

BASIC DESIGN STUDY REPORT
ON
THE GROUNDWATER DEVELOPMENT PROJECT
IN CHAMPASAK AND SARAVAN PROVINCES
IN
LAO PEOPLE'S DEMOCRATIC REPUBLIC

July 1997

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KOKUSAI KOGYO CO.,LTD.

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PREFACE

In response to a request from the Government of Lao People's Democratic Republic, the Government of Japan decided to conduct a basic design study on the Ground Water Development Project in Champasak and Saravan Provinces and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Lao PDR a study team from February 24 to March 16, 1997.

The team held discussions with the officials concerned of the Government of Lao PDR and conducted a field study at the study area. After the team returned to Japan, further studies were made and the present report was finalised.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Lao People's Democratic Republic for their close cooperation extended to the teams.

July 1997



Kimio Fujita

President

Japan International Cooperation Agency

July 1997

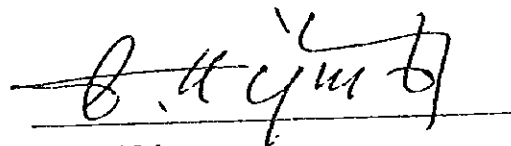
Letter of Transmittal

We are pleased to submit to you the basic design study report on the Ground Water Development Project in Champasak and Saravan Provinces in Lao People's Democratic Republic.

This study was conducted by Kokusai Kogyo Co., Ltd., under a contract to JICA, during the period from February 12, 1997 to July 28, 1997. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Lao PDR and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

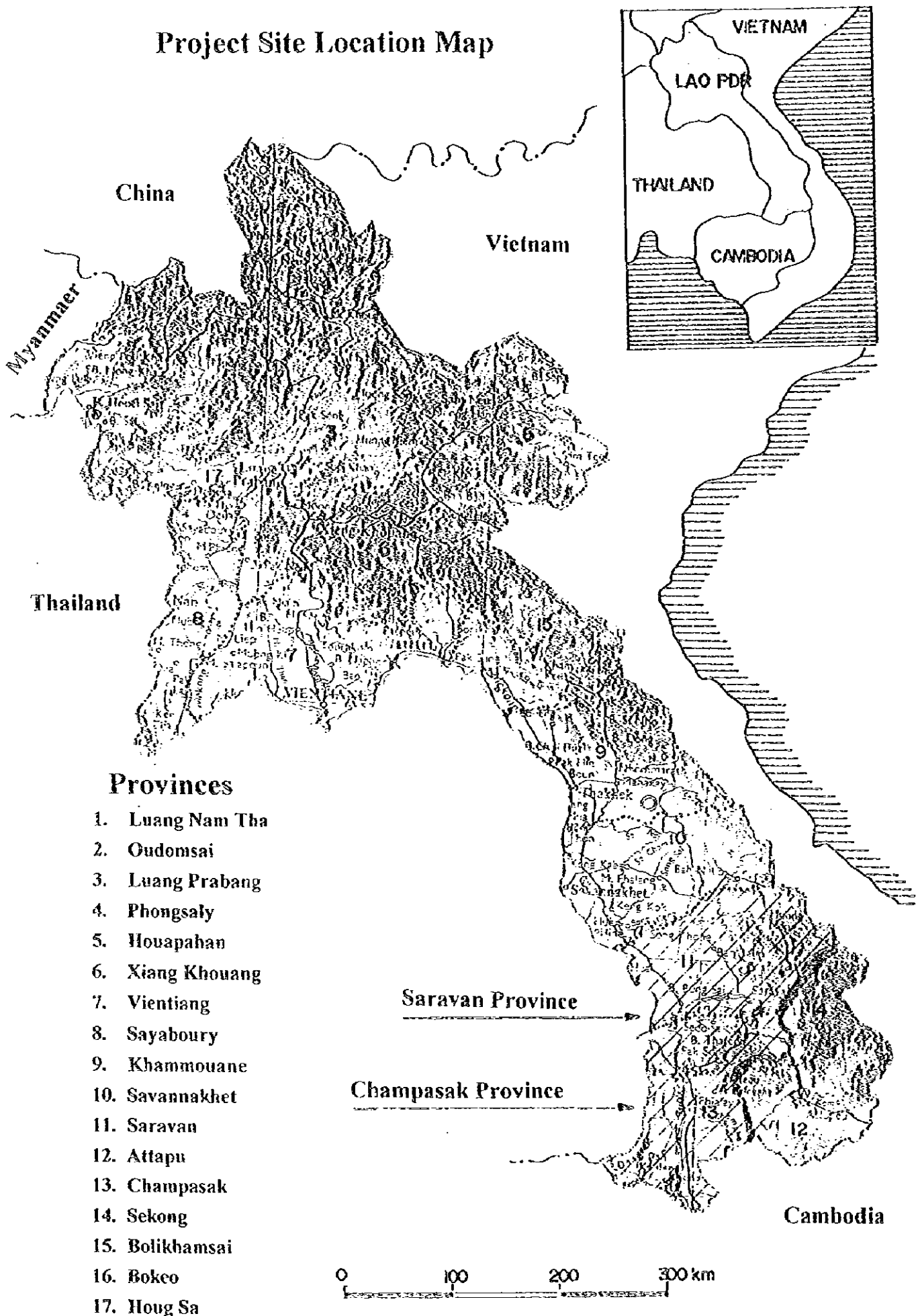
Finally, we hope that this report will contribute to further promote the project.

Very truly yours,

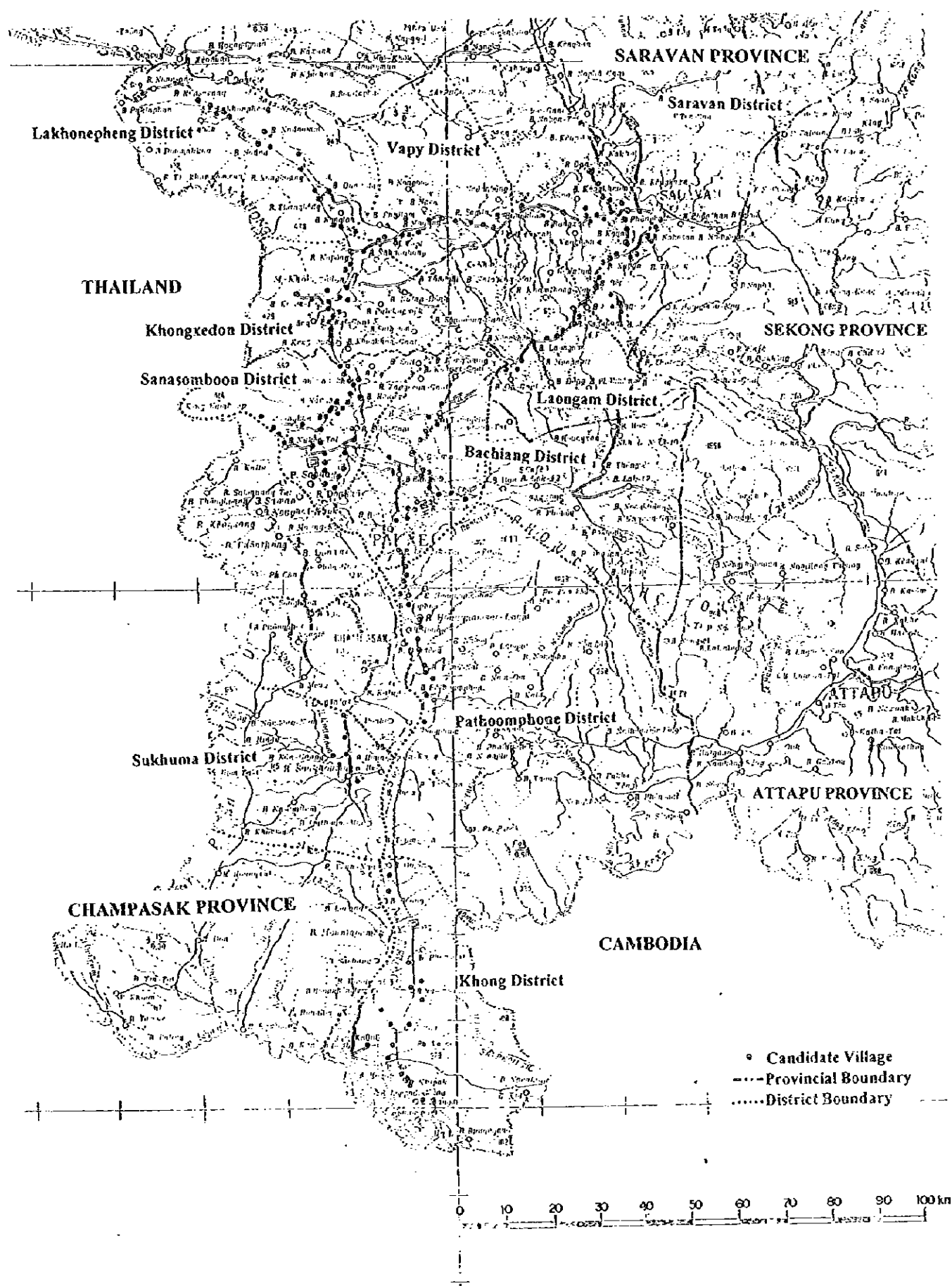
A handwritten signature in black ink, appearing to read 'K. Nakamura', is written over a horizontal line.

Kinya Nakamura
Project Manager,
Basic design study team on the
Ground Water Development Project
in Champasak and Saravan Provinces
Kokusai Kogyo Co., Ltd.

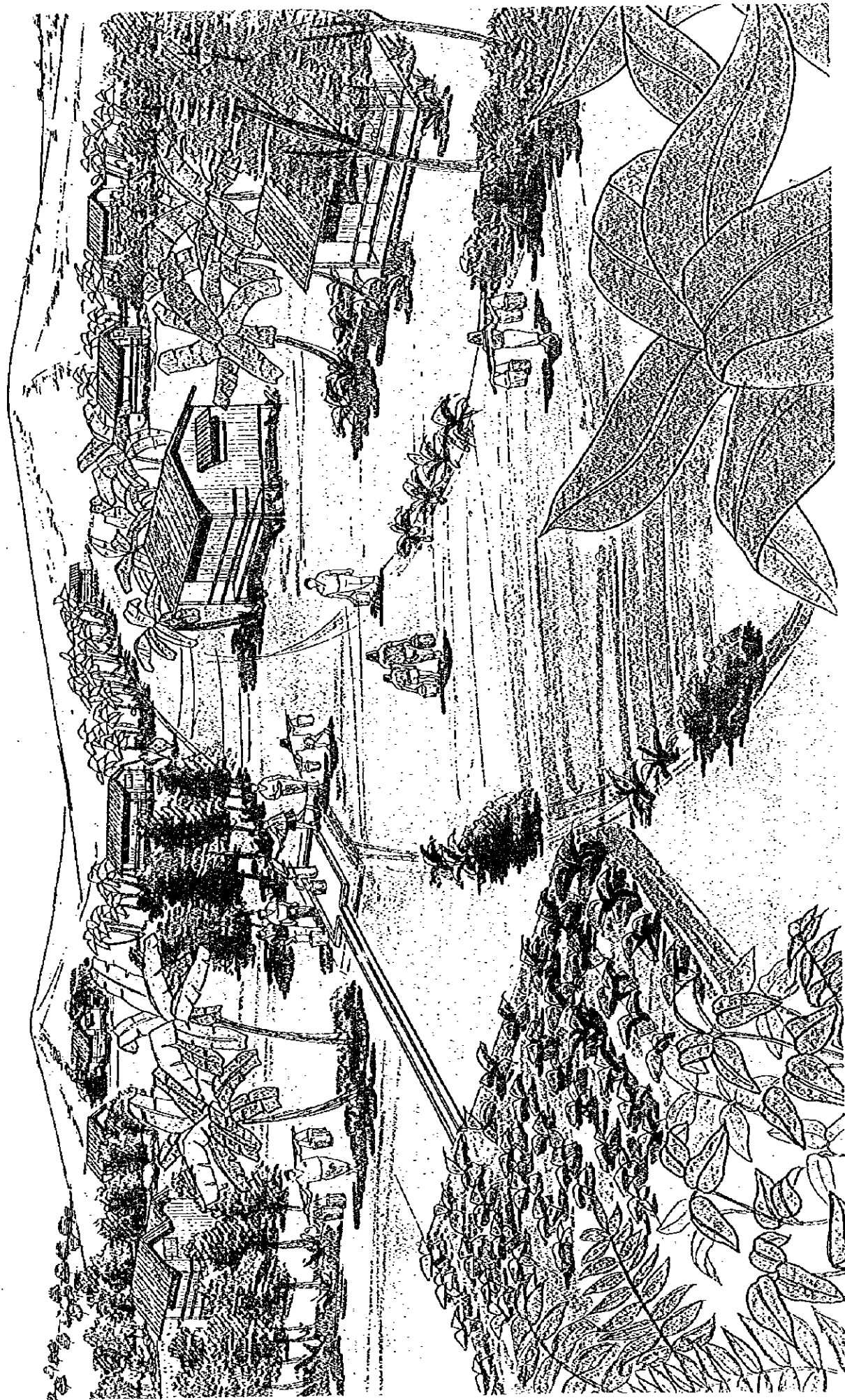
Project Site Location Map



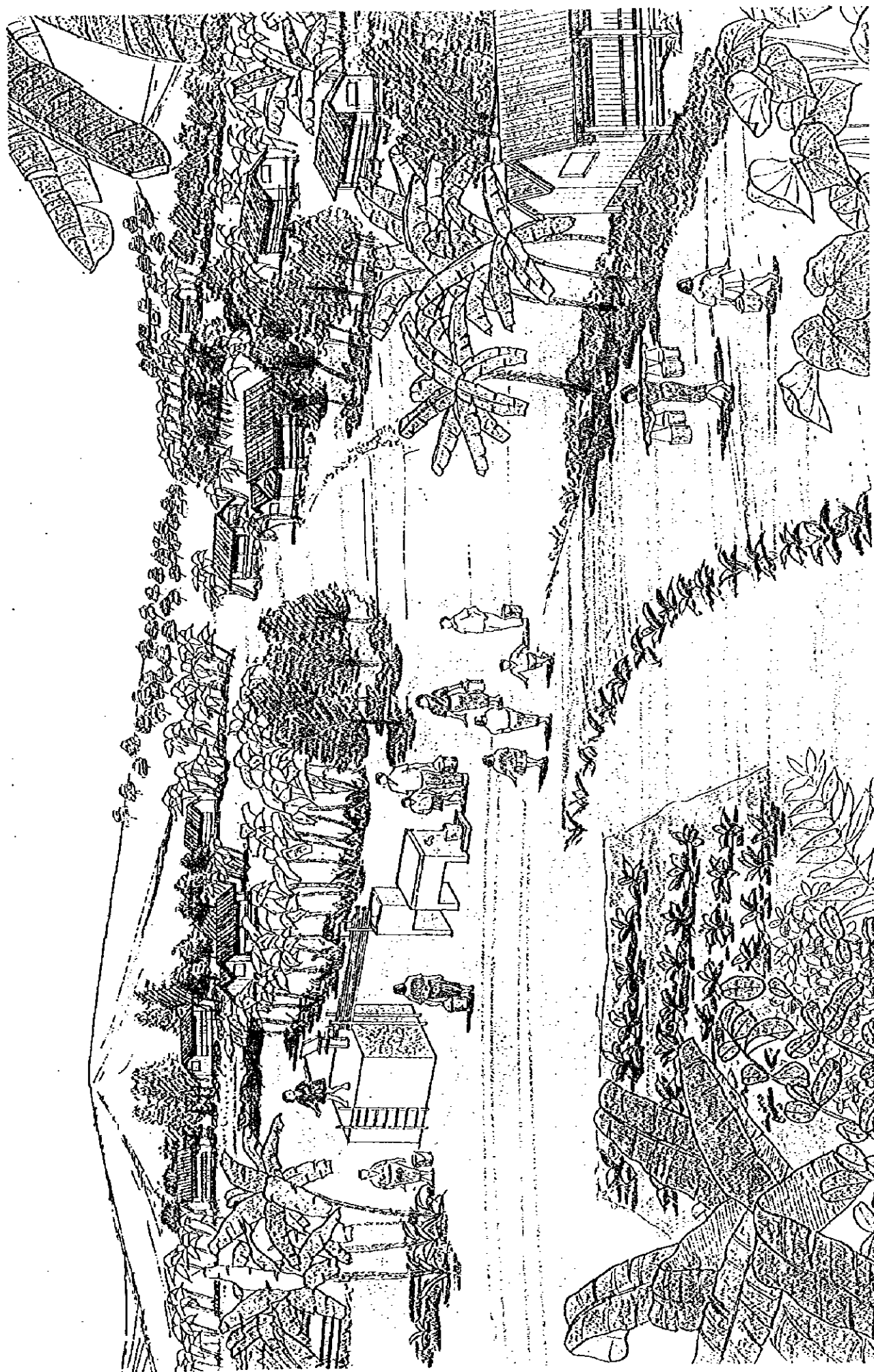
Location of Candidate 200 Villages



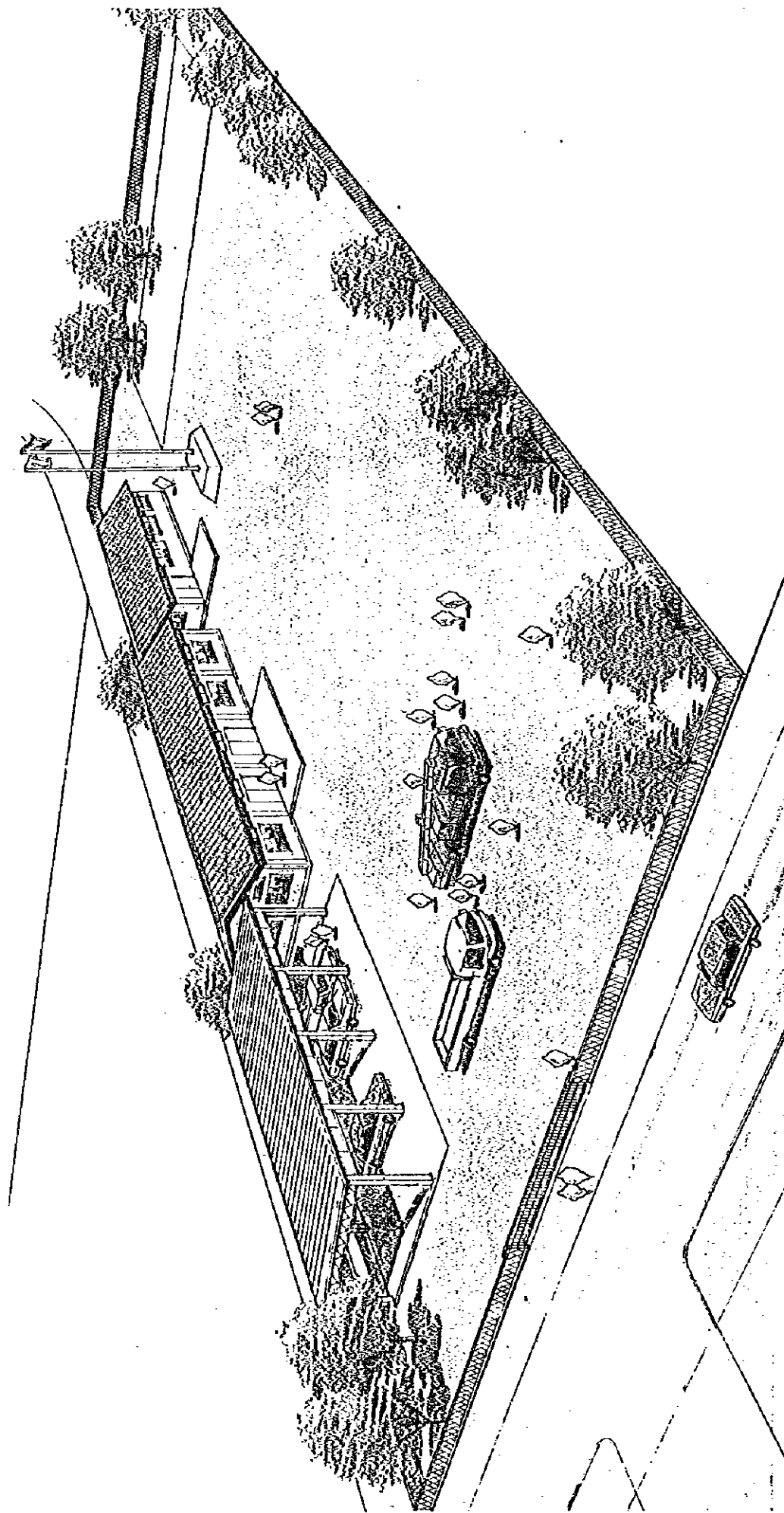
Artistic Impression of the Hand Pump Well



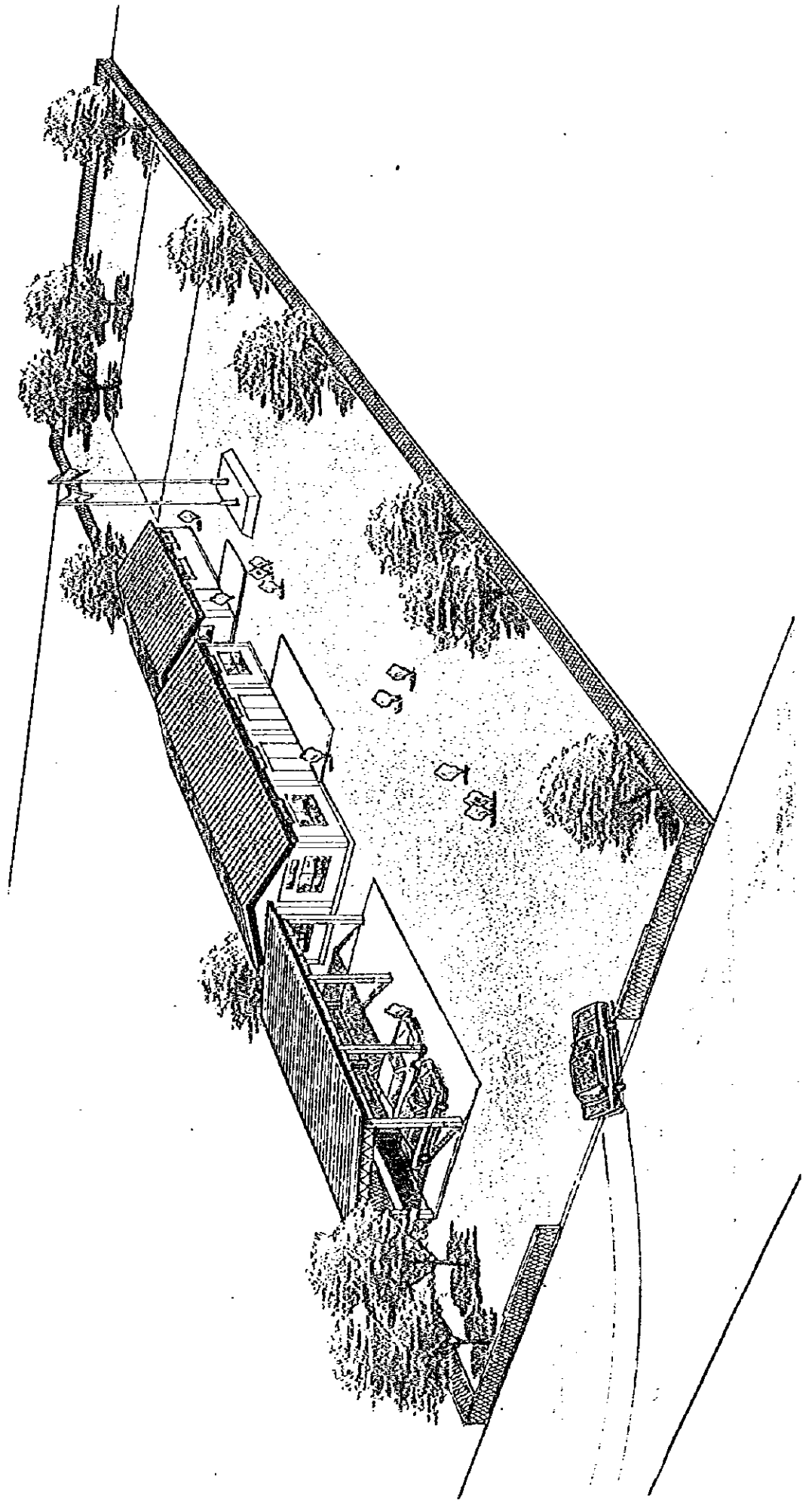
Artistic Impression of the Hand Pump Well with Aeration System



Artistic Impression of the Operation and Maintenance Center (Champasak Province)



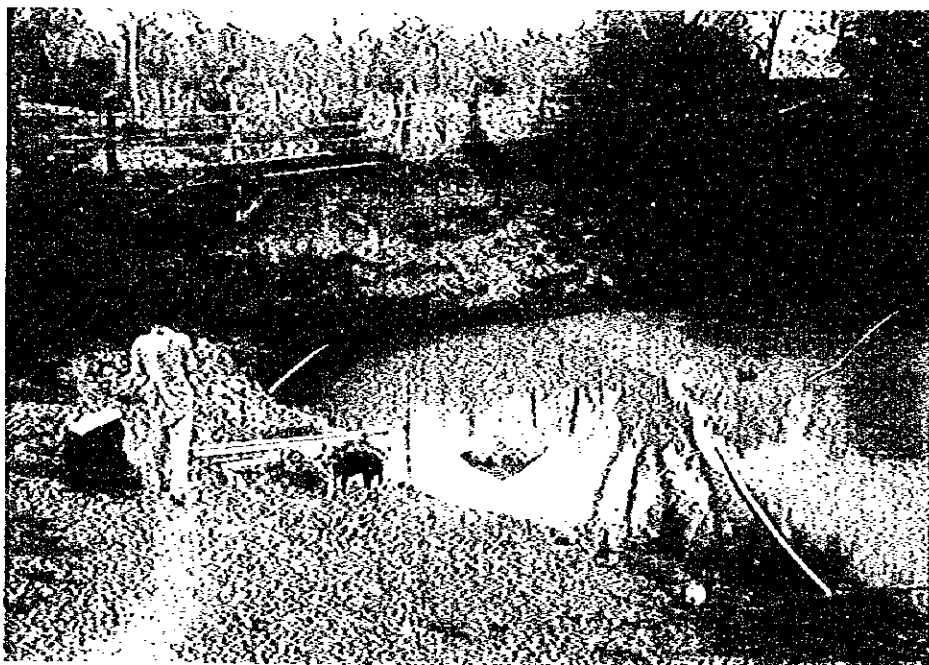
Artistic Impression of the Operation and Maintenance Center (Saravan Province)



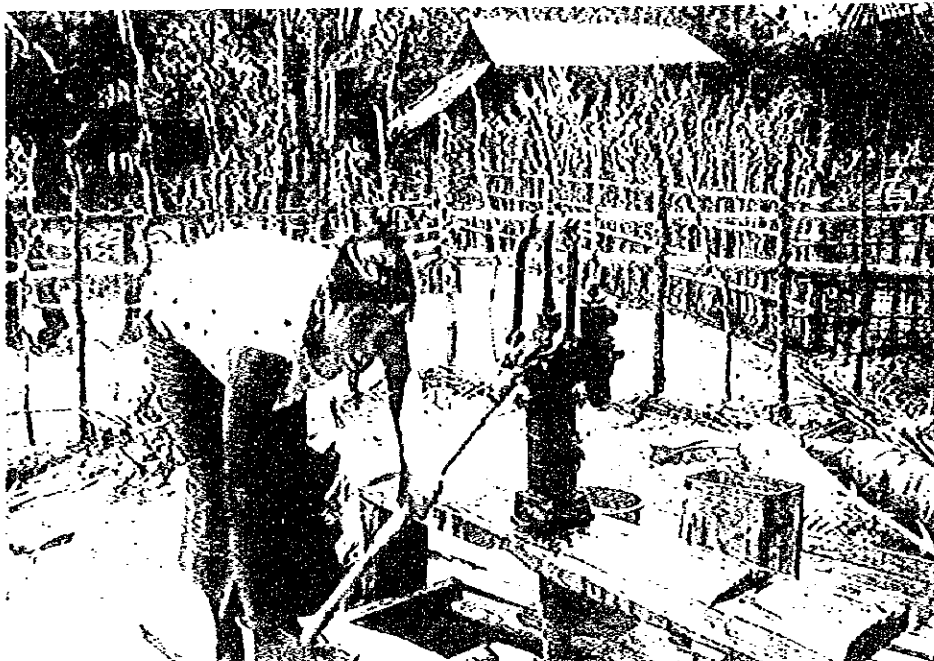
Photos



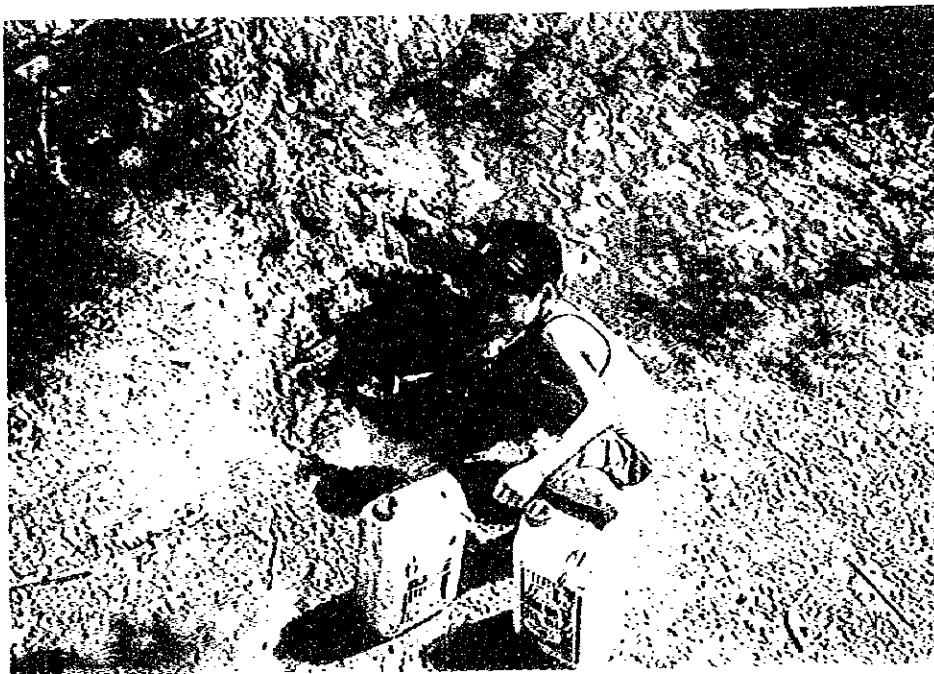
- ① The village roads become quite impassable during in the rainy season. C-1, Nakham Village, Sanasomboon District in Champasak Province



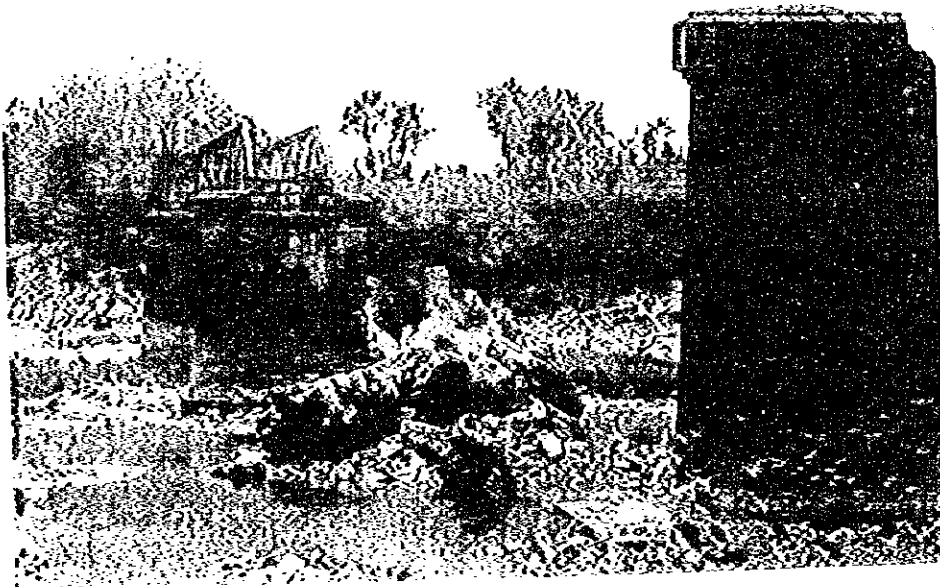
- ② Domestic water is obtained from ponds and is used for laundry, bathing, and cooking. C-63, Lak 20 Village, Pathoomphone District in Champasak Province



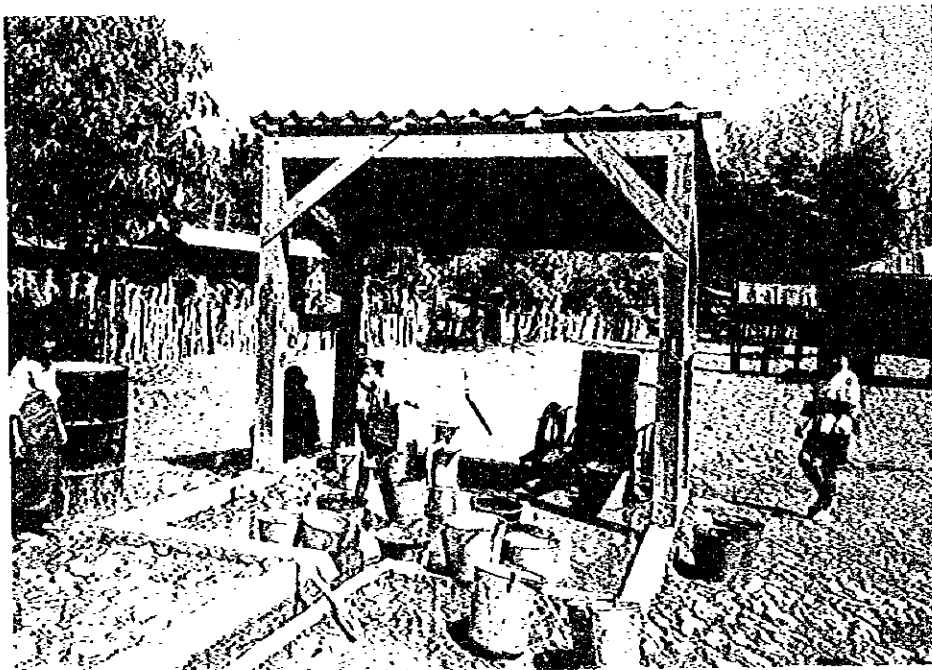
③ Existing Lucky type hand pump well in C-82, Thapcham Village, Sukuma District, in Champasak Province.



④ The gushing water is obtained from the riverbed. C-99, Settaolek Village, Khong District in Champasak Province



- ⑤ The bridge was destroyed during the Vietnam War and the Sedon river can run in the riverbed only during the dry season. Way to S-72,73 Nonoon- Tai Village, Saravan District in Saravan Province



- ⑥ The Test Well being used. S-64 Phonphai Village, Saravan District in Saravan Province



⑦ Girls carrying drinking water in C-50 Phin Village, Bachiang District in Champasak Province



⑧ Signing of the Minute of Discussion in Vientiane, March 5th, 1997.

Abbreviations

ADB : Asian Development Bank

CWI : Clean Water Institute

GDP : Gross Domestic Product

JICA : Japan International Cooperation Agency

MOH : Ministry of Health

MCTPC : Ministry of Communication, Transport, Post and Construction

MAF : Ministry of Agriculture and Forestry

NIHE : National Institute of Hygiene and Epidemiology

PHD : Provincial Health Department

UNDP : United Nations Development Programme

UNICEF : United Nations Children's Fund

WHO : World Health Organization

WSES : Water Supply and Environmental Sanitation

lpcd : liter per capita per day

EOM Center : Enlightening , Operation and Maintenance Center

SUMMARY

Lao People's Democratic Republic (hereinafter referred to as Lao PDR) is an agricultural country of 4.64 million inhabitants. It is located in the Indochina Peninsula and extends along the left bank of the Mekong River, covering approximately 236,800km².

In 1986, Lao PDR abolished the Soviet socialist regime and adopted the free market economic system. Since then its GNP rose an average 6~7% per year (1986-1993), 50% of which was contributed by the agriculture and forestry sector.

The 4th National Socio-economic Development Plan (1996~2000) places priority on the development of the provinces of Champasak and Savannakhet in the southern region, Vientiane in the central region, and Luangphrabang in the northern region, through the expansion of agricultural production and stabilization of rural standard of living. Champasak is one of the provinces covered by this Study.

In Lao PDR, only the main cities such as Vientiane, Savannakhet and Pakxe are equipped with a waterworks system, though the service rate is less than 50% in terms of population. People living in rural communities account for approximately 85% of the national population, and the majority rely on unsanitary water resources such as contaminated rivers, rainwater, ponds, springs and hand-dug wells, for their daily water needs.

The provinces of Champasak and Saravan, the objects of this Study, also rely on unsanitary water resources. The water supply services in these provinces only cover 10-15% of the village population. Consequently, waterborne diseases, such as cholera, dengue fever and diarrhea, are rampant, and the infant mortality rate is extremely high at 14%.

To improve such rural conditions, UNICEF provided the Ministry of Health, the Clean Water Institute and the provincial Health Departments with well construction materials and equipment including drilling rigs, and extended assistance in the installation of water supply infrastructures nationwide from 1986. Various NGOs also started extending assistance from 1990. However, the construction of the facilities, let alone their operation and maintenance, did not go well as planned due to the executing agencies' problems in financing, shortage of staff and lack of know-how and experience.

Considering this situation, the Government of Lao PDR made a request to the Government of Japan for the conduct of a groundwater development study in both provinces. In response, the Japanese government executed the study from 1993 to 1995 in view of the conduct of a development project targeting the year 2005 for 200 villages in both provinces. The results of the study confirmed the necessity of constructing 486 wells. Accordingly, the Government of Lao PDR requested grant aid assistance in 1996 to the Government of Japan for the construction of 486 deep wells and 2 operation and maintenance centers.

In response to this request, the Government of Japan, after due consideration of the soundness and scale of the grant aid program, decided to conduct the basic design study in the villages that are in dire need of wells. Consequently, the Japan International Cooperation Agency (JICA) dispatched the study team to Lao PDR from February 24 to March 16, 1997 to conduct the basic design study based on the results of the

development study.

As previously mentioned, the construction of 486 wells by 2005 was requested. However, only the construction of 305 wells as of 1997 has been deemed urgent. For well casings, PVC (polyvinyl chloride) materials will be used instead of FRP (fiber reinforced PVC) for economic reasons and in view of local availability. Also, in consideration of the number of staff of the executing agencies and the equipment and materials to be stored, the floor area of the 2 operation and maintenance centers was changed from 1,836 to 890m² in total.

As for equipment and materials, 1 set of drilling rig, supporting vehicles and other related equipment will be provided to enable Lao PDR to continue constructing wells even after this project is completed. These equipment will be used to drill 60 wells and for the transfer of drilling techniques. Also a total of 10 motorcycles, one per district, will be provided so that the executing agencies (every District Water Supply Division) can patrol each village and provide continuous assistance in well operation and maintenance after the completion of this project.

This project will be implemented in two phases. The first phase shall entail the procurement of necessary equipment and materials, the construction of 105 wells in 63 villages and an operation and maintenance center of Saravan. In the second phase, 200 wells will be constructed in 126 villages and an operation and maintenance center in Champasak. The details of the basic design are indicated in page VI.

The agency mainly responsible for the implementation of this project is the Clean Water Institute of the Ministry of Health. The Clean Water Institute plans regional water supply undertakings, accordingly guides the provincial health Departments and promotes the rural water supply services. It is also in charge of coordinating support agencies.

The executing agencies of this project are the provincial Health Departments and District Water Supply Divisions. These agencies are currently conducting rural water supply programs by constructing wells using their own equipment. However, the obsolete condition of the equipment and shortage of technicians hinder any development in their works.

Moreover, because of staff and budget shortage, post-construction operation and maintenance services were hardly carried out, and many broken down water supply facilities were left unrepaired.

Consequently, this project will entail the establishment of water users' associations at every beneficiary village and the enforcement of operation and maintenance as the duty of the beneficiaries. In line with the well construction works, the project shall also conduct educational activities concerning the forming of a water user's association, well operation and maintenance techniques and fee collection method. These educational activities are supposed to be conducted by the provincial Health Departments, but in view of their lack of know-how and experience, a Japanese Consultant will be assigned for supervision and assistance.

The main responsibilities of the Government of Lao PDR includes a number of undertakings, such as the provision of access roads, acquisition of land for the

construction of operation and maintenance centers, construction of fences and the provision of electricity, which are roughly estimated to cost 2 million yen (0.7 million yen for phase 1 and 1.3 million yen for phase 2).

The implementation period of the project is estimated as follows:

Phase 1:

14 months: for the implementation design, equipment and materials procurement, construction works (105 wells and an O&M center)

Phase 2:

24 months: construction works (200 wells and an O&M center)

This project intends to equip 189 of the villages in the southern Lao provinces of Champasak and Saravan with water supply facilities by constructing deep wells. If implemented, the project would provide 56,000 inhabitants in the province of Champasak and 48,000 inhabitants in the province of Saravan access to sanitary water, and consequently improve the water supply rate from 11% to 21% in Champasak Province, and from 14% to 31% in Saravan Province. At the same time, it will reduce the prevalence of water borne diseases, improve sanitary conditions, and shorten the time spent by females in the village on water fetching chores.

Also, the procurement of drilling rigs a lot more efficient than what the Government of Lao PDR currently owns is expected to improve the well construction capacity of the executing agencies, leading to the construction of more wells in villages without access to safe water resources, and an increase in the number of villages able to secure clean water.

Executing agencies will be trained in proper well operation and maintenance techniques during the conduct of the project. Concurrently, the conduct of operation and maintenance educational activities for the villagers through the establishment of water users' associations will not only heighten O&M consciousness but also allow the sustainable use of water supply facilities.

However, the current inadequacies of these agencies in terms of technology, budget and personnel will impede the independent conduct of well construction and operation/maintenance activities after the completion of this project. Also the extremely low awareness of the villagers concerning the significance of operation and maintenance necessitates the adoption of the following countermeasures to ensure that the results obtained through the implementation of this project can be sustained:

- (1) The relevant agencies, such as the Clean Water Institute and the provincial Health Departments, will have to rapidly formulate a well construction plan and ensure the construction of new wells and maintenance of water supply facilities after this project's completion, by adopting budgetary measures and organizing a well construction system within the Health Departments.
- (2) To ensure the sustainable use of the constructed wells, the Lao PDR will have to independently implement operation and maintenance activities and design an operation and maintenance system. The adoption of budgetary measures and

posting of some personnel are required to rapidly establish the system and implement its activities.

- (3) The water user's association to be formed through the project will be the responsibility of the beneficiaries, hence educational programs for the adequate operation and maintenance of water supply facilities will be executed. It is necessary, however, that provincial Health Departments continue conducting educational activities even after the completion of this project to have villagers fully understand the significance of operation and maintenance activities to sustain the independent O&M of the facilities.

Basic Design Outline

	Construction of Facilities	Procurement of Equipment & Materials
<i>Phase I</i>	<ul style="list-style-type: none"> ① Deep wells: 105 wells; average depth of 50m ② Operation & maintenance center in Saravan: 346m² 	<ul style="list-style-type: none"> ① Drilling rig: 1 set; 100m drilling capacity at a diameter of 6 5/8 inches ② Truck with crane: 1 unit; 4 ton maximum lifting load; maximum tonnage of 6 to 10 tons ③ Auxiliary materials: 1 set ④ Supporting vehicles: 1 unit (4WD, 3000cc engine displacement) ⑤ Motorcycles: 10 units (125-150 cc) ⑥ Hand pumps: 30 units of rustproof pump materials ⑦ Repair tools: 2 sets ⑧ Physical prospecting apparatus: 2 sets ⑨ Physical logging apparatus: 2 sets ⑩ Water quality test kits: 2 sets ⑪ Water tank: 1 unit (4m³, to be mounted on truck) ⑫ Fuel tank: 1 unit (3m³, to be mounted on truck) ⑬ Pumping test equipment: 1 set ⑭ Computers: 2 units
<i>Phase II</i>	<ul style="list-style-type: none"> 1. Deep wells: 200 wells, average depth of 50m 2. Operation & maintenance center in Champasak 	

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CHAPTER 1

BACKGROUND OF THE PROJECT

1890-1891

1892-1893

CHAPTER 1 BACKGROUND OF THE PROJECT

The Lao Peoples Democratic Republic (hereinafter referred to as Lao) is an inland country of hills and mountains extending on the left bank of the Mekong River that flows north-south of the Indochina Peninsula. The country has a total area of about 236,800km² and a population of 4.64 million.

To revive its sluggish economy, the Government of Lao hammered out policies that concern the shift to a free market economy and national economic activation during the fourth Communist Party Convention in November of 1986. The implementation of these policies incurred a GDP growth rate of 13.5% in 1989. The country continued to experience steady economic growth from that year on, and the per capita GDP by 1995 reached US\$350.

Only the main cities, such as Vientiane, Savannakhet and Pakxe, are equipped with a waterworks system which, however, only covers less than 50% of the population. Approximately 85% of the national population reside in rural areas. As only 10-15% of the national population is covered by the water supply system, which also uses shallow wells and pipes for distribution, the majority use rivers, springs, rainwater, ponds or dug wells as domestic water supply sources. Water collection in rural areas without a water supply system is a colossal chore for women and children, while the use of insanitary water resources causes the prevalence of water borne diseases.

As a countermeasure, Lao established the National Epidemiology Research Center under the Ministry of Health. With the assistance of UNICEF, UNDP-WB, and WHO, the Clean Water Institute formed within this center implemented rural water supply projects. The provincial Health Departments also started implementing rural water supply projects mainly through the construction of shallow hand pump wells from 1987, with UNICEF providing the necessary equipment and materials. However, the construction of the facilities, let alone their operation and maintenance, did not go well as planned due to problems in financing, shortage of staff, and lack of know-how and experience.

The water supply service ratio even in the provinces of Champasak and Saravan is low at 11-14%. One of the significant impediments to creating a stable rural life is the reliance of more than 80% of the villagers on insanitary resources such as contaminated rivers, springs and ponds, for their daily water needs, which incurs a high prevalence of water borne diseases, e.g. dysentery, cholera, especially in the dry season.

To overcome these unsanitary conditions, in 1992, the Government of Lao requested technical assistance from the Government of Japan for the conduct of a groundwater development study in the provinces of Champasak and Saravan. In reply, the Government of Japan conducted the development study for three years (1993-1995) in view of the conduct of a development project targeting 200 villages with a total population of 131,750 for the year 2005. The development study involved the drilling of 20 test wells at every zone in the study area of different hydrogeological make up, physical prospecting and hydrological surveys. Consequently, the immediate construction of water supply facilities (486 hand pump wells and 1 submersible motor pump well) and operation and maintenance centers, and the procurement of equipment and materials relevant to operation and maintenance by 2005 were recommended.

Under these conditions and based on the results of the groundwater development study, the Government of Lao in 1996 requested grant aid from the Government of Japan for the conduct of a groundwater development project in the 200 villages within Champasak and Saravan provinces, for the construction of rural water supply facilities.

CHAPTER 2

OUTLINE OF THE PROJECT

CHAPTER 2 OUTLINE OF THE PROJECT

2-1 Objectives of the Project

In support of the rural water supply installation program promoted by the Ministry of Health of the Government of Lao, this project will construct 305 deep wells in 189 villages in Champasak and Saravan provinces in the south, where rural water supply services only cover 11 to 14% of the population. Further, to strengthen the operation and maintenance system of the water supply facilities, an operation and maintenance center will be constructed in each province provided with equipment and materials relevant to well construction, repair, operation and maintenance, and for the conduct of educational activities.

2-2 Basic Concept of the Project

2-2-1 Justification of the Project

According to the development study results, groundwater reserves in the project area exist in Jurassic shale and sandstone layers in hills and plains, and in layers of basalt (lava) in the southwest slope of the Bolovens Plateau. Based on the analysis of the water balance of the Xedon River and its tributaries, 575m³/day/km² of groundwater is recharged into the Jurassic shale area and 1,370m³/day/km² into the basaltic area. The development of such groundwater would provide the project area with a sufficient supply of clean and safe domestic water.

The project area has a total population of about 800,000 (Champasak: 530,000; Saravan: 270,000) with a water supply service coverage of only 11% and 14%, respectively. If the project is implemented by the development of the above mentioned groundwater resource, it will provide about 56,000 inhabitants in Champasak and 48,000 inhabitants in Saravan with access to safe and stable drinking water supply, consequently improving the service coverage to 21% and 31%, respectively. In areas where water borne diseases are prevalent, the urgent implementation of the project is of great significance.

2-2-2 Basic Concept Behind Water Supply Facilities Installation

(1) Target Villages

In the development study, the accessibility of the villages to whom the project is requested for was classified into easy, difficult, very difficult, and impossible. Villages with impossible access conditions in terms of construction equipment mobilization will be excluded from the project. Of the villages with very difficult access conditions, those requiring the construction of temporary roads for the transport of large scale equipment will be excluded as well. Table 2.1 shows the potential number of villages for well construction based on site accessibility.

Table 2.1 Site Accessibility and Number of Villages

Accessibility	Details	Champasak Province	Saravan Province	Total
Easy	along national road	66	71	137
Difficult	passable in dry season	8	13	21
Very Difficult	requires an approach road	21	10	31
Impossible	requires a bridge	0	0	0
Total		95	94	189

(2) Number of Wells for Construction**a. Target Year**

The number of wells to be constructed was set in consideration of the urgent need for the wells, with 1997 as the target year.

b. Unit Supply Amount

The development study results state an actual water consumption volume ranging from 28 to 42 liters/capita/day, hence the unit water supply amount was set at 35 ℓ /c/d. However, a uniform unit water supply amount cannot be adopted considering that hand pump deep wells will be the supply sources. Moreover, as this project will be implemented through Japan's grant aid program in response to the urgent need for the facilities, the unit supply amount could range from 15 to 35 ℓ /c/d. Accordingly, the project adopts a unit water supply amount of 20 ℓ /c/d.

c. Transportation Distance

Table 2.2 shows the relationship between water consumption volume and the transportation distance established by the WHO. Using this table and the 1997 unit supply amount, the transportation distance was set within 250m.

Table 2.2 Relation Between Water Consumption & Transportation Distance

Transportation Distance	Water Consumption Volume
>1,000m	5 ~ 10 ℓ /c/d
500m ~ 1,000m	10 ~ 15 ℓ /c/d
250m ~ 500m	15 ~ 25 ℓ /c/d
<250m	20 ~ 40 ℓ /c/d
Communal taps within the villages	50 ℓ /c/d

d. Service Population

Hand pumps generally have a potential pumpage of 15 ℓ /min (5.4m³/day). Using this and the established unit supply amount, the service population is established at about 270 persons/well.

c. Number of Wells

The number of wells to be constructed will be determined based on the established service population of 270 persons/well. The number of existing wells in a village will be deducted from the number of wells to be constructed in that village. In villages where rivers and springs can be used to supply domestic water, the number of wells to be constructed will be determined in account of the volume of water obtainable from these resources.

Considering access conditions, the number of wells that can be constructed through this project is 305: 153 for Champasak Province and 152 for Saravan Province. Table 2.3 shows the estimates on village population, number of existing wells, village accessibility, and the well construction plan for 1997.

(3) Well Drilling Depth & Casing Pipe Selection

The results of the analysis of the columnar section and specific capacities of test wells showed that the aquifer is at a depth of 30-50 meters. The well drilling depth will average 50m therefore.

For well construction, the Government of Lao PDR requested a 5 inch FRP casing, but in view of economic viability and local availability, a PVC casing will be provided instead. For durability, the screen slots will either be vertical or diagonal with an opening ratio of more than 3%.

(4) Hand Pump Selection

Of the six types of hand pumps utilized in Lao, the Indian Mark III and/or the AFRIDEV (both made in India) are considered most suitable in terms of pumping head, price, durability, resistance to rust and friction, and ease in operation and maintenance. Whichever pump may be selected, it should consist of the following rustproof materials:

- Pump cylinder - brass or stainless steel
- Pump rod - stainless steel
- Riser pipe - PVC or stainless steel

(5) Water Quality Countermeasures

Some of the wells are anticipated to produce saline water and/or metallic tasting water due to iron and manganese concentrations. In accordance with the water quality guidelines of the WHO, the following countermeasures will be taken for wells producing water unsuitable for drinking:

a. Measures against metallic tasting water

Metallic tasting water or reddish water is mainly caused by:

- ① Rusting of well casing, riser pipes and rods
- ② Oxidation of ionized iron or manganese in groundwater upon contact with air

The countermeasure for the first above mentioned cause would be the use of rustproof materials, and the removal of ionized metal by aeration and filtering for the second. A gutter type aeration system will change ionized iron into solid oxidized iron (reddish turbidity), and a sand filtering system will remove turbidity. However, the aeration or filtering system will hardly remove manganese in the water.

To facilitate water intake, which usually takes 5 to 6 minutes with this system, a water reservoir affixed with a faucet will be attached to the filtering box.

b. Measures against salinity

Saline water was observed to exist in the old rock formation of the Jurassic period or of an older period located at a depth of more than 100m. Therefore, well drilling will not exceed a depth of 100m. The wells will be drilled to a depth between 30 to 80m, averaging 50m.

2-2-3 Basic Concept Behind the O&M Center Construction

To promote the Rural Water Supply Expansion Program, O&M centers will be constructed for well construction, monitoring and assessment of constructed facilities, collection and management of well records, preservation of sanitary conditions, and the management of equipment and facilities. The centers will have the following facilities:

a. Project Office

This building will be capable of accommodating a staff of 5 to 6 in Champasak and 3 to 4 in Saravan.

b. Warehouse

A warehouse will be constructed for the storage of materials such as casings, screens, steel pipes, riser pipes and pumps, and will include a small office for the management of stock.

c. Workshop

This will be used for the repair of hand pumps, cutting of riser pipes, making of screens and other facility accessories. Vehicles will be repaired in this room which will be wide enough to accommodate a welding table. The workshop will be affixed with a station for mechanics.

d. Garage

A garage will be built to house the vehicles.

2-2-4 O&M Center Services

To promote the rural water supply services, the provincial Health Departments will construct new wells, monitor newly constructed facilities, supervise the organization of water users' associations, extend guidance in operation and maintenance, and conduct health education activities. The main services the centers have to execute are shown in Table 2.4. The operation and maintenance services that have to be carried out with the cooperation of the health sections of the districts involved are as follows:

- ①. Regular monitoring and evaluation
- ②. Information and data collection and management
- ③. Village health management
- ④. Guidance in water supply facility repair, operation and maintenance

Table 2.4 O&M Center Administrative Services

Administrative Services	Details
a. Planning, construction and O&M of water supply facilities	<ul style="list-style-type: none"> • formulate new construction plans, direct management and planning of supporting projects. • repair, preserve and inspect existing facilities.
b. Management of responsibilities, personnel and activities	<ul style="list-style-type: none"> • manage personnel, unit and district activities, and understand and manage working conditions of women and children in the village. • formulate implementation plan (Action Plan) for operation and maintenance of existing and new facilities.
c. Monitoring and assessment	<ul style="list-style-type: none"> • monitor district and village conditions once a month.
d. Management of data and information	<ul style="list-style-type: none"> • keep a ledger on wells and pumps, and formulate a method of managing information on water quality, water volume, etc. • estimate consumption of materials and equipment rate of operation.
e. Management of health and sanitary conditions	<ul style="list-style-type: none"> • learn about prevailing epidemics, serious injuries and death situations; formulate and implement countermeasures. • conduct education programs on waste and sewage disposal, and health management.
f. Establish a relationship with relevant agencies and conduct information exchange	<ul style="list-style-type: none"> • conduct meetings and information exchange with high government agencies, cooperating agencies, districts and villages concerned. • hold seminars and workshops on facility maintenance and health management for the districts and villages concerned.
g. Prepare annual budget and financial plans	<ul style="list-style-type: none"> • record and analyze facility construction expenses and operation and maintenance expenses.
h. Training and other activities	
Technical & Management Services	
a. Inspections and selection of well drilling locations	<ul style="list-style-type: none"> • electric prospecting and geological studies
b. Operation and management of drilling rig	<ul style="list-style-type: none"> • training on the operation of equipment to be procured and actual operation of equipment
c. Installation of pumps	<ul style="list-style-type: none"> • training and actual conduct of work
d. Pumping tests and well development	<ul style="list-style-type: none"> • training and actual conduct of work
e. Installation of casing & screen	<ul style="list-style-type: none"> • training and actual conduct of work
f. Management of equipment and spare parts	<ul style="list-style-type: none"> • training and actual conduct of work
g. O&M of repair tools	<ul style="list-style-type: none"> • guidance in the preparation of a ledger for equipment management
h. O&M of vehicles	<ul style="list-style-type: none"> • understanding and practice in the use of repair tools • overall management of vehicles
i. Keep records of repair and rehabilitation	<ul style="list-style-type: none"> • record areas needing repair and the causes of breakdown
j. Keep records of water quality and water volume	<ul style="list-style-type: none"> • record changes in water quality and water volume
k. Others	

2-2-5 Educational Activities

(1) Water Supply Facility O&M System

From June of 1996, the Ministry of Health started to promote the National Water Supply and Environmental Health Programme (2002) with the assistance of international agencies such as UNICEF and UNDP-World Bank, through the provincial health departments. Through workshops and seminars, the Action Plan - aiming to improve and establish social and technical education programs by 2002 - was formulated. The social education programs are on financial, economic and organizational planning, systems operations, functions and responsibilities, development of skills, languages (English), public health improvement and public education. The technical education program mainly involves well drilling techniques.

At present, the Health Departments of Champasak and Saravan provinces are recipients of assistance on the above concerns. Although these departments fully promote rural water supply facilities and the operation and maintenance of existing facilities, they are incapable of carrying out monitoring, assessment, repair and other activities relevant to facility operation and maintenance mainly due to insufficient budget, staff, equipment and materials, poor communication and transportation conditions, on top of inefficient provincial water supply administration. Moreover, none of the existing water users' associations are operating efficiently due to inadequate supervision.

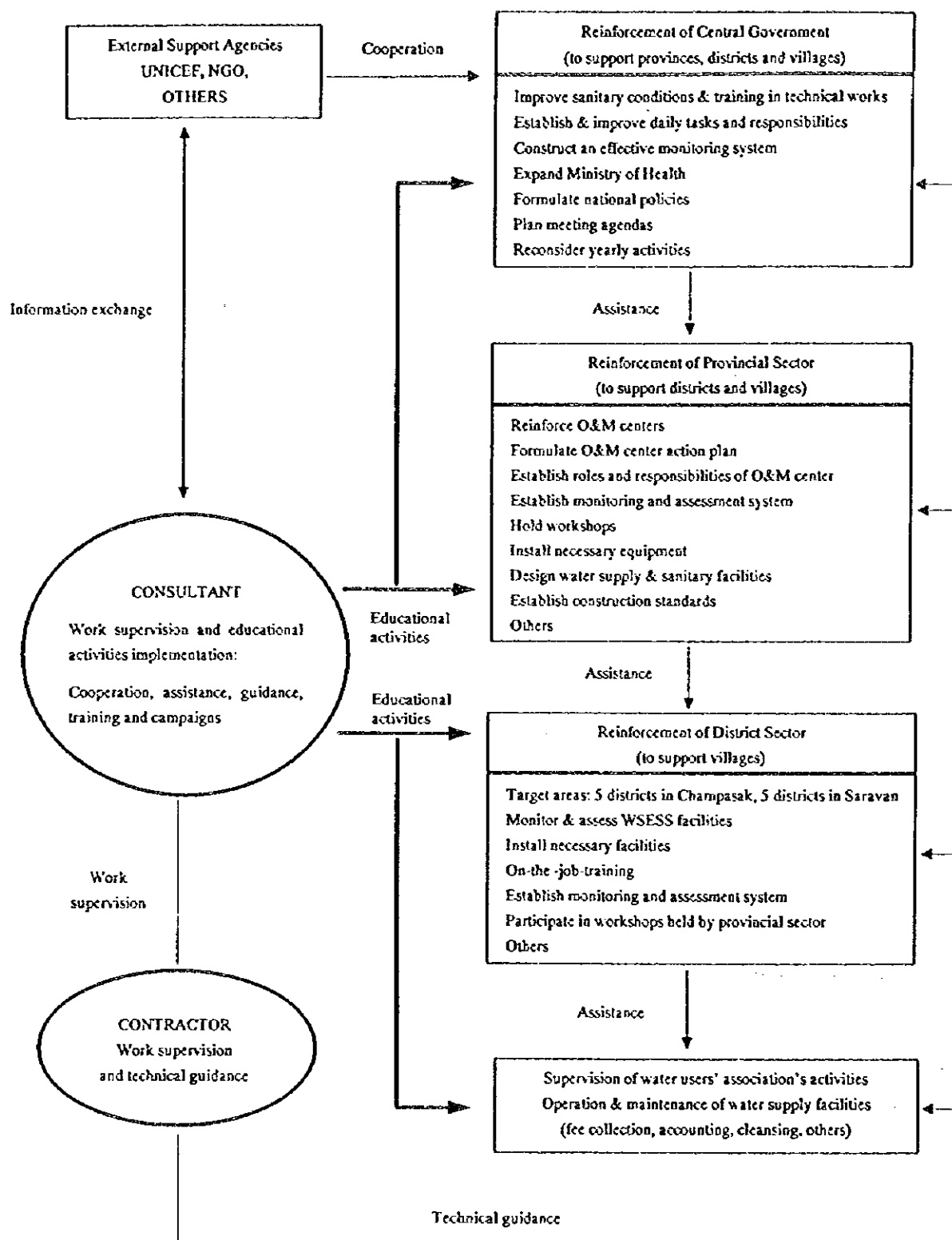
To fully improve these conditions, the responsibilities and roles of the provincial Health Departments and their respective sections should be clearly identified, the Action Plan of each province formulated, the system for the implementation of the plan reinforced, and a system capable of conducting a well organized educational program established.

(2) Concrete Educational Activities

In accordance with the Action Plan of both provinces, the O&M centers will be mainly responsible for the rural water supply services in these provinces, actively developing education programs for the villagers on sanitation and facility operation and maintenance. It will assist in organizing a water users's association in each of the 189 recipient villages, and through education programs equip the villagers with the skills that would enable them to independently manage the facilities. The education programs, which will be carried out by the executing agencies with the help of the beneficiaries, will be supervised by a local consultant under the tutelage of a Japanese consultant.

The local consultant must have basic knowledge of well drilling techniques and experience in the conduct of educational activities, as well as being fluent or can speak English to a degree that would not compromise his reporting of the progress of works to the Japanese counterpart. The responsibilities of the local consultant include holding meetings with village and district representatives and beneficiaries, conducting workshops and seminars, and producing educational materials, manuals, posters and pamphlets for the effective conduct of his activities (see Figure 2-2-5).

**Figure 2-2-5 Water Supply Facilities' Sustainable Operation & Maintenance System
(Development of Educational Activities for the Local Consultant)**



(3) Detailed Implementation of Educational Activities

① Planning & Preparation (Detailed Design Phase & Prior to Commencement)

- a. Explanation of the significance and contents of the project & understanding the importance of operation and maintenance

The significance and goals of this project to be implemented under the Japanese grant aid program will be explained to the executing agencies. Explanations will be carried out regarding the names of the recipient villages, number of wells to be constructed, details of the equipment and materials procurement plan, and the responsibilities of the Lao government. The importance of having to operate and maintain the facilities will also be explained in detail to the executing agencies.

- b. Study of actual village conditions pertaining to sanitation, water supply and environmental awareness prior to project implementation.

Using the results of the study on actual village conditions as a reference, the degree of awareness of villagers concerning the significance of health, water supply, operation & maintenance and environment will be assessed prior to commencement with the help of a local consultant.

- c. Organization of Water Users' Association

After fully understanding village conditions, activities to heighten villagers' awareness of the importance of operation and maintenance will be conducted and water users' associations will be formed. Association members will be selected (chairman, board of directors, accounting staff, health management staff, inspection and maintenance staff) and the policies will be fully explained. The villagers will be made fully aware of the importance of having operation and maintenance funds, by explaining the life span of hand pump wells and the daily well inspection, operation and maintenance methods.

- d. Health Education Programs

The factors affecting the generation of and countermeasures against water borne diseases will be fully explained to the villagers, and guidance in the implementation of basic health improvement measures will be extended. Females in the villages will be taught how to make use of the surplus time that would result from the reduction of time spent fetching water.

② Assistance of Executing Agencies for the Improvement of Water Supply Administrations

- a. Training & Workshop Programmes in line with the Action Plan

After the formulation of the action plan and the allocation of personnel, training and workshops will be held to improve administrative capabilities and technological skills.

- b. Cooperation in Formulation of O&M Center Action Plan

The duties and responsibilities of the O&M centers will be explained and the points requiring improvement fully discussed. Assistance will be extended to the

executing agencies, providing them with the system and skills for the independent conduct of their duties.

c. Technical Guidance for Executing Agency Personnel

Guidance will be extended in the conduct of hydrogeological and pumping analysis, electrical resistivity and drilling operations, to improve existing technical standards for groundwater development.

③ Full Scale Implementation of Educational Activities

a. Resident Participation in Well Construction, and Technical Guidance

Beneficiaries experienced in inspection, overhaul and machinery repair will be assembled and made to participate in the well construction works, to train them on the proper methods of hand pump installation and inspection. The consultant and staff of the O&M center will extend guidance to the villagers in hand pump operation and maintenance after the water supply facilities are constructed.

b. Guidance in Health Improvement

The villagers will be taught ways of improving health and sanitary conditions, which will also cover issues such as keeping the well vicinity clean, the prevalence and prevention of water borne diseases. Further, they will be informed of the economic benefits, e.g. reduced medical bills, improvements in health and sanitary conditions may incur.

2-2-6 Equipment & Materials Procurement Plan

(1) Procurement Plan

The procurement of the equipment and materials requested by the Lao government will be planned with due consideration of quantity, specifications, capacity, and ease in operation and maintenance.

a. Drilling rig (1 unit)

Champasak Province owns a rig that can drill a hole of about 4 inches in diameter and 50m deep. This rig is mainly used to drill shallow wells. However, to construct deep wells with a 4 inch casing, a rig capable of drilling a diameter of 6.5 inches and a depth of 100m is required.

The procured rig will be given to the government and managed mainly by Champasak Province, although it will be used in well drilling operations in the province of Saravan as well.

b. Truck with crane (1 unit)

A 4WD truck with a crane and a 6 ton loading capacity will be required to transport equipment and materials such as a compressor (4 tons), casing pipes (4m), fuel, cement, bentonite, etc., to the sites where roads are in poor condition.

c. Equipment & Materials (1 set)

The bits, spare parts, bentonite, emulsifier, hoses for mud conveyance, etc., for the mud

drilling rig and the DTH hammer rig will be provided.

d. Vehicle (1 unit)

A pick-up truck will be provided for the transport of manpower and conduct of educational activities such as village monitoring, guidance, inspections and assessments.

e. Motorcycles (10 units)

The use of motorcycles is expected in areas where the villages are spread out and access conditions are very poor. They will also be used for the conduct of guidance, monitoring and educational activities. A total of 10 motorcycles will be provided: 5 for each of the five districts in Champasak Province (Sanasomboon, Bachiang, Sukhuma, Pathoomphone, Khong), and 5 for each of the five districts in Saravan Province (Saravan, Vapy, Laongam, Khongxedon, Lakhonepheng).

f. Hand Pumps (30 units)

The number of hand pumps considered necessary in view of operation and maintenance, and which will be provided through the project, will be approximately 10% (30 units) of the wells to be constructed. The Indian Mark III hand pump will be procured together with rustproof riser pipes and piston rods.

g. Repair Equipment & Tools (2 sets)

Welding machines, casing cutters, oxy-acetylene cylinder, pipe screw cutters, repair equipment and tools will be provided for the drilling rigs, vehicles, water supply facilities, etc., and will be kept in the O&M center workshop.

h. Physical Prospecting Apparatus (2 units)

Both provinces have independently carried out groundwater development studies, however, due to lack of relevant survey equipment, the studies have been insufficient resulting in many unproductive wells. Therefore, an electric prospecting apparatus will be provided.

i. Physical Logging Apparatus (1 unit)

This logging apparatus with probes for resistivity and spontaneous potential logging will be provided to determine the casing program for newly drilled wells.

j. Water Quality Test Kits (2 sets)

Test kits to determine the physical and chemical properties of water for drinking use will be provided to check the water quality of newly drilled wells and to regularly control water quality.

k. Water Tank (1 unit)

A tank with a capacity of approximately 4m³ will be provided for mud water drilling.

l. Fuel Tank (1 unit)

A tank with a capacity of approximately 3m³ will be provided for the on-site storage of fuel necessary for drilling works.

m. Pumping Test Equipment (1 set)

This equipment will be provided for the conduct of pumping tests prior to pump installation.

n. **Computers (2 units)**

Personal computers will be provided including printers for the maintenance of well and pump records and relevant information.

2-3 Basic Design

2-3-1 Design Policy

The design of the facilities will be determined with due consideration of the following conditions:

(1) Natural Conditions

In planning the construction of water supply facilities, the decline in work efficiency during the rainy season will be taken into consideration. Wells will be constructed in the rainy season in villages along the national road, and in the dry season in villages quite difficult to access during the rainy season. None will be constructed in sites that get flooded during the rainy season or have inefficient drainage conditions. The ground height of the well platform and the drainage canal direction and length will be carefully designed.

(2) Social Conditions

Water supply systems should be carefully designed, particularly with regard to height of pump handle, size of platform, etc., to facilitate well water drawing and laundry activities. And to emphasize the importance of sanitation, the water quality produced by the wells will be set in accordance with the standard of WHO for drinking water quality. The villagers will be taught about the relationship of sanitation and the prevalence of diseases.

(3) Local Conditions

The use of local workers is taken into consideration in the construction plan in view of regional economic activation, to improve the beneficiaries' willingness to participate in the project and to educate them on the importance of operation and maintenance. Also, for ease in repair and utilization, the structural design will be in accordance with local conditions.

(4) Use of Local Equipment, Materials and Contractor

The transfer of technology to the implementing agencies is considered through the well drilling works. In view of regional activation, a local contractor will be hired. As much as possible, the equipment and materials will be procured locally or in neighboring countries in consideration of ease in future procurement.

(5) Schedule of Works

To shorten the project implementation period, the hiring of local contractors will be taken into consideration.

Well operation and maintenance education and training programs should be carried out prior to well construction. The project will be divided into two phases and the construction of the O&M centers will be carried out in the early stages of Phase I and Phase II.

2-3-2 Basic Plan

(1) Number of Wells to be Constructed

The number of wells to be constructed per village was calculated in accordance with section 2-2-2. The water supply facility construction work will be planned based on the 305 wells to be constructed through this project.

(2) Drilling Method

Since the majority of the sites are made up of rock formations (soft, medium and hard rocks), the rotary drilling method with mud water circulation and the DTH drilling method, or the combination of both, will be applied. The drilling diameter shall be more than 8 inches.

(3) Screen Installation

The outer diameter of the screen will be 4 inches and 4 meters long, same as the well casing. The opening ratio will be more than 3% and the slot size will be 1mm, in consideration of the geological structure of the well sites. The screen will be made of PVC and will total 3 pieces per well, or 4 depending on the condition of the aquifer. The position of the screen will be determined based on drill cutting and well logging operations.

(4) Work Supervision and Educational Activities

A Japanese consultant and a local consultant will be assigned to the site through the entire project term, to supervise the construction of the wells and the O&M centers, and to conduct education programs for the beneficiaries on proper facility operation and maintenance.

These consultants will assist in the formulation of educational materials in the local tongue and help the province and the centers prepare the Action Plan. They will also conduct a workshop once every month for technological dissemination, conduct education activities in correlation with the UNICEF workshop in Vientiane, conduct information exchange and build a close relationship with other cooperating agencies.

(5) Well and Hand Pumps

The specification of the hand pump well is as follows:

- | | |
|--------------------------------|---|
| 1. Well depth | : 50m (average) |
| 2. Casing | : 4 inches in diameter, 4m long PVC |
| 3. Screen | : 4 inches in diameter, 4m long PVC (1 to 4 pieces/well);
>3% opening ratio |
| 4. Type of hand pump | : Indian Mark III or AFRIDEV (rustproof materials) |
| 5. Platform | : 1.5m × 2.0m concrete platform with 10m drain (minimum
of 275 sets) |
| 6. Aeration & filtering system | : gutter type aeration system with sand filtering basin and
storage basin (maximum of 30 sets) |

(6) O&M Center

Table 2.10 shows the design of the O&M centers, while Figs 11 to 16 show the building layout.

Table 2.5 O&M Center

Facility	Description	Area	
		Champasak	Saravan
Project Office	Manager's room, working space and meeting room for 3 to 6 persons, toilet, small kitchen	144m ²	96m ²
Warehouse	material storage space, shelves for parts, janitor room	120m ²	80m ²
Workshop	repair space, shelves for tools	80m ²	80m ²
Garage	to house vehicles	200m ²	90m ²
total area		544m ²	346m ²
		890m ²	

(9) Equipment & Materials Procurement Plan

The equipment and materials procurement plan and specifications are summarized in Table 2.6.

Table 2.6 Specifications of Equipment & Materials to be Procured

Equipment & Materials	Qty	Specifications
1. Drilling rig	1 unit	<ul style="list-style-type: none"> truck mounted drilling rig capable of conducting mud water drilling and DTH hammer drilling; mud pump capacity: 500ℓ/min×25kg/cm² drilling capacity: 6 5/8 inches in diameter; maximum depth of 100m compressor discharge volume: 10.5kg/cm²; 17.2m³/min
2. Truck with crane	1 unit	<ul style="list-style-type: none"> 4WD (left handle) with a water cooled diesel engine maximum lifting capacity: 4 tons maximum loading capacity: 6 to 10 tons
3. Materials	1 set	<ul style="list-style-type: none"> drilling rig spare parts; tricone bits for mud water drilling rig; hammer bit for DTH; fishtail bit for hole drilling and finishing tools; mud water conveying hose; DTH booster hose; temporary casing (D200mm×5.5m); bentonite; emulsion; additive agent; engine parts (fuel, oil, air filter, jet nozzle)
4. Vehicle	1 unit	<ul style="list-style-type: none"> 4WD (left handle), 4 door-double cabin, water cooled diesel engine, 3000cc engine displacement
5. Motorcycles	10 units	<ul style="list-style-type: none"> 125 to 150cc (off-road type)
6. Hand pumps	30 units	<ul style="list-style-type: none"> Indian Mark III/AFRIDEV (deep well hand pump) 4 inch PVC casing/screen PVC riser pipe stainless steel rod
7. Repair tools	2 sets	<ul style="list-style-type: none"> electric casing cutter (200V; maximum cutting diameter: 115mm) electric welding machine (18kVA; 250V) gas welding machine (inclusive of acetylene, oxygen cylinder nozzle) bench bar (125mm) a set of repair tools
8. Physical prospecting apparatus	2 sets	<ul style="list-style-type: none"> resistivity sounding: 100m deep (including cables, iron poles, batteries, walkie-talkie, voltage tester, mallets, battery recharger, measuring rope)
9. Physical logging apparatus	1 set	<ul style="list-style-type: none"> probes for electrical resistivity logging and spontaneous potential logging 100m long cable with a drum analyzer and recorder
10. Water quality test kits	2 sets	<ul style="list-style-type: none"> for analysis of pH, water temperature, EC, DO, turbidity, colon bacillus simple measuring device with digital indicator
11. Water tank	1 unit	<ul style="list-style-type: none"> 4m³ truck-mountable water tank
12. Fuel tank	1 set	<ul style="list-style-type: none"> 3m³ truck-mountable fuel tank
13. Pumping test equipment	1 set	<ul style="list-style-type: none"> submersible motor pump with diesel engine generator (1kVA) discharge capacity: 200ℓ/min simple water discharge gauge and spare parts
14. Computer	2 units	<ul style="list-style-type: none"> desktop computer (set up in local language) voltage stabilizer, printer

2-4 Project Implementation System

2-4-1 Organization

(1) Executing Government Agency

The government agency responsible for the implementation of this project is the Clean Water Institute, an organization under the National Institute of Hygiene and Epidemiology of the Ministry of Health. In view of the expansion and importance of water supply services, the Clean Water Institute expanded its organization, and plans to change its name to the National Institute for Water Supply and Environmental Health Programme. The CWI is in charge of implementing water supply services in cooperation with the provincial health departments. But as water supply projects are being independently implemented under provincial budgets, the institute is mainly responsible for assisting the set up of rural water supply programmes, distributing donated equipment and materials, and coordinating support agencies.

Figures 2.1 and 2.2 show the organization chart of the Ministry of Health and the Clean Water Institute, respectively.

(2) Local Executing Agencies

The local executing agencies are the Health Departments of Champasak and Saravan provinces, while the implementation of rural water supply services is the main responsibility of the Water Supply Environment & Sanitation Section (WSESS) under the Health Department. Some of the staff of this section will be assigned to the O&M center to supervise the educational activities in districts and villages, and repair and construction of water supply facilities.

The Health Department of Champasak has a total staff of 440, 34 of which belong to the WSESS. Some of the staff are posted in district agencies to assist in rural water supply services, mainly by coordinating provincial and rural government activities.

The Health Department of Saravan has a total of 180 staff, 12 of which make up the WSESS. However, as many of the villages in this province are located in remote mountain areas, 18 of the persons in charge of services in every district cooperated to organize a well construction unit and a spring development unit that will support the section in the execution of rural water supply services. The organizational structure of the Health Departments is shown in Figs. 2.3 and 2.4.

Fig. 2.1

Organization Chart of the Ministry of Health

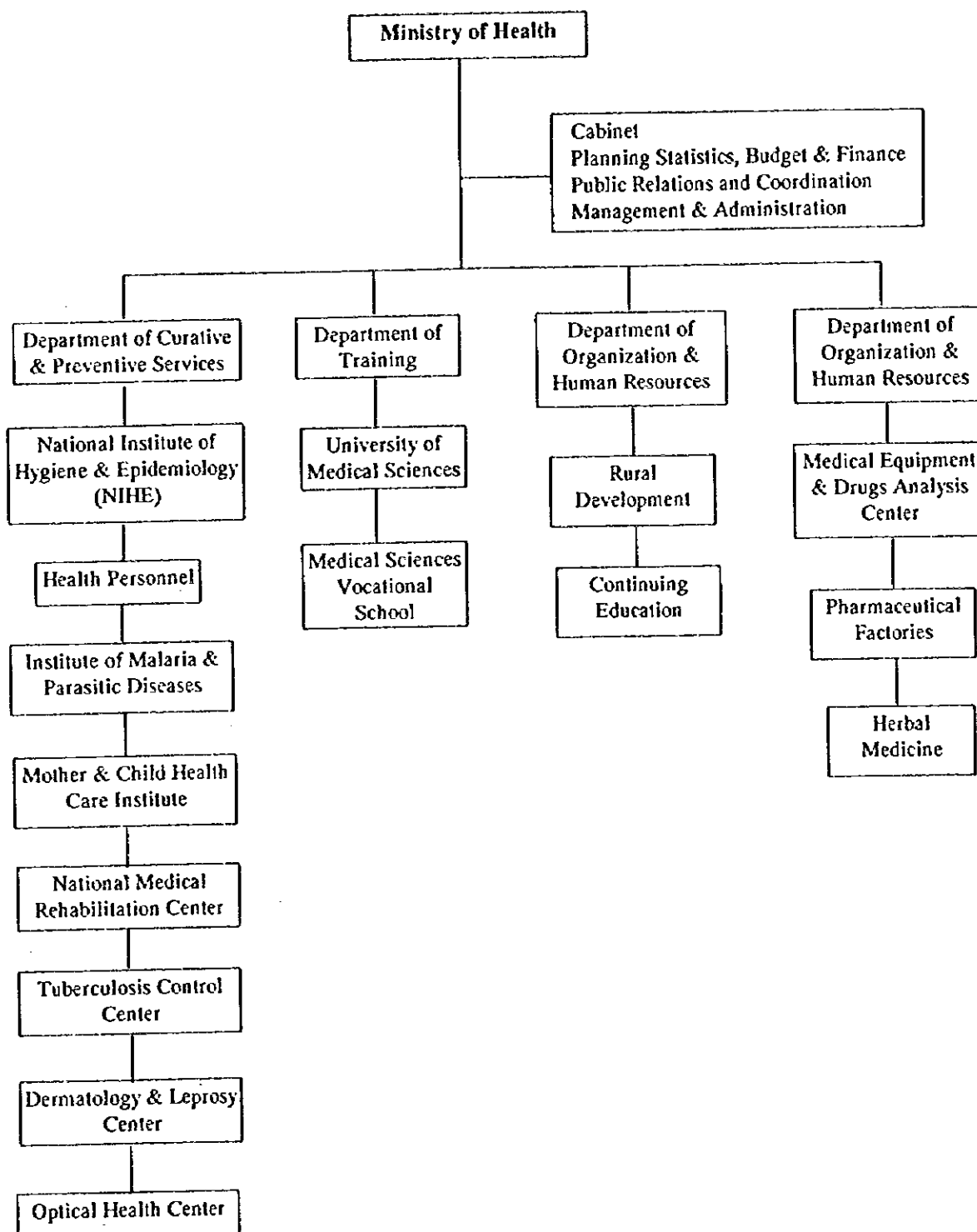


Fig. 2.2

Organization Chart of the Clean Water Institute

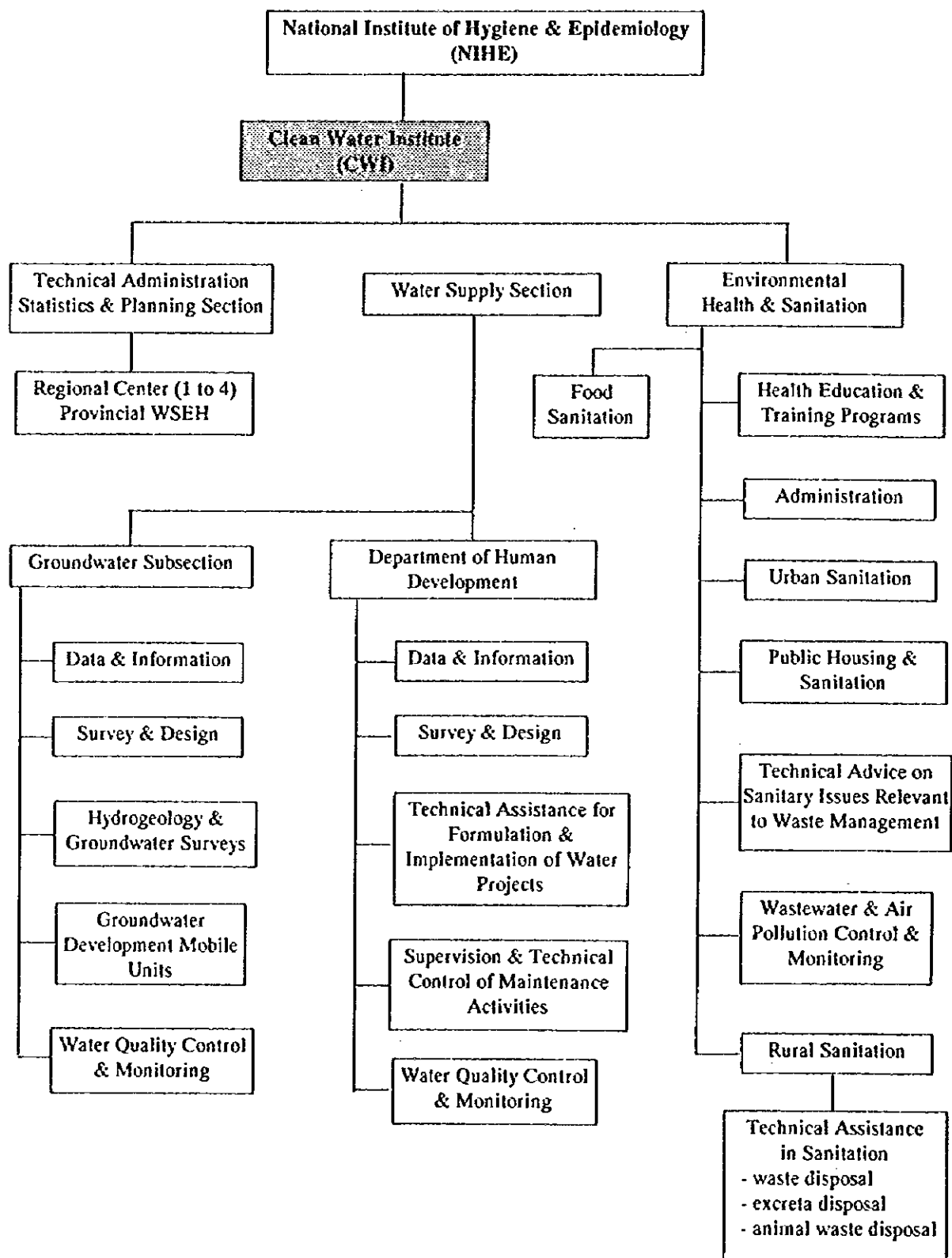


Fig.2.3 Organization Chart of Champasak Provincial Health Department

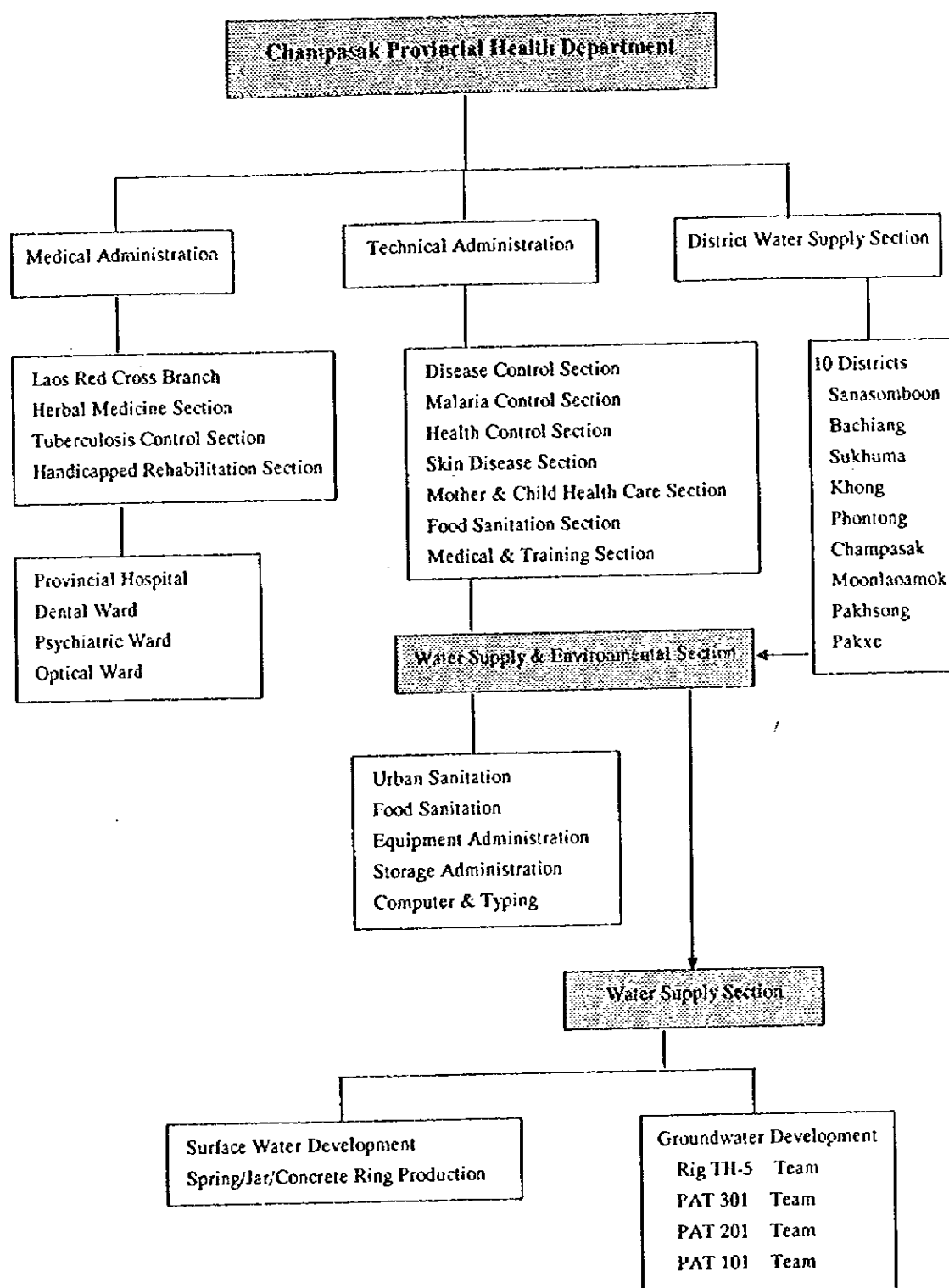


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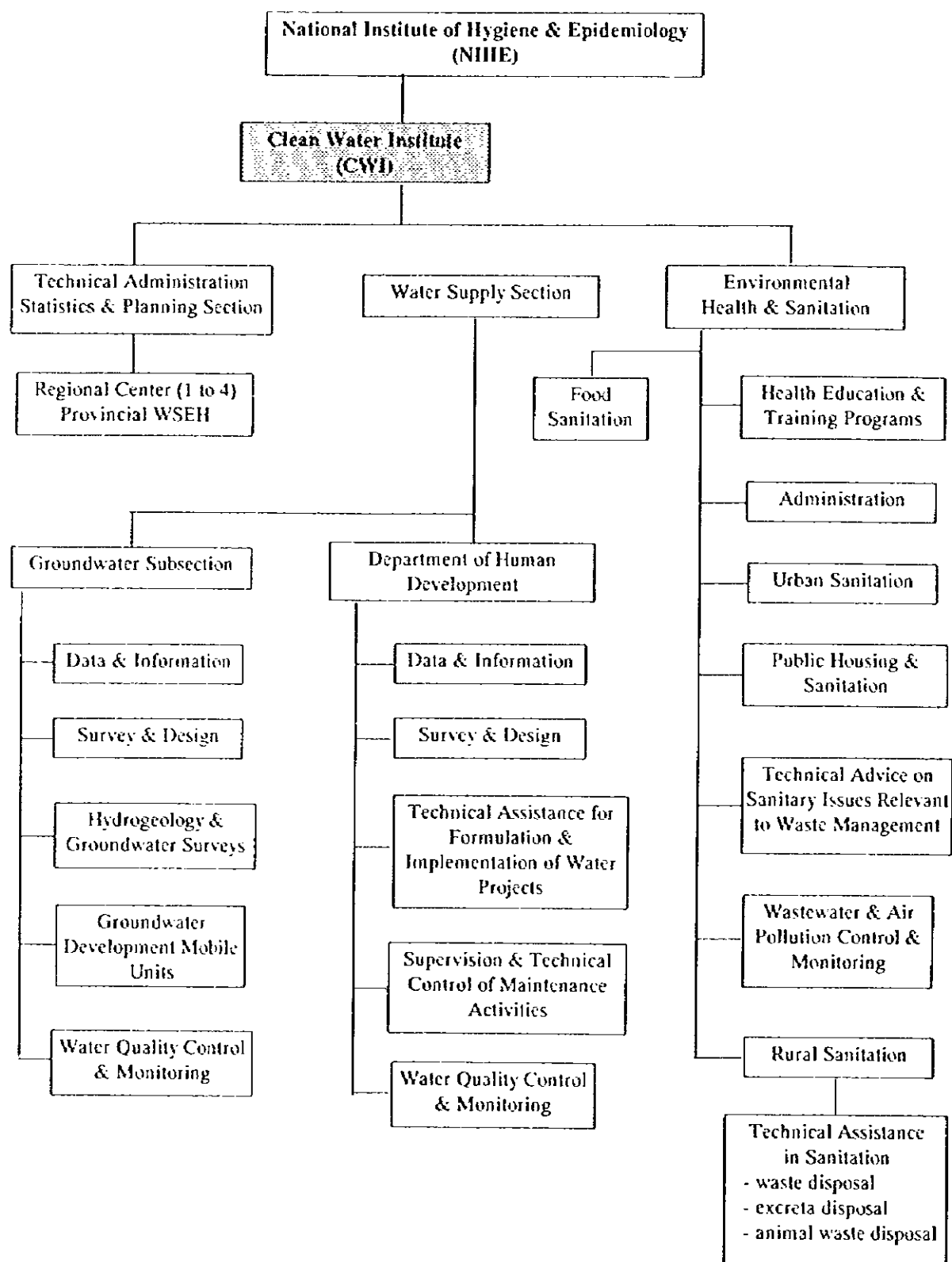


Fig.2.3 Organization Chart of Champasak Provincial Health Department

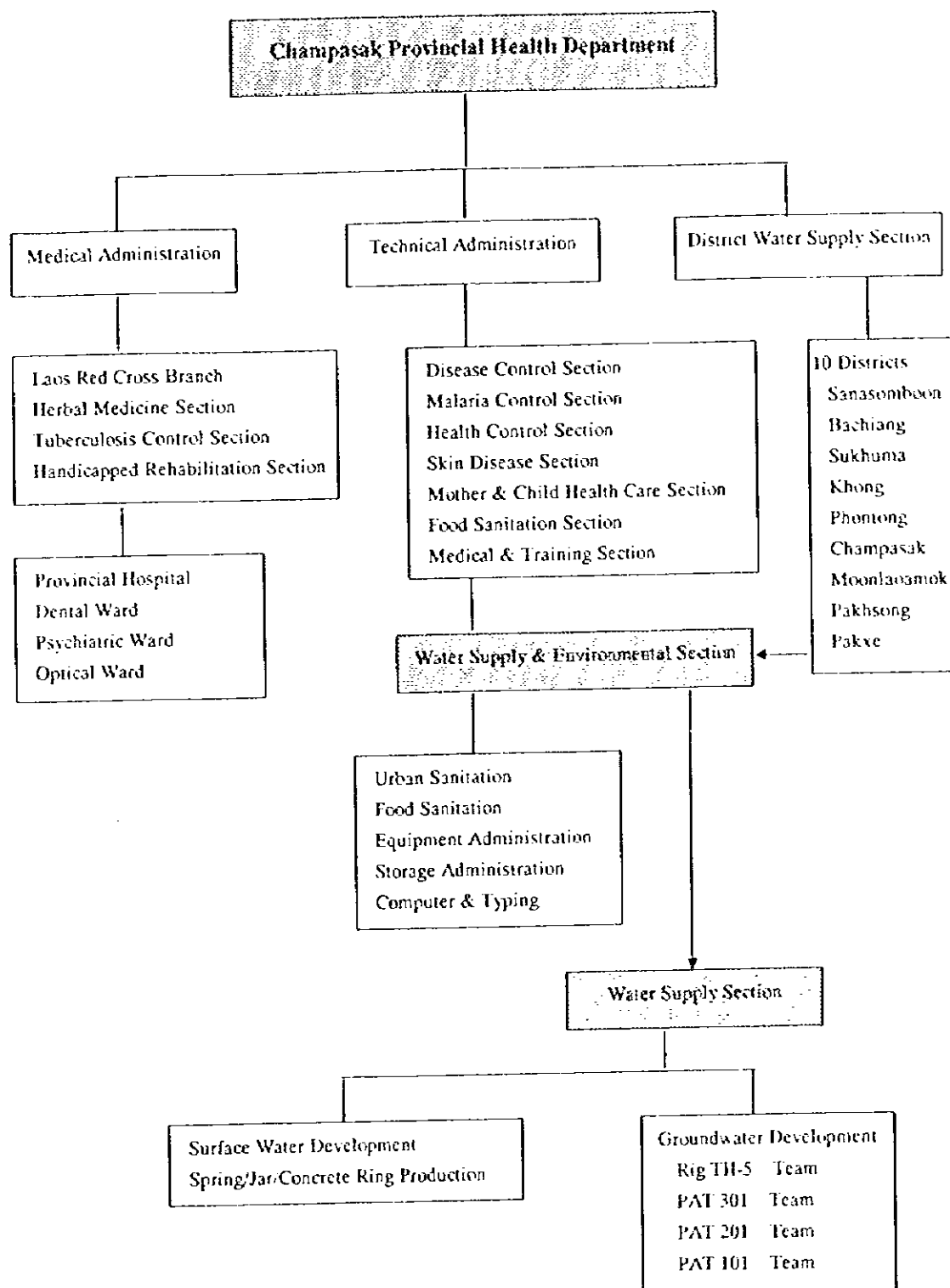
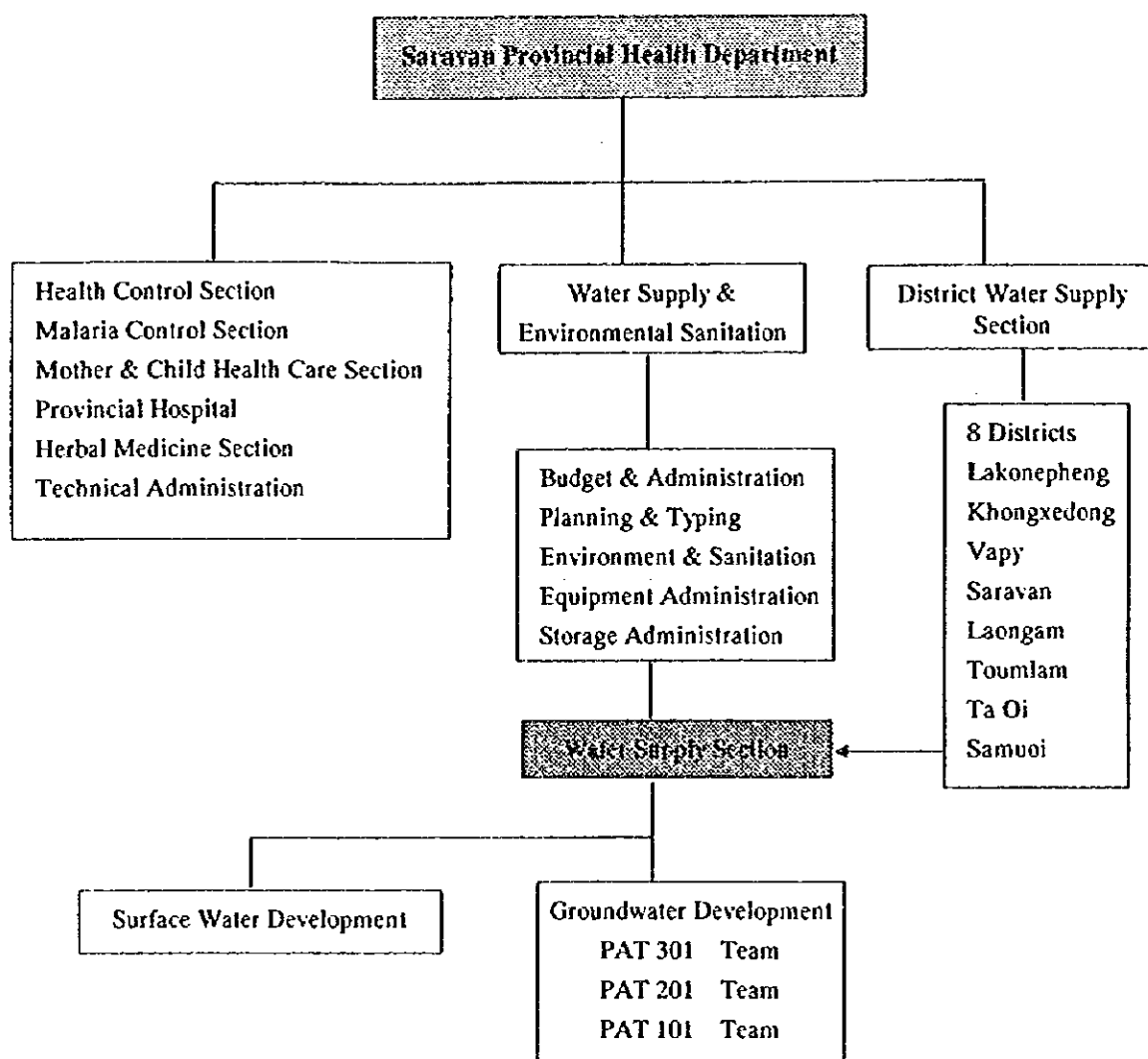


Fig. 2.4 Organization Chart of Saravan Provincial Health Department



2-4-2 Budget

(1) Clean Water Institute (CWI)

The budget of the Ministry of Health of the Government of Lao is mainly appropriated from the overall national budget, and the allocated amount is usually largely inferior to the requested budget. Insufficient funding makes the implementation of government projects (this project included) difficult. The annual budget requested by the Clean Water Institute for 1993 and 1994 is broken down in the table below.

Table 2.7 Clean Water Institute Budget

unit: 1,000 kips		
Expenses	1993	1994
Well construction study, planning, training	20,510	57,400
Public health and sanitation research	3,660	10,000
Gathering of information, data processing	9,600	26,800
Technological studies	12,800	35,840
Staff transport	24,000	30,000
Vehicles/facilities maintenance	16,000	32,000
Fuel for vehicles	1,900	5,300
Water bill	1,600	2,000
Electric bill	3,200	4,000
Telephone bill	400	1,200
Guards	760	800
Staff salary	1,000	2,800
TOTAL	95,430	208,140

(2) Provincial Health Department Budget

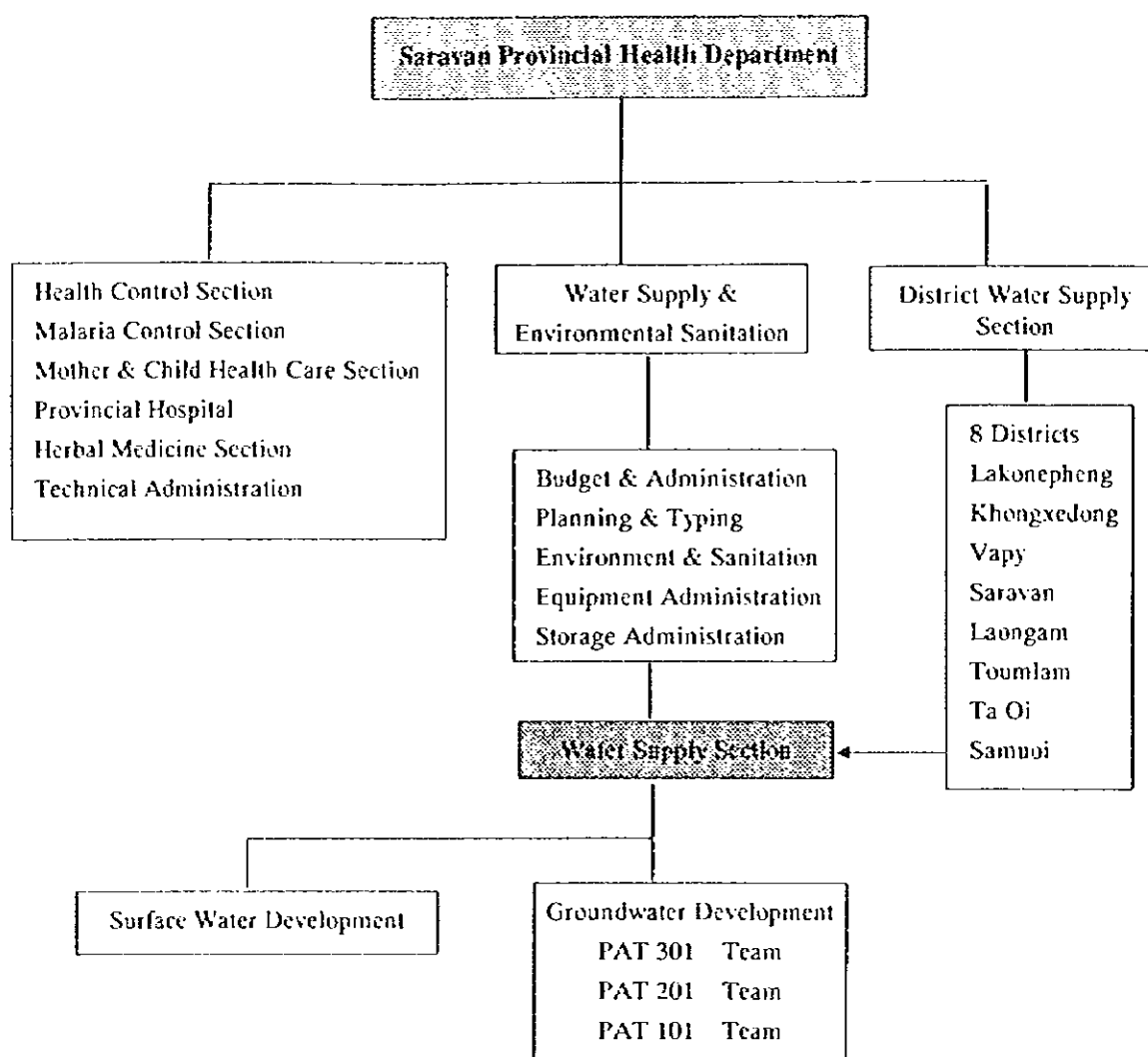
The breakdown of the 1994 budget of the Health Department of Champasak is as follows:

Staff salary (province/district)	614
Public welfare	38
Administration expenses	50
Facility repair, equipment procurement	44
Hospital expenses	106
TOTAL	852 million kips

The breakdown of the 1994 budget of the Health Department of Saravan is as follows:

Staff salary	129
Public welfare	7
Administration expenses	17

Fig. 2.4 Organization Chart of Saravan Provincial Health Department



2-4-2 Budget

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TOTAL	95,430	208,140

(2) Provincial Health Department Budget

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Staff salary (province/district)	614
Public welfare	38
Administration expenses	50
Facility repair, equipment procurement	44
Hospital expenses	106
TOTAL	852 million kips

The breakdown of the 1994 budget of the Health Department of Saravan is as follows:

Staff salary	129
Public welfare	7
Administration expenses	17

Facility repair, equipment procurement	8
Hospital expenses	70
District staff salary, District administration expenses	230
TOTAL	461 million kips

The budget estimates for both provinces are shown in Tables 2.8 and 2.9. (The Lao fiscal year is from October 1 to September 30.)

Table 2.8 Estimated Annual Budget of Champasak Health Department and Water Supply Environment & Sanitation Section

unit: 1,000kips					
Item	1992-93	1993-94	1994-95	1995-96	1996-97
HD	265,106	389,024	852,650	1,072,700	1,244,300
WSESS	1,500	3,000	4,500	7,000	8,000

Table 2.9 Estimated Annual Budget of Saravan Health Department and Water Supply Environment & Sanitation Section

unit: 1,000kips					
Item	1992-93	1993-94	1994-95	1995-96	1996-97
HD	118,000	289,300	395,000	461,900	521,800
WSESS	1,000	1,500	2,500	3,000	4,000

Converted into yen, the WSESS 1997 budget is about ¥50~100 million. But since the implementation of this rural water supply project has been confirmed, both provinces had to plan the following: staff increase, allocation of special funds for the construction of temporary roads, land acquisition, construction of O&M centers, increase in the number of technicians, conduct of operation & maintenance training programs.

2-4-3 Necessary Staff & Technical Skills

Provincial Health Department and Water Supply Environment & Sanitation Section

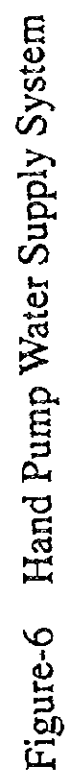
With the assistance of UNICEF, the WSESS of both provinces have been implementing rural water supply projects, mainly by building shallow wells, for the past 10 years. The five drilling rigs, consisting of TH-5, PAT301 and PAT201, donated by UNICEF in June 1995 have enabled Champasak to drill 580 wells, which led to the accumulation of experience in well drilling techniques and hand pump installation and repair. After a 2 month training in the use of the truck-mounted TH-5 rig conducted by an Indian expert, the department is considered to have mastered the techniques for the operation, repair and maintenance of this machinery. Consequently, wells are more efficiently constructed at present.

Technology transfer, in the form of on-the-job-training, is progressively carried out with the younger staff regarding the use of small size PAT drilling rigs. The well construction unit of Champasak is considered to be the best in Lao.

Saravan is currently constructing 280 shallow wells using either the PAT310, PAT201 or PAT101 drilling rigs, accumulating experience in well drilling, hand pump installation and equipment repair. The WSESS of the Saravan Health Department has a staff of 12. Many of the villages in this province are located in remote mountain areas. To extend the services to these areas, the cooperation of 18 people in charge of the services in other districts was obtained in order to organize a well construction unit. Although the well construction unit of Saravan is not as skilled as the unit in Champasak, their mastery of the basic well construction techniques could be further improved through on-the-job-training.

< Figures > Basic Design Drawings

Figure 6	Hand Pump Water Supply System (Plan & Section)
Figure 7	Hand Pump Water Supply System (With Aeration System, Plan)
Figure 8	Hand Pump Water Supply System (Section)
Figure 9	Hand Pump Structure
Figure 10	Deep Well Construction Plan
Figure 11	Outline of O&M Center (Champasak Province)
Figure 12	Outline of O&M Center (Saravan Province)
Figure 13	O&M Center (Champasak Province)
Figure 14	O&M Center (Saravan Province)



Plan

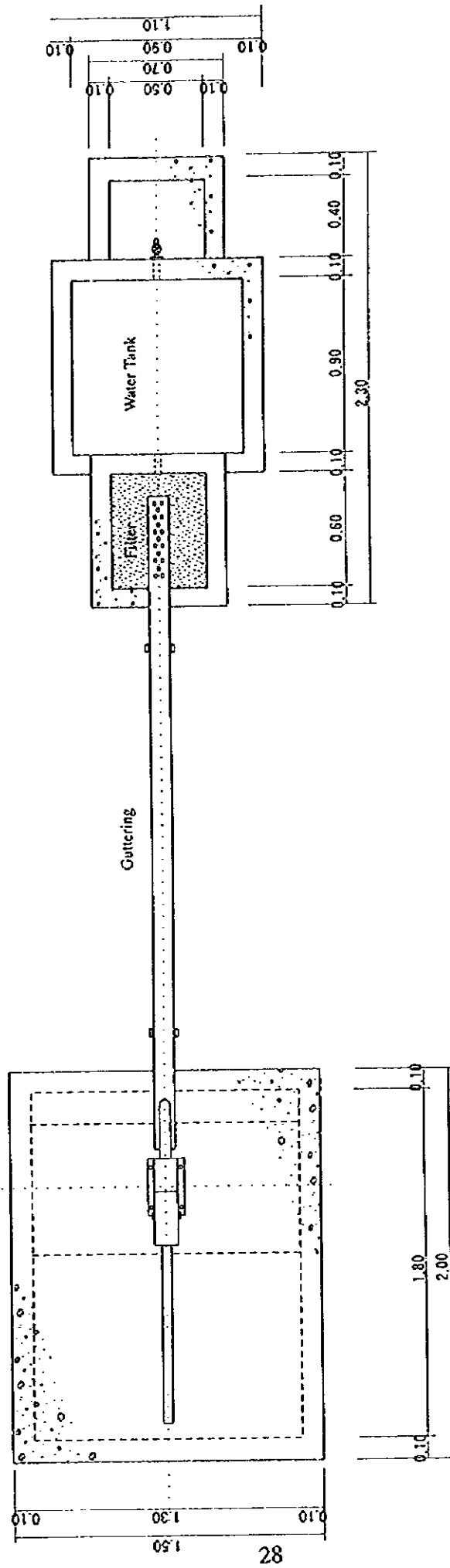
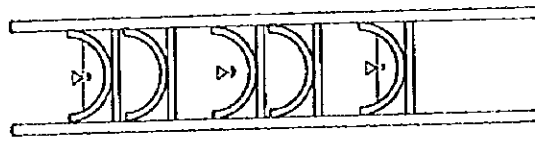


Figure-7 Hand Pump Water Supply System (Aeration Type)

A-A Section



Section

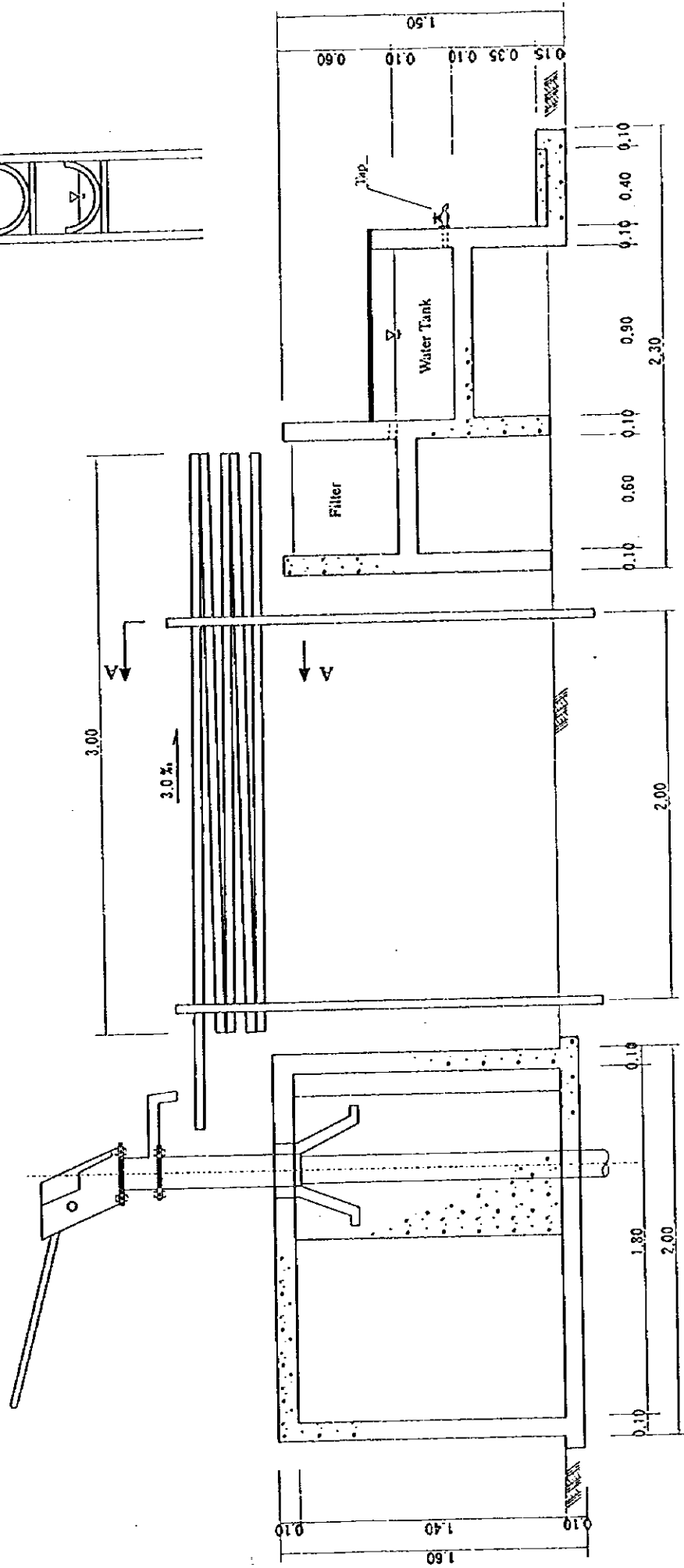


Figure-8 Hand Pump Water Supply System (Aeration Type)

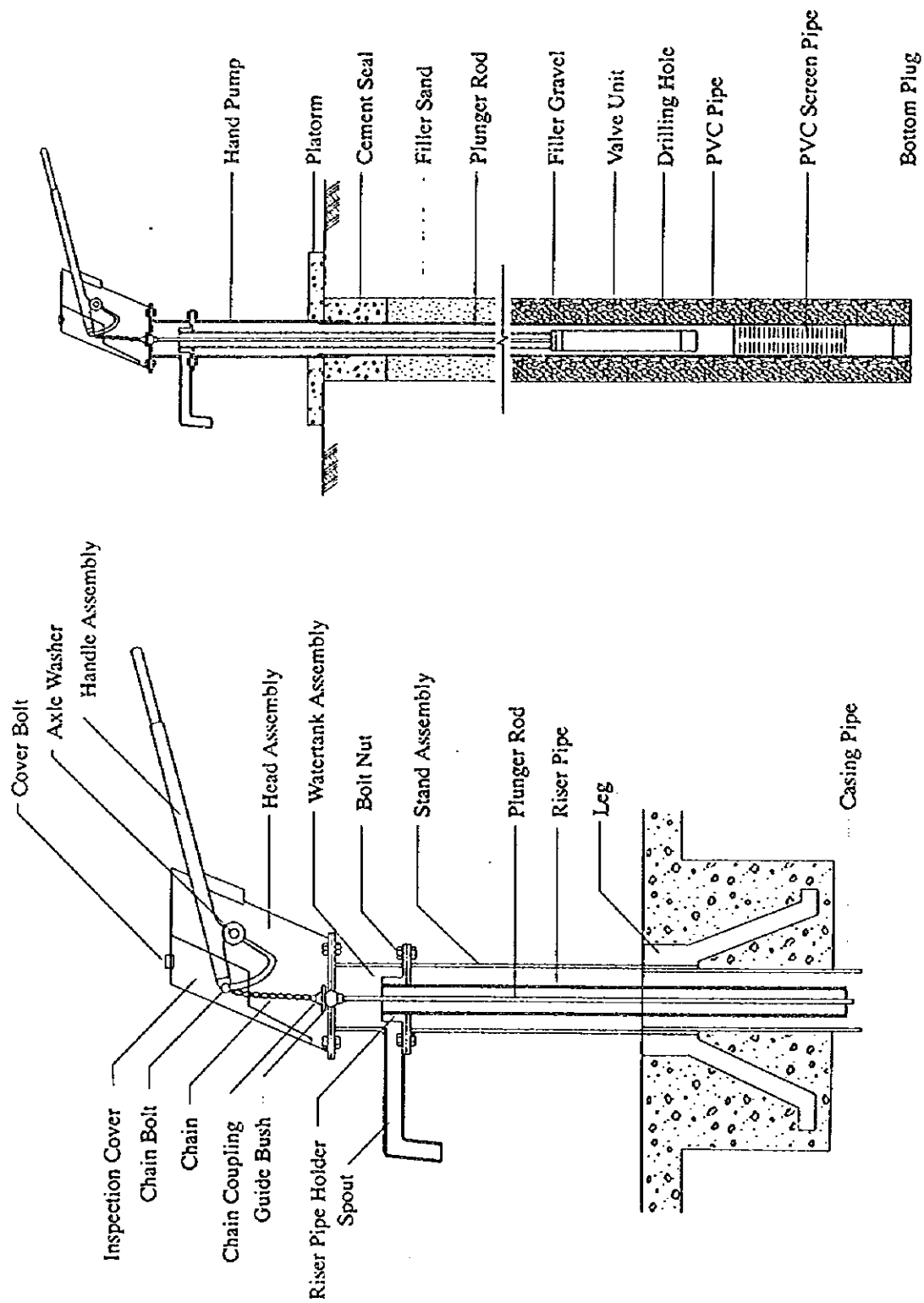


Figure-9 Hand Pump Structure

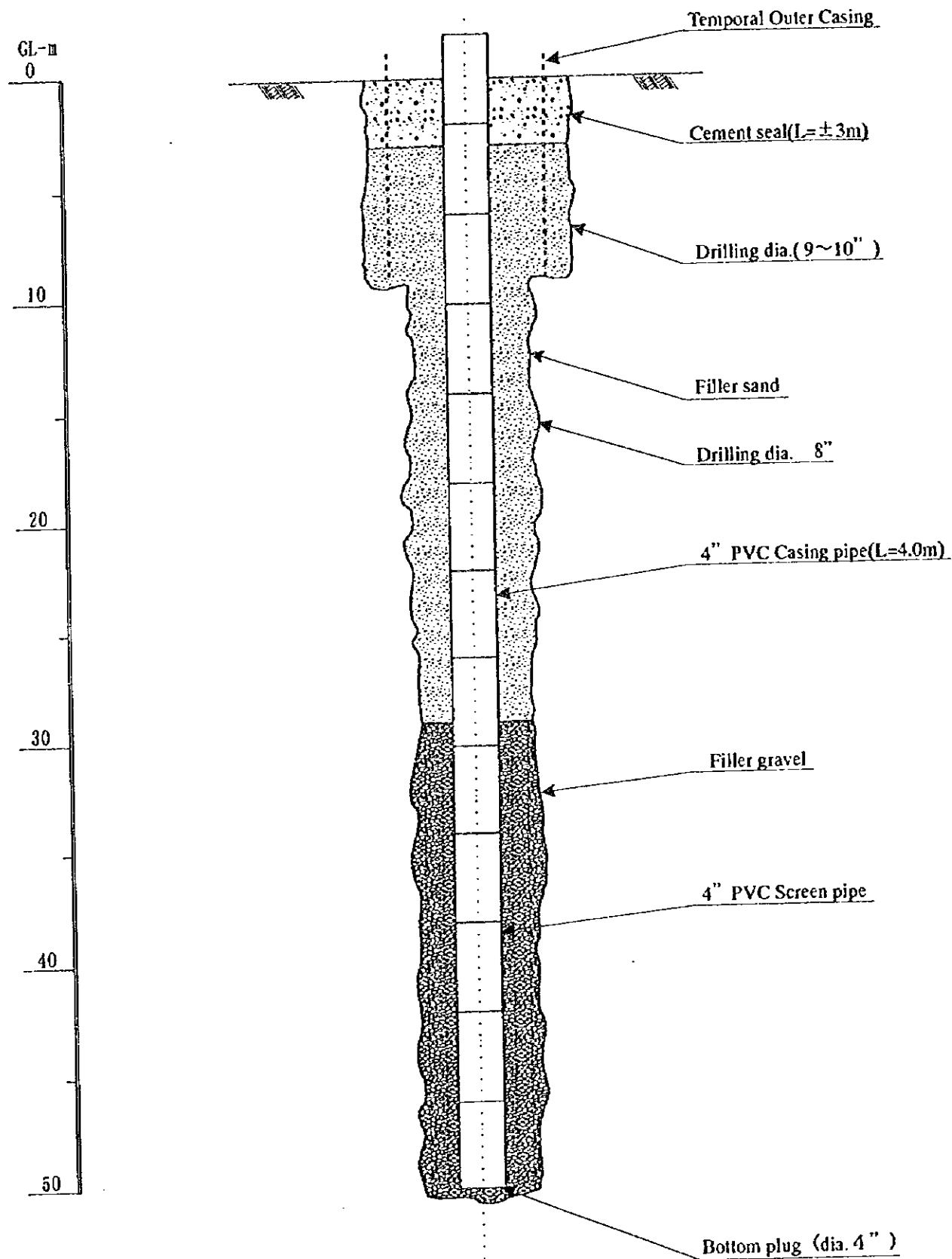


Figure-10 Deep Well Construction Plan

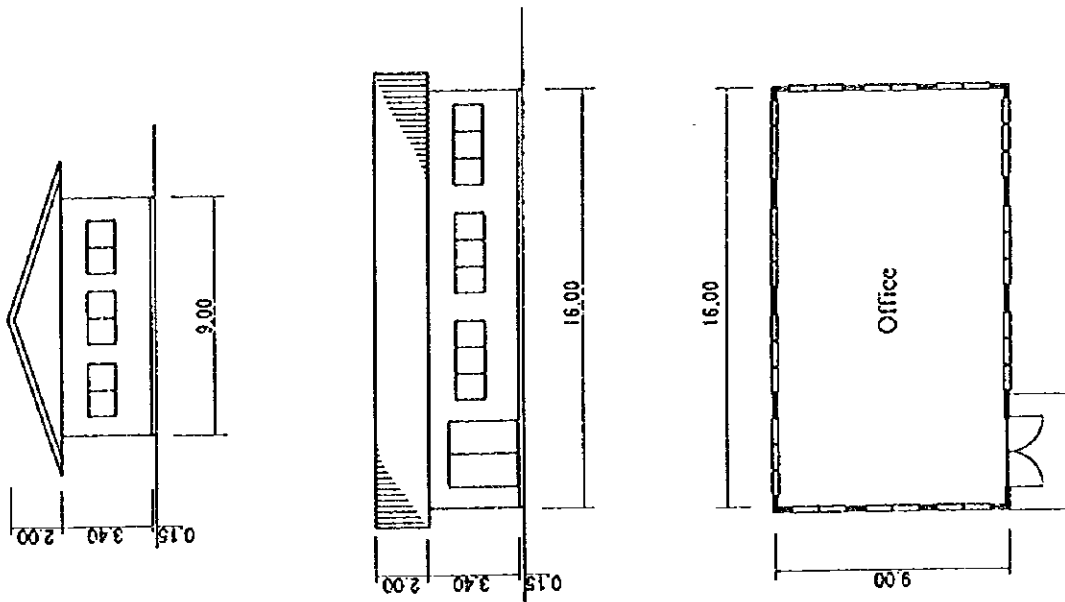
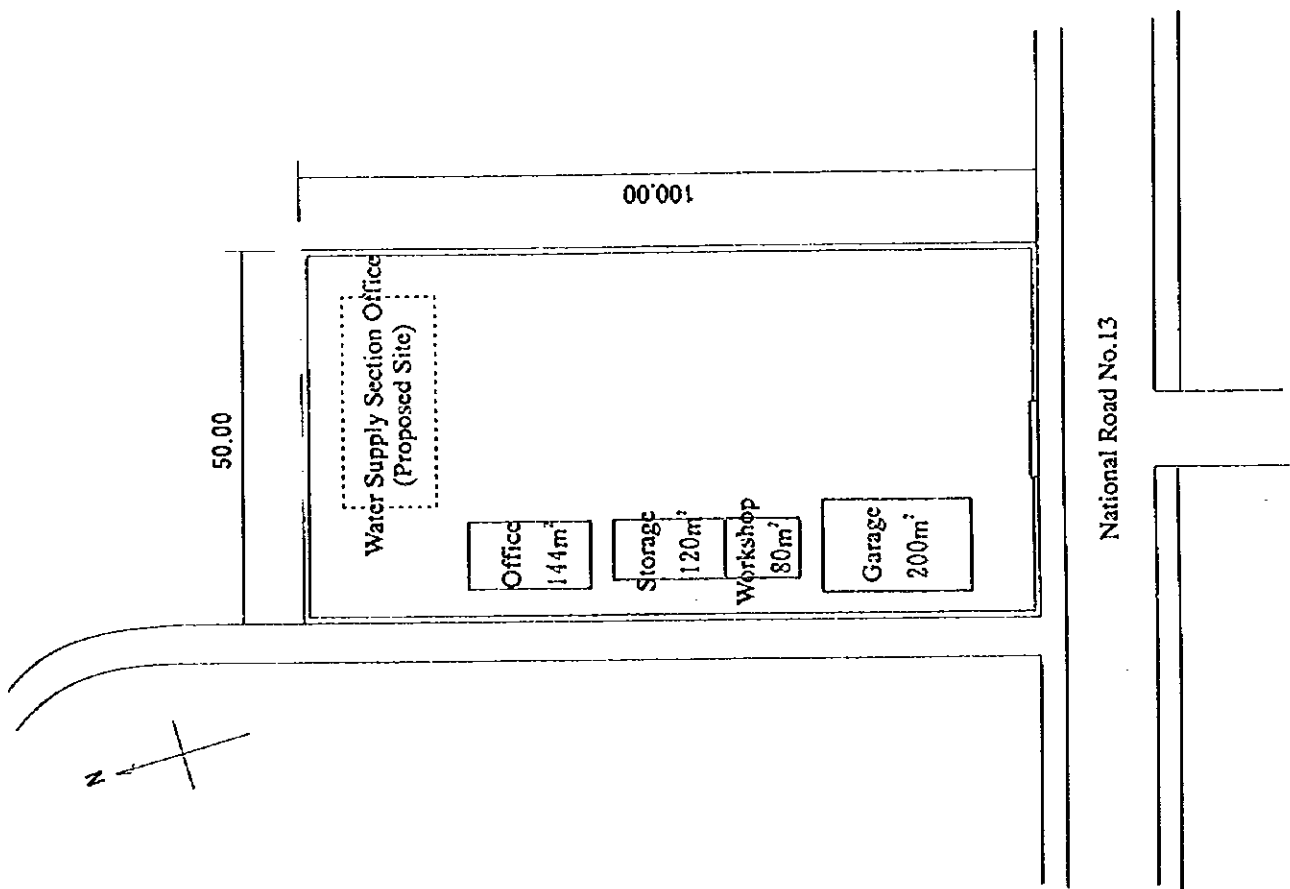


Figure-11 Outline of O&M Center (Champasak Province)

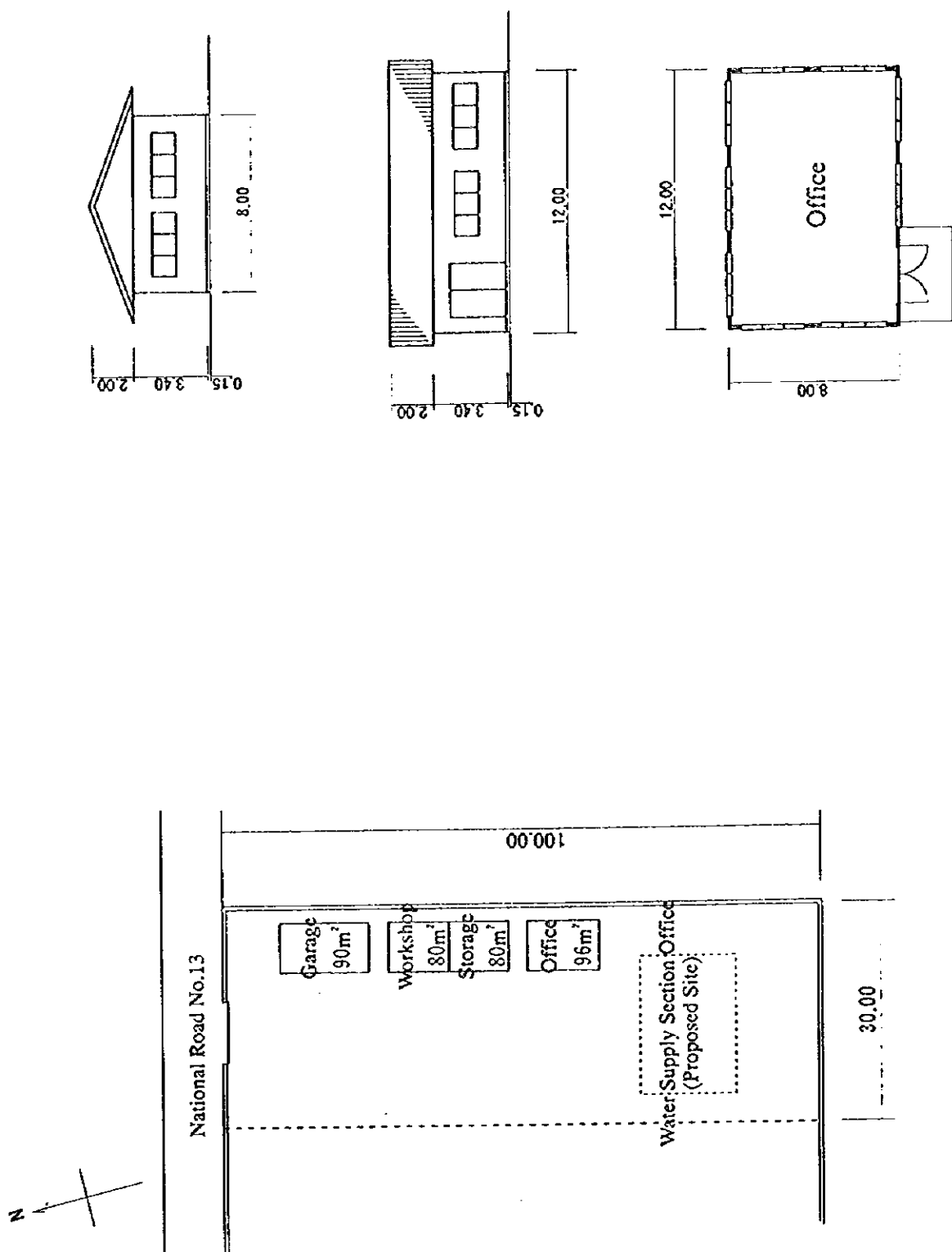


Figure-12 Outline of O&M Center (Saravan Province)

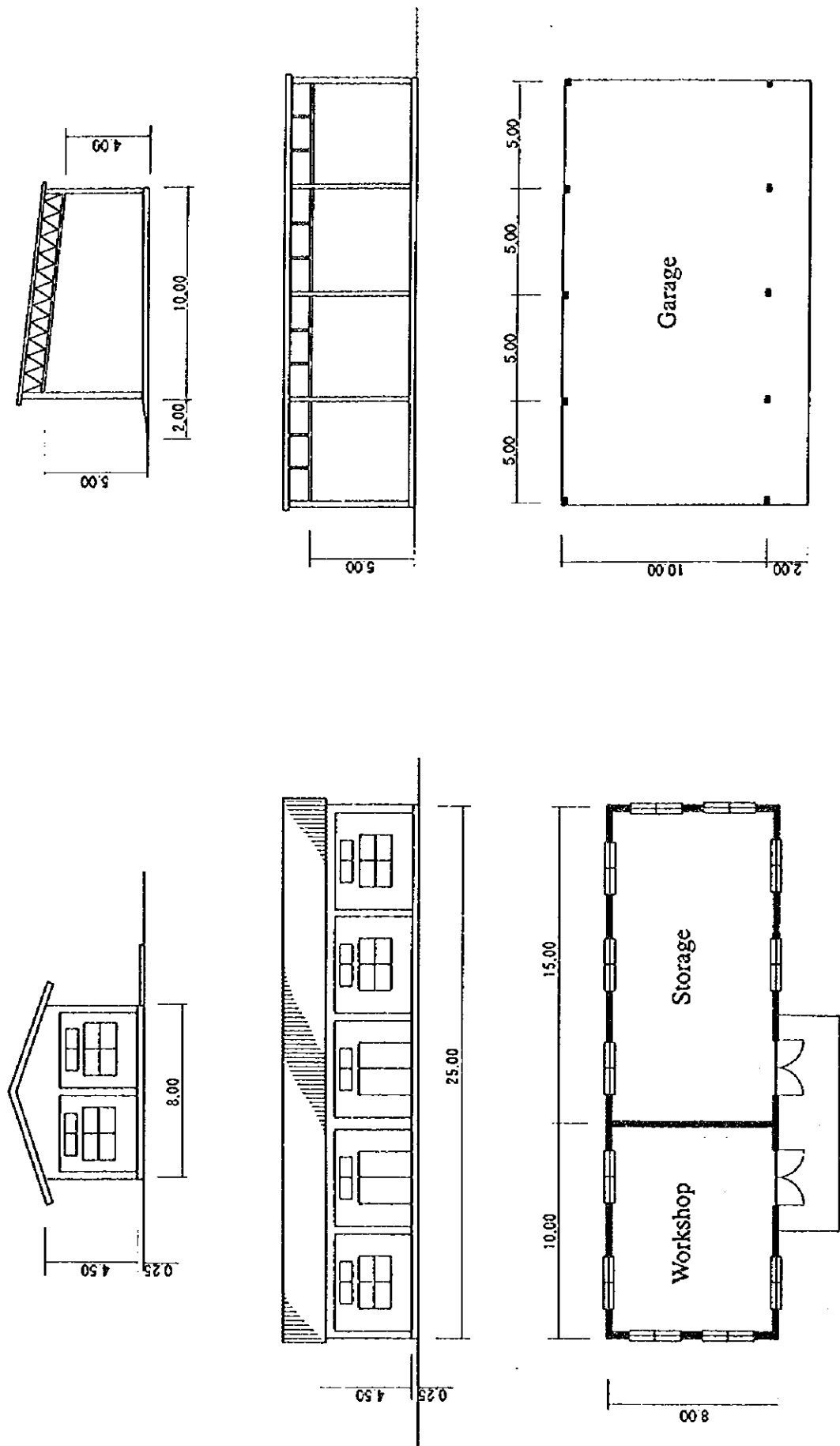


Figure-13 O&M Center (Champasak Province)

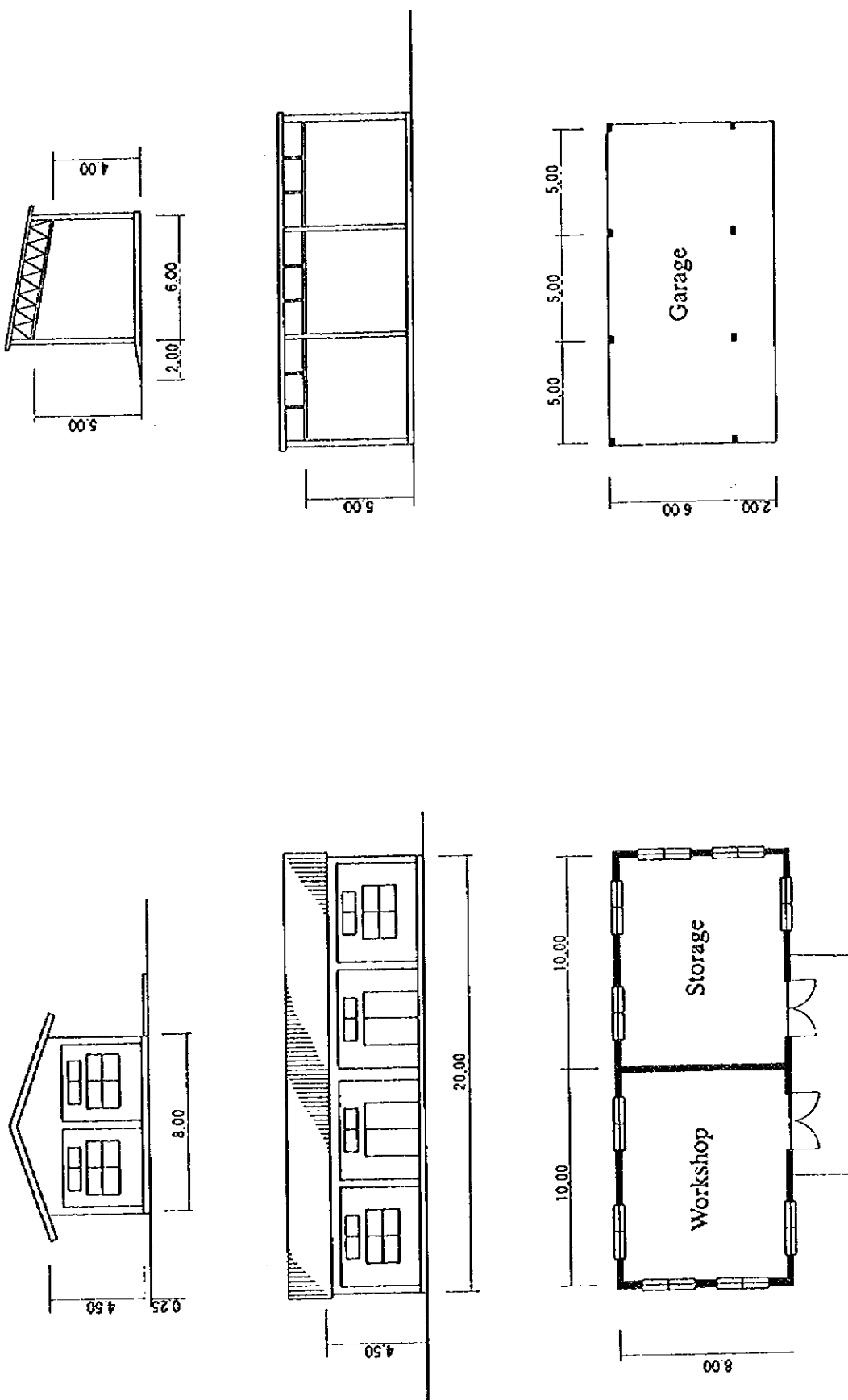


Figure-14 O&M Center (Saravan Province)