APPENDIX I : FIGURES

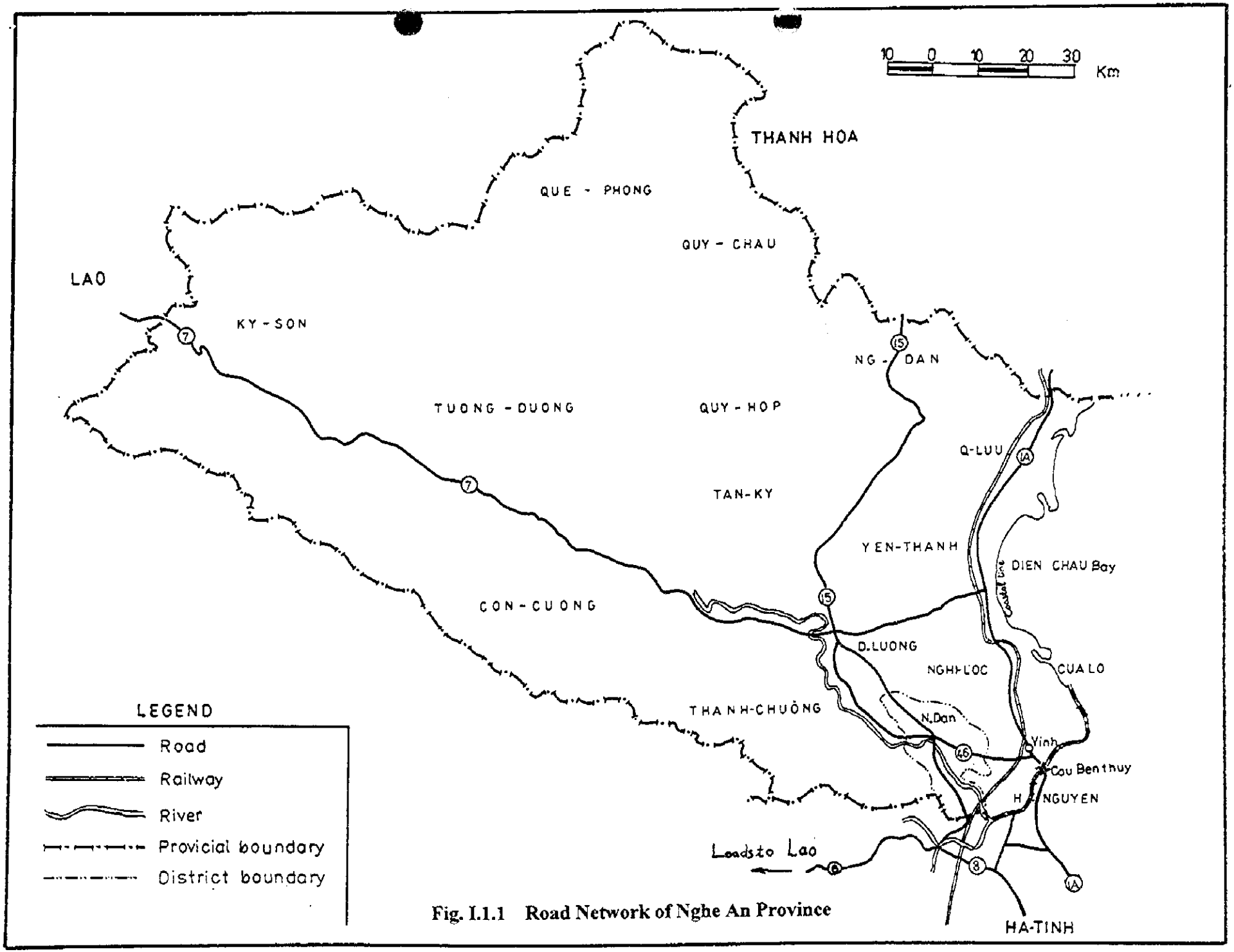


Fig. I.1.1 Road Network of Nghe An Province

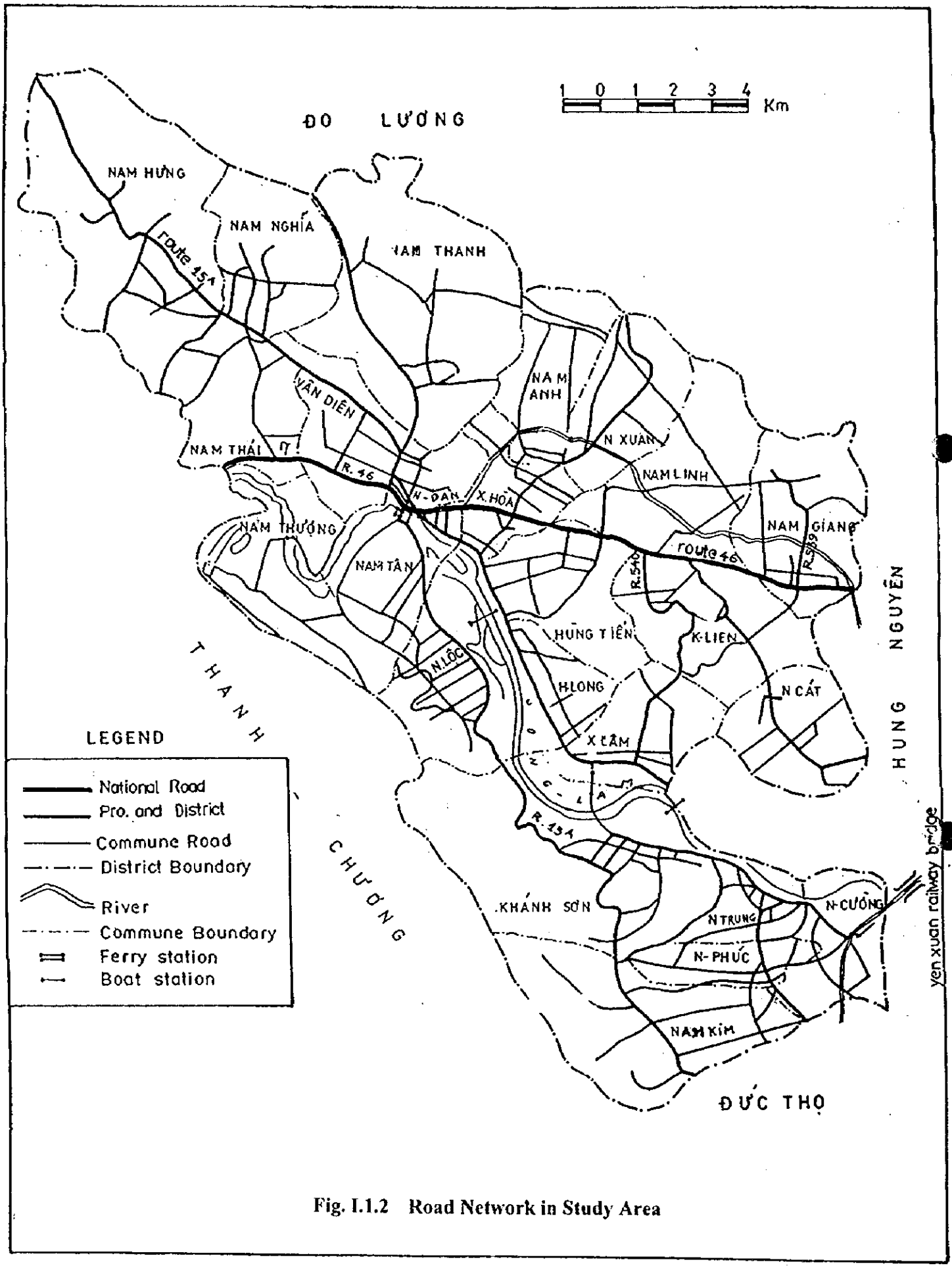


Fig. I.1.2 Road Network in Study Area

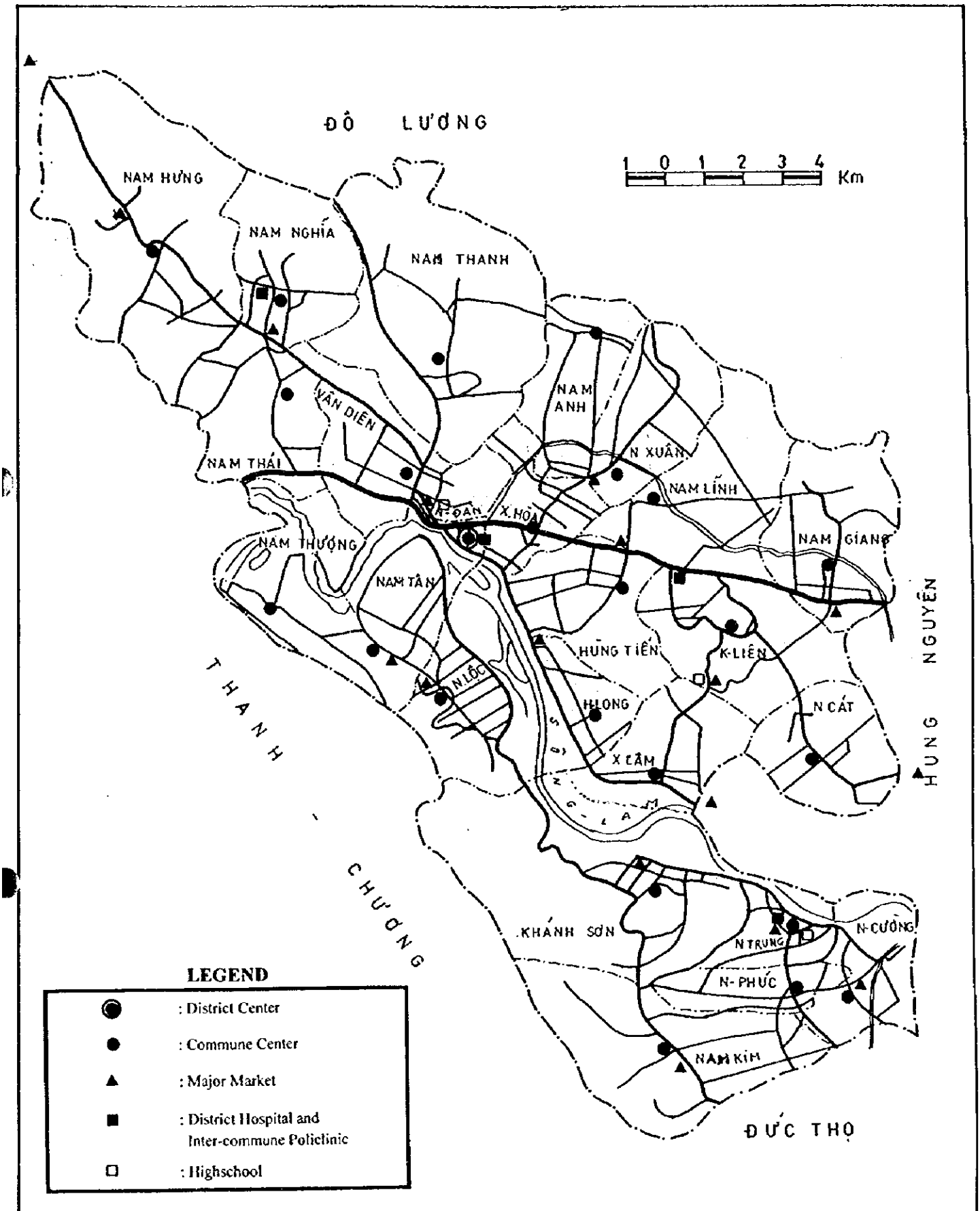


Fig. I.1.3 Map of Key Facilities for Economic and Living Activity

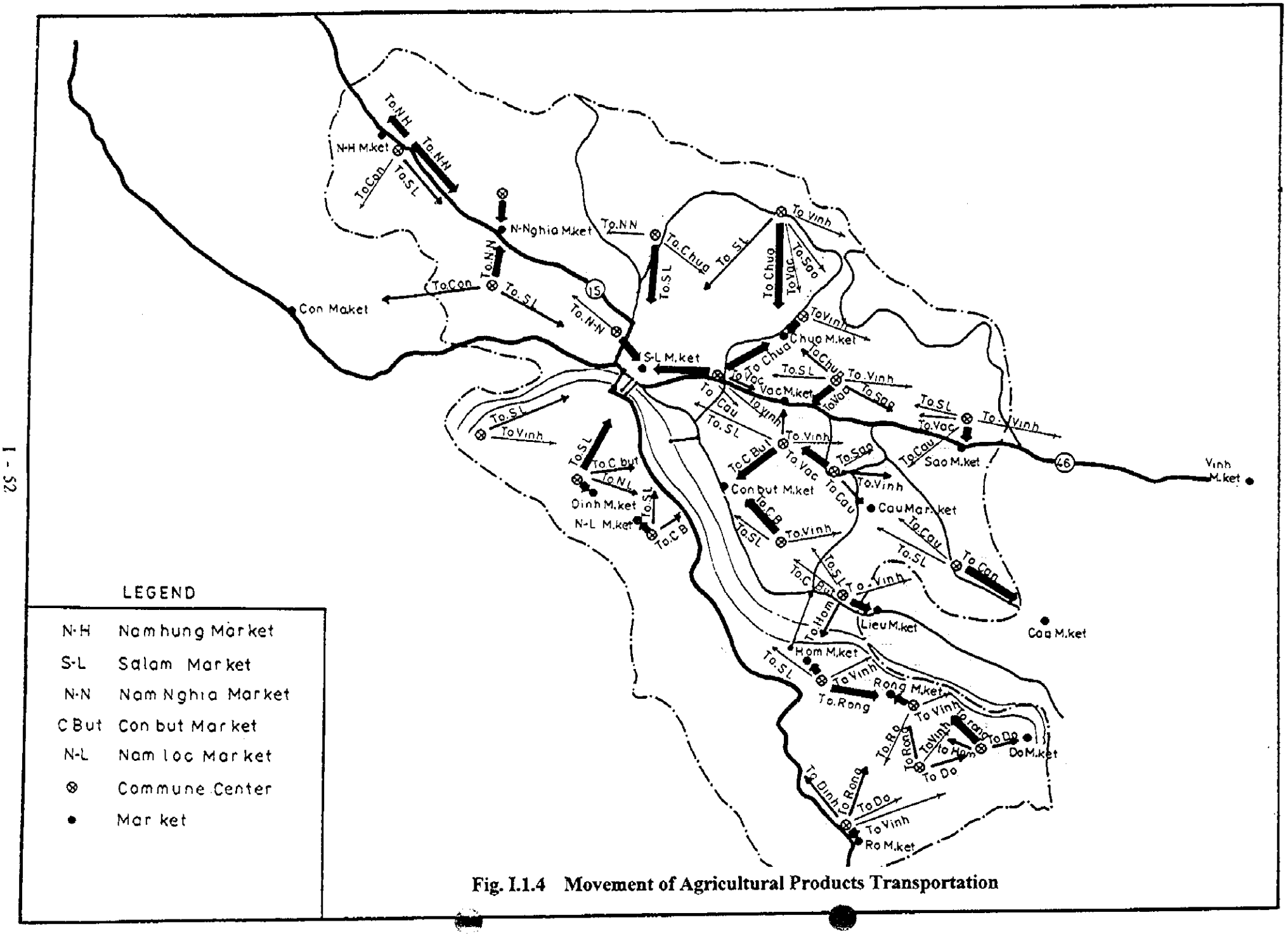


Fig. I.1.4 Movement of Agricultural Products Transportation

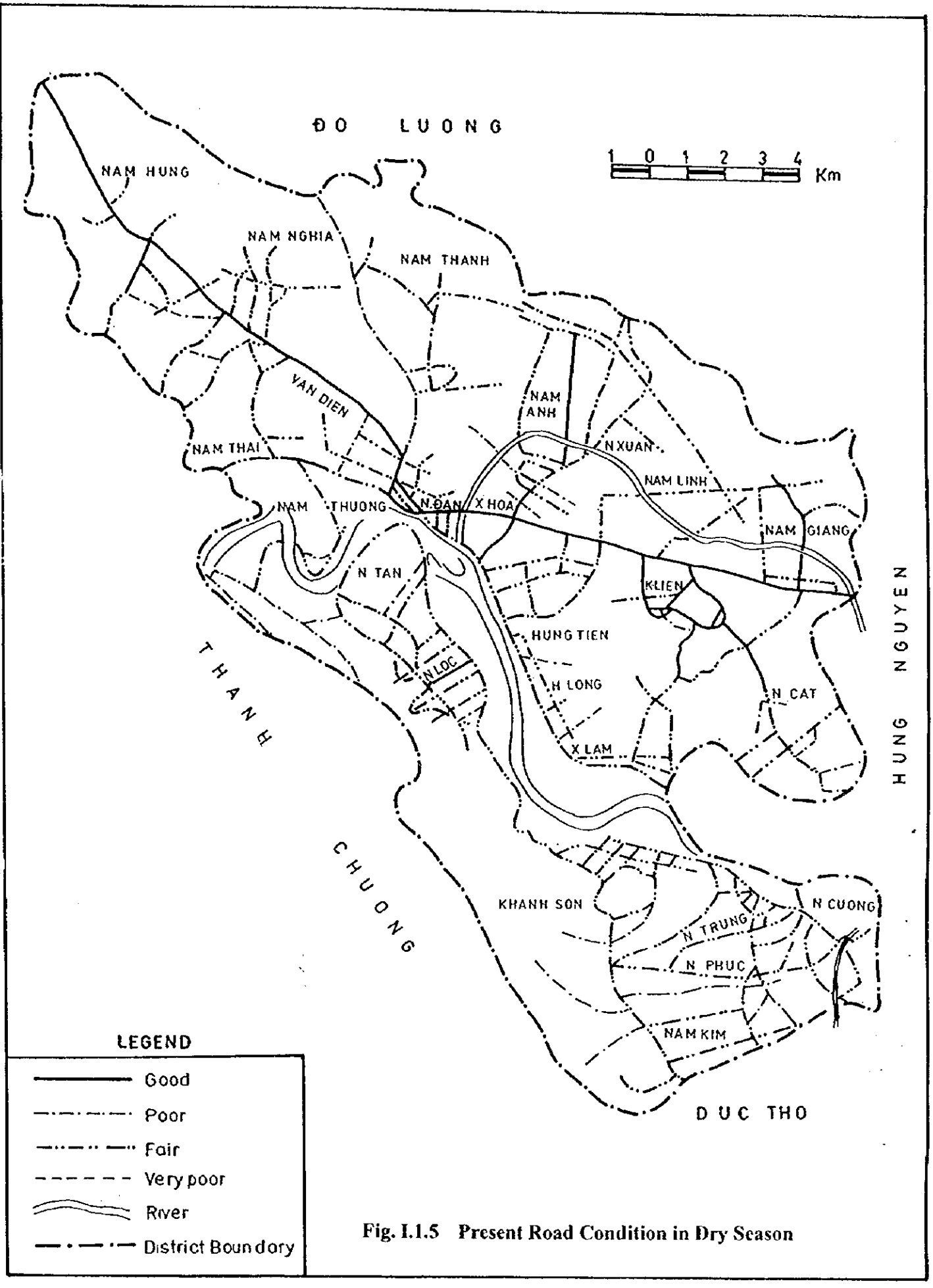


Fig. I.1.5 Present Road Condition in Dry Season

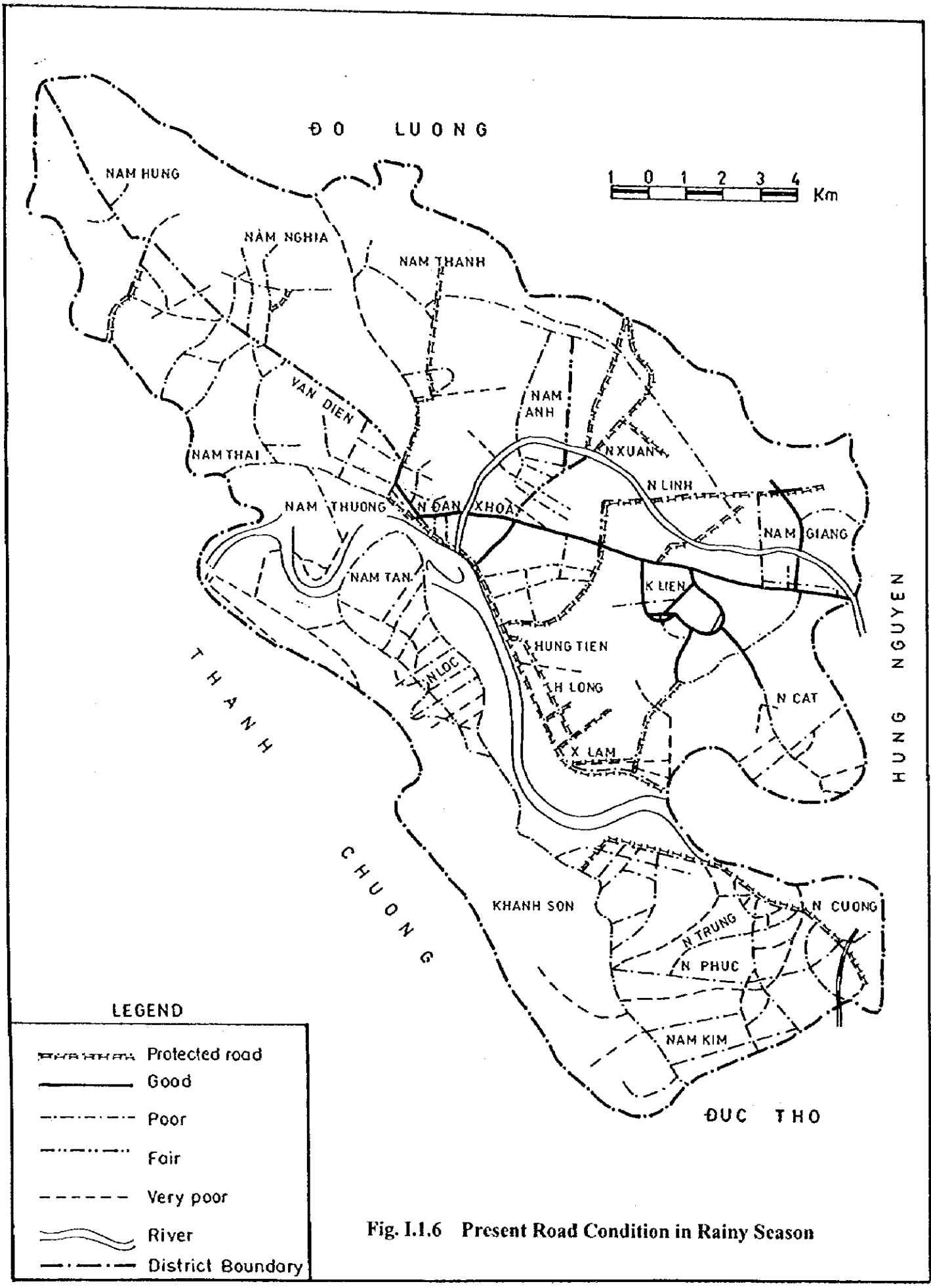
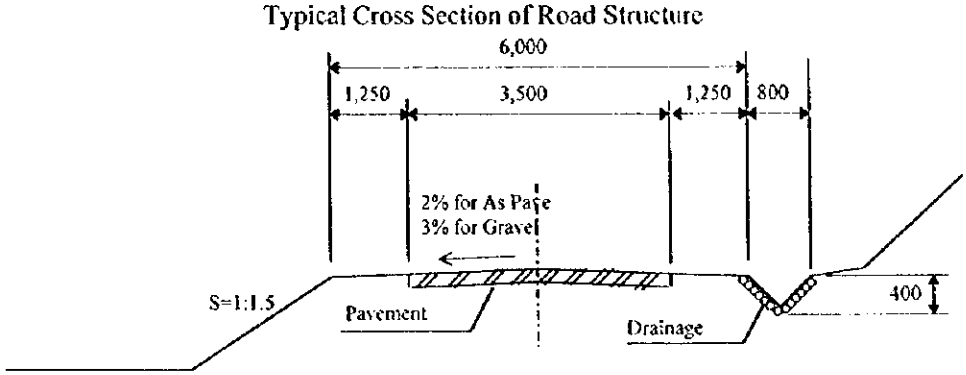


Fig. I.1.6 Present Road Condition in Rainy Season



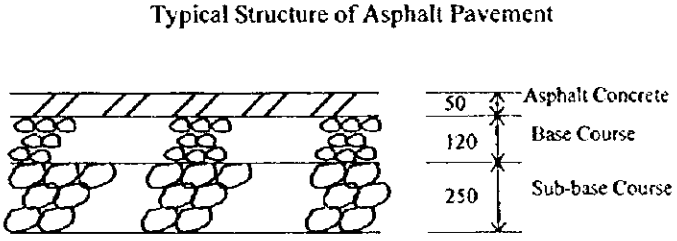


Fig. I.4.1 Typical Cross Section of Road Structure

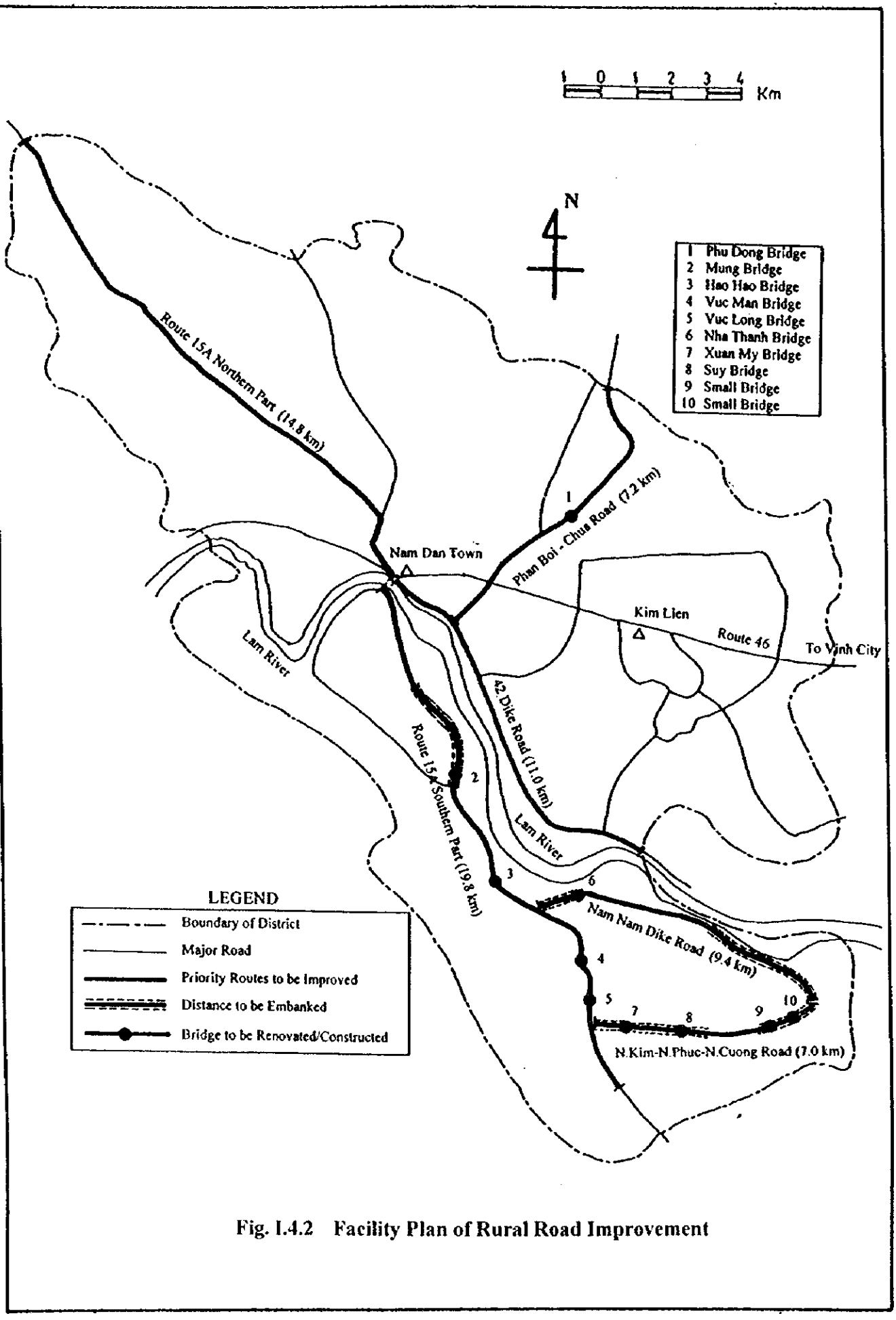
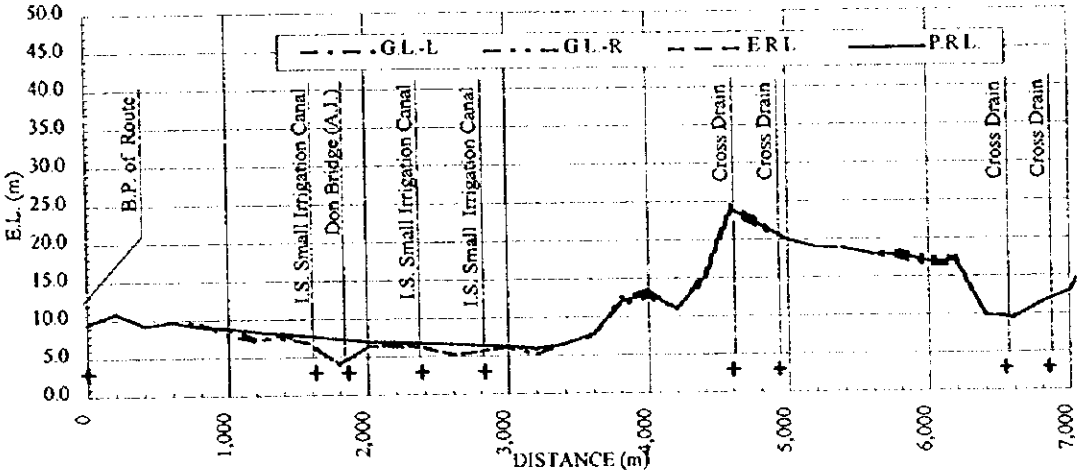


Fig. I.4.2 Facility Plan of Rural Road Improvement

LONGITUDINAL PROFILE OF ROUTE 15A NORTHERN PART (1/3)



LONGITUDINAL PROFILE OF ROUTE 15A NORTHERN PART (2/3)

LONGITUDINAL PROFILE OF ROUTE 15A NORTHERN PART (3/3)

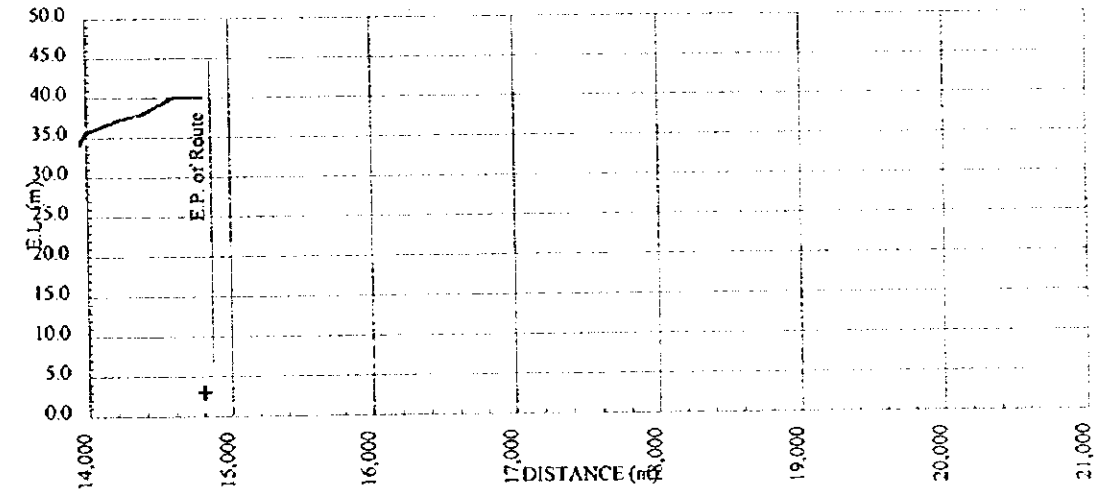


Fig. I.4.3 Longitudinal Profile of Priority Route (1/6)

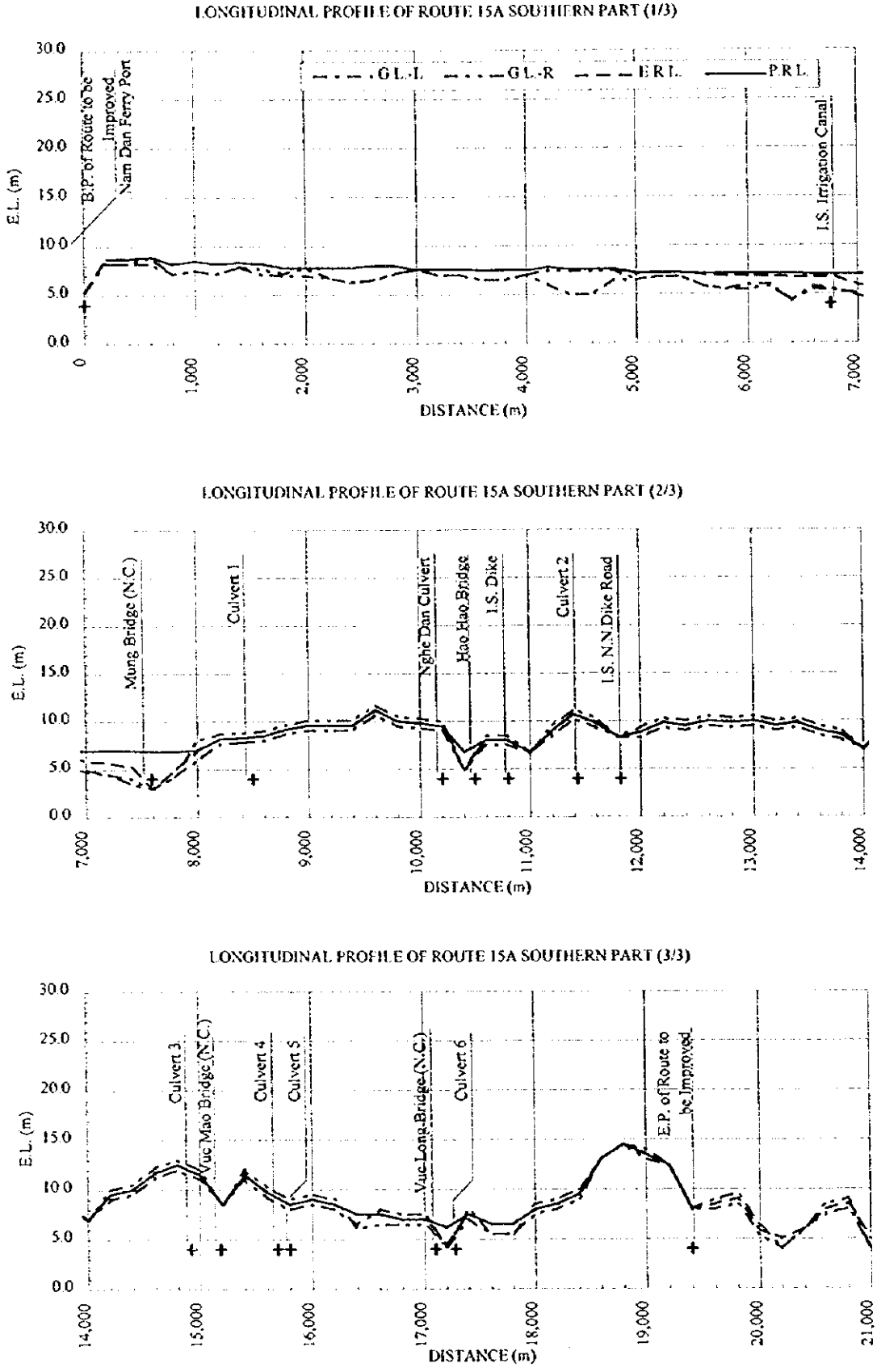
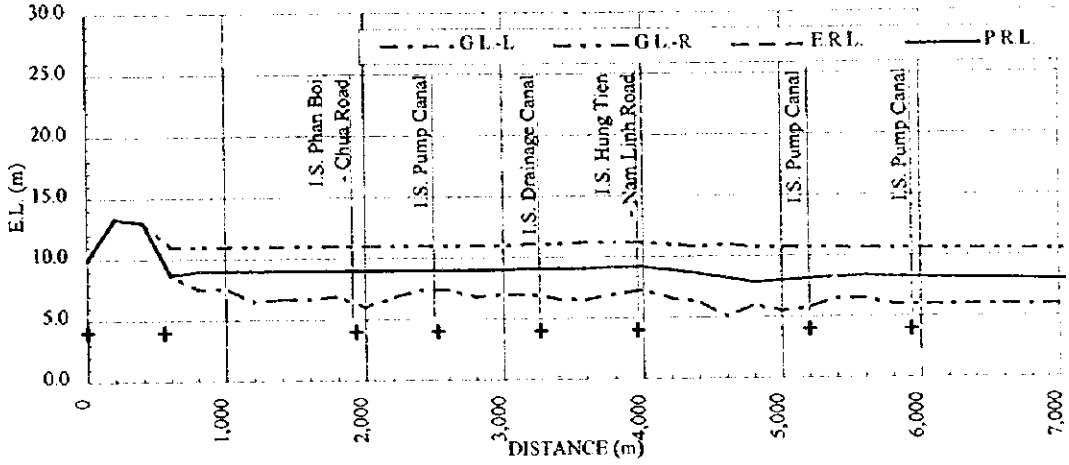


Fig. I.4.3 Longitudianal Profile of Priority Route (2/6)

LONGITUDINAL PROFILE OF 42 DIKE ROAD (1/2)



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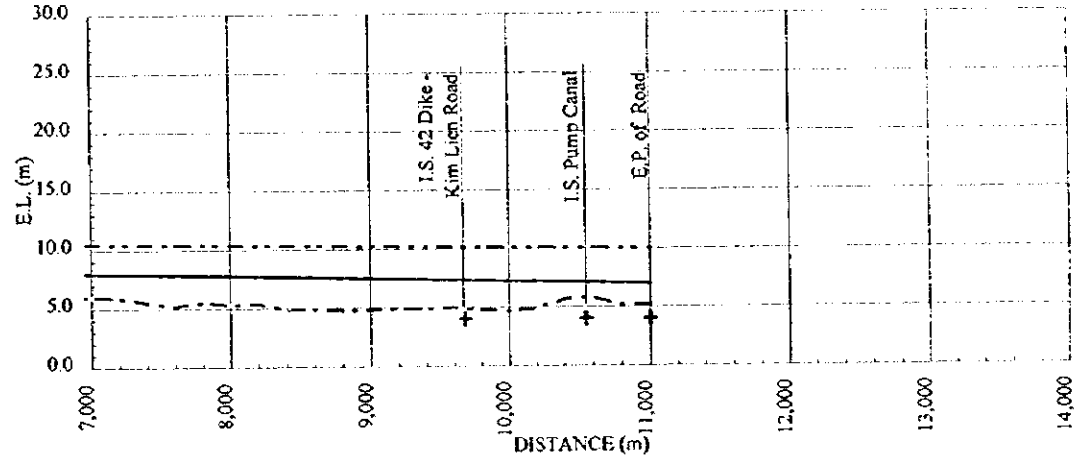


LONGITUDINAL PROFILE OF PHAN BOI - CHUA ROAD

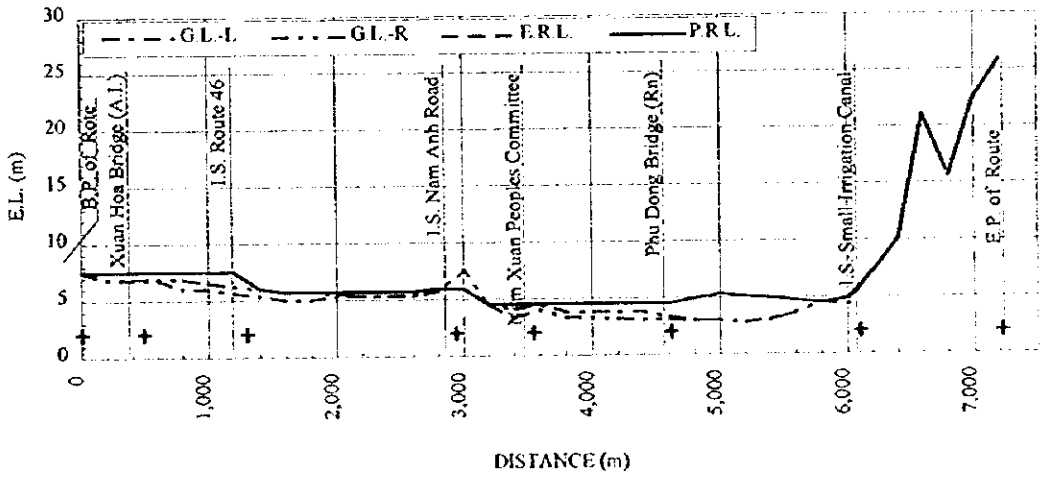
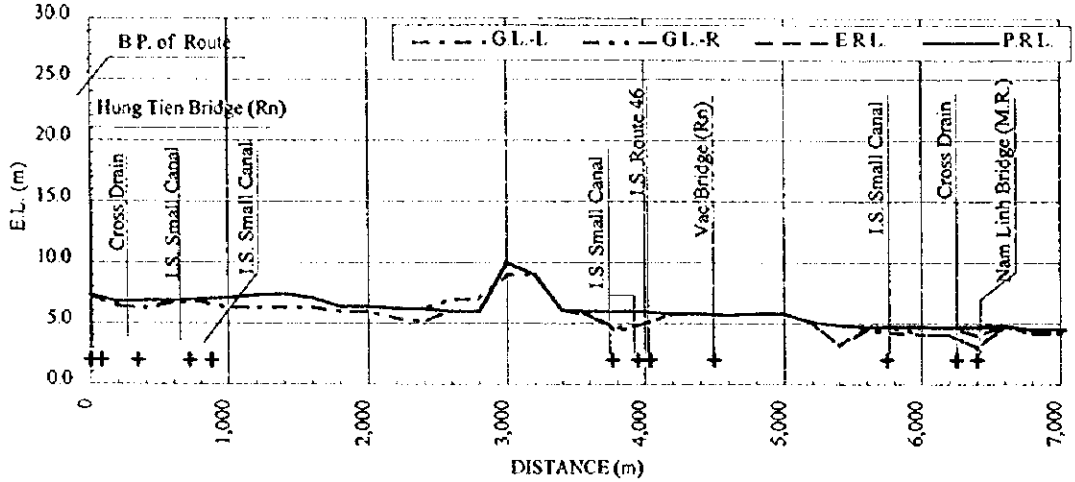
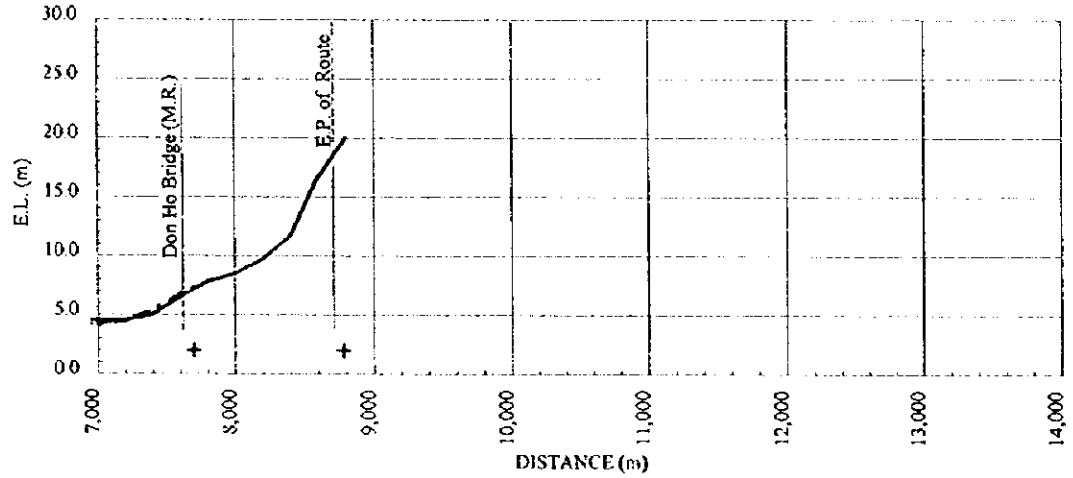


Fig. I.4.3 Longitudinal Profile of Priority Route (3/6)

LONGITUDINAL PROFILE OF HUNG TIEN - NAM LINH ROAD (1/2)



LONGITUDINAL PROFILE OF HUNG TIEN - NAM LINH ROAD (2/2)



LONGITUDINAL PROFILE OF 42 DIKE - KIM LIEN ROAD

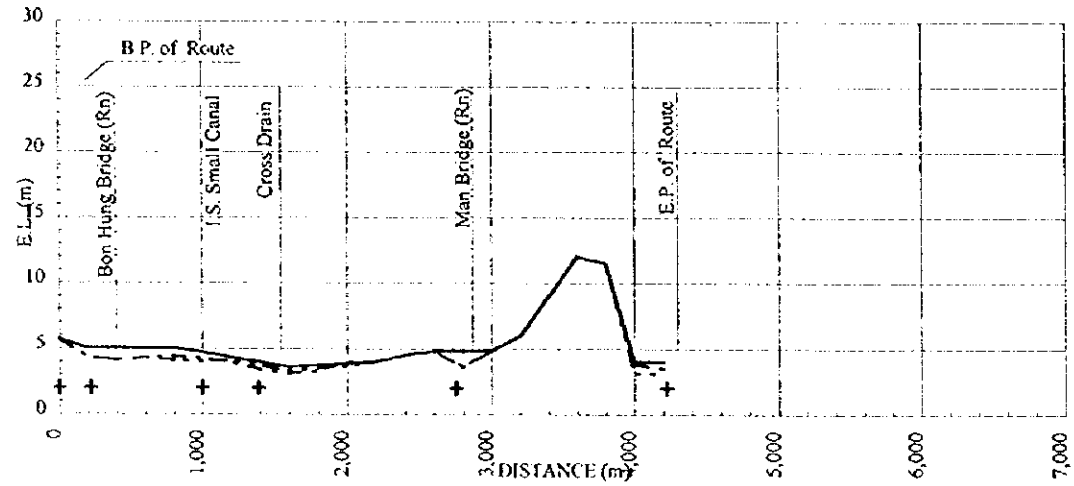
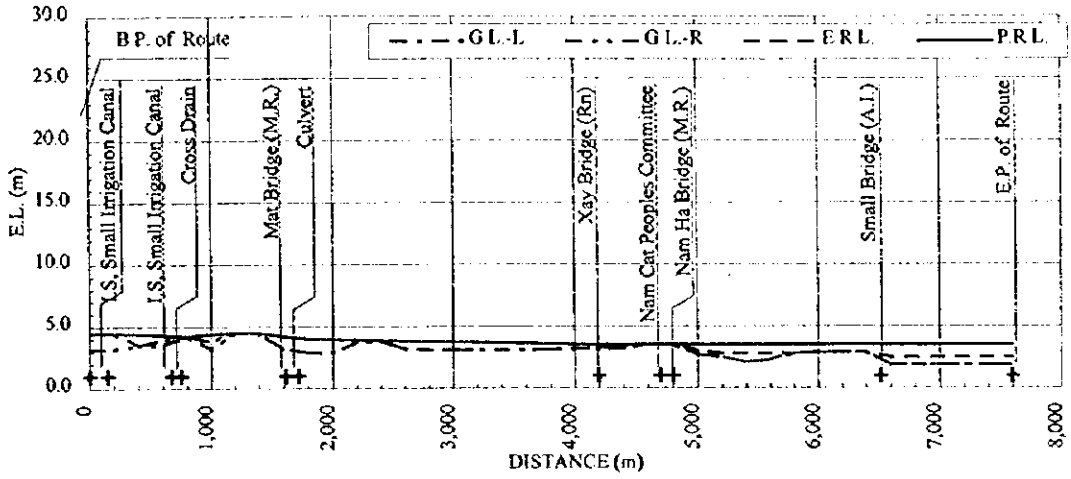
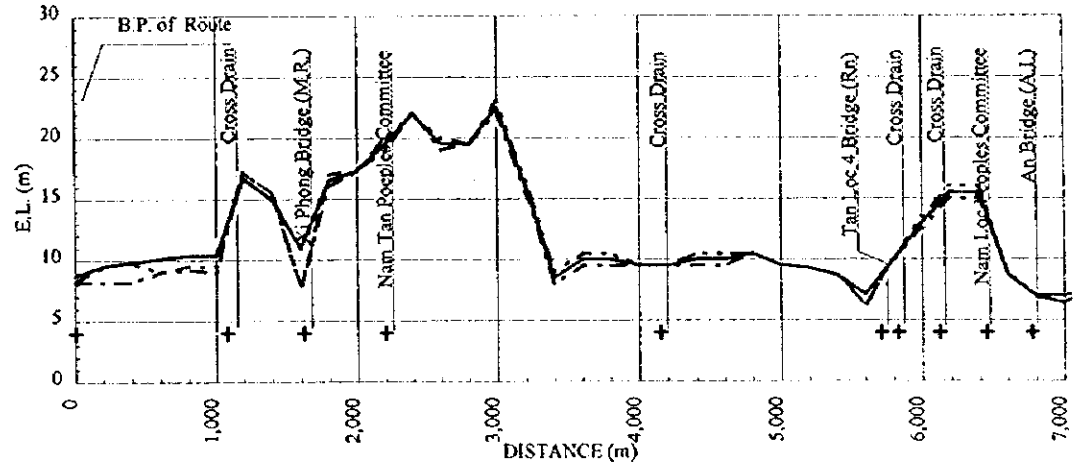


Fig. I.4.3 Longitudinal Profile of Priority Route (4/6)

LONGITUDINAL PROFILE OF NAM CAT ROAD



LONGITUDINAL PROFILE OF NAM TAN - NAM LOC ROAD (1/2)



LONGITUDINAL PROFILE OF NAM TAN - NAM LOC ROAD (2/2)

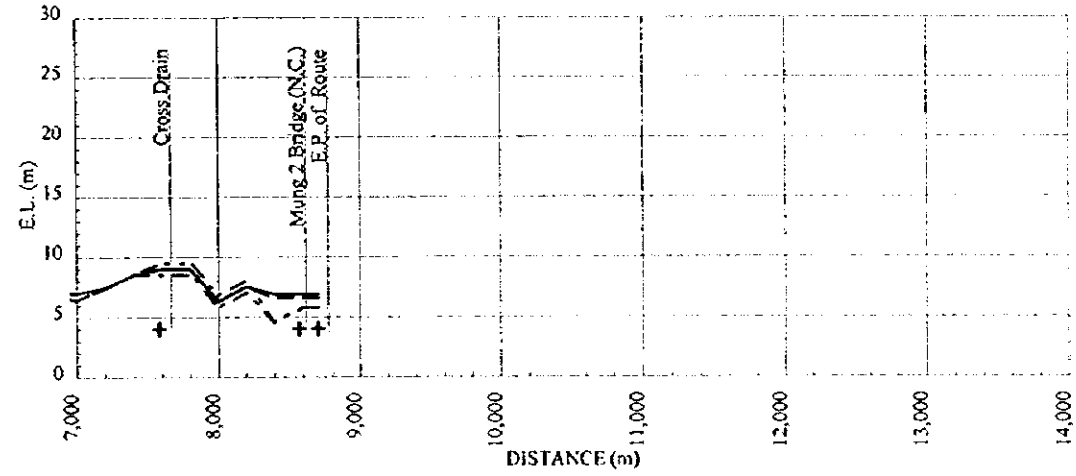
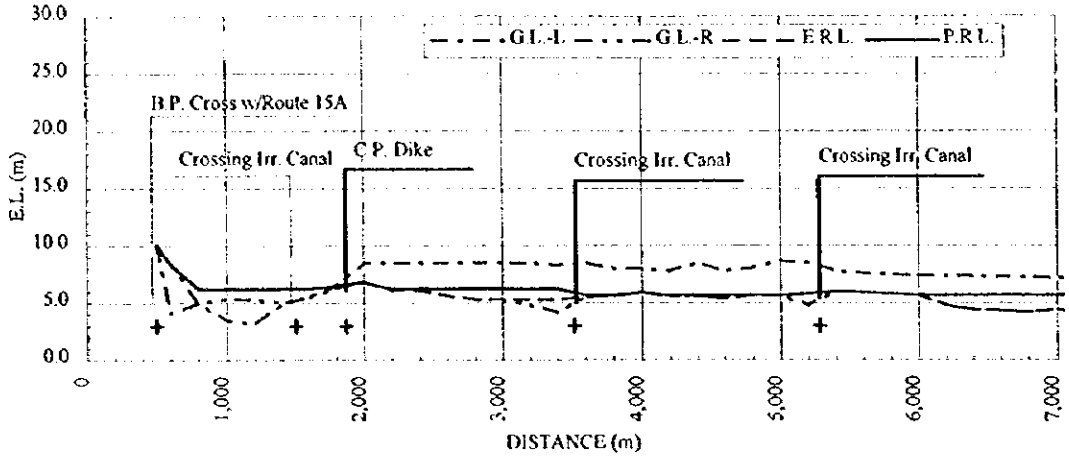
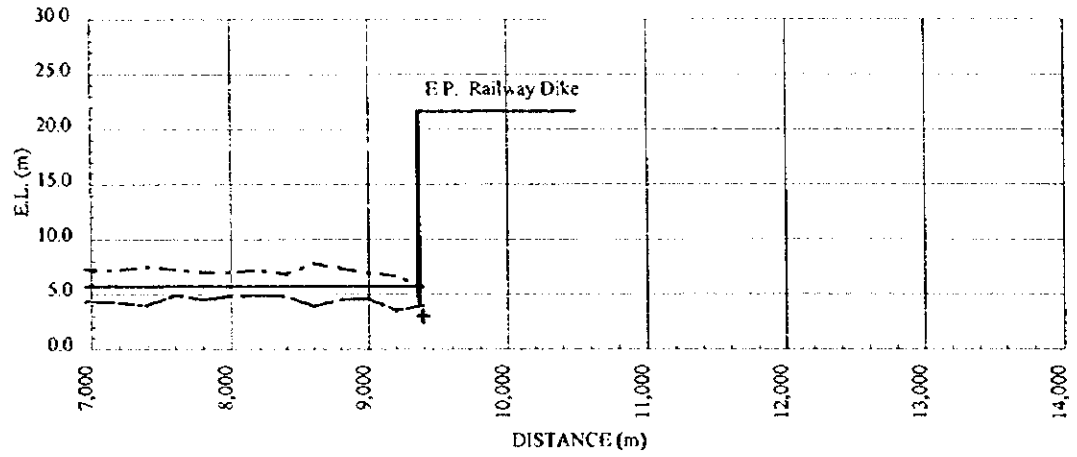


Fig. I.4.3 Longitudinal Profile of Priority Route (5/6)

LONGITUDINAL PROFILE OF NAM NAM DIKE ROAD (1/2)



LONGITUDINAL PROFILE OF NAM NAM DIKE ROAD (2/2)



LONGITUDINAL PROFILE OF N.KIM - N.PHUC - N.CUONG ROAD

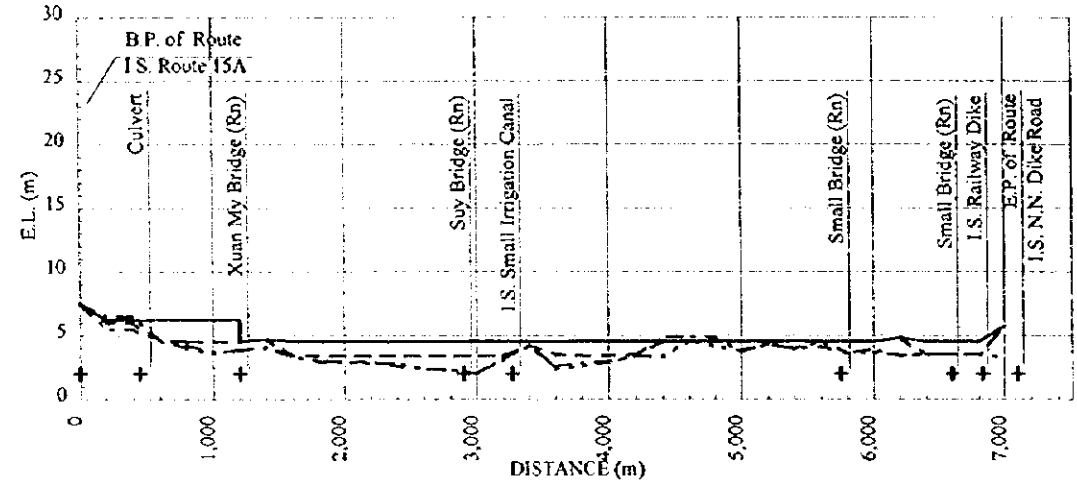


Fig. I.4.3 Longitudinal Profile of Priority Route (6/6)

APPENDIX J : RURAL ELECTRIFICATION

THE STUDY
ON
MODEL RURAL DEVELOPMENT
IN
NAM DAN DISTRIM.T, NGHE AN PROVINM.E

FINAL REPORT

APPENDIX-J : RURAL ELECTRIFICATION

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APPENDIX J : RURAL ELECTRIFICATION

J.1 GENERAL

J.1.1 Institutional Framework

In 1995, the Government through the authority of the Ministry of Industry (MOI) re-organized the power sector, creating the General Company of Electricity of Viet Nam (EVN) to manage the entire power sector. The reorganization of EVN has divided the core activity into several independent entities respectively in charge of generation transmission and distribution of electricity. Other entities cover the following: power investigation and design, power facilities construction and other general services relating to the power sector.

The reform of EVN is in progress and some changes will likely occur during the ongoing program which extends from 1996 to 1997. The organization chart of EVN is shown in Figure J.1.1.

The distribution of electricity is divided into five independent companies, each of them having their specific territorial responsibility:

- Power company No. 1 (PC1) for Northern Region,
- Power company No. 2 (PC2) for Southern Region,
- Power company No. 3 (PC3) for Central Region,
- Power company of Hanoi and
- Power company of HCMC.

The Study Area is included in the territory of the Nghe An Provincial Power Services under Power Company No 1.

The Power Company No 1 is established in Ha Noi City. It includes the general management, common functional divisions and operating divisions. The organization chart of Nghe An Provincial Power Services is shown in Figure J.1.2.

During the investigation it was not possible to obtain clear definition of competencies and responsibilities neither between PC1 and Provincial Power Services. This is due to the reform and restructuring program, which still is in progress. It seems that PC1 owns, manages and controls the whole and operates and maintains the 110 kV, Nghe An Provincial Power Services are in charge of management, operation and maintenance of 35 kV and below systems, including distribution transformers. Nam Dan District's rural development section and each commune are basically in charge of low-voltage distribution line between the secondary distribution transformer and each consumer.

J.1.2 Government Power Sector Policy and Orientation

The Government's power sector policy aims to achieve the following objectives:

- Provided electricity access to the entire population of Viet Nam
- Separate state management functions from business management functions

- Redefine and clarify ownership responsibilities to allow for asset preservation, asset development and commercial management
- Enable Viet Nam to raise financing in the order of US$ 1 billion annually for power sector expansion to meet economic growth targets
- Increase the operating and technical efficiency of the electricity sector to optimize the use of scarce investment resources
- Resolve the mismatch between market-based production costs and state administered prices

In order to achieve the above objectives, the following general orientations have been taken:

- Increase the availability of electricity in rural area
- Development of the power sector to cope with the increasing demand resulting from industry development
- Setting-up of tariffs for consumers reflecting the actual costs, with transparent subsidies from the government budget, directed to particular groups of consumers identified as needing support
- Use of domestic resources as primary energy for electricity generation
- Development of energy conservation efficiency policies
- Integration of environmental protection policy
- Creation of regulatory conditions which encourage domestic and foreign investments in the power sector

J.2 POWER MARKET

J.2.1 General

Over the last decade, Viet Nam has seen a very rapid growth in the demand for electricity averaging 9.9 % p.a. during the period 1981-1993, this could be compared with the GDP growth of around 7 % over the same period.

In 1993 the statistics indicate :

for Viet Nam sales 8,000 GWh
losses 25.6 % (technical plus non-technical)
peak demand 2,082 MW

(Source World Bank report No 13586-VN)

In 1995 the same indicators could be assumed as :

for Viet Nam sales 11,450 GWh
losses 25.6 % (technical plus non-technical)
peak demand 3,675 MW

(Source JICA Study Team figures based on a study from the Institute of Energy)

J. 2.2 Forecast of Electricity Demand

(1) General

Growth in demand for electricity in Viet Nam will be strongly driven by economic development, mainly industry development , resulting in growth in GDP. The

electricity demand elasticity with respect to GDP being likely between 1.5 for a high scenario and 1.25 for a low scenario. The development of rural electrification is also a factor to increase the demand. These pro-factors have to be combined with the adverse factors like development of energy conservation policy and cost-reflective prices policy encouraged by the Government.

(2) Study Area (Nam Dan District)

1) Present Consuming of Electricity

According to data calculated until 31 December 1996 in the district there are 32,907 households, of which there are 31,532 of electricity using households, achieve 95.8% and electricity costuming in the district in 1995 hold 10.3 GWh, the situation of electricity consuming as follows:

+ Region 1: is the delta and district center region, which has good electrical equipment's, good quality of electricity line, economic, living standard of population in the area is not too bad so average electrical consuming level is 70 kWh/person/year and electrical using households is 15,055, achieve 97.7%.

+ Region 2: is the south of Lam river region, which is usually flooded in wet and typhoon season, average electrical consuming is 55 kWh/person/year, and electrical using households is 9,298, consist 92.7% of total households.

+ Region 3 : is the mountainous area, scattered population and poor region, electrical consuming level is low, 60 kWh/person/year, the number of electrical using households are 7,179 households, consist 96.4%, the line and substation usually happens faults.

The number of households using electricity in each commune is shown in Table J.2.1 and power demand in Nam Dan District is shown in Table J.2.2.

2) Demand Forecast in 2000 - 2010

According to the Master Plan of Electricity Network Development (EVN 1996 - 2010) electricity demand forecast in Nam Dan District is as follows:

(a) Period 1996 - 2000:
For the period 1996 - 2000, the forecast of electricity demand in the district area will increase (basic plan) to11.8 %/year
Due to the above mentioned growth rate, in 2000 the biggest capacity demand will be:
P_{max} = 25,000 kW and electrical consuming will achieve : A = 18.00 GWh/year.

(b) Period 2000 - 2010:
For the period 2000 - 2010, the forecast of average growth rate of electricity demand in the district area (basic plan) will be : 11.2 %/year.
Due to the above mentioned growth rate, in 2010 the biggest capacity demand will be:

P_{max} = 65,050 kW and electrical consuming will achieve : A = 52.04 GWh/year.

J.3 GENERATION TRANSMISSION AND DISTRIBUTION FACILITIES

J.3.1 Generation

(1) General

In 1995, the total installed generation capacity of PC1 was 2,000 MW. It represents 59% of total capacity in Viet Nam. Nevertheless Nghe An Province is poor regarding generation facilities, particularly no power plant is installed in the Study Area.

(2) Ban Mai Hydroelectric

1) History and Background of Development

The Ban Mai hydropower project is situated on the Lam River in the Tuong Duong District of the Nghe Tinh Province. The project has been approved as a project part of the sub-regional cooperation between Laos, Myanmar, Thailand and Viet Nam. A ranking study was completed by NEWJEC (Japan) in 1993. The Pre-feasibility study was completed by Knight Piesold (United Kingdom) in 1994 for a site, so called the Ban Mai site No 2, after reviewing the hydro-potential of the Lam River basin, and ranking ten potential developments.

According to General Chart of IV period, the Ban Mai Hydropower construction with capacity from 350 - 500 MW is proposed to be in operation in 2003.

The reservoir with 150 m of area in Ban Mai line, which has about 4.3 billion m^3 of useful capacity and 180 m in Phu Put line with 4.9 billion m^3 of useful capacity increasing would be increased to 200 - 250 m^3/s in the dry season in order to answer the water demand and also contribute on salt prevention and flood control for lowland areas.

In recent years, the Power Company No 1 (PC1) and a French Consultant Company carried out studies to explore and study reservoirs to assess the actual situation of economic and living standards in the area of Road No 7, which becomes flooded during the raining season. The main indicators, parameters and work volumes have been estimated in Table J.3.1.

2) Implementation Progress (proposal)

The Coyne et Bellie Consultant Company agreed with PC1 to carry out a feasibility study from mid - 1996 until the end of 1997. Further steps will be as follows:

- In 1998, approval of feasibility project and preparation of documents for bidding
- In 1999, beginning of the construction
- In 2003, completion of construction and installation

3) Study Issues in the Feasibility Project Concerning Nghe An Province

(a) Problem on old National Road No 7 line replacement.

The project will study some plans about road line including line in the right, left, line surrounding the reservoir.

(b) Problem on water supply for low land area

Some previous studies have found that regarding the work structure of Ban Mai Hydropower Plant, the water volume flows to lowlands can be changed from $50m^3/s$ to ten times multiple, which can not be applied for using in lowlands for irrigation or transportation purposes. Hence, water flow control should be done by a dam with small capacity (20×10^6 m^3). The province should conduct and organize a study on this topic.

4) Problem on electricity supplying for Nghe An province.

The Ban Mai Hydropower Plant is inside of Nghe An Province and nearby Ha Tinh Province, hence the study should be considered a suitable master plan.

J.3.2 Transmission

(1) General

For the time being, the PC1 system is connected to the 500 kV link by the Ha Tinh 500/220 kV substation. The 220 kV link is connected to Hung Dong substation located in Vinh City.

(2) Study Area

1) High-Voltage Line

At present the district has 2 high-voltage lines running across the area, which is not connected to the power network of the district.

- 500 kV transmission line : lies along North-South of the district and runs through Nam Thanh, Van Dien, Nam Tan, Nam Loc, Khanh Son and Nam Kim communes.

- 110 kV transmission line : lies from East to West of the district, through the Nam Giang, Nam Linh, Xuan Hoa, Van Dien, Nam Nghia, Nam Hung communes.

2) Medium-Voltage Line

At present the district has 2 medium-voltage lines : 35 kV and 10 kV

(a) 35 kV lines : 2 ways

- 374 line(C6): electrical source from Vinh City, supplying electricity to transformer substations (35/0.4 kV) and at the same time it also supply electricity to Nam Dan transformer station.

- New 35 kV line (375): starts from Vinh City, as a parallel line of 374 line, which supplies electricity for Nam Dan transformer station only.

The 2 above lines are the main electrical supplying sources to the district. There is also a 35 kV line (377 line), which starts from the East and supplies electricity to distribution substation 35/0.4 kV of Nam Cat commune and part of Xuan Lam commune.

Regarding to actual situation : the 374 line was constructed in1983 and is a AC-50 line. The poles are in rather good conditions, but the ceramic components are broken, conditions of the line are bad, especially in Nam Cat area where 1.9 km of line are seriously damaged.

(b) 10 kV lines

At present the district has 3 lines of 10 kV, which are being fed from Nam Dan transformer substation, supplying electricity to communes in northeast, northwest of Nam Dan District, Thanh Chuong District, communes in the south of Lam river and Duc Chau such as : Nam Xuan, Nam Anh, Nam Thanh, Hung Tien, Hong Long communes, and part of some communes such as Van Dien, Xuan Hoa through the distribution substations 10/0.4 kV.

- Thanh Khai 10 kV line : Feeds electricity from Nam Dan transformer substation. It runs to the west parallel to 35 kV line and 110 kV line, supplying electricity to communes such as : Nam Nghia, Nam Thai, Nam Hung, Nam Thuong and part of Van Dien commune and Thanh Chuong District.

- 10 kV line : (8 southern communes) : The substation also originates from Nam Dan transformer substation to the south and lies accordingly running a 500 kV line from Nam Tan commune, supplying electricity to the communes in the south of Lam river and covering communes as: Nam Tan, Nam Loc, Khanh Son, Nam Kim, Nam Phuc, Nam Trung, Nam Cuong and Duc Chau communes.

Actual situation : lines of 10 kV line is AC-50, which is usually impacted by lightning in the mountainous area. Summary of the medium-voltage line and fault records are shown on the Table J.3.2 and Table J.3.3.

J.3.3 Distribution in the Study Area

(1) General

The distribution system in Nam Dan district includes the following three networks.

Region 1: Including delta communes and town of the district: Nam Giang, Kim Lien, Nam Cat, Xuan Lam, Nam Linh, Hong Long, Hung Tien, Xuan Hoa, Van Dien, and Nam Dan town. The region has 15,418 households representing 72,283 people.

Region 2 : Including communes in the South of Lam river: Nam Trung, Nam Phuc, Nam Cuong, Nam Kim, Khanh Son, Nam Loc, Nam Tan. The region is a midland, mountainous area, which usually has been castigated by floods and typhoons. The region has 10,038 households representing 47,299 people.

Region 3: Including mountainous communes in the northwest of Nam Dan and Northeast of Lam river : Nam Thai, Nam Hung, Nam Nghia, Nam Thanh, Nam Thuong, Nam Xuan, Nam Anh. This is a poor area with a scattered population. It has 7,451 households representing 34,064 people.

Power supply system and distribution networks in the Study Area are shown in Figure J.3.1 and Figure J.3.2.(1/5)-(5/5).

(2) Distribution line

Low voltage line is 3-Phase 4-Wire System with the following characteristics:

- Feeder : A-50, A-60 lines, each cooperative has about 3 - 5 km; the line capacity is small, over capacity, which is required to be rehabilitated as soon as possible.

- Branch line : this line had been done by farmer, main features: conveniently constructed (depending on opinion and existing materials of the households), which create high rate of accident, significant loss especially in mountainous region. Summary of the distribution line for each commune in shown of the Table J.3.4.

(3) Substation

1) Central Transformer Substation

At present in the district there is a central transformer substation, which is located in Nam Dan town, with a 35/10 kV electricity level. It is the source for three 10 kV lines and supplies electricity for density population communes, northwest of Nam Dan and south of Lam river. Its load density has been gradually extended, and the demand power of the 10 kV lines is also increasing according to the load density.

2) Distribution Transformer Substation

From December 1995, in the whole district there were 75 distribution substations, with 20,570 kVA of total capacity, of which 57 substation belonged to cooperatives and absorbed 15,490 kVA of capacity.
Regarding to voltage supply: 17 substations supplies 35/0.4 kV, remaining supplied 10/0.4 kV.

The distribution transformer substations of commune level have characteristics such as :
a) Many substations locations are rather not suitable related to the center of the distribution line. This makes the low - voltage network to be too long, in some areas reaching up to 3,000 m.
Burnt - down transformer: Annually in the district area 1.5 transformer equipment per year has been burnt out in mountainous regions. It is 1 transformer equipment/year is burnt down.
Statistics for the electricity network of Nam Dan District are summarized below:

(until 31 December 1995)

Items	Unit	Ownership		Total
		Cooperative	State	
1. No of Distr. substation	substation	57	18	75
2. Capacity	kVA	15,490	5,080	20,570
3. Mid - voltage line	km	113.2	27.6	140.8
4. Low - voltage line	km	128.8	12.4	141.2

J.4 ELECTRICTY TARIFFS

(1) General

Tariffs has been increased several times since 1992. A comparison with the tariffs prevailing in other Asian countries is shown in Figure J.4.1. The tariffs are currently uniform across Viet Nam with some exception in the HCMC area.

In 1997 the Government set up tariffs effective since May 1997. These tariffs are given in the attached Table J.4.1

The Government policy aims at:

- Progressive raise of average retail tariff up to 7 UScent/kWh by 1999
- determine and adopt an appropriate bulk transfer price between the distribution companies and the EVN generation-transmission core

In the framework of the reform of the power sector initiated by the Government, a tariff study, on line with the Government's orientation is in progress with the support of ADB.

(2) Study Area

1) Measuring System

There are two kind of measuring meters installed. One is installed at the secondary line of distribution transformers to measure total supplying power and the other one is installed at individual consumer location. Power company supplies power to the transformers of communes and total consumption of the power is measured at the meter of the transformer. Electricity charges is shared by each consumer based on consumption measured at the individual meter including distribution energy loss. The loss of electricity in the distribution line is rather high, especially in region 2 and 3 as follows:

- Region 1 : Power loss = 35 - 40 % of supplying capacity
- Region 2 : Power loss = 50 % of supplying capacity
- Region 3 : Power loss = 50 - 60 % of supplying capacity

2) Tariff

Tariff of rural consumers at main meter installed at village transformer is shown below.

- Domestic use	360 VND/kWh
- Non domestic use	530 VND/kWh

Actual tariff for each commune including power losses is rather high, which creates a significant gap between top and end sources, such as:

- Region 1 : 750 - 1,400 VND/kWh
- Region 2 : 750 - 1,000 VND/kWh
- Region 3 : 900 - 1,400 VND/kWh

For actual tariff for each commune, refer to Table J.4.2.

J.5 DEVELOPMENT PROGRAM

J.5.1 Introduction

When analyzing power system development it is necessary to have a nation-wide approach. This is due to the fact that such a system is by nature an inter-linked one and furthermore in the case of Vietnam where water resources, inherently dependent of geography, are largely used for power generation. The existing structure of Viet Nam power system is typical in this respect. The presence of large energy resources (hydrology and coal) mainly concentrated in the north has led to establish the existing interconnected system. The recent development of natural gas field in the south has changed this unbalanced situation, but the need to be able to exchange electric energy between the regions still exists. From economic point of view, the interconnected system allows an economic competition between the various alternative generation projects and a reduction of the total reserve capacity. The backbone of the national grid is the extra high voltage (EHV) 500 kV line installed in 1994, to link north, central and south regions.

Thus the development of power sector in north region has to be analyzed in the context of the whole country. The development of generation and transmission facilities depends of planning decision prepared at national level (EVN), even they have to take into account the demand resulting of regional development. Only distribution systems development are the responsibility of regional planner (PC1).

J.5.2 EVN Generation Master Plan

EVN is preparing a Development Master Plan for the Power Sector in Vietnam covering the period 1995 - 2010.
This study is a "Least Cost Plan" for development of power generation. It is based on demand forecasts corresponding to three scenarios: Low, Medium and High. These scenarios integrate different assumptions regarding socio-economic development GDP, population and so on in total and per economic region. The Table J.5.1 indicates the electricity demand forecasts for the three scenarios per region.
The development program for power generation and energy balance are shown in the Table J.5.2 and Table J.5.3.
It is not possible to draw out any final conclusion of this simple exercise which has no pretension to replace the comprehensive planning studies in progress at EVN. Nevertheless it allows to makes some comments which could be of interest for the development of the northern region and particularly for the Nghe An province covered by the study.

1. Up to 2000, the Northern Region will have to import energy from the central region.
2. After 2000 up to 2003, this situation will end with the commissioning of Ban Mai project.
3. After 2003, the Northern Region will be self-sufficient in energy on normal operation.
4. The generation capacity in the Northern Region is 66 % hydropower and 34 % thermal power at 2000.

J.5.3 EVN Transmission Development Plan

In parallel with the development of power generation, EVN intends to develop transmission systems. The general objectives are: development of transmission capacity; improvement of the power supply reliability and losses reduction.
The needs for new transmission facilities, during the period 1995 - 2005, to be considered for the whole country are as follows (rounded figures):

- 750 km of 500 kV lines
- 5,000 km of 220 kV lines
- 5,000 km of 110 kV lines

- 1,200 MVA substations 500 kV
- 13,500 MVA substations 220 kV
- 18,200 MVA substations 110 kV

J.5.4 Development Program in the Study Area

EVN is preparing a proposal on the orientation of Nam Dan district electricity network development in the period 2000 - 2010 for Power Sector.

(1) Period 1996-2000

1) Electricity lines

- Install some new 10, 35kV lines to the villages in order to serve newly constructed transformers stations.

- Rehabilitate the 35, 10 kV lines, which are in old and in bad conditions and are unable to meet the technical standard demands of the communes

- Improve 1/3 of the low-voltage network according to technical standards.

2) Transformer Stations

- Newly constructed 57 distribution transformer stations for communes and Nam Dan town. Especially for Nam Dan town, the capacity will be raised twice for 8 new 250kVA transformers (35/0.4) with a total capacity of 15 MVA.

(2) Period 2001-2010

1) Transformer stations

- Mid-transformer station: In order to supply energy to power equipment sources, which is raising in this period and demands rehabilitation of medium voltage to become a 22KV line, the Nam Dan mid-transformer station will be improved to become a 110/22KV line with a capacity of 75MVA, power supply will be obtained from the near-by 110KV line.

- Distribution transformer station: To supply enough power and improve the quality of power network. The improvements will be carried out as follows:

  - Construction of new 250 transformer stations with a capacity of 250KVA (22/0.4 kV)
  - Rehabilitation and upgrading of 132 old transformer substations to be 22/0.4 kV substations

Thus, in the year 2000, total capacity of distribution transformer substations in the whole district area will be around 100 MVA.

2) High-Voltage Lines

- High-voltage: Construct a new110 kV line of 1.7 km of length to supply power for mid-transformer substations

3) Medium-voltage lines

- Change two old 35 kV lines to be two 22 kV lines, powered from new transformer substations supplying electricity to the communes

- Improve old 10 kV lines to be new 22 kV lines

- New 22 kV line (10 kV line of North Central Coast area) to supply electricity only to Nam Anh, Nam Thanh and Nam Xuan communes

- New 22 kV line (35 kV line, old G6) to supply electricity for the communes within this area and Hong Long commune and half of the Hung Tien, Xuan Lam communes.

4) Low-Voltage lines

- Rehabilitate remaining 2/3 low-voltage network according to standard

(3) Volume of Investment Estimation

The total of construction volume and investment capital is estimated as follows:

Date: Nov 1996

No	Items	Unit	Construction volume		Investment capital (Mill VND)	
			96 - 2000	2001-2010	96 - 2000	2001-2010
1	I. Electricity line					
	- Newly constructed:					
	+ 110 kV line	Km		1.7		706.7
	+ 35 kV line	-	5.4		486	
	+ 10 kV line	-	23.8		1,904	
	+ 22 kV line	-		0.28		25.2
	- Rehabilitation:	-				
	+ 35 kV line	-	17.5			
	+ 10 kV line	-	64.4			
	+ low voltage line	-	47	94.2	4,700	9,420
	+ 22 kV line	-		111.7		11,170
2	II. Substation:					
	- Newly constructed:					
	+ 320kVA s/s (10/0.4)	Station	20		1,692	
	+ 320kVA s/s (35/0.4)	-	5		562.5	
	+ 250 kVA s/s(10/0.4)	-	8		640	
	+ 250 kVA s/s(35/0.4)	-	10		1,065	
	+ 360 kVA s/s(35/0.4)	-	2		235	
	+ 180 kVA s/s(10/0.4)	-	7		526.4	
	+ 180 kVA s/s(35/0.4)	-	1		90.2	
	+ 100 kVA s/s(10/0.4)	-	3		197.4	
	+ 100 kVA s/s(35/0.4)	-	1		75.2	
	+ 250 kVA s/s(22/0.4)	-		250		25,000
	- Rehabilitation:					
	+ TR. station bc 75 MVA (110/22 kV)	Station/ MVA		3/75		23,000
	+ 22/0.4 station			132		14,700
	Total				12,173.7	81,021.9

(Source: Master Plan of Electricity Network Development in Nam Dan District, EVN 1996-2010 year)

Total amount of investment capital for the construction is : VND 96,195.6 million and divided to 2 periods:

+ Period 1996 - 2000 :
The amount of capital, which has to be collected and contributed is VND 12,173.7 million capital for rehabilitation of the 10 and 35 kV electricity lines.

+ Period 2001 - 2010:
Capital amount to be mobilized is: VND 84,021.9 million

(4) Form of Capital Mobilization (proposal)

High - voltage : The Viet Nam Electricity Company may carry put the investment using its own capital sources, which includes internal capital, ODA funds, borrowed capital, etc...)

Medium - voltage : The investment could be carried out by local electricity companies. The capital to be used may include the one of national and local budget (30 - 40%), priority credit borrowing capital (30%), and the remains amount may be obtained through issuing of construction government bonds and mobilization from other subsidiary sources.

+ Low - voltage : Investment capital may be obtained by encouraging and mobilizing resources from the private sector and local people.

J.6 STUDY AREA DEVELOPMENT

J.6.1 General (Basic Development Concept)

The following three proposals are recommended for the rural electrification development plan considering the problems of existing power supply system.

- Extension of Electrification
- Rehabilitation of Distribution Networks
- Up-grading of Distribution Network

Target of the rural electrification in the Study Area is as follows:

- Complete electrification of the Study Area by the year 2000
- Reduce actual tariff in to the Study Area to a level similar to the rest of the country by the year 2010
- Increase supply capacity for improvement of living standards by the year 2010

J.6.2 Needs and Opportunities

(1) Extension of Electrification

(a) In accordance with 1996 statistical data, 31,532 households in Nam Dan district had electricity. There was a total of 32,9907 households in the district. Thus, the electrification rate was 95.8%. 1,375 households did not have a power supply. The number of the households that did not have a power supply in each area in the district (see Fig. J.6.1 and Table J.2.1) was as follows:

Region 1:		363
Region 2	Northeast Area:	740
Region 3	Northwest Area:	272
Total		1,375

(b) Households in each area not having power supplies are under conditions similar to the follow (see Fig. J.6.2):

- Although some households are located along the 0.4 kV low voltage distribution lines, no 220 volts hookup have installed for them (approximately 20% of the non-power supplied households);

- There are some households located relatively close to the terminal points of the 0.4 kV low voltage distribution lines. It would be possible to provide power supplies to those households by extending the 0.4 kV low voltage distribution liens (approximately 40% of the non-power supplied households);

- Also, there are some households that are located a great distance from the 0.4 kV low voltage distribution lines. It would not be possible to extend the power lines. thus, it would be necessary to build a 100 kV, 10/0.4 kV transformer station and new 0.4 kV low voltage distribution lines to provide those households with power supplies (approximately 40% of the non-power supplied households).

(2) Rehabilitation of Distribution Network

Each cooperative has around 3 - 5 km of low-voltage distribution line; the line has a small capacity and usually works beyond its capacity. The line must be rehabilitated as soon as possible.

It is very difficult to use electricity due to the following technical and financial reasons:

(a) Voltage Drop
Due to excessive length of the low-voltage feeder, even reaching to 3.0 km in some places, the voltage at the end of the line (Vr) is very low in comparison with the designed voltage (Vd) such as:

- Region 1 : Vr = 140 V, Voltage Drop $\Delta Vmax = 36.4\% \times Vd$
- Region 2 : Vr = 130 V, Voltage Drop $\Delta Vmax = 40.9\% \times Vd$

- Region 3 : Vr = 90 V, Voltage Drop ΔVmax = 59.0% x Vd

(b) Power Loss

The power loss in the distribution network is rather high due to undersizing of lines, especially in region 2 and 3. The power loss is as follows:

- Region 1 : Power loss = 35 - 40 % of supplying capacity
- Region 2 : Power loss = 50 % of supplying capacity
- Region 3 : Power loss = 50 - 60 % of supplying capacity

(c) Electricity Charges

Rural electricity tariffs are as follows:

- Domestic use	360 VND/kWh
- Non domestic use	530 VND/kWh

Actual tariffs for each commune, including power losses are rather high, which creates the significant gap between top and end sources, such as:

- Region 1 : 750 - 1,400 VND/kWh
- Region 2 : 750 - 1,000 VND/kWh
- Region 3 : 900 - 1,400 VND/kWh

(3) Electrical Condition of Public Facilitates and Irrigation Use

(a) School Condition

There are 55 schools in most of the schools, the classrooms are badly illuminated, specially in the rainy days, lighting conditions are bad in the Study Area. These facts do not contribute to an adequate learning environment. 30% of the schools, which have lighting fixtures. It is too dark condition to learn in classroom at rainy days because of almost the classroom are poorly lighting from outside due to providing small windows only.

(b) Irrigation Use

About 50% of actual irritable area is irrigated. In order to increase to irrigated area it will be necessary not only to increase electricity services for the pumping stations but to also improve water resources and supply.

(4) Operation and Maintenance of Electrical Facilitates in the Commune

(a) Organization

An electrical engineer has been posted at the Rural Development Section in Nam Dan District. 36 electricians have been appointed for maintenance of the distribution lines at each commune under the supervision of the electrical engineer.

(b) Technical Problem

Electrician grades are classified as follows:

Class 1: 18 months education and examination pass
Class 2: , 2 years experience and examination pass
Class 3: , 2 years experience and examination pass
Class 4: , 2 years experience and examination pass
Class 5: , 3 years experience and examination pass
Class 6: , 4 years experience and examination pass
Class 7: , 6 years experience and examination pass

Maintenance of the distribution line in the commune requires a Class 2 electrician according to the level of the works. However, usually the electrician assigned to each commune has been educated 3 months due to shortage of funds.
Technical grade-up of the electrician should be done as soon as possible.

J.7 DESIGN OF ELECTRICAL FACILITIES

J.7.1 Design Policy

The power transmission and distribution facilities of this project will comprise the key component of the electricity supply in Nam Dan District. Basic design will hteref ore be conducted in accordance with the following design policies.

(1) Reliability and Safety of Facilities

The factor which should be gjiven first priority is that the distribution system, materials and equipment that comprise it, should display high reliability. This reliability must be maintained for a long period at a comprehensively high level, and ensure equipment and human safety. Operations and maintenance will be jointly planned so that equipment or component breakdowns can be quickly repaired, allowing continuous operation.

(2) Convenience of Maintenance

Design should focus on convenience so that maintenance of power distribution facilities will not require special knowledge or skills, and can be implemented safely and easily. In particular, standard items must be used for electric poles, transformers, switches, electric wires, insulators and metal fixtures. The range of products and sizes should be minimized, and compatibility between equipment and components must be ensured. Design should also consider compatibility with specifications of existing facilities.

(3) Economy of Designing

While ensuring convenience and reliability, consideration should be given to the use of standard products at the equipment and component level, and minimal numbers of components.

J.7.2 Study and Examination on Design Criteria

In carrying out basic design of power distribution lines, the following design conditions should be followed.

(1) Elevation

The areas where power distribution liens are installed will be less than 1,000 meters above sea level.

(2) Climatic Conditions

(a) Design temperature	:	40°C
(b) Relative design humidity	:	Maximum 85%
(c) Design wind speed	:	10 min average 40 m/s
(d) Annual rainfall	:	2133 mm

(3) Applicable Standards

The following standards and criteria will be used in designing facilities and equipment.

(a) Japanese Industrial Standards (JIS)
(b) Institute of Electrical Engineers of Japan Standards (JEC)
(c) Japanese Electric Wire and Cable Makers' Association Standards (JCS)
(d) Standard of International Electrotechnical Commission (IEC)
(e) Relevant standards, codes and Regulations of the Vietnam Electricity Company

J.7.3 Insulation Design

(1) Switching Surge Withstand Voltage Design

Nominal voltage	(kV)	35	10
Maximum allowable voltage	(kV)	37	10.52
Require insulation strength	(kV)	101	41
Minimum insulation clearance	(cm)	20	10
Insulation clearance phase to phase	(cm)	30	15

(2) Commercial Frequency Design

Nominal voltage	(kV)	35	10
Maximum allowable voltage	(kV)	37	10.52
Insulation clearance in abnormal condition	(cm)	9	4

J.7.4 Extension of Electrification

(1) Construction of New Substations

Commune	No. of Substations	Capacity of Trrans. (KVA)	Voltage (kV)
Nam Linh	1	100	35/0.4
Hong Long	1	100	10/0.4
Hung Tien	1	100	10/0.4
Region 1	3	300	
Khanh Son	1	100	10/0.4
Nam Kim	1	100	10/0.4
Nam Phuc	1	100	10/0.4
Nam Cuong	1	100	10/0.4
Nam Tan	1	100	10/0.4
Nam Loc	1	100	10/0.4
Region 2	6	600	
Nam Thai	1	100	10/0.4
Nam Hung	1	100	10/0.4
Nam Nghia	1	100	10/0.4
Nam Thuong	1	100	10/0.4
Region 3	4	400	
Total	13	1,300	

(2) Construction of 35 kV and 10 kV Overhead Distribution Lines

Commune	Length of Line (km)	No. of New Poles	Overhead Line Voltage (kV)
Nam Linh	0.8	2	35
Hong Long	1.0	2	10
Hung Tien	0.7	2	10
Region 1	2.5	6	
Khanh Son	0.3	1	10
Nam Kim	0.45	1	10
Nam Phuc	0.6	1	10
Nam Cuong	0.55	1	10
Nam Tan	0.85	2	10
Nam Loc	0.35	1	10
Region 2	3.1	7	
Nam Thai	0.1	1	10
Nam Hung	1.5	3	10
Nam Nghia	1.2	3	10
Nam Thuong	1.25	3	10
Region 3	4.05	10	
Total	9.65	23	

(3) Extension and Construction of New 0.4 kV Distribution Lines

Commune	Length of Line (km)	No. of New Poles
Nam Giang	2.7	5
Kim Lien	1.7	3
Xuan Lam	1.7	3
Nam Linh	6.7	10
Hong Long	4.3	7
Hung Tien	3.5	6
Xuan Hoa	2.0	3
Van Dien	2.7	5
Region 1	25.3	42
Khanh Son	6.9	10
Nam Trung	2.5	4
Nam Kim	5.4	8
Nam Phuc	3.9	6
Nam Cuong	2.4	3
Nam Tan	5.4	8
Nam Loc	4.3	7
Region 2	30.8	46
Nam Anh	2.7	5
Nam Thai	6.7	10
Nam Hung	6.9	10
Nam Nghia	5.6	8
Nam Thanh	2.5	5
Nam Thuong	3.85	6
Region 3	28.25	44
Total	84.35	132

J.7.5 Rehabilitation of Distribution Networks

(1) 35 kV and 10 kV Overhead Distribution Lines

Commune	Length of Line (km)	No. of New Poles	Overahead Line Voltage (kV)
Nam Giang	1.4	1	35
Kim Lien	2.2	2	35
Nam Cat	2.8	3	35
Xuan Lam	2.4	2	35
Nam Linh	0.5	–	35
Hong Long	3.8	4	10
Hung Tien	2.0	2	10
Xuan Hoa	0.4	–	10
Van Dien	1.1	–	10
Region 1	16.6	14	
Khanh Son	1.5	1	10
Nam Kim	2.7	3	10
Nam Phuc	0.5	–	10
Nam Cuong	0.6	–	10
Nam Tan	1.0	–	10
Region 2	6.3	4	
Nm Xuan	2.0	2	10
Nam Anh	0.4	–	10
Nam Thai	0.7	–	10
Nam Hung	1.5	1	10
Nam Nghia	2.0	2	10
Nam Thanh	4.0	4	10
Nam Thuong	1.4	1	10
Region 3	12.0	10	
Total	34.9	28	

(2) 0.4 kV Overhead Distribution Lines

Commune	Length of Line (km)	No. of New Poles
Nam Giang	4.9	5
Kim Lien	13.4	13
Nam Cat	7.3	7
Xuan Lam	5.8	5
Nam Linh	6.5	6
Hong Long	6.5	6
Hung Tien	6.3	6
Xuan Hoa	2.8	3
Van Dien	8.5	8
Region 1	62.0	59
Khanh Son	8.8	8
Nam Trung	4.5	4
Nam Kim	6.7	6
Nam Phuc	2.5	3
Nam Cuong	3.1	3
Nam Tan	4.1	4
Nam Loc	3.9	4
Region 2	33.6	32
Nam Xuan	7.6	7
Nam Anh	4.1	4
Nam Thai	4.9	5
Nam Hung	5.0	5
Nam Nghia	3.0	3
Nam Thanh	8.6	8
Nam Thuong	5.0	5
Region 3	38.2	37
Total	133.8	128

APPENDIX J : TABLES

Table J.2.1: Number of Households Using Electricity in the Study Area

Date: Dec. 1996

Commune		Total number of households	Number of households using electricity	Percentage of electrified households using electricity	Population	Average number of consumers	Remarks
Code No	Name	A	B	C=B/A	D	E=D*C	
Region 1 Total		15,418	15,055	97.65%	72,283	70,581	*
8	Nam Dan Town	1,192	1,192	100.00%	6,274	6,274	
13	Nam Giang	1,133	1,128	99.55%	5,108	5,085	
12	Kim Lien	2,484	2,385	96.00%	11,075	10,725	
16	Nam Cat	1,262	1,262	100.00%	4,798	4,798	
15	Xuan Lam	1,618	1,589	98.20%	8,898	8,737	
11	Nam Linh	1,289	1,185	91.90%	5,995	5,509	
14	Hong Long	951	949	99.78%	4,920	4,909	
10	Hung Tien	1,921	1,895	98.64%	8,720	8,601	
9	Xuan Hoa	1,286	1,194	95.84%	5,831	5,413	
7	Van Dien	2,282	2,276	99.73%	10,664	10,635	
Region 2 Total		10,038	9,298	92.63%	47,299	43,812	*
21	Nam Trung	1,510	1,507	99.80%	7,188	7,173	
23	Nam Phuc	696	635	91.23%	3,248	2,963	
24	Nam Cuong	1,235	1,230	99.59%	5,745	5,721	
22	Nam Kim	2,030	1,723	84.87%	9,650	8,190	
20	Khan Son	2,556	2,428	94.99%	11,755	11,166	
18	Nam Tan	893	758	84.88%	4,208	3,572	
19	Nam Loc	1,118	1,017	90.97%	5,505	5,008	
Region 3 Total		7,451	7,179	96.35%	34,064	32,820	*
3	Nam Thai	605	472	78.00%	3,443	2,686	
1	Nam Hung	774	760	98.19%	3,543	3,479	
2	Nam Nghia	921	906	98.40%	4,086	4,020	
4	Nam Thanh	1,770	1,730	97.74%	7,922	7,743	
17	Nam Thuong	520	494	98.40%	2,441	2,402	
6	Nam Xuan	1,370	1,370	100.00%	5,968	5,963	
5	Nam Anh	1,491	1,447	97.04%	6,661	6,464	
Total		32,907	31,532	95.82%	153,646	147,226	*

Note 1: Marked with * data Source : EN master plan dated 1996.

Note 2: Average number of consumers is calculated by using ratio of electrified households.

Table J.2.2 Power Demand in the Study Area

Date: Nov. 1996

Item	1995	1994	1993
Energy Sold (GWh)	10.50	10.15	7.10
Residential (GWh)	8.50	8.60	6.50
Others (GWh)	2.00	1.55	0.60

Table J.3.1 Main Indicators of Ban Mai Project

No	Item	Unit	Ban Mai Line	Phu Put Line
I	Condition			(Reference)
1	Location		Lam river lines in downstream, Nuoi Nguyen intersection	Lam river lines in upstream, Nuoi Nguyen intersection
2	Hydrometeodology			
	- Area of catchment	km^2	14,240	13,232
	- Annual content	m^3/s	256	238
3	Reservoir			
	- MNDBT	m	155	180
	- MNC	m	110	135
	- W total	10^9m^3	5.64	7.24
	- W ineffectively	10^9m^3	4.37	4.92
4	Plant			
	- Q_{max}	10^9m^3	477	423
	- Nbd	MW	107	182
	- Eo	10^9kWh	1,65	1.74
5	Spillway Operation			
	- Flood control	m^3/s	13,300	12,200
6	Dam:			
	- High x Length of top	m	135 x 500	165 x 750
7	Energy line			
	- Water turbine tunnel x D x length		2 x 12 x 360	2 x 12 x 610
8	No of machinery groups x capacity of each group	MW	4 x 95	4 x 100
II	Reservoir			
1	Population within flood region			
	- No of households	h.hold	6,697	5,580
	- No of people	person	39,837	33,939
2	No of communes	commune	20	15
3	No of hamlets	hamlet	108	75
4	No of villages	village	2	2
5	Semi permanent house	piece	3,200	2,472
6	Permanent house	piece	80	89
	Temporary	piece	3,768	3,171
7	Land			
	- Residential of which garden	ha	328.56	316.41
	- Land	ha	135.76	116.17
	- Agricultural land	ha		
	- Of which: wet land	ha	254.02	251.41
	- Area of upland	ha	5,075.0	3,341.5
8	Infrastructure			
	- Road	km	carrying out to survey	carrying out to survey
	- Electricity line	km	ditto	ditto
	- School	piece	ditto	ditto
	- Clinic house	piece	ditto	ditto
	- Factory	piece	ditto	ditto

Table J.3.2 Medium-Voltage Lines in the Study Area

Date: Nov. 1996

List	Voltage (kV)	Circuit Length (km)	Conductor Type	No. of Circuit	Year of Construction	Remarks
Existing						
Vinh - Nam Dan 37	35	20.0	AC95	1	1975	
Nam Dan 971	10	11.0	AC95	1	1975	
Nam Dan 971	10	24.6	AC35	1	1975-1996	
Nam Dan 972	10	3.7	AC50	1	1975	
Nam Dan 972	10	30.5	AC35	1	1975	
Nam Dan 973	10	12.3	AC70	1	1975	
Nam Dan 973	10	17.9	AC35	1	1975	

Table J.3.3 Fault Records of Medium-Voltage Lines in the Study Area

Date: Nov. 1996

Year	1995	1994	1993	Total	Remarks
Line	(Times)	(Times)	(Times)	(Times)	
35 kV 375 Line	18	22	24	64	
10 kV 971 Line	21	26	27	74	
10 kV 972 Line	23	25	28	76	
10 kV 973 Line	22	27	29	78	
Total	84	100	108	292	

Table J.3.4 Distribution Line in the Study Area

Date: Nov. 1996

Commune		Total number of households	Number of households using electricity	Number of substations (S/S)	Total number of transformers (TR.)	Total transformer capacity (kVA)	Unit capacity per households (VA/EA.)	Total length of low-voltage lines (km)	Average line length per households (m/EA.)	During of construction (19xx - 19xx)	Estimated required number of S/S (Unit)	Estimated required total TR. capacity (kVA)	Remarks
Code No	Name	A	B	C	D	E	F=E/A	G	H=G/B	I	J	K=A x Unit	
Region 1 Total		15,487	15,010										
8	Nam Dan Tov	1,192	1,192	5	5						1		
13	Nam Giang	1,133	1,128	2	2	640		13.0		83; 94	2		
12	Kim Lien	2,484	2,385	7	7	1,390		16.0		84; 89; 90	3		78; 90; 84; 90
16	Nam Cat	1,262	1,262	3	3	960		13.0		83; 86; 91	1		
15	Xuan Lam	1,618	1,589	3	3	960		12.0		83; 91; 87	2		
11	Nam Linh	1,289	1,185	2	2	640		15.0		86; 90	3		
14	Hong Long	951	949	2	2	360		9.0		85; 87	2		
10	Hung Tien	1,921	1,895	4	4	1,220		17.5		85;86;88	5		85
9	Xuan Hoa	1,286	1,194	2	2	500		12.0		1986; 1988	1		
7	Van Dien	2,282	2,276	3		820		20.0		88; 90; 93	4		
Region 2 Total		10,062	9,379										
21	Nam Trung	1,510	1,507	2	2	640		10.0		85; 93	2		
23	Nam Phuc	696	635	1	1	320		5.0		87	1		
24	Nam Cuong	1,235	1,230	2	2	500		11.0		85; 87	2		
22	Nam Kim	2,030	1,723	4	4	860		14.0		94; 87; 88	4		
20	Khanh Son	2,556	2,428	4	4	1,140		18.0		84; 86; 89	4		
18	Nam Tan	893	758	2	2	640		9.0		89	2		
19	Nam Loc	1,118	1,017	2	2	420		7.5		88; 85	2		
Region 3 Total		7,451	7,179										
3	Nam Thai	605	472	1	1	320		7.5		1,985	3		
1	Nam Hung	774	760	1	1	400		11.0		1,989	3		
2	Nam Nghia	921	906	1	1	250		6.5		1,989	3		
4	Nam Thanh	1,770	1,730	4	4	500 x 2		18.8		85;87;88;91	4		
17	Nam Thuong	520	494	2	2	420		12.0		86; 90	4		
6	Nam Xuan	1,370	1,370	3	3	680		14.0		85;88;91	2		
5	Nam Anh	1,491	1,447	2	2	430		11.2		1,986	3		
Total		33,000	31,568				0		0				

Table 4.1 Electricity Tariffs (1/2)

Tariffs are in accordance with Government Decree 31/VGCP-TLSX dated 23 April 1997. These tariffs are effective since 15 May 1997	
A. Electricity tariff for production, agencies, administrative units	
Electricity tariff is selling according to Voltage	
1. Electricity tariff from > 110 KV	
- Normal hour (4h- 18h)	700VND/Kwh
- Slow hour (22h - 4h)	400VND/Kwh
- Rush hour (18h - 22h)	1,150VND/Kwh
2. Electricity tariff from 20KV to less than 110KV	
- Normal hour (4h- 18h)	730VND/Kwh
- Slow hour (22h - 4h)	420VND/Kwh
- Rush hour (18h - 22h)	1,200VND/Kwh
3. Electricity tariff from 6KV to less than 20KV	
- Normal hour (4h- 18h)	770VND/Kwh
- Slow hour (22h - 4h)	450VND/Kwh
- Rush hour (18h - 22h)	1,250VND/Kwh
4. Electricity tariff less than 6KV	
- Normal hour (4h- 18h)	810VND/Kwh
- Slow hour (22h - 4h)	480VND/Kwh
- Rush hour (18h - 22h)	1,300VND/Kwh
B. Selling for fresh water production	
1. Selling Voltage > 6KV	720 VND/Kwh
2. Selling Voltage < 6KV	760VND/Kwh
C. Tariff for wholesale	
1. Wholesale tariff for rural area	
- Electricity using for living activities	360VND/Kwh
- Electricity using for other purposes	650VND/Kwh
2. Electricity tariff for living quarter	
a. Electricity tariff for living activities	
- Autometer in transformer of customer	470VND/Kwh
- Autometer in transformer of the line sector	490VND/Kwh
b. Electricity tariff for other purposes	700VND/Kwh
D. Electricity tariff for rice and subsidiary crop irrigation and drainage pumping	
1. Electricity tariff > 6KV	
- Slow hour (22h - 4h)	250VND/Kwh
- Remaining hour	630VND/Kwh
2. Electricity tariff < 6KV	
- Slow hour (22h - 4h)	260VND/Kwh
- Remaining hour	660VND/Kwh
E. Electricity tariff for doing business	
1. Electricity tariff > 6KV	
- Normal hour (4h- 18h)	1,200VND/Kwh
- Slow hour (22h - 4h)	750VND/Kwh
- Rush hour (18h - 22h)	1,875VND/Kwh
2. Electricity tariff < 6KV	
- Normal hour (4h- 18h)	1,250VND/Kwh
- Slow hour (22h - 4h)	780VND/Kwh
- Rush hour (18h - 22h)	1,950VND/Kwh
F. Electricity tariff for urban's household's consumption	
- Price of 100Kw beginning	500VND/Kwh
- Price of continuing 100Kw	900VND/Kwh
- Price of continuing 100Kw	1,100VND/Kwh
- Price from > 350Kw	1,250VND/Kwh

Table 4.1 Electricity Tariffs (2/2)

G. Electricity tariff for foreigners paying by foreign currency USD (including joint-venture)	
Voltage > 20KV	0.095USD
Voltage 6 - 20KV	0.105USD
Voltage < 6KV	0.115USD
Electricity tariff for production	
Voltage > 110KV	
- Normal hour (4h- 18h)	0.075USD/Kwh
- Slow hour (22h - 4h)	0.050USD/Kwh
- Rush hour (18h - 22h)	0.120USD/Kwh
Voltage 20 - 110KV	
- Normal hour (4h- 18h)	0.080USD/Kwh
- Slow hour (22h - 4h)	0.055USD/Kwh
- Rush hour (18h - 22h)	0.125USD/Kwh
Voltage 6- 20KV	
- Normal hour (4h- 18h)	0.085USD/Kwh
- Slow hour (22h - 4h)	0.060USD/Kwh
- Rush hour (18h - 22h)	0.130USD/Kwh
Voltage < 6KV	
- Normal hour (4h- 18h)	0.090USD/Kwh
- Slow hour (22h - 4h)	0.065USD/Kwh
- Rush hour (18h - 22h)	0.135USD/Kwh
Electricity tariff using for services	
Voltage > 20KV	
- Normal hour (4h- 18h)	0.105USD/Kwh
- Slow hour (22h - 4h)	0.075USD/Kwh
- Rush hour (18h - 22h)	0.160USD/Kwh
Voltage 6- 20KV	
- Normal hour (4h- 18h)	0.115USD/Kwh
- Slow hour (22h - 4h)	0.080USD/Kwh
- Rush hour (18h - 22h)	0.170USD/Kwh
Voltage < 6KV	
- Normal hour (4h- 18h)	0.125USD/Kwh
- Slow hour (22h - 4h)	0.085USD/Kwh
- Rush hour (18h - 22h)	0.180USD/Kwh

Table J.4.2 Actual Tariff of Each Commune in the Study Area

Date: Nov. 1996

Commune		Actual tariffs (VDN)		Remarks
Code No	Name	Range	Average	
Region 1 Average				
8	Nam Dan Town	550 - 680	650	
13	Nam Giang	750	750	
12	Kim Lien	600 - 800	700	
16	Nam Cat	800 - 1200	1,000	
15	Xuan Lam		750	
11	Nam Linh	1000 - 1800	1,200	
14	Hong Long		750	
10	Hung Tien	1400	750	
9	Xuan Hoa	1000 - 1200	1,100	
7	Van Dien	1000 - 1100	1,050	
Region 2 Average				
21	Nam Trung	700	700	
23	Nam Phuc	800 - 1300	1,050	
24	Nam Cuong	1000 - 1600	1,300	
22	Nam Kim	700 - 1200	950	
20	Khan Son	750 - 950	850	
18	Nam Tan	800 - 1400	1,100	
19	Nam Loc	980 - 1050	1,015	
Region 3 Average				
3	Nam Thai	950	950	
1	Nam Hung	1100	1,100	
2	Nam Nghia	850	850	
4	Nam Thanh		850	
17	Nam Thuong		900	
6	Nam Xuan	1000 - 1200	1,100	
5	Nam Anh	850	850	
Average region 1,2 and 3				

Table J.5.1 Electricity Demand Forecast for the Three Scenarios per Region

Electricity Demand Forecast (GWh)										
	1995	2000			2005			2010		
		Low	Med.	High	Low	Med.	High	Low	Med.	High
North										
Energy Sales	5,102	8,655	9,802	10,767	14,624	17,133	19,010	23,676	28,707	31,387
Losses - auxil . consum	1,470	1,938	2,198	2,413	2,648	3,097	3,430	31,226	3,793	4,143
Energy Demand	6,562	10,590	12,000	13,180	17,270	20,230	22,440	26,800	32,500	35,530
Center										
Energy Sales	974.3	1,860	1,970	2,181	3,357	3,632	3,996	5,902	6,400	6,650
Losses - auxil . consum	280	450	477	499	630	691	761	798	865	890
Energy Demand	1,255	2,310	2,447	3,680	3,987	4,323	4,757	6,700	7,265	7,540
South										
Energy Sales	5,383	11,583	12,765	14,033	21,759	24,648	28,753	37,177	42,380	49,509
Losses - auxil . consum	1,359	2,357	2,795	3,037	3,881	4,402	5,337	4,633	5,670	6,631
Energy Demand	6,742	14,120	15,560	17,070	25,640	29,050	34,090	41,810	48,050	56,140
Vietnam										
Energy Sales	11,452	22,098	24,556	26,982	39,738	45,413	51,750	66,454	77,488	87,547
Losses - auxil . consum	3,109	4,924	5,474	5,948	7,152	8,187	9,530	8,856	10,332	11,663
Energy Demand	14,568	27,020	30,010	32,930	46,890	53,600	61,290	75,310	87,820	99,210

Source : EVN , Development Master Plan

Table J.5.2 Development Program For Power Generation

Date : Nov. 1996

development program for power generation						
Year			Installed Capacity (MW)			
	Name	Type	North	Centre	South	Total
	Existing in 1995		2,000	213	1,200	3,413
1996	Baria	GT			35	35
	Phumy 2 u.1	GT			200	200
1997	Baria	CC			56	56
	Phumy 2 u.2	GT			200	200
	Phumy 3 u.1	GT			200	200
1998	Baria	CC			56	56
	Phumy 2 u.3	CC			200	200
	Phumy 1 u.1	GT			200	200
	Phumy 3 u 2	GT			200	200
	Song Hinh u .1	Hydro		35		35
1999	Phalai 2 u.1	Th .coal	300			300
	Quangninh u.1	Th.coal	300			300
	Phumy 1u 2.3	GT +CC			400	400
	Phumy 3 u.3	CC			200	200
	Song Hinh u 2	HYdro		35		35
	Yali u.1	Hydro		180		180
2000	Phalai 2 u.2	Th.coal	300			300
	yali u.2.3	Hydro		360		360
	Ham tuan -Dami	Hydro			472	472
	Decomissioning		-200		-217	-417
	Total at 2000		2,700	823	3,402	6,925
2001	Yali g.4	Hydro		180		180
	Phumy 4 u.1	GT			300	300
	Decomissioning			-129		-129
2002	Phumy 4 u.2	GT			300	300
	Nhon trach u.1	GT			300	300
	Seasan 3	HYdro		220		220
	Buonkuop	hydro		85		85
2003	Daininh	hydro			300	300
	Banmal	hydro	350			350
	High Kontum	hydro		260		260
	Decomissioning				-90	-90
2004	Plei Krong	Hydro		120		120
	Daithi	Hydro	250			250
	Dong nai 8	Hydro			140	140
	Nhon trach u .2.3	GT +CC			600	600
2005	Quang ninh u.2.3	Th.coal	600			600
	Hai phong/Phalai	Th	600			600
	Total at 2005		4,500	1,559	5,252	11,311
2006	Nhon trach	CC			300	300
	Quang ninh u.4	Th.coal	300			300
	Mekong Delta u.1.2	Th.coal			600	600
2007	Sonla u.1.2	Hydro	600			600
	A vuong	Hydro		145		145
	Mekong delta u.3	Th.coal			300	300
	Mekongdelta 1.2.3	GT (DO)*			600	600
	Decomissioning		-67			-67
2008	Son la u.3.4	Hydro	600			600
	An khe	Hydro		116		116
	Mekong delta u.4	Th.coal			300	300
	Mekong delta 4.5.6	GT (DO)*			600	600
2009	Son la u.5.6	hydro	600			600
	Sesan 4	hydro		366		366
2010	Son la u.7.8	Hydro	600			600
	Mekong delta u.5	Th.coal			300	300
	Mekong delta 7-8	GT (DO) *			400	400
	Dong nai 4	Hydro			200	200
	Decomissioning		-110		-132	-242
	Total at 2010		7,023	2,186	8,720	17,929
After	Son la u.9.10.11.12	Hydro	1,200			1,200
2010	Candon	Hydro			650	650
	Huoiquang	Th.coal	600			600

GT=gas trubine , CC= steam part of combined cycle, Th = steam power plant, * = peak load operation

Table J.5.3 Energy Balance

	Energy Balance															
	Center				North				South				Viet nam			
	1995	2000	2005	2010	1995	2000	2005	2010	1995	2000	2005	2010	1995	2000	2005	2010
Installed capacity (MW)	213	823	1559	2186	2000	2700	4500	7023	1200	3420	5252	8720	3413	6925	11311	17929
Hydro (%)	70%	70%	100%	100%	82%	61%	50%	66%	47%	30%	28%	19%	69%	47%	47%	47%
Thermal (%)	30%	30%	0%	0%	18%	39%	50%	34%	53%	70%	72%	81%	31%	53%	53%	53%
Generation capacity (GWh/y)	575	3755	7523	10194	8186	13617	23220	34610	6124	20852	30889	47613	14885	38224	61632	92417
Hydro (%)	55%	93%	100%	100%	81%	49%	36%	54%	25%	21%	21%	15%	57%	38%	36%	39%
Thermal (%)	45%	7%	0%	0%	18%	51%	64%	46%	75%	79%	79%	85%	43%	62%	64%	61%
Low scenario																
Energy demand (GWh/y)	1255	2310	3987	6700	6562	10590	17270	26800	6742	14120	25640	41810	14559	27020	46897	75310
Energy balance (GWh/y)	-680	1445	3536	3494	1624	3027	5950	-7810	-618	6732	5249	5803	326	11204	14735	17107
Load factor	0.44	0.46	0.50	0.60	0.48	0.50	0.55	0.60	0.43	0.50	0.55	0.60	0.45	0.50	0.55	0.60
Peak load(MW)	326	573	910	1275	1561	2418	3584	5099	1790	3224	5322	7955	3676	6215	9816	14328
Reserve capacity	-53%	30%	42%	42%	22%	10%	20%	27%	-49%	5%	-1%	9%	-8%	10%	13%	20%
Medium scenario																
Energy demand(GWh/y)	1255	2447	4323	7265	6562	12000	20230	26800	6742	15560	29050	48050	14559	30007	53603	82115
Energy balance (GWh/y)	-680	1308	3200	2929	1624	1617	2990	7810	-618	5292	1839	-437	326	8217	8029	10302
Load factor	0.44	0.46	0.50	0.60	0.48	0.50	0.55	0.60	0.43	0.50	0.55	0.60	0.45	0.50	0.55	0.60
Peak load factor (MW)	326	607	987	1382	1561	2740	4199	5099	1790	3553	6029	9142	3676	6899	11215	15623
Reserve capacity	-53%	26%	37%	37%	22%	-1%	7%	27%	-49%	-4%	-15%	-5%	-8%	0%	1%	13%
High scenario																
Energy demand (GWh/y)	1255	2680	4757	7540	6562	13180	22440	35530	6742	17070	34090	56140	14559	32930	61287	99210
Energy balance (GWh/y)	-680	1075	2766	2654	1624	437	780	-920	-618	3782	-3201	-8527	326	5294	345	-6793
Load factor	0.44	0.48	0.55	0.65	0.48	0.55	0.60	0.65	0.43	0.55	0.60	0.65	0.45	0.54	0.60	0.65
Peak load factor (MW)	326	637	987	1324	1561	2736	4269	6240	1790	3543	6486	9860	3676	6916	11743	17424
Reserve capacity	-53%	23%	37%	39%	22%	-1%	5%	11%	-49%	-4%	-23%	-13%	-8%	0%	-4%	3%

Consultant figures

Table J.6.1 School, Hospital and Irrigation Facilities in the Study Area

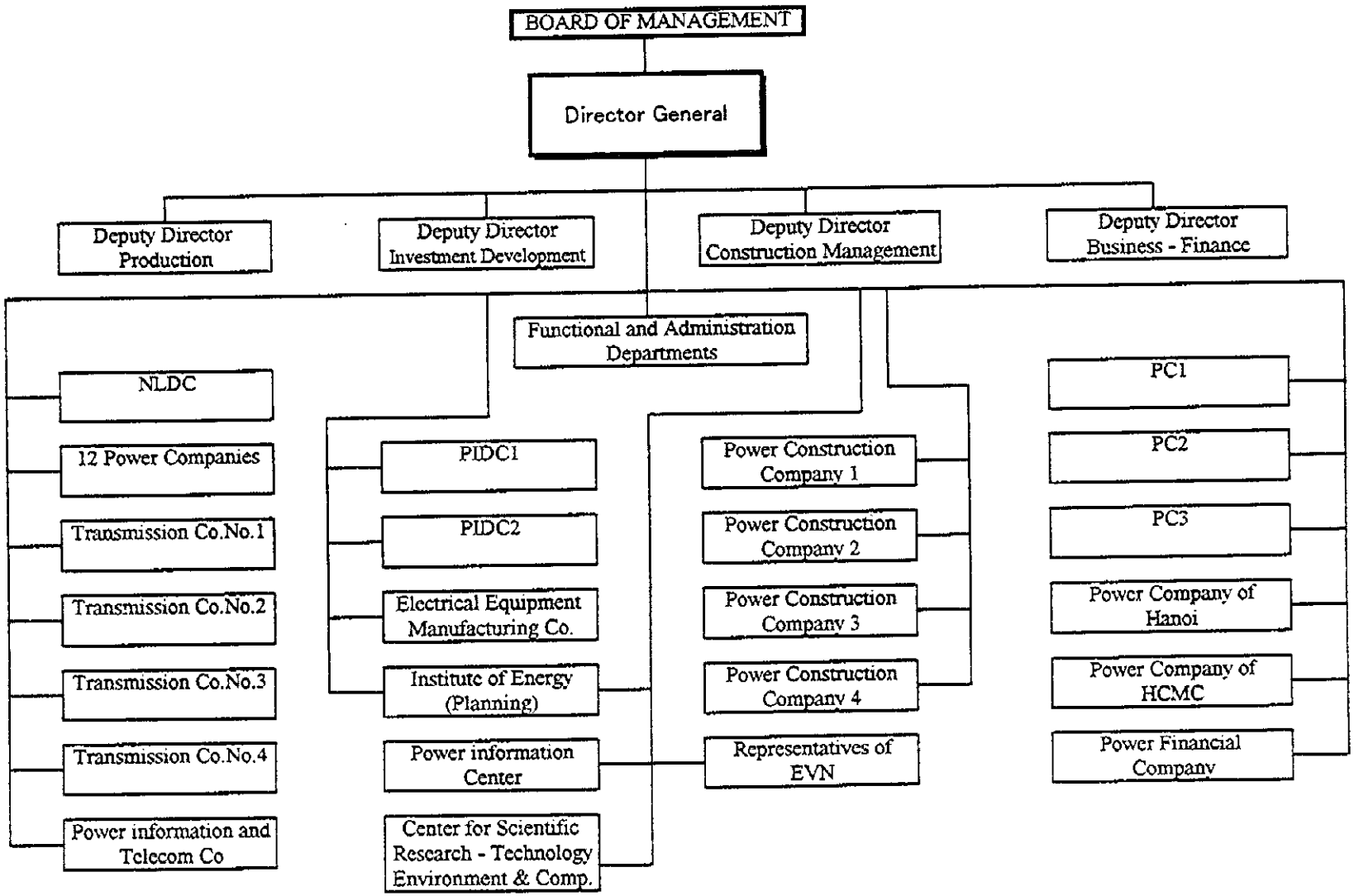
Dete: Nov. 1996

Commune		Total number of schools	Total number of classrooms	Number of schools using lights in classroom	Percentage of school using lighting (%)	Total number of hospitals	Number of hospitals using electricity	Percentage of hospitals using electricity (%)	Number of pumping facilitates using electricity	Total capacity of motor driven (kW)	Remarks
Code No	Name	A	B	C	D=C/A	E	F	G=F/E	H	I	
Region 1 Total		37	588	150		2hsp+10cli	12		35	1,194.0	
8	Nam Dan Tov	4	58	20	34%	1hosp+1cli	2	100%	0	0.0	
13	Nam Giang	3	43	12	27%	1clinic	1	100%	7	156.0	
12	Kim Lien	5	94	32	34%	1hosp+1cli	2	100%	8	132.0	
16	Nam Cat	3	46	14	30%	1clinic	1	100%	4	100.0	
15	Xuan Lam	4	69	8	11%	1	1	100%	3	196.0	
11	Nam Linh	3	48	6	12%	1	1	100%	2	100.0	
14	Hong Long	3	43	8	18%	1	1	100%	2	132.0	
10	Hung Tien	5	66	15	22%	1	1	100%	3	196.0	
9	Xuan Hoa	3	42	10	23%	1	1	100%	2	66.0	
7	Van Dien	4	79	25	31%	1	1		4	116.0	
Region 2 Total		22	342	77		1hosp+7cli	7		23	997	
21	Nam Trung	4	63	20	31%	1hosp+1cli	1	100%	2	99.0	
23	Nam Phuc	2	19	3	15%	1clinic	1	100%	1	66.0	
24	Nam Cuong	3	49	14	28%	1clinic	1	100%	2	132.0	
22	Nam Kim	4	74	15	33%	1clinic	1	100%	6	206.0	
20	Khanh Son	4	75	12	16%	1clinic	1	100%	7	230.0	
18	Nam Tan	2	26	3	11%	1clinic	1	100%	2	132.0	
19	Nam Loc	3	36	10	27%	1clinic	1	100%	3	132.0	
Region 3 Total		21	281	58		1hosp+7cli	8		17	694	
3	Nam Thai	2	20	4	20%	1clinic	1	100%	1	66.0	
1	Nam Hung	2	26	3	11%	1clinic	1	100%	2	40.0	
2	Nam Nghia	3	38	6	15%	1hosp+1cli	2	100%	1	66.0	
4	Nam Thanh	4	61	13	21%	1clinic	1	100%	3	110.0	
17	Nam Thuong	3	23	4	17%	1clinic	1	100%	3	126.0	
6	Nam Xuan	3	46	16	34%	1clinic	1	100%	4	156.0	
5	Nam Anh	4	67	12	17%	1clinic	1	100%	3	130.0	
Total		80	1,211	285		28Hosp+cli	27		75	2,885	

Table J.7.1 Standard Conductor (Wire) Size

1. 35KV Distribution Line	
- Main Line :	AC 120mm2 or more
- Sub-main Line :	AC 95mm2 or more
- Branch Line :	AC 56mm2
2. 10KV Distribution Line	
- Main Line :	AC 95mm2 or more
- Sub-main Line :	AC 70mm2 or more
- Branch Line :	AC 50mm2
3. 0.4KV Distribution Line	
- Main Line :	PVC 95mm2 or more
- Sub-main Line :	PVC 70mm2 or more
- Branch Line :	PVC 50mm2

APPENDIX J : FIGURES



Note: NLDC = National Load Dispatch Center, PIDC = Power Investment Design Co.

Fig. J.1.1 Organization Chart of EVN

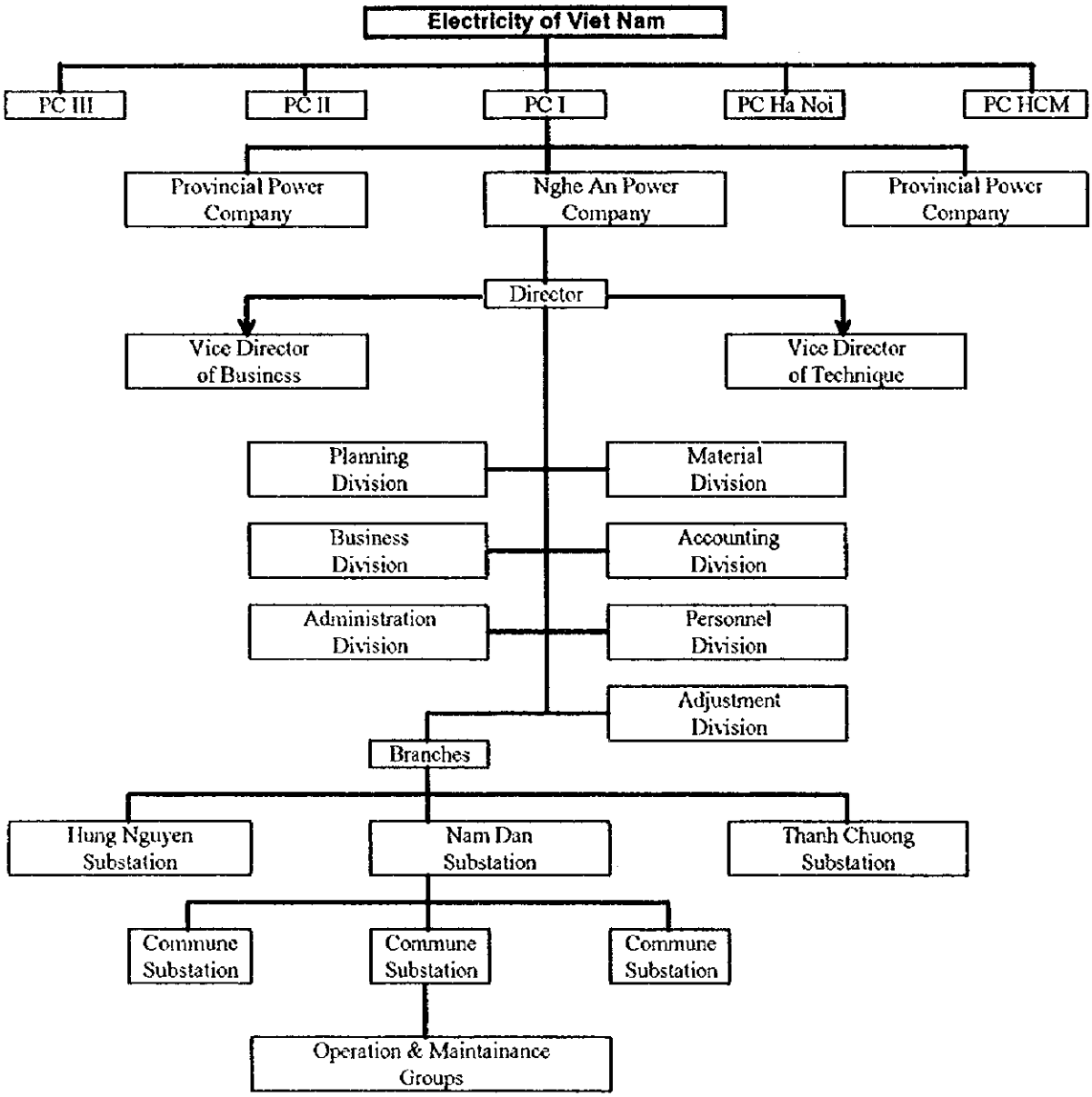


Fig. J.1.2 Organization Chart of Provincial Power Service

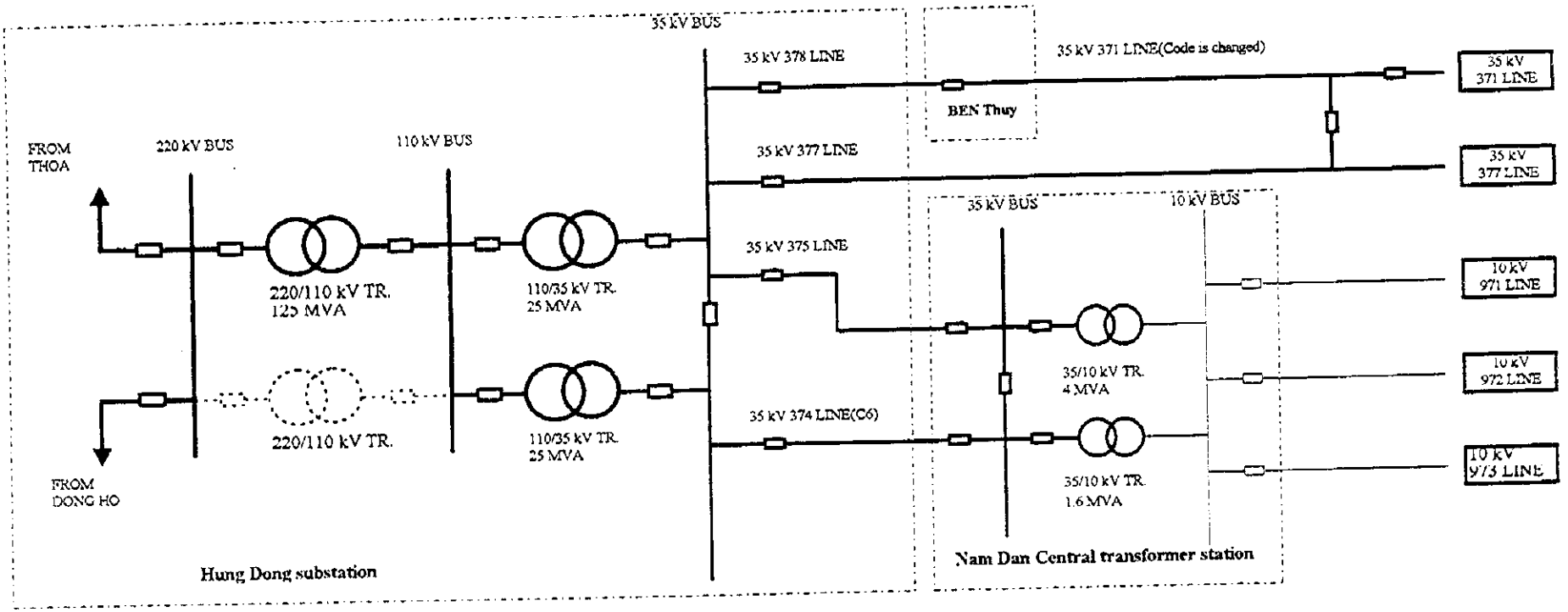


Fig. J.3.1 Power Supply System in the Study Area

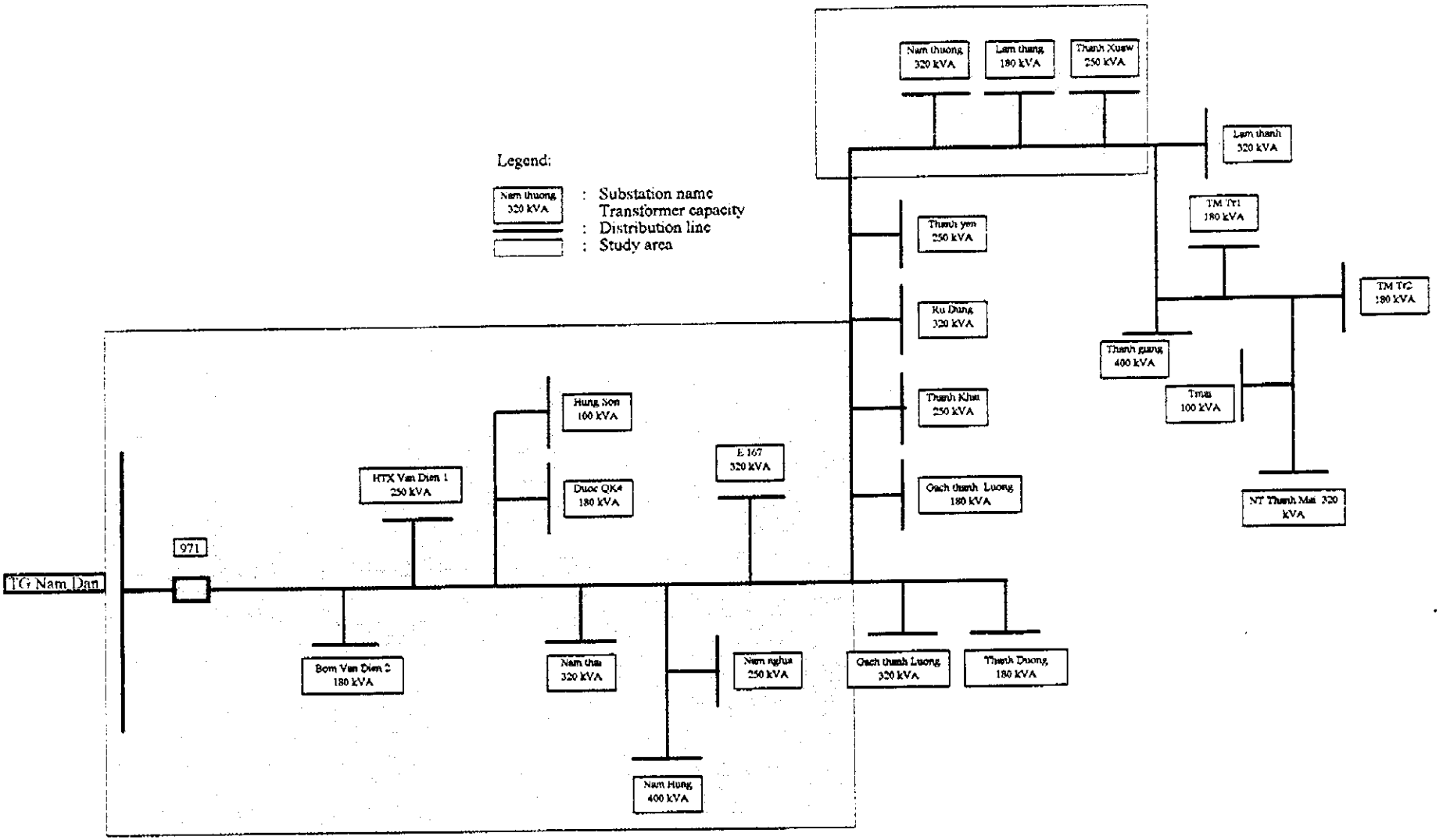


Fig. J.3.2 Distribution Network (1/5)

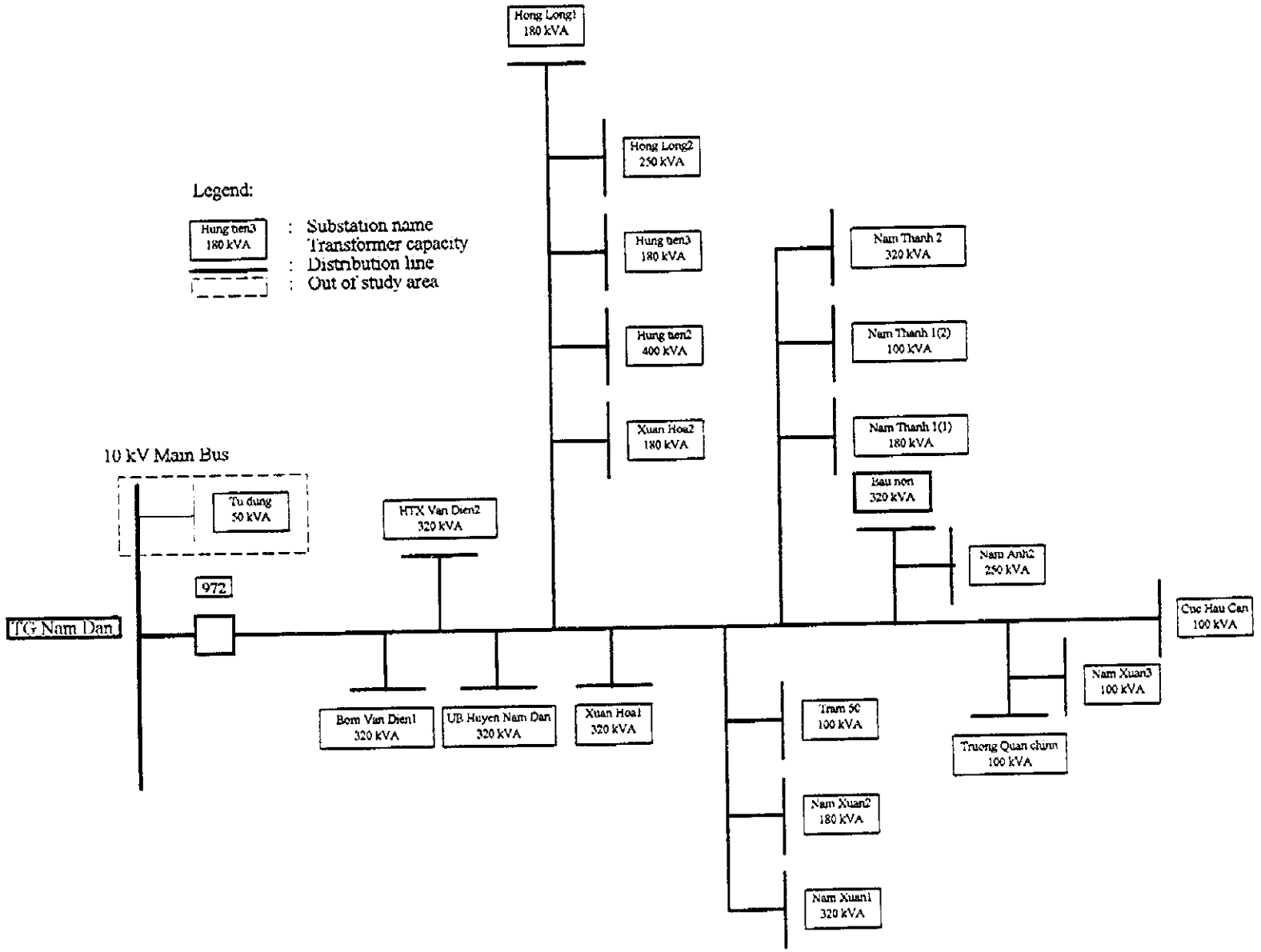


Fig. J.3.2 Distribution Network (2/5)

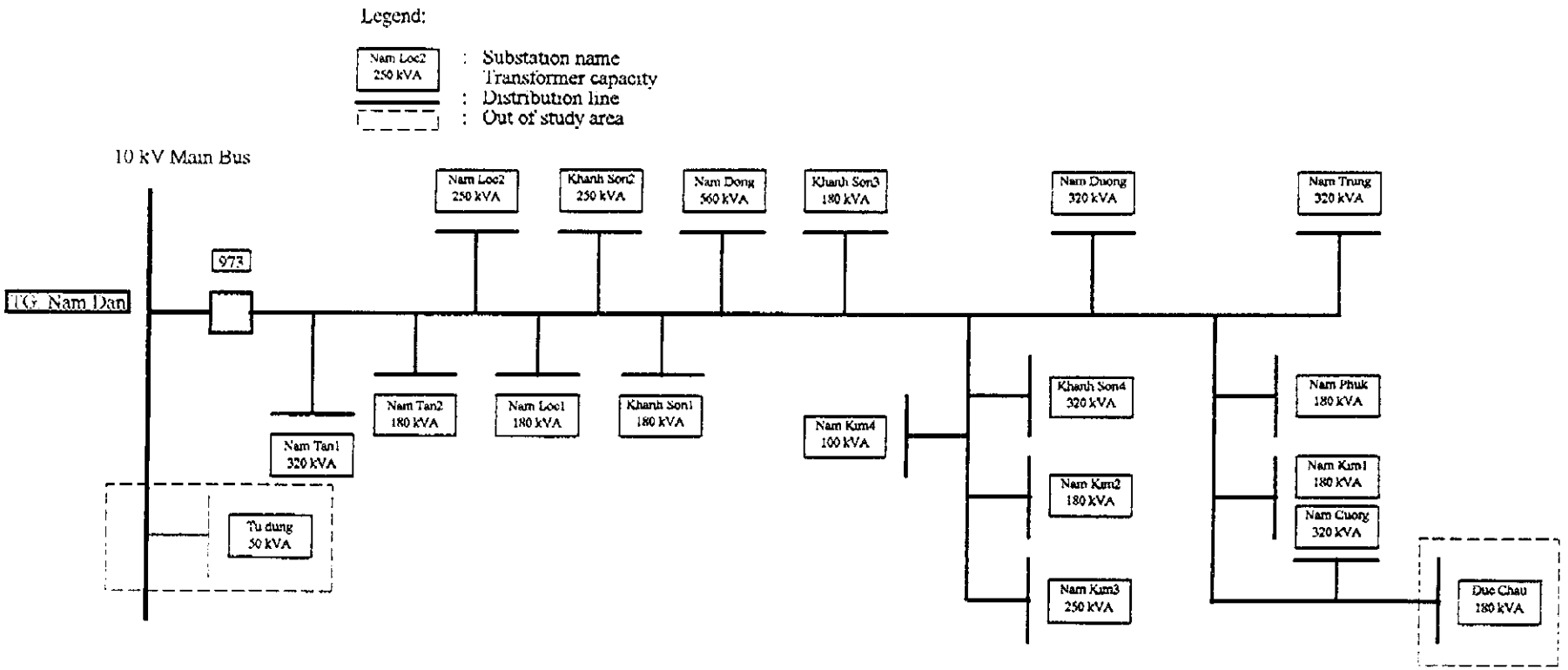


Fig. J.3.2 Distribution Network (3/5)

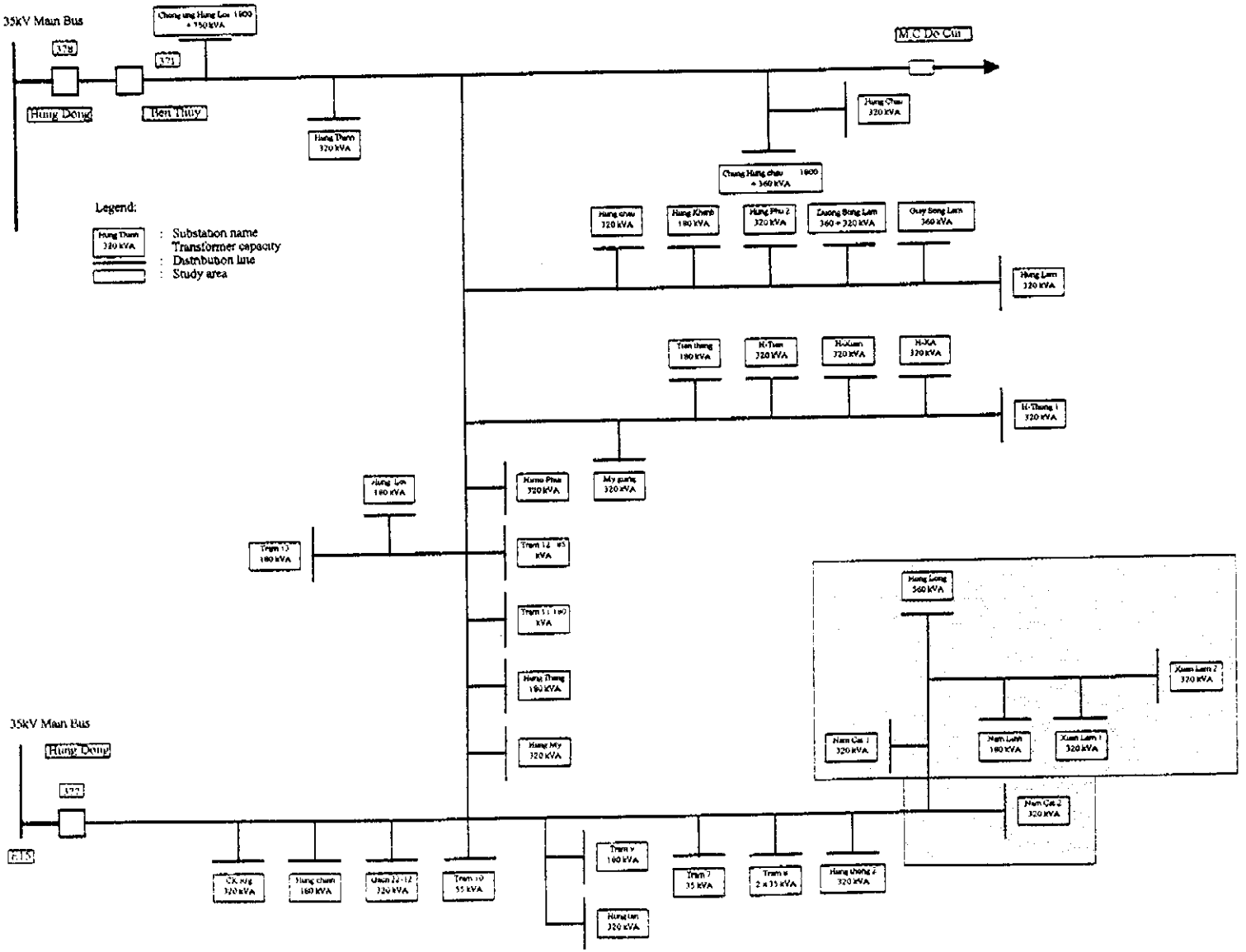


Fig. J.3.2 Distribution Network (4/5)

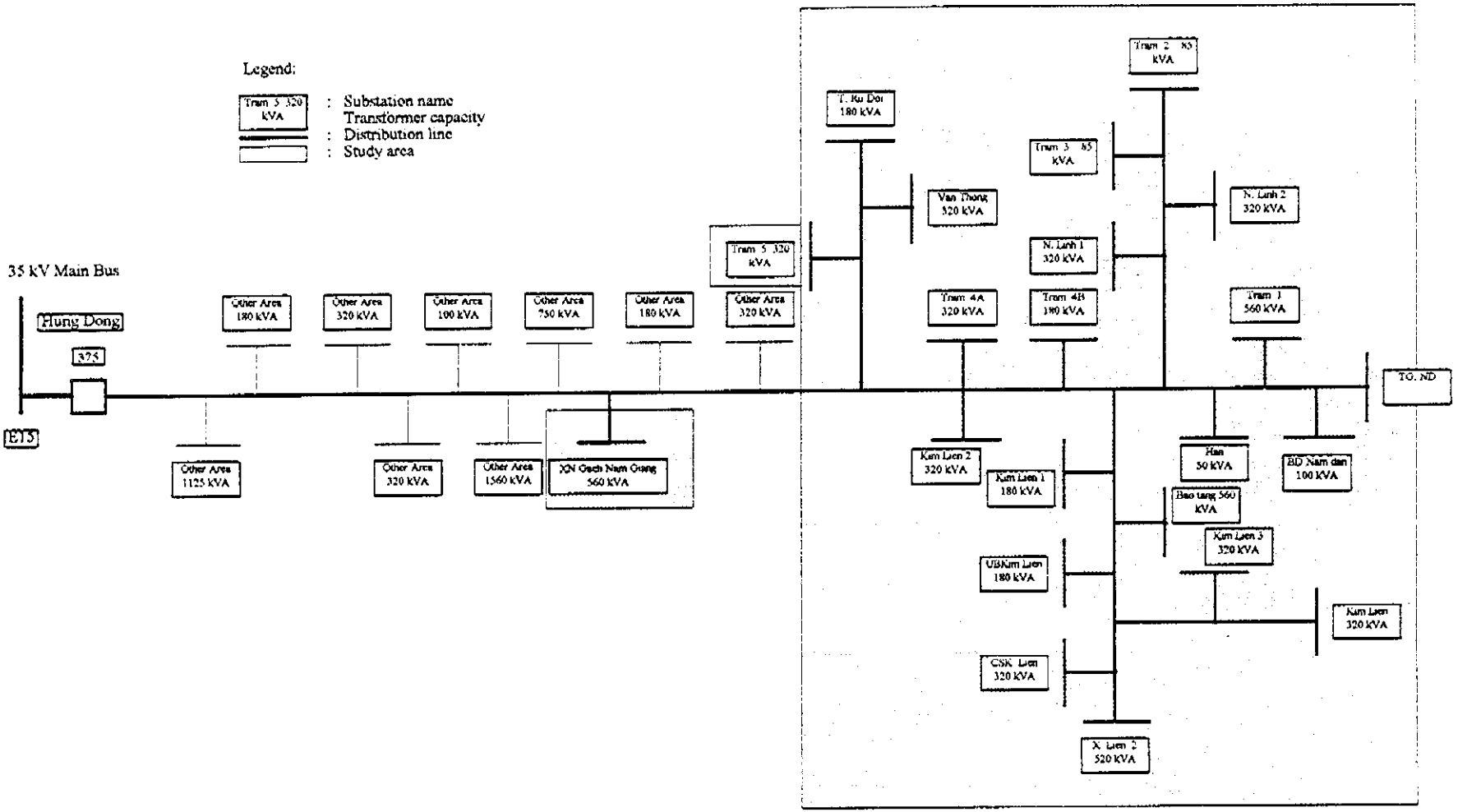
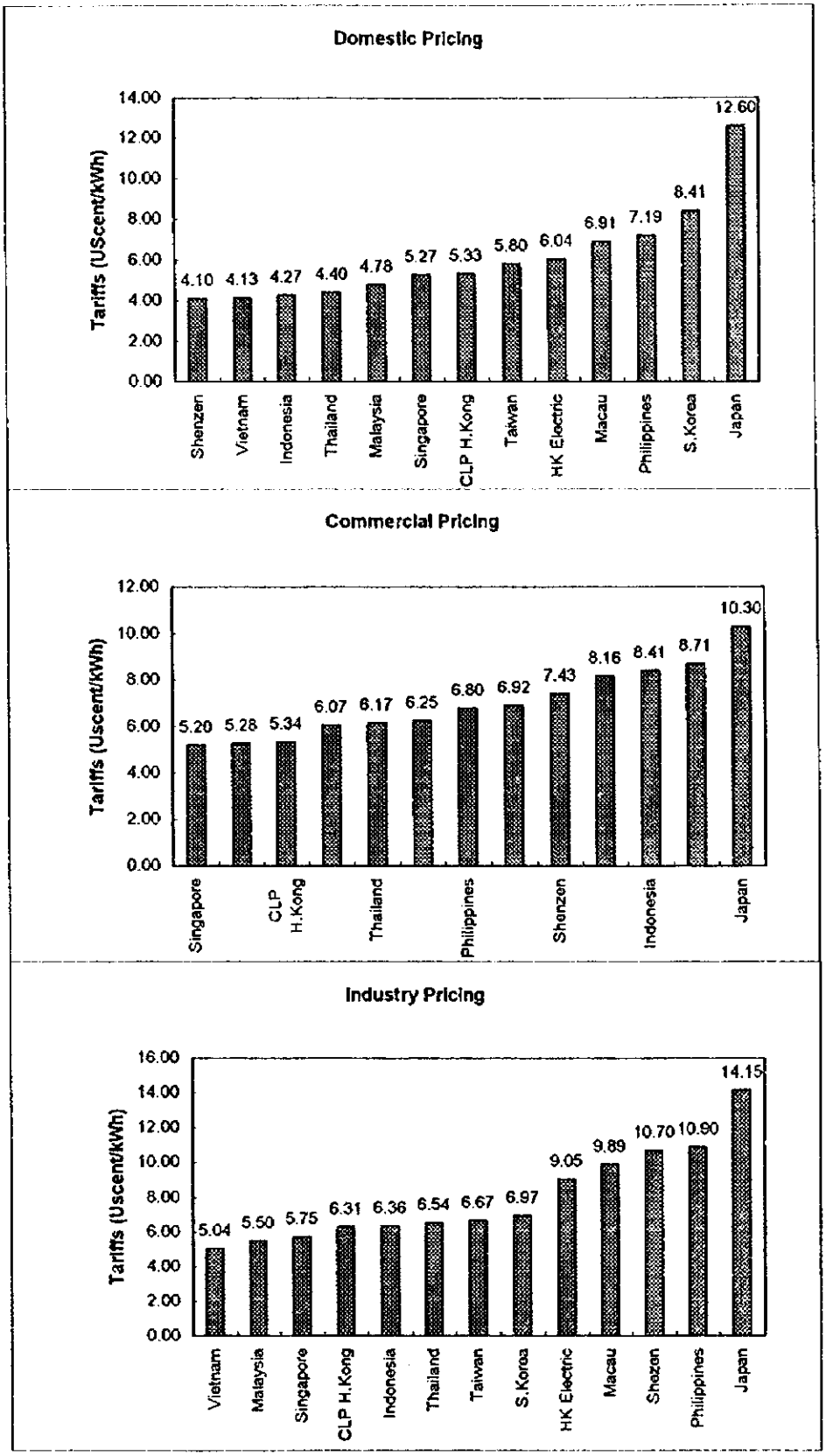


Fig. J.3.2 Distribution Network (5/5)



Domestic Pricing

Shenzen	4.10
Vietnam	4.13
Indonesia	4.27
Thailand	4.40
Malaysia	4.78
Singapore	5.27
CLP H.Kong	5.33
Taiwan	5.80
HK Electric	6.04
Macau	6.91
Philippines	7.19
S.Korea	8.41
Japan	12.60

Tariffs (US cent/kWh)

Commercial Pricing

Singapore	5.20
Malaysia	5.28
CLP H.Kong	5.34
Taiwan	6.07
Thailand	6.17
HK Electric	6.25
Philippines	6.80
S.Korea	6.92
Shenzen	7.43
Macau	8.16
Indonesia	8.41
Vietnam	8.71
Japan	10.30

Tariffs (US cent/kWh)

Industry Pricing

Vietnam	5.04
Malaysia	5.50
Singapore	5.75
CLP H.Kong	6.31
Indonesia	6.36
Thailand	6.54
Taiwan	6.67
S.Korea	6.97
HK Electric	9.05
Macau	9.89
Shezen	10.70
Philippines	10.90
Japan	14.15

Tariffs (US cent/kWh)

according: to China Light & Power - Hong Kong and EVN, mid 1994

Fig. J.4.1 Tariff Comparison in Asian Countries

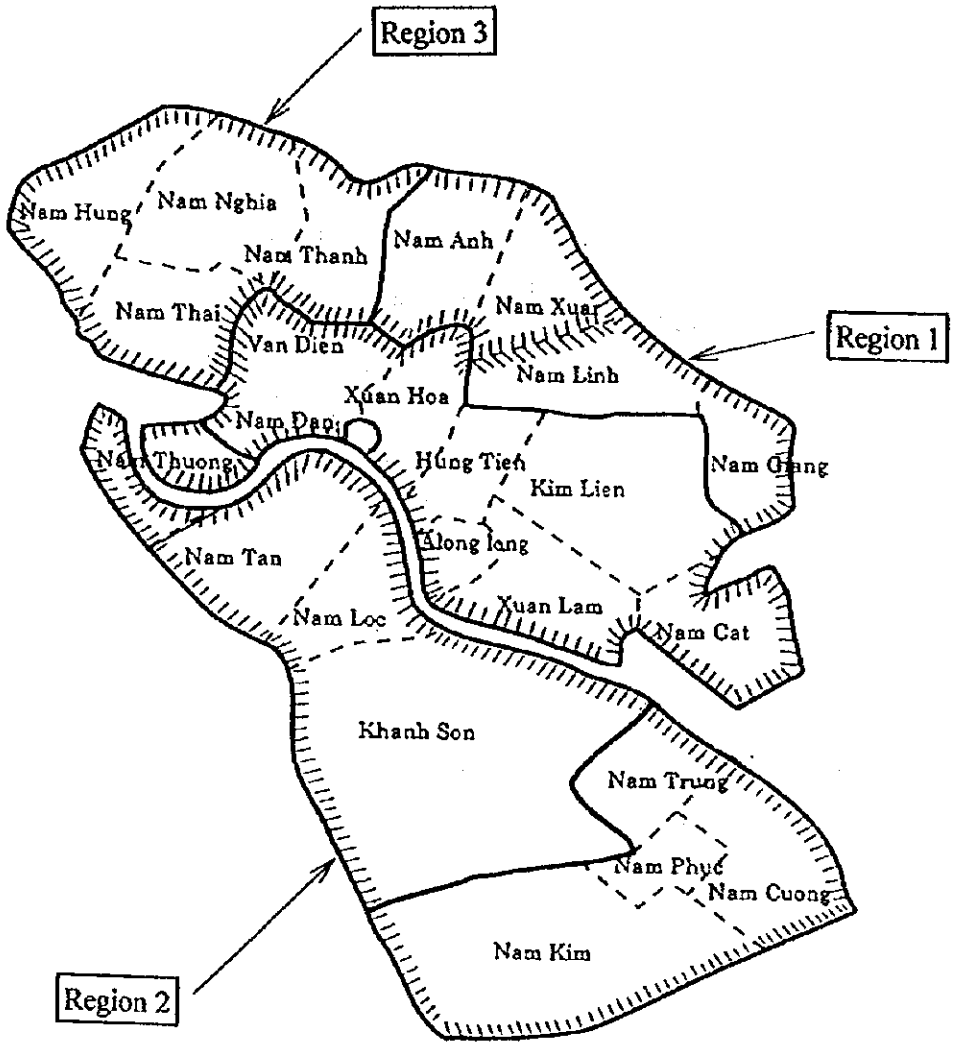


Fig. J.6.1 Three Area for Rural Electrification Survey

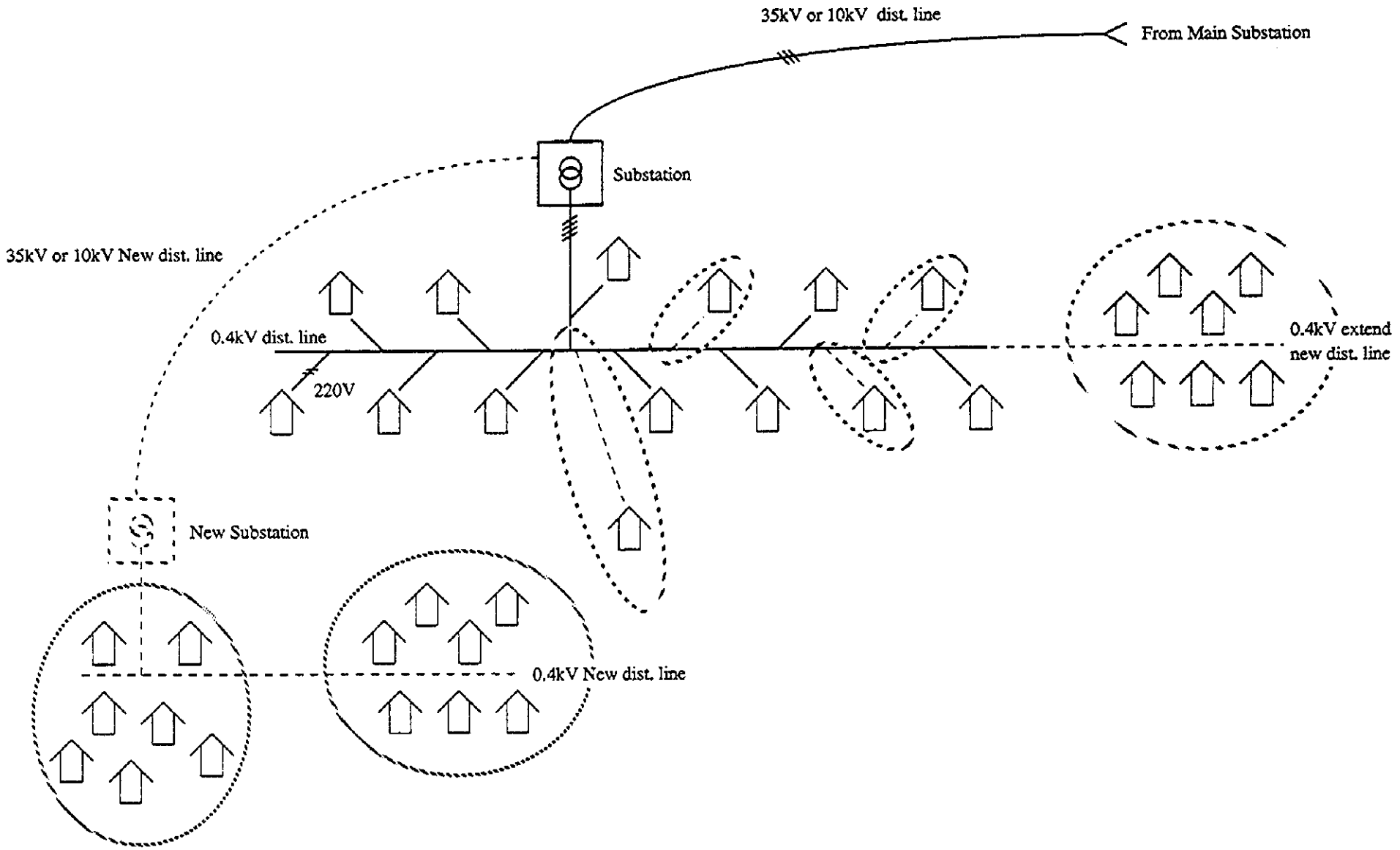


Fig. J.6.2 Outline of Complete Electrification

APPENDIX K : RURAL WATER SUPPLY

THE STUDY
ON
MODEL RURAL DEVELOPMENT
IN
NAM DAN DISTRICT, NGHE AN PROVINCE

FINAL REPORT

APPENDIX-K RURAL WATER SUPPLY

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APPENDIX K : RURAL WATER SUPPLY

K.1 Present Conditions

K.1.1 Present Conditions

Even though most of households have a well near their houses, people in the Study Area are still distressed by lack of adequate amount of good quality water for living purposes. Improved access to a year-round safe water source is one of the greatest perceived needs of the people in the Study Area.

The Study Area extends over a part of the semi-mountainous area, plain area and the right side of Lam river area, according to the topographical conditions.

In the Study Area, most people are taking domestic water from shallow wells (dugwells and tubewells). In the rainy season the water quantity of each well is enough for households to use, but in the dry season the water level of well decreases to a very low level and water color becomes murky. In the semi-mountainous area and the right side of Lam river area, most of dugwells usually dry up in the dry season.

Furthermore, the flood prone area and the depressed area at the right bank side of Lam river suffer from frequent flood and heavy inundation, the water quality in dugwells becomes worse because polluted water in the river infiltrates the wells during flood. After a flooding, the consumption of polluted water in the dug wells has a negative and serious influence on the health conditions of children.

During these periods in which the water use condition is poor, people in these areas are forced to collect water from other distant areas. The water collection occupies a large part of the workload of the people. Many wells are polluted by animals wastes which creates difficulties for the people to keep proper health and sanitation conditions. Water quality of dugwell is not suitable for drinking and is found to be infected by bacteria. The water has iron and manganese concentrations which are higher than those use for drinking water standards.

People in the Study Area mainly uses water from dugwells and tubewells which were installed through the Rural Water Supply Program of UNICEF. They also take water provided by a gravity flow system and iron filter tanks. The results of the interview survey made with the People's Committee of each commune concerning the water facilities at commune level are shown in Table K.1.1.

Water Supply System in the Study Area

System	Water Source	No. of Facilities	Population Covered
Tubewell	Ground water	1,404	8,289
Dug well	Ground water	26,414	146,015
Gravity Flow System	Stream	2	1,000
Total		27,820	155,304

The total number of wells and population covered by the existing water supply facilities in the Study Area are summarized in the table above:

UNICEF's Program in Nam Dan District started in 1986. At present, the Rural Water Supply Office under the Department of Agriculture and Rural Development of Nghe An Province is administering this program.

The following achievements were made in Nam Dan District by the UNICEF's Program during 1986 and 1996:

Water Supply Facilities made by UNICEF, 1986-1996

Year	No. of Tubewells	No. of Gravity Flow Systems	No. of Iron Filter Tanks	Supplied Material Cost (1,000 VND)
1986 - 1992	278	-	150	231,296
1993	40	-	8	73,556
1994	70	1	30	65,072
1995	88	-	45	96,960
1996	116	-	44	112,832
Total	592	1	277	579,716

K.1.2 Existing Water Supply Facilities

(1) Tubewells

In the Study Area there are 1,404 tubewells confirmed by the interview survey. Among these tubewells, 592 tubewells were constructed by the UNICEF's Program and the remaining ones were constructed using the local people's own resources.

The number of tubewells, number of population using them and the average depth of tubewell in each area are shown in the following Table:

Present Conditions of Tubewells in Nam Dan District

Area	No. of Tubewells	Population Covered	Population / Well	Average of Well Depth
Semi - mountainous	5	24	4.8	25.5 m
Plain	1,125	6,749	6.0	14.1 m
Right side of Lam river	274	1,516	5.5	15.9 m
Total	1,404	8,289	5.9	18.5 m

All of the tubewells are equipped with handpumps and their average depth in the Study Area is 18.5 m.

There are little tubewells in the communes located at relatively high elevations due to the topographical and geological conditions. The number of tubewells is low because it is difficult to construct tubewells in hard rock formations of the hilly areas and on the right side of Lam river area by using the present manual drilling method.

UNICEF is assisting the Department of Rural Water Supply Program of Nghe An Province by providing PVC pipes and casing, handpumps and a few bags of cement for construction of the wells. The commune is responsible for helping in the construction by providing labour and locally available materials, and by covering part of the labour cost. To maintain and repair the new system, one commune handpump caretaker for each commune was trained on the job and provided with spare parts and repair manual.

(2) Dugwells

Dugwells traditionally represent the water source in most areas of Viet Nam. Almost all the households have its own dugwell and there are also some traditional commune well. Many people in the Study Area use cans, buckets and jars to take water from wells. The household's dugwell is basically constructed using a concrete sewer with a diameter of 0.6 m., an average depth of 6.4 m which in some cases can go deeper than 8 m. Due to inappropriate location and well structure, most of dugwells are polluted by human and domestic animal wastes which causes the bad quality of water and harm effects directly over human health. For communal purposes, usually a dugwell of 2 to 3 m is installed in the center of the commune. UNICEF has supplied rehabilitation support and hand pumps for some traditional communal wells in the Study Area.

The number of dugwells, number of people using them and the average depth of dugwells in each area are shown in the following Table:

Present Conditions of Dugwells in Nam Dan District

Area	No. of Dugwells	Population Covered	Population / Well	Average of Well Depth
Semi - mountainous	9,569	49,144	5.1	6.9 m
Plain	9,098	47,914	5.3	5.4 m
Right side of Lam river	7,747	48,957	6.3	7.0 m
Total	26,414	146,015	5.5	6.4 m

(3) Gravity Flow System

In Nam Anh Commune located in the semi-mountainous area, there are two gravity flow systems using stream water for some villages and for a military training school located at relatively high elevations.

A gravity flow system for the villages was constructed with assistance from UNICEF (1993). It takes the water from a stream and conveyed it to some water storage tanks in villages through PVC pipes by gravity flow. During the dry season it is has been reported that the water storage tanks volume decrease to almost a third of their capacity.

About 200 households in three villages are confirmed to be using the gravity flow systems according to the interview survey.

K.1.3 Constraints against Rural Water Supply

Based on the results of field surveies, the following constraints can be said:

Water shortage in the dry season
Many people in the Study Area suffer from drinking water shortage in the dry season. Almost all the shallow wells located at relatively high elevations are dried up during the dry season. People, who live in those areas take water from reservoirs or rivers without any filtration system for drinking use during the dried up period of shallow wells.
Unsafe Drinking Water
The use of unsafe drinking water is one of the causes for the high rate of water borne diseases. There is a large number of households, located nearby the river and reservoirs, which take water from them for drinking and cooking purposes during the dried up period of shallow wells in the dry season. Under such a poor sanitation situation, the Study Area is reported to still have many cases of diarrhea and infant mortality. Furthermore, many wells in the Study Area have high iron contents.

Inadequate Water Supply Facilities
Most of the dugwells are constructed with a poor and inadequate technique using brick or concrete pipe. Many wells are polluted by the human and domestic animals wastes. This fact affects directly the health conditions of the people. However, only about 30% of the total number of wells (dugwells and tubewells) are equipped with filter tanks. This fact has a strong impact over the people health.

Difficulties for the Sustainable Development of Water Resources
The development of water sources are mainly restrained by lack of human resources, lack of information and lack of funds. The human resources are lacking in availability and in qualification causing a low implementation capacity for the development of new water resources. There is lack of adequate information, specially geological/hydrogeological information, to facilitate planning and implementation process.

The insufficiency of funds for development of water resources is hindering the development of more sophisticated technical approaches for deepwells or hard rock drilling in order to respond effectively to the enormous needs in the areas.

K.2 Test Boring

The objective of the test boring is to obtain the basic data necessary to confirm the possibility of deep groundwater development for the rural water supply by conducting machine drilling, pumping test and water quality analysis in the selected areas based on the results of the field reconnaissance survey and geoelectric prospecting in the Nam Dan Province. The test borings were carried out at 6 sites for 3 months, from June 1997 to August 1997.

K.2.1 Geology of Nam Dan District

The geology of Nam Dan District mainly comprises Paleozoic, Mesozoic, Cenozoic sedimentary rocks and Magma. The geologic map of the district is shown in Fig. K.2.1.

The map was constructed by Quan, D. T. in 1981 and was then revised by Hoanh, N. V. in 1992.

1) Paleozoic group (PZ), Ordovic (O) and Silur (S) systems, Song Ca formation (sc_2): The Song Ca formation is divided into three sub-formations, namely lower, middle and upper formations. Rock of the Paleozoic group found in Nam Dan district are mainly from the Middle Song Ca sub-formation (O_3 - S_1 . sc_2). They contain elements like sericite, sandstone, siltstone and quarzic sandstone. They are found at Yen Cu, Southwest Nam Dan District. Thickness of the formation is about 1000 m.

2) Mezozoic group (MZ), Trias system (T), Dong Trau formation (T_2 *a dt*): The Dong Trau formation is subdivided into two sub-formations, i.e. Lower Dong Trau (T_2 *a* dt_1) and Upper Dong Trau (T_2 *a* dt_2).

- Rocks found in Nam Dan District are mainly from the Lower Dong Trau sub-formation. They are widely found at many places in the district such as Trac and Hung Vang shrubby forests. It contains elements like conglomerate, siltstone, sandstone, yellow-gray, gray-green and gray-purple shale, porphyric ryolite and its tuff, and siliceous rock. Fossils are also found e. g. *Balatomites cf. lemoinei, Costatorria Proharpa, C. cf. goldfussi, Neoschizodus laevigatus, Acrochordicesas sp., and Epaczochordiceras sp..* Thickness of this sub-formation is about 1000 m.

- The Upper Dong Trau sub-formation comprises of bright gray limestone, siltstone containing *Plychites sp., Velopecten abberti, Coenothyris rulgaris, Adygella hoang maiensis, Costatoria, Proharpa, Ocurvirostris.* Thickness of this sub-formation is about 600 m. It is found in the southwest of the district.

3) Cenozoic group (KZ), Quartenary system (Q):
Three different formations of the Cenozoic group are found in Nam Dan District i.e. Late Pleistocene, Early-middle Holocene and Late Holocene.

- Late Pleistocene deposits contain clay, colorful sand with spore and pollen such as *Polypodium sp., Lygodium sp., Salix sp.*, and *Lythocarpus sp.* The Late Pleistocene deposits in this area have alluvial and marine formation (amQ_{III}). The formation thickness ranges from 5 - 30 m. It is found in small areas along shrubby forests such as Thung Nua.

- Early-middle Holocene sediments have alluvial and marine formation (Q_{IV}^{1-2}). They contain green-gray clay, silty sand, and loamy sand containing foraminifera such as *Ammonia beccari* and *Elphidium sp...* Thickness of the formation ranges from 5 - 40 m. It is found at many places in the district.

- Late Holocene sediments contains sand, silt, and clay with river origin (aQ_{IV}^{3}). Thickness of the formation is about 2 - 25 m. It can be found in the lowland areas of Nam Dan District.

4) Magma:

Magmatic rocks of the Song Ma complex ($\gamma rT_{2-3}sm$) are found at Ba Noi mountain. They contain of porphyric granite, granite and granophyr.

K.2.2 Summary of the Results of Test Boring

The results of the test borings are summarized as shown in the table below:

Boreholes / Results	JICA1 Nam Kim	JICA2 Nam Trung	JICA3 Khanh Son	JICA4 Nam Nghia	JICA5 Kim Lien	JICA6 Nam Xuan
Borehole depth (m)	100	55	100	100	60	100
Depth to static WL (m)	3.25	3.2	3.0	1.45	3.61	3.0
Discharge (l/s)	4.65	12.48	2.3	0.042	8.5	1.2
(m^3/h)	16.74	44.93	8.28	0.15	30.6	4.32
Dynamic WL (m)	13.62	7.06	17.8	43.27	16.71	38.45
Drawdown (m)	10.37	3.5	14.8	41.82	13.11	35.45
Specific capacity (l/sm)	0.45	3.24	0.16	0.001	0.65	0.033

K.2.3 Methods and Equipment for Test Boring

(1) Field Reconnaissance Survey

The purpose of the field reconnaissance survey was to determine the stratigraphic units present in the area with water demand, to have a general idea about the hydrogeological conditions and to orientate the geophysical works.

As a result of the field reconnaissance survey, the following remarks have been made:

Nam Kim commune:
This commune is divided into two parts, plain area and hilly area. The test boring site is located in hilly area. The terrain here is composed of sediments of the O_3-S_1ld formation. The groundwater development prospects were focused on the tectonic shear zone and fractured zones in the bedrock.

Nam Trung commune:
This commune is located adjacent to Lam river. Here are present Quaternary sediments (Q) and T_2adt formation. The groundwater development prospects were directed to the coarse grained Quaternary sediments: cobbles, pebbles, sand and some fractured zones in the bedrock.

Khanh Son commune:
Here are distributed Quaternary sediments and those of the T_2adt formation. At the point of water demand, the Quaternary sediments (Q) are thin, with low water supply potential. The main target for groundwater development prospects were the tectonic shear zones and fractured zones in the bedrock.

Nam Nghia commune:
The Quaternary sediments (Q) here are thin. The groundwater developments prospects here were aimed to the tectonic shear zones and fractured zones in the bedrock (T_2adt).

Nam Xuan commune:
The Quaternary sediments (Q) are thin. The object of groundwater development prospects were in the tectonic shear zone and fractured zone of the bedrock (T_2adt)

Kim Lien commune:
According to the results of the groundwater exploration in the previous study, the Quaternary sediments (Q) here are relatively thick, reaching 40 - 60 m. The groundwater supply potential here is from the coarse grain Quaternary sediments (cobbles, pebbles, sand).

(2) Geoelectric Prospecting

The purpose of geoelectric prospecting is as follows:
- To determine the thickness of the Quaternary cover sand on the weathered zone of the bedrock.
- To delineate the boundary between different lithologic formations according to their resistivity.
- To discover the fractured zones and tectonic shear zones in the bedrock.
- Prognosticate the fresh - saline boundaries (if any) of the groundwater in area and depth.

Through its reference of the geophysical data of the previous survey conducted in Nam Damn area and other areas with similar geological and hydrogeological conditions, in combination with the actual field survey, Vertical Electrical sounding method was selected. This method aimed at determining the changes in lithological composition of the formations in area and depth through their resistivity, based on which the geo-electrical profiles along the survey lines were established.

Self potential method with steps of d = 10 m, with the aim to determine the variation in the natural electrical field created underground in the contact area of the formations with different lithological composition, areas with groundwater flow causing red-ox electrical fields. Therefore for the formations stable in lithological composition the natural electrical field has little change and vice versa at the contact zones, shear zones, which are favorable for the storage of the groundwater where the electrical field would change abruptly against the surroundings. Based on these characteristics, in combination with VES, the best location for boreholes can be selected.

(3) Drilling

The purpose of the drilling work is to study the geological section, lithologic composition, thickness, mode of occurrence of the aquifers. Total of 5 drilling machines were utilized for the work. They are Russian made UKB-500, URB-2A and URB-3AM drilling rigs. The technical specifications of these drilling rigs are shown in the table below.

Technical parameters	Unit	Type of rig		
		UKB-500	URB-2A	URB-3AM
Nominal drilling depth	m	500	300	500
Drilling diameter: Starting:	mm	131	190	250
Final		76	76	76
Inclination angle of borehole	degree	90	96	90
Rod diameter	mm	42/50	50/60.3	60.3/70
Type of drive		Main axis	Rotary	Rotary
Rotary speed	rpm	132;214	100;	110;
		308;770	197;	190
		1116	360	314
Feed off system		Hydraulic	Winch	Winch
Maximum speed when the tool is				
going down:	m/min	1.1	-	-
going up	m/min	2.65		
Maximum feed off force				
down		4200	2000	
up		6000		
Feed off length	mm	400	6000	6000
Type of draw-work		Planetary	Friction	Friction
Capacity of draw work	kG	2000	2500	2500
Speed of cable winding on the drum	m/s	1.1; 1.76	0.68;1.38	1.08;1.88
		2.53	2.0	3.12
Cable diameter	mm	15.17	13;15.5	15.5
Winch drum		260	240	300
Driving engine for the equipment		Diesel	From truck	Diesel

(4) Method of core sampling

- Rotary drilling method was applied for core drilling.
- For drilling in Quaternary sediments, clay mud with density 1.1 g/cm3 was used. In bed rock clean water was used for circulation.
- The cores recovered were arranged in accordance with the regulation, according to the actual stratigraphic order in the boreholes. The core boxes are firmly closed and provided with clear labels.
- The technical supervisor compiled the drill log of each borehole based on the geologic data obtained during the drilling operation.

(5) Groundwater level measurement during the drilling operation

After each drill run, before raining and after dropping drilling tool, the groundwater level in the boreholes was measured with the use of special electrical water level indicator and the values obtained were recorded in the book.

(6) Installation of casing and screens

Before installation, the length of each casing and screen section was measured and the sections were enumerated upward from bottom to avoid confusion.The drilling rig was used for lowering the casing and screens into the borehole.

(7) Gravel packing and grouting of the boreholes

The gravel packing was carried out in the boreholes reamed to the diameter of 250 mm and installed with 146 mm casing.

(8) Borehole development by flushing

After the installation, the pump of the drilling rig was used to flush the borehole at the screened interval, repeatedly section by section. The purpose was to clean the mud around the borehole which prevented the water to flow into the borehole.

(9) Pumping tests

The pumping test was carried out for each borehole in one drawdown with constant discharge. The pumping was stopped only when the borehole performance had been in stabilized condition for 16 - 24 hours. The water pumped out during the borehole development and pumping test was conducted by a PVC pipe or a gutter lined with polyethylene sheets to a distance of 500 m. Step drawdown tests were carried out in 5 steps continuously, each lasting 120 minutes. After each pumping cycle the water level in the borehole was measured until the full recovery.

(10) Water sample collection

The water samples were collected from the pumping hose with the use of special devise. The number of water samples collected from each borehole were as follows:

- 3 samples for basic chemical analysis: collected at the beginning, the middle and the end of a pumping cycle.
- 1 comprehensive chemical analysis and one trace element analysis were collected at the end of the pumping cycle.
- 2 samples for bacteriological analysis were collected at the middle and the end of the pumping cycle.

(11) Water samples analysis

- Basic chemical analyses were carried out at the laboratory of Geological Subdivision No 2F.
- The comprehensive chemical and trace element analyses were carried out at the laboratory of the Institute of Nuclear Science and Technology (Hanoi)
- Bacteriological analyses were carried out in the laboratory of the Preventive Medical Centre of Nghe An province (Vinh city).

K.2.4 Result of Drilling and Water Quality Analysis

(1) Borehole JICA No.1 (Nam Kim)

This borehole was drilled areas the crumbled and cataclastic zone faults in the O3-S1ld formation. During the drilling, the collection of core samples was very difficult. The rocks were much broken, mainly composed of black, black grey siliceous schist, coaly shale, claystone and siltstone. In depth the fracture opening of the rock is not even. From 13.5 to about 60 m: the rock was little to moderately fractured. From 60 to 100 m: highly

fractured, especially in the section 85 - 87 m, the drilling fluid was completely lost.

Regarding chemical composition of water, most of the indicators conform to the drinking water quality standard for rural areas except PH (5.5) and Fe (3.25 mg/l). The bacteria composition also satisfied the standard.

(2) Borehole JICA No.2 (Nam Trung)

In this borehole, the underlying cobble layer does not met as in some other boreholes, but only a medium-coarse grained sand layer mixed with pebbles and cobbles in the lower part. The sand layer here is fairly thick (3.6 - 37.8 m and is also the main aquifer). Compared with the geological log of other boreholes in the Nam Dan District, this sand layer is attributed to QI-IV. The bedrock underneath the quaternary sediments are composed of gravelstone, conglomerate, claystone of brown purple, light pink and grey colour. The claystone is strongly compressed. Compared with other boreholes in Ha Tinh area, the bedrock is temporarily attributed to the Neogene sedments.

Regarding chemical composition of water, most of the indicators conform to the standard except NH4 (4.66 mg/l), Fe (3.83 mg/l) and Mn (0.54 mg/l). The bacteria composition also satisfied the standard.

(3) Borehole JICA No.3 (Khanh Son)

This borehole was drilled areas the fractured and crumbled zones as affected by the fault in T2adt formation. During the drilling, the collection of core samples were very difficult. The rock is mainly composed of siliceous schist intercalated with claystone and black coal shale. The layer is crossed by quartz veins. In the fractures pyrite is met in the disseminated form (increasing with the depth).

This borehole was drilled into the bedrock using clean water for circulation, but the pumped out water was muddy and fishy odour until the end of the pumping test. Comparing each component analysed with the standard, most of indicators conform to the standard in chemical composition, except Fe (53.68 mg/l)) and Mn (1.84 mg/l). The bacteria composition is satisfied the standard.

(4) Borehole JICA No.4 (Nam Nghia)

The rock was poorly fractured with low water bearing capacity consisting of siliceous sandstone, black and black grey coaly shale, grey and white grey quartz and siliceous sandstone. The chemical analysis was not conducted because this borehole is of very low yield, it was not reamed to make the production well.

(5) Borehole JICA No.5 (Kim Lien)

In this borehole, the quaternary sediments was 51.5 m thick and the bedrock consists of grey siltstone, claystone of cement grey colur (age in T2adt). The water bearing material is composed of blue grey, black grey fine to coarse sand and sandy gravel.

In chemical composition of the water, most of indicators conform to the standard except Fe (62.3 mg/l) and Mn (1.08 mg/l). The bacteria composition also satisfied the standard.

(6) Borehole JICA No.6 (Nam Xuan)

The rock was poorly fractured in this borehole and composed of siltstone, shale and sandstone in the lower part. This borehole was identified with low water productivity. However in a water scarce areas to some extent, it can be used for water supply.

Results of the chemical analysis show that NH4 (4.35 mg/l), Fe (0.69 mg/l) and Mn (0.22 mg/l) have contents higher than the permissible standard. The bacteria composition was not meet the sanitation standard.

K.2.5 Observations from the Test Boring

Combining the newly obtained results of the JICA borehole tests with the previous survey data, the characteristics of the water bearing units in the Nam Dan District are summarized as follows:

In Nam Dan District, the following 4 water bearing units were obsedved:

1. Aquifer aged QIV3: Alluvial sand, clayey sand
2. Aquifer aged Q_{I-IV}: Cobbles, pebbles, sand
3. Water bearing formation T_2adt
4. Water bearing formation O_3-S_1ld

(1) Aquifer aged Q_{IV}^3

This aquifer occurs along the Lam river. Up to present no borehole has been drilled for investigating the hydrogeological characteristics of this aquifer. Previous survey of Nam Dan area shows a test data form dug wells, giving discharge hardly exceeding 0.02 l/s. This aquifer has close relationship with the rain water and the Lam river. It is considered that there must be bands of sand, gravel, pebbles in this aquifer, where if a borehole is drilled and tested, it would have a discharge many times greater than the above value. As this aquifer is just at the surface, it is easily contaminated.

(2) Aquifer aged Q_{I-IV}

In terms of water supply potential, this aquifer can be divided into two parts:

The first part is where the aquifer is composed of all lithological types: sand, clayey sand ($amQ_{IV}^{1-2}cl_1$), coarse grained sand (amQ_{II-III}) and cobbles, pebbles, sand (apQ_{I-II}).

The second part is where the cobbles, pebble, sand sequence (apQ_{I-II}) is absent.

The first part is distributed both on the NE and SW sides of the Lam river. On the NE side it is divided into two main strips. One runs along the Lam river and the other runs in an arc form from the middle of the first strip (at BH508, 519 in Xuan Lam commune), passing Nam Hung (BH510), to Kim Lien. On the SW side it is seen in Nam Trung and may be

also in Nam Phuc, Nam Cuong.

In our study, two boreholes JICA2 and JICA5 were drilled into this aquifer.

In general, the boreholes are very productive, they may reach thousands of m^3/ day, sufficient for water supply to one commune or more. In order to tap water from the cobbles, pebbles and sand aquifer we can drill wells with depths 50 - 60 m.

The second part (where the apQI-IV sequence is absent) has large distribution area. People in most of the communes in the plain area when digging their wells usually meet this aquifer. Here it is composed of fine to medium and coarse sand. The thickness varies from a few meters to some tens meters. In the previous study 3 boreholes were drilled for investigation:

BH504: The thickness of the aquifer is 10.9 m, the discharge is 3.16 l/s, the specific capacity is 1.32 l/sm,

BH518: The thickness of the aquifer is 6 m, the discharge is 0.71 l/s, the specific capacity is 0.10 l/sm,

BH517: The thickness of the aquifer is 2 m, the discharge is 0.2 l/s, the specific capacity is 0.02 l/sm.

From the above results, we can see that the yield of the borehole depends much on the thickness of the aquifer.

Therefore in order to tap the groundwater from this aquifer, it is necessary to use the geophysical method to discover the places with relatively large thickness, which could meet the water demand.

On the other hand, in order to increase the discharge of the well, if the underlying bedrock (here T_2adt formation) is not saline, it is recommended to find the fractured and tectonic fault zone to combine the intake of the groundwater from both layers.

(3) Water bearing formation T_2adt

In this study, 3 boreholes were drilled to this formation: JICA3, JICA4 and JICA6. Together with the data from previous stage of investigation, it has been concluded that this formation is of low groundwater yield.

However, the results of the pumping test in JICA3 and JICA6 boreholes show, if boreholes are drilled to the shear zones of the faults, the metamorphic zones or to places with predominantly coarse grained formations which are fractures, it could be also get certain amounts of water. This might be of significance, as this formation is present in most parts of Nam Dan District.

The boreholes should be designed to 80 - 100 m deep.

(4) Water bearing formation O_3-S_1ld

The results of JICA1 (Nam Kim) and BH513 borehole tests show the fractured and broken zone along the faults in the O_3-S_1ld formation are relatively productive, the only difference is in BH513 from the depth of 80 m downward where the rock is less fractured, whereas in JICA1 at the depth of 100 the fractures are still considerable. Therefore, along the major faults it is proposed to drill to the depth of 120 m or more.

In summary, the hydrogeological conditions of the Thanh Hoa, Nghe An and Ha Tinh in general and the Nam Dan District in particular are very complicated. The water bearing formations vary intensively in extent of distribution, groundwater yield and groundwater quality. Therefore in order to attain high efficiency in the exploration for water supply, it is recommended to apply an integrated gemorphological, geological, geophysical method, especially for exploiting groundwater potentials in the fractured zones, broken zones of the bedrock strata.

K.3 Rural Water Supply Plan

K.3.1 Basic Concept

(1) Target and Strategy

The proposed rural water supply plan aims to achieve a stable, reliable and year round continuous water supply. The highest priority in the plan is given to improvement of areas where many people are suffering from contaminated water and shortage of safe water in wells. The following targets and strategies are set for the basic development concepts for the rural water supply projects:

1) Target:

- To provide stable, reliable and year round continuous water supply, by implementing a public water supply system.
- To provide safe domestic water for the inundated area along Lam River, in which shallow wells are infiltrated with flood water during rainy season.
- To provide stable and reliable domestic water supply for the dried-up areas located at relatively high elevation, in which shallow wells are dried up during dry season.

2) Strategies:

- To introduce deep groundwater development by providing deep wells which are expected to provide safe, stable and reliable water source.
- To introduce public water supply system which are efficient in the use of water

(2) Project Area

The Project Area covers approximately 30,000 ha including one local town and twenty three communes in the Nam Dan District and to be classified into 4 areas according to the

topographical conditions, village distribution and water supply situation in the commune described as below:

1. Nam Dan Town area.
2. Plain area, which consists of communes of Hung Tien, Kim Lien, Hong Long, Xuam Lam and Xuan Hoa.
3. Inundation area along the Lam river, which consists of communes of Nam Thai, Nam Cat, Nam Thuong, Khanh Son, Nam Trung, Nam Cuong, Nam Kim, Nam Phuc.
4. Dried-up area in relatively high elevation area, which consists of communes of Nam Hung, Nam Nghia, Nam Thanh, Nam Anh, Van Dien, Nam Xuan Nam Linh, Nam Giang, Nam Tan and Nam Loc.

K.3.2 Examination of Water Supply Systems

(1) Available Water Sources

The available water sources in the Project Area are evaluated as stated below.

Shallow Groundwater
Shallow groundwater is the dominant water resource for domestic use in the Project Area with dugwells and tubewells. The water quantity is unreliable and, as for the quality, it is considered to be unsafe. Judging from the situation of water shortage in dry season, the capacity is considered not enough for usage through year.

Deep Groundwater
Deep groundwater has not been utilized in the Project Area. However, availability of groundwater was identfied by test boring in this Study. It is expected as the most desirable water source since deep groundwater can get a year round clean water in general.

Stream
There are two gravity flow systems using streams flowing in the Project Area. The perennial streams are found to be quite few in the Project Area except for Nam Ahn commune in the high elevations of semi-mountainous area. If this source is to be utilized, it is difficult to secure sufficient amount of water in dry season.

River
The rivers in the Project Area have enough water for domestic use, though the water is extremely contaminated by domestic sewerage. If this source is to be utilized for domestic water supply, it is required to construct intake facilities with treatment facilities. It is difficult to use water source for rural water supply systems because of high investment and O/M costs if the area has less than a certain number of population.

Reservoir
All of the existing reservoirs have been developed for irrigation purpose and there are no availability to utilize them for domestic water supply. If this source is to be utilized, it is required to provide an alternative water source in the dry season.

Rainwater

Rainwater is also considered as one of the available water sources in the Project Area. However, during the dry season, an alternative water source must be provided. Rainwater stored on the roof of public facilities would be utilized as a supplementary water source.

(2) Water Supply Methods

The following water supply methods are proposed considering the topographical condition, water source and village distribution conditions:

- House connection method : Nam Dan Town area
- Public water hydrants method : Plain area, Inundation area and Dried-up area

(3) Examination of Water Supply System Options

To select the water supply system and establish the water supply area, the following water supply system options are proposed.

Option	Water Supply System
A:	Dugwell with filter tank using shallow groundwater
B:	Tubewell with hand pump and filter tank using shallow groundwater
C:	House connections system supplied by distribution pipelines with submersible pump and treatment plant using deep groundwater
D:	Public hydrants system supplied by distribution pipelines with submersible pump and treatment plant using deep groundwater
E:	Public hydrants system supplied by distribution pipelines with power pump and treatment plant using stream water
F:	Public hydrants system supplied by distribution pipelines with power pump and treatment plant using reservoir water
G:	Public hydrants system supplied by distribution pipelines with power pump and treatment plant using river water
H:	Tanks of rainwater harvested by roof catchment

The possibilities for installing water supply system options A through H were examined from the viewpoint of;

1. natural conditions, such as water sources and topography,
2. water use, facility operation and maitenance conditions, and
3. economic aspects.

The examination results were as shown in Table K.3.1.

(4) Groundwater Development

To solve the problems of shortage of safe water in the dry season and contaminated flood water in the rainy season, it is necessary to develop alternative water sources instead of shallow wells which is the dominant water source in the area. Available water sources in the Project Area were evaluated in the previous section and it has been judged to be difficult to develop surface water due to high construction cost and O/M cost for rural water supply systems. The deep groundwater has not been utilized because there is very little information of this aquifer, although the deep groundwater is considered as one of the most desirable water source since deep groundwater can get a year round clean water in general. Availability of deep groundwater was identified by test boring in this study although more study is needed in order to verify the potential.

The selected water source for the proposed water supply plan is the deep groundwater, although more detailed investigation is necessary before carrying out the project implementation.

(5) Selected Water Supply Systems

Considering the topographical conditions, water sources, village distribution conditions and existing water supply situations, the following two new water supply systems and two improvement of existing water supply facilities are proposed. The water supply system proposed here is an independent water supply system to be operated and maintained by each commune.

a. New Water Supply Systems

System N-1:
House connection system using deep well. (Nam Dan Town area)

System N-2:
Public water supply system using deep well. (Plain area, Inundation area and Dried-up area)

b. Improvement of Existing Water Supply Facilities

System I-1:
Improvement of existing gravity flow system (Nam Ahn commune)

System I-2:
Material supply of filter tank to the existing wells. (Non covered area by new water supply systems)

The summary of rural water supply systems is shown in Table K.3.2.

K.3.3 Prioritization of the Projects

Prioritization of the projects was studied based on urgency, inhabitant needs and synergistic effect in the rural water supply plan.

Urgency :'a' rank is given to the projects which has problems to be solved immediately, 'b' rank is given the projects to be implemented in early stage, 'c' rank is given to others.

Inhabitant needs :'a' rank is given to the projects required for most of the inhabitants, 'b' rank is given to others.

Synergistic effect :'a' rank is given to the projects which can reduce the workload for collection of drinking water in the dry season and inundation period, 'b' rank is given to others.

Comprehensive Assessment:
If ranking of urgency is 'a', the project rank should be A. For other cases, the project rank should be B or C depending on the ranking of inhabitant needs, and synergistic effect.

Project	Facter			
	Urgency	Inhabitant Needs	Synergistic Effect	Comprehensive Assesment
N-1 House connection system (Nam Dan Town)	c	b	a	C
N-2a Public water supply system (Inundation area)	a	a	a	A
N-2b Public water supply system (Dried-up area)	a	a	a	A
N-2c Public water supply system (Plain area)	b	b	b	B
I-1 Improvement of existing gravity flow system	b	b	b	B
I-2 Material Supply of filter tank	a	a	b	A

K.4 Priority Projects

K.4.1 Public Water Supply System by Deep Wells

Public water supply system by deep wells including water source facility, treatment facility and distribution facility is adopted for the priority project. In this system, the groundwater is pumped up from deep wells by using submersible pumps. The water is then treated and distributed through pipelines to users via public hydrants.

The following supplementary field surveies on the public water supply system were conducted to provide additional data and information for the design of water supply facilities:

- Confirming the project area using the topographic map (Scale: 1/5,000)
- Investigating groundwater availability by conducting the test boring (6 wells)

(1) Design Conditions

1) Project Area and Population

Project Area
Considering the present water supply conditions in the commune, the project area was selected and classified into two areas as follows:

- Inundation area along the Lam river, in which shallow wells are infiltrated with flood water during the rainy season, consists of the communes of Nam Thai, Nam Cat, Khan Son, Nam Trung, , Nam Phuc, Nam Kim and Nam Cuong. (7 Communes)
- Dried-up area in relatively high elevation area, in which shallow wells are dried-up during the dry season, consists of the communes of Nam Hung, Nam Nghia, Nam Thanh, Nam Anh, Nam Xuan, Van Dien, Nam Linh, Nam Giang, Nam Tan, and Nam Loc. (10 Communes)

Service Block
A service block is a group of villages in which water is provided with one water supply system. In principle, one service block is planned in one commune. As the project area has low population density and the communes are located far apart from each other, it is economically infeasible to connect these communes with water pipes. Therefore, the proposed water supply system is planned for each commune separately. However, in consideration of the geophysical and topographical conditions of the communes, it was found to be better to organize a combined and/or separated system in in Nam Kim, Khanh Son, Nam Trung, Van Dien, Nam Xuan and Nam Anh communes. Therefore, the proposed water supply systems in these communes are designed collectively. Classification map of service block is shown in Fig K.4.1.

Population and Coverage Rate
The proposed public water supply system is planned with the target year of 2010. The population in the 2010 was estimated from the statistical data of Nghe An Province. The population growth rate was set at 1.4% based on the annual average population growth rate in Nam Dan District for the period 1991 - 1995.

The coverage rate, percentage of the served population to administrative population in each commune, was set at 100%.

2) Water Demand

Unit Water Demand
According to the results of interview survey conducted during the field survey, the total water demand in the rural area is estimated to be between 60-90 liters/capita/day, though it varies widely depending on the conditions of the water source. Within this estimated figure, 40-60 liters/capita/day is considered to be used for washing and bathing, and the rest of 20-40 liters/capita/day is considered as the water for drinking and cooking. Generally in the project area, when peoples have water problems with their wells, they go

to other wells every day to get the water for drinking and cooking even if that well is located far away from their houses. They will get water for bathing and washing from rivers, canals and reservoirs nearby their houses. Therefore, the unit water demand was set at 30 liters/capita/day on the daily minimum required demand based on the consideration of the present water consumption level and the design standard of UNICEF's program.

Water Demand

Water demand was estimated based on the population and unit water demand of the each water supply system. Breakdown of the water demand by each water supply service block is shown in Table K.4.1.

3) Water Source

Water source is planned to be deep groundwater. The test borings were conducted at 6 sites in the project area for the confirmation of availability and water quality of deep groundwater during the study period.

Aquifers in the Project Area

Two types of aquifers are distinguished in the project area, namely aquifer in quaternary sediments and fissure water of fractured limestone in bedrocks. Aquifer in quaternary sediments is widely distributed along Lam river and this aquifer has high water content. Most of the abstraction from shallow wells is from this aquifers at surface level. The aquifer is widely found in the area where thickness varies strongly from place to place and water yield depends on the thickness and composition the aquifer. From results of two test borings by this study, it is found that the aquifer gave high discharge at thick aquifer (8.5 liters/sec and 12.48 liters/sec). On the other hand low values of discharge (1 liter/sec), were observed in thin aquifer by a previous study.

Aquifer in bedrocks can be divided into two parts, Dong Trau formation and Long Dai formation. Water from this aquifer has not been utilized and there is still limited information. Pumping test results of four test borings show that discharge is 4.65 liters/sec at Long Dai formation and 2.3, 1.2 and 0.04 liters/sec at Dong Trau formation. Rocks in this aquifer are found to have strong cracks that contain water, however discharge rates of aquifer differ greatly with respect to their location. Even though, the discharge rates are high in the crack areas, there are also places where there is no water. Therefore in order to attain high efficiency in the exploration of wells,it is required to apply an integrated geomorphological, geological, geophysical methods, especially for the groundwater prospecting in the fractured zones of the bedrock strata.

Water Quality

From the results of water quality analysis at 6 test wells, water quality of groundwater varies at each well site. There are some wells where high concentration of parameters were observed which is higher than the drinking water standard, such as iron (5 wells), manganese (4 wells), anmonia (2 wells) and bacteria (1 well). Accordingly, the groundwater needs treatment for drinking water though it is difficult to grasp the relation between geology and high contents of water quality parameters from the results of 6 test well sites. The water quality should comply with the Vietnamese drinking water standard. However it is very expensive to install and maintain full treatment facilities for control the

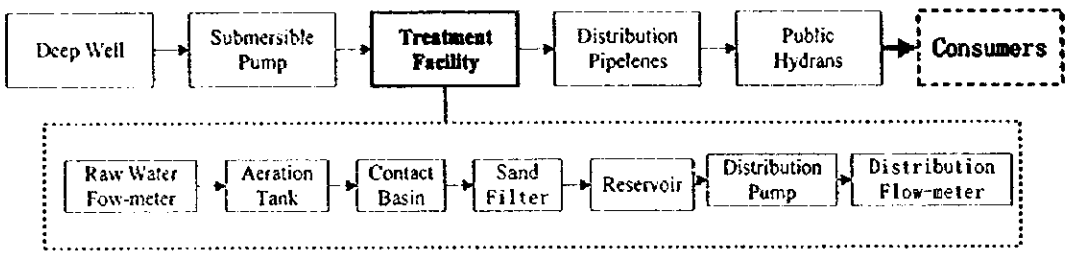
water quality in order to comply with the standard. Therefore, the aim of the proposed treatment process is the removal of iron and manganese considering the present level of which is treated by filter tanks within the rural water supply program. The well sites should be selected carefully trying to find the places where the concentration of ammonia and bacteria are minimum, i.e. sites located at prudent distance from human and animal waste sources. The results of test wells and Vietnamese drinking water standard for rural area are shown below.

Item	Water Quality from Test Wells	Drinking Water Criteria
Iron	0.12 ~ 62.3 mg / l	Max. 0.5 mg / l
Manganese	0.05~ 1.84 mg / l	Max. 0.1 mg / l
Ammonia	1.05 ~ 4.66 mg / l	Max. 3.0 mg / l
Bacteria	0 ~ 2 ml	Max. 0.05 ml

(2) Facility Plan

1) Proposed Water Supply System

The proposed water supply system consists of water source facility, treatment facility and distribution facility. The proposed water supply system and its facilities are shown below.



2) Design Criteria

a) Service Level

Service Hours

The system, all facilities for water intake, treatment and distribution, is to be planned by 24 hours continuous operation basis.

Type of Service

Water is to be supplied via public hydrants to all consumers. All public hydrants are consist with 2 m3 storage tanks, water hydrants and water meters.

b) System Capacity

Peak Day Factor

The peak day factor which will be applied to size dimensions of facilities of water treatment and water intake and diameter of distribution pipelines is to be 1.35 (135%).

Water Intake Capacity

Taking consideration of in the course of treatment, i.e. filter back-wash water and miscellaneous use in the treatment plants, water intake capacities is set to be 108% of the production capacity. (Treatment loss = 8% of treatment capacity)

Design Standard

Considering the standardization of design, installation and maintenance, the design standard for typical representative of facilities are adapted based on the classification of water supply systems by each service block. The 19 service blocks are classified into 3 classes for the design standard of water supply system. They are Class A (1 larger communes), Class B (9 middle communes) and Class C (9 smaller communes). Facilities for each water supply system are planned for typical representatives of Class A, B and C, as their standards. The design standard would represent typically each class and summarized in the below Table. The breakdown of design condition together with water demand of each service block is shown in Table K.4.2.

c) Water Demand by Design Standard

Water demand by design standard was estimated based on the population in the year 2010 and unit water demand of Class A, B and C as shown below table.

Item	Class A	Class B	Class C
a. Population	15,854	7,563	4,314
b. Average daily demand (m3/day)	476	227	129
c. Average daily distribution (m3/day)	560	267	152
d. Maximum daily distribution (m3/day)	756	360	206
e. Maximum daily intake (m3/day)	800	500	300

Note: Average daily distribution = Average daily demand / (1 - 0.15), (Leakage losses : 15%)
Maximum daily distribution = Maximum daily distribution X 1.35
Maximum daily intake =Treatment losses were added to maximum daily distribution.

2) Facility Plan

a) Water Source Facility

The groundwater is to be taken through deep wells by submersible pumps for each service block.

Required Numbers of Well

The required number of wells for each service blocks is estimated based on the well yield and water demand. The well yield of one well is estimated according to the characteristics of the aquifer in each proposed well field. In the Project area, two types of aquifers are distinguished, namely aquifer in quaternary sediments and aquifer in bedrocks based on geological formations. Thickness of the aquifer in quaternary sediments varies widely from place to place and water yield depends on the thickness. On the other hand, aquifer in bedrocks is divided into two parts, Dong Trau formation (T2ad!) and Long Dai formation (O3-S1). The design well yield was estimated as 80 % of the discharge from the results of pumping tests considering the safety factor. The well yield for each water supply

system was determined based on the results of test boring as follows;

1. Quaternary-A, Thick aquifer: 9.98 liters/sec, (JICA2 Borehole, discharge rate = 12.48 liters/sec)
2. Quaternary-B, Thin aquifer: 0.86 liters/sec, (BH518, discharge rate = 1.0 liters/sec)
3. Long Dai formation (O3-S1): 3.72 liters/sec, (JICA1 Borehole, discharge rate = 4.65 liters/sec)
4. Dong Trau formation (T2adt): 0.96 liters/sec, Thick aquifer (JICA6 Borehole, discharge rate = 1.2 liters/sec)

The required number of wells for each service blocks are shown in Table K.4.1.2.

Deep Well and Intake Pump

Typical hydrogeological conditions of the well sites and the proposed deep well structure are shown in Fig. K.4.2. They were estimated and decided referring to the results of test boring.

The groundwater is to be taken through deep wells to be equipped with submersible pumps (one pump to one well). The capacity of submersible pump are determined assuming 20 hours-operation of the pumps. Manual operation is proposed for the submersible pump which is controlled by a console panel installed in the control house.

b) Treatment Facility

The treatment facility consists of treatment equipment, distribution reservoir and distribution pump. The facility is to be constructed nearby the deep well. Design water capacity of the treatment facility is planned according to the design standards of Class A, B and C. The treatment facility by design standards is summarized in Table K.4.3. The treatment flow sheet is illustrated in Fig.K.4.3.

Treatment Equipment

The objective of treatment is to be remove iron and manganese. The treated water is to be treated to meet the Vietnamese criteria for drinking water quality for rural areas.

Iron concentration is targeted to be 0.5 mg/l, and as to manganese concentration, it is targeted to be 0.1 mg/l of raw water quality. The treatment capacity is decided by the water demand of each representative class. The equipment should be constructed nearby the intake well. The equipment consist of aeration tower, contact basin and filter beds. Filter sand is required to be replaced regularly in order to keep the function of manganese sand.

Distribution Reservoir

Volume of distribution reservoir is to be equivalent to two hours of the daily maximum distribution capacity, taking into account of the hourly change of water consumption and the capacity of reservoir tanks at public hydrants. The reservoir, to be of reinforced concrete, will be constructed on the ground level in the treatment facility yard.

Distribution Pump

Distribution pump is to be operated within 20 hours per day. Manual operation is proposed for the distribution pump which is controlled by a console panel installed in the

control room of pump house.

Power Supply
Electric power supply for pumps is planned to be used of the public electricity. Stop or start for the pumps can operate at pump house.

c) Distribution Facility

Distribution Pipelines
HDPE pipes are to be employed, which in principle will be installed underground for water distribution from the distribution reservoir to the public hydrants. Diameter of the pipelines are decided considering the flow rate, pipeline loss, etc..

Public Hydrants
Water is to be supplied to users through public hydrants. Considering the scattered villages, the public hydrants are planned to be located at a distance of 300 m from each other. As consumers get water mainly in the morning and early evening, reservoir tanks with a capacity of 2 m3 should be installed so as not to suffer a water shortage in these hours. Water meters will be installed at all public hydrants for consumption measurement.

(3) Implementation Plan

1) Proposed Organization

The project will be implemented with the responsibility of Nghe An Province coordinating the activities of all government agencies and regional administrative organizations concerned with the project implementation. Rural Water Supply Office under the Department of Agriculture and Rural Development of Nghe An Province should assist the Province for implementation of the Project.

For the smooth and effective execution of the Project, it is proposed that Project Implementation Office of Rural Water Supply Project in Nam Dan District will be established under the administration of the Province People's Committee and District People's Committee througth the Rural Water Supply Office.

For execution of the construction works, Project Implementation Office will be conducted for following works:

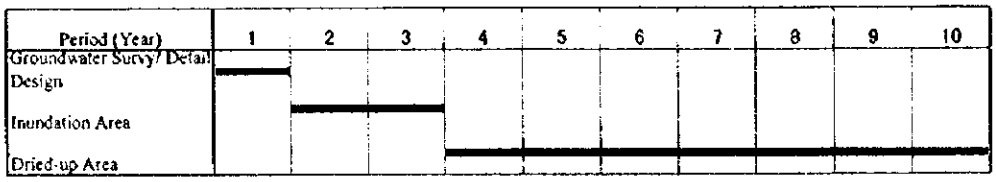
- Survey and study for physical (hydrogeology etc.) and socio-economic conditions
- Engineering of water supply facilities
- Supervision of construction work

Project Implementation Office is to conduct the necessary works by following staff proposed:

- Office Manager	1	Overall supervision and management
- Water Supply Engineer	1	Engineering and supervision of construction work
- Assistant. Engineer	1	Supervision of well construction and civil works
- Administrator	1	Accounting and administration work

2) Construction Schedule

The construction work is schedule to be completed in 10 years including one year for preparation period as shown in the table below. It is scheduled that 3 water supply systems will be constructed in one year at initial stage and 2 water supply systems will be simultaneously constructed in one year. 19 water supply systems will be constructed in 9 years. During the preparation period, groundwater investigation and detailed design will be conducted. The implementation of the works in the inundation area should be scheduled to be conducted ahead from the works for dried-up area, this is because the inundation area is suffering worse poor sanitation conditions than the dried-up area.



3) Project Cost

Project cost consisting of costs for water source facilities, treatment facilities and distribution facilities was estimated at the year of 1997 price level. Land acquisition cost does not included because well and treatment facility sites shall be set the public land.

Project cost for 19 water supply systems (19 service blocks) was estimated to be 69,669 million VND. The project cost is shown in the table below.

Facility	Project Cost (Million VND)		
	Inundation Area	Dried-up Area	Total
Water Source Facility	5,615	32,389	38,004
Treatment Facility	7,551	14,496	22,047
Distribution Facility	2,886	6,732	9,618
Total	16,052	53,617	69,669

(4) Operation and Maintenance Plan

1) Proposed Organization

The proposed water supply system is an independent system to be operated by each service block. A new organization shall be formed, and have the responsibility of all the activities including billing and money collection, as well as operation and maintenance of the system. At present, in the Project Area as well as in rural areas of Viet Nam, almost households have their own shallow wells for domestic consumption. Therefore, there is not any public water supply system in the Project Area and as a result, there is no institution to operate and maintain the water supply system. In order to successfully operate and maintain the water supply system, a new organization should be introduced.

It is proposed that the establishment of new organizations such as a Rural Water Management Office (RWMO) and Operation and Maintenance Unit of each service block

Management Office (RWMO) and Operation and Maintenance Unit of each service block (O/M Units), which will take full responsibility for matter relevant to the subject of operation and maintenance and water fees. The functions of the RWMO and O/M Units should be more comprehensive covering the activities mentioned below.

a) Rural Water Management Office (RWMO)

Organizational Structure and Its Functions

The proposed RWMO will be administrated by the People's Committee of Nam Dan District coordinating with Rural Water Supply Office of Nghe An province. The RWMO takes care of overall technical management work and water administration work for all the service blocks. The RWMO will conduct following activities:

- General administration and control of operation and maintenance works for all the systems,
- Technical assistance for operation and maintenance techniques to be provided to operator/worker at site level (periodically maintenance, field repair works, etc.)
- Administration and accounting for water fee collection,
- Purchase and storage of operation and maintenance materials,
- Promoting operation and maintenance activities at commune level.

Office staff:

Office staff is proposed to be 4 persons to carry out the functions of PMO mentioned above. They will be:

Title	Number	Task
- Office manager	1	Overall supervision and management
- O/M technical staff	2	O/M technical management
- Administrator	1	Accounting and administration work

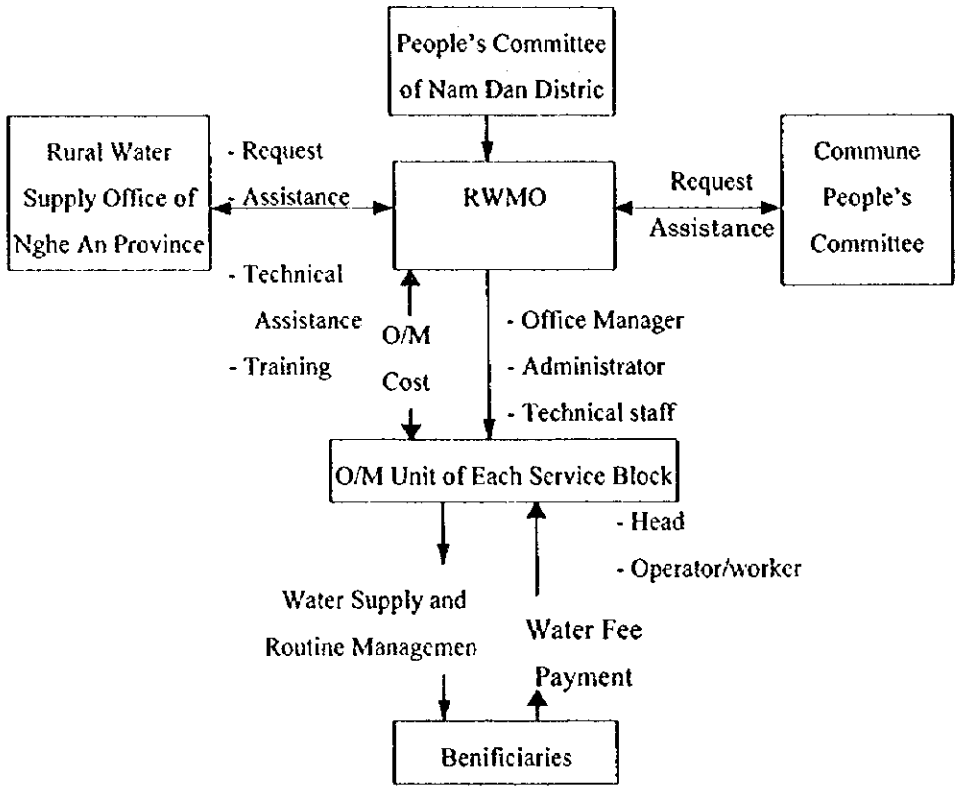
b) O/M Unit of Each Service Block

O/M Unit will be established to conduct operation and maintenance work including collection of water fees for each water supply system at service block level. O/M Unit of each Service Block will be under the administration of PMO with the coordination of People's Committee of each commune. O/M Unit will conduct following activities.

- Operation and maintenance works of each system at site level,
- Water fee collection from users,
- Guidance and extension of operation and maintenance techniques to the users. (self-awareness of the need for saving water, cleaning of public hydrants, etc.)

The following staff will be assigned in O/M Unit of each service block:

Title	Number	Task
- Head	1	Overall supervision and management
- Operator/worker	2	Operation and maintenance at service block



The proposed organizational structure of RWMO and O/M Unit is shown above.

2) Operation and Maintenance Cost

The system's operation and maintenance cost consist of the expenditure for RWMO and O/M Units. The operation and maintenance cost is summarized as shown in the table below.

Components	Cost
Annual Expenditure	
1. RWMO	38,592,000 VND/year
2. O/M Units (19 systems)	1,690,453,600 VND/year
Total	1,729,045,600 VND/year
Cost per Consumption	
1. RWMO	29 VND/m3
2. O/M Units	1,258 VND/m3
Total	1,286 VND/m3

Note: Water consumption :
1,344,047 m3/year (30 liters/capita/day x 365 days x 122,744 persons)

RWMO's expenditure consists of staff cost for 4 persons and office maintenance cost (20 % of total staff cost). The expenditure for O/M Unit is presented in Table K 4.4. O/M Unit's expenditure will be different for each system capacities according to the populations of service blocks.

3) Water Fee Collection System

Water fee will be collected from users for operation and maintenance of the systems. The water fee rate will cover all the expenditures incurred for operation and maintenance works. Based on the estimated expenditures and by taking into account the financial capacity of farmers, it is proposed that a fixed water fee rate of 1,170 VND/person/month at the year of 1997 price level should be implemented.

Water fee rate for one person was set as follows:

- Monthly rate per person :1,170 VND/person/month (30 liters/capita/day x 30 days x 1,300 VND/m3)
- Monthly rate per household :6,201 VND/household/month (5.3 persons/household x 1,170 VND/person/month)
- Monthly net profit per household :625,000 VND/household/month (based on the results of the Rural Socio-Economic Survey)

The monthly water fee of 1,1170 VND per person was set based on the unit water consumption per person (30 liters/capita/day) and the basic cost of water fee (1,300 VND/m3), operation and maintenance cost per water consumption is estimated to be 1,286 VND/m3. Therefore, the water fee revenue will cover operation and maintenance cost. It is considered that the farmers could afford to pay the water fee as the monthly water fee rate is about 2.5% of the average net profit per family.

K.4.2 Material Supply of Filter Tank

(1) Supply Plan of Filter Tanks

Groundwater of shallow wells in the project area contains bacteria, iron, manganese etc. concentration of which is extremely higher than those set for drinking water standards. Also water becomes murky in the dry season. Most of the shallow wells are polluted by human and animal wastes due to inappropriate location and structure of wells. Although filter tanks are installed at the shallow wells by the UNICEF's program in the Project Area, there are still 19,470 wells (70% of total existing wells) which do not have filter tanks because of shortage of funds. Among them, 16,170 wells will be covered by the proposed public water supply system. Therefore, it is planned to provide construction materials for the installation of filter tanks on the remaining 3,500 existing wells only. The filter tank will be of the same structure as the one installed in the UNICEF program. The people can install filter tanks by themselves with the assistance of Rural Water Supply Program under the Department of Agriculture and Rural Development of Nghe An Province.

(2) Materials Cost

Construction materials of filter tank consisting of steel bar, cement, PVC pipe, brick, etc. are to be supplied to the peoples through the above mentioned Program. The supply material for one filter tank is as follows:

Item	Quantity	Item	Quantity
Steel bar	6 kg	Brick	600 pcs
Cement	150 kg	Broken brick	0.5 m3
Gravel	0.6 m3	PVC pipe	4 m
Sand	22 m3	Hydrant	1 pc.

(3) Material Cost

The construction material cost of one filter tank was estimated 1.76 million VND at the year of 1997 price level. Total material cost for 3,300 existing wells was estimated 5,808 million VND.

(4) Implementation Plan

Implementation period is planned to be 10 years considering the capacity of present number of the stuff at the Rural Water Supply office in Nghe An Province.

K.5 Recommendation

It is necessary to establish new organizations with inhabitants' participation, for operating/maintaining water supply facilities. At the initial stage of operation, technology and finance of the organization will be insufficient. So, it is recommended that the People's Committee of Province/District and Provincial Rural Water Supply Office provide appropriate support to the organizations at the beginning for operation/management techniques and financial management which is necessary for the operation.

Also, information regarding underground water in the project area is insufficient. So, it is necessary to confirm potentiality and quality of underground water by conducting an investigation covering wide areas to clarify location of well construction before commencement of each project. Under these circumstances, it is recommended to conduct an electric resistivity survey over the entire project area to locate sites for well construction, then to conduct a test boring, a pumping test and a water quality test at the well sites.