conditions shall be complied with such as: material on the expanded bed road shall be always leveled, filled and backfilled material on the road bed shall be transported within the day for possibility of vehicle traffic. Number of vehicle traffic prohibition per day shall not exceed once or twice. Each time shall not be over 4 hours. Especially, during road bed expansion, the concerned units shall be agree with one another about construction method and ensure absolute safety for people and traffic vehicle.

- *Topography and Geomorphology*:

+ During exploitation of leveling soil and construction rock, removal of top soil and vegetation coverage will destroy topographical surface and decline plant coverage and increase washing away of loosen soil. Therefore, in order to avoid soil sliding into the exploited foundation pit, during exploitation process slopes of foundation pit shall be executed as specified.

+ Referring to material sources, after removing the top soil layer, tree planting method will be executed to recover the existing environmental status and protect the surface from soil degradation, erosion, sliding and settlement in the area and avoid soil degeneration relating to erosion, washing out, loss of soil nutrients or increase of disadvantageous matters, destroy of soil structure due to construction activities.

+ Temporary land occupation area: After completion of construction, some permanent facilities such as working houses, operation roads,…can be reused (permanent land occupation area), other facilities in the temporary land occupation area (worker housing area, material stockpile,…) shall be removed and leveled to return the layout. Dumping area without further storage capacity shall be leveled and covered.

- *Ecosystem:* Among total project land area, natural forest area is affected a little, mostly are local people' industrial, forestry tree planted land (sandal tree, bead-tree, casuarinas..) along two banks of Ma river and in streams.

Solutions:

+ Compensating damages of forest tree (bead-tree).

+ Additional forest planting:

Referring to affected natural forest area in the project area, resettlement – settlement area, reservoir bed...the Owner will support the local expenses for newly planting in the project temporary occupation area (auxiliary area, stockpile, dumping area), bare hilly area and upstream of the reservoir.

Referring to Xuan Nha reserve area, 603.4 hectares are reclaimed for the project, of which only 580.37 hectares has vegetation coverage. In which 213.11 hectares are paddy and farming product area, 361 hectares are planted forest only 5.3 hectares are natural forest. Therefore, it is recommended to newly plant 5.3 hectares of affected natural forest area.

In addition, in the planning of resettlement-settlement area, it is recommended to hand protective forest area for local resettlement people so that they have additional income to stabilize life.

Accordingly, the newly planted forest area which supports the project affected area is about 350 hectares.

The Owner contracts with the local to have plan on new forest planting: location, type of tree, method of planting and caring.

Expenses of new forest planting will be paid by the Owner.

Obeying the noise imigation pressures to reduce lowestly the impacts of the noise to animals.

The project owner, client, implementing company give out the pressures and combine with local authority and related parties in forest protection. Forbiting the activities which is relating to forest preservation and natural protection (exploiration, catch, wooden, animal and rare goods trade). The owner contractor will sign the plegement with no catch, animal trade and usage of wild animal.

Construction and operation will be invested for two forest management stations in order to monitor and protect Pu Hu and Xuan Nha reserve areas within 5 years of construction and two beginning years of reservoir water storage.

The next stage will be handed over for Management board of nature reserve areas for further management and protection.

- *Advantage, disadvantage, feasibility and efficiency of the method*

If the methods are well done, people whose have to leave the project area and resettle in new places will have more improved life; ecosystem is recovered.

Compensation, support and resettlement and agricultural settlement and bamboo should have strict cooperation between the authority, people and the project owner.

The method will have high efficiency in term of stabilizing and improving life, production and forest protection.

4.1.2.2. Mitigation measure for negative impacts from change of local affected people' social – economic matters

- *Mitigation measure*

- The Owner will monitor, evaluate and be responsible for social stabilization and economic development of resettlement people.

- The Owner will cooperate with local authority to educate protection awareness of forest and its products for construction staff, local people and free immigration people.

- Referring to management system of local authority: The Owner will cooperate with the local authority to enhance regional population management, labor and security

- For human being:

When the contractor start project construction, it is necessary to declare temporary residence of construction workers for local authority.

Effective protection method will be applied to reduce possibility of epidemic spreading in the residential community and construction workers such as: propagandize and campaign to keep living place clean, use clean water, and vaccinate to prevent some deceases, kill mosquito and insects, further supply health caring equipment, treatment medical and staff of nurse and doctors, ambulance. Specifically as follows:

+ Cooperate with local health care center to have prevention methods on popular diseases such as malaria, fever, stomachache, dysentery, propagandizing method of preventing and avoiding disease from cattle, domestic fowls,…

+ Establishing portable medicine cabinets at project construction units.

+ Cooperate with local health care staff to have periodic plan on health examination for carder, workers on site, spray epidemic prevention medicine…

- *Advantage, disadvantage and efficiency of the method*

- Enhancing protection awareness of forest reserve, biological diversity, health of workers and local people.

- To execute mitigation measures, it is necessary to have strict cooperation among the owner, local people, border guard, construction worker and local people.

- Given method will have high feasibility when having cooperation among related parties.

- The method will mitigate press on the environment of social, forest reserve, animal and vegetable reserve and prevent of infectious diseases.

4.1.2.3. Mitigation measures for impacts relating to resettlement – agricultural settlement matters

- *Mitigation measure*

  - The Owner has planned on area of land occupancy for resettlement and agricultural settlement. Aternatives are defied as follows:

Table 4.3: Land using plan in resettlement areas

No	Name of places	Househol	Resettlement land plan

		ds 2011	Total	Agricultural land	Forestry cultivated land	Residental and , constructing land
	Total	**507**	**1728**	**-**	**710**	**21,8**
I	**Thanh Hóa Province**	**337**	**780**			**14,8**
I .1	***Quan Hóa District***	**216**	**400,2**			**9,2**
	Trung Sơn Commune					
	Resettlement Area No.1	**216**	**400,2**	**391**		**9,2**
	Tà Bán village	185	364	356		8
	Xước village	25	36	35		1,2
I .2	***Mường Lát district***					
	Mường Lý Commune					
	Resettlement Area No.2	**85**	**240,6**	**237**		**3,6**
	Nàng village	47	118	116		2
	Tài Chánh village	38	123	121		1,6
	Trung Lý Commune					
	Resettlement Area No.3	**36**	**139,0**	**137**		**2**
	Lìn village	18	51	50		1
	Chiềng Lý village	18	88	87		1
II	**Sơn La Province**	**170**	**948**		**710**	**7**
II.1	***Mộc Châu District***	**170**	**947,7**		**710**	**7**
	Xuân Nha commune	**170**	**947,7**	**230,7**	**710**	**7**
	Tà Lào Đông village	113	686,6	152,0	530	4,6
	Ta Lào Tây village	57	261,1	78,7	180	2,4

(Source: Master plan report of resettlement produced by PECC4)

- **In the area of Thanh Hoa province, three areas are determined**. In which two focus resettlement area are Trung Son and Muong Ly communes, and one area in Trung Ly commune. Such areas are arranged as follows:

*** Resettlement area No.1 – Trung Son commune**

Focusing resettlement is provided for 216 households, 1030 persons of two mountain village (Ta Ban village 190 households, 910 persons; Xuoc village 26 households, 120 persons).

The location of resettlement area is 2km far from the border of Pù Hu Natuaral Preseravation Zone.

Total area of the site is 400,2 ha which is distributed to households for resettlement and recultivated land as below:

- Acquisition land area for resettlement: 9,2ha
- Agricultural exploited land further for resettlement plan (agricultural, rich soil land, ...): 161,8ha in which:
  + Aquatic agricultural land: 35,2ha
  + Paddy rice land: 8 ha
  + Annual plant land: 98ha
  + Long term plant land: 20,6ha

- The rest of argricultural land of households is not unindated: 229,2ha
  + Aquatic paddy rice land: 8,8ha
  + Paddy rice land: 51 ha
  + Annual plant land: 168ha
  + Long term plant land: 1,4ha

Besides the argricultural land is not submerged, the area of Luong (bamboo) is 627 ha cultivating land of Tà Pán, Bản Xước villagers

Besides the argricultural land is not submerged, households have Luong (bamboo) plant area given and used for cultivation. The land area is 627 ha of Tà Pán, Xước villagers.

***Resettlement area No.2 – Muong Ly commune**

Resettlement if provided for 85 households, 461 persons of two villages (Nang 1 village has 47 households, 255 persons, Tai Chanh village has 38 households, 206 persons).

The location of resettlement area does not affect Pù Hu, Xuan Nha Natuaral Preseravation Zones, 10km far from the Natuaral Preseravation Zones.

Total area of the site is 240,6ha which is distributed to households for resettlement and recultivated land as below:

- Acquisition land area for resettlement: 3,6ha
- Agricultural exploited land further for resettlement plan (agricultural, rich soil land, ...): 7,5 ha in which:
  + Aquatic paddy rice land: 7,5ha
- The rest of argricultural land of households is not unindated: 232,5ha:
  + Aquatic paddy rice land: 9,5ha
  + Paddy rice land: 61 ha
  + Annual plant land: 146ha
  + Long term plant land: 13ha

Besides the argricultural land is not submerged, households have Luong (bamboo) plant area given and used for cultivation. The land area is 38 ha of Nàng, Tài Chánh villagers.

*** Resettlement area No.3 – Trung Ly commune**

Providing resettlement for 36 households, 195 persons from two villages (Lin village 18 households, 107 persons, Chieng village 18 households, 88 persons)

The location of resettlement area is 5km far from the Pu Hu Natuaral Preseravation Zones.

Total area of the site is 139ha which is distributed to households for resettlement and recultivated land as below:

- Acquisition land area for resettlement: 2 ha
- Agricultural exploited land further for resettlement plan (agricultural, rich soil land, ...): 7,6ha in which:
  + Aquatic paddy rice land: 7,6ha
- The rest of argricultural land of households is not unindated: 131,4ha:
  + Aquatic paddy rice land: 0,4ha
  + Paddy rice land: 49 ha
  + Annual plant land: 74ha
  + Long term plant land: 6ha

Besides the argricultural land is not submerged, households have Luong (bamboo) plant area given and used for cultivation. The land area is 55 ha of Lin, Chieng villager

On the area of Son La province, one area is determined

*** Resettlement area No.4 – Xuan Nha commune (new):**

Focus resettlement is planned for Dong Ta Lao and Tay Ta Lao villages: 170 households, 834 persons.

The location of resettlement No.04 is 4 km far from Xuan Nha Natuaral Preservation Area
Area land for resettlement plan: 947,7 ha
In which:

+ Agricultural production land: 231ha
+ Forest plant area: 710 ha
+ Rural residential land: 7ha.

The location of resettlement No.04 is out of Xuan Nha Natural Preservation Area, 4km far from Xuan Nha Natural Preservation Zone. The current of resettlement is poor forest land and local people's rich soil.

Table 4.4: Total area of resettlement households affected by Trung Son Hydropower Construction

No	Name	Affected land in reservoir bed and construction ground			Number of resettlement households in 2011	Land needed to be exploited				Land not inundated		
		Agricultural land	Residential land, garden	Forest plant land		Total	Argricultural land	Forestry plant land	Đất ở NT, đất XD	Total	Argricultural land	Forestry plant land
	Total	**280,3**	**30,83**	**865,6**	**507**	**1139**	**407,6**	**710**	**21,8**	**1308**	**588,1**	**720**
I	**Thanh Hóa Province**	**82,07**	**17,28**	**568,6**	**337**	**191,7**	**176,9**		**14,8**	**1308**	**588,1**	**720**
I .1	***Quan Hóa Ditrict***	**73,32**	**9,96**	**410,9**	**216**	**171**	**161,8**		**9,2**	**856,2**	**229,2**	**627**
	Trung Sơn Commune											
	Resettlement area 1	**73,32**	**9,96**	**410,9**	**216**	**171**	**161,8**		**9,2**	**856,2**	**229,2**	**627,0**
	Tà Bán village	56,75	7,89	325,3	185	168	159,8		8	648,2	196,2	452,0
	Bản Xước village	5,95	1,52	47,9	25	3,2	2,0		1,2	208,0	33,0	175,0
I .2	*Mường Lá* ***Ditrictt***	14,97	8,06	228,1								
	Mường Lý Commune											
	Resettlement area 2	**2,96**	**4,44**	**119**	**85**	**11,1**	**7,5**		**3,6**	**267,5**	**229,5**	**38,0**
	Nàng village	1,63	2,48	56,4	47	5,5	3,5		2	130,5	112,5	18,0
	Tài Chánh village	1,33	1,96	62,6	38	5,6	4,0		1,6	137,0	117	20,0
	Trung Lý Commune											
	Resettlement area 3	**5,79**	**2,88**	**38,6**	**36**	**9,6**	**7,6**		**2**	**184,4**	**129,4**	**55,0**
	Lìn village	5,79	1,49	9,3	18	4,6	3,6		1	76,4	46,4	30,0
	Chiềng Lý village	0	1,39	29,4	18	5,0	4		1	108,0	83	25,0
II	**Sơn La Province**	**198,22**	**13,55**	**297**	**170**	**947,7**	**230,7**	**710**	**7**			

II.1	*Mộc Châu* ***Ditrict***	198,22	13,55	297	170	947,7	230,7	710	7			
	Xuân Nha Commune	**198,22**	**13,55**	**297**	**170**	**948**	**230,7**	**710**	**7**			
	Tà Lào Đông village	117,17	9,34	229,5	113	686,6	152,0	530	4,6			
	Ta Lào Tây village	81,05	4,21	67,5	57	261,1	78,7	180	2,4			

(Source: The report of genaral plan for resettlement prepared by PECC4)

Based on the current survey, the number of resettlement households have to be calculated the evolume of construction investment of items as follows:

- **Irrigation system for dometic water supply for resettlement sites.**

Table 4.5: Volume of expected contructions for domestic water supply in resettlement sites

No	Items	Water supply method	Canel (Km)
A	**Thanh hóa Province**		
1	**Resettlement Area 1**		
	- Water supply construction for Piềng Poong Resetttlement area	flowing	1.5
2	**Resettlement Area 2**		
	- Water supply construction for Nàng villageResetttlement area	flowing	1.5
	- Water supply construction villageTài Chánh Resetttlement area	flowing	1.5
3	**Resettlement Area 3**		
	- Water supply construction for Lìn village Resetttlement area	flowing	2.5
	- Water supply construction for Chiềng village Resetttlement area	flowing	3.5
B	**Tỉnh Sơn La**		
4	**Resettlement Area 4**		
	- CT cấp nước điểm TĐC Na Hàng -Piền Diến	flowing	4

(Source: The report of genaral plan for resettlement prepared by PECC4)

- **Traffic system and internal regions in resettlement areas**

Table 4.6: Expected volume of traffic system construction in resettlement sites

No	Content	Unit	Type	Quality
A	**Thanh Hoá Province**			
1	**Resettlement Area 1**			
	- Newly constructing intervillage road			
	(From Co Me Bridge to Piềng Poong RA)	Km	Rural Traffic - Type A	5.5
	- Newly constructing internal road at Piềng Poong RA	Km	Rural Traffic- Type B	3.0
	- Newly constructing production station	Cái		2,0
	- Newly constructing serving road	Km		9.0
2	**Resettlement Area 1**			
	Newly constructing internal road at Nàng village	Km	Rural Traffic-	2.0

			Type B	
	Newly constructing road in Tà chánh RA	Km	Rural Traffic-Type B	2.0
3	**Resettlement Area 1**			
	- Build interprovincal traffic road from Bản Lìn Chiềng village resettlement area	Km	Rural Traffic-Type B	3.0
B	**Sơn La Province**			
1	**Resettlement Area 1**			
	- Newly constructing intervillage traffic road	Km	Rural Traffic-Type A	3.5
	(From main road of the commune to Na Hằng - Piền Diến resettlement area			
	- Newly constructing internal road in resettlement area	Km	Rural Traffic-Type B	3.0
	- Newly constructing serving road	Km		3.5

(Source: The report of genaral plan for resettlement prepared by PECC4

*** Build a power system supplier to resettlement plan**

To the power system supplier to resettlement plan **is divided into two different types:**

+ Phase1: In the case of electricity network is not available in Muong Ly People Commite Commune: Resettlement area No 2 and No 3 will be invested power for Mini-generator and facilitated power supply system in home completely.

Table 4.7: Expected volume of power system construction in resettlement sites

(when power system is not available in Resettlement areas no.2 and no 3 in the first phase)

no	Districts, communes	35kV Tranmission line (km)	160kVA Transfomer station (generator)	100kVA Transfomer station (generator)	0,4kV Tranmission line (km)	Domestic electricity (household)
	Total	**6.0**	**1**	**1**	**5**	**507**
	Thanh Hóa Province	**3.0**	**1**	**0**	**3**	**337**
1	**Resettlement area 1**	**3.0**	**1**	**0**	**3**	**216**
	- Piềng Poong resettlement area	3.0	1	0	3	216
2	**Resettlement area 2**	**0.0**	**0**	**0**	**0**	**85**
	- Nàng resettlement area					47
	- Tài chánh resettlement area					38
3	**Resettlement area 3**	**0.0**	**0**	**0**	**0**	**36**
	- Lìn village resettlement area					18
	- Chiềng villige resettlement area					18
	Sơn la Province	**3.0**	**0**	**1**	**2**	**170**
3	**Resettlement area 4**	**3.0**	**0**	**1**	**2**	**170**
	Na Hằng-Piền Diến resettlement area	3.0		1	2	170

(Source: The report of genaral plan for resettlement prepared by PECC4)

+ The second phase: when power is available in Mường Lý People Committe Commue

To build 35kV tranmission line for resettlement areas No.02, and No.3, there is transformer genarators, building lowe transmission line to resettlement households and connectors to power system available in home.

Table 4.8: Expected volume of power system construction in resettlement areas (when power system is avalaible in resettlement areas no.02, and no.03)

no	Districts, communes	35kV transmission line (km)	Transfomer station 35kV (generator)	0,4kV (km)	Domestic power (household)
A.	**Tỉnh Thanh Hoá**	**8.50**	**4.00**	**2.00**	**121.00**
1	**Resettlement area no.02**	**4.50**	**2.00**	**1.40**	**85.00**
	-Nàng Village Resettlement area (power pulling from the Committee to Nàng Village Resettlement area)	1.50	1	0.7	47
	-Tài chánh Village Resettlement area (power pulling Nàng village to Tài Chánh Resettlement area)	3.00	1	0.7	38
2	Resettlement area **no.03**	**4.00**	**2.00**	**0.60**	**36.00**
	Lìn Resettlement area (power pulling from Mờng lý commune to Lìn village)	2.00	1	0.3	18
	- Chiềng Village Resettlement area (power pulling from Lìn village to Chiềng Village)	2.00	1	0.3	18

(Source: The report of genaral plan for resettlement prepared by PECC4

- **To build public works for resettlement areas**

Table 4.9: Expected volume of public works construction in resettlement areas

no	Items	Village classes (m2)	Kindergarten, nursery (m2)	Teachers's residents (m2)	Cultrural house (m2)
	Total area	**400.0**	**480.0**	**200.0**	**480.0**
	Thanh Hóa Provice	**200.0**	**320.0**	**100.0**	**300.0**
1	**Resettlement area 1**	**200.0**	**160.0**	**100.0**	**180.0**
	Piềng Poong **Resettlement site**	200.0	160.0	100.0	180.0
2	**Resettlement area 2**	**0.0**	**160.0**	**0.0**	**120.0**
	- Nàng village **Resettlement site**		80.0		60.0
	- Tài chánh village **Resettlement site**		80.0		60.0
	Sơn la Provice	**200.0**	**160.0**	**100.0**	**180.0**
3	**Resettlement area 4**	**200.0**	**160.0**	**100.0**	**180.0**
	Na Hằng - Piền Diến village **Resettlement site**	200.0	160.0	100.0	180.0

(Source: The report of genaral plan for resettlement prepared by PECC4)

- **Asessement of expected alternatives to construction investment in resettlement areas**

+ Planning on investment of traffic system: Currently, in the expected construction area and surrounding areas of traffic systems, it is mainly pathway which is usually eroded.

Therefore, when constructing resettlement areas with traffic system meeting the standards of Rural Traffic type A and tpe B, will bring advantages to local people in transporting, develop economy and culture in the areas.

+ Investment of power system: Currently, there is not power network in expected resettlement areas and surrounding environments, the local people have to use water-based generator. The usage of this power resource caused damages of electric equipments and lose economy to the local people. Therefore, when briging power network to resettlement areas, the local people will use stable power resource, it will increase the local's incomes and they are able to access different cultural resources.

+ Investment in water supply system: People have currently used available water sources being unstableness, deficiency in dry season and redundancy in wet season that is not secure about quality. Construction of running water supply system in resettlement area for people will help to ensure a stable life, quality of water and health of people.

+ Investment in water supply system for production in order to secure for people in resettlement area – resettled agriculture having permanent water supply, increasing water source for cultivated crops, domestic animals and productivity of plants. Civilian will be initiative in their economy and life. Plan of irrigation by rolling weir system and flow measured in a number of proposed areas ensure the water supply for production in frequency.

+ Investment in reclaiming field: To replace for production land lost, ensure the stable life in order to avoid reclaiming in surrounding natural forest by affected people, avoid starving and ensure food security.

+ Investment in construction of public project in resettlement area to give back space for public, cultural and religious activities, school for children of affected people in order to set their mind at rest in case of movement, stabilize production, help household economy to be more and more developed.

- In order to carry out investments in work, minimize impacts related to resettlement – agricultural resettlement, investor should perform the followings:

+ Project land used and complete legal procedure on land used right, construct infrastructure, provide water and electricity in order to make favor of creating stable life for household affected by movement.

+ Compensate, support for damage and construct resettlement - agricultural settlement before revoking land for project.

+ Upon moving to resettlement area, investor should cooperate with local goverment in meeting and setting their mind at rest in order to help people be resettlment - agricultural settlement and to integrate life of native.

+ Construction of agricultural settlement - resetlement areas should be monitored according to regulations on constructing control during executing stage in order to secure about the quality that contribute to recovering household income and stabilizing their life.

+ Take part in solving the complain of people during stage of compensation, support for resettlement - agricultural resettlement.

+ Do control compensation, support and construction of resettlement - agricultural resettlement.

+ After compensation, support and resettlement work completed, Investor should cooperate with local goverment in examining and evaluating quality of life, transportation, irrigation and production works that help to have additional policy, timely solutions in order to prevent negative issues arised.

- To carry out imitigations impacts of resettlement - agriculture resettlement, investor should do in compliance with regulations on compensation support and resettlement that include following main points:

***** LAND COMPENSATION

Principles applied to compensate affected people are implemented according to regulations in Decree no.*197/2004/NĐ-CP* dated 03/12/2004 by Government on compensation, allowance and resettlement for land acquisition.

*** Properties compensation**

Principles applied to compensate affected properties are implemented according to regulations in clause 18 in Decree 197/2004/ND–CP dated Dec. 03rd, 2004 by Government. Including:

*** Compensation for affected houses and structures**

+ The PAH shall be entitled for house compensation under the form of cash compensation by the Project Owner to construct a new house in destination place. This cash-for-house compensation shall be made equivalent to the house value considering the area.

- To make it suited with custom, habits as well as expectations of PAHs and at the same time making use the labour force of the whole community and creating budget somehow to PAHs, the Project Owner will not provide constructed house to PAH but instead will compensate by cash for PAHs to construct house themselves, compensation and allowances will be stipulated as following:

- Single household or household with 2 individual: 30 million VND/PAH;

- PAH with 3 to 5 individual: 13 million VND per individual;

- PAH from 6 individual: 12 million VND/individual;

The allowances schedule for construction of house will be:

- Phase 1: 30% total value for any necessary demolishing, transporting and preparing material;

- Phase 2: 40% of total value once the house has been constructed and/or completed with the primary construction of house;

- Final phase: the remaining 30% of total value once the inspection and handling over minutes of the Committee on Compensation, allowances and resettlement is furnished and available.

Small sized PAH, policied PAH who have no condition to construct house themselves in resettlement site, the Project Owner will consider to construct houses for them on an area and structure as stipulated in article 2 of this present clause and give to them.

PAHs having flat-roofed house or tile-roofed house having remaining value higher than the house area stipulated in article 2 of this clause shall be entitled for cash compensation for such differences. If the remaining value is lower than the value of house constructed on an area stipulated in article 2 of this clause the PAH shall not be entitled for compensating the differences. The remaining value of the house shall be evaluated by the Committee of Compensation at the time of compensation and the final decision will be made by the PPC.

The area of house constructed in resettlement site shall be estimated basing on number of legal individual living in such PAH, as following:

- The single PAH or PAH having up to two individual shall be constructed with 25 m^2/PAH;

- PAH having from 3 to 5 individual shall be constructed with 45 m^2/PAH;

- PAH having from 6 individual shall be constructed with 65 m^2/PAH;

- During designing process of house, depending on real condition, it is allowable to adjust the real area of house by ± 5% from the said stipulated limit.

In the case of remaining architectural items, the compensation shall be estimated equal to 100% value of new constructed (having equivalent specification) using be tariff on infrastructure construction issued by the Province at the time of replacement

+ Compensation for affected public structures

The Government Decree 197/2004/ND-CP dated 03/12/2004 on land compensation, allowance and resettlement for the Government carrying out land aquisision.

In the case of village, hamlet who are not subjected to replacement or being replaced partially only, or being affected by partially or completely from the losses of the public infrastructure, shall be considered for investment on improving, rehabilitation or new construction of public infrastructure so as to ensure the production activities and livehood of the remaining population

- Compensation for crops and animal husbandry

The compensation to annual crops shall be estimated equal to the value of crop productivity. The value of such crop shall be estimated equal to the highest crop productivities in the last 3 years of main crop cultivated in the local and the average price at the time of land acquisition.

The compensation for perennial tree, long-term trees shall be estimated equal to the existing value of the perennial tree, long-term tree (excluding the land use right value) applying the local tariff at the time of land acquisition.

Forestry land area planted by state budget, natural forestry land area allocated to organization, PAHs for caring and protection shall be entitled for compensation according to the real damages and losses of such area; the compensation amount shall be paid to the one who managing, caring and protecting such area under the Law on Forest Protection and Development.

In the case of crop, husbandry (aquatic cultivation) the compensation shall be done as following stipulating:

a. In the case if crop, husbandry has come to the harvest at the time of land acquisition, there will be no compensation;

b. If the crop, husbandry at the time of land acquisition has not come to its harvest time, it shall be entitled for compensation due to the fact of early harvest; in the case if replacement could be done, the compensation will cover only the cost of replacement and damages caused by such replacement; Tariff for such compensation shall be stipulated by the PPC to make it suited with real conditions.

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*** CONSTRUCTION OF THE RESETTLEMENT SITE**

- Land allocation to PAHs
Residential land area in resettlement site: each PAH will be allocated with one plot having area of 200-400m^2 per PAH;
. Cultivated land area: in regards to the land availability in resettlement site PAHs shall be considered to be allocated with cultivation land area, while the limitation is not over than allowance pursuant to Clause 70 in Law on land and clause 69 Decree No.181/2004/ND Cp dated 2910/2004 of Government
Area of land to PAH is allowanced by authority with liensce of land using rights as occorrance.

- Construction of public infrastructures in resettlement sites

Project size: to be estimated taking into account the population size of the resettlement site, both resettlees and host population;

- In the case if the population of the resettlement site is less than 30 households and less than 1km from the host population, the Project Owner shall consider to expand and/or upgrade the existing infrastructures to satisfy the demand but shall anyhow not to exceed the size stipulated for the resettlement site.

- General principles on construction:

- Houses belonging to public ownership of the resettlement site shall be constructed under grade IV houses with structure as: brick wall, tiled roof, brick concreted floor paved with flowered enameled tile or equivalent, doors and windows by timber or glass-aluminum frame and combination;

Construction of public houses shall be furnished with auxiliary works such as toilet and/or latrine, parking ground with no wall/fence surrounded, other auxiliary structure for teachers if found necessary**.**

- Infant school, kindergarten:

Classes of infant school, kindergarten are intended to take care of children all the day.

Infant schools and kindergartens constructed in resettlement site shall be in accordance with design standard of Infant school, kindergarten – TCVN 3907-1984.

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- Classes of primary and secondary grades:

+ The number of classes of primary grade is calculated for children to learn all the day.

+ Size and structure of classes in the resettlement site shall be constructed according to the design standard of secondary school TCVN 3978-1984.

+ If it is the case that the destination place is existed with schools of all good conditions for children, there will be no particular classes built for the resettlement site; if necessary, it can be subjected to be supported partially with allowances to enlarge or upgrade such existing school

structure. This allowances for enlarging and/or upgrading school per household shall be two million VND per PAH.

- Health care in resettlement site

In the case of independent resettlement site which is not the commune center, there shall be investment for training on health care employer with cost of 3 million VND per one; will be furnished with 01 drug cabinet (including the cabinet itself and normal drug). Cost of dry cabinet will be estimated by number of PAH with an expenses of 100,000 VND per PAH per two years.

- Cultural House in the resettlement site

+ Resettlement site where are living with more than 30 PAHs will be constructed with one cultural house for the village with structure as

+ From 30 to 60 PAHs: construction on an area of 60 m^2; more than 60 PAHs it will be 100 m^2.

The cultural house shall be constructed and facilitated with fence, flag pole, public WC.

Electric system in the cultural house shall be installed under designed.

- Playing ground

In the case of independent resettlement site which is not the commune center where are living with more than 50 households, if the land availability is allowable, a playing ground will be arranged. If it is the case, the playing ground will be invested only for ground preparation cost.

- Place of holding a market

If the resettlement site has demand on market places, an area of land with suitable size shall be arranged. If it is the case, the items will be invested only for ground preparation cost.
*** Building public infrastructures in the concentration resettlement site**

- Irrigation

It shall be based on the survey results in the resettlement site to decide the method of improving or building new irrigational works according to the scheme so as to exploit the agricultural production land effectively.

Land reclaiming, building fields and internal traffic system in the resettlement site:

- Resettlement site will be invested in reclaiming, establishing fields according to the scheme before handling to PAH for using;

- Field internal traffic system is schemed and built in accordance with general production scheme of the region.

- Access road system:

The access road system shall be constructed in accordance with general planning on access road system in the region, such as:

- Inter-communal roads, roads from outside to the resettlement site where are living with more than 100 resettling households will be constructed in conformity with the standard of rural and mountainous access roads of grade A (standard 22 TCN – 210- 92). The road surface is covered with concrete or asphalt in order to be more suitable with the topographical conditions.

- Internal roads within the resettlement site, roads connecting 2 resettlement sites shall be constructed according to standard of B- grade rural and mountainous access roads (standard 22 TCN – 210- 92). The road surface is made according to hilly proportioning (or macadam, or gravel), if the sloping exceeds 6%, concrete road with surface of 2m width shall be constructed with drainage system as well.

- **Domestic water supply**

Depending on the real conditions in each resettlement site each PAH shall be supplied with water for living activities by dug wells. In the case existed with possibility of convenient gravity water supply means will be considered to be supplied with water to public water supplying sites.

Water supply system for domestic demand in the resettlement site shall be done in conformity to the design standard on water supply TCXD 33-1985 and other applicable quality criteria for domestic water.

- **Power supply for domestic and production demand**

Power supply for domestic demand at the resettlement site: the project owner will construct distribution line and sub-station. Domestic power supply will be connected to each PAH. PAH is expected to buy themselves electric devices and equipment for their demand. The project owner shall supply one meter for only once.

The estimated and proposed load demand of rural PAH is between 400 and 700 W/household.

In the case of public infrastructure: the load demand is estimated basing on the power demand of the resettlement site.

Power supply for production demand: this is estimated basing on the power demand of each production forms existed in the resettlement site.

- **Water drainage and environment in resettlement site**

- Surface drainage system shall be arranged taking into account the topographical conditions or combined with the domestic drainage system by means of exposed drainage system arranging along the access road.

- Drainage system in the residential land area shall be constructed.

- Latrine, husbandry barn facilities shall be located and arranged far from houses of human and the water resources as stipulated.

- Graveyard

Each resettlement site will be furnished with an area for graveyard (if any) in accordance with the local planning.

*** Construction of public infrastructures in the inserted resettlement sites**

Communes receiving PAH to be resettled inserted to host population will be supported by allowances for necessary upgrading, enlargement, rehabilitation of existing public infrastructures which will be affected by an increased number of population. However, the allowance shall not in any case exceeding 25 million VND per legal PAH. The PPC is expected to stipulate this concretely**.**

*** Allowances for displacement**

Displacement allowance is the sum of money for households that have to displace their residential place affected by Trung Son Hydropower Project and for households affected by the resettlement site construction of Trung Son Hydropower Project.

- Limit of allowances applied to PAH

Displacement within the commune: VND 2 million per household;

Displacement to another commune but within the same district: 3 million VND per PAH;

Displacement to other district but within the same province: VND 5 million per household

- Households displacing by themselves but not moving to the resettlement site

Apart from the allowance mentioned in the article 1 of this Clause, there will be additional allowance for expenditure of contacting and taking Certificate of Confirmation in the destination place.

Limit of support:

Displacement within the district: VND 400,000 per household;

Displacement to another district but within the same district: 800,000 VND per PAH;

Displacement to other province: VND 2 million per household

Graveyard displacement allowance: the allowance for graves displacement is calculated for expenditure of digging, exhuming and moving graves to another place, displacement to new place, expenditure of land and rebuilding graves, and other expenditures according to customs of each ethnic group at the displacement time. The concrete support limit is made by the Provincial People's committee.

***Livehood allowances**

- Allowance on food:

Each legal member of the resettled household will receive food allowance in cash equivalent to the value of 15 kg of rice per capita per month within 2 years.

Food allowances will be applied only to PAH losing productive land area but not being replaced from residential land area.

Those are not entitled to displacement but being affected by productive land acquisition, if being allocated with replacement land for cultivation, they shall be entitled for food allowances in cash for each legal member depending on the area of acquired land. The PPC is expected to regulate the tariff and time of paying allowances basing on the real area of acquired land. However, the maximum allowance shall not, in any case, exceeding 15 kg of rice per capita per month in a duration of not more than 2 years (in the case of PAH affected by 100% of cultivated land acquisition).

Economic organizations, production and trading households having Certification of Trading who have to stop doing business and production because of acquired land area will be supported with allowance.

The allowances shall equal to 20% of income after tax of one year, according to the average level of the last continuous 3 years which is confirmed by the tax agency.

- Health care allowance:

Every resettled households shall be entitled to health care allowance in the new residential place, and to buy health insurance. This will be cash allowances of VND 100,000 per household for only once.

- Education allowance:

Each member of a resettled household who is a school pupil will be subjected to allowance in cash which is paid only once to buy schoolbook under government stipulated price**:**

- Cash allowance to support the electric fee or kerosene for lighting in off-grid places.

The resettled households shall be entitled for this kind of allowances in the first six months ever from the time arriving at the new place. This allowance is 10,000VND/individual/month.

- Allowance on Production

- For cultivation: PAH involving in agricultural work will be supported in cash allowance, only once, equal to 100% cost to buy seeds, seedlings, insecticide as required by technical procedures for each type of planned crop/tree.

- In regards to husbandry: the allowances for only once will be three million VND per PAH.

Apart from the what stipulated and the specified limit of allowances described in articles 1, 2 of this clause, PAH shall be subjected to allowances on agro-extension program as applicable by existing law and regulations.

- Allowance for policy- families

Households with their members enjoying social subsidy from the Government, lonesome old people, disabled people who have to be displaced will be supported once of VND 1,000,000 per person.

- Allowance on training cost to change careers

+ This kind of allowances will be applied to each farm labour being converted into non-farm labour and lasting in six months. Allowances shall be one million VND per labour per month.

+ Beneficiaries on allowances to convert their careers shall be legal individual being affected by this project implementation. They are expected to submit their apply form under which the commune people's committee of the destination place has confirmed and sealed.

+ Who receive allowances on changing careers from farm to non-farm labour shall not be entitled for giving agricultural cultivated land area to such person.

+ Allowance for laborers who change to new careers (after training and facilitated with certificate) to buy working tools for the new careers. The limit of support is of VND 5,000,000 per laborer, allowance shall be paid only once.

- Allowances for training commune officers in departure places

Departure communes if to be found lacking with commune officers as being resulted from resettlement, shall be considered by the Project Owner for allowances on training replacement officer. The allowance of this title shall not exceed three million VND per one replaced officer and shall be done only once.

*** Allowances ENCOURAGING movement under schedule**

PAHs moving following the informed schedule of resettlement disclosing by the Committee of Resettlement shall be entitled for an allowances of encouragement which shall not exceed five million VND per PAH (paid only once). The PPC is expected to regulate this concretely.

- *Advantage, disadvantage and efficiency of mitigation measure*

- Persons who are in charge of compensation, support and resettlement shall have knowledge in culture, manners and customs, lifestyle and production method of native people.

- Mitigation measures for affects relating to resettlement – agricultural settlement has relationship with the native people' manners and customs, therefore, it is necessary to have positive cooperation among related parties and local authority.

The method has high feasibility thanking to the fact that resettlement – agricultural settlement area is not far from the previous living place, then it does not strongly affect to their manners and customs; limiting disorder caused by change of living location.

4.1.2.4. Impact mitigation method related to labor safety during construction time

- *Mitigation method*

- In order to insure labor safety during construction time of Project, it is necessary to conform strictly with the existing regulations of Socialist Republic of Vietnam on labor safety. They are the following standards:

TCVN 5308-91	"Safe Technical Regulation in construction"
TCVN 3985-85	"Noise – Allowable level at labor positions"
TCVN 4086-95	"Electricity safety in construction - General requirement"
TCVN 3254-89	"Fire safety - General requirement"

TCVN 3255-86	“Exploide safety - General requirement”
TCVN 3146-86	“Electricity welding - General requirement on safety”
TCVN 4245-85	“Code of Safe Technical and Hygiene Technical in production". Acetylene and oxygen use to process metal ”
TCVN 3147-90	“Safe Code in hauling and loading works - General requirement”
TCVN 2293-78	“Wood process - General requirement on safety”
TCVN 2292-78	“Painting - General requirement on safety”
TCVN 4744-89	“Safe Technical Code in exploitation and natural exposed rock process”
TCVN 3146-86	“Safe Code in preservation, hauling and usage of detonators”
QPVN 2-1975	“Safe Technical Code for pressured tank”
TCVN 4244-86	“Safe Technical Code for lifting equipment
TCVN 5863-95	“Lifting equipment- Requirement on installation and use”

- Besides regulations in Labor Safety Standard System of Vietnam, the following specific requirements will be stipulated for Contractor in Bidding Invitation Document.

- Project areas will be shown in design drawings, auxiliary area of Contractor, soil-rock borrow area, workshop, working office must be protected, prevented from non-authorized access.

- Contractor will have responsibility on design, construction and maintenance auxiliary areas. Warehouses for equipment, machine and material shall be ventilated well, out of wet. Fuel shall be stored in underground tanks and these areas shall be protected strictly. Fuel stored tanks must be located in sand holes with minimum depth of 0.5m and Contractor must prepare necessary overcome methods in the case of problem.

- Contractor shall establish an effective protection system that operates 24/24 hours at all areas of the site, check closely person and machine entrance at the site.

- Contractor shall have responsibility to prepare emergency evacuation process at each area, organize, train and equip for rescue teams. Necessary health devices and medicine for first aid shall be available at the site.

- When construction is done in night time, at area shortage of lighting Contractor shall make a high voltage lighting system to insure safe working condition for all persons.

- Workers at project site shall be trained on labor safety and equipped enough labor protection devices. All workers shall use protection devices that is suitable with the work.

- At exploded mine area, Contractor shall erect and operate signal horn that can be heard clearly in allowable safety radius. Mine explode is only executed when safety insurance methods for human, project and other properties are been done.

- Before exploding mine, procedures shall be prepared as stipulated. At the mine exploded areas for construction and material exploitation, roads with risk of sliding shall be set up board of risk warning. Right of way for seism wave caused by mine explode is 195.74m thus warning station for mine exploded time and position will be arranged for inhabitant and construction workers.

- Informing broadly time, placing warn signal and safe technical method during mine exploded process at material borrow areas near residential areas.

- Organizations, trade union check regularly ordinance obey of labor protection; labor worker executes in ordinance and labor safety standard.

- Investor has sent letter to army authorized agency for comment on construction area where bomb, mine and detonator remain after war and bomb, mine sweep will be done at necessary areas before constructing to limit accidents happened by bomb, mine retaining in the war.

- *Advantage, disadvantage and effect of measure*

Retaining mitigation measures are simple and easy to implement.

- Effect of mitigation measures are depend on labor safe awareness of staff, worker of construction companies at the site.

- If these measures are implemented, risks caused by labor accident and local inhabitant who lives near project area will be limited.

4.1.2.5. Mitigation measure for bomb, mine detonator, chemical poison treatment

- *Mitigation measure*

To insure water quality environment and health of inhabitant on every fields in long term. Investor has contracted with professional agencies of army to: mine sweep, treatment at construction project site, material borrow area, auxiliary areas, scouting, searching and cleaning chemical poison (OB) in the reservoir area.

- Sweep range:

+ Mine and detonator sweeping includes: mine and bomb sweeping is done at auxiliary area, at stockpiles, at borrow areas, at settled agriculture area.

+ Area of sweeping, searching, treating chemical poison: land area is submerged accounting to FSL.

- *Advantage, disadvantage and effect of measure*

- Implementation expense is high

- It is feasible

- Scouting, treating OB before filling water will prevent polluted agent spread and dispersion.

- Bomb, mine and detonator sweeping will create safety on detonator during construction process (especially in soil/rock excavation)

4.2. MITIGATION MEASURES DURING INPOUNDATION AND OPERATION OF THE PROJECT

4.2.1. Mitigation measure for water environmental pollution (Clearance of reservoir bed)

- *Measures:*

Determining and declaring the houses acquisition to the Client, related firms, officers, worker and local people.

Clearance and hygiene at reservoir bed area shall be done:

- Clearance of residential area: 432households (accounting to the year resettlement shall be completed)

- Cemeteries clearance:

All the cemeteries in the resevoir site should be moved, a mount of graves has to move upto 20 tombs. The clearances including decomtaminating, sterilizing poles after moving moral

remains by lime or decomatminator according to authority's regulations, wastes clearance (coffin wood, clothes, wood covering graves, vv...) is settled and fired at this place.

- Clearance vegetation cover:

+ Taking all agricultural products, including crop and long-term tree.

+ Taking all forestry products: bamboo, jet, bead-tree, ... (planting forest); wooden tree (natural forest) in reservoir bed area; vegetation covers with erosion and sliding protection capacity such as bamboo, neoheuzeaua, reed, jet ... shall be kept in particular for reservoir bed area near residential area.

+ Clearing vegetation cover before dam in distance of 2 km. Clearance area is 75 ha.

+ Clearing brush edge of planting forest and along riverbank.

- Project owner, implementation contractor, and other related firms/organizations provide measures to manage seriously riverbed clearance, ban gathering land out side of planed area for preventing people abuse clearance to exploit and cut vegetation cover, illegal animal catching in other regions. Clearance of vegetation cover in river bed to ensure water quality when storing water, limits to minimize abundant phenomena when th ereservoir is available, after decontaminating of vegatation cover, water quality will gain type B Standard compared to water in river, ponds.
- To impacts by liquid waste araising in the plant operation phase,

+ Plant area

To hydropower tuabin, the plant chose updated advanced equipments and it is ensured that lubricant will not leaked out in the operation phase.

Lubricant from tourbin, hydro-pressured equipments, valves….when these changed, they will be renewable and recycled and put these into set forth and resolving these basing on operation procedure, mainainance and currency standard. .

+ Domestic areas of workers operating plant:

With thw amount of 130 workers, the wastes from domestic activities by workers is very small compared to construction implementation phase. Waste is collected in to waste systemm of plant so that waste will not discard directly into natural environment, therefore, it is ensured that the domestic activities by the workers operating the plant does not affect to water environment. .

- *Advantage, disadvantage and effect of measure:*

+ Insuring requirement on hydraulic.

+ Insuring well quality of water environment.

+ Insuring good-looking of the project.

+ High expense

+ High feasibility.

4.2.2. Mitigation measure of impact caused flow regime change

- *Mitigation measure*

- For reservoir of Trung Son HPP: flow regulation shall comply with regulation of reservoir operation. Investor shall engage to comply strictly with regulation of reservoir operation, existing regulation on water discharge to generate electricity, flood discharge and informed promptly for authority levels and local inhabitant behind dam at downstream to limit damages on life and property.

- Investor shall have responsibility to compensate, support in the case discharged flood caused damage on human, property, crop... of inhabitant.

- For downstream section behind Trung Son HPP: Investor shall engage to comply strictly with regulation of reservoir operation. Otherwise, during operation process Investor shall regularly co-ordinate with local authority in flow monitoring (discharge and water level monitoring) and bank erosion and sliding to put forth reasonable mitigation measure.

Effectiveness of measure

Conformation of reservoir operation, regulation stipulate; information and warning in time will mitigate damages on human and property caused for downstream area of powerhouse.

4.2.3. Mitigation measure of impact caused by sliding, reservoir bank regeneration; reservoir bed sediment

- *Mitigation measure*

- Investor shall coordinate with local authority to plan, protect and develop forest, especially protection and development of semi-submerged forest vegetation at area near bank (especially at residential areas).

- Investor shall have responsibility to monitor reservoir bank sliding at residential areas, resettlement - settled agricultural area, inter-hamlet, inter-commune roads. And

- Reservoir will be create with volume enough to store sediment at reservoir bed corresponding to life of the project. If storage volume (dead storage) does not insure to store sediment volume, reservoir dredge will be done period.

- *Advantage, disadvantage and effect of measure*

- If the above measures are implemented well to contribute increasing coverage of forest, and prevent sliding from reservoir bank area; increase life of the project.

- When measures are implemented reducing income of local inhabitant due to planting area do not take full

In the case if the implemented measures cause deduction in income of local resident due to reducing the planted area since they do not cultivate the semi-flooded area.

- These mitigation measures need cooperation between local inhabitant with Powerhouse Management Board to execute.

4.2.4. Bank and riverbed erosion, sliding at area behind powerhouse

- *Mitigation measure*

- To mitigate erosion and sliding of riverbank behind powerhouse, energy dissipation of submerged flow is designed to reduce kinetic energy of water, reduce flow speed behind tailrace channel, flow behind scouring pool flowing to natural river.

- Investor shall have responsibility on cost and coordinate with local authority to hire functional agencies to construct monitoring points for bank sliding after filling water into reservoir and operating the project.

+ When reservoir of Hoi Xuan HPP is not constructed, riverbank sliding and erosion will be monitored closely at area behind (01 time/1 month) from behind dam to Co Luong confluence.

+ When reservoir of Hoi Xuan HPP is constructed, riverbank sliding and erosion will be monitored up to tail of Hoi Xuan reservoir.

- Investor shall have responsibility to implement timely treatment measures and protect effectively for sliding: bank embankment, problem treatment caused by bank erosion and sliding, especially for areas where is possible to slide near residential area (Co Me hamlet) and other structures to protect life and property for inhabitant surrounding reservoir bank.

- *Effect of measure*

- Minimizing erosion and sliding of bank, mitigating damage on life, land, properties and infrastructure at downstream cause bank erosion and sliding.

4.3. MITIGATION MEASURE FOR ENVIRONMENTAL FAILURE

4.3.1. Impact from blasting

The Owner requires construction units to strictly comply with current regulations in term of transport, storage and explosive usage. Specifically, explosive shall be transported safely and accompanied with safeguard staff for loss prevention. Blasting procedures will be complied.

4.3.2. Safety methods during reservoir operation

Reservoir operation process will be approved by Ministry of Trade and Industry based on the regulations and inter-reservoirs operation of the ladder hydropower in Ma river system. The main processes are the followings as below:

a) General regulations

- Requirements for operation activities are in following priority: Ensuring absolute safety for Trung Son important irrigational works, actively preventing any failure for flood with small repetition cycles or cycle of 1000 years/time, level of reservoir shall not exceed strengthening water level of 161.68m.

+ Ensuring continuous operation of units, yearly supplying to about 1055 millions kWh to the national grid.

+ Reducing flood for the lowlands with water level before major flood season of 150m, corresponding to flood prevention storage capacity of 112 million cubic meters.

- Basis for operation procedures:

+ Law of dykes and dyke-maintenance (Law No. 79/2006/QH11 approved at eleventh session of National Assembly on 29/11/2006) and becoming valid from 1/7/2007 and replacing ordinance dated 24/08/2000).

+ Decree No. 72/2007/ND-CP dated 07/5/2007 in management of dam safety.

+ Decision No. 285/2006/QD-TTg dated 25/12/2006 issued by Prime Minister referring to content of jurisdiction and organization of hydropower reservoir operation.

+ Other standards, codes relating to hydraulic works and reservoir..

- Working principle of Steering committee of flood and flood prevention:

Trung Son hydropower project shall annually establish Steering committee of flood and flood prevention. The steering committee will be responsible for flood and flood prevention from May to November for Trung Son hydro power plant. During floor occurrence, the steering committee shall be present at the plant under direction of the committee leader to execute following duties:

+ Strictly monitoring meteo-hydrological conditions (reservoir level, flood water flow at related stations (Xa La, Muong Lat, Hoi Xuan, Cam Thuy,…) and informing flood , flood, rainy forecasts.

+ Examining actual working condition of the work: operation status of equipment for flood discharge, enhancing observation of hydraulic works, timely overcoming damages of works and equipment and ensuring its safety operation prior, during and after flood season.

+ Organizing on-duty flood staff, and timely acting as required..

+ Carrying out orders from Steering committee of flood and flood prevention of Thanh Hoa province. In case the above orders are not suitable with regulations of operation procedures, the leader of steering committee of Trung Son hydropower project will have right of decision and be responsible for his decision, and timely report t authorized bodies.

- Operation in special cases: During flood season, when special case not specified in this procedures occurs, operation and regulation of flood prevention for the reservoir shall follow unified direction from People Committee of Thanh Hoa province, directly from the provincial flood prevention steering committee.

b) Activities of floor prevention

- Annually, prior to flood season (May), director of Trung Son hydropower project will made decision on establishing the plant steering committee of flood and flood prevention.

- The plant committee leader shall organize examination works to ensure sound operation status of work and equipment, including:

+ Examination and overcoming defects may harm stability and normal operation, reliability of the work, observation equipment and execution of observation during flood season.

+ Sufficiently maintaining and ensuring normal operation of generator units, power mechanical, hydraulic equipment at the dam, water intake gate and main & standby power source. Preparing spare parts for replacement as required.

+ Examining test of related equipment for closing/opening gate valve of the dam, standby power source, maintaining equipment of the dam and recording in routine examination book.

- Annually, at the beginning of flood season, the plant steering committee leader (Plant director) will organize meeting of flood and flood prevention for reporting preparation works and preventive methods and discussing coordination method, the following participants will attend:

Representatives from Thanh Hoa province steering committee of flood and flood prevention

Representatives from Quan Hoa district steering committee of flood and flood prevention

Representatives from Meteo-hydrological forecast center of Thanh Hoa province

Representatives from Thanh Hoa province power

Representative from Quan Hoa district post office

- During flood period, it is necessary to ensure normal operation of information facilities such as television, telephone for connection between the plant & the plant steering committee and related bodies:

National load dispatch center (Ao)

Central load dispatch center (A3)

Steering committee of flood and flood prevention of Thanh Hoa province, Quan Hoa district.

Meteo-hydrological forecast center of Thanh Hoa province

- Prior to flood season, director of Trung Son hydropower will be responsible for monitoring activities, collection of meteo-hydrological data relating to flood and flood prevention, organizing completion of repair and maintenance of work and equipment relating to operation safety during flood season.

c) Operation during flood season

Gates will be numbered from the left to the right following water flow directions as 1, 2, 3, 4, 5 and 6.

Operation method of the gate valve of the dam:

- Method for operation of early and late flood prevention

For early and late flood, the gate of spillway shall ensure reservoir water level of 160m.

Gates will be opened following each step corresponding to opening grade of 0.5m. The subsequent opening is executed after completion of the previous one. Closing procedure is execute in contrast with opening procedure, the subsequent closing order is execute after completion of the previous one.

- Method for operation of flood prevention:

For main flood season, the gate of spillway shall maintain reservoir water level of 150m corresponding to flood prevention capacity of 112 millions m3.

Gates will be opened following each step corresponding to opening grade of 0.5m to maintain stable reservoir water level of 150m. When all Gates have been open up to 150m, the reservoir water level still increases, the gate of overflow valve will be increased to ensure free overflowing mode.

- Method of emergency operation

In emergency case, Gates are permitted to be opened at maximum.

- Mode of manual operation

In case of power failure or control equipment, manual dam operation is permitted.

Requirement: Prohibiting water overflowing through spillway peak curve in any case.

- Prior to flood discharge, the Trung Son plant steering committee of flood and flood prevention shall inform related bodies and execute following activities:

+ The committee leader shall inform the flood condition, and report to the national load dispatch center (A0), Central load dispatch center (A3) so that Trung Son hydropower project officially control flood discharge of reservoir, and inform to the provincial steering committee for control coordination.

+ Steering committee of flood and flood prevention of Thanh Hoa province will be responsible for timely informing local bodies and authorities and people at lowlands about flood status and have timely prevention methods.

+ The Thanh Hoa province' steering committee will be responsible for organizing staff and facilities for flood prevention and limiting damages caused by flood at the local and timely support flood& flood prevention staff of Trung Son hydropower project in emergency cases.

d) Responsibility of the plant and authorities

- Trung Son hydro power plant:

+ Strictly executing regulations for procedures of Trung Son hydropower reservoir operation and ensure safety of the work and generate power at high productivity.

+ During exploitation and management process, annually Trung Son hydro power will summarize operation and regulation of the reservoir and conduct such procedure. If any necessary adjustment and addition for the procedure is found, it is necessary to report Department of industry and commerce, People committee of Thanh Hoa province.

+ During flood season, regular contact should be done with People committee of Thanh Hoa province, Department of industry and commerce, Department of agricultural and rural development, provincial steering committee of flood and flood prevention, and strict relationship should be done with people committee of people committee of districts, communes, towns in the affected area in term of the work condition and flood discharge plan. Having plan and treatment method for case of failure potential and timely reporting related bodies.

- Department of industry and commerce of Thanh Hoa province

+ Directing, guiding and examining Trung Son hydropower project in execution of this procedure, especially the reservoir flood discharge

+ Appraising content of adjustment and addition following proposal of Trung Song hydropower plant, asking for guidance from Ministry of industry and commerce, submitting for Thanh Hoa province people committee decision.

+ Appraising method of annual flood prevention for Trung Son hydropower reservoir and reporting steering committee of provincial flood prevention and submission for Thanh Hoa people committee approval.

- People committee of Thanh Hoa province

+ Supervising execution procedures of department and levels

+ Dealing with prevention and harming actions for this procedure in competence scope.

+ Creating favorable conditions for Trung Son hydropower project for operating and regulating Trung Son reservoir as specified.

+ Directing steering committee of provincial flood prevention, Trung Song hydropower project and departments, levels to rightly execute their functions and duties.

- People committee of Quan Hoa district

+ Strictly complying with this procedure.

+ Preventing, solving and informing for the hydropower about action of prevention, harming this procedure following permissible competence

+ Executing methods for assurance of safety for lowlands during reservoir flood discharge and failure occurrence.

+ Propagandizing and campaigning local people to comply with this procedures and participate in flood prevention, safety protection for Son Trung hydro power reservoir.

+ Assisting and creating favorable condition and together with Trung Son hydropower project to solve difficulties in upgrading and maintaining the work. Overcoming natural calamity which cause failure for the project.

4.3.3. Mitigation of impact caused by cofferdam failure, dam failure

To prevent from dam break, frequency cofferdam and max design water level of the project are determined according to Vietnamese Standard TCXD VN 285: 2002 and Degree No 209/2004/NĐ-CP of Government. Besides, during design process, impact treatment methods caused by faults and tectonic fracture for dam are recommended, emergency spillway is designed by Design to prevent from dam failure. However, failure of cofferdam and dam are still possible to happen.

- In the case of floods exceeding design frequency: for cofferdam larger than 5%, for dam larger than 0.1% dam and cofferdam failure risk may be happened. Mitigation measures are as follows:

+ Steering committee of provincial flood prevention Communities shall be formed who is on-dudy regularly (24/24hours) at the site and area with failure risk.

+ Discharging all discharge volume through diversion work.

+ Preparing materials to embank cofferdam when design flood has risk to exceed .

+ Informing timely for workers, operators at construction site and moving construction machines at the site out of dangerous area.

+ Informing promptly for local authority at downstream to remove inhabitant from area where may be submerged by flood to prevent from human life and property loss.

- Considering evacuation range when dam is broken down or discharge of flood volume through spillway, determine erosion and bank support method at downstream area during Technical Design Stage, monitor continuously flood and check spillway layout when flood of P = 0.1% is happened. Hydraulic model of spillway shall be made to check, adjust and design spillway, determine river water surface curve at upstream, downstream sections of dam based on different discharge levels.

- Propagandizing regularly for local people to comply with safe procedures that are necessary to execute, informing and evacuating timely in the case of large flood discharge. Checking regularly projects related to discharge of spillway such as spillway closing and opening.

4.3.4. Impact imigation measures to fishes and fisheries.

- There is a ladder system on Ma, Chu River, therefore, the impacts to fish and fisheries in the river system is remarkable. There are Lang, Mang, Vu fishes, they oftem turn to the highland for the borning, so that in order to reducing these imitigation, there are some measures as follows:

- There is a river with no hydropower construction on a river system for fish coming here ro borning. The consultant request not to undertake the construction on Buoi River in Ma river system for fish in their borning.

- For fisheries, the local people used to catch fish on the flows, therefore, when dam constructed, it is changing from flows to ponds. The client makes a guidline to help the people using the sustable fishing with the statement of ponds and rivers, guilde to local

people feed several types of fishes such as Euphorbiaceae, fabaceae, to improve their living standards.

4.4. FORCE MAJEURES

- Impact related to biological landscape variations at reservoir bed, construction layout, material borrow area.

- Impact related to mud creation of soil at reservoir bottom after filling water into reservoir.

- Impact related to change of silt flow.

- Mitigating impact caused by reduction of river sediment.

- Impact related to change of aquatic ecosystem at reservoir area.

CHAPTER 5: COMMITTMENT ON IMPLEMENTATION OF ENVIRONMENT PROTECTION MEASURES

In order mitigate negative impacts on the environment during construction and operation stages, the project investor commit to follow all legal regulations, discharge to water source, implementation of environment protection measures during construction and operation stages. Commitments of the project investor are:

5.1. Commitment on compliance with laws, decrees, standards

- Law on environment protection No.52/2005/QH11 passed on 29 November 2005 and valid since 1 July 2006.

- Government decree No.80/2006/NĐ-CP dated 9 August 2006 on specific stipulations and guidance on implementation of several articles of the Law on environment protection

- Law on water resource No.08/1998/QH10 passed by the 10th National Assembly in the 3rd meeting on 20/05/1998, and valid since 01/01/1999

- Land law No.13/2003/QH11 passed by the National Assembly on 26/11/2003, and valid since 01/07/2004

- Law on forest protection and development No.29/2004/QH11 passed by the National Assembly on 03/12/2004, and valid since 01/04/2005.

- Dyke law (Law No.79/2006/QH11 passed by the National Assembly in the 11th meeting on 29/11/2006) and valid since 1/7/2007

- Decree No. 17/2006/NĐ-CP of the Government dated 27/01/2006 on modification of and supplementation to several articles of the Land law 2003

- Decree No.149/2004/NĐ-CP of the Government dated 27/07/2004 on granting license on inv investigation, exploitation, use of water resource, waste water discharge to water source

- Implementation of mitigation measures for surface and underground water quality of the project area during construction in compliance with standards TCVN 5942-1995 for surface water quality and TCVN 5944-1995 for underground water quality.

- Implementation of mitigation measures in compliance with standards TCVN 5937-2005 for air pollution; TCVN 5939-2005 for surrounding air quality; TCVN 6438 -2001 for industrial exhaust fumes for dust and inorganic substances; TCVN 5948-1999 for maximum allowable limit for exhaust fumes for road transportation means and environment criteria on noise

- Material exploitation and transportation means will ensure environment protection criteria: TCVN 6565-2006: road transportation means, visible exhaust fumes (smoke) from compressed combustion engine. Requirement and test method for type approval; TCVN 6567-2006: road transportation means. Compressed combustion engine, forced combustion engine using liquidized petroleum and natural gas for cars. Requirement and test method for polluted exhaust fumes for type approval; TCVN 6785-2006: road transportation means. Polluted exhaust fumes from cars by fuel types. Requirement and test method for type approval

5.2. Preparation and constrution stage

- Implement all policies on compensation, subsidies for resettlement and settled agriculture for affected households; ensure permanent living stability for affected households after resettlement and settled agriculture

- Implement mitigation measures for negative impacts on ecological environment as mentioned in EIA report

- Follow strictly sweep measures for bomb, mine, detonators remained under the ground as a result of war

- Implement reconnaissance measures for chemical toxics (OB) and treatment of chemical toxics in the reservoir area before impounding water.

- Collect and treat waste lubricant resulting from construction stage

- Implement measures to mitigate negative impacts on ecological environment during construction time

- Implement all technical and technological measures for construction works, have prevention program, mitigate risks so as to minimize environment impacts

- Implement measures to collect and treat solid waste and waste water. Ensure standard TCVN 6772-2000 allowable limit for domestic waste water.

- The Investor commits to coordinate with defense units during construction time to ensure national security in the Laotian-Vietnamese border area.

- Commit to implement prevention measures for fire and explosion of warehouse for fuel and explosive substance to serve construction works.

5.3. OPERATION STAGE

- Implement measures to prevent corrosion and protect soil environment quality

- Implement all observation and supervision activities, prevention measures against sliding, lake and river regeneration in initial storage and operation period

- The Investor commits to coordinate with defense units during operation stage to ensure national security in the Laotian-Vietnamese border area.

- Commit to implement flow regulation to meet water supply demand for the lower part in accordance with reservoir operation procedure approved by ministry of industry and commerce

5.4. Implementation of environment protection measures

- Implement measures to protect health and safety for construction and operation workers

- Implement measures for traffic safety during construction stage

- Follow strictly sweep measures for bomb, mine, detonators

- Implement reservoir cleaning according to mentioned mitigation measures to ensure the reservoir water quality

- Implement measures to limit impact on socio-economic environment during operation stage

- Implement all environment management and monitoring program

- Ensure full preparation of budget for mitigation measures, environment monitoring and treatment, observation and training

For contractor and operation units, environment protection and mitigation measures are mentioned in subsequent contracts so as to bind responsibility of contractor and operation units with environment protection

The investors commit to meet all requirements on environment impact mitigation, ensure criteria on environment quality during construction and operation stage as mentioned in the report and commit to be responsible to law for violent to Vietnamese standard on investment, construction as well as incidents resulting environment pollution

CHAPTER 6: ENVIRONMENT TREATMENT CONPONENTS, ENVIRONMENT MANAGEMENT AND MONITORING PROGRAM

To ensure that recomendation and mitigation measures for negative impacts are followed and implemented, it is recomended as follows:

6.1. Lists of environment treatment conponents

Table 6.1. Lists of environment treatment conponents

No	Environment treatment component	Implementation schedule
I	**Construction stage**	
1	Sweeping works for bomb and mine	Before construction commencement
2	Domestic waste water treatment system: Domestic waste water treatment project	As the same time with construction of building and camping for workers
3	Domestic waste water treatment system: industrial waste water treatment system (collect waste lubricant from means of transportation	Equip tank for waste lubricant upon project construction and completion
4	Project on domestic solid waste treatment, concentration rubbish dump of 0.0863hecta Equip tank for domestic solid waste	Implement in construction preparation year Equip upon project construction and construction completion
5	Reservoir cleaning	Before impounding water
II	**Operation stage**	
1	Domestic waste water treatment system of operation workers	As the same time with construction of management and operation building
2	Waste collection treatment system of operation workers: equip tank for domestic solid waste	Contact with local urban environment company to collect and handle waste in accordance with the local waste treatment planning.

The contents of implementation steps, procedures and detail progress and implementation cost of environmental treatment hired by contractor, or comsulting firms are presented in the next phases of project.

6.2. Environment management and monitoring program

6.2.1. Environment management program

6.2.1.1. Environment management program for construction stage

In order to manage environment issues in construction stage, the Investor shall set up a special unit to manage, implement: environment – compensation, allowances and resettlement – settled agriculture

Duties:

- Managing environment protection issues during construction time such as: manage surrounding environment, waste and prevent environment incidents, carry out environment monitoring during construction time

- Monitoring implementation of mitigation measures for environment impacts, environment management programs, environment monitoring programs of Contractor's units, staffs and construction workers

- Natuaral environment management

+ Requesting the Contractor to commit with the Investor on management of staffs and construction workers so that they would not do trading, store, consume, transport and exploit forest products, hunt wild animals which would affect the forest resources, follow strictly the regulation on waste treatment, implement mitigation measures for negative impacts caused by construction works.

+ Cooperating with the local communes, Management Board of Xuan Nha and Pu Hu Natural Preservation Zones on the natural resource protection, exploitation and gathering all production of forest in the process of reservoir bed clearence.

- Receiving response of construction units, local people and authority, incharged environment management unit in the project area, management board of Xuan Nha, Pu Hu conservation areas... on environment issues during project implementation

- Giving consultancy for Investor on solution for project-relating to environment problems during project implementation

- Coordinating with the local authority and functional units to promptly solve environment incidents. After solving environment problems, the Investor shall inform concerned bodies of the result

- Reporting gradually to the local authority, Thanh Hoa DONRE on environment protection activities: every 6 months or 12 months depending on the monitoring activities

6.2.1.2. Environment management program for operation stage

In order to manage environment issues in operation stage, the Trung Son HPP management board shall assign 2 environmental staffs

Duties:

- Managing environment protection issues during operation stage such as: manage surrounding environment, manage and treat waste, prevent environment incidents

- Monitoring implementation of mitigation measures for environment impacts, environment management programs, environment monitoring programs of Contractor's units, staffs and operation workers

- Managing use of the reservoir water resource

- Managing reservoir exploitation and aquaculture

- Proposing solution for preventing environment incidents that may happen during operation stage: risk of reservoir water lost, dam break, sliding of traffic and operation roads, etc.

- Collecting information, monitor all environment changes during operation stage

- Receiving response of local people and authority, incharged environment management unit in the project area on environment issues during project operation

- Giving consultancy for Trung Son HPP management board on solution for project-relating environment problems
- Coordinating with and inform the local authority and functional units to promptly solve environment incidents.
- Reporting gradually to the state authority incharge of environment protection.

6.2.2. Environmental monitoring program

a) Monitoring program

Table 6.2. List of environmental monitoring program during construction time

No	Environmental factor monitored	Parameters	Position	Frequency	Monitored by	Notes
I	**PREPERATION AND CONSTRUCTION STAGES**					
1	**Socio- Economic environment**					
a	Monitoring compensation, resettlement and resettled agriculture	Compensation for resettlement and resettled agriculture is based on existing regulation of the State.	-Reservoirbed area, Co Luong- Co Me road area, resettlement and resettled agriculture area		- Project Management Board (PMB) - Assembly for resettlement compensation	
2	Waste monitoring					
a	*Waste water, liquid waste monitoring*					
	- Waste water from camping area of workers. - Waste water from concrete mixing plant. - Waste water from truck clearance area. - Areas cause other waste	Quantity, suspended solid, DO, BOD, COD, total of N, total of P, coliform, wash agent, disposal lubricant.	Area of the project layout. Area of camping. Maintenance site of car, machine	4 times/year* 4,5 year	- Monitoring Contractor - Construction Contractor - PMB	
b	*Monitoring of solid waste:*					
	Monitoring domestic waste:	Monitoring of domestic solid waste treatment and collection.	- Camping of workers. - Rubbish dump	4times/1year* 4,5year	- Monitoring Contractor - Construction Contractor - PMB	
	Monitoring for construction waste Quantity of disposal rock/soil during construction of foundation pit. Quantity of cover excavation of borrow area; leveling for space; construction of	- Monitoring disposal rock/soil pouring following stipulated areas, monitoring disposal rock/soil pouring process. - Monitoring collection, treatment of scattered and wasted material	- Disposal area - Construction site	2times/1year* 4,5year	- Monitoring Contractor - Construction Contractor - PMB	

No	Environmental factor monitored	Parameters	Position	Frequency	Monitored by	Notes
	transportation-operation road, scattered and wasted materials.					
3	Monitoring of surrounding environment					
a	*Monitoring air environment:* Observing and monitoring air environment during construction time.	Total of dust PM10, noise, vibration, CO, NO_2,SO_2, Pb,O_3	13 positions: - 7 positions at project layout (figure 6a) - 2 borrow areas. - 4 areas of resettlement-resettled agriculture (figure 6)	2 times/year	- Monitoring Contractor - Construction Contractor.	
b	*Monitoring of water environment:* - Monitoring implementation of mitigation measures for water environment pollution. - Monitoring water quality supplied for construction workers *(water source supplied in construction time at downstream of dam)*	pH;COD;BOD;DO; total N;PO^-_4; total Fe; lubricant; turbidity; suspended solid; coliform .pH;COD;BOD;DO, total N;PO^-_4; total Fe; lubricant; turbidity; suspended solid; colifom, As,Cd,Hg,Cu, flora protection.	- 3 positions: Reservoirbed area (at upstream of dam 500m), d/s (behind dam 500m), 10km far from the project site at the d/s (figure 6) - 1 position: water supply area for construction worker	2times/year* 4,5year 2times/1year*4,5 year	- Monitoring Contractor - Construction Contractor - Monitoring Contractor - PMB	
c	*Monitoring for hydrology:* - Hydrological regime, monitoring flow fluctuation, intensity and frequency of flood.	- Discharge, - Water level - Besides, flood control: intensity, frequency,…	u/s of dam (Figure 6)	Water level: 2 times/1 day* 2 year Discharge: 2times/month * 4,5year.	- Monitoring Contractor	
4	Monitoring of ecological environment					

No	Environmental factor monitored	Parameters	Position	Frequency	Monitored by	Notes
a	*Monitoring forest planting:*	Type of tree, planting method and care	Stockpile area, disposal area after closing other auxiliary areas when construction is completed, forest will be replanted, forest planting plan area to add submerged forest area and recover reservoirbed area and resettlement-resettled agriculture area		- Locality - PMB - Inhabitants take part in forest planting	
b	- Monitoring illegal activities of construction workers - Monitoring plant and animal transportation out of project area (during clearance process for space and clearance of reservoirbed)	- Monitoring wood exploitation, hunt, trade flora and fauna of construction worker, especially flora and fauna in forbid list. - Not taking all forestry product out of clearance range	Project area	During construction time	- Management board of Natural Conservation area - PMB.	
5	Monitoring labour safety					
a	Monitoring health, labour safety for construction worker s at the site.	Implementing labour safety protection measures for construction workers at the site. Equipping labour protection stools Carrying out disease prevention measures, health examine periodic for construction workers	Construction site	2 times/year* 4,5year	- Construction Contractor. - PMB	

b) Organization of monitoring activities

- For environment monitoring activities, Investor shall train or recruit monitoring staff, contact with units who have enough capacity and specialize in environmental monitoring and observation.

- For ecological environment monitoring activities, activities relating to forest vegetation cover and wild fauna in construction time, Investor shall have responsibility to contact with Project Management Board of Xuan Nha Natural Conservation Area and Pu Hu Natural Conservation Area to monitor ecological environment in construction time.

- Report shall be submitted regularly to local authority and Resource & Environment Department of Thanh Hoa, Son La province: 6months/time of 1year/time, Number of report will be based on monitoring program.

6.2.2.2. Environmental monitoring program in operation time of the project

a) Monitoring program

After Trung Son HPP is completed, operation stage will start from the end of forth construction year. During operation stage, environmental impacts will happen in a wide range: from upstream, reservoirbed area to downstream of the project. Impacted time will also prolong, many impacts will be still latent up to now it is not forecasted. In our country, environmental monitoring, studying process at area of some large reservoirs such as Hoa Binh, Thac Ba that last 15-20 years from operation but these monitoring data are not synchronous and continuous, results are still limited. Thus, environmental monitoring program in operation time of Trung Son HPP will be:

Table 6.3. Environmental monitoring program in operation time

No	Monitoring factors	Monitoring parameters	Monitoring position	Monitoring frequencies	Monitored by	Notes
II	MONITORING IN OPERATION TIME					
1	- Monitoring hydrology	- Water level - Discharge	- Reservoirbed - Downstream of powerhouse	- Discharge time/month - Water level 1 day/month (monitoring 24time/day) * monitored in 05years	- Contractor - Operation management Board	
2	Monitoring labour safety for operation workers	Implementing labour safety protection measures for operation workers	- In powerhouse area	- 1 times/year	- Management board of powerhouse	
3	Monitoring surface water quality	Color, smell, taste, pH;COD;BOD;DO, total of N;$PO^{-}_{4;}$ total of Fe;	- Reservoirbed - D/s of powerhouse	2 times/year* 5year started from impounding time for		

No	Monitoring factors	Monitoring parameters	Monitoring position	Monitoring frequencies	Monitored by	Notes
		lubricant; turbidity; suspended solid; colifom		operation of the project.		
4	Monitoring sediment of reservoirbed	Measuring and observing periodic terrain of reservoirbed area	- Reservoirbed	5 years after impounding.		
5	Monitoring, observing erosion at downstream	Measuring and observing periodic terrain of downstream area behind powerhouse	- Reservoirbed - Behind dam (at Co Me hamlet)	-1times/ month * first 5years of impounding	-PMB	Monitoring river section behind dam accounting to tail of Hoi Xuân reservoir about 7km
6	Monitoring dam safety, displacement	Monitoring dam displacement	- Damsite	- During operation time	- PMB	PMB has established dam safety monitoring board in operation time
b	Monitoring ecological environment: Monitoring illegal activities of operation workers	- Monitoring forestry product exploitation, hunt animal at Xuan Nha, Pu Hu Conservation areas and surrounding area, wild animal transportation, store, especially is species in forbid list	- Xuân Nha, Pù Hu Conservation areas and forest near the project area	- 2 years impounding	- Management board of Conservation Areas - Management and Operation Board of powerhouse	- PMB support cost for Management board of conservation area
c)	Monitoring ecological system: Ecological system and	- Investigating periodic annual on fish and aquatic in reservoirbed	- Reservoirbed	1times/year * 2years	- Expert on ecology - Expert on aquatic and fishery	- Engaged cost for expert will be paid by Investor

No	Monitoring factors	Monitoring parameters	Monitoring position	Monitoring frequencies	Monitored by	Notes
	biological diversified at project area.	area and downstream area behind dam from starting to fill water into reservoir to detect species components and their development when reservoir is created			- PMB	

b) Organization of monitoring activity

Monitoring activities will be responsible by Investor, represented by Trung Son HPP Management Board. Implementation based on method will contact with monitoring consulting companies and experts on environment.

Implementation cost will be paid by Trung Son HPP Management Board.

CHAPTER 7: COST ESTIMATE FOR ENVIROMENTAL MITIGATION MEASURES

In order to ensure that all mitigation measures will be followed and implemented the procedures for treatment, management and environmental monitoring presented in chapters 4 and 6 should be implemented. Cost for construction of environmental pollution treatment facilities and programs to mitigate the project's environmental impact is estimated at the investment project as below:

7.1.Cost for environmental treatment facilities

7.1.1. Treatment facilities for domestic waste water

The cost component is for construction of following components: Water collection and discharge pile of waste water, tanks for collection of waste water, biological disintegrated tanks, tanks for sediment deposit, sterilized tanks. The cost will be included in the general cost category of contractors.

Cost to operate and maintain of the facilities in included in the general cost category of contractors.

7.1.2. Treatment facilities domestic, industrial and construction waste matters

7.1.2.1. Treatment program for industrial and construction waste matters

The cost is for following works: levelization of dumping ground, coffer dam, construction of cannels around the dumping ground to collect rain water, ramming after dumping. The cost will be covered by the contractors.

7.1.2.2. Treatment program for domestic waste matters

Based on the amount of wastes from workers in the dam site in construction years, the wastes filler area is estimated 0,918ha

Cost for construction of dumping ground is estimated as below:

0.0918 ha x VND 1 billion /ha = VND 91.8 mil

This cost will be included in the construction package.

7.1.3. Reservoir clearance work

<u>Cleaning of residential areas:</u>

Cost for cleaning of residential areas is as below:

432 HH x VND 2.10 mil/H = VND 864 million

<u>Cleaning of cemeteries:</u>

Cost for cleaning of cemeteries is as below:

20 tomb x VND 1mil/tomb = VND 20.0 million

<u>Cleaning of vegetation cover:</u>

To avoid/mitigate pollution due to storing water in the reservoir, local HH are required to harvest all rice, crops, long term trees and bamboo before the water storing.

Cost to clean vegetation cover in dimension 2 km upstream of the dam is as below:

75 ha x VND 10 mil = VND 750 million

The cost in included in the contingency cost of the project.

7.1.4. Clearance of mines, explosives and toxic chemicals

Implementation budget:

Mines and explosive investigation and clearance in main construction work, auxiliary facilities and resettlement are: VND 7,951.09 mil.

Investigation of toxic chemical (OB) in the reservoir area is estimated VND 9,373.652 mil.

Table 7.1. Total investment cost for environmental treatment facilities

No	Item	Value (VND mil)
1	- Clearance of residental arae and vegetational cover in dimention of 2 km upstream of the dam site	1,634.00
2	- Mine investigation and clearnace	7,651.09
3	- Toxic chemical clearance	9,373.65
4	- Construction of residential dumping ground	91.80
5	Total	18,750.54

Cost for environmental monitoring

7.2.1. Cost for environmental monitoring during construction period

Table 7.2. Cost for environmental monitoring during construction period

No	Item	Frequency	Unit price (VND/1sample)	Value (VND mil)	Note
1	Monitoring of waste matters				
a	Monitoring of domestic liquid waste	4 time / year * 2 location * 4.5 year	3.000.000 VND/sample	108.00	
2	Monitoring of surrounding area				
a	Monitoring of air	13 location * 2 time / year *4.5 year	4.000.000 VND/sample	468.00	
b	Monitoring of water quality in the river	3 location * 2 time / year * 4.5 year	3.000.000 VND/sample	81.00	
3	Hydrography data collection				

No	Item	Frequency	Unit price (VND/1sample)	Value (VND mil)	Note
a	labour	1 location * 12 month * 4.5 year	2.000.000 VND/month/person	108.00	
b	Equipment (estimated)		20,000,000	20.00	
4	Other monitoring				
a	Reforestation	350 ha	5,000,000 VND/ha	1,750.00	
b	Monitoring of ecological environment				
	- Construction of monitoring station (150 ND mil / station)	2	150,000,000	300.00	
	- Labour (2 station x 3 person x 4.5 year)		2,000,000 VND/month/person	54.00	
c	Monitoring of health care and work safety				Born by contractors
d	Monitoring of resettlement and livelihood restoration				Born by the PMB
5	**Total**			**2,889.0**	

7.2.1. Cost for environmental monitoring during operation period

Table 7.3. Cost for environmental monitoring during operation period

TT	Item	Frequency	Unit price (VND/1sample)	Value (VND mil)	Note
1	Dam safety monitoring	1 time / year			Operation cost
2	Monitoring of reservoir sedimentation	1 time / year			Operation cost
3	Monitoring of aquatic creature	1 time / year * 5 year	20,000,000 VND/time	100.00	Operation cost
4	Monitoring of resettlement and livelihood restoration				Operation cost
5	Monitoring of water environment	2 location * 2 time / year * 5 year	3,000,000 VND/sample	60.00	Operation cost
6	Monitoring of erosion of the reservoir bank (upstream and down stream)				Operation and management cost
	- Establish of monitoring section				Operation cost
	- Assessment and reporting				Operation cost
7	Observation of changes of water level at downstream				Operation and management cost
A	Labour	2 location *	2,000,000	240.00	Operation and

		12 month * 5 operation year	VND/month/person		management cost
8	Collection and treatment of domestic waste matters				Operation and management cost
9	**Total**			**400,00**	

Table 7.4: Total cost for environmental treatment facilities

No	Item	Value (VND mil)
1	Cost for construction of environmental treatment facilities	18,750.54
2	Cost for environmental monitoring during construction period	3.289
2.1	**Implementing stage**	**2.889**
2.1	**Operatiomm stage**	**400**
3	Cost for training and environmental communication	70
3.1	**Implementing stage**	**50**
3.2	**Operatiomm stage**	**20**
	Total	22.109,54

Environmental supervision in the operational phase is hired to plan in detail estimate cost, implemental organization by Departments or Firms of Plant operational Management Board. Suppervisory implementing cost is financed by Plant operational Management Board (included in administrative cost of plant operational management)

7.3. Cost for training cources and communicative information on environemental protection.

7.3.1. Cost for training cources on communicative information in construction execution phase

Implementing cost including:

+ Organizing traing courses on environmental protection in commnues
+ Printing documents for traning courses, propagandizing information to attendants
+ Printing documemts deliverying to villages

Implementing expenditures as follows:
+ Workforce for implementing guildeline:
2 persons x 4.000.000 VND/person/time x 1time/year x 5 years = 40.000.000 VND
+ Printing documents for communicative information:
2.000.000 VND/time x 1 time/year x 5 years = 10.000.000 VND
Total: 50.000.000 VND
(This expenditure is included in contigencies cost of the project)

7.3.2. Cost for training cources on communicative information in construction operational phase

Implementing expenditures including:

+ Organizing traing courses on environmental protection in commnues
+ Printing documents for traning courses, propagandizing information to attendants
+ Printing documemts deliverying to villages

Implementing cost (estimated cost) including:
+ Workforce for implementing guildeline:
2 persons x 4.000.000 VND/personsi/time x 1time/year x 2 years = 16.000.000 VND
+ Printing documents for communicative information
2.000.000 VND/time x 1 time/year x 2 year = 4.000.000 VND
Total: 20.000.000 VND
(This expenditure is included in plant operational cost)

Chapter 8: Public consultation

The project area includes following communes: Van Mai, Mai Hich – Mai Chau district – Hoa Binh province; Xuan Nha and Tan Xuan – Moc Chau district – Son La province; Trung Ly, Tam Xuan and Muong Ly – Muong Lat; and Trung Son, Thanh Son – Quan Hoa district – Thanh Hoa province.

Public consultation with Commune People Committee and National Front Committee of all mentioned communes.

8.1. Public consultation

Public consultation was conducted as follow:

The project owner (Hydropower Project Management Board No. 2 – EVN) on June 18, 2007 sent official letters 636/CV-ATĐ2-P3; 637/CV-ATĐ2-P3; 638/CV-ATĐ2-P3; 639/CV-ATĐ2-P3; 640/CV-ATĐ2-P3; 641/CV-ATĐ2-P3; 642/CV-ATĐ2-P3; 643/CV-ATĐ2-P3; 644/CV-ATĐ2-P3 to Commune People Committee and National Front Committee of the communes sending the summary report of EIA (see in annex) and asking communes' comments for the report.

The communes responded in following letters:

+ Trung Sơn commune in the letters of June 21, 2007 with subject "Comments on EIA report of Trung Son hydropower project"

+ Muong Ly commune in the letters of June 26, 2007 with subject "Comments on EIA report of Trung Son hydropower project"

+ Trung Ly commune in the letters of June 27, 2007 with subject "Comments on EIA report of Trung Son hydropower project"

+ Tam Trung commune in the letters of June 29, 2007 with subject "Comments on EIA report of Trung Son hydropower project"

+ Xuan Nha commune in the letters of July 03, 2007 with subject "Comments on EIA report of Trung Son hydropower project"

+ Tan Xuan commune in the letters of July 02, 2007 with subject "Comments on EIA report of Trung Son hydropower project"

+ Van Mai commune in the letters of July 27, 2007 with subject "Comments on EIA report of Trung Son hydropower project"

+ Mai Hich commune in the letters of July 26, 2007 with subject "Comments on EIA report of Trung Son hydropower project"

+ Thanh Xuan commune in the letters of July 22, 2007 with subject "Comments on EIA report of Trung Son hydropower project"

Copies of the letters are in the annex of the report.

8.2. Feedbacks from the public consultation

8.2.1. Agreement feedback

8.1.1.1. F feedback from Commune People Committee

All Commune People Committee agreed as follow:

+ Agree with the project location and project design.

+ Agree with assessment on negative impact on environment and proposed mitigation measures.

+ Recommend the project owner to implement the mitigation measures and protect environment as requested by current regulation.

8.2.1.2. F feedback from National Front Committee

National Front Committee of all the communes agree with recommendation of Commune People Committee.

8.2.2. Non-agreement feedback

None

8.2.3. Other feedback

None

8.3. Response of project owner to recommendation of Commune People Committee and National Front Committee

The project owner committed to implement measures to protect environment as request by the current law and regulations.

1. Implement all mitigation measures to reduce negative impact on environment and surrounding communities as proposed in the EIA report.

2. Implement resettlement and provide support to affected people following current regulation of the Government.

3. Collaborate with local authorities in dealing with complain if any during the implementation of the project.

4. Implement measures according to other related regulations as mentioned in the EIA report.

CHAPTER 9: REFERENCE SOURCE AND DATA SOURCE OF SUPPLY AND ASSESSMENT METHOD

9.1. Data source

The report "Environment impact assessment on Trung Son HPP" in Investment project stage has made use of research result on environment factors of research and environment related units, EIA on Trung Son HPP prepared by PECC1 in April 2007. Survey and investigation data on the existing natural environment as well as socio-economic data of the proposed project area and entire basin area are used

9.1.1. Reference source and data

9.1.1.1. Reference source and data

The report "**Environment impact assessment on Trung Son HPP**" is prepared basing on the following documents and data:

- Annual statistic book 2005 of Quan Hoá, Mường Lát districts – Thanh Hoá province, Mai Châu district – Hoà Bình province, Mộc Châu district – Sơn La province.

- Report "Pù Luông natural conservation area – bio-diversity surveys for focus areas in order to reserve Pù Luông – Cúc Phương limestone mountain range" prepared by *the International organization for wild fauna and flora reservation* in 6 - 2005.

- "Investment project on Pù Luông natural conservation area – Thanh Hoá province" prepared by *Institute of forest survey and planning - Thanh Hoá people's committee* in 1998.

- "Supplemental investment project on Pù Hu natural conservation area – Thanh Hoá province" prepared by *management board of Pù Hu* natural conservation area in 5-2006.

- Xuân Nha, Pà Cò – Hang Kia natural conservation areas – Information on existing and proposed conservation areas of Viet Nam – International Birdlife Program and Institute of forest survey and planning prepared in 02/2001.

- Existing data, documents, special maps on environment of the project area stored at Institute of geology and environment, Institute of geography, Institute of ecology and biological resource

9.1.1.2. Assessment of reference source and data

The above mentioned source and data has been collected by Investor, consulting company of Investor during project implementation in office and at field. These are related to the project area researched and summarized by functional units so they are well reliable

The socio-economy is a changeable factor by time, thus the project implementation company has collect additional data and update according to implementation stages

9.1.2. Reference source and data of Investor and consultant

9.1.2.1. Reference source and data of Investor and consultant

- Main report on Trung Sơn HPP, Thanh Hoá province, basic design - Investment project stage prepared by PECC 4 in 2005.

- Environment impact assessment on Trung Son HPP prepared by PECC 4 in 7/2005.

- Survey report on impacts prepared by PECC 4 in 07/2005.

- Overall report on resettlement action plan prepared by PECC 4 in 12/2007.

- Report on flood Assessment report of flood control effectiveness at downstream for Bản Uôn Hydropower project prepared by Hà Nội water resource institute in 2007.

- The survey and investigation data on environment of the project area were obtained in 6 – 8/2007.

- The survey documents on topography, geology, hydrology and meteorology of Trung Son Hydropower project were prepared in Investment project stage PECC 4 in 2005

- The data on measurement and water sample analysis compiled by PECC 4 in coordination with Environment research and community development center in 9/2007

- Documents on socio-economic data, income were collected in 6 – 8/2007 by PECC 4

- Result of public consultation made by PECC 4 in 6 – 8/2007

- Reference to EIA for Hồi Xuân Hydropower project – made by PECC 4 in 09/2007

- General report on Trung Sơn HPP (Bản Uôn), component: construction and operation roads from Co Lương to Co Me bridge – Detail engineering design stage prepared by Transport engineering consulting joint stock company in 8/2006

9.1.2.2. Assessment of source and data of Investor

The document and data obtained by the Investor are mainly result of investigation, survey, measurement, testing, sampling at the project area and its vicinity subject to affection to serve compensation, allowance and resettlement – settled agriculture, EIA. These documents are updated according to project implementation stages so they are well reliable and most updated

9.2. Methods used in environment impact assessment

9.2.1. List of methods

The report "Environment impact assessment on Trung Son HPP" in Investment project stage has made use of research result on environment factors of research and environment related units. Survey and investigation data on the existing natural environment as well as socio-economic data of the proposed project area and entire basin area are used. Refer to research result for preparation of Environment impact assessment on Trung Son Hydropower project which is upper plant of Trung Son Hydropower project.

Table 9.1 : List of Environment Impact Assessment (EIA) method

No	Assessment methods	Method contents	Significant
1	*General method group (used in preparation of report)*		
1.1	*Statistics method*	Statistics data collected by locality (provincial, district, commune level), as well as studied document implemented from previous to now of related agencies in socio-economic natural environment are used.	Data on meteo-hydrologial conditions, socio-economy, and biological diversify, etc... at the project construction site and vicinity area are collected and handled.
1.2	*Investigation and survey*	Basing on available environmental document and	The latest data and document as well as

	method	data, investigation and survey are done at the project site.	environmental status investigation at the project site are updated and supplemented.
1.3	*Rapid assessment method*	Depending on experiences of experts in investigation and survey at the site, right at studied area.	Preliminary assessment of impact caused by project for some environmental factors such as: ecological environment, socio-economic environment,...
1.4	*Studied, analyzed method in laboratory*	Going to the site, sampling and analyzing in laboratory. Comparing analyzed results with Vietnamese standard to assess base environment.	Determine data on status of air, water quality, noisy at the project implementation site and surrounding.
2	*Group of method used to assess, forecast impacts*		
2.1	*Expert method*	Offering experts in environment fields: Meteorology – Hydrology – Oceabigraphy, Geography – Geology, Environment, Soil expert and landscape biology to participate in impact assessment caused by project.	Assessing impact caused by project in unprejudiced and deep way with high experience.
2.2	*Comparing method*	Studying environment changes at some hydropower and irrigation projects that are constructed and under construction and operation such as Son La, Hoa Binh, Thac Ba, Yaly, Song Hinh, Dau Tieng, Tri An HPPs,...	Forecast impacts possible to happen for factors: geology, climate, hydrology, water quality,... for project.
2.3	*Matrix method*	Making matrix of impacts, and giving point for impact to assess synthetic environmental impacts.	Prepare relationship between activities of project with environment impacts
2.4	*Public comment consultation*	Implement public consultation at communes in project areas	Collect comment of authorities and agencies (where the project implemented) on negative impact to environment caused by project and mitigation measure.
2.5	*Experimental method*	This is group of methods taken from experimental	Use experimental study results of local and foreign authors to serve forecast, assess impact caused by project

9.2.2. Assessment of method reliability

Most above mentioned methods are used in many projects for research, assessment and forecast on environment impact such as : Srêpok 3, Srêpok 4, Krông Hnăng, Buôn Tua Srah, Nho Quế 2, Hồi Xuân, La Ngâu Hydropower projects, etc. thus, it is reasonable to use them in research, assessment and forecast on environment impact and the forecast result is acceptable. Assessment reliability and forecast is presented in item 9.3

Among methods used for impact assessment and forecast (used in chapter 3), the expert method is mainly dependent on evaluator subjectiveness, other methods are almost experimental. Experimental methods used are:

1. Pollution factor

Dust, exhaust fumes, noise arising from mine explosion, vehicles, construction machines mainly in the construction time and almost insignificant in operation stage

At present there is survey on average exhaust fumes of vehicles and construction machines in the world. Specifically, fume discharge factor from vehicles of American environment protection company, World and Netherlands health organizations; fume discharge factor from machines during leveling, filling of soil and rock of American NATZ Transport. Dust arising from mine explosion; leveling, filling of soil and rock; vehicles and construction machines are taken from WB's guideline on environment impact assessment, guidelines of Phạm Ngọc Đăng and Netherlands. Noise arising from vehicles and construction machines are taken from documents of American FHA

These methods are used in many projects for polution forecast (exhaust fume, dust, noise) such as : Srêpok 3, Srêpok 4, Krông Hnăng, Buôn Tua Srah, Nho Quế 2, Hồi Xuân, La Ngâu Hydropower projects, An Hoà paper powder plant, Bãi Bằng paper expansion company, etc. It is therefore possible to use the above mentioned method for calculation

2. Noise spread

Noise spread method provided by U.S department of transportation (1972) were used in many projects for forecasting Noise spread such as: An Hoà paper powder plant, Bãi Bằng paper expansion company; Srêpôk 3, Krông Hnăng, Srêpok 4 Hydropower projects, etc.

According to this method, noise level is reversal to the distance to noise source; as such it is used for forecast the impact area of noise arising from project activities

3. Reservoir biomass calculation

The reservoir biomass is calculated by method for vertical trees of Doctor Trần Tý and biomass calculation method of Kato, Oga Wa

According to the survey, the reservoir of Trung Son HPP is mainly covered with planted forest (bamboos), bushes and crops

The vertical-tree biomass calculation method of Doctor Trần Tý allows calculation of biomass for inundation forest area in the reservoir

For agricultural cultivation area, use vertical-tree biomass calculation method of Kato, Oga Wa. Therefore, it is resonable to combine 2 methods for reservoir biomass calculation

4. Forecast of change in nutrition and organic substance in water in initial storage period

Forecast of oxygen content consumed due to organic substance disintegration progress submerged in the reservoir

The oxygen content consumed for organic substance disintegration progress (flora, organism found in the soil, creature dead body submerged in the reservoir, etc.) is forecasted by experimental formula of A.I. Denhinova, thus the application for conditions of Vietnam is forecast only

5. Forecast of reservoir bank sliding and regeneration

"Due to complexity and diversity of phenomena belonging to bank exploration and lack of direct observation data on dynamicology development of such phenomena, there have been no reliable forecast method for reservoir bank exploration so far. Up to now we have inadequate data on direct observation at permanent stations on bank exploration for reservoirs, as such there are no data for checking given methods" (V. Đ. Lômtadze – Structure dynamic geology – Project geology – Publishing house of University and Professional high school – Hà Nội, 1982). Therefore, the given methods are used in preliminary directional assumption on possible phenomenon scope

The method of Zôlôtarev is much used. This method is based on summation of documents on geology, geomorphy, hydrology ; it is applied for reservoirs both in plain and mountainous area and being one of the most promising method but it needs improvement for more reliable forecast

Therefore, to forecast Trung Sơn reservoir bank sliding, use bank exploration forecast method of reservoir of Zôlôtarev

Basing on the topographical and geological maps, geological cross-section of the reservoir prepared by PECC4, hydro-meteorological data, the scope and volume of bank sliding were obtained

The forecast result of reservoir bank sliding and regeneration is basis for proposing prevention and mitigation measures during operation stage of reservoir.

9.3. COMMENTS ON DETAILED LEVEL AND RELIABILITY OF ASSESSMENTS

9.3.1. General commence

- When implementing the project from the design stage, investigation and design processes have been done in compliance with present standards of Vietnam and internationally. Therefore optimum, cost safety options have been pointed out, mitigating maximum excavated volume of rock, soil and disposing into environment; also reducing number of people who have to replace, and also submerged land area at the reservoir and land to be occupied for the headwork of the project. Data on land and affected works are realizable.

- Collected data include of:

+ Materials on ecological environment, meteorology, hydrology, geology, topography which have been done by specialized experts at the area of the project. These data also have been analyzed and evaluated by various methods.

+ Data on quality of water and air: Collected data from mapping, collecting and analysing water and air samples at different places, have typical features for the project that following the present standard. These data have been applied to evaluate quality of pattern environment and forecasting change of environmental quality in the case of existence of the project. And they can be used as references for other projects.

- Data introduced to forecast of impacts during construction and operation processes of the project have been done by present Vietnamese standards.

- Experts involved in reporting of activity in various aspects, have taken part on assessment of environmental impacts of many projects such as : Buon Tua Srah, Krong Hnang, Srepok 4, Nho Que 1, Tr'Hy HPPs, 220kV Doc Soi - Quang Ngai , 500kV Quang Ninh - Mong Duong transmission line projects and in series of other HPPs and transmission line projects. Data, materials relating to report all have been analysed and evaluated properly by experts, concentrating on project area and main impacts as well as features for each project.

- Methods to evaluate environmental impacts resulting from the project, have been made in details through computed models of previous studies by domestic and international authors and have been applied in practice for many projects.

9.3.2. Risks on environmental problem when the project shall not be implemented and done

9.3.2.1. Assessment of risks when the project shall not be done

Presently our country is in the situation of lack of electric power. EVN has bought electric power from China with high price. Therefore, if the project is not existed, the natural resource for generating power shall be waste.

9.3.2.2. Assessment of ricks when the project shall be done

Labour safety: if safety method shall not be applied well, accident might be happened during construction time.

Blasting, fire safety: if procedures and regulation on blasting, transporting dynamite etc., shall not be done well, fire, blasts might be occured leading to casualties for human beings and also damages and loss in term of materials.

During operation period before discharging, if it's not well forecasted on hydrology, and not timely announced and well organised, it shall lead to negative affects to D/S of the powerhouse, in detail : it shall be a risk for human being, lossing assessts and works, projects on land, and land itself to produce subsidies of households.

9.3.3. Usage of results on assessment and proposal

Some results of forecast and conclusions received from modelised method are still suffered from affect of factors which might be changed during later operation process. Therefore, when applied forecasted results, it should be adapted during management and supervision of mitigated methods to be suitable.

- *Sliding, re-embankment of reservoir slopes and reservoir settlement:*

Impacts due to slides, reclaimation of reservoir slopes and reservoir settlement depend on quantity of mud, silt from dissolved erosion following the flow (bed load, suspended load) and quantity of mud, silt from sliding, reembankment of reservoir slopes. The volume of mud, silt from slides, reservoir slope re-embankment has been forecasted based on geological and hydrological sections, suspended load is forecasted based on gauging results of hydrology.

- *Changing of aquatic ecological system at the reservoir area:*

Presently, there're only some projects have studieds and monitorings of ecology of hydropower reservoir during operation time. They are : Hoa Binh HPP, Thac Ba reservoir etc.,. Changes of aquatic ecology at the reservoir area have been forecasted based on monitoring results of these reservoirs.

- *Thermal regime, mineral level, nutriment of reservoir:*

Thermal regime, mineral level, nutriment of the reservoir are forecasted based on monitoring results on environmental control of reservoirs that in opeartion such as : reservoirs of Dau Tieng, Tri An, Hinh river etc., . At present, many HPPs also base on monitoring results of these reservoir to forecast thermal regime, mineral level, nutriment of reservoir such as : Srepok 3, Krong Hnang, Buon Tua Srah, Buon Kuop, etc

CONCLUSIONS AND RECOMMENDATIONS

I. CONCLUSIONS

After studying the assessment of impacts to the projects to environmental factors, conclusions have been made as below:

1. Trung Son HPP, located at U/S of Ma river, is the upper cascade of the Hoi Xuan HPP, with reservoir capacity in corresponded with FSL of 16m is 384.53 x $10^6 m^3$, installed capacity of 260MW. The project is aimed at supplying and connecting to National and local Grid with annual energy output of 1029.47 x 10^6 kWh.

2. During the time of prepartion, construction as well as operation of the project , the Trung Son HPP shall cause some impacts to environments, both natural and social economics at the region. These impacts are included of positives and negative ones.

Negative impacts include of:

- Taking land that causing damage in land, properties, architectural works and land usage: when the project is developed, about 1538,95 ha of lands at all types shall be taken for the project layout, reservoir area, resettlement area and the area for buiding the Co Me-Co Luong construction system road shall case damage on land and properties on land, affecting to imcomes of local people. Loss assests, land shall be compensated and supported in accordance with regulation and following wish of people, with taking reference from local authority and representatives of affected people.

All items of property of households, individual that be damanged, if not be invested for constructing at the Resettlement area, then shall be compensated by cash. For produced land, compensated cost shall be calculated the deviation value after having deduct cost for creating land budget such as: fee for purchasing land, improvement for building fields, investing for irrigation etc.,.

Regarding to infrastructural works such as : school, housing, office building, etc., they shall be new built at the resettlement area. Works of traffic road shall not calculate regarding to loss but shall be invested newly or upgraded, improved to assure normal operation for local people.

- Life of local people at the project area shall be disordered during construction time:

At the investigated time (in 2005) : there were 423 households at the reservoir area that be affected both house and produced land, 75 households are affected their produced land, they are Thai, Mong people that be affected so that have to remove. Counting to the year of completion of resettlement (in 2011), proposed that number of households must be resettled is 526 households of which 20 ones are voluntary move, 507 households have concentrated resettlement.

This is a remarkable impact of the project to social economic environment, relating to people policy of the State. Thefore, elaboration of a detailed compensated, resettlement plan and implemented it properly shall create conditions for people to develop production, improving life and stablizing their lives early.

- Regarding to flora, fauna, ecological environment and function of forest:

+ Concentration of many construction workers and free imigrants shall not only cause disorder, making more complicated of cultural-social live and safety at the locality, but also

might impact badly to forest natural resources, and ecological environment surorunding the project area. It also affects to reservation, protection functions of the forest due to deforested activity for creating slope land field, exploring forest products, hunting animals illegally, especially to the Xuan Nha and Pu Hu natural reserves.

+ Among retaken land area for project construction, there're 603.4ha located within the scope of the Xuan Nha natural reserve, belonging to splitted zone of ecological recovery region, affecting to preserved function. However, the land taken area of the natural reserve is mainly of planted forest land (among 603.4 ha, only 367.26 ha of land having forest, including of 5.3 ha of natural forest and 361.96 ha of planted forest), agricultural land belongs to villages of East Ta Lao and West Ta Lao therefore the impacts have been reduced remarkably.

Generally, components of species, biological diversity of vegetation layer at the project area are not high. Among the submerged area, only 2 valuable & rare plants are textured wood (lat hoa) and china-root which are species having widely ecological range (large distributed scope, distributing also at the area that not be flooded) therefore impacts are evaluated not high. Howver, to mitigate impact to ecological environment, recovering consequences due to loss of vegetation, it has been recommended to afforest to supplement forest area that be taken for special use. It's absolutely not allow to develop, taking used advantage beyond the taken area for the project, particularly to Xuan Nha and Pu Hu natural reserves.

+ As ditributed closely to the project area, hence noises have big impact to wide animals living at surrounded natural resevers and forest floors, particularly to the Xuan Nha natural reserve. Animals shall remove further from the project area, up to high mountainous area where are quiet for living.

With above mentioned mitigated methods, the impacted level shall be reduced very much. These impacts shall be recovered after stability of resettlement and completion of the construction period of the project.

- To meet construction demand of the project, a large quantity of means of transport shall be mobilised to the site. Presently, traffic road routines at the region are almost of earth made road, equipment, loaded devices serving at the site almost have large load weight therefore shall cause settlement and failures of road foundation, resulting to increasement of muddy level during wet season that affecting to traffic of local people.

To meet requirement of project construction, the Co Me-Co Luong road routine connected with National Road No QL15A shall be upgraded. This is the solely routine connecting clearly with National Road No QL15A. Consequently, during construction time, besides requirement of safety, healthy for people and means of transport, it's also required to assure the circulation of the rountine. Detailed mitigated methods shall be mentioned in Chapter 4. Background environment shall be impacted during construction time: construction activities shall produce exhausted fumes, noiseness, household waste water, disposal oil, gasoline, disposal rock, soil and household rubbish. However, onces mitigated methods are apllied correctly, impacted level shall be reduced very much, then the impacts are just locally, occuring mainly at the project area, resettlement area, quarry areas and at the area of road rountine for construction and operation of Co Me – Co Luong. From that, impact shall be evaluated at the unlarged level.

- Particularly, water quality has been changed in negative way during the beginning time of impoundment due to disintegration of mass livings. This is inevitable impact when constructing any projects. Present situation of vegetation at the reservoir area are mainly of agricultural cultivated plants: paddy rice, subsidies; planted forest, and a small area of natural poor forest. Of which agricultural plants, planted forest (bamboo, textured wood, bead tree) have

been taken in advantage by people before impoundment therefore the volume of mass livings at the reservoir area is small. Calculated results shown that it's necessary only to take advantage of forest trees before impoundment of the reservoir.

- According to calculation, with the volume of silt load transferring into the reservoir by flow and silt coming from slope erosion, it occupies only about 62.53% dead capacity of the reservoir so that not impact to life-time of the project.

- Silt load volume discharging to D/S occupies only about 20% total quantity of silt load coming to the reservoir, that resulting in increasement of possibility of carrying mud, silt of water. In addition, the power plant shall generate in accordance with load chart during dry season (generating at peak time) therefore deviation water level within a day is high, hence slope and bottom erosion at the D/S area is large. However, to confine minimum damages from slope erosion, it's recommended to the Owner for strictly supervising slope ersion as well as banks of the Ma river at the project area.

Negative impacts are mainly occured at the area where constructing the project and happen during prepartion and construction time, that prolonging nearly 4 to 5 years.

Positive impacts comprise of:

- When the project is constructed, annually an average energy output of 1044.12 x 10^6 kWh shall be generated and connected to the National Grid.

- Increasing budget to the locality from tax of the power plant, increasing investment fund for other aspects.

- At the beginning of impoundment, ecological system of the new reservoir in accompanied with aquatic creature system that featurelised for this aquatic species shall be formed. Aquatic living system in the reservoir shall have change in term of species component as well as quantity, appearance of some new species due to breeding activity of human right.

- Water, land environment surrounding the reservoir shall be improved. In accompany with Hoi Xuan reservoir, climatic condition of the whole large area shall be improved. Climatic conditions at the areas surrounding the reservoir shall be more moderate, this shall result in improvement of ecology in positive way.

- Partly replacement of people among population at the Xuan Nha natural reserve, according to the Report of the Resettlement Plan to beyond the strictly protected area, shall also contribute to confine hunting and protecting valuable and rare animals in the natural reserve.

- Regarding to social economic environment: the Trung Son HPP, being constructed, shall change the face of the area in both infrastructure and economic industries.

Landscape of the reservoir that be formed, climatic conditions be improved, that good for health of local people, shall be a background to develop tourist-service industry and the fishery at the reservoir.

Traffic system,s some infrastructures at the region are improved. In accompany with power source be supplied that affirm to encourage for development of industry, handy craff, agricultural industries at the region, then drawing more people coming from other places to live there.

Construction of a reservoir shall contribute to supplement water source for irrigation and for household usage for people living surrounding the reservoir, particularly during dry, drough season.

The resevoir has flood controlled capacity of 112 millions m^3. Comparing with other projects on Ma river, this figure of flood controll of Trung Son is not large but this is a remarkable contribution of the Trung Son project to control the flood at D/S, reducing pressure to the dyke system of the region. In addition, Trung Son also contributes remarkably to the work of anti-salty at D/S.

These positive impacts have fairly wide affected. They are not only within the project area and at D/S but also to economy of the whole region and whole country during the whole procedure of long term development.

3. After carrying out evaluation and forecast environmental impacts, when developing for construction of the Trung Son HPP, it's found that negative impacts are fairly large, but positive impacts are still predominated compared with negative impacts. This is a project with synthesized benefits, in one hand affirming social benefit, on the other hand affirming economic benefit (affirming source of income in term of electric power).

4. Methods to mitigate impacts, committing on implementation mitigated methods and program of environmental monitor recommended that mentioned on Chapters 4, 5, 6, 7 shall be combined by the Owner with construction contractors, local authority and relevant agencies, and authorised agencies to implement thoroughly according to specified law.

5. *In brief*, it's found that if mitigated methods of negative impacts and management program, supervision program that be set up, are well conducted, then positive impacts that benefited from the project to natural environment as well as social economic environment shall be at high level, on large, wide scale and prolonged. On the other hand, on point of view of harmony combination between environmental protection and essential demand on power energy for production and livelihood of local people, as well as construction and development cause of the state economy, construction of Trung Son HPP is appropriate.

6. Issues of negative impacts that have no mitigated method due to exceeding allowable capability of the Owner:

- Noiseness of construction equipment, device, and blastings at the area of the project layout, at the rock quarry area during construction stage.

- Population management at the construction site during construction time.

- Decrease of silt load at D/S of the power plant.

- Aquatic, fishery changing from natural flow system to reservoir ecology.

II. RECOMMENDATIONS

It's recommended the Ministry of Natural Resources & Environment paid attention and help for early organization of reviewing and approving the EIA report of the project so that the Owner can develop sucessive steps of the project to meet the scheduled program.

Local authority: It's recommended Thanh Hoa, Son La provinces and communes, districts at the project area and relevant agencies to pay attention to and support the constractor in term of managing population.

Local authority also pays attention to and create condition for the Owner to conduct well program of compensation & supporting to resettlement so that project affected households shall stablize their lives early.

APPENDIX

Appendix 1: Decisions, Official letters, and relevant Working Minutes

- Decision No 907/QĐ-EVN-HĐQT of EVN dated 02/11/2007 referring to establishment of the Trung Son HPP Management Board.

- Official Letter No 865/TTg-CN dated 28/06/2005 of the Govermental Prime Minister on "*Report of Pre-FS stage of Ban Uon Hydropower Project-Thanh Hoa province*".

- Decision No 1195/QĐ-NLDK of Ministry of Industry on approval of the Plan of hydropower cascade on Ma river on 31st March 2005.

- Official Letter No 1808/QP ngày 26/04/2004 of Ministry of National Defence on "*comment on water level of the reservoir of Ban Uon hydropower project in Thanh Hoa province".*

- Official Letter No 3455/BTNMT-TĐ dated 16/08/2006 of Ministry of Natural Resources and Environment on "*comments for Ban Uon HPP*".

- Official Letter No 1680/BXD-XL dated 18/08/2006 of Ministry of Construction on "*giving permisison for investment on construction of Ban Uon HPP*".

- Official Letter No 6292/BKH-KTCN dated 24/08/2006 of Ministry of Plan and Investment on "*comments on Feasibility Study of Ban Uon HPP*".

- Official Letter No 611/UBND ngày 08/04/2006 of the People's Committee of Son La province on "*tham gia Feasibility Study of Trung Son HPP*".

- Official Letter No 3728/UBND-CN dated 06/09/2006 của People's Committee of Thanh Hoa province on "*giving comments on Ban Uon -Thanh Hoa HPP*".

- Official Letter No 1427/UBND-CN dated 14/04/2006 of the People's Committee of Thanh Hoa province on "*Feasibility Study of Trung Son –Thanh Hoa HPP*".

- Official Letter No 185/UBND-VP dated 27/06/2007 of the People's Committee of Quan Hoa district on "*agreement on master plan of replacement, resettlement and compensation for resettlement of Trung Son HPP*".

- Working Minutes on dated 23/06/2005 between representatives of Management Board of Xuan Nha Natural Reserve and representative of PECC4 on defining impacts of the Trung Son hydro power project to the Xuan Nha natural Reserve.

- Meeting Minutes dated 23/06/2007 between representatives of thePeople's Committee of Quan Hoa district - Thanh Hoa province, and representatives of PMU 2, PECC4, Istitute of Agriculture Plan and Design on "*General plan on replacement, resettlement, and Compensation Framwork for resettlement of Trung Son HPP".*

- Meeting Minutes dated 28/06/2007 between representatives of the People's Committee of Muong Lat district - Thanh Hoa province with representatives of PECC4, Institute of Agriculture Plan and Design on "*General plan on replacement, resettlement, and Compensation Framwork for resettlement of Trung Son HPP".*

- Anouncement No 79/TB-UBND dated 10/07/2007 of the People's Committee of Moc Chau district - Son La province on "*comment of Mr. Tran Thanh Hai – Vice Chairman of the People's Committee of the district at the meeting with PMU 2 on taking part on*

giving comment of cons truction of the Framework for compensation and support for resettlement and general plan for movement and resettlement of Trung Son HPP".

- Official Letter dated 21/06/2007 of the People's Committee and Committee of Fatherland Frontial of Trung Son commune on "*Giving comments on the report of Environmental Impact Assessment of Trung Son HPP*".

+ Official Letter dated 26/06/2007 of the People's Committee and Committee of Fatherland Frontial of Muong Ly commune on "*Giving comments on the report of Environmental Impact Assessment of Trung Son HPP*".

+ Official Letter dated 27/06/2007 of the People's Committee and Committee of Fatherland Frontial Trung Lý commune "*Giving comments on the report of Environmental Impact Assessment of Trung Son HPPe*".

+ Official Letter dated 29/06/2007 of the People's Committee and Committee of Fatherland Frontial of Tam Trung commune on "*Giving comments on the report of Environmental Impact Assessment of Trung Son HPP*".

+ Official Letter dated 03/07/2007 of the People's Committee and Committee of Fatherland Frontial of Xuan Nha commune on "*Giving comments on the report of Environmental Impact Assessment of Trung Son HPP*".

+ Official Letter dated 02/07/2007 of the People's Committee and Committee of Fatherland Frontial of Tan Xuan commune on "*Giving comments on the report of Environmental Impact Assessment of Trung Son HPP*".

+ Official Letter dated 27/07/2007 of the People's Committee and Committee of Fatherland Frontial of Van Mai commune on "*Giving comments on the report of Environmental Impact Assessment of Trung Son HPP*".

+ Official Letter dated 26/07/2007 of the People's Committee and Committee of Fatherland Frontial of Mai Hich commune on "*Giving comments on the report of Environmental Impact Assessment of Trung Son HPP*".

+ Official Letter dated 22/06/2007 of the People's Committee and Committee of Fatherland Frontial of Thanh Son commune on "*Giving comments on the report of Environmental Impact Assessment of Trung Son HPP*".

- Statement No.613/BNN-TL dated 13/03/2008 of Ministry of Argricultural and rural Development on Food Prevention Capacity – Trung Son Hydropoweer – Thanh Hoa Province.

ANALYTICAL RESULT NOTE

Sample No. 05/CLKK

1	Samples (KTS1)	Test the quality of air
2	Place where samples are collected	Chieng Nua village
3	Analytical method	Direct measure and analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	**Indicators**	**Unit**	**Monitoring result**	**TCVN 5937- 2005**
1	Hanging dust	mg/m^3	0.097	0.20
2	MP Dust 10	mg/m^3	0.070	0.15
3	Pb Dust	mg/m^3	0.00068	0.0015
4	NO2	mg/m^3	0.002121	0.20
5	CO	mg/m^3	0.298948	30
6	SO2	mg/m^3	0.011156	0.35
7	Noise	dBA	29.8	75 (TCVN 5949-1998)

Notes:

- TCVN 5937 -2005: Quality standard for surrounding air
- TCVN 5949 – 1998: Noise standard in public area and community

Date: ……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTES

Sample No. 06/CLKK

1	Samples (KTS2)	Test the quality of air
2	Place where samples are collected	Co Me village – Trung Son
3	Analytical method	Direct measure and analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	**Indicators**	**Unit**	**Monitoring result**	**TCVN 5937- 2005**
1	Hanging dust	mg/m^3	0.088	0.20
2	MP Dust 10	mg/m^3	0.061	0.15
3	Pb Dust	mg/m^3	0.00062	0.0015
4	NO2	mg/m^3	0.001937	0.20
5	CO	mg/m^3	0.363936	30
6	SO2	mg/m^3	0.010527	0.35
7	Noise	dBA	30.4	75 (TCVN 5949-1998)

Notes:

- TCVN 5937 -2005: Quality standard for surrounding air
- TCVN 5949 – 1998: Noise standard in public area and community

Date…….2007

Representative of Analytical Team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTES

Sample No. 07/CLKK

1	Samples (KTS3)	Test the quality of air
2	Place where samples are collected	Tao (Trung Son Secondary School) – Trung Son
3	Analytical method	Direct measure and analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	**Indicators**	**Unit**	**Monitoring result**	**TCVN 5937- 2005**
1	Hanging dust	mg/m^3	0.114	0.20
2	MP Dust 10	mg/m^3	0.083	0.15
3	Pb Dust	mg/m^3	0.00091	0.0015
4	NO2	mg/m^3	0.001895	0.20
5	CO	mg/m^3	0.489310	30
6	SO2	mg/m^3	0.010678	0.35
7	Noise	dBA	45.9	75 (TCVN 5949-1998)

Notes:

- TCVN 5937 -2005: Quality standard for surrounding air
- TCVN 5949 – 1998: Noise standard in public area and community

Date…….2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 08/CLKK

1	Samples (KTS4)	Test the quality of air
2	Place where samples are collected	Near Chieng Bridge
3	Analytical method	Direct measure and analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	**Indicators**	**Unit**	**Monitoring result**	**TCVN 5937- 2005**
1	Hanging dust	mg/m^3	0.120	0.20
2	MP Dust 10	mg/m^3	0.098	0.15
3	Pb Dust	mg/m^3	0.00087	0.0015
4	NO2	mg/m^3	0.002400	0.20
5	CO	mg/m^3	0.560070	30
6	SO2	mg/m^3	0.012138	0.35
7	Noise	dBA	39.5	75 (TCVN 5949-1998)

Notes:

- TCVN 5937 -2005: Quality standard for surrounding air
- TCVN 5949 – 1998: Noise standard in public area and community

Date……2007

Representative of Analytical **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 09/CLKK

1	Samples (KTS5)	Test the quality of air
2	Place where samples are collected	Co Luong Village – Van Mai Commune –Mai Chau District
3	Analytical method	Direct measure and analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	**Indicators**	**Unit**	**Monitoring result**	**TCVN 5937- 2005**
1	Hanging dust	mg/m^3	0.138	0.20
2	MP Dust 10	mg/m^3	0.100	0.15
3	Pb Dust	mg/m^3	0.00091	0.0015
4	NO2	mg/m^3	0.003828	0.20
5	CO	mg/m^3	2.588459	30
6	SO2	mg/m^3	0.017143	0.35
7	Noise	dBA	59,0	75 (TCVN 5949-1998)

Notes:

- TCVN 5937 -2005: Quality standard for surrounding air
- TCVN 5949 – 1998: Noise standard in public area and community

Date……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 04/CLNM

1	Samples (KTS1)	Test the quality of surface water
2	Place where samples are collected	Next to Lat Village's bridge
3	Analytical method	Analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	Indicators	Unit	Analytical result	TCVN 5942 - 1995	
				Column A	Column B
1	pH	-	7.32	6-8.5	5.5 -9
2	BOD_5	mg/l	4.9	<4	<25
3	Colour	(Pt-Co)	76.211	-	-
4	Smell	-	No smell	-	-
5	Taste	-	No taste	-	-
6	COD	mg/l	8	<10	<35
7	DO	mg/l	6.43	>/ 6	>/2
8	Hanging solid substance	mg/l	197	20	80
9	Fe^{2+}	mg/l	0.124	1	2
10	Fe^{3+}	mg/l	0.020	1	2
11	NH_3	mg/l	0.678	0.05	1
12	NO_3^-	mg/l	2.079	10	15
13	NO_2^-	mg/l	< 0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0. 285	-	-
15	Total mineral level	mg/l	80	-	-
16	Coliform	MNP/100ml	290	5000	10000

Note: TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

Date……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 05/CLNM

1	Samples (KTS2)	Test the quality of surface water
2	Place where samples are collected	100m far from Lat river – Muong Lat
3	Analytical method	Analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	Indicators	Unit	Analytical result	TCVN 5942 - 1995	
				Column A	Column B
1	pH	-	7.36	6-8.5	5.5 -9
2	BOD_5	mg/l	4.9	<4	<25
3	Colour	(Pt-Co)	68.471	-	-
4	Smell	-	No smell	-	-
5	Taste	-	No taste	-	-
6	COD	mg/l	9	<10	<35
7	DO	mg/l	6.51	>/ 6	>/2
8	Hanging solid substance	mg/l	189	20	80
9	Fe^{2+}	mg/l	0.122	1	2
10	Fe^{3+}	mg/l	0.021	1	2
11	NH_3	mg/l	0.725	0.05	1
12	NO_3^-	mg/l	3.011	10	15
13	NO_2^-	mg/l	< 0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0. 287	-	-
15	Total mineral level	mg/l	86	-	-
16	Coliform	MNP/100ml	290	5000	10000

Note: TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

Date……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 06/CLNM

1	Samples (KTS3)	Test the quality of surface water
2	Place where samples are collected	100m far from Cha Lan river downstream
3	Analytical method	Analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	Indicators	Unit	Analytical result	TCVN 5942 - 1995	
				Column A	Column B
1	pH	-	7.35	6-8.5	5.5 -9
2	BOD_5	mg/l	5.1	<4	<25
3	Colour	(Pt-Co)	62.047	-	-
4	Smell	-	No smell	-	-
5	Taste	-	No taste	-	-
6	COD	mg/l	9	<10	<35
7	DO	mg/l	6.59	>/ 6	>/2
8	Hanging solid substance	mg/l	152	20	80
9	Fe^{2+}	mg/l	0.010	1	2
10	Fe^{3+}	mg/l	0.018	1	2
11	NH_3	mg/l	0.790	0.05	1
12	NO_3^-	mg/l	2.246	10	15
13	NO_2^-	mg/l	< 0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0. 126	-	-
15	Total mineral level	mg/l	82	-	-
16	Coliform	MNP/100ml	230	5000	10000

Note: TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

Date……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 07/CLNM

1	Samples (KTS4)	Test the quality of surface water
2	Place where samples are collected	Chieng Nua Village
3	Analytical method	Analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	Indicators	Unit	Analytical result	TCVN 5942 - 1995	
				Column A	Column B
1	pH	-	7.66	6-8.5	5.5 -9
2	BOD_5	mg/l	5.3	<4	<25
3	Colour	(Pt-Co)	62.296	-	-
4	Smell	-	No smell	-	-
5	Taste	-	No taste	-	-
6	COD	mg/l	8	<10	<35
7	DO	mg/l	6.79	>/ 6	>/2
8	Hanging solid substance	mg/l	180	20	80
9	Fe^{2+}	mg/l	0.012	1	2
10	Fe^{3+}	mg/l	0.021	1	2
11	NH_3	mg/l	0.796	0.05	1
12	NO_3^-	mg/l	2.325	10	15
13	NO_2^-	mg/l	< 0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0. 132	-	-
15	Total mineral level	mg/l	86	-	-
16	Coliform	MNP/100ml	240	5000	10000

Note: TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

Date……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 08/CLNM

1	Samples (KTS5)	Test the quality of surface water
2	Place where samples are collected	Quanh River – Ta Ban Village
3	Analytical method	Analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	Indicators	Unit	Analytical result	TCVN 5942 - 1995	
				Column A	Column B
1	pH	-	7.48	6-8.5	5.5 -9
2	BOD_5	mg/l	5.4	<4	<25
3	Colour	(Pt-Co)	66.490	-	-
4	Smell	-	No smell	-	-
5	Taste	-	No taste	-	-
6	COD	mg/l	8	<10	<35
7	DO	mg/l	6.73	>/ 6	>/2
8	Hanging solid substance	mg/l	160	20	80
9	Fe^{2+}	mg/l	0.017	1	2
10	Fe^{3+}	mg/l	0.022	1	2
11	NH_3	mg/l	0.811	0.05	1
12	NO_3^-	mg/l	2.405	10	15
13	NO_2^-	mg/l	< 0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0. 139	-	-
15	Total mineral level	mg/l	88	-	-
16	Coliform	MNP/100ml	250	5000	10000

Note: TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

Date……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 09/CLNM

1	Samples (KTS6)	Test the quality of surface water
2	Place where samples are collected	Trung Son Commune
3	Analytical method	Analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	Indicators	Unit	Analytical result	TCVN 5942 - 1995	
				Column A	Column B
1	pH	-	7.50	6-8.5	5.5 -9
2	BOD_5	mg/l	5.2	<4	<25
3	Colour	(Pt-Co)	59.754	-	-
4	Smell	-	No smell	-	-
5	Taste	-	No taste	-	-
6	COD	mg/l	9	<10	<35
7	DO	mg/l	6.51	>/ 6	>/2
8	Hanging solid substance	mg/l	178	20	80
9	Fe^{2+}	mg/l	0.029	1	2
10	Fe^{3+}	mg/l	0.025	1	2
11	NH_3	mg/l	0.860	0.05	1
12	NO_3^-	mg/l	3.034	10	15
13	NO_2^-	mg/l	< 0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0. 152	-	-
15	Total mineral level	mg/l	98	-	-
16	Coliform	MNP/100ml	300	5000	10000

Note: TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

Date……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 10/CLNM

1	Samples (KTS7)	Test the quality of surface water
2	Place where samples are collected	Centre of Ron Village and Choi village
3	Analytical method	Analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	Indicators	Unit	Analytical result	TCVN 5942 - 1995	
				Column A	Column B
1	pH	-	7.68	6-8.5	5.5 -9
2	BOD_5	mg/l	5.5	<4	<25
3	Colour	(Pt-Co)	43.218	-	-
4	Smell	-	No smell	-	-
5	Taste	-	No taste	-	-
6	COD	mg/l	10	<10	<35
7	DO	mg/l	6.51	>/ 6	>/2
8	Hanging solid substance	mg/l	165	20	80
9	Fe^{2+}	mg/l	0.016	1	2
10	Fe^{3+}	mg/l	0.020	1	2
11	NH_3	mg/l	0.823	0.05	1
12	NO_3^-	mg/l	2.487	10	15
13	NO_2^-	mg/l	< 0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0. 143	-	-
15	Total mineral level	mg/l	92	-	-
16	Coliform	MNP/100ml	280	5000	10000

Note: TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

Date……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 11/CLNM

1	Samples (KTS8)	Test the quality of surface water
2	Place where samples are collected	Chieng Nua Village
3	Analytical method	Analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	Indicators	Unit	Analytical result	TCVN 5942 - 1995	
				Column A	Column B
1	pH	-	7.41	6-8.5	5.5 -9
2	BOD_5	mg/l	6.0	<4	<25
3	Colour	(Pt-Co)	30.769	-	-
4	Smell	-	No smell	-	-
5	Taste	-	No taste	-	-
6	COD	mg/l	10	<10	<35
7	DO	mg/l	6.44	>/ 6	>/2
8	Hanging solid substance	mg/l	140	20	80
9	Fe^{2+}	mg/l	0.015	1	2
10	Fe^{3+}	mg/l	0.023	1	2
11	NH_3	mg/l	0.785	0.05	1
12	NO_3^-	mg/l	3.322	10	15
13	NO_2^-	mg/l	< 0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0. 738	-	-
15	Total mineral level	mg/l	177	-	-
16	Coliform	MNP/100ml	320	5000	10000

***Note**:* TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

Date……2007

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Tong Thanh Ha **Nguyen Tri Tham**

ANALYTICAL RESULT NOTE

Sample No. 12/CLNM

1	Samples (KTS9)	Test the quality of surface water
2	Place where samples are collected	Ma river – Co Luong
3	Analytical method	Analytical sample collecting
4	Date of sample collecting	31/08/2007
5	Date of Analysis	01/9 -5/09/2007

No	Indicators	Unit	Analytical result	TCVN 5942 - 1995	
				Column A	Column B
1	pH	-	8.12	6-8.5	5.5 -9
2	BOD_5	mg/l	5.6	<4	<25
3	Colour	(Pt-Co)	45.041	-	-
4	Smell	-	No smell	-	-
5	Taste	-	No taste	-	-
6	COD	mg/l	9	<10	<35
7	DO	mg/l	6.83	>/ 6	>/2
8	Hanging solid substance	mg/l	196	20	80
9	Fe^{2+}	mg/l	0.111	1	2
10	Fe^{3+}	mg/l	0.027	1	2
11	NH_3	mg/l	0.925	0.05	1
12	NO_3^-	mg/l	4.065	10	15
13	NO_2^-	mg/l	< 0.001	0.01	0.05
14	PO_4^{3-}	mg/l	0. 174	-	-
15	Total mineral level	mg/l	95	-	-
16	Coliform	MNP/100ml	360	5000	10000

***Note**:* TCVN5942-1995: Quality standard for surface water: Volume A is applied to water sources which can be used for residential water uses (but require to be treated as regulations). Volume B is applied to surface water using for other purposes.

Date……2007

Representative of Analytical team **Director**

Tong Thanh Ha **Nguyen Tri Tham**