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FOREWORDS

1. OVERALL OF TRUNG SON HYDROPOWER PROJECT

Trung Son hydropower project is located in Ma river hydropower cascade system, the basin area up to the project is \( F = 13175 \text{km}^2 \). The project is located in Quan Hoa, Muong Lat districts of Thanh Hoa province and Moc Chau district of Son La province. The installed capacity of Trung Son hydropower project (Trung Son HPP) of 250 MW would be transmitted to the National Grid with \( E_0 = 1,055.03 \text{ million kWh} \) and help preventing flood for the downstream with the flood prevention capacity of \( 150 \times 10^6 \text{ m}^3 \) in which the regular flood storage is 112 million m\(^3\). Moreover, the project would help to regulate water, increase supply capacity in dry season for the dam upstream and downstream.

The reservoir and headwork area of Trung Son hydropower project co-ordinates at \( X=2279739 \) and \( Y=482791 \) (Vietnam coordinate 2000). At \( FSL = 160 \text{m} \), the reservoir surface area would be 13.13km\(^2\); storage \( W= 348.53 \times 10^6 \text{ m}^3 \). It is an annual regulating reservoir which supplies water for Trung Son HPP.

The back water level corresponding to flood peak discharge \( P=1\% \) (\( Q=9,100 \text{m}^3/\text{s} \)) would inundate approximately 1,538.95 ha land of all types. There would be impacts on structures, associated assets on land and arable land of 507 households, of which 432/2353 PAH/individual are subject to impact on houses and arable land, 75 households are subject to impact on arable land only.

2. PROJECT SALIENT FEATURES (REFER TO TABLE 1).

Table 1 – Main parameters of Trung Son hydropower project

<table>
<thead>
<tr>
<th>No</th>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Basin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Basin area ( F )</td>
<td>Km(^2)</td>
<td>13175</td>
</tr>
<tr>
<td>2</td>
<td>Average rainfall in many years ( X )</td>
<td>mm</td>
<td>1420</td>
</tr>
<tr>
<td>3</td>
<td>Annually average rainfall ( Q )</td>
<td>m(^3/\text{s})</td>
<td>243.7</td>
</tr>
<tr>
<td>4</td>
<td>Annually total flow ( W )</td>
<td>(10^6\text{ m}^3)</td>
<td>7695</td>
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<tr>
<td>II</td>
<td>Reservoir</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Full Supply Level (FSL)</td>
<td>m</td>
<td>160</td>
</tr>
<tr>
<td>2</td>
<td>Minimum Operating Level (MOL)</td>
<td>m</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>Waiting Flood Level</td>
<td>m</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>Flood prevention storage ( W_f )</td>
<td>(10^3\text{ m}^3)</td>
<td>112.00</td>
</tr>
<tr>
<td>5</td>
<td>Storage corresponding to FSL ( W_{fk} )</td>
<td>(10^3\text{ m}^3)</td>
<td>348.53</td>
</tr>
<tr>
<td>6</td>
<td>Active storage ( W_a )</td>
<td>(10^3\text{ m}^3)</td>
<td>112.13</td>
</tr>
<tr>
<td>7</td>
<td>Minimum storage ( W_c )</td>
<td>(10^3\text{ m}^3)</td>
<td>236.40</td>
</tr>
<tr>
<td>4</td>
<td>Area corresponding to FSL</td>
<td>km(^2)</td>
<td>13.13</td>
</tr>
<tr>
<td>III</td>
<td>Discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dam crest discharge corresponding frequency</td>
<td>(m^3/\text{s})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- ( P= 0.5% )</td>
<td>(m^3/\text{s})</td>
<td>10400</td>
</tr>
<tr>
<td></td>
<td>- ( P= 0.1% )</td>
<td>(m^3/\text{s})</td>
<td>13400</td>
</tr>
<tr>
<td></td>
<td>- ( P= 1% )</td>
<td>(m^3/\text{s})</td>
<td>9100</td>
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### IV Main dam

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<tr>
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<tr>
<td>1</td>
<td>Dam elevation m</td>
<td>163.7</td>
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<tr>
<td>2</td>
<td>Length of dam crest L_d m</td>
<td>353</td>
</tr>
<tr>
<td>3</td>
<td>Maximum dam height m</td>
<td>88</td>
</tr>
<tr>
<td>4</td>
<td>Width of dam crest b m</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Upstream slope m= 0; 0.4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Downstream slope m= 0.4; 0.8</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Dam type Rolled compact concrete</td>
<td></td>
</tr>
</tbody>
</table>

### VI Spillway

<p>| | | |</p>
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<tr>
<td>1</td>
<td>Spilling sill elevation m</td>
<td>145</td>
</tr>
<tr>
<td>2</td>
<td>Number of spilling chambers</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Spilling span BxH m</td>
<td>14X15</td>
</tr>
<tr>
<td>4</td>
<td>Dimension of radial gate BxH m</td>
<td>14X15.5</td>
</tr>
<tr>
<td>5</td>
<td>Design flood discharge P=0.5% m³/s</td>
<td>8841</td>
</tr>
<tr>
<td>6</td>
<td>Check flood discharge P=0.1% m³/s</td>
<td>12046</td>
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<tr>
<td>7</td>
<td>Form of energy dissipation Eject bit</td>
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</tbody>
</table>

### V Waterway

#### A Intakes

<p>| | | |</p>
<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Intake sill elevation m</td>
<td>138</td>
</tr>
<tr>
<td>2</td>
<td>Dimension of trash rack nxBxH m</td>
<td>8X5.5X10.5</td>
</tr>
<tr>
<td>3</td>
<td>Dimension of emergency gate nxBxH m</td>
<td>4X5.5X5.5</td>
</tr>
<tr>
<td>4</td>
<td>Dimension of flat valve nxBxH m</td>
<td>4X5.5X5.5</td>
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</tbody>
</table>

#### B Tunnel/penstock

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<th></th>
<th></th>
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</thead>
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<tr>
<td>1</td>
<td>Diameter of tunnel/penstock m</td>
<td>5.5</td>
</tr>
<tr>
<td>2</td>
<td>Total length of 1 tunnel/1 penstock m</td>
<td>235.5</td>
</tr>
<tr>
<td>3</td>
<td>Penstock wall thickness (d) mm</td>
<td>16 - 21</td>
</tr>
<tr>
<td>4</td>
<td>Penstock inclination %</td>
<td>29.83</td>
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</table>

#### C Powerhouse features

<p>| | | |</p>
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<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type of turbine</td>
<td>PO</td>
</tr>
<tr>
<td>2</td>
<td>Number of units</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Installed capacity N_{im} MW</td>
<td>250</td>
</tr>
<tr>
<td>4</td>
<td>Firm capacity N_{fa} MW</td>
<td>41.29</td>
</tr>
<tr>
<td>7</td>
<td>Maximum head H_{max} m</td>
<td>71.1</td>
</tr>
<tr>
<td>8</td>
<td>Minimum head H_{min} m</td>
<td>54.20</td>
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<tr>
<td>9</td>
<td>Average head H_{a} m</td>
<td>62.99</td>
</tr>
<tr>
<td>10</td>
<td>Net head Ht m</td>
<td>56.50</td>
</tr>
<tr>
<td>11</td>
<td>Maximum Powerhouse discharge Q_{max} m³/s</td>
<td>503.84</td>
</tr>
</tbody>
</table>

### VI Outlet channel

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<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Bottom width (b) m</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>Slope factor (m)</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Channel bottom inclination (i)</td>
<td>0.001</td>
</tr>
<tr>
<td>4</td>
<td>Channel length (L) m</td>
<td>80</td>
</tr>
</tbody>
</table>

Source: PECC4
CHAPTER 1: NATURAL CONDITIONS, SOCIAL-ECONOMIC SITUATION IN PROJECT AREA

1.1 CURRENT SITUATION OF MA RIVER WATER QUALITY

Based on analysis results of water samples collected in Ma River and estuaries in Trung Son hydropower project site submitted by MT-05.1 Consultant (undertaken by EVN) to analyze, evaluate present situation of water environment in the project area and downstream area. Evaluation of water quality bases on different criteria such as COD, BOD5, DO, P … In this case, DO criteria in water is used as it indicates the flourishing of aquatic creatures (pollution indicator) and calculated losses of DO in water during water filling (degree of pollution).

Analysis result of surface water quality in project area can be found in Appendix 1.

Average results of DO content in water samples collected in project area are listed in table 1.1 (temporarily referred to as DOave\text{E VN}).

Table 1.1 - Average DO content in surface water sample in project area

<table>
<thead>
<tr>
<th>No</th>
<th>Name of sample</th>
<th>Position of sampling</th>
<th>Analysis result</th>
<th>TCVN 5942-1995</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Column A</td>
</tr>
<tr>
<td>1</td>
<td>NTS1</td>
<td>Near Ban Lat bridge-Muong Lat</td>
<td>6.43</td>
<td>≥6</td>
</tr>
<tr>
<td>2</td>
<td>NTS2</td>
<td>100m from Lat stream-Muong Lat</td>
<td>6.51</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>NTS3</td>
<td>100m downstream of Cha Lan stream</td>
<td>6.59</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>NTS4</td>
<td>Chieng Nua village</td>
<td>6.79</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>NTS5</td>
<td>Quanh stream- Ta Pan village</td>
<td>6.73</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>NTS6</td>
<td>Trung Son commune</td>
<td>6.60</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>NTS7</td>
<td>Between Ron and Choi villages</td>
<td>6.51</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>NTS8</td>
<td>Sia Stream- Co Luong</td>
<td>6.44</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>NTS9</td>
<td>Ma River- Co Luong</td>
<td>6.83</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td></td>
<td>6.60</td>
<td>≥6</td>
</tr>
</tbody>
</table>

Source: Environmental Department – EVN, 2007

Note: TCVN 5942-1995: Standard on surface water quality: Column A is applicable to surface water which can be used as living water (after treatment process as stipulated). Column B is applicable to surface water used for other purposes.

Also referring to document available at Hydro-Meteorology Center in 2007, content of DO in Ma river as recorded at Muong Lat and Hoi Xuan stations (Thanh Hoa province) in dry season is 5.23 mg/l and 4.83mg/l respectively; in flood season is 5.25 mg/l and 5.13mg/l, respectively. Taking average DO of Ma river at those two locations in dry season and similarly in flood season (DOave=5.19mg/l), we have average DO in project area as follow:

\[
DOave = \frac{(DOave(dry)+DOave(flood)+DOave_{E VN})}{3} = 5.62mg/l \text{ (rounded)}
\]

Therefore, the average DO of Ma river in project area would be 5.62mg/l
It can evaluate the dissolved oxygen in water in project area more or less reach to quality standard stipulated in TCVN5942-1995 (type A), or in other words, the Ma water quality in project area and downstream of damsite to Co Luong is slightly polluted, ensuring quality of water supply for other using purposes.

1.2 CURRENT STATUS OF VEGETATION IN THE RESERVOIR AREA

Trung Son hydropower project is located in two provinces including 3 districts, 5 communes, in which communes affected by the project construction comprise: Muong Ly, Trung Ly, Tam Chung (Muong Lat district), Trung Son (Quan Hoa district) in Thanh Hoa province; Xuan Nha (Moc Chau district) in Son La province.

Study on vegetation cover in flooded area has been conducted for calculation of flooded area of vegetation cover and biomass when reservoir of Trung Son hydropower project is formed, thus, establishing the plan for clearance and destruction of biomass in flooded area, pursuant to TOR in Package MT-05.2.

1.2.1 FLORA

1.2.1.1 Species

According to study and survey by Institute of Biography and Biology Resources – Institute of Sciences of Vietnam in 2006 and verifying surveys in May and June, 2008, there are 591 species of 75 Tracheophyta families of 4 phylum.

1. Lycopodiophyta: 2 families, 6 species
2. Equisetophyta: 1 family, 2 species
3. Polipodiophyta: 3 families, 11 species
4. Magnophyta: 69 families, 572 species

1.2.1.2 Flora resources

Among 591 flora species in the studied area, there are 72 species giving timber, 127 species giving food, 216 species giving medicine, 17 species giving fiber, 5 species giving attar, 10 species giving tannin, dyes, 27 ornamental plant species, 15 species giving food for cattle.

There are 2 rare species:

Chukrasia tabularis
Smilax glabra

Flooded plants are species with wide biological amplitude (widely distributed), therefore, gene source in the local biosystem will not be affected.

1.2.2 VEGETATION COVER

1.2.2.1 Natural vegetation cover

Pictures of vegetation covers available in flooded area – See photo appendices.

Distribution of vegetation in submergence area, see:

Figure 1: Map of vegetation cover in Trung Son HPP area

a. Evergreen broad-leaved dense forest

This type of forest covers a small area and locates in Xuan Nha commune, near residential area and near the river, so it is strongly affected. Timber and other
non-timber products with high value is excessively exploited. Forest structure only remains three layers: timber, bushes and grass.

Timber: consists of trees with height of 10-15 m, most likely to be seen are species in Ficus, Artocarpus (Moraceae), Wallsura, Dysoxylum (Meliaceae) and families such as Sapindaceae, Sapotaceae, Ebenaceae, Euphorbiaceae, Magnoliaceae, Anacardiaceae, Fagaceae, Fabaceae.

Bush: consists of bushy trees and small timbers of families such as Acanthaceae, Ebenaceae, Euphorbiaceae, Lauraceae, Sterculiaceae, Rutaceae...

Grass: most likely to be seen are species in families such as Gleicheniaceae, Adiantaceae, Poaceae, Cyperaceae, Araceae...

b. Mixed forest + Bamboo

This vegetation cover accounts for about 217.71 ha in flooded area. Most likely to be seen are bamboo species in Bambusa, Dendrocalamus, Neohouzeaua (Poaceae), timber species in families Dilleniaceae, Elaeocarpaceae, Euphorbiaceae...

c. Bushes, scattered timbers

This vegetation cover scatters in the whole flooded area. It consists of bushes, small timber with the height under 5m. Most likely to be seen are species in branches and families such as: Mallotus, Aporusa, Acalypha, Macaranga, Alchornea (Euphorbiaceae); Helicteres (Sterculiaceae); Fissistigma, Desmos (Annonaceae); Ilex (Aquifoliaceae); Osbekia (Melastomaceae), Myrtaceae.

1.2.2.2 Planted vegetation cover

a. Planted forest

Artificial forest covers a large area in the flooded area of the project in which bamboo trees account for the highest quantity. According to site survey in Trung Son hydropower project area, bamboo trees are mostly distributed in communes of Muong Lat district, Thanh Hoa province. Bamboo trees are 3-5 years old, and mostly under harvest time.

Besides, there are some other timbers scattering such as: bead trees, Chukrasia tabularis, etc...

b. Plants in residential area (Fruit trees):

Fruit trees in this area are mostly grown in gardens, farms of residents. Most likely to be seen are species such as mango tree, orange tree, jack-fruit tree, lemon tree, banana tree, longan tree, litchi tree, etc... and some other shading trees.

c. Annual crop

This consists of vegetable, bean, corn, cassava, potatoes, upland and wet rice, sweet potatoes, etc. Annual crop area is small in flooded area, mostly distributed in farms near the Ma river banks.

1.2.2.3 Area of vegetation covers in flooded area

In general, flora system in the flooded area is divided into basic vegetation covers such as:

a. Evergreen broad-leaved dense forest;

This has small area (1.4 ha), in Xuan Nha commune, upstream of Quanh stream basin in buffer area of Xuan Nha reverse
b. **Mixed forest + Bamboo:**

This is 217.71 ha large, scattering in the reservoir area, quite densely distributed in Quanh stream basin.

c. **Poor forest:**

Consisting of bush, timbers scattering near river and stream, on hill and mountain area, and has been exploited a lot during reproduction time. This vegetation cover accounts for 184.4 ha distributing along Ma river banks in vicinity of future reservoir.

d. **Planted forest:**

Mostly consists of Thanh Hoa bamboo tree, with a large area (445.59 ha) and very small area of other timbers such as bead trees, Chukrasia tabularis, etc. with an area of about 13.3 ha.

e. **Annual crop:**

Subsidiary crops (corn, upland and wet rice, beans, vegetables, sweet potatoes, etc.), with area of 140.67 ha.

f. **Plants in residential area:**

Consist of fruit trees and trees for shading; with an area of 46.65 ha

### 1.3 SOCIO-ECONOMIC FEATURES OF PROJECT AREA

#### 1.3.1 POPULATION

According to statistics of 2005, there are totally 4,294 households, 25,482 people in 5 communes of the project area (refer to Table 2.2). The annually average natural population growth rate is 3%, this is a relatively high rate compared to that of Thanh Hoa and Son La provinces.

Totally there are 12,882 laborers in the area, accounting for 50.5% of the population. Of which agricultural labor is 98%, non-farming labor is 2%.

The main ethnic minorities include: Thai, Muong, Kinh. Ethnic minorities, in general, have revolutionary tradition, solidarity, mutual assistance in life.

<table>
<thead>
<tr>
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<th>Name</th>
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</thead>
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<td></td>
<td></td>
<td>Household</td>
<td>People</td>
<td>Laborer</td>
</tr>
<tr>
<td>A</td>
<td>Thanh Hoa province</td>
<td>2,779</td>
<td>15,587</td>
<td>8,337</td>
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<td>I</td>
<td>Quan Hoa district</td>
<td>527</td>
<td>2,529</td>
<td>1,581</td>
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<tr>
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<td>Trung Son commune</td>
<td>527</td>
<td>2,529</td>
<td>1,581</td>
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<td>Muong Lat district</td>
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<td>13,058</td>
<td>6,756</td>
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<td>955</td>
<td>5,517</td>
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<td>Tam Chung commune</td>
<td>552</td>
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<td>1,656</td>
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<td>Muong Ly commune</td>
<td>745</td>
<td>4,617</td>
<td>2,235</td>
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<td>Son La province</td>
<td>1,515</td>
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<td>4,545</td>
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</tbody>
</table>
1.3.2 **Living Condition of Local People**

According to inventory data in Trung Son HPP reservoir, the survey undertaken by PECC4 in 2005 shows the living condition of local residents as follows:

- **Housing**: 56.5% of household has wooden silt house, 32.5% of household has bamboo house on stilts. Permanent and semi-permanent houses basically located along main roads and in central communes account for 1%.

- **Clean water**: few households use well water, about 97% of household uses stream water taken from source and transmitted to villages and households by bamboo gutters or rubber and plastic pipes.

- **Latrine**: ~ 70% of household has simple and unsanitary bamboo closets, ~ 30% of household does not have water closet.

- **Income of farming household**: main product of farmer household is food, of which there are milpa rice, partly water rice and mainly maize and corn. The average food equivalent to paddy is 338kg/person/year. Besides, households have other income from gardening, breeding and forestry such as plant forest. On the average each household earns 6-11 million dong/year, of which 5-8 million is from agriculture and 1-3 million is from forestry.

1.3.3 **Present Land Usage in Project Area**

The total natural land area is 78,823.51 ha, of which 62,471 ha is agricultural and forestry land, accounting for 79.25% of the total natural land area, in agricultural land group there is 10,407.67 ha (taking 10.66%), forestry land area 52,045.78 ha (taking 83.31%).

Unused land area is 14,855.85 ha, accounting for 53.98% total natural land area in which only 266 ha is hilly and river/stream area.

1.3.4 **Present Condition of Various Sectors**

1.3.4.1 **Agriculture**

Cultivation is a main production activity, earning from food accounts for 40% - 60% of farmer household's income. Food production by farming method: water rice and terrace with main crops of rice, maize and corn. Households' cultivation skill is not good, production depends mainly on nature, the output is low due to lack of initiative in water source and intensive farming.

Terrace cultivation is a popular method of the project people, each household owns 2-3ha terrace land on the average. Normally the terrace land is used for planting terrace rice, corn, maize to satisfy self demand on food. Production is extensive farming, it depends on the natural condition, thus the plant output is low and unstable.

Beside foodstuff crop, the locals also plant maize, peanut, vegetable, beans and orchard trees such as plum, jackfruit, custard apple which mainly serve daily demand of the locals. In general, the productivity is not high because of inadequate investment and lack of new cultivation techniques.

Refer to Table 1.3 for total average food output per head in 2004
Table 1.3. Total average food output per head in 2004

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Trung Son</th>
<th>Trung Ly</th>
<th>Tam Chung</th>
<th>Muong Ly</th>
<th>Xuan Nha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total food output equivalent to paddy</td>
<td>ton</td>
<td>514.84</td>
<td>1808.43</td>
<td>1134.84</td>
<td>1009.00</td>
<td>2169.70</td>
</tr>
<tr>
<td>Of which: - Paddy</td>
<td>ton</td>
<td>109.84</td>
<td>383.43</td>
<td>396.84</td>
<td>349.00</td>
<td>929.70</td>
</tr>
<tr>
<td>- Crop</td>
<td>ton</td>
<td>405.00</td>
<td>1425</td>
<td>738.00</td>
<td>660</td>
<td>1240.00</td>
</tr>
<tr>
<td>2. Average food output/head/year</td>
<td>kg</td>
<td>203.58</td>
<td>327.79</td>
<td>388.11</td>
<td>218.54</td>
<td>219.27</td>
</tr>
</tbody>
</table>

Source: Inventory report in reservoir area, PECC4, 2005

Refer to Table 1.4 and Figure 1 for present condition of land usage in project area.

Breeding is spontaneously developed. Local farmers do not consider breeding one of the main income source of their families. As the breeding techniques and skill is no good, the domestic animal and fowl variety is mainly from the locality and small, slowly grew one. Especially the poor prophylactic ability results in low economic efficiency as their main way of breeding is leave unbridled.

At present each household in the area has 1-2 cattle, main breeding households may have 3-4 types, 1-2 pigs, 10-15 domestic fowls.

1.3.4.2 Forestry

Forestry is a strong point of the project area. The statistics show that forestry area of 4 communes of Thanh Hoa province is 35,924.28 ha accounting for 73.64% of the total natural area, of which 15,243.58 ha is production forest (accounting for 42.43% of forest area), 12,165 ha is special forest (accounting for 33.86%) and 8,515 ha is protective forest (accounting for 23.7%). Xuan Nha commune of Son La province is in charge of 16,121 ha forest land of which 25 ha is planting forest, accounting for 0.16%, 16,096 ha is special and protective forest, accounting for 99.84% of forest area. Forest production, in general, is underdeveloped which is mainly production and protection basing on the projects and programs carried out in the area. In recent years many households in Trung Ly, Muong Ly, Trung Son communes have built bamboo farms which are an effective model contributing to revenue from forest production. However, revenue from forestry production is relatively moderate compared to that from agriculture production.

1.3.4.3 Industry, handicraft and services

Industry, handicraft in the project area are underdeveloped. The main products are knitting, weaving of Thai and Muong, Mong minorities... to satisfy the household demand, they are not goods.

At present service sector is not developed owing to low demand and partly because of private control. In general the main service available is trading, small business to service daily demand and production of the local people.

1.3.5 Socio-Cultural Conditions

1.3.5.1 Health care

There are medical stations in all communes, each station has 1 physician and 2-3 nurses on the average. Initial health care for people and family planning is rather good, some epidemic diseases such as malaria, goitre, etc. However, there is a shortage of medical equipment and medicine, thus serious cases were all transferred to the district hospital.

1.3.5.2 Education:
There are primary and secondary schools in all communes of Thanh Hoa province. Schools are permanent as a result of program 135, school strengthening program, distant villages have classes themselves. In general, not many children go to school, many children in villages even leave school.

1.3.5.3 Infrastructure

a. Traffic road

At present there are traffic roads to centers of project communes, yet they are pathways mainly, some even have proportioning or asphalt roads. In dry season cars may access commune centers as Trung Son, Trung Ly, Xuan Nha communes, it is very difficult to travel in rainy season. The existing inter-village roads are mainly pathways via plenty of sloping mountain passes, streams that make it difficult for goods exchanges, especially in the flood season.

b. Irrigation

There is no large irrigation project in the project area except for several small-scale dams built by farmers for watering rice, crop in 4 communes of Thanh Hoa province. There is an irrigation station in Quanh stream in Xuan Nha commune which is invested by the state to water 60ha of 2-season rice crop. Besides, the local people have built some small dam gates to water 60-70ha of rice and vegetable.

c. Power lines

At present the power sector has invested in power lines for project communes except for Trung Son commune of Quan Hoa district.
### Table 1.4. Present land usage of project communes

**Unit: ha**

<table>
<thead>
<tr>
<th>Land type</th>
<th>Total Natural Area</th>
<th>Thanh Hoa province</th>
<th>Muong Lat district</th>
<th>Son La province</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Quan Hoa district</td>
<td>Muong Lat district</td>
<td>Moc Chau district</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trung Son</td>
<td>Trung Ly</td>
<td>Tam Chung</td>
</tr>
<tr>
<td>Total natural area</td>
<td>78,823.51</td>
<td>7,934.13</td>
<td>40,846.82</td>
<td>19,290.32</td>
</tr>
<tr>
<td>1. Agricultural area</td>
<td>62,471.19</td>
<td>6,311.99</td>
<td>36,071.37</td>
<td>17,876.59</td>
</tr>
<tr>
<td>1.1. Land for agriculture</td>
<td>10,407.67</td>
<td>738.99</td>
<td>5,707.65</td>
<td>3,045.72</td>
</tr>
<tr>
<td>1.1.1. Land for annual tree</td>
<td>10,065.02</td>
<td>726.71</td>
<td>5,667.85</td>
<td>3,036.86</td>
</tr>
<tr>
<td>1.1.2. Land for perennial tree</td>
<td>342.65</td>
<td>12.28</td>
<td>39.80</td>
<td>8.86</td>
</tr>
<tr>
<td>1.2. Land for forestry</td>
<td>52,045.78</td>
<td>5,572.30</td>
<td>30,351.98</td>
<td>14,830.67</td>
</tr>
<tr>
<td>1.3. Land for aquaculture</td>
<td>17.74</td>
<td>0.70</td>
<td>11.74</td>
<td>0.20</td>
</tr>
<tr>
<td>2. Non-agricultural area</td>
<td>1,496.47</td>
<td>456.80</td>
<td>825.18</td>
<td>317.90</td>
</tr>
<tr>
<td>2.1. Residential land</td>
<td>162.40</td>
<td>26.80</td>
<td>75.60</td>
<td>22.50</td>
</tr>
<tr>
<td>2.2. Special land</td>
<td>263.14</td>
<td>34.00</td>
<td>179.55</td>
<td>79.90</td>
</tr>
<tr>
<td>2.3 Cemetery area</td>
<td>17.54</td>
<td>9.00</td>
<td>8.54</td>
<td>8.50</td>
</tr>
<tr>
<td>2.4 Stream, lake area and unused surface</td>
<td>1,053.39</td>
<td>387.00</td>
<td>561.49</td>
<td>207.00</td>
</tr>
<tr>
<td>3. Unused land</td>
<td>14,855.85</td>
<td>1,165.34</td>
<td>3,950.27</td>
<td>1,095.83</td>
</tr>
</tbody>
</table>

*Source from cadastral and statistic departments of Quan Hoa, Muong Lat, Moc Chau districts in 2003. Combination of statistics on area measured on existing commune land map, scale 1/10000*
CHAPTER 2: RESERVOIR IMPACTS

2.1 NUMBER OF PROJECT AFFECTED HOUSEHOLDS AND INDIVIDUAL

According to survey report on human and economic impacts of the project area carried out by Power Engineering Consulting Company No.4 (PECC4) in 9/2005. Survey result for FSL=160m (selected option) is summarized in Table 2.1:

Table 2.1 - Number of PAH impacted by Trung Son HPP reservoir (FSL=160 m)

<table>
<thead>
<tr>
<th>No</th>
<th>Locality</th>
<th>Number of households</th>
<th>Number of people</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thanh Hoa province</td>
<td>288</td>
<td>1,464</td>
</tr>
<tr>
<td>1.1</td>
<td>Quan Hoa district</td>
<td>161</td>
<td>806</td>
</tr>
<tr>
<td></td>
<td>Trung Son commune</td>
<td>161</td>
<td>806</td>
</tr>
<tr>
<td>1.2</td>
<td>Muong Lat district</td>
<td>127</td>
<td>658</td>
</tr>
<tr>
<td></td>
<td>Muong Ly commune</td>
<td>36</td>
<td>195</td>
</tr>
<tr>
<td></td>
<td>Trung Ly commune</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Tam Chung commune</td>
<td>88</td>
<td>455</td>
</tr>
<tr>
<td>2</td>
<td>Son La province</td>
<td>135</td>
<td>673</td>
</tr>
<tr>
<td></td>
<td>Moc Chau district</td>
<td>135</td>
<td>673</td>
</tr>
<tr>
<td></td>
<td>Xuan Nha commune</td>
<td>135</td>
<td>673</td>
</tr>
<tr>
<td>3</td>
<td>Total</td>
<td>423</td>
<td>2,137</td>
</tr>
</tbody>
</table>

Source: PECC4 survey data as of 2005

All of PAH to be replaced are 498 PAH and 2490 individual.

2.2 IMPACT ON INFRASTRUCTURE, STRUCTURES

Impact on asset: with FSL=160m, the asset impact caused by Trung Son HPP reservoir is presented in Table 2.2.

Table 2.2 – Assets flooded in Trung Son HPP reservoir

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>House</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Moc Chau district</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Xuan Nha commune</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>House class IV</td>
<td>m²</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td>Silt house</td>
<td>m²</td>
<td>8426.1</td>
</tr>
<tr>
<td></td>
<td>Thatched cottage</td>
<td>m²</td>
<td>239.5</td>
</tr>
<tr>
<td></td>
<td>Kitchen, warehouse and breeding facilities</td>
<td>m²</td>
<td>3113.7</td>
</tr>
<tr>
<td>1.2</td>
<td>Quan Hoa district</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trung Son commune</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>House class IV</td>
<td>m²</td>
<td>186.8</td>
</tr>
<tr>
<td></td>
<td>Silt house</td>
<td>m²</td>
<td>7142.1</td>
</tr>
<tr>
<td></td>
<td>Thatched cottage</td>
<td>m²</td>
<td>1076.6</td>
</tr>
<tr>
<td>1.3</td>
<td>Muong Lat district</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a Trung Ly commune</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Silt house</td>
<td>m²</td>
<td>1428.5</td>
</tr>
<tr>
<td></td>
<td>Thatched cottage</td>
<td>m²</td>
<td>43</td>
</tr>
</tbody>
</table>
Trung Son Hydropower Project

Reservoir vegetation cover clearance plan

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen, warehouse and breeding facilities</td>
<td>904.58</td>
</tr>
<tr>
<td>House class III</td>
<td>180.95</td>
</tr>
<tr>
<td>House class IV</td>
<td>138.4</td>
</tr>
<tr>
<td>Silt house</td>
<td>3734.2</td>
</tr>
<tr>
<td>Thatched cottage</td>
<td>30.36</td>
</tr>
<tr>
<td>Kitchen, warehouse and breeding facilities</td>
<td>1787.47</td>
</tr>
<tr>
<td>Silt house</td>
<td>55</td>
</tr>
<tr>
<td>Kitchen, warehouse and breeding facilities</td>
<td>73.5</td>
</tr>
<tr>
<td>Grave</td>
<td>20</td>
</tr>
<tr>
<td>Inter-commune road</td>
<td>10.5</td>
</tr>
<tr>
<td>Inter-village road</td>
<td>32</td>
</tr>
<tr>
<td>Hanging bridge</td>
<td>50</td>
</tr>
<tr>
<td>School</td>
<td>737.89</td>
</tr>
<tr>
<td>Accommodation for teachers</td>
<td>61.25</td>
</tr>
<tr>
<td>Cultural palace</td>
<td>77</td>
</tr>
<tr>
<td>Medical station</td>
<td>73</td>
</tr>
<tr>
<td>Ta Com forest station</td>
<td>42</td>
</tr>
</tbody>
</table>

Source: PECC4 survey data as of 2005

Moreover, 12 km inter-commune road and 26 km inter-village road in Thanh Hoa province is submerged. Apart from 13.4 km inter-village road and a suspension wooden bridge, almost no inter-commune road in Son La province is submerged. Besides, Trung Son HPP reservoir also leads to submersion of schools, accommodation for teachers and forest station in Trung Ly commune, village cultural palace and Muong Ly clinic.

2.3 ALL TYPES OF IMPACTS IN RESERVOIR AREA

Basing on available maps, satellite pictures from:
- Map of land using in Trung Son reservoir area scale 1/10,000 published by Binh Minh Information Technology and Map Survey Co., Ltd..
- Topographical map covering project area scale 1/50,000;
- Satellite picture in project area

Preparing vegetation map for Trung Son reservoir area scale 1/10,000. Using this map and Mapinfo 8.0 software to measure area of each type of vegetation in the region and in submerged area. Distribution of each vegetation in the reservoir area is also estimated.

(See Figure 2 - Layout of vegetation cover of flooded area of Trung Son HPP)
Table 2.3: Impact on land in Trung Son HPP reservoir (FSL = 160m )

<table>
<thead>
<tr>
<th>No</th>
<th>Land type</th>
<th>Designation</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Evergreen broad-leafed forest</td>
<td>RTX</td>
<td>1.4</td>
</tr>
<tr>
<td>2</td>
<td>Mixed forest + Bamboo</td>
<td>RHG</td>
<td>217.71</td>
</tr>
<tr>
<td>3</td>
<td>Bamboo forest</td>
<td>RTN</td>
<td>445.59</td>
</tr>
<tr>
<td>4</td>
<td>Bush, timbers scattering on hill and mountain area</td>
<td>CBG</td>
<td>30.01</td>
</tr>
<tr>
<td>5</td>
<td>Bush, timbers scattering near river area</td>
<td>CBUI</td>
<td>154.39</td>
</tr>
<tr>
<td>6</td>
<td>Plants in residential areas</td>
<td>OTC</td>
<td>46.65</td>
</tr>
<tr>
<td>7</td>
<td>Planted forest</td>
<td>RT</td>
<td>13.3</td>
</tr>
<tr>
<td>8</td>
<td>Annual crop</td>
<td>CHN</td>
<td>110.49</td>
</tr>
<tr>
<td>9</td>
<td>Water rice</td>
<td>LUC</td>
<td>29.18</td>
</tr>
</tbody>
</table>

Source: PECC4 survey data as of 2007

2.4 OVERALL IMPACT ASSESSMENT

2.4.1 IMPACT ON HOUSES

The total building area flooded by water level is 22,852m². Area of class-IV houses, silt houses, thatched cottage accounts for 98% of the total submerged area.

2.4.2 IMPACT ON OTHER STRUCTURES

Other structures in residential land of households are kitchen, breeding facilities, toilet of 21.7m²/household on the average. They are mainly temporary or simple structures.

2.4.3 IMPACT ON PUBLIC ARCHITECTURE MONUMENTS AND INFRASTRUCTURE

2.4.3.1 Impact on public architecture monuments

Public architecture monuments affected include: school, accommodation for teachers, cultural palace, medical station, etc. The area flooded by water level is 991,14m².

2.4.3.2 Impact on infrastructure

Infrastructure flooded includes inter-commune roads, inter-village pathway, simple and temporary transportation projects. 10.5km of inter-commune roads and 32km of inter-village pathway are submerged.

In general, the impacted public architecture monuments and infrastructure are simple, invaluable. New investment and replacement for the resettlement site would create better condition for PAHs and entire local people.

Other infrastructures within land area owned by PAH are kitchen, barn, latrine with average area of some 21.7m²/PAH mainly temporary structure or simple structure.

2.4.3.3 Impact on vegetation in reservoir area (see table 2.3)

2.5 PROPOSED RESETTLEMENT SITES FOR TRUNG SON HPP

According to planning on proposed resettlement sites for Trung Son HPP, it can summarize as follows:
Referring to agricultural land availability of each project communes including Trung Son (Quang Hoa district), Muong Ly, Trung Ly, Tam Chung (Muong Lat district) and Xuan Nha commune (in Moc Chau district), forestry land area and other cultivation conditions ensure recovery of production and income for local resident living in the commune (both PAHs and host population).

Referring to expectancies of PAH about resettlement sites and comments/proposal from local authorities (destination and departure) about resettlement problems so as to stabilize soon production activities and income of PAH, pushing social-economic development in the whole region, ensuring national security in border area.

Refering to Policy Framework on Compensation, Resettlement And Allowances of Trung Son HPP.

Site investigation in proposed 4 resettlement sites of Trung Son HPP in territory of four project affected communes, found that, they can receive all PAHs. Resettlement sites are:

2.5.1 RESETTLEMENT SITE 1 – TRUNG SON COMMUNE

This is proposed for 176 PAH, 971 individual living in 3 villages (Ta Ban, 141 PAH, 707 individual, Quan Nhuc 11 PAH, 44 individual, Xuoc, 24 PAH, 120 individual).

2.5.2 RESETTLEMENT SITE 2 – MUONG LY COMMUNE

This is proposed for 90 PAH, 487 individual living in 3 villages (Nang, 47 PAH, 255 individual, Tai Chanh with 41 PAH, 206 individual, Muong 2 village, 5 PAH, 26 individual).

2.5.3 RESETTLEMENT SITE 3 – TRUNG LY COMMUNE

This is proposed for 45 PAH, 227 individual living in 3 villages (Lin, 21 PAH, 107 individual, Chieng Lo with 18 PAH, 88 individual, Pa Buavillage, 6 PAH, 32 individual).

2.5.4 RESETTLEMENT SITE 4 – XUAN NHÀ COMMUNE

This is proposed for 169 PAH, 834 individual living in 2 villages (Tay Ta Lao, 58 PAH, 322 individual, Dong Ta Lao with 111 PAH, 512 individual).

Location of resettlement sites proposed for Trung Son HPP, see figure following.

Figure 3: Location of proposed resettlement sites of Trung Son HPP.
CHAPTER 3: STANDARD FOR RESERVOIR CLEARANCE -
TARGET AND CRITERIA

Based on design criteria for reservoir clearance for some hydropower projects in Vietnam such as Yaly, Song Hinh, PleiKrong, Se San 4 projects… we present here the basic criteria for clearance and cleaning of reservoir bed for Trung Son hydropower project.

3.1 CLEARANCE CRITERIA

3.1.1 GENERAL REQUIREMENTS

1. This standard sets the basis for design, reservoir clearance and acceptance work in Trung Son hydropower project;

2. The identification of flooded areas bases on calculations of reservoir hydraulic and hydrograph regimes.

3. Scope of reservoir clearance is defined according to the boundary line of reservoir at Full Supply Level of 160m. More details about the clearance scope can be seen in Item 4.1.2 of this standard.

4. Reservoir cleaning and clearance of vegetation cover in flooded areas are done at one time and up to the Full Supply Level of 160m.

5. All cleaning work shall conform to technical specifications, ensuring the quantity of work and safety.

6. All cleaning work of the reservoir shall be finished before river stoppage for water filling in the reservoir.

7. The reservoir cleaning shall be inspected and witnessed by Trung Son hydropower project management board and designing company.

8. Acceptance work shall be done by the Acceptance Boards of different levels.

3.1.2 DEFINITION IN REPORTS

2.5.4.1 Flooded areas

- **Permanent flooded area**

  Permanent flooded area means the area flooded to Minimum Operating Level (150 m)

- **Long-term flooded area**

  Long-term flooded area means the area flooded from Tail Water Level (150 m) to Full Supply Level (160 m) in case of no floods (semi-flooded area).

  In the range of long-term flooded areas, it is not allowed to have any type of projects built.

- **Temporary flooded area**
Temporary flooded area means the area flooded from Full Supply Level in case of no floods to the overflow water level in case of flood with frequency of 1% (overflow level is defined when water in the reservoir is at Full Supply Level).

In the range of temporary flooded areas, it is possible to have some types of temporary works built, however, with the permission of relevant authority.

2.5.4.2 Definition of Vegetation cover destruction and clearance

- **Vegetation cover clearance**
  The term “clearance” refers to cutting down trees in the woods while leaving some intact. Thus, after clearance, there remain some biomass in the cleared areas. It does not imply that all trees are cut down and all biomass are destroyed over the whole area before water filling in the reservoir.

- **Vegetation cover destruction**
  The term “destruction” refers to getting rid of biomass by physical or chemical methods. Thus, after destruction of vegetation cover, all trees are cut down and all biomass are destroyed over the whole area before water filling in the reservoir.

- **Vegetation cover collection**
  The plant components cut down are collected for different life purposes such as house building, tools, fire wood, etc. These biomass is usually consisted of tiber bodies, big branches.

All concepts in item 3.1.2.2 above are defined by concept “vegetation cover clearance” in this report.

### 3.2 TARGETS OF DESTRUCTION AND CLEARANCE PLAN

Management, clearance and destruction of vegetation cover in Trung Son HPP reservoir are quite important with the following main targets:

- Reduce oxygen demand of organic matters in the reservoir.
- Reduce initial impacts when nutrition in water increases during vegetation disintegration.
- Reduce impacts on water quality in the reservoir and speed up the restoration process.
- Increase the potential of community health improvement, waterway communication on the reservoir in the future, fishing and recreational activities in the reservoir area.

Clearance of biomass in Trung Son reservoir will bring substantial benefits:

- Improve water quality in the reservoir in short term and long term.
- Improve water quality in the downstream area.
- Save efforts in controlling wild water-plants and mosses, aquatic plants in the reservoir.
- Improve living condition quality for aqua-creatures in the flooded areas.
- Reduce disease on-burst and infection due to harmful insects.
- Improve navigation condition for local people at riverside and nearby areas.
- Develop caged fish cultivation and net fishery in the reservoir.
- Create and develop tourism and recreation services in the area in the future.
- Facilitate local people in using semi-flooded area for agricultural cultivation, increasing income for households in the locality.
- Minimize negative impacts on community health in the area as well as relocation areas nearby.
- Collect and make best use of products in the flooded area (agricultural and forestry products, wood, bamboo, etc.), improve people’s living standard.
- Protect the reservoir bank, especially regions with sloping terrain and unsecured geology.

3.3 SCOPE OF WORKS AND IMPLEMENTATION CRITERIA

3.3.1 SCOPE OF WORKS

The report will identify all environmental and social criteria with an aim to:

- Clearance and destruction of vegetation cover in some specified areas in the reservoir and basins (small basins at the confluence of flows and main reservoir).
- Identifying vegetation cover and quantifying biomass in selected positions in the order of environmental and social priority.
- Selection of suitable techniques for clearance and destruction of vegetation cover.
- Proposing plans, time schedule of clearance work and related costs, planning in consistent with construction works, water filling in the reservoir and starting the hydropower project operation.

Besides, the report also mentions the plan for cleaning and tidying inhabitance areas after relocation and cemetery areas after tombs are removed from the flooded areas.

3.3.2 CRITERIA FOR VEGETATION COVER DESTRUCTION AND CLEARANCE

Criteria for selecting position of clearance and biomass destruction comprise:

- Ensure water quality after disintegration of flooded biomass after cleaning in the reservoir area (TCVN 5942-1995). These criteria bases on results of water quality researches which were conducted independently, analysis result for water samples in the project area.
- Efficiently exploit wood and other forestry products in the reservoir bed flooded area;
- Preserve gene values of regional plants, protect wild animals;
- Control development degree of water plants and mosses in stagnant water basins (little flow), especially near relocation areas.
- Situations of water quality worsening due to excessive nutrient content in specific areas of the reservoir;
- Navigation channels used for special transport purposes such as transportation of bamboos on the reservoir.
- Deposit areas, such as at the downstream of the reservoir or flow.
- Convenient positions for local residents to access to reservoir or waterway communication, especially residents in the new relocation areas.
- Un-interfered positions, for example, ones with high slopes or with unstable surface (high likelihood of erosion) in the reservoir;
- Positions in the reservoir with big depth, below Minimum Operating Level, and best representing the situation of water quality worsening;
- Management of vegetation cover in semi-flooded area of the reservoir and potential for local residents taking use of this area.
- Retaining some vegetation strips for the movement of animals during water filling in the reservoir;
CHAPTER 4: PLAN AND CONTENTS OF RESERVOIR CLEANING AND VEGETATION COVER CLEARANCE AND DESTRUCTION

4.1 WORK CONTENT

4.1.1 VEGETATION COVER DESTRUCTION AND CLEARANCE

Areas to be cleaned and cleared and area/biomass of such region in flooded area (to be detailed in Item 5.2) and identified according to criteria and contents in Item 3.3.2 of Chapter 3.

a. Destruction of vegetation cover

- Cutting down trees and branches until the remaining part is \( \leq 20 \text{ cm} \) from the ground level.
- Collecting round-section timbers, big branches and bamboos to be transported out of the long-term flooded area or made into rafts to be moved out after reservoir water filling.
- Remaining branches and leaves are piled up and burnt.

b. Clearance of vegetation cover

Clearance of vegetation cover comprises:

- Cutting down trees, with remaining height depending on specific locations, elevations, purposes and criteria (for example: for reservoir traffic, net fishery, net fishing on reservoir, etc.).
- Big branches and trunks are left at the spot (making advantage of trenches and covering by soil)
- Remaining branches and leaves are piled up, left dry and burn locally.

4.1.2 CLEANING OF RESIDENTIAL AREA

All residential areas from elevation of FSL = 160m + overflow level 1% to below elevations must be cleaned after relocation. Cleaning work is only done at areas occupied with houses, kitchens, breeding facilities and it comprises:

- Tidying away rubbish after houses and auxiliary works are removed or left behind. All kinds of rubbish will be piled up (about 30-50m\(^2\)/pile) then burnt at the spot.
- Sprinkling lime to pasteurize breeding facilities, toilets, with layers with thickness of 20m and smaller.
- Remove walls, fences, electric towers, cutting down trees so that the remaining height is not higher than 50 cm, soil filling of deep wells.

4.1.3 CLEANING GRAVEYARD

All cemetery areas in reservoir area from elevation of FSL = 160m + overflow level 1% to below elevations must be cleaned after removing tombs. Cleaning work comprises:
4.2 PLAN AND METHODOLOGY

4.2.1 VEGETATION COVER DESTRUCTION AND CLEARANCE

4.2.1.1 Establishment of Vegetation cover status map

a. Background:
   - Base map of 3 districts: Muong Lat, Quan Hoa (Thanh Hoa) and Moc Chau (Son La) with the scale of 1/10,000.
   - Map showing land use status in the project area, with the scale of 1/25,000
   - Field survey proceedings at the site of Trung Son HPP.
   - Documents about bio-system in the project area by Institute of Biography and Biology Resources – Institute of Sciences of Vietnam.

b. Products:
   Vegetation cover status map in flooded area of Trung Son HPP, with the scale of 1/10,000
   - Map of existing vegetation cover condition of the reservoir shall be divided into 4 smaller areas including:
     + Area 1: basin of Quanh stream (from confluence of Quanh stream – Ma river to upstream).
     + Area 2: from fornt of dam to reservoir area in Tai Chanh village of Muong Ly commune.
     + Area 3: continue of “Area 2” from Tai Chanh village to reservoir area in Chieng Nua village.
     + Area 4: remaining area of reservoir upward.

4.2.2 CALCULATION OF BIOMASS IN RESERVOIR AREA

a. Method

Method using sample box.
   - Designing sample box

Preliminary inspection.
1. Conduct site survey, inspect the distribution of forest resources, evaluate the coverage and species content.
2. Identify boundaries of sample box for measurement.
3. Measure on map: Using tape measure to measure boundary of design area, plot, lot. Measurement points have markers. Estimating plot area by rectangular mesh.
4. Marker: At the junction of lot and plot, markers shall be established.
For all designed forest lots after divided and measured, forest resources must be surveyed and identified.

Area of sample box for measuring big timber layer: 400 m² (20 x 20 m). Put 4 boxes of plate type of 4 m² (2 x 2 m) at 4 corners of sample box to measure reproduction trees. Use typical sample box for measurement and evaluation, calculation of biomass for the entire sample box.

Site survey and evaluation: using gridline method, route survey, sample box or Quadrat method (Mishra, 1968; Odum 1971, Rastogi, 1999 and Sharma, 2003) for routing in the survey. Taking sample by standard plot method (sample) of Kurniatun Hairiah and associates (ICRAF)

Survey content in the sample box

1. Record in the description the following contents: In the sample box, fully describe biological features and measurement of survey factors: name of species, diameter, height, quality of all trees in the sample box.

2. Measuring tree body considering indicator: Doo (D stump) and Doi (diatermet at location 1/10H), Hcc, Hdc.

3. Take fresh sample on the analyzed tree: Divide the analyzed tree into 04 parts: main trunk, crust, branch and leaves. Weigh each part and take fresh sample from each part at the rate of 1% of quantity.

b. Results for each vegetation cover

Basing on present status map of vegetation in Trung Son reservoir, scale 1/10,000 prepared to list the area of each vegetation cover plot, total area (ha) of each vegetation cover in an individual area and total area of vegetation to be submerged in reservoir. As the same way, this method is used to estimate area of various submerged vegetation cover and total area of submerged vegetation of Trung Son HPP.

Biomass in sample box

This biomass is measured and calculated for sample boxes of most typical vegetation cover in the area and their submerged area is many times larger than that of much smaller vegetation covers. Below is the biomass calculated:

Table 4.1a : Investigation on biomass (form 1)

1. Vegetation type: bushes, timber tree along river, stream (poor forest)

2. Location of standard box: right bank of Quang stream – near hanging bridge and
Trung Son Hydropower Project
Reservoir vegetation cover clearance plan

Dong Ta Lao village
3 Date: 25/6/2006
4 Dimension of standard box: 20m x 20m

<table>
<thead>
<tr>
<th>No</th>
<th>Forest type</th>
<th>Organ biomass</th>
<th>Dry biomass</th>
<th>Fresh biomass</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Bushes, timber tree along river, stream</em></td>
<td>Body (63%)</td>
<td>18.9</td>
<td>37.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Branch (21%)</td>
<td>6.3</td>
<td>12.6</td>
<td>Fresh biomass = dry biomass x 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Root, stump (10%)</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaf (5%)</td>
<td>1.5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grass under (1%)</td>
<td>0.3</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>100%</strong></td>
<td><strong>30</strong></td>
<td><strong>60</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Sources:** 2008

Table 4.1b - Investigation on biomass (form 2)

1 Vegetation type: Bamboo (planted forest)
2 Location of standard box: In front of dam, river bending
3 Date: 27/5/2008
4 Dimension of standard box: 20mx20m

<table>
<thead>
<tr>
<th>No</th>
<th>Forest type</th>
<th>Organ biomass</th>
<th>Dry biomass</th>
<th>Fresh biomass</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td><em>Planted bamboo</em></td>
<td>Body, leaf (83%)</td>
<td>12</td>
<td>39.84</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Root (10%)</td>
<td>2</td>
<td>4.8</td>
<td>Fresh biomass = dry biomass x 3.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaf (7%)</td>
<td>1.6</td>
<td>3.36</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total 2</strong></td>
<td><strong>14.4</strong></td>
<td><strong>48</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Center of Hydrological Application and Environmental Technology, 2008

Table 4.1c - Investigation on biomass (form 3)

1 Vegetation type: *Mixed forest bamboo, brushes (R. recovery)*
2 Location of standard box: Near Ma river, close to quarry 3A
3 Date: 27/
4 Dimension of standard box: 20m x20m

<table>
<thead>
<tr>
<th>No</th>
<th>Forest type</th>
<th>Organ biomass</th>
<th>Dry biomass</th>
<th>Fresh biomass</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td><em>Mixed forest</em></td>
<td>Body (65%)</td>
<td>26</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Branches (19%)</td>
<td>7.6</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.1d - Investigation on biomass (form 4)

1 Vegetation type: Annual crops (up-hill fields: corn, cassava)
2 Location of standard box: along Ma river, opposite Quanh stream)
3 Date: 28/6/2006
4 Dimension of standard box: 2m x 2m

Unit: ton/ha

<table>
<thead>
<tr>
<th>No</th>
<th>Forest type</th>
<th>Organ biomass</th>
<th>Dry biomass</th>
<th>Fresh biomass</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Annual crop</td>
<td>Body, leaf</td>
<td>6</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(83%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Root, stump</td>
<td>1.2</td>
<td>3</td>
<td>Fresh biomass = dry biomass x 2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(17%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>7.2</td>
<td>18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Center of Hydrological Application and Environmental Technology, 2008

Besides using sample box method which are calculated and measured in similar forest cover with vegetation cover in project area (North region of Vietnam), the report also uses calculation results of some scientists in their released researches, calculation results of EIA report for hydropower projects in Vietnam which have been approved by Ministry of Environment and Resources and Provincial Department of and Resources regarding to biomass calculation method in flooded area.

Biomass of vegetation cover in flooded area is calculated basing on biomass from standard plots set up and calculated by results in tables 4.1a to 4.1d.

On the basic of site investigation on vegetation and basing on experiences of Ogaw (1964) and Kato (1978) for standing trees. Based on the specially of reservoir area, biomass of vegetation covers in flooded area remaining can be calculated as shown in Table 4.2

Table 4.2. Biomass of vegetation covers in project area

<table>
<thead>
<tr>
<th>No</th>
<th>Forest type</th>
<th>Organ biomass</th>
<th>Unit: ton/ha</th>
<th>Area (ha)</th>
<th>Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Poor forest</td>
<td>Body (63%)</td>
<td>37.8</td>
<td>184.4</td>
<td>6970.32</td>
</tr>
<tr>
<td></td>
<td>(bushes, scatter timber)</td>
<td>Branches (21%)</td>
<td>12.6</td>
<td>184.4</td>
<td>2323.44</td>
</tr>
<tr>
<td></td>
<td>Along river, stream</td>
<td>Root, stump (10%)</td>
<td>6</td>
<td>184.4</td>
<td>1106.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaf (5%)</td>
<td>3</td>
<td>184.4</td>
<td>553.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grass underneath (1%)</td>
<td>0.6</td>
<td>184.4</td>
<td>110.64</td>
</tr>
<tr>
<td>Sub-Total</td>
<td>100%</td>
<td>60</td>
<td>11064</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>----</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Bamboo forest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body, Leaf (83%)</td>
<td>39.84</td>
<td>445.59</td>
<td>17752.3056</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root, stump (10%)</td>
<td>4.8</td>
<td>445.59</td>
<td>2138.832</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf (7%)</td>
<td>3.36</td>
<td>445.59</td>
<td>1497.1824</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Total 2</td>
<td>48</td>
<td></td>
<td>21388.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Mixed forest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timber + Bamboo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body (65%)</td>
<td>65</td>
<td>217.71</td>
<td>14151.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branches (19%)</td>
<td>19</td>
<td>217.71</td>
<td>4136.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root, stump (10%)</td>
<td>10</td>
<td>217.71</td>
<td>2177.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf, Grass underneath (6%)</td>
<td>6</td>
<td>217.71</td>
<td>1306.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Total 3</td>
<td>100</td>
<td></td>
<td>21771</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Broad leaf evergreen forest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body (70%)</td>
<td>70</td>
<td>1.4</td>
<td>98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branches (15%)</td>
<td>15</td>
<td>1.4</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root, stump (10%)</td>
<td>10</td>
<td>1.4</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf (5%)</td>
<td>5</td>
<td>1.4</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Total 4</td>
<td>100</td>
<td></td>
<td>140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Other planted woodland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(bead tree, texture wood, ...)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body (70%)</td>
<td>42</td>
<td>13.3</td>
<td>558.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branches (15%)</td>
<td>9</td>
<td>13.3</td>
<td>119.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root, stump (10%)</td>
<td>6</td>
<td>13.3</td>
<td>79.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf (5%)</td>
<td>3</td>
<td>13.3</td>
<td>39.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Total 5</td>
<td>60</td>
<td></td>
<td>798</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Vegetation in settlement area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perennial tree, fruit tree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body (75%)</td>
<td>37.5</td>
<td>46.65</td>
<td>1749.375</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branches (15%)</td>
<td>7.5</td>
<td>46.65</td>
<td>349.875</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root, stump (10%)</td>
<td>5</td>
<td>46.65</td>
<td>233.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf (5%)</td>
<td>2.5</td>
<td>46.65</td>
<td>116.625</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 6</td>
<td>50</td>
<td></td>
<td>2449.125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Annual tree: corn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rain-fed rice, potatoes, sweet potatoes..</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body (80%)</td>
<td>15</td>
<td>139.67</td>
<td>2095.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root, stump (20%)</td>
<td>3</td>
<td>139.67</td>
<td>419.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paddy rice</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Total 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 1-7</td>
<td></td>
<td></td>
<td>60124.505</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The reservoir vegetation covers in table 4.2 are numbered as 1, 2, 3 and 7 which are calculated with biomass in the sample box measured at field. The remaining vegetation covers in table 4.2 are numbered as 4, 5 and 6 are calculated by methods of Ogaw (1964) and Kato (1978), the biomass is calculated as follow:

\[
W_s = 0.396 \left(D^2H\right)^{0.9326}
\]

\[
W_B = 0.006002 \left(D^2H\right)^{1.027}
\]

\[
W_R = 0.0264 \left(D^2H\right)^{0.775}
\]
Trung Son Hydropower Project
Reservoir vegetation cover clearance plan

\[ \frac{1}{WL} = \frac{1}{0.124 W_s^{0.794}} + \frac{1}{125} \]

Where:

- \( W_s \): biomass of tree body
- \( W_b \): biomass of tree branch
- \( W_r \): biomass of tree root (according to scale in table 4.2).
- \( W_l \): biomass of tree leaf (according to scale in table 4.2).
- \( D \): diameter of tree body at 1.3m (cm)
- \( H \): height of tree upto top (m)

This is an experimental formular used for calculation for the world tropical forests and accepted by UNESCO, PNUE and FAO for analysis of tropical forests in the world and asia

Thus, by the above method the total biomass being submerged in Trung Son reservoir would be 60,124 tons.

Biomass in submergence area is divided into organ to be estimated and shown in table follows:

**Table 4.3: Submerged biomass dividing by its organ**

<table>
<thead>
<tr>
<th>No</th>
<th>Vegetation</th>
<th>Dividing into</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Body</td>
<td>Root, stump</td>
</tr>
<tr>
<td>1</td>
<td>Poor forest (Bush, timber scattering along hill, river, stream)</td>
<td>6970</td>
<td>1106</td>
</tr>
<tr>
<td>2</td>
<td>Bamboo (Planted)</td>
<td>17752</td>
<td>2139</td>
</tr>
<tr>
<td>3</td>
<td>Mixed forest (brush, small timber + bamboo)</td>
<td>14151</td>
<td>2177</td>
</tr>
<tr>
<td>4</td>
<td>Broad leaf evergreen forest</td>
<td>98</td>
<td>14.5</td>
</tr>
<tr>
<td>5</td>
<td>Other planted woodland (bead tree, textured wood,…)</td>
<td>559</td>
<td>80.5</td>
</tr>
<tr>
<td>6</td>
<td>Vegetation in population area (perennial tree, fruit trees)</td>
<td>1749</td>
<td>233</td>
</tr>
<tr>
<td>7</td>
<td>Up-hill land/annual crop (corn, cassava, paddy rice)</td>
<td>2095</td>
<td>419</td>
</tr>
<tr>
<td></td>
<td><strong>Total organ</strong></td>
<td>43374</td>
<td>6169</td>
</tr>
</tbody>
</table>

Among vegetation being submerged, there is biomass being product used in daily living of local resident, on the other hand it has remarkably economic value then will be collected by local resident. Area of bamboo, timber in population area, planted woodland and all of reservoir where traffic conditions are favorable and exposed with exploiting ability, the local resident will make use for their daily living.

Using the above calculation method mentioned in table 4.3, we can estimate the biomass volume making use by local resident as follows:

**Poor forest + Bamboo forest**: (comprising bushes, timber scattering on hill, along river bank)

These are low valuable timber trees, however trees are next to the river which is favourble for transport. It is estimated that about 10% of body biomass will be collected by local resident for making tool, and fire wood. Biomass to be collected is estimated of about 697 tons.

**Bamboo:**
This is a relatively important product for the locals’ income, thus they will be collected, estimating about 80% of quantity (except young bamboo, bamboo shoot), equal to 70% of biomass on ground will be collected. Biomass to be collected is estimated of about 12,427 tons.

**Evergreen forest:**
This vegetation cover is included of more valuable timbers, yet it is small and far from residential area, estimating that about 30% quantity of timber will be collected by local resident, this volume is about 29.5 tons.

**Planted forest:**
Including texture wood, bead tree and some others.

This vegetation cover is included of valuable timbers which are planted and cared by local people so they will be collected as much as possible. Estimating about 50% of log, branches will be collected for normal life, some of 279 tons.

**Vegetation in population area:** including fruit tree, shadow trees.

The resettlement sites of the hydropower plant submerged area are relatively closed to the existing residential area, therefore, wood products of this vegetation cover shall be collected as much as possible. Forecasting about 500% biomass from body, branches will be collected by resident, equal to some 1,050 tons.

Total biomass collected by local resident will be 14,482 tons and biomass remaining in reservoir will be about 45,642 tons.

While local resident collecting as estimating above, a certain percentage of leaf resulted from such vegetation will be treated reducing volume of fresh leaf flooded in reservoir. Estimating about 1,632 tons.

**Table 4.4:** Estimated biomass collected by local resident together with leaf

<table>
<thead>
<tr>
<th>No</th>
<th>Vegetation</th>
<th>Submerged biomass</th>
<th>Collected biomass</th>
<th>% collected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Body, Branches</td>
<td>Leaf</td>
<td>Body, Branches</td>
</tr>
<tr>
<td>1</td>
<td>Bushes, timber along river, stream</td>
<td>6970</td>
<td>553</td>
<td>697</td>
</tr>
<tr>
<td>2</td>
<td>Bamboo (planted forest)</td>
<td>17752</td>
<td>1497</td>
<td>12427</td>
</tr>
<tr>
<td>3</td>
<td>Broad leaf evergreen forest</td>
<td>98</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>4</td>
<td>Other planted tree</td>
<td>559</td>
<td>40</td>
<td>279</td>
</tr>
<tr>
<td>5</td>
<td>Tree in population area</td>
<td>1749</td>
<td>117</td>
<td>1050</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>14482</strong></td>
<td><strong>1632.32</strong></td>
<td></td>
</tr>
</tbody>
</table>

**4.2.2.1 Estimating biomass to be cleared**

**a. General**

So far, in Vietnam no detail calculation methodology is applied in estimating necessary biomass required for reservoir clearing to minimize potential pollution. To estimate the biomass to be flooded in reservoir so as to ensure the water quality, control the ecosystem in reservoir and some socio-economic development of the nearby locals, this present report concentrates on the follows:
Trung Son reservoir is annual regulated reservoir, and annually there will be about 7,590 million m³ will be regulated by this reservoir. According to calculation done by hydrologist, Trung Son reservoir has variation coefficient Cv=0.25 it means that about ¼ reservoir storage is regularly replaced by incoming flow from upstream (in dry season).

Estimation of DO in reservoir and loss DO during organic disintegration process will be considered under the condition of water exchanging in reservoir. From such argument when estimating DO volume in reservoir under static condition there shall be a volume of DO equal to ¼ DO in reservoir shall be added for the same condition, in other words, the reservoir will take part in the process of disintegrating organic: to be

\[ V_{PH} = V_{MNDBT} + \frac{1}{4} V_{MNDBT} \]

In which: \( V_{PH} \) = volume of organic disintegration
\( V_{MNDBT} \) = Storage at FSL static.

According to design, at FSL 160m, reservoir has gross storage of 348.53*10⁶ m³. Under static condition, when reservoir reaches to its FSL, there will be 2,300.298 tons of dissolved oxygen (DO) and from the above mentioned point of view the volume of DO in reservoir takes part into disintegration process will be 2,875.373 tons (equal to \( V_{reservoir} = 435.66 \) million m³).

The annual crop cultivated land area (up-hill area) is plants, in the case if local resident do not collect and abandon the biomass will equal to grass, bush (5 tons/ha). In the case with area of annual crop of 139.7 ha, it will equal to 698.5 ton/ha of fresh vegetation. Therefore, the Total biomass to be disintegrated fast when filling reservoir will be some of 1200 tons (excluding leaves treated during collection of timber).

Volume of small branches and part of skin of timber body to be subjected to disintegration during first year of filling, this biomass take some 10% of biomass from body, branches and root. According to the above calculation, there will be 4444 ton of biomass of body branches and 1200 tons of fresh vegetation, leaf in the first year. In fact, what learning from other hydropower reservoirs throughout the country show that, such biomass will disintegrate very fast (first 6 months to one year) after filling water. The biomass of small branches and part of tree skins (~10% of the total bodies, branches, roots) and fresh leaves and vegetation under forest shadow, annual trees and grass plots in disintegration will use large volume of dissolved oxygen in water (60kg DO/tons leaf, fresh vegetation), remaining 90% flooded biomass to be body, branches and root, stump which will be gradually disintegrated and in long-term from 5 to 25 years or longer (slow disintegration) from the second year this biomass will impact unremarkably to water quality and impact will be in long-term and in the trend of reducing.

From that argument, the estimation of water quality in reservoir when disintegrating organic matter (vegetation) will be calculated in the case the reservoir water is changed under operation of powerhouse and this biomass will disintegrate very fast (causing largest pollution) including skin, leaf, fresh vegetation.

b. **Volume of DO in reservoir and scenarios of vegetation collection in flooding area**

When local resident collect 100% biomass as estimated (no collection to other vegetation)

For forecasting the oxygen dissolved in Trung Son hydropower project reservoir, it is necessary to calculate the oxygen required to disintegrate all organic substances of plants and soil in the reservoir area. Use empirical equation proposed by A.I.Denhinova below:
\[ O_2 = \frac{(K_{0_{soil}} \cdot S_{soil} + K_{0_{tv}} \cdot D_{tv})}{1000}. \]

**Where:**

- \( O_2 \): oxygen required to disintegrate all organic substances of plants and soil in the reservoir area.
- \( K_{0_{soil}} \): experience factor presenting oxygen required to disintegrate all organic substances for 1 submerged hecta of the reservoir.
- \( K_{0_{tv}} \): experience factor presenting oxygen required to disintegrate all organic substances for 1 submerged ton in the reservoir.
- \( S_{soil} \): submerged area in the reservoir
- \( D_{tv} \): submerged plant biomass in the reservoir

According to experimental, \( K_{0_{tv}} \) of each plant organs is various:

- For timber body (body, branch, root): \( K_{0_{tv}} = 9.4 \) kg/ton.
- For leaf, grass: \( K_{0_{tv}} = 60 \) kg/ton.
- For tropical soil \( K_{0_{soil}} = 48.8 \) kg/ha.

According to empirical equation proposed by A.I. Denhinova about biomass of standing tree, when disintegrating over 10 ton of fresh leaf, fresh vegetation in reservoir it will consumes 60 kg of DO. When disintegrating over one ton of

According to experimental, \( K_{0_{tv}} \) in the above formular, 41,774 tons of DO is needed to oxidize all small branches and skins (10% of body, root, branch) and 72 tons of DO to oxidize all leaf, fresh biomass. The volume of dissolved oxygen required to disintegrate such biomass will be 170,918 ton.

The reservoir flooded area at FSL=160m would be 1,313ha of which area of river and stream is 142ha. Also using the above equation to oxidize 01 ha of land flooded in reservoir, requiring a volume of dissolved oxygen of 48.8 kg DO, the volume of DO to oxidize flooded land area (1,171ha) will be 57.15 tons. In that case total DO volume required to oxidize organic resulted from vegetation and flooded land in the first year (will be the year causing strongest pollution to water) will be 170,918 tons, equal to a volume of DO of 0.334mg/l.

Results gained from analyzing water surface samples which has been measured, monitored in project area (item 1.1/chapter 1), the average DO in Ma river to the reservoir will be 5.62mg/l.

Volume of DO reservoir 5,286mg/l, (5.62mg/l – 0.334mg/l).

Comment: the reservoir will be polluted comparing with present situation and comparing to standard on living water TCVN 5942-1995 (type A: DO ≥6 mg/l).

When Local resident only collect 50% of estimated biomass (no clearing to other vegetation)

The volume of DO required to disintegrate leaf of uncleared part, fresh biomass and oxidize land will be the same, only 10% of biomass resulted from body, root, stumps, branches (skin and smaller branches) will vary. In that case the 10% of biomass will equal to 5168 tons and oxidize all above leaf, fresh biomass and small branches, part of skin will require 48.58 tons.

Therefore, the total DO used for oxidize organic matters resulted from plants and land flooded in reservoir will be 177,724 tons, equal to DO of 0.347 mg/l. So DO reservoir 5.273mg/l, (5.62mg/l – 0.347mg/l).

Comments: the reservoir will be polluted comparing with present conditions and comparing to standard on living water TCVN 5942-1995 (type A: DO ≥6 mg/l).

When Local resident only collect 30% of estimated biomass (no clearing to vegetation)
The volume of DO required to disintegrate leaf, fresh biomass and land will be the same, only 10% of biomass resulted from body, root, stumps, branches (skin and smaller branches) will vary. In that case the 10% of biomass will equal to 6166 tons (DO volume loss will be 51.3 tons). Total DO used for oxidize organic matters resulted from plants and land flooded in reservoir will be 180.45 tons, equal to DO of 0.352 mg/l. So DO reservoir 5.268/l, (5.62mg/l – 0.352mg/l).

Comments: the reservoir will be polluted comparing with present conditions and comparing to to standard on living water TCVN 5942-1995 (type A: DO ≥6 mg/l).

So under the condition if local resident collects 100% of forecasted biomass the dissolved oxygen volume spent to oxidize the flooded biomass in first year to be DO loss = 0.334mg/l.

Below is biomass resulted in some component in scenario of biomass.

Table 4.5: Biomass in some component in various scenario of biomass collection

<table>
<thead>
<tr>
<th>No</th>
<th>Items</th>
<th>Collected biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>1</td>
<td>Timber, log, branches</td>
<td>14842</td>
</tr>
<tr>
<td>2</td>
<td>Leaf to be treated together</td>
<td>1632</td>
</tr>
<tr>
<td>3</td>
<td>Biomass remaining after collection</td>
<td>45642</td>
</tr>
<tr>
<td>4</td>
<td>Biomass from body, root, stump, branches remaining</td>
<td>44442</td>
</tr>
<tr>
<td>5</td>
<td>Biomass from body, root, stump, branches disintegrating in first year</td>
<td>4444</td>
</tr>
</tbody>
</table>

Data listed in table 4.6 below is DO volume in reservoir in the said above scenario of biomass collection.

Table 4.6 – DO volume in reservoir in various scenario of biomass collection

<table>
<thead>
<tr>
<th>No</th>
<th>Items</th>
<th>DO disintegrated (ton)</th>
<th>DO loss (mg/l)</th>
<th>DO left in reservoir (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Collecting 100% estimated biomass</td>
<td>170.918</td>
<td>0.334</td>
<td>5.286</td>
</tr>
<tr>
<td>2</td>
<td>Collecting 50% estimated biomass</td>
<td>177.724</td>
<td>0.347</td>
<td>5.273</td>
</tr>
<tr>
<td>3</td>
<td>Collecting 30% estimated biomass</td>
<td>180.45</td>
<td>0.352</td>
<td>5.268</td>
</tr>
</tbody>
</table>

Due to volume of required DO for oxidize organic substances in the above 3 cases is not much different, the loss DO shall be calculated in this report \( \text{DO loss} = 0.334 \text{g/l} \).

c. Estimating biomass required to be cleaned from reservoir (in addition to collection)

By estimation, found that, to make water quality in reservoir equivalent to that of original river, a certain biomass shall be collected, this biomass if not being collected will increase DO volume in reservoir up to some 0.3mg/l. Basing on such assumption, there shall be some of 4700-5000 ton of flooded biomass shall be collected and cleaned (47-50 ha).

This shall be solved as follows, basing on destroy criteria set of cleaning biomass in reservoir, basing on biomass/ha of plants, show that if 47 ha of mixed forest will be collected, biomass will be as in table 4.7 and location of vegetation in reservoir are see table 4.8.

Table 4.7: Biomass shall be cleaned up in addition to collection

<table>
<thead>
<tr>
<th>Forest type</th>
<th>Organ biomass</th>
<th>Unit (ton/ha)</th>
<th>Area (ha)</th>
<th>Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed forest</td>
<td>Body (65%)</td>
<td>65</td>
<td>47</td>
<td>3055</td>
</tr>
</tbody>
</table>
Bushes + bamboo Branches (19%) 19 47 893
Root, stump (10%) 10 47 470
Leaf, Grass underneath (6%) 6 47 282

100  4700

Table 4.8 – Location of reservoir up to upstream about 2km (to be destroyed, clearly collected)

<table>
<thead>
<tr>
<th>No</th>
<th>Location</th>
<th>Symbo</th>
<th>Co-ordinates</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixed forest</td>
<td></td>
<td>N (latitude)</td>
<td>E (longitude)</td>
</tr>
<tr>
<td>1</td>
<td>Upstream of the dam, left bank, (timber mixed with bamboo)</td>
<td>HG1</td>
<td>N1 : 20.6324</td>
<td>E1 : 104.8128</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N2 : 20.6346</td>
<td>E1 : 104.8126</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N3 : 20.6131</td>
<td>E3 : 104.7877</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HG2</td>
<td>N1 : 20.6129</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N2 : 20.5907</td>
<td>E1 : 104.8341</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N3 : 20.5909</td>
<td>E3 : 104.8329</td>
</tr>
</tbody>
</table>

Basing on the above leaf biomass, the oxygen required to oxidize all leaves shall be 16.92 tons, DO needs to oxidize hilly soil, and DO used for log, branches in this area 39.762 tons. Total DO needs to disintegrate the above biomass is 138.83 tons.

\[
\text{DO}_{\text{leaf}} = 16920 \\
\text{DO}_{\text{soil}} = 57144.8 \\
\text{DO 47ha} = 39762 \text{ kg} \\
\text{Total DO (ph%)} = 113826.8 \text{ kg} = 138.83 \text{ ton}
\]

Then, DO reduces in reservoir is 0.27mg/l and DO in reservoir will be 5.556 mg/l. See below:

\[
\text{DO}_{\text{reservoir}} = 2875.37 \text{ Ton}  \\
\text{DO}_{\text{disintegrated}} = 138.83 \text{ Ton} \\
\text{Round} 0.27 \text{ mg/l}
\]

Then \( \text{DO}_{\text{reservoir}} = 5.556 \text{ mg/l} \)

In addition to the above areas, to ensure more criteria on socio-economic development for the locals and resettlers (in 4 planned sites), some mixed forests of ~10ha in “Area 1” (Quanh stream) in the middle of resettlement site 1 between Ta Pan and Na Khao villages (Trung Son commune) and ~20ha mixed forests in “Area 3” and “Area 4” will be cleared.

Navigation on Ma river is favorable so a certain area of mixed forest in flooded area upstream of “Area 3” and “Area 4” will be collected by local resident for their normal life, then the biomass to be disintegrated in reservoir will be reduced, it means that DO will increase in reservoir.

So if 4700 tons (equal to 47 ha) of mixed forest in front of the dam is collected, the water quality will be ensure similar to the origin river water (DO reservoir ≈5.62m/l). Basing on the criteria on collection and clearance for the reservoir, socio-economic issue as well as favourable condition for reservoir clearance, select some areas of mixed forest in front of the dam to confluence of Quanh stream – Ma river for cleared beside forest areas for collection and clearance.
4.2.3 PROPOSING TECHNIQUES FOR CLEARANCE AND DESTRUCTION OF VEGETATION COVER

4.2.3.1 Area to be cleaned

Purpose of vegetation clearing in this area has been described in section d2.1. Basing on the estimation of biomass for each area and each vegetation type in the location and whole reservoir, basing on the volume of DO loss in reservoir comparing with present status, recommending to clear 47-50 ha of mixed forest (equal to 4700-5000 tons of biomass) in “Area 2” on map of reservoir submerged area. Proposal for clearance for the area in front of the dam to upstream about 2 km (over confluences with Quanh stream about 200 m) is made basing on distribution of mixed-forest areas. Beside these vegetation areas, people also cleared in addition to collection in “Area 1” in reservoir at middle of Tan Pan to Na Khao village (Trung Son commune) for ~10ha. The mixed forest areas are located in “Area 3” and “Area 4” of Tam Chung, Muong ly communes which are favourable for road transport, as such people would collect for firewood or other domestic purposes. These area is estimated at ~ 30ha (selected trees and wood cutting)

Location of area to be cleared in addition to collection, see Figure 4 – Vegetation distribution map of dam location – Quanh stream area

4.2.3.2 Analysis of location characteristics

a. Topography

In general, the described area is valley on both banks of Ma river, sloping, some locally rather high, (25-30%).

b. Traffic conditions:

Road: There is a natural path going upstream of the dam and starting from Quanh river, only on left bank, difficult in accessing, on feet but not any other means. It is very difficult to access Quanh stream confluence from the dam and going around is required by path from Co Me village to Ta Pan village to confluence of Quanh stream and Ma river. There is a track road from Quanh stream to reservoir upstream which is accessible by automobiles in dry season with much difficulty. According to the project design, this path will be enlarged later into construction access road (from Quarry 3A to the project site and waste pen No.19 in Cu stream. There are not any roads on the right bank in this section. There is a motorway from middle of reservoir area to upstream on the left bank from Muong Lat town, collected products may be transported by automobile.

Water way: traffic condition is favorable in this area is from navigation by boat on Ma river, which is the main transportation means for traveling, transporting goods between upstream and downstream of Ma river by local resident, down to Co Luong. This is a main access of local resident by boats, canoes. Wood and bamboos collected in Ma river upstream would be transported downstream by raft.

c. Manpower

- Forest area for collection

Manpower for collecting forest products is mainly people inhabiting in the area. They are households which are currently in charge of care, management of this forest area or vegetation cover in their residential area

- Other forest areas

The vegetation management contractor will sign contract with various organization and shall mobilize local resident living in project area to perform this work
basing on contract, lump sum contract, under supervision of the authorized institutional and agencies mentioned above.

d. Apparatus and construction tools

Apparatus and construction tools will be estimated and mobilized by contracted units and individuals depending on the Contractor’s method as the terrain is rather complicated and difficult for access by automobiles. The regional vegetation cover is mainly of bamboos and mixed timbers with small diameter and height. Construction vehicles and tools will be mainly by manual in combination with small machines such as handy sawing machine, boat, raft bringing bamboo downstream of Ma river, other means to cut tree as knife, axe, handy sawing machine, hammer, etc...)

e. Present condition of bomb and mine

This is location used to be a battlefield, so there shall be possibility of mine, bomb left from the war and it shall be disarmed in the area where collection, clearance activities will be performed. For precision, a special report carried out by a professional unit is required (usually a sapper unit under Ministry of Defense) to propose method for bomb and mine clearance in the proposed vegetation area subject to clearance (refer to item 4.2.4.1 for detail)

Collection of useful biomass and vegetation cover clearance in the submerged area shall only be done after completion of bomb and mine clearance.

4.2.3.3 Implementation plan and schedule

a. Implementation plan

a1. Landmark for cleared area

Trung Son hydropower project management board shall create landmark for reservoir area to identify the reservoir border line (FSL = 160m). This task should be completed prior to reservoir clearance. This is a basis for classification of areas for cleared and destructed as well as supervision of reservoir clearance by the local forest management and monitoring consultant so as to avoid illegal exploitation of forest resources.

a2. Compensation for units and individuals with vegetation impacted or submerged

After identifying the reservoir border line, Trung Son hydropower project management board shall measure area, count trees for all submerged area. This task shall be undertaken under witness and certification of the local people, owners and managers, local authority representatives of the areas. Once there are statistics on tree types and vegetation areas and basing on the unit price for each tree type, forest of each locality, Trung Son hydropower project management board shall work out a reasonable compensation plan which would ensure fair for the locals and affected units. Compensation works shall be completed prior to clearance works.

To ensure binding between Contractor and Investor and timely implementation of clearance works, ensure technical and economical requirements, Trung Son hydropower project management board may retain (late payment) part of compensation money. Trung Son hydropower project management board shall released the retained money to related individuals and units upon completion of clearance works.

To meet the project implementation schedule, Trung Son hydropower project management board shall be responsible for settlement of PAHs’ grievances during and after clearance period.
a3. Bidding, Contractor assignment – Collected subject

For collected areas

After compensation for submerged areas, Trung Son hydropower project management board shall inform the involved PAHs of the plan, time and schedule for collecting impacted vegetation in the submerged areas. Basing on that to assign specific organizations and individuals (they themselves take care and manage such forest areas) for collecting valuable bamboos, timbers in each specific area. Trung Son hydropower project management board should try to make full use of the local people for collection works for efficiency and create job for the locals in general and PAHs in particular.

In case Trung Son hydropower project management board could not reach an agreement on contract assignment, it shall advise widely of the bidding for clearing and collecting for the above mentioned areas. Bidding shall end in an official economic contract between Trung Son hydropower project management board and the Contractor. Bidding and contract signing shall be completed 2-3 months prior to implementation.

a4. Training on collection techniques and supervision

- Training on collection techniques

Trung Son hydropower project management board shall coordinate with an experience unit in cleaning and clearing for the reservoir; organizing technical training on cleaning and clearing for Contractors or assignees. In these training courses, trainees shall be given knowledge on cleaning and clearing for part or the entire reservoir. Specifically, they are instructed to set up camps, access roads, move products out of the submerged areas, cut trees, collect bodies and branches, leaves; burn different types of branches, leaves.

In areas with bamboos and timbers, branches and leaves and bodies of each type shall be so piled up and burnt to ensure safety for nearby forests and economic efficiency, ecology for the area and its vicinity. In the training courses, trainees can practice with models or go to the fields.

In the training course, trainees are given knowledge on labour safety, risk and fault prevention such as tree falling, tree weighing, land slide, scald due to burn of forest trees and leaves; guidance on experience of collecting and transporting useful products out of the submerged area by different traffic means and systems.

The training on collection techniques for the submerged vegetation cover in the reservoir will last 1 month and end 2 months prior to collection and cleaning works

- Training on collection and cleaning works

Together with training on collection and cleaning techniques, Trung Son hydropower project management board in coordination with departments of forest management of Thanh Hoa and Son La provinces; branches of forest management of Quan Hoa, Muong Lat and Mai Chau districts held training for some officials of Trung Son hydropower project management board or other specialists (invited by Trung Son hydropower project management board). Officials of Trung Son hydropower project management board or other specialists invited to take part in the training course in coordination with district branches of forest management to monitor the Contractors’ collection and cleaning works
Duty of monitoring team is to monitor works scope of units, technical supervision on transport of biomass out of the submerged area, collecting of branches and leaves and burn of branches and leaves at site; prompt discovery of violation to the eco-system outside the allowable boundary; strict treatment of organizations and individuals for violation; ensure time, techniques, schedule of implementation and compliance to requirements on environment protection for the area, reservoir water and ecology of reservoir side.

b. Implementation schedule of works prior to exploitation and clearance

Implementation schedule of works prior to exploitation and clearance of the flooded vegetation cover is presented below and in table 4.9 as follows:

b1. Landmark for reservoir boundary, classification of the submerged areas

This work is expected to conduct in 01 year after project commencement, starting from January 1/2010 to January 1/2011.

b2. Statistics on damages, compensation implementation.

The implementation of this work when complete plugged landmark boundary for the reservoir, the estimated time is 15 months (2/2011 to 5/2012).


This work can be conducted in parallel during the implementation of damage compensation for flooded areas, expected 6/2011 to 6/2012.

b4. Organize training on “Cleaning techniques” for flooded areas of Trung Son hydropower project reservoir.

The training courses are expected to last 3-5 days/course and in 02 months, location and cost is responsible by Trung Son HPMB. Time for the training courses is estimated to be from 6-8/2012.

b5. Preparation of other conditions prior to collection and cleaning works

Preparation for involved organizations and individuals participating in collection and cleaning works includes temporary access, camps, ordnance, health care, construction means, personnel, etc. (detailed in item 2.2.4 below).

It is proposed to last about 4 months (June to end of September 2012).

b6. Collection and cleaning works of submerged vegetation cover of Trung Son hydropower project the submerged area

The collection and cleaning works of submerged vegetation cover shall be carried out once the above steps are completed. It is proposed to last about 18 months (October to December, 2014) and finish before to water filling in reservoir from 1 to 2 months (finish March, 2014).

This works is proposed to last. Detail of collection and cleaning works of submerged vegetation cover by area (4 areas) is detailed in c/4.3.3.2.
### Table 4.9 - Implementation schedule prior to collection and cleaning of submerged vegetation cover

<table>
<thead>
<tr>
<th>No</th>
<th>Works</th>
<th>Implementation time</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Start</strong></td>
<td><strong>End</strong></td>
</tr>
<tr>
<td>1</td>
<td>Landmark for reservoir boundary, classification of submerged areas</td>
<td>1/2010</td>
<td>1/2011</td>
</tr>
<tr>
<td>2</td>
<td>Statistics on impacted timbers, orchard trees and vegetation covers in submerged areas Compensation</td>
<td>2/2011</td>
<td>End of 5/2012</td>
</tr>
<tr>
<td>3</td>
<td>Bidding, contract assignment and signing on clearance, collection</td>
<td>6/2011</td>
<td>6/2012</td>
</tr>
<tr>
<td>4</td>
<td>Training: - Clearance, collection techniques. - Monitoring of collection and cleaning works</td>
<td>6/2012</td>
<td>8/2012</td>
</tr>
<tr>
<td>5</td>
<td>Preparation for collection and cleaning works</td>
<td>6/2012</td>
<td>End of 9/2012</td>
</tr>
<tr>
<td>6</td>
<td>Collection and cleaning of submerged vegetation cover</td>
<td>10/2012</td>
<td>End of 3/2014</td>
</tr>
</tbody>
</table>

**c. Implementation schedule for collection and cleaning works**

Basing on the following factors:

- Development and distribution of submerged vegetation cover
- Purpose of socio-economic development for lakeside and nearby areas
- Climatic condition of the project area and some other criteria

To divide collection and cleaning areas by 2 following stages:

**c1. Stage 1**

In this stage works are proposed to take place in the dry season for 7 months form beginning of 10/2012 to end of 4/2013

* For planted and evergreen forests, residential areas

These areas are covered with timbers of remarkable height, diameter and value. Yet there are of moderate regeneration. Moreover, post-collection biomass are bid branches and small trees which need more time to get dry and be ready for burn (burning techniques are presented in the next item). Therefore, they can be collected right after completion of preparation works. Collection and cleaning works for residential areas can be carried out upon unit price based compensation given by Trung Son hydropower project management board. this time in the dry season is favourable for collection, transportation of log, timber out of the submerged area and leaf burn (for vegetation cover in residential area only).
* For mixed forest areas (poor forest closed to river and stream)

Similar to the above mentioned trees, these areas are covered with trees of moderate regeneration. Beside there is a biomass of round timbers with diameter of 10-30cm which need relatively long time for getting dry and burning. Thus, mixed forests areas mentioned in item 4.2.3.1 shall be collected and cleared in this stage.

**c2. Stage 2**

In this stage works are proposed to take place in the dry season for 7 months form beginning of 10/2013 to end of 4/2014.

* For vegetation in residential areas and mixed forest areas in stage 1

Undry and un-burnt branches of stage 1 shall be piled up and burn out

* For bamboo forests

This vegetation cover shall be collected and cleared in this stage because of the following reasons:

This plant type have considerably high regeneration speed, especially in rainy season (young trees from spout). Therefore, bamboo tree collection in this stage shall reduce much regenerable biomass, cost for cutting and transporting unused young trees out of the submerged area.

Living mass of a tree body is moderate compared to that of a timber, they are easy for handling and distributed along 2 sides of Ma river which is favourable for waterway transport.

Living mass of branches and leaves is quite small compared to that of a body, one salient feature of this tree is that its branches and leaves dry up quickly, thus burning may take place 7-10 days after cutting.

The implementation schedule of collection and cleaning works for the submerged area of Trung Son hydropower project is presented in table 4.10.

**Table 4.10 - implementation schedule of collection and cleaning works for submerged area**

<table>
<thead>
<tr>
<th>No</th>
<th>Works</th>
<th>Implementation time</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Start</strong></td>
<td><strong>End</strong></td>
</tr>
<tr>
<td>1</td>
<td>Stage 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Planted and evergreen forests, vegetation in residential areas</td>
<td>10/2012</td>
<td>4/2013</td>
</tr>
<tr>
<td>b</td>
<td>Mixed forest areas for collection and cleaning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Stage 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Planted and evergreen forests, vegetation in residential areas</td>
<td>10/2013</td>
<td>3/2014</td>
</tr>
<tr>
<td>b</td>
<td>Bamboo forest areas in Thanh Hoa</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

d. Clear techniques for submerged vegetation cover

d1. Clearance area
The area for clearance and collection for the submerged area is identified by landmark of reservoir boundary and selection in table 4.10

d2. Scope of works

The collection and cleaning works cover:

* For forests to be cleaned (47 ha of “Area 2”)
  - Set up landmark, area for collection and cleaning works
  - Forest clearance, timber cutting
    - Timber trees of > 20 cm and good value shall be transported out of the submerged area prior to water filling in the reservoir
    - Remaining timbers shall be sawn into 1.5-2m sections and piled up
    - Other covers in this area shall be cleared, gathered and piled up together with the above bodies and branches for drying and burning at site

- Other un-burnt bodies and branches of stage 1 shall wait for a while and be piled up and burnt out in stage 2

- Create a safe boundary, select a reasonable time and weather for burning. Use right techniques in burning, prevent forest burn and ensure environment protection

- The implementation schedule of collection and cleaning works for the submerged area is presented in table 4.10

* For forests to be collected
  - Set up landmark, area for collection and cleaning works
  - Planted forests (13.13ha), evergreen forests (1.4ha):
    - Cut timber trees with valuable bodies, big branches and leaves shall be gathered at site or in a suitable place and then transported out of the submerged area prior to water filling in the reservoir (by buffalo cart, split into planks or shipped by river)
    - As this area is dispersed and scattered, small branches and leaves shall be left dry at site

- Vegetation cover in residential areas:
  - Cut and transport timber trees with valuable bodies, big branches and leaves in the same way
  - Timber trees of standard diameter of 10-20 cm shall be sawn into 1.5-2m sections for drying and burning at site together with leaves

- Forest areas for clearacne: ~30ha of mixed forest (poor forest along river and streams)
  - Timber trees with diameter of >20 cm shall be cut down and transport out of the submerged area

- Bamboo forest areas:
- Cut bodies, gather useful ones and transport out of the submerged area (downstream of Ma river by raft or by automobile)
- Branches and leaves shall be piled up and burnt at site
- Young trees shall be cut down, cut into 2-3m sections and piled up for drying and burning
- Un-burnt branches of stage 1 shall wait for a while and be piled up and burnt out in stage 2
- Create a safe boundary, select a reasonable time and weather for burning. Use right techniques in burning, prevent forest burn and ensure environment protection
- The implementation schedule of collection and cleaning works for the submerged area is presented in table 4.10

d2.1. Clearance of forest living mass: 47 ha of “Area 2” – (Stage 1)

* Set up the landmark and area for clearance and collection

The landmark and area for clearance and collection are bases for implementation, monitoring and forest management as well as contracting and payment

The landmark shall be made of reinforced concrete in accordance with the design. There will be a separate design for landmark for clearance and collection area

* Clear forests, cut and collect forest trees

1. Present condition of forest cover:
   - Area: ~ 47ha (according to the existing map of submersion for Trung Son hydropower project reservoir, scale 1/10,000)
   - This area includes mixed forests (poor forest type II) with density of young trees and creepers accounting for 2/3 of the total area and there are 5-25 trees having diameter of 5-10cm/100m². On the average:
     - Standing trees: 10 trees / 100m²
     - Trees with average diameter: 15cm
     - Trees with diameter ≥ 20cm: 2 trees / 100m²
     - Average slope : 25°

2. Clearance techniques
   - Saw, cut timber trees at 20-30cm above the ground
   - Trees with diameter ≥ 20cm and high value shall be transported out of the submerged area prior to water filling in the reservoir
   - Make use of sloppy terrain and locations next to Ma river to transport this living mass to riverbank, make raft and transport by waterway downstream. Meanwhile, it is advantageous to transport this living mass out of the submerged area by access roads to waste dump No.19 (Cu stream) by lorry
   - Remaining timbers shall be sawn into 1.5-2m sections and piled up in heaps (50x50)m/heap for drying and burning at site
- Clear forest
  - Other bushy covers, creepers in the area shall be cleared, gathered and piled up together with the above bodies and branches for drying and burning at site
  - Un-burnt branches of stage 1 shall wait for a while and be piled up and burnt out in stage 2
  - Create a safe boundary, select a reasonable time and weather for burning. Use right techniques in burning, prevent forest burn and ensure environment protection
  - The implementation schedule of collection and cleaning works for the submerged area is presented in table 4.10

**d2.2. Clearance of forest living mass: (Stage 1)**

* Set up the landmark and area for clearance and collection

The landmark and area for clearance and collection are bases for implementation, monitoring and forest management as well as contracting and payment. There will be a separate design for landmark for clearance and collection area

* Cut and collect bamboo trees

1. **Present condition of forest cover:**
   - Area: ~ 14.7ha
   - This is planted forest area of the locals which includes mainly bead-trees. They are 3-6 years of age, 10-30cm of diameter. On the average:
     - Standing trees: 15-20 trees / 100m²
     - Trees with average diameter: 18cm
     - Average slope : 20°

2. **Clearance techniques**
   - Saw, cut timber trees at 10-20cm above the ground. Tree bodies shall be transported out of the submerged area prior to water filling in the reservoir. Make use of sloppy terrain and locations next to Ma river to transport this living mass to riverbank, make raft and transport by waterway downstream or by buffalo cart where possible (near villages) or split into planks and transport manually. Remaining timbers shall be sawn into 1.5-2m sections and piled up in heaps (50x50)m/heap for drying and burning at site
   - Un-burnt branches of stage 1 shall wait to next dry season and be piled up and burnt out in stage 2
   - Create a safe boundary, select a reasonable time and weather for burning. Use right techniques in burning, prevent forest burn and ensure environment protection
   - As this cover area is small, dispersed and scattered, small branches and leaves shall be left dry at site
   - The implementation schedule of collection and cleaning works for the submerged area is presented in table 4.10
Planted trees in residential areas (46.65ha)

* Set up the landmark and area for clearance and collection

The landmark and area for clearance and collection are existing household’s land boundary

* Clear, cut and collect trees

1. Present condition of vegetation cover:
   - Area: ~ 46.65ha
   - This is planted area of the locals in residential areas which includes mainly orchard-trees: jackfruit, mango, orange, longan, grapefruit, etc. and some shadow trees. They are of different age, 15-30-40cm of diameter or even more. The average slope is 5-10°

2. Clearance techniques
   - Saw, cut timber trees and gather at site for transport out of the submerged area by buffalo cart or transport manually by small truck (5 tons).
   - Remaining timbers shall be sawn into 1.5-2m sections and piled up in heaps ~2500m³/heap for drying and burning at site

Clearance of mixed forest: 10 ha of “Area 1” and 20 ha of “Area 2+3”

* Set up the landmark and area for clearance and collection

The landmark and area for clearance and collection are bases for implementation, monitoring and forest management as well as contracting and payment. There will be a separate design for landmark for clearance and collection area

* Clear forests, cut and collect forest trees

1. Present condition of forest cover:
   - Area: ~ 30ha (according to the existing map of submersion for Trung Son hydropower project reservoir, scale 1/10,000)
   - This area includes mixed forests (poor forest type II) with density of young trees and creepers accounting for 2/3 of the total area and there are 5-25 trees having diameter of 5-10cm/100m². On the average:
     - Standing trees: 10 trees / 100m²
     - Trees with average diameter: 15cm
     - Trees with diameter > 20cm: 2 trees / 100m²
     - Average slope : 25°

2. Clearance techniques
   - Depending on position and demand criteria of the locals, saw and cut timber trees at 20-50cm above the ground. Some trees with diameter ≥ 20cm and high value shall be transported out of the submerged area prior to water filling in the reservoir
   - Remaining bodies, branches and leaves of cut mass in this area may be kept at site for drying or brought down slit and filled soil if possible

d2.3. Collection of forest living mass: (Stage 2)
**Bamboo forests (445.6ha)**

* Set up the landmark and area for clearance and collection

The landmark and area for clearance and collection are bases for implementation, monitoring and forest management as well as contracting and payment. There will be a separate design for landmark for clearance and collection area of Trung Son hydropower project.

* Clear forests, cut and collect forest trees

1. **Present condition of forest cover:**
   - Area: ~ 13.7ha (according to the existing map of submersion for Trung Son hydropower project reservoir, scale 1/10,000)
   - This is a purebred bamboo area which are 3-5 years of age, harvested or under-harvest. The mature trees are 8-15cm of diameter. On the average:
     - Standing trees: 150 trees / 100m²
     - Trees with average diameter: 10cm
     - Average length: 8m
     - Average distribution of young trees: 30 trees / 100m²
     - Average slope: 25°

2. **Clearance techniques**
   - Cut all bamboos on the clearance area, gather useful trees and move out of the submerged area
     - In “Area 1”, downstream of Quanh stream: bamboos may be transported manually up to storage pen near waste dump No.19 (Cu stream). In upstream: bamboos may be transported manually by human, buffalo to 2 storage pens in centers of East and West Ta Lao villages and then transported out of the submerged area by automobiles
     - In “Area 2”, sides of Ma riverbanks: bamboo bodies may be transported down to water edge of flow by raft and boat to downstream. Local people’s experience shows that each raft should handle 800-1200 trees
     - In “Area 3” and “Area 4” in Tam Chung, Muong Ly, Chung Ly communes which are favourable for both motorway and waterway transport. Thus, depending on each location bamboos may be transported to Muong Lat by automobiles or raft, boat. Each raft should handle 800-1200 trees
     - All branches and leaves shall be piled up in heaps (50x50)m/heap for drying and burning at site
     - Young bamboos shall be cut into 2-3m sections and piled up drying and burning at site
     - Create a safe boundary, select a reasonable time and weather for burning. Use right techniques in burning, prevent forest burn and ensure environment protection

The implementation schedule of collection and cleaning works for the submerged area is presented in table 4.10.
d2.4. Burn at site in stage 1

* Clearance area (47 ha of “Area 2”)

In this report, the unit prices of Reservoir vegetation cover clearance plans for Ban Ve and Se San 4 HPPs were used

1. Quantity of collected heaps:
   According to Reservoir vegetation cover clearance plan for Se San 4 HPP, quantity of collected heaps is specified basing on norm on collection by which the collected area for 1 heap is (50x50)m

2. Safety measures
   To ensure absolute safety for human and forest resource, it is necessary to apply the following safety measures before burning: organize guards around burning area. Guards and burners shall have shelter-pit to avoid remaining bombs and mines to explode in high temperature. The shelter-pit shall be so arranged to fit the burning place, 1 pit for every 10ha on the average. Pit shall be in rectangle: (1x1.5x1.8)m. As such this area needs 5 shelter-pits

+ Excavation of guard-pit

- Unit price calculation

Basing on the pit dimension, labour unit price, cost in accordance with the existing regulation, the unit price calculated for 1m$^3$ of pit excavation is VND 210,104/m$^3$

- Budget for implementation

Budget for implementation is specified basing on the pit excavation volume

Concrete result is tabulated in summation table

+ Safety guard

- Unit price calculation

Basing on the labour unit price, cost in accordance with the existing regulation, the unit price calculated for a man-day of guard is VND 89,788/m$^3$

- Budget for implementation

Budget for implementation is specified basing on the concrete man-day, above unit price

Concrete result is tabulated in summation table

+ Burn at site

- Unit price for burning

Unit price for burning is on heap basis, according to the norm is VND 179,078/heap (stage 1) and VND 75,928/heap (stage 2)

To ensure absolute safety for human and forest resource, it is necessary to apply suitable safety measures before burning

- Budget for implementation

Budget for implementation is specified basing on the concrete burning area
Concrete result is tabulated in summation table

* Clearance areas

Vegetation cover in residential area

Quantity of collected heaps:

Quantity of collected heaps is specified according to area (ha) as well as quality of each area in the cleared vegetation cover. Clearance area is equal to % of collected living mass compared to the total mass of the vegetation cover. Therefore, the total clearance area in all submerged residential areas (10 villages of 5 communes) is equal to ~50% of the total area (equaling to 23.23ha). The collected quantity for 1 heap for burning is proposed to be 10-15 m³ (excluding leaves).

Safety measures:

To ensure absolute safety for human and forest resource, it is necessary to apply the following safety measures before burning: organize guards around burning area. However, due to the clearance area is small and scattered, the residential area is long lasting with scattered fruit tree and others (10 villages), shelter-pit is not needed as we can make use of low land and rock wall for hiding.

Concrete result is tabulated in summation table

+ Safety guard

- Unit price calculation

Basing on the labour unit price, cost in accordance with the existing regulation, the unit price calculated for a man-day of guard is VND 89,788/m³

- Budget for implementation

Budget for implementation is specified basing on the concrete man-day, above unit price

+ Burn at site

- Unit price for burning

Unit price for burning is on heap basis, according to the norm is VND 179,078/heap (stage 1) and VND 75,928/heap (stage 2)

To ensure absolute safety for human and forest resource, it is necessary to apply suitable safety measures before burning

- Budget for implementation

Budget for implementation is specified basing on the concrete burning area

Concrete result is tabulated in summation table

Bamboo vegetation cover

Quantity of collected heaps:

Quantity of collected heaps is specified according to area (ha) as well as quality of each area in the cleared vegetation cover. Clearance area is equal to 100% of collected living mass in the total vegetation cover. Therefore, the clearance area in the submerged area is 445.6ha. The collected area for 1 heap is (50x60)m. As the biomass of bamboos is small compared to the body, especially in dry condition, pile heap by area (3000m²/heap) is reasonable

Biomass of 1 collected heap:
Biomass of 1 collected heap is dependent on collected volume and distribution of thin and thick vegetation covers for collection and cleaning

**Safety measures:**
To ensure absolute safety for human and forest resource, it is necessary to apply the following safety measures before burning: organize guards around burning area. Guards and burners shall have shelter-pit to avoid remaining bombs and mines to explode in high temperature. The shelter-pit shall be so arranged to fit the burning place, 1 pit for every 20ha on the average. Pit shall be in rectangle: (1x1.5x1.8)m. As such this area needs 22 shelter-pits

  + Safety guard

  - Unit price calculation

  Basing on the labour unit price, cost in accordance with the existing regulation, the unit price calculated for a man-day of guard is VND 89,788/m³

  - Budget for implementation

  Budget for implementation is specified basing on the concrete man-day, above unit price

  Concrete result is tabulated in summation table

  + Burn at site

  - Unit price for burning

  Unit price for burning is on heap basis, according to the norm is VND 89,539/heap (stage 2). As bamboo branches and leaves are easy to get dry and burnt, it is taken at ½ burning value/heap of other covers

  To ensure absolute safety for human and forest resource, it is necessary to apply suitable safety measures before burning

  Burn in many turns of stage II, once every month on the average and end in 3/2014: in favorable weather condition (dry season). Young trees (takes time to be dry) may be burned together.

  To ensure absolute safety for human and forest resource, it is necessary to apply suitable safety measures before burning

  - Budget for implementation

  Budget for implementation is specified basing on the concrete burning area

  Concrete result is tabulated in summation table

* **Clearance and collection** (10ha “Area 1” and 20ha “Area 3+4”)

  Inform the local people of the area for collecting big and high value timbers, clearing vegetation cover in the submerged area especially mixed forest area (poor forests on mountains and along streams) to reduce the flooded biomass broken up in water and create material source for the locals, meanwhile help to improve their living condition in terms of socio-economic development for the lakeside and nearby areas

  Depending on position and demand criteria of the locals, saw and cut timber trees at 20-50cm above the ground. Some trees with diameter > 20cm and high value shall be transported out of the submerged area prior to water filling in the reservoir. Make use of sloppy terrain and locations next to Ma river to transport the living mass
collected in “Area 3+4” to riverbank, make raft and transport by waterway downstream or use buffalo and horse carts to transport to villages

Remaining bodies, branches and leaves of cut mass in this area may be kept at site for drying or brought down slit and filled soil if possible

Concrete result is tabulated in summation table

d3. Cost estimate for collection and cleaning works

d3.1. Overall

For detail and good estimate of actual cost for collection and cleaning works, it is necessary to have a concrete and detail survey, measure and count standing trees, biomass on detail map of 1/200 or 1/500. The cost estimate for collection and cleaning works is usually made after dividing and numbering plots for vegetation covers in the submerged area. This report only deals with estimate basing on the actual condition in combination with some norms established in reports for Ban ve and Se San 4 HPPs basing on the existing regulations of the state, ministry of Defense, involved provinces and approved by relevant authorities. Refer to item d3.2 for detail

d3.2. Cost estimate

Summation of cost estimate for collection and cleaning works is included in table - cost estimate for collection and cleaning works for Trung Son hydropower project reservoir (end of report)

4.2.4 Plant, Schedule of Vegetation Clearance for Submerged Area

4.2.4.1 Pre-collection and cleaning works

a. Exploration of bombs, mines, fuzes

The technical proposal on collection and cleaning works for the submerged area is only for biomass above the ground (no deal with root dig). Besides, areas subject to collection and cleaning works are not easily accessible by automobiles and machines (heavy equipments and machines), construction activities shall be mainly by mannal method. The above conditions are less exciting for bombs, mines, warheads. Therefore, areas recommended for exploration and no exploration include:

Areas with annual trees in the permanently submerged area which are under cultivation for years have never been coped with bombs, mines, warheads as well as explosion. Besides, no collection and cleaning works shall take place here so no exploration of bombs, mines, fuzes is required

Areas with bushes, grass-fields are not subject to collection and cleaning works, thus no exploration of bombs, mines, fuzes is required

Long-lasting residential area with perennial trees for wood, shade and fruits have never been coped with bombs, mines, warheads as well as explosion, thus no exploration of bombs, mines, fuzes is required

Areas with planted bamboo forests are places where local people plant and take care of trees for years. Due to small bodies, tree fall shall not place much pressure on the ground. Thus, excitability for explosion is rendered as none exciting. Moreover, collection and cleaning works will not deal with root dig, no exploration of bombs, mines, fuzes is required for this area

Therefore, areas requiring exploration of bombs, mines, warheads would include different planted forests (13.3ha), evergreen wild-leaf forests (1.4ha), mixed forests of ~47ha (Area 2) are places in front of the main dam to confluence of Quanh
stream and Ma river. Moreover, to ensure exchange on the reservoir and other socio-economic development purposes for people living at reservoir side, some mixed forests of ~10ha in “Area 1” (Quanh stream) in the middle of resettlement site 1 between Ta Pan and Na Khao villages (Trung Son commune) and ~20ha mixed forests in “Area 3” and “Area 4” are reservoir area between resettlement site 2 and resettlement site 3 of Muong Ly and Trung Ly communes

b. Study, rehabilitation and construction of access roads

The planted forest, bamboo forest in flood area are normally located nearby Ma river bank, other planted vegetation by local resident is favorable in regard to the accessing possibility so the biomass to be transported out of the reservoir will be more favorable.

The area in front of main dam up to confluence between Ma river and Quanh stream will be navigation to transport the collected biomass out from reservoir area. Except the location at one end of Quanh river where it connects to disposal site of the project, will be connected by project internal access road. This is favorable condition for collection, clearing vegetation and the priority location according to criteria required in TOR. Upstream of Quanh stream can be connected by access road connecting Xuan Nha commune as path transporting timber, log, bamboo from flooded area. Some other locations in upstream will be accessed by National Road 15 (NR15).

In general, the reservoir area has a sophisticated topography. However, the waterway is rather convenient. Thus, transportation of timbers and bamboos out of the submerged area shall be in favour of waterway. The project construction road to the waste dump No.19 in Cu stream is favourable for collection and cleaning works of mixed forests in “Area 2”. The National Road 15 can be used for transportation of timbers and bamboos in reservoir middle and upstream

The above conditions in combination with manual collection and cleaning method would require no construction of access roads to the reservoir area for collection and cleaning works

c. Worker camp

The location where worker camp will be constructed, the clearance will be decided considering the number of staff required by each contractor. Due to long implementation time (~18-19 months), camps shall be firm, high and dry, well ventilated and wide enough for long residence

The worker camp shall be constructed in place favourable for daily life as well as for collection and cleaning works, ensure safety and avoid submission due to flood or land sliding, rock falling and shall be constructed completely before starting vegetation clearing. Clearance for area around camps is required; no stagnant water hollow or ditch is allowed to avoid forest mosquito and pathogenic intersects.

Normally local resident will do the collection, clearing of vegetation to use in their daily life. However if worker camp is required in large area for large number of workers when they are far from home, it shall be constructed equivalent. Size of worker camp shall be decided considering number of workers living there and the area to be cleared for this purposed will be equivalent decided.

d. Assurance of livelihood, health conditions of workers, surrounding population

Each contractor(s) in charge of clearing the vegetation shall mobilize a certain staff who will provide logistics services required for living activities, accommodation and resting. The worker camp shall be available with living water supply which can be taken directly from stream or from borehole well after being treated to satisfy requirement of the existing Vietnamese standard.
In addition, the logistics activities shall ensure that all workers will be served with eutrophic food while ensuring good sanitation conditions. The health care services and disease prevention for workers shall be taken care by each contractor to his staff. Workers shall be served with sanitation and nutrition foods.

Worker camp shall be provided with suitable latrine which shall not be constructed nearby flows, water sources and shall be higher than future reservoir water level of 160m to ensure environmental standard. The water closet shall have box for waste substances with firm cover to avoid castle disturbance and waste overflow into water sources in the area.

Disease prevention and treatment for workers involving collection and cleaning works for the submerged area shall be strictly followed by Contractors. Units with many workers (about 20 people or more) shall need a nurse and sufficient medicines for coping with simple diseases and prompt first-aid for accidents before transporting patients to higher treatment level. Workers shall be served with sanitation foods, inspected for health conditions, sleeping in screen.

Due to the fact that this area is sensible against social diseases (drug, prostitution) contractor, local resident shall be aware about the implementation of working regulations and community health. No use and trade of heroin is allowed. No social evils such as prostitution, drug addict

Safety condition during works such as: falling tree, land slide, rock fall, snake bit, etc... shall be taken care, prevented and treated by contractor and Trung Son HPMB and local health care system. Telling workers and local resident to take part into clearing process of vegetation and how to prevent themselves from the above risks such as equip workers with knowledge on snake bit, no works implementation during heavy rain to avoid risks, land slide, rock fall; leaf and branch burning shall pay attention to wind direction and velocity, safe distance from fire heap to man in charge as well as to forest trees out of the demarcation set for collection and cleaning works. Workers shall be equipped with labour safety tools such as gloves, stocks and anti-leech and snake medicine

During implementation period, Trung Son hydropower project management board in combination with local health care stations of Trung Son, Xuan Nha, Muong Ly, Trung Ly communes to support timely treatment for workers and locals who are in contact with disease or on-work risks; authorities in management of workforce, avoid from happening conflict between local community and working staff in the implementation of vegetation collection and clearing.

e. Regulations on environmental protection in project area

Agencies and individual in the region who is contracted for vegetation clearing shall strictly obey every regulation in environmental protection in the area they are in charge:

Prohibiting the dumping of wastes disorderly in worker camp area, wasted resulted from daily living life shall be collected and dumped in pit before covering carefully. Worker camp shall be provided with suitable latrine which shall not be constructed nearby flows, and shall be higher than future reservoir water level of 160m to ensure environmental standard.

During cutting vegetation (burning leaf, small branches) strictly obeying the forest firing which may occur in surrounding locations. Pay attention to wind direction and burn in less windy days. Have white corridor (without forest trees) as safe space for fire anti-spreading to nearby forest area out of the submerged area. Absolute burning is required for branches and leaves (via 2 stages mentioned in above item c/4.2.3.3).
No encroachment shall be accepted into the ecological system beyond the demarcation set for the reservoir.

No hunting in the reservoir area and its vicinities shall be accepted. Make workers aware of environment protection and enhance their sense of environment protection.

No burning of biomass when it is too fresh and no dry enough for to be burnt, use adequate oil and petrol for efficient burn and least smoke.

Contractor and individual who performing the services of clearing and collecting vegetation shall furnish himself with an environmental handbook. Who responsible for this job is expected to record completely what has been done by his agency including area to be cleared, destroyed, quantity of log, timber, bamboo transported to temporary unloading yard, out of reservoir area, how many ha has been treated by burning leaf, branches, etc...

Environmental handbook shall be prepared including components to be monitored by the contractor, such as extent of dumping domestic wastes improperly, no latrine (temporary) or latrine is wrong, breaking regulations set on hunting wild animal, encroachment to ecological system (cutting down timber) out of stipulated area, no implementation and application of fire prevention in forest area during normal living life as during burning leaf, branches when collecting, destroying, breaking regulations set on community relationship, etc...

Such as job shall be performed regularly and shall be summarized, reported every week, every month to the HPMB.

The environmental handbook shall be done considering the following forms.
ENVIRONMENT RECORD

Agency: 
Package: 
Implemented area: ..................field..................plot..................area
Representative of package: 
Monitoring by: 
Date: 

<table>
<thead>
<tr>
<th>No</th>
<th>Clearance status</th>
<th>Environmental conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Body, branch</td>
<td>Leaves, fresh</td>
</tr>
<tr>
<td></td>
<td>Wrong dumping</td>
<td>No latrine</td>
</tr>
<tr>
<td></td>
<td>Illegal hunting</td>
<td>Illegal tree cutting</td>
</tr>
<tr>
<td></td>
<td>Fire prevention failure</td>
<td>Social custom</td>
</tr>
</tbody>
</table>

4.2.4.2 Co-operation with local authorities and communities

Before any activities concerning to clearing vegetation in flooding area, the Trung Son HPMB and authorities of Xuan Nha commune, Moc Chau district, Trung Son commune in Quan Hoa district shall come to an agreement on the collection of valuable timber and bamboo.

The area of bamboo in flooded area is mainly cared and managed by local communities, the area of flooded bamboo shall be collected by local resident, which will help increasing income for them while helping the HPMB in reducing cost spent on hiring workers to do such a job.

Having been agreed on the area to be cleared, location of vegetation in flooded area where local resident is allowable for collection, the HPMB shall provide training courses on applicable technique for vegetation cutting and clearing and also timetable for this job in each location and each vegetation type in reservoir area where the contractor is assigned for this job.

The Trung Son hydropower project management board shall co-operate with forest management administration of Moc Chau district and Quan Hoa district, Muong Lat district to supervise the vegetation collection (this collection shall include treatment of left products such as leaf, branches conforming to specification: drying up an burning), vegetation destroying. Supervising and stopping promptly any illegal exploitation, hunting in forest area beyond the demarcation. In addition, the same force shall supervise vegetation area location in reservoir need to be kept (in sloping area, where geological conditions are weak, loosen rock conditions, etc...).
4.2.4.3 Draft cost estimate for vegetation clearance

This shall be prepared in details for packages on collection and cleaning up vegetation in reservoir area when the Project owner signs contracts with contractors or individual.

4.2.5 Clearance in Population area

All of population areas, from water level (FSL 160 m + back water level 1%) downward having been replaced shall be cleaned and cleared. The job shall be done as stipulated in section 4.2.1. Volume of work and cost estimates shall be performed by Project owner after the inventory list of the project has been available.

4.2.6 Clearance in Graveyard

All of graveyard from water level (FSL 160 m + back water level 1%) downward having been replaced shall be cleaned and cleared. The job shall be done as stipulated in section 4.2.1. Volume of work and cost estimates shall be performed by Project owner after the inventory list of the project has been available.
CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS

The clearing and destroying of vegetation in Trung Son reservoir area has been prepared basing on criteria required by TOR for package MT-05.2 proposed by the World Bank aiming at good water quality in Trung Son reservoir and its downstream area in Ma river. On the other hand it will also serve the social-economic development of communities living around the reservoir.

The vegetation management will relate to cutting, destroying partially of vegetation area and biomass in reservoir area, help preventing alga from growing in the reservoir area, so as to increase water quality in reservoir, ensuring sustainable development of social-economy in this region.

Basing on the vegetation map scale 1/10,000 and related document describing flora in reservoir area, the biomass has been estimated. Basing on also requirements and criteria of cutting, destroying vegetation as has been mentioned in TOR of package MT-05.2 and biomass to be collected, it is recommended to paid attention for cleaning in area in front of the dam to the confluences between Ma river and Quanh stream (Area 2). Additionally, collect 100% of bamboo area and part of other vegetation covers (30ha of mixed forest) in the submerged area

Estimation has shown that, all of reservoir area is 60,124 tons. Basing on water quality and biomass to be collected during clearing, and ensuring factors, environmental criteria, socio-economic development, there shall be 47ha more of mixed forest in the same location shall be cleaned and cleared off.

2. RECOMMENDATIONS

Inventory investigation about number of PAH, graves, house, infrastructure in reservoir area done by PECC4 since 2005 so far will existed with lots of different. The vegetation clearance in reservoir area, sanitation in population area, graveyard when they have been displaced under resettlement action plant will be finalized in details in next phase.

This report proposes only plan of vegetation clearance and destroying in reservoir area basing on requirements of WB TOR. The detail cost estimate for this job implementation shall be described in a separated report “Design on Trung Son reservoir clearance and vegetation management”. Such a job will require site investigation and using of map scale 2/2000

As mentioning else where, this location has been battle field during the war so there shall be mine, bomb, explosive substance left. Recommending the Project owner considers contracting specialist for disarming the area to be cleared off.
ANNEX 1

ANALYZED RESULTS ON SURFACE WATER
TRUNG SON HYDROPOWER PROJECT
PHOTOGRAPHS

SOME PHOTOGRAPHS ON VEGETATION COVER OF TRUNG SON HYDROPOWER PROJECT RESERVOIR