# Chapter 3 Pilot Models Construction

## 3.1 Purposes of Pilot Models

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

- 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 is the ethnic minority people and 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 sustainability.

**(2) Local management skills**

On the other hand, the communities in G2 have had an issue between the two major ethnic groups (the Kinh and Gia Rai). The people's committee has been expected to solve the issue by themselves to ensure the harmonious management of the water supply system.

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

Water charges collection from users of house connections to obtain estimated revenues is the most important for the sustainable O/M. To achieve successful O/M, effective IEC activities are essential for the promotion of safe and clean water in both communes. 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 and materials to be basically procured from the local markets considering the availability of spare parts. The skill to keep the construction schedule and to prepare the design drawings to meet the satisfying construction is also one of the important key factors.

## 3.2 Background Information

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

### 3.2.1 Dak Ui Commune (K3-1)

#### (1) General Background

It takes one and half hours by car from the provincial capital, Kon Tum city. The target area is located along a minor dirt (not asphalt) road, which is a turnoff at Dak Ha from the national road No. 14.

The target area (K3-1) includes 5 villages, i.e. nos. 1A, 1B, 5B, 6, and 7, with the total population of about 2,164 (412 households). The biggest village is village No. 7 with a population of 1,044, followed by villages 1B (361), 1A (355), 5B (275), and 6 (129).

The target area is inhabited by various ethnic minority people. Xe Dang and Xo Dra people live in villages 1A, 1B, 5B, and 6, and a few Roman households also live in village No. 7. The Kinh people dwell in villages 1B, 5B, 6, and 7.

The poverty ratio, 33 %, is reported only for the commune level, although the specific data for K3-1 is unavailable.

There are public buildings in K3-1, i.e. CPC, a secondary school, and the commune health center in village 1B, and primary schools in village 1A and 7.

#### (2) Existing Water Supply

Most of the existing water supply is in the form of shallow dug wells, and many people still believe that spring water is clean and drinkable.

There are 2 bamboo piped systems where spring water gravitates to villages Nos. 5B and 7. Maintenance of the bamboo systems is of local responsibility, and both Kinh and ethnic minority people have managed the systems very successfully. The inside of the bamboo pipes has been reinforced by plastic pipes self-sustainablly contributed by the local users of the existing systems.

According to the social survey, 49% of the respondents were reportedly unsatisfied with the quantity of water in the dry season, and only 7% were unsatisfied with the quality of the existing water supply. Urgency and necessity of development of groundwater is therefore very potential in the target area.

#### (3) Piped System

The study team has explored a well with a safety yield of 259 $m^3$/day near the commune health center. The depth of the well is only 38 m with a screen 28 m in length. The water taken from the well has high contents of iron (3.49 mg/l) and manganese (0.12 mg/l), and water treatment by aeration and filtration is necessary.

The estimated water demands (maximum daily demands) are 27.5 $m^3$/day in 2001, 59.7 $m^3$/day in 2005, 224.3 $m^3$/day in 2010, and 322.6 $m^3$/day in 2020. One more well with the same capacity as the explored well will be necessary to meet the water demand in 2020.

Alternative 2a is recommended for the system in K3-1. Water is pumped from the drilled well to a treatment plant on the hill in village No. 7 from where the water runs to a ground level reservoir. The target area will be supplied from the proposed reservoir.

### 3.2.2 Nhon Hoa Commune (G2)

#### (4) 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.

**(5) 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.

**(6) Piped System**

The study team has drilled a deep well with a yield of 173 m3/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.

## 3.3 Overall Progress of Pilot Model

### 3.3.1 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 of the pilot model plants 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 3.1.

The basic parameters for the construction works are as follows:

| Items | Dak Ui (K3-1) | Nhon Hoa (G2) |
|---|---|---|
| A. Water resource | | |
| 1. Permissible yield of JICA`s deep well | 3.0 l/sec | 2.0 l/sec |
| 2. Altitude of JICA`s deep well | El 687 m | El 420 m |
| 3. Elevation of reservoir tank | El 750 m | El 426 m |
| B Water demand | | |
| 1. Number of villages | 5 | 2 |
| 2. Number of households | 412 | 200 |
| 3. Number of population, 2001 | 2,164 | 1,150 |
| 4. Maximum hourly demand, 2001 | 2.0 m3/h | 1.1 m3/h |
| 5. Maximum daily demand, 2001 | 20.0 m3/d | 11.0 m3/d |
| 6. Maximum hourly demand, 2020 | 26.0 m3/h | 13.3 m3/h |
| 7. Maximum daily demand, 2020 | 238.0 m3/day | 122.0 m3/day |
| 8. Minimum pressure at tapping point | 3.0 m | |

## 3.3.2 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 appurtenant
- Installation of electric panels and its 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 K3-1 and G2 in 2001 are as follows:

| Description | K3-1 | G2 |
|---|---|---|
| Well diameter | 150 mm | 150 mm |
| Well depth (reamed) | 38 m | 110 m |
| Dynamic water level | 18 m | 61 m |
| Permissible yield | 3 l/s | 3 l/s |
| Ground elevation (m) | 685 | 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 K3-1 and G2 systems respectively.

| | Description | K3-1 | G2 |
|---|---|---|---|
| Pump | Type | Calpeda submersible pump, Italy | Calpeda submersible pump, Italy |
| | Model | 4SD 10/17N N 021525 | 4SD 10/17 |
| | Performance | H max. 114 m, Q min. 1.5 m3/h<br>H min. 35 m, Q max. 12 m3/h | H max. 114 m, Q min. 1.5 m3/h<br>H min. 35 m, Q max. 12 m3/h |
| Motor | Type | Franklin Electric, Germany | Franklin Electric, Germany |
| | Model | 3 kW, 3-Phase, 380 V | 3 kW, 3-Phase, 380 V |

**(2) Power Supply**

The power required for the operation of submersible pumps and lightning is supplied from national grid. The line connection 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 of dimension 100 mm (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 Dense Poly-ethylene (HDPE) for secondary and small pipelines and Poli-vinyl Chlorine (PVC) for the main pipelines. The distribution pipe lengths and diameters are shown in the following:

| Pipe Material | K3-1 | | G2 | |
|---|---|---|---|---|
| | Dia. (mm) | Length (m) | Dia. (mm) | Length (m) |
| PVC (for mains) | 100 | 600 | 140 | 460 |
| PVC (for mains) | - | - | 100 | 1,435 |
| HDPE (for secondary pipes) | 75 | 500 | - | - |
| HDPE (for secondary pipes) | 63 | 1,600 | 63 | 665 |
| HDPE (for secondary pipes) | 50 | 3,200 | 50 | 1,500 |
| HDPE (for secondary pipes) | 32 | 4,500 | 32 | 800 |

### (5) Iron Treatment Plant

A treatment plant (aeration and slow sand filtration) was constructed at the hill top of the K3-1 system to reduce iron from 3.49 mg/l to less than 0.5 mg/l (the Vietnamese standard). No treatment plant was constructed for the G2 system.

### (6) Storage Reservoirs

The storage reservoirs with a capacity of 5 $m^3$ of a temporary nature was 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.

In K3-1 the concrete reservoir equipped with the iron removal plant was constructed.

### (7) Public Taps

The number of public taps constructed was 50 in K3-1 and 4 in G2 respectively. Two shower rooms are equipped with each public tap in K3-1 considering the local customs.

### (8) Pressure Testing and Disinfection

In K3-1 system, the pressure testing at every 300 m in length and at 1.5 times of the design pressure was carried out from 29$^{th}$ December of 2001 to 11$^{th}$ January of 2002 in the presence of PCERWASS and the JICA study team. In K3-1 system, the pressure test was also carried out from 1$^{st}$ to 7$^{th}$ of January 2002.

Following the pressure testing, the disinfection was carried out in the G2 and K3-1 system subjecting to all the relevant parts of the pipelines with a 50-mg/l solution for 24 hours. After disinfecting the system the residual chlorine content was reduced below 1 mg/l.

**(9) Preliminary Design and Actual Construction**

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

| System | Work Item | K3-1 | | | |
|---|---|---|---|---|---|
| | | Content | Original | Actual | Reason |
| K3-1 | Public tap | Quantity | 45 sets | 50 sets | Request from CPC and villagers |
| | Distribution pipe | Material, spec. | PE D75 and D50 | HDPE D75 and D50 | Stronger than PE |
| | Distribution pipe | Material, spec. | PE D65 | HDPE D63 | Stronger than PE and local availability |
| | Distribution pipe | Material, spec | PE D25 | HDPE D32 | Stronger than PE and local availability |
| | Iron treatment plant | Item | none | Aeration & slow sand | Remove iron contents |
| 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 |
| | Distri. pipe | Material, spec. | PE D40 | HDPE D50 | Local availability & hydraulic calculation |

### 3.3.3 Water Tariff and Financial Sustainability

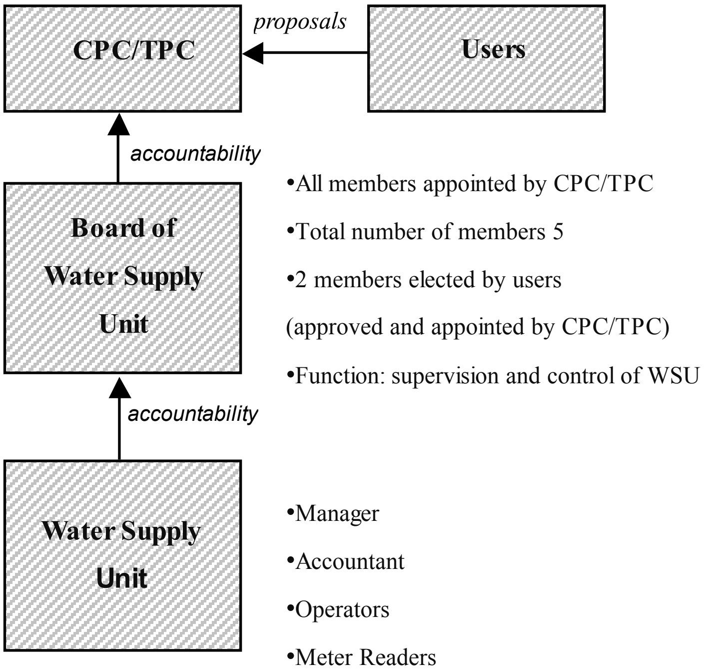
The water tariffs were preliminary set by the study team consulting with CPC/TPC. The basic concepts in December 2001 are as follows:

| 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) |
|---|---|---|---|---|---|---|---|
| K3-1 | 2164: 25% HC and PT 75% | 35 for HC 15 for PT | 38 | 2000 | 27.5 | 26.6 | **0.97MVND** |
| 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 will fall in 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 been strongly requesting to WSUs and PCERWASS for the necessity of more house connections to maintain sustainable management. IEC activities are most important to achieve the target number of house connections. The monitoring of the management of WSU will be continued for the reliable economic evaluation.

### 3.3.4 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 K3-1**

Board of WSU: by the selection from users (2 persons from users) and 3 from CPC

| | |
|---|---|
| - Manager | Half day work only |
| - Accountant | Half day work only |
| - Operator | Full time work |
| - Inspector | Half day work only |

**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 periodical water quality check by using portable kits was introduced to the operator of each WSU.

### 3.3.5 On-going IEC Activities

As the importance of IEC has been explained, the IEC activities are committed 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:

K3-1: Doctors and nurses in the health center

G2: Former vice-chairman of CPC

Necessary information to be distributed as follows:

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.

## 3.4 Percentage of House Connections

The most crucial issue is how to involve more users to the piped network through house connections. The willingness to pay in the social survey is relatively on the positive side.

As a result of IEC activities in the 2 pilot model areas, the number of house connections have been increased, which will raise the revenue level. The cost for IEC promoters are necessary and recommended to be supported by the Vietnam government. It is strongly recommended for PCERWASS to be involved in more IEC activities.

There are two (2) households which already had a house connections on 29 January 2002in K3-1 system. The installation of 5 additional public taps was requested to the study team from CPC because the target area is mostly composed of poor and very poor minority households. Some of the houses are willing to connect to the piped system in K3-1 system, but it was not yet achieved at the end of Jan. 2002, but three households were connected by the end of May 2002.

There are twenty-six (26) households which already had a house connections on 29 January 2002 (out of 138 houses ; 19%), and reached to 38 house holds at the end of May 2002 in G2 system (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 designed as many as 100 house connections. 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 horizontal training between PCERWASS for IEC and technical issues are recommended.

## 3.5 Local Construction Skills and Materials

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

1) General construction companies locating Hanoi and Ho Chi Minh------- 9 companies
2) Middle sized construction companies in Da Nan, Nya Tran and Da Rat cities—7 companies
3) Construction companies for water supply system in the target provinces which have the experience of the 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 by the local contractor, Gia Lai Construction and Electric Assembly Company (in Pleiku City, Gia Lai Province). The following table summarizes an evaluation of the local contractor in the course of construction supervision of the pilot models construction from November 2001 to December 2001:

| Evaluation items | Evaluation |
|---|---|
| Understanding of contract | Still needs experience |
| Cost proposal | On-time, acceptable |
| Document preparation | Speedy, acceptable but needs English skill-up |
| 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 assessed that 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 made in India. The both meters were installed in G2 and K3-1 systems.

## 3.6 Necessary Monitoring Items

Necessary documents for monitoring items are 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

## 3.7 Results of the Monitoring of O&M

### 3.7.1 Purpose and Methodology

A follow-up mission to collect the 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 May 04-08 May 2002. The mission collected records and documents from the two Water Supply Units (WSUs) operating the respective schemes, 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 K3-1 system and Table 3.2 for G2 system in daily basis.

### 3.7.2 Progress and Status

Both pilot models had been taken 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. G2 has managed to operate and maintain the system and collect revenues.

The problem is 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 Dak Ui, which has probably resulted in some confusion and misinterpretation of its 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 by May 08. 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 with some interruptions particularly in K3-1. Interviewed customers reported to have benefited from almost uninterrupted service in both communes. Interruptions in K3-1 were explained to have resulted from power failures (one power failure occurred during a site visit) and few interruptions in G2 from installation of new customer connections.

Since the beginning, the total pumping in 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) or rather metered water use was about 930 $m^3$ against the total pumping of about 1700 $m^3$. This suggests that non-revenue water is some 45%. Obviously the most significant single reason for high losses is substantial overflow from the treatment plant, due to long pumping periods. By the arrangement of communication tools, there is 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 $m^3$. Consequently, the non-revenue water is 13%.

The tariff in G2 is VND 2,000 per $m^3$ and it is said to be VND 1,500 per $m^3$ in K3-1. 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 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. IEC activities are important to increase the house connection.

According to the water analysis reports the water quality in both schemes is incompliance with the Vietnamese standards and international water quality standards. However, users in G2 have complained about water quality. Although nitrite was traced in the sample in an unknown amount at the beginning of the operation, repeated sampling and analysis managed by PCERWASS showed that no nitrite was traced. 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. However, 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 restricts 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 much to explain the cause of sedimentation. It is very likely that the problem is mainly aesthetic and does not involve any risks.

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 in G2 include water quality in G2, 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 filter basin of the treatment plant. The WSU constructed the cover after collecting the necessary money by the beginning of June 2002. Manual pump operation in K3-1 is not convenient due to the location of treatment plant far and high from the pumping station. Yet, the percentage of water losses and long-time pumping suggest that there is an urgent need to improve cost-consciousness of WSU. JICA Study Team donated the set of transceivers recently (June 2002) to WSU of K3-1 system for communication tool between the reservoir tank (iron removal treatment) and pump station.

The time for information, education and communication (IEC) has been far too short to achieve perfect 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. It will take time whereas the capacity building of WSUs is a more urgent matter.

## 3.8 Lessons Learned

### 3.8.1 Institutional Aspects

Some of the communes selected for the Study, Dak Ui (K3-1) among them, 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 extensive capacity building and mental reform is still required at the provincial level it is impossible 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 upgraded and prepared to play the role suggested in the NRWSS.

### 3.8.2 Financial Aspects

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

The tariff of VND 1,500/$m^3$ in K3-1 is enough for salary, electrical charge payment and small size of repairs. Excessive pumping, 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 does not provide for meaningful lessons. However, the laissez-faire management style of K3-1 WSU (No contracts, no formation of user groups) does not give an encouraging signal.

### 3.8.3 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 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 manifold and should allow more accurate optimization of pumping than in G2.

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

# Table 3.1 Daily operation record

| 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/$m^3$) | Time (s) | Time (e) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 710 | 1685 | 1793 | 108 | 251 | 292 | 41 | | Tue | 9.1 | 0.38 | 6.30 | 18.20 |
| | 27 | 595 | 1793 | 1889 | 96 | 663 | 667 | 4 | | Wed | 9.7 | 0.04 | 7.20 | 17.15 |
| | 28 | 650 | 1889 | 1819 | -70 | 624 | 711 | 87 | | Thu | -6.5 | -1.24 | 7.25 | 18.15 |
| | 29 | 0 | 1819 | 1819 | 0 | | | 0 | | Fri | 0.0 | #DIV/0! | No | power |
| | 30 | 0 | 1819 | 1819 | 0 | | | 0 | | Sat | 0.0 | #DIV/0! | No | power |
| | 31 | 615 | 1930 | 2020 | 90 | 729 | 772 | 43 | | Sun | 8.8 | 0.48 | 8.05 | 18.20 |
| Apr | 1 | 660 | 2020 | 2124 | 104 | 772 | 791 | 19 | | Mon | 9.5 | 0.18 | 7.00 | 18.00 |
| | 2 | 680 | 2124 | 2202 | 78 | 213 | 242 | 29 | | Tue | 6.9 | 0.37 | 8.05 | 18.25 |
| | 3 | 715 | 2202 | 2324 | 122 | 281 | 294 | 13 | | Wed | 10.2 | 0.11 | 6.20 | 18.15 |
| | 4 | 320 | 2324 | 2367 | 43 | 195 | 134 | -61 | | Thu | 8.1 | -1.42 | 12.25 | 17.45 |
| | 5 | 665 | 2367 | 2422 | 55 | 934 | 952 | 18 | | Fri | 5.0 | 0.33 | 7.15 | 18.20 |
| | 6 | 740 | 2422 | 2554 | 132 | 919 | 959 | 40 | | Sat | 10.7 | 0.30 | 7.10 | 19.30 |
| | 7 | 0 | 2554 | 2554 | 0 | | | 0 | | Sun | 0.0 | #DIV/0! | No | power |
| | 8 | 715 | 2554 | 2636 | 82 | 102 | 102 | 0 | | Mon | 6.9 | 0.00 | 6.25 | 18.30 |
| | 9 | 0 | 2636 | 2636 | 0 | | | 0 | | Tue | 0.0 | #DIV/0! | No | power |
| | 10 | 745 | 2636 | 2729 | 93 | 102 | 113 | 11 | | Wed | 7.5 | 0.12 | 6.00 | 18.25 |
| | 11 | 660 | 2729 | 2801 | 72 | 111 | 114 | 3 | | Thu | 6.5 | 0.04 | 7.15 | 18.15 |
| | 12 | 405 | 2801 | 2863 | 62 | 114 | 116 | 2 | | Fri | 9.2 | 0.03 | 7.35 | 14.20 |
| | 13 | 450 | 2863 | 2928 | 65 | 116 | 119 | 3 | | Sat | 8.7 | 0.05 | 7.45 | 15.15 |
| | 14 | 550 | 2928 | 3014 | 86 | 119 | 124 | 5 | | Sun | 9.4 | 0.06 | 7.30 | 17.00 |
| | 15 | 670 | 3014 | 3123 | 109 | 124 | 129 | 5 | | Mon | 9.8 | 0.05 | 7.20 | 18.30 |
| | 16 | n.a. | 3123 | 3123 | 0 | 129 | 132 | 3 | | Ti | 0.0 | #DIV/0! | 6.30 | n.a. |
| | 17 | 365 | 3123 | 3183 | 60 | 132 | 152 | 20 | | Wed | 9.9 | 0.33 | 7.15 | 13.20 |
| | 18 | 0 | 3183 | 3183 | 0 | | | 0 | | Thu | 0.0 | #DIV/0! | No | power |
| | 19 | 710 | 3183 | 3349 | 166 | 135 | 139 | 4 | | Fri | 14.0 | 0.02 | 7.55 | 19.45 |
| | 20 | 310 | 3349 | 3396 | 47 | 139 | 142 | 3 | | Sat | 9.1 | 0.06 | 6.50 | 12.00 |
| | 21 | 530 | 3396 | 3474 | 78 | 142 | 145 | 3 | | Sun | 8.8 | 0.04 | 7.15 | 16.15 |
| | 22 | 0 | 3474 | 3474 | 0 | | | 0 | | Mon | 0.0 | #DIV/0! | No | power |
| | 23 | 605 | 3474 | 3558 | 84 | 145 | 149 | 4 | | Tue | 8.3 | 0.05 | 7.00 | 17.15 |
| | 24 | 580 | 3558 | 3639 | 81 | 149 | 153 | 4 | | Wed | 8.4 | 0.05 | 6.30 | 16.10 |
| | 25 | 705 | 3639 | 3724 | 85 | 153 | 157 | 4 | | Thu | 7.2 | 0.05 | 6.30 | 18.15 |
| | 26 | 510 | 3724 | 3787 | 63 | 157 | 160 | 3 | | Fri | 7.4 | 0.05 | 6.15 | 14.45 |
| | 27 | 710 | 3787 | 3793 | 6 | 160 | 164 | 4 | | Sat | 0.5 | 0.67 | 7.25 | 17.15 |
| | 28 | 710 | 3793 | 3883 | 90 | 164 | 168 | 4 | | Sun | 7.6 | 0.04 | 7.25 | 17.15 |
| | 29 | 0 | 3883 | 3883 | 0 | | | 0 | | Mon | 0.0 | #DIV/0! | No | power |
| | 30 | 465 | 3883 | 3966 | 83 | 168 | 171 | 3 | | Tue | 10.7 | 0.04 | 8.00 | 15.45 |
| May | 1 | 450 | 3966 | 4040 | 74 | 171 | 174 | 3 | | Wed | 9.9 | 0.04 | 8.00 | 15.30 |
| | 2 | 495 | 4040 | 4087 | 47 | 174 | 177 | 3 | | Thu | 5.7 | 0.06 | 8.45 | 17.00 |
| | 3 | 0 | 4087 | 4087 | 0 | | | 0 | | Fri | 0.0 | #DIV/0! | No | power |
| | 4 | 630 | 4087 | 4156 | 69 | 177 | 182 | 5 | | Sat | 6.6 | 0.07 | 6.00 | 15.00 |
| | 5 | 1480 | 4156 | 4367 | 211 | 182 | 187 | 5 | | Sun | 8.6 | 0.02 | 7.20 | 18.00 |
| | 6 | 740 | 4367 | 4476 | 109 | 187 | 1020 | 833 | | Mon | 8.8 | 7.64 | 6.00 | 18.20 |

# Table 3.2(1/4) 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/$m^3$) | Time (s) | Time (e) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 27 | 25 | 270 | 273 | 3 | 150 | 152 | 2 | 3 | Sun | 7.2 | 0.67 | 13.00 | 13.25 |
| | 28 | 45 | 273 | 278 | 5 | 152 | 155 | 3 | | | 6.7 | 0.60 | 6.10 | 6.55 |
| | | 25 | 278 | 280 | 2 | 155 | 155 | 0 | 7 | Mon | 4.8 | 0.00 | 11.40 | 11.65 |
| | 29 | 30 | 280 | 285 | 5 | 155 | 158 | 3 | 5 | Tue | 10.0 | 0.60 | 6.40 | 6.70 |
| | 30 | 30 | 285 | 289 | 4 | 158 | 160 | 2 | | | 8.0 | 0.50 | 12.15 | 12.45 |
| | | 35 | 289 | 294 | 5 | 160 | 163 | 3 | 9 | Wed | 8.6 | 0.60 | 17.15 | 17.50 |
| | 31 | 30 | 294 | 298 | 4 | 163 | 165 | 2 | | | 8.0 | 0.50 | 6.00 | 6.30 |
| | | 40 | 298 | 303 | 5 | 165 | 168 | 3 | 9 | Thu | 7.5 | 0.60 | 16.10 | 16.50 |
| Feb | 1 | 40 | 303 | 308 | 5 | 168 | 171 | 3 | | | 7.5 | 0.60 | 14.30 | 14.70 |
| | | 35 | 308 | 312 | 4 | 171 | 173 | 2 | 9 | Fri | 6.9 | 0.50 | 18.00 | 18.35 |
| | 2 | 30 | 312 | 316 | 4 | 173 | 175 | 2 | | | 8.0 | 0.50 | 6.00 | 6.30 |
| | | 25 | 316 | 318 | 2 | 175 | 175 | 0 | 6 | Sat | 4.8 | 0.00 | 13.00 | 13.25 |
| | 3 | 45 | 318 | 323 | 5 | 175 | 178 | 3 | | | 6.7 | 0.60 | 9.45 | 9.90 |
| | | 35 | 323 | 328 | 5 | 178 | 181 | 3 | 10 | Sun | 8.6 | 0.60 | 17.40 | 17.75 |
| | 4 | 30 | 328 | 332 | 4 | 181 | 183 | 2 | | | 8.0 | 0.50 | 9.10 | 9.40 |
| | | 35 | 332 | 336 | 4 | 183 | 185 | 2 | 8 | Mon | 6.9 | 0.50 | 14.15 | 14.50 |
| | 5 | 60 | 336 | 340 | 4 | 185 | 187 | 2 | | | 4.0 | 0.50 | 8.30 | 8.90 |
| | | 30 | 340 | 347 | 7 | 187 | 191 | 4 | 11 | Tue | 14.0 | 0.57 | 10.30 | 10.60 |
| | 6 | 30 | 347 | 352 | 5 | 191 | 194 | 3 | 5 | Wed | 10.0 | 0.60 | 17.00 | 17.30 |
| | 7 | 55 | 352 | 362 | 10 | 194 | 198 | 4 | | | 10.9 | 0.40 | 9.00 | 9.55 |
| | | 30 | 362 | 366 | 4 | 198 | 199 | 1 | 14 | Thu | 8.0 | 0.25 | 15.00 | 15.30 |
| | 8 | 50 | 366 | 372 | 6 | 199 | 202 | 3 | | | 7.2 | 0.50 | 8.00 | 8.50 |
| | | 35 | 372 | 377 | 5 | 202 | 205 | 3 | 11 | Fri | 8.6 | 0.60 | 17.00 | 17.35 |
| | 9 | 35 | 377 | 382 | 5 | 205 | 208 | 3 | 5 | Sat | 8.6 | 0.60 | 10.00 | 10.35 |
| | 10 | 50 | 382 | 388 | 6 | 208 | 214 | 6 | 6 | Sun | 7.2 | 1.00 | 6.00 | 6.50 |
| | 11 | 45 | 388 | 394 | 6 | 214 | 218 | 4 | | | 8.0 | 0.67 | 6.50 | 6.95 |
| | | 55 | 394 | 400 | 6 | 218 | 222 | 4 | 12 | Mon | 6.5 | 0.67 | 16.00 | 16.55 |
| | 12 | 30 | 400 | 404 | 4 | 222 | 224 | 2 | | | 8.0 | 0.50 | 10.00 | 10.30 |
| | | 50 | 404 | 410 | 6 | 224 | 228 | 4 | 10 | Tue | 7.2 | 0.67 | 16.00 | 16.50 |
| | 13 | 50 | 410 | 416 | 6 | 228 | 234 | 6 | | | 7.2 | 1.00 | 7.00 | 7.50 |
| | | 50 | 416 | 422 | 6 | 234 | 237 | 3 | 12 | Wed | 7.2 | 0.50 | 13.00 | 13.50 |
| | 14 | 50 | 422 | 428 | 6 | 237 | 240 | 3 | | | 7.2 | 0.50 | 8.00 | 8.50 |
| | | 30 | 428 | 432 | 4 | 240 | 241 | 1 | 10 | Thu | 8.0 | 0.25 | 16.15 | 16.45 |
| | 15 | 30 | 432 | 436 | 4 | 241 | 242 | 1 | | | 8.0 | 0.25 | 7.15 | 7.45 |
| | | 40 | 436 | 442 | 6 | 242 | 244 | 2 | 10 | Fri | 9.0 | 0.33 | 14.10 | 14.50 |
| | | | | | | | | | | | | | | |
| | 16 | 40 | 449 | 455 | 6 | 244 | 246 | 2 | 6 | Sat | 9.0 | 0.33 | 7.10 | 7.50 |
| | 17 | 55 | 455 | 462 | 7 | 246 | 249 | 3 | | | 7.6 | 0.43 | 6.00 | 6.55 |
| | | 55 | 462 | 469 | 7 | 249 | 252 | 3 | 14 | Sun | 7.6 | 0.43 | 13.00 | 13.55 |
| | 18 | 40 | 469 | 475 | 6 | 452 | 454 | 2 | 6 | Mon | 9.0 | 0.33 | 8.10 | 8.50 |
| | 19 | 40 | 482 | 489 | 7 | 454 | 456 | 2 | | | 10.5 | 0.29 | 8.30 | 8.70 |
| | | 25 | 489 | 493 | 4 | 457 | 457 | 0 | 11 | Tue | 9.6 | 0.00 | 13.15 | 13.40 |
| | 20 | 45 | 493 | 498 | 5 | 457 | 458 | 1 | | | 6.7 | 0.20 | 7.45 | 7.90 |
| | | 60 | 498 | 505 | 7 | 458 | 461 | 3 | | | 7.0 | 0.43 | 13.00 | 13.60 |
| | | 35 | 505 | 510 | 5 | 461 | 462 | 1 | 17 | Wed | 8.6 | 0.20 | 17.00 | 17.35 |
| | 21 | 60 | 510 | 516 | 6 | 462 | 464 | 2 | | | 6.0 | 0.33 | 7.00 | 7.60 |
| | | 60 | 516 | 522 | 6 | 464 | 467 | 3 | 12 | Thu | 6.0 | 0.50 | 14.00 | 14.60 |
| | 22 | 30 | 522 | 526 | 4 | 467 | 468 | 1 | | | 8.0 | 0.25 | 7.00 | 7.30 |
| | | 35 | 526 | 531 | 5 | 468 | 469 | 1 | 9 | Fri | 8.6 | 0.20 | 14.00 | 14.35 |
| | 23 | 60 | 531 | 538 | 7 | 469 | 473 | 4 | | | 7.0 | 0.57 | 6.00 | 6.60 |
| | | 35 | 538 | 541 | 3 | 473 | 473 | 0 | 10 | Sat | 5.1 | 0.00 | 12.00 | 12.35 |
| | 24 | 40 | 541 | 546 | 5 | 473 | 476 | 3 | | | 7.5 | 0.60 | 7.10 | 7.50 |
| | | 50 | 546 | 552 | 6 | 476 | 477 | 1 | 11 | Sun | 7.2 | 0.17 | 13.40 | 13.90 |
| | 25 | 30 | 552 | 556 | 4 | 477 | 478 | 1 | 4 | Mon | 8.0 | 0.25 | 10.00 | 10.30 |
| | 26 | 45 | 556 | 561 | 5 | 478 | 480 | 2 | 5 | Tue | 6.7 | 0.40 | 16.30 | 16.75 |
| | 27 | 30 | 561 | 565 | 4 | 480 | 481 | 1 | | | 8.0 | 0.25 | 6.30 | 6.60 |
| | | 40 | 565 | 570 | 5 | 481 | 483 | 2 | 9 | Wed | 7.5 | 0.40 | 11.00 | 11.40 |
| | 28 | 65 | 570 | 578 | 8 | 483 | 487 | 4 | 8 | Thu | 7.4 | 0.50 | 6.00 | 6.65 |

# Table 3.2(2/4) 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$^3$) | Time (s) | Time (e) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mar | 1 | 45 | 578 | 582 | 4 | | | 0 | | | 5.3 | 0.00 | 8.30 | 8.75 |
| | | 50 | 582 | 588 | 6 | | | 0 | 10 | Fri | 7.2 | 0.00 | 14.30 | 14.80 |
| | 2 | 50 | 588 | 593 | 5 | | | 0 | | | 6.0 | 0.00 | 9.00 | 9.50 |
| | | 50 | 593 | 599 | 6 | | | 0 | 11 | Sat | 7.2 | 0.00 | 17.00 | 17.50 |
| | 3 | 50 | 599 | 605 | 6 | | | 0 | | | 7.2 | 0.00 | 8.00 | 8.50 |
| | | 50 | 605 | 612 | 7 | | | 0 | 13 | Sun | 8.4 | 0.00 | 15.30 | 15.80 |
| | 4 | 0 | 612 | 612 | 0 | | | 0 | 0 | Mon | 0.0 | 0.00 | No | power |
| | 5 | 370 | 612 | 633 | 21 | | | 0 | | | 3.4 | 0.00 | 7.00 | 13.10 |
| | | 110 | 633 | 638 | 5 | | | 0 | 26 | Tue | 2.7 | 0.00 | 18.00 | 19.50 |
| | 6 | 80 | 638 | 644 | 6 | | | 0 | | | 4.5 | 0.00 | 8.00 | 8.80 |
| | | 70 | 644 | 651 | 7 | | | 0 | 13 | Wed | 6.0 | 0.00 | 15.00 | 15.70 |
| | 7 | 80 | 651 | 661 | 10 | | | 0 | | | 7.5 | 0.00 | 6.00 | 6.80 |
| | | 100 | 661 | 669 | 8 | | | 0 | 18 | Thu | 4.8 | 0.00 | 15.10 | 16.50 |
| | 8 | 60 | 669 | 675 | 6 | | | 0 | | | 6.0 | 0.00 | 7.00 | 7.60 |
| | | 40 | 675 | 670 | -5 | | | 0 | | | -7.5 | 0.00 | 13.00 | 13.40 |
| | | 80 | 670 | 676 | 6 | | | 0 | 7 | Fri | 4.5 | 0.00 | 18.00 | 18.80 |
| | 9 | 80 | 676 | 683 | 7 | | | 0 | | | 5.3 | 0.00 | 7.10 | 7.90 |
| | | 85 | 683 | 690 | 7 | | | 0 | 14 | Sat | 4.9 | 0.00 | 14.00 | 14.85 |
| | 10 | 75 | 690 | 696 | 6 | | | 0 | | | 4.8 | 0.00 | 8.00 | 8.75 |
| | | 40 | 696 | 700 | 4 | | | 0 | 10 | Sun | 6.0 | 0.00 | 13.30 | 13.70 |
| | 11 | 50 | 700 | 706 | 6 | | | 0 | 6 | Mon | 7.2 | 0.00 | 12.00 | 12.50 |
| | 12 | 50 | 706 | 712 | 6 | | | 0 | 6 | Tue | 7.2 | 0.00 | 6.00 | 6.50 |
| | 13 | 50 | 712 | 718 | 6 | | | 0 | | | 7.2 | 0.00 | 6.30 | 6.80 |
| | | 40 | 718 | 723 | 5 | | | 0 | 11 | Wed | 7.5 | 0.00 | 13.00 | 13.40 |
| | 14 | 50 | 723 | 729 | 6 | | | 0 | 6 | Thu | 7.2 | 0.00 | 6.30 | 6.80 |
| | 15 | 90 | 729 | 737 | 8 | | | 0 | | | 5.3 | 0.00 | 7.10 | 8.40 |
| | | 40 | 737 | 742 | 5 | | | 0 | 13 | Fri | 7.5 | 0.00 | 18.10 | 18.50 |
| | 16 | 50 | 742 | 748 | 6 | | | 0 | | | 7.2 | 0.00 | 7.30 | 7.80 |
| | | 60 | 748 | 754 | 6 | | | 0 | 12 | Sat | 6.0 | 0.00 | 13.00 | 13.60 |
| | 17 | 80 | 754 | 764 | 10 | | | 0 | | | 7.5 | 0.00 | 6.00 | 6.80 |
| | | 25 | 764 | 767 | 3 | | | 0 | 13 | Sun | 7.2 | 0.00 | 14.00 | 14.25 |
| | 18 | 40 | 767 | 773 | 6 | | | 0 | | | 9.0 | 0.00 | 8.30 | 8.70 |
| | | 40 | 773 | 778 | 5 | | | 0 | 11 | Mon | 7.5 | 0.00 | 14.10 | 14.50 |
| | 19 | 50 | 778 | 784 | 6 | | | 0 | | | 7.2 | 0.00 | 6.00 | 6.50 |
| | | 30 | 784 | 788 | 4 | | | 0 | | | 8.0 | 0.00 | 11.00 | 11.30 |
| | | 70 | 788 | 796 | 8 | | | 0 | 18 | Tue | 6.9 | 0.00 | 16.00 | 16.70 |
| | 20 | 65 | 796 | 805 | 9 | | | 0 | | | 8.3 | 0.00 | 6.00 | 6.65 |
| | | 30 | 805 | 809 | 4 | | | 0 | 13 | Wed | 8.0 | 0.00 | 11.00 | 11.30 |
| | 21 | 45 | 809 | 816 | 7 | | | 0 | | | 9.3 | 0.00 | 6.00 | 6.45 |
| | | 40 | 816 | 822 | 6 | | | 0 | 13 | Thu | 9.0 | 0.00 | 13.00 | 13.40 |
| | 22 | 40 | 822 | 828 | 6 | | | 0 | | | 9.0 | 0.00 | 6.00 | 6.40 |
| | | 35 | 828 | 833 | 5 | | | 0 | | | 8.6 | 0.00 | 11.00 | 11.35 |
| | | 30 | 833 | 837 | 4 | | | 0 | 15 | Fri | 8.0 | 0.00 | 15.00 | 15.30 |
| | 23 | 55 | 837 | 844 | 7 | | | 0 | | | 7.6 | 0.00 | 6.00 | 6.55 |
| | | 60 | 844 | 850 | 6 | | | 0 | 13 | Sat | 6.0 | 0.00 | 18.00 | 18.60 |
| | 24 | 120 | 850 | 861 | 11 | | | 0 | | | 5.5 | 0.00 | 7.00 | 9.00 |
| | | 30 | 861 | 864 | 3 | | | 0 | | | 6.0 | 0.00 | 15.00 | 15.30 |
| | | 30 | 864 | 867 | 3 | | | 0 | 17 | Sun | 6.0 | 0.00 | 17.00 | 17.30 |
| | 25 | 35 | 867 | 872 | 5 | | | 0 | | | 8.6 | 0.00 | 8.00 | 8.35 |
| | | 40 | 872 | 877 | 5 | | | 0 | 10 | Mon | 7.5 | 0.00 | 15.00 | 15.40 |
| | 26 | 40 | 877 | 883 | 6 | | | 0 | | | 9.0 | 0.00 | 6.00 | 6.40 |
| | | 55 | 883 | 890 | 7 | | | 0 | 13 | Tue | 7.6 | 0.00 | 14.15 | 14.70 |
| | 27 | 60 | 890 | 896 | 6 | | | 0 | 6 | Wed | 6.0 | 0.00 | 6.00 | 6.60 |
| | 28 | 40 | 896 | 901 | 5 | | | 0 | | | 7.5 | 0.00 | 6.00 | 6.40 |
| | | 60 | 901 | 909 | 8 | | | 0 | 13 | Thu | 8.0 | 0.00 | 11.00 | 11.60 |
| | 29 | 40 | 909 | 914 | 5 | | | 0 | | | 7.5 | 0.00 | 6.00 | 6.40 |
| | | 40 | 914 | 919 | 5 | | | 0 | 10 | Fri | 7.5 | 0.00 | 11.00 | 11.40 |
| | 30 | 105 | 919 | 928 | 9 | | | 0 | | | 5.1 | 0.00 | 6.00 | 7.05 |
| | | 60 | 928 | 936 | 8 | | | 0 | 17 | Sat | 8.0 | 0.00 | 11.00 | 11.60 |
| | 31 | 120 | 936 | 945 | 9 | | | 0 | | | 4.5 | 0.00 | 8.00 | 10.00 |
| | | 100 | 945 | 957 | 12 | | | 0 | | | 7.2 | 0.00 | 9.20 | 11.00 |
| | | 30 | 957 | 961 | 4 | | | 0 | 25 | Sun | 8.0 | 0.00 | 15.30 | 15.60 |

## Table 3.2(3/4) 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/$m^3$) | Time (s) | Time (e) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Apr | 1 | n.a. | 961 | 973 | 12 | | | 0 | 12 | Mon | #VALUE! | 0.00 | 11.20 | n.a. |
| | 2 | 90 | 973 | 983 | 10 | | | 0 | | | 6.7 | 0.00 | 8.30 | 10.00 |
| | | 60 | 983 | 990 | 7 | | | 0 | | | 7.0 | 0.00 | 13.00 | 13.60 |
| | | 80 | 990 | 1000 | 10 | | | 0 | | | 7.5 | 0.00 | 6.00 | 6.80 |
| | | 60 | 1000 | 1008 | 8 | | | 0 | 35 | Tue | 8.0 | 0.00 | 11.00 | 11.60 |
| | 3 | 55 | 1008 | 1015 | 7 | | | 0 | | | 7.6 | 0.00 | 6.00 | 6.55 |
| | | 95 | 1015 | 1024 | 9 | | | 0 | | | 5.7 | 0.00 | 10.00 | 10.95 |
| | | 60 | 1024 | 1032 | 8 | | | 0 | 24 | Wed | 8.0 | 0.00 | 17.00 | 17.60 |
| | 4 | 55 | 1032 | 1039 | 7 | | | 0 | | | 7.6 | 0.00 | 6.00 | 6.55 |
| | | 65 | 1039 | 1048 | 9 | | | 0 | | | 8.3 | 0.00 | 11.00 | 11.65 |
| | | n.a. | 1048 | 1051 | 3 | | | 0 | 19 | Thu | #VALUE! | 0.00 | n.a. | n.a. |
| | 5 | 115 | 1051 | 1066 | 15 | | | 0 | | | 7.8 | 0.00 | 9.50 | 11.45 |
| | | 50 | 1066 | 1074 | 8 | | | 0 | 23 | Fri | 9.6 | 0.00 | 3.00 | 3.50 |
| | 6 | 110 | 1074 | 1085 | 11 | | | 0 | | | 6.0 | 0.00 | 6.15 | 8.05 |
| | | 90 | 1085 | 1094 | 9 | | | 0 | 20 | Sat | 6.0 | 0.00 | 13.10 | 14.40 |
| | 7 | 90 | 1094 | 1105 | 11 | | | 0 | | | 7.3 | 0.00 | 6.00 | 6.90 |
| | | 40 | 1105 | 1110 | 5 | | | 0 | | | 7.5 | 0.00 | 12.00 | 12.40 |
| | | 40 | 1110 | 1115 | 5 | | | 0 | 21 | Sun | 7.5 | 0.00 | 16.10 | 16.50 |
| | 8 | 125 | 1115 | 1132 | 17 | | | 0 | | | 8.2 | 0.00 | 6.00 | 8.05 |
| | | 90 | 1132 | 1145 | 13 | | | 0 | 30 | Mon | 8.7 | 0.00 | 11.00 | 11.90 |
| | 9 | 0 | | | 0 | | | 0 | 13 | Tue | #DIV/0! | #DIV/0! | | |
| | 10 | 60 | 1145 | 1153 | 8 | | | 0 | | | 8.0 | 0.00 | 6.00 | 6.60 |
| | | 60 | 1153 | 1161 | 8 | | | 0 | | | 8.0 | 0.00 | 11.00 | 11.60 |
| | | 30 | 1161 | 1165 | 4 | | | 0 | 20 | Wed | 8.0 | 0.00 | 14.00 | 14.30 |
| | 11 | 90 | 1165 | 1177 | 12 | | | 0 | | | 8.0 | 0.00 | 6.00 | 6.90 |
| | | 90 | 1177 | 1188 | 11 | | | 0 | 23 | Thu | 7.3 | 0.00 | 11.00 | 11.90 |
| | 12 | 95 | 1188 | 1199 | 11 | | | 0 | | | 6.9 | 0.00 | 6.00 | 6.95 |
| | | 130 | 1199 | 1215 | 16 | | | 0 | 27 | Fri | 7.4 | 0.00 | 13.00 | 15.10 |
| | 13 | 80 | 1215 | 1225 | 10 | | | 0 | | | 7.5 | 0.00 | 7.10 | 7.90 |
| | | 130 | 1225 | 1237 | 12 | | | 0 | 22 | Sat | 5.5 | 0.00 | 13.00 | 15.10 |
| | 14 | 110 | 1237 | 1252 | 15 | | | 0 | | | 8.2 | 0.00 | 7.10 | 9.00 |
| | | 180 | 1252 | 1268 | 16 | | | 0 | 31 | Sun | 5.3 | 0.00 | 17.00 | 20.00 |
| | 15 | 60 | 1268 | 1275 | 7 | | | 0 | | | 7.0 | 0.00 | 9.00 | 9.60 |
| | | 140 | 1275 | 1279 | 4 | | | 0 | 11 | Mon | 1.7 | 0.00 | 17.30 | 18.50 |
| | 16 | 65 | 1279 | 1286 | 7 | | | 0 | | | 6.5 | 0.00 | 7.15 | 7.80 |
| | | 60 | 1286 | 1292 | 6 | | | 0 | | | 6.0 | 0.00 | 13.00 | 13.60 |
| | | 40 | 1292 | 1296 | 4 | | | 0 | 17 | Tue | 6.0 | 0.00 | 15.00 | 15.40 |
| | 17 | 60 | 1296 | 1312 | 16 | | | 0 | | | 16.0 | 0.00 | 8.00 | 8.60 |
| | | 40 | 1312 | 1316 | 4 | | | 0 | 20 | Wed | 6.0 | 0.00 | 12.30 | 12.70 |
| | 18 | 135 | 1316 | 1326 | 10 | | | 0 | | | 4.4 | 0.00 | 8.00 | 10.15 |
| | | 60 | 1326 | 1335 | 9 | | | 0 | 19 | Thu | 9.0 | 0.00 | 14.00 | 14.60 |
| | 19 | 140 | 1335 | 1345 | 10 | | | 0 | | | 4.3 | 0.00 | 8.00 | 10.20 |
| | | 100 | 1345 | 1351 | 6 | | | 0 | | | 3.6 | 0.00 | 15.00 | 16.40 |
| | | 50 | 1351 | 1355 | 4 | | | 0 | 20 | Fri | 4.8 | 0.00 | 18.00 | 18.50 |
| | 20 | 150 | 1355 | 1368 | 13 | | | 0 | | | 5.2 | 0.00 | 8.00 | 10.30 |
| | | 60 | 1368 | 1376 | 8 | | | 0 | | | 8.0 | 0.00 | 14.00 | 14.60 |
| | | 45 | 1376 | 1380 | 4 | | | 0 | 25 | Sat | 5.3 | 0.00 | 18.00 | 18.45 |
| | 21 | 150 | 1380 | 1392 | 12 | | | 0 | | | 4.8 | 0.00 | 8.00 | 10.30 |
| | | 60 | 1392 | 1399 | 7 | | | 0 | | | 7.0 | 0.00 | 14.00 | 14.60 |
| | | 50 | 1399 | 1404 | 5 | | | 0 | 24 | Sun | 6.0 | 0.00 | 19.00 | 19.50 |
| | 22 | 75 | 1404 | 1414 | 10 | | | 0 | | | 8.0 | 0.00 | 7.30 | 8.45 |
| | | 75 | 1414 | 1422 | 8 | | | 0 | | | 6.4 | 0.00 | 11.00 | 11.75 |
| | | 40 | 1422 | 1429 | 7 | | | 0 | 25 | Mon | 10.5 | 0.00 | 17.40 | 17.80 |
| | 23 | 70 | 1429 | 1438 | 9 | | | 0 | | | 7.7 | 0.00 | 7.00 | 7.70 |
| | | 60 | 1438 | 1450 | 12 | | | 0 | | | 12.0 | 0.00 | 12.00 | 12.60 |
| | | 60 | 1450 | 1456 | 6 | | | 0 | 27 | Tue | 6.0 | 0.00 | 19.00 | 19.60 |
| | 24 | 80 | 1456 | 1470 | 14 | | | 0 | | | 10.5 | 0.00 | 7.30 | 8.50 |
| | | 30 | 1470 | 1480 | 10 | | | 0 | | | 20.0 | 0.00 | 12.00 | 12.30 |
| | | 60 | 1480 | 1487 | 7 | | | 0 | 31 | Wed | 7.0 | 0.00 | 18.00 | 18.60 |
| | 25 | 90 | 1487 | 1500 | 13 | | | 0 | | | 8.7 | 0.00 | 8.30 | 10.00 |
| | | 120 | 1500 | 1510 | 10 | | | 0 | 23 | Thu | 5.0 | 0.00 | 17.00 | 19.00 |
| | 26 | 80 | 1510 | 1519 | 9 | | | 0 | | | 6.8 | 0.00 | 7.00 | 7.80 |
| | | 100 | 1519 | 1530 | 11 | | | 0 | 20 | Fri | 6.6 | 0.00 | 13.00 | 14.40 |

## Table 3.2(4/4) 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/$m^3$) | Time (s) | Time (e) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 27 | 70 | 1530 | 1538 | 8 | | | 0 | | | 6.9 | 0.00 | 7.30 | 8.40 |
| | | 50 | 1538 | 1543 | 5 | | | 0 | | | 6.0 | 0.00 | 13.00 | 13.50 |
| | | 40 | 1543 | 1548 | 5 | | | 0 | 18 | Sat | 7.5 | 0.00 | 18.10 | 18.50 |
| | 28 | 80 | 1548 | 1558 | 10 | | | 0 | | | 7.5 | 0.00 | 7.00 | 7.80 |
| | | 60 | 1558 | 1563 | 5 | | | 0 | | | 5.0 | 0.00 | 13.00 | 13.60 |
| | | 60 | 1563 | 1568 | 5 | | | 0 | 20 | Sun | 5.0 | 0.00 | 18.00 | 18.60 |
| | 29 | 80 | 1568 | 1578 | 10 | | | 0 | | | 7.5 | 0.00 | 7.30 | 8.50 |
| | | 40 | 1578 | 1588 | 10 | | | 0 | 20 | Mon | 15.0 | 0.00 | 16.00 | 16.40 |
| | 30 | 90 | 1588 | 1597 | 9 | | | 0 | | | 6.0 | 0.00 | 6.00 | 6.90 |
| | | 120 | 1597 | 1608 | 11 | | | 0 | 20 | Tue | 5.5 | 0.00 | 18.00 | 20.00 |
| May | 1 | 70 | 1608 | 1615 | 7 | | | 0 | | | 6.0 | 0.00 | 6.20 | 6.90 |
| | | 60 | 1615 | 1620 | 5 | | | 0 | | | 5.0 | 0.00 | 14.00 | 14.60 |
| | | 70 | 1620 | 1627 | 7 | | | 0 | 19 | Wed | 6.0 | 0.00 | 18.00 | 18.70 |
| | 2 | 75 | 1627 | 1635 | 8 | | | 0 | | | 6.4 | 0.00 | 7.00 | 7.75 |
| | | 75 | 1635 | 1642 | 7 | | | 0 | | | 5.6 | 0.00 | 15.00 | 15.75 |
| | | 60 | 1642 | 1648 | 6 | | | 0 | 21 | Thu | 6.0 | 0.00 | 19.00 | 19.60 |
| | 3 | 80 | 1648 | 1658 | 10 | | | 0 | | | 7.5 | 0.00 | 7.30 | 8.50 |
| | | 65 | 1658 | 1667 | 9 | | | 0 | 19 | Fri | 8.3 | 0.00 | 15.25 | 15.90 |
| | 4 | 65 | 1667 | 1672 | 5 | | | 0 | | | 4.6 | 0.00 | 8.10 | 8.75 |
| | | 75 | 1672 | 1679 | 7 | | | 0 | | | 5.6 | 0.00 | 13.30 | 14.45 |
| | | 80 | 1679 | 1685 | 6 | | | 0 | 18 | Sat | 4.5 | 0.00 | 18.20 | 19.40 |
| | 5 | 90 | 1685 | 1695 | 10 | | | 0 | | | 6.7 | 0.00 | 7.30 | 9.00 |
| | | 70 | 1695 | 1701 | 6 | | | 0 | | | 5.1 | 0.00 | 14.30 | 15.40 |
| | | 60 | 1701 | 1705 | 4 | | | 0 | 20 | Sun | 4.0 | 0.00 | 18.00 | 18.60 |
| | 6 | 120 | 1705 | 1717 | 12 | | | 0 | | | 6.0 | 0.00 | 8.00 | 10.00 |
| | | 110 | 1717 | 1726 | 9 | | | 0 | | | 4.9 | 0.00 | 14.00 | 15.50 |
| | | 60 | 1726 | 1730 | 4 | | | 0 | 25 | Mon | 4.0 | 0.00 | 18.00 | 18.60 |
| | 7 | 80 | 1730 | 1738 | 8 | | | 0 | | | 6.0 | 0.00 | 7.30 | 8.50 |
| | | 50 | 1738 | 1747 | 9 | | | 0 | | | 10.8 | 0.00 | 14.10 | 14.60 |
| | | 100 | 1747 | 1755 | 8 | | | 0 | | | 4.8 | 0.00 | 17.20 | 18.40 |

# Chapter 4 Cost Estimation and Implementation Plan

## 4.1 Project Cost

### 4.1.1 Conditions and Assumptions for Cost Estimate

The construction cost for the selected 21 priority systems has been estimated under the following conditions and assumptions:

1) The price level is the year 2001
2) Exchange rate is US$ 1.0 = VND = 15,000 = JY 120.0
3) The estimates were reviewed on a financial basis with the cost composition and conditions as given in the Table 4.1.

**Table 4.1 Composition of Project Cost**

| Project Cost item | Parameters | No. |
|---|---|---|
| Direct construction cost | Unit cost or lump sum basis | A |
| VAT (Value Added Tax) | 10 % of A | B |
| Construction cost | A+B | C |
| Land acquisition and compensation cost | | D |
| Engineering services expenses | 15 % of C | E |
| Base cost | C+D+E | F |
| Physical contingency | 10 % of F | G |
| Project cost | F+G | H |
| Price contingency | 10 % of H | I |
| Total investment cost | | H+I |

4) The unit costs applied for the cost estimates are tabulated in Table 4.2.

**Table 4.2 Unit Cost for Major Items with Foreign and Local Currency Portion**

| No. | Construction Items | Unit | Unit Cost (US$) | FC Portion (US$) | FC Portion (%) | LC Portion US$ | LC Portion (%) |
|---|---|---|---|---|---|---|---|
| 1 | Deep well | well | 40,000 | 20,000 | 50 | 20,000 | 50 |
| 2 | Submersible pump | set | 6,000 | 5,000 | 83 | 1,000 | 17 |
| 3 | Well head arrangement | head | 1,900 | 500 | 26 | 1,400 | 74 |
| 4 | Control panel | panel | 2,200 | 2,000 | 91 | 200 | 9 |
| 5 | Power supply | station | 4,300 | 0 | 0 | 4,300 | 100 |
| 6 | Well head house | m2 | 180 | 0 | 0 | 180 | 100 |
| 7 | Reservoir, ground 50 m3 | m3 | 107 | 0 | 0 | 107 | 100 |
| 8 | Treatment plant | | | | | | |
| | Aeration & reaction basin | m3 | 400 | 0 | 0 | 400 | 100 |
| | Rapid sand filter | m2 | 2,000 | 0 | 0 | 2,000 | 100 |
| | Roughing & slow sand filter | m2 | 1,500 | 0 | 0 | 1,500 | 100 |
| 9 | Booster pump station | m3/hr | 518 | 300 | 58 | 220 | 42 |
| 10 | Chlorinator | item | 4,400 | 2,200 | 50 | 2,200 | 50 |
| 11 | Raw water lines, GI 100 mm | m | 16 | 0 | 0 | 16 | 100 |
| | included fittings, tests & all other works | | | | | | |
| 12 | Distribution lines including fittings, | | | | | | |
| | tests & all other works | | | | | | |
| | PVC 100 mm | m | 16.0 | 0 | 0 | 16.0 | 100 |
| | PVC 150-200 mm | m | 17.0 | 0 | 0 | 17.0 | 100 |
| | HDPE 25-65 mm | m | 6.0 | 0 | 0 | 6.0 | 100 |
| | HDPE 75-125 mm | m | 9.5 | 0 | 0 | 9.5 | 100 |
| 13 | Public taps | tap | 500 | 0 | 0 | 500 | 100 |

Foreign and Local currency portions are categorized as following a) and b). The project cost was expressed by US$.

a) Local currency portion
- Labor costs
- Locally available materials, facilities and equipment
- Inland transportation cost for materials to be imported
- Value added tax (VAT)
- Land acquisition and compensation costs
- Local portion of engineering services expenses
- Contingencies for local portion

b) Foreign currency portion
- Cost of materials, facilities and equipment to be imported
- Foreign portion of engineering services expenses
- Contingencies for foreign portion

5) The direct construction cost was estimated by multiplying work quantity and unit construction cost in principle. The work quantity was estimated based on

the system layout, outline dimensions and proposed capacities of the facilities for the priority systems of each commune. The cost for capacity building, IEC, O&M activities and other soft components are estimated by man-month basis for human resource input ant tools required for these activities. It shall be prepared by Vietnamese side.

6) The unit costs in Table 4.1 was determined with referring the published current cost standards in 3 provinces of Kon Tum, Gia Lai and Dac Lac, international market price of construction materials and facilities, cost proposals for the construction of 2 pilot model plants at K3-1 and G2 communes, and other data obtained during the study period. The unit costs presented in this study are to be reviewed in future.
7) The power required for the rural water supply system is by connecting system to the existing power line of national grid. The cost comparison between the generator driven system and the existing power lone is shown in Appendix 5.
8) A 10 % of construction cost was added as for the value added tax (VAT) following to the Vietnamese regulation.
9) Land acquisition and compensation costs were itemized in the format sheet of cost estimate. No cost was accounted it as the government owned land.
10) Engineering service expenses assume at 15 % of construction cost for the survey, investigation, and design and construction supervision for respective scheme.
11) A 10 % of base cost was counted for the physical contingency considering present maturity of the project and for unforeseeable site conditions, etc.
12) Price contingency was itemized in the format sheet of cost estimate. No cost was accounted on an assumption that project will be implemented in an early stage.

Project costs were further subdivided in the next section of 3.1.2 "Construction Cost".

### 4.1.2 Construction Cost

The construction cost of the 21 systems has been estimated at US$ 13.7 million or equivalent VND 205.5 billion. Its foreign currency and local currency portion are 13 % and 87 %, respectively, excluding procurement for drilling equipment. Table 4.3 shows summary for 21 systems in phase 1 by four steps to the year 2010.

**Table 4.3 Cost for the 21 Systems by 4-step Implementation**

| Phasing | Implementation Period | No. of System | Cost excluding procurement of equipment (US$ million including VAT) |
|---|---|---|---|
| Step 1 | 2002-2004 | 5 | 5.1 |
| Step 2 | 2004-2006 | 5 | 3.0 |
| Step 3 | 2006-2008 | 4 | 1.8 |
| Step 4 | 2008-2010 | 7 | 3.8 |
| **Total** | | **21** | **13.7** |

The step-wised project cost is tabulated in Table 4.4 with the implementation mode of four cases of step 1, step 2 step 3 and step 4.

**Table 4.4 Alternative Cost Study by Phasing Implementation in Phase1**

(Alternative1:Four step implementation)

US$ 1.0=VND 15,000.0=JY 120.0

| Serial 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 %)** | | | | **361,792** | **191,721** | **176,239** | **275,179** | **1,004,931** |
| | | **Total** | | | | **5,004,511** | **3,132,108** | **1,824,487** | **3,756,195** | **13,717,301** |

Notes *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

Table also shows summary cost for 21 systems in phase1 divided into foreign and local currency portions.

**Table 4.5 Summary of Project Cost Divided FC and LC in Phase 1(to 2010)**

| Serial No. | | Syatem No. | Name of Commune | FC <1 (US$) | LC <2 (US$) | Total <3 (US$) | Total Equivalent <3 (1,000 VND) |
|---|---|---|---|---|---|---|---|
| | | **Kon Tum** | | **384,633** | **2,323,485** | **2,708,118** | **40,621,772** |
| 1 | 1 | K1-1 | Bo Y | 255,043 | 852,952 | 1,107,995 | 16,619,918 |
| 2 | 2 | K2-1 | Dak Su | 9,708 | 187,999 | 197,707 | 2,965,603 |
| 3 | 3 | K2-3 | Dak Su | 99,457 | 461,877 | 561,334 | 8,420,004 |
| 4 | 4 | K3-1 | Dak Ui | 9,708 | 250,201 | 259,908 | 3,898,622 |
| 5 | 5 | K4-1 | Dak Hring | 10,719 | 570,456 | 581,175 | 8,717,624 |
| | | **Gia Lai** | | **504,580** | **3,787,073** | **4,291,653** | **64,374,794** |
| 6 | 1 | G1 | Kong Tang | 59,635 | 709,028 | 768,663 | 11,529,950 |
| 7 | 2 | G2 | Nhon Hoa | 238,308 | 1,108,871 | 1,347,179 | 20,207,692 |
| 8 | 3 | G3-1 | Chu Ty | 62,229 | 689,112 | 751,342 | 11,270,125 |
| 9 | 4 | G4-1 | Thang Hung | 55,591 | 381,578 | 437,169 | 6,557,532 |
| 10 | 5 | G5-1 | Ngia Hoa | 52,386 | 378,422 | 430,808 | 6,462,126 |
| 11 | 6 | G6-1 | Ia Rsiom | 21,916 | 247,102 | 269,019 | 4,035,280 |
| 12 | 7 | G7-1 | Kong Yang | 14,515 | 272,958 | 287,473 | 4,312,088 |
| | | **Dac Lac** | | **817,870** | **4,894,729** | **5,712,600** | **85,688,994** |
| 13 | 1 | D1 | Krong Nang | 106,815 | 703,584 | 810,399 | 12,155,992 |
| 14 | 2 | D2 | Ea Drang | 203,055 | 969,410 | 1,172,465 | 17,586,979 |
| 15 | 3 | D3-1 | Krong Buk | 63,603 | 362,752 | 426,354 | 6,395,315 |
| 16 | 4 | D3-2 | Krong Buk | 46,301 | 360,435 | 406,735 | 6,101,032 |
| 17 | 5 | D4-1 | Ea Drong | 93,843 | 594,669 | 688,513 | 10,327,694 |
| 18 | 6 | D4-2 | Ea Drong | 40,196 | 271,118 | 311,314 | 4,669,710 |
| 19 | 7 | D5-1 | Ea Wer | 96,743 | 620,041 | 716,784 | 10,751,766 |
| 20 | 8 | D6 | Kien Duc | 106,381 | 620,644 | 727,026 | 10,905,388 |
| 21 | 9 | D7 | Krong Kmar | 60,932 | 392,076 | 453,008 | 6,795,118 |
| | | **Total** | | **1,707,084** | **11,005,286** | **12,712,371** | **190,685,559** |
| | | (%) | | 13 | 87 | | |

<1 FC: Foreign Currency Portion
<2 LC: Local Currency portion
<3 excluding value added tax

The estimated cost for respective system and summary of procurement cost of drilling and other ancillary equipment are in Appendix 6 and Appendix 7.

In case of alternative implementation method by the three phasing, the cost for three steps and two steps implementation will be at once as shown an example below Table 4.6 and 3.7.

**Table 4.6 Cost for the 21 Systems by 3-step Implementation**

| Phasing | Implementation Period | No. of System | Cost excluding procurement of equipment (US$ million including VAT) |
|---|---|---|---|
| Step 1 | 2002-2005 | 10 | 8.1 |
| Step 2 | 2004-2006 | 4 | 1.8 |
| Step 3 | 2006-2008 | 7 | 3.8 |
| **Total** | | **21** | **13.7** |

**Table 4.7 Cost for the 21 Systems by 2-step Implementation**

| Phasing | Implementation Period | No. of System | Cost excluding procurement of equipment (US$ million including VAT) |
|---|---|---|---|
| 1st step | 2002-2006 | 14 | 9.9 |
| 2nd step | 2005-2007 | 7 | 3.8 |
| Total | | 21 | 13.7 |

### 4.1.3 Cost for Soft Components

The soft components will be required for the cost of the human resources input by the Vietnamese side and other source on the following major scope and activities. The salary for local promoter of IEC and hygiene activities is estimated at approximately VND 100,000/month/promtor. A few foreign donor's specialist may be necessary to confirm or to check the performance of soft components. Necessary man powers are as following:

- IEC promotion (Vietnamese side)
- Capacity building for the agencies concerned (Donors & Vietnamese side)
- O&M training (Vietnamese side)
- Preparation of O&M manuals (Donors)
- Other soft components (Vietnamese side)

As described in Chapter 5 "Guideline for information, education and communication (IEC) and Hygiene Promotion", the soft components are responsible by Vietnamese side. A few human resources to support IEC etc, may be supported by donors, volunteers, and NGOs. The IEC campaign will be employed locally due to local language issue to communicate with ethnic minorities by using the budget of Vietnamese side. Detail of the work is mentioned in Chapter 5.

**Table 4.8 Soft Components**

| Cost Item | Unit | Quantity |
|---|---|---|
| Input men-month | M/M | 396 |
| Minor equipment and tools | - | LS |

### 4.1.4 Procurement for Equipment

The procurement of A) well drilling and ancillary equipment B) equipment for solar and generator driven pumping system, and C) supporting vehicles is recommended. The cost was estimated at US$ 2.76 million and US$ 0.25 million, respectively. The item of equipment is;

**A) Drilling equipment**
- Water well drilling equipment
- High pressure air compressor
- Miscellaneous ancillary equipment
- Air lift equipment
- Supporting equipment
- Mobile workshop equipment
- Spare parts

**B) Equipment for solar and generator driven pumping system**
- Solar
- Generator

**C) Supporting Vehicles**

### 4.1.5 Total Project Cost excluding the Soft Components

The project cost in phase 1 (2002-2010) was estimated at around US16.5 millions US$ for the 21 systems with exception of the soft components.

**Table 4.9 Summary of Project Cost**

| Item No. | Project Cost Component | Cost (US$ million) |
|---|---|---|
| 1 | Construction Costs | 13.70 |
| 2 | Procurement of equipment | 3.017 |

## 4.2 Implementation Plan

### 4.2.1 Introduction

This chapter outlines an implementation plan for a number of schemes for the rural water supply. The framework was planned to cover eight years period up to the year 2010 to meet the NRWSS strategy. The following shows basic principles to formulate the implementation plan for the 21 prioritized schemes:

- To implement the schemes meeting to the NRWSS implementation strategy.
- To give high priority with sustainability rather than speed of implementation.
- To implement soft components and construction in parallel.
- No sizable front load investment.
- Due consideration of the balance between development and environment.

### 4.2.2 Development Schemes

**(1) Methodology of Implementation**

The 21 selected priority systems was reviewed by reflecting the lessons learned from monitoring results of the 2 pilot model plants (constructed at G2 and K3-1 communes).

The review result conducts a probable implementation order. It was tentatively arranged with the four groups of implementation priority.

GroupA : Immediately implementation, when donor or the Vietnamese government's budget is ready

GroupB : stage 2 implementation after the Group A was successfully completed

GroupC : stage 3 implementation after the Group B

GroupD : stage 4 implementation after the Group C

**(2) Implementation Priority**

An implementation priority of Groups A, B, C and D in order is presented with physical information in Table 4.10 after careful interpretation of the selected 21 systems from the viewpoints of project sustainability.

**Table 4.10 Grouping for Implementation Priority**

| Serial No. | | Province/ System No. | Name of Commune/Town | **Grouping for Implementation** | Water Source / numbers of drilling well & construction of intake till 2010 | |
|---|---|---|---|---|---|---|
| | | Kon Tum | | | | |
| 1 | 1 | K1-1 | Bo Y | **D** | Groundwater | 7 |
| 2 | 2 | K2-1 | Dak Su | **D** | Groundwater | 0 |
| 3 | 3 | K2-3 | Dak Su | **A** | River water | 0 |
| 4 | 4 | K3-1 | Dak Ui | **C** | Groundwater | 0 |
| 5 | 5 | K4-1 | Dak Hring | **B** | Groundwater | 1 intake |
| | | Gia Lai | | | | |
| 6 | 1 | G1 | Kong Tang | **B** | Groundwater | 1 |
| 7 | 2 | G2 | Nhon Hoa | **A** | Groundwater | 6 |
| 8 | 3 | G3-1 | Chu Ty | **A** | Groundwater | 1 |
| 9 | 4 | G4-1 | Thang Hung | **B** | Groundwater | 1 |
| 10 | 5 | G5-1 | Ngia Hoa | **C** | Groundwater | 1 |
| 11 | 6 | G6-1 | Ia rsiom | **C** | Groundwater | 0 |
| 12 | 7 | G7-1 | Kong Yang | **D** | Groundwater | 0 |
| | | Dac Lac | | | | |
| 13 | 1 | D1 | Krong Nang | **A** | Groundwater | 2 |
| 14 | 2 | D2 | Ea Drang | **A** | Existing boreholes | 6 |
| 15 | 3 | D3-1 | Krong Buk | **B** | Groundwater | 1 |
| 16 | 4 | D3-2 | Krong Buk | **D** | Not drilled yet | 1 |
| 17 | 5 | D4-1 | Ea Drong | **C** | Groundwater | 2 |
| 18 | 6 | D4-2 | Ea Drong | **D** | Not drilled yet | 1 |
| 19 | 7 | D5-1 | Ea Wer | **D** | Groundwater | 2 |
| 20 | 8 | D6 | Kien Duc | **B** | Existing boreholes | 3 |
| 21 | 9 | D7 | Krong Kmar | **D** | Groundwater | 1 |

### (3) Scope of Works

The scope of works required for implementation is as follows:

- Capacity building for rural and national level (donors)
- IEC, training for O&M and other in the site (Vietnamese side)
- Field survey and investigation, and basic and detailed design including preparation of tender document (donors)
- Procurement of construction materials and necessary equipment (donors)
- Construction supervision (donors)

### 4.2.3 Implementation Schedule

The phasing implementation for the 21 systems is recommended taking into consideration of sustainability of projects as shown in Table 4.11.

**Table 4.11 Phasing Plan of Implementation for 21 Systems**

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

## 4.3 Mode of Implementation

It is necessary to consider many factors and elements to introduce the mode of implementation to realize the project.

### 4.3.1 Soft Components

The soft components of capacity building, IEC, organization of WSU, training of O&M are crucial prior to construction the project. This is the matter of the pre-condition for the project.

The activities of capacity building of PCERWASS, IEC and establishment of WSU, training of O&M for WSU and other are important for sustainable projects. The soft components should be conducted and carried out mainly by Vietnamese side as a task, when a foreign grant aid is requested.

The necessary items of soft component are presented in this supporting report-B, Chapter 5. A human resource input plan for soft component composed of the following staff to implement.

**Overall Management Team (Mainly by Vietnamese side, partly by Donors)**

- Team Leader
- Capacity building specialist
- Administrator

**Provincial and Commune Team (Vietnamese side)**

- Capacity building specialist
- IEC specialist
- O&M specialist

### 4.3.2 Construction

To implement construction, an international consultant team will carry out the survey, plan, design and supervision of the proposed systems involving local consultant team. The following type of human resource will be required to input on these engineering services.

**Design stage**

- Team leader
- Hydro-geologist
- Design engineer
- Cost estimator
- Specification writer
- CAD operator

**Construction stage**

- Team leader
- Supervisor as piping specialist
- Supervisor as treatment plant specialist
- Surveyor

During the design stage the established water supply units (WSU) will be involved. Operators from the WSU will be engaged for supervision during construction of systems by the contribution of about 2 months for each system (WSU). CPC/TPC and/or the users (WSU) have the responsible to support their salaries for about 2 months. Considerable plans for the construction of the systems are listed below.

- Alternative 1: Contract system with Vietnamese contractor
- Alternative 2: Contract system with local constructor
- Alternative 3: CERWASS force account system
- Alternative 4: Users themselves
- Alternative 5: NGO’s / Grass roots

Table 4.12 shows an evaluation for the construction and technical capability for each alternative plan.

**Table 4.12 Evaluation of Facilities Construction Capability by Alternative Implementation Method**

| Descriptions | Constructor, Vietnamese | Constructor, abroad | CERWASS force account | WSU/ Users | NGO |
|---|---|---|---|---|---|
| **Alternative** | **1** | **2** | **3** | **4** | **5** |
| Deepwell construction | O | O | Δ | X | X |
| Raw water main | O | O | Δ | X | Δ |
| Booster pump | O | O | Δ | X | Δ |
| Treatment plant | Δ | O | Δ | X | X |
| Reservoir | O | O | O | Δ | Δ |
| Distribution | O | O | O | Δ | Δ |
| House connection | O | O | O | Δ | O |
| Public taps | O | O | O | O | O |

Notes O : possible Δ : difficult X : impossible

The lessons learned from JICA exploratory test well drilling, and construction of the two pilot models at K3-1 and G2 communes, it is judged that Vietnamese contractor is possible to construct systems. Therefore, alternative 1 or 2 will be selected to implement the project. It is recommended to select the alternative 1 and 2. The technical and financial viewpoints are as following.

**Table 4.13 Technical and Financial Soundness of Alternatives 1 and 2**

| **Alternative** | Source | Technical Aspects | | Financial Aspect |
|---|---|---|---|---|
| | | Quality | Schedule | Cost performance |
| **1** | Contractor, Vietnamese | Δ | Δ | O |
| **2** | Contractor, abroad | O | O | Δ |

Notes O : advantage Δ : disadvantage

Alternative 1 may be recommendable with the conditions of the following counter measures to solve the disadvantages:

- Guidance engineer/s from consultant will have to be involved for 1) technical instruction of drilling operation for procured machine, and 2) strengthening of technology for construction of water treatment plant, deep well and other facilities to ensure the quality.
- Down the Hole (DTH) driven rotary machine shall be used for the drilling to save the construction time schedule.

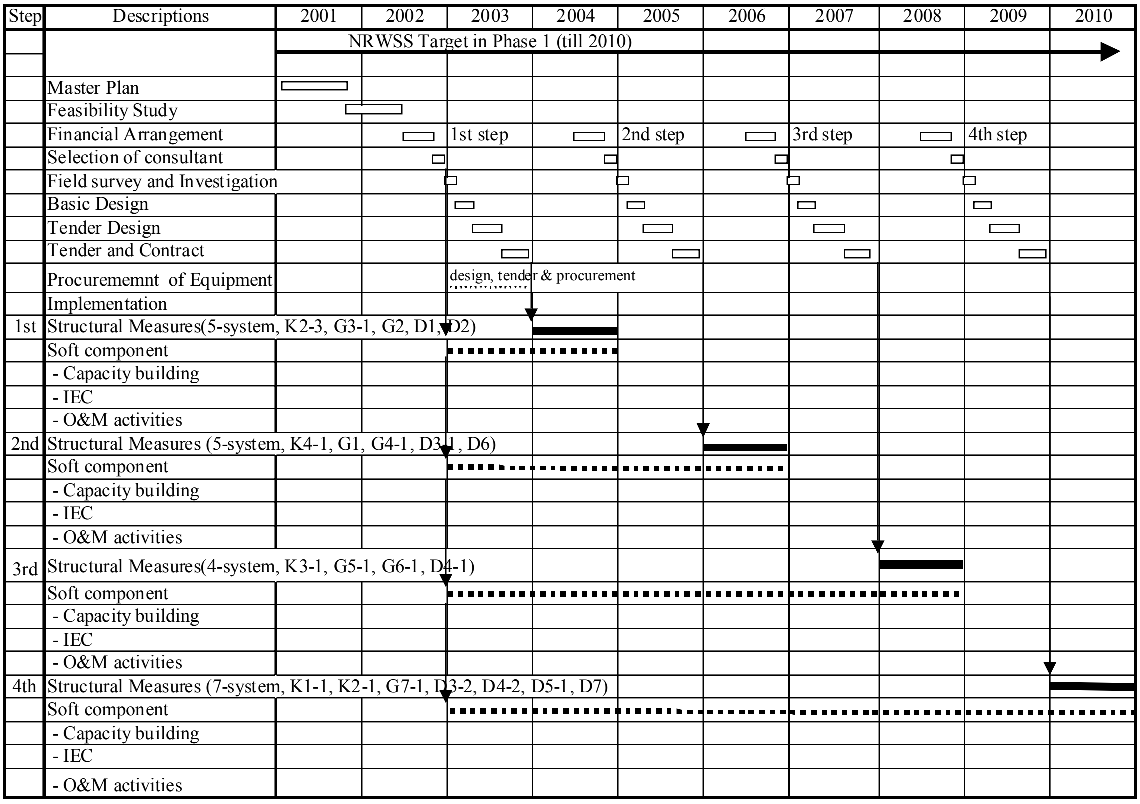
### 4.3.3 Implementation Schedule

It was recommended that the phase 1 scheme be implemented until the year 2010 in accordance with the NRWSS. Three alternatives implementation plans are prepared in this study. Tentative implementation schedule of the 21 systems are shown in Figure 4.1 by four steps. Table 4.14 shows its summary.

**Table 4.14 Summary of Implementation Schedule**

| Step | Commune/Town | Implementation schedule | |
|---|---|---|---|
| | | Soft components | Construction |
| 1 | K2-3, G2, G3-1, D1, D2 | 2003-2004 | 2002-2004 |
| 2 | K4-1, G1, G4-1, D3-1, D6 | 2003-2006 | 2004-2006 |
| 3 | K3-1, G5-1, G6-1, D4-1 | 2003-2008 | 2006-2008 |
| 4 | K1-1, K2-1, G7-1, D3-2, D4-2, D5-1, D7 | 2003-2010 | 2008-2010 |

**Table 4.15 Construction Schedule Plan**



### 4.3.4 Funding / Finance

The NRWSS stated that international assistance should be fully utilized. Donor may be fund for construction portion of rural water supply projects.

In principal, soft components should be well-off with self support by Vietnamese side. A donor may support it in some extents within his capacity. The following scenarios may be envisaged.

Firstly at the Central government level: MARD/CERWASS will explain and report to MPI for the project's urgency and necessity with satisfaction data regarding sustainability of projects. Then, MPI will request to foreign donors to implement it.

Secondly, at provincial and commune level: PCERWASS will coordinate well for IEC, establishment of WSU, and necessary budget arrangement for soft component.

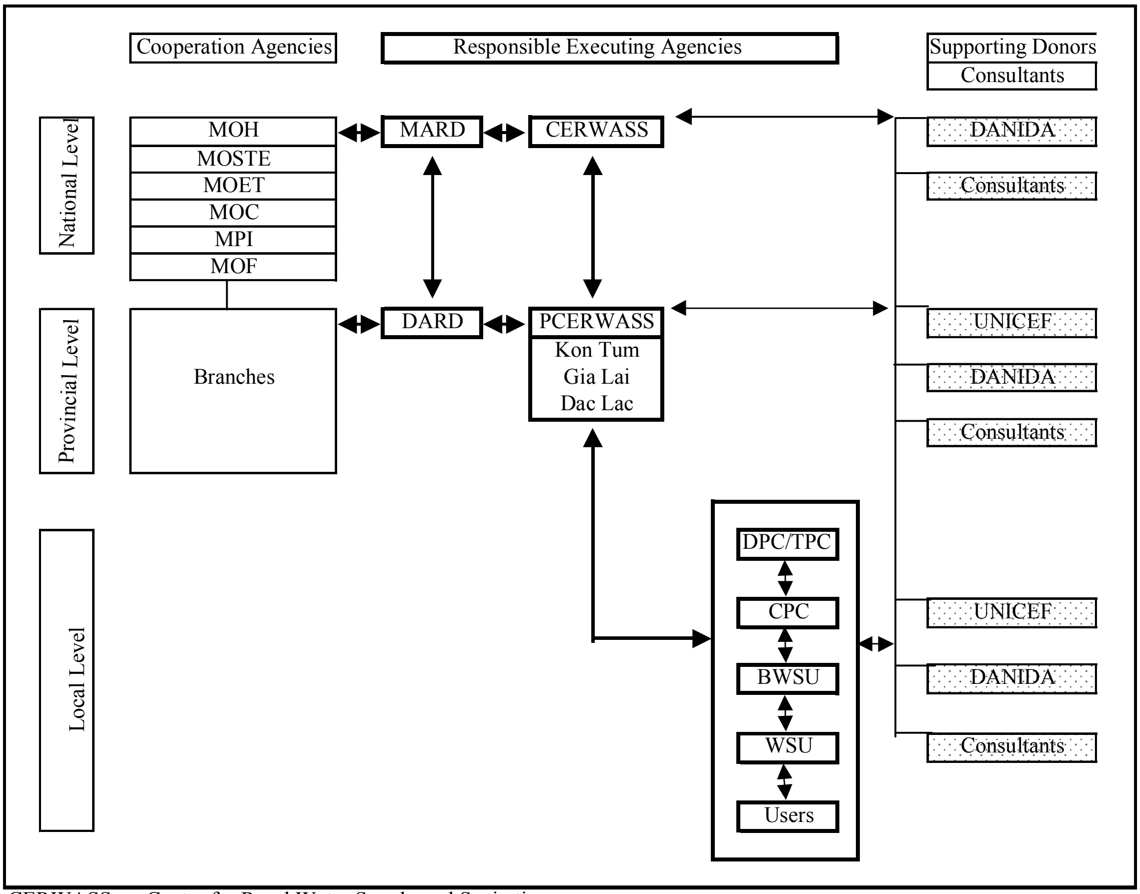
There are two kinds of financial preparation types. One is the Vietnamese government plans, including budgetary arrangements for IEC, HRD, technology guidance and investment costs for the projects. Two is by grant aid or loan funds from foreign countries based on the request from Vietnamese government.

The followings are considerable financial source for the implementation.

- Loan of Vietnamese national budget
- Grant of Vietnamese national budget
- Donor's grant aid
- Foreign countries' project type loan
- Combination of donor's grant aid and Vietnamese national budget

### 4.3.5 Organization for Implementation

Tentative plan of the Organization for implementation is shown below Figure 4.1.




| | |
|---|---|
| CERWASS | : Center for Rural Water Supply and Sanitation |
| PCERWASS | : Provincial Center for Rural Water Supply and Sanitation |
| MARD | : Ministry of Agriculture and Rural Development |
| DARD | : Department of Agriculture and Development |
| DPC/TPC | : District Peoples Committee / Town Peoples Committee |
| CPC | : Commune Peoples Committee |
| BWSU | : Board of Water Supply Unit |
| WSU | : Water Supply Unit |
| MOH | : Ministry of Health |
| MOSTE | : Ministry of Science, Technology and Environment |
| MOET | : Ministry of Education and Training |
| MOC | : Ministry of Construction |
| MPI | : Ministry of Planning and Investment |
| MOF | : Ministry of Finanace |
| JICA | : Japan International Cooperation Agency |
| DANIDA | : Danish International Development Assistance |
| UNICEF | : United Nations Children`s Fund |

**Figure 4.1 Organization Structure Plan for Implementation of Rural Water Supply Project in the Central Highlands**

# Chapter 5 Operation and Management

## 5.1 Organization of Operation and Maintenance

### 5.1.1 Principles

The operation and maintenance of the water supply facilities in the project will be organized along the following principles, based on the NRWSS and the lessons learnt from rural water supply in other countries:

- organization of operation and management arrangements of the facilities prior to construction of facilities (could not be fully applied in the pilot schemes due to time constraints),
- **integration of the responsibilities** for implementation, management and operation and maintenance, including major rehabilitation, extension and re-investment,
- retaining at least the majority of the ownership of the system with the commune or users,
- relative **autonomy** of the O&M organization, meaning its ability to operate with minimum control from any governmental body, but with necessary oversight and regulation,
- a **business-like approach**, meaning the water supply operator, although public, operates just as if it was a private business, in terms of its efficient system of billing and collecting revenues, financial self-sustainability, planning and budgeting, and treatment of the users of its services as true users, and
- provision of services related to O&M of the schemes by the private sector, to the extent reasonable and possible.

### 5.1.2 Organization of O&M

The NRWSS recommends that users (communes) decide how they wish to organize O&M. However, as rural piped schemes are a novelty in most project communes, an organizational model has been developed as a basis for discussion in communes. The model is based on the above principles, lessons learned from Vietnam and other countries, and extensive discussions with stakeholders ranging from

CERWASS and PCERWASS to commune leaders and user representatives. This model is considered realistic at this stage of development in the Central Highlands.

**Proposed Organizations**

For the O&M of the facilities implemented in the pilot models, following organizations are proposed.

- **Board of Water Supply Unit** will be established under **CPC/TPC** for piped water supply.
- This organizations will be materialized through representation of users in the Board of the WSU.
- **Water Supply Unit** (WSU) will be established under the Board of Water Supply Unit.
- **Representation of the users** will be included in the management structure of the WSU.

The chart of the organizations for piped water supply is shown in the following figure.

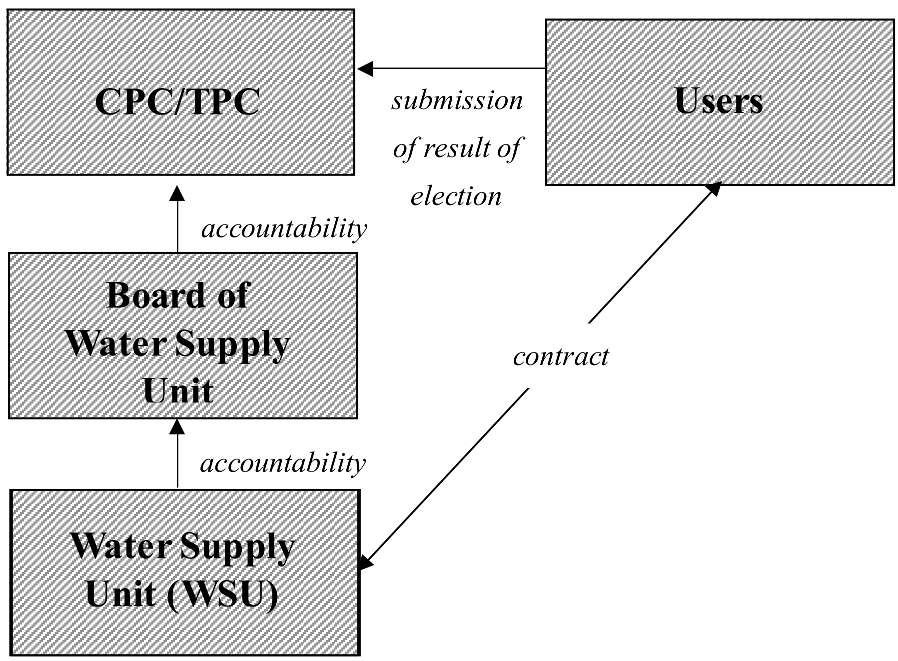



**Figure 5.1 Organization for piped water supply**

**Board of Water Supply Unit Scheme**

The purpose of the Board is to have a rigid and responsible body to supervise the WSU. The Board of WSU will be established based on following procedures;

- The Board comprises of five members appointed by the People's Committee of the commune or town for a two years period,
- At least two of the five members of the Board should be elected by the users as their representatives. This election could take place for instance in an annual meeting of registered users of the WSU,
- The chairperson of the Board, on behalf of the Board, is accountable to the PC,
- The People's Committee appoints the members of the Board and adopts the tariff and other relevant decisions of the Board, and
- The Board convenes meetings according to the schedule decided by them, however at least once a month.

**WSU Scheme**

In order to achieve sufficient autonomy and separate the accounts of the WSU, it should have a staff of its own. The WSU will be established based on following procedures;

- Board appoints the Manager of the WSU,
- Board appoints other staff members of the WSU on the basis of the proposal of the Manager, and
- It is estimated that the proposed piped schemes will have the following staff;
- **manager,**
- **accountant,**
- **pump operator/treatment plant operator,**
- **network inspector/ meter readers, and**
- **water charge collectors.**

**Duties and Responsibilities of CPC/TPC**

Functions and duties of CPC/TPC on this O&M model shall be includes followings;

- PC is in charge of resolving problems on sabotage, damaging the safety of the water supply system, and enforcing the measures against the violators of the general regulations and other relevant rules and misconduct of the staff of the WSU and the members of the Board,
- PC provides support to the Board and the WSU in their duties, especially in training, and
- If PC refuses to adopt the new tariffs decided by the Board and accepted by the representatives of the users in the Board, PC should reimburse the WSU losses incurred due, or related to, the PC's decision of not adopting the required tariff.

**Functions of Board of WSU**

The main duties of the Board are to **monitor and supervise the financial and technical performance** of the WSU, and to **approve the annual plans** and **decide upon the water tariff** and other payments and fines related to water supply services provided by the WSU.

- **Responsibilities**

Responsibilities of Board for WSU shall be includes followings;

- decisions on the salaries and possible performance incentives of the Manager and other staff members of the WSU,
- decision of the general regulation of the WSU and the conditions of contracts between the users and the WSU,
- decisions on protection of the water source and the water supply system,
- approval of annual (financial) plans proposed by the WSU, (if the Board is not satisfied with the WSU's proposal, it requests WSU to submit a new plan that takes into account the guidance provided by the Board), and
- decisions on water tariff, connection fees, meter rents, reconnection fees, fines etc.

- **Duties**

Duties of Board of WSU shall be includes followings;

- close and timely monitoring of the balance of costs and revenues against the financial plan and taking measures to ensure the sustainability in the case of possible deficit (either by reducing costs or increasing revenues),
- monitoring of the efficiency and performance of the WSU,
- provision of transparent information of the performance and accounts of the WSU to PC and users,
- promotion of water use in collaboration of health and educational authorities and mass organizations,
- settlement of disputes between the users and the WSU,
- reporting to PC and submission of tariff decisions and other decisions to PC for adoption, and
- support to the WSU in the enforcement of the General Regulations and requesting support from relevant authorities if necessary.

**Functions of WSU**

Duties and responsibilities of each staff on the WSU shall be includes followings.

- **Manager**

- The manager will have the overall responsibility of the utility and he/she will be accountable for his work to the Board.
- Consequently, the duties of the manager would include planning and budgeting, monitoring of the performance of the utility, reporting, personnel management, liaison with relevant stakeholders, user relations, material management, contract management and supervision and control of his/her staff.

- **Accountant**

- The duties of the accountant are self-explanatory. In addition to accounting the accountant will also be responsible for preparing monthly water bills, based on the data provided by network inspectors, and maintaining user ledgers.

- **Pump operator/Treatment plant operator**

- The main tasks of the pump/treatment plant operator are the operation and control of well pumps, including recording flow, pressure and power use measurements in the operation record of the intake, general control of the volume and quality of inflow and outflow at the treatment plant.

- The operator is, in the first place, responsible for the water quality, and in general for the technical performance, operational and financial efficiency of the plant, reporting about the purchase needs (chemicals, spare parts, etc.) to the manager, and technical condition and housekeeping at the plant.
- The operator would also be the recommended person to be responsible for the sanitary inspection of the well/intake facilities and their cleaning when necessary.

❑ **Network inspector/meter reader**

- The main tasks of the network inspector cover the overall network operation including general monitoring of the performance of distribution, based on readings of the master meters and user meters, observation of any irregularities (pressure, power consumption, etc.), detection of potential leaks and illegal connections, consequent repair, and installation, possible disconnection and reconnection of house connections.
- When the number of users in on the increase, the network inspector's main duty is the provision of house connections. The installation work can be outsourced to a contractor but the inspector has to assume the responsibility for quality control.
- The network inspector is, in the first place, responsible for the supply of water to the users in adequate quantity and with adequate pressure, and in general for the technical performance, operational and financial efficiency of the wells and distribution system (paying particular attention on minimizing the unaccounted-for water) and their technical condition.
- In this aspect, s/he will be responsible for the implementation of the maintenance plan in the network, including public water points, testing of water quality in the system, reporting about the purchase needs (pipes, fittings, etc.) to the manager.
- The network inspector/meter reader shall be carry out monthly reading of user meters, distribution of water bills.
- The network inspector/meter reader reports the readings to the accountant

- **Water charge collector**

- The main tasks of water charge collector are to collect the water charge based on the bill prepared by the accountant, and to inspect the functioning and condition of the meter as well as its seal.
- The water charge collector receives the bills from the accountant.
- He/she is accountable for his/her work and the collected payments to the manager. He/she also reports about his/her work and any observed irregularities to the manager.

**Staffing of WSU**

The salaries of WSU staff are paid from the revenues collected from the users. In the initial period of the water supply system operation, some staff members may not be paid at all if they perform their duties as an additional task associated with their previous duties.

As a general principle the manager and the Board should ensure that for each activity of the WSU there are always at least two staff members who are familiar with this activity. This means that although there have to be clear responsibilities with one person having the responsibility for the task there is a need to develop overlapping skills. This will ensure uninterrupted operation and performance if a staff member is temporarily or permanently out of service.

Proposed staffing scheme of WSU includes followings.

- **Manager/Accountant**

It is assumed that there would be one manager and one accountant in every WSU. It is assumed that as long as the number of connections is less than 750 the manager can work on a half-time basis. In larger schemes there would be a full-time manager. Respectively, an accountant is assumed to be able to work on a half-time basis in schemes serving less than 1,000 connections.

- **Pump/treatment plant operators**

The number of pump/treatment plant operators depends on the type of treatment, the number of hours of operation per day and the volume of the treated water reservoir. Because pump operation has been designed to be manual, the pump operator needs to be available during the pumping hours,

It is assumed that there will be one full-time pump operator in each scheme but s/he can assume other responsibilities as well. For example, it is assumed the pump operator could manage to assume the responsibility for simple water treatment. It is estimated that initially water treatment can be undertaken in one eight-hour shift (until 2005) but, as the water use increases, plant operators will work in two shifts (2006-2009) and three shifts (tentatively since 2010).

- **Network inspector/meter reader**

It is estimated that generally one network inspector/meter reader will work in one shift except in large systems with a network exceeding 40 km and/or the number of connections exceeding 2,000. Thereafter, there would be two network inspector/meter reader. It is estimated that each meter reader can manage 300 connections, including meter reading. The number of meter readers will vary, consequently, from one half time reader of the smallest scheme in until 2005 to 11.5 readers of the largest scheme in 2020. The number of meter readers have been estimated at the accuracy of 0.5 full time worker.

The estimated staffing needs of each scheme in the years 2005, 2010 and 2020 are shown in the following Table 5.1;

**Table 5.1 Staffing Requirements**

| Commune | Manager | | | Accountant | | | Pump/treatment plant operator | | | Network inspector Meter reader | | | Water charge collector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 |
| K1 Bo Y | ½ | ½ | 1 | ½ | ½ | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 1 | 1½ | 3½ |
| K2-1 Dak Su | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 1 |
| K2-3 Dak Su | ½ | ½ | ½ | ½ | ½ | ½ | 1 | 3 | 3 | 1 | 1 | 1 | ½ | 1 | 2 |
| K3 Dak Ui | ½ | ½ | ½ | ½ | ½ | ½ | 1 | 3 | 3 | 1 | 1 | 1 | ½ | 1 | 2 |
| K4 Dak Hring | ½ | ½ | 1 | ½ | ½ | ½ | 1 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 2½ |
| G1 Kong Tang | ½ | ½ | 1 | ½ | ½ | 1 | 1 | 3 | 3 | 2 | 2 | 2 | 1½ | 2 | 5 |
| G2 Nhon Hoa | ½ | 1 | 1 | ½ | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 2 | 2½ | 3½ | 7½ |
| G3 Chu Ty | ½ | 1 | 1 | ½ | ½ | 1 | 1 | 3 | 3 | ½ | ½ | 1 | 2 | 3 | 7 |
| G4 Thang Hung | ½ | ½ | 1 | ½ | ½ | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 1 | 1½ | 3½ |
| G5 Nghia Hoa | ½ | ½ | 1 | ½ | ½ | ½ | 1 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 2½ |
| G6 Ia Rsion | ½ | ½ | 1 | ½ | ½ | ½ | 1 | 3 | 3 | 1 | 1 | 1 | 1 | 1½ | 3½ |
| G7 Kong Yang | ½ | ½ | ½ | ½ | ½ | ½ | 1 | 3 | 3 | 1 | 1 | 1 | ½ | ½ | 1½ |
| D1 Krong Nang | 1 | 1 | 1 | ½ | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 2 | 2½ | 4 | 8½ |
| D2 Ea Drang | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 2 | 3½ | 5½ | 11½ |
| D3-1 Krong Puk | ½ | ½ | 1 | ½ | ½ | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 1½ | 2½ | 5 |
| D3-2 Krong Puk | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 3 | 1 | 1 | 1 | 1 | 1½ | 3 |
| D4-1 Ea Drong | ½ | ½ | 1 | ½ | ½ | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 1½ | 2½ | 5½ |
| D4-1 Ea Drong | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 3 | 1 | 1 | 1 | ½ | 1 | 2 |
| D5 Ea Wer | ½ | ½ | 1 | ½ | ½ | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 1½ | 2 | 4 |
| D6 Kien Duc | ½ | 1 | 1 | ½ | ½ | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 2 | 3 | 6½ |
| D7 Krong Kmar | ½ | ½ | 1 | ½ | ½ | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 1½ | 2½ | 5 |

For the meaningful financial management of the utility it is extremely important to apply cost/profit center accounting even if this requires additional work in comparison or in addition to the administrative accounting practiced by organizations accountable to CPC/TPC. The accountant should have appropriate education and preferably some relevant experience,

**Recommendations**

It is recommended to use a performance agreement between the owner (represented by the Board). Typically the performance agreement defines the general obligations of the key players, tariff policy, conditions of services including remedies in the event of non-payment, qualitative and quantitative performance criteria, and the frequency and modalities in the provision of information.

In discussions with stakeholders a possibility to make use of user committees (e.g., WATSAN committees) instead of a Board was raised. However, experience suggests that such committees are not so suitable to assume responsibility for full piped schemes and it would probably be quite complicated if possible at all to hand over the ownership and responsibility from PCs to such committees.

There are more also radical models in use especially in the Mekong Delta, where the O&M has often been organized applying a joint stock company model. This model has certain advantages:

- it would allow mobilization of private capital from users or other investors,
- it would eliminate possible aggressive drainage of revenues from the commune,
- and it would facilitate necessary autonomy of the organization of O&M in a transparent way.

On the other hand this model has not been legalized in Vietnam so far and it is not supported by CERWASS.

Master Plan introduced another option, also based on Vietnamese experience, of combining the responsibility for the O&M of water supply with power supply. This model did not seem to be popular, mainly because power suppliers are normally district level organizations whereas water supply should be organized "at the lowest appropriate level". It seems that even where these functions have been combined in the past, e.g., in Chu Ty Town (G3), they have been recently separated. Consequently, this is not considered a realistic option any longer.

It is also possible to outsource some functions to be undertaken by external personnel. That would call for careful definition of duties and performance standards, indicators and monitoring mechanisms and transparent competitive bidding. It is recommended, therefore, that if WSU or Boards wish to consider outsourcing, CERWASS and PCERWASS assist them in developing procedures and criteria to protect the public and the users' interests.

### 5.1.3 Guideline for Operation and Maintenance

Prior to and during the second field work period guidelines for operation and maintenance were developed. **Model documentation** was developed and designed especially to help the establishment and mobilization of WSUs and the Boards in the two pilot communes and to support them to develop working modalities. This model documentation includes *General Regulations of Services* and an *Application* *for a Connection to Piped Water Supply* (Appendix 8), a *Contract for Water Supply between the user and the WS*U (Appendix 9) and a form for *Daily Operations Record* (Appendix 10). These documents can be revised and further developed on the basis of experience from the two pilot schemes to be applied in other project schemes.

The *General Regulations* define the mission statement, service area and organization of the WSU, the rights and responsibilities of the users, the WSU, the Board and the People's Committee, the responsibilities of the staff of the WSU, and implications of the violations of the regulations.

The *Application for a Connection to Piped Water Supply* and the *Contract for Water Supply* are based on the *General Regulations* and they define the rights and responsibilities of the contracting parties and conditions of the contract.

The *Daily Operations Record* provides a format for collection and recording of the most necessary technical data.

The comprehensive O&M guidelines will need to be prepared at the time of implementation of each scheme. The operating instructions will include all the **manuals** provided by the suppliers of the pumps, switchboards and other installations. As the schemes are based on manual pump operation, the pump operators need hands-on training on the spot in order to be able to develop pumping patterns for their respective schemes. The pump operators need to apply an iterative method, learning from their experience, to optimize pumping to supply sufficiently water 24 hours a day and simultaneously avoiding overflows at the reservoir and consequent waste of water, energy and possibly chemicals.

According to the role based on the NRWSS, PCERWASS will focus on supporting and facilitating functions. They include initial capacity building of the utility staff, the Board, DPC/TPC and users, development and distribution of model procedures, contracts, ledgers, guidelines, etc., maintaining lists of suppliers and service providers, facilitation of cross-fertilization and learning from others' experience: successes as well as failures. PCERWASS could also support the utilities in performance evaluation and, in association with this, maintain benchmarking data bases.

It is unlikely that small water utilities would be able to have spare or stand-by pumps. PCERWASS could possibly have a couple of spare pumps to be borrowed or leased by utilities in the case of emergency as long as there is a healthy market and, consequently, private enterprise who can provide emergency service.

In the course of time at least some of the supporting functions of PCERWASS will be decentralized to the districts (Units for Agriculture and Rural Development), at the pace of their increased capacity. It is anticipated that by the time of the completion of the schemes under this pilot model, at least in some of the project districts UARD could possess capacity to provide advisory services to rural water utilities, although their role is likely to be more vital in smaller scale water supply applying lower cost technologies and directly owned and managed by users or user groups.

Guidelines, model procedures etc. that are widely applicable in the country, will be developed by CERWASS or jointly between CERWASS and at least some PCERWASS and possibly some advanced utilities, in order to incorporate hands-on experience. CERWASS could also take the leading role in the development of performance indicators and benchmarking.

Repair of pumps and electric appliances as well as meter testing and calibration are functions, in which small rural utilities are likely to rely on services provided by private (or state-owned) companies. The availability of spare parts and prompt repair of pumps and other equipment should be one major criterion in the selection of technology. For meter testing and calibration a realistic alternative seems to be signing a contract with an urban water utility in the center of the province or in another major town at a reasonable distance.

## 5.2 Strengthening of Implementing Organizations

### 5.2.1 Principles

The implementation of the project will be organized along the following principles, mainly based on the NRWSS:

- building, to the extent possible, on existing organizations and their mandates and present roles, avoiding the establishment of parallel institutions and project-specific administration and bureaucracy,
- decentralization of implementation to the lowest appropriate level, which in the case of piped water supply schemes means the commune level,
- extension of the responsibility for water supply schemes to the communes while provision of support by the government (government bodies only carry out their state management responsibility and provide advisory guidance),

- organization of operation and management arrangements of the facilities prior to construction of facilities,
- integration of the responsibilities for initial implementation, management and O&M, including the financial and technical responsibility for rehabilitation and re-investment, to the ownership of the schemes, and
- provision of services related to implementation and O&M of the schemes by the private sector, to the extent reasonable and possible.

### 5.2.2 National and Provincial Level

The **Ministry of Agriculture and Rural Development**, particularly through **CERWASS**, is the focal body responsible for project coordination at the central level. In the implementation of the project MARD/CERWASS will particularly ensure the compliance of the project with NRWSS, provision of capacity building (IEC and HRD) to the respective PCERWASS in Dac Lac, Gia Lai and Kon Tum provinces, coordination of inter-provincial cooperation, and monitoring of the progress in the provinces. MARD/CERWASS will also ensure that the respective PCERWASS will have adequate human and material resources to support the communes in project implementation. An implementation of water supply systems will support the implementation of NRWSS in the three provinces and build on the achievements of CERWASS and other stakeholders, particularly DANIDA, prior to project implementation.

The **Ministry of Health** will have a key role in the capacity building of the provincial and lower level health authorities in IEC and water quality monitoring.

It is recommended that a **Steering Committee** (SC) will be established and a Project Director appointed. The SC will tentatively meet at least quarterly and its main duties of will include supervision of the implementation of the project, approval of the project's annual work plans, and monitoring and regular review of the progress of the project, and recommendation of action to be taken if necessary.

The members of the SC will tentatively comprise MARD (chairperson), CERWASS, MOH, PCP, Government officer in charge of rural water supply, State Bank, relevant mass organizations, Project Director (non-voting member), and Team Leader (non-voting member).

MARD/CERWASS will appoint a **Project Director**. He/she will be accountable to MARD/CERWASS and the SC for the progress of the project and the efficient and transparent use of the allocated resources. MARD/CERWASS may also appoint other staff to be accountable to the Project Director for specific tasks of the project.

The key sector organization at the provincial level is **PCERWASS**. The PCERWASS in each project province is the focal point of institutional strengthening of organizations at lower level and support to communes in project implementation. PCERWASS will also be responsible for project coordination and monitoring in each of the project provinces.

It is expected that the respective **Provincial Steering Committees for Water and Sanitation** (PSCWS) in the project provinces will extend their duties to the coordination and monitoring of provincial resources to facilitate the implementation of the project. For that purpose, the Provincial Project Heads and Provincial Team Heads should participate in the meetings PSCWS as non-voting members. The duties and working modalities of PSCWS would be similar to those of the SC at the central level.

DARD/PCERWASS will appoint a **Provincial Project Head**. He/she will be accountable to MARD/CERWASS and PSCWS for the progress of the project and the efficient and transparent use of resources. DARD/PCERWASS may also appoint other staff to be accountable to the Provincial Project Head for specific tasks of the project.

An international team of experts or consultants will be appointed to provide institutional strengthening and technical assistance to the CERWASS and respective PCERWASS. There will be a **Provincial Team Head** (PTH), responsible for the technical assistance in each of the project provinces. He/she will have other long and short term experts/consultants under his/her responsibility. One PTH will assume the role of the **Team Leader**, who is responsible for the entire international team and will also liaise with and provide necessary support to CERWASS.

**Mass organizations**, particularly Women's Union will have a major role in IEC activities at the district and commune level and capacity building of the users/users in the project area. The role of DOC, together with PCERWASS, will be important in the quality assurance of construction and protection of the users (communes). This will call for substantial strengthening of regulatory framework at the central level and capacity building of and support to communes and Water Supply Units.

### 5.2.3 District and Commune/Town Level Organizations

According to NRWSS the government support to rural water supply should be decentralized to the **district level**. However, the implementation of NRWSS and the related capacity building is at initial stage. Consequently, the capacity of the Units of Agriculture and Rural Development will not allow them to assume a major role in project implementation. In longer term, the districts will be the main level of implementation of the following functions: detailed planning and organization of the implementation of RWSS, giving advice to users about various technology options, mechanisms and procedures of financial support or other kinds of support through district water supply advisory service centers, managing systems of grants and loans through at the district giving guidance to user groups to manage construction and operation of piped schemes.

**Communes** (and towns) are the lowest administrative level, which is closest to the people. According to NRWSS, this level will work in close coordination with individual users, user groups, mass organizations, in particular the WU and banks to carry out most of government support function for RWSS. The commune level will act as coordinator and advisor to users and organizer of implementation of commune's RWSS plan.

As water supply system involves relatively complicated technology, deep boreholes with motorized pumping and piped supply, it is not likely that the schemes would be initiated, implemented and managed by cooperatives or other user-based organizations. Therefore, it is expected that the scheme implementation and management will be organized under respective CPC and TPC.

It is recommended that a specific body, **Water Supply Unit** (WSU), will be established under CPC/TPC for piped water supply. It is recommended that key staff members will be recruited prior to project implementation, in order to train the staff during the construction and involve them in project supervision. It is also recommended that representation of users will be included in the management structure of the unit. A **board** would be a distinct body to supervise unit management and staff. Boards will need substantial training and follow-up support to become efficient and effective, focusing on strategic decisions, monitoring of the performance, and supervision.

In the post-implementation management the board will generally monitor and control the financial and technical performance of the WSU, user satisfaction, agree upon resetting of tariff, support the WSU management and staff in enforcement of rules and regulations, and take strategic decisions, such as promotion to increase water sales when necessary, demand management measures (tariff adjustment, regulation of water use) if necessary and investment in expansion/upgrading and rehabilitation. It is important that the board will not interfere in the day-to-day management and operation.

Services provided by the **competitive sector**, public and private companies, will be utilized in the implementation. Private and state construction companies will be invited to bid for the construction of schemes in selected communes. It is expected that the communes will be responsible for construction management and supervision. They will obviously need substantial support to successfully undertake this responsibility. This support is one of the key areas of the technical assistance.

Private and public institutions can also be involved in capacity building and IEC in addition to government bodies and mass organizations. The assignments should be tendered and managed in transparent and competitive manner.

### 5.2.4 Coordination with Relevant Donors

To strengthen the executing agencies, the study team has held a series of meetings to discuss about the possible coordination, especially, with DANIDA, UNICEF, and ADB.

The concept paper was prepared in Figure 5.2 for coordination with the relevant donors and agencies at the F/S phase. The paper illustrates the present and possible coordination activities for the relevant donors.

**DANIDA**

At the national level, DANIDA started the Water Sector Program Support (WaterSPS) to cover the water sector in Vietnam including national capacity building, and rural water supply and sanitation (RWSS). DANIDA helped formulate the NRWSS for the strategy of rural water supply and sanitation in Vietnam. MARD revised the draft NRWSS submitted by DANIDA, and authorized the revised NRWSS in 2001. The present JICA study is in line with the NRWSS (the target years and goals and the basic approach) formulated by DANIDA.

At the local level, DANIDA initiated the RWSS component of Water SPS in Dac Lac in 2001 to support the implementation of NRWSS by applying the demand responsive approach up to 2005. The program aims to establish guidelines for the rural water supply systems in 3 districts of Dac Lac province (different from the JICA's target districts), considering financial, institutional and social sustainability and focusing on the rehabilitation of piped water supply systems. The RWSS component focuses on IEC, and the establishment of the local organizations for effective O&M and management, and the rehabilitation of the existing piped water systems. DANIDA agreed to the JICA study team that they can provide their IEC materials used for the WaterSPS program for 3 districts in Dac Lac province.

**UNICEF**

UNICEF has been the principal donor in the field of rural water supply and sanitation through the WATSAN Program in cooperation with CERWASS and MOH since 1982. The WATSAN Program focuses on the implementation of IEC activities by developing appropriate approaches and methods, promotion of coordination with the relevant international and national agencies, and the capacity building of the sector related organizations. The present master plan study is based on the IEC documents prepared by UNICEF.

UNICEF tries to help poor people by introducing shallow hand pump wells and sanitary latrines in the Central Highlands since the 1990s. However, most hand pump wells do not function due to the shortage of spare parts and lack of administration. Taking into account the situation of hand pump wells, especially for public use, UNICEF has adjusted its program to support individual households by dug well construction and sanitation. The present master plan recommends that the improvement of individual dug wells be supported by UNICEF.

In the course of the discussions with UNICEF, they were interested in monitoring the piped systems prioritized by the present study. The cooperation by UNICEF shall be integrated at the implementation stage if possible with regard to the monitoring.

**ADB**

In Ngoc Hoi town next to K2-3 (Dak Su), an ADB project is under preparation for the town water supply. There is a preliminary plan available showing the proposed establishment of a reservoir on the same hill as the planned K2-3 reservoir site of this master plan study. It has been recommended to ADB that the K2-3 system be supplied from the town's reservoir and that the O&M of the K2-3 system be taken over by the town.

In response to the request of the study team, the TPC of Ngoc Hoi town and DARD positively agreed to the master plan by the study team. However, Dak Su commune (K2) denied the plan and preferred to have an independent system rather than an integrated system. More effort will be necessary to ensure the integration of the systems and sustainable O&M for the system.

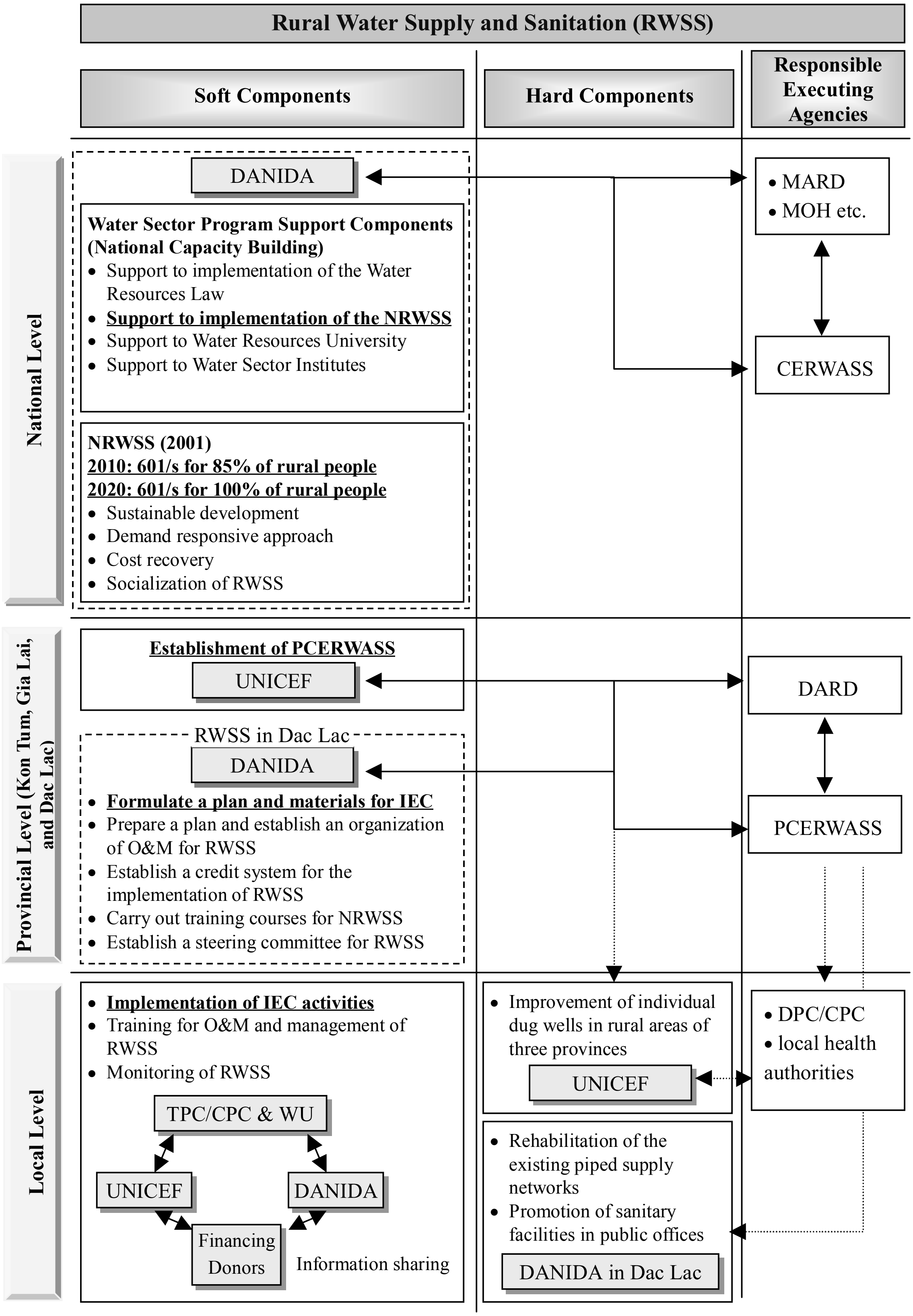



**Figure 5.2 Concept Paper for Coordination**

## 5.3 Economic Evaluation of the Priority Systems

### 5.3.1 General Principles

As a general principle of the NRWSS, **users will be responsible for all construction costs and all operating costs for RWSS facilities**. There are, however, cases, when the government will provide financial support in the form of grants to certain types of users and certain types of technologies:

- the poor, the very poor and the social policy target households who suffer difficulties,
- full piped water supply schemes, which are promoted by the government, and
- a number of special cases.

Water supply systems fall under the category of full piped schemes. Even when accepting grants in investments, NRWSS states that in all cases users shall fund all operation costs and shall control the actual payment for construction, O&M, etc. The NRWSS assumes that in the future an **average rural household could pay between 3% and 5% of its total income for clean water and sanitation**. However, the tariff including the initial investment cost may reach more than five times as the tariff excluding the initial investment cost. Consequently, it is judged to be impossible to refund the initial cost by the users themselves with heavy water charges. Therefore, the initial investment cost is assumed to be donated by grant. Instead, it has been assumed that there will be no second round of grant for rehabilitation, upgrading and other similar re-investments. Therefore, the financial analysis involves an element of **re-investment**. Also, the communes/users will be responsible for their connections, including water meters.

According to NRWSS, in formulating tariff methodologies and recommendations it is recognized that water tariffs should meet five key objectives, namely:

- economic - to ensure that charges for water are related to economic costs, thus achieving efficiency of resource allocation in the water sector,
- financial - to ensure each Water Supply Company (WSC) has sufficient revenue to cover all its operating costs, debt servicing, taxes, and a proportion of capital expenditure,
- social - to ensure that the poorer members of the community have access to a safe water supply at a price which they can afford,

- conservation - that the tariff plays a role in managing the demand for water and the conservation of resources, and
- administrative - to ensure that any recommendations are capable of implementation by each WSC in terms of metering, billing and revenue collection and that the tariffs are readily comprehensible to users.

## 5.4 Estimation of Operation and Maintenance, and Re-Investment Costs

The O&M costs include direct costs and fixed costs. Power and chemical costs are the most notable direct costs. Personnel costs of VND 300,000 – VND 450,000/month, which are quite substantial in the case of small utilities in spite of generally low personnel costs in Vietnam, are in a way a combination of direct and fixed costs. Certain staff is mandatory irrespective of the number of users and volume of water sales, within the scale of these small utilities. On the other hand, the number of staff also depends on the number of users; meter readers are the clearest example of this. The maintenance costs are largely fixed; scheduled maintenance has to be performed irrespective of the volume of business.

This financial analysis recognizes power and chemical costs, personnel costs and maintenance costs. In the previous study maintenance costs were considered to be included in the re-investment cost. The analysis in this stage is more detailed and it has been harmonized with the recommendations of the international consultants providing support to CERWASS in the implementation of NRWSS.

The **direct costs** per produced cubic meter, including power and chemical costs, have been calculated on the following assumptions:

- pumping efficiency of 50%,
- cost of electricity VND 750/kWh, and
- chemical cost (cost of chlorine) VND 25/m3.

The estimation of **personnel costs** is based on the estimated staffing requirements, as presented in Section 5.1.2 and the estimated monthly personnel costs in various categories. These monthly costs reflect the Vietnamese salary level and the requirements of the positions.

In the case of communes where two piped schemes have been recommended, it has been assumed that the minor system (K2-1, D3-2 and D4-2) does not need to employ a manager and accountant at all. In practice, the division of the cost implications of shared staff is to be agreed upon case by case.

The **maintenance costs** have been estimated following the principles recommended in the implementation of NRWSS. They have been calculated on an appropriate percentage basis of the capital costs of the works; 1.0% for building and civil works and 3.0% for electrical and mechanical works. However, the maintenance cost in the year of respective investment (2003 and 2013) is estimated at 50% of the above figures, taking into account warranties provided by contractors and suppliers.

The initial investments are assumed to take place in 2003 and 2013. It is anticipated that the **re-investments** will be implemented by user's contribution or local contractors using locally available materials and equipment. Based on experience from Vietnamese construction costs, the reinvestment cost have been estimated at 50% of the costs presented in cost estimates. The estimated life times of 12 years for electro-mechanical installations and 30 years for civil works and pipelines have been adopted from recommendations of international consultants providing support to CERWASS in the implementation of NRWSS. The life time of boreholes is estimated at more than 28 years of financial analysis period.

The estimate of **water sales** has been reduced from the estimate applied in the previous study. The estimate was based on the design estimates. However, to be on the safe side, design figures need to be excessive rather than too low. On the other hand, financial viability analyses need to be based on conservatively moderate water sale projections rather than overly optimistic figures. Therefore the initial percentage of water users through house connections is estimated at 35% in 2003 and the initial per capita water use through house connections 35 lpcd. In the tariff calculations for the pilot models the initial water use per capita was 35 lpcd for house connections and 15 lpcd for public taps. With the exception of K3, the water use from relatively few public taps will remain very low in comparison with water sold through house connections. Moreover, the public tap water use will decrease over the time as house connections increase. Therefore, in order to simplify calculations, only house connections are included in the cost calculations. In comparison with other uncertain parameters the impact of public taps is negligible.

The annual growth of served population through house connections (including population increase and connection rate) is estimated at 8% and the annual growth of per capita water use at 3%, respectively. The latter growth calculated on the initial water use of 35 lpcd will result in 60 lpcd by 2021.

It is estimated that the **non-revenue water** (including physical leakage, bad debts and administrative losses) represents 20% of water production. Consequently, water production is estimated to include water sales and non-revenue water. Direct costs have been calculated for produced water.

For longer term cash flow analyses the **analysis period** is from 2003 until 2030. However, the population figures and other parameters are constant between 2021 and 2030 in order to avoid bias of the inaccuracy of estimated growth beyond the design period.

Cost projections have been made separately for O&M costs excluding re-investment financing. These costs are the basis of the cash flow analysis together with projected revenues. The re-investment needs have been taken into account by calculating annual and cumulative **saving targets** for financing of re-investments. In financial terms this is equal to annual and cumulative **operation margin**.

The **tariff** analysis has been made on the basis of four principles. Firstly, operation margin has to be positive, although sometimes only marginally, every single year. Secondly, actual cumulative savings (for re-investments) have to account to at least 63% of the cumulative saving targets by 2020. Thirdly, the break-even point between the actual cumulative savings and saving targets has to be reached within 25 years from the initial investment (by 2028). Fourthly, the tariffs are estimated to be constant from 2003 until 2012 and again from 2013 until the end of the analysis period (2030). The tariff increase in 2013 is easily justified by the second tier of investments.

- The **affordability** analysis compares the annual expenditure on water of one user of the scheme (based on estimated per capita water use and assumed tariff) with the average annual income within respective commune/town. To be on the safe side the income has been assumed to stay constant throughout the period. Therefore, the actual ability to pay (ATP) in 2020 is likely to be much higher than in this analysis.

### 5.4.1 Ability of Payment for Estimated Tariff

The annual costs of each scheme, including O&M cost and annualized re-investment costs in three cross-sectional years (2005, 2010 and 2020) are tabulated in Table 5.2. As power and chemical costs are direct costs, they are fully dependent on the operational volume, i.e., the amount of water pumped and treated. Consequently, there is a considerable variation between the utilities and between the years.

The personnel costs, especially during the first years when the water sales will remain substantially below the system capacity, the personnel costs are quite similar to fixed costs because of the relative influence of managers and accountants. The variation between utilities is quite limited in 2005 but it increases along with the number of operational staff and meter readers as the business volume increases.

The annual re-investment saving needs have a significant impact on annual costs, especially in the early years of operation when water sales remain relatively low. The re-investment saving increases the O&M cost in 2005 by about 140%- 300% and in 2020 by about 90%-220%.

## Table 5.2 Annual costs MVND/a

| Commune | Annual cost (MVND/a) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Power and chemicals | | | Personnel | | | Maintenance cost | | | Reinvestment | | Grand total w/o re-investment | | | Grand total | | |
| | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 | -2012 | 2014- | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 |
| **Kon Tum** | | | | | | | | | | | | | | | | | |
| K1 | 7.776 | 13.246 | 38.431 | 19.200 | 30.900 | 44.700 | 62.472 | 62.472 | 82.830 | 265.768 | 357.280 | 89.448 | 106.617 | 165.961 | 355.216 | 372.385 | 523.242 |
| K2-1 | 1.699 | 2.895 | 8.399 | 9.600 | 19.200 | 23.400 | 14.767 | 14.767 | 20.704 | 51.296 | 79.577 | 26.066 | 36.862 | 52.503 | 77.362 | 88.157 | 132.080 |
| K2-3 | 5.128 | 8.734 | 25.342 | 17.100 | 28.800 | 33.000 | 31.046 | 31.046 | 42.354 | 129.363 | 177.033 | 53.273 | 68.580 | 100.696 | 182.637 | 197.943 | 277.729 |
| K3 | 6.052 | 10.309 | 29.910 | 17.100 | 28.800 | 33.000 | 21.830 | 21.830 | 32.680 | 61.058 | 95.397 | 44.982 | 60.938 | 95.591 | 106.039 | 121.996 | 190.988 |
| K4 | 4.335 | 7.384 | 21.423 | 19.200 | 28.800 | 38.100 | 42.064 | 42.064 | 53.084 | 137.166 | 178.367 | 65.599 | 78.248 | 112.607 | 202.766 | 215.414 | 290.974 |
| **Gia Lai** | | | | | | | | | | | | | | | | | |
| G1 | 13.559 | 23.096 | 67.011 | 26.100 | 37.800 | 55.800 | 53.347 | 53.347 | 67.356 | 192.944 | 248.658 | 93.006 | 114.243 | 190.168 | 285.950 | 307.187 | 438.825 |
| G2 | 32.887 | 56.019 | 162.534 | 30.300 | 49.500 | 71.100 | 85.085 | 85.085 | 113.114 | 334.583 | 451.615 | 148.272 | 190.604 | 346.749 | 482.855 | 525.186 | 798.364 |
| G3 | 22.275 | 37.942 | 110.086 | 28.200 | 45.000 | 69.000 | 49.401 | 49.401 | 62.314 | 183.583 | 236.386 | 99.875 | 132.343 | 241.400 | 283.459 | 315.926 | 477.786 |
| G4 | 7.707 | 13.128 | 38.090 | 19.200 | 30.900 | 44.700 | 31.667 | 31.667 | 42.463 | 115.038 | 159.376 | 58.574 | 75.695 | 125.253 | 173.611 | 190.732 | 284.629 |
| G5 | 8.959 | 15.261 | 44.277 | 19.200 | 28.800 | 38.100 | 28.309 | 28.309 | 36.528 | 105.829 | 141.882 | 56.468 | 72.370 | 118.905 | 162.297 | 178.199 | 260.787 |
| G6 | 8.110 | 13.814 | 40.081 | 19.200 | 30.900 | 42.300 | 22.916 | 22.916 | 32.884 | 76.368 | 117.697 | 50.226 | 67.630 | 115.265 | 126.594 | 143.998 | 232.962 |
| G7 | 3.966 | 6.755 | 19.598 | 17.100 | 26.700 | 30.900 | 21.597 | 21.597 | 24.370 | 74.529 | 84.537 | 42.662 | 55.051 | 74.868 | 117.191 | 129.581 | 159.405 |
| **Dac Lac** | | | | | | | | | | | | | | | | | |
| D1 | 18.623 | 31.722 | 92.040 | 28.500 | 46.800 | 70.500 | 53.689 | 53.689 | 70.191 | 202.161 | 273.722 | 100.813 | 132.212 | 232.731 | 302.974 | 334.373 | 506.453 |
| D2 | 38.382 | 65.379 | 189.691 | 35.100 | 53.100 | 83.100 | 61.669 | 61.669 | 84.365 | 253.857 | 354.120 | 135.151 | 180.148 | 357.156 | 389.008 | 434.004 | 711.276 |
| D3-1 | 12.587 | 21.441 | 62.209 | 21.300 | 35.100 | 51.000 | 30.413 | 30.413 | 41.459 | 110.425 | 155.669 | 64.301 | 86.954 | 154.667 | 174.725 | 197.379 | 310.336 |
| D3-2 | 6.567 | 11.185 | 32.453 | 13.800 | 20.700 | 27.000 | 25.794 | 25.794 | 36.948 | 97.949 | 145.069 | 46.160 | 57.679 | 96.401 | 144.110 | 155.628 | 241.470 |
| D4-1 | 15.120 | 25.755 | 74.727 | 21.300 | 35.100 | 53.100 | 47.036 | 47.036 | 58.176 | 176.205 | 221.967 | 83.456 | 107.891 | 186.003 | 259.661 | 284.096 | 407.970 |
| D4-2 | 3.955 | 6.736 | 19.545 | 11.700 | 23.400 | 27.600 | 19.413 | 19.413 | 23.734 | 74.768 | 90.115 | 35.068 | 49.550 | 70.879 | 109.836 | 124.317 | 160.994 |
| D5 | 6.300 | 10.732 | 31.137 | 21.300 | 33.000 | 46.800 | 49.455 | 49.455 | 65.984 | 183.862 | 247.580 | 77.055 | 93.186 | 143.922 | 260.917 | 277.048 | 391.501 |
| D6 | 27.471 | 46.793 | 135.765 | 23.400 | 40.200 | 57.300 | 44.454 | 44.454 | 59.286 | 175.983 | 235.957 | 95.325 | 131.447 | 252.351 | 271.308 | 307.430 | 488.307 |
| D7 | 12.839 | 21.869 | 63.451 | 21.300 | 35.100 | 51.000 | 34.223 | 34.223 | 46.112 | 121.742 | 162.694 | 68.361 | 91.192 | 160.563 | 190.104 | 212.934 | 323.258 |

The annual costs per cubic meter are presented in Table 5.3. These unit costs are more applicable for comparison between schemes.

The mere O&M costs per cubic meter vary between VND 1,600/$m^3$ and VND 6,300/$m^3$ in 2005 and between VND 700/$m^3$ and VND 2,600/$m^3$ in 2020. The re-investment costs per cubic meter increase the costs dramatically up, varying between VND 4,600/$m^3$ and VND 18,600/$m^3$ in 2005 and between VND 1,600/$m^3$ and VND 6,400/$m^3$ in 2020.

The unit costs in the early years are extremely high, due to high impact of fixed costs and very low water sales. The tariffs do not need to include in these critical years any substantial part for re-investment saving. The main thing is that the cash flow (operation margin) is positive.

The unit costs in 2020 that include re-investment saving are much closer to the long term tariff requirements, although the tariffs have to be somewhat higher to fill the financing gaps of earlier years.

The lowest viable tariff in 2005 is VND 1,850/$m^3$ (D2) and the highest required tariff in that year is VND 8,000/$m^3$ (K2-1). The tariff requirements in 2020 vary between VND 2,200/$m^3$ and VND 8,250/$m^3$.

The calculated tariffs look relatively high in the Vietnamese context. For example, the Provincial People's Committee in Dak Lak has set a ceiling of VND 1,800/$m^3$ for rural water tariffs. On the other hand the calculated tariffs do not seem to involve problems with the average affordability, except in all schemes in Kontum and possibly in D5, as can be seen in Table 5.3. Instead of the ability to pay, the calculated tariffs may be a political issue.

The willingness to pay was surveyed during the first field work. The willingness to pay for water was lower than the ability, the willingness ranging between 20% and 90% of the ability. While the ability to pay is really a critical issue for sustainability, the willingness to pay is a more dynamic parameter. The willingness may be raised up to the ability to pay through effective IEC. According to the survey (before any IEC), the estimated water bills would be lower than the expressed willingness to pay in 15 out of the 21 schemes in 2005.

**Table 5.3 Cost of water per cubic meter, tariff requirement and affordability**

| Commu-ne | Annual unit costs (VND/m³) | | | | | | Tariff (VND/m³) | | Affordability (%)* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cost excl. re-investment | | | Cost incl. re-investment | | | | | | |
| | 2005 | 2010 | 2020 | 2005 | 2010 | 2020 | Up to 2012 | After 2013- | 2005 | 2020 |
| K1-1 | 4,438 | 3,106 | 1,666 | 17,625 | 10,847 | 5,253 | 6,750 | 7,000 | 4.8 | 7.8 |
| K2-1 | 6,258 | 5,195 | 2,550 | 18,573 | 12,425 | 6,416 | 8,000 | 8,250 | 10.9 | 17.5 |
| K2-3 | 4,239 | 3,204 | 1,621 | 14,532 | 9,246 | 4,471 | 5,750 | 6,000 | 7.8 | 12.7 |
| K3-1 | 3,455 | 2,748 | 1,486 | 8,146 | 5,502 | 2,969 | 3,750 | 3,800 | 4.8 | 7.5 |
| K4 | 4,680 | 3,277 | 1,626 | 14,466 | 9,022 | 4,200 | 5,500 | 5,600 | 4.7 | 7.4 |
| G1 | 2,952 | 2,129 | 1,221 | 9,075 | 5,723 | 2,818 | 3,400 | 3,750 | 1.5 | 2.7 |
| G2 | 2,363 | 1,784 | 1,118 | 7,697 | 4,915 | 2,575 | 2,850 | 3,350 | 0.7 | 1.3 |
| G3 | 2,767 | 2,153 | 1,353 | 7,853 | 5,139 | 2,678 | 3,100 | 3,500 | 1.0 | 1.7 |
| G4-1 | 2,411 | 1,829 | 1,043 | 7,146 | 4,609 | 2,371 | 2,800 | 3,100 | 1.9 | 3.3 |
| G5-1 | 3,034 | 2,283 | 1,293 | 8,721 | 5,621 | 2,835 | 3,300 | 3,800 | 1.4 | 2.5 |
| G6-1 | 2,309 | 1,825 | 1,072 | 5,820 | 3,886 | 2,167 | 2,500 | 2,800 | 1.3 | 2.3 |
| G7-1 | 5,002 | 3,789 | 1,776 | 13,739 | 8,919 | 3,781 | 5,300 | 5,400 | 2.7 | 4.3 |
| D1 | 1,658 | 1,277 | 774 | 4,983 | 3,229 | 1,685 | 1,950 | 2,200 | 0.6 | 1.1 |
| D2 | 1,609 | 1,259 | 860 | 4,632 | 3,034 | 1,714 | 1,850 | 2,200 | 0.8 | 1.5 |
| D3-1 | 1,711 | 1,359 | 833 | 4,650 | 3,084 | 1,671 | 1,900 | 2,200 | 0.9 | 1.6 |
| D3-2 | 2,355 | 1,727 | 995 | 7,352 | 4,661 | 2,493 | 2,700 | 3,250 | 1.3 | 2.4 |
| D4-1 | 2,160 | 1,639 | 974 | 6,720 | 4,316 | 2,136 | 2,650 | 2,800 | 1.2 | 2.0 |
| D4-2 | 3,470 | 2,878 | 1,419 | 10,868 | 7,221 | 3,223 | 4,000 | 4,500 | 1.8 | 3.1 |
| D5-1 | 2,536 | 1,801 | 959 | 8,588 | 5,353 | 2,607 | 3,100 | 3,500 | 3.2 | 5.7 |
| D6 | 1,956 | 1,584 | 1,048 | 5,568 | 3,704 | 2,028 | 2,300 | 2,600 | 0.7 | 1.2 |
| D7 | 2,084 | 1,632 | 990 | 5,794 | 3,810 | 1,994 | 2,150 | 2,700 | 0.9 | 1.7 |

*Water tariffs more than ATP (5% of income) are shadowed.

## 5.4.2 Financial Cash Flow Analysis

The cash flow of each scheme has been estimated separately. The main principle in cash flow projections is that there is a positive cash flow every single year and that every scheme is able to generate sufficient saving for re-investment in 25 year from the initial investment. The assumptions of the cash flow analysis are presented in Section 7.4.2 above. While the costs have been calculated along the same principles for every scheme the tariffs have been set on an iterative basis to facilitate a healthy cash flow. The financial performance charts, based on operation margin and the charts showing the cumulative savings, are attached in Appendix 11.

On the basis of above, the outcome of the cash flow analysis is not the critical criterion for the assessment of scheme sustainability (see Table 5.4 "Financial Cash Flow Analysis"). Because a healthy cash flow has been a basis for tariff calculation, the critical criterion is the ability and willingness to pay the required tariff. In this connection on has to bear in mind that **WSUs are not intended to generate profit or surplus in excess to financing of re-investment.**

# Table 5.4 Financial Cash Flow Analysis

| | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | K1-1 | | | K2-1 | | | K2-3 | | | K3-1 | | | K4-1 | | | G1 | | |
| Option | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | |
| Phase 1 | 578,218 | | | 151,059 | | | 350,210 | | | 181,568 | | | 406,601 | | | 601,322 | | |
| Phase 2 | 206,762 | | | 17,820 | | | 72,480 | | | 92,120 | | | 126,247 | | | 168,673 | | |
| Population | 7,797 | | | 1,612 | | | 4,862 | | | 2,819 | | | 3,136 | | | 6,988 | | |
| Year | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance |
| 1 | 322 | 110 | (213) | 70 | 27 | (43) | 164 | 58 | (106) | 92 | 39 | (52) | 177 | 62 | (114) | 257 | 87 | (170) |
| 2 | 354 | 122 | (232) | 77 | 30 | (47) | 182 | 65 | (117) | 105 | 44 | (62) | 202 | 69 | (133) | 285 | 96 | (188) |
| 3 | 355 | 136 | (219) | 77 | 33 | (44) | 183 | 72 | (110) | 106 | 49 | (57) | 203 | 77 | (126) | 286 | 107 | (179) |
| 4 | 356 | 151 | (205) | 78 | 37 | (40) | 183 | 80 | (103) | 107 | 54 | (52) | 203 | 86 | (117) | 287 | 119 | (168) |
| 5 | **364** | 168 | (196) | **83** | 41 | (41) | **189** | 89 | (99) | **112** | 60 | (52) | **209** | 95 | (113) | **296** | 133 | (163) |
| 6 | **365** | 187 | (178) | **83** | 46 | (37) | **189** | 99 | (90) | **113** | 67 | (46) | **209** | 106 | (103) | 298 | 147 | (150) |
| 7 | **366** | 208 | (158) | **83** | 51 | (32) | **192** | 111 | (82) | **116** | 75 | (41) | **210** | 118 | (92) | 300 | 164 | (136) |
| 8 | **372** | 232 | (141) | **88** | 57 | (31) | **198** | 123 | (75) | **122** | 83 | (39) | **215** | 131 | (84) | 307 | 182 | (125) |
| 9 | **376** | 258 | (118) | **88** | 63 | (25) | **199** | 137 | (62) | **123** | 92 | (31) | **218** | 146 | (72) | 312 | 203 | (109) |
| 10 | 378 | 287 | (91) | 89 | 70 | (19) | 200 | 152 | (48) | 124 | 103 | (22) | 219 | 162 | (57) | 318 | 226 | (92) |
| 11 | 481 | 331 | (150) | 123 | 81 | (42) | 255 | 177 | (78) | 166 | 116 | (50) | 267 | 184 | (83) | 386 | 277 | (109) |
| 12 | 493 | 368 | (125) | 126 | 90 | (36) | 262 | 197 | (65) | 173 | 129 | (44) | 274 | 205 | (69) | 396 | 308 | (88) |
| 13 | 498 | 409 | (88) | 127 | 100 | (27) | 263 | 219 | (44) | 174 | 144 | (31) | 277 | 228 | (49) | 402 | 343 | (60) |
| 14 | 503 | 455 | (48) | 127 | 111 | (16) | 267 | 243 | (23) | 179 | 160 | (19) | 278 | 253 | (25) | 409 | 381 | (28) |
| 15 | 508 | 507 | (2) | 128 | 123 | (4) | 269 | 271 | 2 | 181 | 178 | (3) | 280 | 282 | 2 | 416 | 424 | 8 |
| 16 | 511 | 563 | 52 | 130 | 137 | 7 | 271 | 301 | 30 | 183 | 198 | 14 | 282 | 313 | 32 | 422 | 472 | 50 |
| 17 | 517 | 627 | 110 | 131 | 153 | 21 | 273 | 335 | 62 | 186 | 220 | 34 | 286 | 349 | 63 | 430 | 525 | 95 |
| 18 | 523 | 697 | 174 | 132 | 170 | 38 | 278 | 373 | 95 | 191 | 244 | 53 | 291 | 388 | 97 | 439 | 584 | 145 |
| 19 | 530 | 776 | 246 | 133 | 189 | 56 | 281 | 415 | 134 | 194 | 272 | 78 | 295 | 432 | 136 | 446 | 650 | 203 |
| 20 | 530 | 776 | 246 | 133 | 189 | 56 | 281 | 415 | 134 | 194 | 272 | 78 | 295 | 432 | 136 | 446 | 650 | 203 |
| **FIRR** | | | **-8%** | | | **-9%** | | | **-7%** | | | **-7%** | | | **-8%** | | | **-7%** |
| **NPV** | US$(=15000VND) | | **-1,153** | | | **-228** | | | **-566** | | | **-275** | | | **-618** | | | **-919** |

| | 7 | | | 8 | | | 9 | | | 10 | | | 11 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | G2 | | | G3-1 | | | G4-1 | | | G5-1 | | | G6-1 | | |
| Option | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | |
| Phase 1 | 965,360 | | | 591,512 | | | 344,955 | | | 337,704 | | | 227,066 | | |
| Phase 2 | 352,676 | | | 143,199 | | | 136,717 | | | 117,396 | | | 29,894 | | |
| Population | 13,779 | | | 7,698 | | | 5,080 | | | 4,008 | | | 4,685 | | |
| Year | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance |
| 1 | 432 | 144 | (287) | 250 | 90 | (159) | 156 | 55 | (101) | 144 | 50 | (95) | 114 | 44 | (70) |
| 2 | 477 | 161 | (317) | 276 | 101 | (176) | 173 | 61 | (112) | 161 | 55 | (106) | 126 | 49 | (77) |
| 3 | 483 | 179 | (304) | 283 | 112 | (172) | 174 | 68 | (106) | 162 | 61 | (101) | 127 | 54 | (72) |
| 4 | 490 | 199 | (291) | 288 | 124 | (164) | 177 | 76 | (101) | 163 | 68 | (95) | 128 | 60 | (67) |
| 5 | **501** | 221 | (279) | **299** | 138 | (160) | **182** | 84 | (98) | **169** | 76 | (93) | **133** | 67 | (66) |
| 6 | 505 | 246 | (259) | 302 | 154 | (148) | 183 | 94 | (90) | 170 | 85 | (86) | 137 | 75 | (62) |
| 7 | 512 | 274 | (239) | 307 | 171 | (136) | 185 | 104 | (80) | 172 | 94 | (78) | 138 | 83 | (55) |
| 8 | 525 | 305 | (221) | 316 | 191 | (125) | 191 | 116 | (75) | 178 | 105 | (74) | 144 | 93 | (51) |
| 9 | 534 | 339 | (195) | 325 | 212 | (113) | 194 | 129 | (65) | 182 | 116 | (66) | 146 | 103 | (43) |
| 10 | 541 | 377 | (164) | 329 | 236 | (94) | 196 | 143 | (53) | 184 | 129 | (54) | 149 | 115 | (35) |
| 11 | 682 | 493 | (189) | 396 | 296 | (100) | 248 | 177 | (71) | 226 | 166 | (60) | 198 | 143 | (55) |
| 12 | 706 | 548 | (158) | 410 | 330 | (81) | 257 | 196 | (61) | 233 | 184 | (48) | 205 | 159 | (46) |
| 13 | 716 | 610 | (106) | 417 | 367 | (50) | 262 | 219 | (44) | 237 | 205 | (32) | 209 | 177 | (33) |
| 14 | 729 | 678 | (50) | 426 | 408 | (19) | 265 | 243 | (22) | 240 | 228 | (12) | 212 | 197 | (15) |
| 15 | 743 | 755 | 12 | 437 | 454 | 17 | 270 | 270 | 1 | 244 | 254 | 10 | 218 | 219 | 1 |
| 16 | 758 | 839 | 81 | 448 | 505 | 57 | 273 | 301 | 28 | 249 | 282 | 33 | 223 | 243 | 20 |
| 17 | 780 | 934 | 154 | 460 | 561 | 101 | 281 | 335 | 54 | 253 | 314 | 61 | 227 | 271 | 44 |
| 18 | 798 | 1,039 | 240 | 478 | 624 | 147 | 285 | 372 | 88 | 261 | 350 | 89 | 233 | 301 | 68 |
| 19 | 819 | 1,155 | 337 | 492 | 695 | 202 | 291 | 414 | 123 | 268 | 389 | 121 | 240 | 335 | 95 |
| 20 | 819 | 1,155 | 337 | 492 | 695 | 202 | 291 | 414 | 123 | 268 | 389 | 121 | 240 | 335 | 95 |
| **FIRR** | | | **-8%** | | | **-7%** | | | **-8%** | | | **-7%** | | | **-7%** |
| **NPV** | | | **-1,556** | | | **-854** | | | **-546** | | | **-507** | | | **-370** |

| | 12 | | | 13 | | | 14 | | | 15 | | | 16 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | G7-1 | | | D1 | | | D2 | | | D3-1 | | | D3-2 | | |
| Option | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | |
| Phase 1 | 227,066 | | | 640,632 | | | 926,850 | | | 337,039 | | | 297,530 | | |
| Phase 2 | 29,894 | | | 233,064 | | | 375,219 | | | 141,311 | | | 133,328 | | |
| Population | 1,837 | | | 12,903 | | | 18,464 | | | 8,556 | | | 4,463 | | |
| Year | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance |
| 1 | 104 | 37 | (67) | 270 | 96 | (174) | 346 | 126 | (221) | 157 | 58 | (99) | 128 | 43 | (85) |
| 2 | 115 | 41 | (74) | 301 | 107 | (195) | 383 | 140 | (243) | 173 | 64 | (109) | 143 | 48 | (81) |
| 3 | 117 | 45 | (72) | 303 | 119 | (184) | 389 | 155 | (234) | 175 | 71 | (103) | 144 | 53 | (77) |
| 4 | 118 | 50 | (67) | 307 | 132 | (175) | 395 | 173 | (223) | 178 | 79 | (99) | 145 | 59 | (74) |
| 5 | **123** | 56 | (67) | **314** | **147** | (168) | **405** | **192** | (213) | **185** | **88** | (96) | **146** | **65** | (70) |
| 6 | 123 | 62 | (61) | 321 | 163 | (158) | 412 | 214 | (199) | 186 | 98 | (88) | 147 | 73 | (66) |
| 7 | 124 | 69 | (55) | 324 | 182 | (143) | 420 | 238 | (183) | 188 | 109 | (79) | 148 | 81 | (62) |
| 8 | 130 | 77 | (53) | 334 | 202 | (132) | 434 | 265 | (169) | 197 | 122 | (76) | 156 | 90 | (58) |
| 9 | 132 | 86 | (47) | 340 | 225 | (115) | 441 | 294 | (147) | 203 | 135 | (68) | 157 | 100 | (54) |
| 10 | 133 | 95 | (38) | 344 | 250 | (94) | 452 | 328 | (124) | 208 | 150 | (57) | 158 | 112 | (47) |
| 11 | 146 | 108 | (38) | 430 | 314 | (117) | 579 | 433 | (146) | 261 | 194 | (67) | 213 | 149 | (63) |
| 12 | 148 | 120 | (28) | 446 | 349 | (97) | 603 | 482 | (121) | 270 | 216 | (55) | 220 | 166 | (54) |
| 13 | 149 | 134 | (16) | 453 | 388 | (65) | 616 | 536 | (80) | 278 | 240 | (39) | 224 | 185 | (39) |
| 14 | 151 | 149 | (2) | 461 | 432 | (30) | 633 | 596 | (37) | 285 | 267 | (18) | 226 | 206 | (20) |
| 15 | 154 | 165 | 11 | 475 | 480 | 5 | 649 | 663 | 15 | 289 | 297 | 8 | 228 | 229 | 0 |
| 16 | 156 | 184 | 28 | 485 | 534 | 50 | 666 | 738 | 71 | 296 | 330 | 34 | 233 | 254 | 21 |
| 17 | 157 | 205 | 47 | 495 | 594 | 99 | 688 | 821 | 133 | 304 | 367 | 63 | 236 | 283 | 47 |
| 18 | 159 | 228 | 68 | 506 | 661 | 155 | 711 | 913 | 202 | 310 | 409 | 98 | 241 | 315 | 73 |
| 19 | 162 | 253 | 92 | 521 | 735 | 214 | 737 | 1,016 | 279 | 319 | 454 | 135 | 245 | 350 | 105 |
| 20 | 162 | 253 | 92 | 521 | 735 | 214 | 737 | 1,016 | 279 | 319 | 454 | 135 | 245 | 350 | 105 |
| **FIRR** | | | -6% | | | **-7%** | | | **-7%** | | | **-6%** | | | -7% |

| | 17 | | | 18 | | | 19 | | | 20 | | | 21 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | D4-1 | | | D4-2 | | | D5-1 | | | D6 | | | D7 | | | Total |
| Option | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | |
| Phase 1 | 500,457 | | | 250,341 | | | 460,679 | | | 469,229 | | | 363,980 | | | **9,209,378** |
| Phase 2 | 165,608 | | | 127,854 | | | 176,027 | | | 104,813 | | | 130,138 | | | **3,081,240** |
| Population | 7,775 | | | 2,034 | | | 8,920 | | | 10,619 | | | 7,484 | | | **145,519** |
| Year | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | Expenditure | Revenue | Balance | |
| 1 | 233 | 83 | (150) | 99 | 33 | (67) | 233 | 76 | (157) | 242 | 91 | (151) | 171 | 57 | (114) | |
| 2 | 258 | 92 | (166) | 109 | 36 | (73) | 258 | 85 | (174) | 269 | 101 | (168) | 189 | 63 | (125) | |
| 3 | 260 | 102 | (157) | 110 | 40 | (69) | 261 | 94 | (167) | 271 | 112 | (159) | 190 | 71 | (120) | |
| 4 | 263 | 114 | (150) | 110 | 45 | (65) | 262 | 105 | (157) | 274 | 125 | (150) | 192 | 78 | (113) | |
| 5 | **270** | 127 | (143) | **116** | 50 | (66) | **267** | **117** | (151) | **285** | **139** | (146) | **200** | **87** | (113) | |
| 6 | 272 | 141 | (131) | 116 | 56 | (60) | 268 | 130 | (138) | 292 | 154 | (137) | 202 | 97 | (105) | |
| 7 | 277 | 157 | (120) | 119 | 62 | (57) | 271 | 144 | (127) | 298 | 172 | (126) | 204 | 108 | (96) | |
| 8 | 284 | 174 | (110) | 124 | 69 | (55) | 277 | 160 | (117) | 307 | 191 | (117) | 213 | 120 | (93) | |
| 9 | 290 | 194 | (96) | 125 | 77 | (48) | 278 | 178 | (100) | 313 | 212 | (100) | 218 | 134 | (85) | |
| 10 | 295 | 216 | (79) | 126 | 85 | (41) | 280 | 199 | (81) | 323 | 236 | (87) | 221 | 149 | (72) | |
| 11 | 350 | 254 | (97) | 144 | 107 | (38) | 355 | 249 | (106) | 399 | 297 | (102) | 273 | 208 | (65) | |
| 12 | 364 | 282 | (82) | 148 | 119 | (29) | 368 | 277 | (91) | 414 | 330 | (83) | 282 | 231 | (51) | |
| 13 | 369 | 314 | (55) | 151 | 132 | (19) | 372 | 309 | (64) | 424 | 368 | (56) | 291 | 257 | (34) | |
| 14 | 376 | 349 | (27) | 152 | 147 | (5) | 374 | 343 | (31) | 433 | 409 | (24) | 295 | 286 | (9) | |
| 15 | 383 | 388 | 5 | 154 | 163 | 10 | 378 | 382 | 3 | 445 | 455 | 10 | 302 | 318 | 16 | |
| 16 | 389 | 432 | 43 | 155 | 182 | 26 | 383 | 425 | 41 | 458 | 506 | 48 | 309 | 354 | 45 | |
| 17 | 398 | 481 | 82 | 157 | 202 | 45 | 388 | 472 | 84 | 472 | 563 | 90 | 315 | 394 | 79 | |
| 18 | 408 | 535 | 127 | 161 | 225 | 64 | 392 | 526 | 134 | 488 | 626 | 138 | 323 | 438 | 115 | |
| 19 | 418 | 595 | 176 | 163 | 250 | 87 | 397 | 585 | 188 | 510 | 697 | 186 | 332 | 487 | 155 | |
| 20 | 418 | 595 | 176 | 163 | 250 | 87 | 397 | 585 | 188 | 510 | 697 | 186 | 332 | 487 | 155 | |
| **FIRR** | | | -8% | | | -6% | | | -8% | | | **-7%** | | | -6% | |

In practice WSUs and their boards have the responsibility for financial management and ensuring of healthy cash flows. When a WSU encounters financial problems it has three principal alternatives: to raise tariffs, increase sales volume or reduce costs, or a combination of the three. Experience has shown that although water is a basic need of human beings, the price to pay for water has a strong impact on water use. Economists call this price elasticity and it implies that the total revenue may not be increased by tariff raise.

## 5.5 Economic Evaluation

To supplement the financial analysis, the economic analysis was first quantitatively carried out using the EIRR analysis.

### 5.5.1 Identification of Economic Benefits and Demerits

The estimated economic benefits to be derived from rural water supply projects will become:

- B-1. Improvement of public health due to decrease in water-borne diseases
- B-2. Increase in work time or study time by reducing water transportation and time
- B-3. Improvement of gender issues by B-1 to B-2, and through the community activities in B-3
- B-4. Decrease in medical expenditures for governments and clinics
- B-5. Increase in employment chance by the construction of the systems and the need for O/M
- B-6. Increase in business activities to provide local materials for the systems
- B-7. Improvement of awareness on hygiene and sanitation through IEC
- B-8. Higher living standard and longer life expectancy by the use of clean and safe water

However, there might be some economic demerits as follows:

- D-1. Decrease in vendor businesses by the systems in some areas
- D-2. Environmental impact of groundwater lowering on shallow wells raising water right issues
- D-3. Land acquisition problems that might be raised if solved properly.

According to the social survey, households who take water from venders are limited. Furthermore, the business for venders is very limited both spatially and seasonally. This economic demerit is considered very limited.

As concluded in the EIA analysis, the water level was lowered in the existing shallow wells in K3 and D5 as a result of the pumping tests. The water right issues should be taken into consideration before the implementation. This issue will raise a social conflict between villages who use piped water and dug wells, and damage the economic foundation for the local communities. In K3-1, the pilot model has been monitored if there is such an issue.

### 5.5.2 Economic Cash Flow Analysis

**General**

Cash flow analysis by the use of economic internal rate of return "EIRR" was calculated based on the estimated economic benefits, and demerits. Most of the benefits and demerits identified in the previous section have qualitative effects, only benefits B1, B2 and demerit D-1 have quantifiable effects.

The quantifiable effect related to B1 is cost reduction for medical care, and that for B2 is cost saving of water collection. Venders will reduce the benefits related to vending business.

**Assumptions**

Assumptions of the quantifiable analysis are as follows:

- ATP (3% of the annual income) will be used if the necessary water tariff exceeds 3% of the annual income.
- Incidences of water-borne diseases collected by the social survey are used for the analysis.
- Reduction in water-borne diseases is estimated as high as 50 % for typhoid, cholera, dysentery, and diarrhea.
- Annual cost saved by reducing the diseases is estimated as high as VND 250,000 (average medical cost) for treatment for typhoid, cholera, dysentery, diarrhea, and trachoma. Cost saving by disease reduction is thus calculated as follows:

  Total saving by water collection =

  250,000 VND/household * no. of households suffering from each disease
- Reduction of time for water collection is due to the households taking water from the springs, and is estimated as long as 1 hour.

- Time saved for water collection is valued at the average VND 1,000 using the household incomes per hour for farmers collected by the social survey. The annual saving is thus calculated as follows:

  Total saving by water collection =

  500 VND/hour * 1 hour/day * 365 days * % of using springs/rivers * no. of households
- Demerits associated with the reduction in vending business are offset by benefits derived by the cost reduction for water bought from venders. In a closed society, net demerits are zero, so the economic analysis omitted did not take any calculations for vending business.

**Results**

EIRR for the every proposed system is calculated as shown Table 5.5. The following are the results of the economic cash flow analysis:

- The EIRRs of K3-1, G6-1, D3-1, D4-2, and D6 are relatively large (+5 to 15%). These systems are economically feasible.
- The EIRRs of K1-1, K2-1, K2-3, and D5-1 could not be calculated or had large negative values (–6% to -27%). These systems are economically unfeasible.
- The EIRR of the other systems varies between –4 to 4%.

# Table 5.5 EIRR Cash Flow

| | 1 | | | | 2 | | | | 3 | | | | 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | K1-1 | | | | K2-1 | | | | K2-3 | | | | K3-1 | | | |
| Option | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Phase 1 | 578,218 | | | | 151,059 | | | | 350,210 | | | | 181,568 | | | |
| Phase 2 | 206,762 | | | | 17,820 | | | | 72,480 | | | | 92,120 | | | |
| Population | 7,797 | | | | 1,612 | | | | 4,862 | | | | 2,819 | | | |
| Year | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL |
| 2003 | 322 | 68 | 36 | (219) | 70 | 7 | 5 | (57) | 164 | 22 | 10 | (131) | 92 | 25 | 24 | (42) |
| 2004 | 354 | 75 | 39 | (240) | 77 | 8 | 6 | (63) | 182 | 25 | 11 | (146) | 105 | 28 | 26 | (51) |
| 2005 | 355 | 84 | 42 | (230) | 77 | 9 | 6 | (62) | 183 | 28 | 12 | (143) | 106 | 31 | 29 | (46) |
| 2006 | 356 | 93 | 45 | (218) | 78 | 10 | 7 | (61) | 183 | 31 | 13 | (139) | 107 | 35 | 31 | (41) |
| 2007 | 364 | 103 | 49 | (212) | 83 | 11 | 7 | (64) | 189 | 34 | 14 | (140) | 112 | 39 | 33 | (40) |
| 2008 | 365 | 115 | 53 | (197) | 83 | 13 | 8 | (63) | 189 | 38 | 15 | (136) | 113 | 43 | 36 | (34) |
| 2009 | 366 | 128 | 57 | (181) | 83 | 14 | 8 | (61) | 192 | 42 | 16 | (134) | 116 | 48 | 39 | (29) |
| 2010 | 372 | 142 | 61 | (168) | 88 | 16 | 9 | (64) | 198 | 47 | 18 | (133) | 122 | 53 | 42 | (27) |
| 2011 | 376 | 158 | 66 | (151) | 88 | 17 | 10 | (62) | 199 | 52 | 19 | (127) | 123 | 59 | 45 | (19) |
| 2012 | 378 | 176 | 72 | (130) | 89 | 19 | 10 | (59) | 200 | 58 | 21 | (121) | 124 | 66 | 49 | (10) |
| 2013 | 481 | 196 | 77 | (208) | 123 | 21 | 11 | (90) | 255 | 177 | 22 | (56) | 166 | 114 | 53 | 2 |
| 2014 | 493 | 218 | 84 | (192) | 126 | 24 | 12 | (90) | 262 | 197 | 24 | (41) | 173 | 127 | 57 | 12 |
| 2015 | 498 | 243 | 90 | (165) | 127 | 27 | 13 | (87) | 263 | 219 | 26 | (18) | 174 | 142 | 62 | 29 |
| 2016 | 503 | 270 | 98 | (136) | 127 | 30 | 14 | (83) | 267 | 243 | 28 | 5 | 179 | 158 | 67 | 46 |
| 2017 | 508 | 300 | 105 | (103) | 128 | 33 | 15 | (80) | 269 | 271 | 30 | 32 | 181 | 175 | 72 | 66 |
| 2018 | 511 | 334 | 114 | (63) | 130 | 37 | 16 | (77) | 271 | 301 | 33 | 63 | 183 | 195 | 78 | 89 |
| 2019 | 517 | 372 | 123 | (22) | 131 | 41 | 18 | (73) | 273 | 335 | 35 | 97 | 186 | 217 | 84 | 115 |
| 2020 | 523 | 413 | 133 | 23 | 132 | 45 | 19 | (68) | 278 | 373 | 38 | 133 | 191 | 241 | 91 | 141 |
| 2021 | 530 | 460 | 143 | 74 | 133 | 50 | 21 | (62) | 281 | 415 | 41 | 175 | 194 | 268 | 98 | 172 |
| 2022 | 530 | 460 | 143 | 74 | 133 | 50 | 21 | (62) | 281 | 415 | 41 | 175 | 194 | 268 | 98 | 172 |
| EIRR | | | | -27% | | | | #DIV/0! | | | | -6% | | | | 7% |
| NPV | US$(=15000VND) | | | -1,287 | | | | -380 | | | | -700 | | | | -161 |

| | 5 | | | | 6 | | | | 7 | | | | 8 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | K4-1 | | | | G1 | | | | G2 | | | | G3-1 | | | |
| Option | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Phase 1 | 406,601 | | | | 601,322 | | | | 965,360 | | | | 591,512 | | | |
| Phase 2 | 126,247 | | | | 168,673 | | | | 352,676 | | | | 143,199 | | | |
| Population | 3,136 | | | | 6,988 | | | | 13,779 | | | | 7,698 | | | |
| Year | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL |
| 2003 | 177 | 62 | 22 | (93) | 257 | 87 | 31 | (139) | 432 | 144 | 21 | (267) | 250 | 90 | 30 | (129) |
| 2004 | 202 | 69 | 23 | (110) | 285 | 96 | 33 | (155) | 477 | 161 | 22 | (294) | 276 | 101 | 32 | (144) |
| 2005 | 203 | 77 | 25 | (100) | 286 | 107 | 36 | (143) | 483 | 179 | 24 | (280) | 283 | 112 | 35 | (137) |
| 2006 | 203 | 86 | 27 | (90) | 287 | 119 | 39 | (130) | 490 | 199 | 26 | (264) | 288 | 124 | 38 | (126) |
| 2007 | 209 | 95 | 30 | (84) | 296 | 133 | 42 | (122) | 501 | 221 | 28 | (251) | 299 | 138 | 41 | (120) |
| 2008 | 209 | 106 | 32 | (71) | 298 | 147 | 45 | (105) | 505 | 246 | 31 | (228) | 302 | 154 | 44 | (104) |
| 2009 | 210 | 118 | 34 | (57) | 300 | 164 | 49 | (87) | 512 | 274 | 33 | (205) | 307 | 171 | 47 | (89) |
| 2010 | 215 | 131 | 37 | (47) | 307 | 182 | 53 | (72) | 525 | 305 | 36 | (185) | 316 | 191 | 51 | (74) |
| 2011 | 218 | 146 | 40 | (32) | 312 | 203 | 57 | (52) | 534 | 339 | 39 | (156) | 325 | 212 | 55 | (58) |
| 2012 | 219 | 162 | 43 | (13) | 318 | 226 | 61 | (31) | 541 | 377 | 42 | (122) | 329 | 236 | 60 | (34) |
| 2013 | 267 | 184 | 47 | (36) | 386 | 277 | 66 | (42) | 682 | 493 | 45 | (144) | 396 | 296 | 64 | (36) |
| 2014 | 274 | 205 | 51 | (18) | 396 | 308 | 72 | (17) | 706 | 548 | 49 | (110) | 410 | 330 | 69 | (12) |
| 2015 | 277 | 228 | 55 | 5 | 402 | 343 | 77 | 18 | 716 | 610 | 52 | (54) | 417 | 367 | 75 | 25 |
| 2016 | 278 | 253 | 59 | 34 | 409 | 381 | 84 | 56 | 729 | 678 | 57 | 6 | 426 | 408 | 81 | 62 |
| 2017 | 280 | 282 | 64 | 66 | 416 | 424 | 90 | 98 | 743 | 755 | 61 | 73 | 437 | 454 | 87 | 104 |
| 2018 | 282 | 313 | 69 | 101 | 422 | 472 | 97 | 148 | 758 | 839 | 66 | 147 | 448 | 505 | 94 | 151 |
| 2019 | 286 | 349 | 74 | 137 | 430 | 525 | 105 | 200 | 780 | 934 | 71 | 225 | 460 | 561 | 102 | 204 |
| 2020 | 291 | 388 | 80 | 177 | 439 | 584 | 114 | 259 | 798 | 1,039 | 77 | 317 | 478 | 624 | 110 | 257 |
| 2021 | 295 | 432 | 87 | 223 | 446 | 650 | 123 | 326 | 819 | 1,155 | 83 | 420 | 492 | 695 | 119 | 321 |
| 2022 | 295 | 432 | 87 | 223 | 446 | 650 | 123 | 326 | 819 | 1,155 | 83 | 420 | 492 | 695 | 119 | 321 |
| EIRR | | | | 2% | | | | 2% | | | | -4% | | | | 2% |
| NPV | | | | -439 | | | | -665 | | | | -1,384 | | | | -608 |

| | 9 | | | | 10 | | | | 11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | G4-1 | | | | G5-1 | | | | G6-1 | | | |
| Option | 1 | | | | 1 | | | | 1 | | | |
| Phase 1 | 344,955 | | | | 337,704 | | | | 227,066 | | | |
| Phase 2 | 136,717 | | | | 117,396 | | | | 29,894 | | | |
| Population | 5,080 | | | | 4,008 | | | | 4,685 | | | |
| Year | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL |
| 2003 | 156 | 55 | 19 | (82) | 144 | 50 | 8 | (86) | 114 | 45 | 24 | (45) |
| 2004 | 173 | 61 | 21 | (91) | 161 | 56 | 9 | (97) | 126 | 50 | 25 | (50) |
| 2005 | 174 | 68 | 22 | (83) | 162 | 62 | 10 | (90) | 127 | 55 | 27 | (44) |
| 2006 | 177 | 76 | 24 | (77) | 163 | 69 | 10 | (84) | 128 | 62 | 30 | (36) |
| 2007 | 182 | 84 | 26 | (72) | 169 | 77 | 11 | (81) | 133 | 69 | 32 | (33) |
| 2008 | 183 | 94 | 28 | (61) | 170 | 86 | 12 | (73) | 137 | 76 | 35 | (26) |
| 2009 | 185 | 104 | 31 | (50) | 172 | 95 | 13 | (63) | 138 | 85 | 37 | (15) |
| 2010 | 191 | 116 | 33 | (42) | 178 | 106 | 14 | (58) | 144 | 94 | 40 | (9) |
| 2011 | 194 | 129 | 36 | (30) | 182 | 118 | 15 | (49) | 146 | 105 | 44 | 3 |
| 2012 | 196 | 143 | 39 | (14) | 184 | 131 | 16 | (36) | 149 | 117 | 47 | 15 |
| 2013 | 248 | 177 | 42 | (29) | 226 | 166 | 18 | (43) | 198 | 143 | 51 | (4) |
| 2014 | 257 | 196 | 45 | (16) | 233 | 184 | 19 | (29) | 205 | 159 | 55 | 9 |
| 2015 | 262 | 219 | 49 | 5 | 237 | 205 | 21 | (12) | 209 | 177 | 59 | 27 |
| 2016 | 265 | 243 | 52 | 31 | 240 | 228 | 22 | 10 | 212 | 197 | 64 | 49 |
| 2017 | 270 | 270 | 57 | 57 | 244 | 254 | 24 | 34 | 218 | 219 | 69 | 70 |
| 2018 | 273 | 301 | 61 | 89 | 249 | 282 | 26 | 59 | 223 | 243 | 75 | 95 |
| 2019 | 281 | 335 | 66 | 120 | 253 | 314 | 28 | 89 | 227 | 271 | 81 | 124 |
| 2020 | 285 | 372 | 71 | 159 | 261 | 350 | 30 | 119 | 233 | 301 | 87 | 155 |
| 2021 | 291 | 414 | 77 | 200 | 268 | 389 | 33 | 154 | 240 | 335 | 94 | 189 |
| 2022 | 291 | 414 | 77 | 200 | 268 | 389 | 33 | 154 | 240 | 335 | 94 | 189 |
| EIRR | | | | 2% | | | | -2% | | | | 10% |
| NPV | | | | -387 | | | | -435 | | | | -170 |

| | 12 | | | | 13 | | | | 14 | | | | 15 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | G7-1 | | | | D1 | | | | D2 | | | | D3-1 | | | |
| Option | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Phase 1 | 227,066 | | | | 640,632 | | | | 926,850 | | | | 337,039 | | | |
| Phase 2 | 29,894 | | | | 233,064 | | | | 375,219 | | | | 141,311 | | | |
| Population | 1,837 | | | | 12,903 | | | | 18,464 | | | | 8,556 | | | |
| Year | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL |
| 2003 | 104 | 37 | 11 | (56) | 270 | 96 | 24 | (150) | 346 | 126 | 50 | (170) | 157 | 58 | 33 | (67) |
| 2004 | 115 | 41 | 12 | (62) | 301 | 107 | 25 | (169) | 383 | 140 | 54 | (189) | 173 | 64 | 35 | (74) |
| 2005 | 117 | 45 | 13 | (59) | 303 | 119 | 28 | (157) | 389 | 155 | 59 | (175) | 175 | 71 | 38 | (65) |
| 2006 | 118 | 50 | 14 | (54) | 307 | 132 | 30 | (146) | 395 | 173 | 64 | (159) | 178 | 79 | 41 | (57) |
| 2007 | 123 | 56 | 15 | (52) | 314 | 147 | 32 | (135) | 405 | 192 | 69 | (144) | 185 | 88 | 45 | (52) |
| 2008 | 123 | 62 | 16 | (45) | 321 | 163 | 35 | (124) | 412 | 214 | 74 | (125) | 186 | 98 | 48 | (40) |
| 2009 | 124 | 69 | 17 | (37) | 324 | 182 | 37 | (105) | 420 | 238 | 80 | (103) | 188 | 109 | 52 | (27) |
| 2010 | 130 | 77 | 19 | (34) | 334 | 202 | 40 | (92) | 434 | 265 | 86 | (83) | 197 | 122 | 56 | (19) |
| 2011 | 132 | 86 | 20 | (26) | 340 | 225 | 44 | (72) | 441 | 294 | 93 | (54) | 203 | 135 | 61 | (7) |
| 2012 | 133 | 95 | 22 | (16) | 344 | 250 | 47 | (47) | 452 | 328 | 101 | (23) | 208 | 150 | 66 | 9 |
| 2013 | 146 | 108 | 24 | (14) | 430 | 314 | 51 | (66) | 579 | 433 | 109 | (37) | 261 | 194 | 71 | 3 |
| 2014 | 148 | 120 | 26 | (2) | 446 | 349 | 55 | (42) | 603 | 482 | 118 | (3) | 270 | 216 | 77 | 22 |
| 2015 | 149 | 134 | 28 | 12 | 453 | 388 | 59 | (6) | 616 | 536 | 127 | 47 | 278 | 240 | 83 | 44 |
| 2016 | 151 | 149 | 30 | 28 | 461 | 432 | 64 | 35 | 633 | 596 | 137 | 101 | 285 | 267 | 89 | 72 |
| 2017 | 154 | 165 | 32 | 44 | 475 | 480 | 69 | 75 | 649 | 663 | 148 | 163 | 289 | 297 | 97 | 104 |
| 2018 | 156 | 184 | 35 | 63 | 485 | 534 | 75 | 125 | 666 | 738 | 160 | 231 | 296 | 330 | 104 | 138 |
| 2019 | 157 | 205 | 38 | 85 | 495 | 594 | 81 | 180 | 688 | 821 | 173 | 306 | 304 | 367 | 113 | 176 |
| 2020 | 159 | 228 | 41 | 109 | 506 | 661 | 87 | 242 | 711 | 913 | 187 | 388 | 310 | 409 | 122 | 220 |
| 2021 | 162 | 253 | 44 | 135 | 521 | 735 | 94 | 309 | 737 | 1,016 | 201 | 480 | 319 | 454 | 131 | 266 |
| 2022 | 162 | 253 | 44 | 135 | 521 | 735 | 94 | 309 | 737 | 1,016 | 201 | 480 | 319 | 454 | 131 | 266 |
| EIRR | | | | 2% | | | | 0% | | | | 4% | | | | 9% |
| NPV | US$(=15000VND) | | | -265 | | | | -740 | | | | -768 | | | | -257 |

| | 16 | | | | 17 | | | | 18 | | | | 19 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | D3-2 | | | | D4-1 | | | | D4-2 | | | | D5-1 | | | |
| Option | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Phase 1 | 297,530 | | | | 500,457 | | | | 250,341 | | | | 460,679 | | | |
| Phase 2 | 133,328 | | | | 165,608 | | | | 127,854 | | | | 176,027 | | | |
| Population | 4,463 | | | | 7,775 | | | | 2,034 | | | | 8,920 | | | |
| Year | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL |
| 2003 | 128 | 43 | 18 | (67) | 233 | 83 | 22 | (129) | 99 | 33 | 8 | (59) | 233 | 71 | 15 | (146) |
| 2004 | 143 | 48 | 19 | (77) | 258 | 92 | 24 | (143) | 109 | 36 | 8 | (65) | 258 | 79 | 16 | (163) |
| 2005 | 144 | 53 | 21 | (71) | 260 | 102 | 25 | (132) | 110 | 40 | 9 | (61) | 261 | 88 | 18 | (155) |
| 2006 | 145 | 59 | 22 | (64) | 263 | 114 | 27 | (122) | 110 | 45 | 10 | (56) | 262 | 98 | 19 | (144) |
| 2007 | 146 | 65 | 24 | (56) | 270 | 127 | 30 | (114) | 116 | 50 | 10 | (55) | 267 | 109 | 21 | (137) |
| 2008 | 147 | 73 | 26 | (48) | 272 | 141 | 32 | (99) | 116 | 56 | 11 | (49) | 268 | 121 | 22 | (124) |
| 2009 | 148 | 81 | 28 | (39) | 277 | 157 | 35 | (85) | 119 | 62 | 12 | (45) | 271 | 135 | 24 | (112) |
| 2010 | 156 | 90 | 30 | (35) | 284 | 174 | 37 | (72) | 124 | 69 | 13 | (43) | 277 | 150 | 26 | (101) |
| 2011 | 157 | 100 | 33 | (24) | 290 | 194 | 40 | (56) | 125 | 77 | 14 | (35) | 278 | 167 | 28 | (83) |
| 2012 | 158 | 112 | 35 | (11) | 295 | 216 | 44 | (36) | 126 | 85 | 15 | (26) | 280 | 186 | 30 | (63) |
| 2013 | 213 | 149 | 38 | (25) | 350 | 254 | 47 | (50) | 144 | 107 | 16 | (21) | 355 | 207 | 33 | (116) |
| 2014 | 220 | 166 | 41 | (13) | 364 | 282 | 51 | (31) | 148 | 119 | 18 | (11) | 368 | 230 | 36 | (103) |
| 2015 | 224 | 185 | 44 | 5 | 369 | 314 | 55 | 0 | 151 | 132 | 19 | 0 | 372 | 256 | 38 | (78) |
| 2016 | 226 | 206 | 48 | 28 | 376 | 349 | 59 | 33 | 152 | 147 | 21 | 15 | 374 | 284 | 41 | (48) |
| 2017 | 228 | 229 | 52 | 52 | 383 | 388 | 64 | 69 | 154 | 163 | 22 | 32 | 378 | 316 | 45 | (17) |
| 2018 | 233 | 254 | 56 | 77 | 389 | 432 | 69 | 112 | 155 | 182 | 24 | 50 | 383 | 352 | 48 | 17 |
| 2019 | 236 | 283 | 60 | 107 | 398 | 481 | 75 | 157 | 157 | 202 | 26 | 71 | 388 | 391 | 52 | 55 |
| 2020 | 241 | 315 | 65 | 139 | 408 | 535 | 81 | 207 | 161 | 225 | 28 | 92 | 392 | 435 | 56 | 100 |
| 2021 | 245 | 350 | 70 | 176 | 418 | 595 | 87 | 263 | 163 | 250 | 30 | 117 | 397 | 484 | 61 | 148 |
| 2022 | 245 | 350 | 70 | 176 | 418 | 595 | 87 | 263 | 163 | 250 | 30 | 117 | 397 | 484 | 61 | 148 |
| EIRR | | | | 3% | | | | 0% | | | | 0% | | | | -10% |
| NPV | | | | -312 | | | | -635 | | | | -294 | | | | -806 |

| | 20 | | | | 21 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commune | D6 | | | | D7 | | | | Total | | | |
| Option | 1 | | | | 1 | | | | | | | |
| Phase 1 | 469,229 | | | | 363,980 | | | | 9,209,378 | | | |
| Phase 2 | 104,813 | | | | 130,138 | | | | 3,081,240 | | | |
| Population | 10,619 | | | | 7,484 | | | | 145,519 | | | |
| Year | EXP | REV | E/B | BAL | EXP | REV | E/B | BAL | | | | |
| 2003 | 242 | 91 | 20 | (132) | 171 | 57 | 0 | (114) | | | | |
| 2004 | 269 | 101 | 21 | (147) | 189 | 63 | 0 | (125) | | | | |
| 2005 | 271 | 112 | 23 | (136) | 190 | 71 | 0 | (120) | | | | |
| 2006 | 274 | 125 | 25 | (125) | 192 | 78 | 0 | (113) | | | | |
| 2007 | 285 | 139 | 27 | (119) | 200 | 87 | 0 | (113) | | | | |
| 2008 | 292 | 154 | 29 | (109) | 202 | 97 | 0 | (105) | | | | |
| 2009 | 298 | 172 | 31 | (95) | 204 | 108 | 0 | (96) | | | | |
| 2010 | 307 | 191 | 34 | (83) | 213 | 120 | 0 | (93) | | | | |
| 2011 | 313 | 212 | 36 | (64) | 218 | 134 | 0 | (85) | | | | |
| 2012 | 323 | 236 | 39 | (48) | 221 | 149 | 0 | (72) | | | | |
| 2013 | 399 | 297 | 42 | (60) | 273 | 208 | 0 | (65) | | | | |
| 2014 | 414 | 330 | 46 | (38) | 282 | 231 | 0 | (51) | | | | |
| 2015 | 424 | 368 | 49 | (7) | 291 | 257 | 0 | (34) | | | | |
| 2016 | 433 | 409 | 53 | 29 | 295 | 286 | 0 | (9) | | | | |
| 2017 | 445 | 455 | 58 | 68 | 302 | 318 | 0 | 16 | | | | |
| 2018 | 458 | 506 | 62 | 110 | 309 | 354 | 0 | 45 | | | | |
| 2019 | 472 | 563 | 67 | 157 | 315 | 394 | 0 | 79 | | | | |
| 2020 | 488 | 626 | 72 | 210 | 323 | 438 | 0 | 115 | | | | |
| 2021 | 510 | 697 | 78 | 264 | 332 | 487 | 0 | 155 | | | | |
| 2022 | 510 | 697 | 78 | 264 | 332 | 487 | 0 | 155 | | | | |
| EIRR | | | | 0% | | | | -6% | | | | |
| NPV | | | | -652 | | | | -603 | | | | |

### 5.5.3 Socio-economic Considerations

Although the EIRRs were very low (around 0%) in some systems, there are many qualitative benefits. The general descriptions of the identified benefits are explained below:

- The present water quality tests show that the water taken from the wells explored by the study team and that will be used for the piped systems is very clean (low level of coliform). Many of the piped systems will be equipped with treatment plant for iron and manganese removal, and reduce the inconvenience related to washing.
- The study area has been affected by high incidences of water borne diseases, i.e. typhoid, cholera, dysentery, trachoma, and diarrhea. These diseases are considered to be originated from unsafe water containing a lot of contamination. Actually, the water quality analysis of the existing water sources (especially, shallow dug wells and springs/rivers) in the study area indicates that the water is overall contaminated by human and animal wastes.
- Usually, a household with these diseases annually spends about VND 250,000 for the treatment, except when the patient is very poor. Households therefore can reduce costs for medical care by using safe and clean water provided by the piped schemes. For poor people, the subsidy is provided to cover medical care costs for free.
- According to the social survey, more than 40% of the respondents take water from nearby springs in K1 and K3, and 30% in D2 and 20% in D5. In these communities, women and children usually fetch water from springs or the points to take water. The proposed piped systems will reduce the opportunity costs for women to work and for children to study.
- The board of water supply unit is recommended to include women for the management. This will increase the opportunity for women to take part in the management of water supply systems, and improve the gender situation.
- The water supply systems will also improve the information management through IEC activities. The promoters will be involved in various IEC activities in cooperation with the health workers in the communes/towns.

**Table 5.6 Construction Cost Per Capita**

| Serial No. | System No. | Pop. | Construction Cost (Thou. US$) | Base Cost (Thou. US$) | Project Cost | | Project cost per capita | |
|---|---|---|---|---|---|---|---|---|
| | | | | | (Thou. US$) | Rank from the smallest | (US$) | Rank from the smallest |
| | **Kon Tum** | | | | | | | |
| 1* | K1-1 | 3,087 | 876 | 1,007 | 1,108 | 20 | **359** | **21** |
| 2 | K2-1 | 638 | 156 | 180 | 198 | 1 | **310** | **20** |
| 3 | K2-3 | 1,925 | 444 | 510 | 561 | 12 | **292** | **19** |
| 4 | K3-1 | 2,306 | 205 | 236 | 260 | 2 | **113** | **7** |
| 5 | K4-1 | 2,474 | 459 | 528 | 581 | 11 | **235** | **18** |
| | **Gia Lai** | | | | | | | |
| 6 | G1 | 5,567 | 608 | 699 | 769 | 18 | **138** | **14** |
| 7 | G2 | 11,084 | 1,065 | 1,225 | 1,347 | 21 | **122** | **12** |
| 8 | G3-1 | 6,377 | 594 | 683 | 751 | 17 | **118** | **11** |
| 9 | G4-1 | 4,292 | 346 | 397 | 437 | 9 | **102** | **9** |
| 10 | G5-1 | 3,288 | 341 | 392 | 431 | 8 | **131** | **13** |
| 11 | G6-1 | 3,843 | 213 | 245 | 269 | 3 | **70** | **2** |
| 12 | G7-1 | 1,507 | 227 | 261 | 287 | 4 | **191** | **17** |
| | **Dac Lac** | | | | | | | |
| 13 | D1 | 10,795 | 641 | 737 | 810 | 15 | **75** | **3** |
| 14 | D2 | 14,853 | 927 | 1,066 | 1,172 | 19 | **79** | **4** |
| 15 | D3-1 | 6,619 | 337 | 388 | 426 | 7 | **64** | **1** |
| 16 | D3-2 | 3,453 | 322 | 370 | 407 | 6 | **118** | **10** |
| 17 | D4-1 | 6,901 | 544 | 626 | 689 | 13 | **100** | **8** |
| 18 | D4-2 | 1,805 | 246 | 283 | 311 | 5 | **172** | **16** |
| 19 | D5-1 | 4,992 | 567 | 652 | 717 | 14 | **144** | **15** |
| 20 | D6 | 8,626 | 575 | 661 | 727 | 16 | **84** | **6** |
| 21 | D7 | 5,735 | 358 | 412 | 453 | 10 | **79** | **4** |

*The shaded systems are not so cost-effective, compared with the other systems.

In conclusion, if the benefits stated above are more than the per capita construction cost calculated below, the implementation of the proposed water supply systems will be verified.

The lifetime of systems is estimated as long as 20 years. Therefore, for example, if the total construction cost per capita is $150 the estimated annual cost per capita would be US$ 7. This amount of money is compared with the expected benefits as shown in Figure 5.1. Figure 5.1 shows that the annual medical expense and water cost per capita is around US$14 in the most of cases. Therefore implementation of some of the water supply facilities will be verified.

However, the systems in K1-1, K2-1, K2-3, K4-1, G7-1, D4-2, and D5-1 will not become cost-effective, compared with the other systems.

Although the construction costs per capita of the systems in D3-2, and D7 are relatively low, these systems should be evaluated with regard to O&M and management potential. The systems of D3-2 and D7 have difficulty in financial affordability, management of the existing facilities (or lack of reliability).

On the other hand, the construction costs per capita of the systems in K4-1, G1, and G5-1 are relatively high, but should be considered with regard to equity. Many poor and ethnic minority people live in these communes.

## 5.6 Conclusion

In conclusion, the study suggests that out of the 21 priority systems the 14 systems in K2-3, K3-1, K4-1, G1, G2, G3, G4-1, G5, G6, D1, D2, D3-1, D4-1 and D6 be implemented by 2005, and the other 8 systems in K1-1, K2-1, K2-3, G7-1, D3-2, D4-2, D5-1, and D7 be implemented by the end of phase 1 as shown in Table 6.1.

The issues related to O&M are very crucial for the implementation. The systems in K1-1, K2-1, K2-3, D3-2, D4-2, D5-1, and D7 need capacity building before implementation as explained in the evaluation of O&M. The water quality of G7-1 has a problem.

The systems in K4-1 and D4-1 need more time for IEC activities to increase house connections and financial sustainability. The total cost for the priority projects at phase 1 is approximately US$ 9.9 millions as shown below. This cost ignores the cost for necessary equipment to be procured in future. For these systems, alternative power supply such as generator and solar power systems will be considered in the Draft Final Report to reduce the O&M cost.

**Table 5.7 Cost for the 13-System for the Implementation in 2003-2005**

(1,000 US$)

| Commune / no. of villages | | Option at phase 1 | Direct Cost | Base Cost | Construction Cost |
|---|---|---|---|---|---|
| **Kon Tum** | | | **1,107** | **1,275** | **1,402** |
| 1 | K2-3 | 1 | 443 | 510 | 561 |
| 2 | K3-1 | 1 | 205 | 237 | 260 |
| 3 | K4-1 | 1 | 459 | 528 | 581 |
| **Gia Lai** | | | **3,165** | **3,640** | **4,004** |
| 4 | G1 | 1 | 608 | 699 | 769 |
| 5 | G2 | 1 | 1,065 | 1,225 | 1,347 |
| 6 | G3-1 | 1 | 594 | 683 | 751 |
| 7 | G4-1 | 1 | 346 | 397 | 437 |
| 8 | G5-1 | 1 | 341 | 392 | 431 |
| 9 | G6-1 | 1 | 213 | 245 | 269 |
| **Dac Lac** | | | **3,023** | **3,477** | **3,824** |
| 10 | D1 | 1 | 640 | 737 | 810 |
| 11 | D2 | 1 | 927 | 1,065 | 1,172 |
| 12 | D3-1 | 1 | 337 | 388 | 426 |
| 13 | D4-1 | 1 | 544 | 626 | 689 |
| 14 | D6 | 1 | 575 | 661 | 727 |
| **Total** | | | **7,295** | **8,392** | **9,000** |
| **VAT (10 %)** | | | | | **900** |
| **Grand Total** | | | | | **9,900** |

Note: The marked commune of K3-1, K4-1 and D4-1 are facing in-sustainable finance condition.

# Chapter 6 Approach to Information, Education and Communication (IEC)

## 6.1 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.

## 6.2 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 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.

### 6.2.1 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.

## 6.3 IEC Campaigns

Promoters appointed by WSU will implement 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.

### 6.3.1 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 **<u>town meeting of the people’s committee is the most common and easiest to organise</u>**. 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.

### 6.3.2 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.

### 6.3.3 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.

## 6.4 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 6.1 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 6.2 Necessary Activities for Target Communes

| Weaknesses | Strengths | Necessary Activities |
|---|---|---|
| **K-1, Bo Y commune, Ngoc Hoi district** | | |
| ▪ Living standard is very low.<br>▪ About 20% suffer from typhoid.<br>▪ 1/4 believes that springs are cleaner than groundwater, and about 43% drink surface water.<br>▪ The quantity of water is insufficient in the dry season (60%).<br>▪ 2/3 do not use a latrine, and 20% rarely collect garbage. | ▪ The influence of CPC and village chiefs is strong.<br>▪ 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.<br>▪ CHC has to hold village meetings with the help of village chiefs for minority communities.<br>▪ 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.<br>▪ More than 40% suffer from typhoid.<br>▪ WU is not active at all.<br>▪ The quantity of water is insufficient in the both seasons (83%, 47%).<br>▪ More than 80% do not use a latrine, and 27% rarely collect garbage.<br>▪ 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.<br>▪ About 36% suffer from typhoid, and 18% suffer from cholera.<br>▪ The quantity of water is insufficient in the dry season (54%).<br>▪ Only 7% use a latrine, and about 18% rarely collect garbage.<br>▪ Latrines are located close to dug wells. | ▪ IEC activities have been carried out through the pilot model project.<br>▪ The influence of CPC and village chiefs is strong.<br>▪ 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.<br>▪ 1/3 still believes that surface water is cleaner than groundwater.<br>▪ The quantity of water is insufficient in the dry season (31%).<br>▪ Only 10% use a latrine, and about 1/3 rarely collect garbage.<br>▪ Hand washing is not well practiced. | ▪ The influence of CPC and village chiefs is strong.<br>▪ 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.<br>▪ The quantity of water is insufficient in the dry season (63%).<br>▪ Only 15% use a latrine for defecation. | ▪ The influence of CPC is very strong.<br>▪ The commune is Kinh-dominated. | ▪ Deep groundwater development, and improvement of dug wells are urgent.<br>▪ 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.<br>▪ The quantity of water is insufficient in the dry season (53%).<br>▪ Only 20% use a latrine for defecation. | ▪ Health workers are influential in the Ba Na communities.<br>▪ The Ba Na people live together with the Kinh people in the same villages. | |

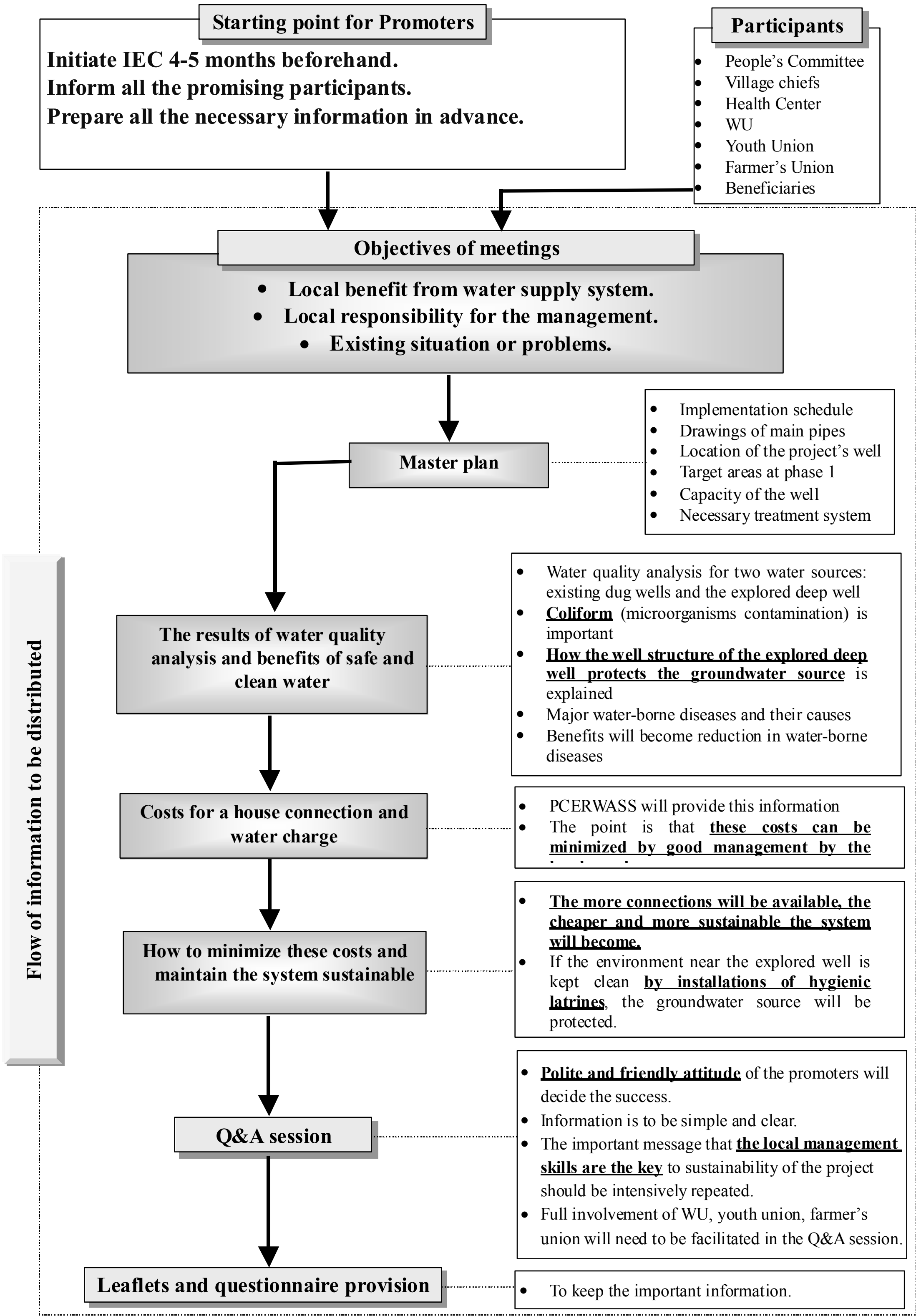



**Figure 6.1 Information Flow at Town Meeting for Well-off Communities**