TỔNG CÔNG TY ĐIỆN LỰC DẦU KHÍ VIỆT NAM – CTCP
PETRO VIETNAM POWER CORPORATION JSC
CÔNG TY CỔ PHẦN THỦY ĐIỆN ĐAKĐRINH
DAKDRINH HYDROPOWER JSC

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
SOCIALIST REPUBLIC OF VIETNAM
Độc lập - Tự do - Hạnh phúc
Independence - Freedom - Happiness

Quảng Ngãi, ngày 27 tháng 08 năm 2021
Quang Ngai, 27th August, 2021

Số - *No.*: 270821/TB/DHC

THÔNG BÁO
NOTICE

Kính gửi: Các Bên có lợi ích liên quan
To whom it may concern

Công ty Cổ phần Thủy điện Đakđrinh xin gửi lời chào trân trọng!

Dakdrinh Hydropower Joint Stock Company would like to send our sincere greetings!

Bằng Văn bản này, chúng tôi trân trọng thông báo tới Các Bên có lợi ích liên quan rằng Báo cáo Đánh giá Tác động Môi trường (Environmental Impact Assessment Report) (**"Báo Cáo"**) được đính kèm Văn bản này là Báo Cáo đã được dịch thuật từ bản gốc tiếng Việt sang tiếng Anh phục vụ mục đích tham khảo.

*We hereby respectfully notify the Stakeholders that the Environmental Impact Assessment Report (**"Report"**) attached to this Notice is a Report translated from original Vietnamese to English language for reference purposes.*

Trong trường hợp có bất kỳ mâu thuẫn nào giữa phiên bản tiếng Việt và tiếng Anh, phiên bản tiếng Việt sẽ được ưu tiên áp dụng.

In the event of any inconsistency between the Vietnamese and English versions, the Vietnamese version shall prevail.

Trân trọng!

Best regards!

Đính kèm - Attachment:
Báo cáo Đánh giá Tác động Môi trường Dự án Thủy điện Đakđrinh
Environmental Impact Assessment Report of Dakdrinh Hydropower Project

NAME OF FIGURE **PAGE**

LIST OF TABLE

NAME OF TABLE **PAGE**

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

DAK DRINH HYDROPOWER PROJECT

PREAMBLE

1. THE ORIGIN OF PROJECT

Dak Drinh River is a class I tributary of Tra Khuc River. Catchment area is 420 km^2, located in the two provinces of Kon Tum and Quang Ngai. Hydropower cascade plan on Tra Khuc river was made in December 2005, supplemented in May 2006 by Power Engineering Consulting Company 2, now Power Engineering Consulting Joint Stock Company 2 (PECC2) and approved by Ministry of Industry on June 21, 2006 according to Decision No. 1567/QD-BCN.

On November 5, 2003, the Government allowed Licogi Corporation -JSC (LICOGI) to own the project and invest in the construction of the Dak Drinh hydropower project according to the official dispatch no. 1519/CP-CN.

On May 15, 2007, the Government Office issued Official Letter No. 2559/VPCP-CN permitting the conversion of the investor of Dak Drinh Hydropower Project from Licogi Corporation -JSC (LICOGI) to Đakđrinh Hydropower Joint Stock Company (DHC), Quang Ngai province.

Dak Drinh hydropower project is the largest one in the Tra Khuc river hydropower cascade system. The project is expected to be built in Kon Plong district (Kon Tum province) and Son Tay district (Quang Ngai province).

Dak Drinh Hydropower Project is a **new type of project**, which the Ministry of Industry has the authority to approve an investment project (according to Decree No. 16/2005/ND-CP dated February 7, 2005 of the Government).

Dak Drinh Hydropower Project has the main tasks:

- Supply energy to the power system of the central provinces and the national grid with a capacity of N = 125 MW, the average annual power output E = 520.8.10^6 kWh.
- According to the water source balance plan, the required amount of water for the downstream is about 45 m^3/s, of which: for irrigation through Thach Nham irrigation project with amount of 25 m^3/s, for people's needs and saltwater intrusion retreating with amount of 5 m^3/s. Because the flow is regulated from DakDrinh reservoir with $Q_{guarantee}$= 9.37 m^3/s and $Q_{average}$= 28.48 m^3/s, it is possible to partially regulate the amount of water downstream, supplement the required amount of water for Thach Nham irrigation project, contribute to retreat saltwater intrusion in downstream.

- Due to the steep natural topography of the river bed, flash floods often occur in the downstream including Quang Ngai town, the North-South railway and National Highway I. Therefore, when Dak Drinh Hydropower Project is built in upstream with a useful capacity of about 205,25,10^6 m^3, it will contribute to reducing floods downstream as well as partially limiting the damage caused by flood.

However, construction and operation of Dak Drinh Hydropower Project will cause changes to the natural environment as well as the socio-economic environment in the construction area, these changes include negative and positive impacts. During the investment project phase, PECC2 performs the task of Environmental Impact Assessment (EIA) for Dak Drinh Hydropower Project in order to assess environmental impacts, in which it focuses on measures to minimize negative impacts and environmental monitoring and management program.

Assessment scope of the Dak Drinh Hydropower Project EIA report includes:

- The entire influence scope due to the construction and operation of the Dak Drinh Hydropower Project, including quarries, sand mines used for the project.

The 110 kV line connects Dak Drinh hydropower plant to the national power system (Dak Drinh hydropower plant - Doc Soi 110 kV line.

- The resettlement areas will arrange residential land, house, public works and infrastructure, and production land for households and localities affected by the project construction.

2. LEGAL AND TECHNICAL BASES OF EIA IMPLEMENTATION

2.1 Legal basis:

- The Law on Environmental Protection issued under the decision of the President of the Socialist Republic of Vietnam on November 29, 2005.

- Decree 80/2006/ND-CP dated August 09, 2006 of the Government detailing and guiding the implementation of a number of articles of the Law on Environmental Protection.

- Circular No. 08/2006/TT-BTNMT dated September 8, 2006 of the Ministry of Natural Resources and Environment on guidance on strategic environmental assessment, environmental impact assessment and environmental protection commitment.

- Land Law in 2003, which was passed by the National Assembly of the Socialist Republic of Vietnam on November 26, 2003 and took effect on July 1, 2004.

- Decree No. 197/2004/ND-CP dated December 3, 2004 of the Government on compensation, support and resettlement when land is acquired by the State.

- Circular No. 116/2004/TT-BTC dated December 7, 2004 of the Ministry of Finance guiding the implementation of Decree No. 197/2004/ND-CP dated December 3, 2004 of the Government on compensation, support and resettlement when land is acquired by the State.
- Decree No. 17/2006/ND-CP dated January 27, 2006 of the Government amending and supplementing a number of articles of Decrees guiding the implementation of the Land Law.
- Decree of the Government No. 84/2007/ND9-CP dated 25/05/2007. Additional provisions on issuance of land use right certificates, land recovery, exercise of land use rights, order and procedures for compensation, support and resettlement when land is acquired by the State and settlement of complaints land claims.
- Circular No. 06/2007/TT-BTNMT dated June 15, 2007 of the Ministry of Natural Resources and Environment guiding the implementation of a number of articles of Decree No. 84/2007/ND-CP dated May 25, 2007 of the Government.
- Law on Water Resources No. 08/1998/QH10, which was passed by the National Assembly of the Socialist Republic of Vietnam on May 20, 1998 and took effect from January 01, 1999.
- Law on Forest Protection and Development No. 29/2004/QH11, which was passed by the National Assembly of the Socialist Republic of Vietnam on December 3, 2004 and took effect from April 1, 2005.
- Decree No. 23/2006/ND-CP dated March 03, 2006 of the Government on the implementation of Law on Forest Protection and Development.

Compulsory Vietnamese standards (TCVN) according to Decision No. 22/2006/QD-BTNMT of the Ministry of Natural Resources and Environment dated December 18, 2006

- TCVN 5937: 2005 - Air quality - Quality standard of surrounding air.
- TCVN 5942: 1995 - Water quality - Quality standard of surface water.
- TCVN 5945: 2005 - Industrial wastewater - Waste standard.
- TCVN 6775: 2000 - Water quality - Domestic wastewater.
- Decision 1329/2002/QD9-BYT dated April 18, 2002 of the Ministry of Health on promulgating hygiene standards for drinking water.
- TCVN 5178: 1990 - Technical safety regulations for exploiting and processing open-cast stones.

2.2 Legal documents related to the project

+ Decision No. 110/2007/QD-TTg dated July 18, 2007 of the Prime Minister approving the National Electricity Development Plan for the period 2006 - 2015 with a vision to 2025.

+ Decision No. 1567/QD-BCN dated June 21, 2006 of the Ministry of Industry approving the planning of hydropower cascade on Tra Khuc river.

+ Official Letter No. 1519/CP-CN dated November 05, 2003 of the Government on permission for investment in hydropower projects of Dak Drinh, Quang Ngai province.

+ Official Letter No. 2559/VPCP-CN dated May 15, 2007 of the Government Office on permitting the conversion of the investor of Dak Drinh Hydropower Project, Quang Ngai Province.

+ Official Letter No. 613 of the Department of Geology and Minerals of Vietnam dated April 10, 2007 on Notice of situation of mineral resources in the reservoir area of Dak Drinh Hydropower Project.

+ Official Letter No. 4038/CV-EVN-TD dated January 11, 2008 of Vietnam Electricity Corporation on the agreement on the plan to connect Dak Drinh hydropower plant (Quang Ngai province) to the national power system.

+ Official Letter No. 2026/UBND-CNXD, dated July 9, 2007 of People's Committee of Quang Ngai province on the agreement of Dak Drinh hydropower project.

+ Official Letter No. 3699/UBND-CNXD dated December 10, 2007 of People's Committee of Quang Ngai Province on the unification of Dak Drinh Hydropower resettlement.

+ Official Letter No. 78/UBND-CNXD dated January 11, 2008 of the People's Committee of Quang Ngai Province on the agreement on the direction of the 110 kV line connecting Dak Drinh hydropower plant to the national power system.

+ Official Letter No. 2605/UBND-TH dated December 7, 2007 sent by People's Committee of Kon Tum province to the Ministry of Industry and Trade on agreement of Dak Drinh hydropower project.

+ Official Letter No. 18/TL - BTTH, dated May 9, 2007 of the General Museum - Department of Culture and Information of Kon Tum province: On the determination of historical, cultural and archaeological relics of Dak Drinh hydropower project.

+ Working report dated October 9, 2007 between the People's Committee of Quang Ngai Province and the People's Committee of Kon Tum province agreed to invest in upgrading National Highway 24 and building Dak Drinh hydropower plant.

+ Official letters of the People's Committees, the Fatherland Front of the communes directly affected by the construction of the main works, the 110 kV line connected to the national power system on community consultation for Dak Drinh hydropower plant.

+ Official letters of Đakđrinh Hydropower Joint Stock Company (DHC) responding to the local official documents regarding the compensation, resettlement support and community consultation for Dak Drinh hydropower plant.

(See the official dispatch in the appendix).

2.3 Technical basis:

- Planning of hydropower cascade on Tra Khuc river was made by PECC2 in December 2005 and supplemented in May 2006.
- Planning project on development of power grid in the Central region for the period up to 2010 with consideration of prospects until 2020 was prepared by Power Engineering Consulting Joint Stock Company 4.
- Report on Dak Drinh Hydropower Project was prepared by PECC2 in 2006.
- Specialized data, documents and maps on environmental factors in the project area are stored in specialized agencies.
- Topographic, geological, hydro-meteorological survey documents for Dak Drinh hydropower project in the pre-feasibility period and investment project were implemented by PECC2 from 2004 to 2007.
- Survey data, survey on environmental factors in the project area were conducted by PECC2 and EPC in September - October 2004 and additional survey was conducted in April - May 2007.
- Documents surveying and investigating population's livelihood and economy in the reservoir bed area were conducted by PECC2 in 2001-2004, and investigated, updated in April - May 2007.
- Statistical yearbook in 2000 - 2006 of Kon Tum and Quang Ngai provinces
- Statistical yearbook in 2000 - 2006 of Kon Plong district, Son Tay district, Son Ha district, Son Tinh district and Binh Son district.

3. IMPLEMENTATION OF EIA

3.1 Investor: Đakđrinh Hydropower Joint Stock Company (DHC)

General Director: Mr. Tran Minh Tuan

Contact address: 116 Hai Ba Trung - Quang Ngai City - Quang Ngai Province

Tel: 055.713.212 Fax: 055.713.213

DHC presides over the implementation of Environmental Impact Assessment (EIA) report for Dak Drinh Hydropower Project.

3.2 Consulting agency: Power Engineering Consulting Joint Stock Company 2 (PECC2)

General Director: Mr. Truong Khac Len

Contact address: 32 Ngo Thoi Nhiem - District 3 - Ho Chi Minh City

Tel: 08.2211057 Fax: 08.2210408

PECC2 is the main consultant for Dak Drinh Hydropower Project in the period of preparing the Investment Project Report. In which, the main consultant task for preparing the Environmental Impact Assessment Report of Dak Drinh Hydropower Project.

List of PECC2 members participating in the preparation of Dak Drinh Hydropower Project EIA:

1. Huynh Le Trung	Chief Engineer	Head of Design, Environment and Resettlement Department - Dean of Faculty of Environment.
2. Chu Duy Tuyen	MSc.	Dean of Faculty of Resettlement.
3. Nguyen Lu Phuong	MSc.	Member of Design, Environment and Resettlement Department
4. Truong Thanh Van	Engineer	Member of Design, Environment and Resettlement Department
5. Dau Duc Nham	Chief Engineer	Head of Hydropower Design Department. Manager of the Project
6. Nguyen Ba Luyen	Engineer	Dean of Faculty of Hydrology
7. Le Ngoc Son	Engineer	Dean of Faculty of Topography
8. Ngo Ngoc Chau	Engineer	Dean of Faculty of Geology
9. Truong Thi Dung	Engineer	Dean of Faculty of Hydropower
10. Do Thanh Hung	Chief Engineer	Dean of Faculty of Construction Organization
11. Nguyen Van Trung	Engineer	Dean of Faculty of Electrical Engineering
12. Ninh Quoc Trung	Engineer	Dean of Faculty of Electrical Design
13. Nguyen Thi Anh Tuyet	Engineer	Deputy Department of Estimation - Head of Department of Estimation
14. Huynh Quoc	Engineer	Project manager of 110 kV transmission line connecting Dak Drinh hydropower plant to the National Power System.

Vinh

In addition, in the implementation process, there is the participation of units and individuals under service contracts, specifically as follows:

3.3 Investment Consulting and Environmental Protection Company (EPC)

- Director: Mr. Nguyen Nam Son
- Address: 04H - To Hien Thanh, Ward 14, District 10, Ho Chi Minh City.
- Tel: 0903345295 - 08 8657906 Fax:

EPC participates in consulting and preparing EIA report

List of EPC members participating in the preparation of the Dak Drinh Hydropower Project EIA:

1. Nguyen Nam Son Master of Environment
2. Nguyen Thien Tu Bachelor of Environmental Ecology
3. Duong Quoc Vinh Master of Environment

3.4 Ecological expert team of Vietnam Environment & Sustainable Development Institute.

Participating in consulting and preparing EIA report is mainly related to surveying, assessing the current status, impacts and minimizing measures for the ecological environment.

List of members of the Ecological Expert Team of Vietnam Environment & Sustainable Development Institute participating in the preparation of the Dak Drinh Hydropower Project EIA:

1. Pham Van Mien: Aquatic expert (Team leader)
2. Nguyen Huu Tuan: Expert in forest ecological resources
3. Nguyen Luu Phuong: Master, expert in forest ecological resources
4. Dao Thanh Son: Master, expert in phytoplankton
5. Pham Anh Duc: Master, expert in benthic animal

3.5 Vietnam Institute for Tropical Technology and Environment Protection (VITTEP)

- Head of water quality monitoring department: Trinh Dinh Binh
- Address: 56 Truong Quoc Dung, Phu Nhuan District, Ho Chi Minh City
- Tel: 0913729237 Fax: (08) 8455140

VITTEP participates in environmental water quality monitoring in the project area in 2004

3.6 Dung Quat Environment Monitoring Technical Center

- Director: Ms. Ngo Thi Hong Thanh

- Contact address: Head office II - Management Board of Dung Quat KKT Management Board, Van Tuong Urban Area, Binh Son, Quang ngai.
- Tel: (055) 610817 Fax: (055) 610704.

Water quality monitoring was carried out in the background environment of the project area in 2007

Members of the Dung Quat Environment Monitoring Technical Center participate in preparing Dak Drinh Hydropower Project EIA:

1. Ngo Thi Hong Thanh Director
2. Bui Tra Khuc Environmental Engineer

The investigation and survey of environmental factors in the project area were conducted by PECC2 and EPC in September - October 2004 with the participation of the ecological expert team of Vietnam Environment & Sustainable Development Institute; at the same time, it is coordinated with VITTEP to monitor water quality in the project area.

April - May 2007, PECC2 and EPC conducted additional investigation, survey, and community consultation according to the requirements and regulations in Circular No. 08/2006/TT-BTNMT dated September 8, 2006 of the Ministry of Natural Resources and Environment together with the Dung Quat Environment Monitoring Technical Center to conduct air and water quality monitoring in the project area.

CHAPTER 1: SUMMARY DESCRIPTION OF THE PROJECT

1.1 PROJECT'S NAME

Dak Drinh Hydropower Project

1.2 PROJECT OWNERS

Project investor:	**Đakđrinh Hydropower Joint Stock Company**
General Director:	Mr. Tran Minh Tuan
Contact address:	116 Hai Ba Trung - Quang Ngai City - Quang Ngai Province
Tel:	055.713.212 Fax: 055.713.213

1.3 GEOGRAPHIC LOCATION OF THE PROJECT

Dak Drinh Hydropower Project consists of 3 main components:

1. Main works: Including: dam routes, reservoirs, energy routes, hydropower plant, quarries and sand mines for the project.
2. 110 kV line connects Dak Drinh hydropower plant to the national power system.
3. Resettlement areas for project-affected households.

The dam route is planned to be located on Tra Khuc River, which is about 70 km to the Southwest from the Quang Ngai city, at coordinates 14°58’38” in North latitude and 108°18’20” in East longitude. The reservoir is located in Dak Drinh and Dak Nen communes of Kon Plong district (Kon Tum) and Son Dung and Son Mua communes of Son Tay district (Quang Ngai).

The plant area has the coordinates of 15°00’56” in North latitude and 108°23’43” in East longitude, located in Son Tan commune, Son Tay district (Quang Ngai).

It is possible to reach the main work area by National Highway 1 from Quang Ngai city to Son Tinh town, then follow Provincial Road 623 from Son Tinh town through Son Ha town to Son Tay town.

It is also possible to go access the main works by Provincial Road 5 from Quang Ngai city through Thach Nham dam to Son Ha, then follow Provincial Road 623 to Son Tay town.

(See *Figure 1.1: Diagram of the location of Dak Drinh hydropower project in the Tra Khuc river hydropower cascade system* on the next page).

110 kV line connecting Dak Drinh hydropower plant to the national power system is derived from Dak Drinh hydropower plant. It then goes through Son Tan commune (Son Tay District), Di Lang town, communes of Son Bao, Son Ha, Son Thanh (Son Ha District), communes of Tinh Giang, Tinh Dong, Tinh Hiep and Tinh Tra (Son Tinh District) and communes of Binh My, Binh Minh, Binh Trung, Binh Nguyen (Binh Son District) - Quang Ngai province, connected to the national electricity system at Doc Soi 220/110 kV substation.

(See *Figures 1.4 and 1.5: Diagram of the 110 kV line connecting Dak Drinh hydropower plant to the national power system*).

Resettlement areas arrange residential land, houses, public works and infrastructures, and production lands for households and localities affected by the project construction in the affected communes of the reservoir's flooded areas including Dak Nen commune, Dak Rinh commune - Kon Plong district, Son Dung commune, Son Mua commune - Son Tay district.

(See *Figure 1.5: Diagram of the Master Plan for Dak Drinh hydropower plant resettlement areas and traffic network, electricity supply for the resettlement areas*)

1.4 MAJOR CONTENTS OF THE PROJECT

1.4.1 Location of Dak Drinh hydropower project in Tra Khuc river hydropower cascade system

Location of Dak Drinh hydropower project in Tra Khuc river hydropower cascade is shown in *Figure 1.1*.

Dak Drinh hydropower project is located on Dak Drinh river, which is the upper branch of Tra Khuc river. According to the report on planning of hydropower cascade on Tra Khuc river prepared by PECC2 and approved by the Ministry of Industry on June 21, 2006 (Decision No. 1567/QD-BCN), there are 7 Hydropower Works on the Tra Khuc river system. The main parameters of Works on hydropower cascade of Tra Khuc river are shown in Table 1.1.

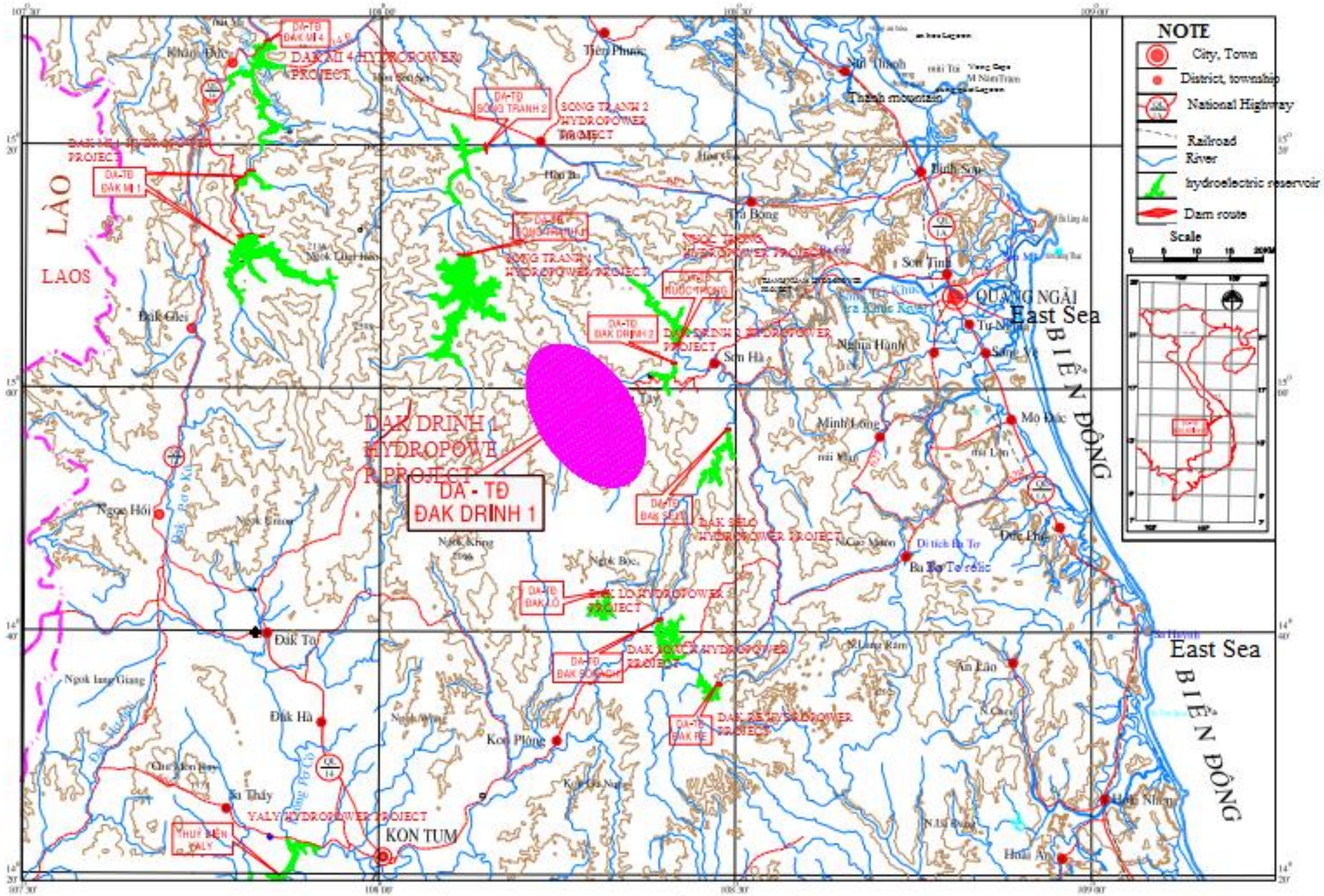


Figure 1.1: DIAGRAM OF THE LOCATION OF THE DAK DRINH HYDROPOWER PROJECT IN THE TRA KHUC RIVER HYDROPOWER CASCADE SYSTEM

Table 1.1: Main parameters of Works on hydropower cascade of Tra Khuc river

No.	Name of Work	Works on the river	Normal water level (m)	MN after NM (m)	Capacity 1.m N (MW)	Electricity E (10^6 kWh)
1	Dak Drinh 1	Dak Drinh	430	120	97	443,9
2	Dak Drinh 2	Dak Drinh	120	57	15	80,4
3	Nuoc Trong	Nuoc Trong	110	74	11	45,1
4	Dak Lo	Dak Lo	1080	674	9	42,3
5	Dak Sorak	Dak Sorak	1180	651	14	69
6	Dak Sour	Dak Sour	90	56	11	42,6
7	Dak Re	Dak Re	970	371	28	131,8
	Total				**185**	**853,1**

In the above table, Dak Drinh hydropower project is the Dak Drinh 1 Work located on Dak Drinh river, a branch of Tra Khuc river and the largest Work on the hydropower cascade system on Tra Khuc river, which is proposed to exploit on the first phase. The table above also shows that flow regime and operation of the Dak Drinh hydropower project only affects the Dak Drinh 2 Work without affecting the incoming flow regime of other Works on the above Tra Khuc river hydropower cascade.

Dak Drinh hydropower project is arranged according to the path diagram, including 2 project clusters: cluster of focal points and cluster of energy routes. In order to choose the plan that brings the highest investment efficiency and minimizes negative impacts on the environment, Works layout options from topographical and geological conditions have been considered to choose the optimal plan as follows:

1.4.2 Research options

See *Figure 1.2 Ground Diagram of the Work layout options* on page 10.

a) Dam route options

The main dam and spillway of Dak Drinh hydropower project are considered under two options:

*** *Option 1***: including 2 main dams on 2 branches and canals connecting the two lakes Dak Drinh and Dak Roman. One dam is on the branch of Dak Drinh river belonging to Group 1 of Son Mua commune, and another is on the branch of Dak Roman belonging to Group 10 of Son Dung commune.

Option 2: including 1 main dam, which is about 1.5 km from the confluence of the river in direction of downstream, located on Dak Rinh river in Son Dung commune and Son Mua commune, Son Tay district, Quang Ngai province.

The dam is considered with 2 structural options:

- Gravity concrete by Roller Compacted Concrete (RCC): the spillway consists of 4 compartments with the size of 14 x 15 m, which is diverted by culverts.
- Concrete Face Rockfill: located in river bed, spillway located on the right bank, including 4 compartments with size 14 x 15 m, which is diverted by culverts in dry season and through canal in flood season.

The alternative calculation shows that: Option 2 with RCC dam structure has the highest economic criteria and is more favorable for construction. In terms of environmental impact, this option also has the lowest pollutant agent (See *Table 1.2*).

Therefore: Option 2 with RCC dam structure is suggested as selected option.

Table 1.2: Comparison of the environmental impact of dam route options

Pollutant agent	**Comparison option**	**Selected option**
1. Dam route option	**Route 1**	**Route 2**
Flooded area in the reservoir bed	831 ha	912 ha. The reservoir bed area increased by 81 ha, including sloping land, shrub forest, regenerating forest.
The river section restricts water supply in the dry season from the dam to the Dak Bua river	Total length of 7.2 km	2.5 km
Digging soil and rock for channels connecting two lakes	Digging soil: 1.33 x 106 m^3 Digging stone: 1.23 x 106 m^3	
2. Dam structure option	**Rockfill dam**	**RCC dam**
Area of land used for construction of main dam	370 m x 434 m	84 m x 360 m
Digging soil and rock to open the main dam foundation	Digging soil: 0.893x106 m^3 Digging soil: 0.182 x 106 m^3	Digging soil: 0.562 x 10^6 m^3 Digging soil: 0.039 x 10^6 m^3
Demand for local materials exploitation to build main dam	Stone filling: 22.77 x 106 m^3 Soil filling: 0.121 x 106 m^3 Concrete: 0.029 x 106 m^3	RCC: 1.059 x 10^6 m^3 Concrete: 0.141 x $10^6$$m^3$

b) Energy route options

Energy route is considered with 2 options of Water intake and 2 options of Hydropower Plant.

1. Water intake options

- *Water intake option 1*: Water intake-1 location is about 2 km in direction of upstream from dam route 2. It includes water intake date, tunnel with length of 10.2 km, open pressure steel pipeline with length of 543 m, open hydropower plant with 2 units with capacity of 125 MW.
- *Water intake option 2*: Water intake-2 location is about 4 km in direction of upstream from dam route 2. It includes water intake date, pressure tunnel with length of 9.66 km. The tunnel section behind the Surge tank, Pressure Pipeline, Surge tank and Hydropower Plant is similar to the Water intake-1 option.

2. Hydropower plant options

- *Hydropower plant route 1*: Hydropower plant route 1 is located upstream. The riverbed elevation at the outlet of the Discharge Canal is 87.1 m. The area where hydropower plant is located has high terrain with natural elevation of about 100-120 m. Hydropower Plant Option 1 has an open steel pipeline with length of 180 m. The topography of the area where Plant Route 1 is located is steep and narrow, so the excavation volume is large.
- *Hydropower plant route 1*: Hydropower plant route 2 is located about 500 m in direction of downstream from hydropower plant route 1. Riverbed elevation is 75.9 m The area where hydropower plant is located has flat terrain with natural elevation from 90-95 m, convenient for locating hydropower plants. The road to the factory area is quite convenient, there is currently a soil road covered with concrete about 2.0 m wide. Hydropower plant option 2 has an open steel pipeline with length of 543 m.

Through comparison and calculation, it shows that: Hydropower plant 1 has the length of the pressure pipe which is about 360 m shorter than that of hydropower plant 2. However, due to the narrow and steep topography, hydropower plant 1 has a larger construction volume than hydropower plant 2. In terms of energy economy, the hydropower plant option 1 has a lower working water column, so the capacity and electricity are lower than that of hydropower plant line 2. The energy route options are studied and there is no big difference in terms of environmental impact. Therefore: Water intake-2 option and hydropower plant route 2 are selected.

c) Water level options

Selection of normal water level elevation: Normal water level and dead water level of the reservoir are calculated together with one type of structure, namely gravity dam by roller compacted concrete, right bank energy route with intake dates at Route 2 and open hydropower plant in Route 2, with 2 units.

Table 1.3: Options for choosing the normal water level in Dak Drinh Hydropower Project

Option		**1**			**2**			**3**	
Normal water level (m)		405			410			415	
Dead water level (m)	375	380	385	375	380	385	375	380	385

Works' components include: rolling weir and river-bed spillway, which is RCC dam located at Route 2. The energy route and the hydropower plant have a capacity of 92 MW – 145 MW.

Through calculation, it is found that the options of 410 m normal water level and 375 m dead water level have the highest economic indicators, so they are recommended to be selected.

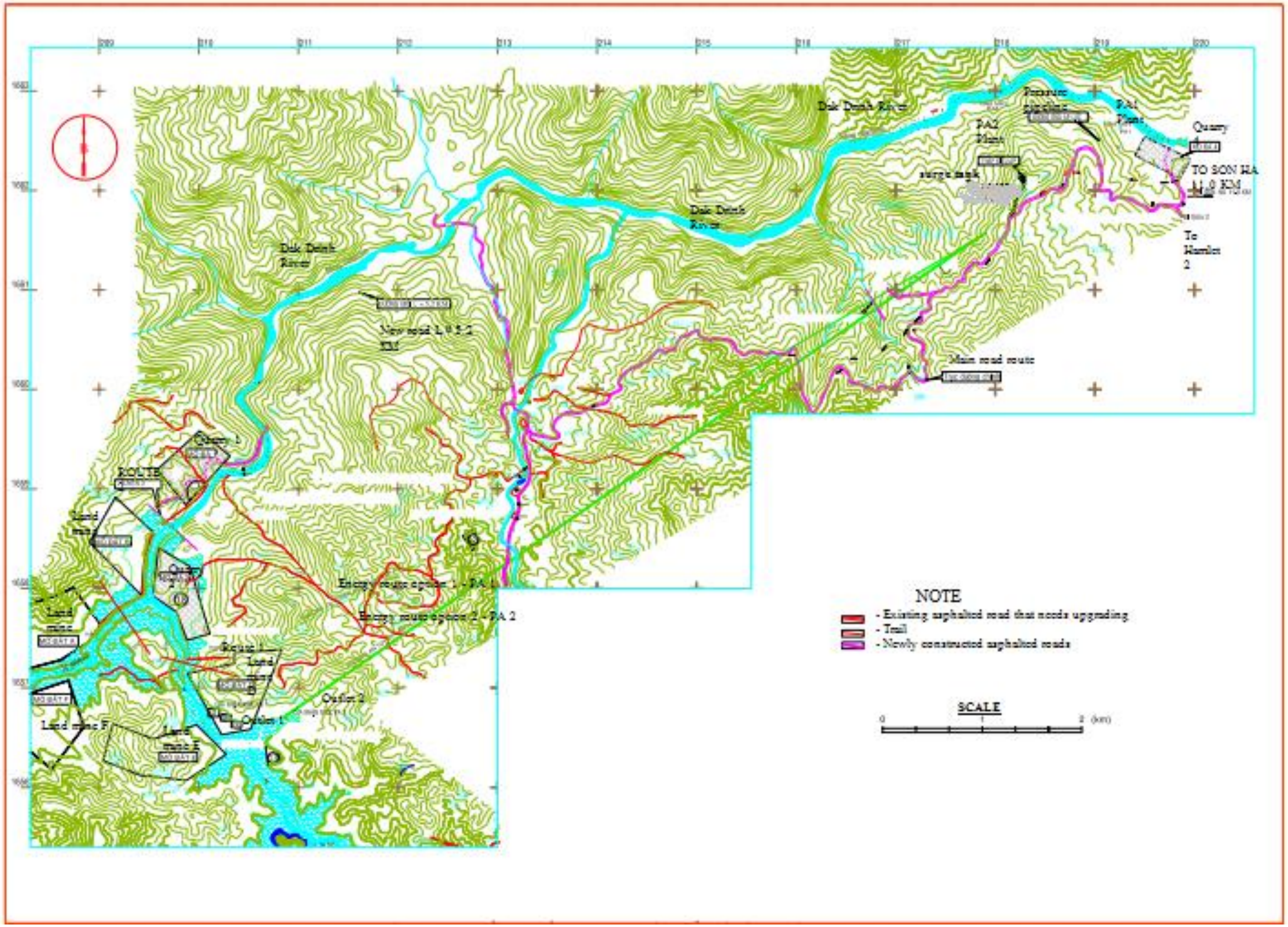


Figure 1.2: GROUND DIAGRAM OF THE WORK LAYOUT OPTION

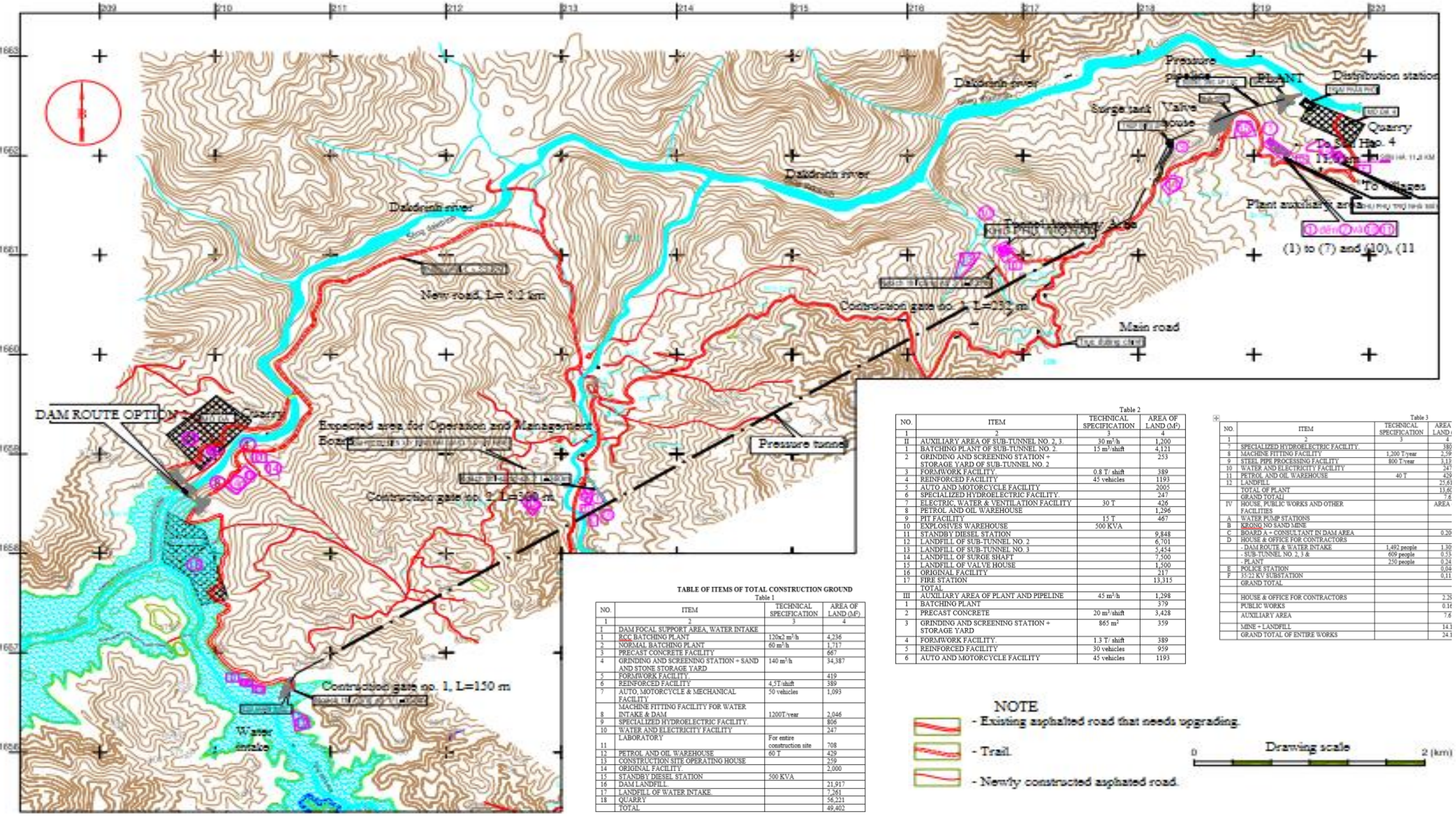


TABLE OF ITEMS OF TOTAL CONSTRUCTION GROUND

Table 1

NO.	ITEM	TECHNICAL SPECIFICATION	AREA OF LAND (M^2)
1	2	3	4
I	DAM FOCAL SUPPORT AREA, WATER INTAKE		
1	RCC BATCHING PLANT	120x2 m^3/h	4,236
2	NORMAL BATCHING PLANT	60 m^3/h	1,717
3	PRECAST CONCRETE FACILITY		667
4	GRINDING AND SCREENING STATION + SAND AND STONE STORAGE YARD	140 m^3/h	34,387
5	FORMWORK FACILITY.		419
6	REINFORCED FACILITY	4,5T/shift	389
7	AUTO, MOTORCYCLE & MECHANICAL FACILITY	50 vehicles	1,093
8	MACHINE FITTING FACILITY FOR WATER INTAKE & DAM	1200T/year	2,046
9	SPECIALIZED HYDROELECTRIC FACILITY.		806
10	WATER AND ELECTRICITY FACILITY		247
11	LABORATORY	For entire construction site	708
12	PETROL AND OIL WAREHOUSE	60 T	429
13	CONSTRUCTION SITE OPERATING HOUSE		259
14	ORIGINAL FACILITY.		2,000
15	STANDBY DIESEL STATION	500 KVA	
16	DAM LANDFILL.		21,917
17	LANDFILL OF WATER INTAKE.		7,261
18	QUARRY		56,221
	TOTAL		49,402

Table 2

NO.	ITEM	TECHNICAL SPECIFICATION	AREA OF LAND (M^2)
1	2	3	4
II	AUXILIARY AREA OF SUB-TUNNEL NO. 2, 3.	30 m^3/h	1,200
1	BATCHING PLANT OF SUB-TUNNEL NO. 2.	15 m^3/shift	4,121
2	GRINDING AND SCREENING STATION + STORAGE YARD OF SUB-TUNNEL NO. 2		253
3	FORMWORK FACILITY.	0.8 T/ shift	389
4	REINFORCED FACILITY	45 vehicles	1193
5	AUTO AND MOTORCYCLE FACILITY		2005
6	SPECIALIZED HYDROELECTRIC FACILITY.		247
7	ELECTRIC, WATER & VENTILATION FACILITY	30 T	426
8	PETROL AND OIL WAREHOUSE		1,296
9	PIT FACILITY	15 T	467
10	EXPLOSIVES WAREHOUSE	500 KVA	
11	STANDBY DIESEL STATION		9,848
12	LANDFILL OF SUB-TUNNEL NO. 2		6,701
13	LANDFILL OF SUB-TUNNEL NO. 3		5,454
14	LANDFILL OF SURGE SHAFT		7,500
15	LANDFILL OF VALVE HOUSE		1,500
16	ORIGINAL FACILITY		217
17	FIRE STATION		13,315
	TOTAL		
III	AUXILIARY AREA OF PLANT AND PIPELINE	45 m^3/h	1,298
1	BATCHING PLANT		379
2	PRECAST CONCRETE	20 m^3/shift	3,428
3	GRINDING AND SCREENING STATION + STORAGE YARD	865 m^2	359
4	FORMWORK FACILITY.	1.3 T/ shift	389
5	REINFORCED FACILITY	30 vehicles	959
6	AUTO AND MOTORCYCLE FACILITY	45 vehicles	1193

Table 3

NO.	ITEM	TECHNICAL SPECIFICATION	AREA LAND (
1	2	3	4
7	SPECIALIZED HYDROELECTRIC FACILITY.		380
8	MACHINE FITTING FACILITY	1,200 T/year	2,59
9	STEEL PIPE PROCESSING FACILITY	800 T/year	3,13
10	WATER AND ELECTRICITY FACILITY		247
11	PETROL AND OIL WAREHOUSE	40 T	429
12	LANDFILL		25,61
	TOTAL OF PLANT		13,60
	GRAND TOTAL		7.6
IV	HOUSE, PUBLIC WORKS AND OTHER FACILITIES		AREA
A	WATER PUMP STATIONS		
B	KRONG NO SAND MINE		
C	BOARD A + CONSULTANT IN DAM AREA		0.20
D	HOUSE & OFFICE FOR CONTRACTORS		
	- DAM ROUTE & WATER INTAKE	1,492 people	1.30
	- SUB-TUNNEL NO. 2, 3 &	609 people	0.53
	- PLANT	250 people	0.24
E	POLICE STATION		0,04
F	35/22 KV SUBSTATION		0,11
	GRAND TOTAL		
	HOUSE & OFFICE FOR CONTRACTORS		2.2
	PUBLIC WORKS		0.16
	AUXILIARY AREA		7.6
	MINE + LANDFILL		14.1
	GRAND TOTAL OF ENTIRE WORKS		24.1

Figure 1.3: TOTAL CONSTRUCTION GROUND - PROPOSED PLAN

1.4.3 Main Work (according to the proposed plan)

Work layout according to the proposed plan is shown in *Figure 1.3 Diagram of total construction ground - Proposed plan* on previous page. Specifically:

a) Cluster of focal point:

It includes main dam and spillway, which form a reservoir.

1. Reservoir*:*

The reservoir is about 12.5 km long along the Tra Khuc River with the largest width of over 1.2 km, and average width of about 350 m.

Corresponding to normal water level: 410 m; the reservoir has surface area (F) of 9,12 km^2; Gross capacity (V_{tb}): 249.3 million m^3; Useful capacity (V_{hi}): 205.25 million m^3. The maximum depth of the lake in normal water level is about over 60 m.

Corresponding to dead water level: 375 m; The reservoir has surface area (F): 2,83 km^2. Dead capacity (V_c): 44.04,10^6 m^3; And the extraordinary water level during check flood discharge p = 0.1% is 412.2 m.

2. Main dam:

It is located on Dak Drinh River at route 2, which is a gravity concrete dam by roller compacted concrete with maximum height ≈ 94 m, vertical upstream roof, downstream roof m = 0.8. The length of the dam along the top is 360 m. The foundation of the dam is granite at zone 1B and reinforced 5 m. Distance between the boreholes is 3.0 m. The depth of the drainage borehole is 0.6 that of the waterproof drill. The water drainage boreholes are arranged 3 m apart.

3. Spillway:

It is located in river bed with elevation of 395 m, including 4 compartments with size of 14 x 15 m and design discharge of Q = 6480 m^3/s. The dam has a practical cross-section and has a height of 75 m. Energy dissipation after overflow is launching unit, the flow after overflow discharges directly into the natural river bed. The dam is equipped with 3 arc valve gates for regulation and they must be repaired. The arc valve gates are controlled by hydraulic lifters and must be repaired by hoisting hoists.

b) Energy route:

It includes the inlet canal, water intake, pressure tunnel, pressure pipeline, hydropower plant and downstream discharge channel, outdoor distribution station.

1. Inlet cannel and water intake

The water intake is located in the right channel of the lake, about 4 km in direction of upstream from the dam route, with two main parts: there will be a garbage screen and a repair valve gate at the beginning of the tunnel. Well (vertical type) located at the operating valve is located 110 m from the tunnel door with Q design of 47.6 m^3/s. Valve gate size (BxH) is 3,9x3,9 m. In front of the water intake, there is a system of garbage screens, garbage collectors, and valve winch. Garbage screen and the repair gate are operated by mobile crane.

2. Pressure tunnel:

The pressure tunnel has a diameter of 4 m and a length of 10,214 m.

3. Pressure pipeline:

The open steel pressure pipeline has length of 543 m and diameter of 2.9 m.

4. Surge tank:

Pressure tower has type of vertical wells with diameter of d = 6 m and height of H = 174 m.

5. Plant:

It is located in village 1, Son Tan commune. This is an open type plant; the number of units is 2. Capacity of each unit: N_{tm} = 62.5 MW. Turbine type: Center shaft. Maximum flow through the plant: Q_{max} = 47.6 m^3/s

6. Outdoor distribution station:

Voltage level is 110 kV. It is 200 m from hydropower plant. Size is 65 m x 36 m.

The basic parameters and main characteristics of Dak Drinh Hydropower Project are detailed in *Table 1.4* below:

Table 1.4: Basic parameters and main characteristics of Dak Drinh hydropower project

NO.	PARAMETER	UNIT	VALUE	REMARK
I	**Catchment characteristic**			
1	Selected catchment area	km^2	420	
2	Average flow for many years			
	Total flow amount	10^6 m^3	971	
	Annual average flow	m^3/s	30.8	
3	Guaranteed flow rate (Qp) p = 90%	m^3/s	13.0	
4	Calculated flood flow (Qp)			
	Design flood p = 0.5%	m^3/s	6480	
	Conductor flood p = 5%	m^3/s	4040	
	Test flood p = 0.1%	m^3/s	8370	
II	**Reservoir**			
1	Normal water level	m	410	
2	Dead water level	m	375	
3	Extraordinary water level during test flood discharge	m	412.2	
4	Lake surface area (F)			
	Corresponding to normal water level	km^2	9.12	
	Corresponding to dead water level	km^2	2.83	
5	Reservoir capacity			
	Total capacity V_{tb}	10^6 m^3	249.3	
	Dead capacity (Vc)	10^6 m^3	44.04	
	Useful capacity (V_{hi})	10^6 m^3	205.25	
III	**Downstream water level of plant**			
1	Maximum water level	m	90.2	

NO.	PARAMETER	UNIT	VALUE	REMARK
2	Minimum water level	m	76.0	
IV	**Water column**			
1	Maximum (H_{max})	m	330.6	
2	Minimum (H_{min})	m	268.5	
3	Calculation (Htt)	m	301.9	
4	Average (Hbq)	m	314.5	
V	**Energy indicators**			
1	Installed capacity (Nlm)	MW	125	
2	Guaranteed capacity (Nđb)	MW	35.77	
3	Average electricity for many years (E)	10^6 kWh	527.9	
4	Guaranteed electricity (Eđb)	10^6 kWh	321.6	
5	Number of hours using the installed capacity	hour	438.5	
VI	**Features of the Work**			
1	***Main dam***			
	Type of dam	m	RCC	
	Dam elevation at the top of the dam	m	414.5	
	Length along the top of the dam	m	360	
	Maximum height		94.0	
2	***Spillway***			
	Type		With valve gate	
	Threshold elevation	m	395	
	Dimension	m	4x14x15	
	Height from the top	m	74	
	Maximum height	m	75	
3	***Water intake***			
	Type		Vertical well	
	Design flow	m^3/s	47.6	
	Gate valve (BxH)	m	3.9 x 3.9	

NO.	PARAMETER	UNIT	VALUE	REMARK
	Garbage screen - Size (BxH)	m	2 x 3.8 x 69	
4	***Pressure tunnel***			
	Type		With pressure	
	Dimension (D)	m	4.0	
	Design flow rate (Q)	m^3/s	47.6	
	Length (L)	m	10,214	
	Number of pipelines		1	
5	***Pressure pipeline***			
	Type		Steel	
	Dimensions (D)	m	2.9	
	Design flow rate (Q)	m^3/s	47.6	
	Length (L)	m	543	
	Number of pipelines		1	
6	***Hydropower plant***			
	Type		Open	
	Number of units	Group	2	
	Unit capacity of unit (Ntm)	MW	62.5	
	Turbine type		Shaft center	
	Plant maximum flow (Q)	m^3/s	47.6	
	Dimension (LxB)	m	56 x 18	
7	***Distribution station***			
	Type			
	Voltage level	KV		
	Dimension (LxB)	m		
8	Synchronous grid system (Line)		110 kV, 70 km	
VII	**Main volume**			
1	Soil digging, stone digging			
	Soil	10^3 m^3	1247.01	

NO.	PARAMETER	UNIT	VALUE	REMARK
	Open stone	10^3 m^3	247.45	
2	Soil filling, stone fillung			
	Soil	10^3 m^3	93.0	
	Stone	10^3 m^3	26.4	
3	Open concrete	10^3 m^3	170	
4	Roller compacted concrete RCC	"	580	
5	Steel reinforcement of all types (including structural steel)	T	5148	
6	Cement drilling and filling	10^3 m^3	35.7	
7	Hydro-mechanical and electromechanical equipment	T	2391	
VIII	**Economic and financial indicators**			
1	**Total investment (price in 1st quarter of 2008)**	**10^9 VND**	**3423,059**	
	a. Power supply	**“**	**3242,344**	
	b. Power transmission grid	**“**	**180,715**	
2	**** Economic indicators according to 2014/QD-NLDK*** (With electricity price of USD 0.048/KWh)			
	EIRR	%	12.35	
	B/C		1.23	
	NPV	10^9 VND	481.653	
3	**** Investor's financial targets*** (Contributed capital of 29.19%) electricity selling price of USD 0.048/kWh.			
	FIRR	%	10.20	
	B/C		1.01	
	NPV	10^9 VND	30.280	

c) Auxiliary Works

In the auxiliary areas, there will be landfills, material storage yards, batching plants; project management and operations management area, contractor camps. There are also other Construction Works: material mines (quarries, sand mines); water supply system, power supply system, communication system; roads for construction.

1. Construction material mines:

Exploration of cohesive soil mines includes: 6 mines (Mine A, Mine B, Mine C, Mine D, Mine E, Mine F), with reserves level C1.

Quarry exploration work includes: 4 quarries (Quarry No. 1, Quarry No. 2, Quarry No. 3, Quarry No. 4) with reserves level C2.

The exploration of reserves of sand mines includes 1 mine, level C2.

For dam embankment and waterproofing components, it is expected to use colluvium soil on granite foundation, which is 0.5 to 1.5 km away from the site. The results of survey and laboratory tests showed that the soil mines are expected to meet the requirements of quality and reserves for dam embankment. However, with the option of choosing RCC dam structure, there is no need to use soil mines.

Stone material for dam embankment, roof paving and concrete, which is expected to be exploited from granite-granodiorite in Quarry No. 1,2 and 3 distributed scatteredly from Quarry No. 2 to water intakes. Gneis stone at quarry no. 4 is for construction of the factory and surge tank. Stone is very hard with saturated compressive strength of 780-960 kG/cm^2. With the option of choosing RCC dam structure, it is not necessary to use all quarries like Face Rockfill Dam and quarry no. 1 is enough for project.

The following is description of construction material mines within the scope of the project:

- ***Quarry No. 1***: It is located on the left bank and about 500 m from the downstream of Dam Route 2. The riverbed and the river bank are completely exposed. The average removed thickness is 17 m, the removed volume is about 2.2 million m^3 with the exploitation area of 5.62 ha and useful reserve of about 2, 67 million m^3.

In exploitation: Opening the curb by the form and method of blasting in small diameter hole with space. The entire area of the mine for safety protection when blasting is 26.5 ha (ensuring safety radius >200 m). Mining mechanical excavation is conducted from top to bottom. Stone is processed by machine.

- ***Sand mine***: Along the Dak Drinh River and from the upstream to the hydropower plant area, there are mostly pebbles and gravels on the river bed. Sand is very little and scattered to create small areas running along the river. From the plant area to the Son Ha bridge and along the river, there are some small sandbanks, where the riverbed is widest and the most deposited sand is a meandering area with length of about 3 km This location is about 25 km from the center of Son Tay district, about 13 km in direction of downstream from the hydropower plant. Here, sand mines are arranged. The reserve is about 3 million m^3, the sand quality is quite clean with middle-coarse grains. Such location is convenient in terms of transportation distance. The above reserve is enough for the project.

The calculation of reserves and criteria of construction materials including soil filling, stone and sand for making concrete chips is shown in Appendix 1.1 ÷ 1.4.

2. Warehouse and storage of materials

Warehouses include 3 types: closed warehouse, covered warehouse and open warehouse.

Closed warehouse type used to store cement, electrical equipment, spare parts for construction equipment… The closed warehouse has a structure of steel trusses with corrugated iron or fibro-cement roof, walls covered with corrugated iron, cement mortar floor.

Covered warehouse type with corrugated iron roofing structure, cement mortar floor. Covered warehouse type is used to store sawn timber, wood semi-finished products, iron and steel. Covered warehouse has corrugated iron roofing structure and cement mortar floor.

Open yard is used to store sand, crushed stone… and has a ground covered with crushed stone with thickness of 30 cm.

There are also a number of specialized warehouses such as petroleum depots, explosives depots… with own suitable structure.

3. Office of management board and auxiliary areas

The auxiliary items and houses are only used for a few years during construction phase. Therefore, except for some items that are used after the completion of the work construction, the structure of the auxiliary items will be temporary, easy to install and dismantle. The house is expected to have 2 types: Administrative house (type 1) and Workshop (type 2). House with type 1 has a brick structure with steel trusses, precast concrete columns, corrugated iron roof, cement mortar floors, plywood or fiberboard ceiling. House with type 2 is used for workshops with frame structure, corrugated iron roof, corrugated iron walls.

Office of Operation and Management Board is expected to be located in Quang Ngai with construction area from 8000 – 8500 m^2.

4. Internal roads of construction site

**** External roads of construction site***

Road for construction and operation is located on the right bank of Dak Drinh river. The starting point of the route is at Son Tay township. The end point of the route is located in Son Dung commune, about 5 km from the dam site. From here, a new section is built to connect to the dam site. The total length of the route is 20 km. This road will be renovated and upgraded before constructing the main works with grade 4 in mountainous areas, road foundation width of 7.5 m, road surface width of 5.5 m.

The route ensures the required transportation of materials, equipment and construction services, travel requirements during operation.

**** Internal roads of construction site***

There are 3 types of internal road system for construction in construction site as follows:

- *Construction - operation roads*: they are routes to operate the work later. During the construction phase, they are used as construction roads. These routes include: road for excessing construction site, road to pressurized well, road to Valve House, road on top of dams.

- *Temporary fixed roads for construction*: they are roads that serve only the construction of works but are fixed during the construction process. These routes are designed to meet the transport requirements between the auxiliary areas and the main construction site and to different dam areas on both banks. Including:

+ Road to the auxiliary tunnels.

+ Road crossing the river to connect the left bank of the dam.

+ Roads to quarries and explosives warehouses.

+ Main road to the foundation pit.

- *Road for construction on top of cofferdam and to foundation pits*: This road exists only in a certain construction period.

5. Communication system for construction:

The information assurance within the construction site as well as from the site to the outside will be undertaken by the Contractor providing professional information services.

1.4.4 110 kV line connecting Dak Drinh hydropower plant with national power system

(See *Figure 1.4: Route diagram of the 110 kV line connecting Dak Drinh hydropower plant to national power system* on the next page).

The 110 kV line connecting Dak Drinh hydropower plant to the national power system (D110 kV line form Dak Drinh - Doc Soi hydropower plant) to connect Dak Drinh hydropower plant to the national power system, improving reliability and stability for the regional 110 kV grid.

a) Route description

Dak Drinh hydropower plant - Doc Soi 110 kV line has length of 56,835 km. Starting from the starting point is the outdoor distribution station of Dak Drinh hydropower plant, going through Son Tay district, Son Ha district, Son Tinh district and Binh Son district - Quang Ngai province to the end point of 220/110 kV Doc Soi substation. Route description is detailed in Table 1.5.

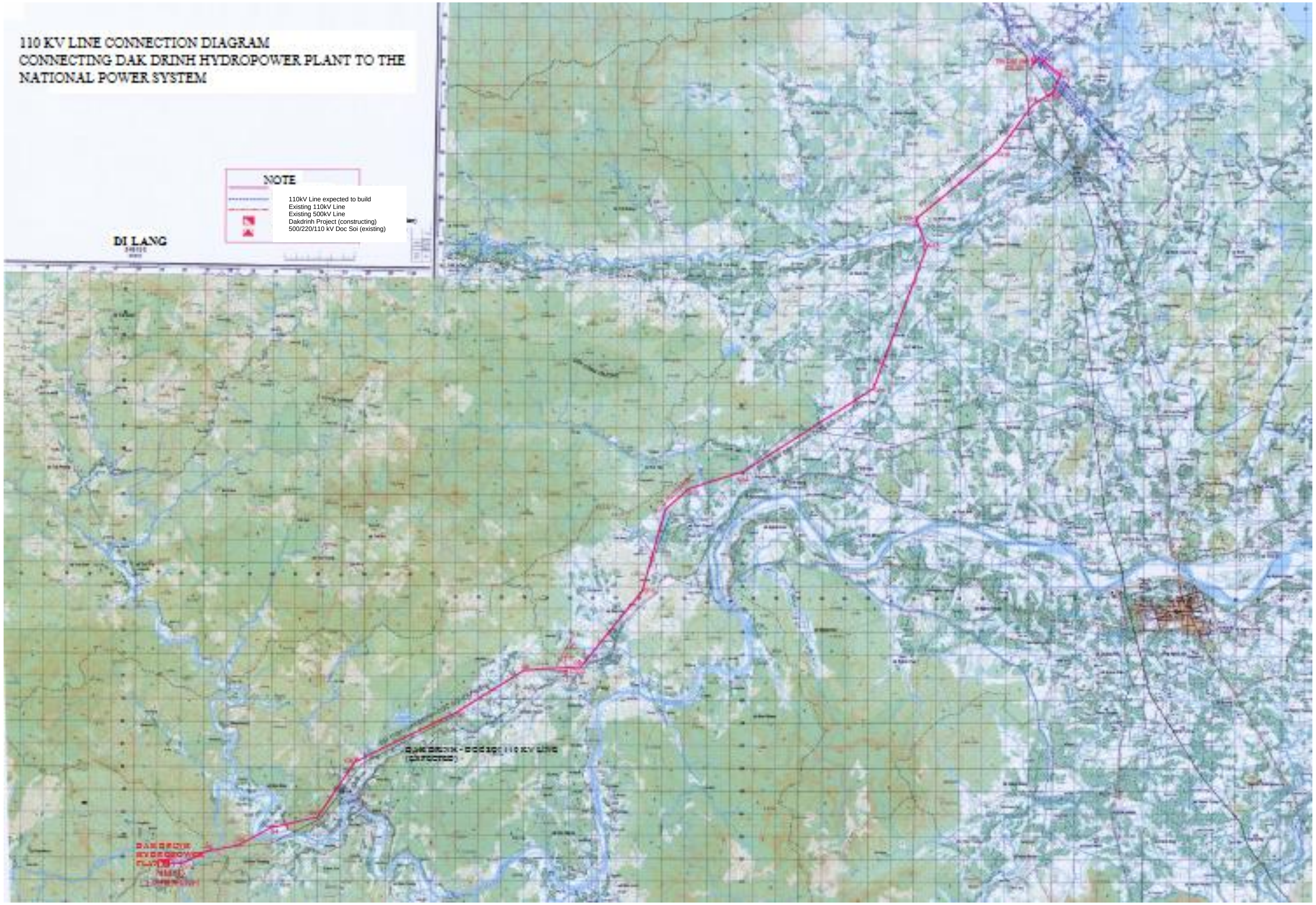


Figure 1.4: ROUTE DIAGRAM OF THE 110 KV LINE CONNECTING DAK DRINH HYDROPOWER PLANT TO NATIONAL POWER SYSTEM

Table 1.5: Description of Dak Drinh hydropower plant - Doc Soi 110 kV line

No.	**Administrative unit**	**Corner**	**Line length (^{m})**	**Intersection with River/Line/Road**	**House in HLT**	**Vegetation cover**
I	**Son Tay district**					
1	Son Tan Commune	ĐĐ - G2	1759	- Provincial road DT 630A: 02 times. - Dak Drinh River: 01 time	1	The topography of the area is high hills and mountains that are always separated by streams with relatively high elevation fluctuations. Vegetation cover is mainly rice, mixed plants and some crops
II	**Son Ha district**					
2	Son Bao Commune	G2-G4	3029	- Dak Drinh River: 01 time - Tra Khuc River: 01 time	0	The topography of the area is high hills and mountains that are always separated by streams, crossing Tra Khuc River, passing through high hills and riverside plain. Vegetation cover is mainly mixed plants and a few crops, rice fields.
3	Di Lang township	G4-G7	9916	- Soil road to Son Bao: 01 time. - Medium voltage line: 02 times.	5	The topography of the area is relatively high hills and mountains and riverside plains with relatively large elevation fluctuations. Vegetation cover

No.	Administrative unit	Corner	Line length (m)	Intersection with River/Line/Road	House in HLT	Vegetation cover
						is mainly pine and rice fields, crops and mixed forests
4	Son Thanh Commune	G7-G8	1870		0	The route goes along the hillside. The terrain is relatively low. Vegetation cover is mainly eucalyptus forest and a few crops.
5	Son Ha Commune	G8-G10	4940	- Medium voltage line: 01 time - Low voltage line: 01 time - Concrete road: 01 time - Inter-commune asphalted road: 02 times.	0	The topography of the area is relatively low. Vegetation cover is mainly rice, crops, planted forests and dense trees
III	**Son Tinh district**					
6	Tinh Giang Commune	G10-G10A-G12	6570	- Medium voltage line: 03 times. - Inter-commune road: 02 times. - Ho Mon Lake: 01 time	4	The route goes through low hills and plains with low altitude fluctuations. Vegetation cover is mainly crops, rice, sugarcane mixed with a little mixed forest
7	Tinh Dong Commune	G12-G13	2523	- 500 kV Pleiku - Doc Soi line: 01 time.		
8	Tinh Hiep Commune	G13-G14	6754	- Low voltage line: 01 time. - Information line: 01 time. - Inter-commune	5	

No.	Administrative unit	Corner	Line length (m)	Intersection with River/Line/Road	House in HLT	Vegetation cover
				road: 01 time.		
9	Tinh Tra Commune	G14-G15	681	- Medium voltage line: 04 times. - Inter-commune road: 03 times	2	
IV	**Binh Son district**					
10	Binh My Commune	G15-G16	5958	- Medium voltage line: 04 times. - Provincial road ĐT622: 01 time - Inter-commune road: 03 times Tra Bong River: 01 time	7	The route goes through the plain terrain mixed with households living independently. Vegetation cover on the route are mainly rice and crops
11	Binh Minh Commune					
12	Binh Trung Commune	G16-G17	2528	- Medium voltage line: 01 time. - Railway communication line: 01 time. - North - South railway: 01 time - Inter-commune road: 01 time		The route passes through the plain with relatively flat terrain. Vegetation cover on the route are mainly rice, sugarcane and cassava
13	Binh Nguyen Commune	G17-G20-ĐC-500 kV Doc Soi Substation	3267	- Medium/low voltage lines: 02/02 times. - National highway 1A: 01 time - Inter-village road: 02 times - Doc Soi - Quang Ngai 110 kV line: 04 times - Branch of Tra		

No.	Administrative unit	Corner	Line length (m)	Intersection with River/Line/Road	House in HLT	Vegetation cover
				Bong river: 02 times		

b) Safety corridor for the line

Corridor of the route is defined as 13-15 m (according to Decree 106/2005/ND-CP dated August 17, 2005 of the Government, for the 110 kV power transmission line limited by two vertical planes parallel to the line with a distance of 4 m to the outer conductor.

For trees and crops: rice, crops and plants are only allowed to be planted at least 0.5 m from the edge of the electric pole foundation, anchor foundation. Other crops can be planted but the distance from the highest vertically top point to the height of the lowest wire at stationary state is not less than 3.0 m.

For houses and Works: Conditions for houses and Works to exist in the safety corridor of 110 kV high-voltage grid:

- Roof and wall must be made of incombustible substances;
- Metal roof, frame and wall must be grounded according to the regulations on grounding techniques;
- Do not obstruct access roads for inspection, maintenance and replacement of high-voltage grid components;
- Distance from any part of the house or building to the nearest conductor when the wire is in the stationary state is not less than 4 m.
- Electric field intensity ≤ 5 kV/m at any point outside the house must be 1 m from the ground and ≤ 1 kV/m at any point inside the house must be 1 m from the ground.

c) Main features of the 110 kV line route

Table 1.6: Main features of Dak Drinh hydropower plant - Doc Soi 110 kV line

Voltage level	: 110 kV
Number of circuits	: 2 circuits
Starting point	: Dak Drinh Hydropower Plant
End point	: Doc Soi 110 kV substation
Route length	: 56,835 km.
Electrics wire	ACSR240/32 steel core aluminum wire.
Lightning conductor	01 wire with GSW5/16"galvanized steel cable, 01 lightning conductor combined with OPGW 50 fiber optic cable.
Column	2-circuit steel tower column, made from galvanized steel by hot dip method, assembled by bolts.
Foundation	Foundations are made of cast in situ place reinforced concrete.
Number of steering angles	: 22 angles (excluding starting point and end point).
Maximum steering angle	: G19, $\alpha t = 74^o44'10''$
Minimum steering angle	: G10, $\alpha t = 03^o06'01''$

Longest edge	: G13- G14 with length of 6754 m
Shortest edge	: G20 - ĐC with length of 303
Number of times crossing through road and rail cuts	: 21 times
Number of times crossing rivers and lakes	: 07 times (Dak Drinh River, Tra Bong River).
Number of times crossing power line	: 28 times
Number of houses in corridor	: 24 houses

1.4.5 Resettlement areas

(See *Figure 1.5: Diagram of the Master Plan for Dak Drinh Hydropower Project resettlement areas and transportation network, power supply for resettlement areas* on page 23).

The area of reservoir bed and focal Work, Dak Drinh Hydropower Project energy route directly affects houses and residential land of 640 households/2976 people, agricultural land of 674 households/3032 people in Dak Rinh commune and Dak Non commune, Kon Plong district, Kon Tum province and Son Dung commune, Son Mua commune, Son Tan commune, Son Tay district, Quang Ngai province.

The above households are mainly local ethnic minorities whose life is still difficult; therefore, it is necessary to build resettlement areas to relocate the above affected households.

a) Scale of population arrangement and land area of resettlement areas

Determination of size of population arrangement and required land area of the resettlement areas is based on:

- Number of people requiring resettlement at present (in 2007) and forecast to 2010.
- Norms of land according to state regulations.
- Actual situation of the local land fund and the agreement between the owner and the People's Committee of Kon Tum province and Quang Ngai province

From there, it is possible to determine the demand for land used for agricultural production and residential areas. The results are shown in *Table 1.7* below.

Table 1.7: Statistics on land use demands in resettlement areas – Dak Drinh Hydropower Project

Name of resettlement area	Demand for land use Area (ha)	Number of resettled households (household/household)		Note
		Present 2007	Forecast 2010	
Resettlement areas of Kon Plong district - Kon Tum province:				
a/ Resettlement Area of Dak Nen Commune:				

1. Nuoc Bao Area: - Land for production and traffic - Residential land	259.34 234.18 25.16	166/805	178/865	
2. Nuoc Dop – Nuoc Buc Area - Land for production and traffic - Residential land	150.16 135.51 14.65	96/500	103/538	
b/ *Resettlement Area of Dak Rinh Commune*: 3. Nuoc Doa Area: (Land for production)	47.36	34/156	36/172	
Resettlement area in the communes of Son Tay district, Quang Ngai province:				
c/ Resettlement Area of Son Mua Commune: 4. Nuoc Vuong Area - Land for production and traffic - Residential land	144.18 130.24 13,94	90/416	99/458	
d/ Resettlement Area of Son Dung Commune: 5. Nuoc Lang Area: - Land for production and traffic - Residential land	187.72 169.71 18.01	117/484	129/532	
6. Anh Nhoi Hamlet Area: - Land for production and traffic - Residential land	273.5 247.33 26.17	171/671	188/738	

b) Description of resettlement areas

Location and area of resettlement areas are agreed between the investor, representatives of affected households and local authorities.

**** Resettlement areas of Kon Plong district - Kon Tum province:***

Resettlement area of Dak So Commune: There are 2 resettlement areas arranged as follows:

1. Nuoc Bao area: (in Groups 11 & 12 - resettlement for 178 households in the villages of Nuoc Bao, Ngoc Sang, Ngoc Na, Tu Let, Tu Thon, Tu Ngu) located between the land of

Nuoc Bao 1 and Nuoc villages. Bao 3, about 600 meters from Nuoc Ta Meo River. Resettlement area will be arranged along a stream in the downstream of Nuoc Ta Meo tributary lake.

2. Old Nuoc Dop - Nuoc Buc resettlement area (for 103 affected households in Nuoc Dop, Nuoc Tieu): Resettlement area is located opposite the group 10 of Son Dung commune, about 1 km from present Nuoc Tieu village to downstream of Dak Ro Man river. The resettlement area is located on two sides of Nuoc Cuc stream or Nuoc Mau stream.

Resettlement area of Dak Rin commune:

3. Resettlement area of Nuoc Doa Village: Only production land is allocated for 36 resettled households in Nuoc Doa village. Production land is arranged close to the current residential area of the village.

**** Resettlement area of the communes of Son Tay district, Quang Ngai province:***

Resettlement area of Son Mua commune:

4. Resettlement area of Quarry No.1 (belonging to Group 16): It is about 1.8 km in direction of downstream from Dak Rinh and Dak Roman junction. It is located in Son Mua commune. Production land will be allocated for 99 households of the quarry area. These households are located in Group 16 area. (According to the layout of the commune and district agreed in the minutes made on July 9, 2005 at the commune and the district official letter No. 158/UBND of Son Tay district dated July 12, 2005)

Resettlement area of Son Dung commune: There are 2 resettlement areas, including:

5. Resettlement area of Nuoc Lang village: 129 households in Nha Nuong village and Group 10 are arranged for resettlement. This area is about 1 km from the confluence of Dak Roman and Ra Phan rivers in direction of upstream of Ra Phan river and about 500 m from the banks of Ra Phan river. The resettlement area is located along the Chit stream.

6. Resettlement area of Anh Nhoi village: 188 households (group 16) from Ra Phan crossroad to Dak Roman stream are arranged for resettlement. This resettlement area is used to arrange for households of Group 22 and Nuoc Dop. The resettlement area is located along Ra Phan and Ra Linh streams.

The location of the resettlement areas is shown in *Figure 1.5: Diagram of the Master Plan for Dak Drinh Hydropower Project resettlement areas and transportation network, power supply for resettlement areas*.

c) Master plan and infrastructure construction of resettlement areas

Construction standards for resettlement areas are based on the current Vietnamese standards that have been applied to newly built hydropower projects in the Central Highlands.

1/ Division of residential land and organization of residential land lot space for resettled households:

Household's residential land is divided with a scale of 1000 m^2/household according to prescribed standards and size of the land plot is designed depending on the micro-topographic features. The land plots are designed in a rectangular shape, with a road surface length of 25-30 m and a depth of 35¬40 m depending on the location of the area. Areas where the terrain is steep or at the corner positions ensure that the lots are not more than 1200 m^2/lot and not less than 800 m^2/lot.

House designs are consistent with the tradition and must be agreed by the resettled households. The construction area of houses and auxiliary works is 55 m^2. An auxiliary works such as a kitchen, a place for storing farming tools to be arranged behind the house. Toilets, livestock barns are in the back garden, which is 10-15 m away from houses and wells. The direction of the house is mainly on the road surface, limiting the house’s direction at the end of the slope.

2/Organization of space and construction of public areas:

For Dak Nen commune, entire commune administrative center and public works will be built. Public works will be built with typical architecture of the area, with elegant shapes and suitable functions. The priority position is selected on high land, which is convenient for transportation. The campus is planned outside the works with area for green trees, yards, roads to create landscape for the environment.

The public works to be built in Dak Nen commune include: Cultural House, Sports Are, Clinics, Kindergartens and Preschools, Schools.

3/Technical infrastructure system:

Technical infrastructure system includes: access roads to resettlement areas, internal roads, in-field roads, drainage systems, water supply and electricity supply (See *Figure 1.5: Diagram of the Master Plan for Dak Drinh Hydropower Project resettlement areas and transportation network, power supply for resettlement areas*).

Access road to resettlement areas and main road passing through the center of the resettlement areas is designed according to the standard of grade A road in rural mountainous areas with asphalted surface. The internal and in-field roads of the resettlement area are designed according to the standards of grade B roads in rural mountainous areas, with aggregate surface.

Drainage and sanitation system: Rain water overflows on the surface of the area in the steep direction of the terrain, concentrating on ditches, drains running along the internal roads, then focusing on streams and lakes.

Because the resettlement areas are located near the lake, all households are built with sanitation and drainage systems for daily life with proper treatment before discharging them into streams and lakes, meeting the standard of grade A in TCVN 5942-2005. (Surface water quality standard)

- Centralized water supply system: Ensuring the standard of water supply for daily life of 100 liters/person/day. The water source is a drilled well or a dug well. Each household has a water storage tank with a capacity of 1.0 - 2.0 m^3. Public buildings are supplied with water from a centralized system similar to that of households and have a spare water tank.

- Power supply system: Ensuring electricity supply for daily life and production for resettled households according to current standards.

On the basis of that Master Plan, infrastructure of resettlement areas is built with the following scales:

Table 1.8: Infrastructure construction demands in the resettlement areas

Item		**Son Tay district resettlement area**	**Kon Plong district resettlement area**	**Total**
1. Demand for land area for resettlement area construction	Ground of resettlement area (ha)	58.12	39.81	97.93
	Residential land adjacent to garden (ha)	55.01	37.29	92.30
	Construction land (m)	3.11	2.52	5.63
	Agricultural land (ha)	547.29	417.05	964.34
2. Demand for traffic construction.	Road to the resettlement area (km)	4	33	37
	Improvement road (km)	10	-	10
	Resettlement internal road (km)	8.24	5.62	14.86
3. Demand for construction	22 kV line (km)	3	30	33
	0.4 kV line (km)	8.24	5.62	14.86

of power supply works	50 kVA substation (station)	3	3	6
4. Demand for construction of water supply works	Water supply demand for production (ha)	416	318	734
	Domestic water supply demand (household)	416	282	698

The current status of resettlement areas is presented in detail in the section on *Sources of impacts from site clearance and construction of resettlement areas in Chapter 3*.

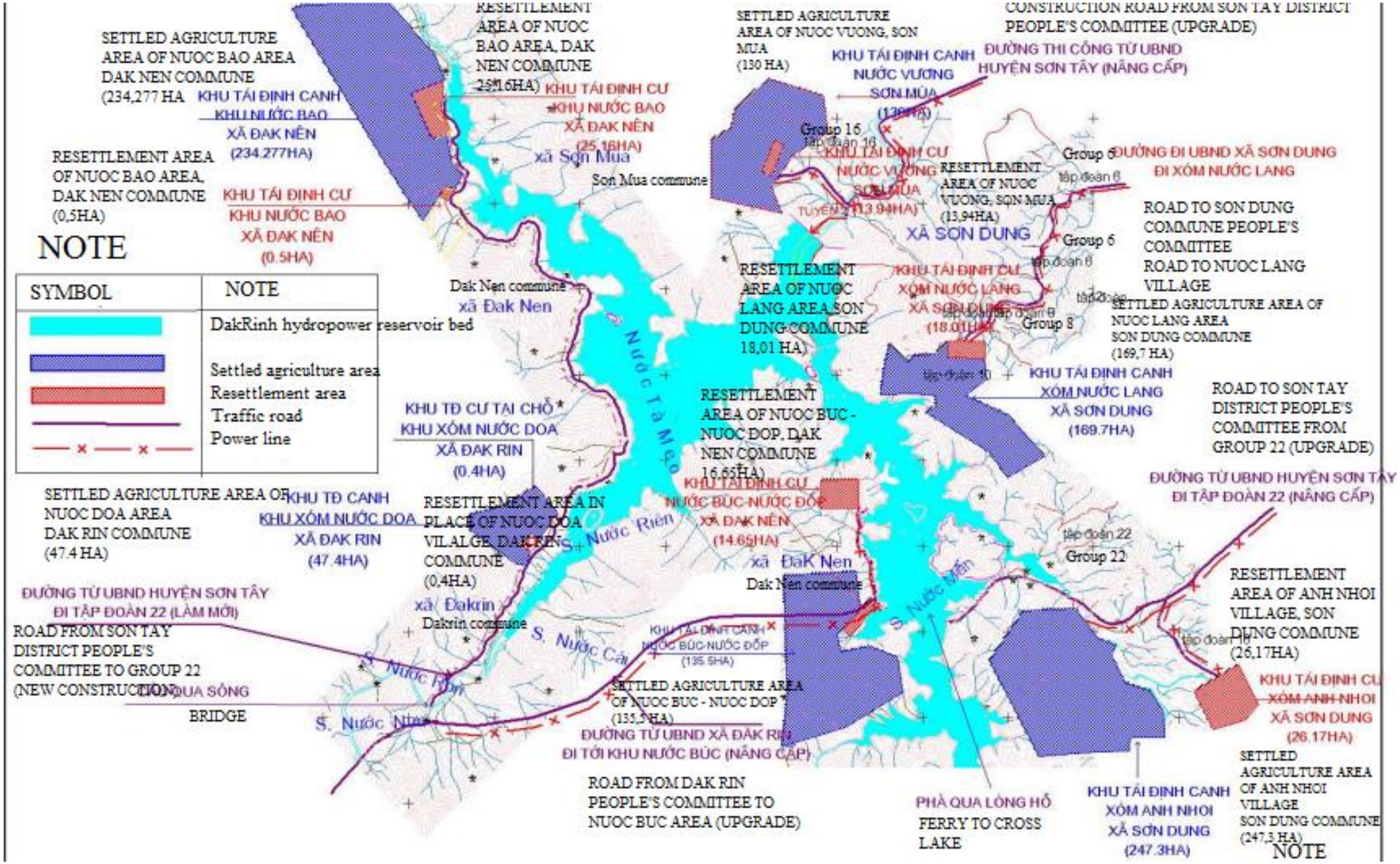


Figure 1.5: APPENDIX 1.6: DIAGRAM OF MASTER PLAN OF RESETTLEMENT AREAS AND TRAFFIC NETWORK ARRANGEMENT IN DAK DRINH PROJECT

1.4.7 Demand for materials to be used

In the construction phase, all kinds of materials such as cement, steel, iron, explosives, asphalt, spare parts and equipment are taken from the Quang Ngai city via Da Nang port or train station. The demand for soil, stone, construction materials, fuel, and equipment is presented in Table 1.9:

In the operation phase, the demand for fuel is not large, mainly for administrative activities and replacing the oils used for turbines and transformers.

Table 1.9: Demand for using materials for DakDrinh Hydropower Project

No.	Material name	Unit	Volume	Source	Distance (km)
1	Cement	T	309436	Da Nang	235
2	Steel reinforcement	“	10030	“	235
3	Gravel	m^3	801579	In place	2
4	Sand	“	470492	“	40
5	Filling stone	“	58655	“	2
6	Rubble stone		8412	“	2
7	Filling land		122114	“	2
8	Explosive	“	326	Da Nang	235
9	Equipment	“	56	“	235
10	Mesh	m^2	37690	“	235
11	Steel plate	“	1943	“	235

1.4.8 Power source for construction

Power grid in the project area has now been brought to Son Tay town for domestic use. However, the capacity is too small compared to the construction demand of the site (6,800 KVA). Power supply plan for construction is as follows:

- The power supply source for the project is expected to build a new 35 kV (22 kV) line branching from the existing Son Ha line with a length of about 13 km, size of AC-95 wire. This line is designed in the permanent form to provide back-up power for the Plant later. Load demand for the site during construction is about 5,900 kW.
- From the main medium-voltage line, branch lines will be built to supply power for other construction works with a total length of about 7 km.
- Production areas using the 0.4 kV voltage level will be supplied from the 35(22)/0.4 kV substation.
- Low voltage stations are designed in the form of hanging on columns, mounted on beams or placed on the ground depending on the capacity of the station. The high-pressure side is

protected by FCO, the low-pressure side is protected by a 600 V circuit breaker with appropriate cutting power.

1.4.9 Construction progress

Project implementation is organized according to the following phases:

a) Investment preparation

Project management in this period was previously carried out by the Infrastructure Development and Construction Corporation and now transferred to Đakđrinh Hydropower Joint Stock Company. Mission in this period is to survey and design investment project reports to submit to competent authorities for evaluation and decision-making on investment.

b) Investment implementation

In the form of Project Manager, Đakđrinh Hydropower Joint Stock Company, as the Project Manager, will sign a contract with the Design Consultant, the Contractor for construction and equipment installation supply, and supervision of the entire project implementation process.

d) Project operation: After the project is completed, Đakđrinh Hydropower Joint Stock Company will manage and operate the plant and 110 kV line.

c) Implementation schedule

1. Investment preparation: 2004 - 2008

2. Construction preparation: 2008. To be able to start construction soon in late 2008, the items will have to be completed before commencement:

- Commencing yard is located in upstream of the Dam route
- Road to foundation pit of dam and sub-tunnel no. 2 and 3.
- Office of management board of construction site.
- Temporary explosives warehouse.
- Original base camp, supplies warehouse and parking lot.

3. Construction period: 2008 - 2011

Dak Drinh hydropower project is a relatively large scale with a long tunnel leading water to the hydropower plant. Based on the fact that some constructions such as Ialy, Song Hinh, Ham Thuan - Da Mi and A Vuong, Plan is considered and proposed a 4-year schedule, which power generation is expected in the fourth quarter of the fourth year of construction.

- Time for construction of main dam: 45 months.
- Time for construction of spillway: 45 months.
- Time for construction of water intake: 36 months.
- Time for construction of hydropower plant: 50 months.
- Time for construction of tunnel: 46 months.

- Time for construction of 110 kV line: 03 months.

Underground construction often determines a project's completion date and construction schedule. The main progress milestones are as follows:

+ January of the second year: Water is discharged through the diversion culvert.

+ December of the second year: Completion of water intake concrete.

+ September of the third year: Dam is built to an altitude of 380 m.

+ The fourth quarter of the second year: Completion of pressure tunneling.

+ October of the third year: Basic completion of concrete factory

+ June of the fourth year: Completion of construction of tunnel concrete.

+ March of the fourth year: Installation of bridge over Tran peak.

+ August of the fourth year: Completion of spillway’s gate.

+ August of the fourth year: Installation of diversion culvert.

+ December of the fourth year: Generation at unit 1; February of the fifth year: Generation at unit 2.

+ Completion of 110 kV line before generating unit 1.

4. Operation phase: From 2012.

1.4.10 Total investment capital of the project

Total investment (price in 1st quarter of 2008)	**VND 3423,059.10^9**
a. Power source	**VND 3242,344**,10^9
- Main building	VND 2023,238,10^9
- Construction	VND 1459,768,10^9
- Equipment	VND 563,470,10^9
* Preparation of construction and synchronous HMCT	VND 92,286,10^9
* Compensation and resettlement costs	VND 281,421,10^9
* Project management costs	VND 22,969,10^9
* Consultancy costs	VND 117,545,10^9
* Other costs	VND 366,242,10^9
* Provision costs	VND 338,643,10^9
b. Power transmission grid	**VND 180,715,10^9**

CHAPTER 2: NATURAL, ENVIRONMENTAL, SOCIO-ECONOMIC CONDITIONS

2.1 TOPOGRAPHIC AND GEOMORPHOLOGICAL CONDITIONS

The project construction area is the transition zone between the low mountains in the East of the outermost and the high mountains of the Truong Son range, so there is a very strong cleavage, the large slopes have an average slope of 20 – 25^0. In many places, the slopes are 35 – 45^0, the elevation difference with the steep slopes is also quite large, on average 300 – 500 m, with many high mountains over 850 m. Dak Drinh River is the confluence of 3 small branches: Dak Drinh, Dak Meo and Dak Roman.

Dak Drinh branch originates from the Southern mountains of the map with an altitude of over 1,000 m flowing in the Southeast direction. Dak Meo branch originates from the Southern mountains with an altitude of over 900 m flowing in the North – Northwest direction. The river tributaries are relative straight, with the width of 20 – 50 m, the slope is medium – small. The network of streams and slots strongly develops throughout the flow in quantity and has a great slope and a small length.

Based on the above strongly divided terrain, the construction project area can be divided into the following terrain types:

- Type of valley slope with streams and rivers:

It is characterized by the hillsides with the slopes of (15 – 20^0) & (30 – 45^0), mainly composed of granite and gneiss soils – this type accounts for 75 – 80%

- Type of upside-down hill:

It is characterized by the slopes with the slope of < 15^0, distributed mainly at the peaks with their altitude of over 400 m and watershed saddles, mainly composed of granite and gneistoit soils – this type accounts for 10 – 15%.

- Type of low hills and mountains:

It is characterized by the geomorphology denuded at the top, low hillsides with the altitude of 50 – 250 m and accumulating in alluvial areas along rivers and streams. This type is distributed mainly at the beginning of 110 kV line (from hydropower plant to G14). It is composed mainly of the formation of eluvion and ruins on a granite foundation of Chu Lai formation (γcl).

- Type of plain mixed low hills:

It is characterized by an alluvial plain at the altitude of 8 – 15 m, sometimes divided by low hills with the altitude of 40 – 60 m. This type is mainly distributed at the end of 110 kW power line (from G14 to Doc Soi 220/110 kV substation). It is composed mainly of the formations of ancient deposits ($aQ_{I – III}$).

2.2 GEOLOGICAL CONDITIONS

2.2.1. Overall geological conditions of the project area

The overall geological conditions of the project area are shown in *Figure 2.1: Tectonic geological map of reservoir area and focal point of Dak Drinh Hydropower Project* on the next page.

a) Geological structure:

The Work area is located in the Kon Tum protrusion near the Northern edge, the focal point of Work area distributes the following types of soil and rock:

- Metamorphic soils and rocks of Tac Po formation (PR_1tp): distributed in the area of energy route, with a highly variable and flexural direction, and thickness of about 2,500 m. It includes quartz schists – biotite, diorite – gneiss, plagio – gneiss biotite which are metamorphic rocks from primitive rocks such as basalt, andesite, dacite, limestone and marlstone. The rocks have a band structure alternating between light and dark colors.

- Soils and rocks of Ben Giang – Que Son (PZ_3bg – qs_3) and Hai Van (aT_3hv_1) intrusive complexes: including granite, granodiorite, diorite distributed in the dam site, tunnel and reservoir.

Deposits in river and stream terraces (aQ^1_{IV}), deposits in alluvial areas and riverbeds (aQ^2_{IV}), undivided eluvial – deluvial deposits (edQ – eQ_{iv}): including the formations of unconsolidated deposits of alluvial area, distributed along river and stream valley. The composition includes sand, clayed sand, pebble, gravel, and boulder.

b) Tectonic structure:

Dak Drinh river basin is limited by Tra Bong deep fault in the North, Ba To – Kon Tum fault in the South, Kongplong fault in the East and Po Co river fault in the West. These deep faults correspond to grade II. In that block of tectonic structure, there are faults divided by the lower grades as faults of grade III, IV and the tectonic fissures of grade V (Fault classification according to the engineering ecological classification in accordance with TCVN 4253-86).

1 Deep fault: Distributed more than 15 – 40 km away from the construction site.

2 The transformation zone of tectonic destruction includes soft breccia and clay in tectonic fissures and millonites.

3 The influence zone of tectonic destruction and large and medium fissures includes increasingly fractured rocks, the changeable rock zone of tectonic fissures is the rocky zone with color change, often oxidized by iron.

Referring to the existing geological documents and when measuring and making the geological map with the scale of 1/10,000, a number of faults of grade III and many zones of grade IV were detected (mainly based on map of interpretation of aircraft images, topographical and geomorphological conditions and survey drilling results).

The regional fault belongs to 3 main groups: longitude, latitude and the secondary one is Northeast – Southwest. There are 4 fracture systems: The main system can be in 230 – 240 ∠ 70 – 80^0 and 350 – 10 ∠ 60 – 70^0. The secondary fracture system can be in 195 – 215 ∠ 50 – 70^0 and 65 – 75 ∠ 60 – 80^0.

Tectonic destruction zones and fractures play an important role in the formation of mountain slopes, all river and stream networks are related to the tectonic destruction zones of grades III and IV.

c) Geophysical process and phenomenon

The characteristics of the research area in terms of topography are complex, thus creating conditions for the strong development of geophysical phenomena of which the main forms are: weathering, erosion, and landslide.

1. Weathering phenomenon: The process of weathering in the research area is also developing like the process of forming the weathering crust of the Southern Vietnam in general. In the process of carrying out the drilling for survey and measurement of geological maps, the section of weathering crust on the intrusive and metamorphic bedrock can be divided from bottom to top as follows:

Relatively intact rock zone (IIB notation): The rock shows no signs of weathering like the surface of fissure without iron oxide. The rock is less prone to fracture and fissure, and it is hollow, narrow or closed. The rock-forming minerals are almost unchanged.

Fractured fresh rock zone (IIA notation): Like IIB zone, but the degree of fracture is higher.

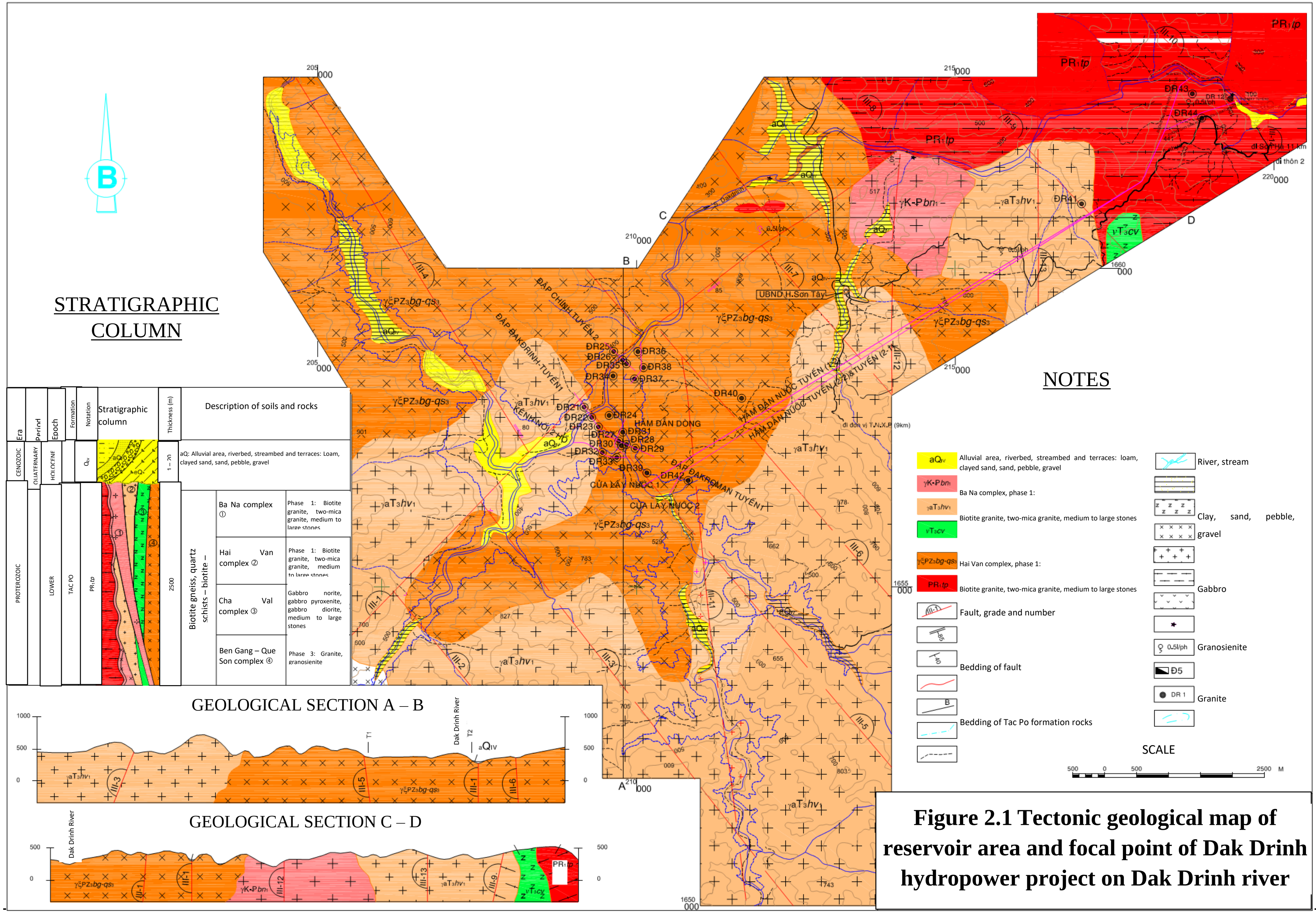


Figure 2.1 Tectonic geological map of reservoir area and focal point of Dak Drinh hydropower project on Dak Drinh river

Weathering zone (IB notation): The main characteristics of rock mass is the traces of weathering process, which is most clearly shown that the surface of fissure is covered with iron oxide layer, and some along the fissure of rocks has been discolored. In general, the color of weathered rock is not different from that of IIA zone. The strength of rock mass is significantly reduced compared to IIA zone, but when testing each individual rock, all physio-mechanical properties are insignificantly lower than that of rock of IIA zone. The zone thickness varies from 2 to 10 m.

Strong weathering zone (IA_2): Most of the rock-forming minerals are changed, the color of rock changes compared to the original rock. The rock is strongly fractured, and the fissures are often open or filled with clay. The thickness of IA_2 zone varies from 1 – 7 m.

Fierce weathering zone (IA_1): The rock is weathered and decomposed into soils and original breccia. The drill core is rocky on the surface, but it can be crushed by hand. Its physio-mechanical properties are close to that of eluvial soil. In the zone, the basement rock structure still remains completely. The thickness of IA_1 zone is only a few meters. The layers of eluvial soil 3 and 2 and eluvial – deluvial layer 1 are distributed on IA_1 zone

**** Layer 3 (eQ^3):*** Clay, loam, clayed sand with the colors of fawn, white gray with black spots, sometimes reddish brown and light purple pink, containing weak grits of breccia, still remaining the structure of basement rock.

The thickness of this layer varies greatly depending on the location of different elevation. At low elevation, near stream and river, the thickness of the layer is usually 1 – 3 m thin. At the top with the slope of > 500 m elevation, this layer is usually 3 – 15 m thick. The distribution of this layer is present in almost all rocks and is almost identical in thickness.

**** Layer 2 (eQ^2):*** Reddish brown – fawn, patchy clay and loam containing 5 – 10% of soft weathered original breccia, the thickness of this layer also depends on the elevation and location, usually 5 – 20 m.

**** Layer 1 (eQ^1):*** Dark gray, reddish brown and fawn clay and foam containing 5 – 10% of laterite clumps or grits of breccia. At the position adjacent to the steep slopes, there can be many granite boulders up to tens of cubic meters in size. The thickness of this layer depends heavily on the stratigraphic surface slope, with 1 – 8 m flat and 0.5 – 2 m slope.

Table 2.1 Division of rocks and soils by weathering level

Notation	Zone	Brief description
IIB	Relatively intact rock	Fresh rock, there are no signs of changed rock-forming minerals, weak fissure.
IIA	Fractured fresh rock	Fresh rock, there are no signs of changed rock-forming minerals, weak fissure, strong fissure.
IB	Weathering	The rock-forming minerals along the fissure surface are often changed or oxidized. The core has little or no change.
IA_2	Strong weathering	Almost all rock-forming minerals are changed. The color of parent rock is completely changed.
IA_1	Fierce	Most of the original rocks have been weathered into soil but still

	weathering	clearly retained the architecture of parent rock.
edQ	Eluvion	The original rocks are completely weathered to be clay, loam mixed with or not mixed with grits of breccia, not keeping the architecture of parent rock, or being very faint, if any.

2. The phenomenon of erosion: Occurring on all steep slopes, creating erosion channels in the form of shallow streams with a large scale and extent in the rainy season. As a result, narrow and deep streambeds on steep slopes are V-shaped cross-section are created. The riverbed has many sections creating a vertical slope with an altitude of 15 – 25 m, completely exposing the original rocks (Dak Roman dam route). The riverbed sections are consolidated with alluvial sandy (aQ) and clay pebble deposits accumulated with the thickness of 1 – 3 m. The main factor causing this phenomenon is rain. In the rainy season, the flood is often very heavy and the groundwater usually appears all year round at any elevation in the rivulets in the whole area and its intensity increases with the rainfall during the year.

3. Landslide phenomenon: This phenomenon causes traffic separation in the project area in the rainy season. Kon Plong and Son Tay are remote districts that have just been invested in and developed with a transport system which the roads have just been newly opened. Due to the mountainous terrain, the traffic routes running on steep hillsides, the instability of talus due to the structure of loam soils and rocks mixed with boulder of the original granite weathering layer, meeting the conditions of water saturation from torrential rains, combined with the erosion phenomenon as mentioned above. In many places, the phenomenon of serious landslide happened. There are some places with a large slopes of hillside eroded.

d) Hydrogeology:

The underground water level varies a lot in accordance with the seasons, the hydraulic relationship between the layers is quite close based on the geological formations in the region. The main source of supply is rain and the drainage sources are rivers and streams. In accordance with the conditions of movement, structure of soils and rocks, distribution area of chemical components, properties, the following aquifers are divided in the research area:

- Porous aquifers – seams in alluvial sediments (aQ_{IV}^1, aQ_{IV}^2, aQ_{IV}).

- Porous aquifers – fissures in intrusive soils and rocks of the complex of the Late Triassic.

- Porous aquifers – fissures in intrusive soils and rocks of Ben Giang – Que Son complex of the Late Paleozoic age.

- Porous aquifers – fissures in soils and rocks of Tac Po formation.

Table 2.2 The results of analysis of chemical composition of underground water

Aquifer	Link / Point No.	Sample No.	Total mineralization mg/l	Total ions mgd/l	pH	Negative ions						Positive ions						Total hardness mgd/l	Free CO_2 mg/l
						HCO_3^-		Cl^-		SO_4^{--}		Ca^{++}		Mg^{++}		$Na^+ + K^+$			
						mg/l	mgd/l	mg/l	mgd/l	mg/l	mgd/l	mg/l	mgd/l	mg/l	mgd/l	mg/l	mgd/l		
Minerals	32	M 4	167.51	2.05	8.3	103.73	1.70	8.86	0.25	4.80	0.10	5.61	0.28	0.85	0.07	43.66	1.70	0.35	0.00
aQ_{iv}^1	DR 10	DR 1	112.42	1.46	7.1	67.12	1.10	7.10	0.20	7.69	0.16	3.21	0.16	2.92	0.24	24.38	1.06	0.40	18.48
γaT_3hv_1	DR 1	DR 2	126.54	1.60	7.3	79.33	1.30	3.55	0.10	9.62	0.20	4.01	0.20	2.43	0.20	27.60	1.20	0.40	9.68
	DR 2	DR 3	356.30	4.44	7.5	256.28	4.20	2.84	0.08	7.69	0.16	56.11	2.80	4.86	0.40	28.52	1.24	3.20	26.40
	DR 3	DR 7	160.22	2.00	7.2	109.84	1.80	1.42	0.04	7.69	0.16	14.43	0.72	2.92	0.24	23.92	1.04	0.96	15.84
	DR 21	DRT 1	202.99	2.23	5.9	109.84	1.80	13.47	0.38	2.40	0.05	17.03	0.85	0.61	0.05	59.64	1.33	0.90	44.00
	DR 22	DRT 2	113.36	1.45	6.0	73.20	1.20	7.09	0.20	2.40	0.05	7.01	0.35	1.82	0.15	21.84	0.95	0.50	33.00
	Min.		**113.36**	**1.45**	**5.9**	**73.20**	**1.20**	**1.42**	**0.04**	**2.40**	**0.05**	**4.01**	**0.20**	**0.61**	**0.05**	**21.84**	**0.95**	**0.40**	**9.68**
	Max.		**356.30**	**4.44**	**7.**	**256.2**	**4.20**	**13.4**	**0.38**	**9.62**	**0.20**	**56.1**	**2.80**	**4.8**	**0.40**	**59.6**	**1.33**	**3.20**	**44.0**

					5	**8**		**7**				**1**		**6**		**4**			**0**
	Average		**191.88**	**2.35**	**6.8**	**125.70**	**2.06**	**5.67**	**0.16**	**5.96**	**0.12**	**19.72**	**0.98**	**2.53**	**0.21**	**32.30**	**1.15**	**1.19**	**25.78**
$\gamma\zeta pz_{2bg-qs3}$	DR 4	DR 11	145.26	1.80	7.0	97.63	1.60	1.42	0.04	7.69	0.16	4.81	0.24	2.43	0.20	31.28	1.36	0.44	17.60
	DR 5	DR 10	135.09	1.70	7.5	91.53	1.50	1.42	0.04	7.69	0.16	8.02	0.40	3.89	0.32	22.54	0.98	0.72	17.60
	DR 6	DR 8	257.84	3.20	7.3	183.06	3.00	1.42	0.04	7.69	0.16	36.07	1.80	2.92	0.24	26.68	1.16	2.04	21.12
	DR 7	DR 4	298.81	3.72	7.0	213.57	3.50	2.13	0.06	7.69	0.16	30.46	1.52	6.32	0.52	38.64	1.68	2.04	24.64
	DR 9	DR 12	147.93	1.82	7.1	97.63	1.60	2.13	0.06	7.69	0.16	6.41	0.32	0.49	0.04	33.58	1.46	0.36	10.56
	DR 24	DRT 7	57.51	0.75	5.9	36.61	0.60	5.32	0.15	0.00	0.00	4.01	0.20	1.22	0.10	10.35	0.45	0.30	10.56
	DR 25	DRT 3	178.81	2.31	6.0	119.60	1.96	9.57	0.27	3.84	0.08	18.04	0.90	5.23	0.43	22.53	0.98	1.33	33.00
	DR 26	DRT 8	73.11	0.97	6.0	42.71	0.70	7.09	0.20	3.36	0.07	5.61	0.28	1.70	0.14	12.64	0.55	0.42	12.32
	DR 27	DRT 9	71.74	0.95	6.0	42.71	0.70	8.86	0.25	0.00	0.00	4.01	0.20	1.22	0.10	14.94	0.65	0.30	10.56
	DR 28	DRT 4	72.27	0.98	5.9	36.61	0.60	8.15	0.23	7.20	0.15	4.01	0.20	1.82	0.15	14.48	0.63	0.35	8.80

	DR 31	DRT 10	85.01	1.11	5.6	51.26	0.84	7.09	0.20	3.36	0.07	4.01	0.20	1.82	0.15	17.47	0.76	0.35	5.60
	DR 32	DRT 11	67.76	0.92	6.1	36.61	0.60	8.86	0.25	3.36	0.07	4.01	0.20	1.82	0.15	13.10	0.57	0.35	12.32
	DR 33	DRT 12	63.43	0.85	5.9	36.61	0.60	8.86	0.25	0.00	0.00	5.61	0.28	0.85	0.07	11.50	0.50	0.35	10.56
	DR 34	DRT 5	148.26	1.90	6.1	91.53	1.50	5.32	0.15	12.01	0.25	18.04	0.90	1.82	0.15	19.54	0.85	1.05	15.40
	DR 36	DRT 13	206.57	2.60	7.6	134.24	2.20	7.09	0.20	9.61	0.20	17.03	0.85	1.82	0.15	36.78	1.60	1.00	1.76
	DR 37	DRT 5	166.15	2.13	6.3	97.63	1.60	6.38	0.18	16.81	0.35	21.04	1.05	0.61	0.05	23.68	1.03	1.10	15.40
	DR 38	DRT 14	81.31	1.08	5.9	42.71	0.70	6.38	0.18	9.61	0.20	4.01	0.20	1.82	0.15	16.78	0.73	0.35	12.32
	DR 39	DRT 15	98.20	1.30	6.2	54.92	0.90	8.86	0.25	7.20	0.15	7.01	0.35	1.82	0.15	18.39	0.80	0.50	8.80
	DR 42	DRT 16	173.88	2.28	6.2	97.63	1.60	11.70	0.33	16.81	0.35	17.03	0.85	2.43	0.20	28.28	1.23	1.05	14.08
	DR 9	DR 12	147.93	1.82	7.1	97.63	1.60	2.13	0.06	7.69	0.16	6.41	0.32	0.49	0.04	33.58	1.46	0.36	10.56
	Min.		**57.51**	**0.75**	**5.6**	**36.61**	**0.60**	**1.42**	**0.04**	**0.00**	**0.00**	**4.01**	**0.20**	**0.49**	**0.04**	**10.35**	**0.45**	**0.30**	**1.76**
	Max.		**298.81**	**3.72**	**7.6**	**213.57**	**3.50**	**11.70**	**0.33**	**16.81**	**0.35**	**36.07**	**1.80**	**6.32**	**0.52**	**38.64**	**1.68**	**2.04**	**33.00**

	Average	**133.84**	**1.71**	**6.4**	**85.12**	**1.40**	**6.01**	**0.17**	**6.97**	**0.14**	**11.28**	**0.56**	**2.13**	**0.17**	**22.34**	**0.97**	**0.74**	**13.68**

The results of analysis of chemical composition of underground water are presented in *Table 2.2* on the above page, showing that the chemical composition of underground water in the structural strata does not change much with the total average mineralization from 110 – 190 mg/l, the water of Chloride – Sodium – Calcium Bicarbonate type or Sodium – Calcium Bicarbonate type, and being corrosive to concrete.

The results of permeability of soils and rocks divided by layer and zone are presented in *Table 2.3*

Table 2.3 Table of indicators for permeability calculation

Formation	**Layer and zone**	**Lugeon Value**	**Permeability coefficient (x 10^{-5} cm/s)**
		Min – Max Average	
Granite	Clay, loam		18
	(edQ – eQ)		3 – 80
	IA		50
			10 – 120
	IB	7	22
		2 – 20	4 – 70
	IIA – IIB	4	10
		0.3 – 18	4 – 40
Gneiss	Clay, loam		5
	(edQ – eQ)		3 – 7
	IA		50
			10 – 120
	IB	6	12
		2 – 15	10 – 20
	IIA – IIB	4	8
		2 – 10	3 – 17

Source: Power Engineering Consulting Joint Stock Company 2

e) Physico-mechanical properties of soils and rocks

Physico-mechanical properties, stability and deformation of soils and rocks were studied by geological measurement, drilling, excavation, geophysical exploration and laboratory experiments. The laboratory experiments are performed in accordance with ASTM standards, documents are revised in accordance with TCVN:4253-86 “Foundation of hydraulic works”. All data are integrated for two types: hard rock and loose soft soil.

1. Physico-mechanical properties of bedrock: The physico-mechanical properties of bedrock are presented in *Table 2.4*, which are integrated for two types of rocks: Intrusive granite and metamorphic Gneiss for different weathering zones (IB, II).

Granite rock:

- IB zone has its criteria: γ_k = 2.63 g/cm^3, air-dry – saturated solid coefficients: 10.3 – 9.0, compressive strength of dry wind – saturation: 890 – 780 kg/cm^2.

- IIA – IIB zone has its criteria: γ_k = 2.65 g/cm^3, air-dry – saturated solid coefficients: 10.8 – 9.8, compressive strength of dry wind – saturation: 980 – 870 kg/cm^2.

Gneiss rock:

- IB zone has its criteria: γ_k = 2.68 g/cm^3, air-dry – saturated solid coefficients: 11.4 – 10.5, compressive strength of dry wind – saturation: 900 – 740 kg/cm^2.

- IIA – IIB zone has its criteria: γ_k = 2.74 g/cm^3, air-dry – saturated solid coefficients: 12.4 – 10.7, compressive strength of dry wind – saturation: 1000 – 880 kg/cm^2.

- Resistance strength of gneiss (metamorphic) > strength of granite (intrusive) with 50 kg/cm^2 for each equivalent zone.

- The physico-chemical properties of IB zone of bedrocks are quite high, meeting the building foundation.

- The physico-chemical properties of IB zone and IIA – IIB zone are qualified to make concrete chips and paving stones for construction Work.

Table 2.4 The physico-mechanical properties of bedrock (Calculation)

Area	Name of rock	Zone	Water content (%)			Density (g/cm^3)			Specific gravity	Porosity (%)	Saturation (%)	Absorption saturability (%)	Solid coefficient f		Ultimate Compressive Strength (kg/cm^2)		Tensile strength (kg/cm^2)		Shear strength (rock)		Shear strength (adjacent to concrete)		Deformation modulus x 103 (kg/cm^2)	Elasticity modulus (kg/cm^2)
			Air-dry	Saturated	Absorption	Air-dry	Saturated	Dry					Air-dry	Saturated	Air-dry	Saturated	Air-dry	Saturated	φ	C (kg/cm^2)	φ	C (kg/cm^2)		
Total area	Granite	IA_2	1.20	1.60		2.55	2.56	2.52	2.68	6.0	67.2		4.00	3.00	200.0	150.0			35.00	1.50	30.00	1.00	12.0	24.0
Dam, water intake	Granite	IB	0.21	0.42	0.46	2.64	2.64	2.63	2.69	2.2	50.2	55.0	8.0	7.0	800.0	700.0	100.0	90.0	50.00	6.00	36.00	1.5	120.0	240.0
	Granite	IIA IIB	0.19	0.36	0.40	2.65	2.65	2.64	2.70	2/2	43.2	48.0	9.0	8.0	900.0	800.0	110.0	100.0	55.00	10.00	40.00	2.00	160.0	320.0
Surge tank, plant	Granite	IB	0.13	0.24	0.28	2.68	2.68	2.67	2.71	1.5	42.7	49.8	8.5	7.5	850.0	750.0	90.0	80.0	50.00	6.00	36.00	1.50	120.0	240.0
	Granite	IIA IIB	0.15	0.26	2.74	2.75	2.75	2.74	2.78	1.4	50.9	60.7	9.5	8.5	950.0	850.0	110.0	100.0	55.00	10.00	40.00	2.00	160.0	320.0

Table 2.5 The physico-mechanical properties of foundation soil

Layer	Composition of particle D (mm) %							Atterberg limits				Density		Proportion	Porosity (%)	Void coefficient	Saturation (%)	Direct cutting – Saturation				Column 3 first				39102	Deformation modulus (kg/cm^2)	Expansive pressure (kg/cm^2)	Swelling capacity (%)	Expansive water content (%)	Organic content (%)
																		Natural		Saturated											
																		Calculation standards		Calculation standards				Pore water pressure coefficient (Saturation)							
	75 – 19	19 – 4.75	4.75 – 2.0	2.0 – 0.425	0.425 – 0.075	0.075 – 0.005	< 0.005	Liquid (%)	Plastic %)	Index plastic (%)	Natural moisture (%)	Natural (g/cm^3)	Dry (g/cm^3)					j (degree.min)	C (kg/cm^2)	j (degree.min)	C (kg/cm^2)	j (degree.min)	C (kg/cm^2)	A	B						
edQ – eQ (Granite) (Dam – Water intake)	0.0	1.1	12.1	29.1	19.5	22.3	15.9	58	34	24	21.3	1.72	1.42	2.67	46.8	0.878	64.6	22.0 / 20.0	0.50 / 0.25	21.0 / 17.0	0.25 / 0.20	27	0.1	0.44	1.00	0.045	90.0	0.040	1.20	30.8	2.6
edQ	0.	1.	12	18	32	25	10	44	33	11	25	1.	1.	2.	50	1.0	6	22.	0.	20	0.2					0.0	50.0	0.01	1.	34	

– eQ (Gneiss) (Surge tank – Plant)	0	2	.5	.0	.0	.6	.7				.7	68	34	71	.6	25	8.0	0 21.0	30 0.25	.0 17.0	1 0.20					52		9	16	.8	
IA_1 (Granite) (total area)	0.0	5.4	19.4	21.7	9.7	27.7	16.1	81	42	39	15.4	1.79	1.55	2.66	41.7	0.716	57.2	22.0 20.0	0.50 0.25	21.0 17.0	0.25 0.20					0.038	100.0	0.080	1.70	23.7	

2. Physico-mechanical properties of foundation soil: In the summarization presented in *Table 2.5: The physico-mechanical properties of foundation soil* in the appendix; the physico-mechanical properties of foundation soil are divided into deluvial – eluvial deposits; and IA_1 strong weathering zone of 2 original rock types of granite and gneiss. It shows that:

- Alluvial soils in rivers and streams: low physico-mechanical properties, index plastic is 14, liquid limit is 41%, belonging to (CL) type.

- Eluvial soils on intrusive rock: medium physico-mechanical properties, index plastic is 26, liquid limit is 58%, belonging to (MH) type.

- Eluvial soils on metamorphic rock have medium physico-mechanical properties. Index plastic is 11, liquid limit is 45%, belonging to (ML) type.

- The soil of fierce weathering zone on intrusive rocks: medium physico-mechanical properties, Index plastic is 39, liquid limit is 81%, belonging to (MH) type.

- Group of sand, pebble and gravel of construction sand pit, the assessment criteria are mentioned in the section "construction materials"

In general, with both types of eluvial soils on the intrusive rocks, there are appropriate properties for exploitation as materials to fill the core of rolling weir.

Due to low physico-mechanical properties, small and narrow distribution area, alluvial soil does not have much significance, so it is necessary to peel and remove at the foundation of construction Work during the construction.

g) Regional seismic and earthquake

The Dak Drinh river basin is limited by the Tra Bong deep faults in the North, Ba To – Kon Tum faults in the South, Kongplong faults in the East and Po Co river faults in the West. These faults correspond to the grade II in accordance with engineering ecological classification (TCVN 4253-86).

In accordance with the earthquake zoning map with the scale of 1/1,000,000 by Institute of Geophysics (1995), Dak Drinh Work is far from the above faults, the earthquake level is 6 (MSK-64 system).

2.2.2 Main engineering geological conditions (optional)

a) Geological conditions of the dam route:

The dam route is 750 m downstream from Dak Drinh river junction, including:

- Main dam: The section crossing Dak Drinh river is about 80 m wide. The dam length up to the normal water level is about 390 m, two shoulders have a quite stable slope and are quite steep, the left shoulder is about 30^0, the right shoulder is $35 – 40^0$, along the riverbed completely exposing the original rock, creating a quite flat surface.

- Spillway: located on the right shoulder of main dam, with the length of approximate 700 m. The inlet canal is the surface of runnel flowing to the upstream, with the relatively stable slope surface of about 15^0. The downstream section has a fairly even slope of about 25^0.

- Sewer line (the sewer line of right side): The length of sewer line is about 365 m.

In terms of geological structure, the soils and rocks of Ben Giang – Que Son complex cover the entire dam route. The stratum of dam route on the upper part of 2 shoulders is edQ – eQ layers: Semi-hard yellowish gray, reddish brown loam and clay, mixed with granite boulders. The lower part is the layers of IA_1, IA_2, IB, IIA, IIB of hard white gray and light pink granite with black spots.

The thickness of covering layer (edQ – eQ) of the two shoulders is very different. The left shoulder is thicker than the right shoulder, with the thickness from 3 – 5 m (lower part) to 15 – 25 m (higher part), the right shoulder is from 1 – 5 m (slope) to 5 – 10 m (watershed). The depth of original rock of the left shoulder is from 10 – 15 m (lower part) to 30 – 35 m (upper part), and that of the right shoulder is from 2 – 8 m (slope) to 10 – 15 m (watershed). The IA_1 – IA_2 fierce weathering zone has a thicker right shoulder than the left shoulder, with the average left shoulder of 2 – 5 m, the average right shoulder of 3 – 10 m. With such stratum, the surface of original rock is not more than 15 m deep with the dam foundation.

At the overflow route, the thickness of covering layer (edQ – eQ) is from 0.5 – 13 m, the thickest place is 14 m (intersecting with the center of rolling weir of route 2). The depth of original rock is from 15 – 18 m, and about 0.5 m in the shallowest place. The IA_1 – IA_2 fierce weathering zone has a thickness of 3 – 5 m, and about 10 m in the thickest place.

At the flow route, the thickness of covering layer (edQ – eQ) is from 0.5 – 7 m, and 9 m in the thickest place.

In terms of tectonic: combining geological map with the scale of 1/10,000 in the previous period with geophysical documents of measurement in current period, it shows that there are faults:

Main dam: - III-1 fault crossing the riverbed of left shoulder

- IV-1 fault crossing the left shoulder

Spillway: - IV-11 fault crossing the inlet canal

- IV-5 fault crossing the part near the overflow tail.

- III-4 fault crossing the overflow tail.

The engineering geological conditions are quite well for the construction of dam route.

b) Geological conditions of reservoir

Stratigraphic structure of the reservoir: The upper part of riverbed and the small alluvial grounds along the river edge are composed of sand, pebbles, loam and clay mud. The thickness of this layer is often < 3 m. The distribution area is small and not continuous.

On the upper slopes of rivers and streams, there are layers of eluvial – deluvial soil: patchy loam and clay colored from yellowish gray to reddish brown. The original rock foundation of the reservoir is mainly composed of granite of Ben Giang – Que Son and Hai Van complexes.

The physico-mechanical properties of soil are of the medium type, the physico-mechanical properties of are of the high type, the site permeability is medium.

Soils and rocks in the reservoir bed have a low permeability coefficient ($K = 10^{-4} – 10^{-6}$ cm/s), the groundwater table is usually 3 – 10 m in the rainy season and 10 – 15 m in the dry season from the ground.

The groundwater of strata is of the Sodium – Potassium Bicarbonate type or Calcium Bicarbonate type with weak concrete corrosion. In the reservoir bed area, there is an exposed silica mineral water point, but it is not found to affect the reservoir significantly.

In accordance with geological map with the scale of 1/10,000, there are 6 faults off grade III and 3 faults of grade IV in the reservoir area. In accordance with the earthquake tectonic map of Institute of Geophysics made in 1995, the focal area of reservoir is 15 km far from Kong Plong fault to the East, the earthquake is level 6.

Potential minerals in the reservoir:

In accordance with documents of Southern Geological Mapping Division, there are no minerals with industrial reserves in the reservoir area.

In accordance with Official Dispatch No. 613 by Department of Geology and Minerals of Vietnam dated April 10, 2007 on Notice of natural resources and minerals situation in the reservoir area of Dak Drinh hydropower project: there is a Suoi Luong mineral water point in the reservoir area of Dak Drinh hydropower project, of Dak Drinh Commune, Kon Plong District, with the geographical coordinates of: Latitude of $14^0 48'10''$ North and Longitude of $108^0 17'10''$ East. The temperature is 61 ^oC, the flow is 3 l/s (See: *Appendix A: Legal documents in relation to the project* in the appendix of Preamble).

During the engineering geological survey for Dak Drinh Hydropower Project, Geological Survey Technical Department of Power Engineering Consulting Joint Stock Company 2 made the engineering geological map with the scale of 1/10,000. The exploration survey results only recorded mines of construction materials in the reservoir bed area and the hot mineral water points at the aforementioned point. There are no mineral deposits of industrial value found.

The survey results recorded at the above hot mineral water point as follows: In the area of **Porous aquifer – fissures in intrusive rocks of the complex in the late Triassic age** near the confluence of Dak Drinh – Dak Tmeo (Xo Luong) rivers, 1.5 km upstream from Dak Drinh dam route, there is a exposed hot mineral water point stretching 50 m along the III-1 fault. Through analysis of water in the form of silica mineral, at the temperature of 60 – 70 ^oC, total flow of about 3 l/s. The chemical composition is shown in the Kour Lov formula:

$$SiO^2{}_{0.47}M_{0.17} \qquad \frac{HCO^3{}_{83}Cl_{12}}{(Na+K)_{72}Mg_{12}Ca_{16}} \qquad pH: 8.3\ t: 60 - 70\ ^oC$$

The analysis results of chemical composition of groundwater are shown in *Table 2.2*.

In accordance with the survey, people arriving to the above hot mineral water point can only use it in the dry months. In the rainy season, the water temperature in the upper stream can almost no longer maintain high temperature.

c) Geological conditions of energy routes:

1. Geological conditions of water intake

The water intake of route 2 is located on a gentle hill, sandwiched between two large streams of Son Dung Commune with a fairly wide area. These streams are the ones with running water all year round, even in the dry season, the flow of stream mouth is also about 0.5 – 1 m^3/s. The two sides of rivulets and tributary streams have water all year round and are the place for rice cultivation of Group 10, Son Dung Commune. The dam center crossing the surface has a relatively stable slope of about 15°, the streambed between both sides and the riverbed all expose the original rock.

In terms of geological structure, the soils and rocks of Ben Giang – Que Son complex cover the enter water intake. The stratum of dam route with covering layer is edQ – eQ layers: Semi-hard yellowish gray, reddish brown loam and clay, mixed with granite boulders. The lower part is the layers of IA_1, IA_2, IB, IIA, IIB of hard white gray and light pink granite with black spots. The thickness of covering layer (edQ – eQ) is 5 – 20 m, and 20 m in the place arranging water intake. The average depth of original rock is from 20 – 30 m, and 20 m in the shallowest place, and 25 m in the place arranging water intake. The IA_1 – IA_2 fierce weathering zone has a thickness of 3 – 5 m, and about 10 m in the thickest place.

In terms of tectonic: combining geological map with the scale of 1/10,000 with geophysical documents of measurement, it shows that there are no crossing faults.

Through the above data, all engineering geological conditions are quite good for the construction of a water intake at this location.

2. Geological conditions of Water tunnel

This tunnel route is connected from water intake of Route 2 to the surge tank. The length from water intake to surge tank is about 9,600 m.

In terms of geological structure, the route crosses the soils and rocks of Ben Giang – Que Son complex, Hai Van complex and Tac Po formation. Along the crossing center of the route, the stratum mainly crosses IIA and IIB zones of granite and gneiss with rather solid intensity. Along the center of the route, on the surface:

- From the water intake to 1,380 m, it is composed of granite and granosienite of Ben Giang – Que Son complex.

- From 1,380 m to 4,580 m, it is composed of biotite granite – two-mica granite of Hai Van complex in phase 1.

- From 4,580 m to 6,080, it is composed of biotite gneiss and quartz schists of Tac Po formation.

- From 6,080 m to 7,640 m, it is composed of biotite gneiss – two-mica granite of Hai Van complex in phase 1.

- From 7,640 m to the end of the route, it is composed of biotite gneiss and quartz schists of Tac Po formation.

The stratum of the route is covered by edQ – eQ layers: Semi-hard yellowish gray, reddish brown loam and clay, mixed with granite boulders. The lower part is the layers of IA_1, IA_2, IB, IIA, IIB of hard white gray and light pink granite with black spots.

In terms of tectonic: combining geological map with the scale of 1/10,000 with geophysical documents of measurement, it shows that there are crossing faults in the order from the beginning to the end of the route: III-9 fault, III-4 fault, III-5 fault, III-10 fault, IV-7 fault, III-4 fault, III-6 fault, III-11 fault, III-12 fault, III-7 fault, IV-8 fault, IV-9 fault, IV-10 fault.

Thus, there are 9 faults of grade III and 4 faults of grade IV. On average, there is 1 fault for the whole route of about 800 m. These faults are deep and high-grade ones with the great impact of destruction. These faults will be a major influence on tunneling.

In the later design stage, it should be drawn attention to these faults, ensuring favorable conditions for treatment on geological stability as well as drainage from these faults upon the construction.

3. Geological conditions of Pipeline area – Plant

Pipeline terrain is gentle, the plant position is located in a place with wide flat terrain, wide riverbed, most of exposed original rocks, near traffic roads. The route length is 1,400 m.

In terms of geological structure, the soils and rocks of the complex of Tac Po formation cover the entire pipeline and plant. The stratum of the covering layer is covered by edQ – eQ layers: Semi-hard yellowish gray, reddish brown loam and clay, mixed with hard granite boulders varied in size. The lower part is the layers of IA_1, IA_2, IB, IIA, IIB of gneiss and hard white gray and light pink curl strips with black spots.

The thickness of covering layer of Route 1 (edQ – eQ) is from 5 – 15 m, and 10 m in the place arranging surge tank, and 1 – 3 m in the plant. The average depth of original rock is from 2 – 20 m, and about 1 – 3 m in the shallowest place, and 15 m in the place arranging valve house. The IA_1 – IA_2 fierce weathering zone has a thickness of 5 – 10 m.

The thickness of covering layer of Route 2 (edQ – eQ) is from 3 – 10 m, and 10 m in the place arranging surge tank, and 1 – 3 m in the plant. The average depth of original rock is from 2 – 15 m, and about 1 – 3 m in the shallowest place, and 12 m in the place arranging valve house. The IA_1 – IA_2 fierce weathering zone has a thickness of 3 – 8 m.

In terms of tectonic: combining geological map with the scale of 1/10,000 with geophysical documents of measurement, it shows that there are the following crossing faults: IV-10 fault crossing the pipeline, III-8 and III-13 faults crossing the plant. With the degree of 2 faults of grade III crossing the plant, this is an unfavorable factor in terms of engineering geology.

d) Engineering geological conditions of lowlands

The lowlands of the dam is mountainous area, extending riverbed and the sparse and small alluvial grounds running straight on both sides composed of layers of clay, loam and clayed sand mixed with pebble boulders. The riverbed exposes the original rocks, being about 10 km far from the plant. The river still flows along the hilly valley. There is almost no population along the two riversides.

Hydrogeological conditions that are regulated by the regulations of water through the plant all year round will be a stable source of irrigation for agricultural production and restrict floods for people, limit the existing disadvantages in the lowlands as dry season and great flood.

2.2.3. Engineering geological conditions of 110 kV power line of Dak Drinh – Doc Soi hydropower plant.

110 kV power line of Dak Drinh – Doc Soi hydropower plant has geological conditions which are relatively simple, in accordance with the exploration to the depth of 8.0 m, belonging to the formations of eluvion, ruins on granite foundation and alluvial deposits. There are 2 main soil layers being all relatively good soil layers which can serve as a natural foundation for the Work.

However, it should be noted that the special construction measures should be taken in the places where exposed rocks are found right on the surface or at a depth of 1.0 – 2.0 m. The groundwater in the crossing power line area has its weak concrete corrosion in pH (TCVN 3994-85).

2.3 LAND RESOURCES AND LAND USE CURRENT STATUS

2.3.1 Classification of soils in the basin

In accordance with *Figure 2.2 Soil map of Kon Plong District – Kon Tum Province* and *Figure 2.3 Soil map of Districts of Son Tay, Son Ha, Son Tinh, Binh – Quang Ngai Province* as shown on the next pages, in the basin of Dak Drinh hydropower project, the following main groups and types of soils are included:

1. Alluvial soil group

- Alluvial soil not extended with gley or extended with weak gley
- Alluvial soil with patchy yellowish red layers
- Alluvial soil in brooks and streams

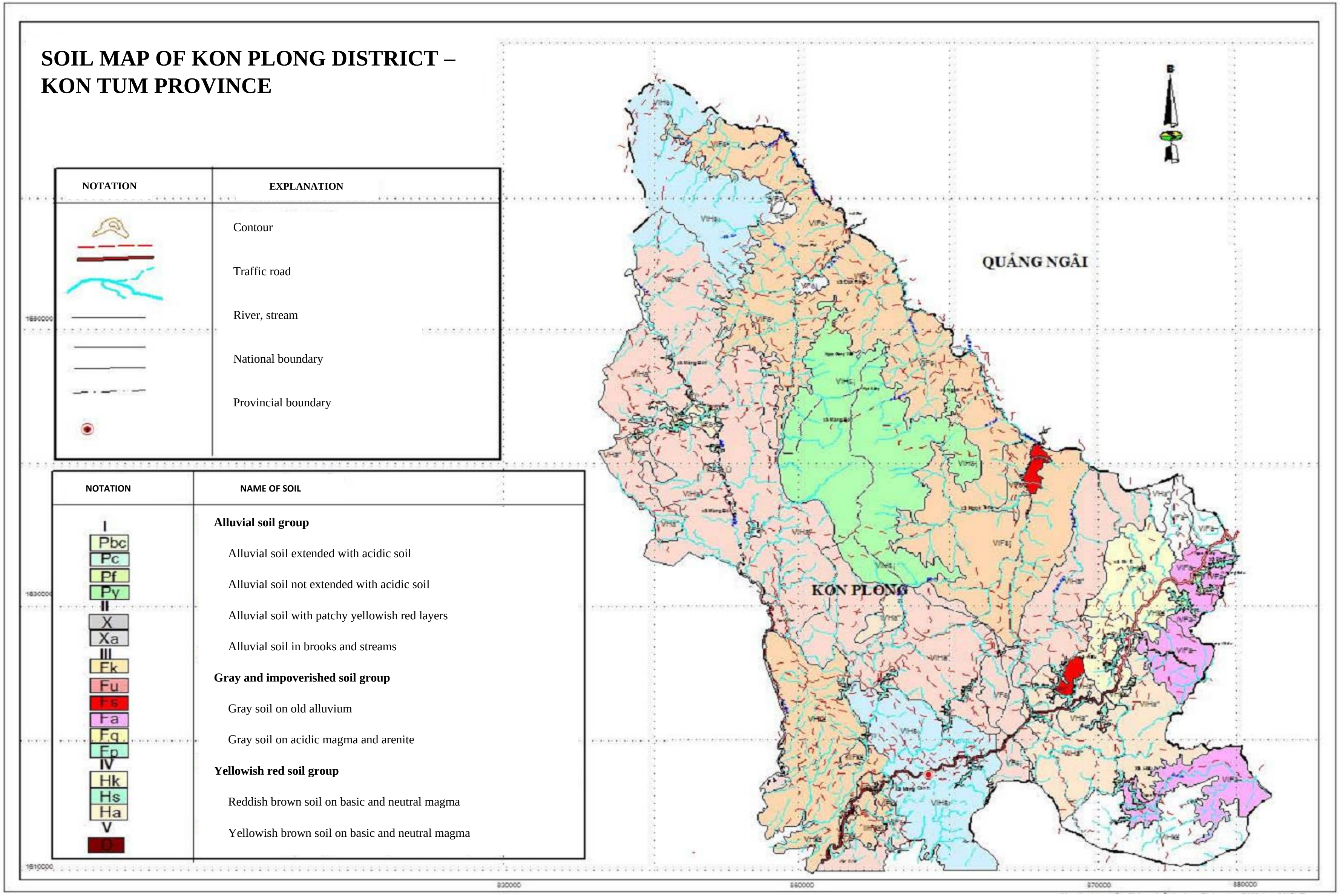
2. Yellowish red soil group

- Yellowish red soil on shale (Fs)
- Yellowish red soil on acidic magma (Fa)

3. Yellowish red humus group

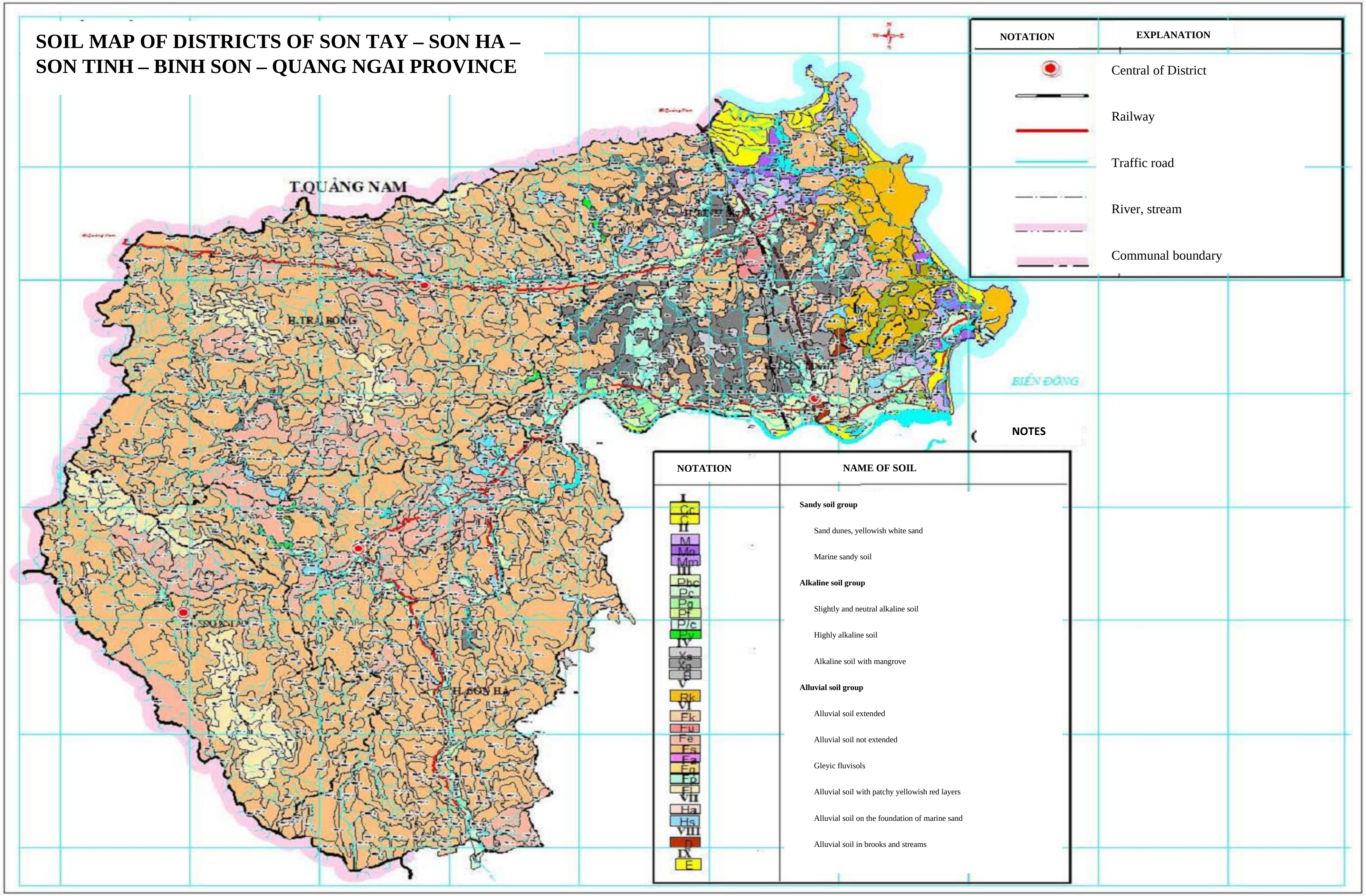
- Yellowish red humus on acidic magma (Ha)
- Yellowish red soil on shale (Hs)

2.3.2 The main characteristics of the land environment resources


SOIL MAP OF KON PLONG DISTRICT – KON TUM PROVINCE
NOTATION
EXPLANATION
Contour
Traffic road
River, stream
National boundary
Provincial boundary
NOTATION
NAME OF SOIL
I
Pbc
Pc
Pf
Py
II
X
Xa
III
Fk
Fu
Fs
Fa
Fq
Fp
IV
Hk
Hs
Ha
V
O
Alluvial soil group
Alluvial soil extended with acidic soil
Alluvial soil not extended with acidic soil
Alluvial soil with patchy yellowish red layers
Alluvial soil in brooks and streams
Gray and impoverished soil group
Gray soil on old alluvium
Gray soil on acidic magma and arenite
Yellowish red soil group
Reddish brown soil on basic and neutral magma
Yellowish brown soil on basic and neutral magma
QUẢNG NGÃI
KON PLONG

Source: Department of Soil, Central Agricultural Design and Planning Sub-Institute No. 16 Hoang Hoa Tham – Khanh Hoa

Figure 2.2 Soil map of Kon Plong district – Kon Tum Province


SOIL MAP OF DISTRICTS OF SON TAY – SON HA – SON TINH – BINH SON – QUANG NGAI PROVINCE
T.QUẢNG NAM
BIỂN ĐÔNG
NOTATION
EXPLANATION
Central of District
Railway
Traffic road
River, stream
Communal boundary
NOTES
NOTATION
NAME OF SOIL
Sandy soil group
Sand dunes, yellowish white sand
Marine sandy soil
Alkaline soil group
Slightly and neutral alkaline soil
Highly alkaline soil
Alkaline soil with mangrove
Alluvial soil group
Alluvial soil extended
Alluvial soil not extended
Gleyic fluvisols
Alluvial soil with patchy yellowish red layers
Alluvial soil on the foundation of marine sand
Alluvial soil in brooks and streams

Source: Department of Soil, Central Agricultural Design and Planning Sub-Institute No. 16 Hoang Hoa Tham – Nha Trang – Khanh Hoa

Figure 2.3 Soil map of Districts of Son Tay, Son Ha, Son Tinh, Binh Son – Quang Ngai Province

2.3.2 Main characteristics of soil environmental resources

a) Alluvial soil group

On the reservoir basin, river alluvial soil (the area of about 35,650 ha) has a mechanical composition of medium rich soil to heavy rich soil, and quite high natural fertility.

The alluvial soil in the reservoir basin can be divided into the 3 types:

Alluvial soil not extended with gley or extended with weak gley (P)

Alluvial soil with patchy yellow layers (Pf)

Alluvial soil in streams (Ps)

The distribution of alluvial soil group is not much, mainly concentrated on the alluvial terraces and being often close to the shore, affected by floods, so a new thin dark brown layer of alluvium is still deposited every year.

The river alluvial soils are very fertile, with the quite flat terrain and the most concentrated distribution in the North, which has been exploited for a long time to transplant 1 – 2 crops of rice, or grow vegetables, beans, peanuts, sugarcanes. If there is an adequate source of water for irrigation during the dry season, the potential to increase the crops for yield increase on the alluvial soil is still very large enough to compensate for the yield on the area of flooded land when the reservoir is filled with water.

b) Yellowish red soil group

Yellowish red soil (Feralite soil) is usually distributed at the altitudes of below 1,000 m and is the largest land covering layer in the area.

Under the direct and profound impact of monsoon tropical climate, many parent rocks are deeply and quite thoroughly weathered, making the primary minerals, except quartz, almost disappear; the composition of clay minerals of the soil is mainly caolinite, hazolite (hydrated caolinite) …, creating weathering crust – Feralite soil … which is very popular in the low hilly and mountainous areas being below 1,000 m and the highlands in Vietnam.

In addition to the feralite weathering process, it should be noted that in the favorable topography, in the depths of Yellowish red soils, it may also take place the process of absolute Fe and Al accumulation which is enough to form quite hard clusters and laterites. The yellowish red soil group in the basin is classified as: *The yellowish red soil growing on arenite and aleurolite (Fs)* and *The yellowish red soil growing on acidic magma (Fa)*.

1. Reddish yellow soil growing on arenite (Fs)

Yellowish red soil and Reddish yellow soil have medium fertility, containing quite high moisture, but topsoil layers are easily exhausted and degenerated after burning forests and clearing milpa.

The natural forests on these lands have been being violently destroyed; therefore, forest maintenance and forest regeneration to retain moisture and generate water source from the upper and middle basin are the best land use practices for Yellowish red soil and Reddish yellow soil.

2. Reddish yellow soil growing on acidic magma (Fa)

Reddish yellow soil growing on acidic magma (Fa), arising and growing on rugged terrain, is steep to very steep (25 – 30^0), distributed in medium-high and high upstream mountains.

It is a very worrying fact that, the overexploitation and burning of forests, especially forests on the apex, slope and upstream forests, results in organic matter and moisture content of the soil rapidly declining, making the process of soil erosion thrive and in danger of spreading over other lands …

Therefore, in order to maintain the water source of supply in the basin, there is no more feasible and effective measure than strict protection of all upstream forests, because most of them are still able to regenerate and develop quite well on all areas of Reddish yellow soil or Grayish yellow soil growing on very steep acidic magma (Fa).

c) Reddish yellow humus group

Reddish yellow humus is distributed on high elevations from 1,000 – 2,000 m, with cool and temperate climate, on the steep to very steep terrain (25 – 40^0), which is strongly divided between medium and high mountainous areas.

Deforestation on reddish yellow humus with rather natural fertility for shifting cultivation is the factor narrowing the area and quickly further tattering the most important upstream forests of the basin.

2.3.3 Types of soils in the sedentarization – resettlement area

In accordance with the Soil map of Districts of Kon Plong and Son Tay (See *Figure 2.2: Soil map of Kon Plong District – Kon Tum Province* and *Figure 2.3: Soil map of Districts of Son Tay, Son Ha, Son Tinh, Binh Son – Quang Ngai Province* as mentioned above), the sedentarization – resettlement areas have the following types of soils:

- Yellowish red soil on siltstone (Fc): the soil has a layer with the thickness of 50 – 70 cm, and some areas are over 100 cm thick. The physico-mechanical composition of rich soil is medium with much humus protein.

- Reddish yellow mountainous humus is distributed in high mountains with many forests, so the coverage is thick, and the surface layer still contains organic matter. The soil has a layer with the thickness of > 70 cm. The mechanical composition of rich soil is medium.

The above soils are suitable for growing perennial industrial crops.

2.3.4. Land use current status

The land use current status in communes of Dak Drinh hydropower project (2005 – 2006) is shown in the *Table 2.6* below:

Table 2.6 The land use current status in communes of Dak Drinh hydropower project (2005 – 2006)

Unit: hectares

No.	Commune	Total natural land	Agricultural production	Forestry	Dedicated land	Residential land	Unused land

1	Dak Rin Commune	11,029.60	441	8,230			2,277.28
2	Dak Nen Commune	11,805.60	580	9,046			2,134.46
3	Son Dung Commune	8,796	798.27	5,996.84	181.65	34.14	1,785.10
4	Son Mua Commune	7,397	857.21	3,460.20	137.82	24.00	2,917.77
5	Son Tan Commune	7,356	718.67	2,272.48	205.92	25.43	4,133.5
6	Di Lang Town	56.92	1,300.55	2,733	182.52	70.20	1,342.90
7	Son Bao	68.45	1,726.30	4,432.70	53.63	34.31	308.69
8	Son Thanh	48.52	1,614.25	2,772.29	70.56	64.50	296.76
9	Son Ha	39.02	2,150.90	963	107.48	92.70	497.89
10	Tinh Giang	1,706.04	995.32	317.37	160.51	56.57	72.89
11	Tinh Dong	2,496.71	986.53	1,074	158.49	42.35	78.21
12	Tinh Hiep	3,580.79	2,054.23	640.5	248.67	60.7	469.5
13	Tinh Tra	2,121.3	1,179.9	606.01	218.82	28.65	12.41
14	Binh My	1,228	973.09				43.32
15	Binh Minh	4,174	2,847.78				
16	Binh Trung	1,458	1,089.49				54.95
17	Binh Nguyen	2,645	2,116				156.15

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

The land use current status in the reservoir bed and the sedentarization – resettlement areas of Dak Drinh hydropower project is shown in *Figure 2.4* on the next page. Currently, the residential land of people of Communes of Dak Drinh and Dak Nen has been still being under agricultural land which has not yet changed its use purpose.

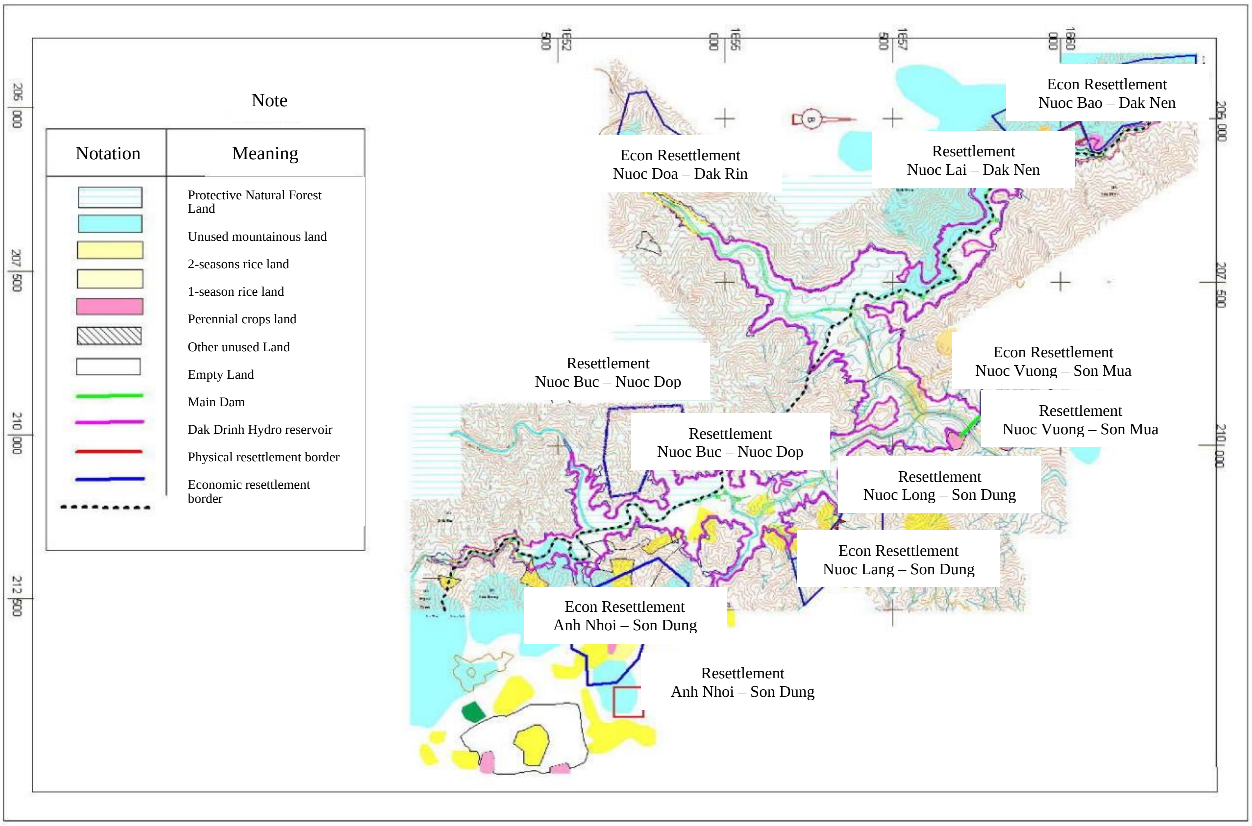


Figure 2. 4 Diagram of current status of reservoir bed and sedentarization – resettlement areas of Dak Drinh hydropower plant

Kon Plong District has been preparing cadastral documents to grant the ownership and convert the purposes for the above land. The sedentarization – resettlement areas planned for arranging the flooded households in the reservoir bed of Dak Drinh hydropower project are mainly unused hilly and mountainous land, which are mostly secondary forest, shrubs and bare land. A small area exploited by local people for growing perennial crops is mainly for areca and upland rice cultivation, but the area is not large and scattered.

2.4 CLIMATIC REGIME

2.4.1 Temperature regime

In the project area, the annual average temperature is quite large. In the period from 1977 – 2003, this value is 25.8 ^oC. This area is still influenced by Northeast monsoons, but with a weak level, the temperature difference between months of the year is small. The hottest month of the year is usually June or July, the coldest month is usually January. The absolute maximum temperature monitored in Quang Ngai was 40.5 ^oC, appearing on June 5, 1983. The absolute minimum temperature monitored in Quang Ngai was 10.3 ^oC, appearing on December 16, 1985. The changes in air temperature during the year are shown in *Table 2.7*.

Table 2.7 The characteristics of air temperature of Quang Ngai station (1977 – 2003)

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
T_{avg} (^oC)	21.7	22.6	24.4	26.7	28.3	28.9	28.9	28.6	27.2	25.7	24.0	22.1	25.8
T_{max} (^oC)	33.1	35.3	35.4	38.7	39.5	40.5	38.8	38.7	37.6	34.5	32.4	31.4	40.5
T_{min} (^oC)	12.4	14.1	13.4	18.6	21.4	22.4	22.0	21.4	21.7	17.1	16.4	10.3	10.3

Source: Mid Central Regional Hydro-meteorological Center

2.4.2 Rain and moisture regime

a) Rain regime

Tra Khuc river basin belongs to the region with heavy rainfall in our country, the annual rainfall increases with altitude, the coastal plain is about 2,200 mm, the high mountainous area is about 3,200 mm. The rainy season in this area usually starts in September, ends in December, the 4-month rainfall in the rainy season accounts for 70% of the annual rainfall (see *Table 2.8*)

Heavy rains are often caused by special weather events such as storms, tropical low pressure, or when a combination of storms and Northeast monsoons occurs. The months of May and June are not in the rainy season, but they often have quite large rainfall, causing the grain buds flood in the area. The actual maximum rainfall measured in the period of 1977 – 2003 is shown in *Table 2.8*.

Table 2.8 The actual maximum rainfall in the period measured at the stations in the area

Station	Period	1 day	3 days	5 days	7 days	1 month	1 year
Tra Mi	X (mm)	494	892	1118	1324	2450	7303
	Year of appearance	1996	1996	1996	1996	1996	1996
Son Giang	X (mm)	677	1598	1800	1909	2268	5917
	Year of appearance	1999	1999	1999	1999	1996	1999
Gia Vuc	X (mm)	723	1228	1298	1330	2083	5876
	Year of appearance	1986	1986	1986	1986	1996	1996

Source: Mid Central Regional Hydro-meteorological Center

Based on the locations of rain-measuring stations in the area, use the rain data from Son Giang, Gia Vuc and Tra Mi stations to calculate the average rainfall in Dak Drinh basin as follow:

$$X_{lv} = (2X_{sgi} + X_{gvu} + X_{trm}) / 4 = 3{,}570 \text{ mm } (*)$$

In which: X_{sgi}: the rainfall of Son Giang substation

X_{gvu}: the rainfall of Gia Vuc substation

X_{trm}: the rainfall of Tra Mi substation

Distribution of monthly rainfall during the year is shown in *Table 2.9* below:

Table 2.9 The average rainfall in Dak Drinh basin

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
X (mm)	107.0	48.4	54.2	78.7	220.1	206.2	156.2	200.3	313.5	805.7	938.7	440.8	3,570

Source: Power Engineering Consulting Joint Stock Company 2

The design rainfall in the period in the basin is also calculated by the (*) formula. Xsgi, Xgvu and Xtrm are the design rainfall in the period of 3 stations of Son Giang, Gia Vuc and Tra Mi. The calculation results are shown in *Table 2.10*.

Table 2.10 The maximum design rainfall in the period in Dak Drinh basin (mm)

Period (day)	Frequency P (%)						
	0.02	0.1	0.5	1	3	5	10

1	1296	1063	855	770	363	576	492
2	1961	1565	1233	1103	902	814	693
3	2305	1853	1470	1317	1082	979	836
4	2598	2088	1655	1481	1216	1098	936
5	2799	2250	1783	1596	1310	1184	1009

Source: Power Engineering Consulting Joint Stock Company 2

b) Evaporation and water surface evaporation loss

Due to the large humidity of the air, the amount of evaporation is small. The months in rainy season have small evaporation and vice versa, the months in dry season have large evaporation.

- *Basin evaporation (Zlv)*: determined by the water balance equation:

$$Zlv = X_o – Y_o = 3{,}570 - 2{,}310 = 1{,}260 \text{ mm}$$

In which: X_o – The average rainfall in the basin (mm)

Y_o – The average depth of flow in the basin (mm)

- *Water surface evaporation (Znc)*: determined by the following formula:

$$Znc = k_1 * k_2 * Z_{piche} = 1.40 * 1.31 * 885.4 = 1{,}624 \text{ mm}$$

In which: k_1: coefficient for calculation of piche evaporation to pan evaporation (k_1 = 1.40)

k_2: coefficient for calculation of terrestrial pan evaporation to water surface evaporation (k_2 = 1.31).

Z_{piche}: The amount of evaporation measured by Piche tube (mm), in accordance with Quang Ngai station

- *Water surface evaporation loss (△Znc):* determined by the following formula:

$$\triangle Znc = Znc – Zlv = 1{,}624 - 1{,}260 = 364 \text{ mm}$$

Distribution of water surface evaporation loss in accordance with piche evaporation at Quang Ngai station. See the calculation results in *Table 2.11* below:

Table 2.11 The distribution of water surface evaporation loss

Unit: mm

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
ΔZnc	22.1	23.0	30.7	34.8	39.8	39.5	42.8	39.1	27.8	23.7	21.0	19.5	364

Source: Power Engineering Consulting Joint Stock Company 2

c) Moisture regime

The air moisture in this area is quite large, the annual average value at Quang Ngai station is 84.9%, the difference between monthly average values of the months during the year is not large, the maximum moisture is almost 100%, the minimum moisture is also 37%. *(see Table 2.12)*

Table 2.12 The relative moisture of air (U%) at Quang Ngai station (1977 – 2003)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
U_{bq}(%)	88	87	86	84	82	80	79	80	85	88	89	89	85
U_{min}(%)	46	51	37	42	43	39	40	39	39	43	46	46	37

Source: Mid Central Regional Hydro-meteorological Center

2.4.3 Wind regime

Wind characteristics are calculated in accordance with the data of Quang Ngai meteorological station. In this place, there are 2 distinct seasons of the wind, from March to August, the prevailing wind directions are East and Southeast, from September to February of the next year, the prevailing wind directions are North and Northwest. The annual average wind speed is 3.2 m/s. The frequency of occurrence of wind directions is shown in *Table 2.13*.

Table 2.13 The frequency of occurrence (%) of wind directions at Quang Ngai station

Direction	N	NE	E	SE	S	SW	W	NW	Windless
Frequency (%)	11.9	6.7	11.3	7.4	1.2	0.7	2.3	9.9	48.7

Source: Mid Central Regional Hydro-meteorological Center

For the maximum wind speed of 8 directions of Quang Ngai station with different frequencies, see *Table 2.14.*

Table 2.14 The maximum wind speed of 8 directions at Quang Ngai station

(Unit: m/s)

Frequency	N	NE	E	SE	S	SW	W	NW	No direction
$V_{1\%}$	49.9	23.1	21.7	20.9	25.3	25.5	27.7	27.8	53.3
$V_{2\%}$	42.0	21.1	19.2	18.9	22.4	23.0	25.0	25.0	46.1
$V_{4\%}$	34.8	19.0	14.0	16.9	19.6	20.5	22.3	22.4	39.4
$V_{10\%}$	24.8	16.0	13.8	14.2	15.6	16.8	18.3	18.5	29.7
$V_{50\%}$	11.1	10.2	8.4	9.3	8.6	9.0	10.0	11.4	15.0

Source: Mid Central Regional Hydro-meteorological Center

2.5 HYDRAULIC CONDITIONS

2.5.1 Summarized characteristics of hydro-geographic conditions

Tra Khuc river originates from the peaks of Truong Son range with an altitude of about 1,000 – 1,500 m. The network of rivers and streams has the fan shape, the lower part of ATra Khuc river flowing in the direction of South – North and West – East flows into the East Sea. The river has the characteristics of the Central coastal river which are short and steep, mainly flowing through the hilly and mountainous areas, the delta part of the river is very narrow. The length from the source to the estuary is 135 km, the whole basin area is 3,240 km^2, of which mainly in Quang Ngai Province, about 25% of basin area in Kon Tum Province and a small part in Quang Nam Province.

Dak Drinh river is a first grade river and one of the three main branches of Tra Khuc river; Dak Drinh river basin is located on the West of Tra Khuc river basin (See *Table 2.15*).

Table 2.15 Morphological characteristics of Dak Drinh river basin

No.	Name of river	Flowing into	Distance from estuary (km)	River length (km)	Basin area (km^2)	Next basin area (km^2)	Remarks
1	Dak Ro Man	Dak Drinh P	39.0	21.0	122.0	7.0	Tributary
2	Dak Drinh	Main river	38.5	26.5	420.0		Dam route 2
3	Dak Ba	Dak Drinh T	36.0	39.0	113.0	6.7	Tributary
4	Nuoc Em	Dak Drinh T	33.6	8.5	28.3	3.4	Tributary
5		Dak Drinh P	31.5	8.3	23.1	3.2	Tributary
6	Dak Drinh	Main river	30.0	35	622.0	24.3	Hydropower plant
7	Dak Drinh	Main river	0.0	65	1,230.0	46.0	Dak Se Lo

Source: Power Engineering Consulting Joint Stock Company 2

The entire basin is hills and mountains with large slope. The covering vegetation is mainly primeval and regenerating forests, but the forest here is also in a state of being exploited profusely, the deforestation for slash-and-burn cultivation has also increased, thereby adversely affecting the flow regime of basin.

2.5.2 Annual runoff

a) Reference annual runoff

The reference annual runoff is calculated using the similar watershed method. For Son Giang basin, the average runoff module for many years M_o = 73.2 l/s/km^2. The average flow for many years of the routes is calculated using the following formula:

$$Q_o = M_o \text{ x } F$$

In which: Q_o – Average flow for many years

M_o – Average runoff module for many years (73.2 l/s/km^2)

W_o – Total annual runoff: $W_o = Y_o.F$

F – Basin area

Y_o – The average depth of runoff for many years (2,310 mm).

Table 2.16 Reference annual runoff calculated using methods

Route	F (km^2)	Q_o (m^3/s)	Y_o (mm)	M_o ($l/s/km^2$)	W_o (10^6m^3)
Dam 2	420	30.8	2310	73.2	970.2

Source: Power Engineering Consulting Joint Stock Company 2

b) Design annual runoff

- Coefficient of variation of annual runoff (C_v), calculated using the following formula:

$$C_v = \frac{A}{M_O^{0.4}.(F+1)^{0.08}}$$

In which: Coefficient A taken by the area (A = 4.0)

M_o – Average runoff module for many years ($l/s/km^2$)

F – Basin area (km^2)

In accordance with the above formula: $C_v = 0.44$

- *Coefficient of bias (C_s):* determined by the ratio of C_s/C_v of the area: $C_s = 3C_v$.

Design annual runoff calculated using Peason 3 distribution, see *Table 2.17* below.

Table 2.17 The characteristics of annual runoff at Dam 2

Route	F(km^2)	Q_o (m^3/s)	C_v	C_s	Q_p (m^3/s)				
					5%	10%	50%	75%	90%
Dam 2	420.0	30.8	0.44	1.32	56.8	48.9	27.9	20.8	16.5

Source: Power Engineering Consulting Joint Stock Company 2

c) Distribution of annual runoff

In accordance with Q_o, C_v, C_s at each route, the annual runoff series is calculated in accordance with the model of annual runoff series at An Hoa station using the following formula:

$$Q_i = Q_o \frac{Q_{ai}}{Q_{oa}}.\frac{K}{K_a}$$

In which: Q_i – Average flow of the i^{th} year of calculation series.

Q_o – Average flow for many years of calculation series.

K – Function of C_v and C_s, in accordance with Peason 3 distribution

a – Similar watershed index

See *Table 2.18* and *Table 2.19*

Table 2.18 The average flow of 3 stations in the area (m^3/s)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Son Giang	162.3	95.6	64.6	50.0	72.6	75.8	58.8	63.4	120.7	447.7	685.0	423.6	193.3

An Chi (81-03)	51.3	28.5	20.3	15.0	17.1	17.0	12.0	13.6	29.1	149.3	244.6	176.8	65.0
An Hoa (82-03)	29.0	15.8	9.6	6.8	7.0	7.3	4.9	5.2	11.0	65.4	117.4	84.2	30.3

Source: Power Engineering Consulting Joint Stock Company 2

Table 2.19 The distribution of annual runoff (%) of 3 stations in the area (in the period of 1977 – 1999)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Son Giang	7.0	4.1	2.8	2.2	3.1	3.3	2.5	2.7	5.2	19.3	29.5	18.2	100
An Chi	7.0	3.7	2.6	1.9	2.2	2.2	1.5	1.7	3.7	19.1	31.4	22.7	100
An Hoa	8.0	4.3	2.6	1.9	1.9	2.0	1.3	1.4	3.0	18.0	32.3	23.2	100

Source: Power Engineering Consulting Joint Stock Company 2

The calculation results of the monthly runoff in the year of Dak Drinh river at dam route 2 are distributed in accordance with the model of An Hoa station (See *Table 2.20*), calculated using the formula:

$$Q_{th(j)} = Q_i . \frac{Q^a_{th(j)}}{Q^a_i}$$

In which: $Q_{th(j)}$ – Flow of the j[th] month in the calculation year

Q_i – Average flow of the i[th] year of the calculation series

a – Similar watershed index

Table 2.20 The calculation results of the flow of Dak Drinh river at dam route 2

F = 420.0 km² *Unit: m³/s*

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1	77	18.94	10.69	9.27	5.30	3.06	4.07	2.85	3.26	12.53	18.84	113.77	20.98	18.63
2	78	34.83	8.05	7.23	5.91	9.17	6.11	6.31	4.58	15.79	28.11	108.98	65.70	25.06
3	79	24.24	10.90	7.03	6.01	8.56	16.30	7.54	6.01	5.50	58.57	103.08	44.71	24.87
4	80	15.58	6.31	5.09	4.89	6.52	8.96	5.50	5.40	20.07	105.93	239.15	44.82	39.02
5	81	23.63	16.19	7.84	6.52	9.27	9.98	6.31	4.69	4.28	133.84	194.03	120.09	44.72
6	82	25.06	12.02	6.10	7.01	4.54	4.91	4.80	3.60	7.93	9.73	15.18	9.31	9.18
7	83	9.35	5.68	4.08	2.68	2.41	3.86	2.53	4.35	3.49	46.85	166.11	30.96	19.36
8	84	22.92	13.44	6.31	3.94	6.12	14.67	5.56	2.94	3.13	27.60	122.23	83.42	26.02
9	85	27.81	13.24	7.09	5.58	6.16	7.88	3.03	2.71	6.95	37.99	182.32	84.34	32.09
10	86	23.22	14.97	10.29	4.91	9.09	4.77	2.45	3.86	2.50	78.84	53.17	151.76	29.99
11	87	26.89	14.16	11.92	5.92	2.99	2.94	2.08	2.09	8.35	4.20	207.78	52.25	28.46

12	88	33.61	20.57	14.06	10.59	6.18	8.42	7.48	3.73	9.27	72.72	72.93	35.34	24.58
13	89	38.09	15.07	14.97	8.58	8.30	6.97	6.35	8.27	19.15	20.57	39.93	27.91	17.86
14	90	15.48	9.30	6.28	4.29	5.44	7.60	4.94	4.09	5.62	129.35	120.19	42.37	29.58
15	91	17.82	15.07	12.32	10.19	4.19	4.28	3.40	3.15	4.30	38.09	34.32	65.29	17.70
16	92	26.89	9.94	4.56	3.77	2.75	4.07	2.51	5.25	4.71	178.25	89.33	29.33	30.11
17	93	11.51	6.34	4.92	3.78	3.46	3.56	3.34	2.42	4.29	59.89	123.24	178.25	33.75
18	94	25.26	11.51	10.19	8.56	7.95	7.50	6.63	6.64	17.72	33.82	36.77	50.32	18.57
19	95	18.74	14.87	9.32	7.17	7.29	7.11	6.01	6.24	10.80	116.11	138.52	89.33	35.96
20	96	41.05	33.92	12.53	7.46	15.28	8.08	5.43	3.92	11.10	101.85	298.43	162.97	58.50
21	97	30.76	12.12	6.64	7.31	7.21	7.37	5.74	4.39	19.56	23.73	104.91	52.96	23.56
22	98	18.33	10.49	6.10	4.01	4.32	2.59	4.56	3.40	17.52	90.04	243.43	174.17	48.25
23	99	71.30	35.55	19.66	13.55	46.50	14.16	7.62	2.66	7.52	90.45	151.66	247.81	56.54
24	00	61.52	38.30	14.97	10.90	15.99	21.59	11.82	16.91	14.87	59.48	167.04	112.04	45.45
25	01	41.25	17.32	14.36	9.98	8.25	8.45	5.56	13.34	7.35	55.82	55.41	58.67	24.65
26	02	30.56	16.30	9.36	5.80	7.72	6.19	4.02	8.31	48.79	30.66	135.47	84.44	32.30
27	03	32.80	14.77	8.86	5.28	5.14	5.69	4.24	3.78	10.59	159.91	121.21	64.07	36.36
Average		28.42	15.08	9.31	6.67	7.18	7.71	5.13	5.18	11.25	67.08	125.50	80.87	30.78
Max		71.30	38.30	19.66	13.55	16.50	21.59	11.82	16.91	48.79	178.25	298.43	247.81	81.91
Min		9.35	5.68	4.08	2.68	2.41	2.59	2.08	2.09	2.50	4.20	15.18	9.31	5.18

2.5.3 Runoff in the dry season

An Hoa hydrological station on Ve river is an adjacent basin and has a similar runoff regime with Tra Khuc river. The basin area of An Hoa station is 383 km^2, approximately the basin area of Dak Rinh dam route. Therefore, based on the minimal runoff of An Hoa station to calculate the minimal runoff at Dak Rinh dam route.

In accordance with the data of An Hoa station, the minimum monitored monthly flow is $Q_{th.min}$ = 2.04 m^3/s, the minimum monitored daily flow is $Q_{ng.min}$ = 1.35 m^3/s (the minimum instant flow monitored in the period of 1982 – 2003). The calculation results of minimum flow in accordance with the actual measurement documents (1982 – 2003) of An Hoa station are shown in *Table 2.21*.

Table 2.21 The calculation results of minimum flow of An Hoa station (m^3/s) (1982 – 2003)

Route	Characteristics	Q 90%	Q 95%	Q 97%	Q 99%	Q actual measurement	Time for appearance
An Hoa	Q_{th-min}	2.19	2.09	2.05	2.01	2.04	Aug, 1987

hydrological station	Q_{ng-min}	1.48	1.40	1.37	1.34	1.35	Aug 10, 1987
	Q_{min} (instant)	1.47	1.39	1.36	1.33	1.35	Aug 10, 1987

Source: Power Engineering Consulting Joint Stock Company 2

The minimum flow of dam route: use the series of runoff to calculate the minimum monthly, daily and instant flows, determined using the following formulas:

$$Q_{ng} = Q_{th} * k_1 \text{ and } Q_{min} = Q_{th} * k_2$$

In which: $k_1 = Q_{ng}/Q_{th}$ (in accordance with An Hoa station)

$k_2 = Q_{min}/Q_{th}$ (in accordance with An Hoa station)

Table 2.22 The calculation results of minimum flow at dam route 2 (m^3/s)

Route	Characteristics	Q 90%	Q 95%	Q 97%	Q 99%
Dam 2	Q_{th-min}	2.27	2.16	2.12	2.08
	Q_{ng-min}	1.53	1.45	1.42	1.39
	Q_{min} (instant)	1.52	1.44	1.41	1.38

Source: Power Engineering Consulting Joint Stock Company 2

2.5.4 Runoff in the flood season

The floods on Tra Khuc river are mainly single-peak floods, double-peak floods appearing less with small flood peaks. The time for maintenance of a flood at Son Giang station is about 3 – 7 days, the time of flood rising and falling is quick with the large flood peak. The maximum flow of some floods in the area shown in *Table 2.23* shows that the magnitude of some major floods having occurred in the area in recent years. Since then, the runoff module in the flood season in this area is founded to be very large.

Table 2.23 The maximum flow of some floods in the area (m^3/s)

River	Station	F_{lv} (km^2)	Q_{max} (m^3/s) / M ($m^3/s/km^2$)	Time of appearance	Q_{max} (m^3/s) / M ($m^3/s/km^2$)	Time of appearance
An Lao	An Hoa	383	5880 / 15.35	Nov 19, 1987	3680 / 9.61	Dec 3, 1999
Tra Khuc	Son Giang	2641	18300 / 6.93	Dec 3, 1986	10700 / 4.05	Dec 4, 1999

Source: Mid Central Regional Hydro-meteorological Center

a) Design flood flow

The maximum design flow is calculated using the flood peak reduction method:

$$Q_{maxp} = q_{pa} \left(\frac{F_a}{F}\right)^n . F$$

In which: Q_{maxp}: Maximum flow corresponding to the frequency p%.

q_{pa}: Similar watershed flood peak module

F: Basin area

n: Coefficient of flood peak module reduction, taken by the area (n = 0.33)

a – Similar watershed index

Table 2.24 The maximum design flow of routes (m^3/s)

Route	F (km^2)	Frequency P(%)				
		0.02	**0.1**	**0.5**	**5**	**10**
Dam 2	420	10,560	8,370	6,480	4,040	3,360

Source: Power Engineering Consulting Joint Stock Company 2

b) Design flood hydrograph

The design flood hydrograph is calculated using the method of Snyder Unit Hydrograph and shown in *Figure 2.5 The 3-route design flood hydrograph*.

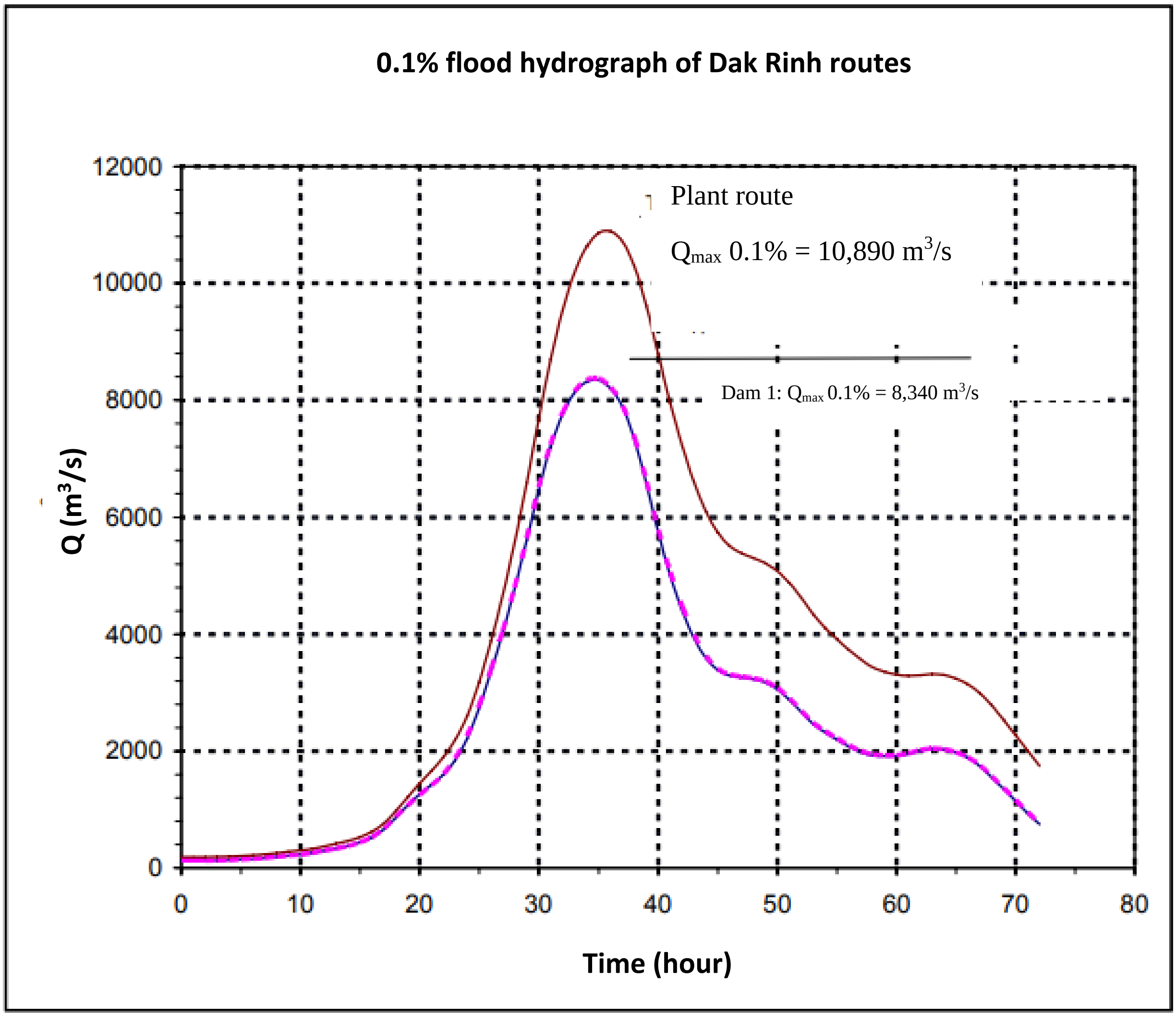


Figure 2.4 The 3-route design flood hydrograph

2.5.4.3 The maximum flow in the period of river filling

The dry season of this area lasts from January to September. However, in September, there are a few years of quite large floods in this area, so the maximum water flow in months from January to August is only calculated in the diversion for construction. The calculation results of Flow in the dry season (see *Table 2.25*) is calculated from the corresponding Q_{max} of Son Giang station using the reduction formula:

$$Q_{maxp} = Q_{pa} \left(\frac{F_a}{F}\right)^n \cdot \frac{F}{F_a}$$

In which: Q_p: Maximum flow corresponding to the frequency p%.

F: Basin area

n: Coefficient of flood peak module reduction in the dry season, taken by the area (n = 0.1)

a – Similar watershed index

Table 2.25 The maximum flow in months of dry season (m³/s)

No.	Route	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Dry season (Jan – Aug)
	Son Giang	Qp – 5%	822	321	683	529	1426	980	543	1,072	1,911
		Qp – 10%	604	217	425	329	1026	696	380	668	1,388
1	Dam 2	Qp – 5%	157	61.4	131	101.1	273	187	104	205	365
		Qp – 10%	115	51.8	81.2	62.9	196	133	72.6	128	265
2	Plant	Qp – 5%	224	87.4	186	144	388	267	148	292	520
		Qp – 10%	164	73.8	116	89.5	279	189	103	182	378

Source: Power Engineering Consulting Joint Stock Company 2

2.5.5 Sandy mud current

At Son Giang station with alluvial materials from 1982 up to now, the minimum annual average turbidity is 32.1 g/m³ (1982), the maximum is 379.4 g/m³ (1999), the average is 142 g/m³.

The chosen annual average design turbidity value is ρ_{bq} = 150 g/m³.

Since then, other characteristics of solid current can be calculated, the results are as *Table 2.26*

Table 2.26 The calculation results of solid current at Dak Rinh dam routes

Route	F (km²)	Q_o (m³/s)	ρ_o (g/m³)	R_o (kg/s)	W_{ll} (10⁶ kg/year)	W_{dd} (10⁶ kg/year)	V_{ll} (10⁶ m³/year)	V_{dd} (10⁶ m³/year)	V_{tc} (10⁶ m³/year)
Dam	420.0	30.8	150.0	4.62	145.7	58.3	0.123	0.038	0.161

Source: Power Engineering Consulting Joint Stock Company 2

In which: Q_o: Average water flow for many years

ρ_o: Average turbidity for many years

$W_{dđ}$: Amount of bed-load sandy mud (= 40% W_{ll})

V_{ll}: Volume of suspended sandy mud (D_{ll} = 1,180 kg/m^3)

$V_{dđ}$: Volume of bed-load sandy mud ($D_{dđ}$ = 1,550 kg/m^3)

V_{tc}: Total volume of suspended and bed-load sandy mud

D: Density of sandy mud

2.5.6 Water sources in the resettlement area

2.5.6.1 Water surface sources:

In the resettlement areas for the households affected by the project, the water sources for the areas are regional river and stream system, especially: Dak Rinh river, Nuoc Ta Meo river, Ra Phan river, Dak Ro Man river … These rivers maintain their runoff throughout the year. The distance between these areas and the rivers fluctuates in the range of 0.5 – 3 km. When there is a reservoir with the elevation of 410 m, the distance between the reservoir to the resettlement areas will be shortened. In general, the water quality is good.

2.5.6.2 Groundwater sources:

Groundwater is closely related to surface water, located about 3 – 10 m away from the ground in the rainy season and 10 – 20 m in the dry season. Abundant and plentiful water source. The water quality of groundwater is still quite good, with a total mineralization of 100 – 350 g/l. It belongs to the type of Sodium – Potassium Bicarbonate. When there is an improved reservoir containing this water source, it is very convenient for the domestic water supply of the resettlement areas when there are appropriate structural solutions. This is an advantage for providing domestic water to the resettlement areas.

The conditions for water source of supply in the resettlement area is shown through the regional river and stream system and the reservoir of Dak Drinh hydropower project to be constructed are shown in *Figure 1.5 Master plan of the resettlement areas of Dak Drinh hydropower project and traffic and electricity supply networks for the resettlement areas*.

2.6 CURRENT STATUS OF ECOLOGICAL ENVIRONMENT

2.6.1 Flora and vegetation

a) Flora

In accordance with the previous research results of National Center for Natural Science and Technology in 1996, the flora area in Tra Khuc river basin has listed 592 species of 425 plant genera.

Survey results in November, 2004 of the flora of Dak Drinh hydropower project recorded: 363 species of 95 families. In the flora of the basin, the branch with the most species is DICOTYLEDONAE with 292 species and MONOCOTYLEDON with 12 families and 48 species shown in *Table 2.27*; details of 363 surveyed species are shown in the *Appendix – Table 2.1 List of plant species in the Dak Drinh hydropower project* in the Appendix.

Table 2.27 The flora in the study area

Branch		Families	Species

POSILOPHYTA	Pterophyta	9	19
GYMNOSPERMAE	Gymnosperms	2	4
MAGIOSPERMAE	Angiosperms		
DICOTYLEDONAE	Dicotyledons	72	292
MONOCOTYLEDON	Monocotyledons	12	48
Total		95	363

Source: Institute of Tropical Biology, 2004

b) Vegetation

The topography of Dak Drinh river basin is mainly craggy mountainous areas with steep and difficult-to-access slopes. Before human intervention, the entire study area was covered with humid tropical evergreen broadleaved forests which were valuable in terms of natural resources as well as biodiversity. However, due to the deforestation, most of the primeval forests were depleted, leaving only very poor secondary forests, bamboo forests, scrub grasslands and milpa. Medium secondary forests were only a little in the Kon Plong area.

1. Natural vegetation:

Humid tropical evergreen dense forest less affected

In the study area, the remaining area off this forest type is very little on the high mountain peaks. Dute the rugged topography, these evergreen forest types still retain some of their primitive nature even though they have been also exploited.

Belonging to the elevation belt of 700 m – 1,000 m: This forest type is mainly distributed in the high mountains of over 700 m on the Kon Plong side, with the negligible area. The evergreen forest here is less affected, so the forest is abundant with its reverses of 150 – 200 m^3. The typical climatic regime of this region is cold and humid, so the dominant species are those of the native endemic tropical Asian flora of Northern Vietnam and Southern China. The representative plant species include: Fagaceae Family: *Lithocarpus annamilerun*, *Quercus baniensi, Quercu setulosa …*; Lauraceae Family: *Phoebe cuneato, Cinnamomum lilseaefolium, Litsea annamensis*; Magnoliaceae Family: *Michelia sp.*, Theaceae Family: *Schima crenata, Eurya muricata, Camellia caudate*, Ericacae Family: *Enkyanthus quiqueflorus*; Clusiaceae Family: *Cratoxylon polyanthum, Cratoxylon prunifolium*.

Belonging to the elevation belt of below 700 m: This forest type is distributed in low terrain of below 700 m, scattered, and occupies a small area on craggy terrains, or concentrates on mountain tops of below 700 m. In addition, they are also distributed in a narrow area along Dak Drinh rivers and streams in the territory of Kon Plong.

Timber layer: The top layer is about 25 m high and 20 – 50 cm in diameter, 30 cm on average, some of them are over 1 m in diameter. The dominant plants include: Podocarpaceae Family: *Podocarpus neriifolius*; Magnoliaceae Family: *Manglietia chevalieri*; Dipterocarpaceae Family: *Dipterocarpus costatus, Shorea harmandii, Shorea guiso, Parashorea steliata*; Fabaceae Family: *Pterocarpus indicus, Dalbergia cochinchinensis*; Flacourtiaceae: *Homalium tomentosum*; Lauraceae: *Cinnamomum polyadelphum, Litsea spp.*; Ixonanthaceae Family: *Irvingia malayana*;

Sterculiaceae Family: *Pterospermum angustifolium*; Verbenaceae Family: *Vitex negundo*; Arecaceae Family: *Calamus dongnaiensis, Livistona saribus, Phoenix hanceana*; Musaceae Family: *Musa wilsoni …*

Secondary evergreen dense forest strongly affected

The secondary evergreen forest type is formed due to the high intensity of deforestation for slash-and-burn cultivation and natural resource logging. The pioneering timber species grow and develop into forests, after which these secondary forests continue to be exploited leading to the very poverty. Almost all kinds of valuable timber have been completed exploited. Only low-quality wood species and regenerated species are left. Most of the forest type is located in the elevation belt of below 700 m, scattered in small areas mixed with bamboo forest, and mixed-wood bamboo forest, around milpa and villages, with its average reserves of 60 – 80 m^3/ha. This reserve fluctuates by terrain. In high and craggy terrain, the reserve is larger than that in the areas along rivers and plain hilly land. The secondary forest with medium to rich reserves is distributed mainly in the high mountainous terrain at the end of branch of reservoir bed of Kon Plong.

Appearance structure: It is possible to see dense closed low forest including pioneer trees with the height of 5 – 7 m, depleted populations has uneven and undulating canopy, there are only sick, crooked individuals with broken branches in the overstory.

Most of the depleted secondary forest in this area is Trema angustifolia combination, which is the largest assemblage appearing on the fallow milpa after 2 – 3 years. In some places, it is possible to see almost pure trees such as *Trema angustifolia, Mallotus apelta, Mallotus cochinchinensis,* which often grow into a mixed cluster with *Macaranga denticulate, Mallotus barbatus*. In this combination, there are also species of *Aralia armata, Peltophorum pterocarpum, Litesa citrate, Ficus hipida, Grewia hirsute, Euodia lepta, Alangium sinensis*

Mixed-wood bamboo forest

Mixed-wood bamboo and secondary broadleaved forest is a degraded secondary forest strongly affected. The intrusive bamboos are usually the genera of: Oxytenanthera and Bambusa. Timber forest only accounts for a coverage percentage of about 40%, broken canopy grow sparsely, alternating between different kinds of bamboo. The timbers are 15 – 20 m high and the small timbers are about 7 – 10 m high, mixed with bamboo in this layer. This type is relatively homogeneous in different climatic belts. In terms of composition: evergreen timbers of the families: Sterculiaceae, Euphorbiaceae, Myrsinaceae, Apocinaceae, Verbenaceae, Acanthaceae, Loganiaceae, Palmae, Zingiberaceae, Musaceae, Orchidaceae, Cyperaceae, Graminae …

This forest type is mainly distributed in the areas along Dak Drinh, Dak Ro Man, Ra Pan rivers and Nuoc Ta Keo stream … in sparsely populated terrain and steep slopes, which are difficult to exploit for milpa. The average diameter of a timber is less than 20 cm, the height of 14 – 16 m, the reserve of 30 – 40 m^3/ha.

Scrub grassland: Formed from the degeneration of evergreen forest depleted by humans for slash-and-burn cultivation and abandoned when the soil is impoverished. The light-loving forest species regenerate and develop. The number of species varies from 20 – 30 species per hectare, the proportion of big timbers accounts for about 30% and 70% for shrubs. The number of individuals varies greatly, depending on the fallow period from 18,000 trees in the first year to about 6,000 trees/ha after 6 years, the average diameter of 1.5 – 6.0 cm, the height of 1.5 – 6.0 m.

The representative species include: *Aporosa microcalyx, Breynia fruticose, Mallotus apelta, Phyllanthus emblica, Cratoxylon polyanthum, Irvingia malayana, Machilus sp., Litsea cubeba, Allophyllus sp., Dodonea viscosa, Ailanthus altissima, Brucea lavanica, Melastoma septemnevium, Syzigium sp., Ormosia sp., Randia depauperata, Eudia lepta, Micromelum tanaca, Clausena excavate, Acronychia pedunculata, Eurycoma longifolia, Helicteres angustifolia, Pierospermum sp., Schima wallichii, Acanthus, Xylopia sp., Holarrhena antidysentecica, Wrightia tomemtosa, Canarium album, Alchornea rugosa*.

Secondary bamboo forest

This type is derived from depletion, without any remaining large timbers or with large timbers that have been burned down for slash-and-burn cultivation, then the milpa is abandoned and species of bamboo quickly invade. The secondary bamboo forests are distributed over a large area of the study area. The structure of this forest type is simple both in appearance and in species composition. Pure growing bamboo species have their height of about 6 – 7 m.

The composition of bamboo species include species with high dominance such as: *Oxytennanthera Nigor-cillata*, small bamboo growing into bushes with the height of 8 – 10 m and growing in pure clumps, *Oxytennanthera pusilla*, growing into each bush with the height of 1 – 2 m in more arid places. The Oxytennanthera plots occupy most of the study area. Besides, there are neuhouzeauas (*Schizostachyum funghomi*) growing into bushes with the vertical trees, 15 m high, 4 – 6 m in diameter, distributed along the humid rivulets and in evergreen forests. In addition, *Bambusa sp.* grows into dense bushes, with the height of 3 – 10 m, the internode length of 40 – 60 cm, on wetter soils and a small area.

2. Artificial vegetation

In the study area, there are the following types of artificial vegetation:

- Plantation forests: mainly Acacia forests and Cinnamon and Acacia forests of different ages from 1 – 4 years old, with the diameter of 5 – 10 cm, the height of 1 – 7 m. Cinnamon is usually planted under the canopy of secondary forest with the diameter of 8 cm, the height of < 8 m.

- Perennial industrial crops: tea, coffee, nuts, pepper, sugar cane, cocoa

- Short-term upland crops: corn, potato, cassava, upland rice, vegetables and beans of all kinds …

- Wet rice

3. Flowing water flora

Due to the specific nature and the regularity ò the flora growing and developing in the areas lying on the stream, a micro-topographic subtype is separated to research. This flora includes the flora living on blocks of marble on the waterfalls, the flora living on the alluvial sandbanks of both sides or in the middle of the stream, the flora growing on the two sides of basin. On the rocky rapids between rivers, the water flows strongly and frequently, the bottom consists only of rocky rapids. Low diversity of terrestrial plants, including humid and light-loving forest trees, and poor aquatic plants. The dominant flood-tolerant plants are Telectadium edule, growing and developing strongly in the dry season. The strong water flow is the factor limiting its growth and development in the rainy season. In addition, on the rocky holes, there are species of Lasia spinose that can be found in the dry season. Green moss (Hyophila inyoluta) and Green Algae are often found in open areas on stagnant rocky holes in the dry season.

The flora on the exposed rocks and alluvial sandbanks along the river corridor; the diversity of submerged aquatic plant species here is not high, mainly semi-submerged species of: *Saccharum spontaneum, Phragmites vallatoria, Panicum repens, Celosia argentea, Cyrtosperma merkusii, Cyperus spp., …*

On both sides along the basin corridor, the flora depends on the seed source of natural flora. In places where the forests have not been or are less affected, the composition of coastal plant species mainly includes the terrestrial plants, consisting of the humid and light-loving pioneer forest species of the secondary forest such as: *Diospyrus spp.*, the species of Ficus genus. On both sides of narrow streams with the high coverage due to forest canopies, or on tight clay beds, *Bambusa spp.* and *Camulus spp*. often appear.

Low slope and flat areas in the lowlands often develop into agricultural and residential land. Land use has narrowed the flora corridors gradually and replaced native flora with agricultural and exotic species. Along the corridor of lowlands in Dak Drinh and Tra Khuc rivers, it is also under threat of invasion by the exotic plant species such as *Mimosa pigra*. *Mimosa pigra* is a light-loving and flood-tolerant plant. Therefore, there are two main factors affecting the abundance of this flora: (1) the inundation. *Mimosa pigra* is a flood-tolerant plant. During the growth and development, it can withstand flooding for a while, and (2) the shade. *Mimosa pigra* is a light-loving plant growing and developing strongly in open areas along clear, empty and wide rivers and streams and fields, where *Mimosa pigra* rises to overwhelm the other species.

c) Rare and precious plant species

In the flora of the study area, around the reservoir bed of the project, rare and precious plant species in the Vietnam's Red Data Book are recorded in *Table 2.28*.

However, in the evergreen forest area submerged in the reservoir bed of the project, they are mostly crooked trees of small diameter affected by pests and diseases.

Table 2.28 List of rare and precious plant species in Dak Drinh hydropower project basin

Rare categories	Species	Vietnamese name
Species of V categories		
	Irvingia malyana	Cay
	Sindora siamensis	Gu mat
	Manglietia dandyi	Vang tam
	Rhodoleia championi	Hong quang
Species of T categories		
	Drynaria fortunei	Cot toai bo

Notes: V – Vulnerable T – Threatened *Source: Institute of Tropical Biology, 2004*

d) Vegetation in the resettlement area

The remaining natural vegetation is mainly poor tropical forests due to overexploitation. The current forest is the regenerating trees and does not have any large trees. These regenerating forests are interspersed with shrubs, and perennial crops which is mainly areca trees (newly planted and perennially planted) and the areas planted to crops. These areas are not concentrated, not large and scattered in the region. The resettlement areas are managed, protected and exploited by commune authorities. The economic value of these forests is currently not high.

2.6.2 Current status of wildlife fauna in the project area

The survey and investigation results in October, 2004 in the study area are recorded species composition of the existing terrestrial vertebrate fauna within the study area (See *Table 2.29*). The research results show that the wildlife fauna of hydropower project area is not diverse in species composition, but some species having their habitats of living in populations such as bamboo forests, open areas, scrub grasslands have their relatively high density.

Table 2.29 Summary of taxon in the fauna of study area

Phylum	Order	Family	Species
Bird	9	24	46
Mammal	8	19	35
Reptile	2	7	10
Amphibian	1	4	11

Source: Institute of Tropical Biology, 2004

a) Mammal fauna

In accordance with the previous research results of the National Center for Natural Science and Technology, the mammal fauna of Tra Khuc river basin has about 52 mammal species of 20 families of 9 orders. Through survey and investigation of the study area of Dak Drinh river, it has recorded 35 mammal species of 19 families of 8 orders, of which 11 rare and precious species listed in the Vietnam's Red Data Book and 6 species of VU categories (vulnerable) of Red Data List, 1994 (IUCN) (See *Table 2.30* and *Appendix – Table 2.2. List of mammal species in Dak Drinh hydropower plant* in the appendix).

Table 2.30 Taxon structure of mammal fauna in Dak Drinh hydropower project

No.	Classified groups	Number of families	Number of species
1.	Carnivora	4	11
2.	Rodentia	4	8
3.	Artiodactyla	4	5
4.	Primates	2	6
5.	Chiroptera	2	2
6.	Lagomorpha	1	1

7.	Pholidota	1	1
8.	Dermoptera	1	1
	Total	**19**	**35**

Source: Institute of Tropical Biology, 2004

b) Bird fauna

In accordance with the previous research results of the National Center for Natural Science and Technology, the bird fauna of Tra Khuc river basin has about 221 bird species of 42 families of 14 orders. Through survey and investigation of the study area of Dak Drinh river, it has recorded 46 mammal species of 24 families of 9 orders, of which 1 rare and precious species listed in the Vietnam's Red Data Book (See *Table 2.31* and *Appendix – Table 2.3. List of bird species in Dak Drinh hydropower plant* in the appendix).

Table 2.31 Taxon structure of bird fauna in the area

No.	Order	Number of families	Number of species
1.	Galliformes	1	3
2.	Columbiformes	1	4
3.	Psittaciformes	1	2
4.	Cuculiformes	1	5
5.	Strigiformes	1	2
6.	Caprimulgiformes	1	1
7.	Apodiformes	1	1
8.	Piciformes	2	3
9.	Passeriformes	15	25
	Total	**24**	**46**

Source: Institute of Tropical Biology, 2004

c) Reptile & Amphibian fauna

In accordance with the previous research results of the National Center for Natural Science and Technology, the reptile and amphibian fauna of Tra Khuc river basin has about 52 animal species of 14 families of 2 orders. Through survey and investigation of the study area of Dak Drinh river, we have recorded that: The Reptilla class has 10 species of 7 families of 2 orders; The Amphibia class has 11 species of 4 families of 1 order (See *Table 2.32*).

Table 2.32 Taxon structure of 2 Reptilla & Amphibia classes

Class	Order	Family	Species
Reptilla	**2**	**7**	**10**

Ambiphia	**1**	**4**	**11**

Source: Institute of Tropical Biology, 2004

List of reptile and amphibian species surveyed in the area is shown in *Appendix – Table 2.4 List of species of Reptilla class in Dak Drinh hydropower plant*, and *Appendix – Table 2.5 List of species of Amphibia class in Dak Drinh hydropower plant* in the appendix.

d) The group of rare and precious animals of conservation value

The list of rare and precious animal species is shown in the next *Table 2.33 List of rare and precious mammal species in the study area, Table 2.34 List of rare and precious reptile species in the study area, Table 2.35 List of rare and precious amphibian species in the study area, Table 2.36: List of rare and precious bird species in the study area.*

Table 2.33 List of rare and precious mammal species in the study area

Rare categories	Categories	Number of species	Name of species
Endangered species	E	2	*Selenarctos thibetamus* *Helarctos malayanus*
Vulnerable, if there are no measures for protection	V	6	*Nycticebus coucang* *Nycticebus pygmaeus* *Macaca arctoides* *Cynocephalus variegatus* *Aonyx cinerea* *Capricornis sumatraensis*
Rare and precious species	R	2	*Arctogalidia trivirgata* *Petaurista philippensis*
Threatened, not clearly identified	T	1	*Lutra perspicillata*
Red Data List, 1994 (IUCN) Vulnerable	VU	6	*Nycticebus pygmaeus* *Nycticebus coucang* *Macaca arctoides* *Macaca leonine* *Selenarctos thibetamus* *Lutra perspicillata*

Notes: E – Endangered; V – Vulnerable; R – Rare; T – Threatened; VU – Vulnerable

Source: Institute of Tropical Biology, 2004

Table 2.34 List of rare and precious reptile species in the study area

No.	Scientific name	Rare categories
	Gekko gecko (Linnaeus, 1758)	T
	Varanus nebulosus (Gray, 1831)	V
	Python molurus (Linnaeus, 1758)	V
	Ptyas korros (Schlegel, 1837)	T
	Bungarus fasciatus (Schneider, 1801)	T
	Indotestudo elongate (Blyth, 1853)	V

Source: Institute of Tropical Biology, 2004

Table 2.35 List of rare and precious amphibian species in the study area

No.	Scientific name	Rare categories
1.	*Bufo galcatus (Gunther, 1864)*	R

Source: Institute of Tropical Biology, 2004

Table 2.36 List of rare and precious bird species in the study area

No.	Scientific name	Vietnamese name	Threatened categories
1.	*Lophura nycthemera*	Ga loi van	T

Source: Institute of Tropical Biology, 2004

Among 102 species recorded in Dak Drinh hydropower project, 25 rare and precious species (accounting for 24% of the total number of species in the area) have been reckoned. These are valuable species to be preserved, restored and developed.

There are 18 species (accounting for 75% of the total number of rare and precious species) nationally threatened as listed in Vietnam’s Red Data Book (2000), of which 2 species (accounting for 8%) at E category (Endangered) are mammals; 9 species (accounting for 37.5%) at V category (Vulnerable) inclusive of 6 mammal species and 3 reptile species; 3 species (accounting for 12.5%) at R category (rare) inclusive of 2 mammal species and 1 amphibian species; 8 species (accounting for 20.8%) at T category (Threatened) inclusive of 1 bird species, 3 reptile species and 1 mammal species.

There are 6 species (accounting for 25% of the total number of rare and precious species) globally threatened as listed in IUCN Red Data List (1994) at VU category (vulnerable) inclusive of 6 mammal species.

In general, the species of this group are valuable in many aspects: science, medicine, food, supply of art materials (skin, feathers), decoration, sometime kept in zoological gardens, public entertainment as well as exchange and trade. These animals not only have economic value but also have large body size, so they have been the target of hunting of local people for local people. In addition, the habitat of forest animals has been being increasingly narrowed due to encroachment on forest land for slash-and-burn cultivation, forest fires, logging for trade, construction and firewood, exploitation of other non-timber products (bamboo shoots, medicinal plants, rattan, …), and hunting wild animals. The wild fauna in the area has been seriously degraded, many specifies have become rare or must be moved to new and safer distributed areas.

2.6.3 Aquatic fauna and fisheries

Carried out on the basis of analysis of the samples collected in the streams of Ta meo, Dak Rin, Dak Ro Man, Dak Ra Phan, Dak Drinh, and Rin river – Son Tan Commune area and tributaries flowing into Rin river in Son Tan Commune in the survey of October, 2004.

Research methods are as follows:

- Phytoplankton: by a net of phytoplankton with a mesh size of 25 µm made in Switzerland – the amount of filtered water through the net of 60 liters.

- Zooplankton: by a Juday-style net of zooplankton with a mesh size of 40 µm, the amount of filtered water through the net of 60 liters.

- Zoobenthos: by Petersen-style sludge hoe, with the area of 0.025 m^2 made in China, a sample taken by 4 hoes with the area of 0.025 x 4 = 0.1 m^2 and handheld racket.

Laboratory analysis methods:

- Determine the species composition ò aquatic groups

- Count the number of each species of phytoplankton in 1/30 sample.

- Count the number of each species of zooplankton

- Count the number of each species of zoobenthos.

The research results are as follows:

a) Phytoplankton

The results of analyzing phytoplankton samples obtained in the field survey of October 2004, on the branches of Dak Drinh river have identified 122 species of phytoplankton of 6 phylum of blue algae (Cyanophyta), diatom (Bacillariophyta), green algae (Chlorophyta), algae (Euglenophyta), Chrysophyta algae and Dinophyta algate. In which, diatoms account for a highest number of species with 51 species, accounting for 41.8% of the total number of species (See *Table 2.37*).

Table 2.37 List of phytoplankton species on the branches of Dak Drinh river

PHYLUM	NUMBER OF SPECIES	%
Cyanophyta	16 species	13.1%
Chrysophyta	1 species	0.8%
Bacillariophyta	51 species	41.8%
Chlorophyta	39 species	32.0%
Euglenophyta	14 species	11.5%

Dinophyta	1 species	0.8%
	122 species	100%

Source: Institute of Tropical Biology, 2004

Through analysis of the structure of phytoplankton species composition, it can distinguish species groups:

- Distributed in most of sampling sites, inclusive of diatom species: Melosira varians, Synedra ulna, Eunotia pectinalis, Achnanthes sp., Cocconeis sp., Navicula viridula, Cymbella lanceolate, Cymbella ventricosa, Gomphonema intricatum, Gomphonema sphaerophorum, Nitzschia palea, Surirella angustata, Surirella robusta.

- The group of indicator species for weak acidic water include properties including diatoms of the genus of Eunotia (5 species), Navicula gastrum, Navicula vividula, Pinnularia (4 species); green algaes of the genus of Closterium (8 species), Cosmarium (3 species), Staurastrum (3 species). The species of this group are scattered in the sampling sites.

- The group of indicator species for the environment with rich organic matter including most species of blue algae, all species of euglenophyta, species of diatoms: Melosira granulate, Synedra ulna, Nitzschia filiformis, Nitzschia palea; species of green algaes: Pediastrum duplex, Scenedesmus dimorphus, Scenedesmus quadricauda.

- The number of phytoplankton is quite high from 5,150,000 – 236,500,000 tb/m^3, diatom species of Navicula sp., Gomphonema sp. and Synedra unla dominate. Synedra ulna species indicates the medium dirty water which is dominant only in Son Tay stream, possibly due to the direct influence of domestic wastewater from the people living along the stream.

b) Zooplankton

The results of analyzing phytoplankton samples obtained in the field survey of October 2004, on the branches of Dak Drinh river have identified 20 collected species of zooplankton, of which 14 species in the project area. In which, there are only 5 species of official zooplankton inclusive of 3 Cladocera species, 2 Copepoda species. The remaining species include 8 species of insect larvae of 2 Ephemeroptera and Diptera orders, and 1 Oligochaeta species of Naididae family, which are unofficial zooplankton. These species have their lifestyles on the bottom and around coastal aquatic shrubs which are swept away by strong flow of streams and rivers (See *Table 2.38*).

Table 2.2 List of zooplankton species on the branches of Dak Drinh river

PHYLUM	NUMBER OF SPECIES	%
Cladocera	6 species	30.0%
Copepoda	5 species	25.0%
Insecta larva	8 species	40.0%
Oligochaeta	1 species	5.0%
	20 species	

Source: Institute of Tropical Biology, 2004

The aforementioned official plankton crustaceans are also found only in Thach Nham dam. For the amples in the reservoir of hydropower project, Rin river, Son Tay river, Son Tan river and the reservoir downstream of hydropower project, the official zooplankton species are not found. It is possible that the fast current in the rainy season has ruined the embryo development of Cladocera and Copepoda.

Cladocera composition includes Macrothrix triserialis species, and Copepoda composition includes Eucyclops serrulatus species at Thach Nam dam, bipedal insect larvae of the Chironomidae family in the proposed reservoir and the rivers and streams of dam downstream. – Endochironomus sp., and Clinotanypus sp., are both typical species of weak acidic water environment.

Red mosquito larvae species of Orthocladius sp., Tanytarsus sp. (Chironomidae), plankton larvae species of Ecdyonuroides vietnamesis indicate strong flowing water environment.

In summary, in the Dak Drinh area, the official zooplankton species are not found, but only the zoobenthos strongly inverted by the water flow to the surface layer, becoming temporary zooplankton. The number of zooplankton is very low, only from 300 – 1,000 animals/m^3. Even at Thach Nham dam, the number of zooplankton is only 900 animals/m^3.

c) Zoobenthos

The results of analyzing phytoplankton samples obtained in the field survey of October 2004, on the branches of Dak Drinh river have identified 34 species. It can be seen that the zoobenthos composition is very small aquatic protozoa (homotope) consisting of only two crustacean species and 4 mollusc species, while the secondary aquatic metazoa (heterotope) has a very large number of species, up to 28 species (See *Table 2.39*).

Most of zoobenthos are species living in flowing and strong flowing water environments such as snail species of Brotia binodona subglobiosa, Thiara scabra and Tarebia ganifera; larvae species of Trichoptera order, bipedal order of Chironomidae family with the genus of Orthocladius sp., Tanytarnus sp. and the adult insect of Heteroptera order: Ptilomera sp., Cercometus sp., Aphelochirus sp., Naucoris sp., Heleocoris sp., Beetle insect: Gyrinus sp.

In the zoobenthos composition in rivers and streams of the project area, there are shrimp species of Caridin tonkinensis, Macrobrachium nipponense and Brotia linodonsa subglobiosa snail which are related to aquatic fauna of Southern Thailand. The insect larvae species of Ecdyonutioides vietnamensis are widely distributed in rivers and streams with the flowing water in the mountains of Vietnam.

Table 2.39 List of zoobenthos species on the branches of Dak Drinh river

	NUMBER OF SPECIES	%
Crustacea	2 species	5.9%
Mollusca	4 species	11.8%
Insecta	28 species	82.3%

	34 species	100

Source: Institute of Tropical Biology, 2004

The number of zoobenthos in rivers and streams of the Dak Drinh hydropower project area is medium, from 100 – 450 animals/m^2. Brotia binodonsa subglobiosa Brandt snail is dominant in upstream branches such as Dak Rin, Ta Meo stream, Ro Man stream, Ra Phan stream; Baetis sp., Cloeson sp., and Ecdyonuroides vietnamensis (Ecdyonuridae) insects are dominant in the area planned to locate the plant (Rin river and its tributary streams).

In the shoreline, the dragonfly larvae of Libellutidae and Agrionidae families are dominant.

d) Fish fauna and fisheries:

The results of survey of October 2004 show that: Fishing and fish farming in the project area have not developed yet. There are only very few residents on rivers and streams of the project area doing fishing with sharp nets in deep pools or angling. The fish species of economic value often caught are Onychostoma gerlachi, Trichopodus microlepis, Pangasius krempfi.

Although there was Thach Nham dam, the eel still appears in the upstream area of Communes of Dak Nen, Dak Drinh, Dak Rin stream, Ta Meo stream, Ro Man stream.

In the surveyed area, the number of fishermen working regularly and continuously is only about 10 persons, the rest only do fishing during the dry season. Fishing tools are mainly fishing rods, fish pot, nets, and small casting-nets. The average daily catch of fish is quite large, estimated at about 1 – 4 kg/boat/day, which are diverse in types.

During the survey, a small number of fisherman and 1 – 2 small fishing boats on the river were observed. At the sampling sites, fish species observed in the market and on some small fishing boats are common species such as goby, drift fish, carp … with small numbers. Most of the interviewed fisherman only fish for family meal. Sometimes when catching large fishes, the fisherman sell them at the market.

2.7 FUNDAMENTAL ENVIRONMENT QUALITY

2.7.1 Water environment:

In order to conduct the water environment quality assessment in the project, two surveys on water sampling and testing have been conducted:

- First time: Conducted in October, 2004 (the rainy season). Mainly sampling and analyzing water quality of Dak Drinh river in the project area and Tra Khuc river at Thach Nham dam.

- Second time: Conducted in May, 2007 (the rainy season). Sampling and analyzing water quality of Dak Drinh river in the project area and other surface water sources on the 110 kV power line of Dak Drinh – Doc Soi hydropower plant;

The locations of monitoring points are shown in *Figure 2.6 Diagram of the locations of monitoring points for fundamental environment of Dak Drinh hydropower project* shown in the next page.

a) Results of survey in phase 1:

The analysis results of water samples in rivers and streams of Dak Drinh hydropower project area in phase 1 are shown in *Table 2.40* below.

Table 2.40 The analysis results of water samples in Dak Drinh river (Phase 1: October, 2004)

Parameters for analysis	**Indicator**	**Sampling positions**					
		1	**2**	**3**	**4**	**5**	**6**
EC	µS/cm	50	195	58	74	38	33
pH	-	5.6	6.5	6.9	7.4	7.1	7.5
H_2S	mg/l		0.01				
NO_2-N	mg/l	0.002	0	0.005	0.005	0	0.005
NO_3-N	mg/l	0.13	0.16	0.25	0.18	0.26	0.14
NH_4-N	mg/l	0.01	0	0.01	0	0	0
PO_4-P	mg/l	0.01	0	0.01	0.01	0.01	0.01
DO	mg/l	6.2	5.4	6.2	7.0	6.5	6.8
BOD_5	mg/l	3	3	3	3	3	3
COD	mg/l	6	6	6	7	6	7
Total clay	mg/l	0.002	0.20	0.06	0.003	0.03	0.10
Total Coliform	MPN/100 ml	930	11,000	1,500	930	150	2,400

Parameters for analysis	**Indicator**	**Sampling positions**				
		7	**8**	**9**	**10**	**11**
EC	µS/cm	45	27	79	48	56
pH	-	7.1	7.4	7.2	7.4	7.2
H_2S	mg/l					
NO_2-N	mg/l	0.002	0.01	0.001	0.007	0.005
NO_3-N	mg/l	0.18	0.14	0.18	0.18	0.27
NH_4-N	mg/l	0.02	0	0	0	0.01
PO_4-P	mg/l	0.01	0.01	0	0.01	0.01
DO	mg/l	6.7	5.9	6.0	7.2	6.0
BOD_5	mg/l	3	4	3	3	5
COD	mg/l	6	10	6	6	10
Total clay	mg/l	0.05	0.25	0.09	0.04	0.68

Total Coliform	MPN/100 ml	930	430	11,000	930	11,000

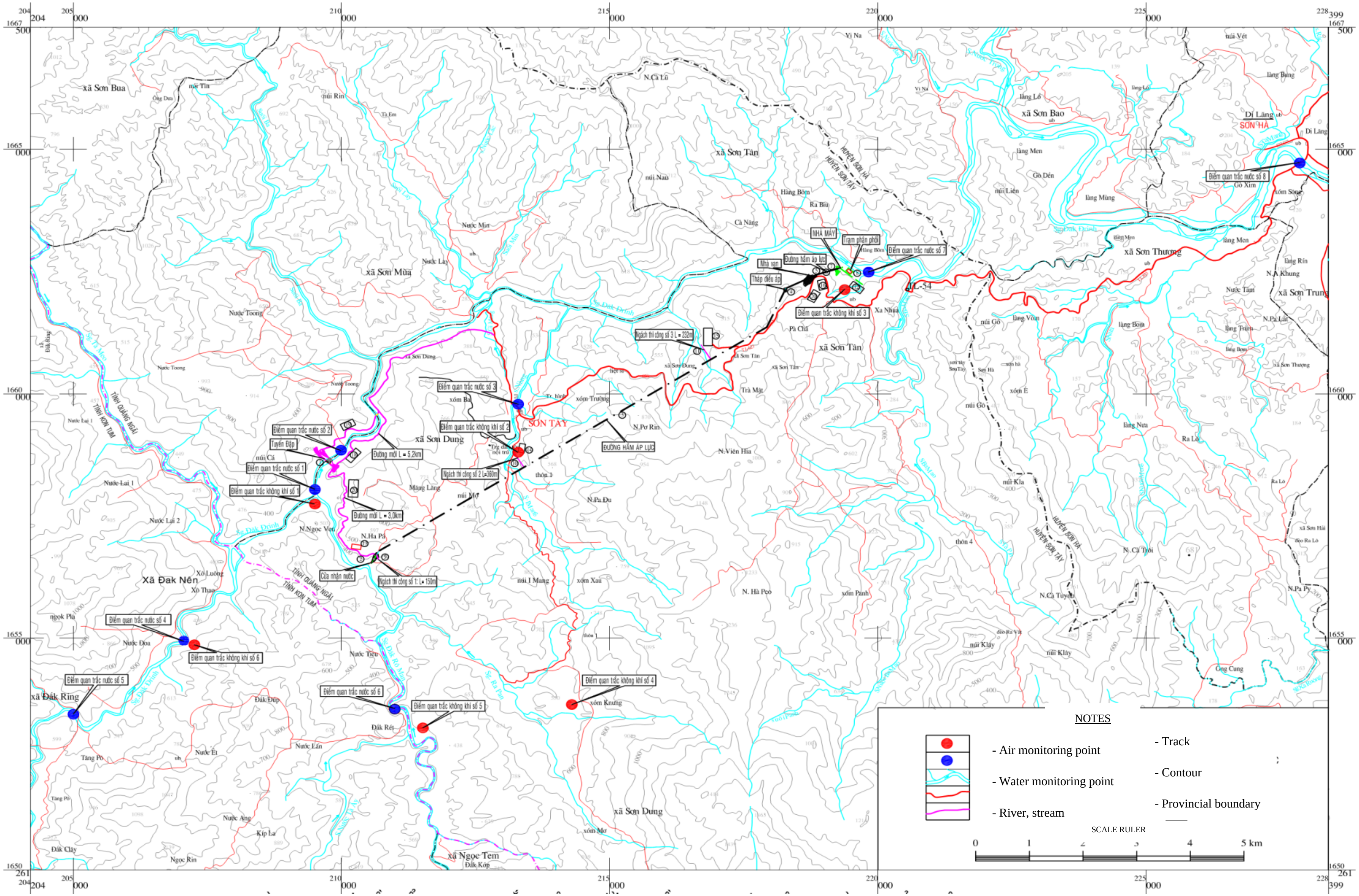

NOTES
- Air monitoring point
- Water monitoring point
- River, stream
- Track
- Contour
- Provincial boundary
SCALE RULER
0
1
4
5 km
xã Sơn Bua
xã Sơn Mùa
xã Sơn Tân
xã Sơn Bao
xã Sơn Thượng
xã Sơn Dung
SƠN TÂY
Xã Đak Nên
xã Đăk Ring
xã Ngọc Tem
xã Sơn Dung
ĐƯỜNG HẦM ÁP LỰC
NHÀ MÁY

Figure 2.6 Diagram of the locations of monitoring points for fundamental environment of Dak Drinh hydropower project

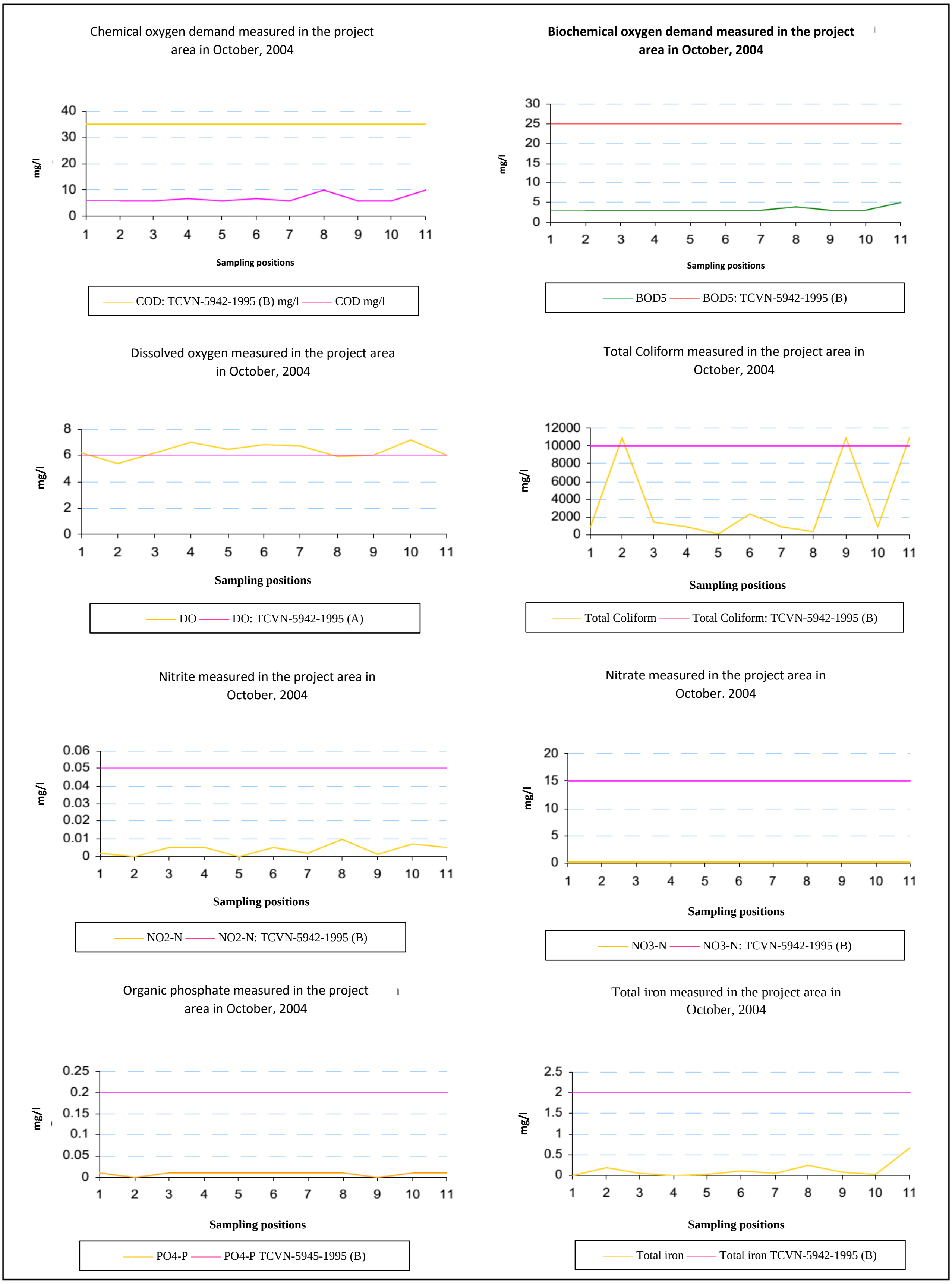


Figure 2.7 Graph demonstrating water quality parameters monitored in phase 1 (October, 2004)

Table 2.41 Sampling positions

1- Dak Rin 1	2- Dak Rin 2 (hot mineral spring)	3- Ta Meo
4- Dak Ro Man 1	5- Dak Ro Man 2	6- Dak Ra Pan
7- Dak Drinh	8- Son Tay stream	9- Son Tan stream
10- Rin river	11- Thach Nham dam	

The graph demonstrating water quality parameters monitored in phase 1 (October, 2004) is shown in *Figure 2.7*. The positions of sampling sites in phase 1 are shown in *Table 2.41*.

Through the first survey results as shown above, it shows that:

- EC: 27 – 195 µS/cm. In which, Dak Rin stream where the hot water source was flowing into has the highest EC (EC = 195 µS/cm), and the lowest pH (pH = 6.5). Here, H_2S = 0.01 mg/l was detected.

- pH: 6.5 – 7.5, neutral type.

- NO_2N: 0 – 0.007 mg/l

- NO_3N: 0.14 – 0.27 mg/l (The lowest in tributary streams in Son Tan Commune, Son Tan District).

- NO_3N: 0.14 mg/l, the highest was in the downstream of Thach Nham reservoir, NO_3N: 0.27 mg/l and the source water of Ta Meo stream and Ro Man stream. NO_3N: 0.25 – 0.26 mg/l because the spring water of these areas was affected by activities of the people living along the stream.

- PO_4-P is low, only from 0 – 0.01 mg/l

- Similarly, in Son Tay stream and Thach Nham, BOD5: 4 – 5 mg/l

- COD: 10 mg/l, higher than the rest sampling sites

- The highest total Coliform was in Son Tan stream and Dak Rin stream where the hot water was flowing into Thach Nham dam

- Total Coliform in the project areas was from 150 – 11,000 MPN/100 ml, the lowest was in Son Tay stream, Ro Man stream and Rin river; Σ Coliform: 150 – 930 MPN/100 L, the highest was in Dak Rin where there was hot water stream, Son Tan stream and Thach Nham dam; Σ Coliform: 11,000 MPN/100 ml.

In general, at some sites, Σ Coliform, BOD5 and COD were high, but the water quality in rivers and streams of Dak Drinh hydropower project area was quite good with the following characteristics: neutral pH, low content of NO_3-N and PO_4-P nutrient salt.

b) Results of survey in phase 2:

The analysis results of water samples in rivers and streams of Dak Drinh hydropower project area in phase 2 (May, 2007) are shown in *Table 2.42* on the next page. The graph demonstrating water quality parameters monitored in phase 2 (May, 2007) is shown in *Figure 2.8*. From these survey results, it shows that:

- The measured pH results were neutral from 6.2 – 8, the lowest was in Tinh Giang (Son Tinh); the highest was in Doc Soi (Binh Son) substation area.

- The measured BOD results were generally low from 1.56 mg/l – 16 mg/l; through the monitoring results, it shows that the water surface in the project area has not had organic pollution, the highest measured BOD in the ditch of Thuy Loi bridge, Tinh Giang and Son Tinh is 16 mg/l within the permissible standard of TCVN 5942-1995.

- The measured COD results were from 3.43 mg/l – 19.2 mg/l, the highest measured COD in Doc Soi (Binh Son) substation was 19.2 mg/l.

- In accordance with the provisions of TCVN 5942-1995, the dissolved oxygen (DO) content in the water was 6 mg/l higher. The lowest measured DO result was 3.2 mg/l in Doc Soi substation (Binh Son); the lack of dissolved oxygen in the water and the BOD at this monitoring point were higher than other monitoring points, indicating that it is necessary to monitor in the coming time to avoid water source pollution here. The highest DO monitoring result was 11.4 at the ditch of Thuy Loi bridge, Tinh Giang, Son Tinh.

Table 2.42 The analysis results of water samples in Dak Drinh hydropower project (Phase 2: May, 2007)

No.	Location	Position		Results of measurement parameters (mg/l)												
		Longitude	Latitude	pH	BOD	COD	DO	SS	As	Cd	Ca^{2+}	Fe	T-P	T-N	Grease	Coliform
1	Confluence of Dak Rinh and Roman rivers, Son Dung Commune, Son Tay	$108^0$18.039’	$14^0$58.485’	7	3.6	5.34	7.42	16	KPH	KPH	102.3	0.24	1.25	0.46	KPH	3,256
2	Nuoc Bua cable-stayed bridge, Son Mua Commune, Son Tay	$108^0$18.426’	$15^0$00.043’	7.4	1.68	3.43	8.79	20	KPH	KPH	84.50	0.50	1.54	0.12	KPH	3,985
3	Nuoc Xiem Bridge – Center of Son Tay District	$108^0$20.957’	$14^0$59.548’	7.2	1.56	3.87	8.72	7	KPH	KPH	75.40	0.16	0.52	0.15	KPH	4,120
4	Dak Rinh river, Dak Nen Commune, Kon Plong District, Kon Tum	$108^0$18.113’	$14^0$57.306’	7.3	4.92	9.75	7.71	53	KPH	KPH	88.70	0.05	0.47	0.16	KPH	4,875
5	Dak Rinh river, near Dak Rinh Commune People’s Committee, Kon Plong District, Kon Tum	$108^0$16.702’	$14^0$55.553’	7.3	5.16	9.57	7.61	112	KPH	KPH	63.60	0.08	0.38	0.24	KPH	3,897
6	Ro Man river, Son Dung Commune, Son Tay District	$108^0$18.770’	$14^0$54.684’	7.2	3.6	9.87	8.49	25	KPH	KPH	81.20	0.08	0.82	0.21	KPH	3,258
7	Rin river, Son Tan Commune, Son Tay District	$108^0$23.699’	$15^0$00.961’	7.6	5.52	8.65	9.2	68	KPH	KPH	90.40	0.17	2.58	0.16	KPH	4,752
8	Rin river, Di Lang Town,	$108^0$28.272’	$15^0$02.257’	7.5	1.56	3.69	9.07	9	KPH	KPH	68.70	0.18	1.15	0.14	KPH	5,210

	Son Ha															
9	Irrigation ditch, Tinh Giang, Son Tinh	$108^0$36.928’	$15^0$10.114’	6.2	16	17.25	11.4	6	KPH	KPH	35.40	0.08	0.62	0.31	KPH	2,254
10	220/110 kV substation area, Doc Soi, Binh Son	$108^0$43.143’	$15^0$20.535’	8	13.4	19.15	3.2	79	KPH	KPH	50.87	1.36	0.71	2.97	KPH	3,324

KPH: Not detected

Measuring unit of Coliform: MPN/100 ml

Table 2.43 The results of measurement and monitoring of air quality in the Dak Drinh hydropower project area (phase 2: May, 2007)

No.	Location	Position		Results of measurement parameters				
		Longitude	Latitude	Dust (µg/m^3)	SO_2 (µg/m^3)	NO_2 (µg/m^3)	CO (µg/m^3)	Noise (dBA)
1	Confluence of Dak Rinh and Roman rivers, Son Dung Commune, Son Tay	108^{0}18.039'	14^{0}58.485'	KPH	KPH	KPH	KPH	45.6
2	Huy Mang Hamlet, near Boarding School, Center of Son Tay Commune	108^{0}20.119'	14^{0}59.027'	56.03	KPH	KPH	KPH	65.2
3	Near Son Tan Commune People's Committee, Son Tay District	108^{0}23.701'	15^{0}00.949'	84.25	KPH	KPH	KPH	58.8
4	The resettlement area of Dak Rinh hydropower project, Group 15, Son Dung Commune, Son Tay	108^{0}21.508'	14^{0}56,298'	KPH	KPH	KPH	KPH	52.4
5	Dak Rinh hydropower project area, Nuoc Tieu Hamlet, Dak Nen Commune, Kon Plong District, Kon Tum	108^{0}19.480'	14^{0}55.518'	KPH	KPH	KPH	KPH	43.8
6	Dak Rinh river area on the wooden bridge crossing the river, Nuoc Doa Hamlet, Dak Nen Commune, Kon Plong District, Kon Tum	108^{0}16.702'	14^{0}55.553'	KPH	KPH	KPH	KPH	42.1
7	Di Lang Town, Son Ha	108^{0}28.225'	15^{0}02.234'	112.15	45.2	KPH	250	65.7
8	Near Thuy Loi bridge, Tinh Giang, Son Tinh	108^{0}36.928'	15^{0}10.114'	196.74	41.3	KPH	315	68.6
9	220/110 kV substation area, Doc Soi, Binh Son	108^{0}43.143'	15^{0}20.535'	225.03	78.6	36.4	458	78.9

KPH: Not detected

- The SS results measured in the project area are generally satisfactory; There was only one point at the location of Dak Drinh river near Dak Rinh Commune People's Committee, Kong Plong District, Kon Tum Province measuring the SS up to 112 mg/l which is higher than the SS content specified in TCVN 5942-1995.

- The Coliform measured at all points was lower than TCVN 5942-1995.

- Arsenic, Cadmium and grease were not found at the monitoring points. The Iron Content, Total Nitrogen, and Total Phosphorus were low.

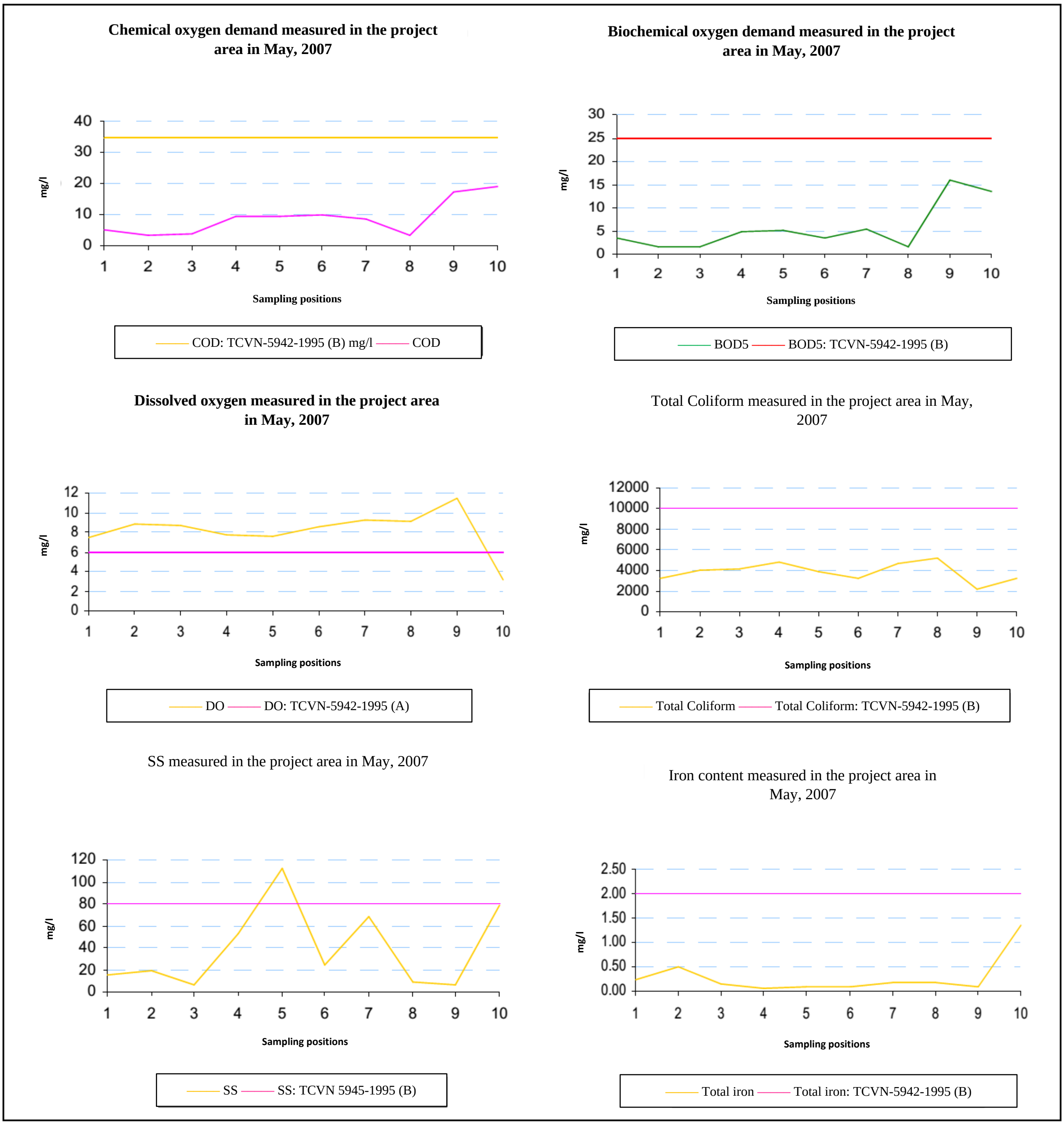


Figure 2.8 Graph demonstrating water quality parameters monitored in phase 2 (May, 2007)

From the above survey results, it shows that the water quality in the area of Dak Drinh hydropower project construction is quite good. The water quality on 110 kV power line also meets the standards. In particular, there are some indicators having not met Vietnamese standards in the area of Doc Soi substation. These results also coincide with the monitoring results of Quang Ngai Province Department of Natural Resources and Environment, and this position is also noted in the environmental current status report of Quang Ngai Province.

2.7.2 Air and noise environment:

In order to conduct the environmental quality assessment, the air quality survey and measurement in the project area (including 110 kV power line of Dak Drinh – Doc Soi hydropower plant) were conducted in May, 2007. The results of air quality measurement and monitoring in Dak Drinh hydropower project area are shown in *Table 2.43*. The graph demonstrating the results of noise measurement in the project area in May, 2007 is shown in the following *Figure 2.9*.

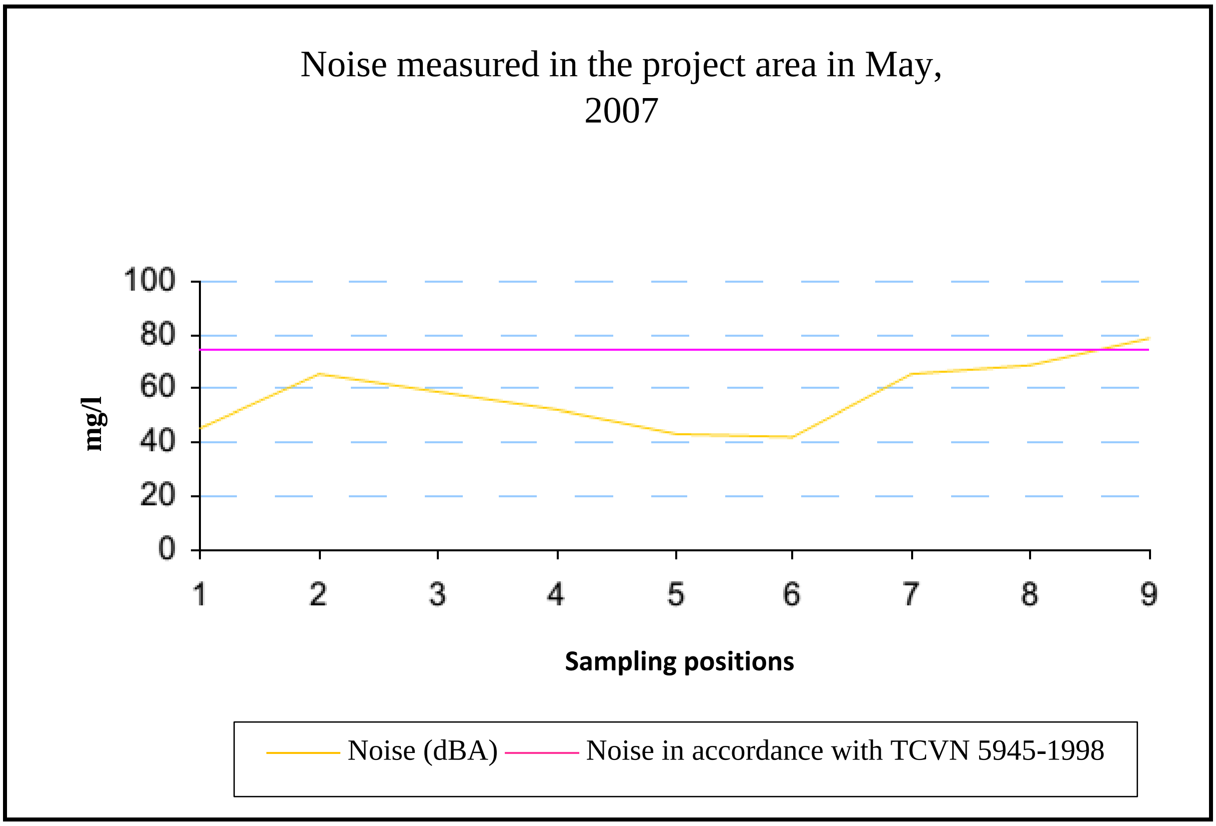


Figure 2.9 The graph demonstrating the results of noise measurement in the project area (May, 2007)

From the field visits for survey in October, 2004 and July, 2005 and the air quality survey and measurement in the project area in May, 2007, it shows that:

In the reservoir bed area of Dak Drinh hydropower project, it is found that the forest coverage was still quite good; industrial economic activities have not developed yet. In general, the air here was still clean, not polluted with many types of toxic gases due to industrial production. The dust content in the air and the noise were within permissible standards (TCVN 5937-2005 and TCVN 5949-1998). Some monitoring positions did not detect the gases of NO_2, SO_2, CO in the area near the reservoir bed and future resettlement area.

In densely populated towns in the Districts of Son Tay (hydropower plant area), Binh Son (the area for construction of 110 kV power line of Dak Drinh – Doc Soi hydropower plant), the dust content in the air and the noise were still within the permissible standards (TCVN 5937-2005). The measured noise at the monitoring points met the standards (TCVN 5949-1998) except for the location at Doc Soi 110 kV substation (See *Table 2.43* and *Figure 2.8* above).

2.8 SOCIO-ECONOMIC CHARACTERISTICS

The reservoir bed, focal works, energy routes, hydropower plant under Dak Drinh hydropower plant affect 5 communes of 2 districts of 2 Quang Ngai and Kon Tum Provinces.

The affected communes in Kon Plong District (Kon Tum Province) are the 2 Communes of Dak Rin and Dak Nen. These communes are affected by inundation when forming the reservoir. The communes affected by the project in Son Tay District (Quang Ngai Province) are: Son Dung, Son Mua (the reservoir bed and focal works); and Son Dung and Son Tan (the energy routes and plant). The above five affected communes are all mountainous and remote communes with the living of ethnic minorities and poor educational level. The lives of people still face many difficulties. There is almost nothing in terms of infrastructure, especially traffic roads, electricity and water.

110 kV power line of Dak Drinh – Doc Soi hydropower plant affects 13 communes and towns of 4 districts of Quang Ngai Province, which are Son Tan Commune (Son Tay District), Di Lang Town, Son Bao, Son Ha and Son Thanh Communes (Son Ha District), Tinh Giang, Tinh Dong, Tinh Hiep and Tinh Tra Communes (Son Tinh District), Binh My, Binh Minh, Binh Trung and Binh Nguyen Communes (Binh Son District).

2.8.1 Socio-economic conditions of the project area

a) Population, ethnicity

Kon Tum Province has a natural area of 9,614.5 km^2. Average population in 2005 was 377,007 people, with the population density of 39.2 people/km^2. The main ethnic groups in the province include: Kinh, Xo Dang, Bana, Gie Trieng, Gia Rai, Brau, Ro Mam, and other ethnic groups.

Quang Ngai Province has a natural area of 5,137.50 km^2. Average population in 2005 was 1,285,728 people, with the average population density of 250 people/km^2. The ethnic groups in the province include: Kinh, Hre, Coho, Xo Dang, and some ethnic groups.

Natural area, average population and main ethnic composition of the districts and communes of the project area are shown in *Table 2.44* and *Table 2.45*.

Table 2.44 Data on the area, average population, the ethnicity of the districts of project area

No.	Indicator	Unit	Kon Plong	Son Tay	Son Ha	Son Tinh	Binh Son
1	Natural area	km^2	1,379.65	380.74	750.31	343.8	466.77
2	Population	people	17,508	15,713	65,937	195,720	181,493

3	Main ethnic composition:	Kinh, Xo Dang (Ca Dong), Bana, Gie Trieng		Kinh, Hre, Xo Dang		Kinh	
4	Population density	mg/km^2	13	41	88	570	389

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

Table 2.45 Data on the area and population of communes of Dak Drinh hydropower project

No.	Communes	Area (km^2)	Population (People)	Population density (People/km^2)	Number of hamlets	Labor (persons)	
						Agriculture	Non-Agriculture
Communes in the area of reservoir bed, focal works and hydropower plant							
1	Dak Ring Commune	110.29	1,505	14	7		
2	Dak Nen Commune	118.06	1,519	13	8		
3	Son Dung Commune	87.96	4,906	56	6	2,378	156
4	Son Mua Commune	73.97	3,629	49	5	1,775	37
5	Son Tan Commune	73.56	3,298	45	5	1,779	48
Communes in the area of 110 kV power line							
6	Di Lang Town	56.92	8,821	156	8	2,516	1,461
7	Son Bao	68.45	3,425	50	6	1,697	134
8	Son Thanh	48.52	6,745	139	5	3,314	360
9	Son Ha	39.02	7,925	203	5	3,786	598
10	Tinh Giang	17.060	7,996	468.7	5	3,054	935
11	Tinh Dong	24.967	6,510	260.7	8	2,615	581
12	Tinh Hiep	35.808	7,867	219.7	6	3,639	363
13	Tinh Tra	21.213	5,432	256.1	4	2,397	295
14	Binh My	12.28	7,423	604	3	4,023	
15	Binh Minh	41.74	9,755	234	4	5,278	
16	Binh Trung	14.58	9,619	660	6	5,141	
17	Binh Nguyen	26.45	10,364	392	5	5,607	

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

Ethnic composition in the 5 districts of the project area are mainly Kinh and indigenous people such as Ca Dong and Hre, making up most of the local population.

In accordance with statistical yearbook of districts in 2005 – 2006: The natural population growth rate of Kon Plong District is 2.09%; Son Tay is 2.04%, which are quite high compared to other districts in the province; while Son Ha District is 1.53%, Son Tinh is 0.37% and Binh Son is 0,89%.

b) Economic activities

1. Agriculture and forestry

In the districts of the project area, agro-forestry production plays a particularly important role. The situation of agricultural cultivation is shown in *Table 2.46*.

Table 2.46 The situation of agricultural cultivation in the districts of Dak Drinh hydropower project area

Content	Kon Plong	Son Tay	Son Ha	Son Tinh	Binh Son
Total land for agricultural production (ha)	**5,310**	**3,217**	**19,227.57**	**17,998**	**21,303.99**
Annual crops	4,454	2,105.40			
Rice (ha)	2,680	1,054.23	5,616	7,053.1	10,178.0
Crops (ha)	1,680	1,051.17			
Other annual crops (ha)				7,189.8	
Perennial crops (ha)	339	1,103.42		3,613.8	
Perennial industrial crops (ha)	98	0			
Fruit trees	124	0			
Other perennial crops	117	0			
Cultivation industry value (million VND)	27,550	17,633	86,282.8	404,135	179,458.4

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

Due to the topographical characteristics, in Kon Plong and Son Tay Districts, the area for rice cultivation is very limited. The exploitation of rice cultivation, especially wet rice, is only available in a few arears with favorable terrain for soil and water. These areas are mainly concentrated on the riverside, which is the future reservoir bed of the project. For the communes in the reservoir bed and hydropower plant, the food production is not high due to high dependence on nature. The rice productivity for the whole year in 2006 of the affected communes was 21.2 – 25.7 quintal/ha. In terms agriculture, the State has currently been still having support policies for the above communes (no tax, supports for seeds and pesticide fertilizers for the people, dissemination of policies and technical advances along with the restructuring of crops). As in Son Dung Commune, the restructuring of crops (cinnamon, areca, coffee, …) was jointly performed by the youth volunteer team and local people (with the seeds provided free of charge by the State). There was also a JBIC project whose goal is to restore acacia (Melaleuca) plantations in bare hills in Son Dung Commune.

Currently, forests are also the source of income for local people. In the districts of the project area, the forests occupy a large area. The current status of forestry sector in the districts of the project area is shown in *Table 2.47*.

Table 2.47 The current status of forestry sector in the districts of the project area

Content	Kon Plong	Son Tay	Son Ha	Son Tinh	Binh Son
I. Forestry land (ha)	114,133	19,411.33	36,081.43	5,987.3	12,130.10
- Natural forest	110,878	13,255.14		72.12	
- Plantation forest	3,255	6,156.19		5,915.14	1,673
II. Forestry production value (VND million)		7,669.4	12,118.5	54,626	37,447
- Exploitation (VND million)		252.1	3,200.4	46,657	32,852
Forest plantation and cultivation (VND million)		7,397.5	3,625.6	3,449	4,592
Other forestry production (VND million)		37.8	5,292.5	0	
Forestry services (VND million)		0	0	4,520	2.8

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

Table 2.48 The current status of husbandry in the districts of the project area

No.	Type (animal)	Kon Plong District	Son Tay District	Son Ha District	Son Tinh District	Binh Son District
1	Buffalo	4,003	1,402	10,392	5,584	1,319
2	Cow	2,083	5,144	20,378	52,196	64,505
3	Pig	6,288	6,605	32,187	97,705	70,839
4	Goat	1,130	1,562	212	1,006	445

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

In addition to cultivation, the husbandry sector is also self-sufficient. The custom of freeing domestic animals such as pigs, cows, chickens, … has been still being popular. Due to the difficult transportation system, the husbandry has not become a local commodity production. The local livestock epidemic has been still persisting. Data on livestock production of the districts of the project area are shown in *Table 2.48*.

2. Aquatic products

The water surface area for aquaculture is very small due to the topographical conditions of the area, mostly for freshwater fish farming in the places where the ponds are formed. The fishing in the river system is also difficult due to the topographical conditions. The production value of fisheries is very small, insignificant and mainly for household consumption. See *Table 2.49 The situation of aquaculture of the districts of the project area*.

Table 2.49 The situation of aquaculture of the districts of the project area

No.	Items	Kon Plong	Son Tay	Son Ha	Son Tinh	Binh Son
1	Farming area (ha)	2.8	1.35	5.2	187.7	176
2	Harvesting production (ton)	6	5.26	17.2	11.676	23,822.5
3	Farming production (ton)	2	5.2	2.7	340.7	285.00
4	Farming value (VND million)		313	50	18,800	17,010
5	Harvesting value (VND million)		300	319	153,743	227,562

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

3. Water supply and irrigational systems

**** Water supply:***

Quang Ngai water plant has a capacity of 15,000 m^3/day and night to supply water to Quang Ngai City has been upgraded to bring capacity up to 20,000 m^3.

In Dung Quat Open Economic Zone, the water plant with a capacity of 15,000 m^3/day in phase I has been put into operation and prepared to invest in increasing capacity to 50,000 – 100,000 m^3/day in phase II.

In the future, the investment in further construction of reservoirs on Tra Khuc river will be carried out to supplement water for Thach Nham and supply water to Dung Quat Open Economic Zone; striving for water supply capacity of 115,000 m^3/day and night. Ensure the domestic water supply of 150 liters/person/day and night, with the proportion of households supplied with clean water of 85%. Water supply for industry ranges from 50 – 60 m^3/ha/day.

On the irrigational – hydroelectric cascade of Tra Khuc river, from upstream and downstream of Dak Drinh hydropower project reservoir to Thach Nham along Dak Drinh river, then to the main stream of Dak Selo, and in Tra Khuc river, there is only Dak Drinh 2 hydropower project reservoir located on the downstream of Dak Drinh hydropower project reservoir. Other existing and planned reservoirs are located on other branches of Tra Khuc river.

**** Irrigation:***

The whole province has over 120 irrigational works, of which Thach Nham is the key project with the total length of canals is 1,200 km and the design irrigation capacity is 50,000 ha for 6 districts and cities in the province.

Nuoc Trong reservoir was started on December 9, 2005 in Son Bao Commune, Son Ha District. This is a large-scale and multi-purpose project, tasked with replenishing water sources, stabilizing irrigation for 52,000 hectares of agricultural land under Thach Nham irrigation system in dry months; creating sources of industrial and domestic water supply for

Dung Quat Open Economic Zone and Van Tuong City (3.95 m^3/s), Quang Ngai City and 7 delta districts of Quang Ngai Province, supplying water for 2,980 hectares of aquaculture, electricity generation, flood and saltwater intrusion reduction in the lowlands, and combining with tourism development and improvement of ecological environment … with the area of 1,450 hectares of land.

Nui Ngang reservoir on Tra Cau river, Ba Lien Commune, Ba To District, Quang Ngai Province, with a capacity of 49,500 m^3/day and night, supplies water for Nam Quang Ngai Indsutrial Park and self-flowing irrigation for 1,450 hectares of upland that Thach Nham – Southern Ve river system does not reach to irrigate.

4. Industry and construction

Quang Ngai Province has strong development of industry and construction, especially heavy industries in industrial zones. In 2005, the total industrial production value reached VND 3,172.43 billion dong (current price). In which: The State economic sector reached VND 1,682.027 billion, accounting for 53.02%; the non-State economic sector reached VND 1,478.33 billion, accounting for 46.61%; the foreign-invested economic sector reached VND 11,666 billion; accounting for 0.37%. There are 2 reckoned areas as Tinh Quang Industrial Park and Dung Quat Open Economic Zone. In Dung Quat Open Economic Zone, as of May 17, 2007, there were 69 projects licensed to investment with a capital of VND 66,542 billion (equivalent to US$ 41.6 billion). In addition, there were 41 projects approved for investment with a capital of VND 13,568 billion (US$ 0.85 billion). From 2000 – 2005, the annual industrial production value increased by 13.7 – 23.4%. Meanwhile, the annual production value of electricity production and distribution sector of Quang Ngai Province only increased by 6.6 – 15.1%. This will be a great pressure on the electricity production and distribution sector of Quang Ngai in the coming years.

By the end of 2005, the whole Kon Tum Province had 2,375 industrial facilities, focusing mainly the processing industry to utilize the local strengths. The industrial production value in the province in 2005 reached VND 651,254 billion, of which the State economic sector accounted for 35.44%, the non-State economic sector accounted for 64.57%; the foreign-invested economic sector accounted for 2.09%. The past years are mainly the period of construction and putting into operation of a number of large-scale key facilities, aiming to increase the density of industry. In addition to the completed Ya Ly hydropower plant, the province has been coordinating with Vietnam Electricity and other investors to prepare for other hydropower projects: Se San 3A, Se San 4, Plei Klong, Thuong Kon Tum. Electricity production accounted for 3.92% of the industrial value of the province. In the next year, the province will focus on prioritizing the development of Dak To industrial park (200 ha) in association with the pulp factory, and Ngoc Hoi industrial park in association with Bo Y border gate.

However, industrial activities of Kon Tum and Quang Ngai are concentrated in industrial parks, Kon Tum Township and Quang Ngai City. In the project area, Kon Plong and Son Tay Districts (reservoir and hydropower plant area), the industry and construction are underdeveloped. Industrial production mainly comes from brick and tile production, and stone, sand and gravel exploitation. Particularly, for the affected communes of the project, only Son Dung Commune has a few small repair facilities, mainly concentrated in Son Tay

Town. Son Mua, Dak Rin, and Dak Nen Communes have nearly had no facilities. The current status of industry in the districts of the project area is shown in *Table 2.50*.

Table 2.50 The current status of industry in the districts of the project area

Content	Kon Plong	Son Tay	Son Ha	Son Tinh	Binh Son
Number of industrial production facilities	49	53	470	2,129	
Industrial production value (VND million)	2,555	1,306	73,934	392,200	157,923
- Exploration industry (VND million)	594	387	87.3	58,830	18,870
- Processing industry (VND million)	2,430	754	73,864.7	333,370	139,053

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

5. Transport – Communication

From Kon Tum, it is possible to follow National Highway 40 through Kon Plong District to Quang Ngai. Also, from Quang Ngai, it is possible to follow National Highway 1 to Son Tinh Town, then follow Provincial Road 623 from Son Tinh Town through Son Ha Town to Son Tay Town. Currently, all communes of the project area have traffic roads to their center. However, the roads to Son Mua, Dak Drinh, Dak Nen Communes are still dirt roads with frequent traffic cuts in the rainy season. The underdeveloped traffic road system has greatly affected the local economy and exchange. This is a strongly divided terrain area with many rivers and streams, so the development of transport system is very difficult, requiring too much budget, that the locality is incapable of taking charge by itself.

All communes of the project area have fixed telephones on the networks.

c) Commercial – service – tourist activities

Kon Tum Province has a tourism potential combined from natural characteristics and long-standing cultural traditions of the ethnic groups living in the province. The province also has many tourism resources such as Ngoc Linh Reserve, Mon Ray National Park, Na Uy special-use forest. Kon Plong District is like Da Lat of Kon Tum with beautiful pine forests and cool climate. In the Communes of Dak Nen and Dak Rin, there is no commercial tourist establishment or beauty spot. Near Dak Nen Commune People's Committee, there is a hot mineral spring, but with a small scale and investment conditions for tourism and commercial purposes are not economic.

Quang Ngai tourism develops but only concentrates in the delta provinces, and the mountainous districts such as Son Tay almost do not. In Son Dung, Son Mua, Son Tan Communes, tourism establishments and tourist areas are also not developed.

d) Education – culture – health

1. Education:

The situation of education in the districts of the project area for the academic year 2005 – 2006 is shown in *Table 2.51* on the next page.

Currently, the communes of the project area have primary schools, some communes have their secondary schools. All districts have secondary schools and high schools. Literacy eradication and primary education universalization have been completed in the communes of the project area. The investment policies for education of the two Kon Tum and Quang Ngai Provinces are attached special importance, particularly in the Communes of Son Tay and Kon Plong, which are being invested by the State and have policies to encourage teaching and learning. The students do not have to pay tuition, being received books and school stationery for free. The teachers enjoy many preferential policies to stay with school and class. In terms of school and classroom, the schools and classrooms in the project area have been currently being improved under the school solidification program of the Government and the Ministry of Education and Training. However, primary schools and their classrooms in the communes of reservoir bed and focal works are still wooden-walled houses with sheet metal roofs.

Table 2.51 The situation of education in the districts of the project area for the academic year 2005 – 2006

No.	Items	Unit	Kon Plong	Son Tay	Son Ha	Son Tinh	Binh Son
I	Number of schools	School	14	15	29	76	88
1	Primary school	-	4	9	16	28	34
2	Primary school and secondary school	-	9	-	-	-	-
3	Secondary school	-	-	1	7	21	23
4	Secondary school and high school	-	1	-	-	-	-
5	High school	-	-	1	1	5	4
6	Nursery school, kindergarten	-	-	4	5	22	27
II	Number of classrooms	Room	269				
III	Number of teachers	Person	425	301	731	1,989	2,106
1	Primary school	-	225	157	351	749	812
2	Secondary school	-	14	78	233	772	796
3	High school	-	186	15	61	295	295
4	Nursery school, kindergarten	-	-	51	86	173	203
IV	Number of students	-	6,641	5,239	15,281	46,176	45,698
1	Primary school	-	3,452	2,857	6,868	15,297	15,909
2	Secondary school	-	3,053	1,268	4,975	18,136	17,536
3	High school	-	136	154	1,441	8,855	7,944

4	Nursery school, kindergarten	-	-	960	1,997	3,888	4,309

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

However, there is a worrying phenomenon in that the dropout status in the communes of reservoir bed. In accordance with the survey in Son Dung Commune, the students dropping out of school focus mostly on children of ethnic minorities. In particular, the number of children attending school in the two Dak Rin and Dak Nen Communes is still low, and the dropout phenomenon is still popular, even though there are primary and secondary schools. There are 458 students in Dak Rin Commune, of which the 5% of dropout phenomenon mostly comes from children of ethnic minorities.

2. Health, community healthcare:

The prevention of epidemics and social diseases, hygiene and prophylaxis have been increasingly effective. The goals from National health program and sector have been effectively deployed. The medical station network is available in most of communes. There are officials in charge of healthcare for local people in 100% of the communes. For the epidemic situation in the district and communes of the project area, there are still some existing common epidemics such as: malaria, cholera, typhoid, tuberculosis … focusing mainly on ethnic minorities because of poor hygiene and epidemic prevention in the community, although local specialized officials have instructed how to prevent them. Data on the medical situation in the districts of the project area are shown in *Table 2.52*.

Table 2.52 Data on the medical situation in the districts of Dak Drinh hydropower project area

No.	Items	Unit	Kon Plong	Son Tay	Son Ha	Son Tinh	Binh Son
I	Health facilities	Facility	11	7	15	24	
1	Hospital	-	1	1	1	1	
2	Sanitation team for epidemic prevention	Team		1	1	1	
3	General clinic	-	1			2	
4	Medical station of commune, ward	-	9	6	14	21	
5	Sickbed	Bed	95	68	166	235	
II	Medical staff	Person	89	53	143	241	
1	Doctor & Post-graduated doctor	-	5	5	18	40	
2	Physician, Technician	-	33	51			
3	Nurse	-	31				
4	Other levels	-					

III	Pharmaceutical staff	Person	3	2	3	6	
1	Senior pharmacist	-			1	2	
2	Pharmacist	-	1				
3	Druggist	-	10				

Source: Statistical yearbook of districts of Dak Drinh hydropower project in 2005 – 2006

The remnants of war still exist in the localities, mainly Agent Orange: Son Dung Commune has 7 affected households, Dak Rinh Commune has 34 affected people.

Mother and children protection activities have also been implemented in districts and communes in the two provinces with good results in recent years.

2.8.2. Socio-economic current status of the expected area for arrangement of the resettlement area

Through the survey and collection of data on the economic population of the affected area in the reservoir bed and focal works of Dak Rin and Dak Nen Communes – Kon Plong District, Son Dung and Son Mua Communes – Son Tay, it shows that most of the affected households are ethnic minorities of Ca Dong and Hre having lived here for a long time. These are poor households with limited farming practices and qualifications. Monetary compensation for houses, residential land and productive land will not guarantee the above households to re-create productive land, residential land and houses as well as maintain the same standard of living and living activities as before. Therefore, it is necessary to implement the compulsory resettlement program for the above households. Content, scale and possible impacts on the regional socio-economic environment of the resettlement program are shown in Chapter 3 and Chapter 4. The following are the main features of socio-economic current status of the communes arranging the resettlement area.

a) Labor

In the communes of reservoir bed and focal works, the labor rate is low, accounting for only 35 – 50% of the population. The labor is mainly agricultural production. Low educational level with limited knowledge of farming techniques. The production also depends heavily on nature with poor productivity. Types of production other than agriculture and forestry are mostly undeveloped. Non-agricultural labor are only full-time government officials, primary school teachers, medical staffs and small traders in the area. The majority of non-agricultural labor are Kinh people.

The labor situation of affected households in the reservoir bed and focal works is shown in *Table 2.53.*

Table 2.53 The labor situation of affected households in the area of reservoir bed and focal works

Ethnic composition	Number of households	Household members	Labor
I/- Son Dung Commune	*288*	*1,155*	*574*

1. Ca Dong ethnic group	241	995	493
2. Kinh ethnic group	47	160	81
II/- Son Mua Commune	*90*	*416*	*147*
1. Ca Dong ethnic group	90	416	147
III/- Dak Nen Commune	*191*	*828*	*431*
1. Ca Dong ethnic group	180	809	418
2. Kinh ethnic group	11	19	13
IV/- Dak Rin Commune	*34*	*156*	*68*
1. Ca Dong ethnic group	34	156	68
Total	**603**	**2,635**	**1,220**

Source: In accordance with data survey made by Power Engineering Consulting Joint Stock Company 2

b) Land

The life of people in the area mainly comes from the economy of agriculture and forestry, so most of the people's houses are attached to land for agricultural production and deforestation. Standards of land for agricultural production are not high. However, if compared with the minimum norm under Decision No. 132/2002/QĐ-TTg dated October 8, 2002 on the in-place settlement of production land and residential land for ethnic minorities in the Central Highlands: the minimum allocation of land for agricultural production to a household is 1.0 hectare of burnt-over land (NR), or 0.5 hectare of wet rice land for single crop, or 0.3 hectare of wet rice land for 2 crops, the above standards are still guarantee (See *Table 2.54*).

Table 2.54 The situation of land of the affected households in the area of reservoir bed and focal works

Content	Unit	Son Dung	Son Mua	Dak Nen	Dak Drinh	Total
Total land area	Ha	176.01	71.05	79.74	15.18	341.98
Residential land	Ha	9.92	3.28	7.48	-	21.84
Agricultural farming land	Ha	166.19	67.77	72.26	15.18	320.14
Rice + Crop land	Ha	124.49	21.93	49.84	9.43	205.59
Burnt-over land	Ha	41.70	45.84	22.42	4.59	114.55
Rice + Crop land / Household	Ha/household	0.43	0.24	0.28	0.28	0.34
Burnt-over land / Household	Ha/household	0.14	0.51	0.12	0.14	0.19

Source: In accordance with data survey made by Power Engineering Consulting Joint Stock Company 2

c) Current status of residential life and income

Table 2.55 The situation of housing of the affected households in the area of reservoir bed and focal works

Content	Unit	Son Dung	Son Mua	Dak Nen	Dak Drinh	Total
Total construction area	m^2	14,273/177	2,228/82	7,494/181	951/30	24,934/580
Thatched bamboo cottage	m^2/cottage	7,934/182	2,030/77	3,167/99	324/7	13,746/381
Fourth-level house	m^2/house	6,339/95	198/5	4,327/92	627/23	11,188/199
Average	m^2/household	57.55	27.17	40.07	31.70	42.99

Note: There are cases of 1 household with 2 houses. The houses of households in Dak Drinh Commune are located out of the reservoir bed

Source: In accordance with data survey made by Power Engineering Consulting Joint Stock Company 2

The current status of housing of the residents is mainly temporary houses with bamboo walls, thatched roofs taken from the forest (accounting for 65.69% of households with an average housing area of only 36.08 m^2/household). A few households of ethnic minorities and Kinh people have the conditions to build wooden houses, corrugated boards, and corrugated iron roofs (accounting for 34.31% of households with an average housing area of 56.22 m^2/household). See *Table 2.55.*

In general, the life still faces many difficulties, especially the households in Dak Rinh and Dak Nen Communes of Kon Plong District. The income is instable because people depend on the weather, having not been able to take initiative in funds of seed and water supply for production. The products harvested from agricultural production as well as exploited from forests are not for commercial use and are mainly self-sufficient. Therefore, the source of income exchanged for money to use and accumulate is almost not available. For Dak Rinh Commune, in 2005, the saving balance of whole commune was VND 6 million, followed by zero in 2006. For Dak Nen Commune, in 2005, the saving balance of whole commune was VND 13 million, followed by VND 7 million in 2006.

In Son Dung and Son Mua Communes of Son Tay District, the products harvested from agricultural production as well as exploited from forests are still mainly self-sufficient, with low commodity exchange prices. However, the income is better than the two Communes of Dak Rinh and Dak Nen, reflected in average food production per capita. In 2005, the average food production per capita of Son Dung Commune was 281.13 kg/person; that of Son Mua Commune was 280.65 kg/person.

d) The current status of infrastructure

1. Traffic:

In the Communes of Son Dung and Son Mua, the automobiles can access the commune center, but they have not been currently able to arrive to the sedentarization and resettlement areas. In Son Mua Commune, the road to the quarry was bulldozed to be wider, the automobiles and power lines were pulled into the quarry. In Son Dung Commune, the new traffic road system and power line were pulled into the expected resettlement areas. Road, electricity and school infrastructure are available in the new areas.

The Communes of Dak Rin and Dak Nen have been invested by Kon Tum Province to open the road from Kon Plong District to the two communes with total length of over 80 km. The automobiles were able to enter the commune center clearing the road on July 13 – 14, 2005. The road connecting the two Communes of Dak Rin and Dak Nen is still quite difficult in travelling. Currently, the road foundation has been completed, the bituminization and concrete casting for road surface are in the stage. During the rainy season, the road to these two communes is often blocked due to landslides and flooding the tunnels through the stream. Currently, it is only possible to walk to enter the arranged resettlement areas. Particularly, in the resettlement area of Dak Nen Commune, in the old Nuoc Buc area, the automobile road was close to the area. The traffic roads have currently not been available in the resettlement area of Ngoc Sang area – Ngoc Linh.

2. Other infrastructure:

Currently, all communes have medical stations with full-time officials and have primary and secondary schools. Son Dung Commune particularly have its own boarding secondary school. The national grid has been brought to the commune, and the hamlets near the commune have electricity. Other infrastructure for production and public welfare is almost nothing. For all other necessary demands, people must go to district or provincial centers, causing great difficulties for the material and spiritual life of the people.

The clean water program is focused and deployed in localities, especially in ethnic minority areas. Program 135 has been deployed in the communes of the project. The water supply only focuses on the central areas of the communes of Son Tay District. In the remote residential areas, with difficulty in travelling, so the water supply for living activities is mainly from the surface water source from river and stream system around the residence. The water quality is clean and unpolluted. At Dak Nen Commune People’s Committee, in October, 2004, the inauguration of clean water supply system in the area of communal committee have been recently taken place, the water flowing from high mountains into the tank by itself. The water quality is good, but the scope is limited. Statistics on the number of households using clean water in the communes of the reservoir bed and focal works is in *Table 2.56.*

Environmental sanitation in the residential areas, particularly in ethnic minority areas, is still a new concept. In the living area, the discharge of human and livestock wastes remains a natural and unconscious manner. Along with the habits of people in concentrated grazing, and pasturing in the area where people live, the strong pollution in the community will be resulted when it rains. This is the cause of diseases in the community.

Table 2.57 The situation of clean water supply in the communes of the reservoir bed and focal works

Communes	Number of households	Number of households using clean water	Percentage (%)

Son Dung Commune	958	600	63%
Son Mua Commune	655	350	53%
Dak Rin Commune	346	-	-
Dak Nen Commune	465	-	-

Source: Statistical documents for the Communes of Kon Plong and Son Tay in 2005 – 2006

e) Cultural life, customs, festivals and beliefs of indigenous households in Dak Drinh hydropower project area:

Dak Nen and Dak Rin Communes of Kon Plong and the area of Group 16 of Son Dung Commune and Nuoc Lang area of Son Mua and Son Tan Communes of Son Tay District have been supplied with electricity, the cultural and spiritual life of local people have had more favorable conditions for development. The communes in the area of reservoir bed and focal works have been covered by television due to the availability of electricity and television reception stations in the district center. There are almost no cultural no cultural and recreational activities. In the project area, indigenous people are mainly Ca Dong and Hre. The following are the main features of customs, festivals and beliefs of the above ethnic groups.

1. Customs, festivals and beliefs of Ca Dong ethnic group:

Ca Dong is a branch of Xo Dang ethnic group. In the project area, Ca Dong people reside mainly in Kon Plong and Son Tay Districts, living mainly on milpa, rice growing, gardening, hunting, and cattle and poultry culture. They have traditional weaving with beautiful motifs and decorative patterns. Ca Cong people also calcine lump ore and sand ore into steel bars to forge production and hunting tools. Ca Dong people living in each village have a community of people sharing or not sharing the same bloodline, with many rooftops. All of the rooftop owners gathered to form the Council of Elders, headed by the most prestigious people.

Ca Dong family is a biracial family (reckoned on the mother's side and the father's side). People do not have a separate term to refer to the family, but put the first consonant of the name to distinguish the family such as (tr, p, …), the name of each person is accompanied by an object indicating gender. Ca Dong people have an equal relationship between men and women, not discriminating against stepchildren, mutual children adopted children, or biological children; popularizing the custom of striking up a brotherhood.

The marriage relationship of Ca Dong people follows the principle that men and women are free to learn, get married and respect marriage practices. The marriage is in accordance with the two-side residence regime. The relationship based on marriage covenant is strictly prohibited. The offence of commit adultery must be severely punished, even the spouse giving birth in the first year then getting married are also considered adultery. The monogamy has been stable, husband and wife have been usually in harmony, rarely left each other, and rarely committed adultery. Ca Dong people do not accept the marriage between people sharing the same bloodline within three generations of both the father's side and the mother's side. The two families being their in-laws usually continue to marry their children to each other. The dualistic marriage principles are still imprinted, and the practice of dual marriage is prevailing, but two biological brothers rarely get married with two biological sisters. Instead, the younger sister of husband usually gets married with the younger brother of wife.

Childbirth: The pregnant woman must take care of everything by herself when giving the birth. Previously, it was customary for a pregnant woman accidentally deceasing within three days of giving birth, then people would bury the child because they thought that the confinement was not over yet. Unfortunately, if the fetus died without cutting the umbilical cord, it would not be buried but bound on the stump in a desolated place.

Funeral: Ca Dong people believe that the dead can still harass. Thus, while the dead are left at home, all activities of giving feasts and sacrifices must be given to the dead.

Beliefs: As an agricultural resident, Ca Dong ethnic group has religious ceremonies, mainly for the God of Moon (y-co, y-ca), praying the super gods for supporting and protecting for peaceful life and good crops. The God of Rice is associated with solemn rites. The roof mistress is the only one being entitled to caring for the ceremonies in relation to the rice spirit. The rice spirit, in the conception, usually resides in the oldest rice variety. This rice variety is pruned separately in the sacred land on the field. Each family member must personally plant a clump close to the hut before clearing the field for rice pruning. This rice is cut its ear and brought back before plucking off the rice in upland fields for use in the new rice ceremony. After completion of rice pruning, the leftover rice seed is not poured into the warehouse but pounded into grain rice to cook. After eating, dance to hunger and then eat again until the empty within 3 – 5 days. Dispose it in case of failure to eat up. When harvesting, the ceremony of bringing rice spirit from the field to the warehouse is very important. The places crossing the stream must be built a bridge or stretched with a thread (symbolizing) in order for the rice spirit to pass. Live trees must be planted at road crossroads as a sign of the way instruction for the rice spirit. The warehouse must be built with a bridge in order for the rice spirit to go up. The resting place of rice spirit must be carefully prepared. Ca Dong people believe that the rice spirit is afraid of water, so they must keep the rice from getting wet when performing the ritual. The above organizations are organized in accordance with the annual farming cycle.

Ca Dong people believe that the even days are bad days which ghosts get around; the odd days are good days, which human get around, so the ceremonies are usually done on an odd day. In giving feasts, people are also respectful of the odd numbers (1, 2, 3, 5, …) and usually only use the right hand, while the left hand is used to nip off the food and throw to the soul of the dead.

Ca Dong people believe that the drought is due to the God of Thunder who has forgotten, so they must pray to remind, or they must “irritate” in order for the God of Rain to descend on earth. In some places, people dip the nest of young sparrow into th water, or put buffalo manure into the hive so that the bees cannot came out, calling the God to deaf, or catch the toads, tie and carry them for the compassion of the God of Thunder. After harvesting, people organize the repair of water trough, set up the pole, and hold a worship at the water trough to pray for a more prosperous New Year. The water trough represents the whole village. The water trough worship is a form of community unification, which the whole village contributes the offerings to worship and eat together at the water trough, then goes home to give feasts. The most prestigious person in the village will come forward and worship the gods and other spirits, praying the villagers for being healthy, good crops and growth of cattle. People stretch and sling the ropes to abstain from the strangers entering when the leaves are not dry yet. Ca Dong Tet lasts a week. During the Tet, there is the custom of “nhay co”, dancing around the cooking fire, near the place of worshiping the ancestors, tossing a scattering of sticky rice cooked in a bamboo cylinder. Gongs and drums start to play, and they sing, cheer, and pray for good crops and surplus food in the next year. During the Tet, it is not allowed to leave the rice in the pot empty – a sign of completeness and prosperity.

The whole village also kill buffaloes and open a party on the occasion of winning over the enemy, or after many times of losses, crop failures, defeat, epidemics, … to pray for good luck.

The banyan tree is considered by Ca Dong people to exist a residing divine, symbolizing immortality. They often take the banyan left hanging from the hair on their heads, wishing to live forever.

2. Customs, festivals and beliefs of Hre ethnic group:

In the project area, Hre people reside in Son Tay and Son Ha Districts, mainly living by wet rice and slash-and-burn cultivation. Hunting, gathering, fishing and forging are secondary occupations but they have critical significance. Hre people sedentarize in each village (pley), residing in stilt houses. Before August, 1945, each village was headed by an elder. The Hre language belongs to the Mon-khme language.

Marriage: The monogamy has been established, under the old regime. A few people from the upper class get married with two or three wives. Some people get married with the second wife due to the lack of children. The custom authorizes a widower to get married with the younger brother of her husband, and a husband to get married with the younger sister of his wife.

Siblings being the children of uncles, aunts, first wife, concubines, or having the same mother but different fathers are not permitted to get married with each other. Having a love relationship being contrary to custom is subject to a heavy penalty, and the incest is considered a felony. The marriage of Hre people is not for commercial purpose. The phenomenon of getting married with person coming from other family has not been popular, but it is gradually developed, especially those who have been residing alternately and close to Viet, Xo Dang and Cor people. Depending on the actual circumstances of each side of family, the groom can go to his wife’s house or the bride can go to her husband’s house. When the spouse give birth their first child, they will separate from their parents, build their own house and become an independent economic unit.

The weddings are usually held at the end of the year, on the occasion of spare time and being comfortably off. The party picking up the person (to stay with the bride’s / the groom’s family) will hold a larger ceremony. They hold savory party with straw liquor, and talk and sing happily. The family will availably prepare for a kitchen for the new spouse to sleep. Here, there are rituals symbolizing the marital bond. The two persons will give a piece of betel and a bowl of wine to each other and put together a circle of thread.

Childbirth: Recently, the Hre spouse has a tendency to prefer a son. During the months of pregnancy, the women abstain and pray a lot in the hope of an easy birth and a healthy and easy-to-rear child. The women give birth right next to the kitchen, a few close sisters and a lay midwife are invited to worship and deliver. The baby is cut off the umbilical cord and bathed. They pack the placenta tightly into a spathe and put it in a cave or under a forest tree or a place next to the house. For a few dozen days after giving birth, the mother quits her job, and abstains from Nien fish (*Onychostoma gerlachi*), eggs, chili, banana, white chicken meat and buffalo meat. When the baby is exactly one month old, he / she will be held by the naming ceremony, avoiding the same name or rhyme with relatives. People think that demons can make their children premature, so they often use ugly names. Along with taking the surname as Vietnamese, Hre people have acquired the word “thi” in female names and the word “van” in male names. Normally, the adults do not call out the names of children directly, but use pronouns to address them instead: the boys are “eo”, the girls are “yen”.

Funeral: The normal dead at home will be laid supine on the floor as if he / she has been still sleeping while alive. Wash his / her face with water, put on two or three layers of clothes, then wrap his / her body in a mat or place in a coffin. When there is a death of somebody in a certain family, the relatives and villagers will come to help take care of the funeral. If the family has not prepared a coffin, a group of men will go to the forest to find wood and make the coffin. Other persons will find wood, thatch, and rope to build a grave, or slaughter pigs and buffaloes to help the homeowner make meals for guests. The sacrificial animal is considered for the dead. Hre people rather meticulously make the coffin of a hollow tree, like a dug-out canoe with sacred board placed on top. The rich often leave the body of their relatives for three or four days, and sumptuously stab the buffaloes. The poor often leave the body of their relatives for one day before burying. If the dead is the head of family, take him / her out through the front door. If it is another member of the family, take him / her out through the side door.

Hre people believe that the daytime is in the land of living and the nighttime is in the underworld, so there is a custom of burning bee corpses to guide the way when attending the funeral. For the custom of distributing wealth to the dead, there are many types, some put in the coffin such as clothes, rice, meat, silver, betel, some buried outside like chicken, small jar, some put on the ground like knife, cooker, pot, firewood, papoose …

Hre people do not have the custom of mourning. After the burial, the relatives take a few days off from the field work, without singing or celebrating. Five days after the burial ceremony, the family members bring a small chicken to the side of village to worship, express their mournfulness, consolation and sharing their feelings with the dead again. Before celebrating Lunar New Year, the families with bereavement in the year bring glutinous rice cake to the tomb, lament, clear the seedlings and leave the cakes on the tomb. Since then, people only worship the dead, if any, because there is a lot indicating that their ancestors reprimand them. Hre people believe that those who die on the battlefield, or die of childbirth, clawing tiger, lightning struck … are persons with their bad death (unlucky death), and they must be buried in a separate place far from the village. If they decease outside, do not bring them into the house. There is a custom of holding fake funeral in case of decease without full body or decease with abandoned body in the distance, for the purpose of entombing the remains of the ill-fated.

Beliefs: Hre people sleep across the floor, with the head facing the low ground. The left side the head of the house for men and receiving guests. The back of the house is for women and children.

Hre people believe that the supernatural force consists of many types of gods with different names and specific tasks. Ghost village is the imagination of Hre people about the life of netherworld, the soul of the dead turns into a "ghost" and lives there. All activities take place like those of the village of the living but in contrast, such as the night is the day, the grass is the rice …

Hre people think that each man has 7 souls, and woman has 9 souls. The animals also have their soul. People abstain from many souls hidden in banyan trees, rocks, streams and green snakes. People think that there are gods in relation to children, fearing that the evil spirits will harm their posterity, so they often let their children wear a talisman to protect them from ghost. People are very interested in good or evil dreams, omens on chicken's feet or random signs such as seeing the flying birds, sneezing, tripping … From these points, they can carry out or suspend their scheduled works.

The belief of rice spirit and the rituals in the rice production process occupy a significant position, focusing on two phases of each rice season, when sowing and when harvesting and storing the rice in the warehouse. The position of the woman owing the rice – the wife of landlord – is the food manager who is considered to have a mystical relationship with the rice spirit. On the day of new rice worshiping, she brings the rice back from the fields to roast, pound and cook it then accepts the worship and eats the rice cooked in a "sacred pot" by herself. Only she is permitted to prune rice for working miracles and bringing the first rice papoose back to the storage …

The ceremony to pray for health, worship against sickness, worship on a production cycle, for building a new house, worship for the dead, worship for naming … are all conducted at home. There are rituals attracting a large number of villagers and acquaintances to attend, especially the buffalo-stabbing ceremony. In addition, when there is an epidemic threatening people and livestock, the whole village holds a public ceremony to pray for peace and disease prevention in every two years or three years. This is a communal ritual.

Previously, the colonialists and imperialists tried to introduce Protestantism to Hre region but it was not accepted by Hre people. Nor did Buddhist and Christian influence penetrate Hre people.

2.9 FORECAST OF ENVIRONMENTAL CHANGES IN CASE OF FAILURE TO IMPLEMENT THE PROJECT

Dak Drinh hydropower project is located in the Districts of Son Tay, Son Ha, Son Tinh, Binh Son (Quang Ngai) and Kon Plong (Kon Tum). Through the research and analysis of the current status of environment in the area, we found some main issues as follows:

- The forest coverage in the area decreases gradually with the lowering of terrain (Kon Plong District: 82.7%, Son Tay District: 51%, Son Ha District: 48%, Son Tinh District: 17.4%, Binh Son District: 25.99%). The forest coverage in the basin (including the dam route 2) compared to other areas nationwide is still quite good, about over 65% with rich forest resources (The forest coverage of communes in the area of reservoir bed and focal works: Dak Rinh: 75%, Dak Nen: 77%, Son Dung: 68%, Son Mua 47%). The elements of fundamental environment such as water and air are still of good quality.

- In the area of reservoir bed and focal works (Kon Plong District (82.7%), Son Tay District), the living people are mainly ethnic minorities of Hre, K'ho, Xo Dang (Ca Dong) … The natural population growth rate is quite rapid with 2.5 – 3.0 %/year. The life still faces many difficulties with low income. The farming practices still highly depend on nature, and the status of deforestation for slash-and-burn cultivation still exists.

On the basis of some of the aforementioned environmental issues, the forecasts of environmental changes in the area in case of failure to implement the project are as follows:

- For the area of reservoir bed and focal works (Kon Plong and Son Tay Districts): Despite the great attention and investment efforts from the State, this is still the area in which socio-economic life has not developed yet, with the poor infrastructure, the population is mainly ethnic minorities with their low educational level. The harmful effects of natural calamities have made the lives of local people face many difficulties. Thus, the natural environment has been increasingly at risk of destruction. The forest area continues to be destroyed for cultivation, especially for industrial crops; forest products continue to be indiscriminately exploited for the daily life of the people; The rare and precious fauna and flora are still lost in oblivion. The results of these activities will lead to land degradation and floods will occur more frequently, and droughts will be prolonged. The lives of local people, especially ethnic minorities, will continue to face many difficulties.

- For other areas in the project area (Son Ha, Son Tinh and Binh Son Districts and Quang Ngai City): Although the population growth rate is lower than that in the area of reservoir bed and focal works, these are densely populated areas. The main workforce comes from agriculture, forestry and fisheries, accounting for 40 – 50% of the population, the non-agriculture, non-forestry and non-fisheries workforce accounts for only about 10% of the population. Currently, the industry – construction in the area has strongly developed, particularly heavy industries in Dung Quat Open Economic Zone and Tinh Phong Industrial Park. In addition to 69 projects licensed to invest with a capital of VND 66,542 billion (equivalent to US$ 4.16 billion), there are 41 projects approved for investment with a capital of VND 13,568 billion (US$ 0.85 billion). The annual industrial production value will continue to increase by 15 – 20%. This will be a great pressure on the electricity production and distribution industry of Quang Ngai in the coming years, which is also the pressure in socio-economic development, solving the regional labor structure transformation. At the same time, the demand for water in the dry season in the lowlands, particularly Quang Ngai City, will be more stressed out.

CHAPTER 3: ENVIRONMENTAL IMPACT ASSESSMENT

3.1 IMPACT SOURCES:

3.1.1 Impact sources related to waste:

a) Identification of impact sources related to waste

Identification of impact sources related to waste, see Table 3.1

Table 3. 1 Impact sources related to wastes

No.	Items	Pollutants	Potential impacts	Quantification
I	**Construction stage**			
1	***Activities for construction***			
1.1	Transportation: transport materials, waste soil and rock	- Noise - Dust, exhaust fumes	- Quality pollution of the surrounding air environment	- Table 3.13 - Table 3.14 - Table 3.15
1.2	Mechanical and motorbike maintenance and repair facilities	- Waste oil	- Pollution of river water quality - Pollution of soil, groundwater	- Table 3.19
1.3	Housing for workers, executive board, construction team of 110kV power line	- Domestic wastewater - Domestic Waste.	- Pollution of river water quality - Pollution of soil, groundwater. - Health effects of construction forces	- Table 3.17 - Table 3.18 - Domestic waste (page 97)
1.4	Storage are of soil and rock, waste collection and treatment area	- Stored and waste soil - Dust - Industrial waste.	- Quality pollution of the surrounding air environment - Pollution of soil, groundwater - Pollution of river water quality	- Tables 3.2, 3.4, 3.6, 3.7 - Waste soil and rock (page 97)
2	***Construction of Works***			
2.1	Remove the topsoil layer of construction locations,	- Dust, noise - Exhaust fumes from construction and transportation vehicles	- Quality pollution of the surrounding air environment	- Table 3.2 ÷ 3.11 - Table 3.13 ÷ 3.16

	landfills, quarries, roads		- Pollution of river water quality	
2.2	Construction: dam, energy line, hydroelectric plant. - Power line 110kV - Resettlement area	- Dust, noise, exhaust fumes from motorbikes for construction and transportation - Loss of specialized chemicals, materials	- Quality pollution of the surrounding air environment - Pollution of river water quality - Pollution of soil, groundwater	- Table 3.2 ÷ 3.10 - Table 3.13 ÷ 3.16
II	**STAGE OF WATER STORAGE INTO RESERVOIR AND OPERATION**			
1	Water storage into reservoir	- Decomposition of plant biomass submerged in the reservoir bed - Backlog of war poisons	- Pollution of water quality in reservoirs and downstream	- Appendix 3.1. - Table 3.21
2	Operation of hydropower plant and power transmission line	- Noise, vibration caused by generators - Oil leakage	- Quality pollution of the surrounding air environment - Pollution of river water quality	- Page 92 - Production wastewater (p. 94)
3	Hydropower plants, operating clusters and housing for employees, resettlement areas	- Domestic wastewater - Domestic Waste.	- Water quality pollution of Dak Rinh river - Pollution of soil, groundwater - Health effects of operating forces	- Table 3.20 - Domestic waste (p. 98)

Note: In the table above, the ***Quantification*** *column shows the results of the quantitative calculation of pollution sources presented in which table and section of this Chapter 3.*

b) Air pollution sources:

1. Dust and exhaust fumes:

For hydropower plants and transmission lines during their operation, there is almost no source of dust and exhaust fumes. Dust and exhaust fumes are mainly generated during construction. Dust and exhaust fumes generated during the construction period come from many sources. In the calculation, consider mainly from sources with large amounts of waste:
(a) Dust generated from construction activities: excavation and opening of foundations,

leveling of the ground, road construction, landfills, concrete production. (b) Dust and exhaust fumes arising from traffic activities: transporting materials, soil and rock to landfills.

Dust dispersion level from construction activities: depends mainly on the volume of soil and rock filling or excavation. The amount of diffused dust is calculated based on the pollution coefficient and the volume of earthwork. According to the World Bank's Environmental Assessment Sourcebook (Volume II, Sectoral Guidelines, Environment, World Bank, Washington D.C 8/1991), the pollution coefficient E is calculated by the following formula:

$$E = k \times 0,0016 \times \frac{\left(\frac{U}{2,2}\right)^{1,4}}{\left(\frac{M}{2}\right)^{1,3}} \qquad (3.1)$$

Of which: E - pollution coefficient (kg/ton)

k - particle structure, with average value of 0.35 U - average wind speed (m/s)

M - Mean humidity of materials is 20%

Gauss is a model used for estimating the concentration of gaseous pollutants at the end of wind direction from the emission source. For the large traffic volume of a Work, the pollution problem can be viewed as an infinite and continuous source of emissions. When the wind direction is orthogonal to the road source's emissions, the gaseous pollutants concentration at the end of the wind direction is calculated as follows:

$$\boxed{C(x,\ z, H) = \frac{2Q_L}{(2\pi)^{1/2}\, u\, \sigma_z \sin\varphi} \exp\left[-\frac{(z-H)^2}{2\sigma_z^2}\right] \quad \left(for\ \varphi > 45^0\right)}$$

Of which:

C: Contaminant concentration (ug/m3)

Q_L: Amount of emission from sources (mg/m.s)

z: The highest position in the vertical direction of the center line of the smoke and dust column

H: Height of emission source (m)

U: Wind speed (m/s)

σ_z: Vertical dispersion coefficient, showing the amount of smoke and dust dispersed vertically at distance x towards the wind end and at a given atmospheric endurance (m)

φ: The angle between the road source and the wind direction

Applying the formula shown in *Table 3.1*, σ_y, σ_z will be calculated.

Table 3. 2: McElroy – Pooler formula for calculating σ_y, σ_z

Stable type	**σ_y**	**σ_z**
A	$0.32X\ (1.0+0.0004\ X)^{-1/2}$	$0.24X\ (1.0+0.001\ X)^{1/2}$
B	$0.32X\ (1.0+0.0004\ X)^{-1/2}$	$0.24X\ (1.0+0.001\ X)^{1/2}$
C	$0.22X\ (1.0+0.0004\ X)^{-1/2}$	0.20 X
D	$0.16X\ (1.0+0.0004\ X)^{-1/2}$	$0.14X\ (1.0+0.003\ X)^{-1/2}$
E	$0.11X\ (1.0+0.0004\ X)^{-1/2}$	$0.08X\ (1.0+0.015\ X)^{-1/2}$
F	$0.11X\ (1.0+0.0004\ X)^{-1/2}$	$0.08X\ (1.0+0.015\ X)^{-1/2}$

Source: Air Pollution: Its Origin and Control-3rd edition, 1998

Table 3. 3: Calculation of the amount of dust generated by earthwork - Pollution coefficient: E = 0.000047 (kg/ton)

		VOLUME (m^3)					Construction time (months)	Construction intensity (tons/month)	Dust generated (kg/month)
		Soil excavation	**Soil filling**	**Rock excavation**	**Rock filling**	**Total**			
I	**Area of key works**					**1.300.960**		**232.625**	**10,93**
	Main dam	558,025		50,247		608,272	12	79,057.67	3.72
	Spillway	3,638		6,724		10,362	12	1,581.48	0.07
	Construction diversion	17,584	5,527	6,962		30,073	2.5	19,621.09	0.92
	Retaining dike of main dam, spillway,		9,713		36,166	45,879	2	43,547.88	2.05
	Retaining dike for diversion intake		5,527		7,842	13,369	2	12,042.52	0.57
	Dam landfill	551,484		41,521		593,005	12	76,774.81	3.61
II	**Water intake, tunnel areas**					**1,557,326**		**629.554**	**29.59**
	Water intake	126,705		14,157	1,437	142,299	3	74,593.20	3.51
	Retaining dike for water intake		25000		6200	31,200	3	16,800	0.79
	Tunnel	126,787		223,926		350,713	21	30,503.25	1.43
	landfill of water intake					720,630	3	422,769.60	19.87
	landfill of tunnel + pipeline	246,505		97,154		343,659	21	27,095.03	1.27
III	**Construction niche**					**235,277**		**124,988**	**5.87**
	Construction niche	173,073		10,056		183,129	3	94,394.32	4.44
	landfill					52,148	3	30,593.49	1.44
IV	**Plant, pipeline**					**945,191**		**175,552**	**8.25**
	Plant, discharge channel	120,143	81,653	76,727		278,523	9	51,131.55	2.40
	Pipeline	119,718		8,178		127,896	9	22,036.37	1.04
	Surge shaft	126,787		15,210		141,997	9	24,792.92	1.17
	landfill					396,775	9	77,591.56	3.65
V	**Mines**			**784,153**		**784,153**	**8**	**196,038.25**	**9.21**
VI	**110kV power line**								
	- Whole line	44,755	43,494			88,249	1.5	89,425.65	4.20
	- Maximum foundation position	548.53	539.45			1,087.98	-	1,653.73	0.08
	- Minimum foundation	136.92	154			136.92	-	208.12	0.01

	position								

CALCULATION FOR THE AMOUNT OF DUST GENERATED FROM CONSTRUCTION ACTIVITIES FOR EACH PROJECT AREA

1. Area of focal works: With U_s = 3.14; Q = 3221.1 µg/s; Dust content in the base environment: 56.03 gg/m^3, Choose the height H of the trucks' chimney is 4m, the highest position in the vertical direction of the center line of the smoke column Z is 8.4m.

Table 3. 4: CALCULATION OF THE DUST CONTENT AT THE END OF THE WIND DIRECTION IN THE CONSTRUCTION STAGE FROM THE DAM LANDFILL

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
	25m	50m	75m	100m	150m	200m	25 0m	300m	400m	500m
Calculated dust content	154.18	92.87	63.45	47.63	31.54	23.07	18.11	14.81	10.72	8.28
Dust content during construction (including the dust amount of base environment)	210.21	148.90	119.48	103.66	87.57	79.10	74.14	70.84	66.75	64.31
TCVN 5937: 2005 (1 hours) (µg/m3)	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**

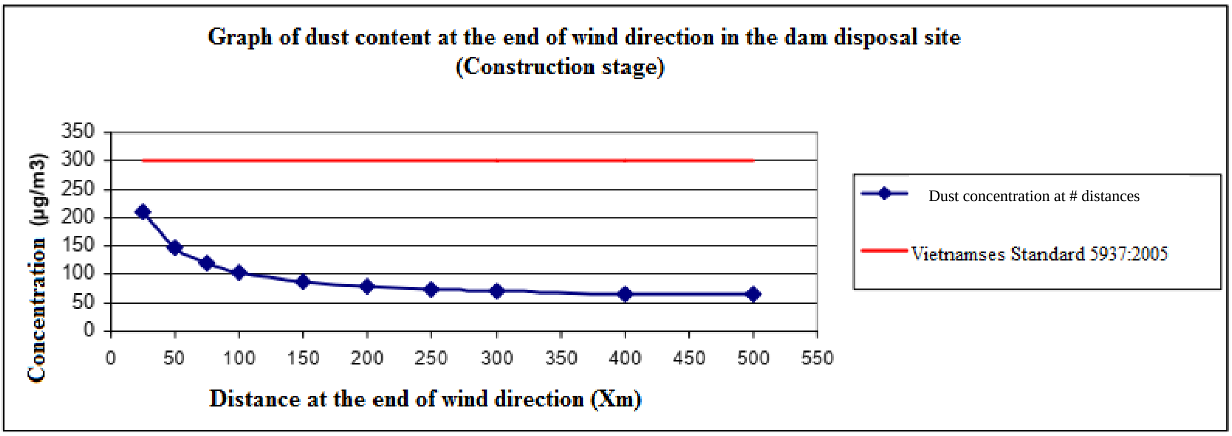


Figure 3. 1. Graph of dust content at the end of wind direction in the dam landfill

2. Water intake, tunnel areas: With U_s = 3.14; Q = 2686.84 µg/s; Dust content in the base environment: 56.03 gg/m^3, Choose the height H of the trucks' chimney is 4m, the highest position in the vertical direction of the center line of the smoke column Z is 8.4m.

Table 3. 5: CALCULATION OF THE DUST CONTENT AT THE END OF THE WIND DIRECTION IN THE STAGE OF CONSTRUCTING THE WATER INTAKE AREA

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
	25.00	50.00	75.00	100.00	150.00	200.00	250.00	300.00	400.00	500.00
Calculated dust content	99.83	60.14	41.08	30.84	20.42	14.94	11.73	9.59	6.94	5.36
Dust content during construction (including the dust amount of base environment)	155.86	116.17	97.11	86.87	76.45	70.97	67.76	65.62	62.97	61.39
TCVN 5937: 2005 (1 hours) (µg/m3)	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**

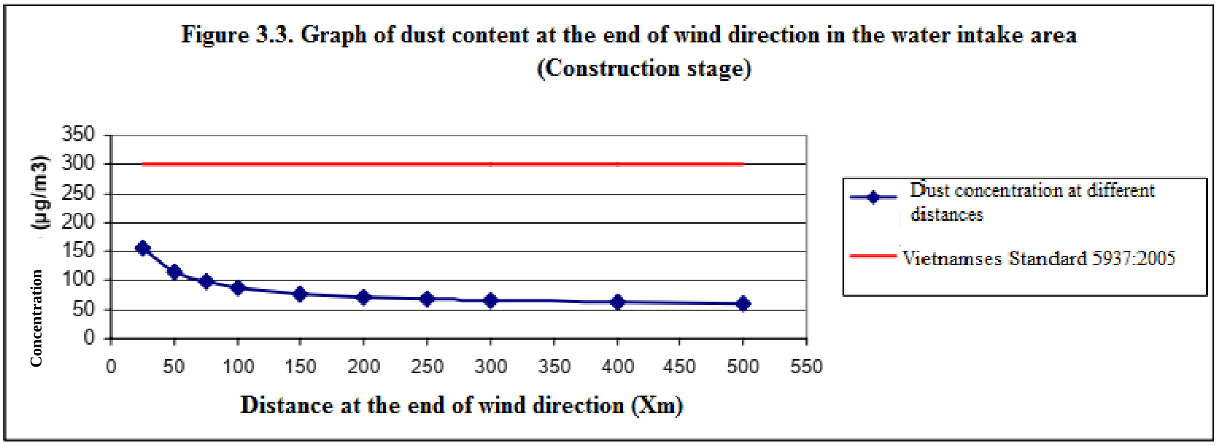


Figure 3. 3. Graph of dust content at the end of wind direction in the water intake area

With U_s = 3.14; Q = 1523.84 µg/s; Dust content in the base environment: 56.03 gg/m^3, Choose the height H of the trucks' chimney is 4m, the highest position in the vertical direction of the center line of the smoke column Z is 8.4m.

Table 3. 6: CALCULATION OF THE DUST CONTENT AT THE END OF THE WIND DIRECTION IN THE STAGE OF CONSTRUCTING THE WATER INTAKE LANDFILL

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
	25.00	50.00	75.00	100.00	150.00	200.00	250.00	300.00	400.00	500.00
Calculated dust content	56.60	34.09	23.29	17.49	11.58	8.47	6.65	5.44	3.93	3.04
Dust content during construction (including the dust amount of base environment)	112.63	90.12	79.32	73.52	67.61	64.50	62.68	61.47	59.96	59.07
TCVN 5937: 2005 (1 hours) (µg/m3)	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**

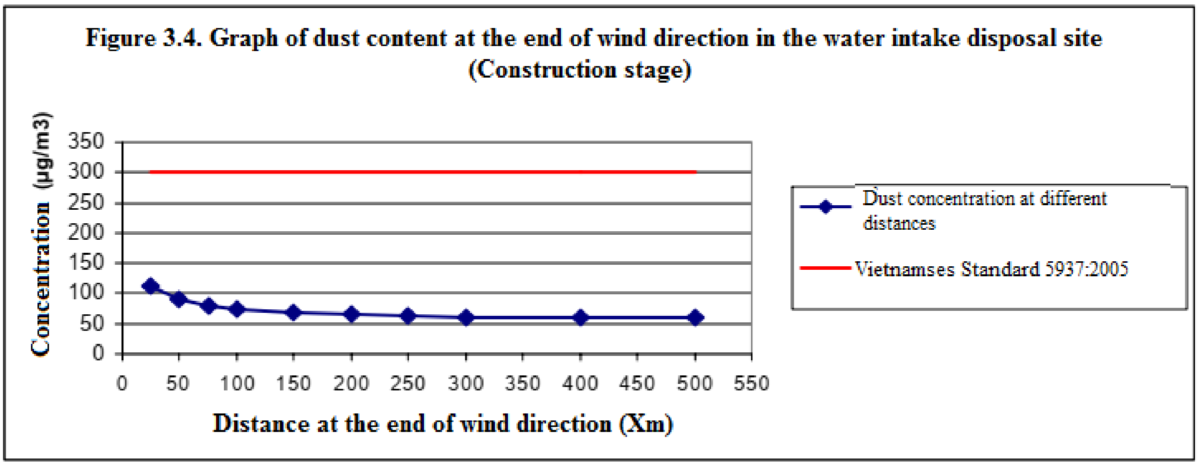


Figure 3. 4. Graph of dust content at the end of wind direction in the water intake landfill

With U_s = 3.14; Q = 2277 µg/s; Dust content in the base environment: 56.03 gg/m^3, Choose the height H of the trucks' chimney is 4m, the highest position in the vertical direction of the center line of the smoke column Z is 8.4m.

Table 3. 7: CALCULATION OF THE DUST CONTENT AT THE END OF THE WIND DIRECTION IN THE CONSTRUCTION STAGE FROM THE LANDFILL OF TUNNEL AND PIPELINE

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
	25.00	50.00	75.00	100.00	150.00	200.00	250.00	300.00	400.00	500.00
Calculated dust content	84.64	50.98	34.83	26.15	17.31	12.67	9.94	8.13	5.88	4.55
Dust content during construction (including the dust amount of base environment)	140.67	107.01	90.86	82.18	73.34	68.70	65.97	64.16	61.91	60.58
TCVN 5937: 2005 (1 hours) (µg/m3)	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**

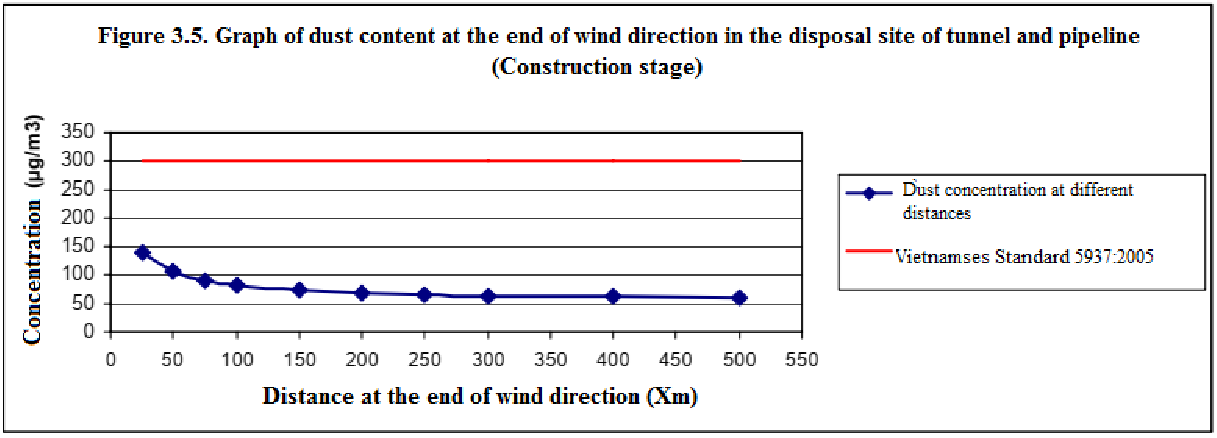


Figure 3. 5. Graph of dust content at the end of wind direction in the landfill of tunnel and pipeline

3. Area of the plant, pipelines: With U_s = 3.14; Q = 2455.55 µg/s; Dust content in the base environment: 84.25 gg/m^3, Choose the height H of the trucks' chimney is 4m, the highest position in the vertical direction of the center line of the smoke column Z is 8.4m.

Table 3. 8: CALCULATION OF THE DUST CONTENT AT THE END OF THE WIND DIRECTION IN THE STAGE OF CONSTRUCTING THE PLANT, DISCHARE CHANNEL

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
	25.00	50.00	75.00	100.00	150.00	200.00	250.00	300.00	400.00	500.00
Calculated dust content	91.27	54.98	37.56	28.20	18.67	13.66	10.72	8.77	6.34	4.90
Dust content during construction (including the dust amount of base environment)	175.52	139.23	121.81	112.45	102.92	97.1	94.97	93.02	90.59	89.15
TCVN 5937: 2005 (1 hours)	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**

(µg/m3)										

Figure 3.6. Graph of dust content at the end of wind direction in the area of the Plant, discharge channel (Construction stage)

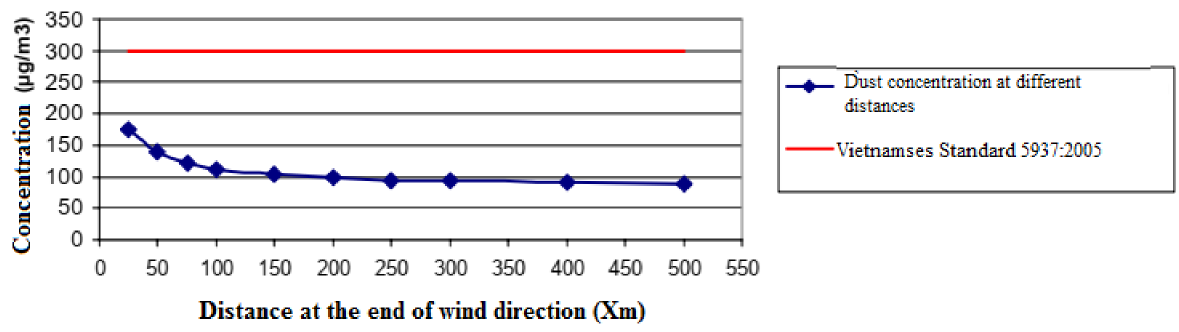


Figure 3. 6. Graph of dust content at the end of wind direction in the area of the Plant, discharge channel

4. Quarry area: With U_s = 3.14; Q = 4541.81 µg/s; Dust content in the base environment: 56.03 gg/m^3, Choose the height H of the trucks' chimney is 4m, the highest position in the vertical direction of the center line of the smoke column Z is 8.4m.

Table 3. 9: CALCULATION OF THE DUST CONTENT AT THE END OF THE WIND DIRECTION IN THE STAGE OF CONSTRUCTING THE QUARRY AREA 1

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
	25.00	50.00	75.00	100.00	150.00	200.00	250.00	300.00	400.00	500.00
Calculated dust content	168.81	101.69	69.47	52.16	34.53	25.26	19.83	16.21	11.74	9.07
Dust content during construction (including the dust amount of base environment)	224.84	157.72	125.50	108.19	90.56	81.29	75.86	72.24	67.77	65.10
TCVN 5937: 2005 (1 hours) (µg/m3)	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**

Figure 3.7. Graph of dust content at the end of wind direction in the quarry area 1 (Construction stage)

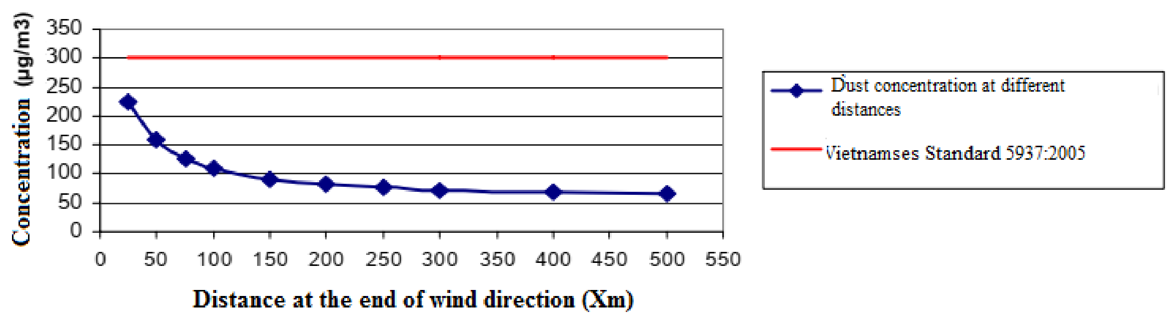


Figure 3. 7. Graph of dust content at the end of wind direction in the quarry area

5. Construction area of 110kV power line: With U_s = 3.14; Q = 59.57 µg/s; Dust content in the base environment: 196.74 gg/m^3, Choose the height H of the trucks' chimney is 4m, the highest position in the vertical direction of the center line of the smoke column Z is 8.4m.

Table 3.8: CALCULATION OF THE DUST CONTENT AT THE END OF THE WIND DIRECTION IN THE STAGE OF CONSTRUCTING THE 100KV LINE AT THE LARGEST FOUNDATION LOCATION

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
	25.00	50.00	75.00	100.00	150.00	200.00	250.00	300.00	400.00	500.00
Calculated dust content	22.14	13.34	9.11	6.84	4.53	3.31	2.60	2.13	1.54	1.19
Dust content during construction (including the dust amount of base environment)	218.88	210.08	205.85	203.58	201.27	200.05	199.34	198.87	198.28	197.93
TCVN 5937: 2005 (1 hours) (µg/m3)	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**

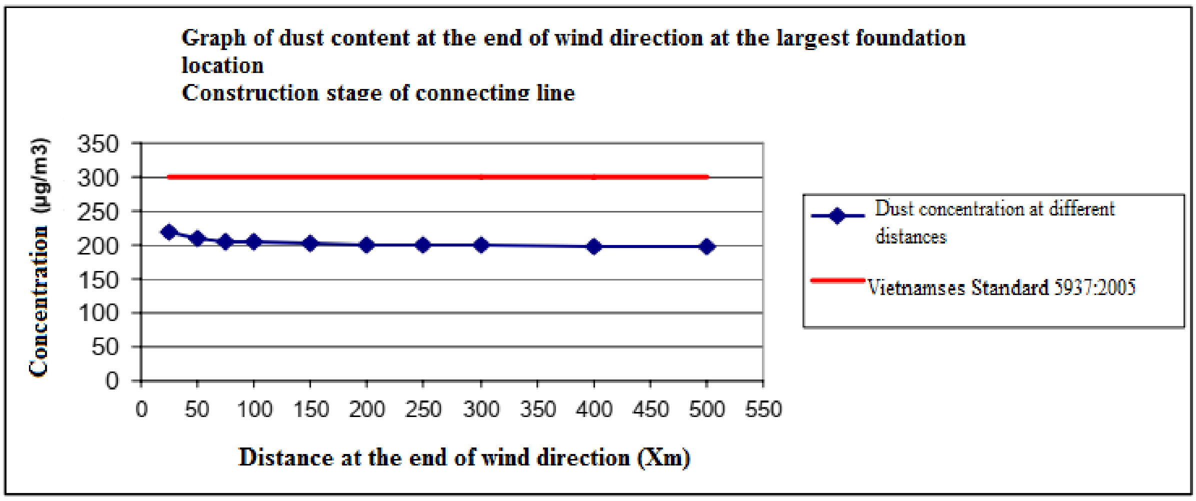


Figure 3. 8. Graph of dust content at the end of wind direction at the largest foundation location on 110kV power line

From the volume of earthwork by items and construction sites, calculate the amount of dust generated by earthwork activities as shown in Table 3.2; The amount of dust dispersed for each area from construction activities is shown in Table 3.3 ÷ 3.10 and Graph of dust content at the end of wind direction in the areas is shown in Figure 3.3 ÷ 3.8.

Summary of the calculations of the amount of dust generated from earthwork is presented in Table 3.11. From the calculation results, it can be seen that outside the construction site (>100m away from the source), the ambient air quality meets the standard TCVN 5937: 2005.

Table 3. 10: Summary of the calculations of dust amount generated from earthwork

Areas	**Main dam**	**Main dam landfill**	**Intake water**	**Intake water landfill**	**Pipeline**	**Plant**	**Quarry 1**	**110kV power line**
Generated amount (kg/8h)	356,02	358,40	232,14	1315,71	196,75	212,16	392,41	5,15
Concentration 10m away (µg/m^3)	98.70	98.99	83.85	213.73	79.61	109.68	103.06	197.36

Concentration 100m away (μg/m^3)	56.44	56.45	56.30	57.56	56.26	84.50	56.49	196.75

Level of dust and emission generation from transportation activities:

In order to assess the level of dust pollution during construction, using the table of pollution coefficients of vehicles using diesel according to *Handbook of Emision, Non Industrial and Industrial source, Netherlands (See Table 3.12)*

Table 3. 11 Pollution Coefficients of Vehicles using Diesel

	Dust	**SO2**	**NOx**	**CO**	**VOC**
For vehicles weighing less than 3.5 tons (10 vehicles):					
Pollution Coefficient (kg/1000km)	0.20	1.16*S	0.7	1	0.15
For vehicles weighing from 3.5 to 16 tons:			**0.90**	**4.29*S**	**11.80**
Pollution Coefficient (kg/1000km)	0.90	4.29*S	11.80	6.00	2.60

Note: - S: Sulfur content in diesel oil ranges from 0.5 - 1.0%.

Source: Handbook of Emision, Non Industrial and Industrial source, Netherlands

Forecast of dust and emissions generated: average transportation distance: 70km/vehicle.day, (working 8 hours). With the number of vehicles used to transport materials and other construction equipment, equivalent to: 37 vehicles < 3.5 tons; 65 vehicles > 3.5 tons (see Table 3.13 Main construction machinery and equipment).

Table 3. 12: Main construction machinery and equipment

No.	**Name of equipment**	**Unit**	**Quantity**
1	Excavator1.25	Piece	8
2	Backhoe excavator 1.6m^3	“	5
3	Excavator 2.5m^3	“	7
4	Excavator 1 – 1.5m^3	“	5
5	240 CV bulldozer	“	4
6	140 CV bulldozer	“	10
7	12T dump truck	“	30
8	3 - 5T Dump truck	“	10
9	Drilling machine D = 105 - 150mm	“	15
10	Air-compressor 10m^3/min	“	20
11	10 - 20T Compactor	“	8
12	25T Tower crane	“	3
13	25 - 50T Chain crane	“	3
14	6m^3 truck carrying concrete mortar	“	15
15	Mixing plant 125m^3/hour	Plant	2
16	Mixing plant 60m^3/ hour	Plant	4
17	Concrete pump	Piece	6
	Equipment for construction of tunnel, drilling equipment		
18	2-rod driller	Piece	8
19	Driller D = 70 - 105mm	Piece	5
20	Pioneering tunnel boring equipment	Piece	
21	Backhoe excavator 1.5m^3	Piece	8
22	Excavator 0.25m^3	Piece	7
23	12T dump truck	Piece	20

24	50T Chain crane	Piece	1
25	Air-compressor 10m^3/min	Piece	5
26	Ventilation equipment	Set	5
27	Concrete pump 120 m^3/h	Piece	6
28	Rotary driller D = 51-76 mm	“	15
29	Concrete spraying equipment	Set	5
30	Jet grouting equipment	Set	8

Estimated maximum pollution loads of dust for each vehicle type is shown in Table 3.14. It can be seen that dust and emission pollution caused by traffic activities during the construction is not large and mainly within the construction site.

Table 3. 13 Amount odd exhaust fumes from vehicles using diesel

	Dust	SO2	NOx	CO	VOC
For vehicles weighing less than 3.5 tons (10 vehicles):					
Load of exhaust fumes (kg/month.vehicle)	0,42	2.42	1.46	2.08	0.31
Load of exhaust fumes (g/s.vehicle)	0,005	0.04	0.03	0.03	0.01
For vehicles weighing from 3.5 to 16 tons:			**0.90**	**4.29*S**	**11.80**
Load of exhaust fumes (kg/month.vehicle)	1,88	8.94	24.58	12.50	5.42
Load of exhaust fumes (g/s.vehicle)	0,022	0.14	0.39	0.20	0.09

3. Noise and vibration:

During the construction:

Noise generated by blasting, construction and transportation vehicles. Mines cause loud explosions and create vibrations from quarry sites or construction sites. The radius of effect is about 3 km in each quarry site. For construction activities and means of transport, the noise usually has an impact radius of about 1 km. Construction will require some type of noisy equipment which can reach 80-90 dBA for 15 m distance or 85-95 dBA for 2 m distance (see Table 3.15).

Table 3. 14 Noise levels generated by some construction machinery

	Noise level (dBA)	
	Within 15m *	***Within 2m *****
Heavy truck	70-96	85
Bulldozer	77-95	95
Compressed compactor	72-88	-
Concrete mixer	71-85	85
Excavator	72-96	-
Generator	70-82	-
Monitoring equipment	70-80	-
Compression hammer	90-104	95

*Source: * From FHA (USA); ** From the EIA Report for the project on Western China 500 kV power line*

In fact, for Dai Ninh hydropower project under construction, noise monitoring results show that the biggest noise concentrated in the tunnel area is about over 90dBA, while in the construction areas on the construction site, such as main dam, spillway, quarry, noise fluctuates in the range of 60-70dBA (see Table 3.16). Thus, it can be predicted that in the construction camp area and the neighboring residential area, the noise and vibration caused by construction activities do not exceed the permitted level of TCVN 6962: 2001.

Table 3. 15 Noise and vibration monitored on the construction site of Dai Ninh hydropower plant

Locations	Noise level (dBA)
May 2006	
Tunnel (tunneling)	93
Da Nhim main dam, spillway	70
Plant	63
DaQueyon quarry	71
November 2006	
Da Nhim main dam	52
Plant	70
DaQueyon quarry	60
Bac Binh quarry	71

Source: Institute for Tropical Technology and Environment Protection, 2006

During the operation:

Noise and vibration are generated by the operation of the turbine and generator. In the hydropower plant, it will be designed and built to operate with the limited effects of noise and vibration.

Vibration speed: designed according to standard VDI 2056.

Noise: Designed within the limits of standards ISO NR80 (within frequency range of 62.5 - 8000 Hz) and ISO 1996/1-1982 to ensure the health of operators and maintenance staff. The operating room ensures standard ISO NR40 (within frequency range of 250-2000 Hz) to ensure that the operators can communicate and concentrate on working.

c) Sources causing water environment pollution in the construction stage:

During the construction stage, the source receiving wastewater is Dak Drinh River. The main sources of pollution are: (1) Domestic wastewater. (2) Production wastewater. (3) Due to construction activities (excavation, construction ...).

1. Domestic wastewater:

Generating due to the living activities of construction workers. According to Wastewater Engineering. Treatmen, disposal, and Reuse, domestic wastewater is mainly composed of bacteria, organic matter, and suspended solids as shown in Table 3.17.

Table 3. 16: Typical components of domestic wastewater

Pollutants	Unit	Concentration		
		Low	**Average**	**High**
1. Total solids	mg/l	350	720	1200
- Dissolved solids	mg/l	250	500	850
- Suspended solids	mg/l	100	220	350
2. Settleable solids	mg/l	5	10	20
3. BOD_5	mg/l	110	220	400
4. COD	mg/l	250	350	500
5. Total organic carbon	mg/l	80	160	290
6. Total Nitrogen (in N)	mg/l	20	40	85
- Organic	mg/l	8	15	35

- Free Ammonium	mg/l	12	25	50
- Nitrite	mg/l	0	0	0
- Nitrate	mg/l	0	0	0
7. Total Phosphorus (in P)	mg/l	4	8	15
- Organic	mg/l	1	3	5
- Inorganic	mg/l	3	5	10
8. Total Coliform	No/100ml	10^6 - 10^7	10^7 - 10^8	10^8 – 10^9
9. Volatile organic carbon	μg/l	<100	100 - 400	<400

Source: Wastewater Engineering. Treatmen, Disposal, Reuse

The pollution level of domestic wastewater caused by workers' activities in the project areas is expected to be at an average level in Table 3.17. The concentration of typical pollutants are presented in Table 3.18.

Table 3. 17 Load of typical pollutants from domestic wastewater in construction stage

	Labor	**Average wastewater**	**Total Nitrogen**	**Total Phosphorus**	**SS**	**COD**	**BOD_5**
	Person	***(m^3/day)***	***kg/ day***				
The amount of wastewater	50 (lít/người.ngày)						
Concentration (mg/l)			40	8	10	350	220
Load of pollutants from domestic wastewater							
1. Damsite and water intake	1,492	74.6	2.98	0.60	0.75	26.11	16.41
2. Auxiliary tunnels 2, 3 and surge shaft	609	30.45	1.22	0.24	0.30	10.66	6.70
3. HYDROPOWER PLANT	250	12.5	0.50	0.10	0.13	4.38	2.75
4. 110kV power line	120	6.2	0.24	0.05	0.06	2.18	1.36

The average amount of wastewater is 50 liters/person.day, with the number of workers of 2471, the total amount of domestic wastewater in the whole construction site is estimated at: 123.6m3/day and night. Thereby it is possible to calculate the wastewater flow and load of typical pollutants from wastewater in the project areas during the construction stage (See Table 3.18).

2. Production wastewater:

During the construction stage, production wastewater generates due to the operation of supporting facilities for the works. There are 03 facilities for maintenance and repair of construction vehicles on 03 main construction areas of the project, expected capacity of 100 vehicles/year. The amount of oil discharged from these facilities will be a significant source of pollution to the quality of surface water as well as groundwater in the region. The generated waste oil amount calculated for maintenance and repair facilities is presented in Table 3.19.

Table 3.19. Calculation of the amount of waste oil generated at maintenance and repair facilities

	Facility 1: damsite & water intake	**Facility 2: tunnel & sub-niche area**	**Facility 3: plant area**
Average amount of oil used for 1 change	18 liters/time.vehicle		
The average number of changes per vehicle	4 times/vehicle.year.		

The number of vehicles to be repaired & maintained	40 vehicles/year	35 vehicles/year	25 vehicles/year
Total amount of waste oil	240 liters /month	210 liters /month	150 liters /month
Total	**600 liters /month**		

3. Due to construction activities:

In addition, the source of surface water pollution during the construction period is due to erosion of the rock and soil, the washout of construction materials ... increasing the turbidity of Dak Drinh river. This amount of pollution is difficult to accurately determine and depends on topographic conditions, water sources, construction methods, environmental management in each site area.

d) Sources of water pollution in the operation stage

During the operation stage, the source receiving wastewater is Dak Drinh River. Sources of water pollution include: (1) Domestic wastewater of the operator. (2) Production wastewater. (3) Water quality of the reservoir. (4) Water quality of the dowstream.

1. Domestic wastewater: Generated by operating workers' living activities. The total amount of domestic wastewater from the operating areas is estimated: 6.4m3/day.

From Table 3.10, it is possible to calculate the wastewater flow and load of typical pollutants from the wastewater in the areas of the hydropower plant during the operation stage (See Table 3.20).

Table 3. 18 Load of typical pollutants from domestic wastewater during the operation stage

	Labor	**Average wastewater**	**Total Nitrogen**	**Total Phosphorus**	**SS**	**COD**	**BOD_5**
	Person	***(m^3/day)***	***kg/ day***				
The amount of wastewater	50 (lít/người.ngày)						
Concentration (mg/l)			40	8	10	350	220
Load of pollutants from domestic wastewater							
1. PX. đầu mối đập	10	0,5	0,02	0,004	0,005	0,175	0,11
2. Office, hydropower plant, repair, security	98	4,90	0,20	0,04	0,05	1,74	1,05
3. Trạm PPNT và vận hành ĐD110kV	20	1,0	0,04	0,008	0,01	0,35	0,22

2. Production wastewater:

For hydropower plants, during the operation stage, production wastewater can be polluted due to oil leakage, or breakdown. There are two main oil systems: the oil system used for turbines, generators and the oil system for the transformer.

In operation, the amount of oil leakage is negligible. In order to recover the above amount of oil, in addition to the common recovery tank of leaked oil for turbines, generators, transformers (volumeof 3m^3) of the production wastewater system, mobile recovery equipment with a capacity of 4 m^3/h is also used.

The oil system used for turbines and generators has 3 storage tanks with a volume of 10,0m3 each. In case of a incident with the worst possibility, about 10 m^3 of oil will be poured into 2 oil treatment tanks with a volume of 2 x 6 m^3.

The oil system used for the transformer has 3 storage tanks with a volume of 37.5 m^3 each. In the event of an incident, it is likely that a maximum of 80m3 of oil and fire water will be poured into the oil treatment tank with a volume of 80m^3.

3. Changes in water quality of the reservoir

During the operation stage, the change of water quality from the reservoir accumulation process depends on activities in the basin, the reservoir-bed cleaning.

- Currently, the basin is mainly forest land, the agricultural cultivation level is small, only accounting for about 5% of the natural area in Kon Plong district and 15% in Son Tay district. The cultivation practices of the people here mainly are slash-and-burn for cultivation, increasing the possibility of soil erosion, the amount of mud and sand entering the lake bed. In contrast, the use of chemical fertilizers and pesticides is not much. In the future, if the management of economic activities in the basin is maintained well, the possibility of water quality pollution from this source will be negligible.
- The change in water quality of the reservoir depends on the reservoir-bed cleaning, including: (a) Mines and toxic substances left behind by war. (b) Graves and farming facilities. (c) Vegetation in reservoir bed and developments in water quality.

a/ Landmines and toxic substances left behind by the war:

The project area is the base area that was severely beaten. The reservoir-bed is the area where there may be bombs, mines, toxic residues caused by war. The evidence as presented in Chapter 2: Son Dung commune has 7 households, Dak Rin commune has 34 people with sequelae due to Agent Orange. Currently, the amount of residues on the reservoir bed has not been assessed. When the reservoir is stored with water, this will be a potential source of pollution to the water quality.

b/ Graves and farming facilities:

According to the survey results, in the reservoir-bed, there are 418 graves. The Ca Dong and Hre people have a custom of leaving graves (After dividing the property and burying the dead, the Ca Dong people will not return to those places). Therefore, it will be very difficult to determine the location for tidying and cleaning. If graves are not cleaned and sanitized, they will be a major source of pollution when accumulating water into the reservoir.

Due to local people's customs, there are almost no toilets in the reservoir bed. Farming facilities are located under the house of the household (due to free-range farming practices).

c/ Vegetation in reservoir bed and developments in water quality.

The formation of a reservoir on the river has changed the flow regime, so the quality of water (including the water of the reservoir and river water of the downstream) also fluctuates very strongly. However, depending on the size of the reservoir, the topography of the reservoir bed, the turbidity of the reservoir water, the change of water quality will also be different. The project of Dak Drinh reservoir is small, the amount of water reaching the reservoir (approximately 971.3 million m3), 4.73 times higher than the working capacity of the reservoir. However, the depth of the reservoir is large (over 50m), the dead capacity of the reservoir compared to the total capacity is low (17.7%), so the disturbance of the bottom water layer will occur frequently, the rate of lake water stagnation will be small. In order to forecast the change in water quality when passing through the reservoir, we use a method comparing with other reservoirs that have been built and the method calculated by empirical formulas.

**** Construction period:*** The process of preparing and constructing the works with the activities mentioned above will also affect the water quality in the area. Industrial wastes as well as domestic wastes will increase significantly, causing water pollution. This amount of waste depends on the number of construction workers and the number of machinery and vehicles operating during the construction period. However, these are only immediate impacts during the construction stage. After the reservoir is completed, the works will come into operation and such impacts will gradually decrease and stabilize.

Operation period: In the initial stage of water accumulation, the quality of reservoir water depends heavily on the reservoir -bed cleaning. If the cleaning of the reservoir bed is done well, the quality of reservoir
water will be less affected. On the contrary, if this task is not done well, the reservoir water will be polluted, leading to many other negative impacts on the lives of local people as well as on aquatic systems and fisheries in the area.

With the documents of monitored water quality, an assessment of the change in water quality is conducted through three criteria:

- Temperature (The phenomenon of thermal stratification of water in the reservoir)
- Mineralization level (Represents total ions dissolved in water)
- The content of water pollutants (organic matter and nutrients) through the content of oxygen dissolved in water.

* <u>The phenomenon of thermal stratification of water in the reservoir:</u>

It can be seen that there are two types of vertical temperature distribution in Vietnam:

Reservoirs with thermal stratification according to the depth: Reservoirs in the North of Vietnam

Reservoirs without thermal stratification include two types:

+ The type of reservoirs with large temperature difference of the surface and bottom layers at about 6-7^{0}C, commonly in reservoirs with the altitude of over 400 m above sea level is in the Central Highlands and Central Vietnam.

+ The type of reservoirs with large temperature difference of the surface and bottom layers at only 1-2^{0}C, commonly in reservoirs with the altitude below 300 meters above sea level is in the Southeast region.

Carry out to survey the temperature distribution according to the depth in Ham Thuan, Da Mi reservoirs (altitude over 400 m above sea level), Bien Ho (Pleiku - 800 m), Yaly (Gia Lai - Kontum: 700m), finding that there is no phenomenon of thermal stratification, there is no layer with temperature leap, but the temperature decreases gradually from the surface layer to the bottom layer. The temperature difference between the surface and bottom layers is 6 - 7^{0}C.

Dak Drink Reservoir is located in Mid Central, at an altitude of over 400m above sea level, so no phenomenon of thermal stratification is expected. The temperature difference between the surface and bottom layers is quite large at 6-7^{0}C, similar to reservoirs with altitude of above 400m in the Central Highlands and Central region.

* <u>Mineralization level:</u>

According to environmental control monitoring data, reservoirs in the South have come into operation such as Dau Tieng reservoir, Tri An (Southeast region), and Hinh river reservoir (Mid Central region), which shows that: after the reservoirs come into operation, the mineralization level of river water as well as reservoir water increases very small (approximately from 3 to 5% compared to natural water), even for large reservoirs, the mineralization of their water decreases. In the flood season, the mineralization level increases (approximately 5-10%), but in the dry season, it decreases very clearly (10-15% of the mineralization).

It can be predicted that the water mineralization level of Dak Drinh reservoir and Dak Drinh river in the downstream of the dam will not change much compared to natural river water. In the flood season, the mineralization level increases while it decreases in the dry season, with the effect of reducing the amplitude of natural river water mineralization level according to seasons.

<u>* Nutrients and organic matter:</u>

Comparative method: In order to evaluate the variation of nutrients and organic matter, we use the dissolved oxygen index. In water ecosystems, dissolved oxygen (DO) exhibits general well-being and is closely related to the presence of biodegradable components. According to monitoring data of reservoirs which have been put into operation, the first period of water accumulation is when the oxygen content in the reservoir decreases the most due to the very large organic matter as well as nutrients in the submerged surface area. With Tri An, Dau Tieng, Hinh river reservoirs ... after the first year of water accumulation, the amount of DO in the reservoir sharply decreases to (30-39)% of the same into the reservoir. And reservoirs with reservoir-bed cleaning have less dissolved oxygen reduction than reservoirs without reservoir-bed cleaning. Thus, the average dissolved oxygen (DO) content reaching Dak Drinh reservoir is 7.26 mg/l, after the first year of water accumulation, the DO will decrease, the average DO content of reservoir water is only (5.0 - 5.5) mg/l but tends to increase gradually in the following years.

Empirical formula: The bed of Dak Drinh reservoir is mainly hilly terrain, the area of land exploited for agriculture is not large. According to the data of the current land use in the reservoir bed, the area of forest land (natural forest) accounts for 46.41%. The area exploited for agriculture accounts for approximately 15.06% of the reservoir bed area, but mainly annual crops such as rice ... (accounting for more than 73.19% of agricultural land area).

According to the observed empirical data for tropical forests in the Central Highlands and the method of calculating standing tree biomass types of Brown, Kato and Oga Wa for trees, based on the current land use status in the reservoir bed of Dak Drinh hydropower project, the total biomass in the reservoir bed can be calculated.

By A.I.Denhinova's empirical formula, calculate the amount of oxygen required to fully oxidize the organic matter of plants and soil in the reservoir bed for the clean-up plan (See *Appendix 3.1 Calculation of submerged vegetation biomass in the reservoir bed of Dak Drinh hydropower project and Table 3.21 below*):

Table 3. 19. Total biomass in the reservoir bed of Dak Drinh Hydropower project

Unit: ton

Types	Area (ha)	Trunk	Branch	Root	Leaf	Dust layer	Vegetation layer	Total
Natural wood forest	45.29	3,955		593.3		235.5	199.3	4,982
Bamboo forest	378.17	17,207		5,294	3,441			25,942
Shrubs	213.61					1.182		1,182
Annual crops	100.54				384.1			384.1
Perennial crops	36.83	486	90.23	56.35	30.57			663.3
Rivers and streams	137.96							
Total	912.40	21.647	90.23	5,944	3,856	1.417	199.3	33,154

Source: Ecological expert group of Institute for Environment and Sustainable Development.

- The plan of not cleaning up the reservoir bed: The total amount of biomass submerged in the reservoir bed will be 33,154 tons. The amount of oxygen required to fully oxidize the organic matter in the reservoir bed is 505 tons. If the average value of the amount of oxygen reaching the reservoir under the flow is 7.26 mg/l and the total volume of the reservoir is 249 million m3, the amount of oxygen in the reservoir will be: 7.26 mg/l x 249 million m3 = 1809 ton. The remaining amount of oxygen in the reservoir bed will be: 1809 - 505 = 1,304 tons and the dissolved oxygen (DO) content in the reservoir will then be: 5.23 mg/l.

- The plan of carefully cleaning up the reservoir bed: In the reservoir bed, when accumulating water, all round wood of trunks and bamboos, small branches are removed, leaves are cut off in place. The dry biomass of the remaining organisms in the reservoir are roots, leaves and grass. The total biomass remaining in the reservoir in this case reaches 10,090 tons. And the amount of oxygen lost due to oxidation of these organic substances will be 297 tons. The amount of oxygen remaining in the reservoir will be: 1809 - 297 = 1512 tons and DO in the reservoir will reach 6.07 mg/l.

- The plan of thoroughly cleaning up the reservoir bed: In the reservoir bed, before accumulating water, trees, branches, including roots are removed; grass, leaves are burned. The total amount of biomass of vegetation (grass) regenerated in the reservoir bed from the time of cleaning up to the time of water accumulation will reach 6143 tons. The amount of oxygen lost to oxidize organic matter in the regenerated soil and grass is 66 tons. The remaining amount of oxygen in the reservoir is: 1809-66 = 1743 tons and DO in the reservoir is: 6.99 mg/l.

Calculation results are presented in Appendix 3.5 Biomass of vegetation cover submerged in Dak Drinh hydropower reservoir bed.

4. Changes in water quality of the downstream

The impact of the reservoir on downstream water quality in the first years of water accumulation (from 4-5 years) is negative, the level of impact is low and medium. But in the long term, the negative effect mainly depends on the sediment content deposited in the reservoir, reducing the amount of sediment discharged to the downstream and will reach the equilibrium state as the water quality in the base environment presented above. Other environmental indicators such as content of dissolved oxygen, COD, BOD content will be improved.The change in river water quality in the downstream will affect the following indicators:

- Temperature: because Dak Drinh hydropower reservoir has no phenomenon of thermal stratification, the temperature decreases gradually from surface layer to bottom layer, different from 6-7^0C. The altitude of the water intake will be in the middle (50m). Therefore, water, after passing through hydropower plant, is expected to decrease by 3 -5^0C, not much affect the water temperature indicator in the downstream.
- Mineralization level, nutrients and organic matter: After the reservoir is in place, sediment is mostly deposited in front of the dam, so the mineralization level and nutrient content in the downstream water are also reduced.

e) Calculation of environmental pollution loads of solid waste:

1. Industrial waste:

Industrial solid waste only generated ***during construction***, includes 2 types:

* Excess, damaged materials: material packages; scrap; wood chips; other damaged materials and tools ... This amount of waste is not much and can be controlled to collect and sell to waste collectors.

** Waste soil and rock:*

Waste soil and rock from the construction process in the 3 construction sites have a large volume, about over 1,274 million m3 (See Table 3.2 above). This amount of excavated soil and rock will be transported to the landfill. Locations of landfills are selected in low-lying areas, near construction sites and not at the head of water sources (see Figure 1.3 in Chapter 1). This amount of waste soil and rock, if not treated appropriately, will also be a source of dust dispersion; When being eroded into rivers and streams, it will create a source of water pollution.

2. Domestic waste:

During the construction period: At the highest construction intensity, it is expected to gather 2,451 persons in 3 construction sites.

- Average amount of waste generation: 0.5 kg/person/day
- Total estimated amount of domestic waste: 1,235.5kg/day and night (divided by areas as follows: Dam route and water intake: 746kg /day and night. Tunnel niche and surge shaft: 304.5kg/day and night) Plant and construction team of 110kV line: 185kg/day.)

The main ingredients in domestic waste include:

- Organic-derived compounds such as foods, vegetables, leftovers ...
- Paper-derived compounds from food and beverage packaging.
- Inorganic compounds such as plastics, plastics, PVC, and glass.
- Metal: box cover.

The total amount of daily domestic waste due to workers' activities is quite large and the stay period of workers is relatively long (4 years), will be a potential source of pollution to water quality, soil and water environment without treatment methods.

During the operation period: there are approximately 138 operating staff and employees in the region. Except for the operation team of the dam, the remaining persons mainly gather at the hydropower plant

- Average amount of waste generation: 0.5 kg/person/day
- Total estimated amount of domestic waste : 69kg/day (about 2 tons/month).

3.1.2 Impact sources not related to waste

a) Identification of impact sources not related to waste

Identification of impact sources that are not related to the waste of Dak Drinh Hydropower Project is shown in Table 3.22

Table 3. 22 Impact sources not related to waste

No.	Items	Pollutants	Potential impacts	Level
I	**CONSTRUCTION STAGE**			
1	***Site preparation***			
1.1	Site clearance and compensation	- Requisition of land for constructing works, power transmission lines - Relocation of affected households to new resettlement areas.	- Damage to land, property on land, public works and infrastructure. - Impacts on daily life, customs and economy of households - Impacts on socio-economic factors in	- Medium term - Inevitable - Can be minimized

No.	Items	Pollutants	Potential impacts	Level
			the region	
1.2	Clean up of reservoir bed, construction sites, resettlement areas	- Clearance, clean up of the ground	- Impacts on natural resources, forests, land resources and land use in the flooded area - Loss of dry ecosystems in the reservoir bed, wildlife habitat - Changes in landscape of the region	- Long-term - Inevitable - Unrecoverable
2	***Construction***			
2.1	Construction site area	- Social evils	- Affect the construction force's health - May harm the lives - Conflict between workers and local people	- Medium term - Can be minimized
2.2	Construction of works	- Construction of dams	- Obstruct local people from traveling by boat on the river section from the dam to Dak Ring commune - Prevent fish migration	- Long-term - Inevitable - Unrecoverable
		- Remove the topsoil at the construction sites, landfills, quarries, traffic roads.	- Erosion, landslide - River bank erosion	- Medium term - Can be minimized
		- Construction of 110kV transmission line	- Obstruct small boats and rafts on rivers and streams that the transmission line pass over - Obstruct traffic on the roads that the transmission line pass over.	- Short term - Can be minimized
II	**STAGE OF WATER ACCUMULATION AND OPERATION**			
1	Water accumulation, reservoir operation and flood regulation	- Change the upstream hydrological regime (reservoir)	- Change in landscapes - Mud and sand	- Long-term - Inevitable

No.	Items	Pollutants	Potential impacts	Level
			sedimentation in the reservoir - Loss of water due to evaporation of reservoir surface - Impact on the microclimate regime; on community health near the reservoir.	
			- Loss of reservoir water due to seepage - Erosion and regeneration of banks and reservoir beds - Earthquake	- Long term - Can be minimized
		- Change the downstream hydrological regime	- Change in landscapes - Prevent the travel by small boats of local people from Son Tan to Dak Rinh - Prevent fish migration - Reduce the flow of mud and sand; increase the possibility of river-bed erosion	- Long-term - Inevitable
		- Regulate the flow of electricity generation	- Produce dry river section in dry season from dam route to the hydropower plant - Impact on the downstream water demand - Limit flood leakage	- Long term - Can be minimized
	Electric load operation	- Electromagnetic fields on power lines	- Impact on land use capacity. - Affect the construction force's health - May harm the lives	- Long term - Can be minimized

b) Impact sources due to site clearance and construction of resettlement areas

The construction of Dak Rinh hydropower project will cause flood to 912 ha (Normal rising water level of 410m) and expropriate land outside the reservoir bed for construction of items. The site clearance for project construction will cause the following impacts: (1) Damage due to land requisition. (2) Impact due to the construction of resettlement areas. (3) Impact on population and regional socio-economic factors.

1. Damage due to land requisition:

Damages caused by land requisition include: (a) Damage to land. (b) Damage to crops. (c) Damage to houses or public facilities.

**** Damage to land:***

In order to build Dak Rinh hydropower project, will have to requisite: 912.4 ha of land in the planned reservoir bed and 186.4 ha of land outside the reservoir bed. The area of Quang Ngai province is 707 ha and Kon Tum province is 391.61 ha. Of which: 2.19 ha of residential land; 189.47 ha of agricultural land; 314.12 ha of natural forest (poor forest); 174ha of protective forest.

The survey results of land damages in the reservoir bed and main works of Dak Drinh hydropower project are shown in Table 3.23 next page.

The land impact due to the construction on the 110 kV transmission line connecting Dak Drinh hydropower plant to the national electricity system in 4 districts: Son Tay, Son Ha, Son Tinh and Binh Son, is shown in Table 3.25. The area of permanent land acquisition for the construction of transmission poles is 1,581 ha; The area of line corridor on which the land is limited in use is 74 ha.

**** Damage to crops:***

The survey results of damage to crops of Dak Drinh hydropower project are shown in Table 3.23.

Table 3. 23: Impacts on Land in main works area and reservoir bed

No.	Items	Unti	Kon Plong District - Kon Tum province	Son Tay district - Quang Ngai province	Total
	Total area of requisition land	Ha	391.61	707.0	1098.8
	Area flooded in the reservoir bed	Ha	391,61	520.6	912.4
	Requisition area outside the reservoir bed	Ha		186.4	186.4
	Area of reservoir bed	Ha	391.61	520.6	912.4
	Rice land	Ha	43.22	81.69	124.91
	Perennials	Ha	6.13	38.43	44.56
	Protection forest land	Ha	99	75	174
	Natural forest land	Ha	100.4	109.82	210.22
	Unused hilly land	Ha	94.01	166.81	260.82
	Rivers and streams	Ha	48.85	48.85	94.7
	Land requisition for construction of works outside the reservoir bed	**Ha**	**-**	**186.4**	**186.4**
	Land for rice and	Ha		20.0	20.0

	perennials				
	Regenerated poor forest land	Ha		103.9	103.9
	Residential land	Ha		0.1	0.1
	Unused hilly land	Ha		5.5	5.5
	Quarry (bare land and poor forest)	Ha		26.5	26.5

For main works, the damage of crops and crops is mainly on the permanent land requisition in the flooded area and the scope of construction requisition. Of which, the area of short-term crops (rice, cassava, color, ...) is: 144.91 ha. The cultivated area of perennials is 44.56 ha. Fruit trees such as jackfruit and industrial crops such as areca and litsea glutinosa are grown intercropped.

For 110 kV power line, Dak Drinh hydropower plant - Doc Soi (See Table 3.25), the damages to rice and crops are occured mainly during the construction of poles, pulling rope, specifically: On the line corridor (30.42 ha); on the area of temporary land requisition: 2.79ha. Damage of planted forest: due to permanent clearing within the safety corridor is 12.32 ha of planted forest; On the scope of temporary land requisition: 0.22ha (can be restored).

**** Damage to houses, public works:***

The survey results of damage to houses, structures, infrastructure and public works in Dak Drinh hydropower project are shown in Table 3.24.

For main works:

- Damage to houses of households is 581 units with total construction area of 24,934 m2, of which: grade IV houses are 199 units with an area of 11308m2; bamboo house are 381 units with an area of 12212m2.
- Damage to public works is mainly in the reservoir-bed area of Dak Nen commune with the total construction area of 1750m2.
- Damage to technical infrastructure is 3km of 22/0.4kV power line, 3 low voltage 22/0.4kV stations (capacity of 15-50KVA).

The damage to houses of households is mainly due to the limited ability to build in terms of height. Houses in the line corridor are 4 m high, mainly grade IV houses with tiled roofs; Only 7 houses of wooden walls with tile roof. So these houses can still be used to live in the line corridor without relocation.

Table 3. 24: Impacts on houses, structures, infrastructure and public works

No.	Items	Unit	Kon Plong District - Kon Tum province	Son Tay district - Quang Ngai province	Total
A. Scope of construction of main works, operating roads and reservoir bed					
I	**Reservoir bed and focal-point areas**				
1	Houses And Auxiliary Works				
	Thatched Cottage	m^2/house	3794/122	9942/259	12212/381
	Grade IV houses	m^2/ house	4651/99	6537/100	11188/199
2	Other structures				
-	Fish ponds	m^2	226	297	523

	Graves (backfilling)	Piece	269	318	587
3	Infrastructure and public works				
-	Head-offices of the People's Committee	m^2	300		300
-	Infirmaries	m^2	200		200
-	Schools	m^2	1000	450	1450
-	22 and 0.4kV power lines	Km	3	3	11
-	22/0.4kV substation	Station	3	3	6
	Clean water supply tank	m^3	12		12
-	Water pipelines Ø30	M	1000		1000
-	Suspension bridge with 120m long, 1.5m wide (2 bridges)	m^2	360		360
II	**Hydropower plant area, energy route**				
1	Houses and auxiliary works				
-	Grade IV houses	m^2	-	120/1	120/1
-	Goat barn	m^2	-	4	4
2	Infrastructure and public works				
-	22/0.4kV substation	Station		1	1

Table 3. 25 Impacts on land and houses due to the construction of 110kV power line of Dak Drinh hydropower plant - Doc Soi

No.	Items	Unit	Volume
I	Land		
1	- Permanently occupied land area	ha	1,581
2	- Area of the line corridor	ha	74,000
3	- Area of temporary requisition for construction	ha	3,020
	Of which: area of forest and perennial crops	ha	0,225
	: Area of rice and annual crops	ha	2,795
II	Current state of land use in the line corridor	ha	
1	Mixed forest and unused hilly and mountainous land	ha	16,506
2	Artificial forest (pine and eucalyptus)	ha	12,320
3	Agricultural land (rice, crops, fruit trees)	ha	30,420
4	Residential land	ha	4,474
III	Houses and auxiliary works		
-	Houses with wooden walls, corrugated iron roof or tiles	Căn/m^2	7/400
-	Grade IV houses	Căn/m^2	17/1376
-	Cowshed	Căn/m^2	20/1216

Source: Survey Data of Southern General Investigation Enterprise - PECC2 (December 2007).

2. Impact due to the construction of resettlement areas

As mentioned in Chapter 2, in the communes affected by the reservoir bed and the focal works, we can see that: most of the affected households are the Ca Dong and Hre who have lived in this area for a long time. These are poor households with low incomes and living standards; limited farming practices and qualifications. The compensation for houses, residential land and productive land in cash will not guarantee the above households to build houses, residential land and productive land; as well as maintain the same living standards as before. This leads to the destruction of forest for cultivation, indiscriminate exploitation of forest resources, leading to other potential environmental and social impacts. Therefore, it is necessary to implement the compulsory resettlement program for the above affected households. The construction of the resettlement areas for the project creates impacts: (a) Impacts due to the exploitation of land fund for the resettlement areas. (b) Impacts due to construction of resettlement areas:

**** Impacts due to the exploitation of land fund for the resettlement areas:***

Estimated size of resettlement areas is based on the survey results of current and forecasted damages up to 2010. Current number of persons who will be resettled (2007), forecast to 2010, demand for land used for agricultural production and residential areas are presented in Table 1.7, Chapter 1. Location of resettlement areas shown in *Figure 1.5: Diagram of the Master plan of Dak Drinh Hydropower project's resettlement areas and traffic, power supply networks for resettlement areas*. The construction of resettlement areas for the project will have to exploit the land fund to meet the demand for agricultural land and to arrange residential areas. The current land use in resettlement areas is shown in Table 3.26 as follows:

Table 3. 26 Statistics on current land use in resettlement areas - Dak Drinh Hydropower project

Name of resettlement areas	Area (ha)		Protection natural forest (ha)	Unused mountainous land (ha)	Other unused land (ha)
	Nature	Demand			
Resettlement areas of Kon Plong district - Kon Tum province:					
a/ Dak Nen Commune:					
1. Nuoc Bao area:	260	259.34		260	
2.Nuoc Dop-Nuoc Buc area	160	150.16	70	90	
b/ Dak Rin Commune:					
3. Nuoc Doa area:	86	47.36		27,5	58,5
Resettlement areas of Son Tay district, Quang Ngai province:					
c/ Son Mua Commune:					
4. Nuoc Vuong area	220	144.18		36	184
d/ Son Dung Commune:					
5. Nuoc Lang hamlet area:	270	187.72		20	250
6. Anh Nhoi hamlet area:	300	273.5			300

Source: - Map of the current land use of Kon Plong district made by the Division of Natural Resources and Environment of Kon Plong District and the Cadastral Center of Land and Environment Faculty - University of Agriculture I - Hanoi.

- Map of the current land use of Quang Ngai province provided by Center for Information and Archives - Department of Natural Resources and Environment of Quang Ngai Province.

- Results of field surveys and statistical data collection in Kon Plong district, Son Tay made by the Division of Environmental Design and Resettlement -PECC2.

Thus, in addition to Nuoc Dop - Nuoc Buc resettlement area, 70ha of natural protective forest land must be exploited (regenerated forest land, sparse land with bamboo, bambusa balcooa, shrubs, small trees, vines). The remaining locations of other resettlement areas are all hilly and mountainous land or other unused land. See Figure 2.4: Current land use in the reservoir bed and resettlement and re-sedentarization areas of Dak Drinh Hydropower project presented in Chapter 2 and Figure 3.9: Some images of the current state of resettlement areas on the next page..

**** Impacts due to construction of resettlement areas***

In resettlement areas, there will be construction activities such as: leveling residential areas, building houses for resettled households and public works, reclaiming and constructing fields, water supply works for production. The construction scale of resettlement areas is presented in *Section 1.4.5 Resettlement areas of Chapter 1*. The construction of resettlement areas will also produce the sources of impact such as construction activities presented in the next section. However, the scale of such sources is not large.

The planned resettlement area in Nuoc Lang hamlet (July 2005)

Dak Ra Phan Resettlement Area, Son Dung Commune (July 2005)

Old Nuoc Dop Resettlement Area and road accessing to the resettlement area (July 2005)

Nuoc Bao Resettlement Area and Dak Nen People's Committee Area (July 2005)

Nuoc Doa village resettlement area, Dak Ring commune and the newly-opened road

House and crops in the reservoir bed of Son Dung commune from Dak Ring to Dak Nen (July 2005)

Figure 3. 9 Images of Planned Resettlement areas of Dak Drinh Hydropower Project

c) Impact sources caused by construction activities

Construction activities will take place over 4 years, in addition to production of waste-related impact sources as described in the above sections, such activities also provides other sources of impact. Specifically:

1. Landslide:

Landslides are likely to occur in locations of excavation, filling, landfills, storage yards, and foundations of 110kV power line (See Table 3.2). However, in addition to depending on the nature of the soil and rock, the terrain conditions, this possibility also depends on the construction solution of the contractor.

As mentioned in Chapter 1, during the construction of all items, 3.266 million m3 of soil and rock will be excavated. 1.274 million m3 of soil and rock. is transported to landfills, storage yards (See Table 3.2).

For the dam site, the work of foundation excavation is estimated in 12 months, construction measures have noted the condition of a slope shoulder of 30 - 400 with the cover geology of edQ -eQ layer with common thickness from 3 - 5m, some places are 10-14m thick.

The retaining dikes in this area with a volume of nearly 60,000 m3 of soil and rock will be removed in the rainy season after completing items.

For the pressure tunnel of geological structure, the route intersects the rock and soil of Ben Giang - Que Son complex, Hai Van complex and Tac Po formation. According to the center of the route, the stratigraphy mainly intersects zones IIA, IIB of granite and gneiss with quite solid intensity. On average, there is one fault at about 800m in the whole route, these faults are deep ones and high levels with large impact and destruction. These faults will be a major influence on tunneling.

With the above topographical and geological conditions, if there are no reasonable construction measures, it will create a source of great impact on the rock and soil slip.

2. Traffic obstruction:

During the construction as well as the operation, small boats and rafts of local people will not be able to pass through the river section from the dam to Dak Nui commune. Fishing activities, sand exploitation of local people on the river section above will be affected. For the 110kV power line, during the time of tension, it will prevent small boats and rafts of local people from traveling on rivers and streams as well as road traffic means on the roads that 110kV power line crosses. However, this time is not long, maximum 1-2 hours for each distance of crossing rivers, streams or roads.

3. Labor and traffic accidents:

The possibility of these accidents within the construction site is largely due to the subjectivity of the construction units, workers, operators of vehicles and equipment, and local people participating in the construction.

4. Health of construction forces and local people:

A large number of construction workers and people migrate to the project area, they can bring strange diseases and pass them on to local people and vice versa. In addition, construction activities without proper treatment will pollute water and air, creating conditions for pathogens to thrive, especially common diseases in the region: malaria, diarrhea, typhoid,...

5. Take advantage to exploit forest resources:

The project construction needs to clear the forest in the reservoir bed and in the resettlement areas. There will be the possibility that individuals, construction groups, local residents, and other migrant groups will take advantage to exploit forest resources in the reservoir bed, resettlement areas, and neighboring forests. Besides, the demand for food and medicine from forest resources will also stimulate activities harming the forest environment.

6. Social issues:

During the construction period, some other social problems may arise: security and order in the area, conflicts between the workforce and local people, other social evils ... disturbing to the lives of the local people.

d) Impact sources due to reservoir formation

Dak Drinh hydropower reservoir is located in the system of reservoirs and hydropower irrigation works exploiting the flow on Tra Khuc River, mainly for electricity production by taking advantage of the high terrain difference. However, with the effective capacity (Vhi) of the reservoir of $205.25x10^6m^3$, accounting for 21% of the total flow of Dak Drinh river to the average reservoir (971 million m^3 of water), Dak Drinh reservoir will be able to regulate the the flow of Dak Drinh River. However, there are also sources of impact: (1) The change of hydrological regime in the upstream and downstream of the reservoir. (2) Sources affecting the aquatic system. (3) The change of geological environment.

1. Changes in hydrological regime when operating the reservoir and hydropower plant

Sources affecting the change of hydrological regime due to the operation of the reservoir and Dak Drinh hydropower plant lead to: (a) Changes in flow regime of the upstream of the dam. (b) Fluctuation of surface water potential in the basin. (c) Changes in flow regime of the downstream of the dam. (d) Reservoir sedimentation and changes in flow regime of mud and sand in Dak Drinh river.

***Change in the flow regime at upstream of the dam (reservoir)**

As mentioned above, after the project is formed, 16km of Dak Drinh river in the upstream part of the dam was converted into a reservoir and the flow regime in the river did not exist but replaced by reservoir hydrology, shown through level of fluctuation in water level. In natural conditions, the fluctuation of water level in the river depends on the rainfall and the regulation of the basin buffering factors.

During the operation, the fluctuation of river water depends mainly on regulation mode for power generation. Dak Drinh hydropower reservoir operates under the regulation regime for many years with the coefficient $\beta = 0.21$. At the end of the flood season (Octobers and Novembers), the reservoir is full of water at 410m of normal water level and brought to approximately 390m of elevation at the end of dry season. Fluctuation in water level in the reservoir changes from normal water level (410m) down to dead water level (375m). Most of the reservoir water level is in the "area providing a guaranteed level".

At the end of the reservoir during flooding with flood frequency p = 0.5%, the overflowed water level can reach the elevation of 421.5m on Dak Drinh branch and up to 424.3m on Dak Tameo branch. See Table 3.27 Calculation results of overflowed water in Dak Drinh reservoir and *Figures 3.10 ÷ 3.12 Dak Rinh reservoir - river water surface, Dak Rinh, Dak Tameo, Dak Roman branches corresponding to flood 0.5%; 0.1%.*

Table 3. 27 Calculation results of overflowed water in Dak Drinh reservoir.

No.	**Sections**	**R.s**	**Flood P=0.5%**		**Flood P=0.1%**	
			River m)	**Reservoir (m)**	**River m)**	**Reservoir (m)**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**

Dak Rinh branhc						
1	TD2	1	335.72	410.20	338.42	412.20
2	NS4	2	337.78	410.20	340.38	412.20
3	TD1T	4	349.92	410.21	351.94	412.22
4	DR5	5	356.65	410.22	358.34	412.23
5	DR4	6	361.83	410.22	363.14	412.23
6	DR3	8	365.38	410.22	366.74	412.23
7	DR2	9	389.51	410.25	390.66	412.27
8	LH.05	10	404.74	410.52	405.63	412.55
9	DR1	11	421.50	421.50	422.40	422.41
Dak Tameo branch						
10	TM5	12	363.68	410.22	365.18	412.23
11	Lh-02	13	365.79	410.22	366.99	412.23
12	TM4	14	381.34	410.23	382.24	412.24
13	Lh-01	15	401.03	410.33	401.98	412.34
14	TM3	16	410.74	411.71	411.48	413.32
15	TM2	17	420.14	420.14	421.05	421.06
16	TM1	18	424.26	424.26	425.26	425.26
Dak Roman branch						
17	TD1P	19	355.27	410.22	356.88	412.22
18	RM7	20	370.20	410.23	371.88	412.24
19	RM6	21	375.58	410.25	377.60	412.26
20	RM5	22	379.10	410.25	381.00	412.28
21	RM4	23	382.59	410.27	384.26	412.29
22	Lh-03	24	385.43	410.27	386.40	412.30
23	RM3	25	389.67	410.27	390.49	412.30
24	RM2	26	398.77	410.29	399.60	412.32
25	RM1	27	414.10	414.12	414.68	414.84

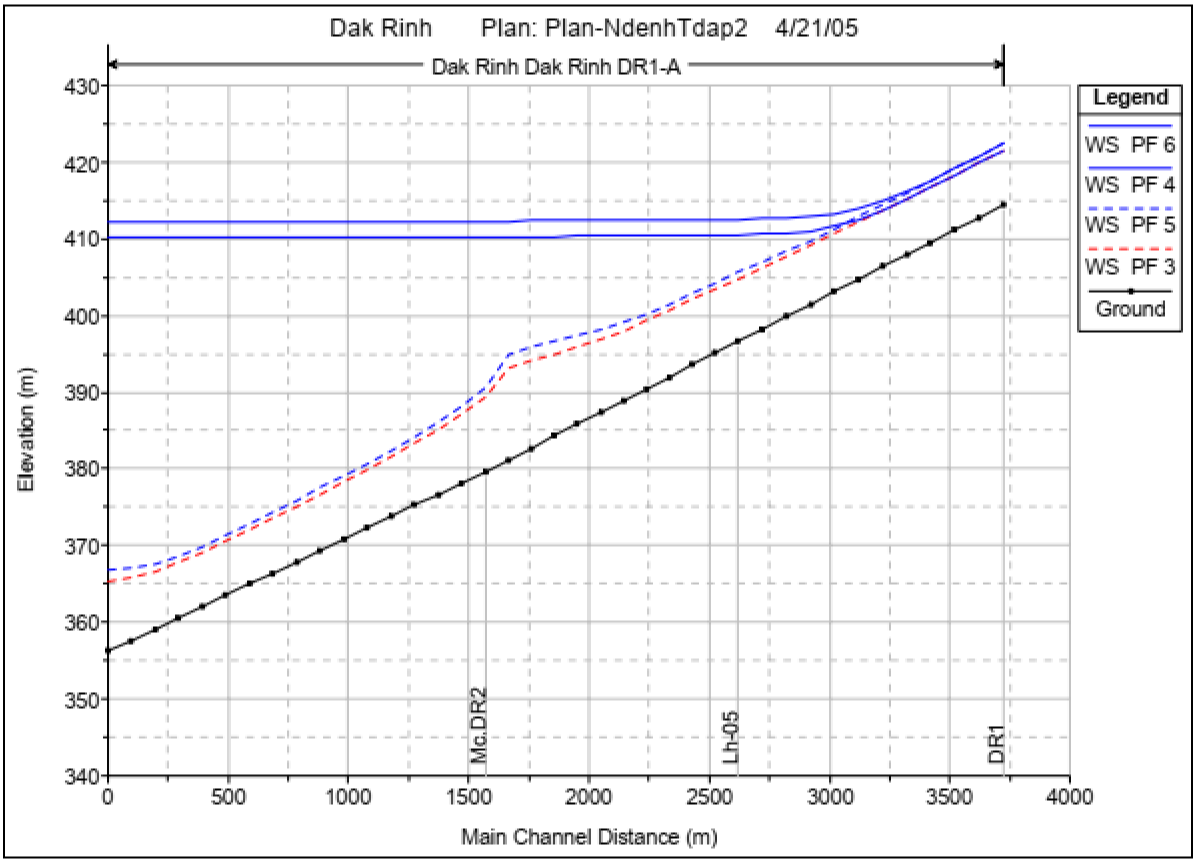


Figure 3. 10 Dak Rinh reservoir-river water surface, Dak Rinh branch corresponding to flood 0.5%; 0.1%.

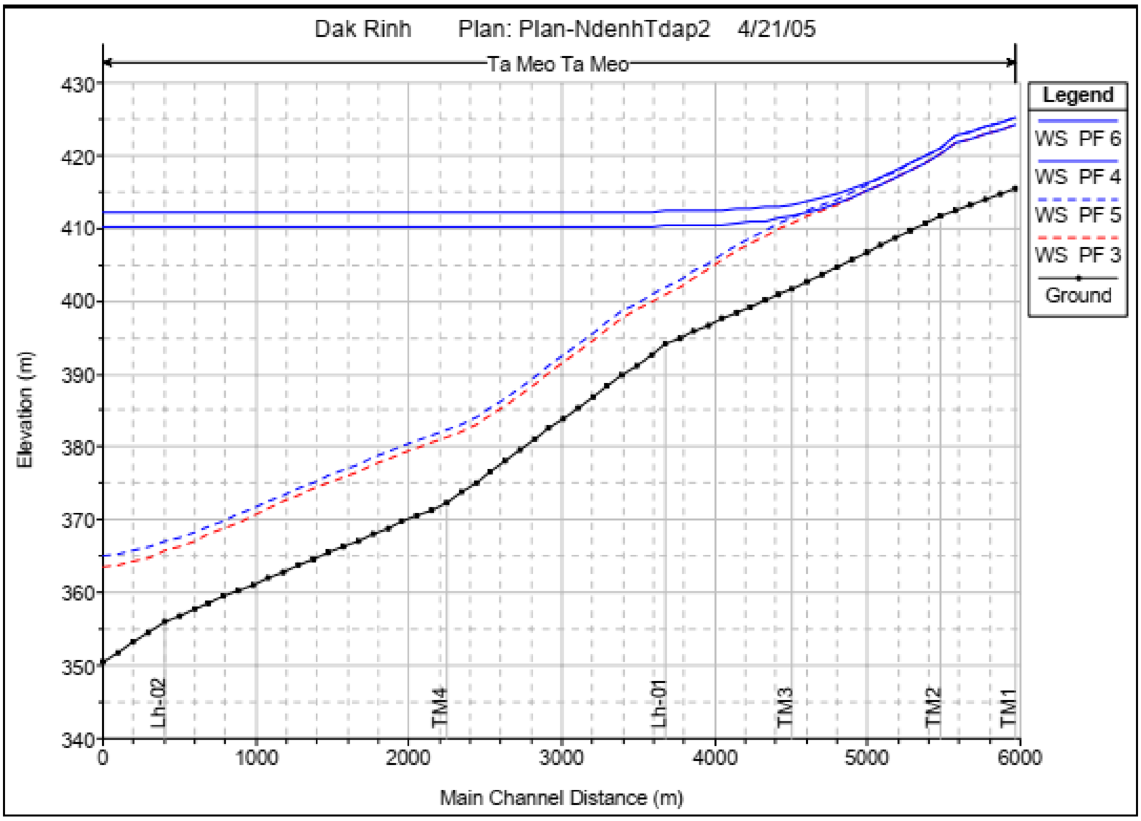


Figure 3. 11. Dak Rinh reservoir-river water surface, Dak Tameo branch corresponding to flood 0.5%; 0.1%.

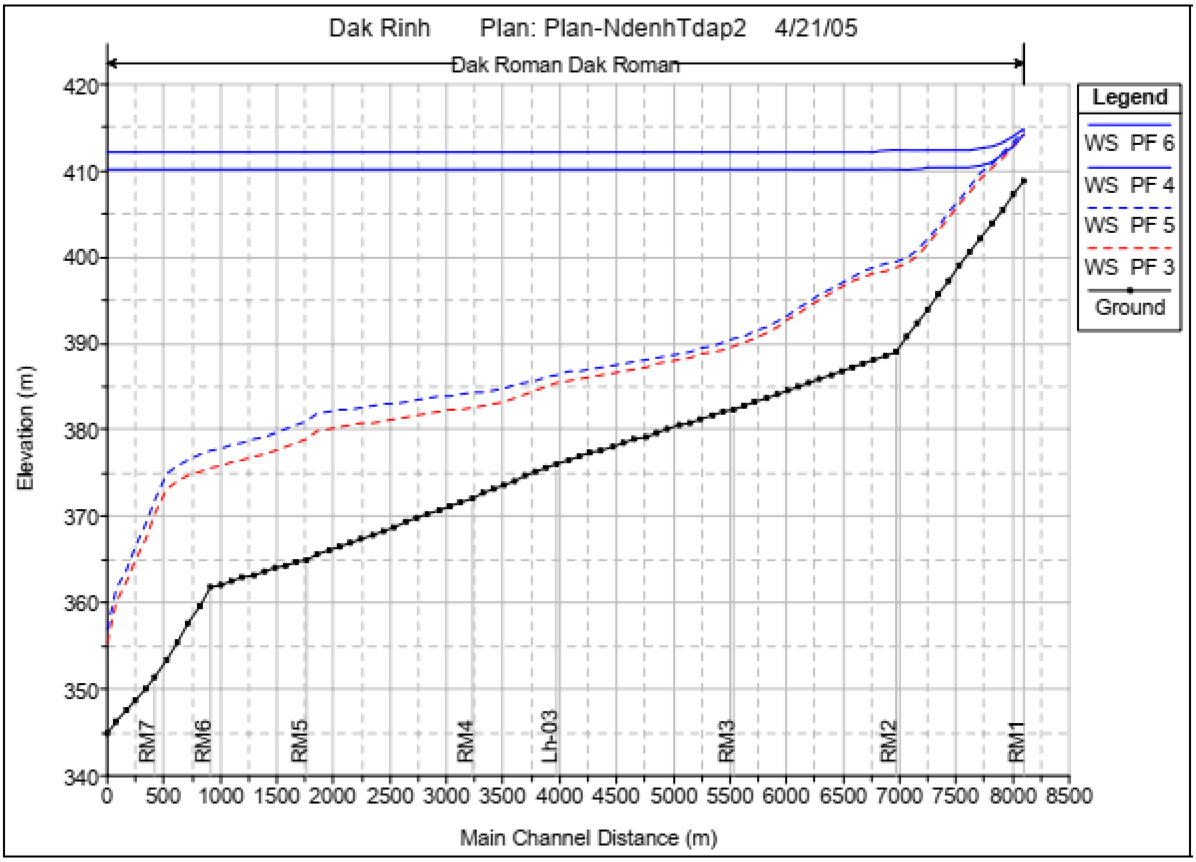


Figure 3. 12 Dak Rinh reservoir-river water surface, Dak Roman branch corresponding to flood 0.5%; 0.1%.

In the flood season, corresponding to flood frequency p = 0.5%, water level in the reservoir at the dam location can reach 410.14m in case of uncontrolled flow through the spillway and up to 412.3 in case of controlled flow through the spillway to reduce flood peak for downstream. See Tables 3.28 and 3.29 Results of calculation of flood regulation in Dak Drinh reservoir presented in Appendix.

Table 3. 28 Result of calculation of flood regulation in Dak Drinh reservoir in case of uncontrolled flow through the spillway

THE FLOOD REGULATION OF THE RESERVOIR								
Open date		**Clear Result**		**Input Finished**		HEC-HMS		
Save to file		**Clear All**		**Run...**				
Relational line		Process line of		The discharge capacity line		**Project:**		Dakdrinh spillway
Z~W		coming flood		of the spillway + Q plant		**Option:**		Design flood, p=0.5%
Elevation	Capacity	Period	Flow	Elevation	Flow	Original reservoir capacity, Vo		249.30
Z	W	T	Q	Z	Q	Clculation period, Dt		0.20
(m)	(tr.m3)	(qid)	(m3/s)	(m)	(m3/s)	Threshold elevation,		395.0

						Ctn		
330.00	0.43	26.0	2572	410.00	0.00	Control water level, Mnbd		410.0
340.00	1.31	27.0	3095	410.00	1562.32	Time of starting discharge, tdbd		30.0
350.00	4.56	28.0	3676	410.00	2192.24	End time, tdkt		40
360.00	13.56	29.0	4336	410.00	2885.83	Initial discharge flow, Qo		126.0
370.00	31.16	30.0	5005	410.00	3632.49			
375.00	44.04	31.0	5560	410.00	4426.78			
380.00	60.01	32.0	5975	410.00	5266.83	The amount of water changed in the reservoir		
385.00	79.91	33.0	6264	410.00	6244.47	Additional capacity (tr.m3)		1.463
395.00	133.80	34.0	6429	411.50	7261.60	Discharge capacity later (tr.m3)		1.475
400.00	167.60	35.0	6480	413.00	8349.18	Water level in the reservoir		
405.00	206.10	36.0	6387	414.50	9482.02	Water level at the time of starting discharge		410.0
410.00	249.30	37.0	6144	416.00	10683.99	Water level at the time of ending discharge		410.0
415.00	297.70	38.0	5728	417.50	11923.70			
420.00	351.80	39.0	5164	419.00	13231.50	Calculation results		
430.00	476.50	40.0	4560	420.50	14583.02	Maximum water level		410.1
440.00	565.00	41.0	4020	422.00	15989.25	Q maximum discharge		6338.4
		42.0	3564	423.50	17449.86	Max overflowing water column		15.1
		43.0	3190	425.00	18947.04			

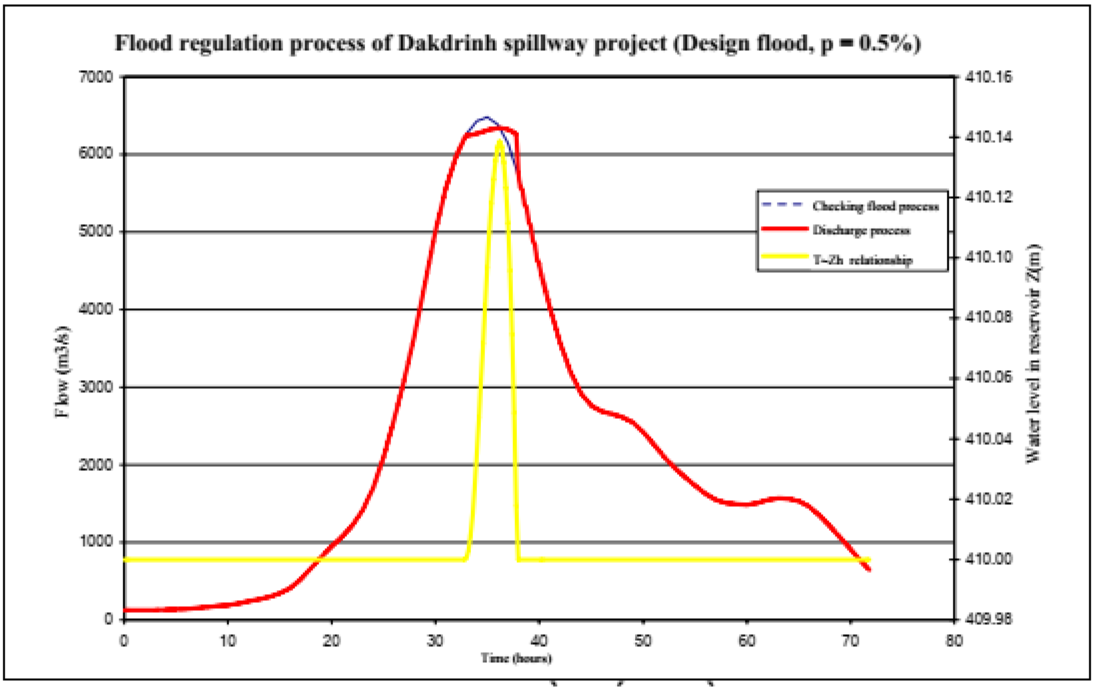


Figure 3.13: The process of flood regulation in Dak Drinh reservoir in case of uncontrolled flow through the spillway

Table 3. 29 Result of calculating flood regulation in Dak Drinh reservoir in case of failure to open a valve gate or of repair

THE FLOOD REGULATION OF THE RESERVOIR								
Open date		Clear Result		Input Finished		HEC-HMS		
Save to file		Clear All		Run...				
Open date		Clear Result		Input Finished		HEC-HMS		
Save to file		Clear All		Run...				
Relational line		Process line of		The discharge capacity line		Project:	Dakdrinh spillway	
Z~W		coming flood		of the spillway + Q plant		Option:	Design flood, p=0.5%	
Elevation	Capacity	Period	Flow	Elevation	Flow	Original reservoir capacity, Vo		249.30
Z	W	T	Q	Z	Q	Clculation period, Dt		0.20
(m)	(tr.m3)	(qid)	(m3/s)	(m)	(m3/s)	Threshold elevation, Ctn		395.0
330.00	0.43	27.0	3095	410.00	0.00	Control water level, Mnbd		410.0
340.00	1.31	28.0	3676	410.00	575.80	Time of starting discharge, tdbd		30.0

350.00	4.56	29.0	4336	410.00	989.23	End time, tdkt	43.0
360.00	13.56	30.0	5005	410.00	1558.16	Initial discharge flow, Qo	126.0
370.00	31.16	31.0	5560	410.00	2299.85		
375.00	44.04	32.0	5975	410.00	3232.48		
380.00	60.01	33.0	6264	410.00	4376.30	The amount of water changed in the reservoir	
385.00	79.91	34.0	6429	410.00	4685.79	Additional capacity (tr.m3)	18.817
395.00	133.80	35.0	6480	411.50	5447.19	Discharge capacity later (tr.m3)	19.394
400.00	167.60	36.0	6387	413.00	6261.32	Water level in the reservoir	
405.00	206.10	37.0	6144	414.50	7109.34	Water level at the time of starting discharge	410.04
410.00	249.30	38.0	5728	416.00	8009.09	Water level at the time of ending discharge	410.4
415.00	297.70	39.0	5164	417.50	8937.10		
420.00	351.80	40.0	4560	419.00	9916.09	Calculation results	
430.00	476.50	41.0	4020	420.50	10927.80	Maximum water level	412.3
440.00	565.00	42.0	3564	422.00	11980.46	Q maximum discharge	5886.2
		43.0	3190	423.50	13073.83	Max overflowing water column	17.3
		44.0	2920	425.00	14194.58		

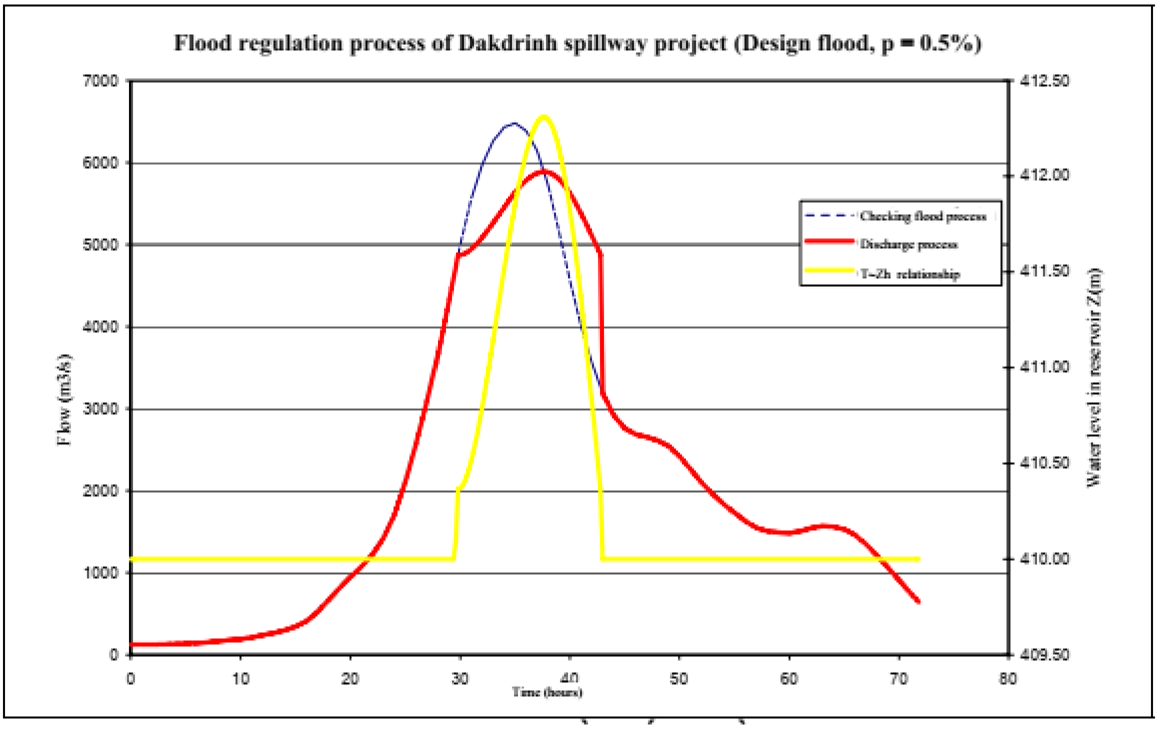


Figure 3.14: **Process of flood regulation in Dak Drinh reservoir in case of failure to open a valve gate or of repair**

**** Potential fluctuations of surface water in the basin.***

As mentioned in Section 2.4.2 Rainfall regime in Chapter 2, the basin of Dak Drinh river has abundant water potential, with average rainfall for many years reaching 3570 mm. However, due to the impact of climatic seasons, the rainfall between the rainy and dry seasons is very different, November has the largest average monthly rainfall, nearly 20 times that of February, with the smallest average monthly rainfall (see Table 2.9 Average rainfall of Dak Drinh basin in Chapter 2).

Along with the regulatory impact of the basin's buffer surface, it leads to a great differentiation in the flow season. In a year, the flow in only 3 months is higher than the average annual flow. Average flow in many years of 3 months of flood season accounts for 73.76% of the total average annual flow. November has the largest average monthly flow, more than 24 times in July, with the smallest average monthly flow.

After the completion of Dak Drinh hydropower project, a reservoir will be established with about 16 km long along Tra Khuc River, with the largest width of over 1.2 km, an average of 1 km. The total capacity of the reservoir is $249.3 x 10^6 m^3$, used for electricity generation, which will create a big change in surface water potential in the basin.

The calculation of the flow variation on Dak Drinh river after the downstream of the Dak Drinh hydropower dam is shown in Table 3.30 and Table 3.31.

Water loss due to increased evaporation of the reservoir surface: After the reservoir is formed, the area of the reservoir's open surface increases, the evaporation capability increases.

As shown in Section 2.4.2.2 and in Table 2.11 in Chapter 2, we can see that after the reservoir formation, the evaporation amount increased by 364 mm. The average open surface area of Dak Drinh reservoir is 5.98 km2 (at normal water level, it is 9.12 km2, at dead water level, it is 2.83 km2), therefore, the amount of water loss through evaporation of the reservoir surface is estimated at 2.18 million m3 corresponding to a flow of 0.06 m3/s. Compared with the total amount of water reaching to Dak Drinh reservoir, it accounts for 0.22%. So the water surface evaporation loss is not large and the impact of the reservoir on the water balance change in the basin is negligible.

**** Changes in the flow regime of the dam downstream:***

Table 3. 30 Flow variation on Dak Drinh river from the dam to the hydropower plant

Q(m³/s)

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
Average monthly flow to DakDrinh hydropower reservoir (1977 - 2003)												
28.4	15.1	9.31	6.67	7.18	7.71	5.13	5.18	11.3	67.1	126	80.9	30.8
Average monthly flow passing through DakDrinh hydropower plant												
26.8	16.7	14.4	14.4	14.4	14.4	14.4	14.4	15.6	39.0	41.2	38.8	22.0
Average monthly flow after DakDrinh hydropower plant reaches the Dak Ba basin												
1.47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.16	52.52	37.63	8.07
Average monthly of flow after the confluence of Dak Ba stream												
9.67	4.35	2.65	1.92	2.09	2.24	1.49	1.50	3.19	23.8	88.3	60.8	16.8
Average monthly flow before DakDrinh hydropower plant												
15.2	7.20	4.49	3.20	3.42	3.69	2.47	2.5	5.3	37.5	112	75.7	22.9

According to the calculation presented in Table 3.30, the changes in downstream flow regime are divided into 2 different sections:

Downstream from the dam to the hydropower plant: Dak Drinh reservoir has Vhi = 205.25 million m3, compared with the total volume of water up to 971 million m3, the total reservoir capacity reaches 21.14%. Therefore, the construction of Dak Drinh reservoir has the effect of regulating flow on the river to generate electricity. On average, 72.36% of the annual flow will go through the tunnel to generate electricity. Thus, on average, annually only 27.64% of the flow from the reservoir passes through the downstream of the dam to the hydropower plant and 4 months of the flood season (from October to January next year). In the months from February to September, the river section behind the dam reaching the confluence with Dak Ba stream at 2.5km long is almost dry. This drying will affect the aquatic ecosystem of the river section behind the dam which will be specifically assessed in the following section Impact assessment due to changes in flow regime of river section behind the dam to the hydropower plant.

Then the Dak Drinh River was replenished with the flow from Dak Bua stream. In the dryest month, the average flow also reaches 1.92m3/s. The section from Dak Bua stream to the hydropower plant is 6.5km long, Dak Drinh river is replenished with the flow from Nuoc Em and Nuoc Siam streams..., in the dryest month, the average flow gradually increases from 1.92-3.2m3/s. See Table 3.30.

Downstream section behind the hydropower plant: Annual flow regulation capability: Table 3.31 shows the flow on Dak Rinh River after hydropower plant before and after the project is constructed. We can see that, when the project is completed, in the flood season (September-January), the downstream section behind Dak Drinh hydropower plant decreases 13.22% and increases 1.51 times in dry season (February- September).

Table 3. 31 Flow variation on Dak Drinh river after constructing the hydropower plant

Q(m³/s)

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
Average monthly flow to DakDrinh hydropower reservoir (1977 - 2003)												

42.1	22.3	13.8	9.87	10.6	11.4	7.60	7.68	16.6	99.4	185	119	45.6
Average monthly flow passing through DakDrinh hydropower plant												
42.0	23.9	18.9	17.6	17.8	18.1	16.9	20.9	76.5	20.9	153	115	44.8

Flood regulation capability: According to the regulation calculation results with frequency flood (p = 0.5%), the flood peak flow to Dak Drinh reservoir is 6480 m3/s and after the spillway is 6338 m3/s, decreasing 2.19%. Time to slow the flood peak is 1h20min. See Appendix 3.10 of the Appendix.

d. The variation of mud and sand flow and sedimentation of the reservoir bed

The construction of dams and prevention of rivers to form reservoirs has profoundly changed the hydrological - hydraulic regime of the flow. When water accumulates, the presence of a static water area facilitates the sedimentation of mud and sand from upstream to the reservoir bed. According to monitoring data of reservoirs built on rivers such as Hoa Binh, Tri An reservoirs,... the amount of sand and mud in the downstream of the Work often decreases (90 - 95)% of the amount of sand and mud before constructing Works . The amount of sand and mud brought back from the upstream will remain in the reservoir bed and reduce the operation capacity of the reservoir, reducing the efficiency of the Work.

The amount of sand and mud coming to Dak Drinh reservoir is quite small, the reservoir has a small dead capacity (44.04 million m3) and has overflow in the flood season. Therefore, the amount of sand and mud coming to the reservoir is not fully deposited in the reservoir bed. The total amount of sediment deposited in Dak Drinh reservoir is calculated as shown in Table 3.32.

Table 3. 32 Total sediment deposited in Dak Drinh reservoir (Dam Route 2)

Characteristics				Value	Unit
Medium-to-flow discharge				30.8	m^3/s
Total amount of medium-to flow				971.4	10^6m^3/year
Total average amount of mud and sand entering the reservoir				0.161	10^6m^3/year
Normal water level				410.0	m
Dead water level				375.0	m
Capacity corresponding to normal water level				249.3	10^6m^3
Ratio of Reservoir capacity/Total incoming flow.				0.26	
Ratio of mud and sand deposited				**93**	%
Operation time of the reservoir (years)	Mud and sand entering the reservoir (10^6m^3)	Mud and sand deposited (10^6m^3)	Elevation of reservoir bottom at dam route (m)		
1	0.161	0.150	323.48		
5	0.805	0.749	332.70		
10	1.610	1.497	339.04		
20	3.220	2.995	344.69		
100	16.100	14.973	360.80		

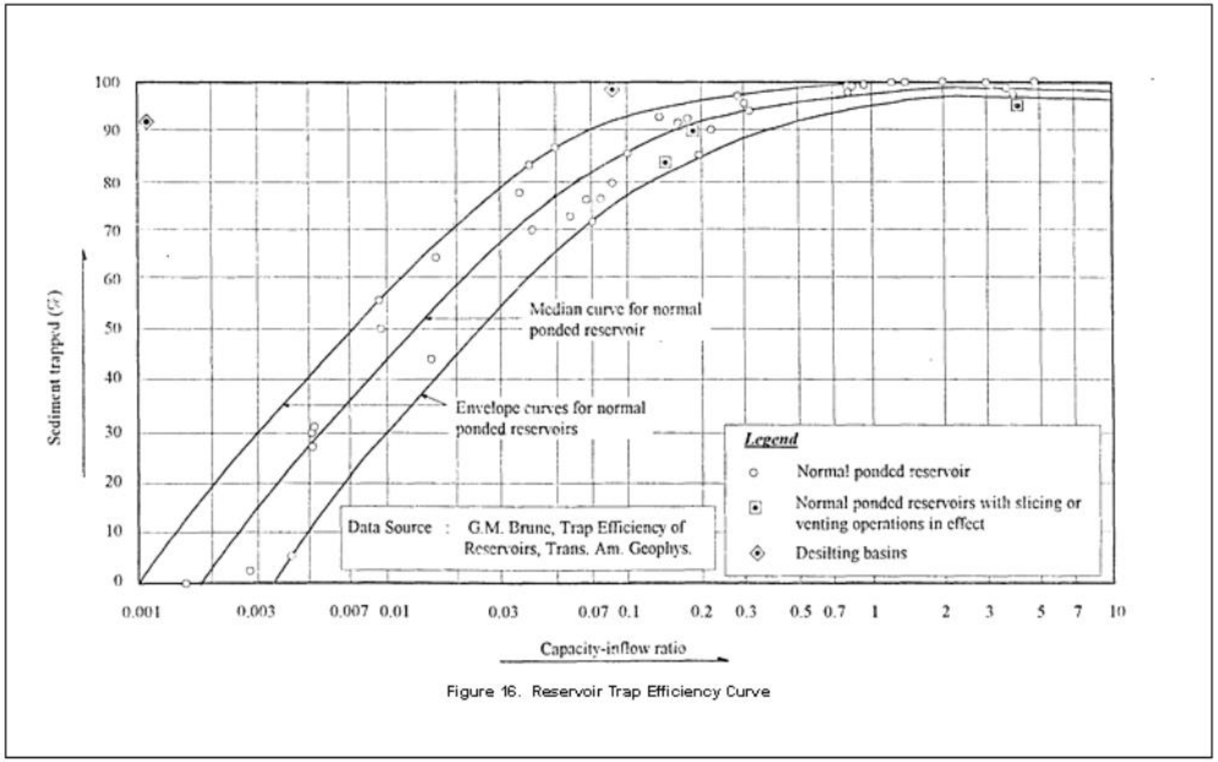


Figure 3.15: Relational curve of coefficients of sediment retained in reservoirs of Brune

Deposited sediment: The amount of sediment deposited in Dak Drinh reservoir is evaluated on the following basis:

- The total amount of sediment poured into Dak Drinh reservoir is calculated as in Section 2.5.5, the total volume of suspended mud and sand is 0.161 million m3/year.
- The relational curve between the coefficient of sediment retained in the reservoir and the ratio between the reservoir capacity and the total average flow into the reservoir of Brune. According to this relationship, the coefficient of sediment retained in Dak Drinh reservoir is 0.90.

According to the above calculated data, the total average amount of sediment to the reservoir is 0.16 million m3/year, and deposits 0.145 million m3/year. After 100 years, the total amount of sediment deposited in Dak Drinh reservoir is 14.49 million m3.

Thus, after the Dak Drinh dam, the annual amount of sediment will be reduced to only 10%. To the confluence of Dak Ba stream, due to the addition of an annual amount of mud and sand, 30% was added as before the construction works. After Dak Drinh hydropower plant, the annual flow of mud and sand will reach 39.2% as before the construction works.

2. Impact sources of the aquatic system.

In the early years of flooding, the aquatic flora of Dak Drinh reservoir basically indicates groups of organisms for the Vietnamese reservoir such as Microcystis, Melosira, and the riverhead is Dinobryon spp. (floating plants), Bosmina, Diaphanasoma (dendritic crustaceans), Mongolodiaptomus birulai, Vietodiaptomus hatinhensis, Allodiaptomus spp., Dentodiaptomus javanicus, Mesocyclops leukartii, Thermocyclops spp. (Copepoda) which will appear in dominant densities in reservoir plankton.

The density and biomass of plankton groups will be very large in the first time (zooplankton density reaches tens of thousands of animals/m3, phytoplankton density reaches several hundred thousand to millions of cells/l), even causing blooming of floating plants. In composition, Dinobryon yellow algae grow. Also in the early flooding period, the Atyidae Palaemonidae will grow in large numbers in coastal areas. Molluscs species decreased significantly in species as well as number due to the unstable foundation of the reservoir bottom.

The number of fish species decreased, of which, the species of fish eating plants and organic humus and adapting to standing water life develop, the species of fish adapting to flowing water rivers decreased both in species and in number. Reservoir fishery was formed, in the beginning, natural fish catch was high with many individuals with larger sizes than today, such as carp, hypophthalmichthys, and labeo rohita. Wild fish catch can range from 60-100 kg/ha/year. Reservoir fish farming has opportunities to develop, fish productivity can reach over 100 kg/ha/year.

The distribution characteristics of the composition as well as the number of plankton in the reservoir in general, Dakdrinh reservoir in particular are related to the distribution characteristics of nutritional salts and some other environmental factors. In general, the qualitative and quantitative distribution of plankton tends to change very markedly according to the hydrological season. With the reservoir type, the density of plankton is generally higher than that of the existing stream and river water bodies. A gradient of plankton density will be formed along the reservoir. During the dry season, the density of plankton is lowest in the upstream area, highest in the middle stream near the upstream, and lower in the downstream area. During the flood season, the density of plankton is lowest in the upstream area, gradually higher in the downstream area, and highest in the area near the dam. Besides the different distribution in width, plankton has vertical distribution in number: the highest in the surface layer, and lower in the deeper water layers.

The formation of a reservoir ecosystem usually goes through three phases:

** Stage 1: The destruction of old ecosystems*

The old ecosystem consists of life forms on dry land along the reservoir, including plants and animals on earth; aquatic species, specific to fast-flowing water bodies - upstream rivers and streams - and aquatic species living in small shallow water bodies such as old ponds, fields in the reservoir bed.

During this stage, the nutrient salt content in the reservoir water increases due to the solubility from the bottom and the decomposition of the plant and animal carcasses in the reservoir and from rivers and streams flowing into the reservoir. The $Mn2+$ content increased and toxic gas appeared in the bottom layer ($H2S$, $CH4$). Thus, most of the benthic animals, the plankton, which are mostly insect larvae and adult insects, and snails living in the strong-flowing water will be destroyed. Shrimp species will change to a reservoir-side lifestyle, where there is a lot of vegetation. In the reservoir, began to form a system of macrobrachium nipponense crayfish, which is abundant in quantity that can be exploited as commercial products. Shrimp thrive thanks to a very large source of food which is organic humus (detritus) decomposed from plant remains.

According to the assessment, this stage in DakDrink reservoir lasted not long - about one year - because the plants covering the wetlands were mainly herbaceous plants, food crops (rice, cassava... will decompose quickly). In other words, the factors that have a negative effect on the water quality of DakDrinh reservoir (eutrophication due to the accumulation and decomposition from the remains of plants and animals in the reservoir, increased $Mn2+$, the presence of toxic gases $H2S$, $CH4$ ...) in case of occurring only exists for a short time because the amount of flora in the flooded area is small compared to the reservoirs that have been and will be built such as Ialy, Thac Mo, Dami, Bung 4 river .

** Stage 2: The formation of a new aquatic system.*

From the analysis of aquatic samples in rivers and streams in the project area, Thach Nham reservoir and Phu Ninh reservoir (the same natural geographic area of Kontum - South - Ngai - geographical region of South Central – Southern Vietnam) shows an increase in species composition and phytoplankton numbers due to accumulation of nutritional salts and the inorganic of organic matter, mainly phytoplankton in the wetlands.

Plankton will appear species which prefer to live in slow-flowing or static water environments such as Rotatoria, Cladocera, Copepoda including species of Eodiaptomus draconisignivomi, Allodiaptomus rapportae (Diaptomidae) are popularly distributed in the Kontum - South - Ngai - Geographical Region of South Central, Southern Vietnam, Copepoda. Due to narrow river valleys, deep reservoir, water flowing into the reservoir from streams originates from short high mountains, steep slopes, poor nutrition, the plankton are poor in species composition and number, predominantly Copepoda because the water layer contains a lot of food which is the plant remains under decomposition in raw form.

At the bottom will appear bipedal insect larvae of the Chaoboridae family living in the water layer close to the bottom and red mosquito larvae (Chironomidae) living on the bottom mud surface. At this stage the benthic animals are poor in species composition and number. However, the DakDrink reservoir bed is long narrow, and the possibility of flow occurs in the hypolimnion. At that time, large numbers of Trichoptera larvae will appear at the bottom of the reservoir. If this happens as expected, it will be an important factor for the fish farming in DakDrink reservoir

** Stage 3: The formation of the aquatic system is relatively stable*

The stability is shown in species composition and number. Due to the characteristics: deep, narrow reservoir, nutritional salts from short streams with steep slopes, poor nutrition, poor aquatic flora - especially zooplankton and benthic animals.

Reservoir ecological succession

From the perspective of waterbody nutrition, the regular supply of nutrients for the reservoir from two main sources are:

- The external source of nutrients, this source generates from the main stream pouring in and from the basin area through erosion.
- Nutrients are created right from internal reservoir due to mineralization decomposition from bottom sediments (granular nutrients become soluble nutritional salts) and from fish cages (if any).

Thus, the amount of external nutrients adding to the reservoir depends on the intensity of erosion, on the other hand depends mainly on the type of soil, the method of land use, the degree of land intensification and the type of vegetation covering in the basin area. Also to mention the possibilities of industrialization development and new population clusters concentrating in the basin area which are also factors that increase the amount of nutrients for the reservoir. These things show that human impacts in the basin area will be a very important factor affecting the quality of ecological environment of the reservoir. According to our comments, the DakDrinh hydropower reservoir will belong to the mesotrophic or oligotrophic type

3. Changes in the geological environment

Sources affecting the changes in geological environment due to the operation of reservoirs and Dak Drinh hydropower plant can create: (a) Water-losspermeability of the reservoir. (b) Erosion to regenerate banks and reservoir beds. (c) Induced earthquakes. (c) Mineral resources submerged in the reservoir bed

**** Water-loss permeability.***

Potential loss of water to another basin: The source of water supply to groundwater is rain, and reservoir water after the water accumulation. The fluctuation of the underground water level depends mainly on the reservoir water level rising and falling. The water loss of the reservoir only occurs on the valley sides, the saddle sides with elevation equal to the normal water level. In the reservoir area, these peaks are almost absent and are usually higher than the normal water level, the topography of the area also has no adjacent deep cut valleys, so the loss of water from the reservoir to the lateral basin can be confirmed as not.

Permeability through dam foundation and shoulder: Assess the water-loss permeability for the selected option (focal option of Line 2), calculate the water loss through dam foundation and shoulder.

Permeability through foundation: Use Kamenxki G. N formula as follows:

$$\mathbf{Qn = D.Ktb.h.M/(M+b)}$$

Of which: Ktb = K1M1+K2M2+....KnMn /(MI+M2+...Mn)

Qn: flow penetrated through the dam foundation (m3/ng)

D: dam length (m)

Ktb: average permeability coefficient of the aquifer (m/day)

h: pressure head (m)

M: thickness of the vadose zone (m)

b: width of dam base (m)

The calculation shows that the amount of water loss through the dam foundation is 337 m3/day. Corresponding to 3.9 liters/s.

Penetration through dam shoulder: **Qv=(h12-h22).q/2h**

Of which: Qv: penetration flow (m3/ng)

q: unit seepage penetration flow, m2/ng

q = Ktb. Ho.i

Ktb: average permeability coefficient of the aquifer (m/day)

h1: upstream water column (m)

h2: downstream water column (m)

h = h1-h2

h0: thickness of the vadose zone at the dam shoulder (m)

i: the bottom slope away calculated from the river bed to 2 dam shoulders

The calculation shows that the amount of water loss across the two dam shoulders is 805 m3/day. Corresponding to 9.3 liters/s. Through calculation, we can see that the total amount of penetration through the dam's foundation and shoulder is 1073m3/day, corresponding to 13.2 liters/s, which is negligible. Thus, the reservoir water-loss penetration can be concluded as insignificant.

Erosion to regenerate reservoir banks and beds.

Assessment on the stability of the reservoir bank:

After the reservoir is put into operation, due to the difference between normal water level of 410m and dead water level of 375m, the natural conditions of the reservoir bank side will be changed. The stability of the reservoir bank depends on many factors as follows: the side slope of the bank, the vegetative cover, the geological structure and the physico-mechanical properties of soil and rock, in addition to the operation of the reservoir.

Due to the regional topography, the upper part where the elevation is> 570-600m usually has quite large slope (> 35^0), often landslides at a strong level. River and stream valley areas creating reservoirs has a slope of 10° -25°, virtually no landslides have been observed.

In practice, the instability of reservoir banks usually occurs only on sides with slope > 250. In the reservoir area of the project, the reservoir-bed area with slope <10^0, very small, is the alluvial ground close to the bank and river bed and is often deeply submerged, so assessing the stability for the reservoir bank is mainly calculated for reservoir banks with slope > 10^0 or more.

Table 3. 33 Calculation results of slope stability on reservoir banks

Section		Coefficient of stability without earthquakes	Section		Coefficient of stability without earthquakes	Section		Coefficient of stability without earthquakes
1-1’	a	1.946	2-2’	a	1.265	3-3’	a	1.039
	b	3.015		b	1.442		b	1.135
4-4’	a	1.083	5-5’	a	1.365	6-6’	a	1.373
	b	1.367		b	1.115		b	1.666
7-7’	a	1.470	8-8’	a	1.537	9-9’	a	2.709
	b	0.964		b	1.058		b	0.669

To assess the stability of the reservoir, prepare 9 typical geological sections, physico-mechanical criteria of soil and rock in the appendix, analyze according to the Zôlôtariev method, the calculation is applied after the reservoir is accumulated with water in normal cases and in cases that the earthquake in the region is at class 6.

The calculation results shown in Table 3.33. shows that under normal conditions the smallest stability coefficient after water accumulation is 0.669 (MC 9-9 ”side b) where the slope is 30^0, where the slope is 25^0 (MC7-7” side b), the stability coefficient is 0.964. In other cases, the stability coefficient is 1.0-1.2, with a slope of 15^0-25^0; stability coefficient > 1.2, side slope <15^0

Summary of calculation results, topographical - geomorphological characteristics, geological conditions, it is able to divide the reservoir bank into 3 zones with different bank stability as follows under normal conditions with the earthquake class of the region < 6:

Zone I: places with the slope of <15^0 are relatively stable, slope stability coefficient> 1.2, unlikely to occur landslides.

Zone II: places with the slope ranging from 15 to 25^0, the stability coefficient is 1.0-1.2, less likely to occur landslides, in case of landslides, they occur at the local level with small landslide blocks.

Zone III: places with rather sloping side > 25^0, stability coefficient <1, likely to occur landslides at large slope > 35^0, with large landslide blocks.

The reservoir corresponding to normal water level of 410m has an area of 9.12km^2. The lake floods mainly stream valleys covered with marsh sediments and gentle sides, slope <10^0. A part of the reservoir wall in the northern part of the reservoir has a large slope, with a large thickness of the cover, so there is a possibility of wall landslides under normal conditions, the southern and southwest parts of the reservoir are likely to occur landslides under special conditions and tectonic earthquakes.

Forecast of the capability to regenerate reservoir walls and reservoir bed:

In order to predict the capability to regenerate reservoir walls, the report calculated according to Zôlôtariev method with adjustment according to the experience of Da Nhim reservoir (the reservoir has been operated for nearly 40 years), together with the preparation of 9 sections on different surfaces in 3 types of terrain < 15^0, 15-25^0 and > 25^0.

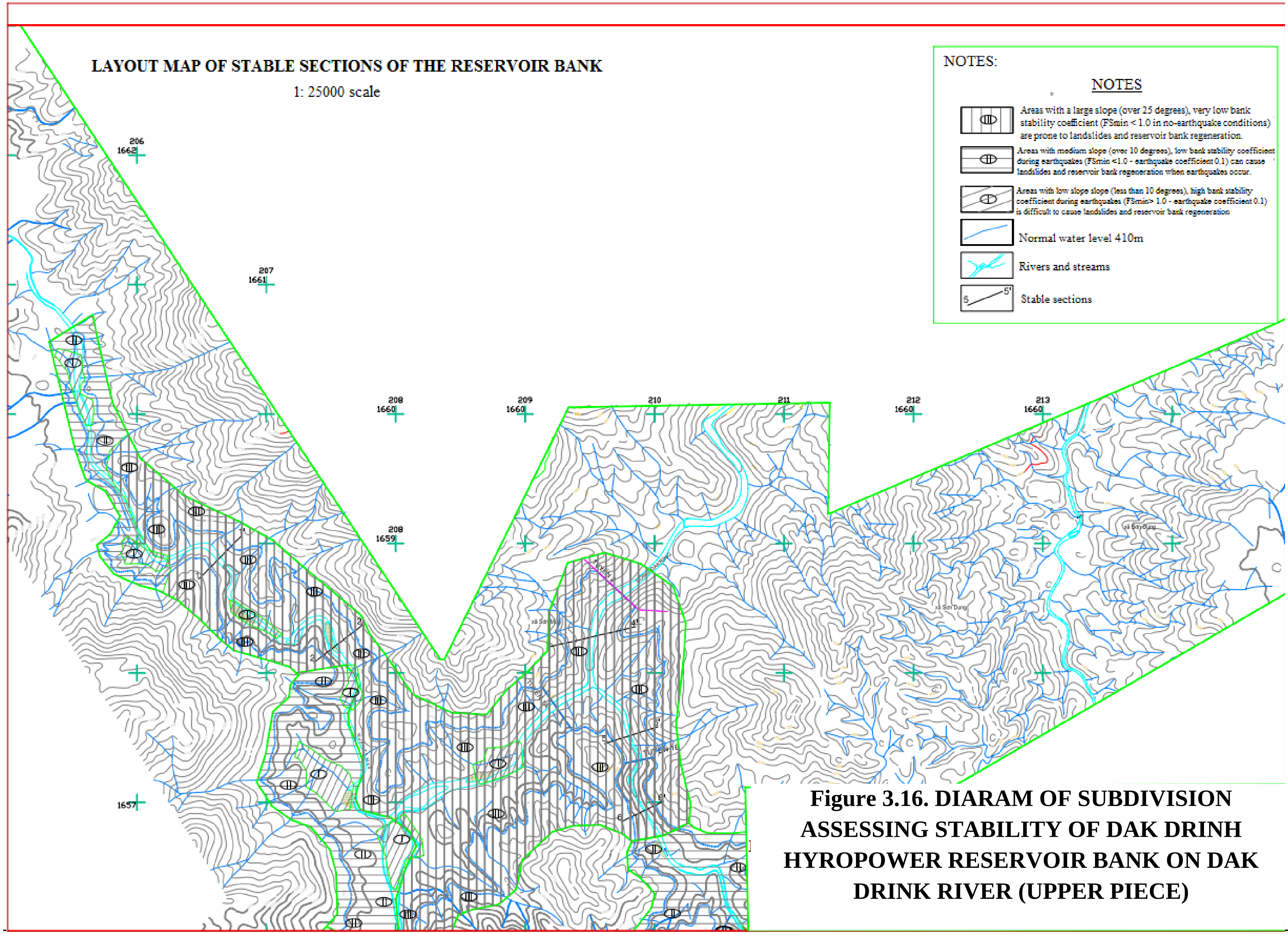


Figure 3.16. DIARAM OF SUBDIVISION ASSESSING STABILITY OF DAK DRINH HYROPOWER RESERVOIR BANK ON DAK DRINK RIVER (UPPER PIECE)

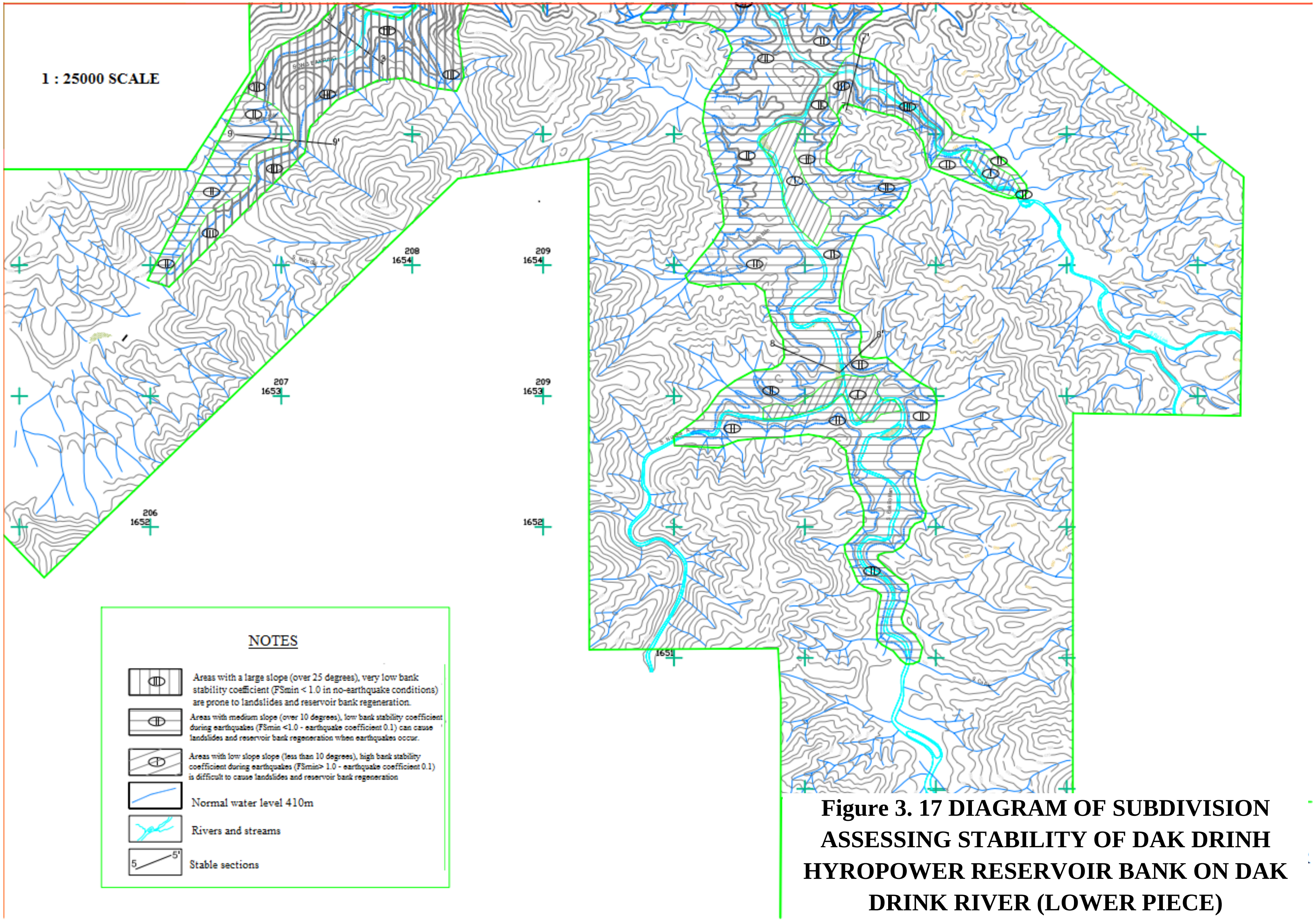
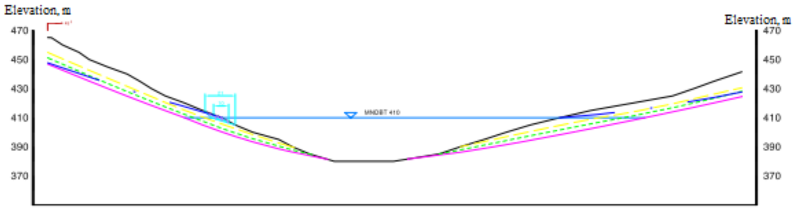


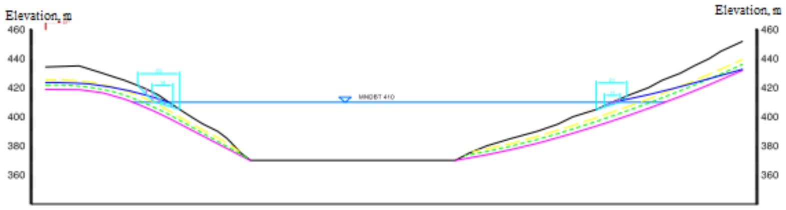
Figure 3. 17 DIAGRAM OF SUBDIVISION ASSESSING STABILITY OF DAK DRINH HYROPOWER RESERVOIR BANK ON DAK DRINK RIVER (LOWER PIECE)

STABLE SECTIONS OF RESERVOIR BANK

SECTION 1-1'



SECTION 2-2'



SECTION 3-3'

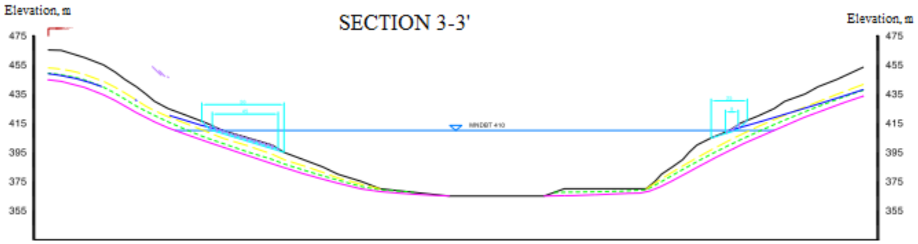
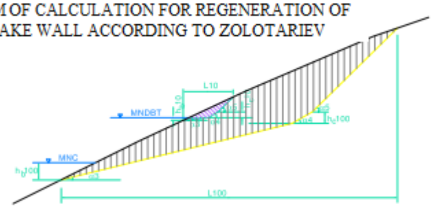


TABLE OF CALCULATION FOR REGENERATION OF RESERVOIR WALL ACCORDING TO ZOLOTARIEV

SECTION		STABILITY COEFFICIENT WITHOUT EARTHQUAKE	STABILITY COEFFICIENT WITH EARTHQUAKE
1-1'	a	1.478	1.137
	b	1.858	1.291
2-2'	a	1.056	0.855
	b	1.261	0.973
3-3'	a	1.254	1.031
	b	0.852	0.676
4-4'	a	0.451	0.308
	b	0.730	0.542
5-5'	a	0.516	0.383
	b	0.405	0.282
6-6'	a	1.033	0.780
	b	0.874	0.704
7-7'	a	1.202	0.917
	b	0.837	0.670
8-8'	a	2.229	1.375
	b	0.735	0.611
9-9'	a	0.985	0.741
	b	0.656	0.506

DIAGRAM OF CALCULATION FOR REGENERATION OF LAKE WALL ACCORDING TO ZOLOTARIEV



L10: Width of eroded zone after 10 years
L100: Width of eroded zone after 100 years
h: Wave height - 1.5m

$h_c100 = 0.3h$
$h_c10 = 1/2h_c100$
$h_b10 = h$
$h_b100 = 2h$

$\alpha3 = 17^0$ (Erosion slope angle of the underground shoreline)
$\alpha4 = 19^0$ (Slope angle of the shoreline in the shear wave zone
$\alpha5 = 45^0$ (Slope angle of the slope surface of the shoreline)

PHYSICO-MECHANICAL CRITERIA OF COVER LAYER SOIL
TEST SAMPLE FOR C.U CRITERIA

Soil	γ kg/cm^3	φ độ	C kg/cm^2
edQ-eQ	1.72	22	0.4

SOIL ZONING

- edQ+eQ — Soil of eluvion and ruin
- IA' — Strongly weathered zone
- IA — Moderately weathered zone
- IB — Slightly weathered zone

NOTES

- Regeneration after 10 years
- Regeneration after 100 years

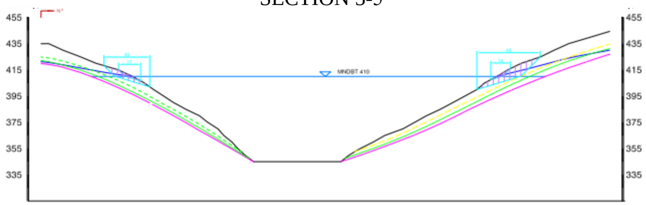
APPENDIX 3.18

STABLE SECTIONS OF RESERVOIR BANK

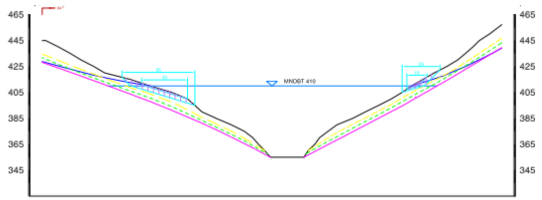
DAK DRINH HYDROPOWER PROJECT

RESERVOIR BANK STABILITY SECTIONS

Altitude, m | SECTION 5-5’ | Altitude, m



Altitude, m | SECTION 6-6’ | Altitude, m



Altitude, m | SECTION 4-4’ | Altitude, m

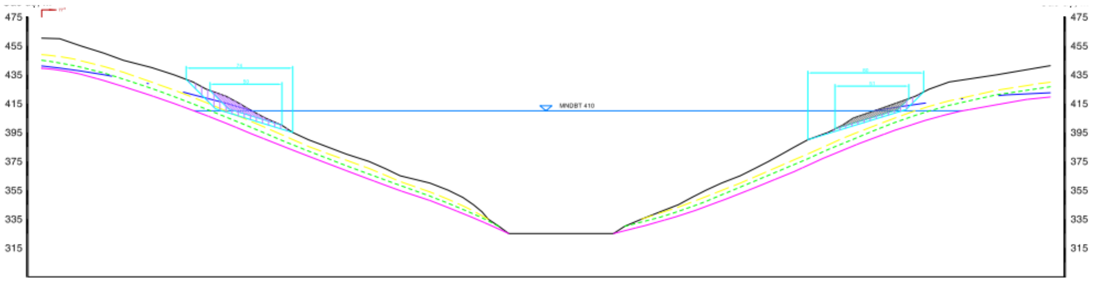
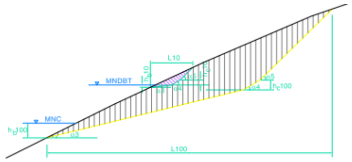


DIAGRAM FOR CALCULATING REGENERATION OF RESERVOIR WALL ACCORDING TO ZOLOTARIEV



L10: Width of landslide zone after 10 years	$h_c100=0,3h$	$\alpha3=17^o$ (Eroded slope angle of the underground bank)
L100: Width of landslide zone after 100 years	$h_c10 = 1/2h_c100$	$\alpha4=19^o$ (The slope angle of the shoreline in the shear zone)
h=Wave height=1,5 m	$h_b10 = h$ $h_b100 = 2\ h$	$\alpha5 = 45^o$ (Slope angle of the slope surface of the shoreline)

Calculation of regeneration of the reservoir bank in the presence of earthquakes

Area	Earthquake coefficient	Slope	SECTION		Regeneration after 10 years		Regeneration after 100 years	
					Width	Area m2	Width	Area m2
II	0.1	> 10^0	1-1’	a	10	4	21	16
			2-2’	a	14	19	29	71
				b	11	3	21	12
			3-3’	a	45	6	56	26
				b	9	4	26	23
			4-4’	a	50	126	74	285
				b	51	64	80	123
			5-5’	a	17	14	35	66
				b	15	13	48	167
			6-6’	a	35	5	56	53
				b	16	17	29	62
			7-7’	a	23	14	32	28
				b	16	22	30	72
			8-8’	a	25	23	45	51
				b	17	21	31	68
			9-9’	b	26	73	59	230
		Average			23	26	41	85

Calculation of regeneration of the reservoir bank in the absence of earthquakes

Area	Earthquake coefficient	Slope	SECTION		Regeneration after 10 years		Regeneration after 100 years	
					Width	Area m2	Width	Area m2
III	NO EARTHQUAKE	> 25^0	1-1’	a	10	4	21	16
			2-2’	a	14	19	29	71
				b	11	3	21	12
			3-3’	a	45	6	58	26
				b	9	4	25	23
			4-4’	a	50	125	74	285
				b	51	64	80	123
			5-5’	a	17	14	35	66
				b	15	13	48	167
			6-6’	a	35	5	56	53
				b	16	17	29	62
			7-7’	a	23	14	32	28
				b	16	22	30	72
			9-9’	b	26	73	59	230
		Average			24	27	42	88

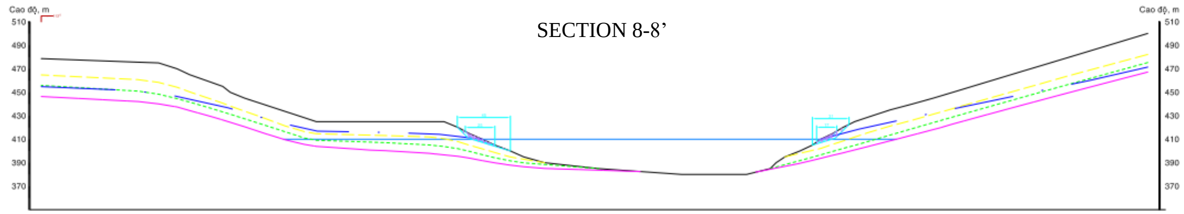
Calculation for regeneraton of the entire reservoir

Calculation conditions	Length, km	Regeneration after 10 years		Regeneration after 100 years	
		Average sectional area, m2	Shear zone mass, m3	Average sectional area, m2	Shear zone mass, m3
Earthquake	46,2	26	1 201 200	85	3 927 000
No earthquake	26,2	27	707 400	89	2 331 800

APPENDIX 3.19

RESERVOIR BANK STABILITY SECTIONS

RESERVOIR BANK STABILITY SECTIONS



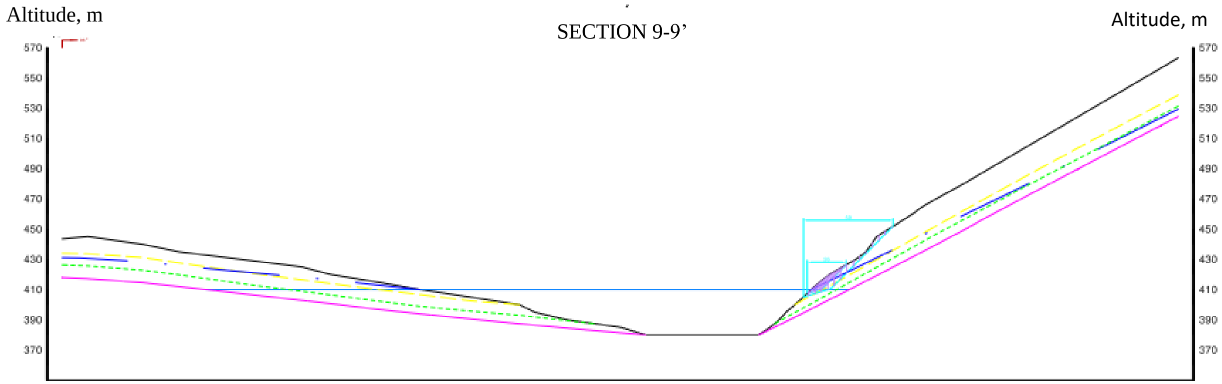
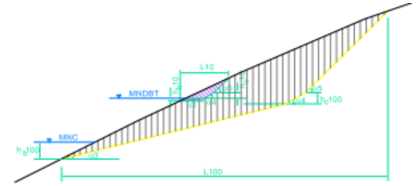
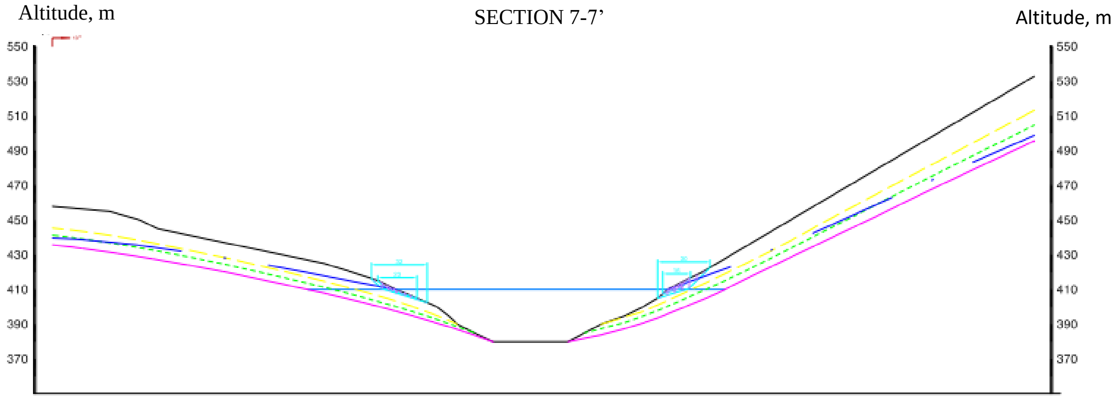


DIAGRAM FOR CALCULATING REGENERATION OF RESERVOIR WALL ACCORDING TO ZOLOTARIEV



L10: Width of landslide zone after 10 years	$h_c100=0,3h$	$\alpha3=17^o$ (Eroded slope angle of the underground bank)
L100: Width of landslide zone after 100 years	$h_c10 = 1/2h_c100$	$\alpha4=19^o$ (The slope angle of the shoreline in the shear zone)
h=Wave height=1,5 m	$h_b10 = h$ $h_b100 = 2\ h$	$\alpha5 = 45^o$ (Slope angle of the slope surface of the shoreline)



Rock and soil zoning

edQ+eQ	Land slopes of ruins and ruins
IA1	Strongly weathered zone
IA2	Moderately weathered zone
IB	Slightly weathered zone

NOTES

Regeneration after 10 years

Regeneration after 100 years

APPENDIX 3.20

RESERVOIR BANK STABILITY SECTIONS
DAK DRINH HYDROPOWER PROJECT

Calculation results show that after 100 years, the average thickness of landslide is 1.9 - 2.3 m (eluvi-deluvi layer has an average thickness of 10-15m), the average width of the landslide zone is about 42m, then the total amount of landslide is about 2.33 million m^3, equivalent to 5.3% of dead capacity of the lake. This shows that the volume of landslide regeneration of reservoir walls is not large, does not affect much of the reservoir capacity. Calculation results have been shown in Figure 3.16 ÷ 3.20 in previous pages.

Dak Drinh reservoir is near the dam site, most of the reservoir wall is slope at 20-30°, semi-inundation phenomenon does not occur or occurs insignificantly. The parts which are far from the dam site in the Northwest and Southwest has some reservoir walls with slope < 15-20^0, semi-inundation will occur in a small area, mostly located in the stream valley of the upstream adjacent to the reservoir. Most of these areas without a reservoir were still mostly dense forests. In short, Dak Drinh lake is small, located entirely in the valley of 3 rivers and streams. Due to the topographical structure of the reservoir bed, the forest or agricultural land are along the reservoir, the semi-inundation phenomenon occurs in a small area and does not affect any fields in the region.

**** Induced earthquakes***

As mentioned in *Section 2.2.1, point g) Regional Seismic and Earthquakes in Chapter 2,* DakDinh hydropower project is far from level II fault, the background earthquake level is 6 (MSK-64 system).

The possibility of induced earthquakes: According to UNESCO statistics, the induced earthquake with the ability to increase the intensity of general background earthquakes of the region, can cause serious disasters. These are the dam failures to a number of storage dams around the world of which the structural design does not take into account the earthquake-induced magnitude increase. According to recorded data, there are about 40 artificial water reservoirs in the world occurring induced earthquakes. According to this organization, the conditions for the reservoir to cause induced earthquakes are that the capacity of the reservoir must be over 10^9 m3, the lake depth is greater than 90 m, the soil and rock of the reservoir and neighboring areas are divided by tectonic faults

According to this condition applied to the project, it can be seen that: the condition of the maximum water column height is approximately 60 m, geological cleavage condition which is far from level II tectonic faults together with reservoir capacity is only equal to 24.93% ($249.3x10^6m^3$) of the possible level of induced earthquakes. Therefore, the reservoir area will be almost unlikely to appear induced earthquakes.

****. Mineral resources submerged in the reservoir-bed:***

As described in Section 2.2.2., Chapter 2, according to the documents of the Southern Geological Mapping Division as well as the results of geological mapping measurements at 1/10,000 scale made by the Geological Survey Engineering Department of PECC2, the reservoir contain no minerals reaching industrial reserves. Exploration survey results only recorded construction material mines in the reservoir-bed and hot mineral water points.

The exposed hot mineral water point spreads 50m along fault III-1. Through analysis of water in the form of silica mineral, at 60-70^0 temperature, the total flow is about 3 l/s, which can only be used in the dry season, in the rainy season, the water temperature in the above stream can almost no longer maintain high temperature. The exploitation of this hot mineral water point is not economical.

e) Impact sources due to operation of transmission lines

The impact source due to the operation of 110kV power line in Dak Drinh hydropower plant - Doc Soi is mainly from the electromagnetic field on the line: (1) The influence of electromagnetic fields in the corridor and the vicinity of 110kV power line. (2) Limited use of land under lines and in safety corridors. (3) The influence to communication lines and radio equipment.

1. The influence of electromagnetic fields in the corridor and the vicinity of 110kV power line

During the operation period, the electricity is loaded on 110kV power line will cause electromagnetic fields that can affect the health of line operators and residents in the line corridor. Calculation results of the electromagnetic field intensity at 110kV power line (according to the Japanese CRIMAG model - see Figure 3.1) with the selected solution, the maximum electromagnetic field intensity at 1m from the ground right below the point of suspending the external two-phase wire is < 3.5kV/m. Thus, in the corridor, the electromagnetic field intensity does not exceed the permitted standards of Vietnam (< 4.5kV/m). From a distance of 5m at 1m from the ground right below the point of the wire suspension, the electromagnetic field intensity is 2.0kV/m and to a distance of 10m back out, it almost no longer affects.

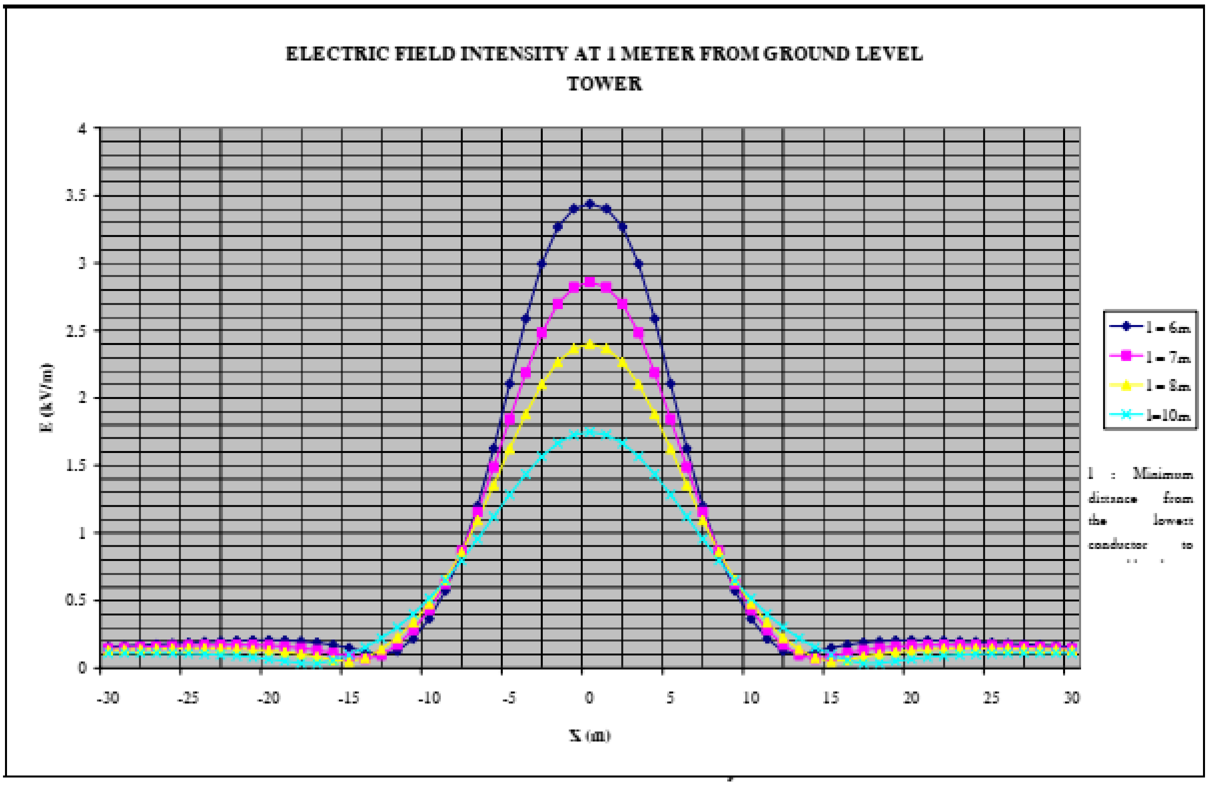


Figure 3.21: The electric field intensity at 1m from the ground of 110kV power line

2. Limited use of land under lines and in safety corridors.

As shown in Section 1.4.5, Chapter 1: The line corridor is defined as 13-15m according to Decree 106/2005/ND-CP, which will limit the use of land:

For trees and crops: only rice and crops can be cultivated. Other crops should only be planted with varieties that ensure the distance from the highest point of the tree vertically to the height of the lowest conducting-wire when in the static state not less than 3.0m.

For houses and works: Houses and works existing in the safety corridor of 110 kV high-voltage grid will be restricted from expanding, heightening when renovated and materials used when renovating also ensure the prescribed conditions.

3. The influence to communication lines and radio equipment

The phenomenon of corona discharge on the surface of conductors, electrical tools of the high voltage system is the cause of interference to communication lines and radio equipment such as radio, television, measurement circuits, the control signal in its area of influence. When a single-phase short circuit has occurred on the line, the induced voltage on the communication line can reach a rather high value, endangering the operator and equipment. In addition, when there is a earth fault short-circuit, it is necessary to pay attention to the potential affecting the sheath of communication cables, control cables, and low voltage cables because the insulation level of these cables is very low (1000 - 2000V). If the voltage applied to the cable sheath is too large, it will destroy the insulation, causing problems in communication, signal or low voltage networks. The influence of the corona phenomenon on the line to radio and television equipment is designed to be reasonable limit, according to IEC and TCVN standards.

3.1.3 Forecast for the risks of environmental incidents caused by the project.

The risks of environmental incidents caused by Dak Drinh Hydropower project are shown in Table 3.34.

Table 3.34: Risks of environmental incidents caused by the project

No.	Items	Pollutants	Potential impacts	Level
I	**CONSTRUCTION STAGE**			
1	***Auxiliary items for construction***			
1.1	- Fuel warehouse. - Explosives warehouse.	- Gather many flammable materials - Explosion incidents of explosives warehouse	- Possibility of fire and explosion - Adversely affect the environment - May harm lives, property, public health.	- Medium term - Can be minimized
2	***Construction of works***			
2.1	Construction of retaining dikes for diversion	Break to retaining dikes	- Adversely affect the environment - Water pollution in Dak Rinh river - May cause harm to lives and property.	- Short term - Can be minimized
2.2	Tunnel construction	- Tunnel landslide	- Land subsidence, adversely affect the environment - May cause harm to lives and property.	- Short term - Can be minimized
II	**STAGE OF WATER ACCUMLATION AND OPERATION**			
1	Water accumulation into the reservoir	- Dam break	- Cause flood to downstream areas - Adversely affect the environment - May cause harm to lives	- Short term - Can be minimized

			and property.	
2	Operation of power transmission lines	- Collapsed poles, broken wires, electric shock caused by natural disasters	- Traffic obstruction - May cause harm to lives and property.	- Short term - Can be minimized
		- Incidents caused by violation of the grid safety corridor	- Traffic obstruction - May cause harm to lives and property.	- Short term - Can be minimized

a) Regarding the risk of fire and explosion.

During the construction stage: In order to meet the demand for raw materials during the construction process, 3 petroleum warehouses will be built in 3 areas: Warehouse 1 for the focal area, water intake with a capacity of 60 tons, warehouse 2 for auxiliary tunnels 2, 3 with a capacity of 30 tons, warehouse 3 for the hydropower plant, pressure pipeline with a capacity of 60 tons. There is also an explosives warehouse with a capacity of 15 tons serving the needs of the entire construction site. (See Appendix 1.3 Construction Master Plan - Recommended Option in Appendix)

Potential environmental problems in fuel and explosives warehouses. The possibility of leakage and explosion in the event of an incident should be taken into account. The main cause to the problem of explosives warehouses, gasoline containers is mainly subjective reasons in production, lack of inspection, or other causes such as corrosion of the container walls or defects in manufacturing, in addition to the improper operation of workers. Therefore, it is necessary to pay attention to safety measures for warehouses.

During operation: may occur incidents of turbine oil and transformer oil containers, as well as explosion of the transformer. In addition to the operator's subjectivity, the above incidents can also be caused by the equipment, the system. However, the system is designed to meet the standards of fire prevention. But it is also important to pay attention to build effective prevention and response measures.

b) Environmental incidents during construction:

During the construction process, there may be environmental incidents such as: (1) Break to retaining dikes. (2) Tunnel collapse. These are situations that should be considered in order to take incident prevention and response measures. (See section 4.3 Measures to prevent and respond to environmental incidents in Chapter 4)

1. Break to retaining dikes:

The break to retaining dikes can occur when the flood, during the construction period, exceeds the designed flood frequency (according to the norm of temporary works, for Dak Drinh hydropower project, the flow frequency to calculate the construction diversion p = 10%), or it can be due to the quality of construction of retaining dikes.

2. Tunnel collapse:

Dak Drinh hydropower project has the energy line with the pressure tunnel of 9660 m long. During the construction process, incidents may occur due to: collapse of rocks, foundation swelling, collapse and creation of rock arches, movement of soil and rock. In which, the rock collapse is the most dangerous, especially when the construction is at great depths. This phenomenon is the sudden collapse of an amount of rock and soil into the tunnel and is accompanied by a loud bang that vibrates the area.

c) Environmental incidents during operation

During the operation, there may be environmental incidents such as: (1) Incident of flood discharge through the spillway. (2) Dam break. (3) Incidents on the power transmission line

1. The incident of flood discharge through the spillway:

Such incident can occur when a valve gate is broken. Dak Drinh hydropower project is designed with a spillway consisting of 4 compartments with the size of 14 x 15m, flow design Q = 6480m3/s. The dam is equipped with delivery valve gate, globe valve gate and repair stop-log valve. The delivery valve gates are controlled by hydraulic lifters and the repair stop-log is lifted by a gantry crane.

The incident to one valve gate or repair stop-log has a very small probability, so here we do not calculate the probability of incident overlap when 2 valve gates are jammed simultaneously. In Table 3.29 the calculation results of flood regulation in Dak Drinh reservoir show that if only 3 or 2 valve gates and stop-log can be opened in response to the designed flood frequency p = 0.5%, at the dam location, the highest water level can reach 412.3m, which is 2.2m higher than the non-incident level. and maintain water levels above this level up to 12h. It can be seen that the probability of this incident is very small.

2. Dam break:

In case when a dam break occurs, after a short time, the flood peak flow after the dam quickly increases, the flood wave quickly travels downstream. However, the flood peak will decrease due to the accumulation of water by rivers. In order to calculate the flood caused by the dam break, in addition to simulating the breach development situations, sufficient documents to simulate the downstream flow conditions are also required. In the scope of this report, only attention is paid to the possibility of occurrence and qualitative description to provide measures to prevent and respond to the incident.

For Dak Drinh reservoir, Vtb 249.3 million m3 is equal to 45.32% of total incoming water of flood with frequency of 0.5% and approximate total amount of incoming water of flood with frequency of 5%. The section of the river behind the dam to the hydropower plant is 9km long and 39km to the outlet of Dak Seok. In this section, the river valley is narrow, the residential areas are mostly located in high places, so the possibility of flooding in the downstream residential areas is not great. It can be predicted that the flood peak at the Dak Selo entrance will quickly decline like a normal flood. However, when an incident occurs, the downstream will create unforeseen surprise to residents operating on the river such as fishing, sand exploitation ....

3. Incident on power transmission line:

There are 2 types of incidents occurring on power transmission lines: (a) Incidents caused by violation of regulations on safety corridor. (b) Incidents caused by natural disasters.

(a) Incidents caused by violation of regulations on safety corridor:

Such incidents can be caused by climbing, construction or other activities under the line such as vehicles with a height exceeding the regulation. It can cause problems: electric shock, fire, explosion, wire break, pole break. The impact scale of this incident is limited to the spot, to the person who directly caused the incident. When the incident occurs, the protective relays located on the line will automatically disconnect the circuit. If the fire or explosion is not extinguished in time, it can lead to the danger of spreading the fire, especially at places where the line pass through residential areas.

This type of incident can also be caused by deterioration of conductors or lightning arrester after a period of operation or due to excessive external load on the wire.

(b) Incidents caused by natural disasters:

The causes of such incidents are lightning, storms and stormwind, landslides at pole foundation on soft soil or near the river. It can also cause problems such as fires, explosions, wire breaks, and pole breaks. In fact, the design and calculation are made according to construction safety standards, based on natural data series of more than 20 years of the region. When the incident occurs, the protective relays located on the line will automatically disconnect the circuit. The incident will cause an interruption of power supply, obstruct traffic at locations near the location of the incident.

3.2 AFFECTED SUBJECTS, SCALES:

3.2.1 Subjects affected by the impact source related to the waste.

As mentioned in Section 3.1.1, during the construction period, impacts on air environment, solid waste, domestic and production wastewater, these sources of pollution impacts are only localized in and around construction and operation sites such as: Material mines; concrete mixing plant; construction sites: focal areas, water intakes, construction niches, plant, poles on power transmission lines; construction camps; construction roads within the construction site and provincial road 623.

In terms of time: these effects occur only during the construction period. The sources of air pollution are of a temporary nature (discontinuous). When there are construction and transportation activities, they will create a source of pollution and the impact duration is not long. According to the monitoring data at the projects currently under construction such as A Vuong, Srepok 3, Dai Ninh, in the current normal construction conditions, right at the construction sites, only when there is construction activities, background environment indicators are violated.

However, it is also required to provide measures to protect the health of construction workers who are directly affected. At the same time, there must be effective measures to avoid pollution in the neighborhood of the construction site.

For reservoir water quality, the object and scale of impacts is not only the people surrounding and around the lake but also the downstream. Dak Drinh River is still used to supply domestic water for the people in downstream and pour into Tra Khuc River, supplying water for Quang Ngai city.

3.2.2 Subjects affected by factors other than waste

a) Subjects affected by land acquisition for project construction

As mentioned in Section 3.1.2, the construction of Dak Rinh hydropower project will expropriate a total of 1072.30 hectares of land of all kinds. The scope of direct influence on residents in the reservoir area, the power route and the Dak Drinh hydropower plant includes 5 communes: Dak Rinh, Dak Nen communes - Kon Plong district; and Son Dung, Son Mua, Son Tan communes - Son Tay district.

The direct scope of influence on 110kV power line of Dak Drinh hydropower plant - Doc Soi is the population in Son Tan commune (Son Tay district), Di Lang town, Son Bao, Son Ha, Son Thanh communes (Son Ha district), Tinh Giang, Tinh Dong, Tinh Hiep, Tinh Tra communes (Son Tinh district), Binh My, Binh Minh, Binh Trung, Binh Nguyen communes (Binh Son district) - Quang Ngai province. The survey data on the population directly affected by the construction of Dak Drinh hydropower project is shown in Table 3.35.

As mentioned above in chapter 2, the affected communes of the reservoir bed and focal works show that: most of the affected households are the Ca Dong and Hre ethnic minorities who have lived in this area for a long time. These are poor households with low incomes and living standards; their farming practices and qualifications are still limited. Cash compensation for houses, residential land and productive land will not guarantee for the above households to build houses, residential land and productive land; as well as maintain the same living standard as before, leading to the destruction of forest for slash-and-burn, over-exploitation of forest resources, leading to other potential environmental and social impacts. Therefore, it is necessary to implement the compulsory resettlement program for the above households. The above households, after receiving compensation, residential land, house, production land in the resettlement areas still face many difficulties, cannot stabilize their daily life and production, so they need to be supported even when the project come into operation.

Table 3. 35 People directly affected by the construction of Dak Drinh hydropower project.

No.	Items	Unit	Kon Tum province	Quang Ngai province	Total
A. Scope of construction of main works, operating roads and reservoir bed					
1	Total number of directly affected households	Household/ person	296/1461	447/1776	743/3237
2	Number of ethnic minority households affected on the spot	Household/ person	285/1403	397/1679	682/3082
3	Number of affected Kinh households	Household/ person	11/58	50/97	61/155
4	Number of households to be resettled	Household/ person	296/1461	378/1571	674/3032
B. Scope of 110kV power line connecting Dak Drinh hydropower plant with national power system					
1	Total number of households with affected house	Household		24	24

b) Subjects affected by construction activities

Scale and subjects affected are mainly construction sites and neighboring residential areas during the construction.

For the construction site of the main dam and the quarry, directly affect 20 households (90 persons) belonging to Group 16 of Son Mua commune. These households are all the Ca Dong. These households will be relocated to the resettlement area before the construction starts at the main dam and quarry area. In addition, the radius affected by quarry blasting is 300m. In order to ensure the safety, the clearance area or limit of farming activities should be taken up to 400m.

For the water intake area, directly affect 59 households (242 persons) in Nuoc Lang village, Son Dung commune. Of which 52 households (212 persons) are the Ca Dong. These households will be relocated to the resettlement area before constructing the water intake.

For the area of the hydropower plant and the pressure pipeline, directly affect 68 households/305 persons in Ra Nhua village, Son Tan commune. Of which, 64 households/289 persons are the Ca Dong and Hre. These households will be compensated and supported in site clearance before construction in the area. In addition, this is the construction site closest to the residential area (the center and Son Tan Commune People's Committee) which will be indirectly affected during the construction and operation of the hydropower plant, so it is necessary to strengthen social and environmental safety measures.

c) Subjects affected by operation activities

Influence due to the creation of a dry river section behind the dam, 2.5 km long from the dam to the confluence of Dak Bua stream: Due to the fact that the above river section has no water demand for agricultural production or daily life, the affected subject is just an aquatic ecosystem. The average annual drought time is 8 months. This impact will be detailed in the following section.

d) Subjects affected by reservoir sedimentation.

The mud and sand decrease due to sedimentation in the reservoir mainly affects households who exploit sand in the downstream of the dam and the plant. This decrease is up to 60%. (See Section 3.1.2)

3.2.3 Subjects, scale affected by risks of environmental incidents caused by the project.

a) Subjects and scale affected by environmental incidents in the construction stage

Environmental incidents in the construction stage can directly affect the construction workforce in the incident areas.

For the fire and explosion incident, because the petroleum warehouses are isolated from residential areas and housing areas of the construction force and placed at the end of the main wind direction, however, there is still a possibility of damage to people or equipment. For explosives warehouses, the destructive power could affect more than 200m from the exploding source, so the warehouse area is surrounded and isolated with a distance greater than the above destructive power.

For the break to retaining dikes, it can directly affect the construction force and the equipment operating on the dike. Further, floods, soil and rocks can affect the the population in downstream. For the retaining dikes used for the construction of the main dam, when occurring the break, it can bring out nearly 40 thousand m3 of soil and rock. However, in this river section, the population lives in high places. Therefore, mainly indirect effects on downstream water quality. Likewise, a retaining dike at the water intake when being broken can lead to nearly 30 thousand m3 of rock and soil from Roman stream to Dak Drinh river. However, it may be more serious that it could affect the force constructing the pressure tunnel.

For a tunnel incident, it may directly affect construction forces and equipment under operation and the tunnel. The repair for the above incident will cause a lot of cost and directly affect the project progress..

b) Subjects and scale affected by the environmental incident during the operation stage

For the incident due to the jam of discharge valves, as mentioned in section 3.1.3, when the incident occurs, if a flood occurs with frequency p = 0.5%, the upstream water level will be 2.2m higher than when there is no incident. Thus, it may affect the productive land of the reservoir-side households in Dak So and Dak Drinh communes, as well as the forest land around the reservoir bed. However, this flood retention time is only about a maximum of 12 hours.

For the incident of dam break, the impact scale is mainly from the dam to the confluence with Dak Selo. Flood time due to the incident can be predicted to not exceed 48 hours. Directly affected subjects are people fishing and exploiting sand. However, during the flood season, these activities hardly take place. The subjects are mainly affected by the deterioration of river water quality in the downstream.

For incidents on 110kV power line, the impact scale of this incident is limited to the spot, for the person who directly causes the incident or gets the incident. The interruption of traffic can last 1 - 2 hours. The ability to interrupt power supply can last 1-2 days or 1 week depending on the nature of the incident.

3.3 ASSESSMENT OF IMPACTS:

3.3.1 Impact assessment in construction stage

a) Assessment of impacts on the physical environment

The project's impacts on the physical environment will be assessed in turn: (1) Impact on the air environment. (2) Impact on the water environment. (3) Impact on the soil environment.

1. Impact on the air environment:

In Section 3.1.1, the sources of polluting the surrounding air environment and the load of main sources, the dispersion capability are presented. Section 3.2.1 also identifies that the scope of this impact mainly is in the construction site. In addition to the construction site and neighboring residential areas, the calculations confirm that the indicators of surrounding air environment quality meet the TCVN 5937: 2005 standard and the noise and vibration indicator do not exceed the permitted level of TCVN 6962: 2001.

However, on the construction sites, during the construction period, these indicators almost exceeds the permitted standards. These pollution sources will greatly affect the health of workers and pose a risk of occupational diseases.

Các biện pháp giảm thiểu tác động này sẽ được đề cập trong Các biện pháp giảm thiểu tác động xấu đối với môi trường không khí trong Chương 4).

2. Impact on the water environment:

At the construction stage, the sources of water pollution are: domestic wastewater, industrial wastewater, and construction activities (soil and rock excavation, construction...). The calculations of load for these sources are presented in Section 3.1.1 Sources causing water pollution in the construction stage. The source receiving wastewater is Dak Drinh River. Therefore, if wastewater is not thoroughly treated, it will directly affect water quality in Dak Drinh river.

3. Impact on the soil environment:

Impacts of Dak Drinh hydropower project on the land environment include: (a) Change of current land use status. (b) landslide during the construction.

a / Change of current land use status:

The reservoir of Dak Drinh hydropower project will have 912.4 ha, the requisition area outside the reservoir bed will be 186.4 ha. Thus, during the period of site clearance for construction and cleaning up of the reservoir bed, the agricultural land, protective natural forest, mountainous land and other unused land will change the current use purpose. use. The data on current land use status in the reservoir bed and the land requisition for construction outside the reservoir is shown in Table 3.23

110kV power line will have 1,581ha of land requistioned permanently for foundation poles and 28,828ha including artificial forest, mixed forest and unused mountainous land which will change the use purpose.

At the same time, there will be over 746.11 ha of unused mountainous land, 70ha of natural protective forest land will be converted to agricultural land and residential land in the resettlement areas. Current land use of resettlement areas is shown in Table 4.13 above. (See Figure 2.4: Diagram of Current Land Use in the Reservoir bead and Resettlement Areas - Dak Drinh Hydropower Project).

b / Landslide during the construction:

As mentioned in Section 3.1.2, with the geological condition of the project, if there is no reasonable construction method, it will create a source of impacts leading to the landslide. The resulting impacts are unsafe for people and equipment; air environment pollution; The soil and rocks that slip into rivers and streams also pollute the river water.

However, in the design of the construction organization, there are measures of earthwork to minimize the risk of landslide, such as ensure the roof slope, choose excavation equipment, blasting scale, conduct parallel reinforcement when digging tunnels ... If these measures are implemented correctly, the impact of landslide is negligible.

b) Impact on the ecosystem

The impacts during the construction stage on the ecosystem are assessed to include: (1) Impacts on the terrestrial flora. (2) Impact on habitat of the terrestrial fauna

1. Impact on the terrestrial flora:

When the construction starts, it will create positive and negative impacts on the flora and vegetation. The impacts are:

The project will form a reservoir with a normal water level of 410 m, the total flooded area is about 912 ha. The area of land outside the reservoir bed to be requisitioned for storage of materials, equipment, vehicles, machinery, mines for materials exploitation and construction of housing for workers is 159.9 ha. Land area for resettlement areas: 1014.9 ha. Area for the line corridor of 110kV power line: 74 ha.

When the cleanup is carried out to prepare the construction site and accumulate water, the entire flora ecosystem located in the reservoir bed and the construction items will be lost forever. Only the scope of temporary requisition for the construction, the landfills and quarry areas can be restored, this area is approximately 20 ha.

Loss of agricultural ecosystems: The area of main works has about 189.47 ha. Which is mainly swidden land of Dak Drinh, Dak Nen, Son Dung communes. The area of 110kV power line is about 0.6 - 0.7 ha, mainly wet rice and crops.

Loss of forest ecosystems: The area of reservoir bed and main works has: 314,12.5 ha of regenerated poor forest (mainly low shrubs) and 174ha of protective forest. A part of evergreen forest, secondary forest, and fragmented artificial forest is scattered in the reservoir bed area. The vegetation cover of natural forests rich in reserves in the floodplain of the reservoir bed is not large, because most of the evergreen forest here on the slope has been completely exploited for cultivation and afforestation. The resettlement areas have 70 ha of protective forest. 110kV power line area has 12.32ha of artificial forests, mainly pine and eucalyptus and 16.5 ha of mixed forests.

The survey data shows that among the submerged agricultural land, the coffee, areca, and cinnamon areas are of the highest value. Most of the flooded forest land are shrubland, grassland and scattered small timbers; Some rare and precious tree species such as Smilax glabra, Irvingia malayana, Scaphium macropodium have very small and insignificant number of individuals.

Due to the long construction period and convenient traffic conditions, there will inevitably be a large number of timber species outside the above requisition areas being exploited. Abuse of this will reduce the area and quality of the forest in the region.

2. Impacts on habitat of terrestrial fauna

** For bird fauna*

In the construction area, during the construction of the project, noise is the main factor signaling for bird populations to migrate away, so it does not affect individuals of species, but their nests and eggs will be lost along with the destroyed forest area serving the site and construction of roads for equipment transportation.

Species associated with well-forested areas, barely affected by humans, include the Corvus macrorhynchus, Arborophila rufogularisi, Gallus gallus which only live in forests that have not been affected by humans such as logging, exploitation of forest products, or deforestation for cultivation.

Pycnonotus jocosus, Ficedula parva, Streptopelia chinensis, often live near upland fields for eating seeds, Psittacula finschii, Dicrurus aeneus often catch prey in the air, so they need to have an open place with grassland and upland fields.

Gallus gallus, Pycnonotus jocosus, Dicaeum cruentatum, Orthotomus atrogularis often distributes in bamboo forest habitat types.

Species of the Aves class will move away from the construction site. Therefore, the construction activities will have little change in species composition but only cause the species of the Aves class to migrate elsewhere; they will have some initial difficulties when changing habitats such as food sources, nest building...

** For the mammals*

In the construction area, noise will repel the mammals to migrate to other places, the mammals building caves underground and their offspring are most vulnerable. A road which is continuously constructed with tens of kilometers will definitely separate the populations and will greatly affect the hunting habits of many species.

Rattus surifer, Rattus fulvescens, Tamiops rodolphei, Ratufa bicolor, Dremomys ruílgenis, are commonly found in habitats of upland fields, shrub grassland .

Atherurus macrourus, Hystrix brachyura, Manis javanica, and wild boar (Sus scrofa) often distribute in bamboo forest habitats.

Prionailurus bengalensis, Tragulus javanicus, Rattus surifer often distribute in mixed bamboo forest habitats. Large mammals can also be found in such habitats such as Cervus unicolor, Sus scrofa, which often search for food here in the rainy season.

Macaca arctoides, Nycticebus pygmaeus, Tragulus javanicus, Petaurista petaurista, Cervus unicolor often distribute in evergreen broadleaf forest habitats which have been affected more or less.

In the expected reservoir bed area, most of the area is upland fields, grassland, shrubs, and bamboo, so there are not many large mammals. Large mammal species such as chamois, wild boar, wild cat, monkey, weasel, .. have the ability to move quickly and far away so they can migrate to other areas that are less affected. The main impact for this group is that hunting has been decreasing numbers regardless of the presence or absence of the hydropower project.

** For reptiles and amphibians*

Rana sp., Rhacophorus leucomystax, Microhyla beramorei, these are insectivorous species and lay eggs in puddles on wet rice fields.

Bufo melanosticus, Rana nigrovittata, Rana rugulosa, Python molurus distribute in mixed bamboo forest habitats.

Rhacophorus leucomystax, Varanus nebulosus, Ptyas korros, Bungarus fasciatus, Trimeresurus stejnegeri distributing in evergreen forest habitats havebeen affected.

c) Impact on the socio-economic environment

1. Impact due to relocation and clearance of the focal works, hydropower plant, reservoir:

According to the survey conducted by PECC2 in the special subject on the Plan of compensation, support and resettlement, it is found that: The reservoir bed area, and the area with land requisition for construction of main works have the number of directly affected households: 743 households / 3237 persons (See Table 3.35).

The damages of land, crops, houses and public facilities are shown in section 3.1.2 and in Tables 3.23 ÷ 3.25.

Affected households, after receiving compensation and assistance in cash, or receiving productive land, residential land, and newly-built houses in the resettlement areas, still face many difficulties to stabilize their production, life and daily activities. The affected land is mainly alluvial soil along streams and rivers, currently cultivated mainly by wet rice and crops. When moving to the resettlement areas, compensated production land is mainly swidden land, water supply conditions become more difficult, and farming practices change. These impacts should have appropriate policy of attention and support to avoid the accompanying negative social impacts due to income decline. In order to mitigate these impacts, the employer will implement the compensation, support and resettlement program which will be presented in Section 4.2.1 in Chapter 4.

2. Impacts due to relocation and clearance for construction of the power transmission line:

According to Decree 106/2005/ND-CP, the land in the line corridor is limited to use for the following purposes:

+ According to Article 5, in the line corridor, it is still allowed to transplant rice, grow crops and fruit trees with maximum development height away from the line at least 4m. Rice and crops must be planted at least 0.5m from the edge of electric poles.

+ Exist or newly develop new houses and works if detailed provisions in Decree 106 are ensured, of which the vertical distance from the conductor when the wire is in static state to any part of houses and works must be equal to or greater than 6m.

As shown in Section 3.1.2 and Table 3.25, the area of permanent land acquisition for transmission line is not large (1,518 ha) with 231 foundation locations, of which foundation with the largest permanent land acquisition area is 123, 21 m2. Existing houses on the line corridor are not displaced. However, development possibilities are limited. Similarly, the land in the line corridor cannot cultivate fruit trees or industrial trees with height, affecting the economic performance of households with land on the line corridor.

3. Impacts on the regional economy and infrastructure

As a mountainous area, when Dak Drinh hydropower project is built, the first thing that the local government and people benefit is the infrastructure system. In order to carry out the construction of the project, as stated in the Auxiliary facilities section in chapter 1, the employer will upgrade or renew the road system and establish a communication line for transporting and gathering materials, equipment. The upgraded road system not only facilitates easy transportation but more importantly, it is the basis for local people to have access to a new business environment, a new more active lifestyle.

The project construction will create conditions for commercial business and service activities to develop. The service business establishments will be formed to meet the living needs of the construction employees. These are the initial bases for the local urbanization process.

Another great benefit of Dak Drinh Hydropower Project is the employment opportunities for local people. Depending on their ability, local youth will be recruited to work in different parts of the construction site. This workforce through contact and working will learn and acquire new scientific knowledge, get acquainted and operate modern technical facilities.

Thereby, their own knowledge level will be gradually improved and theywill be the factors that have the most positive and effective impact on awareness as well as the cultural and spiritual life of local people.

4. Impacts on the population redistribution and community health in the region

In Son Tay and Kon Plong districts, when there was no hydropower project, natural and mechanical population growth was quite large (2.5% in 2003). When the project is constructed, there will be 2451 workers gathering at construction sites in Son Mua, Son Dung and Son Tan communes. At the same time, it is required to build a traffic network leading to temporary routes and roads for construction. These convenient roads that attract a large number of people in the area or from other places to live and work here. This will have a negative impact on the socio-economic situation in the project area such as: population growth, land clearance, illegal land transfer, deforestation for cultivation, causing difficulties in the control on security and order and arising social evils. Risk of conflict between workers, immigrants and local people.

The relocation of affected households in the reservoir bed under resettlement subjects to the resettlement areas according to the proposed plan also causes changes in population of communes in the region.

When a large number of illegal immigrants and construction workers arrive in the project area, they can bring in strange diseases and spread them to local people and vice versa. In addition, if there are no good treatment methods, construction activities will pollute the air and water sources, creating conditions for pathogens to thrive, especially the common diseases in the area, which are malaria, diarrhea, tuberculosis, typhoid, ...

Another negative impact on the environment and the lives of people in the downstream area of Dak Drinh hydropower plant is that during the construction (main dam, side dams, spillway and plant), a large amount of soil and rock will flow directly into the river, affecting the water quality of the river as well as people in downstream living near the river.

3.3.2 Assessment of impacts in the operation stage

a) Sources affecting the physical environment

1. Impacts on the air environment

Impacts in the project operation stage include: (a) Impacts on the sub-climate regime in the vicinity of the reservoir bed. (b) Effects of noise and vibration in the hydropower plant.

** Impacts on the sub-climate regime in the vicinity of the reservoir bed:*

Regarding the regional climate sub-regime, the Dak Drinh hydroelectric reservoir is small, not large enough to have certain effects on the climate regime in the whole basin. However, in areas near the reservoir, some climatic features will fluctuate. According to research in other reservoirs such as Da Nhim, Vinh Son, Song Hinh ... etc, the temperature regime will change in a positive direction. The maximum values of the temperature will decrease, while the minimum values will increase. In addition, moisture in the reservoir area as well as nearby will be increased due to increased evaporation from the open surface. This will have a positive impact on the growth and development of trees around the reservoir, especially during the dry season. As well as the areas around the reservoir, it is possible to combine the construction of eco-resorts. Especially, Kon Plong district is attracting many investment sources to develop ecotourism projects.

** Effects of noise and vibration in the hydropower plant:*

As described in Section 3.1.1, during the operation, the noise and vibration are generated by turbine and generator operation. However, the above mentioned design standards will ensure requirements on health protection for operating forces.

For the adjacent residential areas, the construction design solutions will ensure the noise and vibration indicators no to exceed the permitted level of TCVN 6962: 2001.

2. Impacts on the water environment:

The impacts on the water environment to be assessed are: (a) Changes in the water quality of reservoir and downstream after constructing the hydropower plant. (b) Change in flow regime upstream. (c) Changes in the flow of mud and sand and reservoir sedimentation

** Changes in the water quality of reservoir and downstream behind the hydropower plant:*

As mentioned above, Section 3.1.1 during the operation stage, the changes in reservoir water quality depend on activities in the basin and the cleanup for the reservoir. Calculation results of reservoir bed are as follows:

- ***Option of not cleaning up the reservoir bed***: dissolved oxygen (DO) content in the reservoir would then be: 5.23 mg/l
- ***Option of carefully cleaning up the reservoir bed:*** DO in reservoir: reaches 6.07 mg/l.
- ***Option of thoroughly cleaning up the reservoir bed:*** DO in the reservoir will be: 6.99 mg/l.

In the long term, water quality in Dak Drinh hydropower reservoir will reach the same balance state as water quality in the background environment.

The change of river water quality in downstream with the trend of nutrient content in downstream water is also reduced.

The change of reservoir water quality will affect the aquatic ecosystem, the people living around the reservoir bed. When the reservoir is accumulated with water, fisheries and aquaculture will be formed.

In addition, the change of reservoir water quality also impacts on the downstream because the water source of Dak Drinh River flowing to Tra Khuc is also used for domestic water supply through treatment. Therefore, it is necessary to ensure that DO> 6.00 mg/l as prescribed in TCVN 5942: 1945, column A which applies to surface water that can be used as domestic water supply through treatment

** Change of upstream and downstream flow regimes.*

When the reservoir accumulates water and comes into operates, the change of hydrological regime on the Dak Drinh river is divided into 3 sections:

In the upstream of the dam, the reservoir hydrological regime is formed through the fluctuation of water level in the reservoir bed from elevation of normal water level = 410m to dead water level = 375m. As a result, the groundwater level in the vicinity of the reservoir is raised.

The river section from the downstream of the dam to the hydropower plant has limited water supply in the dry season. In particular, the 2.5 km section from the downstream of the dam to the Dak Bua stream can be completely dry if it is not discharged behind the dam. However, this river section, currently as well as planned, will have no water demands for agriculture, domestic or industrial purposes (See Official Dispatch No. 96/UBND dated April 19, 2007 of Son Tay District People's Committee on the flow of the river behind the dam of the Dak Drinh Hydropower Project on the Tra Khuc river in written appendices). The main negative impacts on aquatic flora will be discussed in the next section.

The downstream section of hydropower plant, the flow regime of Dak Drinh river is more regulated. In the dry season, the lowest average monthly flow increases from 7.6 m3 to 16.9

m3, more than 2.22 times, contributing to improve the flow and ensure for the lowlands. In the flood season, the largest average monthly flow decreases from 185 m3 to 153 m3, decrease by 17.29%, contributing to control the flood for the lowlands. This is the positive impact of the project.

During the flood period, for floods with a flood peak flow less than the flood peak with the design frequency p = 0.5%, the likelihood of the discharge flow over the spillway is the same as the incoming flood flow and the reservoir water level is approximately the operating water level in normal mode (410,14m). However, with valves and regulation penstocks, in the forecast, the project is able to reduce and delay flood peaks of floods equal or less than designed floods. This is the positive impact of the project.

** Changes of mud and sand flow and reservoir sedimentation*

As well as the change in flow regime, when the reservoir goes into water accumulation and operation, the change of the mud and sand flow regime on Dak Drinh river is divided into 3 sections:

On the upstream (reservoir section): the average total amount of sediment reaching the reservoir is 0.161 million m3/year, and deposited 0.145 million m3/year. After 100 years, the total amount of sediment deposited in Dak Drinh reservoir is 14.49 million m3, only accounting for 32.9% of the dead capacity of the reservoir, not affecting the working capacity of the reservoir.

In the river section behind the Dak Drinh dam to the confluence of Dak Bua stream, the amount of mud and sand will decrease to only 10% as before the construction of the project. As a result, the mud and sand carrying capacity of the flow increases. However, the geological structure of this river section is relatively stable, many sections are exposed with basement rock, so the possibility of erosion is negligible. When flowing to the confluence of Dak Bua stream, the annual amount of mud and sand is added to reach 30% as before the project is constructed.

After the Dak Drinh hydropower plant is constructed, the annual flow of mud and sand will reach 39.2% as before he project is constructed. Currently, in this section, many places are in the process of sedimentation (sand mines), the possibility of deep and horizontal erosion is unlikely to happen. However, the amount of sediment and sand deposited in the downstream decreases, affecting the ability to exploit sand of local people.

3. Impacts on the soil environment and geological process

Impacts on the soil environment and geological process to be assessed include: (a) Loss of soil and mineral resources in submerged areas. (b) Impacts of bank and reservoir bed regeneration. (c) Other impacts on the soil environment when the reservoir is accumulated with water

** Loss of soil and mineral resources in submerged areas*

When the reservoir is accumulated with water, there will be: 912.4 ha of land of all kinds will be submerged in the reservoir bed. The future flooded area is the land of Son Dung, Son Mua, Dak Drinh and Dak Non communes.

Most of the land that will be submerged is Ferralsols developed on argillaceous slate and on magma acid rock, thin layer <30cm, mixed with many gravel or agglomerated> 3%, so the fertility is not high compared to Rhodic Ferralsols and Xanthic ferralsols growing on basalt rocks.

Along the rivers and streams is fertile fluvisols, relatively flat terrain, which has been exploited for a long time to transplant 1-2 crops of rice, or grow vegetables, beans, peanuts, sugarcane... If there is adequate water for irrigation during the dry season, the possibility of crop and yield increases on these soils remains very large. (See Soil Diagrams of Dak Drinh Hydropower Project in Figure 2.2 and 2.3)

The requisition land of households in the reservoir bed is mainly fluvisols, the cultivation income from this soil can be 3 times higher than the ferralic acrisols on argillaceous slate, popular in the planned resettlement areas.

Regarding mineral resources: as mentioned in Section 2.2.2 of Chapter 2, there are no minerals with industrial reserves in the reservoir area other than construction materials. The dam embankment will require the exploitation of a large amount of backfilling soil as described above. According to the option of choosing the main dam structure to be the roller compacted concrete dam, it will allow to reduce the exploitation volume of backfilling soil.

Suoi Luong mineral water point, Dak Drinh commune, Kon Plong district is in the form of silicate mineral, the temperature is 60-70°, the total flow is about 3 l/s. This hot mineral water point can only be used in the dry months, in the rainy season, the water temperature in the above stream almost no longer maintains high temperature. The ability to exploit the hot mineral water point is uneconomical due to the small scale of exploitation, the communication route is very difficult to travel in this area, large investment is required to exploit, while the source has small flow and short annual usage time.

** Impacts of reservoir-bank and bed regeneration:*

As mentioned in Section 3.1.2, a part of the reservoir wall in the northern part of the reservoir has a steep slope of 20-30^0, the cover layer thickness is large, so it is possible to cause landslide of the reservoir wall under normal conditions. The Southern and Southwestern parts of the reservoir are capable of landslides in special conditions and tectonic earthquakes.

Calculation results show that after 100 years, the volume of landslides around the reservoir is about 2.33x10^6 m^3 equivalent to 5.3% Vdead of the reservoir. If including the amount of deposited sediment after 100 years, the reservoir capacity will decrease by 38.2%. This shows that the volume of sedimentation and regeneration due to the reservoir wall erosion is not large, does not affect much the reservoir capacity.

The deposited and eroded mud and sand were initially located close to the end of the reservoir and on the flooded valley slope, then tended to move to the bottom area of the main dam.

After the reservoir was accumulated with water, the soil was sunk for 3 - 6 months, not only plants, remains of organisms living in the ground (worms, crickets ...) become rotten, but also the structure of the reservoir bottom was broken, loss of cohesion, pasty-ing..., gradually forming mud sediment in the reservoir bottom. Only after a short time of water accumulation, the productivity of shrimp and fish in the reservoirs increased rapidly and highly.

The semi-submerged phenomenon will occur in a small area, mostly located in the stream valley in the upstream adjacent to the reservoir. These areas without a reservoir were mostly still dense forests, completely do not affect any areas in the region. When the reservoir is formed, a part of this area will be used for cultivation, a part will form grasslands and shrubs during the dry season, and be decomposed during the flood period.

However, cultivation in the semi-submerged area will have the effect of increasing bottom displacement. On the other hand, farming activities increase the ability of reservoir-bank erosion, affecting speed of sedimentation of the reservoir bed. Also according to the above calculation, after 100 years, the regeneration area of the reservoir-bank is 110ha. Therefore, the use of semi-submerged land should not be encouraged for cultivation.

** Other impacts on the soil environment when the reservoir is accumulated with water*

The impacts on the basin's soil environment are also shown in the following aspects:

Due to the increased water reserve in the basin and is regularly preserved in the reservoir, the humidity of the air and reservoir-side land during the dry season increases significantly. Create a number of shallow ground water tables, these new shallow ground water tables are the source of water to maintain the amount of water for dug wells and drilled wells to handle domestic water, high quality irrigation water in the dry season for the local people.

As the groundwater level is raised, the coefficient of land use around the reservoir will inevitably increase.

b) The impacts on ecological environment

The impacts on the ecological environment to be assessed include: (1) Impacts on the flora. (2) Impacts on wildlife fauna. (3) Impacts on aquatic environment and aquaculture

1. Impact on the flora

** Reservoir area and resettlement areas:*

When the project is put into operation with the operating road system; The communication routs are upgraded and renewed for the newly built resettlement areas, which will create favorable exchange conditions in the area. This may bring about the free migration, especially from the Northern mountainous provinces. The risk leads to the destruction of forests for timber, firewood, and farmland, especially for rare species of trees that are still scarce in the region. Local authorities should closely monitor and take strict and effective measures to prevent this migration.

In the region, evergreen forest is less affected by its distribution mainly on the tops of the mountain range on the Kon Plong side of the DakDrinh river. Therefore, when inundated, it does not cause much inundation to the evergreen forest populations here, but when inundated, the land around the floodplain will be abandoned due to no cultivation, when the soil moisture increases, the surrounding bamboo species will quickly develop thanks to on-spot seed sources.

Previously, the study area was located in a very diverse evergreen forest of Quang Ngai - KonTum, with many rare species of flora and fauna, forests with rich reserves. In the process of population and socio-economic development, this area has been exhaustedly exploited, so whether the Dak Drinh hydropower plant is built or not, with the speed of migration, population development, the need for farmland, then the evergreen forests outside the floodplain of the reservoir bed are also not available.

In addition to the above negative impacts, the positive impacts will also created, that is:

- When the reservoir is accumulated with water, it will create a large, long and open reservoir, making the humidity in the region increase, creating conditions for plants and natural trees in the surrounding area to grow and develop. The reservoir will improve the source of active irrigation water for the plants grown in the reservoir-side and lowlands. Especially, the resettlement areas of Dak Nen, Dak Drinh communes which are adjacent to the reservoir.
- In order to ensure water resources for the reservoir, the watershed protection should be strengthened .. This is the meeting point of interests between those who take care of watershed forests and the employer of the hydropower project, that is a factor that helps the flora and fauna here maintain and develop.

** Lowlands:*

In the area behind the dam to Dak Ba stream is currently poor regenerated forest. This area will be a place gathering auxiliary zones for construction. When the project comes into operation, a part of the temporary requisition area such as landfills, storage yards, quarries will turn into vacant land and bare hills, which should be restored and afforested (about over 20 ha).

In the area along the river, behind the confluence with Dak Bua stream to Nuoc Em stream, due to the narrow topography of two slopes on the bottom of the river valley, the vegetation cover is mainly provided from rainwater and groundwater without depending on the water source of Dak Drinh river.

2. Impacts on wildlife fauna

** For bird fauna*

In the reservoir-bed area, the main factor of impacts is inundation. Because most of the flooded area is upland fields, shrublands, grasslands and bamboo forests, the most affected objects are nests and eggs of birds that live and nest in empty places such as grasslands, shrublands and upland fields and bamboo forests.

Most of the birds are able to move long distances, can move to the flood-free areas to live, moreover, when blocking the dam, the water rises slowly, not quickly. The reservoir bed area only includes streams and mountain slopes, with no wetland suitable for the life of waterfowl groups. Therefore, the inundation problem caused by the hydropower plant does not affect the waterfowl fauna.

On the contrary, the formation of the reservoir will create marshlands along the DakRinh and Dak Roman rivers and the streams flowing into these two rivers will form a new wetland system, and the waterfowl fauna.

This is a factor creating the appearance of species as well as increasing the number of individuals of species with water-attached life such as: otters, Ardeidae, Anatidae, Charadrlidae, Alcedinidae, varanids, water snakes, Amyda cartilaginea, Ranidae ...

** For mammals*

In the reservoir-bed area, most of the area is upland fields, grassland, shrubs, and bamboos, so there are not many large mammals. Therefore, when the water level rises, it affects the habitats of small mammals and cave-dwelling mammals such as Atherurus macrourus, Hystrix brachyura, Nycticebus pygmaeus, Nycticebus coucang which are easily killed by not moving in time.

When the reservoir is formed, it will flood a certain area, the forest will be flooded and a part of the distribution area and active area of the species will be narrowed. Many flooded areas will create fragmentation of habitat for animals. Along with the formation of a reservoir, people in the reservoir-bed area will have to move to a higher place to live. The formation of a new residential area will generate demand for farmland, housing land, construction timber and daily fuel. These factors will affect the animals in the region. Many species will move away from the region

Species that live near residential areas such as deer, moose, wild boar, ... which have moved away from the construction site during the construction stage, often find forests in valleys or low and deserted mountains to live and then come back to forest patches, upland fields near works to search food. Small mammals only move away from flooded areas or spread far away from works to live.

Due to the hydroelectric plant, the population distribution in the region changes, exchanges between regions are increasing. Thanks to the regulation of water volume, the agriculture of the area around the reservoir bed as well as the landlows is more developed than before, which leads to the appearance of some more species as well as the number of individuals, and changes in the distribution of species living near humans, seed eaters such as Mus musculus, Mus, Passeriformes, Hemidactylus frenatus, Duttaphrynus melanostictus.

** For reptiles and amphibians*

In the reservoir-bed area, most reptiles live in forests, or coastal trees, bushes near water sources such as rivers and streams, in low hills, this is a habitat with a fairly high level of biodiversity for amphibians and reptiles.

They have a narrow range of activity, are less likely to travel long distances, so some will die when the water rises. The survivors will migrate to the forests on the slopes adjacent to the reservoir surface, provided that the construction process does not affect or destroy, separate these forests along the stream.

Swimming-able species may move to higher elevations, but they have to face survival struggles such as gaining food and habitat due to high concentration density. This competitive process takes place not only in reptiles but also in carnivores, as many species of mammals will gather here to search for food. The hydroelectric reservoir's wetlands and marshy places will later be the habitat of many species of amphibians.

3. Impacts on aquatic environment and aquaculture

Dakdrinh hysropower project is located on Tra Khuc River in the territory of Kon Plong and Son Tay districts. Dakdrinh reservoir has medium size. The reservoir surface area at the normal water level is 9.12 km2 corresponding to Vtb: 249.3×10^{6} m^{3}. Once formed, Dakrinh reservoir will fundamentally change terrestrial ecosystems as well as types of water bodies in flooded areas. A new reservoir ecosystem together with the aquatic system specific to this type of water body is formed.

As stated in Section 3.2.1 in the early years of inundation the indicator species for the Vietnamese reservoir will appear with predominant population densities in the reservoir plankton. The density and biomass of plankton groups will, in the first time, be very large, even cause blooming of plant plankton. The Atyidae Palaemonidae will grow in fairly large numbers in coastal areas. Molluscs species decreased significantly in species as well as number due to the unstable foundation of the reservoir bottom.

The number of fish species decreased, the fish species adapted to the flowing river water bodies decreased both in species and in number. In contrast, the plant-eating fish and organic humus adapted to the standing water life grow. Fishing in reservoirs was formed. In the first period, natural fish catch was high, many individuals has larger size than today, such as Cyprinus carpio, Hypophthalmichthys nobilis, and Labeo rohita. Natural fish yield can range from 60-100 kg/ha/year.

The reservoir fish-farming also has a chance to develop, the yield of farmed fish can reach over 100 kg/ha/year. However, this will also create a risk of polluting the reservoir quality due to food sources for fish and domestic wastewater from fish farmers.

c) Impacts on socio-economic environment

When Dak Drinh hydropower project is put into operation, every year there will be a power source with a capacity of 125MW corresponding to 520.8 million kWh of power will be put into use. This is a very important source of energy to serve the needs of socio-economic development of the locality, especially Dung Quat new economic zone and Tinh Phong Industrial Park. Jobs will be created and the living quality of local people will also be improved.

It is the investment in the construction of Dak Drinh hydropower project that will change the local economic structure and contribute to promote the industrialization of rural agriculture in particular and industrialization in general. Specifically, in a mountainous area where agriculture - forestry is the industry with main proportion, the project itself, when invested, has significantly increased the proportion of the industry and basic construction.

For agricultural production, when Dak Drinh hydropower project is constructed, the irrigation for crops will be more active, especially during the dry season, in the upstream areas around the reservoir bed (including resettlement areas) and improve the flow to ensure for hydropower plant's downstream area. When the irrigation is active, the implementation of crop and animal restructuring will be more favorable and provide higher yields.

As shown in Section 2.8.1 Chapter 2. The total current aquaculture area of Kon Plong district is 2.8 ha and Son Tay district is 1.35 ha. The dam block will create an area of 912 ha of water surface (Kon Plong district: 528.6 ha; Son Tay district: 383.8 ha), significantly increase for the fisheries sector of communes in the project area, contribute to improving the nutritional quality for people in the short term. If invested and managed well, it will bring higher economic efficiency.

At the same time, the area of the reservoir surface together with the spillway in flood season is a good condition for the development of local eco-tourism and resort establishments. The reservoir area will also create conditions for forest rangers to develop artificial forests around the reservoir, using canoes to patrol and protect the forest.

In brief, the construction of the Dak Drinh hydropower project not only contributes to promote local economic development, increase income and improve the lives of employees, but also disrupt the close of villages, improve people's knowledge and reduce the gap with other regions.

In addition to the above positive impacts, during the operation, it is also important to note negative impacts that may occur:

- People who are currently living in concentrated areas under rivers and streams have changed to resettlement areas along the reservoir, some changes of old habits and lifestyles cannot be adapted immediately..
- After receiving the compensation money, some households can spend money wasteful, not for the right purpose, causing social evils in their family and community.
- Households who come to the new cultivation place will face difficulties because they have to change their farming practices from crops grown on alluvial soils of rivers and streams, to crops on upland fields.
- In the newly built resettlement areas, living conditions change, at first, some diseases will arise. If the water supply for domestic use is not guaranteed, leading to the direct use of the reservoir water, it will directly affect people's health.
- Thus, if the implementation of the program on compensation, support, and resettlement is not effective, it will greatly affect the lives of resettled households, leading to other negative impacts such as deforestation, encroachment on reservoir bed, dispute, causing insecurity in the region.

d) Impact assessment due to changes in flow regime of the river section from dam to the hydropower plant

As shown in Section 3.1.2, when the project is put into operation and power generation, on average, there will be 72.36% of the flow amount passing through the tunnel, only 27.64% of the flow amount from the reservoir passes through the river downstream of the dam to the hydropower plant and 4 months of the flood season (from October to January next year). From February to September, the river section behind the dam to the hydropower plant is 9 km long, the flow amount decreases. Especially, the section from behind the dam to the confluence with Dak Ba stream with 2.5km long, is almost dry (broken line). In order to evaluate these impacts, we conducted: (1) Determination of the environmental flow. (2) Assessment of impacts on aquatic systems.

1. Determination of environmental flow

Environmental flow is the amount of water that is managed to retain for the river to obtain sufficient amount of water needed to ensure environmental, social and economic benefits in the downstream. For a river system, it is necessary to define the object and target for management: for environmental, economic or social purposes. The environmental flow must meet these purposes.

Due to the socio-economic development, land use has led to changes in the ecosystems of the flow. In order to facilitate the management and application of the measures to provide environmental flows for ecosystems, the aquatic ecosystems can be classified into the following four basic types:

Table 3. 36 Aquatic ecosystems and target of use management of the downstream region behind the damsite

Type of aquatic ecosystems	Description	Management purposes	Regions
Natural ecosytem	Ecosystems have been around for decades	- The primary target is to maintain the existing primitive ecosystem. - The second target is to meet the needs of entertainment.	Cutoff section of 9.0 km
Affected ecosystem	The ecosystem is affected by water usage or changed in flow regime	Satisfy functions, entertainment and conservation	From the hydropower plant to the downstream of Tra Khuc river
Water supply ecosystem	Ecosystem for water supply reservoir	- The primary target is water supply - The second target is conservation	Irrigation lakes, reservoirs in the downstream of Tra Khuc river
Artificial ecosystem	Ecosystem of lakes, ponds and artificial canals in the urbanization process	Satisfy functions, entertainment, conservation and irrigation	Canal for water supply and drainage in urban areas in the downstream of Tra Khuc river

According to the exploitation scheme for Dak Drinh hydropower project, the amount of water is used to generate electricity, then it will be returned to the river behind the hydropower plant. Therefore, when determining the environmental flow, only considering the water loss section of 9.0 km from the dam to the hydropower plant.

Currently, there are many environmental flow methods that have been developed and applied, which vary in a very wide range. Here, we apply the methods: Hydrological method, Habitat simulation and Downstream Response to Imposed Flow Transformation. - DRIFT)

Here, the environmental flow is determined by the mean value of the minimum monthly average flow corresponding to a frequency of 95% (Standard low flow index. Gordon et al.

1992 and Smakhtin 2001). From the results of hydrological calculation mentioned in section 2.5.3 Low flow in Chapter 2, the minimum monthly average flow corresponding to a frequency of 95% is determined: - At the damsite: $Q_{damsite}$ 95% = 2.16 m3/s.

This flow will be sufficient to ensure environmental, social and economic benefits in the downstream. However, this river section at present as well as planned, will have no water demand for agriculture, domestic or industrial purposes (See Official Dispatch No. 96/UBND dated April 19, 2007 of Tay Son District People's Committee on the flow of the river behind the dam of the Dak Drinh Hydropower Project on the Tra Khuc river)

Therefore, the environmental flow defined for this 9.0 km cutoff section is only required to maintain the aquatic ecosystem. Table 3.37 assesses the benefit value of the cutoff section in terms of environment, society and economy

Table 3.37. Assessment of the environmental, social and economic benefits of the cutoff section.

Environment	Society	Economy
There are no rare species of native flora	The number of people using water of this river for domestic use is not many	The water in this river section is not used for irrigation of crops, upland fields on either side of the bank.
There are not much activities of large mammals because most are cleared area and upland fields	There is no ecotourism or fishing activity on this river	There is no industrial activity using this river section
Tributary streams continue to receive water from rainfall and groundwater in the sub-basin, Nuoc Bua and Nuoc Lat streams.	This river section is owned by the state without any dispute over water use. This river section is located on the Vietnamese territory, so there is no dispute about the distribution of benefits from using water resources between countries.	People in the region do not harvest the main aquatic resources from this river section.

From the above assessment, it shows that in the present and future, the environmental flow determined for this 9.0 km cutoff section is mainly to ensure the maintenance of aquatic ecosystems. According to the French Freshwater Fishing Act of 1984, the remaining flows in the converted river sections are at least 1/40 of the average flow of the current water regime.

This regulation was also proposed by the Southern Institute of Water Resources Planning to apply to Dak Mi 4 hydropower plant on Vu Gia river, Quang Nam province and proposed by PECC2 to apply to Dong Nai 4 hydropower plant on Dong Nai river.

Apply to Dak Drinh Hydropower Project:

- At the dam site: $Q_{damsite\ 1/40\ (Qo)}$= 0.77 m/s.
- At the confluence with Dak Bua stream: $Q_{DakBua\ 1/40\ (Qo)}$ = 1.01 m3/s.

As shown in Table 3.30 Flow variation on Dak Drinh river from the dam to the hydropower plant, the minimum monthly average flow at the confluence of Dak Bua stream is 1.49 m3/s. Thus, the environmental flow determined to ensure the maintenance of aquatic ecosystems should only be considered on the 2.5 km section from behind the dam to the confluence of Dak Bua stream. There are 2 scenarios to consider for selection:

a / Scenario DR1: When the project is put into operation, it will ensure the discharge of environmental flows of 0.77 m3/s in 8 months of dry season. The total volume of this flow is 16.19x10^6 m^3, corresponding to the output power reduction of 10 million kWh (about 7 billion VND) per year.

b / Scenario DR2: When the project is put into operation, it will not discharge in 8 months in dry season from the river section behind the dam to Dak Bua stream which is cut off, it does not ensure to maintain the aquatic ecosystem.

In order to assess this impact, we based on the simulation of aquatic habitats on the cutoff section as follows:

In flowing water bodies, there are two large habitats: fast flowing water (waterfall) and slow flowing water, and there are two types of communities: fast flowing and slow flowing communities. The structure of the community depends on the phenotype of the bottom foundation: rock, sand, and mud. Flows are the limiting factor where water flows fast, but the hard bottom foundation consists of gravel, boulders and coobble, suitable for animals and plants to adhere to.

Table 3. 38 Distribution of higher flora species according to the flow and morphology of the river bed in the cutoff section

Flow	Morphology of bottom foundation	higher flora species
Fast flowing water	River bed is wide, shallow or narrow	None
Slow flowing water	The river bed is narrow and deep	None
Slow flowing water	The river bed is wide and shallow, obtains only open rocks	*Telectadium edule*
Slow flowing water	The river bed is wide and shallow, exposing the convex sand	*Telectadium edule* *Lasia spinosa* *Celosia argentea* *Saccharum spontaneum* *Panicum repens* *Cyrtosperma merkusii*
Standing water	The river bed is wide or narrow, water stagnates on rock holes	*Hyophila involuta* *Najas indica*, Chlorophyceae

Table 3. 39 Growth cycle of flora communities on the flow area

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bambusa sp.	x	X	x	X	x	x	x	x	x	x	x	**x**
Celosia argentea			x	X	x	x	x	x				
Cyperus spp						x	x	x				
Cyrtosperma merkusii						x	x	x				
Diospyros spp.	x	X	x	X	x	x	x	x	x	x	x	**x**
Ficus spp.	x	X	x	X	x	x	x	x	x	x	x	**x**
Hyophila involuta		X	x	X	x	x	x	x				
Lasia spinosa			x	X	x	x	x	x				

Panicum repens						x	x	x	x			
Phragmites vallatoria					X	X	X	X	X			
Saccharum spontaneum					X	X	X	X	X			
Telectadium edule	X	X	X	X	X	X	X	X	X			
Mimosa pigra					X	X	X	X	X			

From an ecological perspective, it is possible to assess the impact of the cutoff on the dehydrated area into 4 levels:

Table 3. 40 Different levels of impact on the biota

Levels	**description**
A	Insignificant variation from natural conditions, a negligible threat to susceptible species
B	Slight variation from natural conditions, posing a slight threat to biota
C	Moderate variation from natural conditions, reducing the number and growth of biota
D	Variations in high degree from natural conditions are almost absent.

For terrestrial flora, the water loss of the 2.5 km river section is only affected at A level, meaning that the flow block does not significantly threaten the number of native flora species growing in the flow and coastal area. However, associated with human activity is the spread of an exogenous species such as Mimosa pigra, in standing water or slow-flowing conditions, the invasion of such specie could threaten native plant species.

There is no basis to determine the loss value for the scenario DR2 in money. However, it can be seen that: During the dry season, morphologically corresponding to the shallow and slow flowing or standing riverbeds, the higher plant species present during this period still remain in the downstream behind the Dak Bua stream. Therefore, we recommend to apply the scenario DR1.

3.4. ASSESSMENT ON THE METHOD OF USE

3.4.1 Methods to assess pollution of waste-related sources:

1. Rapid and analog assessment methods:

The Rapid Assessment method proposed by the World Health Organization (WHO) has been accepted for use in many countries, we use to calculate the load of wastewater and air pollution. In Vietnam, this method is introduced and applied in many EIA studies, it is possible to perform relatively precise calculation of pollution load under the limited conditions of measuring and analytical equipment. In this report, the pollutant load coefficients are obtained from the World Bank EIA guidelines (Environmental Assessment Sourcebook, Volume II, Sectoral Guidelines, Environment, World Bank, Washington DC 8/1991) and Handbook of Emision. , Non Industrial and Industrial source, Netherlands.

At the same time we have used analog assessment method based on monitoring sources measured from similar works: From FHA (USA); From the EIA Report for the West China 500 kV transmission line project; Results of environmental monitoring in Dai Ninh hydropower plant, Institute of Tropical Technology and Environment Protection, 2006.

2. Modeling method:

For dust dispersion, the air pollution dispersion model was used (Larry W. Canter, Environmental Impact Assessment, 2nd Edition, McGraw-Hill, INC 660pp, 1996).

For reservoir water quality prediction, using the empirical formula of A.I.Denhinova made from model experiments. Calculation of standing tree biomass was based on the method of Brown, Kato and Oga Wa. This is the method that has been used for many irrigation and hydroelectric reservoirs in Vietnam. This method is also calculated by PECC2 for Tri An, Thac Mo, Ham Thuan, Da Mi reservoirs. These reservoirs are currently in operation and the water quality monitoring results show that it does not exceed the calculated results.

3. Notes and recommendations:

Through the application of assessment we found a number of notes and recommendations as follows:

- Dai Ninh hydropower project is implemented by Japanese contractors with strict environmental management program, it is necessary to visit and study to apply similar management measures to Dak Drinh hydropower project and others.
- The model for calculating dust dispersion has not yet fully calculated the dispersion caused by deposited dust during the construction period, as well as the influence of the terrain factor. Although the results show that the areas more than 100m from the construction site meet the set standards, it is still necessary to apply water spray measures in hot weather to protect workers in the construction site and surrounding residential areas. Especially, the hydropower plant is near the residential center of Son Tan commune.

3.4.2 Methods to assess non-waste related sources:

1. Methods of sociological investigation:

It is used to assess the damage caused by the project to residential households and collectives; aspiration to choose the form of compensation.

The results of damage investigation in this period are only declaration and have not been counted on the basis of setting up boundary landmarks for site clearance and recovery. In the coming stages, it is necessary to comply with regulations to ensure the fairness.

Households in the reservoir-bed area wish to receive compensation in cash, but the ability to create productive land by themselves will mainly clear forest for cultivation, so it is necessary to carry out compulsory resettlement

2. Method of equilibrium calculation and modeling:

For assessment of impacts due to reservoir operation and power generation, equilibrium calculation methods are applied in hydrological calculation and flood regulation.

For the prediction of sedimentation, use the predictive modeling of Brune.

These are the current methods used in hydrological calculation, design of irrigation and hydropower projects in Vietnam.

For the calculation of the regeneration process of the reservoir bank and bed, use Zôlôtariev's model. In Vietnam, this method is usually applied to mountainous reservoirs, such as Thac Ba, Hoa Binh, Se San 3. The actual monitoring results are not larger than the calculated results. In fact, the reservoirs which have been operated, such as Da Nhim reservoir after nearly 40 years, Tri An reservoir after 17 years, Thac Mo reservoir after 10 years, occurred landslides but their volume is negligible.

3. Statistical method and other methods:

For the prediction of induced earthquakes, use statistics from UNESCO.

In order to determine the environmental flow, a combination of methods is applied: Hydrological method, Habitat simulation and Downstream Response to Imposed Flow Transformation - DRIFT.

4. Shortcomings and recommendations

As mentioned above, there are many methods of determining environmental flows that have been built and applied in the world, these methods have changed results in a very wide range. For Vietnam, this concept has only been approached for about 10 years and is in the learning step towards building a suitable method. Currently there is also a lack of a basis to value the losses to the ecosystem in terms of money, from which to consider and select losses and gains. Therefore, it is recommended to have a program to monitor the relationship between the aquatic ecosystems with the flow in the river section behind the dam to the confluence of Dak Bua stream to determine the appropriate environmental flow discharge regime in the operation stage.

The results of the environmental impact assessment presented above are the basis for the review and construction of Dak Drinh hydropower project, establishment of negative impact mitigation measures, the development of a Environment Monitoring Program (EMP) which are discussed further in Chapters 4 and 6.

Chapter 4: MEASURES OF NEGATIVE IMPACT MITIGATION, PREVENTION AND RESPONSE TO ENVIRONMENTAL INCIDENTS

4.1 MEASURES OF NEGATIVE IMPACT MITIGATION RELATED TO WASTE

4.1.1 Waste treatment measures

a) Measures to minimize negative impacts on the air

As mentioned in *Section 3.1.2* of *Chapter 3*, air pollution is mainly caused by dust and exhaust fumes from excavation activities, ground leveling, road construction, landfill, manufacturing and casting concreting; transport of materials, waste soil and rock. In order to reduce this impact, during the preparation and construction, the Investor will require the Contractor to implement some measures to minimize air pollution as follows:

- All vehicles must have a material-covered canvas when transporting.
- Apply moisture spray during leveling; spray moisture at least 02 times a day in sunny and windy days
- Spray water on roads near the construction site, where vehicles transporting materials pass.
- There is a suitable vehicle regulation to avoid increasing vehicle density.
- All trucks and motorized construction equipment must meet standards prescribed by the Vietnam Register on safety engineering and environmental safety.
- In addition, a number of other measures will be taken to ensure safety, such as: compacting, ditching sewage for landfills, storage areas; control of fuel depots, fire prevention, etc., and will be presented in the following sections.

Dust monitoring results can be found at Dai Ninh hydropower project (See *Table 4.1*). This is a project that implements environmental management in accordance with the above measures.

Table 4. 1 Results of monitoring the air quality around Dai Ninh hydropower project

Location	**Dust**	**SO_2**	**NO_2**	**CO**	**O_3**	**Pb (10^{-4})**
TCVN 5937 : 2005	**(mg/m³)**					
May, 2006	0.3	0.125	0.2	30	0.12	15
Hamlet 4, Ninh Gia District						
Hamlet 6, Ninh Gia District	0.62	0.35	0.08	15.9	0.06	0.1
Da Nhim main dam, spillway	0.15	0.15	0.05	7.9	0.06	0.1

November, 2006	0.2	0.05	0.069	7.9	0.06	0.1
Hamlet 4, Ninh Gia District						
Hamlet 6, Ninh Gia District	0.3	0.11	0.043	5.5	0.036	0.1
Da Nhim main dam, spillway	0.6	0.24	0.09	6.7	0.028	0.1
Queyon quarry	0.21	0.088	0.05	4.5	0.023	0.1

Source: Results of environmental monitoring in Dai Ninh hydropower project, Institute of Tropical Technology and Environmental Protection, 2006

Thus, with the strict management according to the above requirements, except for points close to emission source, camps and neighboring residential area will be ensured that the ambient air quality meets the TCVN 5937: 2005. These requirements will be included in bidding documents. These are the measures often applied by contractors as in hydropower projects built in Vietnam. Costs for construction given by the Contractor must include the costs for these measures.

b) Measures to minimize negative impacts on the water environment

1. Construction of water supply systems for construction

Water demand for the construction site includes the main groups of items: dam heads; Water intake (CLN); Tunnel route has sub-tunnel No. 2 (HP2), sub-tunnel No. 3 (HP3); Surge tank tower (NV & TDA) and hydropower plant (NMTD) (See *Table 4.2*).

Table 4. 2 Water demand of the auxiliary area and construction site (m^3 /day & night)

	Water user	**Dam**	**Water intake**	**Sub-tunnel No. 2**	**Sub-tunnel No. 3**	**Surge tank tower**	**Hydro-power plant**	**Total**
1	Auxiliary area	954.6		91.0			136.6	
2	Houses, camps	56.8		27.9			12.8	
	Total (m^3 /day & night)	1011.4		118.9			149.5	1279.7
	Design flow m^3/ s	0.020		0.002			0.0030	
3	Construction site m^3 day & night	1112.6	77.34	176.2	213.2	131.6	52.5	1763.6

	Design flow m^3/s	0.023	0.0016	0.004	0.0045	0.0027	0.0011	
	Total (m3)							3043.3
	Source	River	River	Stream	Stream	Water vein	River	

Water supply for production and daily life is mainly from Dak Drinh and Dakroman rivers. In addition, you can take advantage of the water from the streams and tributary stream with abundant water all year round. Demand for domestic water is calculated according to the norm of 50 liters/person-day. Considered that the arrangement of mixing plants, crushing and screening areas, laboratories and houses near rivers and streams is very convenient for water supply. The water supply scheme is as follows:

- At the dam heads, Water intake, Upstream tunnel, Hydropower plant area: Take water directly from the river by pump, put the pipes to the high 10 – 50 m3 tanks, from here water is distributed through pipes to consumers.
- Because the areas of Surge Tank Tower, Construction niche No. 3 and Valve house are located high and far away from rivers and streams, two methods can be applied here is to use local underground water vein and water trucks (capacity of 12,000 liters) to carry water to consumers. At the locations of tunnel, there must be 10-15 m^3 water tanks to serving the construction. Particularly, Construction niche No. 2 takes water directly from the nearby Gi Man stream.

2. Construction of Drainage system for construction

Drainage for the road system by drainage ditches combined with the drainage culverts across the roads located at the dividing locations. Depending on the catchment section and basin, the drainage ditch is reinforced with hard-walled stone. The road culverts are made of precast concrete with a diameter of 75-100 cm.

3. Wastewater treatment system construction:

As mentioned in *Section 3.1.1* of *Chapter 3*, during the project construction and operation process, the receiving source of domestic and production wastewater is the Dak Drinh River. Therefore, the following measures will be taken to protect the water environment:

- Build wastewater treatment system before discharging into the river: The wastewarter drainage system must not flow into the clean water supply. Avoid placing hazardous materials near water sources.
- *Domestic wastewater treatment system*: At construction workers' camps and project management board during the construction phase; Hydropower plants and the executive building in the operation phase have a wastewater treatment system to ensure that treated

wastewater reaches level II as specified in TCVN 6772 - 2000 (Water quality - domestic waste standard.).

Details of the technological procedure of the wastewater treatment system and the scale of the specific wastewater treatment systems for each zone during construction as well as operation are presented in *Section 6.1 List of Environmental treatment facilities* of *Chapter 6* and *Figure 6.1 Diagram of the domestic wastewater treatment before discharging into Dak Drinh river.*

- *Waste oil and grease collection system:*

During the construction phase, waste oil and grease generated mainly from mechanical maintenance and repair facilities and motorbikes will be thoroughly collected by the construction contractor.

The wastewater treatment system for hydropower plant operation includes collection, treatment and separation works of leaking oil and grease during the operation; domestic wastewater collection works of operating forces in the regions. This system is designed and built to guarantee according to the TCVN 6980:2001: Standards of industrial wastewater entering river water areas for domestic water supply purposes and TCVN 6772: 2000: Domestic wastewater.

During the operation process, waste oil and grease generated by leakage will be handled through oil separation tank with a capacity of about 100 m^3.

After treating wastewater produced from oil separation tanks, it must satisfy the standards specified in column A of TCVN 5945 - 2005 (Industrial wastewater - waste standard).

- Take measures to prevent erosion during excavation and backfill to prevent soil and rock from being washed away to water sources.

During construction, the wastewater treatment system and fulfillment of water protection requirements will be included in the bidding document. The costs of constructing auxiliary areas, construction camps, and construction costs given by the Contractor must include the cost of constructing the wastewater treatment system and fulfilling water source protection requirements.

4. Clearing the reservoir bed before filling with water:

As stated in *Section 3.1.1.4* of *Chapter 3* to ensure the quality of reservoir water, the reservoir bed cleaning must be carried out before filling up, including: (a) Clear bombs, mines and toxic substances left in the war. (b) Wash graves and barns. (c) Remove cover plant in the reservoir bed.

a/ Bombs, mines and toxic substances clearance left in the war:

The clearance of bombs, mines and toxic substances left in the war will be done by a specialized military unit under the contract with the investor (Dak Drinh Hydropower Company). Funding for the above work is shown in Chapter 7.

b/ Cleaning of graves and barns.

In order to locate graves for collection, investors combine with local authorities, mass organizations, and fronts to organize propaganda and mobilization of people through village elders. Perform the rituals according to local customs.

Graves will be relocated to a new appropriate area. In addition to meeting the sanitation requirements, the approval of the local people is also required.

c/ Removing of cover plant in the reservoir bed.

Dak Drinh River is located upstream of Tra Khuc River in the demand for downstream water (provided by Quang Ngai city for daily life through a treatment system) according to Vietnamese standard (TCVN 6774:2000) “Fresh water quality for protection of aquatic life", dissolved oxygen content in the reservoir (DO) must reach over 5 mg/l according to the Vietnamese standard (TCVN 5942: 1995) "Standard of surface water quality ", DO must reach more than 6 mg/l.

As calculated in *Section 3.1.1.4* of *Chapter 3*. For Dak Drinh lake, calculation plan shows:

Plan for not cleaning the reservoir bed: the amount of dissolved oxygen is greatly lacking, only meeting the standards of using water for agriculture and fisheries (DO = 5.23 mg/l).

Plan for carefully cleaning the reservoir bed: dissolved oxygen content in water (DO = 6.07 mg/l) meets the permissible standards for use for living through the treatment system.

In case of thorough cleaning of the reservoir bed: the remaining dissolved oxygen in the reservoir is much higher (DO = 6.99 mg/l) than the permitted standard.

In two cases, the careful and thorough collection of dissolved oxygen in the reservoir are all up to the standards. However, according to the plan for thoroughly cleaning the reservoir bed, the funding will be very high due to the need to dig up the roots. Therefore, from the point of view of protecting water quality and ensuring economic efficiency, it will be done to clean up the cover plant in the reservoir bed according to ***the plan of carefully cleaning the reservoir bed***, specifically: The cultivated areas are harvested, trees and branches are exploited fully, bamboo trees, neohouzeaua ... are used as fire wood for residents and construction sites.

The reservoir bed cleaning process should focus on the following points:

- Clearance and disposal of bombs, mines and explosives must be completed before trimming and clearing reservoir bed.

- Exploitation of agricultural products to recover economically valuable trees, clean the plant volume to reduce the amount of rotten organics, thereby reducing water pollution after floods, decreasing the risk of floating waste and improving boat accessibility and traffic. The rate of felling is calculated specifically to be inexpensive and still ensure hygiene of the reservoir bed.
- Accurately and clearly mark the area and forest area for clearing. There are regulations and supervision on which plants will be cut (size, type ...) and classified for salvage.
- Clear the areas one by one.
- Build a rule of cut plant burning
- Areas where graves and barns are moved from the old residential areas in the reservoir bed will be removed, cleaned by sprinkling of disinfectant lime and covered with clean soil before filling with water.

Regarding organization of implementation: In the next step of implementation, the Investor will sign a contract with consultants, specialized units to perform the reservoir bed cleaning. Specifically:

- Sign contracts with specialized forest investigation and exploitation units to conduct forest re-checking, plan to exploit and make full use of forest resources.
- On the basis of the plan to clear the cover plant in the reservoir bed approved in the environmental impact assessment and forest re-examination results, the consulting unit is hired to correct the biomass calculation results, set standards and make detailed plans and funding for reservoir bed cleaning.
- The reservoir bed cleaning contractor must comply with approved standards and detailed plans for reservoir-bed cleaning.
- Before filling with water, it should conduct the acceptance of reservoir bed cleaning (it is possible to accept in many phases according to the construction progress and water filling). This work must involve local health and environmental management agencies.

Funding for the above works is presented in *Chapter 7*.

c) Construction of solid waste treatment system

1. Industrial waste treatment system:

In the construction phase, industrial waste is mainly waste soil and rock, damaged and excess materials. During the operation phase, the hydropower plant does not have industrial solid wastes.

For waste soil and rock: mainly waste soil and rock due to the opening of the foundation, covering the mines of materials from the construction process with a large volume of over

$1,274,10^6$ m^3. This waste soil and rock will be collected in the landfills. Large waste volumes require separate disposal to avoid environmental problems such as long-term stabilization of the edge of waste soil and rock mass; limit air pollution when it is sunny and windy; limit water sources pollution during the rainy season. Specifically:

- During this design phase the proposed sites for disposal of soil and rock were identified during the design phase (see *Appendix 1.3 Total Site Plan - Proposed Plan* in the *Appendix*). Locations of landfills are determined on the basis of convenience for constructing and gathering near main dams and auxiliary dams, limiting the water sources pollution. The landfills will be located in 3 main construction areas (cluster 1: a landfill at the dam, a landfill at the water intake; cluster 2: a landfill in a sub-tunnel 2, sub-tunnel 3, a surge shaft and a landfill at the valve house; cluster 3: a landfill in hydropower plant area).
- At the landfills, the waste soil and rock are compacted. At the same time, the measure of ditching around the landfill to collect rainwater, limiting the entraining of suspended solids and settling before flowing into the river is applied.
- Depending on the specific conditions, the project's landfill can be used to collect domestic waste of workers during the construction process (will be presented in the next section).
- In addition, on the basis of geological research, the soil and rock excavated in the foundation, tunnels are calculated to be reused as construction materials, estimated at over 350,000 m^3 of soil and rock (excluding the volume of use of retaining dike embankment).

These measures will be identified in the bidding documents, including: precise location and reasonable waste scale, maximum utilization of the soil and rock from foundation excavation, making the roof to ensure a stable slope depending on the waste materials, banking surrounding landfills, planting grasses on roofs and surfaces, reasonable waste height. These measures aim to prevent washout of the waste material to the rivers, streams and reservoirs and protect landscape. Construction contractors will be required to state specific measures in bidding documents.

Damaged and excess materials:

Other solid wastes generated from the auxiliary areas such as cement bags, wooden plank and scrap iron will be completely collected and sold to scrap purchase establishments.

At the operation stage of industrial solid waste, there is very little, mainly materials and equipment due to processing, repair and replacement. These materials and equipment will be collected and sold to scrap purchase establishments.

2. Domestic waste treatment system.

As mentioned in *Section 3.1.1* in *Chapter 3*, domestic waste in the construction process is mainly generated by the high concentration of construction workers. At present, there is no landfill in the project area. Two plans are expected to handle this amount of waste.

Option 1: 3 landfill pits will be built in the area at the 3 spoil areas mentioned above. These landfill pits are located not in the flooded area and the area affected by the flood discharge, because this is a pollution source of river water if flooded. The distance from these regions to water sources of rivers and reservoirs should not be less than 1 km.

The landfill pit will be constructed according to sanitary regulations, with a leachate treatment system according to Treatment Wall method. The base of the landfill pit will be waterproof. After each day of garbage disposal a 10-20 cm thick layer of soil must be covered to limit the odor and activity of insects. The waste treatment will be carried out methodically and ensure proper technical procedure. The location and size of the specific landfill pits for each site will be presented in *Section 6.1 List of environmental treatment works* of *Chapter 6* and *Figure 6.2 Diagram of the principles of hygienic domestic waste burial with leachate treatment by Treatment Wall method.*

Option 2: Daily waste is collected to transfer stations which are located at a reasonable location in each construction area (capacity depends on the amount of waste in each area. Dam route and water intake: 4.5 tons. Tunnel and surge shaft: 2 tons. The Hydropower plant and 110 kV line construction team: 1.5 tons). Then local Urban Environment Company is contracted periodically 5 times/month to collect to the centralized waste treatment site in Quang Ngai province.

For the option 1, it will make use of the solid waste landfills (waste rock and soil) present in the construction sites and actively for the construction units. Option 2 is more costly as the solid waste has to be transported for treatment together with the whole province.

Through the analysis of the 2 mentioned options, we suggest choosing Option 1 for the project's waste treatment during the construction period:

- At each auxiliary area, a landfill pit will be built in the above mentioned spoil areas. The landfill pit is not located in the flooded area and the area affected by flood discharge. The distance to these regions should not be less than 1 km.
- In the construction areas, hygienic trash will be arranged in a reasonable position. The garbage is collected daily to the listed landfill pits. Construction units must ensure hygiene regulations.

These measures will be identified in the bidding documents. Construction contractors will be required to state specific measures in bidding documents.

During the operation phase, hygienic waste bins will be arranged in a reasonable position at the operating areas. Every day, garbage is collected to the transfer station with a capacity of 2 tons which is located at a suitable location in the factory area. Then contract with the local Environmental Sanitation company to collect garbage to the centralized waste treatment site every 1 month.

4.2. MEASURE OF NEGATIVE IMPACT MITIGATION NOT RELATED TO WASTE

4.2.1. Implementation of compensation, assistance and resettlement programs

As mentioned in Chapter 3, when the project is formulated, it will affect 743 households with 3237 people. In which, households in Son Dung commune, Son Mua commune of Son Tay district, Dak Rin commune, Dak So district of Kon Plong district had to relocate (resettlement).

To mitigate these negative impacts during the hydropower project period, detailed topics on ***Compensation, Assistance and Resettlement Plan*** have been developed. This plan will be implemented in the site clearance phase before the construction of items. In the technical design document phase, the consultant selected by the investor will prepare the detailed planning and design steps of construction items for resettlement areas. (See the map of the resettlement and sedentarization areas of the Dak Drinh hydropower project - Kon Tum and Quang Ngai provinces). The following is a summary of the main features of the topic: ***Compensation and Resettlement Plan*** for Dak Drinh Hydropower Project.

a) Objectives of the compensation and resettlement plan.

Objectives of the compensation, assistance and resettlement program in Dak Drinh hydropower project:

- Pursuant to the Government's Decree 197/2004/ND-CP dated December 3, 2004, establishing the plan of compensation, assistance and resettlement to ensure that affected households after being compensated, will be supported and resettled to quickly stabilize their lives and production, creating favorable conditions for site clearance, and ensuring construction progress of hydroelectric projects.
- The resettlement areas chosen to build actually have better living and production conditions for the resettled households. Housing in resettlement areas will be improved. Land for compensation and resettlement ensures production conditions for higher income.
- The resettlement areas are planned and constructed in accordance with local planning, local customs and practices of local ethnic minorities, ensuring to maintain socio-cultural standards of affected households and communities.

- Infrastructure built in the resettlement areas will contribute to promoting the local technical infrastructure and rural transport development.

b) Compensation, assistance and resettlement plan for focal works and hydropower plant.

1. Policy on compensation, assistance and resettlement: Pursuant to:

- Government's Decree No. 197/2004/ND-CP dated December 3, 2004 on compensation, assistance and resettlement when the State recovers land.
- Circular No. 116/2004/TT-BTC dated December 7, 2004 of the Ministry of Finance, guiding the implementation of Government's Decree 197/2004/ND-CP.
- Government Decree No. 84/2007/ND9-CP dated May 25, 2007. Additional provisions on issuance of land use right certificates, land recovery, exercise of land use rights, order and procedures for compensation, assistance and resettlement when the land recovered by the State and settlement of land complaints.
- Circular No. 06/2007/TT-BTNMT dated 15/06/2007 of the Ministry of Natural Resources and Environment, guiding the implementation of a number articles of Government's Decree No. 84/2007/ND-CP.
- Decision No. 73/2006/QD-UBND of Quang Ngai province, promulgating regulations on compensation, assistance and resettlement when the State recovers land in Quang Ngai province.
- Decision No. 50/2005/QD-UBND dated September 16, 2005 of the People's Committee of Kon Tum province on promulgating the price list of houses, structures and plants in Kon Tum province. Decision No. 60/2006/QD-UBND dated December 27, 2006 of the People's Committee of Kon Tum province on announcing the land price list in Kon Plong district, Kon Tum province.

The investor has agreed with the local authorities for the policy on compensation, assistance and resettlement for Dak Drinh hydropower project (See Official Dispatch No. 3699/UBND-CNXD of the People's Committee of Quang Ngai Province and Official Dispatch No. 2605/UBND-TH of People's Committee of Kon Tum province in Appendix A)

2. Compensation, assistance and resettlement plan:

- *Compensation plan for houses, structures, residential land and agricultural land of affected households:*

a/ For the reservoir bed and focal works:

The communes affected by the reservoir bed area and the focal works, most of the affected households are the Ca Dong and Hre ethnic minorities who have lived in this area for a long time. These are poor households with low incomes and living standards; farming practices and qualifications are still limited. Cash compensation for houses, residential land and productive land will not guarantee the above households to create houses, residential land and productive land; as well as maintain the living standard as before. This leads to the destruction of forest for cultivation, indiscriminate exploitation of forest resources, resulting in other potential environmental and social impacts. Therefore, a compulsory resettlement program must be implemented.

The above damages will be compensated with houses, structures, residential land and agricultural land in the resettlement areas.

The norm of land compensation for resettled households is based on Article 2 of the Prime Minister's Decision No. 132/2002/QD-TTg dated October 8, 2002 on the settlement of productive and residential land for local ethnic minority people in the Central Highlands. Each resettled household is allocated 1 of the following 3 levels: 0.5 ha of 1-crop rice field, or 0.3 ha of 2-crop rice land, or 1.0 ha of burnt-over land and 400 m^2 of residential land.

However, based on the actual situation and the proposal of the People's Committee of Kon Tum province under the Notice No. 248/TB-UBND dated August 20, 2007 of the People's Committee of Quang Ngai Province and the Official Dispatch No. 3699/UBND-CNXD dated December 10, 2007, it is agreed that the norm of garden land for resettled households is 1000 m^2/household.

In terms of the area of housing and auxiliary works, compensation for resettlement households is on average 55 m^2 (for households with 4-5 people).

For households with losses greater than the above limit, they will be compensated in cash for the excess. Households with losses less than the above limit will not have to pay money back for the excess.

b/ For construction niches, energy routes and hydropower plant: productive land is mainly suffered a loss, however, the requisitioned area of each household is small, the above households still has enough agricultural land norm outside the affected area. Only 1 house will be affected on housing and residential land. Therefore, the option for household in this area will be compensated in cash. These households, after receiving cash compensation, are able to stabilize their lives and reorganize production to restore their income.

- *Compensation plan for crops and plants*:

Damage to crops and plants will be compensated in cash according to the unit price issued by the People's Committee of Kon Tum province, Quang Ngai province at the time of land acquisition. For annual crops, land will be requisitioned after the next harvest season.

- *Funding amounts*:

Types of support include support for migration; support for life and production stabilization; support for beneficiaries of social policies, poor households, elderly and lonely households, households with difficulties of sudden migration; Support for the relocation of graves, villages according to customs and beliefs; and bonus on punctual relocation.

c) Plans for planning and construction of resettlement areas.

1. Forecast of resettlement population.

The size of the resettlement areas is expected based on the results of the current damage survey and forecast for the year of 2010. The above affected households need to arrange resettlement. Statistics on the number of resettled households at present and forecast until 2010 by communes are presented in *Table 4.3*.

Table 4. 3: Number of resettled households at present (2007) and forecast for 2010

Contents	Dak Rinh	Dak Nen	Son Dung	Son Mua	Total
2007 current situation					
Number of households that need to arrange houses and residential land		262	288	90	640
Number of people that need to arrange houses and residential land		1035	1155	416	2606
Number of households that need to allocate land for agricultural production	34	262	288	90	674
Number of people that need to allocate land for agricultural production	156	1035	1155	416	2762
Forecast for 2010					
Number of households that need to arrange houses and residential land		282	317	99	698
Number of people that need to arrange houses and residential land		1403	1244	458	3105
Number of households that need to allocate land for agricultural production	36	282	317	99	734
Number of people that need to allocate land for agricultural production	172	1403	1244	458	3277

Note: Source according to the 2014 survey data of the Power Engineering Consulting Company 2, updated in July 2005. The population growth rate is forecasted at 2.5% per year, based on the statistical yearbooks of Son Tay and Kon Plong Districts.

2. Plans to arrange resettlement areas in flooded areas.

Basic principles of developing resettlement plans is to try to arrange resettlement in affected communes and districts to ensure the distance to the resettlement place and the shortest transition time as most of them are local ethnic minority people. Based on the specific conditions of the project area, the resettlement will be arranged in the form of on-site relocation: Relocating affected households to the concentrated resettlement area in the commune. The main features of these resettlement areas are presented in *Section 1.4.5.2 Description of the resettlement areas* of *Chapter 1*.

3. Infrastructure planning, construction and restoration options of resettlement areas

The master plan and construction for infrastructure restoration of the resettlement areas are presented in *Chapter 1*.

4. Solutions to life stabilization, production development, income restoration.

Specific solutions for providing initial material support and investment in rural infrastructure development, investment in production will create conditions for households to solve difficulties in organizing production, quickly stabilize the life after resettlement as follows:

Most of the affected households of Dak Rinh Hydropower project are local ethnic households, agricultural production and exploitation of forest resources are their main source of income. Agricultural products depend on nature because their farming knowledge is still limited, their cultural standard is not high, the farming methods are still primitive and poor. The technical advances in farming has not been applied much and successfully despite in recent times, local agencies and departments support with time, cost, method and crop ..

Therefore, the issue of productive land is of great significance in income recovery for ethnic households. Due to the natural characteristics and topography, most of the farm land for rice cultivation of people nowadays has a single crop and only a little paddy land will be inundated when filling with water. The solution to farm land is to reclaim the existing forest area near the resettlement area to have sufficient conditions for productive land.

From here, it is found that the households have to resettle, the affected land is mainly alluvial soil along rivers and streams, currently cultivated mainly by wet rice and crops. When moving to the resettlement areas, compensated productive land is mainly burnt-over land, water supply conditions become more difficult, and farming practices change. Therefore, in order to stabilize life, develop production to restore income, in addition to reclaiming and building fields to compensate, they will: (a) invest in the construction of irrigation structures to subsidize fertilizers for land reclamation. (b) Provide capital and technical support through the agricultural - forestry – fishery extension program for resettled households.

** Investment in construction of irrigation structure.*

With the set target is to supply water to ensure the needs of agricultural production (combining with water supply for domestic use) for the resettlement areas, the construction of irrigation structure will be invested to ensure production water supply, fertilizer subsidy to improve land of about 657 ha for all households whose farm land will be acquired for project construction.

** Technical and capital support through the agricultural - forestry - fishery extension program for resettled households*

This work includes providing support in terms of capital, materials, breading animals, seedlings and technical solutions, including transformation of plant and seedling structure for each resettled household.

Most of the resettled households are ethnic minority people, this initial support will help reduce their difficulties and create conditions for households to organize their production and economic development in the first time so that they quickly recover their economy and develop in a new place and have a long-term development orientation.

d) Compensation and support plan for 110 kV line route

However affected households on the 110 kV power line do not have to relocate, their houses have limited capacity for development and construction; farm land is restricted to planting trees with height. Therefore, in addition to the application of the Government's Decree No. 197/2004/ND-CP dated December 3, 2004, on compensation, assistance and resettlement when the State recover land, and Circular No. 116/2004/TT-BTC dated December 7, 2004 of the Ministry of Finance, guiding the implementation of Decree No. 197/2004/ND-CP, there will be policies and guidelines for compensation and assistance for households affected by the characteristics of the transmission power line, including:

- Government’s Decree No. 106/2005/ND-CP dated August 17, 2005, detailing and guiding the implementation of a number of articles of the Electricity Law regarding the safety protection of high-voltage grid works.
- Joint Circular No. 106/2002/TTLT/BTC-BCN dated November 22, 2002 of the Ministry of Finance and the Ministry of Industry, guiding the compensation and assistance for high-voltage grid construction.

Compensation and assistance policies: Affected households are only considered for compensation and resettlement (if any) when certified by the local authority on the valid ownership of trees, land, other affected homes and assets. Compensation for crops; fruit trees, land, houses, structures, trees and other assets caused by the works will be calculated according to the current price regulated by the provincial People’s Committees.

+ Compensation policy for households affected on their houses

- Land in the line corridor will be used in accordance with Decree 106/2005/ND-CP.
- Households whose houses are partially directly affected will be compensated for the damage corresponding to the price set by the provincial People’s Committee or will be

compensated for the entire area of the existing house in case it is unable to be renovated and must be relocated.

- Houses and works with people regularly living under 220 kV electric corridors must ensure safety conditions as prescribed.

See House statistics of households within the line corridor in the *Appendix 4.1*.

<u>+ Compensation policy for affected people on residential land, agriculture, crops and plants</u>

The amount of detailed compensation for residential land, agricultural land, crops and plants is based on the Statistical table of farm land in the line corridor as shown in the *Appendix 4.2*.

- Temporary affected land, land in the line corridor temporarily affected during construction (foundation excavation, construction of columns, pulling and straining ...) will not be compensated but damaged rice, crops and plants will be compensated in cash according to the price set by the provincial People’s Committee. In case perennial trees are cut, compensation will be paid in cash according to the unit price of the provincial People’s Committee based on tree classification, age and production value.

- The land eligible for compensation according to regulations, will not be recovered by the State. However, the land located in the safety corridor of the line and has limited usability, will be compensated for damage according to current regulations.

- Based on the decision of land acquisition of the Provincial People's Committee, for land and assets permanently affected at the column foundation, the operating road will be compensated at the prescribed price.

e) Organization of implementation.

** Assignment of duties*

Local government (People's Committee of Kon Tum and Quang Ngai provinces): Make a decision to establish a District Compensation, Assistance and Resettlement Council, which is responsible for coordinating with the investor to ensure the progress of the project according to Article 40 of Government’s Decree 197/2004/ND-CP dated December 3, 2004.

The investor is Dak Drinh Hydropower Joint Stock Company, managing the investment and construction of Dak Drinh Hydropower project. There is a specialized department in the company’s apparatus to manage compensation and resettlement. The investor is responsible for assisting the Chairman of the Compensation, assistance and resettlement Council to make a compensation plan, ensuring sufficient funds to pay the compensation punctually (Article 40 Government’s Decree 197/2004/ND- CP dated December 3, 2004).

** Implementation plan*

The main progress of the Dak Drinh Hydropower project is as follows:

- Commencement date is in May 2007. (in the hydropower plant area)
- The button of the diversion tunnel and filling the reservoir with water is in August 2011.
- Generation of unit 1 is in December 2011; Generation of unit 2 is in February 2012;

Design profile: To implement the work of compensation, assistance, migration for land clearance, the Investor will sign a contract with a consultant to prepare a specific design profile of the Compensation, assistance and resettlement in 3 steps: Master plan, basic design, construction drawing design and bidding documents.

To ensure the progress of the project, the progress of compensation, assistance, and migration for land clearance of the hydropower plant must be completed before commencing (Quarter I/2008); areas of focal works and water intakes, construction niches must be completed from the mid-year to the end of 2008; reservoir bed area will be completed by the 2011 flood season.

Method of implementing the project includes 2 parts: Bidding and non-bidding

- Non-bidding part: Consultation, Compensation payment, assistance and land clearance, insurance, fee management, settlement verification
- Bidding part: Construction and installation of items in the resettlement areas.
- It is expected that the bidding packages are divided according to construction and installation specialties: Traffic, Irrigation, Electricity, Construction in each province.

4.2.2. Measures for negative impact mitigation during construction phase

As stated in *Section 3.1.2.3*, construction activities will create impact sources such as: (1) Landslide. (2) Traffic obstruction. (3) Labor and traffic accidents. (4) Health of construction forces and local people. (5) Taking advantage of the exploitation of forest resources. (6) Social problems. The following are the main mitigation measures that will be implemented on the Dak Drinh hydropower site during the construction period corresponding to each impact above. Specifically:

a) Prevention and limitation of landslide:

At the main dam, spillway and quarry, because the topography is steep, the excavation of overburden, the quarrying is done by bulldozing from the top, shoveling to the landfill, storage yard.

The terrain of the route from the central auxiliary area to the plant is very steep and when digging the foundation hole of the plant and the water intake so the appropriate measures will be applied to treat the slope to avoid landslides during the rainy season.

At the excavation or backfilling position, there must be staff to guide machines, especially where the excavation is on high or on the slope, it is necessary to have a watcher for vehicles and pedestrians below.

b) Measures to limit traffic and occupational accidents:

In order to limit traffic and occupational accidents during the construction process, it is necessary to comply with the State's Procedures - Rules, Standards on occupational safety ... fire prevention, especially for underground work, quarrying, foundation excavation, blasting:

- At the construction site, there must be a specialized safety board to manage and supervise all conditions - Safety performance standards and the compliance of production safety rules.
- All workers on the construction site must attend training courses on occupational safety and possess safety cards.
- There must be adequate warning signs on the construction routes to guide the traffic. Especially at night construction on curved road section with great slopes must have warning signs and lights.
- In the rainy season at the temporary construction road sections with a high steep slope, it is necessary to have a 0.5 m thick stone pavement layer to avoid slippery for motor vehicles.
- All unauthorized persons are not permitted to enter the construction site, especially the Tunnel.
- The construction area must have a light system with enough light to ensure safety at night.
- Camps must be located at least 400 m away from the rock blasting position.
- Blasting workers must learn about technical expertise. Before and after blasting, there must be loudspeakers, whistles and flags indicating the beginning and ending of blasting and there must be a guard station to prevent entry into the area.
- One day before blasting, the Contractor must notify all construction site of the expected blasting time. The best times for blasting are usually at 12 noon or 18 o'clock daily.
- Regularly check to remind electrical safety in construction and the grounding of the system, electrical equipment.
- Immediately stop all blasting when it rains with thunderstorms and lightning.
- Regularly check, maintain motor equipment.
- It is absolutely forbidden to build houses, open shops near the main construction roads, obstructing traffic and possibly causing accidents.
- Regularly check safety corridors protecting high-voltage power lines (especially power lines running along traffic roads) to prevent trees from touching electrical wires, falling trees or

rolling rocks, making electric poles fallen, causing danger for people, vehicles, and slowing production.

- Avoid placing the tower crane too close to the blasting area.

Safety measures in tunnel construction: Underground work is heavy and dangerous, so the occupational safety is especially focused:

- Take effective ventilation during construction
- Often check for toxic gases that are dangerous to workers.
- Absolutely obey the regulations on electrical safety, use qualified electric cables, placed on the supports along the tunnel walls, to avoid flooding the electrical system in the tunnel.
- Before blasting, the power must be cut off.
- The tunnel is quite small in size, the construction conditions are narrow, so every worker working in the tunnel wears helmets or reflective jackets.
- At the water intake position, a large-capacity pump station and a standby diesel generator will be arranged in the rainy season to maintain continuous drainage from the tunnel out.
- For surge shaft and inclined lines due to the use of cranes and winches to transport materials and equipment, regular inspection of lifting equipment and cable winch is extremely essential. Arranging a system of iron ladder leaning on the wall of surge shaft and inclined line for workers up and down.
- Provide adequate light in the tunnel during construction.

c) Measures to minimize negative impacts in construction of 110 kV line

** Safety measures in construction of 110 kV line:*

In addition to complying with regulations on traffic and labor safeties, the 110 kV line construction team must follow the correct procedure for the transmission line:

- Construction sites must have secure drainage systems. Do not leave water stagnant on the road surface of the construction site and do not allow rain water or wastewater to flow into surrounding works.
- The foundation pits on the construction site will be tightly covered or firmly fenced, ensuring safety for people traveling. Trenches, foundation holes located near or on the traffic road will have a barrier that is 1 m high, and there will be signal lights at night.
- At the temporary land acquisition sites of the project, the clearance will be carried out after completion, leveling, low-lying areas and returned to the locality in accordance with the previous agreement.

When digging the foundation for construction of columns

Strictly take safety measures while digging a foundation. The columnar foundation is mainly done by manual methods. The construction force is mainly local people so training in occupational safety will be paid attention.

Safety measures for erection of columns, beams and porcelain for wire spreading, wire connecting, wire stretching, deflection and installation of other fittings

Workers participating in the above work will ensure labor discipline, safety rules and comply with regulations on labor equipment (wearing helmets, gloves, ...).

All workers are health checked, meeting health standards to work at high altitude, learnt about the work they undertake and are informed about the labor safety procedures.

* *Prevention of incidents – safety assurance when installing electrical works*

- The construction of the line must comply with the provisions of the Industry Ministry's electrical equipment regulations to ensure safety during construction and installation as well as the line operation.
- During construction, do not use explosive solutions, but mainly use manual excavation methods (at the line).
- When using an electric or pneumatic hand tool, the worker must not work on the steps but on the safety supports. Heavy tools are made a bracket or other safety means.
- Strictly comply with the regulations on safety for electrical equipment installation. Transporters who install electrical equipment are trained in regulations on safe transportation and installation of electrical equipment.
- Before energizing to test the grid and equipment, relevant work will be stopped, and personnel in the distribution room must be out of the danger area.
- When installing overhead structures, the safety rules of the outfit and the belt will be followed.
- When a fire occurs due to an electrical problem, first of all, it is necessary to report the power cut off and then follow the normal fire-fighting procedure.
- Install danger warning signs where necessary (electric poles ...).
- Disseminate knowledge of transmission line corridor safety to communities living near the area where the line passes.

* *Solutions to minimize impacts on traffic roads, information transmission lines, electricity:*

- Before pulling the wire across the traffic road and the river, the Project Management Board will notify the authorities to coordinate temporarily suspending traffic flow, pay attention to the warning signs.

- When pulling the wire through the power line, there will be a specific plan, informing the authorities to temporarily cut off power, ensuring safety for workers and residents during construction, as well as informing locality to proactively produce, minimizing possible effects.

d) Solution for domestic water supply and health protection for workers:

During the construction of Dak Drinh hydropower work, the demand for domestic water will be calculated according to the norm of 80 liters/person.day. Water sources for domestic use are sampled for testing water quality to design and build treatment systems.

- Regularly (periodically) re-check the domestic water source, the air pollution and the working environment.
- There are street sprinkler to daily water the road to reduce smoke and dust within the site.
- Employees working at the field are fully equipped with necessary protective equipment in accordance with regulations such as helmets, safety belts, shoes, etc. and undergo periodic health checks.
- There must be a medical station serving first aid and emergency on site at the construction site. There is at least 1 ambulance available 24/24 hours.
- Officers working at high altitude or driving heavy motor vehicles are regularly checked the health and treated timely to avoid unfortunate risks that may occur.
- The employer must sign the contract and pay full insurance costs with the employees.

e) Measures to minimize negative impacts on ecological environment:

1) Management to limit exploitation of forest resources:

The process of site clearance for construction areas, resettlement areas, 110 kV transmission lines, reservoir bed cleaning, are ensured compliance with the Law on Forest Protection and Development No. 29/2004/QH11, and Government’s Decree No. 23/2006/ND-CP dated March 3, 2006 on the implementation of the Law on Forest Protection and Development. Strictly manage the exploitation on the areas to limit the exploitation of forest resources.

Strengthen the forest guards to set up posts on the access roads to the construction sites and forest gates, to patrol the forests during the construction period to prevent illegal logging and hunting. In addition, the duty of forest guard and patrol staff should is to record, monitor and analyze regularly data of logging, illegal fuelwood collection or forest fire, thereby identifying trends in exploitation, or exploited area.

Implement education programs to raise awareness on environmental protection through many lively forms such as panel, posters and radio in the area to minimize deforestation as well as hunting and using forest animals for local people and construction workers. This work must be coordinated by local mass organizations, investors, construction contractors.

2. Mitigation of negative effects on aquatic systems:

At the construction sites near and on rivers and streams such as dams, water intakes, hydropower plants it must be properly implemented the measures of waste and wastewater treatment, and cover plant clearance in the reservoir bed as described in the *Section 4.1.1*; landslide prevention measures described in section 4.2.2 to limit surface water pollution.

Do not arrange concentrated construction camp areas near rivers and streams.

Educate and manage workers to avoid the use of mines, detonators and electric fishing gear.

g) Prevention of negative social impacts.

In order to avoid negative social impacts during construction such as conflicts caused between construction workers and local people, disease development described in *section 3.3.1.3*, the following measures will be taken:

- Disseminate to the forces on site about customs, festivals and beliefs of Ca Dong and Hre people. Educate workers, build healthy relationships with the local community.
- Strengthen the exchange of support between construction units and localities. Implement good relations and solidarity between workers and local people.
- Hire local people as much as possible for non-professional jobs to avoid crowding around construction workers.
- The Contractor provides accurate information on the time and regulations for groups of construction workers to the local People's Committees. Open information channels and relationships between local People's Committees and contractors to discuss and make necessary decisions in management.
- Register temporary residence with local Public Security for easy management of other criminals entering the area.
- After the project is completed, the temporary requisition areas for construction, all 110 kV line construction camps will have to be moved, restored and returned as the original state to the people and local government.
- Take measures for hygiene and disease prevention on the construction site and neighboring residential areas.

4.3. MINIMIZING MEASURES IN OPERATION STAGE

4.3.1. Measures to regulate flows, and safely operate reservoirs and dams:

a) Establishment and implementation of the Operational Procedure of Dak Drinh hydropower reservoir

In order to exploit the reservoir effectively and safely for the project itself and all objects in the reservoir area and downstream in the project period, Investor (Dak Drinh Hydropower Joint Stock Company) with the consulting unit (PECC2) established the ***Operational procedure of Dak Drinh hydropower reservoir*** in accordance with the Decision No. 285/2006/QD-TTg dated December 25, 2006 of the Prime Minister on the content of authority to promulgate and organize the implementation of operational procedures of Hydropower reservoir.

In the **Operational procedure of Dak Drinh hydropower reservoir**, regulations on flood control, flood regulation, valve opening and closing procedures are identified to ensure safe operation, regulations on power generation, and responsibility for hydropower reservoir organization and operation for Dak Drinh hydropower reservoir.

In the stage of engineering design and construction, after having the test results of the hydraulic model, the above operation procedure will be adjusted.

Dak Drinh hydropower reservoir with a capacity of 249.3 million m^3 will be chaired by the Ministry of Industry, in coordination with the Ministry of Agriculture and Rural Development, the Central Committee for Flood and Storm Control and other Ministries, branches, Quang Ngai province, Kon Tum province to appraise and approve the operational procedure of Dak Drinh hydropower reservoir.

The investor (Dak Drinh Hydropower Joint Stock Company), using, exploiting and operating hydropower projects is responsible to the law for the compliance with the operational procedure of hydropower reservoir.

b) Implementation of Dam Safety Management measures

During the operation of the Dak Drink hydropower reservoir and dam, the Investor (Dak Drinh Hydropower Joint Stock Company) will comply with Government's Decree No. 72/2007/ND-CP dated May 7, 2007 on dam safety management and operational procedures. Specifically:

Follow the Reservoir Water Regulatory Procedures, which regulate the reservoir filling and discharge, under normal conditions and in emergency situations.

Comply with the valve handling and operating procedures. It is strictly forbidden for unauthorized persons to order or coerce operations. It is strictly forbidden to operate the work in contravention of the procedure; only responsible people can operate the work.

Perform a test run for the valve gates that are not frequently operating or during periods of non-routine operation, including the backup valve gate.

The operation and test run of the valve gates of the works must be recorded in the operation record book.

Implement the dam maintenance. Check periodically before and after the rainy and flood seasons. Every year, the dam owner will make and send dam safety reports to the Ministry of Industry, the Ministry of Agriculture and Rural Development and relevant agencies in accordance with regulations.

Organize periodic dam safety inspections.

c) Taking measures to protect reservoirs and downstream

Before accumulating water to operate the Dak Drinh hydropower reservoir and dam, the Investor (Dak Drinh Hydropower Joint Stock Company) signs a contract with the geographic unit to identify and set up landmarks in the dam protection vicinity according to the provisions of Article 25 of the Ordinance on Exploitation and Protection of Irrigation Structures; and is responsible for ensuring the safety of the dam and the dam protection vicinity in accordance with the provisions of Article 26 of the Ordinance on Exploitation and Protection of Irrigation Structures and other relevant law provisions.

For the area of Dak Drinh hydropower reservoir, the People's Committees of Kon Tum and Quang Ngai provinces shall, based on the characteristics of the local situation, specify and organize the marking of boundary line; be responsible for managing the work protection vicinity according to regulations. Propose the boundary of the area of Dak Drinh hydropower reservoir determined according to the results of water level calculation and regulation with floods of 5% frequency (with low water) corresponding to 410 m of normal water level.

During the reservoir flood discharge operation, sudden increase of water level in the upstream reservoirs, downstream river and stream sections of the flood discharge works, the investor will take measures to alert and notify in advance to ensure safety for people, ships, boats and vehicles, activities on rivers and streams. Specifically: The communication system at the dam and the center will be guaranteed with backup power supply and communication with the communes of Dak Nen, Dak Rinh, Son Dung, Son Mua, the resettlement areas along the reservoir, and Son Tay district. There are sirens in case of flood discharge at the dam site.

4.3.2. Measures of negative impacts mitigation related to water environment:

a) For the river section behind the dam leading to the confluence of Dak Bua stream

As mentioned in *Section 3.2.2*, it is recommended to apply the DR2 scenario without discharging water from the reservoir to the river section behind the dam in dry season.

However, the design is still created to build the discharge gate. In the field of the results of the monitoring program of the relationship between the aquatic ecosystems and the flow in the river section behind the dam leading to the confluence of Dak Bua stream, there is enough basis to determine the need to discharge environmental flows, that will adjust the reservoir operation procedure. In this case, the DR1 scenario will be applied to discharge water from the reservoir to the river section behind the dam in dry season months with a flow of 0.77 m^3/s will be applied to maintain environmental flow.

b) Ensuring water quality

For water quality, during operation, bottom discharge will be carried out, creating conditions for disturbance of the bottom water layer, ensuring oxygen flow at the reservoir bottom area, reducing organic matter of the bottom layer.

Besides, it is necessary to control fertilizers for crops in the upstream basin of the reservoir. With chemical fertilizers used upstream (for industrial crops, fertilized with relatively large amounts of nitrogen and phosphate) will accumulate and circulate in the reservoir, promoting development of types of algae in the reservoir, increasing the fertility of the reservoir and affecting the operation of hydropower plants.

The fisheries development plan will only proceed when the potential risks are not assessed due to the existence of dioxin in the area.

All resettlement areas are located near the reservoir, so all households are built with sanitation and domestic water drainage systems properly treated before discharging into streams and reservoirs, meeting the standards specified in column A in TCVN 5945 - 2005. (Industrial wastewater - waste standards).

4.3.3. Measures to minimize the negative impact on the geological and geomorphological environment.

The downstream discharge of the plant into the river bed with clear water will increase the possibility of erosion in this area. Stilling works will be constructed to reduce this impact.

According to calculations, the semi-flooding phenomenon has happened, but with a small area, it does not affect any areas in the region. After the operation procedure of the reservoir, a part of this area will be used for cultivation, a part will form grass and shrubs during the dry season, and decompose during floods. Because farming in the semi-flooded area will have the effect of increasing bottom displacement. On the other hand, farming activities increase the ability of reservoir bank erosion, affecting speed of sedimentation of the reservoir bed. Therefore, the use of semi-flooded land should not be encouraged for cultivation.

- In areas of weak sub-clay textured soil banks, with a slope of more than 15^o, new bank regrowth processes can still take place (as mentioned in section: Reservoir bank regeneration). Note that this process takes place frequently (as on all other reservoirs) due to the rocky shoreline structure, wind, waves, boat displacement, and flow impacts during flood season or during spillage and underground discharge ...

Some land areas are inevitable to be destroyed during construction (housing, working houses, workers' camps, earth mines, stones, disposal sites, storage yards ...). After construction of the project, in addition to some reused fixed facilities such as working houses, power transmission lines, operation lines ..., the remaining land area will be leveled and restored to protect the environment.

To prevent erosion in the reservoir area and limit the amount of alluvial deposited in the reservoir bed, it is necessary to protect watershed and protective forests.

4.3.4. Measures to minimize the impact on the ecological environment

To mitigate the impacts of the works to the ecosystem during the period of water filling and operation, it is necessary to apply the following measures:

The area of temporary requisition for construction will restore the reforestation forest. Specifically: The focal auxiliary area of water intake: 10 ha; Auxiliary area of sub-tunnel No. 2, No. 3: 5 ha; Factory auxiliary area and pipeline: 3 ha; and a part of quarry area is expected to be about 12 ha.

In the resettlement areas in the bad sloping lands that cannot cultivate non-productive rice, the allocation of land to people for afforestation (eucalyptus, acacia ...) is encouraged to increase the proportion of green space in the residential area and public works.

To restore and develop the fauna of the forest in the region, strengthen education, management and planning for watershed protection.

Aquatic flora and fisheries of the water body are influenced by many natural factors as well as human factors. When it becomes a reservoir, on one hand, aquatic organisms and fisheries change to reservoir fisheries, on the other hand, the hydrological regime of the reservoir can affect downstream and fisheries here.

+ The reservoir bed and dam areas: Management and development of reservoir fisheries, including natural exploitation and reservoir aquaculture. Establish a water environment monitoring station in terms of hydrology, physics, chemistry and biology.

+ The downstream area: Guide local people to exploit fish with methods and time suitable to the hydrological regime and resource protection, not fishing with mines, electric pulses, toxic chemicals ... .).

In order to implement mitigation measures to the ecological environment, it is necessary to coordinate with local authorities and educate the people about environmental protection awareness.

The above-mentioned activities are mainly carried out by Forest Protection Sub-Departments, Fisheries Protection Sub-Departments in conjunction with local authorities.

The investor will share this benefit through royalties and other contributions according to government regulations.

4.3.5. For the socio-economic environment.

To ensure the safety of local people, it is necessary to strictly comply with the current regulations on flood discharge; Timely notification is required to minimize the possible loss of life and property.

In the event of flood discharge causing damage to crops or material facilities, the investor shall reimburse the investor.

After compensating for the affected households of the project, the resettlement organization will continue to take measures such as support for agricultural extension, medical assistance, mosquito spraying, and additional funding to buy preventive medicine. and treat common diseases such as malaria, diarrhea, cholera, typhoid ... to ensure a long and stable life.

Strengthen management of demographics and labor in the reservoir area. With the coordination of 2 districts Son Tay, Kon Plong and investor (DHC).

Create favorable conditions for affected households to benefit directly from the project such as tourism exploitation, aquaculture in the reservoir bed.

4.3.6 Mitigation of the bad impact of 110 kV mobile phone in the operation phase

a) Mitigation of the electromagnetic field effects on 110 kV lines

For the voltage line of equal or less than 110 kV, the influence of electric and magnetic fields is negligible, the design must comply with the applicable regulations and rules. In order to reduce the electric field intensity caused by the line when passing through a residential area, the distance from the lowest conductor to the ground h > 13 m is designed. According to that distance, the maximum electric field intensity at the point of 1 m away from the ground in the corridor has the corresponding value less than 2 kV/m (according to regulations, it must be less than 5 kV/m).

Thus, the electric field intensity caused by the line in the corridor ensures the conditions that the houses can be existed and the health of the residents is not affected in the area.

b) Prevention of 110 kV line effects on communication lines

The effect of the halo phenomenon on the line to the radio and television equipment is designed to be reasonably limited, according to IEC and TCVN standards.

The designed line has a voltage of 110 kV, so the effect on the communication line is negligible. However, for equipment using radio waves and information technology equipment sensitive to electromagnetic fields, some measures are also needed to limit the effects such as:

Select radio and electronic radio equipment with high interference stability and large test voltage.

Use remote and local shielding measures (such as wires, shields, screen grid, protective boxes ...).

Use digital to transmit signals.

Use metal shielded cables, fiber optic cables to conduct signals.

Ensure the minimum distance from high-voltage lines to information works.

c) Minimize the impact of the 110 kV line on the ecological environment

To minimize the impact of the line on the ecological environment when in operation, trees must be pruned down within safety corridor range to ensure safety for the corridor in accordance with the provisions of Decree 106/2005/ND-CP.

4.4 MEASURES TO PREVENT AND RESPOND TO ENVIRONMENTAL INCIDENTS

4.4.1 Prevention and response to the risk of fire and explosion

In the construction auxiliary areas, processing workshops, workers' camps and offices will be designed and installed firefighting systems. Contractors must develop fire prevention plans, rules of action when there is a fire incident in a specific way. Make plan to coordinate fire prevention with fire stations of Quang Ngai province.

For petroleum depots, the following control measures will be taken:

- Minimize the permeability of the waste oils to the ground and the aquifers, to perform this work, there will be a mode of checking the fuel tanks before being put into use and regular test mode during operation, especially for underground tanks.
- Build a separate fire and explosion prevention system for the fuel storage area such as fire prevention equipment, regulations on fire and explosion prevention, action plans when there is a fire incident ...
- Build the sewer system to collect storm water and design and construct the grease separation system for storm water from the warehouse area.
- The lost grease and oil collected will be put into a container with a lid before transferring to the competent agency for handling.

In order to minimize the negative effects caused by explosives depot, the following measures are taken:

- The explosives depot is in accordance with technical specifications, located far away from residential areas and surrounded by hills and mountains, ensuring a safety radius when exploding.

- Explosives are safely transported into explosives depot.

- Set out fire and explosion prevention measures

- Build a bank around the depot in order to limit the risk effects to the explosives depot caused in the event of an incident.

- Take measures to monitor explosives depot during storage period.

- Assign security guard to look after the depot carefully, when there is an incident, promptly report it to the higher level for resolution.

4.4.2 Prevention and response to incidents in the construction process

a) Prevention of broken retaining dike incidents:

At the beginning of flood season, conduct general inspection and assessment of the stability of the dike; closely coordinate with the flood and storm prevention and fighting forces of the investor, the contractor and the locality to develop plans for flood and storm prevention and fighting, incident response for the retaining dike and flood prevention and fighting plans for downstream area;

Coordinate with Quang Ngai Hydrometeorology Forecast Center to be proactive in construction plans during the rainy season. When there is heavy rain and flood, construction activities absolutely must not conducted on the retaining dike. Motorbikes and people must be exited.

- At the entrance to the tunnel in the rainy season, there must be a unit on duty to check the dike condition and the flood water level.

At the time after the end of the flood season, it should re-check to detect the erosion (if any) to monitor the progress of the existing erosion of the retaining dike; learn from experience in flood and storm prevention and fighting; proposing measures and plans for repairing and overcoming existing defects;

b) Prevention and response to tunnel landslide incidents:

Observe the safety regulations for tunnel construction as outlined in *Section 4.2.2.2*.

Carry out reinforcement of the tunnel wall simultaneously with excavation, paying special attention to detected faults and signs of fault detection.

Develop and practice emergency response plans when tunnel collapses. At the portals of tunnels, there must be a communication system to coordinate the rescue forces.

In the event of a breakdown, the construction equipment in the tunnel must be cut off immediately. Gather the rescue force according to the plan to fix the problem, quickly digging (in the case of someone in the collapsed tunnel, quickly dig, perform the first aid method as practiced.)

4.4.3 Prevention and response to problems during operation

c) Prevention and response to flood discharge through spillway:

Perform a test run of the valve gate that are not frequently operating or during periods of non-routine operation, including the backup valve gate. The operation and test run of the construction valve gate must be recorded in the operation monitoring book.

Notify people of Dak Nen, Dak Rinh communes and resettlement areas. In this case, it is necessary to support and coordinate the authorities of the above communes and Kon Plong district to move people up from the flood altitude.

b) Prevention and response to dam failure:

1. Performance of test mode:

The Investor will conduct regular dam inspections through analysis, evaluation of dam measuring and monitoring documents and visualization at the site. According to the modes

Check periodically before and after the rainy and flood season every year:

Carry out an unscheduled inspection immediately after a heavy rain, strong earthquake or unexpected damage.

Check and survey in detail the dam: when the dam is severely damaged, the dam owner must organize a detailed investigation and survey to determine the cause and extent of the damage; design and repair; At the same time, it must take proactive measures to prevent, fight and ensure safety of dams and safety in the downstream area.

2. Development of flood and storm prevention plan

Every year, before the rainy season, the investor will establish or update and supplement the flood and storm prevention plan and submit it to the competent state management agency for approval. After the plan is approved, the preparation must be carried out; supplies, materials and spare tools must be gathered and stored at the prescribed place; technical staff, rescue force, rescue means must be managed according to regulations to be ready to mobilize when necessary. The Committee for flood and storm control must conduct a meeting, approve the working regulations and the standing regime.

During the rainy and flood season, the investor must maintain the communication regime, the regime of reporting the situation to the Superior Committee for Flood and Storm Control and competent state management agency according to regulations.

3. Response to dam failure

In the event of an incident, which can cause unsafety of the dam, the rescue must be carried out urgently with the highest priority efforts to keep the project safe and minimize the damage.

People's Committees at all levels, according to their functions, duties and powers, are responsible for organizing the rescue of dams in their respective localities and participating in the rescue of dams for other localities according to the provisions of law.

The Investor takes measures to immediately alert and notify to ensure the safety of people, ships, boats and means of travel, operating on rivers, streams and potentially flooded areas.

e) Response to incidents on power transmission lines:

1. Prevention of electric pole collapse at 110kV lines

Prevent collapse of high voltage poles, the following measures will be strictly taken:

- Design and construct foundation pits and high-voltage columns of high quality, suitable to the engineering geology of each location. Closely supervise the construction process of the foundation pit, ensuring the correct type, volume of materials and construction techniques.
- Install lightning protection systems at all high-voltage columns in accordance with regulations. Color paint (as defined) on columns with a height of over 50 m.
- In the area where the high-voltage columns crossing the river, coordinate with local authorities to prohibit on-shore and under-river exploitation to avoid landslides.

In the design, the column-foundation is calculated to ensure to withstand the total load acting on them with a necessary reserve (factor of safety).

In the event of a column collapse, the troubleshooting measures are replacement of a broken column or a damaged column foundation. Handling is carried out by vehicles and specialized equipment to ensure safety and limit power outages. Because it takes a lot of time to replace the new columns and foundations, in some cases the problem must be solved by constructing a temporary detour line for provisional current connection to isolate the fault location. The temporary line section uses a specialized troubleshooting column (KEMA column) so it is built very quickly to supply temporary power to the line. After the temporary power supply, the faulty column or foundation will be replaced. When the renewal is completed, the temporary line will be dismantled and restored by the original line.

2. Plan for fire, explosion and electric shock prevention and response

During operation, when there is a breakdown, the protective relays located on the line will automatically disconnect the circuit. The line corridor must ensure technical conditions in accordance with the Government’s Decree 106 , so there will be no fire caused by the line.

3. Prevention of risks caused by natural disasters:

a/Earthquake: When there is a breakdown, the protective relays located on the line will automatically break the circuit.

b/Flood: when the flood water level will exceed the design calculation, the power will be cut temporarily.

c/Lightning: In order to protect against direct lightning strikes, the line is designed to hang 2 lightning protection wires on the whole line. Protection angle between earth line and conductor at the top of column is equal and more than 20^0, meeting the requirements of regulation 11 TCN-19-84. In which, one wire uses galvanized steel cable, one wire uses earth line with fiber optic cable. The river crossings are sections where lightning is concentrated because the support column is high. In oder to enhance the protection against repeated lightning strikes in the crossing, the earth line must be directly grounded.

CHAPTER 5: COMMITMENT TO IMPLEMENT ENVIRONMENTAL PROTECTION MEASURES

1. Dak Drinh Hydropower Joint Stock Company ensures the truthfulness of the data and documents in the report and undertakes to build and operate the project's items in accordance with the following Vietnamese regulations and standards:

- Law on Environmental Protection, issued by decision of the President of the Socialist Republic of Vietnam on November 29, 2005.
- Government’s Decree 80/2006/ND-CP dated August 9, 2006, detailing and guiding the implementation of a number of articles of the Law on Environmental Protection.
- Circular 08/2006/TT-BTNMT dated September 8, 2006 of the Ministry of Natural Resources and Environment on guiding strategic environmental impact assessment, environmental impact assessment and environmental protection commitment.
- Government’s Decree No. 106/2005/ND-CP dated August 17, 2005, detailing and guiding the implementation of a number of articles of the Electricity Law regarding safety protection of high-voltage grid works.
- Government’s Decree No. 169/2003/ND-CP dated December 24, 2003 on Electricity safety
- Government’s Decree No. 197/2004/ND-CP dated December 3, 2004 on Compensation, Support and Resettlement when the land recovered by the State.
- Government’s Decree No. 17/2006/ND-CP dated January 27, 2006, amending and supplementing a number of articles of the Decrees guiding the implementation of the Land Law.

- Government Decree No. 84/2007/ND9-CP dated May 25, 2007. Additional provisions on issuance of land use right certificates, land recovery, exercise of land use rights, order and procedures for compensation, support and resettlement when the land recovered by the State and settlement of land complaints.
- Circular No. 06/2007/TT-BTNMT dated June 15, 2007 of the Ministry of Natural Resources and Environment, guiding the implementation of the Government's Decree No. 84/2007/ND-CP dated May 25, 2007 on additional provisions on the issue of land use right certificates, land recovery, exercise of land use rights, order and procedures for compensation, support and resettlement when the land recovered by the State and settlement of land complaints.
- Law on Water Resources No. 08/1998/QH10, passed by the National Assembly of the Socialist Republic of Vietnam on May 20, 1998 and took effect from January 01, 1999.
- Government's Decree No. 72/2007/ND-CP dated May 7, 2007 on the dam safety management
- Law on Forest Protection and Development No. 29/2004/QH11, passed by the National Assembly of the Socialist Republic of Vietnam on December 3, 2004 and took effect from April 1, 2005.
- Government's Decree No. 23/2006/ND-CP dated March 03/, 2006 on the implementation of Law on Forest Protection and Development.

Compulsory Vietnamese standards (TCVN) according to Decision No. 22/2006/QD-BTNMT of the Ministry of Natural Resources and Environment dated December 18, 2006

- TCVN 5937: 2005 - Air quality - Quality standard of surrounding air.
- TCVN 5942: 1995 - Water quality - Quality standard of surface water.
- TCVN 5945: 2005 - Industrial wastewater - Waste standard.
- TCVN 6775: 2000 - Water quality - Domestic wastewater.
- Decision 1329/2002/QD9-BYT dated April 18, 2002 of the Ministry of Health on promulgating sanitary standards of potable water
- TCVN 4086: 1995 Group H: Electrical safety standards in construction.
- TCVN 5949-1998: Noise standard.
- TCVN 6980: 2001: Standards of industrial wastewater entering river basins for domestic water supply.
- ISO 14001: 1998 Environmental management systems.
- Local regulations and policies issued during project construction and operation.

2. We are committed to implementing the mitigation measures of the adverse environmental impacts outlined in *chapter 4*, as well as implementing the environmental management program outlined in chapter 6 of this EIA report. Specifically:

In construction phase:

- Take measures to minimize air pollution, minimize negative impacts on the water environment, treat solid wastes generated during construction and operation as stated in *section 4.1* and construct Environmental treatment works presented in *section 6.1*.
- Implement the compensation, assistance and resettlement program in accordance with the State regulations and agree with the local authorities as described in section *4.2.1*. At the same time, take measures to minimize the negative impact on the economic and social environment of the project area.
- Implementation of the mitigation measures for bad impacts in the construction phase presented in section 4.2.2 includes preventing and limiting landslide, limiting labor accidents and traffic, supplying water for domestic use, protecting the health of construction forces and local people, Minimizing bad impacts on ecological environment, minimizing negative impacts on society. The above measures will be implemented in project construction activities including the construction of 110 kV transmission power line and construction of resettlement areas.
- Implement mitigation measures for ecological environment. Comply with regulations on forest protection under Law on Forest Protection and Development No. 29/2004/QH11, strictly comply with the provisions of Government's Decree No. 23/2006/ND-CP dated March 3, 2006 on the implementation of the Law on Forest Protection and Development as described in Section 4.2.2.5.
- Together with construction contractors to coordinate with the locality and relevant units to develop plans for fire prevention and fighting and incident response during the construction process.

During operation:

- Take measures to ensure safe operation of reservoirs and dams in compliance with the provisions of Government's Decree No. 72/2007/ND-CP dated May 7, 2007 on Dam Safety Management.
- Implement measures to minimize negative impacts on the water, geomorphological and ecological environments, as well as the regional socio-economic environment.
- Coordinate with the locality and relevant units to develop fire and exploision prevention and incident response plans during the operation.

Undertake and secure funding for the implementation of the environmental management program during its construction and operation as outlined in chapter 6.

3. We are committing to taking responsibility to the Law of the Socialist Republic of Vietnam for any violation of international conventions, TCVNs and environmental pollution incidents.

Chapter 6: ENVIRONMENTAL TREATMENT WORKS ENVIRONMENTAL MANAGEMENT AND MONITORING PROGRAM

6.1 LIST OF ENVIRONMENTAL TREATMENT WORKS

6.1.1 Domestic wastewater collection and treatment system:

In the construction stage: there are 3 systems located in 3 zones: (1). The dam route and the water intake with an average discharge of 74.6 m^3/day and night; (2). Sub-tunnels 2 and 3 and surge wells, the average discharge of 30.45 m^3/day and night; (3) Hydropower Plant and Site Management Board, the average discharge of 15 m^3/day and night.
In the operation stage: there are 3 systems located in 3 operating zones: (1). The key workshop with an average discharge of 0.5 m^3/day and night; (2). In the center of the factory, the average discharge of 4.9 m^3/day and night; (3) Power distribution station, the average discharge of 1.0 m^3/day and night.

After going through the treatment system, domestic wastewater will reach level II as prescribed in the Vietnamese Technical Regulation TCVN 6772 - 2000 (Water quality - Domestic wastewater). Diagram of the treatment process of domestic wastewater before discharging into Dak Drinh river is shown in *Figure 6.1*.

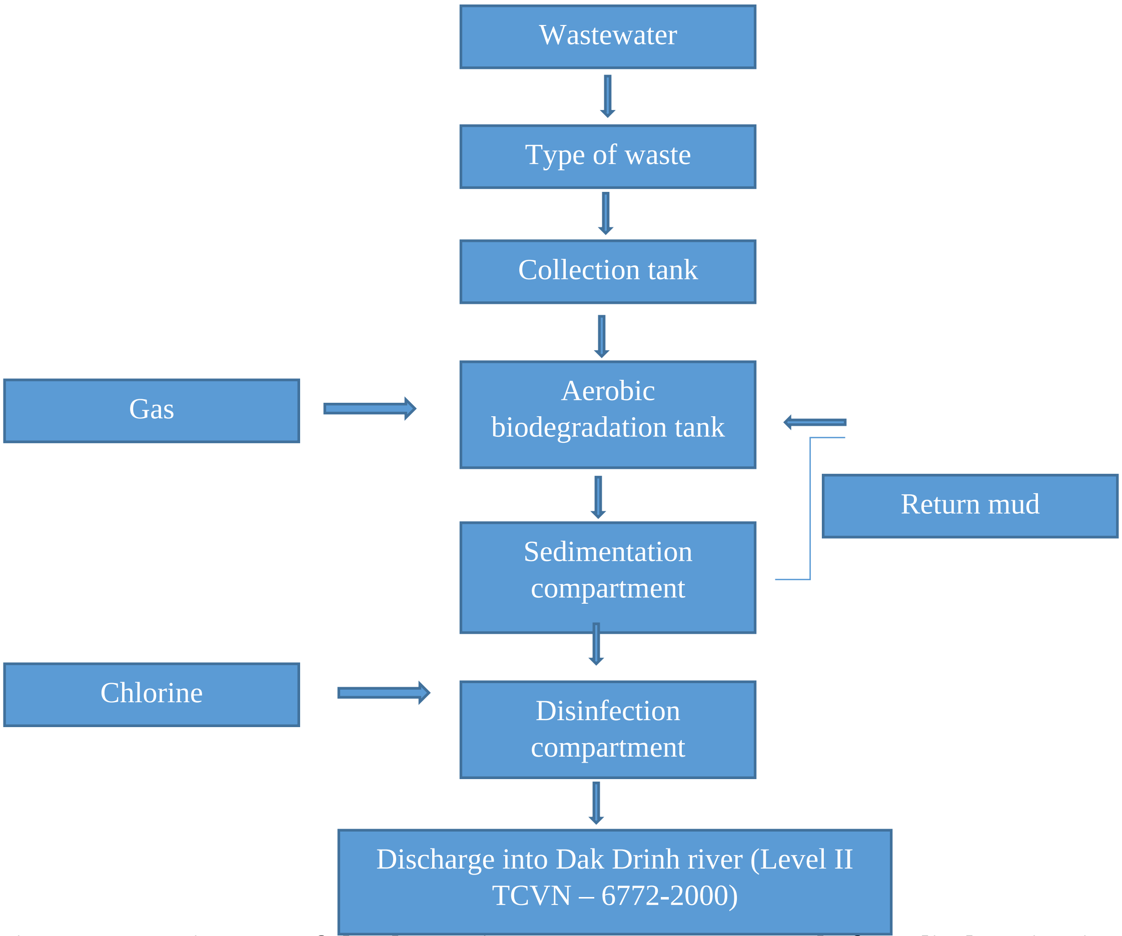


Figure 6. 1: Diagram of the domestic wastewater treatment before discharging into Dak Drinh river

The domestic wastewater treatment system is designed and built to meet the requirements of:

1. The baseline data

Wastewater flow: depending on each zone

Waste water characteristics: pH : 6 - 7,5
BOD_5 : 220 mg/l
COD : 350 mg/l
Total Nitrogen: 30 mg/l
Total Phosphorus : 20 mg/l

2. Requirement of treatment level: After treatment, the standard reached is Level II - TCVN 6772 - 1200:

pH : 5 - 9
BOD_5: 30 mg/l
Suspended solids (SS): 50 mg/l
Sulfide according to H_2S: 1.0 mg/l

3. Principle of operation:

Domestic wastewater is collected through a common sewer pipe through a waste removal net into the collection tank, then wastewater is pumped through aerobic biodegradation tank (fixed buffers). Here, in the condition of continuous aeration, the aerobic microorganisms clinging to the surface of the buffer material will decompose organic matter in wastewater, then wastewater is transferred to sedimentation tank to sedimentation. Wastewater after sedimentation is transferred to the disinfection compartment using chlorine. After disinfection, wastewater meets Level II TCVN - 6772-2000 and is discharged into Dak Drinh river.

6.1.2 Waste oil and grease collection system:

During the construction stage: at the maintenance area: 03 facilities for maintenance and repair of construction vehicles in the three main construction areas of the project: (1).The dam route and water intake with the average oil collection volume is 240 liters/month; (2). Sub-tunnels 2 and 3 and surge wells with an average waste oil collection volume of 210 liters/month; (3) Hydropower Plant and Site Management Board with an average waste oil collection volume of 150 liters/month.

In the operation stage: to recover the general amount of leaked oil for turbines, generators and transformers with the production wastewater treatment system (capacity of 3m^3), at the same time, use mobile recovery equipment with capacity 4 m^3/h. The oil system used for turbines and generators has 2 oil treatment tank with a capacity of 2 x 6 m^3. The oil system used for transformers with oil treatment tank with a capacity of 80m^3.

The production wastewater, after going through the above treatment system, meets the standards specified in Column A in TCVN 5945 - 2005 (Industrial wastewater - waste standard).

6.1.3 Solid waste landfill (waste rock and soil):

Waste soil and rock from construction is over 2,900,000 m^3. The disposal sites are located in 3 main construction areas (1). Disposal site at the dams, Disposal site at the water intake; (2). Disposal site at sub-tunnel 2, sub-tunnel 3, surge wells and Disposal site at the valve house; (3). Disposal site at Hydropower Plant area. The disposal sites are selected in low-lying land areas, and not at the head of water sources, waste soil and rock that are folded tightly, with ditches arranged around the disposal sites to collect rainwater, limiting the entrapping of suspended solids deposited before flowing into the river.

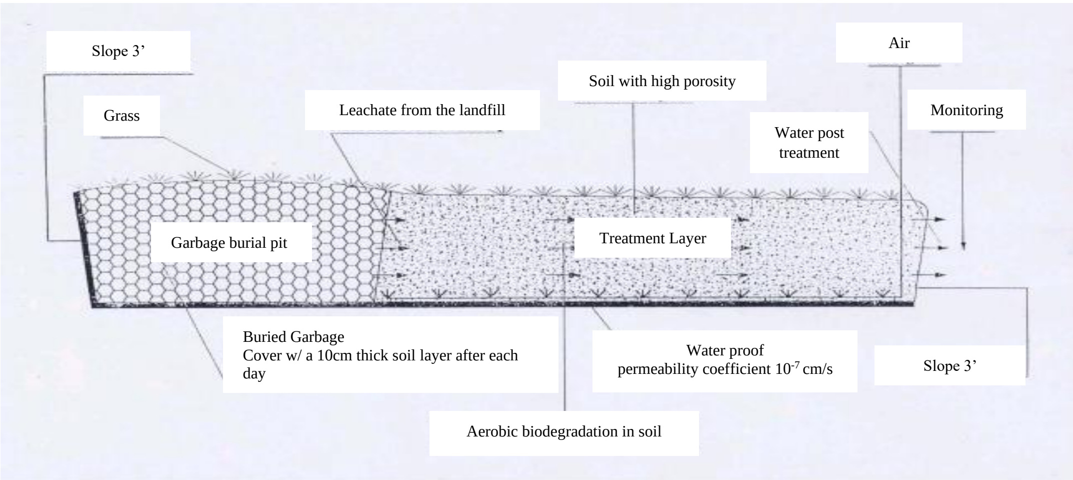
6.1.4 Domestic solid waste collection system:

According to Plan 2 in Section 4.1.1.3 in Chapter 4, daily waste is collected to the transfer stations which are located at appropriate locations in 3 zones: (1). Dam route and water intake: volume of waste is 4.5 tons/month; (2). Tunnel area and surge wells: volume of waste is 2 tons/month; (3). Plant and Line construction team 110kV: volume of waste is 1.5 tons/month. Then they are taken to the waste pits placed in the waste soil and rock disposal sites. The landfill pit will be built in accordance with the sanitary regulations, with a leachate treatment system equipped following the Treatment Wall method as shown in Chapter 4. See *Figure 6.2. Diagram of the principles of hygienic domestic waste burial with the leachate treatment by the Treatment Wall method*.

During the operation stage, hygienic waste bins will be arranged in a reasonable position at the operating areas. Every day, waste is collected to the transfer station with a capacity of 2 tons which is located at a suitable location in the central area of the plant. Then, every month,

DIAGRAM OF THE PRINCIPLES OF HYGIENIC DOMESTIC WASTE BURIAL WITH THE LEACHATE TREATMENT BY USING TREATMENT LAYER

waste is collected to the centralized waste treatment site of Quang Ngai province.



6.1.5 Clearance of lake bed:

Lake bed cleaning includes: (1). Clearing bombs, mines, toxic chemicals left due to the war; (2). Clean graves and farms; (3). Clean up vegetable matter in the lake bed. (See Section *4.1.1 Waste-related mitigation measures* in Chapter 4).

6.1.6 Forest restoration:

Landfill areas, storage yards, quarries, camps and other temporary requisition areas for construction after the construction completed will be leveled, and have forest restoration: (1) Key auxiliary area of water intake: 10 ha; (2) Auxiliary area of sub-tunnels 2 and 3: 5 ha; (3)

Auxiliary area of Plant and pipeline: 3 ha. (4) Dam and quarry area: 12 ha. (5) Other area: about 15 ha

6.2 ENVIRONMENTAL MANAGEMENT AND MONITORING PROGRAM

6.2.1 Environmental management program

a) Environmental management agency

Dak Drinh Hydropower Plant Project will cause a number of impacts on the environment, thus during the construction and activities, the project will implement an appropriate environmental management program to assign responsibilities, organize and monitor implementation of negative impact mitigation measures as well as evaluate performance and report.

In Kon Tum and Quang Ngai provinces, the Departments of Natural Resources and Environment of Kon Tum and Quang Ngai are responsible for environmental management within their respective localities.

The Project Management Board is the Investor (Dak Drinh Hydropower Joint Stock Company) who is responsible for fully implementing the content of Environmental Protection stated in this EIA report, conducting environmental management and monitoring programs and submitting management and monitoring reports to the Departments of Natural Resources and Environment of Kon Tum and Quang Ngai for consideration.

b) Human Development

- The Investor (Dak Drinh Hydropower Joint Stock Company) will set up its own environmental management department. The task of this department is to collect information on the environment during the project implementation, to monitor any environmental changes caused by the project impacts and to promptly handle environmental incidents. After handling, this information should be notified to relevant organizations.

- The environmental monitoring during the construction will be selected by the Investor who will be responsible for independent monitoring of the environmental management of Dak Drinh Hydropower Plant Project. The above unit must have the capacity and function to monitor and measure the environmental parameters to be monitored as stated in Section 6.2.2 of the next section.

- For the ecological environment monitoring activities, the activities related to the forest vegetation and wildlife systems will be carried out by the forestry and forest protection unit. Funding is responsible by the Investor. The Investor needs to support the forest rangers to set up, patrol and protect the neighboring forests.

- The aquatic monitoring and monitoring activities need to be performed by ecologists; the fund is responsible by the Investor.

- Monitoring of compensation, assistance and resettlement should be done regularly and the compensation, assistance and resettlement council of districts is liable. However, it is required for the Investor to have annual inspections, conducted by groups of independent experts to ensure objectivity.

c) Capacity training

Training classes are held for staff of the units responsible for the construction and operation of the Project and some representatives of the relevant departments and local authorities. The training content is focused on guidance on the method of implementing environmental monitoring according to EMP report and the method of result reporting implemented according to quarterly or regular report. The training course also provides guidance on the methods for correcting the action plan in each case when some of the activities proposed in the EMP report cannot be implemented. Specifically:

+ **Training on safety:** general training on safety issues during the system development, operation and maintenance.

+ **Training on methods of monitoring and reporting of the environmental management plan:** instructions on implementing environmental quality monitoring in the field and methods of filling in monitoring report forms. The training session will guide the local government representatives on the roles and participation of local Government during the implementation of the Environmental Management Plan.

The organizational framework for the implementation of environmental management of Dak Drinh Hydropower Plant Project is shown in Table 6.1 as follows:

Table 6. 1 : Organizational framework for the implementation of environmental management of Dak Drinh Hydropower Plant Project

Role	Responsibility	Organization
Project Manager	Be responsible for the management of the entire Project. Fully implement the content of Environmental protection mentioned in this EIA report.	Dak Drinh Hydropower Joint Stock Company (DHC)
Organization for managing the entire Project	Be responsible for coordinating and managing the entire Project implementation, including guidance and monitoring of the implementation of the Environmental Management Plan (EMP)	Dak Drinh Hydropower Joint Stock Company (DHC)
Environmental staff	Be specially responsible and act as communicator of environmental issues	Environmental staff of DHC
Organization for implementing the Project	Be responsible for the daily running of the Project, including the activities: - Make plans and implement environmental management activities during the construction. - Cooperate with other member units on the activities related to environmental	Environmental staff of DHC

	management - Perform internal supervision, and monitoring, as well as independent monitoring. - Provide funding for monitoring activities. - Report environmental information to stakeholders	
Operator of the Project	Be responsible for the project operation including environmental management and monitoring activities during the operation stage	Dak Drinh Hydropower Joint Stock Company
Environmental consultant	Be responsible for preparing and writing EMP reports	Consulting unit hired by the Contractor (Environmental Issues Department)
Contractor-related technical supervisor	Be responsible for supervision of construction contractors, including the implementation of environmental management activities in the EMP	Consulting unit and Dak Drinh Hydropower Joint Stock Company
Construction Contractor	Be responsible for the construction and monitoring of the specific key activities that the Contractor must undertake in the EMP. Including: - Apply mitigation measures during the construction. - Ensure labor safety for workers and local residents during the construction.	Dak Drinh Hydropower Joint Stock Company selects through bidding
Safety-related independent supervisor	Be responsible for independent supervision of implementation of EMP	Supervision unit selected by the Investor

6.2.2 Environmental monitoring program

6.2.2.1 Environmental Monitoring Organization for the Project

1. Before construction: There is no agency responsible for environmental monitoring in the project investment stage. Only the environmental consultant conducts a number of surveys, data collection and analysis of environmental samples for this report.

2. Construction stage:

a) Waste monitoring and surrounding environment

Construction work of hydroelectric works will generate a number of wastes, mainly exhaust gas, solid waste, domestic wastewater, wastewater from construction stages generated during construction at the site. Hence monitoring of this waste will be carried out along with the surrounding environmental monitoring.

- Monitoring air quality and noise during the construction period:

** Monitoring locations:* The expected monitoring at 09 locations representing the construction areas such as: rolling weirs and spillways, water tunnels (with methane parameters), plant areas, downstream discharge canal, material extraction area at construction site (earth quarry, quarry), landfill area, storage and auxiliary area, contractor’s and construction units’ camps, 110KV line . These are the locations where the air quality survey was conducted. These 9 locations are shown in *Figure 2.6. Diagram of Dak Drinh Hydropower Plant Project background’s environmental monitoring point location* in Chapter 2.

Selected location for monitoring:

- Point 1: Dam route (Dac Rinh and Roman River confluence), Son Dung commune in Son Tay district.

- Point 2: Huy Mang Hamlet, near Boarding School – Central Son Tay town in Son Tay district

- Point 3: River area near the plant and People’s Committee of Son Tan commune, Son Tay district.

- Point 4: Resettlement area of Dakring Hydroelectricity, Group 15, Son Dung commune, Son Tay district

- Point 5: Dakring Hydroelectricity area, Nuoc Tieu village, Dak Nen commune in Kon Plong district

- Point 6: Area of Dakring River on the wooden bridge over River, Nuoc Doa village, near People's Committee of Dak Ring commune, Kon Plong district

- Point 7: Di Lang town (110kV line) in Son Ha district

- Point 8: Near Thuy Loi bridge, in Tinh Giang commune (110kV line) in Son Tinh district

- Point 9: At 220/110kV Doc Soi substation in Binh Son district.

** Monitoring parameters:* air pollution including dust, SO_2, NO_2, CO, noise.

** Monitoring frequency:* every 3 months during the construction period.

- Monitoring of water quality during the construction period

** Monitoring location:* 10 locations at the plant construction site, dam route, resettlement area, near the route. These are locations where the second-stage water quality survey was conducted (May 2007). The locations are shown in *Figure 2.6 Diagram of Dak Drinh DBH base environmental monitoring point location* in Chapter 2. Selected locations for specific monitoring:

- Point 1: Dam route (Dac Rinh and Roman River confluence), Son Dung commune in Son Tay district.

- Point 2: Nuoc Bua bridge, Son Mua commune, Son Tay

- Point 3: Nuoc Xiem bridge – the Center of Son Tay district

- Point 4: Dak Dring river, Dak Nen commune, Kon Plong district

- Point 5: Dak Dring River, near People's Committee of Dak Dring commune, Kon Plong district

- Point 6: Roman River, Son Dung commune, Son Tay district

- Point 7: Rin River, Son Tan commune, Son Tay district

- Point 8: Rin River, Di Lang Town, Son Ha

- Point 9: Ditches of Thuy Loi, Tinh Giang and Son Tinh bridges

- Point 10: Area of 220/110KV substation, Doc Soi, Binh Son

* *Monitoring parameters:* including: pH, BOD_5, DO, COD, SS, Total Nitrogen, Total Phosphorus, Total *Fe, and grease.*

* *Monitoring frequency:* Monitoring parameters with frequency of every 03 months: Temperature, pH and turbidity, Total Nitrogen, Total Phosphorus, Total Fe. During the construction period.

- Monitoring of quality of supplied water and groundwater during the construction period

* *Monitoring location:*

- 02 domestic water supply wells in the construction workers' area on the right and left banks.

- 05 water supply wells for domestic use in the local areas in Dak Rinh, Dak Nen communes (Kon Plong district), Son Dung, Son Mua and Son Tan communes (Son Tay district).

* *Monitoring frequency:* every 3 months.

* *Monitoring parameters:* The criteria stated in TCVN 5944: 1995 Water quality: Groundwater standard.

b) Monitoring of change of ecological conditions in the lake bed and downstream behind the dam:

Carry out monitoring before the project goes into operation:

When Dak Drinh lake accumulates water, the limited amount of water released downstream of the dam may affect the local aquatic system from Dak Drinh dam to the confluence of Dak Bua. Therefore, it is necessary to survey the aquatic system in the downstream area behind Dak Drinh dam in the dry season (select the month with the driest flow, around April and July) to find out the changes in the aquatic system occurring with the low water volume, river bed's cross-section that is narrow.

The specific monitoring content is as follows:

1. Monitoring of aquatic plants in the dry season on the river section behind Dak Drinh dam, including herbaceous plants, woody stem plants and epiphyte.

2. Plankton monitoring: including zooplankton and phytoplankton.

3. Monitoring of large invertebrates living on the bottom and banks of the river (semi-flooded area).

4. Monitoring of migration of fish and shrimp species in this river section.

Implement after the construction to be put into operation:

Periodically survey every 6 months for fish and aquatic species in the lake bed and downstream area (behind the dam and the plant) to detect any changes in species composition and their development after the reservoir is present. The workforce is aquatic experts.

Implementation organization:

1. Monitoring location: Along the river from behind the dam to the confluence of Dak Bua stream, divided into 3 sampling areas along the river, each area chooses 4 sampling points across the river. Locations of the sampling points were located using handheld GPS and dotted on a 1/10,000 map to determine the distance to the main dam and the riverbank.

2. Methods of monitoring: Use the method of measuring the sample plots and use equipment such as aquatic sweep-net, bottom-layer sampling equipment. Follow the method of water quality assessment (edited by Deborah Chapman). Monitoring the water level at the hydrological site of downstream of the dam 2. Based on the hydrological calculation document at the downstream of the dam 2, determine the corresponding flow rate.

3. Monitoring period: 2 times in the dry season when the water flow is lowest

Report-making: Analyze the sample measurement results, synthesize the data and make the report to give conclusions and recommendations.

c) Other monitoring

- Community health monitoring: During the construction, in addition to the communities living in the construction area, and the project's sphere of influence, a large number of construction officials and workers are present and some service providers on the construction site. The process of living together among different communities will inevitably have some impacts on the health of the community, especially for those who have lived for a long time in the communes such as Dak Ring, and Dak So (Kon Plong district), Son Dung, Son Mua, Son Tan (Son Tay district). Besides, on the construction site, arising some diseases such as cholera, dysentery, typhoid, etc. is very quick, thus monitoring of health, water quality, epidemics is very necessary.

- Medical condition and death monitoring

Public health monitoring and disease vectors (by year) (according to the investigation by the local health center)

- The cases of diseases such as malaria, cholera, dysentery, etc.	every 3 months
- Number of deaths caused by the above diseases	every 6 months

Monitoring of lake-bed cleaning, organizing migration and resettlement:

Monitoring and cleaning of the lake bed are carried out during the cleaning process before filling with water and flowing into the reservoir.

- Monitoring of compensation, assistance and resettlement

In general, the work related to compensation, land clearance assistance, and resettlement migration is complicated. The organizational structure of the monitoring agency must reflect the combined responsibility of the local governments from the provincial level to the district, commune and village level and the representatives of affected people. The resettlement migration monitoring program has been specifically mentioned in the section on Compensation, Assistance and Resettlement Plan; Hereby we just highlight the following points:

- The Steering Committee for Compensation, Assistance, Resettlement must be responsible by the Provincial level. The district level will establish a compensation and assistance council chaired by a district leader, members including representatives of the district departments and divisions, including representatives of affected communes and villages with the Investor's attendance.

- The mission of the compensation and support council is in accordance with the provisions of Decree 197 is to coordinate investigating all contents of compensation, assistance, and monitoring the implementation of those contents, supporting the Provincial Steering Committee to resolve all complaints and questions of the people about compensation, assistance, resettlement and environmental protection.

- Monitoring of compensation, assistance and supporting for the people in resettlement areas according to the compensation and resettlement process (annual monitoring and termination after the completion of compensation, assistance, and resettlement and settlement of this work).

- Funding for these activities is planned and agreed between the Investor and the local authority.

- ***Other monitorings:*** Statistics of diseases and deaths at public health monitoring locations, resettlement areas.

3. Operation stage:

Dak Drinh Hydropower Joint Stock Company is responsible for environmental monitoring and sending annual environmental monitoring reports to the Department of Natural Resources and Environment of Kon Tum and Quang Ngai.

Flow monitoring and environmental monitoring:

Establish a flood-discharge notification station with the following locations and tasks:

- Location of the station: at the dam route of Dak Drinh hydropower project.

- Mission: to notify flood-discharge in case of unexpected flood-discharge.

Monitoring of ecological environment:

- Sampling in the lake to analyze phytoplankton, zooplankton, algae, benthos (seasonal), (February and August every year, making within 9 years)

- Research on fish in the lake and river according to species composition, number of individuals (every 3 years) (every August within 9 years)

Monitoring of socio-economic environment:

- Community health and disease vectors in the communes along the reservoir (each year), (according to the survey of the local health center and combined questionnaires using after 8 years of Works commencement)

- Socio-economic changes in the resettlement area and the area the people residing near the reservoir (by year), according to annual local statistics, combined with the survey questionnaire.

CHAPTER 7: ESTIMATE FOR EXPENDITURE FOR ENVIRONMENTAL WORKS

7.1 EXPENSES FOR ENVIRONMENTAL TREATMENT WORKS

1. Domestic wastewater collection and treatment system:

In the construction phase, there are 3 systems for 3 zones: (1). The dam and the water intake with estimated expense of VND 200,000,000; (2). Sub-tunnel no. 2, 3 and surge shaft with estimated expense of VND 150,000,000; (3) Hydropower and Construction Site Steering Committee with estimated expense of VND 120,000,000; (This expense is included in the construction expense of the contractor's construction camp).

During the operation phase, there are 3 systems located in 3 operating zones (This expense is included in the construction expenses of project items).

2. Waste oil and grease collection system:

In the construction phase, there are 03 systems in 3 zones: (1). The dam and the water intake with estimated expense of VND 12,000,000; VND (2). Sub-tunnel no. 2, 3 and surge shaft with estimated expense of VND 11,000,000; (3) Hydropower and Construction Site Steering Committee with estimated expense of VND 8,000,000. (This expense is included in the construction of the auxiliary areas and construction of the contractor).

In the operation phase, there is a production wastewater treatment system, oil recovery equipment (Expense is included in the construction expenses of project items).

3. Daily-life solid waste collection system:

In the construction phase, there are 03 systems in 3 zones: (1). The dam and the water intake with estimated expense of VND 9,000,000; (2). Sub-tunnel no. 2, 3 and surge shaft with estimated expense of VND 5,000,000; (3). Factory and construction team of 110 kV line with estimated expense of VND 4,000,000; (This expense is included in the construction of contractor's camp and construction).

During the operation phase, there are trash bins in the areas and collection Works to the transfer station in the central area of the plant (This expense is included the construction expenses of project items).

4. Solid waste landfills (waste rock and soil):

(This expense is included in the construction expense of landfills and storage yards of the project).

5. Cleaning the reservoir bed:

Area for cleaning plants in the reservoir bed according to the careful cleaning plan includes forest areas and perennial trees is 428.78 ha. Plant clearance unit price is based on the Work construction unit price. The total expense for this item is:

428.78 ha x VND 4,462,000 = VND 1,913,216,000

(It is included in the expense of environmental protection for the Dak Drinh Hydropower Project shown in *Table 7.1*).

Expense of detecting explosive is calculated for each area including resettlement site. The unit price is according to Circular 146/2007/TT-BQP dated September 11, 2007 of the Ministry of Defense (Details are presented in *Appendix 7.1*) Total expense for the above work is VND 27,937,570,000.

Expense of detecting and handling toxic chemicals is temporarily calculated based on the current operating systems in the Central Highlands and Central regions. Total estimated expense for this work is VND 10,193,000,000.

Estimated expense of cleaning and leveling barns, relocation of temporary graves is VND 500,000/household. Total estimated expense is VND 348,500,000.

6. Work of levelling and filling, site restoration and afforestation:

Area of leveling for ground restoration and reforestation for temporary requisition areas is about 45 ha. Estimated expense is VND 900,000 (It is included in the expense for the implementation of the environmental protection works for Dak Drinh Hydropower Project shown in *Table 7.1*).

7.2 EXPENSES FOR ENVIRONMENTAL PROTECTION IN THE CONSTRUCTION PHASE

Expenses for environmental protection work for Dak Drinh Hydropower Project is presented in *Table 7.1*, and detailed in *Appendix 7.1*, which mainly includes expenses for environmental work for site clearance, reservoir bed cleaning; expenses for environmental management and monitoring, expenses for measurement and monitoring of environmental factors serving environmental monitoring and management, and expenses for forest protection and rehabilitation in in temporary requisition areas.

Expenses for detecting and handling toxic chemicals, determining flood boundaries, rehabilitation and protection of protective forests and vegetation, leveling and filling of barns, graves, measures of impact mitigation and environmental protection are temporarily calculated based on the current hydropower projects in the Central Highlands and Central regions.

Table 7. 1: Estimated expense of environmental protection in Dak Drinh Hydropower Project

No.	Content	Value (10^3 VND)
	EXPENSIVE OF ENVIRONMENT PROTECTION	**62.934.690**
1	Detecting and handling explosives	42.733.020
2	Detecting and handling toxic chemicals	10.193.000
3	Determining flood boundaries	500.000
4	Reservoir bed cleaning	1.913.216
5	Restoring and protecting protective forests and vegetation cover	900.000
6	Leveling and filling of barns, graves	348.500
7	Measures of impact mitigation and environmental protection	2.200.000
8	Cadastral expenses	2,161,065
9	Expenses for environmental measurement and verification	1.223.858
10	Expenses for management and supervision of the implementation of environmental protection measures	771.031

The above expense does not include the expense for construction of the hydropower plant's oil leakage and incident oil recovery system, sanitation and wastewater treatment system in construction phase.

The hydropower plant's construction expense for environmental Works is included in the hydroelectric power plant's construction and installation expense estimate.

The expense in *Table 7.1* also does not include: construction expense system for domestic water supply, wastewater treatment system and sanitation system in the construction auxiliary areas. This expense is estimated in the general expense of construction of construction auxiliary areas.

The expense in *Table 7.1* also does not include: Expense for environmental mitigation measures integrated in construction such as: spraying water in hot weather, soil filling in the landfill and these expenses have been identified in construction expense of contractor.

7.3 EXPENSES FOR THE ENVIRONMENTAL PROTECTION IN THE OPERATIONAL PHASE

Environmental protection in the operation phase of Dak Drinh Hydropower Plant is implemented according to the contents stated in the Environmental Monitoring and Management Program in Chapter 6.

Expense for environmental protection during the operation phase of Dak Drinh hydropower plant will be determined according to the annual plan of annual power generation, and recorded in production expense.

The expense estimate for main works is as follows:

- Expense for periodic and unscheduled measurement and verification of environment (unscheduled inspection and handle when there is a complaint): VND 50,000,000.
- Expense for implementing environmental sanitation measures: VND 50,000,000.
- Expense for management, monitoring and implementation of environmental protection: VND 50,000,000.

CHAPTER 8: COMMUNITY CONSULTATION

8.1 COMMUNITY CONSULTATION ACTIVITIES

Scope of direct influence on residents in the reservoir area, energy route and the Dak Drinh hydropower plant includes 5 communes: communes of Dak Rinh, Dak Nen - Kon Plong district; and communes of Son Dung, Son Mua, Son Tan - Son Tay district.

Direct influence on the Dak Drinh hydropower plant - Doc Soi 110 kV line is resident in the communes of Son Tan (Son Tay district), communes of Di Lang town, Son Bao, Son Ha, Son Thanh (Son Ha district), communes of Tinh Giang, Tinh Dong, Tinh Hiep, Tinh Tra (Son Tinh district), communes of Binh My, Binh Minh, Binh Trung, Binh Nguyen (Binh Son district) - Quang Ngai province.

To consult the people in the affected area, on July 23, 2007, the Investor (Đakđrinh Hydropower Joint Stock Company) sent Official Letter No. 41/DHC-KTKT on community consultation for Dak Drinh hydropower project to all the People's Committees, Fatherland Front Committees of the above communes according to the provisions of the Circular No. 08/2006/TT-BTNMT dated September 8, 2006 of the Ministry of Natural Resources and Environment. The content of this Official Letter is presented in the appendix of the documents.

The project owner also encloses brief description of the project, project location map, summary of negative environmental impacts and proposed mitigation measures with the above Official Letter.

Being implemented simultaneously with the sending of documents to the locality, the Investor and the consultant unit have followed the following steps and activities in the community consultation process:

- Information to local authorities in the project area
- Investigate and enumerate the impacts and damages of households affected by the project. In which, attention was paid at investigating on aspirations to receive compensation and opinions on the selection of resettlement areas.
- Inform local authorities about the results of the above investigation, agree with local authorities about project implementation, compensation, assistance and resettlement as well as environmental protection in the project area.
- The Investor and the consultant unit went to the directly affected communes to record and answer the questions of the representatives of the local government about the environmental issue of the project.

After that, we have received feedback letters from the People's Committees and Fatherland Front Committees of the above communes. (See the responses of the People's Committee and Fatherland Front Committee at commune level in the *Appendix of Correspondence Documents on Community Consultation i*n the appendix of documents).

The responses of the People's Committees and Fatherland Front Committees of communes are summarized as follows:

8.2 OPINIONS OF PEOPLE'S COMMITTEES AT COMMUNE LEVEL

Comments of the People's Committees at commune level at the meeting were recorded as follows:

- The government agreed to implement the project in the area.
- Agree with the environmental impact mitigation measures proposed by the consultant unit.
- In the process of project implementation, it is necessary to ensure permissible standards on environmental protection prescribed by the environmental protection law. In which, attention should be paid that emission, wastewater, dust, noise and solid waste must be disposed of in accordance with techniques.
- When implementing construction, protection of health of workers and residential communities should be paid attention and it is necessary to promptly remedy environmental problems.

In addition, in the process of working with the locality, the Investor and the consultant unit have received opinions of representatives of the People's Committee at commune level as follows:

- The environmental issue of the reservoir area is of more concern than in other areas.
- DHC needs to have a separate policy for residents in the flood areas of Dak Drinh hydropower plant such as living and housing support for those who will separate households and building new houses and gardens.
- Recommend the investor to check the construction unit to properly implement the mitigation measures during the construction process given by the consultant unit to ensure that it does not affect the local people as well as the surrounding environment.
- Construction unit must clean at each location after construction is completed.
- Design must ensure strict regulations as well as regulations on occupational safety.

8.3 OPINIONS OF FATHERLAND FRONT COMMITTEES AT COMMUNE LEVEL

- Agree to implement the project in the locality.
- Agree with proposed environmental impact mitigation measures.

- Ensure the permissible standards on environmental protection specified by the environmental protection law. In which, attention should be paid that emission, wastewater, dust, noise and solid waste must be disposed of in accordance with techniques.
- Pay attention to implement programs on environmental management, environmental quality monitoring, minimizing impact on the surrounding environment to ensure the health of workers and residential communities, promptly overcoming environmental problems.

8.4 INVESTOR'S RESPONSE TO PEOPLE'S RECOMMENDATIONS

After receiving the responses from the People's Committees and Fatherland Front Committees at commune level and local authorities at all levels, the Investor and the consultant unit received and adjusted the content of the Compensation, Assistance and Resettlement Work Plan as well as completed this EIA report.

At the same time, an official dispatch is sent BACK to the People's Committees and Fatherland Front Committees of the communes mentioned above, recording the acceptance of people's recommendations in adjusting the content of the Compensation, Assistance and Resettlement Work Plan and the EIA report. The Investor and the consultant unit also affirm commitment to the full implementation of mitigation measures after this EIA report is approved by the Ministry of Natural Resources and Environment.

Community information: After this EIA report is approved by the Ministry of Natural Resources and Environment, the Investor will send main information of this EIA report as well as the decision to approve the Ministry of Natural Resources and Environment to the People's Committee at commune level.

CHAPTER 9: INDICATION OF DATA SOURCES, DATA AND EVALUATION METHODS

9.1 DATA AND DATA SOURCES

9.1.1 Reference data and sources

In the process of preparing an environmental impact assessment report, Dak Drinh Hydropower Project uses the following reference documents and data:

1. Ministry of Science, Technology and Environment. (2000). Vietnam Red Book - Animal Part. Hanoi: Science and Technics Publishing House, 408 pages.

2. Bui Cong Que and Nguyen Kim Lap. (1992). Deep crust structure and territorial seismic properties of Vietnam. Hanoi: Archives of Vietnam Academy of Science and Technology.

3. Power Engineering Consulting Joint Stock Company 2 (2007). Notes, Basic Design, Survey Report for Construction Investment Project of “Dak Drinh Hydropower Project”.

4. Dao Ngoc Phong. (1972). Weather and illness. Hanoi: Medical Publishing House.

5. Dang Huy Huynh (editor). (1994). List of mammal species (Mammalia) of Vietnam. Hanoi: Science and Technology Publishing House.

6. Dang Huy Huynh, Hoang Minh Khien. (1992). Initially learn about the economic animals of the Central Highlands. (p. 116-123). Hanoi: Biological science research report.

7. Dang Huy Huynh, Hoang Minh Khien, Bui Kinh, Vu Thi Thuy, Dang Ngoc Can. (1992). The Central Highlands fauna. (p.102-110). Hanoi: Biological science research report.

8. Ho Thu Cuc, Nguyen Van Sang (1982). Research results on the composition of reptiles and amphibians in the Central Highlands (p.136-144). Hanoi: Biological science research report.

9. Hoang Duc Dat, Thai Ngoc Tri. (2001). List of freshwater fish species in study areas. (p. 396-405). Collection of scientific and technological research works (1999-2000). Hanoi: Science and Technology Publishing House.

10. Results of environmental monitoring in Dai Ninh Hydropower (2006). Institute for Tropical Technology and Environment Protection

11. Le Duc An, Lai Huy Anh, Ngo Quang Toan. (1999). Geology and geomorphology characteristics of Vietnam. Vietnam Geographic Monograph. Hanoi.

12. Le Ba Thao. (2001). Nature Vietnam. Hanoi: Education Publishing House.

13. Le Trinh. (2001). Environmental impact assessment. Hanoi: Science and Technology Publishing House.

14. Mai Trong Thong et al. (1996). Some initial results of studying the changes of climate characteristics due to the impact of Hoa Binh reservoir. Under the Basic Research Program. Code 6.2.2. Hanoi.

15. Kon Tum Province Statistical Yearbook (2005, 2006). Kon Tum Statistical Office.

16. Quang Ngai Province Statistical Yearbook (2005, 2006). Quang Ngai Statistical Office.

17. Statistical Yearbook of Kon Plong District - Kon Tum Province (2005, 2006), Kon Plong District Statistical Office - Kon Tum Province.

18. Statistical Yearbook of Son Tay District - Quang Ngai Province (2005, 2006), Son Tay District Statistical Office - Quang Ngai Province

19. Statistical Yearbook of Son Ha District - Quang Ngai Province (2005, 2006), Son Ha District Statistical Office - Quang Ngai Province

20. Statistical Yearbook of Son Tinh District - Quang Ngai Province (2005, 2006), Son Tinh District Statistical Office - Quang Ngai Province

21. Statistical Yearbook of Binh Son District - Quang Ngai Province (2005, 2006), Statistical Office of Binh Son District - Quang Ngai Province

22. Ngo Dinh Tuan. (1999). Overview of water resources and proper management, exploitation and use. Science and technology topic 07-12-01. Hanoi,

23. Nguyen Dinh Xuyen. (1989). Earthquake territory zoning of Vietnam. Journal of earth sciences, vol. 3-4.

24. Nguyen Can, Nguyen Dinh Xuyen, Nguyen Kim Hap. (1984). Seismic tectonic features of Vietnam's Territory. Geological Journal No. 163.

25. Nguyen Huu Hao. (1994). Fishery development in reservoirs in Vietnam. National workshop on integrated water resources management in reservoirs in Vietnam. General Department of KT-TV.PHYS.VN.

26. Nguyen Kim Hap et al. (1985). Seismic properties of Vietnam. The works of geophysics No. 4 in 1985.

27. Nguyen Lap Dan. (1997). Hydrological geography of Vietnam. Under the topic of “Building geographic monograph of the Socialist Republic of Vietnam”. Hanoi: Archives report of Institute of Geography

28. Nguyen Van Chien. (1985). Central Highlands with natural conditions and resources. Hanoi: Science and Technology Publishing House.

29. Nguyen Uyen. (2006). Handling geological phenomena in construction. Hanoi: Construction Publishing House.

30. Monitoring data of the current environmental status in Quang Ngai province. (2005). Department of Natural Resources and Environment of Quang Ngai province.

31. Thai Van Trung. (1998). Tropical forest ecosystems in Vietnam. Hanoi: Science and Technology Publishing House.

32. Thai Van Trung, (1978). Forest vegetation cover in Vietnam from an ecosystem perspective. Hanoi: Science and Technology Publishing House.

33. International Union for Conservation of Nature, IUCN Vietnam (2007). Flow - Environmental flow handbook. IUCN Vietnam, Hanoi.

34. Larry W. Canter (1996). Environmental Impact Assessment, 2nd Edition, McGraw- Hill, INC 660pp.

35. TeChow, Ven., Maidment, R.D., Mays, L.W., (1988). Applied Hydrology. New York: Mc Graw-Hill.

36. Tchobanoglous, G., H.Theisen, and S.Vigil. (2002). Integrated Solid Waste Management. New York: Mc Graw-Hill.

37. Tchobanoglous, G., F.L. Burton, and H.D. Stensel. (2002). Wastewater Engineering Treatment and Reuse, New York: Mc Graw-Hill.

38. The International Union for the Conservation of Nature and Natural Resources. (2002). IUCN Red List of Threatened Species. CD data.

39. Wark, K., Warner, C.F., Davis, T.W. (1998). Air pollution: Its Origin and Control. 3rd Edition. Addison-Wesley Longman, Inc.

40. World Health Organization, (1993), Assessment of sources of air, water, and land pollution, A guide to rapid source inventorytechniques ans their use in formulating environmental control strategies, Geneva;

41. World Health Organization (1993), Assessment of Sources of Air, Water, and Land Pollution, Part1: Rapid Inventory Techniques in Environmental Pollution, WHO, Geneva;

42. World Bank. (1991). Environmental Assessment Sourcebook, Volume II. Sectoral Guidelines. Environment. Washington D.C.

In addition, EIA reports prepared previously by PECC2 are also source of reference.

9.1.2 Documents and data created by the project owner

- The data of surveys and investigations on socio-economic people and affected households are carried out by Power Engineering Consulting Joint Stock Company 2.
- Report on Dak Drinh Hydropower Works Construction Investment Project.
- "*Results of water environment monitoring*" implemented by the Institute of Tropical Technology and Environment Protection in October 2004.
- "*Results of air and water environment monitoring*" implemented by the Center for Environmental Monitoring Technology - Dung Quat KTM Management Board in May 2007.

9.2 METHODOLOGY APPLIED IN EIA PROCESS

1. Rapid and analog assessment method:

Rapid Assessment method is used to calculate the pollutant load of wastewater and air. This method recommended by the World Health Organization (WHO) has been approved for use in many countries. In Vietnam, this method is introduced and applied in many EIA studies, it is possible to perform relatively precise calculation of pollutant discharge under the limited conditions of instrumentation and analysis. In this report, the pollutant load coefficients are obtained from the World Bank EIA guidelines (*Environmental Assessment Sourcebook, Volume II, Sectoral Guidelines, Environment, World Bank, Washington DC 8/1991*) and *Handbook of Emision, Non Industrial and Industrial source, Netherlands*.

At the same time, we have used Analog Assessment method based on monitoring sources measured from similar works: *From FHA (USA); From the EIA Report for the West China 500 kV line project; Results of environmental monitoring in Dai Ninh Hydropower, Institute of Tropical Technology and Environment Protection, 2006.*

2. Modeling method:

For dust dispersion, air pollution dispersion model was used (according to *Larry W. Canter, Environmental Impact Assessment*, 2nd Edition, McGraw-Hill, INC 660pp, 1996).

For reservoir water quality prediction, empirical formula of A.I.Denhinova made from model experiments has been used. Calculation of standing tree biomass was based on the method of Brown, Kato and Oga Wa. This is the method that has been used for many irrigation and hydroelectric reservoirs in Vietnam. This method has also been calculated by PECC2 for reservoirs of Tri An, Thac Mo, Ham Thuan, Da Mi. These lakes are currently in operation and the water quality monitoring results do not exceed the calculated results.

For the calculation of the regeneration process of the bank and reservoir bed, Zolotarev's model has been used. In Vietnam, this method is usually applied to mountainous lakes, such as Thac Ba, Hoa Binh, Se San 3. The actual monitoring results are not larger than the calculated results. In fact, the reservoirs have been operating like Da Nhim lake after nearly 40 years, Tri An after 17 years, Thac Mo after 10 years, landslides have occurred but their volume is negligible.

3. Method of sociological investigation:

The sociological investigation method is used to assess the damage caused by the project to residential households and collectives; aspiration to choose the form of compensation.

For the result of damage investigation in this period, it is only declaration, which is not counted on the basis of setting up boundary markers of site clearance recovery. In the next period, it should be carried out according to the rules to ensure fairness.

For households in the reservoir area who wish to receive cash compensation, the ability to create productive land by themselves will mainly be clearing forest for cultivation, so it is necessary to develop a compulsory resettlement program.

4. Balance calculation method:

For assessment of impacts due to reservoir operation and power generation, balance calculation methods are applied in hydrological calculation and flood regulation.

For the prediction of sedimentation, forecast model of Brune has been used.

These are the current methods used in hydrological calculation, irrigation and hydropower project design in Vietnam.

5. Statistical method and other methods:

For the forecast of stimulating earthquakes, statistics from UNESCO have been used.

To determine the environmental flow, a combination of methods of hydrological method, Habitat simulation and Downstream Response to Imposed Flow Transformation - DRIFT) is applied.

6. Method of Conjecture:

It is based on the documentary basis, experience of previous projects and the nature of the project's operations, similar phenomena and incidents. It is used in the preliminary review of the project's impacts on natural and socio-economic environments, and in the prediction and assessment of dam failure.

9.3 COMMENTS ON THE LEVEL OF DETAIL AND RELIABILITY OF THE ASSESSMENTS

When implementing the project, surveys and designs are conducted from the investment project stage in accordance with current Vietnamese and international standards; therefore, plan for optimal design, cost saving, minimizing the volume of soil and rock to be excavated and discharged into the environment, the volume of people to resettle, the area of flooded land in the reservoir area and being constructed for the focal works were proposed. Documents and data on topographic, geological, hydrological surveys, civil and damage surveys conducted by PECC 2 ensure reliability.

For water and air environment: Samples at the monitoring locations were taken and analyzed with specialized equipment, in collaboration with monitoring agencies (Institute for Tropical Technology and Environmental Protection and Dung Quat Environment Monitoring Technical Center) with high reliability

To assess dam failure for downstream dams, the scope of this report only notes the probability of the failure and qualitative description based on the experience of hydrologists to propose preventive measures and incident response. Reliability is acceptable.

To determine environmental flow, a combination of the following methods was applied: Hydrological method, Habitat simulation and Downstream Response to Imposed Flow Transformation - DRIFT. Determination results are acceptable. Currently, there are many methods of determining environmental flows built and applied to change results in a large range in the world. There is also a lack of a basis for valuing the losses to the ecosystem in terms of money, from which different options have been considered. Therefore, it is recommended to have a program to monitor the relationship between the aquatic ecosystems with the flow in the river section behind the dam to the confluence of Dak Bua stream to determine the appropriate environmental flow discharge regime during the operation.

For ecological environment: survey was conducted with the participation of ecological experts from Vietnam Environment & Sustainable Development Institute, who have long experience in ecological issues of the project area. Reliability is guaranteed at a high level.

For the soil environment: refer to the soil maps, current land use status of Kon Plong district prepared by Natural Resources and Environment Division of Kon Plong District, Center of Geography and Environment Faculty of Hanoi University of Agriculture in Quang Ngai Province and provided by Archive Information Center of Quang Ngai Province Department of Natural Resources and Environment, which incorporates field surveys conducted by PECC2. Regarding the classification as well as the characteristics of each soil type in the region, there are no conditions to analyze soil samples. Reliability is acceptable.

During the assessment, project also consulted the EIA report prepared by PECC 2 and compared with the monitoring reality at hydropower projects which have been operating and under construction sites such as Tri An, Thac Mo, Ham Thuan - Da Mi, A Vuong, Dai Ninh, Buon Kuop, Srepok 3, Dong Nai 3 and Dong Nai 4.

It is possible to ensure the reliability of the contents given by the report on the current environmental situation, forecast of impacts and mitigation measures of negative impacts on the environment for the construction and operation of Dak Drinh hydropower project.

CONCLUSIONS AND RECOMMENDATIONS

After studying the impacts of Work on environmental factors, we have the following conclusions:

1. Dak Drinh Hydropower Project located on Tra Khuc River is a medium-scale Work. The basin area is over 420 km^2, the reservoir surface area corresponding to normal water level is 9.12 km^2, the deepest water level is 100 m. During the construction as well as the operation of the Dak Drinh Hydropower Plant, there will be some impacts on the natural and socio-economic environment in the area.

2. The main positive impacts include: supplying power to regional and local economic development, bringing many job opportunities, increasing local people's income; the air environment as well as the water environment around the reservoir will be improved after the Work comes into operation, this will improve the ecological environment in a positive direction. The reservoir formation has the impact of regulating flow, improving flow to ensure water supply for the downstream, increasing an average of about 7-9 m^3/s in the dry season for the downstream, contributing to reducing floods for downstream and 912 ha of reservoir bed will be a good condition for the development of aquaculture and tourism of the two provinces.

3. The main negative impacts include:

**** During preparation and construction of the Work:***

- The lives of local people will be disturbed during the initial preparation. There will be 672 households with 2840 people affected. 640 households with 2606 people must relocate from the construction site, mainly ethnic minorities (Ca Dong). Although compared to other Works, the number of people which must relocate is not much, but this is also an impact of the Work on the local socio-economic environment, related to the ethnic policy of the State.
- There will be a concentration of many construction workers, and especially freelance migrants, complicating the socio-cultural life and security of the locality.
- The background environment will be heavily polluted, but only locally. At the area of work construction, the level of air and water pollution always exceeds the permissible level many times. These impact mitigation measures must be included in the bidding document as a mandatory provision.
- The affected ecological environment affects the living conditions of flora and fauna species in the area. Some habitats will be harmed, forest resources will be exploited indiscriminately. A few individuals of some rare plant species can be submerged in the reservoir bed. However, these impacts, after a certain time when the Work operates stably and a new living environment

is formed, will be gradually overcome. It is essential to have restoration activities as well as environmental protection in the post-project period.

- The formation of a reservoir will cause a loss of land in the basin, mainly forestry and agricultural land. It is necessary to have appropriate compensation policies for people to continue production and improve their lives. For forestry land area, it is necessary to take measures to minimize the impacts such as planting more watersheds, protection forests, and restoring used forest areas, etc.

**** During operation stage***

Due to the regulatory characteristics of the Dak Drinh hydropower reservoir, the flow on the Dak Drinh river does not change much. On the other hand, due to the geological and geomorphological structure of the area, the common impacts such as water loss, landslide, earthquake’s simulation, etc. for Dak Drinh reservoir are negligible.

- A river section right behind the dam is likely to lose water in the dry season. Investor will continue to observe research to reduce this impact.
- At the first time, the aquatic system in the reservoir area as well as downstream will change in composition and quantity of species. However, this situation will gradually stabilize after a few years of operation.

Summary:

Although Dak Drinh Hydropower Project has impacts on the environment in the region, the impact level is negligible. The most remarkable is the environmental impacts that are flooding of reservoir bed and requisition of land to build the project. They are unavoidable and irreversible damages. This leads to the losses of households directly affected by land, crops, houses and structures. These damages can be overcome by a compensation, assistance and resettlement program. Damage over 2.5 km of cut-off river section lasts for 8 months in dry season and mainly impact on aquatic system. The impacts of background environmental pollution during the construction process are inevitable. However, just like the other possible impacts on the natural environment and socioeconomics, if there is good management measures, there will be the ability to reduce. We are committed to implementing measures to treat waste, mitigate impacts and implement an environmental management program as outlined in this EIA report.

Recommendations:

We realize the positive impacts that the Work will bring to the natural environment and socioeconomics are dominant. On the other hand, the urgent need for electric energy for the production and life of the local people as well as for the construction and development of the country's economy is very urgent.

We request the Ministry of Natural Resources and Environment, and other authorities to review and approve the EIA Report of Dak Drinh Hydropower Project.

DOCUMENT APPENDICES

INTRODUCTION APPENDICES

APPENDIX A: LEGAL DOCUMENTS RELATED TO THE PROJECT

+ Decision No. 1567/QD-BCN dated June 21, 2006 by the Ministry of Industry approving the planning of hydroelectric cascade on Tra Khuc river.

+ Official Dispatch No. 1519/CP-CN dated November 05, 2003 by the Government on permitting the investment in Dak Drinh Hydropower Project, Quang Ngai Province.

+ Official Dispatch No. 2559/VPCP-CN dated May 15, 2007 by the Government Office on permitting the conversion of the investor of Dak Drinh Hydropower Project, Quang Ngai Province.

+ Official Dispatch No. 613/DCKS-DC, dated April 10, 2007 by the Department of Geology and Minerals of Vietnam (Ministry of Natural Resources and Environment): on notification of mineral resources situation in the reservoir area of the Dak Drinh Hydropower Project.

+ Official Dispatch No. 4038/CV-EVN-TD dated August 2, 2007 by the Vietnam Electricity Corporation regarding the agreement on the plan to connect Dak Drinh Hydropower Plant (Quang Ngai Province) to the National Power System.

+ Official Dispatch No. 2026/UBND-CNXD, dated July 9, 2007 by the People's Committee of Quang Ngai Province on the agreement of Dak Drinh Hydropower Project.

+ Official Dispatch No. 3699/UBND-CNXD dated December 10, 2007 by the People's Committee of Quang Ngai Province on the unification of resettlement of Dak Drinh Hydropower Project.

+ Official Dispatch No. 78/UBND-CNXD dated January 11, 2008 by the People's Committee of Quang Ngai Province on the agreement on the alignment of the 110kV line connecting the Dak Drinh Hydropower Plant to the National Power System.

+ Official Dispatch No. 96/UBND dated April 19, 2007 by the People's Committee of Son Tay District on the flow of the river behind the dam of the Dak Drinh Hydropower Project on the Tra Khuc river.

+ Official Dispatch No. 2605/UBND-TH dated December 7, 2007 sent by the People's Committee of Kon Tum Province to the Ministry of Industry and Trade on the agreement of DakDrinh Hydropower Project.

+ Working minutes dated October 9, 2007 between the People's Committee of Quang Ngai Province and the People's Committee of Kon Tum Province agreeing the investment in upgrading National Highway 24 and building Dak Drinh Hydropower Plant.

+ Official Dispatch No. 18/TL-BTTH dated May 9, 2007 by the General Museum (Department of Culture and Information of Kon Turn Province) on the determination of historical, cultural and archaeological relics of Dak Drinh Hydropower Project.

MINISTRY OF INDUSTRY	**SOCIALIST REPUBLIC OF VIETNAM**
---------------	**Independence – Freedom – Happiness**
No.: 1567/QD-BCN	-----------------
	Hanoi, June 21, 2006

DECISION

On the approval of planning of hydroelectric cascade on Tra Khuc river

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MINISTER OF INDUSTRY

Pursuant to Decree No. 55/2003/ND-CP dated May 28, 2003 by the Government defining the functions, tasks, powers and organizational structure of the Ministry of Industry;

Pursuant to Decree No. 52/1999/ND-CP dated July 8, 1999, No. 12/2000/ND-CP dated May 5, 2000, No. 07/2003/ND: CP dated January 30, 2003 and No. 16/2005/ND-CP dated February 7, 2005 by the Government on Management of work construction and investment projects;

Pursuant to Document No. 923/CP-CN dated August 6, 2002 by the Prime Minister assigning the Ministry of Industry to appraise and approve the hydroelectric planning of rivers;

Pursuant to the Prime Minister's opinions in Document No. 1519/CP-CN dated November 5, 2003 on permitting the investment in the Dak Drinh Hydropower Project in Quang Ngai Province;

Considering Report No. 4855/TTr-EVN-TĐ dated October 1, 2004 and Document No. 1537/CV-EVN-TD dated March 29, 200 by the Vietnam Electricity Corporation on approving the planning of hydroelectric cascade on Tra Khuc river; Record of planning of hydroelectric cascade on Huong river made by Power Engineering Consulting Joint Stock Company 2 in 2004, December 2005 and additional report in May 2006;

At the request of the Director of the Department of Energy and Petroleum,

DECIDES:

Article 1: To approve the planning of hydroelectric cascade on Tra Khuc river submitted by the Vietnam Electricity Corporation with the following main contents:

1. Diagram of exploiting hydroelectric cascade on Tra Khuc river system includes the following hydropower projects:

- Dak Drinh Hydropower Project on Dak Drinh branch (approved by the Prime Minister on investment policy in Document No. 1519/CP-CN dated November 5, 2003):

+ Normal water level: 410 m;

+ Downstream water level of the plant: 77.0 m

+ Installed capacity: 138 MW

- Other hydropower projects in the basin: According to the National Small Hydropower Approval Decision No. 3454/QD-DCN dated October 18, 2005 by the Ministry of Industry.

2. The main task of Dak Drinh Hydropower Project: main task is power generation, combining flood reduction and adding water in dry season for downstream.

Article 2: Chief of the Ministry Office, Director of Department of Energy and Petroleum, General Director of Vietnam Electricity Corporation, Quang Ngai Provincial People's Committee, Heads of relevant agencies, units and individuals are responsible for implementing this decision./.

Recipients:	**PP. MINISTER**
- As Article 2;	**DEPUTY MINISTER**
- Filing: VT, NLDK	*(Signed and Sealed)*
	Do Huu Hao

GOVERNMENT

No.: 1519/CP-CN

On permitting the investment in Dak Drinh Hydropower Project, Quang Ngai Province

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Hanoi, November 05, 2003

To:

INFRASTRUCTURE DEVELOPMENT AND CONSTRUCTION CORPORATION

INCOMING OFFICIAL DISPATCH
No. 1442 dated November 05, 2003

- Ministries: Industry, Planning and Investment, Construction, Agriculture and Rural Development
- People's Committee of Quang Ngai Province,
- Vietnam Electricity Corporation,
- Infrastructure Development and Construction Corporation

At the proposal of the Infrastructure Development and Construction Corporation (Official Dispatch No. 434/TCT-QLDA dated March 26, 2003); comments of the Ministry of Industry (Official Dispatch No. 4833/CV-NLDK dated October 28, 2003); Ministry of Planning and Investment (Official Dispatch No. 6319/BKH-KTCN dated October 15, 2003); Ministry of Construction (Official Dispatch No. 1778/BXD-KHTK dated October 17, 2003); People's Committee of Quang Ngai Province (Official Dispatch No. 1941/UB dated October 10, 2003); Vietnam Electricity Corporation (Official Dispatch No. 4824/CV-EVN-KH dated October 22, 2003) on investment policy for Dak Drinh Hydropower Project, Quang Ngai Province in the form of independent power plant (IPP), the Prime Minister has the following comments:

1) The Infrastructure Development and Construction Corporation (LICOGI) is allowed to receive comments from relevant ministries and agencies, prepare a feasibility study report for the Dak Drinh Hydropower Project, Quang Ngai Province, invest in the form of the independent power plant (IPP) and submit for approval in accordance with current regulations.

2) The Ministry of Industry shall direct the Vietnam Electricity Corporation to complete the planning of hydroelectric cascade on Tra Khuc river, appraise and approve the planning according to current regulations./.

Recipients:
- As above,
- Prime Minister, Deputy Prime Minister Nguyen Tan Dung,
- Government Office: Minister-Chairman, Vice Chairman Nguyen Cong Su, Departments: TH, KTTH, DP, TV.
- Filing: CN (3), VT.

PP. PRIME MINISTER
DEPUTY PRIME MINISTER
(Signed and Sealed)
Nguyen Tan Dung

GOVERNMENT OFFICE

No.: 2559/VPCP-CN

On permitting the investment in Dak Drinh Hydropower Project, Quang Ngai Province

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Hanoi, May 15, 2007

DAKDRINH HYDROPOWER JSC

INCOMING OFFICIAL DISPATCH
No. 16 dated May 22, 2007

To:

- Ministries: Industry, Construction;
- People's Committee of Quang Ngai Province;
- DakDrinh Hydropower Joint Stock Company;
- Infrastructure Development and Construction Corporation.

At the request of enterprises participating in DakDrinh Hydropower Joint Stock Company (Official Dispatch No. 1972/TTR-PVN-BIDV-LICOGI- SD dated April 13, 2007); Comments of the Ministry of Industry (Official Dispatch No. 1972/BCN-NLDK dated May 7, 2007) on permitting the conversion of the investor of the Dak Drinh Hydropower Project, Quang Ngai Province, Prime Minister Nguyen Tan Dung has the following comments:

- It is allowed to transfer the investor of the Dak Drinh Hydropower Project from the Infrastructure Development and Construction Corporation (LICOGI) to the DakDrinh Hydropower Joint Stock Company.
- DakDrinh Hydropower Joint Stock Company and Infrastructure Development and Construction Corporation (LICOGI) urgently hand over documents and workloads to ensure the project implementation progress as stipulated.
- The Government Office would like to inform the ministries, branches, localities and relevant units for implementation.

Recipients:

- As above,
- Prime Minister,

Deputy Prime Minister Nguyen Sinh Hung;

- Government Office: Minister-Chairman, Vice Chairman Nguyen Xuan Phuc, Van Trong Ly, Departments: TH, KTTH, DP, TV.
- Filing: VT, CN (3).

PP. PRIME MINISTER – CHAIRMAN

VICE CHAIRMAN

(Signed and Sealed)

Van Trong Ly

PEOPLE’S COMMITTEE OF THANH XUAN DISTRICT
CERTIFIES THAT THE COPY IS TRUE
No.: 840 Date: May 18, 2007
PP. CHAIRMAN OF PEOPLE’S COMMITTEE OF THANH XUAN DISTRICT
VICE HEAD OF JUDICIAL OFFICE
(Signed and Sealed)
Nguyen Thi Huyen

MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT

DEPARTMENT OF GEOLOGY AND MINERALS OF VIETNAM

No.: 613/DCKS-DC

On announcing the situation of mineral resources in the reservoir area of Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Hanoi, April 10, 2007

To: DakDrinh Hydropower Joint Stock Company

The Department of Geology and Minerals of Vietnam has received the Official Dispatch No. 03/DADT-DHC dated April 6, 2007 from your company asking for information on mineral resources in the reservoir area of Dak Drinh Hydropower Project with the document of scope of the Work. After researching all the project documents in the field of mineral resources, the Department of Geology and Minerals of Vietnam has the following comments:

- The planned submerged area of the DakDinh hydropower reservoir in the areas of Son Dung, Son Mua, Son Tan Communes, Son Tay District, Quang Ngai Province; Dak Drinh and Dak Nen Commune, Kon Plong District, Kon Tum Province were investigated and mapped geological minerals at the scale of 1:200,000 (series of sheets Hue - Quang Ngai, 1986); scale of 1: 50,000 (group of sheets Ba To, 2004).
- According to the existing mineral geological survey results, the area of the Dak Drinh hydropower reservoir has a Dak Drinh mineral water point (Suoi Luong), in Tu Ngoc Village, Dak Drinh Commune, Kon Plong District, with geographic coordinates: 14°48’0”, 108°17’10”, temperature of 61°C, flow of 31/s. The potential and quality of use should be further investigated and assessed.
- Due to the preliminary investigation, the pavement area is too large, (9.12km^2), your Company needs to investigate and survey at the scale of 1:25,000 or greater. During the investigation, if any mineral point is found in the reservoir area, your Company is requested to promptly notify the Department of Geology and Minerals of Vietnam for joint research.

Recipients:
- As above;
- Ministry of Natural Resource and Environment (to report)
- Filing: VP, DC, Kh (03).

PP. DIRECTOR

DEPUTY DIRECTOR

(Signed and Sealed)

Trinh Xuan Ben

VIETNAM ELECTRICITY CORPORATION

No. 4038/CV-EVN-TD

On Agreement on the plan to connect Dak Drinh Hydropower Plant (Quang Ngai Province) to the National Power System

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Hanoi, August 02, 2007

To: DakDrinh Hydropower Joint Stock Company

Vietnam Electricity Corporation has received Document No. 11/DHC-KTKT dated May 28, 2007 by DakDrinh Hydropower Joint Stock Company on the agreement on the plan to connect and locate electricity metering system of Dak Drinh Hydropower Plant to the National Power System, attached to the report of connection plan made by Power Engineering Consulting Joint Stock Company 2 (TVD2) in October 2006. On the basis of the conclusion of the meeting dated July 4, 2007 on the revised report of TVD2 in July 2007 and Document No. 45/PHC- KTKT dated July 26, 2007 of DakDrinh Hydropower Joint Stock Company, Vietnam Electricity Corporation (EVN) has the following comments:

1/ Regarding the connection plan

Agree to connect Dak Drinh Hydropower Plant (with a capacity of 125 MW) to the National Power System according to the approved plan (plan to build double-circuit 110 kV line from Dak Drinh 110 kV substation to 110 kV busbar at Doc Soi 220/110 kV station, specifically:

a/ Scale of plan

- Construction of dual-circuit 110 kV line from the 110 kV Dak Drinh booster substation connected to feeders E08 and E09 (backup 110 kV feeder at Doc Soi 220/110 kV station).
- Installation of 02 110 kV feeders at Doc Soi 220/110 kV station.

b / Main technical solutions

- The conductor is steel-core aluminum wire with a cross-section of 240mm^2, the lightning-arresting wire combined with the OPGW-50 fiber optic cable contains 12 optical fibers, the line length is about 57 km. This line uses hot-dip galvanized 02-circuit steel poles.
- Electrical information and telecommunications system: is installed to ensure operation and supervision (SCADA/EMS), taking into account the possibility of participating in the electricity market in the future.
- Additional equipment installed at 02 110 kV feeders must be compatible with existing equipment and structure of Doc Soi 220/110 kV station.

2/ Regarding the electricity metering points:

EVN agreed in principle that the electricity metering system would be installed at 110 kV feeders (E08 and E09) of Doc Soi 220/110 KV substation. Specific metering equipment locations, methods of metering and payment of electricity bills will be determined accurately through negotiation of power purchase agreement and specific requirements in the technical design step. It is required that the metering equipment must comply with the technical and business regulations of EVN and in accordance with the regulations of the Ministry of Industry in Decision No. 37/2006/QD-BCN and 1592/QD-BCN.

3/ Regarding investment responsibility:

Dakdrinh Hydropower Joint Stock Company is responsible for investment in the construction of Dakdrinh 110kV booster substation, double-circuit lines connecting Dakdrinh 110kV substation and 110 kV busbar at Doc Soi 220/110 kV station, 110 kV feeders at Doc Soi 220/110 kV station for telecommunications equipment synchronized with Dak Drinh Hydropower Plant.

4/ Some other related issues:

- Dakdrinh Hydropower Joint Stock Company reports to Quang Ngai Province and the Ministry of Industry to adjust the connection point of this connection line in Grid Plan of Quang Ngai Province in 2006-2010 period, with consideration to 2015 before implementing the next step.
- This connection plan is the basis for completing the volume and technical solutions in the project document for investment in construction of Dak Drinh Hydropower Plant. In the design stage, it is necessary to re-determine the location of the Dak Drinh 110 kV distribution station, the Dak Drinh – Doc Soi double-circuit line layout, and re-correct technical solutions for the technology part, the relay protection part, solutions for information and telecommunications part, metering equipment of 110 kV station. It is noted that the equipment should be compatible with existing ones at Doc Soi 220/110 kV station. The technical design needs to be agreed upon by EVN for the technology part before the investor takes steps according to the current regulations.

PP. GENERAL DIRECTOR

DEPUTY GENERAL DIRECTOR

(Signed and Sealed)

Nguyen Manh Hung

Recipients:

- As above;
- Ministry of Industry (to report)
- People's Committee of Quang Ngai Province
- DL3 Company (to coordinate)
- TTD2 Company (to coordinate)
- A0, A3 Load Dispatch Center
- TVD2 (to implement)
- Departments: KH, TTD, KD & DNT, KTLD,
- Filing: VP, TD Department.

PEOPLE'S COMMITTEE OF QUANG NGAI PROVINCE

No. 2026/UBND-CNXD
On the agreement of Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

Hanoi, July 09, 2007

To: DakDrinh Hydropower Joint Stock Company

Considering the proposal of DakDrinh Hydropower Joint Stock Company in Document No. 23/DHC-KTKT dated June 8, 2007 on applying for agreement on investment project to build DakDrinh Hydropower Work and recommendations of Department of Planning and Investment in Official Dispatch No. 662/SKHDT-KTDN dated July 2, 2007, the People's Committee of Quang Ngai Province has the following comments:

1. Agree on some main contents of Dak Drinh Hydropower Project as follows:

1.1. Name of investment project: DAK DRINH HYDROPOWER.

1.2. Investor: DakDrinh Hydropower Joint Stock Company.

1.3. Objective and scale of the project:

- Objective: To produce electricity to sell to Vietnam Electricity Corporation.
- Scale: Grade II Work.

1.4. Implementation location and used land area:

- Implementation location: Son Tay District, Quang Ngai Province and Konplong District, Kon Tum Province.
- Area of land used: about 2,139.8 ha.

Particularly, the land of Quang Ngai Province has an area of about 1,338.3 ha. This area includes the area of resettlement areas for households affected by the project and will be determined during the land lease procedures.

1.5. Main items:

- Reservoir: normal water level (MNDBT) = 410 m; dead water level (MNC) = 375 m; total volume is 249.29 million m^3; Useful volume is 205.25 million m^3.
- Main dam: type of RCC dam; the dam crest altitude is 415.5 m; length of dam crest is 360 m; maximum height is 94 m.
- Spillway: type of dam with gate valve; size 4x14x15 m; length according the dam crest is 74 m; spillway threshold altitude is 395 m.
- Pressure tunnel: type of pressure; length is 9,660 m; design flow is 47.6 m^3/s; size (D) is 4 m.
- Pressure piping: steel; length is 543 m; design flow is 47.6 m^3/s; size (D) is 2.9 m.
- Hydropower Plant: Installed capacity is 125 MW, 02 units, the average annual output is 520.8 million KWh. The outdoor power distribution station is 200m from the plant and is connected to the national power system at Tinh Phong substation via the 53km-long 110 KV line. In case the electricity industry

invests in Son Ha 110 kV substation before 2010, the power system of the Plant is connected to this Substation. The investor needs to work with Vietnam Electricity Corporation to agree on the connection to the national grid.

In which, the main items to be built in the territory of Quang Ngai Province are:

A part of reservoir, all head clusters, tunnels, factory areas, pipes, transmission lines, and 03 resettlement areas.

1.6. Total investment: about VND 3,002 billion.

+ Capital of the investor: accounts for 30% of total investment.

+ Loan capital: accounts for 70% of total investment.

1.7. Form of investment: New construction in the form of Build-Own-Operate (BOO);

1.8. Form of project management: the investor directly manages the project implementation.

1.9. Implementation time: 2008-2011.

2. Request DakDrinh Hydropower Joint Stock Company (the investor) to note the following issues:

- Complete the project document according to the conclusion of the Provincial People's Committee in Notice No. 162/TB-UBND dated May 22, 2007 and the comments of the Department of Planning and Investment in Official Dispatch No. 662/SKHDT-KTDN dated July 2, 2007 in the process of preparing documents and implementing the project.
- Coordinate with People's Committee of Son Tay District to formulate compensation, support and sedentarization plans to submit to competent authorities for approval in accordance with current regulations;
- When submitting the application for Investment Certificate, the Investor needs to add the agreement between the People's Committee of Kon Tum Province and the People's Committee of Quang Ngai Province on this land, and also supplement legal bases to prove the Investor's ability to ensure that the Investor's capital can meet the ratio as prescribed in Decision No. 30/2006/QD-BCN dated August 31, 2006 by the Ministry of Industry. Above is the comments of the provincial People's Committee about the Dak Drinh Hydropower investment project, DakDrinh Hydropower Joint Stock Company and relevant agencies of the province are required to implement./.

CHAIRMAN

(Signed and Sealed)

Nguyen Xuan Hue

Recipients:

- As above;
- Ministry of Industry;
- Standing Provincial Party Committee, Standing Provincial People's Council;
- Chairman, Vice chairman of provincial People's Committee;
- Departments: Planning and Investment, Industry, Construction, Natural Resources and Environment, Agriculture and Rural Development;
- People's Committee of Son Tay District;
- VPUB: CPVP(CN), KHTH;
- Filing: VT, CNXD. To394

PEOPLE'S COMMITTEE OF QUANG NGAI PROVINCE

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

No. 3699/UBND-CNXD

Quang Ngai, December 10, 2007

On the agreement of resettlement of Dak Drinh Hydropower Project

DAKDRINH HYDROPOWER JSC

INCOMING OFFICIAL DISPATCH
No. 181 dated December 10, 2007

- People's Committee of Son Tay District;
- DakDrinh Hydropower Joint Stock Company

Considering the proposal of the People's Committee of Son Tay District in Report No. 74/TTr-UBND dated November 26, 2007 on the agreement of resettlement of Dak Drinh Hydropower Project (attached with the Working Minutes between the People's Committee of Son Tay District and the DakDrinh Hydropower Joint Stock Company dated November 15, 2007), Chairman of the Provincial People's Committee has the following comments:

Agree to arrange resettlement land for households in DakDrinh Hydropower Project, Son Tay District with an area of 1000m^2/ household, specifically as follows:

No.	**Resettlement area**	**Commune**	**Number of households**	**Area (m^2)**
1	Nuoc Vuong Hamlet	Son Mua	99	99,000
2	Anh Nhoi Hamlet	Son Dung	188	188,000
3	Nuoc Lang Hamlet	Son Dung	129	129,000
Total			**416**	**416,000**

The above resettlement land area does not include the land area for technical and social infrastructure works such as traffic, electricity, water, schools, kindergartens, etc. Therefore, when planning the resettlement areas, DakDrinh Hydropower Joint Stock Company (the Investor) is responsible for fully supplementing technical and social infrastructure works in accordance with current regulations, at the same time, supplementing the planning of the sedentarization areas to serve the people's production in order to ensure the living standards for resettled households better than their old residence.

Functional departments, localities and relevant units are required to implement the contents of this Official Dispatch./.

Recipients:

- As above;
- Chairman, Vice chairman (Cadre Nhi)
- Departments: Planning and Investment, Industry, Construction, Natural Resources and Environment,
Agriculture and Rural Development;
- VPUB: CPVP(CN), KHTH;
- Filing: VT, CNXD. To616

PP. CHAIRMAN

VICE CHAIRMAN

(Signed and Sealed)

Truong Ngoc Nhi

PEOPLE’S COMMITTEE OF

QUANG NGAI PROVINCE

No. 78/UBND-CNXD

On the agreement on the alignment of the 110kV line connecting Dak Drinh Hydropower Plant to the national grid

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, January 11, 2008

<table>
<tr><td colspan="11">Incoming Official Dispatch No.: 188 Date: January 11, 2008</td></tr>
<tr><td rowspan="4">TRANSFER</td><td>1</td><td>~~2~~</td><td>~~3~~</td><td>~~4~~</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>01</td><td>02</td><td>03</td><td>04</td><td>05</td><td>06</td><td>07</td><td>08</td><td>09</td><td>10</td></tr>
<tr><td>11</td><td>~~12~~</td><td>13</td><td>14</td><td>15</td><td>~~16~~</td><td>17</td><td>18</td><td>19</td><td>~~20~~</td></tr>
<tr><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td></tr>
</table>

To: Power Engineering Consulting Joint Stock Company 2

Considering the proposal of Power Construction Consultant Joint Stock Company 2 in Official Dispatch No. 424/CV-TVD2-P20 dated December 25, 2007 on the agreement of the alignment of the 110kV line connecting Dak Drinh Hydropower Plant to the national grid; and the recommendations of the Department of Industry in Official Dispatch No. 05/SCN-QLD dated January 07, 2008, Chairman of People's Committee of Quang Ngai Province has the following comments:

Agree on the connection of Dak Drinh Hydropower Plant to the national power system at Doc Soi 220kV substation according to the alignment plan prepared by Power Engineering Consulting Joint Stock Company 2 together with Official Dispatch No. 424/CV-TVD2-P20 dated December 25, 2007.

The consulting unit needs to collect comments from the relevant departments, branches and localities to complete the documents in the following stages: formulation of investment project, technical design, construction drawing design to limit relocation and resettlement, limit the impact of the Work on the ecological environment and not to affect other economic works./.

Recipients:

- As above;
- Chairman of provincial People’s Committee;
- Department of Industry;
- DakDrinh Hydropower Joint Stock Company
- VPUB: PVDCN, KHTH;
- Filing: VT, CNXD. To9

CHAIRMAN

(Signed and Sealed)

Nguyen Xuan Hue

PEOPLE'S COMMITTEE OF	**SOCIALIST REPUBLIC OF VIETNAM**
SON TAY DISTRICT	**Independence – Freedom – Happiness**
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No. 96/UBND	*Son Tay, April 19, 2007*

On the flow of the river behind
the dam belongs to the Dak Drinh Hydropower Project on Tra Khuc River

To: Power Engineering Consulting Joint Stock Company 2

Based on the current state and expected local planning, People's Committee of Son Tay District confirms the area along the Dak Drinh river from behind the main dam of Dak Drinh hydropower reservoir to the plant in Son Tay District - Quang Ngai Province with the following contents:

- This area is currently a natural forest without inhabitants and cultivation and production land.
- In the local development plan, this area does not develop population and production but only the watershed forest of the Dak Drinh river. Therefore, there will be no demand to use water for agricultural and industrial production and domestic use of the people. So when building hydroelectric works, the river area behind the dam does not affect the daily life and production of the people.

People's Committee of Son Tay District informs your Company to know./.

Recipients:

- As above;
- Filing

CHAIRMAN

(Signed and Sealed)

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PEOPLE'S COMMITTEE OF KON TUM PROVINCE	SOCIALIST REPUBLIC OF VIETNAM Independence – Freedom – Happiness
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No. 2605/UBND-TH	*Kon Tum, December 07, 2007*
On the agreement of Dak Drinh Hydropower Project	

To: Ministry of Industry and Trade

Pursuant to the Document No. 2559/VPCP-CN dated May 15, 2007 by the Government Office on permitting the conversion of the investor of Dak Drinh Hydropower Project;

Pursuant to Document No. 1567/QD-BCN dated June 21, 2006 by the Ministry of Industry approving the planning of hydroelectric cascade on Tra Khuc river;

Pursuant to the Document No. 1057-CV/VPTU, dated August 01, 2007 by the Standing Party Committee of Kon Tum Province on a number of proposals of the Joint Stock Commercial Bank for Investment and Development of Vietnam;

Considering the request of DakDrinh Hydropower Joint Stock Company in Document No. 10/DHC-VPKT, dated December 29, 2007 on the application for agreement on investment project for construction of Dak Drinh hydropower works and suggestions of People's Committee of Kon Plong District at Report No. 144/TT-UBND dated November 28, 2007;

Based on the conclusion of the Provincial People's Committee at the meeting on December 7, 2007,

The People's Committee of KonTum Province agreed on some main contents of Dak Drinh Hydropower Project as follows:

1. Name of investment project: DAK DRINH HYDROPOWER.

2. Investor: DakDrinh Hydropower Joint Stock Company.

3. Location: The part located in Kon Tum Province is in Dak Nen Commune and Dak Ring Commune - Kon PLong District.

Coordinates are in the range: X: 580-500 ÷ 588-500; Y: 1648.500 ÷ 1659.500,

4. Impact of the project:

4.1- Submerged area: 390 ha (Dak Drinh hydropower reservoir bed), of which:

+ Agricultural land: 71.9 ha;

+ Forest land: 26.9 ha (protection forest 15.93 ha; production forest 10.97 ha).

- Residential land area: 9 ha.

- Area of unused land: 232.4 ha.
- Specialized land: 0.8 ha
- Area of rivers and streams: 49 ha

4.2. Number of affected households and people (as of November 28, 2007):

- Affection on sedentarization - resettlement: 262 households with 1,305 people.
- Affection on resettlement: 32 households with 165 people.

5. Main parameters of the Work: According to the parameters in Document No. 10/DHC-VPKT dated December 29, 2007 of DakDrinh Hydropower Joint Stock Company.

6. Total investment capital: VND 3,159 billion.

- Investor's capital: accounting for 30% of total investment.
- Loan capital: accounting for 70% of total investment.

7. Form of investment: New construction in the form of Build - Own - Operate (BOO).

8. Form of project management: The investor directly manages the project implementation.

9. Implementation time: 2008 - 2011.

10. Arrangement of sedentarization - resettlement area and communal administrative center: Total resettlement area is 43 ha; the sedentarization area is 375 ha; area for construction of commune cluster center is 30 ha, specifically:

10.1 - Nuoc Bao Concentrated Sedentarization - Resettlement Area - Dak Nen Commune:

- Resettlement area: 2 5 ha.
- The resettlement area: 220 ha (of which, the area of wet rice: 55 ha).

10.2- Nuoc Puk Concentrated Sedentarization - Resettlement Area - Dak Nen commune:

- Resettlement area: 18ha
- The resettlement area: 120 ha (of which, the area of wet rice: 20 ha).

10.3- Nuoc Doa Concentrated Sedentarization - Resettlement Area – Dak Ring Commune: The sedentarization - resettlement area is located in DakReng stream area of DakDoa Village with an area of about 35 ha (of which, the area of wet rice: 10 ha).

10.4 - Center of Dak Nen Commune, Health Station, school, communal cultural area, etc.: The center will be arranged with about 30 ha in Dak Lai Village.

11- Distribution of tax revenues:

- Natural resource tax: Kon Tum Province enjoys 70%; Quang Ngai enjoys 30%.
- VAT: Kon Tum Province enjoys 40%; Quang Ngai enjoys 60%.

(For this content, the two provinces have worked and agreed in the working minutes dated October 9, 2007)

12 - Creating conditions for the people of Kon Tum Province to buy preferential shares: According to the original par value of the Work with the ratio from: 3% to 5%.

13- Requirements for DakDrinh Hydropower Joint Stock Company (the investor):

13.1- The investor is only allowed to start the construction of the Work after reclaiming the construction of fields and production land; compensate for damage to the people and get the consent of the people (The compensation, support, and resettlement must comply with the spirit of Official Dispatch No. 4263/VPCP-NC dated August 08, 2006 by the Government Office on resettlement in hydropower projects in the Central Highlands, specifically: The People's Committee of KonPlong District is assigned to be the investor of a component project on resettlement. KonPlong District People's Committee coordinates with relevant departments, agencies and DakDrinh Hydropower Joint Stock Company to plan the resettlement area, develop a compensation policy, support immigration and resettlement, determine the amount of compensation, set up procedures according to current regulations, and report to competent authorities for approval to pay compensation. The compensation and resettlement must be timely, ensuring that people have a better life in a new place than their old one.

13.3. Coordinate with the People's Committee of Kon Plong District and related sectors, complete procedures for changing the purpose of using agricultural and forestry land to land for construction of hydroelectric works.

13.4. Coordinate with the Department of Natural Resources and Environment and submit to the competent authority to implement the acquisition, allocation of land and environmental protection according to the current regulations.

People's Committee of Kon Tum Province proposed the Ministry of Industry and Trade to consider and decide./.

Recipients:
- As above;
- Provincial Party Committee (to report);
- Ministry of Agriculture and Rural Development (to report);
- DakDrinh Hydropower Joint Stock Company;
- Departments: Planning and Investment, Industry, Construction, Agriculture and Rural Development, Natural Resources and Environment;
- People's Committee of Kon Plong District;
- Filing: VT- TH3

ON BEHALF OF PROVINCIAL PEOPLE’S COMMITTEE

DEPUTY CHAIRMAN

(Signed and Sealed)

Tran Quang Vinh

DEPARTMENT OF CULTURE AND INFORMATION OF KON TUM PROVINCE

……………………..

GENERAL MUSEUM

No.: 18/TL – BTTH

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Kon Tum, May 09, 2007

To: - DakDrinh Hydropower Joint Stock Company

- Department of Culture and Information

After receiving the Official Dispatch No. 02/DADT-DHC of DakDrinh Hydropower Joint Stock Company on April 6, 2007 "On the determination of historical, cultural and archaeological relics of Dak Drinh Hydropower Project", Department of Culture and Information of Kon Tum Province has instructed the Provincial Museum to conduct field surveys in the Dak Nen and Dak Hring Communes. Now the Provincial General Museum would like to respond as follows:

1. Through surveying the area of Dak Hring and Dak Nen Communes, Kon Plong District, Kon Tum Province in the flooded area of the DakDrinh hydropower reservoir, we have not discovered any archaeological relics. However, we also know that archaeological relics are often deep underground; now we do not have the budget for exploration and therefore cannot answer exactly.

2. Regarding the historical and cultural relics: In the two communes mentioned above, we have discovered 2 communal houses of indigenous ethnic minorities in Tang Po and Dak Roi Villages in Dak Hring Commune.

Therefore, after relocating people along with the relocation of the communal house mentioned above, it is suggested that Dak Drinh Hydropower Joint Stock Company should have a plan and support funding for the people to continue to have communal houses in the new place.

Upon receiving this dispatch, if there is anything unclear, please let us know. We are please to respond.

Recipients:

- DakDrinh Hydropower Joint Stock Company.

- Department of Culture and Information. (to report)

- Filing: Office

PP. DIRECTOR

DEPUTY DIRECTOR

(Signed and Sealed)

Vu Thi Minh

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

Quang Ngai, October 09, 2007

WORKING MINUTES

The meeting was held at 14:00 on October 9, 2007 at the office of the People's Committee of Quang Ngai Province.

Participants of the meeting:

Kon Tum Province:

- Comrade Tran Anh Linh - Standing Deputy Secretary of the Provincial Party Committee, Chairman of the Provincial People's Council.
- Comrade Tran Quang Vinh - Member of the Standing Committee of the Provincial Party Committee, Standing Vice Chairman of the Provincial People's Committee.
- Comrade Le Quang Chuong - Member of the Provincial Party Committee, Director of Department of Planning and Investment.
- Comrade Le Khac Tinh - Director of the Department of Transport,
- Comrade Vo Xuan Truyen - Deputy Secretary of the District Party Committee, Chairman of KonPlong District People's Committee.

Quang Ngai Province:

- Comrade Cao Khoa - Standing Deputy Secretary of the Provincial Party Committee.
- Comrade Nguyen Xuan Hue - Deputy Secretary and Chairman of the Provincial People's Committee
- Comrade Bui Thanh Quang - Vice Chairman of Provincial People's Council.
- Comrade Truong Ngoc Nhi - Member of the Provincial Party Committee, Vice Chairman of the Provincial People's Council.
- Comrade Le Tan Hung - Deputy Director of Department of Planning and Investment.
- Comrade Le Viet Chu - Member of the Provincial Party Committee, Director of the Department of Transport.

Content: The Kon Tum and Quang Ngai Provinces agree on the following contents:

1/ Regarding the investment in upgrading National Highway 24:

Coordinate closely in proposing the Ministry of Transport and the Government to invest in upgrading National Highway 24 to facilitate traffic on the whole route, contributing to socio-economic development of the two provinces and the regions.

Implementation methods:

The Director of the Department of Transport of each province was assigned, based on the current state of National Highway 24 in the province's territory, to synthesize the general report of the whole route and draft inter-provincial submission to request the Ministry of Transport and the Government to give the policy of upgrading the whole route from Km9 in the territory of Quang Ngai Province to Km168 + 454 - the point adjacent to National Highway 14, the scale of the highland grade 3 road; the route respects the planning when passing through the urban areas of the two provinces.

The Department of Transport of Quang Ngai Province was assigned to proactively work to soon register the working schedule for the Chairmen of the People's Committees of the two provinces to work with the Minister of Transport to unanimously submit to the Government for the policy (at the end October, early November 2007).

2/ Regarding the construction of the Dak Drinh Hydropower Plant:

- The two provinces agreed on the investment policy of the project invested by Dakdrinh Hydropower Joint Stock Company.

- Regarding the compensation and resettlement policy, Kon Tum Province requires Dakdrinh Hydropower Joint Stock Company to implement the following contents:

+ Arrange residential land for resettled households with an area of 1000 m^2/01 household.

+ Determine the number of preference shares for resettled households of 3-5%

+ Organize the implementation of compensation and resettlement before starting the work construction.

+ Request the investor to start construction soon.

Quang Ngai Province basically agreed with the recommendations of Kon Tum Province, asking DakDrinh Hydropower Joint Stock Company to implement a uniform compensation and resettlement policy in the same project in the two provinces because these two provinces has the same characteristics of ethnic minority areas with the same difficult economic life.

- Regarding the division of tax revenues, the Kon Tum Province proposes:

+ Natural Resources Tax: Kon Tum Province enjoys 70%; Quang Ngai enjoys 30%.

+ VAT: Kon Tum Province enjoys 40%; Quang Ngai enjoys 60%.

Quang Ngai province basically agreed with the recommendations of Kon Tum province; However, Quang Ngai Province will agree with the Standing Leadership of the Provincial Party Committee, Standing Committee of the People's Council and the Provincial People's Committee, then send a document to Kon Tum Province to request Ministry of Finance to submit to the Government for the decision of the distribution of tax revenues.

The meeting ended at 15:30 on the same day, the Minutes was passed and the leaders of the two provinces agreed.

The minutes is made into 10 copies, each party keeps 05 copies./.

ON BEHALF OF PEOPLE'S COMMITTEE

OF QUANG NGAI PROVINCE

CHAIRMAN

(Signed and Sealed)

Nguyen Xuan Hue

ON BEHALF OF PEOPLE'S COMMITTEE OF KON TUM PROVINCE

PP. CHAIRMAN

VICE CHAIRMAN

(Signed and Sealed)

Tran Quang Vinh

APPENDICES

APPENDICES

TABLE APPENDICES AND CALCULATION

NAME OF TABLE APPENDICES AND CALCULATION **PAGE**

DOCUMENT APPENDICES

NAME OF DOCUMENT APPENDICES **PAGE**

APPENDIX 3.1: BIOMASS CALCULATION OF VEGETATIONAL COVER SUBMERGED IN DAK DRINH HYDRAULIC RECOVERY

I. Research purposes

The assessment of the impact of the Dak Drinh hydropower work construction project is based on the statistical survey data on the characteristics of natural resources of the vegetation cover, of which forest biomass is one of the necessary data to evaluate the role of vegetation cover in the process of forming reservoirs,

The calculations of plant biomass in the reservoir area will be a reliable scientific basis for the prediction of water pollution in the reservoir bed, from which to propose solutions and appropriately use the area of reservoir surface,

II. Research methods

Due to the limited study time, complex topography, the study of vegetation biomass is based on: (1) identifying the types of vegetation cover; (2) sampling on typical plots; (3) using biomass calculation methods of previous domestic and foreign studies to interpolate; (4) compare the results obtained in the field and in the laboratory with those of previous research works on similar types of vegetation cover to correct the data. Therefore, the methods of studying vegetation biomass include:

1. Location of survey points

Use the provided GFS and UTM topographic maps with a 1/10,000 scale to locate major types of vegetation cover and sampling sites,

2. Investigation method of sampling

Standard plot capacity

On each current vegetation cover, based on uniformity; the number of sample plots needed to be set up for investigation, research and measurement varies from 3 to 6 standard plots for each type of status quo

Standard plot size:

□ 50m x 50m for investigation of secondary forests, industrial and agricultural forest,

□ 25m x 50m for investigation of secondary broad leaved shrub land, bamboo,

□ 2m x 2m and 5m x 5m for investigation of grass land, short-term agricultural crops,

Methods of measurement and sampling:

For the purpose of determining the density, growth, volume, and species composition of secondary forests, industrial and agricultural forest, we use the standard plot of 50m x 50m. For large wooden tree species of the canopy layer with a height of over 10m, we do not cut trees, but only measure the diameter at the height of 1.3 m from the stump ($D_{1,3m}$) according to the diameter hierarchy 1cm and height of tree with Brumley rule over the entire standard plot area. In addition, for the purpose of verifying, comparing and adjusting the calculated data later, we measure $D_{1,3m}$, the lower diameter of branches, calculate the coefficient of clearance F, cut the 5cm cutting board of fallen forest trees, or cut down trees around the study area,

For grass, low shrubs, regenerating trees under the forest canopy, we weigh and measure the whole fresh weight of each nourishing organ of the plant: leaves, stems, roots, and rotten cover layer on the sample plot 2m x 2m, then take 10% of the total fresh weight for drying samples. The results of weighing and measuring the dried samples in the laboratory will be the database to compare and correct with the results calculated from the empirical formula,

For bamboo communities, on the area of each plot (25m x 50m), the average number of bushes and the average number of trees in a bush were measured. In each plot, select 3 standard bushes, on each standard bush, cut 3 trees with the eye-level diameter of Dmin, Dmed, Dmax, then weigh and measure the fresh weight of leaves, branches and stems to calculate the percentage of each part. For each tree, cut 3 5cm-thick internode sample at the root, middle and tip to make drying sample. Particularly leaves, branches, take 10% of fresh weight for drying sample, for roots, dig 1 standard bush to calculate percentage and take 1% of weight for drying sample,

2. Weighing and drying in the laboratory,

Samples collected and classified into stems, branches, leaves, and roots will be dried separately in ovens maintained at a constant temperature of 105°C, until sample weight stabilizes.

3. Calculating and correcting the data,

Depending on the characteristics, status and role of each type of vegetation cover, accuracy, field working conditions and funding in addition to using experimental measurements in the field and in the laboratory, when calculating the biomass of standing trees in the forest vegetation types, we also use the empirical formula for calculating the biomass of tropical trees of Brown et al., 1989 based on the document *"Estimating biomass and biomass change of tropical forest"*, Sandra Brown, FAO, 1997,

Formula 1,

$$\mathbf{Y = Exp\{-2.134 + 2.530 * \ln (D)\};\ n = 170,\ r^2 = 0.97}$$

Y = Aboveground biomass of trees (kg),

D = Diameter of stem at $D_{1,3m}$ (cm); grade D = 5 - 148cm

n = Number of trees

r^2 = Quantitative variable

Formula 2,

$$\mathbf{Y = VOB * WD * BEF}$$

Y = Aboveground biomass of trees (ton),

VOB = Volume of wooden stems under branches (m^3)

WD = Density of dried wood (ton/ m^3 or g/cm^3)

BEF = Ratio of the aboveground biomass of trees and the biomass of wooden stems under branches

BEF = Exp {3.213 – 0.506 * In(BV)}; n = 56 r^2 = 0.76 (applied for BV < 190 tons/ha)

BEF = 1.74 (applied for BV ≥ 190 tons/ha)

BV = Biomass of wooden stems under branches (ton/ ha)

BV = VOB * WD

For forestry and industrial trees concentrated on a certain area, we apply formula 1 to calculate biomass per unit area.

For fruit trees planted scattered around houses, gardens and fields not concentrated on a certain area, we select average standard trees that were representative of the area and apply formula 2 to calculate biomass

III. Research results

According to the design of the Dak Drinh Hydropower Project in the dam site with normal water level of 410m, the total submerged area is 912.4 ha, but the biomass is not too large because the area is mainly grass land, shrubs and fields.

The total amount of submerged biomass in the reservoir bed area is estimated at about 33,150 tons, this biomass will start to decompose after being submerged, the process of natural decomposition will increase the content of organic matter and toxins (SO_2, NH_3, CI, SO_4), etc. causing water pollution in the reservoir bed. Therefore, cleaning the reservoir bed should be implemented before impoundment.

According to field survey results, the types of evergreen forests with little impact in the submerged area of DakDrinh Hydropower Reservoir no longer exist. According to the analytical results, the biomass of secondary forest strongly affected ranges from 100 - 120 ton/ ha; biomass of all types of bamboo forest status is 60-70 ton/ ha, grassland and shrub is 5-6 ton/ ha; biomass of crops in fields is 4-5 tons/ ha,

□ ***Biomass of all types of vegetation cover statuses***

Biomass of secondary evergreen forest fluctuates greatly, this biomass index depends on the intensity of human exploitation, including many states from forests with medium reserves to forests with low reserves, scrub forests, in which the remaining big trees are less and less.

Table 1: Average biomass per unit of affected secondary forest area

Diameter level	**10-**	**20-**	**30-**	**40-**	**50-**	**60-**	**70-**	**>80**

		19	29	39	49	59	69	79		
Number of trees	(tree)	360	52	17	2,5	0,5	0,3	0,2	0,1	
Biomass/ tree	(kg)	112	407	954	1802	2995	4570	6563	9008	
Biomass	(t)	40.3	21.2	16.2	4.5	1.5	1.4	1.3	0.9	87.3

Other parts	**Coefficient**	***Biomass (t/ha)***
Wooden stem	1.0	*87.3*
Wooden stem root	0.15[1]	*13.1*
Layer of shrub + grass	0.06[2]	*5.2*
Layer of rotten falling object	0.05[3]	*4.4*
Total		*110 t/ha*

Table 2: ***Average biomass per unit of bamboo forest area***

Biomass components	**Unit**	**Whole population**
Aerial stem	(kg/ tree)	6.5
Leaves	(kg/ tree)	1.3
Underground stem	(kg/ tree)	2.0
Number of trees/ ha	(tree)	7000
Total biomass	(ton/ha)	68.6

Table 3. ***Average biomass per hectare of grassland – shrub***

Type of cover	**Fresh weight**	**Fresh/dry ratio**	**Biomass**
	(ton/ha)		(ton/ha)
Wooden stem shrub	16.2	0.53	8.6
Herbaceous shrub	11.1	0.27	3.0
Herbaceous grass	15.1	0.33	5.0
Average biomass			5.5

Source: Institute of Tropical Biology

Refer to the observed experimental data for tropical forests and the standing tree biomass calculation method of Kato, Oga Wa for trees, based on the current land use in the reservoir bed

[1] Phuong 2003.
[2] Lugo 1992
[3] Brown and Lugo 1982.

area of Dak Drinh Hydropower Project, we calculate the total biomass in the reservoir bed area for artificial vegetation (annual cultivation land, perennial crops),

Brown, and Kato-Ogawa Experimental method					
Type	**Stem** (ton/ha)	**Branch** (ton/ha)	**Root** (ton/ha)	**Leaf** (ton/ha)	**Total** (ton/ha)
Perennial tree	13.2	2.45	1.53	0.83	18.01
Annual cultivation land				3.82	3.82

□ ***Total biomass submerged in the reservoir bed area***

Based on the measured and analyzed data, the above calculation determined the average amount of plant biomass per hectare for each major vegetation type in the study area, thereby estimating the total plant biomass submerged in the reservoir bed area based on the submerged area of each type of vegetation cover.

In the large reservoir bed area of the main river branch, it can be seen clearly that most of the vegetation cover in the center of the reservoir bed is grassland, shrubs, bamboo, fields, impoverished secondary forest and a remaining wood forest with only large trees remaining scattered among shrubs and grass,

Evergreen forest is less affected here due to its distribution on high mountain peaks, and on steep slopes at the normal water level of 410m, the submerged area is negligible.

Brown, and Kato-Ogawa Experimental method

Total biomass of various types of vegetation cover submerged in Dak Drinh reservoir area

Type of vegetation cover	**Submerged area (ha)**	**Average biomass (ton/ha)**	**Total biomass (ton)**
Evergreen forest	45.29	110	4981.9
Bamboo forest	378.17	68.6	25942.462
Grassland and shrub forest	213.61	5.53	1181.968213
Annual cultivation land	100.54	3.82	384.0628
Perennial tree	36.83	18.01	663.3083
River	137.96		
Total submerged biomass	**912.40**		**33153.70131**

Calculation table of standing tree biomass in Dak Drinh reservoir bed for natural vegetation cover (Brown method)

Type of cover	**Area (ha)**	**Stem**	**Ko (ton/ha)**	**Root**	**Ko (ton/ha)**	**Layer of shrub + grass**	**Ko (ton/ha)**	**Layer of rotten plants**	**Ko (ton/ha)**	**Total biomass (ton)**
Natural wood forest	45.29	3953.82	87.3	593.30	13.1	235.51	5.2	199.28	4.4	4981.90
		Number of bamboos (7000 trees/ha)		**Aerial stem (ton)**	**Ko (ton/ha)**	**Leaf (kg/tree)**	**Ko (ton/ha)**	**Underground stem (ton)**	**Ko (ton/ha)**	
Bamboo forest	378.17	2647190.00		17206.74	6.5	3441.35	1.3	5294.38	2	25942.46
		Woody stem shrub	**Ko (ton/ha)**	**Herbaceous stem shrub**	**Ko (ton/ha)**	**Herbaceous stem grass**	**Ko (ton/ha)**			
Grassland + shrub	213.61	1837.05	8.6	640.83	3	1068.05	5			1181.98
Calculation table of standing tree biomass in Dak Drinh reservoir bed for artificial vegetation (Kato-Ogawa method)										
		Stem	**Ko (ton/ha)**	**Branch**	**Ko (ton/ha)**	**Root**	**Ko (ton/ha)**	**Leaf**	**Ko (ton/ha)**	
Perennial tree	36.83	486.16	13.2	90.23	2.45	56.35	1.53	30.57	0.83	663.31
Annual cultivation land	100.54							384.06	3.82	384.06
Total	774.44									33153.71

Forecast scenarios for DakDrinh hydropower reservoir bed				
		Biomass (10^3 tons)	**Ko (ton/ ha)**	**Oxygen loss (ton)**
Not cleaning	Stem	21.65	9.4	203.5
	Branch	0.09	9.4	0.8
	Root	5.94	9.4	55.9
	Leaf	3.86	60	231.4
	Shrub layer	1.42	9.4	13.3
	Cover layer	0.20	48.8	9.7
Total				**504.88**
Preliminary cleaning	Branch	0.09	9.4	0.8
	Root	5.94	9.4	55.9
	Leaf	3.86	60	231.4
	Cover layer	0.20	48.8	9.7
Total				**297.81**
Carefully cleaning	Root	5.94	9.4	55.9
	Cover layer	0.20	48.8	9.7
Total				**65.60**

ESTIMATION OF DISSOLVED OXYGEN (DO) IN DAK DRINH HYDROPOWER RESERVOIR BED THROUGH SCENARIOS

	The amount of natural oxygen in the tank before decomposition occurs (ton)	**The amount of oxygen used for the process of aeration in the reservoir bed**	**Remaining oxygen (tons)**	**DO (mg/l)**
When not cleaning the reservoir bed	1809.09	504.88	1304.2	5.23
When cleaning preliminarily	1809.09	297.81	1511.3	6.06
When cleaning thoroughly	1809.09	65.60	1743.49	6.99

TCVN 6774:2000 "Quality of fresh water for protection of aquatic life", dissolved oxygen in the reservoir (DO) must reach over 5 mg/l

BRIEF DESCRIPTION OF THE PROJECT

1.1. NAME OF PROJECT

Dak Drinh Hydropower Project

1.2. OWNER OF PROJECT

Project investor: **DakDrinh Hydropower Joint Stock Company**

General Director: Mr. Tran Minh Tuan

Contact address: 116 Hai Ba Trung - Quang Ngai City - Quang Ngai Province

Phone: 055.713.212

Fax: 055.713.213

1.3. GEOGRAPHY OF THE PROJECT

Dak Drinh Hydropower Project is planned to be located on Tra Khuc River, about 70km to the Northeast from Quang Ngai Town. The reservoir bed is located in Son Dung, Son Mua Communes of Tay Son District (Quang Ngai) and Dak Drinh and Dak Nen Communes of Kon Plong District (Kon Tum). The plant area is located in Son Tan Commune, Tay Son District (Quang Ngai). It is possible to reach the work on provincial road 5 from Quang Ngai Town to Thach Nham, through Son Ha Town to Son Tay Town.

1.4. MAJOR CONTENTS OF THE PROJECT

1.4.1. Research plan

Dak Drinh Hydropower Plant is arranged according to the path diagram, including 2 work clusters: clusters of focal points and cluster of energy lines. During the investment project stage, in order to select the plan to bring the highest investment efficiency and to minimize negative impacts on the environment, the Consulting Unit considered the plans to arrange the Work and select the optimal plan. (See *Figure P1.1, Construction site plan*).

1.4.2. Main works (according to the proposed plan)

A. Cluster of focal lines: including rolling weir and spillway forming a reservoir.

1. Reservoir

The reservoir is about 12.5 km long along the Tra Khuc River, the largest width is over 1.2 km, averaging about 350m.

Corresponding to normal water level: 410m; the reservoir has a reservoir surface area (F) 9.12km^2; Total capacity (V_{tb}): 249.3 million m^3; Useful capacity (V_{hi}): 205.25 million m^3. The maximum depth of the reservoir in normal water level is about over 100 m.

Corresponding to dead water level: 375m; the reservoir has a reservoir surface area (F): 2.83 km^2. Dead capacity (V_c); 44.04.10^6 m^3; And the extraordinary water level when discharging flood for inspection p = 0.2% is 412.2m.

2. Rolling weir

It is located on Dak Drinh River at line 2, is a gravity concrete dam made of roller compacted concrete, maximum height ≈ 94m, vertical upstream roof, downstream roof m = 0.8. The length of the dam along the crest is 360m. The foundation of the dam is granite of zone 1B and reinforcement is 5m, the distance between the boreholes is 3.0m. The depth of the drainage borehole is 0.6, the depth of waterproof drilling. The water drainage boreholes are arranged 3m apart.

3. Spillway

Arranged in reservoir bed with altitude of 395m, including 4 compartments with size 14 x 15m, design discharge Q = 6480m^3/s. The dam has a practical cross-section and has a height of 75m. Energy dissipation after overflow by discharging head, the flow after overflow is discharged directly into the natural river bed. The dam is equipped with 3 valve gates and must be repaired. Valve gates must be controlled by hydraulic lift and repaired by goat foot bridge.

B. Energy route: including inlet canal, water intake, pressure tunnel, pressure pipe, hydropower plant and distribution station.

1. Inlet channel and water intake.

The intake is located at the right channel of the reservoir, about 4km upstream from the dam site. The water intake has 2 main parts, the head of the water intake tunnel is arranged with a trash net and repair valve door. The well located at the operating valve gate is located 110m from the tunnel door. With this arrangement, the volume of excavation of the water intake and the volume of concrete is significantly reduced and construction costs are reduced.

Type of vertical wells. Design flow: 45m^3/s. Number of compartments: 2 with dimensions (BxH) of 3.8 x 6.9m. In front of the water intake, there is a system of trash nets, garbage pickups and valve hoists. Operate the garbage screen and the repair door with a mobile crane.

2. Pressure tunnel

The pressure tunnel carrying water from the water intake to the hydropower plant has the following main sections:

- The section from the water intake to the pressure tower is 9660m long, with an inner diameter varying from 3.4 to 3.9m, and covered by 30cm-thick reinforced concrete.
- The section from the pressure tower to the Valve House is 554m long, d = 3.1 - 3.9m, in which the steel-lined section is 414m long.

3. Pressure pipeline

The open-pressure steel pipeline is 543m in length and 2.8m in diameter, including 1 pipe. The pipeline is divided into 2 branches to lead water to the 2 units. The branching position is 25.0m from the center of the unit, the diameter of the branch duct is 1.9m. The pipeline has 3 abutments and support abutments which is 15m apart.

At the beginning of the pipeline, there is a valve house, in the valve house, there is a butterfly gate to prevent the problem of the pipe and steering wheel to serve the installation of the valve.

4. Pressure control tower

Pressure control tower is located 9,660m from the water intake. The tower has 2 chambers, upper chamber d = 11m, H = 31.5m; lower chamber d = 5.5m, H = 108m covered with 45cm-thick concrete. The highest water level in the tower is 435m, and the lowest water level is 301.52m.

5. Plant and downstream discharge channel

Located in Village 1, Son Tan Commune. This is an open type plant, the number of units is 2. Capacity of each unit: N_{tm} = 62.5 MW. Turbine type: Francis vertical shaft. Maximum flow through the plant: Qmax = 45 m^3/s

Dak Drinh Hydropower Plant is connected to the national power system via 70km-long 110kV line to Dung Quat subtation.

6. Outdoor distribution station: The outdoor distribution station is 200m from the plant, 65m x 36m in size and located at the altitude of 92m.

1.4.3. Auxiliary works

In the auxiliary areas, there will be dumps, material storage yards, mixing plants; Project management area, operation management and contractor camp. There are also other construction works: Material mines (earth mines, quarries, sand mines); Water supply system, power supply system, communication; Roads for construction.

1. Construction material mines

- Cohesive soil mine: including 6 mines (Mine A, Mine B, Mine c, Mine D, Mine E, Mine F)

Mine A: located on the upstream hillside on the left shoulder of Dak Drinh rolling weir, about 880m from Dakrinh dam route, about 1420m from Dak Roman dam route, with an altitude of 375-550m, useful reserves of about 1.8 million m^3. This mine has the most economic significance in terms of distance for the Dak Drinh dam site.

Mine B: located in the upstream hillside of on the left shoulder of Route 2 rolling weir, about 520m from main dam route 2, 720m from Dakrinh dam to the downstream, with an altitude of 375-675m, useful reserve of about 2, 9 million m^3.

Mine C: located on the downstream hillside of the eight spillway tail of Route 2, about 860m from Route 2, with an altitude of 375-675m, useful reserves of about 3.7 million m^3

Mine D: located on the hillside of the water intake area 2 and the right shoulder of Dak Roman dam, about 200m from Dak Roman dam, with an altitude of 375-550m, useful reserves of 1.9 million m^3.

Mine E: located on the hillside opposite to Dak Roman river with the water intake area 2, about 960m from Dak Roman dam, with an altitude of 375-550m, useful reserve of about 2.8 million m^3.

Mine F: Contingency is located on the right hillside of Ta Meo – Dak Dinh river junction, 1200m from Dak Dinh dam route to the upstream, with an altitude of 375-550m, useful reserves of 1.7 million m^3.

- ***Quarry:*** includes 4 mines (number 1, number 2, number 3 and number 4) with reserves level C1

Quarry No. 1: located downstream of Route 2, 500m from the rolling weir, on the left bank. Here the river bed and rocky river banks are completely exposed, useful reserve is about 2.67 million m^3.

Quarry No. 2: located upstream of Route 2, 500m from the rolling weir, on the right bank. Here is the low hill, on the river bank, the rocks are completely exposed, useful reserve is about 3.1 million m^3.

Quarry No. 3: located on the side of the Water intake 2. On the side, there are many rolling granite rock with the size of 1x2x3m, useful reserve is about 1.5 million m^3.

Quarry No. 4: located downstream on the side next to the Plant Route 2. Here is a terraced field with wet rice cultivation all year round, useful reserve is about 3.6 million m^3.

- ***Sand mine:*** the exploitation of a mine with C1 reserves.

Along the Dak Drinh river, from the upstream to the plant area, there are mostly pebbles and gravels in the river bed, the sand is very little and scattered creating small strips that run along the river. From the Plant area to the Son Ha bridge, along the river began to be scattered with small sand, where the riverbed widened and the most deposited sand is the meandering river of about 3 km long. This location is about 25 km from the center of Son Tay District, about 13 km from the plant. There is a sand mine here. The reserve is about 3 million m^3, the sand quality is quite clean and belongs to middle-earth grain type sand. Such a location is convenient in terms of transportation distance. The above reserve is enough for the project.

2. Material disposal and storage yards

Warehouses include 3 types: closed, covered and open yards. Closed warehouse is used to store cement, electrical equipment, spare parts for construction equipment, etc. Covered warehouse is used to store sawn timber, semi-finished products of wood, iron and steel. Open yard used to store sand, crushed stone, etc. has a compacted 30cm thick crushed base. There are also a number of specialized warehouses such as petroleum depots, explosives depots, etc. with appropriate structure.

3. Building office of management and auxiliary areas

The auxiliary items and housing are only used for a few years of construction. Therefore, except for some items which are used after the completion of construction, the structure of the auxiliary items will be mainly temporary, easy to install and dismantle. The house is expected to have 2 types: Administrative building (type 1) and Workshop (type 2).

* Operation and Management Area is planned to be located in Quang Ngai with construction area of 8000-8500 m2.

4. Roads in the construction site

- Roads outside the construction site

Dak Drinh Hydropower Project is located 80 km from Quang Ngai Town and about 2 to 7 km from Provincial Highway 630A. The road to the Work in service of construction and operation is located on the right bank of Dak Drinh river. The start point is in the Son Tay Town. The end point of the route is located in Som Dung Commune, about 5 km from the dam route. From here, a new section connecting to the dam route is built. The total length of the route is 20 km. This road will be renovated and upgraded before the construction of the main Work with grade 4 scale in mountainous areas.

The route will ensure the required transportation of materials, equipment and construction services, travel requirements during operation.

- Roads in the construction site

There are 3 types of road system serving the construction site as follows:

- *Construction-operating roads:* are routes to operate the Work later, in the construction stage, to be used as construction roads. These routes include: road to the Work, way to pressurized well, road to Nha Van, road on dam crest.

- *Temporary fixed roads for construction*: are roads that serve only construction work but are fixed during the construction process. These routes are designed to secure the transport requirements between the auxiliary area and the main construction site and reach different sections of the dam on both banks.

- *Road serving construction on top of cofferdam and down to foundation pits*: This road only exists in a certain construction period.

5. Communication system for construction

At the Dak Drinh hydropower site, there is no separate information for the whole site. The information assurance within the construction site as well as from the site to the outside will be undertaken by the Contractor providing professional information services.

1.4.4. Resettlement - sedentarization areas

A - The resettlement and sedentarization area of communes in Son Tay District - Quang Ngai Province

- *Resettlement area of Son Mua Commune* (90 households): includes 1 area according to the arrangement of commune and district (Minutes dated July 9, 2005 at the commune and District Official Dispatch No. 158/UBND of Son Tay District dated July 12, 2005)
- *Resettlement area of Son Dung Commune:* there are 2 resettlement areas according to the arrangement of commune and district (Minutes dated July 12, 2005 and Official Dispatch No. 158/UBND of Son Tay District dated July 12, 2005). Resettlement areas of Nuoc Lang Hamlet (117 households) and Anh Nhoi Hamlet (171 households)

B - The resettlement areas of communes in Kon Plong District - Kon Tum Province

- *Resettlement area of Dak Nen Commune:* There are 2 resettlement areas: Nuoc Bao (95 households) and the old Nuoc Dop (60 households).
- *Resettlement area of Dak Rin commune:* (34 households).

1.4.5. Electricity and water sources for construction

1.4.5.1 Water supply system for construction

The water demand for the construction site includes four main categories: dam head, water intake, tunnel route and the hydropower plant.

Water supplied for production and living is mainly from the Dak Drinh and Dakroman rivers. In addition, the water can be taken advantaged from the tributaries and tributary stream with abundant water all year round. Demand for drinking water is calculated at 50l/person/day. Mixing plants, crushing and screening areas, laboratories and houses near rivers and streams are considered for arrangement which is very convenient for water supply.

1.4.5.2. Power supply system for construction

The power grid in the project area is now coming to Son Tay Town to serve the town's activities. However, the capacity is too small compared to the construction demand of the site (6,800 KVA).

The power supply source for the project is expected to build a new 35kV (22kV) line branch from the existing Son Ha line with a length of about 13km, wire size AC-95. This line is designed in the permanent form to provide back-up power for the Plant later. Load demand for the site during construction is about 5,900kW.

- The plan for power supply for construction will be accurate in the following design stage.
- From Son Ha, a 35kV (22kV) AC-95 principal arterial line will be built to supply electricity for the Dak Drinh Hydropower Plant area with a length of about 13km.
- From the principal arterial medium-voltage line, branch lines will be built to supply electricity for other construction works with a total length of about 7km.
- The production areas using the 0.4 kV voltage level will be supplied from the 35 (22)/ 0.4kV substation.
- Low voltage stations are designed in the form of hanging on columns, mounting on beams or placed on the ground depending on the capacity of the station. The high-pressure side is protected by FCO, the low-pressure side is protected by a 600V circuit breaker with appropriate cutting power.

1.4.6. Construction progress

Expected implementation progress is 4 years, plus 1 year of preparation, power generation in the fourth quarter of the fourth year of construction. It is divided into timelines as follows:

- Preparation of investment: 2005 - 2007
- Preparation for construction: 2007
- Construction stage; 2008 - 2011
- Operation stage: From 2012.

1.4.7. The total investment capital of the project

Total investment VND 3332.647.10^9. Of which:

- Construction investment capital	:	VND 2769.893	.10^9.
- Construction costs	:	VND 1295.863	.10^9.
- Equipment costs	:	VND 469.973	.10^9.
- Other costs	:	VND 241.610	.10^9.

Table Impacts on the environment and impact mitigation measures

No.	**Impacts**	**Mitigation measures**
I	**STAGE BEFORE CONSTRUCTION**	
1	**Waste soil and rock:** It is estimated that the excavation of the foundation of the work items will release more than 2 million m^3 of soil and rock.	- Determine the location of the planned areas to discharge soil and rock for the construction. Locations of dumps are determined on the basis of convenience for construction and limitation of water pollution. In addition, on the basis of geological research, the excavated soil is calculated to be reused as construction materials. - The measures for long-term stabilization of the edge of waste rock mass and limitation of pollution of water sources during the rainy season will be identified in the following study and stated in bidding documents. These solutions can be to determine the exact location and reasonable waste scale, make the most of the excavated soil, make the roof to ensure a stable slope depending on the waste materials, make the banks around the dump, plant turf for roof and surface, reasonable discharge height, etc.
2	**Seism**	- The water volume of the reservoirs will not cause any seismic activities during the accumulation period, - For the work structure, seismic coefficients are considered in the stability calculations. In the design according to the earthquake level 6 and the accumulation depth to over 100m corresponding to the flood water level checked.
3	**Water penetration through the dam**	Although the penetration through the dam is not large, to minimize the water permeability, a

		30-35 m deep waterproof membrane will be used for the Work to ensure safety for the dam foundation.
4	**Flood control:** According to calculations, the flood peak flow with the re-emergence time is 200 years. Similarly, checked for spill over the dam with floods reappearing after 1000 years.	- In the following design stage, continue calculating, checking flood and checking overflow arrangement to discharge in case of flood p = 0.1%. Building a hydraulic model with overflow to check and adjust the spillway design, determine the river water surface in the upstream and downstream sections of the dam according to different flow levels to identify the evacuation range when discharging the different flood flows through the spillway, determine erosion and reinforcement measures downstream of the banks.
5	**Compensation and resettlement**	- Prepare detailed special matter on ***Compensation and Resettlement Plan***, this plan will be implemented in the site clearance stage before construction of items. During the feasibility study stage, the consultant (PECC 2) will undertake detailed planning and design of construction items for resettlement areas.
II	**CONSTRUCTION STAGE**	

1	**Issues on reservoir environment**	- To protect the water environment of the reservoir, before storing water, it is necessary to preliminarily clean up the reservoir bed. The reservoir bed cleaning process should focus on the following points: - Before flooding, agricultural products must be exploited to recover trees of economic value, and reduce the risk of water pollution. - Monitor which plants will be cut (size, type, etc.) and classify to use up. - Complete the clearing of an area before transferring to another area. - Clean up and clean breeding facilities by removing and filling with clean soil before storing water in the reservoir. - Graves need to be moved to the appropriate place. Detect and handle bombs, mines, and explosives.
2	**Transport of wild animals**	- It is necessary to investigate the density of mice and other wild animals capable of causing epidemic. If the density is high, a contingency plan should be drawn up to reduce the density by means of bait. This plan must be in place before water filling can begin. Control measures should be proposed by the local Department of Health and for the local people to implement.
3	**Construction of waste treatment system**	*Industrial waste.*
	1. Solid waste	- Normally, the solid waste generated during the construction process will be collected into the dumps, which are the connection points before transferring the waste to the garbage collection

site. The dumps should be arranged sufficiently and reasonably for convenient waste collection.

- It is possible to apply the method of digging ditches around the landfill to collect rainwater carried by suspended solids and deposited before it flows into the river.

- Solid wastes arising from other industrial production establishments in the region should be thoroughly collected, depending on specific conditions, the project's dumps can be used to collect waste.

Domestic waste.

- Domestic waste during construction is mainly due to the number of construction workers. At present, there is no landfill in the project area. Therefore, one landfill pit must be built in the area.

- The waste treatment will be conducted methodically and ensure proper technical process.

2. Liquid waste

- During the construction of the project, wastewater is mainly from the daily life of construction workers. The receiving source of wastewater is Dak Drinh River. Therefore, it is necessary to have a wastewater treatment system before being discharged into the river. Wastewater after being treated must meet standard grade B - TCVN 5945 - 1995.

- At the same time with wastewater treatment, it is necessary to have a plan to supply clean water for daily activities of the worker. One of the feasible options is to use local groundwater resources by drilling wells or exploiting shallow strata. Because this is a rather high area, groundwater is of good quality, ensuring hygiene for daily life.

Waste oil and grease generated mainly from mechanical and motorcycle maintenance and repair facilities need to be thoroughly collected.

3. Air environment

- All vehicles must have a canvas covering materials when transporting.

- Apply warm spray method during leveling. During the sunny and windy times, it is necessary to spray moisture at least 2 times a day. Spray water on the roads near the construction site, where vehicles transporting materials pass.

- There is a suitable vehicle regulation to avoid increasing vehicle density.

- All trucks and motorized construction equipment must meet the standards prescribed by the Registry Department on technical and environmental safety.

- In addition, it is also necessary to apply a number of other measures to ensure safety such as: control of fuel depots, fire and explosion prevention, etc.

4. Soil environment

- Some land areas cannot avoid being destroyed during construction (constructing housing, working houses, workers' tents, land mines, stones, disposal sites, storage yards, etc.) . After the construction of the Work, in addition to a number of fixed facilities such as office building, transmission lines, operation lines, etc. can continue to be used, the remaining land area needs to be restored for environment protection.

II OPERATION STAGE

1 For the ecosystem

When becoming a reservoir, on one hand, aquatic organisms and fisheries change to reservoir fisheries, on the other hand, the hydrological regime of the reservoir can affect downstream and

		fisheries here. Some measures to minimize negative impacts are: + Basin area: Conserve and develop watershed forests, especially, minimize erosion and protect biodiversity. Manage watershed waste (both point source and scattered source). + Reservoir bed and dam area: Form a water environment monitoring station from a hydro, chemical and biological perspective. + Downstream area: fishing with appropriate methods, time suitable with the hydrological regime and resource protection, not fishing with mines, electric pulses, toxic chemicals, etc.).
3	**Flood control**	- Set up a hydro-meteorological station system for flood forecasting and warning, and a communication system between Thach Nham and Dak Drinh reservoir. Regularly inform people about safety regulations - It is necessary to organize the prompt notification and evacuation in the event of a major flood discharge. Regularly inspect Works related to overflow such as overflow opening and closing systems.
4	**For water environment.**	
	1. Issues on flow regulation:	- During the initial period of water accumulation, the amount of river water will decrease and river water quality will be affected by construction materials. Therefore, the flow control must comply with regulations on coordination and timely information to downstream residents (the process of discharging water, discharging floods from the reservoir, etc. to ensure safety for the Works of the downstream area.

2. Surface anti-erosion on reservoir basin

- In order to reduce the sedimentation of the reservoir bed, increase the life of the Work, in addition to technical measures to prevent surface erosion (tree structure, tree planting in the mean line, etc.) it is necessary to ensure the forest coverage rate in the upstream areas of the river as well as the quality of forests, during the construction and operation of works where deforestation is prohibited. Trees should be planted along the banks of the reservoir to keep soil from landslides

- Research and develop the process of exploiting semi-flooded areas. Manage and guide the cultivation of semi-flooded areas in accordance with the procedures.

- The downstream discharge of the plant into the reservoir bed with clear water will increase the possibility of erosion in this area. Energy dissipation works need to be built to reduce this impact.

3. Assurance of water quality

For water quality, during operation, it is necessary to continuously blow down to create conditions for disturbance of the bottom water layer, ensure oxygen flow at the reservoir bottom area, and reduce organic matter in the bottom layer.

Besides, it is necessary to control fertilizers for crops on the surface upstream of the reservoir. With chemical fertilizers used in upstream areas (for industrial plants, fertilizers with relatively large nitrogen and phosphate origin) will be accumulated and circulated in the reservoir, promoting development of types of algae in the reservoir, increasing the denaturation of the reservoir and affecting the operation of the hydropower plant.

- To ensure the safety of local people, it is necessary to strictly comply with the current regulations on flood discharge; timely notify to minimize the damage on people and properties.

- After compensating, it is necessary to continue to take measures such as support for agricultural extension, medical support, mosquito spraying, additional funding to buy medicines to prevent and treat common diseases such as malaria, diarrhea, cholera, typhoid, etc. to ensure a long and stable life.

- Strengthen the management of demographics and labor in the region.

5. For socio-economic environment

BRIEF DESCRIPTION OF THE 110kV LINE CONNECTING THE DAK DRINH HYDROPOWER PLANT TO NATIONAL POWER SYSTEM

1.1. NAME OF PROJECT

The 110kV line connecting the Dak Drinh Hydropower Plant to the national power system

1.2. GEOGRAPHICAL LOCATION OF THE PROJECT

- Start point: Dak Drinh hydropower plant
- End point: Doc Soi 110kV substation

The 220kV line is about 59km long, passing through Son Tay District (Son Tan Commune), Son Ha District (Di Lang Town, Son Bao, Son Ha, Son Thanh Communes), Son Tinh District (Tinh Giang, Tinh Duong Commune, Tinh Hiep, Tinh Binh, Tinh Tra Communes), Binh Son District (Binh Minh, Banh Chuong, Binh Trung, Binh Nguyen Communes) - Quang Ngai Province

The line mainly runs parallel with DT 630A (from Son Ha to Son Tay) and DT 623 (from Son Tinh to Son Ha) roads. From the start point to G10, the line always goes through a relatively steep terrain. From G10 to the end point, the line is relatively flat.

Vegetation on the line is mainly mixed forests, crops, fruit trees and some wet rice.

1.3. MAJOR CONTENTS OF THE PROJECT

1.3.1 General

The 110kV line connecting the Dak Drinh Hydropower Plant to the national power system is built with 2 circuits to improve the reliability and stability of the regional 110kV grid, which is very important because in the future when the electricity industry follow the market mechanism to ensure continuous, stable power supply and minimum breakdown time.

The line is considered on the line option connecting to Doc Soi 110kV substation. This line is about 59 km long.

Table 1. Information on the line

Rice, crops (m)	Houses (unit)	Crossing traffic road (time)	Crossing rivers (time)	Length (km)
19.214	21	12	3	59

With the line characteristics of the two options above, it is recommended to choose option 1.

1.3.2 Description of the selected line

The line has the following main features:

Start point : 110kV distribution yard of Dak Drinh Hydropower Plant.

End point	: Doc Soi 110kV substation
Localities that the line crosses	: Son Tay, Son Ha, Son Tinh, Binh Son Districts - Quang Ngai Province
Line length	: 52 km.
Number of steering angles	: 21 angles (without start and end points).
Minimum steering angle	: G14, αp - 48°30'
Maximum steering angle	: G7, αp = 02°31'
Longest edge	: G14 - G15, length of 4,630m.
Shortest edge	: G20 - G21 to substation, length of 410m.
Number of road (National Highway) crossings	: 12 times
Number of river crossings	: 03 times (Dak Drinh and Tra Khuc rivers).
Number of power line crossings	: 20 times
Number of affected houses in the line corridor	: 21 houses

1.3.3 Safety corridor for 110kV line

Line corridor according to Decree No. 106/2005/ND-CP dated August 17, 2005 by the Government, for a voltage of 110 kV limited by two vertical planes parallel to the line with a distance to the outer conductor of 4m plus the width of the beam. Thus, the average corridor width for the whole route is determined to be 13-15m.

For trees and crops: according to Article 5 of Decree 06: Rice, crops and plants are only allowed to be planted at least 0.5m from the edge of the electric pole or anchor foundation. Other crops may be planted but the distance from the highest vertically top point to the height of the lowest line while stationary must not be less than 3.0m.

For houses and works: Protection corridor must comply with Article 6 of Decree No. 106 on houses and works in the overhead transmission line protection corridor.

Conditions for houses and works to be corrected to exist in the safety corridor of 110 kV high-voltage grid;

- Roof and wall must be made of incombustible substances;

- The metal roofing, frame and wall must be grounded in accordance with the regulations on grounding techniques;

- Do not obstruct access roads for inspection, maintenance and replacement of high voltage grid construction components;

- The distance from any part of a house or building to the nearest conductor when the wire is in the stationary state is not less than 4m.

Electric field intensity ≤ 5kV/m at any point outside the house which is 1m from the ground and ≤ 1kV/m at any point inside the house which is 1m from the ground.

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 42/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (Main Work)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF DAK DRINH COMMUNE
FATHERLAND FRONT COMMITTEE OF DAK DRINH COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of DAK DRINH Commune a summary of the project and information on the environment of the main work (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of DAK DRINH Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee – Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee – Fatherland Front Committee of DAK DRINH Commune in the shortest time.

Best regards!

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR
(Signed and Sealed)
Tran Minh Tuan

PEOPLE'S COMMITTEE OF DAK RING COMMUNE

KON PLONG – KON TUM

No.: 51/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Dak Ring, July 24, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 42/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Dak Ring Commune - Kon Plong District - Kon Tum Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River. The People's Committee of Dak Ring Commune has the following opinions:

- The first opinion: Agree on the construction of the Dak Drinh Hydropower Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Dak Ring Commune for the community consultation of your Company

Recipients:

- As above

- Filing

ON BEHALF OF PEOPLE'S COMMITTEE

CHAIRMAN

(Signed and Sealed)

Bui Van Duong

FATHERLAND FRONT COMMITTEE OF DAK RING COMMUNE

KON PLONG – KON TUM

No.: 51/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Dak Rinh, July 20, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 42/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Dak Ring Commune - Kon Plong District - Kon Tum Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River. The Fatherland Front Committee of Dak Ring Commune has the following opinions:

- The first opinion: Agree on the construction of the Dak Drinh Hydropower Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Dak Ring Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

CHAIRMAN

(Signed and Sealed)

…………..

DAKDRINH HYDROPOWER JOINT STOCK COMPANY	SOCIALIST REPUBLIC OF VIETNAM
----------------	**Independence – Freedom – Happiness**
No.: 42/DHC-KTKT	--------------------
Regarding the community consultation on Dak Drinh Hydropower Project (Main Work)	Quang Ngai, July 23, 2007

To: PEOPLE’S COMMITTEE OF DAK NEN COMMUNE
FATHERLAND FRONT COMMITTEE OF DAK NEN COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of DAK NEN Commune a summary of the project and information on the environment of the main work (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People’s Committee and Fatherland Front Committee of DAK NEN Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People’s Committee – Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People’s Committee – Fatherland Front Committee of DAK NEN Commune in the shortest time.

Best regards!

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

PEOPLE’S COMMITTEE OF DAK NEN COMMUNE

No.: 05/CV-UBND

Regarding the reply to the Official Dispatch No. 42 of DakDrinh Hydropower Joint Stock Company

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Dak Nen, July 24, 2007

***To:* DAKDRINH HYDROPOWER JOINT STOCK COMPANY**

- Communal People's Committee has received Official Dispatch No. 42/CV-DHC- KTKT, dated July 23, 2007 of DakDrinh Hydropower Joint Stock Company "regarding the community consultation for Dak Drinh Hydropower Project".

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

People's Committee of Dak Nen Commune has the following opinions: At present, the Communal People's Committee has not received any legal documents on the policy allowing the survey to invest in Dak Drinh Hydropower Project. Therefore, the People's Committee of Dak Nen Commune has no basis for community consultation on the DakDrinh Hydropower Project.

Therefore, the DakDrinh Hydropower Joint Stock Company is proposed to provide additional legal documents to the People's Committee of Dak Nen Commune.

Recipients:

- As above
- District PC (to report)
- Filing: VT

ON BEHALF OF PEOPLE’S COMMITTEE OF DAK NEN COMMUNE

VICE CHAIRMAN

(Signed and Sealed)

Nguyen Van Sanh

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 42/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (Main Work)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE’S COMMITTEE OF SON DUNG COMMUNE
FATHERLAND FRONT COMMITTEE OF SON DUNG COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of SON DUNG Commune a summary of the project and information on the environment of the main work (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of SON DUNG Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of SON DUNG Commune in the shortest time.

Best regards!

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR
(Signed and Sealed)
Tran Minh Tuan

PEOPLE'S COMMITTEE	**SOCIALIST REPUBLIC OF VIETNAM**
OF SON DUNG COMMUNE	**Independence – Freedom – Happiness**
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No.: 122/CV-UBND	*Son Dung, July 24, 2007*
Regarding the community consultation on Dak Drinh Hydropower Project	

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 42/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Son Dung Commune – Son Tay District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River. The People's Committee of Son Dung Commune has the following opinions:

- The first opinion: Agree on the construction of the Dak Drinh Hydropower Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Son Dung Commune for the community consultation of your Company.

Recipients:	**ON BEHALF OF PEOPLE'S COMMITTEE**
- As above	**CHAIRMAN**
- Filing	*(Signed and Sealed)*
	……………….

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 42/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (Main Work)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF SON MUA COMMUNE

FATHERLAND FRONT COMMITTEE OF SON MUA COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of SON MUA Commune a summary of the project and information on the environment of the main work (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of SON MUA Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of SON MUA Commune in the shortest time.

Best regards!

Recipients:

- As above;
- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

PEOPLE'S COMMITTEE	**SOCIALIST REPUBLIC OF VIETNAM**
OF SON MUA COMMUNE	**Independence – Freedom – Happiness**
----------------	--------------------
No.: 87/CV-UBND	*Son Dung, July 24, 2007*

Regarding the community consultation on
Dak Drinh Hydropower Project

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 42/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Son Mua Commune – Son Tay District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River. The People's Committee of Son Mua Commune has the following opinions:

- The first opinion: Agree on the construction of the Dak Drinh Hydropower Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Son Mua Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE
CHAIRMAN OF PEOPLE'S COMMITTEE OF SON MUA COMMUNE
(Signed and Sealed)

Dinh Trong Yen

FATHERLAND FRONT COMMITTEE
OF SON MUA COMMUNE

No.: 02/CV-UBMT
Regarding the community consultation on
Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

Son Dung, July 24, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 42/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Son Mua Commune – Son Tay District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River. The Fatherland Front Committee of Son Mua Commune has the following opinions:

- The first opinion: Agree on the construction of the Dak Drinh Hydropower Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Son Mua Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE
(Signed and Sealed)
Dinh Quang Tuong

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 42/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (Main Work)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE’S COMMITTEE OF SON TAN COMMUNE
FATHERLAND FRONT COMMITTEE OF SON TAN COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of SON TAN Commune a summary of the project and information on the environment of the main work (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of SON TAN Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of SON TAN Commune in the shortest time.

Best regards!

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

PEOPLE'S COMMITTEE	**SOCIALIST REPUBLIC OF VIETNAM**
OF SON TAN COMMUNE	**Independence – Freedom – Happiness**
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No.: 08/CV-UBND	*Son Tan, July 24, 2007*
Regarding the community consultation on Dak Drinh Hydropower Project	

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41 and 42/CV-DHC-KTKT sent by DakDrinh Hydropower Joint Stock Company to People's Committee of Son Tan Commune – Son Tay District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River and 110kV transmission line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Son Tan Commune has the following opinions:

- The first opinion: Agree on the construction of the Dak Drinh Hydropower Project and 110kV transmission line connecting the Dak Drinh Hydropower Plant to National Power System in the area.

- The second opinion: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Son Tan Commune for the community consultation of your Company.

Recipients:	**ON BEHALF OF PEOPLE'S COMMITTEE**
- As above	**PP. CHAIRMAN**
- Filing	**VICE CHAIRMAN**
	(Signed and Sealed)
	……………

FATHERLAND FRONT COMMITTEE

OF SON TAN COMMUNE

No.: 04/CV-UBMT

Regarding the community consultation on
Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Son Tan, July 24, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41 and 42/CV-DHC-KTKT sent by DakDrinh Hydropower Joint Stock Company to Fatherland Front Committee of Son Tan Commune – Son Tay District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River and 110kV transmission line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Son Tan Commune has the following opinions:

- **The first opinion:** Agree on the construction of the Dak Drinh Hydropower Project and 110kV transmission line connecting the Dak Drinh Hydropower Plant to National Power System in the area.
- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.
- **The third opinion:** When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Son Tan Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

(Signed and Sealed)

…………….

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE’S COMMITTEE OF SON BAO COMMUNE
FATHERLAND FRONT COMMITTEE OF SON BAO COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV transmission line connecting Dakdrinh Hydropower Plant to the national power system passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of SON BAO Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of SON BAO Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of SON BAO Commune in the shortest time.

Best regards!

Recipients:

- As above;
- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

PEOPLE'S COMMITTEE OF SON BAO COMMUNE

SON HA – QUANG NGAI

No.: 02/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Son Bao, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Son Bao Commune – Son Ha District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Son Bao Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Son Bao Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE
VICE CHAIRMAN
(Signed and Sealed)
Nguyen Huu Sau

FATHERLAND FRONT COMMITTEE OF SON BAO COMMUNE

SON HA – QUANG NGAI

No.: 01/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Son Bao, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT sent by DakDrinh Hydropower Joint Stock Company to Fatherland Front Committee of Son Bao Commune – Son Ha District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Son Bao Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Son Bao Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

(Signed and Sealed)

……………

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF SON THANH COMMUNE

FATHERLAND FRONT COMMITTEE OF SON THANH COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV transmission line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of SON THANH Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of SON THANH Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of SON THANH Commune in the shortest time.

Best regards!

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR
(Signed and Sealed)

Tran Minh Tuan

PEOPLE'S COMMITTEE OF SON THANH COMMUNE

SON HA – QUANG NGAI

No.: 13/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Son Thanh, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Son Thanh Commune – Son Ha District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River and 110kV transmission line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Son Thanh Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Son Thanh Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE OF SON THANH COMMUNE
CHAIRMAN
(Signed and Sealed)
……………

FATHERLAND FRONT COMMITTEE OF SON THANH COMMUNE

SON HA – QUANG NGAI

No.: 03/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Son Thanh, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Son Thanh Commune – Son Ha District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Son Thanh Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Son Thanh Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

(Signed and Sealed)

Dinh Van Loan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF SON HA COMMUNE
FATHERLAND FRONT COMMITTEE OF SON HA COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV transmission line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of SON HA Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of SON HA Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of SON HA Commune in the shortest time.

Best regards!

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR
(Signed and Sealed)
Tran Minh Tuan

PEOPLE'S COMMITTEE OF SON HA COMMUNE

SON HA – QUANG NGAI

No.: 51/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Son Ha, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Son Ha Commune – Son Ha District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV transmission line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Son Ha Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Son Ha Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE
CHAIRMAN
(Signed and Sealed)

Dinh Hong Nhanh

FATHERLAND FRONT COMMITTEE OF SON HA COMMUNE

SON HA – QUANG NGAI

No.: 01/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Son Ha, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Son Ha Commune – Son Ha District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Son Ha Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Son Ha Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

(Signed and Sealed)

… Van Ba

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE’S COMMITTEE OF DI LANG TOWN
FATHERLAND FRONT COMMITTEE OF DI LANG TOWN

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV transmission line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of DI LANG TOWN a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of DI LANG TOWN to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of DI LANG TOWN in the shortest time.

Best regards!

Recipients:

- As above;
- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

PEOPLE'S COMMITTEE OF DI LANG TOWN

SON HA – QUANG NGAI

No.: 15/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Di Lang, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Di Lang Town – Son Ha District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Di Lang Town has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Di Lang Town for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE
CHAIRMAN
(Signed and Sealed)

……………..

FATHERLAND FRONT COMMITTEE OF DI LANG TOWN

SON HA – QUANG NGAI

No.: 15/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Di Lang, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Di Lang Town – Son Ha District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River and 110kV transmission line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Di Lang Town has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

Recipients:
- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE
VICE CHAIRMAN
(Signed and Sealed)

Nguyen Van …………

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT
Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

Quang Ngai, July 23, 2007

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Di Lang Town for the community consultation of your Company.

To: PEOPLE’S COMMITTEE OF TINH GIANG COMMUNE
FATHERLAND FRONT COMMITTEE OF TINH GIANG COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV transmission line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of TINH GIANG Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of TINH GIANG Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Recipients:

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR
(Signed and Sealed
Tran Minh Tuan

PEOPLE'S COMMITTEE OF TINH GIANG COMMUNE
SON TINH – QUANG NGAI

No.: 113/CV-UBND
Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

Tinh Giang, July 25, 2007

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of TINH GIANG Commune in the shortest time.

Best regards!

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Tinh Giang Commune – Son Tinh District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Tinh Giang Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- The second opinion: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Tinh Giang Commune for the community consultation of your Company

Recipients:
- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE OF TINH GIANG COMMUNE
CHAIRMAN
(Signed and Sealed)

FATHERLAND FRONT COMMITTEE OF TINH GIANG COMMUNE

SON TINH – QUANG NGAI

No.: 01/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Tinh Giang, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Tinh Giang Commune – Son Tinh District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River and 110kV transmission line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Tinh Giang Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Tinh Giang Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

(Signed and Sealed)

Trinh Van Hoc

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF TINH DONG COMMUNE

FATHERLAND FRONT COMMITTEE OF TINH DONG COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV transmission line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of TINH DONG Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of TINH DONG Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of TINH DONG Commune in the shortest time.

Best regards!

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

PEOPLE'S COMMITTEE OF TINH DONG COMMUNE

SON TINH – QUANG NGAI

No.: 11/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Tinh Dong, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Tinh Dong Commune – Son Tinh District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Tinh Dong Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Tinh Dong Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE OF TINH DONG COMMUNE
CHAIRMAN
(Signed and Sealed)
…………………

FATHERLAND FRONT COMMITTEE OF TINH DONG COMMUNE

SON TINH – QUANG NGAI

No.: 23/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Tinh Dong, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Tinh Dong Commune – Son Tinh District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Tinh Dong Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Tinh Dong Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

(Signed and Sealed)

………………

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF TINH HIEP COMMUNE
FATHERLAND FRONT COMMITTEE OF TINH HIEP COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV transmission line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of TINH HIEP Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of TINH HIEP Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of TINH HIEP Commune in the shortest time.

Best regards!

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR
(Signed and Sealed)
Tran Minh Tuan

PEOPLE'S COMMITTEE OF TINH HIEP COMMUNE

SON TINH – QUANG NGAI

No.: 31/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Tinh Hiep, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Tinh Hiep Commune – Son Tinh District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Tinh Hiep Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Tinh Hiep Commune for the community consultation of your Company.

Recipients:

- As above

- Filing

ON BEHALF OF PEOPLE'S COMMITTEE OF TINH HIEP COMMUNE
CHAIRMAN
(Signed and Sealed)

Dang Ngoc Dung

FATHERLAND FRONT COMMITTEE OF TINH HIEP COMMUNE

SON TINH – QUANG NGAI

No.: 02/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Tinh Hiep, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Tinh Hiep Commune – Son Tinh District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Tinh Hiep Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Tinh Hiep Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

VICE CHAIRMAN

(Signed and Sealed)

Than Van Hung

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF TINH TRA COMMUNE
FATHERLAND FRONT COMMITTEE OF TINH TRA COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV transmission line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of TINH TRA Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of TINH TRA Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of TINH TRA Commune in the shortest time.

Best regards!

Recipients:
- As above;
- Filing: KT-KT

GENERAL DIRECTOR
(Signed and Sealed)
Tran Minh Tuan

PEOPLE'S COMMITTEE OF TINH TRA COMMUNE

SON TINH – QUANG NGAI

No.: 18/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Tinh Tra, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Tinh Tra Commune – Son Tinh District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Tinh Tra Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Tinh Tra Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE

CHAIRMAN

(Signed and Sealed)

Luong Thanh Hoang

FATHERLAND FRONT COMMITTEE OF TINH TRA COMMUNE

SON TINH – QUANG NGAI

No.: 02/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Tinh Tra, July 25, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Tinh Tra Commune – Son Tinh District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River and, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Tinh Tra Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Tinh Tra Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

(Signed and Sealed)

Huynh Thuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE’S COMMITTEE OF BINH CHUONG COMMUNE
FATHERLAND FRONT COMMITTEE OF BINH CHUONG COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of BINH CHUONG Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of BINH CHUONG Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of BINH CHUONG Commune in the shortest time.

Best regards!

Recipients:

- As above;
- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

PEOPLE'S COMMITTEE OF BINH CHUONG COMMUNE

BINH SON – QUANG NGAI

No.: 48/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Binh Chuong, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Binh Chuong Commune – Binh Son District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Binh Chuong Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Binh Chuong Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE

CHAIRMAN

(Signed and Sealed)

Vo Quang Thanh

FATHERLAND FRONT COMMITTEE OF BINH CHUONG COMMUNE

BINH SON – QUANG NGAI

No.: 03/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Binh Chuong, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Binh Chuong Commune – Binh Son District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Binh Chuong Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- The second opinion: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Binh Chuong Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

(Signed and Sealed)

Vo Can

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF BINH MINH COMMUNE
FATHERLAND FRONT COMMITTEE OF BINH MINH COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of BINH MINH Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of BINH MINH Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of BINH MINH Commune in the shortest time.

Best regards!

Recipients:

- As above;
- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

PEOPLE'S COMMITTEE OF BINH MINH COMMUNE

BINH SON – QUANG NGAI

No.: 95/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Binh Minh, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Binh Minh Commune – Binh Son District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Binh Minh Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Binh Minh Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE

CHAIRMAN

(Signed and Sealed)

Pham Quang Son

FATHERLAND FRONT COMMITTEE OF BINH MINH COMMUNE

BINH SON – QUANG NGAI

No.: 02/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Binh Minh, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Binh Minh Commune – Binh Son District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Binh Minh Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- The second opinion: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Binh Minh Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE

CHAIRMAN

(Signed and Sealed)

………………..

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF BINH TRUNG COMMUNE
FATHERLAND FRONT COMMITTEE OF BINH TRUNG COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of BINH TRUNG Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of BINH TRUNG Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of BINH TRUNG Commune in the shortest time.

Best regards!

Recipients:

- As above;
- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

PEOPLE'S COMMITTEE OF BINH TRUNG COMMUNE

BINH SON – QUANG NGAI

No.: 40/CV-UBND

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Binh Trung, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to People's Committee of Binh Trung Commune – Binh Son District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The People's Committee of Binh Trung Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the People's Committee of Binh Trung Commune for the community consultation of your Company.

Recipients:

- As above
- Filing

ON BEHALF OF PEOPLE'S COMMITTEE
PP. CHAIRMAN
VICE CHAIRMAN
(Signed and Sealed)

Trinh Phu Dinh

FATHERLAND FRONT COMMITTEE OF BINH TRUNG COMMUNE

BINH SON – QUANG NGAI

No.: 04/CV-UBMT

Regarding the community consultation on Dak Drinh Hydropower Project

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Binh Trung, July 26, 2007

To: DAKDRINH HYDROPOWER JOINT STOCK COMPANY

Pursuant to the Law on Environmental Protection passed by the National Assembly of the Socialist Republic of Vietnam on November 29, 2005 and takes effect from July 1, 2006.

Responding to Official Dispatch No. 41/CV-DHC-KTKT dated July 23, 2007 by DakDrinh Hydropower Joint Stock Company sent to Fatherland Front Committee of Binh Trung Commune – Binh Son District – Quang Ngai Province about community consultation for the environmental impact assessment of the Dak Drinh Hydropower Project on the Tra Khuc River, section of 110kV line connecting the Dak Drinh Hydropower Plant to National Power System. The Fatherland Front Committee of Binh Trung Commune has the following opinions:

- The first opinion: Agree on the construction of the Project in the area.

- **The second opinion**: In the process of project implementation, permissible standards must be ensured according to the law on environmental protection. In which, attention should be paid to: exhaust gas, wastewater, dust, noise, solid waste, and these factors must be handled in accordance with techniques.

- The third opinion: When implementing the construction, ensure implementation of measures proposed by your Company to minimize negative impacts on the environment, minimize the impact on the surrounding environment in order to protect the health of workers and residential communities, and promptly overcome environmental incidents.

Above is the opinion of the Fatherland Front Committee of Binh Trung Commune for the community consultation of your Company.

Recipients:
- As above
- Filing

ON BEHALF OF COMMUNAL FATHERLAND FRONT COMMITTEE
(Signed and Sealed)
………………..

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 41/DHC-KTKT

Regarding the community consultation on Dak Drinh Hydropower Project (110kV line)

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, July 23, 2007

To: PEOPLE'S COMMITTEE OF BINH NGUYEN COMMUNE
FATHERLAND FRONT COMMITTEE OF BINH NGUYEN COMMUNE

At present, DakDrinh Hydropower Joint Stock Company is working with Power Engineering Consulting Joint Stock Company 2 to prepare an environmental impact assessment report of Dak Drinh Hydropower Project on Tra Khuc River, within the scope of the report, there is a 110kV line connecting Dakdrinh Hydropower Plant to the National Power System passing through the locality.

According to the guidance of Circular No. 08/2006/TT-BTNMT dated September 8, 2006 by the Ministry of Natural Resources and Environment on guiding environmental impact assessment for community consultation, comments must be made in writing by the Communal People's Committee and the Fatherland Front Committee.

Therefore, we respectfully send to the People's Committee and Fatherland Front Committee of BINH NGUYEN Commune a summary of the project and information on the environment of the 110kV line (including the negative environmental impacts of the project and measures to minimize such negative impacts).

We respectfully request the People's Committee and Fatherland Front Committee of BINH NGUYEN Commune to review and give written comments so that we supplement the document of the environmental impact assessment report and submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

Documents of the People's Committee - Fatherland Front Committee will help us complete the environmental impact assessment report, ensure the construction progress of Dak Drinh Hydropower Plant, and solve the power shortage demand in the Central region.

We hope to receive the help of the People's Committee - Fatherland Front Committee of BINH NGUYEN Commune in the shortest time.

Best regards!

Recipients:

- As above;

- Filing: KT-KT

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

APPENDIX D: THE INVESTOR'S RESPOND DISPATCHES TO THE PEOPLE'S RECOMMENDATIONS

1. Dispatch No. 03/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Binh Trung Commune regarding the community consultation for the DakDrinh Hydropower Project.

2. Dispatch No. 04/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Son Tan Commune regarding the community consultation for the DakDrinh Hydropower Project.

3. Dispatch No. 05/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Tinh Tra Commune regarding the community consultation for the DakDrinh Hydropower Project.

4. Dispatch No. 06/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Tinh Dong Commune regarding the community consultation for the DakDrinh Hydropower Project.

5. Dispatch No. 07/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Tinh Giang Commune regarding the community consultation for the DakDrinh Hydropower Project.

6. Dispatch No. 08/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Son Dung Commune regarding the community consultation for the DakDrinh Hydropower Project.

7. Dispatch No. 09/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Son Bao Commune regarding the community consultation for the DakDrinh Hydropower Project.

8. Dispatch No. 10/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Son Thanh Commune regarding the community consultation for the DakDrinh Hydropower Project.

9. Dispatch No. 11/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Son Ha Commune regarding the community consultation for the DakDrinh Hydropower Project.

10. Dispatch No. 09/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Di Lang Town regarding the community consultation for the DakDrinh Hydropower Project.

11. Dispatch No. 13/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Son Mua Commune regarding the community consultation for the DakDrinh Hydropower Project.

12. Dispatch No. 14/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Tinh Hiep Commune regarding the community consultation for the DakDrinh Hydropower Project.

13. Dispatch No. 15/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Binh Chuong Commune regarding the community consultation for the DakDrinh Hydropower Project.

14. Dispatch No. 16/DHC dated February 29, 2008 sent by DakDrinh Joint Stock Company to the People's Committee and Fatherland Front Committee of Binh Minh Commune regarding the community consultation for the DakDrinh Hydropower Project.

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 03/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Binh Trung Commune – Binh Son District – Quang Ngai

Fatherland Front Committee of Binh Trung Commune – Binh Son District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 40/CV-UBND dated July 26, 2007 of the People's Committee of Binh Trung Commune and the Official Dispatch No. 04/CV-UBMT dated July 26, 2007 of Fatherland Front Committee of Binh Trung Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;

- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 04/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Son Tan Commune – Son Tay District – Quang Ngai

Fatherland Front Committee of Son Tan Commune – Son Tay District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 08/CV-UBND dated July 24, 2007 of the People's Committee of Son Tan Commune and the Official Dispatch No. 04/CV-UBMT dated July 24, 2007 of Fatherland Front Committee of Son Tan Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;

- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 05/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Tinh Tra Commune – Son Tinh District – Quang Ngai

Fatherland Front Committee of Tinh Tra Commune – Son Tinh District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 18/CV-UBND dated July 25, 2007 of the People's Committee of Tinh Tra Commune and the Official Dispatch No. 02/CV-UBMT dated July 25, 2007 of Fatherland Front Committee of Tinh Tra Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;

- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 06/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Tinh Dong Commune – Son Tinh District – Quang Ngai

Fatherland Front Committee of Tinh Dong Commune – Son Tinh District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 11/CV-UBND dated July 26, 2007 of the People's Committee of Tinh Dong Commune and the Official Dispatch No. 23/CV-UBMT dated July 26, 2007 of Fatherland Front Committee of Tinh Dong Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;
- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 07/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Tinh Giang Commune – Son Tinh District – Quang Ngai

Fatherland Front Committee of Tinh Giang Commune – Son Tinh District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 113/CV-UBND dated July 25, 2007 of the People's Committee of Tinh Giang Commune and the Official Dispatch No. 01/CV-UBMT dated July 25, 2007 of Fatherland Front Committee of Tinh Giang Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:
- As above;
- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 08/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Son Dung Commune – Son Tay District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 122/CV-UBND dated July 24, 2007 regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;

- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 09/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People’s Committee of Son Bao Commune – Son Ha District – Quang Ngai
Fatherland Front Committee of Son Bao Commune – Son Ha District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 02/CV-UBND dated July 25, 2007 of the People's Committee of Son Bao Commune and the Official Dispatch No. 01/CV-UBMT dated July 25, 2007 of Fatherland Front Committee of Son Bao Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;

- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 10/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People’s Committee of Son Thanh Commune – Son Ha District – Quang Ngai
Fatherland Front Committee of Son Thanh Commune – Son Ha District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 13/CV-UBND dated July 25, 2007 of the People's Committee of Son Thanh Commune and the Official Dispatch No. 03/CV-UBMT dated July 25, 2007 of Fatherland Front Committee of Son Thanh Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;

- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 11/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Son Ha Commune – Son Ha District – Quang Ngai
Fatherland Front Committee of Son Ha Commune – Son Ha District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 51/CV-UBND dated July 25, 2007 of the People's Committee of Son Ha Commune and the Official Dispatch No. 01/CV-UBMT dated July 25, 2007 of Fatherland Front Committee of Son Ha Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;
- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 12/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People’s Committee of Di Lang Town – Son Ha District – Quang Ngai

Fatherland Front Committee of Di Lang Town – Son Ha District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 15/CV-UBND dated July 25, 2007 of the People's Committee of Di Lang Town and the Official Dispatch No. 15/CV-UBMT dated July 25, 2007 of Fatherland Front Committee of Di Lang Town regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;

- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 13/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Son Mua Commune – Son Tay District – Quang Ngai
Fatherland Front Committee of Son Mua Commune – Son Tay District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 87/CV-UBND dated July 24, 2007 of the People's Committee of Son Mua Commune and the Official Dispatch No. 02/CV-UBMT dated July 24, 2007 of Fatherland Front Committee of Son Mua Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;
- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 14/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Tinh Hiep Commune – Son Tinh District – Quang Ngai

Fatherland Front Committee of Tinh Hiep Commune – Son Tinh District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 31/CV-UBND dated July 26, 2007 of the People's Committee of Tinh Hiep Commune and the Official Dispatch No. 02/CV-UBMT dated July 26, 2007 of Fatherland Front Committee of Tinh Hiep Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;
- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 15/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People's Committee of Binh Chuong Commune – Binh Son District – Quang Ngai

Fatherland Front Committee of Binh Chuong Commune – Binh Son District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 48/CV-UBND dated July 26, 2007 of the People's Committee of Binh Chuong Commune andthe Official Dispatch No. 03/CV-UBMT dated July 26, 2007 of Fatherland Front Committee of Binh Chuong Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;
- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan

DAKDRINH HYDROPOWER JOINT STOCK COMPANY

No.: 16/DHC

Regarding the community consultation on Dak Drinh Hydropower Project on Tra Khuc river

SOCIALIST REPUBLIC OF VIETNAM

Independence – Freedom – Happiness

Quang Ngai, February 29, 2008

To: People’s Committee of Binh Minh Commune – Binh Son District – Quang Ngai

Fatherland Front Committee of Binh Minh Commune – Binh Son District – Quang Ngai

Dakdrinh Hydropower Joint Stock Company (DHC) has received the Official Dispatch No. 95/CV-UBND dated July 26, 2007 of the People's Committee of Binh Minh Commune and the Official Dispatch No. 02/CV-UBMT dated July 26, 2007 of Fatherland Front Committee of Binh Minh Commune regarding the response to community consultation for Dak Drinh Hydropower Project.

All comments of the People's Committee and Fatherland Front Committee were recorded by DHC in the final environmental impact assessment report to submit to the Ministry of Natural Resources and Environment for consideration and appraisal.

DHC commits to fully implement the mitigation measures mentioned in the construction and operation of the project and comply with the Vietnamese regulations and standards on environmental protection, coordinate with the locality to resolve and overcome problems related to the environment caused by the Project.

After the environmental impact assessment report is approved, the report will be sent to the Provincial People's Committee and disseminated to each affected locality.

Best regards!

Recipients:

- As above;

- Filing: Compensation – Site Clearance Dept.

GENERAL DIRECTOR

(Signed and Sealed)

Tran Minh Tuan