Chapter 5 Pilot Models Construction

5.1 Purposes of Pilot Models

Two pilot systems were constructed in the communes under typical different social situation in the Central Highlands. One is a commune with poverty issues (K3-1) and the other is minority-dominated commune (G2). The main purpose of the pilot models in K3-1 and G2 are to assess the feasibility and sustainability of the piped water supply systems with regard to the following issues:

- financial sustainability,
- local management skills,
- monitoring of house connection rate and water charge collection,
- effectiveness of IEC, and
- local construction skills.

(1) Financial sustainability

In K3-1, the majority of the population are of the ethnic minority, the economic conditions are generally poor, and the financial sustainability of the piped supply systems has been unclear. The project cannot achieve its goal without financial subsidy.

(2) Local management skills

At G2, there are issues between the two major ethnic groups (the Kinh and Gia Rai). The people’s committee has been expected to solve the issues by themselves to ensure the harmonious management of the water supply system.

(3) House connection rate, water charges collection and IEC

The collection of water charges from users of house connections is most important for sustainable O/M. To achieve successful O/M, effective IEC activities promoting safe and clean water in both communes are essential. IEC activities have been carried out prior to the construction of the water supply facilities, and their effectiveness needs to be checked and reviewed.

(4) Local construction skills

Piped supply systems are still not common in the rural areas in Vietnam. The level and reliability of the construction contractors need to be technically evaluated to ensure quality of the construction works. Materials are procured from the local markets and the availability of spare parts needs to be considered. The skill to keep to the construction schedule and to prepare the design drawings to meet the construction program is also one of the important key factors.

5.2 Background Information for Nhon Hoa Commune (G2)

Background information includes the target population, ethnicity, economic conditions, present water supply, health, groundwater potential, water quality, future water demands in each target area.

(1) General Background

It takes about one hour by car from the provincial capital, Pleiku city. The target area is part of the G2 system and located along and off the national road No. 14 from Pleiku to Buon Ma Thout.

The target area of the pilot model covers villages Hoa An, Hoa Phu, Plei Lao, and Plei Kia, with the total population of 1,150 (200 households). Village Plei Kia has a population of 744, and Hoa An has 406.

Most of the villagers (98%) in Hoa An is the Kinh, while 90% of the residents are the Gia Rai people in Plei Kia. The poverty ratio of village Hoa An is relatively low (19%), whilst that of Plei Kia is as high as 40%.

Most importantly, this commune had a dispute on the land acquisition. However, the People's Committee and PCERWASS solved the issue with the private land on whose land the well for the pilot model was drilled.

(2) Existing Water Supply

Most of the people use a dug well as their water source in the target area. Especially, in the Kinh dominated Hoa An village every household owns dug well.

According to the social survey, 23% of the respondents were unsatisfied with the quantity of water in the dry season, and 13% were unsatisfied with the quality of the existing water supply.

(3) Piped System

The study team has drilled a deep well with a yield of 173 m^3/d. The drilled deep well is 110 m long with a screen 34 m in length. The water has a somewhat high content of manganese.

The estimated water demands (maximum daily demands) for the G2 system (not only for the pilot area) are 132.5 m^3/day in 2001, 289.2 m^3/day in 2005, 1096.2 m^3/day in 2010, and 1603.2 m^3/day in 2020. At least one more well with the same capacity as the explored well will be necessary to meet the water demand in 2005, 5 more by 2010, and 2 more by 2020.

Alternative 2a is recommended for the system in G2. From the deep well the water is pumped out to an elevated tower from where the water gravitates to the distribution network. The pilot model is conventionally postpond to install reservoir for limited construction time schedule. The water supply facilities are located anywhere near the well while the elevated tower is located at the highest point near the people's committee.

5.3 Overall Progress of Pilot Model

5.3.1 General

The pilot model plants in Dak Ui commune (K3-1) and Nhon Hoa commune (G2) were constructed by the end of January 2002. The selected local contractor carried out the construction works under the contract agreed between the JICA study team and the contractor on 31st October 2001. The construction period took 3 months starting at the beginning of November 2001. The monitoring of the actual and realistic operation and maintenance activities by the users will be continuing after the completion of model plants for about 3 months from February to April 2002. The actual schedule of the construction works is presented in Figure 5.1.

The basic parameters for the construction works are as follows:

Table 5.1 Basic parameters for the Construction Works

Items	Nhon Hoa (G2)
A. Water resource	
1. Permissible yield of JICA`s deep well	2.0 l/sec
2. Altitude of JICA`s deep well	El 420 m
3. Elevation of reservoir tank	El 426 m
B Water demand	
1. Number of villages	2
2. Number of households	200
3. Number of population, 2001	1,150
4. Maximum hourly demand, 2001	1.1 m3/h
5. Maximum daily demand, 2001	11.0 m3/d
6. Maximum hourly demand, 2020	13.3 m3/h
7. Maximum daily demand, 2020	122.0 m3/day
8. Minimum pressure at tapping point	

5.3.2 Construction Works

The scope of the construction works of the pilot models are summarized as follows.

- Design of water supply facilities
- Land clearing
- Installation of submersible pumps with appurtenances
- Installation of electric panels and their protection
- Connection of electric power lines to public power lines
- Construction of well heads
- Installation of raw-water pipelines
- Construction of provisional reservoirs
- Installation of distribution pipelines
- Construction of public taps
- Water pressure tests
- Disinfection

(1) Water Intake

The profiles of the wells explored by the JICA study team in G2 in 2001 are as follows:

Table 5.2 Profiles of the Wells

Description	G2
Well diameter	150 mm
Well depth (reamed)	110 m
Dynamic water level	61 m
Permissible yield	3 l/s
Ground elevation (m)	421

The deep well head was constructed to meet the water demand for the year 2020. The well head consists of a pressure gauge, gate valve, water meters, non-return valve and all necessary couplings and fittings. A protective housing was constructed. The following type of submersible pumps was installed in G2 system.

Table 5.3 Type of Submersible Pump

	Description	G2
Pump	Type	Calpeda submersible pump, Italy
	Model	4SD 10/17
	Performance	H max. 114 m, Q min. 1.5 m3/h H min. 35 m, Q max. 12 m3/h
Motor	Type	Franklin Electric, Germany
	Model	3 kW, 3-Phase, 380 V

(2) Power Supply

The power required for the operation of submersible pumps and lightning is supplied from the national grid. The line connections and installation of control panels have been completed in K3-1 and G2.

(3) Raw Water Mains

The raw water main laid 60 cm below the ground transports the water from the wellhead to the reservoir. The raw water pipe is made from Galvanized Iron (GI) and is 100 mm in diameter for both K3-1 (Dak Ui) and G2 (Nhon Hoa).

(4) Distribution Lines

The distribution pipes were designed and constructed for the maximum hourly demand in year 2020. The distribution pipes are High Density Polyethylene (HDPE) for secondary and small pipelines and Poly-vinyl Chloride (PVC) for the main pipelines. The distribution pipe lengths and diameters are shown in the following:

Table 5.4 Type of Distribution Pipe

Pipe Material	G2	
	Dia. (mm)	Length (m)
PVC (for mains)	140	460
PVC (for mains)	100	1,435
HDPE (for secondary pipes)	-	-
HDPE (for secondary pipes)	63	665
HDPE (for secondary pipes)	50	1,500
HDPE (for secondary pipes)	32	800

(5) Iron Treatment Plant

No treatment plant was constructed for the G2 system.

(6) Storage Reservoirs

Temporary storage reservoirs with a capacity of 5 m^3 were constructed in order to ensure supply during the pilot period. The prefabricated temporary reservoir and elevated tank 6 m high were constructed in G2. The temporary reservoirs in G2 will later be replaced by permanent concrete reservoirs, when the actual implementation is started.

(7) Public Taps

The number of public taps installed was 50 in K3-1 and 4 in G2. Two shower rooms are equipped with public taps in K3-1 in accordance with the requirements of local customs.

(8) Pressure Testing and Disinfection

In K3-1 system, pressure testing of every 300 m length at 1.5 times the design pressure was carried out from between 29th December 2001 to 11th January 2002 in the presence of PCERWASS and the JICA study team. Following the pressure testing, disinfecting was undertaken in the G2 and K3-1 system subjecting all the relevant parts of the pipelines to a 50-mg/l solution for 24 hours. After disinfecting the system the residual chlorine content was reduced to below 1 mg/l.

(9) Preliminary Design and Actual Construction

The following table shows major technical design changes or modification during the construction period of the 2 model plants compared with the preliminary design of the study team.

Table 5.5 Preliminary Design and Actual Construction

System	Work Item	K3-1			
		Content	Original	Actual	Reason
G2	Distribution pipe, PVC	Material, spec	D150 mm	D140 mm	Local availability
	Distri. pipe, PVC D100	Material, quantity	500 m	1,435 m	Base on the hydraulic calculation
	Distri. pipe	Material, spec. & Q`ty	PE D65 x 1,600 m	HDPE D63 x 665 m	Stronger than PE, local availability & hydraulic calculation
	Distri. pipe	Material, spec.	PE D50	HDPE D50	Stronger than PE & local availability
	Distribution pipe	Material, spec.	PE D40	HDPE D50	Local availability & hydraulic calculation

5.3.3 Water Tariff and Financial Sustainability

The water tariffs were initially set by the study team consulting with CPC/TPC. The situation as at December 2001 was as follows:

Table 5.6 Water Tariff

System	Estimated users	Average water use (lpcd)	Water sales volume (m^3/day)	Water Tariff (VND/ m^3)	Total annual revenue (MVND/y)	Estimated annual expenditure (MVND/y)	Annual balance (MVND/y)
G2	1150: 50% HC and 50% PT	35 for HC 15 for PT	26	1600	15.1	15.0	**-0.14MVND**

HC: house connection

PT: public tap

While the calculated annual balance for the K3-1 system is positive, that for the G2 system is negative. In order to meet the balance between the revenue and expenditure including the re-investment cost, the rate of house connections should be increased for the G2 system. Unless the 50 public taps are properly managed and water tariffs are collected by the local people in K3-1, the water supply systems account will fall into deficit.

The present house connections of the K3-1 and G2 systems are reportedly 2 and 26, respectively. The calculations for the estimated water tariffs will become 2000 VND/m3 for K3-1, and 3000 VND/m3 at these house connection levels.

The study team has strongly emphasized, to WSUs and PCERWASS, the necessity for more house connections to maintain sustainable management. IEC activities are the most important method of achieving the target number of house connections. The monitoring of the management of WSU will continue in order to improve the economic evaluation.

5.3.4 Water Supply Management Unit

After the discussions with CERWASS Hanoi and CPC, the Water Supply Unit (WSU) was established for the management of the water supply facilities during the construction stage.

The job positions and their duties were decided in the presence of JICA study team at the pilot model construction stage as follows.

Water Supply Unit of G2

Board of WSU: by the selection from users (1 person from each village) and CPC

- Manager	Sometime work without salary
- Accountant	Half day work
- Operator	Full time work
- Inspector	Half day work

Transfer of technology and know-how of O/M to the WSU staff was carried out by the contractor and the JICA study team. The O/M manual and monitoring forms are provided in Appendix 8-9 in Supporting Report-B. The training for periodical water quality checks using portable kits was introduced to the operator of each WSU.

5.3.5 On-going IEC Activities

The IEC activities are undertaken by Gia Lai PCERWASS in K3-1 and G2.

The following personnel who can speak both the Kinh and the ethnic minority languages are engaged in IEC:

G2: Former vice-chairman of CPC

The information to be distributed included:

1) the objectives of the piped supply system,

2) the master plan drawings,

3) the implementation schedule,

4) the results of the water quality analysis,

5) the benefits of safe and clean water,

6) the costs for house connections and the water tariff,

7) how to reduce the cost for the management of the water supply system

8) how to keep the environment clean, and

9) the responsibilities of the local people.

5.4 Percentage of House Connections

The most crucial issue is how to increase the number of house connections. The willingness to pay in the social survey is relatively positive.

As a result of IEC activities in the two pilot model areas, the number of house connections have increased, which will raise the revenue level. It is recommended that the Vietnam government pay for the IEC promoters. It is strongly recommended that PCERWASS be involved in more IEC activities.

There are two two households in K3-1 which already had house connections as at 29 January 2002. The installation of 5 additional public taps was requested by the study team from CPC because the target area is mostly composed of poor and very poor minority households. Some additional houses were willing to connect to the piped system in K3-1 system, but as at the end of Jan. 2002 no progress had been made. Three were connected by the end of May 2002.

In the G2 area, there were twenty-six households which already had house connections on 29 January 2002 (out of 138 houses, i.e. 19%). This grew to 38 households by the end of May 2002 (27%). The planned coverage for the house connections is 70%. According to the social survey and interviews in the model areas, high willingness for the house connections was reported and designs for as many as 100 house connections have been completed. More intensive IEC activities are imperative in G2.

The capacity building of PCERWASS with regard to financial sustainability, O/M, and IEC is urgent. Regular training at CERWASS Hanoi for PCERWASS, and more involvement by PCERWASS for IEC and technical issues is recommended.

5.5 Local Construction Skills and Materials

In Vietnam, a numbers of construction companies exist as listed below:

1) General construction companies located in Hanoi and Ho Chi Minh - 9
2) Medium sized construction companies in Da Nan, Nya Tran and Da Rat cities - 7
3) Construction companies for water supply systems in the target provinces which have experience of similar projects:
   - Construction Enterprise for Water Supply (Buon Ma Thout city)
   - Tan Viet Groundwater construction company (Buon Ma Thout city)
   - Thien Trung construction company (Buon Ma Thout city)
   - Gia Lai State Enterprise in Mechanical Services (Pleiku)
   - Subdivision No. 709 (Pleiku)
   - Gia Lai Construction and Electric Assembly Company (Pleiku)

The pilot model plants were constructed by local contractor, Gia Lai Construction and Electric Assembly Company (from Pleiku City, Gia Lai Province). The following table summarizes an evaluation of the local contractor in the course of construction and supervision of the pilot models from November 2001 to December 2001:

Table 5.7 Results of Evaluation

Evaluation items	Evaluation
Understanding of contract	Still needs experience
Cost proposal	On-time, acceptable
Document preparation	Speedy, acceptable but needs English up-skilling
Construction material preparation	Speedy and acceptable
Worker organization skill	Speedy and acceptable
Construction schedule	Followed the target schedule, acceptable
Understanding of progress meeting	Clearly understood
Quality control	Understand, but needs more attention at site

It is considered that a simple system for rural water supply could be constructed by the local contractors. Almost all of the construction materials for the rural water supply facilities are available in the local markets of Vietnam, except the submersible pump motors and control panels. Water meters are also available from

Assembly Company in line with the licensed production of a qualified French Company. Popular water meters for house connection are made in China and India. Both meters were installed in G2 and K3-1 systems.

5.6 Necessary Monitoring Items

Necessary documents for monitoring items are shown in Appendix 8-1. The monitoring will be continued by WSU with the help of PCERWASS. The main items are listed below.

Daily operation records

- Pump operation time, production water volume, and meter reading, water loss, conventional water quality test etc. (Form-c1)
- Maintenance records (Form-c2)
- List of summarized pump operation and water production (Form-c3)

Monthly records

- Monthly report for new user registrations and remarkable O/M topics
- Records of every user (water meter reading)
- Records of water charge collections
- Account records (revenues and expenditures)
- Diseases and number of patients

5.7 Results of the Monitoring of O&M

5.7.1 Purpose and Methodology

A follow-up mission to collect management and operation experience from the pilot models in Dak Ui (K3-1) and Nhon Hoa (G2) was undertaken by Mr. Pham Anh Dung (CERWASS) and the Study Team Member (Mr. Hannu Vikamn) in the period of 4 - 8 May 2002. The mission collected records and documents from the two Water Supply Units (WSUs) interviewed the managers and staff of the WSUs as well as customers, and visited sites, including pumping stations, treatment plant (in K3-1), public taps and private connections. The operation data was summarised in Table 3.1 for for G2 system in daily basis.

5.7.2 Progress and Status

Both pilot models came into operation by the end of January 2002. Along with official handing-over, a water quality kit and a set of manuals, model reports, records and documents were distributed to the WSUs.

The institutional capacity of both WSUs needs further building. Both communes have managed to operate and maintain the system and collect revenues. A problem was exacerbated by the status of PCERWASS of Kon Tum. The experience and capacity of PCERWASS is not up to the level of its counterpart in Gia Lai. Furthermore, PCERWASS of Gia Lai was involved in the implementation of the pilot model at Dak Ui, which has probably resulted in some confusion and misinterpretation of the responsibilities by PCERWASS of Kon Tum. The mission tried to clarify the situation and requested Kon Tum PCERWASS to closely follow-up and support the WSU and the People's Committee in Dak Ui.

The total number of house connections in G2 is 38 as at 8 May. There also three public taps at schools and a "public" tap at the market managed and operated by a vendor. The estimated number of beneficiaries, i.e., people using water from the scheme in G2 (excluding customers of the vendor) is about 170.

As shown Table 3.1 and Table 3.2, both schemes have been operated more or less on a daily basis. Interviewed customers reported to have benefited from almost uninterrupted service in both communes. Interruptions in K3-1 were explained as having resulted from power failures (one power failure occurred during a site visit) and few interruptions in G2 arose from the installation of new customer connections.

Since the beginning, the total pumped water volumein K3-1 until May 07 has been about 4,500 m^3. Meters have been read twice. Based on very limited and partly questionable data from the end of March, "sold" water (so far unbilled but metered) was about 930 m^3 against the total pumping of about 1700 m^3. This suggests that non-revenue water is some 45%. The most significant single reason for high losses was substantial overflow from the treatment plant, due to long pumping periods. Communication has now been improved and there has been no overflowing since June 2002.

The total pumping from the beginning until May 08 in G2 has been about 1,800 m^3. WSU has maintained quite reliable monthly records. According to these records, the water use between January 27 and April 30 totalled 1,355 m^3 while the metered water use in the same period was 1,182 m^3, a difference of 13%.

The tariff in G2 is VND 2,000 per m^3 and in K3-1 1,500 per m^3. The tariff in G2 could provide sustainable financial status if the number of house connections and the volume of sold water increased closer to the capacity of the system. The tariff of VND 1,500/ m^3 in K3-1 and its water sales are almost equal to the original estimate for the first year due to high water consumption volume, though the house connection number is limited at present. IEC activities are important to increase the house connection.

According to the water analysis reports the water quality in both schemes is in-compliance with the Vietnamese and international water quality standards. However, users in G2 have complained about water quality. Although some nitrites were identified at the beginning of the operation, repeated sampling and analysis managed by PCERWASS showed that no further occurrence. After boiling a small volume of white/greyish sedimentation can be observed at the bottom of vessels. It is possible and even likely that the problem is mainly aesthetic and does not involve any risks. The most probable cause is calcium. The mission took samples to be analysed in Buon Ma Thuot, Hanoi and Tokyo. The result is shown in Data Book "Water Quality". The water quality in G2 as perceived by the customers is, however, restrictings the interest of existing customers to use water and potential new customers to register. The results have confirmed that the water quality in G2, on the basis of the analysed parameters; i) does not constitute any risk for human health, ii) is in compliance with Vietnamese water quality standards (Standard 5050 of MOH) as well as international standards and guidelines (WHO, EU, EPA of USA, etc), and iii) is not affected by high iron concentrations of any substances that could explain the white/greyish sedimentation. Similar problems are often caused by high hardness, but analysed hardness (about 50 mg/l) and concentration of calcium (about 5 mg/l) in G2 are not sufficient to explain the cause of sedimentation. It is very likely that the problem is mainly aesthetic and does not involve any risk.

The mission did not observe any wastage of water by users. For example, there were no taps of public water points left opened. In K3-1, some civil works of public water points have been partly damaged.

Issues

The issues at G2 include water quality, lack of potential customers along pipelines (designed to serve minority population), manual pump operation (resulting in overflows) and pending action on establishment of rules, proper accounting, and more detailed data base on customers.

There are more issues in K3-1. The most serious are related to low level of system management.

There is rubbish (leaves and small branches from nearby trees) in the filter basin of the treatment plant. The WSU constructed a cover after obtaining the necessary money at the beginning of June 2002. Manual pump operation in K3-1 is not practical due to the location of treatment plant some distance from the pumping station. The percentage of water losses and excessive pumping suggest that there is an urgent need to improve cost-consciousness by the WSU. JICA Study Team donated a set of transceivers recently (June 2002) to WSU of K3-1 system as a communication tool between the reservoir tank (iron removal treatment) and pump station.

The time frame for information, education and communication (IEC) has been too short to achieve good results. For example, customers of K3-1 said that the water quality is very good, yet some of them (even teachers) preferred to drink water from shallow wells, due to the taste that they were used to (saying that the piped water “did not taste sweet”). Further IEC is definitely needed. This will take time whereas the capacity building of WSUs is a more urgent matter.

5.8 Lessons Learned

5.8.1 Institutional Aspects

Some of the communes in the area selected for the Study, (Dak Ui - K3-1), have been generously supported by the Government of Vietnam through free or highly subsidized investments and services.

It is obvious that in a situation where both extensive infrastructure building and changing of inhabitant's attitudes are still required at the provincial level, it is difficult to expect that the district level could have substantial role in supporting communes, WSUs and users. It will take time, probably several years, before the Units of Agriculture and Rural Development in the district will be developed enough and prepared to play the role suggested in the NRWSS. It is strongly recommended that CERWASS shall technically support to PCERWASS, and PCERWASS should train to WSU for the both aspects of technical and managerial viewpoints.

5.8.2 Financial Aspects

The tariff of VND 2,000/m^3 in G2 is sufficient for financial sustainability even for the financing of re-investment in longer term even though the number of house connections is still less than half of the estimated average of the first year.

The tariff of VND 1,500/m^3 in K3-1 is enough for salary, electrical charges payment and small amount of repair. Excessive pumping, the very low number of metered house connections and extremely low start in billing and collection make the situation even worse, and the sustainability is at risk. The short period of operation of the pilot models also does not provide for sufficient information. In future, People's Committee should support to WSU for sudden requirement of replacement for submersible pump etc.

5.8.3 Technical Aspects

One of the most serious technical problems is the vulnerability of power supply. The unreliability of power supply is an external factor. Its impacts can be reduced, however, by taking its impacts into account in the design of the water supply schemes.

Experience from the first few months of operation shows that pumps can be operated manually reasonably well (in G2). On the other hand, operation practice in K3-1 has ignored wastage of water and energy, even though the volume of the reservoir in K3-1 is significant and should allow more accurate optimization of pumping than in G2. The study team supplied the transceiver for proper pump operation to the both WSUs. An automatic pump switch on/off device may be required for other systems.

It is vital that the WSU is able to make connections and repair broken pipelines.

Table 5.8 Daily operation record of G2

Month	Date	Time (min)	F (s)	F (e)	F (m^3)	Power (s)	Power (e)	Power (kWh)	F (m^3/d)	Day	F (m^3/h)	E (kWh/m^3)
Jan	27	25	270	273	3	150	152	2	3	Sun	7.2	0.67
	28	45	273	278	5	152	155	3			6.7	0.60
		25	278	280	2	155	155	0	7	Mon	4.8	0.00
	29	30	280	285	5	155	158	3	5	Tue	10.0	0.60
	30	30	285	289	4	158	160	2			8.0	0.50
		35	289	294	5	160	163	3	9	Wed	8.6	0.60
	31	30	294	298	4	163	165	2			8.0	0.50
		40	298	303	5	165	168	3	9	Thu	7.5	0.60
Feb	1	40	303	308	5	168	171	3			7.5	0.60
		35	308	312	4	171	173	2	9	Fri	6.9	0.50
	2	30	312	316	4	173	175	2			8.0	0.50
		25	316	318	2	175	175	0	6	Sat	4.8	0.00
	3	45	318	323	5	175	178	3			6.7	0.60
		35	323	328	5	178	181	3	10	Sun	8.6	0.60
	4	30	328	332	4	181	183	2			8.0	0.50
		35	332	336	4	183	185	2	8	Mon	6.9	0.50
	5	60	336	340	4	185	187	2			4.0	0.50
		30	340	347	7	187	191	4	11	Tue	14.0	0.57
	6	30	347	352	5	191	194	3	5	Wed	10.0	0.60
	7	55	352	362	10	194	198	4			10.9	0.40
		30	362	366	4	198	199	1	14	Thu	8.0	0.25
	8	50	366	372	6	199	202	3			7.2	0.50
		35	372	377	5	202	205	3	11	Fri	8.6	0.60
	9	35	377	382	5	205	208	3	5	Sat	8.6	0.60
	10	50	382	388	6	208	214	6	6	Sun	7.2	1.00
	11	45	388	394	6	214	218	4			8.0	0.67
		55	394	400	6	218	222	4	12	Mon	6.5	0.67
	12	30	400	404	4	222	224	2			8.0	0.50
		50	404	410	6	224	228	4	10	Tue	7.2	0.67
	13	50	410	416	6	228	234	6			7.2	1.00
		50	416	422	6	234	237	3	12	Wed	7.2	0.50
	14	50	422	428	6	237	240	3			7.2	0.50
		30	428	432	4	240	241	1	10	Thu	8.0	0.25
	15	30	432	436	4	241	242	1			8.0	0.25
		40	436	442	6	242	244	2	10	Fri	9.0	0.33
	16	40	449	455	6	244	246	2	6	Sat	9.0	0.33
	17	55	455	462	7	246	249	3			7.6	0.43
		55	462	469	7	249	252	3	14	Sun	7.6	0.43
	18	40	469	475	6	452	454	2	6	Mon	9.0	0.33
	19	40	482	489	7	454	456	2			10.5	0.29
		25	489	493	4	457	457	0	11	Tue	9.6	0.00
	20	45	493	498	5	457	458	1			6.7	0.20
		60	498	505	7	458	461	3			7.0	0.43
		35	505	510	5	461	462	1	17	Wed	8.6	0.20
	21	60	510	516	6	462	464	2			6.0	0.33
		60	516	522	6	464	467	3	12	Thu	6.0	0.50
	22	30	522	526	4	467	468	1			8.0	0.25
		35	526	531	5	468	469	1	9	Fri	8.6	0.20
	23	60	531	538	7	469	473	4			7.0	0.57
		35	538	541	3	473	473	0	10	Sat	5.1	0.00
	24	40	541	546	5	473	476	3			7.5	0.60
		50	546	552	6	476	477	1	11	Sun	7.2	0.17
	25	30	552	556	4	477	478	1	4	Mon	8.0	0.25
	26	45	556	561	5	478	480	2	5	Tue	6.7	0.40
	27	30	561	565	4	480	481	1			8.0	0.25
		40	565	570	5	481	483	2	9	Wed	7.5	0.40
	28	65	570	578	8	483	487	4	8	Thu	7.4	0.50

Table 5.8 (2/4) Daily operation record of G2

Month	Date	Time (min)	F (s)	F (e)	F (m^3)	Power (s)	Power (e)	ower (kWh)	F (m^3/d)	Day	F (m^3/h)	E (kWh/m^3)
Mar	1	45	578	582	4			0			5.3	0.00
		50	582	588	6			0	10	Fri	7.2	0.00
	2	50	588	593	5			0			6.0	0.00
		50	593	599	6			0	11	Sat	7.2	0.00
	3	50	599	605	6			0			7.2	0.00
		50	605	612	7			0	13	Sun	8.4	0.00
	4	0	612	612	0			0	0	Mon	0.0	0.00
	5	370	612	633	21			0			3.4	0.00
		110	633	638	5			0	26	Tue	2.7	0.00
	6	80	638	644	6			0			4.5	0.00
		70	644	651	7			0	13	Wed	6.0	0.00
	7	80	651	661	10			0			7.5	0.00
		100	661	669	8			0	18	Thu	4.8	0.00
	8	60	669	675	6			0			6.0	0.00
		40	675	670	-5			0			-7.5	0.00
		80	670	676	6			0	7	Fri	4.5	0.00
	9	80	676	683	7			0			5.3	0.00
		85	683	690	7			0	14	Sat	4.9	0.00
	10	75	690	696	6			0			4.8	0.00
		40	696	700	4			0	10	Sun	6.0	0.00
	11	50	700	706	6			0	6	Mon	7.2	0.00
	12	50	706	712	6			0	6	Tue	7.2	0.00
	13	50	712	718	6			0			7.2	0.00
		40	718	723	5			0	11	Wed	7.5	0.00
	14	50	723	729	6			0	6	Thu	7.2	0.00
	15	90	729	737	8			0			5.3	0.00
		40	737	742	5			0	13	Fri	7.5	0.00
	16	50	742	748	6			0			7.2	0.00
		60	748	754	6			0	12	Sat	6.0	0.00
	17	80	754	764	10			0			7.5	0.00
		25	764	767	3			0	13	Sun	7.2	0.00
	18	40	767	773	6			0			9.0	0.00
		40	773	778	5			0	11	Mon	7.5	0.00
	19	50	778	784	6			0			7.2	0.00
		30	784	788	4			0			8.0	0.00
		70	788	796	8			0	18	Tue	6.9	0.00
	20	65	796	805	9			0			8.3	0.00
		30	805	809	4			0	13	Wed	8.0	0.00
	21	45	809	816	7			0			9.3	0.00
		40	816	822	6			0	13	Thu	9.0	0.00
	22	40	822	828	6			0			9.0	0.00
		35	828	833	5			0			8.6	0.00
		30	833	837	4			0	15	Fri	8.0	0.00
	23	55	837	844	7			0			7.6	0.00
		60	844	850	6			0	13	Sat	6.0	0.00
	24	120	850	861	11			0			5.5	0.00
		30	861	864	3			0			6.0	0.00
		30	864	867	3			0	17	Sun	6.0	0.00
	25	35	867	872	5			0			8.6	0.00
		40	872	877	5			0	10	Mon	7.5	0.00
	26	40	877	883	6			0			9.0	0.00
		55	883	890	7			0	13	Tue	7.6	0.00
	27	60	890	896	6			0	6	Wed	6.0	0.00
	28	40	896	901	5			0			7.5	0.00
		60	901	909	8			0	13	Thu	8.0	0.00
	29	40	909	914	5			0			7.5	0.00
		40	914	919	5			0	10	Fri	7.5	0.00
	30	105	919	928	9			0			5.1	0.00
		60	928	936	8			0	17	Sat	8.0	0.00
	31	120	936	945	9			0			4.5	0.00
		100	945	957	12			0			7.2	0.00
		30	957	961	4			0	25	Sun	8.0	0.00

Table 5.8 (3/4) Daily operation record of G2

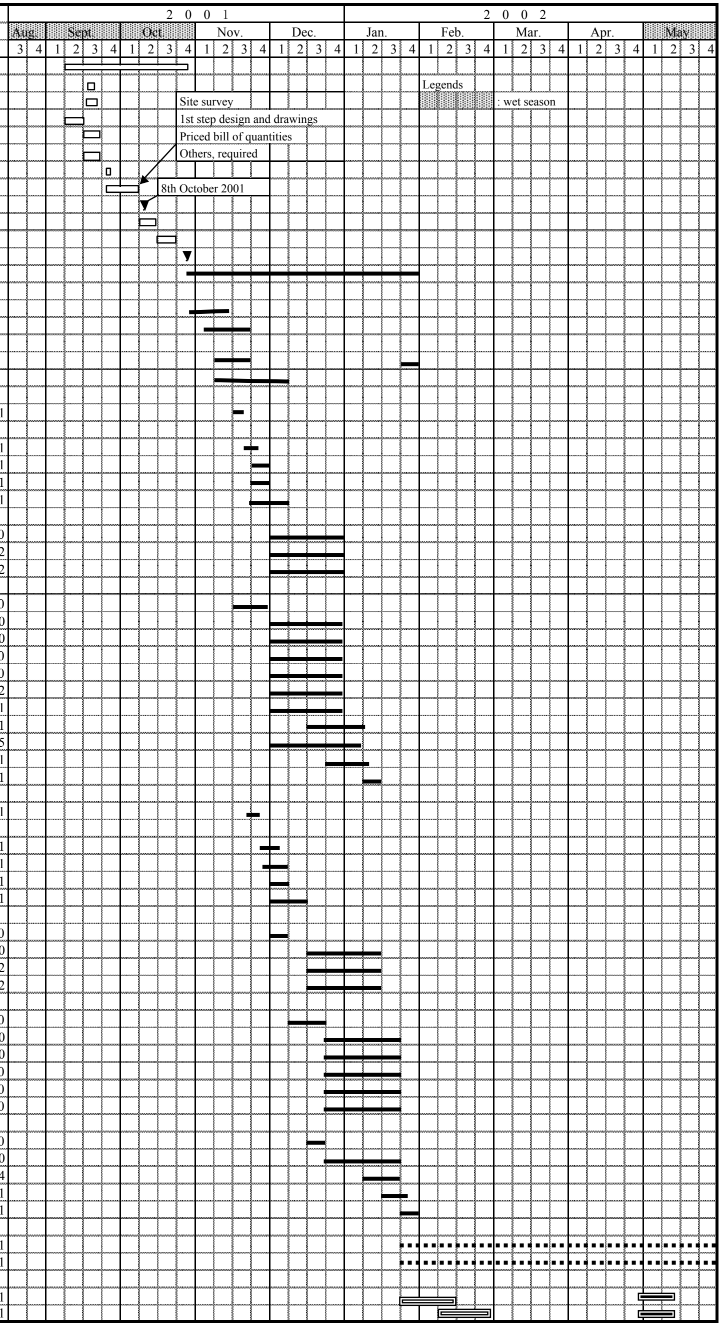
Month	Date	Time (min)	F (s)	F (e)	F (m^3)	Power (s)	Power (e)	ower (kWh)	F (m^3/d)	Day	F (m^3/h)	E (kWh/m^3)
Apr	1	n.a.	961	973	12			0	12	Mon	#VALUE!	0.00
	2	90	973	983	10			0			6.7	0.00
		60	983	990	7			0			7.0	0.00
		80	990	1000	10			0			7.5	0.00
		60	1000	1008	8			0	35	Tue	8.0	0.00
	3	55	1008	1015	7			0			7.6	0.00
		95	1015	1024	9			0			5.7	0.00
		60	1024	1032	8			0	24	Wed	8.0	0.00
	4	55	1032	1039	7			0			7.6	0.00
		65	1039	1048	9			0			8.3	0.00
		n.a.	1048	1051	3			0	19	Thu	#VALUE!	0.00
	5	115	1051	1066	15			0			7.8	0.00
		50	1066	1074	8			0	23	Fri	9.6	0.00
	6	110	1074	1085	11			0			6.0	0.00
		90	1085	1094	9			0	20	Sat	6.0	0.00
	7	90	1094	1105	11			0			7.3	0.00
		40	1105	1110	5			0			7.5	0.00
		40	1110	1115	5			0	21	Sun	7.5	0.00
	8	125	1115	1132	17			0			8.2	0.00
		90	1132	1145	13			0	30	Mon	8.7	0.00
	9	0			0			0	13	Tue	#DIV/0!	#DIV/0!
	10	60	1145	1153	8			0			8.0	0.00
		60	1153	1161	8			0			8.0	0.00
		30	1161	1165	4			0	20	Wed	8.0	0.00
	11	90	1165	1177	12			0			8.0	0.00
		90	1177	1188	11			0	23	Thu	7.3	0.00
	12	95	1188	1199	11			0			6.9	0.00
		130	1199	1215	16			0	27	Fri	7.4	0.00
	13	80	1215	1225	10			0			7.5	0.00
		130	1225	1237	12			0	22	Sat	5.5	0.00
	14	110	1237	1252	15			0			8.2	0.00
		180	1252	1268	16			0	31	Sun	5.3	0.00
	15	60	1268	1275	7			0			7.0	0.00
		140	1275	1279	4			0	11	Mon	1.7	0.00
	16	65	1279	1286	7			0			6.5	0.00
		60	1286	1292	6			0			6.0	0.00
		40	1292	1296	4			0	17	Tue	6.0	0.00
	17	60	1296	1312	16			0			16.0	0.00
		40	1312	1316	4			0	20	Wed	6.0	0.00
	18	135	1316	1326	10			0			4.4	0.00
		60	1326	1335	9			0	19	Thu	9.0	0.00
	19	140	1335	1345	10			0			4.3	0.00
		100	1345	1351	6			0			3.6	0.00
		50	1351	1355	4			0	20	Fri	4.8	0.00
	20	150	1355	1368	13			0			5.2	0.00
		60	1368	1376	8			0			8.0	0.00
		45	1376	1380	4			0	25	Sat	5.3	0.00
	21	150	1380	1392	12			0			4.8	0.00
		60	1392	1399	7			0			7.0	0.00
		50	1399	1404	5			0	24	Sun	6.0	0.00
	22	75	1404	1414	10			0			8.0	0.00
		75	1414	1422	8			0			6.4	0.00
		40	1422	1429	7			0	25	Mon	10.5	0.00
	23	70	1429	1438	9			0			7.7	0.00
		60	1438	1450	12			0			12.0	0.00
		60	1450	1456	6			0	27	Tue	6.0	0.00
	24	80	1456	1470	14			0			10.5	0.00
		30	1470	1480	10			0			20.0	0.00
		60	1480	1487	7			0	31	Wed	7.0	0.00
	25	90	1487	1500	13			0			8.7	0.00
		120	1500	1510	10			0	23	Thu	5.0	0.00
	26	80	1510	1519	9			0			6.8	0.00
		100	1519	1530	11			0	20	Fri	6.6	0.00

Table 5.8 (4/4) Daily operation record of G2

Month	Date	Time (min)	F (s)	F (e)	F (m^3)	Power (s)	Power (e)	'ower (kWh)	F (m^3/d)	Day	F (m^3/h)	E (kWh/m^3)
	27	70	1530	1538	8			0			6.9	0.00
		50	1538	1543	5			0			6.0	0.00
		40	1543	1548	5			0	18	Sat	7.5	0.00
	28	80	1548	1558	10			0			7.5	0.00
		60	1558	1563	5			0			5.0	0.00
		60	1563	1568	5			0	20	Sun	5.0	0.00
	29	80	1568	1578	10			0			7.5	0.00
		40	1578	1588	10			0	20	Mon	15.0	0.00
	30	90	1588	1597	9			0			6.0	0.00
		120	1597	1608	11			0	20	Tue	5.5	0.00
May	1	70	1608	1615	7			0			6.0	0.00
		60	1615	1620	5			0			5.0	0.00
		70	1620	1627	7			0	19	Wed	6.0	0.00
	2	75	1627	1635	8			0			6.4	0.00
		75	1635	1642	7			0			5.6	0.00
		60	1642	1648	6			0	21	Thu	6.0	0.00
	3	80	1648	1658	10			0			7.5	0.00
		65	1658	1667	9			0	19	Fri	8.3	0.00
	4	65	1667	1672	5			0			4.6	0.00
		75	1672	1679	7			0			5.6	0.00
		80	1679	1685	6			0	18	Sat	4.5	0.00
	5	90	1685	1695	10			0			6.7	0.00
		70	1695	1701	6			0			5.1	0.00
		60	1701	1705	4			0	20	Sun	4.0	0.00
	6	120	1705	1717	12			0			6.0	0.00
		110	1717	1726	9			0			4.9	0.00
		60	1726	1730	4			0	25	Mon	4.0	0.00
	7	80	1730	1738	8			0			6.0	0.00
		50	1738	1747	9			0			10.8	0.00
		100	1747	1755	8			0			4.8	0.00

Figure 5.1 Schedule of Model Plants Construction in Dak Ui (K3-1) and Nhon Hoa (G2) Communes

			Activities / Construction Items / Work Items	Unit	Q'ty
A	Pre-construction activities				
	a)		Preparation of Candidate Subcontractor`s List	LS	1
	b)		Selection of Candidate Subcontractors	LS	1
	c)		Preparation of Sub-Contarct Agreement and Terms of Reference (TOR)	LS	1
	d)		Approval of JICA for Sub-Contract Agreement and TOR	LS	1
	e)		Review & Acknowledgement by CERWASS for Sub-Contract and TOR	LS	1
	f)		Distribution of TOR to Candidate Sub-Contractors	LS	1
	g)		Preparation of Proposals by the Candidate Sub-Contractors	LS	1
	h)		Closing Date of Submission of Proposals	LS	1
	i)		Assessment of Proposals / Recommendation to JICA	LS	1
	j)		JICA`s Concurrence and Approval	LS	1
	k)		Conclusion of Sub-Contract Agreement	LS	1
B	Construction				
	B1		Survey and design, K3-1 and G2		
		1)	Topographic survey	LS	1
		2)	2nd step design	LS	1
	B2		Mobilization, Demobilization and Procurement, K3-1 and G2		
		1)	Mobilization / Demobilization		
		2)	Procurement of pump, pipes, fittings and others		
	B3		K3-1 Dak Ui Commune (No. 1A, 1B, 5B, 6 and 7, Peak demand : 2.0 m3/h)		
		1)	Well head arrangements	LS	1
		2)	Raw water pump, furnishing and installation		
			- Submersible pump, 1.0 l/s x 70 m	no.	1
			- Control panel, motor protection, motor cable of 100 m	no.	1
		3)	Power supply from national grid	LS	1
		4)	Storage reservoir, 5 m3 tank, valves, bends & others	LS	1
		5)	Raw water main, furnishing and installation		
			- GI materials, 100 mm dia.	lin.m	1,400
			- Sector valves, 100 mm dia	no.	2
			- Valve chambers, bends 90 degrees, each	no.	2
		6)	Distribution pipes, furnishing and installation		
			- Clearing of piperoute	sq.m	12,000
			- PVC w/valves, 100 mm dia.	lin.m	600
			- PE w/valves, 90 mm dia.	lin.m	500
			- PE w/valves, 65 mm dia.	lin.m	1,600
			- PE w/valves, 50 mm dia.	lin.m	3,200
			- Valve chambers	no.	12
			- bends and tees	LS	1
		7)	Small distribution pipes and valves	LS	1
		8)	Public taps, type 3, w/meter	no.	45
		9)	Pressure testing	LS	1
		10)	Disinfection	LS	1
	B4		G2 Nhon Hoa Commune (Plei Kia & Hoa An Villeges, Peak demand : 1.1 m3/h)		
		1)	Well head arrangements	LS	1
		2)	Raw water pump, furnishing and installation		
			- Submersible pump, 1.0 l/s x 70 m	no.	1
			- Control panel, Motor protection, motor cable of 200 m	LS	1
		3)	Power supply from national grid	LS	1
		4)	Storage reservoir, 5 m3 tank, valves, bends & others	LS	1
		5)	Raw water main, furnishing and installation		
			- Clearing piproute	sq.m	1,000
			- GI materials, 100 mm dia.	lin.m	500
			- Sector valves, 100 mm dia	no.	2
			- Valve chambers, bends 90 degrees each	no.	2
		6)	Transmission pipes w/valves, bends and tees		
			- Clearing of pipe route	sq.m	7,000
			- PVC, 150 mm dia., furnishing and installation	lin.m	600
			- PE, 100 mm dia., furnishing and installation	lin.m	500
			- PE, 65 mm dia., furnishing and installation	lin.m	1,600
			- PE, 50 mm dia., furnishing and installation	lin.m	1,500
			- PE 40 mm dia., funishing and installation	lin.m	1,500
		7)	Distribution pipes		
			- Clearing of piperoute	sq.m	3,000
			- PE w/valves, bends 25 mm dia., furnishing and installation	lin.m	800
		8)	Public taps, type 3, w/meter	no.	4
		9)	Pressure testing	LS	1
		10)	Disinfection	LS	1
C	Operation and Maintenance of Model Plants and Its Monitoring				
	C1		K3-1 Dak Ui Commune	LS	1
	C2		G2 Nhon Hoa Commune	LS	1
D	Intermediate Assessment of Model Plant				
	D1		K3-1 Dak Ui Commune	LS	1
	D2		G2 Nhon Hoa Commune	LS	1



Chapter 6 Recommendations for Implementation Schedule and Method

6.1 Grouping of the Priority 21 Systems

In the feasibility study, the priority 21 systems were prioritised. Based on the prioritisation, two systems were selected for the Pilot Model Project in order to test the plan and to identify unknown problems during the study period.

The Pilot Model project suggested that careful consideration should be given to organisational aspects related to local entrenched habits that require changing

Another grouping of the 21 systems has been considered for the purpose of budgetary arrangement and consequently for the implementation priority. The following three aspects were taken into account for the grouping.

- Feasibility evaluation (Prioritisation)
- Results of the Pilot Model Project
- Equal opportunity for the targeted 3 provinces
- Requests from Vietnam Government

The 21 systems were grouped into 4 groups (A, B, C and D) as shown in the Table 6.1. The following explains the reasons for the grouping for each province:

As shown by the good performance of the G2 pilot scheme, most of the systems in Gia Lai have higher sustainability in economical terms than those of Kon Tum. Therefore, an implementation of two systems in each step has been applied. In the previous evaluation for Gia Lai province G1 and G3-1were ranked as top priority, followed by G2, G4-1, G5-1, G6-1, and G7-1. The G2 pilot scheme has been successful although with only a 10% service coverage area at present. The expansion opportunities for G2 are considerable and with more financial subsidy would be a good model case for the Central Highlands region. Therefore, the implementation program of two systems per step was decided (firstly G2 and G3-1, secondly G1 and G4-1, followed by G6-1 and G7-1).

Table 6.1 Plan of Phased Implementation of 21 Systems

Step	Implementation period	Group	Kon Tum	Gia Lai	Dac Lac	Number
1	2002-2005	A	K2-3	G2, G3-1	D1, D2	5
2	2004-2006	B	K4-1	G1, G4-1	D3-1, D6	5
3	2005-2008	C	K3-1	G5-1, G6-1	D4-1	4
4	2007-2010	D	K1-1, K2-1	G7-1	D3-2, D4-2, D5-1, D7	7

6.2 Implementation Plan

For the consideration of a phased implementation plan, three cases (implementation in 2 steps, 3 steps and 4 steps) were considered. Out of these three cases, implementation in 4 steps was considered to be most appropriate taking into account sustainability and preparedness of communes.

The phased implementation plan is presented in Table 6.2. With this implementation schedule, systems with a high preparedness of inhabitants can be implemented at early stages, while systems with low preparedness of inhabitants may be implemented at a later stage, after sufficient IEC campaign to raise preparedness to a sufficient level.

Table 6.2 Implementation Schedule for 21 systems

Step	Descriptions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
		NRWSS Target in Phase 1 (till 2010)									
	Master Plan										
	Feasibility Study										
	Financial Arrangement			1st step		2nd step		3rd step		4th step	
	Selection of consultant										
	Field survey and Investigation										
	Basic Design										
	Tender Design										
	Tender and Contract										
	Procurememnt of Equipment			design, tender & procurement							
	Implementation										
1st	Structural Measures(5-system, K2-3, G3-1, G2, D1, D2)										
	Soft component										
	- Capacity building										
	- IEC										
	- O&M activities										
2nd	Structural Measures (5-system, K4-1, G1, G4-1, D3-1, D6)										
	Soft component										
	- Capacity building										
	- IEC										
	- O&M activities										
3rd	Structural Measures(4-system, K3-1, G5-1, G6-1, D4-1)										
	Soft component										
	- Capacity building										
	- IEC										
	- O&M activities										
4th	Structural Measures (7-system, K1-1, K2-1, G7-1, D3-2, D4-2, D5-1, D7)										
	Soft component										
	- Capacity building										
	- IEC										
	- O&M activities										

6.3 Allocation of the Project Cost

The construction cost for the development of the 21 prioritized systems has been estimated for a service coverage of 86 % of the population in the targeted communes and provinces of the Central Highlands.

The project cost is summarized in Table 6.3 and meets the 4-step proposed implementation up to the year 2010 in line with the NRWSS strategy.

Table 6.3 Cost of the 21 Piped Water Supply Schemes

US$ 1.0=VND 15,000.0=JY 120.0

No.	No.	System No.	Name of Commune	Construction Cost (US$)*1	Base Cost (US$)*2	Project Cost (US$) *3				
						1st step	2nd step	3rd step	4th step	step 1 to 4
						5-system	5-system	4-system	7-system	21-system
						2002-2004	2004-2006	2006-2008	2008-2010	2002-2010
		Kon Tum		**2,140,805**	**2,461,926**	**561,334**	**581,175**	**259,908**	**1,305,702**	**2,708,119**
1	1	K1-1	Bo Y	875,885	1,007,268				1,107,995	1,107,995
2	2	K2-1	Dak Su	156,290	179,734				197,707	197,707
3	3	K2-3	Dak Su	443,742	510,303	561,334				561,334
4	4	**K3-1**	Dak Ui	205,461	236,280			259,908		259,908
5	5	**K4-1**	Dak Hring	459,427	528,341		581,175			581,175
		Gia Lai		**3,392,611**	**3,901,503**	**2,098,521**	**1,205,832**	**699,827**	**287,473**	**4,291,653**
6	1	**G1**	Kong Tang	607,639	698,785		768,663			768,663
7	2	**G2**	Nhon Hoa	1,064,964	1,224,709	1,347,179				1,347,179
8	3	**G3-1**	Chu Ty	593,946	683,038	751,342				751,342
9	4	**G4-1**	Thang Hung	345,588	397,426		437,169			437,169
10	5	**G5-1**	Ngia Hoa	340,560	391,644			430,808		430,808
11	6	**G6-1**	Ia Rsiom	212,663	244,562			269,019		269,019
12	7	G7-1	Kong Yang	227,251	261,339				287,473	287,473
		Dac Lac		**4,515,889**	**5,193,272**	**1,982,864**	**1,153,380**	**688,513**	**1,887,841**	**5,712,598**
13	1	**D1**	Krong Nang	640,632	736,727	810,399				810,399
14	2	**D2**	Ea Drang	926,850	1,065,878	1,172,465				1,172,465
15	3	**D3-1**	Krong Buk	337,039	387,595		426,354			426,354
16	4	D3-2	Krong Buk	321,530	369,760				406,735	406,735
17	5	**D4-1**	Ea Drong	544,279	625,921			688,513		688,513
18	6	D4-2	Ea Drong	246,098	283,013				311,314	311,314
19	7	D5-1	Ea Wer	566,628	651,622				716,784	716,784
20	8	**D6**	Kien Duc	574,724	660,933		727,026			727,026
21	9	D7	Krong Kmar	358,109	411,825				453,008	453,008
		Total		**10,049,305**	**11,556,701**	**4,642,719**	**2,940,387**	**1,648,248**	**3,481,016**	**12,712,370**
		VAT (10 %)				**360,423**	**239,033**	**130,296**	**275,179**	**1,004,931**
		Total				**5,003,142**	**3,179,420**	**1,778,544**	**3,756,195**	**13,717,301**

Note: *1 Construction cost
*2 Base cost = Construction cost + Land acquisition cost + Engineering services cost (15 % of construction cost)
*3 Project cost = Base cost + Physical contingency (10 % of base cost), excluding price contingency

6.4 Procurement of Necessary Drilling Equipment

The drilling rigs and all equipment used for the study were old and were subject to many mechanical troubles. They have been used for more than 25 years and were donated by the former Soviet Union. Resuming work for well construction after core drilling took much time and effort. Although aquifers were found at approximate 200m depth in Gia Lai province, it was difficult to ream the full depth. The generator, air compressor and electrical logging instruments are old, have small capacity, and are in extremely poor condition.

The Vietnamese authorities considered the equipment would be suitable for the required drilling work provided repairs were undertaken promptly and the equipment was well maintained. In order to improve their drilling work, procurement of a new set of drilling equipment should be considered for the implementation stage. The equipment can be effectively utilized by the Vietnamese authorities after the first implementation, particularly for the financially and economically disadvantaged areas.

The procurement cost of one lot of drilling equipment in the first step was estimated at US$ 2.8 million by ex-go-down Yokohama Port basis.

Chapter 7 Project Evaluation

The project was evaluated from several points of view.

7.1 Contribution to the National Strategy

National Strategy for water supply (NRWSS) set up a target that 85% of the total population should be supplied with water by the year of 2010 (Phase-1). The project was programmed in accordance with the national strategy. Implementation of the project will contribute to the achievement of the target.

7.2 Demonstration Effects as Model Projects

The NRWSS also set up a target that the 100 % of the population should be water supplied by the year of 2020 (Phase-2). Although the study did not include Phase-2 in the feasibility study, implementation of Phase-1 will have positive impacts on the neighbouring communes. It is expected that the project could encourage the neighbouring inhabitants to increase their motivation and to prepare themselves for water supply projects. This could lead to the implementation of Phase-2 projects, which would contribute the full achievement of the national strategy.

7.3 Technical Aspects

Wherever possible, simplified designs were adopted for the water supply facilities to minimize operation and maintenance requirements. Locally available materials were also applied wherever possible. Therefore, the design and concept can also be introduced not only to the second stage (Phase-2) but also to the other unrelated projects. It is considered that the design concept of the project will contribute the technical development of the country. New technology using solar power and related pump systems can be introduced to reduce the running cost for the systems in the poor communes and improve the environmental effect by using clean energy.

7.4 Operation and Maintenance Aspects

The Study proposed organisational arrangement and introduction of comprehensive IEC campaigns. Through the implementation of the arrangement, organisational activities at various levels will be stimulated, clear role distinctions will be recognised and definite responsibility of personal can be realised. This positive effect is expected to spread to other fields of activities.

7.5 Environmental and Hygiene Aspects

In all three provinces, rather high ratios of water related diseases are reported. Implementation of the project will provide those inhabitants with clean water and contribute to a decrease in the population suffering from such diseases. In particular, infant mortality can be drastically reduced.

7.6 Social Equality (Help for Ethnic Minorities)

The special issues inherent to the Central Highlands of Vietnam are said to be poverty and minority. Servicing clean water to the poverty areas and minorities is one of the crucial matters for social stabilisation of the area. Equal allocation of natural resources such as water is essential from this point of view.

The issues of poverty and ethnic minorities were taken into account in the selection of the priority projects, and the social equity issues were duly considered;

- Out of the total 4989 poverty households, 74% (3691 households) will be covered by the priority projects selected by the Study in phase 1; and
- Out of the total 10,139 ethnic minority households, 71% (7,174 households) will be supplied by piped schemes in phase 1.

Implementation of the project will accelerate the establishment of a society where every level of population can enjoy equal opportunities.

7.7 Gender Issues

Presently drinking water is delivered from nearby water sources. In dry seasons, water sources are sometimes very far from individual household. Women and children are currently responsible for drawing water. The water drawing activities impose on them physically heavy work and occupy a significant amount of their time. The project will alleviate such heavy work from women and children and create spare time in which women can participate in social activities (such as IEC activity through women's union). Children can also devote more time to schooling.

The implementation of the project will greatly contribute to the gender aspects.

7.8 Total Evaluation

The project, because it is a water supply project for poverty and minority, is hardly justifiable from an economical and financial point of view. Financial subsidies will be required for sustainable operation and maintenance. The Government of Vietnam expresses their firm commitment to subsidies for poor communes when required.

Provided that the initial investment costs and governmental subsidies are available, various unpredictable positive effects are expected. Among those, increasing of the social equality to the poverty and minority, improvement of hygiene conditions, reducing of infant mortality and contributions to gender aspects are significant.

Implementation of the project will contribute to satisfy the basic human needs of the inhabitants of the Central Highlands of Vietnam.

PART V RECOMMENDATIONS

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Chapter 1 Approach to Information, Education and Communication (IEC)

1.1 IEC and Hygiene Promotion

This section recommends activities for information, education, and communication activities (IEC) to encourage an increased demand for safe and clean water and hygienic latrines, and to increase the number of participants in the water supply systems as much as possible. IEC is the key to the financial sustainability of the proposed water supply systems. If people rely too much on subsidies, their self-dependence will not mature.

Inhabitants of the rural areas of the Central Highlands have lacked experience in paying for centralized water supply systems and in maintaining and operating them.. The use of these systems has resulted in improvements in health conditions of the local people, a reduction in time spent for water fetching and an increase in time for productive activities, especially, for women. IEC has been identified as the best method to promote the use of safe and clean water.

Formal networks, i.e. formal meetings, and home visits will be used for IEC. Promoters should be appointed by WSU to implement IEC activities for the promotion of piped water supply.

1.2 Parties Responsible for IEC

The parties responsible for IEC include:

Management Unit of CERWASS/PCERWASS,

CPC,

WSU, and

Promoters.

CERWASS/PCERWASS have decided to establish a Management Unit within the organization to train the local staff for rural water supply systems. The Management Unit should be responsible for the financial and technical support for IEC in the rural areas of the Central Highlands. The necessary finance should be earmarked for IEC. External support (i.e. international cooperation) may be necessary to formulate a model program of IEC and to train the IEC staff of the Unit for the initial stage. It is recommended that the materials developed by DANIDA for IEC be utilized and revised to formulate the model program.

In each commune, promoters should be appointed by the WSU to promote additional connections to the water supply systems. WSU should pay for the promoters with financial support from the CPC/TPC.

Promoters will also co-operate with IEC activities at the commune. Villagers, including health workers, women's union, and teachers may be appointed as promoters if appropriate. People selected as promoters must have the respect of the local people, be able to communicate in the local languages, and know the benefits of safe and clean water. The Management Unit of PCERWASS should train promoters in the model program to become familiar with IEC.

1.2.1 Necessary Information for IEC

Necessary information to be distributed includes the following:

1) **Objectives** of the town meeting
2) The **water supply plan** including the drawings, project cost, maintenance cost and its implementation schedule
3) The **water quality data of the present water sources** and the benefits of safe and clean water
4) **Benefits** of safe and clean water should be emphasized using pictures and drawings
5) **Costs** for house connections and the water charge
6) **Self support of the water supply system by** the local people
7) **Operation and maintenance procedures for public taps**

Objectives of town meeting

The most important information for meetings is to explain the objectives of the water supply schemes. These will be outlined to the local participants in the local languages by the promoters. It is necessary to explain: 1) that local people will benefit from the water supply system, and 2) the local people will be responsible for the management of the piped water supply system. The objectives should be repeated often during meetings.

The water supply plan

The second of type information to be provided is about the water supply plan itself. The information in the plan includes:

- CERWASS/PCERWASS has to be executed the plan;
- the locations of the explored wells and the main and secondary pipes;
- the amount of construction cost and O&M cost;
- the method of providing house connections;
- the time schedule of construction; and
- the safe well yield of the explored wells.

The structure of the explored well will be visually shown to the local users using pictures and drawings because it will further encourage the promotion of safe and clean water. The 10 m concrete and/or clay sealing at the top of the explored well will protect the water source from contamination by surface water.

Water quality

Health hazards, for example, diarrhea, trachoma, etc, from contaminated water will be explained. The importance of hygienic education such as appropriate latrine arrangement and cleaning of hands will also be explained.

The water quality of the present water sources will be explained to show the improved health benefits of using piped water (safe and clean). A simple table showing the water quality of the existing shallow dug wells (or surface water) compared to that of the explored (deep) well will be presented. Understanding the difference between the water quality in the deep well and the existing dug wells (or springs) encourages the promotion of safe and clean water. The comparison of **coliform** (an indicator of micro-organism contamination) between different water sources makes a difference to the local users. The effect of iron and/or manganese removal will also be explained.

Benefits of safe and clean water

The benefits of providing safe and clean water will be explained, including of the positive effects on health and reduction in workload and time, especially for women and children who currently fetch water from springs or dug wells. This information should be emphasized in the ethnic minority communes.

The explanation shall be modified to suit the social and natural condition of each commune.

Costs of the Project

Promoters need to explain the costs for the project, including construction cost, O&M cost and house connection cost. They also need to explain who shall pay each part of the project cost.

After explaining this information, the local people will have a much better understanding about the costs of a house connection and ongoing water charges.

Responsibilities of the local users

It is necessary to explain that the water charge will include the costs for operation and maintenance, and reinvestment. To minimize O&M costs, the following activities are necessary:

- Protection of the groundwater sources by keeping the environment of the wells clean;
- Maintain in good condition for their water meter or taps
- Regularly payment of bills for water used

Public taps

Public taps have been adopted in the design for many of the target ethnic minority villages during phase 1 (up to 2010). However, the operation and maintenance of public taps is complicated, because the tariff collection for public taps is more difficult than that for house connections. Information on how to collect water tariffs among users should be provided if necessary.

1.3 IEC Campaigns

Promoters appointed by WSU will be implementing IEC campaigns. These include the formal networks, town meetings, face-to-face communication such as home visit, and also local information media such as radio network and loudspeaker.

1.3.1 Formal Meeting

Formal meetings include regular town/commune meetings, meetings at health centers, meetings held by farmer's union, women's union and youth union. In particular, a **town meeting of the people's committee is the most common and easiest to organise**. The key points to follow for formal meetings are as follows:

1) A formal meeting is the starting point for IEC. IEC activities should start **4-5 months before the completion of construction works**.
2) Necessary information should be clearly identified and given to participants.
3) The **health center** (CHC) should be invited to the meeting and asked to co-operate.
4) **Tell simple and clear messages**.
5) A polite, and friendly **attitude** towards the local people is essential.
6) **Leaflets** and simple questionnaires should be provided after the meeting.

Most of the anticipated users of the piped water supply systems will be farmers. They would pay for a house connection by the income from a harvesting. IEC activities should be initiated (4 to 5 months) before the harvest season.

Cooperation from the health center is essential. The objective of the piped systems should be explained to the local people. In most cases, health workers are respected, and the local people follow their advice.

A gentle and polite attitude of promoters makes the local people comfortable and encourages the use of safe and clean water. As informal communication networks among family members, peers, and neighbours are essential for IEC, the attitude of promoters, whether friendly or arrogant, will quickly become known to all members of the communities.

As it is difficult to remember all details of spoken information at the meeting, simple leaflets will be prepared and distributed after the meeting. All the necessary information at the meeting will be printed in the Kinh and/or minority languages, as

UNICEF emphasizes the importance of the combination of printed materials such as leaflets together with the formal communication networks.

1.3.2 Face-to-face Communication

Home visits of exceptional case when it is required will follow the formal meeting. To promote house connections, promoters need to visit users' houses. Usually, home visits will be undertaken by community leaders (e.g. women's union, farmers' union, youth union), and it is recommended they accompany promoters to explain the necessary information.

In addition to the information elaborated above, the benefits of the provision of safe and clean water should be emphasized during the home visits. The most notable benefits of the use of safe and clean water are the promotion of health and the reduction in workload and time for water transportation. Illustrating with examples will help the local people more easily understand the benefits.

1.3.3 Local media

The local radio network and loud speakers are also useful if available. In the rural areas, communes/towns usually have access to the local radio network and loud speakers. The necessary information mentioned above can be broadcast on the radio in the local languages (Kinh and ethnic minorities' languages). Promoters need to contact CPC/TPC to provide the information outlined above.

1.4 Schedule of IEC and Promotors' Work

In order to ensure the effective IEC activities by promotors, a tentative schedule is shown in Table 1.1. The arrangements for staffing and their salaries should be discussed with PCERWASS and CPC/TPC or international donors if available. IEC activities are estimated as longer for the difficult communes by the construction stages. It is recommended to take a counter measurement such as long and periodical promoting to the difficult communes, and demonstrating the successful pilot model to the users.

Table 1.1 Tentative schedule for Soft Component activities

	Descriptions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	M/M
A	**Overall Management Team**											
1	Team Leader											96
2	Capacity building specialist											36
3	Administrator											96
B	**Provincial and Commune Team**											
B1	Implementation Period of 5-system											
	(K2-3, G3-1, G2, D1, D2)					(construction)						
1	Capacity building specialist											12
2	IEC activities by Promoters											24
B2	Implementation Period of 4-system											
	(K4-1, G1, G4-1, D3-1, D6)							(construction)				
1	Capacity building specialist											12
2	IEC activities by Promoters											48
B3	Implementation Period of 5-system											
	(K3-1, G5-1, G6-1, D4-1)									(construction)		
1	Capacity building specialist											12
2	IEC activities by Promoters											72
B4	Implementation Period of 7-system											
	(K1-1, K2-1, G7-1, D3-2, D4-2, D5-1, D7)									(construction)		
1	Capacity building specialist											12
2	IEC activities by Promoters											96

Table 1.2 Necessary Activities for Target Communes

Weaknesses	Strengths	Necessary Activities
K-1, Bo Y commune, Ngoc Hoi district		
▪ Living standard is very low. ▪ About 20% suffer from typhoid. ▪ 1/4 believes that springs are cleaner than groundwater, and about 43% drink surface water. ▪ The quantity of water is insufficient in the dry season (60%). ▪ 2/3 do not use a latrine, and 20% rarely collect garbage.	▪ The influence of CPC and village chiefs is strong. ▪ The Ca Dong and Kinh live together in the villages.	▪ Overall IEC campaigns are necessary with the help of CHC, including the promotion of the use of deep groundwater, hygienic latrines, hand washing, and garbage collection. ▪ CHC has to hold village meetings with the help of village chiefs for minority communities. ▪ Intensive home visits by health workers and WU will be necessary.
▪ **K-2, Dak Su commune, Ngoc Hoi district**	▪	
Weaknesses	**Strengths**	
▪ Living standard is very low, and villages are very scattered and difficult to access. ▪ More than 40% suffer from typhoid. ▪ WU is not active at all. ▪ The quantity of water is insufficient in the both seasons (83%, 47%). ▪ More than 80% do not use a latrine, and 27% rarely collect garbage. ▪ Hand washing is not well practiced.	▪ The influence of CPC and village chiefs is strong.	
K-3, Dak Ui commune, Dac Ha district	▪	
Weaknesses	**Strengths**	
▪ Living standard is very low. ▪ About 36% suffer from typhoid, and 18% suffer from cholera. ▪ The quantity of water is insufficient in the dry season (54%). ▪ Only 7% use a latrine, and about 18% rarely collect garbage. ▪ Latrines are located close to dug wells.	▪ IEC activities have been carried out through the pilot model project. ▪ The influence of CPC and village chiefs is strong. ▪ CHC' awareness is relatively high, and minority-oriented health care is carried out.	
▪ **K-4, Dak Hiring commune, Dac Ha district**	▪	
Weaknesses	**Strengths**	
▪ About 24% suffer from typhoid, and 48% suffer from diarrhea. ▪ 1/3 still believes that surface water is cleaner than groundwater. ▪ The quantity of water is insufficient in the dry season (31%). ▪ Only 10% use a latrine, and about 1/3 rarely collect garbage. ▪ Hand washing is not well practiced.	▪ The influence of CPC and village chiefs is strong. ▪ CHC' awareness is relatively high, and a map is prepared to show the health conditions of the local people.	
K-5, Sa Nghia commune, Sa Thay district		
Weaknesses	**Strengths**	**Necessary Activities**
▪ About 53% suffer from typhoid. ▪ The quantity of water is insufficient in the dry season (63%). ▪ Only 15% use a latrine for defecation.	▪ The influence of CPC is very strong. ▪ The commune is Kinh-dominated.	▪ Deep groundwater development, and improvement of dug wells are urgent. ▪ IEC campaigns for appropriate environment of dug wells, and latrine promotion are necessary.
▪ K-6, Chu Hreng commune, Kon Tum city	▪	
Weaknesses	**Strengths**	
▪ About 27% suffer from typhoid. ▪ The quantity of water is insufficient in the dry season (53%). ▪ Only 20% use a latrine for defecation.	▪ Health workers are influential in the Ba Na communities. ▪ The Ba Na people live together with the Kinh people in the same villages.	

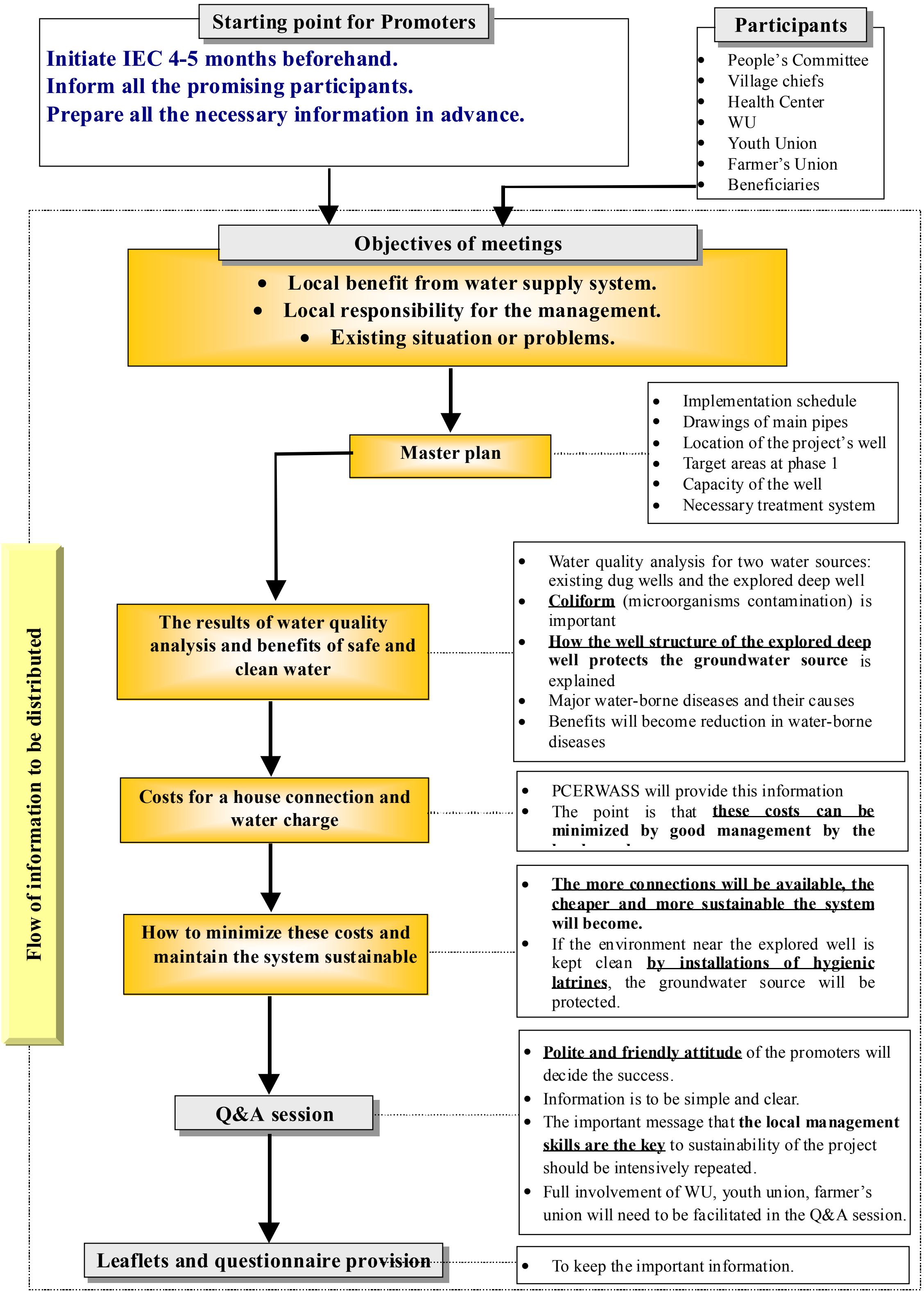


Figure 1.1 Information Flow at Town Meeting for Well-off Communities

Chapter 2 Other Recommendations

2.1 Short-term Measures

It would be very important to have the WSUs properly established through general regulations adopted by the respective CPCs. The articles should include provisions on the institutional structure of the WSU, rights and responsibilities of the WSU, its staff members and clients, management of public taps, and the implications of violating regulations. The regulations would clarify the roles of various parties and authorize the WSU to take measures in case of non-payment and vandalism K3-1 would need closer follow-up and support than G2, but Kon Tum PCERWASS itself would need considerable capacity building. There is no easy solution. The support should come from a higher level of the government hierarchy.

Much of the necessary IEC could not be carried out in the short time prior to and during the construction of the schemes. There is a great need to promote IEC.

2.2 Long-term Measures

One of the most important aspects of successful implementation will be to give time for the communes to be ready for the investment. In practice this can take place by phasing the implementation such that the first stage of physical implementation will commence in about five of the communes (those with the most potential). Simultaneously, extensive IEC activities will need to be carried out in the other communes to build their capacity to implement the project in later stages.

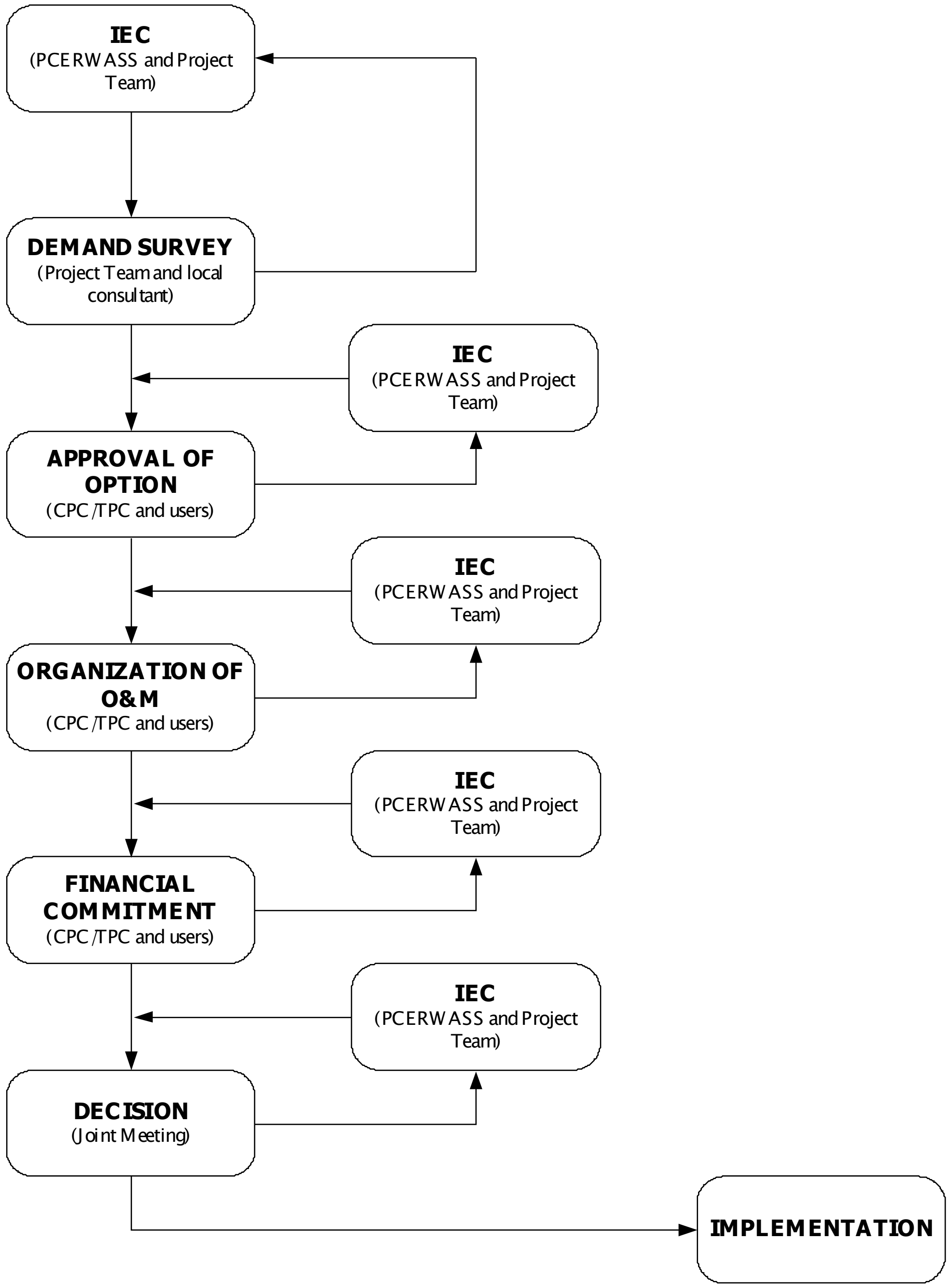


Figure 2.1 Flowchart of Community Sensitivity for Project Implementation

2.3 Preconditions for Construction

2.3.1 Central Level

Objectives:

- Adequate capacity of all relevant PCERWASS to assume responsibilities in accordance with NRWSS and the Project; and
- Assurance of timely and efficient IEC and support to be provided by PCERWASS.

Preconditions for decision on scheme construction:

- Proven capacity of PCERWASS to coordinate and support IEC, training, follow-up and long-term support;
- Secure budget allocations to relevant PCERWASS for IEC activities, training, follow-up and long -term support; and
- Appropriate IEC and training materials and management and O&M manuals made available by PCERWASS for distribution to Project communes

2.3.2 Provincial level

Objectives:

- Capacity to coordinate and support IEC; and
- Capacity to provide training (courses and on-the-job) to WSUs and board members, to follow-up their performance and provide them with long-term support.

Preconditions for the decision on scheme construction:

- Adoption of and commitment to NRWSS;
- Secured budget for IEC activities, training, follow-up and long-term support (from CERWASS/PCP); and
- Proven capacity to provide support to CPC/TPCs, and WSUs.

2.3.3 Commune Level

Objectives:

- Generation of demand for improved water supply (health, convenience, status,) through education and "social marketing";
- Introduction of option(s) available, their impacts and related costs, rights and duties; and
- Introduction of Project concept: conditions, procedures, and contribution requirements

Preconditions for decision on scheme construction:

- Adequate demand for improved water supply: at least 35% of households to be willing (and able) to pay for water on a monthly basis that initially covers the cost of one cubic meter *per capita* per month at a tariff calculated to cover all costs in the long term;
- Acceptance of the option(s) provided by the Project: the location of facilities accepted by the community members, the service level and costs known and accepted by the users, and the decision on inclusion/exclusion of public taps made in consultation with the users;
- Management and operation of the system organized: WSU and its board established (the latter includes user representation), regulations adopted, rights and responsibilities of WSU and users defined and accepted by both parties, relevant documentation formats adopted, user groups of possible public taps established; and
- Measurable commitment to sustain the system[1]: households to be connected to have deposited at least 50% of the connection cost, user groups of public taps to have deposited at least 10% of the public tap cost, and CPC/TPC to have deposited sufficient amount to cover i) at least the salaries/wages of two WSU staff members for their participation in construction for the entire construction period, and ii) to cover the cost of necessary O&M tools.

[1] On the other hand, the Project has to assure the community of the quality of the improved water supply. If the service level (including water quality) does not comply with what has been advertised, deposits shall be returned.

2.4 Necessity of Subsidy from Government

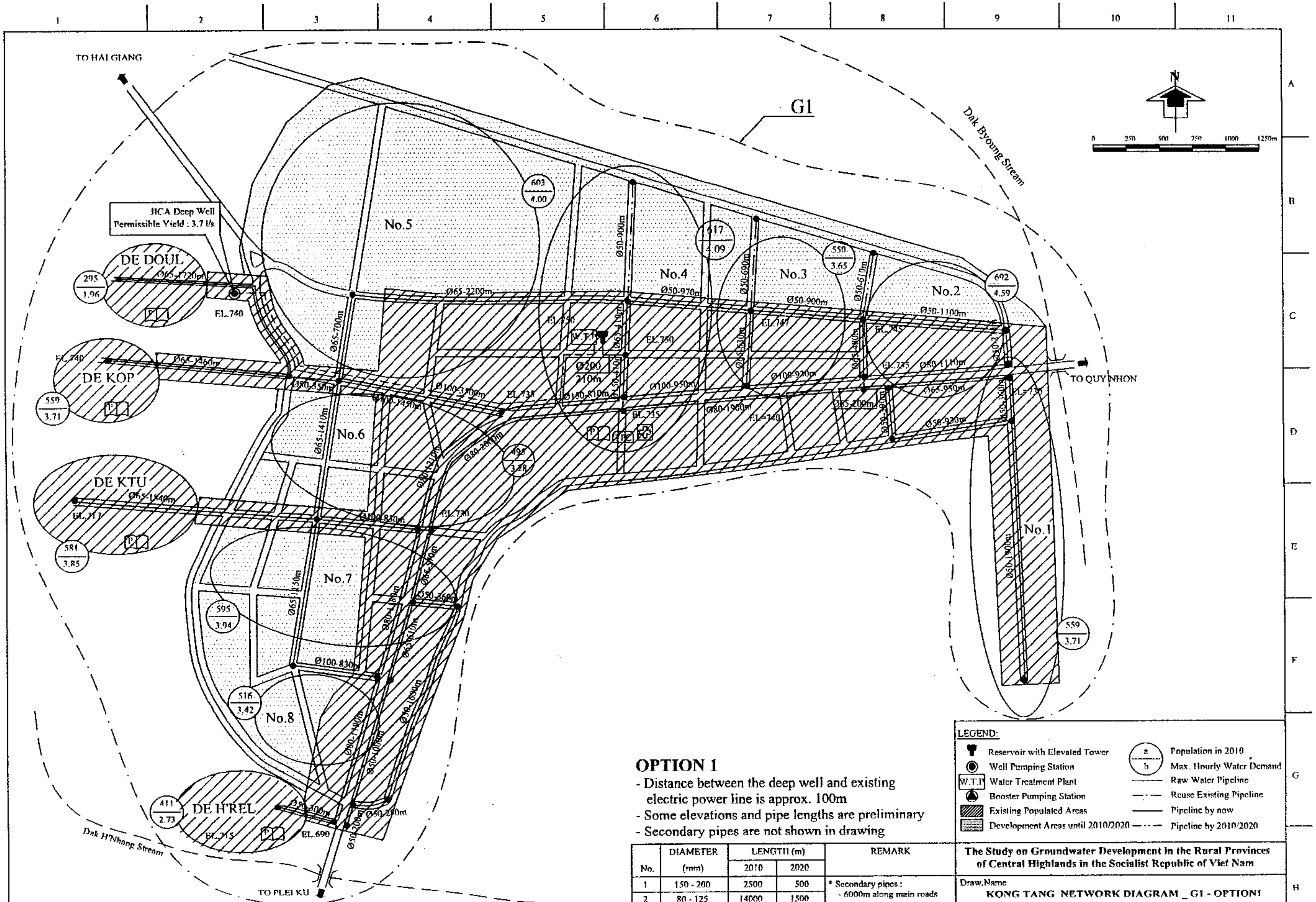
Because of the rather unstable and difficult management of the small sized rural water supplies, it is recommended that support, by way of subsidy, be provided by the Vietnam government.

2.5 Sustainable Operation of Two Pilot Models

It is recommended that the two pilot models constructed by JICA study team should be properly and sustainably operated as a model case in the rural area in the central highlands and also as a model for the entire rural area of Vietnam.

Appendix 1

Water Supply Systems in the 9 Systems
(Tables of Facilities in Each System)



OPTION 1

- Distance between the deep well and existing electric power line is approx. 100m
- Some elevations and pipe lengths are preliminary
- Secondary pipes are not shown in drawing

No.	DIAMETER (mm)	LENGTH (m) 2010	LENGTH (m) 2020	REMARK
1	150 - 200	2500	500	* Secondary pipes : - 6000m along main roads
2	80 - 125	14000	1500	
3	25 - 65	31000	3000	
	Total	47500	5000	

The Study on Groundwater Development in the Rural Provinces of Central Highlands in the Socialist Republic of Viet Nam

Draw.Name
KONG TANG NETWORK DIAGRAM _ G1 - OPTION1

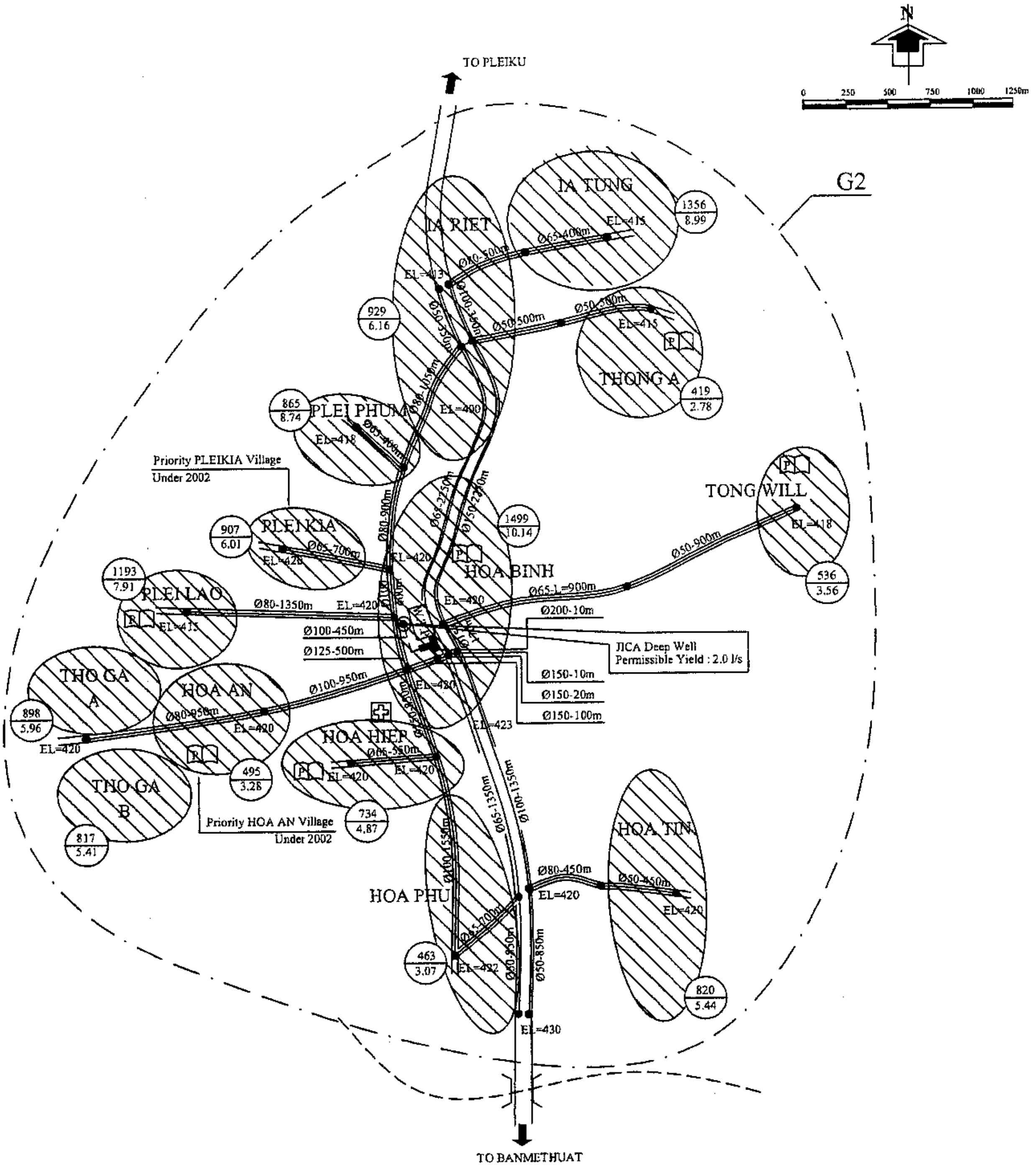
Date. Nov. 2001 | Scale. 1 : 25000 | For A3 size | Draw.No. G1-NW-01/1

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CAD File : G1-NW-01-01.DWG

Format A3

G2-NW-01-1.dwg



No.	DIAMETER (mm)	LENGTH (m) 2010	LENGTH (m) 2020	REMARK
1	150 - 200	3500		* Secondary pipes : - 6000m along main roads - 16000m (1000-1500m/Village) Total : 14 Village
2	80 - 125	11000	1500	
3	25 - 65	29700	3500	
	Total	44200	5000	

LEGEND:

- Reservoir with Elevated Tower
- Well Pumping Station
- W.T.P Water Treatment Plant
- Booster Pumping Station
- Supplied Area by 2010
- Supplied Area by 2020
- a / b: Population in 2010 / Max. Hourly Water Demand
- Raw Water Pipeline
- Reuse Existing Pipeline
- Pipeline by 2010
- Pipeline by 2020

OPTION 1

- Distance between the deep well and existing electric power line is approx. 100m
- Some elevations and pipe lengths are preliminary
- Secondary pipes are not shown in drawing

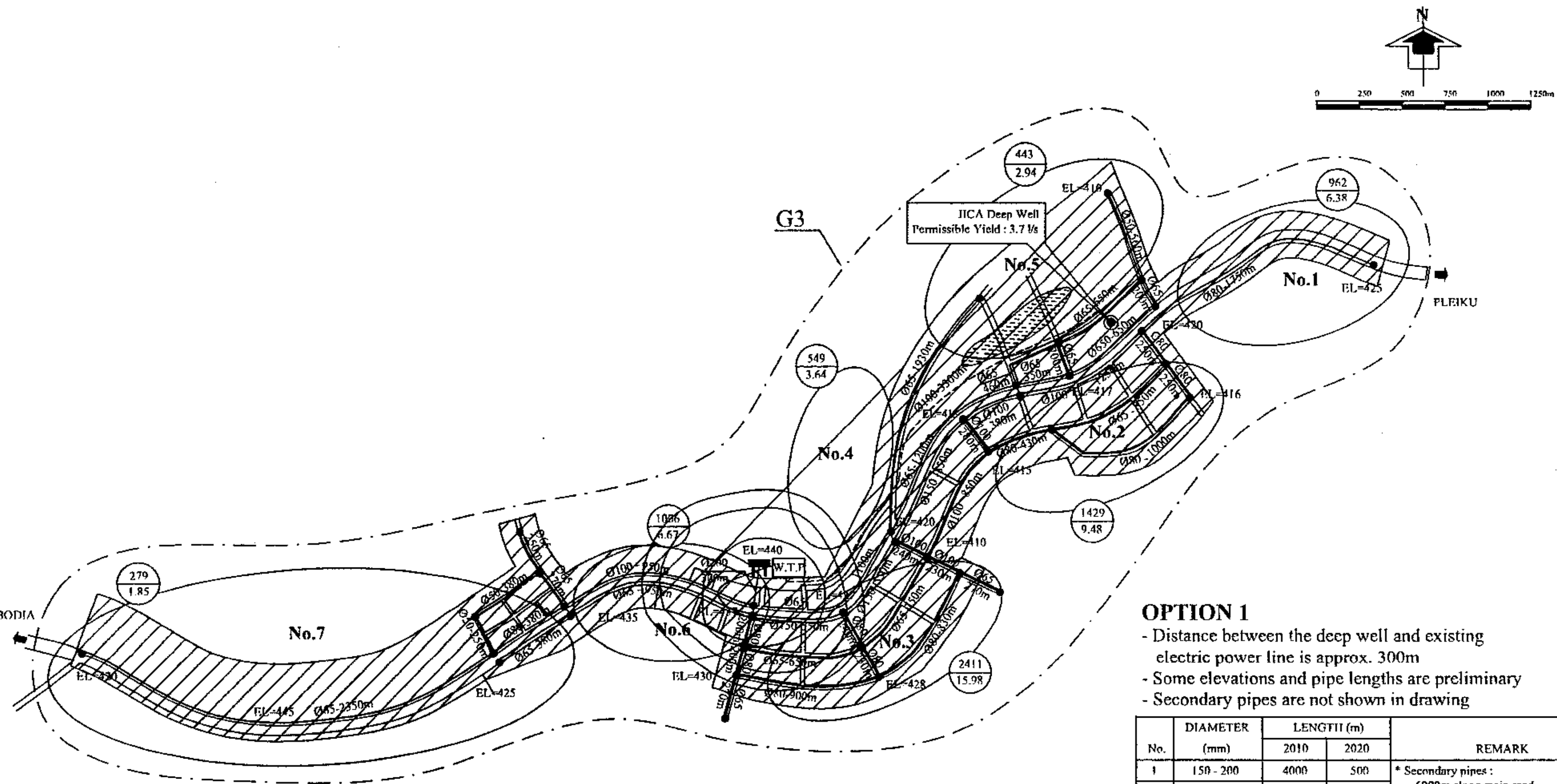
The Study on Groundwater Development in the Rural Provinces of Central Highlands in the Socialist Republic of Viet Nam

Draw.Name: NHON HOA NETWORK DIAGRAM _ G2

Date. Nov. 2001	Scale. 1 : 25000	For A3 size	Draw.No. 2

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Format A3



OPTION 1

- Distance between the deep well and existing electric power line is approx. 300m
- Some elevations and pipe lengths are preliminary
- Secondary pipes are not shown in drawing

No.	DIAMETER (mm)	LENGTH (m) 2010	LENGTH (m) 2020	REMARK
1	150 - 200	4000	500	* Secondary pipes : - 6000m along main road - 4000m (1000m/community)
2	80 - 125	12500	1500	
3	25 - 65	25000	4000	
	Total	41500	4200	

LEGEND:

- Reservoir by Semi-Elevated
- Well Pumping Station
- W.T.P Water Treatment Plant
- Booster Pumping Station
- Supplied Area by 2010
- Supplied Area by 2020
- a / b : Population in 2010 / Max. Hourly Water Demand
- Raw Water Pipeline
- Reuse Existing Pipeline
- Pipeline by 2010
- Pipeline by 2020

The Study on Groundwater Development in the Rural Provinces of Central Highlands in the Socialist Republic of Viet Nam

Draw.Name

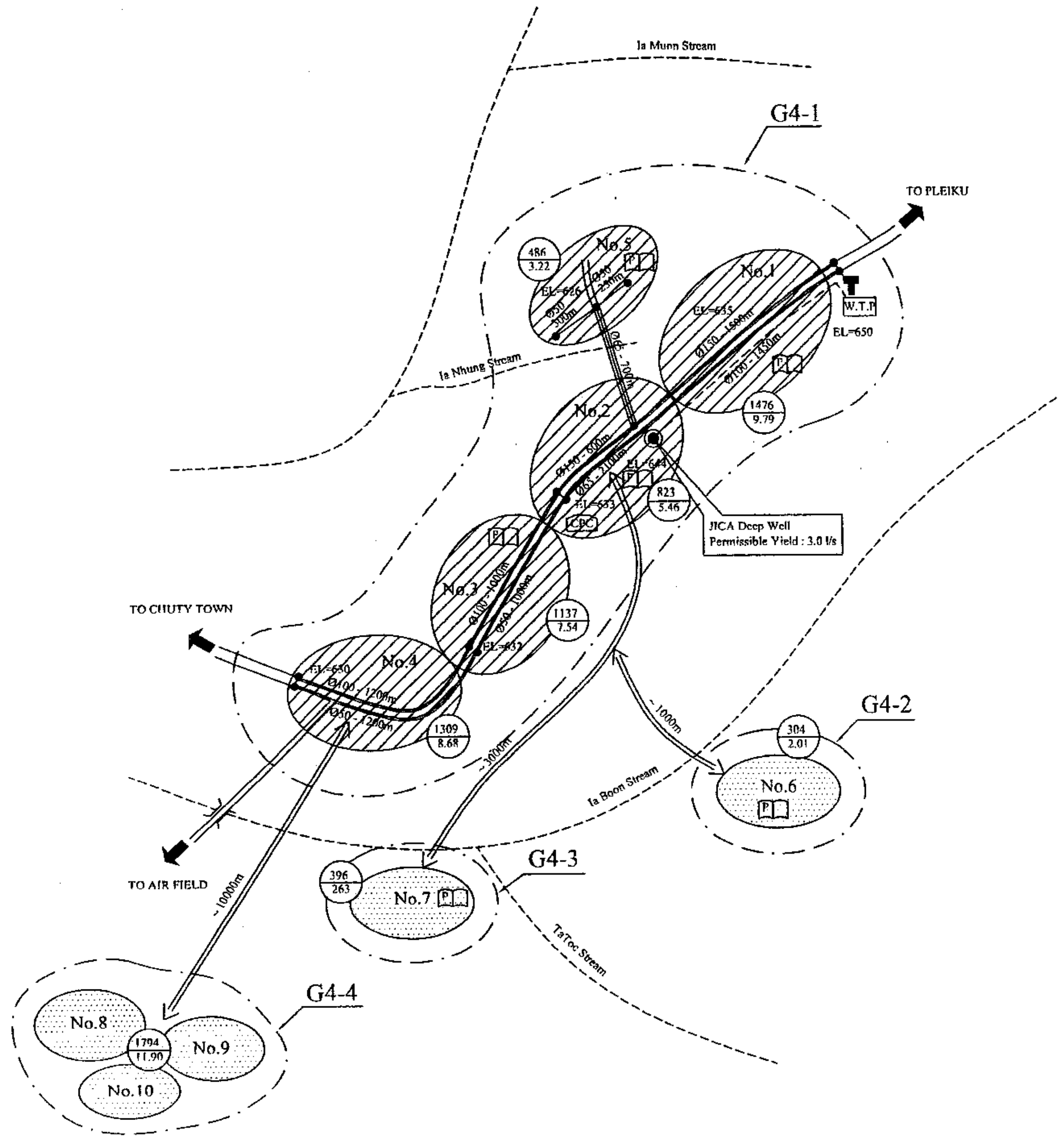
CHU TY NETWORK DIAGRAM _ G3 - OPTION 1

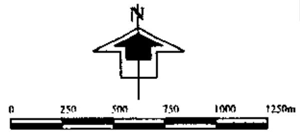
Date. Nov. 2001	Scale. 1 : 25000	For A3 size	Draw.No. G3-NW-01/1

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CAD File : G3-NW-01-1.DWG

Format A3





OPTION 1

- Distance between the deep well and existing electric power line is approx. 100m
- Some elevations and pipe lengths are preliminary
- Secondary pipes are is not shown in drawing

No.	DIAMETER (mm)	LENGTH (m) 2010	2020	REMARK
1	150 - 200	2500		* Secondary pipes : - 2000m along main roads - 2000m (1000m/Village)
2	80 - 125	2500	500	
3	25 - 65	10500	2500	
	Total	15500	3000	

LEGEND:

- Reservoir with Elevated Tower
- Well Pumping Station
- W.T.P Water Treatment Plant
- Booster Pumping Station
- Supplied Area by 2010
- Supplied Area by 2020
- a / b: a = Population in 2010, b = Max. Hourly Water Demand
- Raw Water Pipeline
- Reuse Existing Pipeline
- Pipeline by 2010
- Pipeline by 2020

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Draw.Name

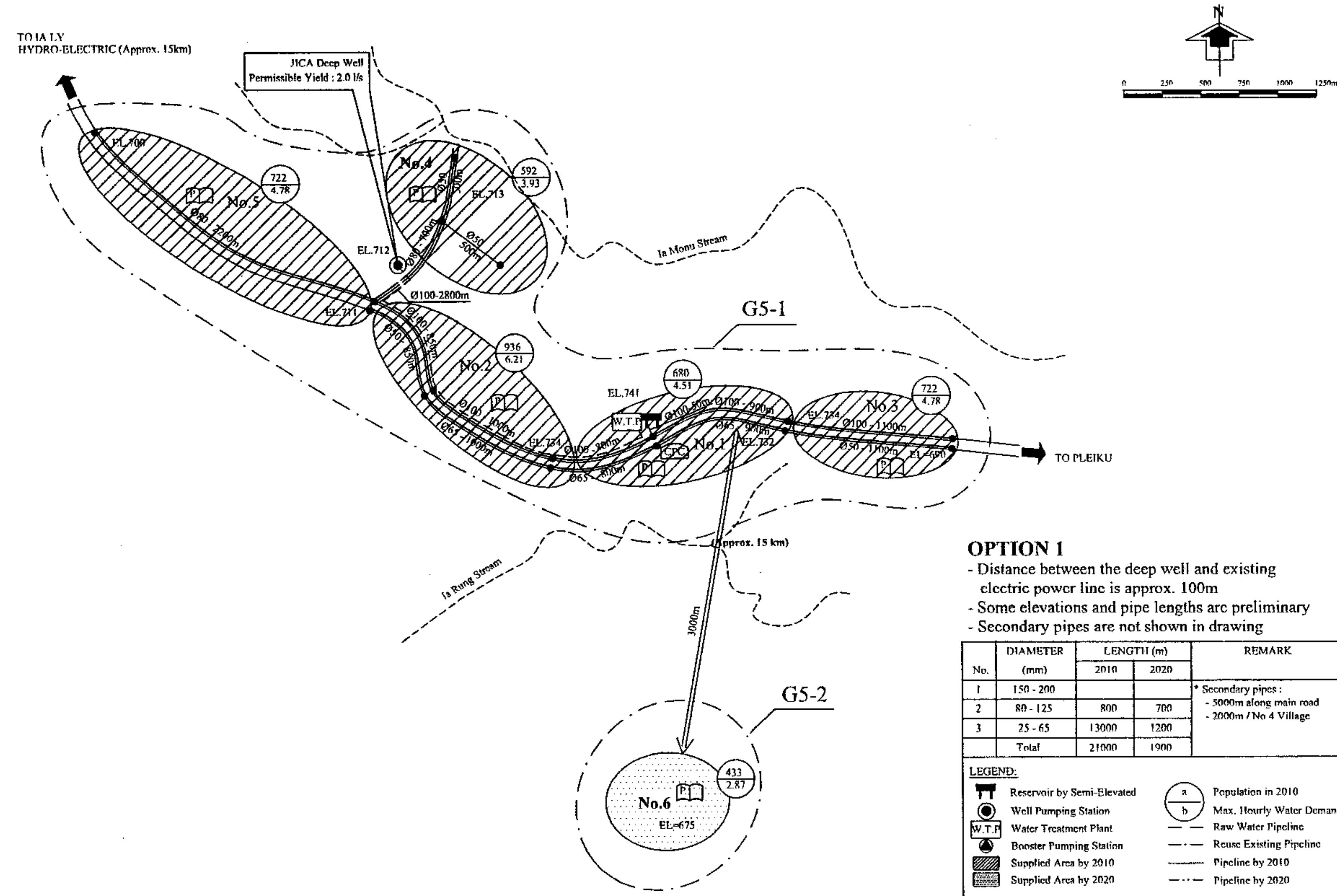
THANG HUNG NETWORK DIAGRAM _G4 - OPTION 1

Date. Nov. 2001	Scale. 1 : 25000	For A3 size	Draw.No. G4-NW-01/1

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CAD File :G4-NW-01-1.DWG

Format A3



OPTION 1

- Distance between the deep well and existing electric power line is approx. 100m
- Some elevations and pipe lengths are preliminary
- Secondary pipes are not shown in drawing

No.	DIAMETER (mm)	LENGTH (m) 2010	LENGTH (m) 2020	REMARK
1	150 - 200			* Secondary pipes : - 5000m along main road - 2000m / No 4 Village
2	80 - 125	800	700	
3	25 - 65	13000	1200	
	Total	21000	1900	

LEGEND:

- Reservoir by Semi-Elevated
- Well Pumping Station
- W.T.P Water Treatment Plant
- Booster Pumping Station
- Supplied Area by 2010
- Supplied Area by 2020
- a / b: Population in 2010 / Max. Hourly Water Demand
- Raw Water Pipeline
- Reuse Existing Pipeline
- Pipeline by 2010
- Pipeline by 2020

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Draw.Name

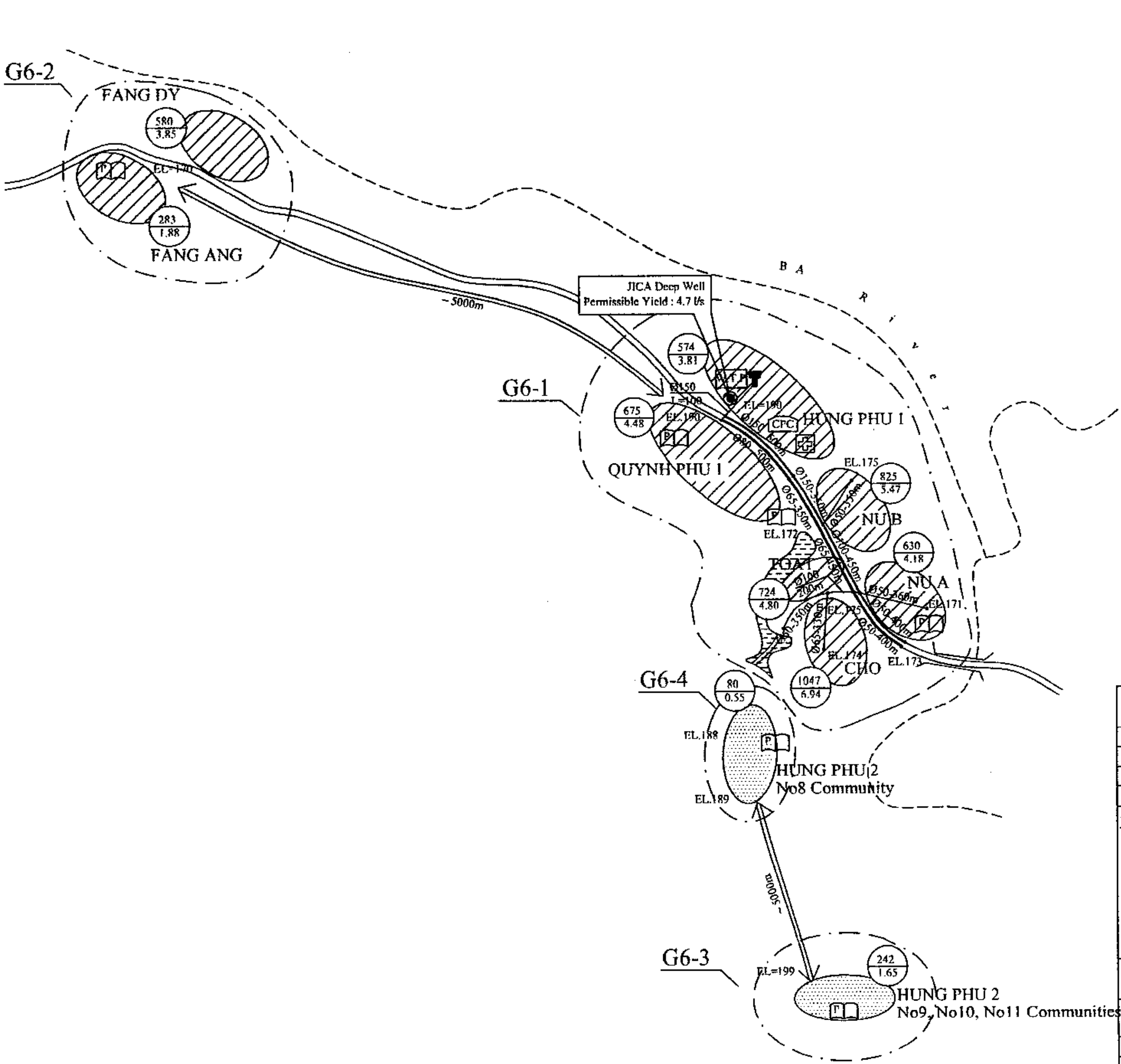
NGHIA HOA NETWORK DIAGRAM _ G5 OPTION 1

Date. Nov. 2001	Scale. 1 : 25000	For A3 size	Draw.No. G5-NW-01/1

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CAD File :G5-NW-01-1.DWG

Format A3



OPTION 1

- Distance between the deep well and existing electric power line is approx. 50m
- Some elevations and pipe lengths are preliminary
- Secondary pipes are not shown in drawing

No.	DIAMETER (mm)	LENGTH (m) 2010	LENGTH (m) 2020	REMARK
1	150 - 200	1500		* Secondary pipes : - 2000m along main road - 5000m (1000m/Village)
2	80 - 125	1900	200	
3	25 - 65	10000	700	
	Total	13400	900	

LEGEND:

- Reservoir with Elevated Tower
- Well Pumping Station
- W.T.P Water Treatment Plant
- Booster Pumping Station
- Existing Populated Areas
- Development Areas until 2010/2020
- a / b: Population in 2010 / Max. Hourly Water Demand
- Raw Water Pipeline
- Reuse Existing Pipeline
- Pipeline by now
- Pipeline by 2010/2020

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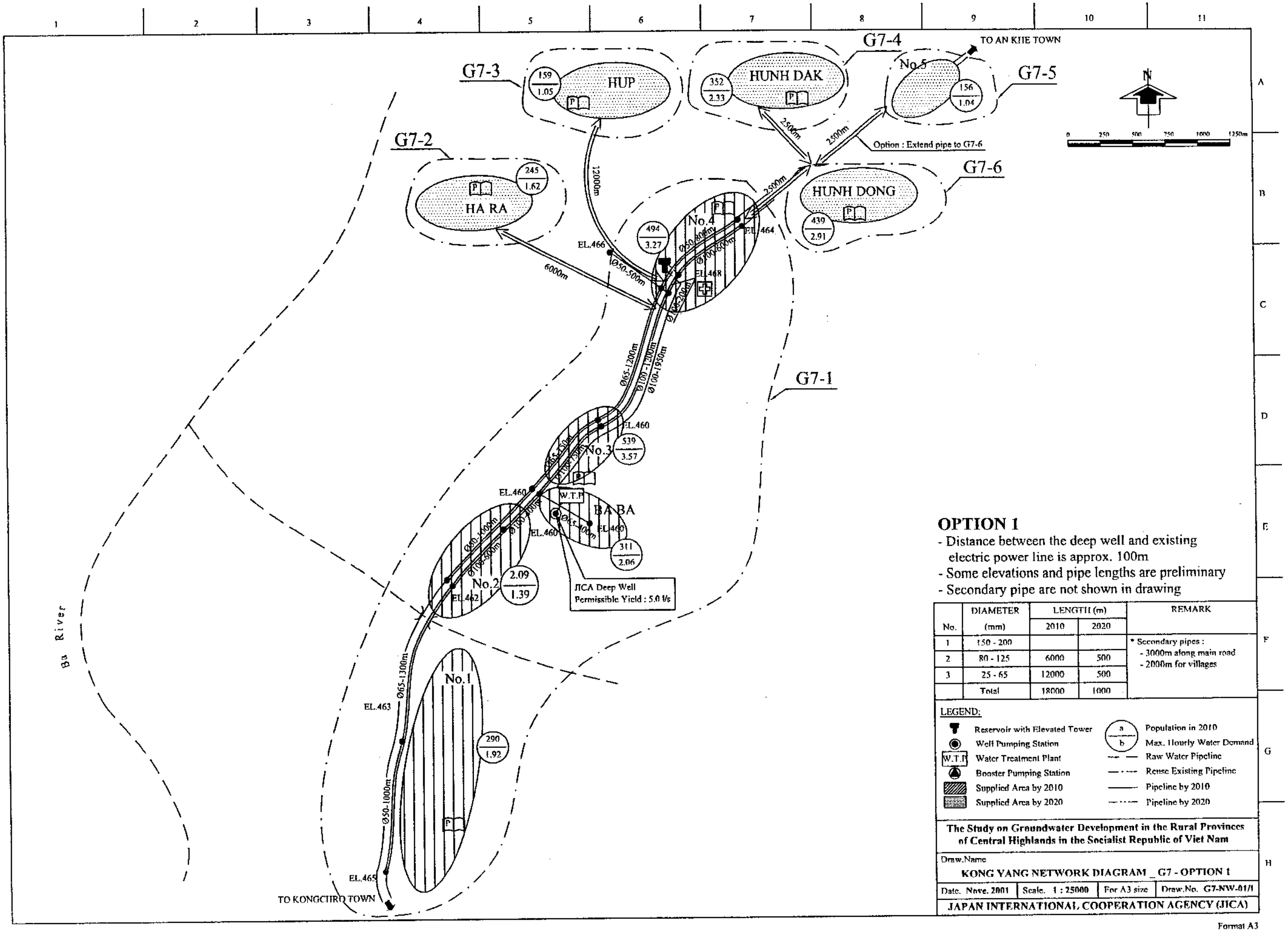
Draw.Name: IA RSION NETWORK DIAGRAM _ G6 - OPTION 1

Date. Nov. 2001	Scale. 1 : 25000	For A3 size	Draw.No. G6-NW-01/1

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CAD File : G6-NW-01-1.dwg

Format A3



OPTION 1

- Distance between the deep well and existing electric power line is approx. 100m
- Some elevations and pipe lengths are preliminary
- Secondary pipe are not shown in drawing

No.	DIAMETER (mm)	LENGTH (m) 2010	LENGTH (m) 2020	REMARK
1	150 - 200			* Secondary pipes : - 3000m along main road - 2000m for villages
2	80 - 125	6000	500	
3	25 - 65	12000	500	
	Total	18000	1000	

LEGEND:

- Reservoir with Elevated Tower
- Well Pumping Station
- W.T.P Water Treatment Plant
- Booster Pumping Station
- Supplied Area by 2010
- Supplied Area by 2020
- a / b: Population in 2010 / Max. Hourly Water Demand
- Raw Water Pipeline
- Reuse Existing Pipeline
- Pipeline by 2010
- Pipeline by 2020

The Study on Groundwater Development in the Rural Provinces of Central Highlands in the Socialist Republic of Viet Nam

Draw.Name

KONG YANG NETWORK DIAGRAM _ G7 - OPTION 1

Date. Nove. 2001	Scale. 1 : 25000	For A3 size	Draw.No. G7-NW-01/1

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CAD File : G7-NW-01-01.DWG

Format A3

Appendix 2

Cost Estimation in Priority Communes

Cost Estimates for feasibility Study, kong tang town _ g1 **option 1**

Nos		Description	Unit	Quantity		Cost Amount (US$)				Cost amount (Mil. VND)	
				2,010	2,020	2010		2020		2010	2020
A	**Structural Facilities**					Material	Installation	Materials	Installation		
	1	Well Pumping Station									
		Drilling Well	well	1	1	38,000	2,000	38,000	2,000		
		Well head	Set	2	1	3,400	400	1,700	200		
		Submersible,MotorProtection,Pipe and Acessories	set	2	1	10,000	2,000	5,000	1,000		
		Power Suppy System	set	2	1	8,000	600	4,000	300		
		Well House	m2	24	12	3,600	720	1,800	360		
	2	Treament Plant									
		Access road, Management house, Fence	Set	1	1	33,000	3,300	16,500	1,650		
		Aeration Tower	m2	5	2	450	135	200	60		
		Reaction Tank	m3	24	11	4,700	1,645	2,200	770		
		Rapid Filter	m2	10	4	17,000	3,000	6,800	1,200		
		Reservoir	m3	163	77	12,551	4,890	5,929	2,310		
		Elevated Tower	m3	24	11	5,520	2,400	2,530	1,100		
		Booster Pumping Station : Pumps, Pipes and Acessories	m3/hour	46	22	18,560	5,568	8,880	2,664		
		Chlorinator	item	1		4,200	200				
		Power Supply System	item	1		4,000	800				
		Sub-Total				162,981	27,658	93,539	13,614		
B	**Pipeline Network**										
	1	Rawwater Pipeline	km	3.0	1.5	36,000	12,000	18,000	6,000		
		80-100									
		150-200									
	2	Distribution Pipeline	km								
	2.1	25-65		31.0	3.0	77,500	108,500	7,500	10,500		
	2.2	80-125		14.0	1.5	84,000	49,000	9,000	5,250		
	2.3	150-200		2.5	0.5	28,750	13,750	5,750	2,750		
	3	Public taps		15		6,750	750				
		Sub-Total				233,000	184,000	40,250	24,500		
C	**Construction cots (A+B)**					395,981	211,658	133,789	38,114		
D	**Land cost**										
E	**Engineering Service (15%C)**					59,397	31,749	20,068	5,717		
		(Incl. Soil investigation, field serve, detailed design and construction supervisor									
F	**Base cost (C+D+E)**					455,378	243,407	153,857	43,831		
G	**Physical contingency (10%F)**					45,538	24,341	15,386	4,383		
H	**Project cost (F+G)**					500,916	267,747	169,243	48,214		
I	**Price contingency (10%H)**					50,092	26,775	16,924	4,821		
J	**Total financing required (H+I)**					**551,008**	**294,522**	**186,167**	**53,036**		

Note : Cost 2001 year level
Exchange rate US$ 1.00 = 15,000 VND

Cost estimates for feasibility study, nhon hoa commune _ g2 **option 1**

Nos		Description	Unit	Quantity		Cost Amount (US$)				Cost amount (Mil. VND)	
				2,010	*2,020*	*2010*		*2020*		*2010*	*2020*
A	**Structural Facilities**					Material	Installation	Materials	Installation		
	1	Well Pumping Station									
		Drilling Well	well	6	3	228,000	12,000	114,000	6,000		
		Well head	Set	7	3	11,900	1,400	5,100	600		
		Submersible,MotorProtection,Pipe and Acessories	set	7	3	35,000	7,000	15,000	3,000		
		Power Suppy System	set	7	3	28,000	2,100	12,000	900		
		Well House	m2	84	36	12,600	2,520	5,400	1,080		
	2	Treament Plant									
		Access road, Management house, Fence	Set	1	1	42,000	4,200	21,000	2,100		
		Aeration Tower	m2	9	5	900	270	450	135		
		Reaction Tank	m3	47	22	9,300	3,255	4,400	1,540		
		Rapid Filter	m2	19	9	32,300	5,700	15,300	2,700		
		Reservoir	m3	323	154	24,871	9,690	11,858	4,620		
		Elevated Tower	m3	47	22	10,810	4,700	5,060	2,200		
		Booster Pumping Station : Pumps, Pipes and Acessories	m3/hour	92	44	36,960	11,088	17,600	5,280		
		Chlorinator	item	1		4,200	200				
		Power Supply System	item	1		4,000	800				
		Sub-Total				480,841	64,923	227,168	30,155		
B	**Pipeline Network**										
	1	Rawwater Pipeline	km	10.5	4.5	126,000	42,000	54,000	18,000		
		80-100									
		150-200									
	2	Distribution Pipeline	km								
	2.1	25-65		29.7	3.5	74,250	103,950	8,750	12,250		
	2.2	80-125		11.0	1.5	66,000	38,500	9,000	5,250		
	2.3	150-200		3.5	0.0	40,250	19,250	0	0		
	3	Public taps		18		8,100	900				
		Sub-Total				314,600	204,600	71,750	35,500		
C	**Construction cots (A+B)**					795,441	269,523	298,918	65,655		
D	**Land cost**										
E	**Engineering Service (15%C)**					119,316	40,428	44,838	9,848		
		(Incl. Soil investigation, field serve, detailed design and construction supervisor									
F	**Base cost (C+D+E)**					914,757	309,951	343,756	75,503		
G	**Physical contingency (10%F)**					91,476	30,995	34,376	7,550		
H	**Project cost (F+G)**					1,006,233	340,947	378,131	83,054		
I	**Price contingency (10%H)**					100,623	34,095	37,813	8,305		
J	**Total financing required (H+I)**					**1,106,856**	**375,041**	**415,944**	**91,359**		

Note : Cost 2001 year level
Exchange rate US$ 1.00 = 15,000 VND

Cost estimates for feasibility study, chu ty town _ g3-1 **option 1**

Nos		Description	Unit	Quantity		Cost Amount (US$)				Cost amount (Mil. VND)	
				2,010	*2,020*	*2010*		*2020*		*2010*	*2020*
A	**Structural Facilities**					Material	Installation	Materials	Installation		
	1	Well Pumping Station									
		Drilling Well	well	1	1	38,000	2,000	38,000	2,000		
		Well head	Set	2	1	3,400	400	1,700	200		
		Submersible,MotorProtection,Pipe and Acessories	set	2	1	10,000	2,000	5,000	1,000		
		Power Suppy System	set	2	1	8,000	600	4,000	300		
		Well House	m2	24	12	3,600	720	1,800	360		
	2	Treament Plant									
		Access road, Management house, Fence	Set	1	1	33,000	3,300	16,500	1,650		
		Reservoir	m3	186	89	14,322	5,580	6,853	2,670		
		Semi-Elevated Tower	m3	27	13	6,210	2,700	2,990	1,300		
		Booster Pumping Station : Pumps, Pipes and Acessories	m3/hour	53	25	21,280	6,384	10,080	3,024		
		Chlorinator	item	1		4,200	200				
		Power Supply System	item	1		4,000	800				
		Sub-Total				146,012	24,684	86,923	12,504		
B	**Pipeline Network**										
	1	Rawwater Pipeline	km	3.0	1.5	36,000	12,000	18,000	6,000		
		80-100									
		150-200									
	2	Distribution Pipeline	km								
		25-65		25.0	4.0	62,500	87,500	10,000	14,000		
		80-125		12.5	1.5	75,000	43,750	9,000	5,250		
		150-200		6.0	0.5	69,000	33,000	5,750	2,750		
	3	Public Tap		9		4,050	450				
		Sub-Total				246,550	176,700	42,750	28,000		
C	**Construction cots (A+B)**					392,562	201,384	129,673	40,504		
D	**Land cost**										
E	**Engineering Service (15%C)**					58,884	30,208	19,451	6,076		
		(Incl. Soil investigation, field serve, detailed design and construction supervisor									
F	**Base cost (C+D+E)**					451,446	231,592	149,124	46,580		
G	**Physical contingency (10%F)**					45,145	23,159	14,912	4,658		
H	**Project cost (F+G)**					496,591	254,751	164,036	51,238		
I	**Price contingency (10%H)**					49,659	25,475	16,404	5,124		
J	**Total financing required (H+I)**					**546,250**	**280,226**	**180,440**	**56,361**		

Note : Cost 2001 year level
Exchange rate US$ 1.00 = 15,000 VND

Cost estimates for feasibility study, thang hung commune _ g4-1 **option 1**

Nos		Description	Unit	Quantity		Cost Amount (US$)				Cost amount (Mil. VND)	
				2,010	*2,020*	*2010*		*2020*		*2010*	*2020*
A	**Structural Facilities**					Material	Installation	Materials	Installation		
	1	Well Pumping Station									
		Drilling Well	well	1	1	38,000	2,000	38,000	2,000		
		Well head	Set	2	1	3,400	400	1,700	200		
		Submersible,MotorProtection,Pipe and Acessories	set	2	1	10,000	2,000	5,000	1,000		
		Power Suppy System	set	2	1	8,000	600	4,000	300		
		Well House	m2	24	12	3,600	720	1,800	360		
	2	Treament Plant									
		Access road, Management house, Fence	Set	1	1	25,000	2,500	12,500	1,250		
		Aeration Tower	m2	4	2	400	120	150	45		
		Reaction Tank	m3	18	9	3,600	1,260	1,700	595		
		Rapid Filter	m2	8	3	13,600	2,400	5,100	900		
		Reservoir	m3	126	59	9,702	3,780	4,543	1,770		
		Elevated Tower	m3	18	9	4,140	1,800	2,070	900		
		Booster Pumping Station : Pumps, Pipes and Acessories	m3/hour	36	17	14,320	4,296	6,800	2,040		
		Chlorinator	item	1		4,200	200				
		Power Supply System	item	1		4,000	800				
		Sub-Total				141,962	22,876	83,363	11,360		
B	**Pipeline Network**										
	1	Rawwater Pipeline	km	3.0	1.5	36,000	12,000	18,000	6,000		
		80-100									
		150-200									
	2	Distribution Pipeline	km								
		25-65		10.5	2.5	26,250	36,750	6,250	8,750		
		80-125		2.5	0.5	15,000	8,750	3,000	1,750		
		150-200		2.5	0.0	28,750	13,750	0	0		
	3	Public taps	Unit	7		3,150	350				
		Sub-Total				109,150	71,600	27,250	16,500		
C	**Construction cots (A+B)**					251,112	94,476	110,613	27,860		
D	**Land cost**										
E	**Engineering Service (15%C)**					37,667	14,171	16,592	4,179		
		(Incl. Soil investigation, field serve, detailed design and construction supervisor									
F	**Base cost (C+D+E)**					288,779	108,647	127,205	32,039		
G	**Physical contingency (10%F)**					28,878	10,865	12,720	3,204		
H	**Project cost (F+G)**					317,657	119,512	139,925	35,243		
I	**Price contingency (10%H)**					31,766	11,951	13,993	3,524		
J	**Total financing required (H+I)**					**349,422**	**131,463**	**153,918**	**38,767**	**1,972**	**582**

Note : Cost 2001 year level
Exchange rate US$ 1.00 = 15,000 VND

Cost estimates for feasibility study, nghia hoa commune _ g5-1 option 1

Nos		Description	Unit	Quantity		Cost Amount (US$)				Cost amount (Mil. VND)	
				2,010	2,020	2010		2020		2010	2020
A	Structural Facilities					Material	Installation	Materials	Installation		
	1	Well Pumping Station									
		Drilling Well	well	1	1	38,000	2,000	38,000	2,000		
		Well head	Set	2	1	3,400	400	1,700	200		
		Submersible,MotorProtection,Pipe and Acessories	set	2	1	10,000	2,000	5,000	1,000		
		Power Suppy System	set	2	1	8,000	600	4,000	300		
		Well House	m2	24	12	3,600	720	1,800	360		
	2	Treament Plant									
		Access road, Management house, Fence	Set	1	1	25,000	2,500	12,500	1,250		
		Reservoir	m3	96	46	7,392	2,880	3,542	1,380		
		Semi-Elevated Tower	m3	14	7	3,220	1,400	1,610	700		
		Booster Pumping Station : Pumps, Pipes and Acessories	m3/hour	27	13	10,960	3,288	5,280	1,584		
		Chlorinator	item	1		4,200	200				
		Power Supply System	item	1		4,000	800				
		Sub-Total				117,772	16,788	73,432	8,774		
B	Pipeline Network										
	1	Rawwater Pipeline	km	3.0	1.5	36,000	12,000	18,000	6,000		
	1.1	80-100									
		150-200									
	2	Distribution Pipeline	km								
		25-65		13.0	1.2	32,500	45,500	3,000	4,200		
		80-125		8.0	0.7	48,000	28,000	4,200	2,450		
		150-200		0.0	0.0	0	0	0	0		
	3	Public taps		8		3,600	400				
		Sub-Total				120,100	85,900	25,200	12,650		
C	Construction cots (A+B)					237,872	102,688	98,632	21,424		
D	Land cost										
E	Engineering Service (15%C)					35,681	15,403	14,795	3,214		
		(Incl. Soil investigation, field serve, detailed design and construction supervisor									
F	Base cost (C+D+E)					273,553	118,091	113,427	24,638		
G	Physical contingency (10%F)					27,355	11,809	11,343	2,464		
H	Project cost (F+G)					300,908	129,900	124,769	27,101		
I	Price contingency (10%H)					30,091	12,990	12,477	2,710		
J	Total financing required (H+I)					**330,999**	**142,890**	**137,246**	**29,811**		

Note : Cost 2001 year level
Exchange rate US$ 1.00 = 15,000 VND

Cost estimates for feasibility study, iarsion commune _ g6-1 **option 1**

Nos		Description	Unit	Quantity		Cost Amount (US$)				Cost amount (Mil. VND)	
				2,010	*2,020*	*2010*		*2020*		*2010*	*2020*
A	**Structural Facilities**					Material	Installation	Materials	Installation		
	1	Well Pumping Station									
		Drilling Well	well	0	1	0	0	38,000	2,000		
		Well head	Set	1	1	1,700	200	1,700	200		
		Submersible,MotorProtection,Pipe and Acessories	set	1	1	5,000	1,000	5,000	1,000		
		Power Suppy System	set	1	1	4,000	300	4,000	300		
		Well House	m2	12	12	1,800	360	1,800	360		
	2	Treament Plant									
		Access road, Management house, Fence	Set	1	1	33,000	3,300	16,500	1,650		
		Aeration Tower	m2	3	2	330	99	150	45		
		Reaction Tank	m3	16	8.0	3,200	1,120	1,600	560		
		Rapid Filter Basin	m2	7	3	11,900	2,100	5,100	900		
		Reservoir	m3	112	54	8,624	3,360	4,158	1,620		
		Elevated Tower	m3	16	8	3,680	1,600	1,840	800		
		Booster Pumping Station : Pumps, Pipes and Acessories	m3/hour	32	15	12,800	3,840	6,160	1,848		
		Chlorinator	item	1		4,200	200				
		Power Supply System	item	1		4,000	800				
		Sub-Total				94,234	18,279	86,008	11,283		
B	**Pipeline Network**										
	1	Rawwater Pipeline	km	1.5	1.5	18,000	6,000	18,000	6,000		
	1.1	80-100									
	1.2	150-200									
	2	Distribution Pipeline	km								
		25-65		7.4	0.7	18,500	25,900	1,750	2,450		
		80-125		1.9	0.2	11,400	6,650	1,200	700		
		150-200		0.6	0.1	6,900	3,300	1,150	550		
	3	Public taps	Unit	7		3,150	350				
		Sub-Total				57,950	42,200	22,100	9,700		
C	**Construction cots (A+B)**					152,184	60,479	108,108	20,983		
D	**Land cost**										
E	**Engineering Service (15%C)**					22,828	9,072	16,216	3,147		
		(Incl. Soil investigation, field serve, detailed design and construction supervisor									
F	**Base cost (C+D+E)**					175,012	69,551	124,324	24,130		
G	**Physical contingency (10%F)**					17,501	6,955	12,432	2,413		
H	**Project cost (F+G)**					192,513	76,506	136,757	26,543		
I	**Price contingency (10%H)**					19,251	7,651	13,676	2,654		
J	**Total financing required (H+I)**					**211,764**	**84,157**	**150,432**	**29,198**		

Note : Cost 2001 year level
Exchange rate US$ 1.00 = 15,000 VND

Cost estimates for feasibility study, kong yang commune _ g7-1 | **option 1**

Nos		Description	Unit	Quantity		Cost Amount (US$)				Cost amount (Mil. VND)	
				2,010	*2,020*	*2010*		*2020*		*2010*	*2020*
A	**Structural Facilities**					Material	Installation	Materials	Installation		
	1	Well Pumping Station									
		Drilling Well	well	0	0	0	0	0	0		
		Well head	Set	1	0	1,700	200	0	0		
		Submersible,MotorProtection,Pipe and Acessories	set	1	0	5,000	1,000	0	0		
		Power Suppy System	set	1	0	4,000	300	0	0		
		Well House	m2	12	0	1,800	360	0	0		
	2	Treament Plant									
		Access road, Management house, Fence	Set	1	1	33,000	3,300	16,500	1,650		
		Aeration Tower	m2	2	1	200	60	60	18		
		Reaction Tank	m3	9	0.2	1,860	651	40	14		
		Rapid Filter Basin	m2	4	0.0	6,800	1,200	0	0		
		Reservoir	m3	44	21	3,388	1,320	1,617	630		
		Elevated Tower	m3	7	3	1,610	700	690	300		
		Booster Pumping Station : Pumps, Pipes and Acessories	m3/hour	13	6	5,040	1,512	2,400	720		
		Chlorinator	item	1		4,200	200				
		Power Supply System	item	1		4,000	800				
		Sub-Total				72,598	11,603	21,307	3,332		
B	**Pipeline Network**										
	1	Rawwater Pipeline	km	1.5	0.0	18,000	6,000	0	0		
		80-100									
		150-200									
	2	Distribution Pipeline	km								
		25-65		12.0	0.7	30,000	42,000	1,750	2,450		
		80-125		1.9	0.2	11,400	6,650	1,200	700		
		150-200		1.5	0.0	17,250	8,250	0	0		
	3	Public taps	Unit	7		3,150	350				
		Sub-Total				79,800	63,250	2,950	3,150		
C	**Construction cots (A+B)**					152,398	74,853	24,257	6,482		
D	**Land cost**										
E	**Engineering Service (15%C)**					22,860	11,228	3,639	972		
		(Incl. Soil investigation, field serve, detailed design and construction supervisor									
F	**Base cost (C+D+E)**					175,258	86,081	27,896	7,454		
G	**Physical contingency (10%F)**					17,526	8,608	2,790	745		
H	**Project cost (F+G)**					192,783	94,689	30,685	8,200		
I	**Price contingency (10%H)**					19,278	9,469	3,069	820		
J	**Total financing required (H+I)**					**212,062**	**104,158**	**33,754**	**9,020**		

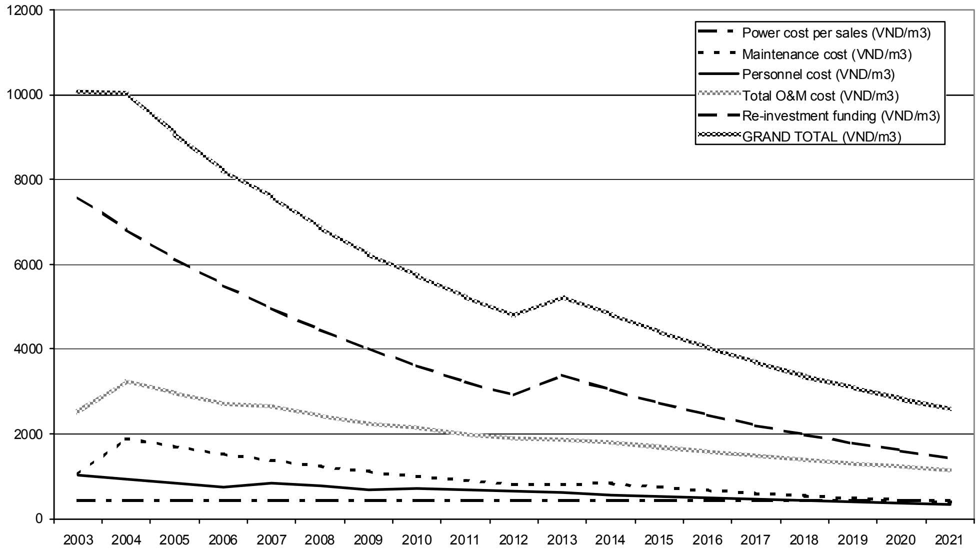
Note : Cost 2001 year level
Exchange rate US$ 1.00 = 15,000 VND

Appendix 3

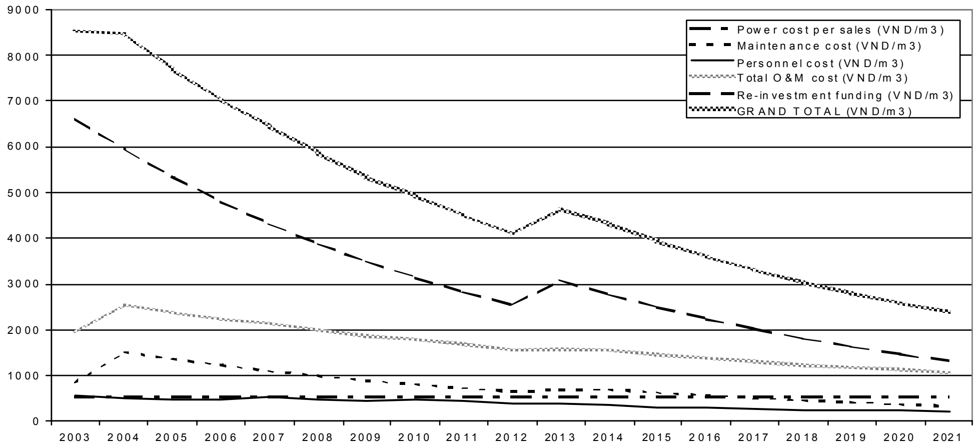
O&M Costs for Each Target Communes

Appendix 3

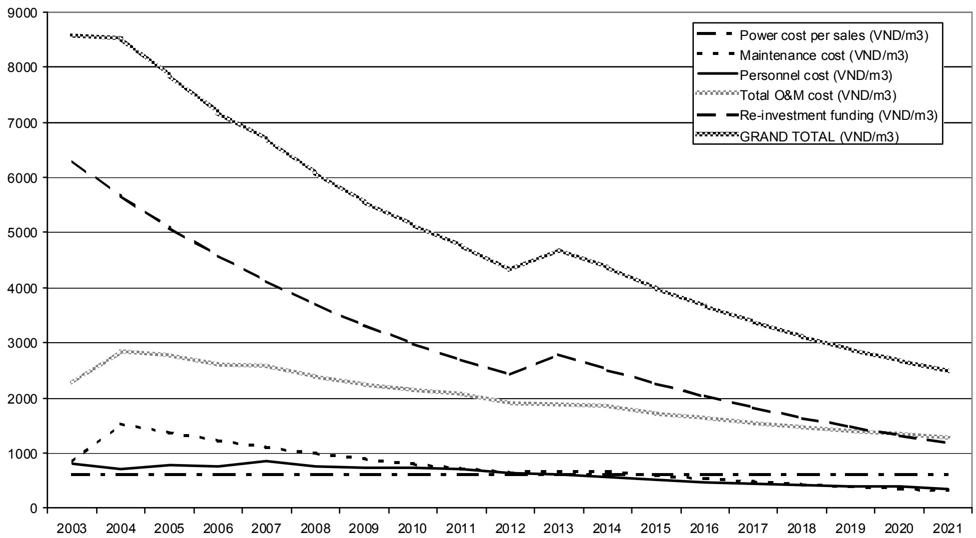
O&M costs of Kong Tang scheme G1



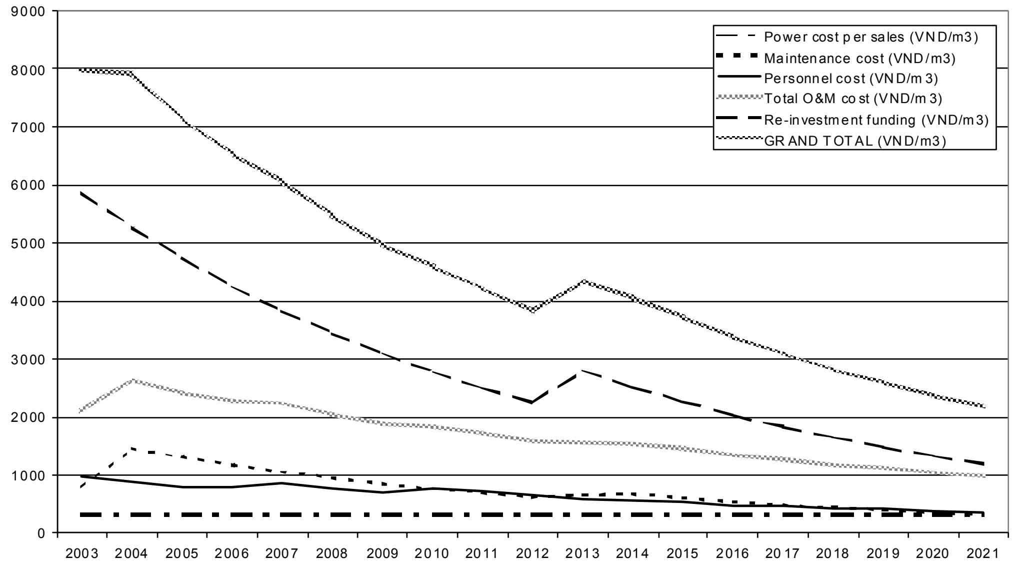
O&M costs of Krong Kmar scheme G2



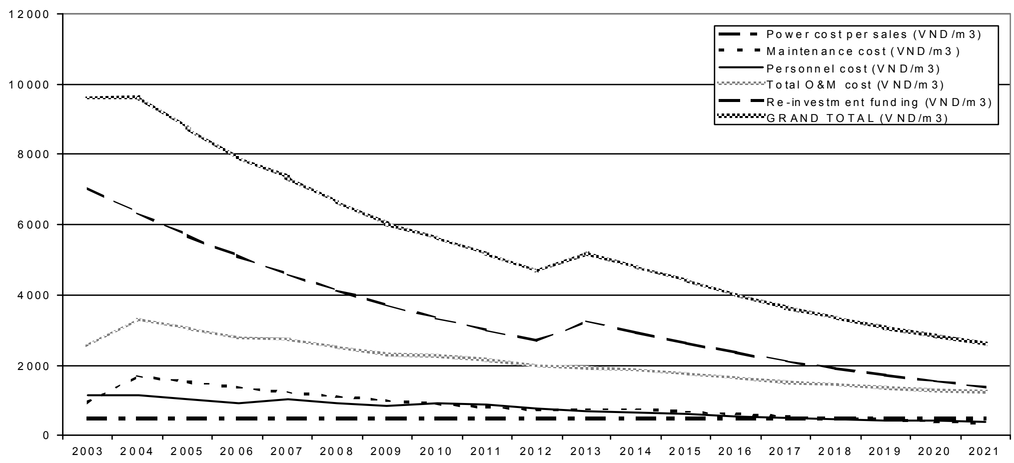
O&M costs of Chu Ty scheme G3



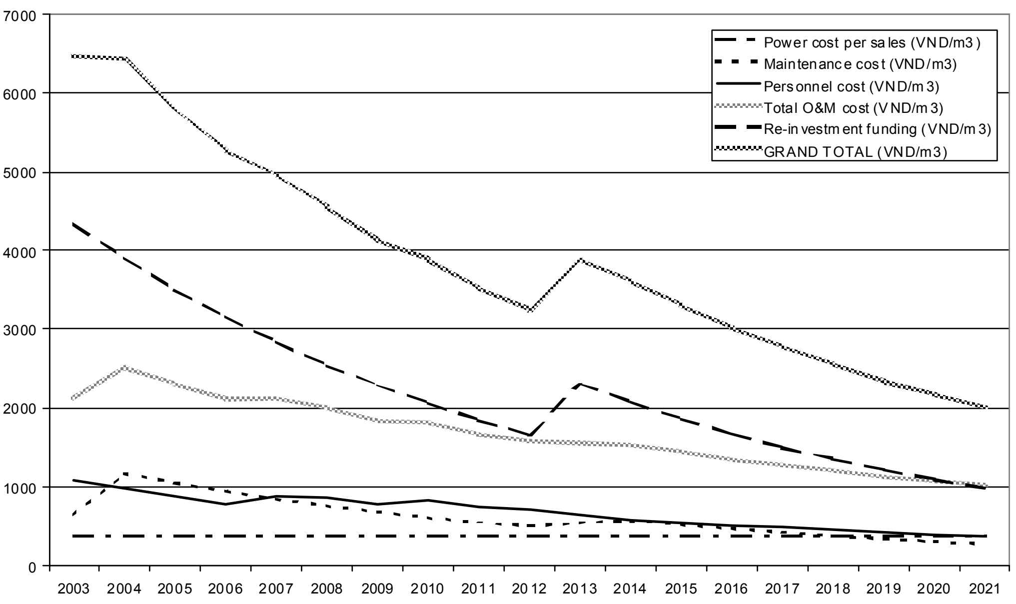
O&M costs of Thang Hung scheme G4



O&M costs of Nghia Hoa scheme G5



O&M costs of Ia Rsion scheme G6



O&M costs of Kong Yang scheme G7