No. 2

JAPAN INTERNATIONAL COOPERATION AGENCY
LAO PEOPLE'S DEMOCRATIC REPUBLIC
MINISTRY OF PUBLIC HEALTH

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR

GROUNDWATER DEVELOPMENT

IN VIENTIANE PROVINCE

IN

LAO PEOPLE'S DEMOCRATIC REPUBLIC

OCTOBER, 1993

NIPPON JOGESUIDO SEKKEI 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 Project for Groundwater Development in Vientiane Province in Lao People's Democratic Republic and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Lao People's Democratic Republic a study team headed by Mr. Shigeki Kobayashi, Grant Aid Division, Bureau of Economic Cooperation, Ministry of Foreign Affairs, from May 22, 1993 to June 25, 1993.

The team held discussions with the officials concerned of the Government of Lao People's Democratic Republic, and conducted a field survey at study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Lao People's Democratic Republic in order to discuss a draft report and as this result, the present report was finalized.

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.

October, 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

October, 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for Groundwater Development in Vientiane Province in Lao People's Democratic Republic.

This study was conducted by the Nippon Jogesuido Sekkei Co., Ltd., under a contract to JICA, during the period from May 17, 1993 to October 20, 1993. In conducting the study, we have examined the feasibility and rationale of the Project with due to the present situation of Laos, and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

We wish to take this opportunity to express our sincerest gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, the Ministry of Ministry of Health and Welfare in Japan. We also wish to express our deep gratitude to the officials concerned of the Clean Water Institute, Ministry of Public Health, the Vientiane Province, the Japanese Embassy in Laos for their close cooperation and assistance throughout our field survey.

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

Very truly yours

K. Takayanagi

Kenji Takayanagi
Project Manager.
Basic Design Study Team on the Project for Groundwater Development in Vientiane Province.
Nippon Jogesuido Sekkei Co., Ltd.

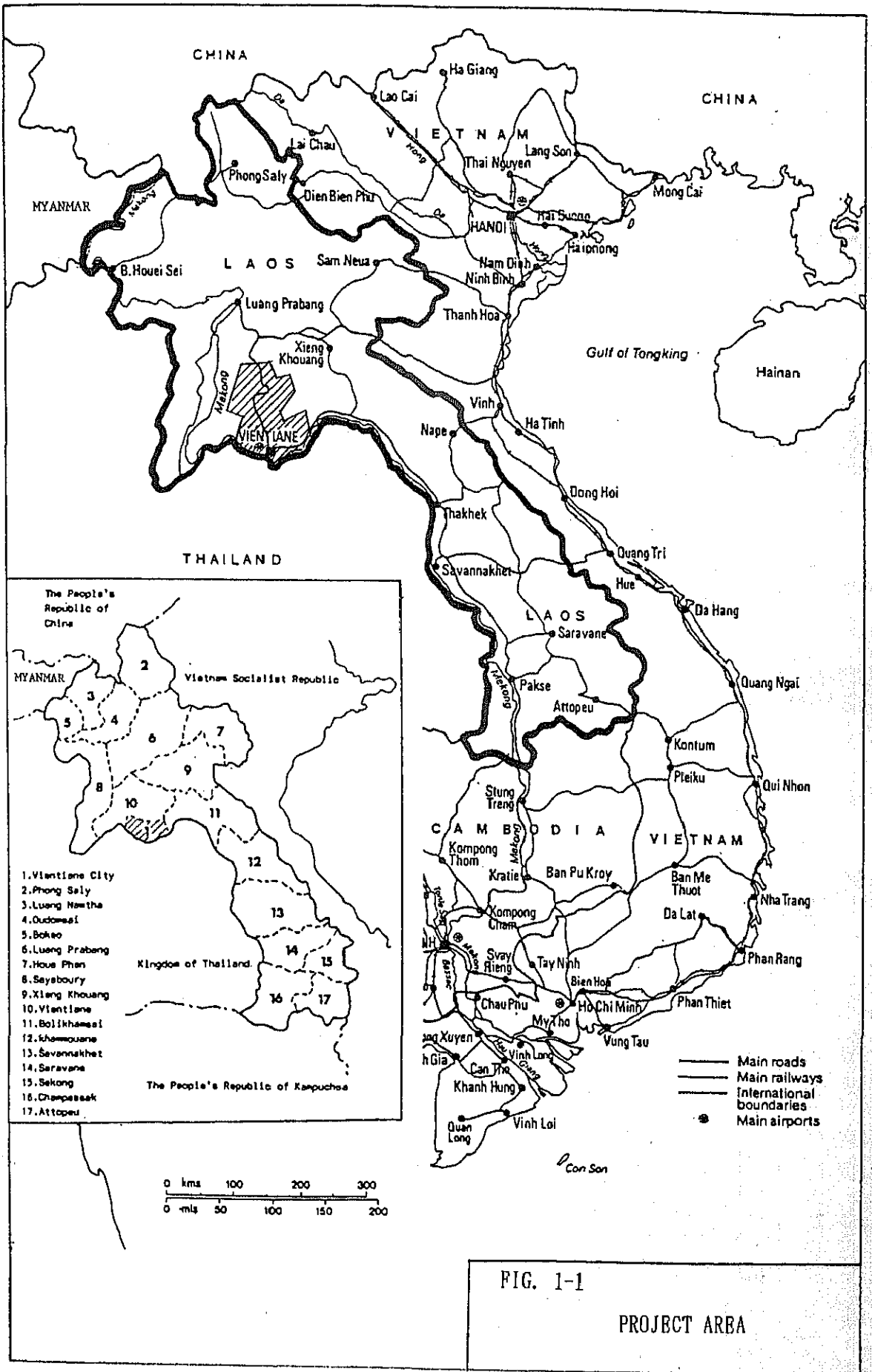

FIG. 1-1

PROJECT AREA

SUMMARY

SUMMARY

The Lao People's Democratic Republic (hereinafter referred to as the Lao PDR) is an inland country which is bordered by the Kingdom of Thailand, the People's Republic of China, the Union of Myanmar, Cambodia, and the Socialist Republic of Viet Nam. It has a total land area of 236,800 km2 and is composed of 16 provinces and the capital, Vientiane City. The subordinate organizations of the provinces are districts, and those of the districts are the villages. The climate is tropical monsoon and has two distinct seasons, namely, a rainy season from May to September and a dry season from October to April. The average annual rainfall is 1,800 mm.

The project area, Vientiane Province, is located to the north of Vientiane City. The area is an agricultural district where many villages are ranging and the villagers are using dug wells as their main water sources. However, most of the dug wells usually go dry during the dry season and the water is also polluted due to the infiltration of domestic waste or excreta of livestock, which results in a high mobidity rate due to water-borne deseases. In particular, the infant mortality rate is high and it has become a serious social problem. Under such circumstances, villagers are obliged to secure their domestic water by getting water from distant villages where there is a well which will not dry up or by buying bottled water during the dry season.

The Lao Government planned the Third Five Year Plan Development Plan (issued by Ministry of Public Health), in accordance with the Third Five Year National Development Plan (1991-1995) and "The United Nation's International Drinking Water Supply and Sanitation Decade Plan (1981-1990), and established a large-scale hygiene and sanitation plan aiming to raise the water supply ratio in rural area up to 40%. However, development in the field of public health is slow in comparison with the country's economic growth. Under these circumstances, the Lao Government proposed a groundwater development plan in Vientiane Province and requested grant aid assistance from the Japanese Government. The scope of the Project is to construct water supply systems, using deep wells which will not dry up in the dry season, for 80 villages in the three districts of Vientiane Province. These systems are to be composed of deep wells with handpumps and systems with public faucets.

In response to the request, the Japan International Cooporation Agency (hereinafter reffered to as JICA) dispatched a preliminary study team to the Lao PDR in August of 1992 and they fixed the framework of the Project and provided the survey contents of the Basic Design Study. During this study, the Project area was focused on 3 districts in Vientiane Province namely, Phon Hong, Thoulakhom, Keo-Oudom, and the type of water supply systems was also limited to deepwells with handpumps and public faucets. In request form, 80 villages are ranked according to their degree of distress regarding water supply and priority for the construction of water systems. The ranking established at this time was judged as reasonable during this study.

Based on the results of the preliminary study, the Japanese Government decided to implement the Basic Design Study and JICA dispatched the Basic Design Study Team to the Lao PDR in the period from May 22 to June 26, 1993. The study team reconfirmed the contents of the request from the Lao Government, and surveyed and examined the Project area in detail with the assistance of their Lao counterparts. This field survey consisted of an investigation on the existing water supply systems, the water supply conditions, the topography and geology of the area and core boring, electric resistivity and pumping tests. Based on these data and their analysis, the draft final report was worked out. The discussion and arrangement of the draft final report was conducted with the Lao Government during the period August 28 to September 8, 1993 and the final report was completed including the final agreement on the Project.

The implementation agencies for the Project are the Ministry of Public Health (hereafter referred to as MDPH), the Clean Water Institute (hereinafter reffered to as CWI) and the related agencies of Vientiane Province. CWI manages planning, construction, and supervision of the rural water supply systems in all over the nation and instructs the Public Health Department of each provinces.

As a result of the survey, it was revealed that ADB had a master plan for the construction of water supply systems with house connections in the seven villages near the provincial capital namely, Phong Hong, Nong'-Kork, Phonsi Tai, Nam Linh, Phon Kham, Phon Xay, and Phon Ngam. Moreover, the Government of France planned to construct a water supply system using the Nam Ngum River as its water source for the village of Keun. Thus, these villages are

excluded from the Project. In addition, eight villages were found to have amalgamated four villages through mergers.

The Project area has many small undulating hills which consist of sand, gravel, clay and silt layers of the Pliocene of Tertiary to the Pleistocene of Quaternary in geological age. The low land in the hills is composed of alluvial deposits and is used for paddy fields. Most of the villages are ranging in the higher portion of the hills. To the west of the Project area impervious layers of mudstone, shale and sandstone of the Mesozoic era are distributed and their outcroppings can be seen in some places. As a result of the geological and the electrical resistivity surveys, 19 villages were excluded from the Project due to the minimal potential for groundwater development. Besides, there is a deep well in the Project area owned by a salt production firm, which pumps up salt water and the well depth is 81 m. Thus, there was the apprehension of salty water caused by halite deposits. But the results of the survey revealed that all 24 of the public deep wells constructed by UNICEF and USAID have no saline water and the water quality is within the WHO drinking water standard. The results of the core boring investigation and the survey of the existing deep wells also clarified that the aquifer in the higher portion of the hills are thin due to the presence of impervious layers of the Mesozoic era near the ground surface and that the lower portion of the hills are thick since impervious layers extend deeper underground. Thus, the locations of the Project wells should be placed in the lower portion of the hills.

In accordance with the request of the Lao Government, the Project intends to construct the water supply facilities, including the provision of equipment and materials for operation and maintenance. Construction machinary should be excluded. The Basic Design Study includes the following facilities:

(1) Water Supply Systems

The water supply facilities with public faucets were determined most suitable for the sites with a high population density and an ability to pay the electricity charges for the submersible pumps.

(2) Deep Wells with Handpumps

Deep wells with handpumps were planned to be constructed with at least one in every village as a presupposition. The depth of the planned wells were determined based on the results of the geological survey, the core boring investigation, the electrical resistivity survey, and the depth of the existing deep wells which range from 15 m to 50 m.

(3) Maintenance Center

A maintenance center consisting of an office, a warehouse, a repair room and a vehicle garage was planned for the operation and maintainance of the completed water supply systems. The following items are also planned to be supplied through the Project.

- Vehicles for Operation and Maintenance
- Equipment and Materials for Repair
- Water Quality Analysis Equipment
- Spares and Spare Parts

In addition, the training for technology transfer on the repair of handpumps, water quality analysis methods, the formation of an organization for operation and maintenance, and the establishment of data base of well inventories for the officials of the CWI, the MODH and Vientiane Province will be conducted. The contents of the Detailed Design are shown in Table 1-1.

Regarding the Project cost, the maintenance cost undertaken by the Lao side is estimated to be 10.5 million kip/year. The total project period will be about 17 months, consisting of a period of five months for the detailed design and tendering and contract; 12 months for construction, manufacturing, transportation, actual construction, trial operation and arrangement.

The implementation of the Project is considered to have the potential to strongly influence the development of rural water supply in the Lao PDR.

The completion of the Project will contribute to supply water to 51 villages and 1 area (Maintenance Center) with the population of about 44,893 people living in the three districts of Vientiane province.

The Project was judged to be reasonable for the implementation by the Japanese Grant Aid Program since the coordination with the Project and the National Development Plan of the Lao PDR was confirmed and there is no objection regarding the project implementational/operational and maintenance set-up and budgetary status of the implementing agencies.

Table 1-1-A Contents of Basic Design

1. Water Supply System with Public Faucets	2. Deep Well with Handpump
(1) Planned Project Sites	
Number of Villages: 4 Village + 1 M.Center	Number of Villages: 47
Served Population : 7,349	Served Population : 35,111
(2) Water Supply Facilities	
1) Design Criteria of Deep Wells	
・Planned Pumping Rate : 46 lit/min/well ・Operation Heurs of Submerisble Pump : 8 - 10 hours/day Pump Structure : Open hole method /Gravel Packing /Cement Shield ・Casing Diameter : 6" ・Screen Length : 20% of Total Well Depth ・Well Depth : 15 ～ 50 m	・Served Population : 200/well ・Well Structure :Open Hole Method /Gravel Packing /Cement Shield ・Casing Diameter : 4" ・Screen Length : 20% of Total well Depth ・Well Depth : 15 ～ 50 m
2) Design Criteria of Water Supply Facilities	
・Target Year : after 5 Years (1998) ・Planned Population : Population Graft Ratis 5 %, 16 % up of present population ・Per Capita Per day: 60 lpcd ・An Average Daily Water Consumption Planned Pop. ×Average Unit Consumption/day ・Maximum Daily Water Consumption / 1.3 ×Average Daily Water Consumption	

Table 1-1-B Contents of Basic Design

1. Water Supply System with Public Faucets	2. Deep Well with Handpump
2) Design Criteria of Water Supply System	
・Maximum Hours Water Consumption 2.5 ×Average Daily Water Consumption ・Water Pressure 3.5 m Height in Faucet located /Gravel Packing in the rim of Distribution Dipeline	
3) Facility Design	
・Storage Tank : 1/4 Volume of Maximum Daily Water Consumption ・Transmission Pipeline : GI pipe ・Distribution pipe : PVC ・Well Casing, Screen : PVC ・Pump : Submerrible Pump	・Well Casing, Screen : PVC ・Pump : India Mark Ⅲ
(3) Maintenance Center (Total floor area 320 ㎡ excluding Garage Space)	
・Office, Meeting Room, Library 130㎡, Warehouse 90㎡, Workshop 40㎡ ・Others (Chief's Room, Toilet) 60㎡ ・Garage Space 90㎡	
(4) Vehicles	
・Pickup : 1 Unit ・5 tons truck with 1.5tons Hydraculic Pressure Unic : 1 Unit ・Motorcycle (125 cc) : 2 Units	
(5) Equipment and Materials	
・Spare (PVC pipe, Handpump, Water Meter, etc.) ・Spare Parts (Spare Parts for Handpump, etc) ・Repair Equipment (Electric Welding Equipment, glinder, etc) ・Maintenance Equipment (Portablle Compressor, Tripod, etc) ・Distribution : PVC ・Water Quality Analysis Equipment	

LIST OF ABBREVIATIONS

The following abbreviations have heen adopted in this report

Country :

Lao PDR	Lao People's Democratic Republic

Lao government Organizations:

CWI	Clean Water Institute
MOPH	Ministry of Public Health
MCTPC	Ministry of Communication, Transport, Post and Construction
MOF	Ministry of Finance
MACF	Ministry of Agriculture and Forests
NWC	National Water Council
NPL	Nam Papa Lao
NIHE	National Institute for Hygiene and Epidemiology
PNPs	Provincial Nam Papa
SCPC	State Committee for Planning and Cooperation

Others

ADB	Asian Development Bank
GOJ	Government of Japan
HEC	Hydropower Engineering Consultants
JICA	Japan International Cooperation Agency
LWU	Lao Women Union
MPO	Master Plan of Operations
UNICEF	United Nations Development Programme
USAID	United States Agency for International Development
WHO	World Health Organization
Village No.	Village Number in the Original Plan Requested by Lao PDR

Technical Terms

Cl	Chloride
Ca-H	Calcium Hardness

CP	Casing Pipes
E.C.	Electric Conductivity
Level I	Deep Well With Handpump
Level II	Water Supply Systme with Public Faucets
Level III	Water Supply System with House Connection
NH^4	Ammonium
No^2	Nitrite
PVC	Polyvinyl Chloride
T-H	Total Hardness
T-Fe	Total Iron
W.Q.	Water Quality

Units of Measurement

%	Percent	-Rate Unit
°C	Degree celsius	-Temperature Unit
mm	Millimetre	-Length Unit
cm	Centimetre	-Length
m	Metre	-Length Unit
m_2(sq.m)	Square metre	-Area Unit
Km_2	Square kilometer	-Unit Measurement of Area
M_3(w.m)	Cubic metre	-Volume Unit
lit/min	Liter/minutes	-Flow Rate
lpcd	Per capita per day	-Unit Volume of Consume
m_3/day	Cubic metre per day	-Flow Rate

Currency Conversion

1 kips	= 0.16 yen
1 U.S. Dollar	= 116.51 Japanese Yen
1 U.S. Dollar	= 719.81 kips
1 Japanese Yen	= 6.18 kips

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CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

The Government of the Lao PDR is currently implementing the Third Five Year Plan (1992-1996) intends to realize the healthy life for all segments of its population by the year 2000. With the explicit goal of providing more equitable access and distribution of this basic service throughout the country, the Government has drawn 4 major objectives to achieve this goal. They are: 1.Reduction of infant mortality 2.Reduction of maternal mortality 3.Reduction of malnutrition and 4.Improvement in the water supply ratio in rural area.

One of these objectives is to serve safe water for an additional 1 million persons in the rural area and it will achieve 40 % of served popuration ratio in rural area by 1996. To attain this objective, 9 major health projects and another 7 support-related projects were identified including a project on water supply and latrines in the rural area. Specifically, this project targets to give access to safe water supply and hygienic latrines for 10,000 villagers by 1996.

The Government recognizes that the development in the sector of public health lags behind against the country's economic development for the last 5 years. The need to further improvement and accelerate the delivery of water and sanitation services prompted the Government of the Lao PDR to request for grant aid assistance to the Government of Japan (GOJ) for the Project for Groundwater Development in Vientiane Province. The Project involves the conduct of a basic design study covering 80 villages in the 3 districts of the province. The main activities of the study are: 1) field surveys, 2) data analysis, and 3) report preparation. The study was carried out during the period May 17 to October 20, 1993.

The GOJ responded to the request and decided to conduct Basic Design Study, and JICA dispatched a Study Team to the Lao PDR to conduct field surveys. The team is composed of Mr. Shigeki Kobayashi, Team Leader and 4 other experts. Field surveys in Vientiane Province were performed from May 22 to June 25 1993. Survey on the operational status of the existing water supply systems, the water supply condition, the topographical and geological surveys, core boring investigation, electric resistivity survey, pumping test, and other surveys were undertaken in the project area. Interviews to vil-

lagers were also conducted to clarify the village water supply condition. Other field activities includes collection of secondary data on technical, socio-economic and institutional aspects and consultation with CWI and provincial officials. Based on the results of the survey, data analysis and preparation of the draft final report were carried out. Then, discussion with the Lao Government through explanation of this report was held from August 28 to September 8, 1993 and both sides agreed with the contents. This report stipulates the result of verious survey activities. The Composition of the Study Team, Field Work Schedule in the Lao PDR, Local Agencies and Officials Met With, and Minites of Discussion are shown in the Appendices.

CHAPTER 2

BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 Background of the Project

The Lao PDR is composed of 16 provinces including Vientiane Province and Vientiane City. Of the country's total population of 4.14 million, only about 580,000 persons or 14 % live in urban areas. Only Vientiane City and four provincial capitals have water supply systems. These are Vientiane, MoungXai, Louangprabang, Savanaket, and Pakxe. About half of the urban population in the country, or 300,000 persons, have access to water supply facilities. The remaining 50 % depend on private or public wells, spring or river water. On the other hand, the percentage of the rural population having access to clean water is only from 10 to 15%. Most of the village people depend on homemade dug wells without linings and a depth of 5-15m for their domestic water use. A few depend on wells with handpumps.

The water supply condition in Vientiane Province is also relatively poor. There are various types of water supply systems such as dug wells, gravity feed systems, public deep wells, and river/stream water sources which are used by the villagers in the province.

The majority of the rural population in Vientiane Province still depends on dug wells. In areas with very high water tables these dug wells are prone to be contaminated. There are 21 gravity feed systems and all are UNICEF assisted. 19 of these systems are operational and have water all year round and are used for drinking. The total number of users is 13,434 persons with an average number of users of 640 per facility or 40 users per tap. Moreover, the villagers use many public deep wells constructed by UNICEF that are still functioning. As these wells do not go dry during the dry season, they have become a precious water source for each village.

The number of recipients which are supplied by stable water sources such as gravity feed systems and public deep wells are very small in comparison with the total rural population in the province. Thus, most of the population uses shallow dug wells which often dry up in the dry season. The villagers transport water by themselves to their houses from a few shallow or deep wells in distant villages which do not dry up in the dry season, or they buy

water from bottled water production companies. Serious water quantity and quality problems usually occur during the dry season when most of these dug wells dry up. The population, especially the women, have to spend much energy and time in water collection during the dry season.

The incidence of water-borne diseases is at its highest during the dry season due to the shortage of potable water and the usage of shallow well water with poor water quality. According to the MOPH's Third Five Year Plan (1992-1996), half of those who died in 1991 were under the age of five and a high estimate of maternal mortality of 580 per 100,000 live births was given. One of main causes of mortality for persons under the age of five was diarrhea (dysentery and dehydration) due to water-borne diseases, and the main cause of maternal mortality was a lack of safe water.

In response to the serious water shortage problems and in keeping with the tenets of the United Nation's Water Decade Plan, the Government of the Lao PDR is promoting the development of water supply facilities, aiming at raising the water served population rate from 27 percent to 80 percent by the year 2000. This goal is contained in the country's Third Five Year National Development Plan for the years (1991-1995) as well as in the MOPH's Third Five Year Plan (1992-1996). In the latter plan, water supply infrastructure development is among the 4 major objectives. These objectives are: 1.Reduction of infant mortality 2.Reduction of maternal mortality 3.Reduction of malnutrition and 4.Improvement in the water supply ratio in rural area. Further, the goal is to attain an improved health and welfare status of both the urban and rural populace through the provision of a safe and sufficient water supply following the international time-frame set by the United Nations.

This Project is in conformity with these National Development Plans, and the implementation of the Project will contribute to the improvement of the villager's living standard and health.

Regarding water-related matters, a number of ministries in the national government of the Lao PDR are also involved. These ministries are as follows:

- the Ministry of Communication, Transport, Post and Construction (MCTPC)
- the Ministry of Public Health (MOPH)

- the Ministry of Finance (MOF)
- the State Committee for Planning and Cooperation (SCPC)
- the Ministry of Agriculture and Forests (MACF)

With the overlapping of functions of these different ministries/agencies, no single agency is responsible for management, project coordination and regulation of water utilization, waste water re-use or disposal. The formation of a National Water Council (NWC) has been recommended to serve as the coordination and regulatory body for the various activities of the water supply and waste disposal sector. The existing administrative structure for water supply and sanitation is shown in Figure 2-1.

The MCTPC is responsible for urban water supply and sanitation policies and projects. Under this ministry is the Department of Construction and Urban Planning which is responsible for the operations and policies of the Nam Papa Lao (NPL) under the Vice-Minister for Construction. Before February 1991, the activities of NPL were limited to Vientiane City but this was then expanded to include all provincial urban water supply facilities, previously known as the Provincial Nam Papa (PNPs).

The implementation agency of the Project is the Ministry of Public Health, in cooperation with Vientiane Province. Activities of the rural water supply development programs and the other related policies are under the jurisdiction of the MOPH through the National Institute for Hygiene and Epidemiology (NIHE). There are a total of 16 departments under the MOPH with a staff of approximately 1,500. Of this number, 68 persons are assigned to the NIHE. The organization chart of the MOPH is shown in Figure 2-2.

For this Project, technical activities will be conducted by the CWI. Under the NIHE, is the CWI, with a staff of 68 persons, which coordinates rural water supply development activities and provides for training and technical assistance. The organizational chart of the CWI is shown in Figure 2-3. The total staff complement of the CWI is 26.

The CWI is divided into two technical sections: 1) the Surface Water Section, and 2) the Groundwater Section. The primary duty and responsibility of the Surface Water Section, with a staff of six, is providing technical

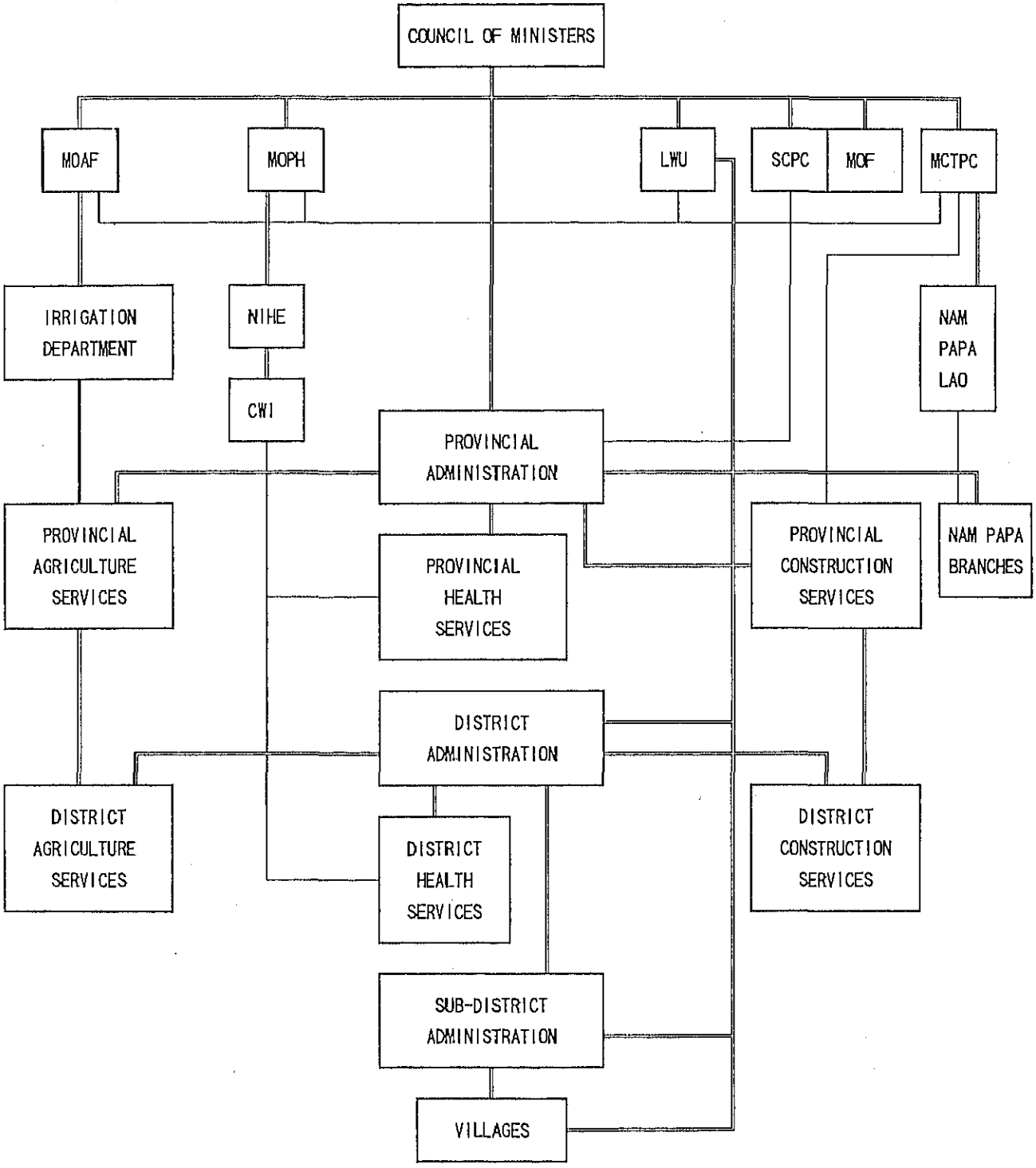


FIG. 2-1
EXISTING ADMINISTRATIVE STRUCTURE FOR WATER SUPPLY AND SANITATION

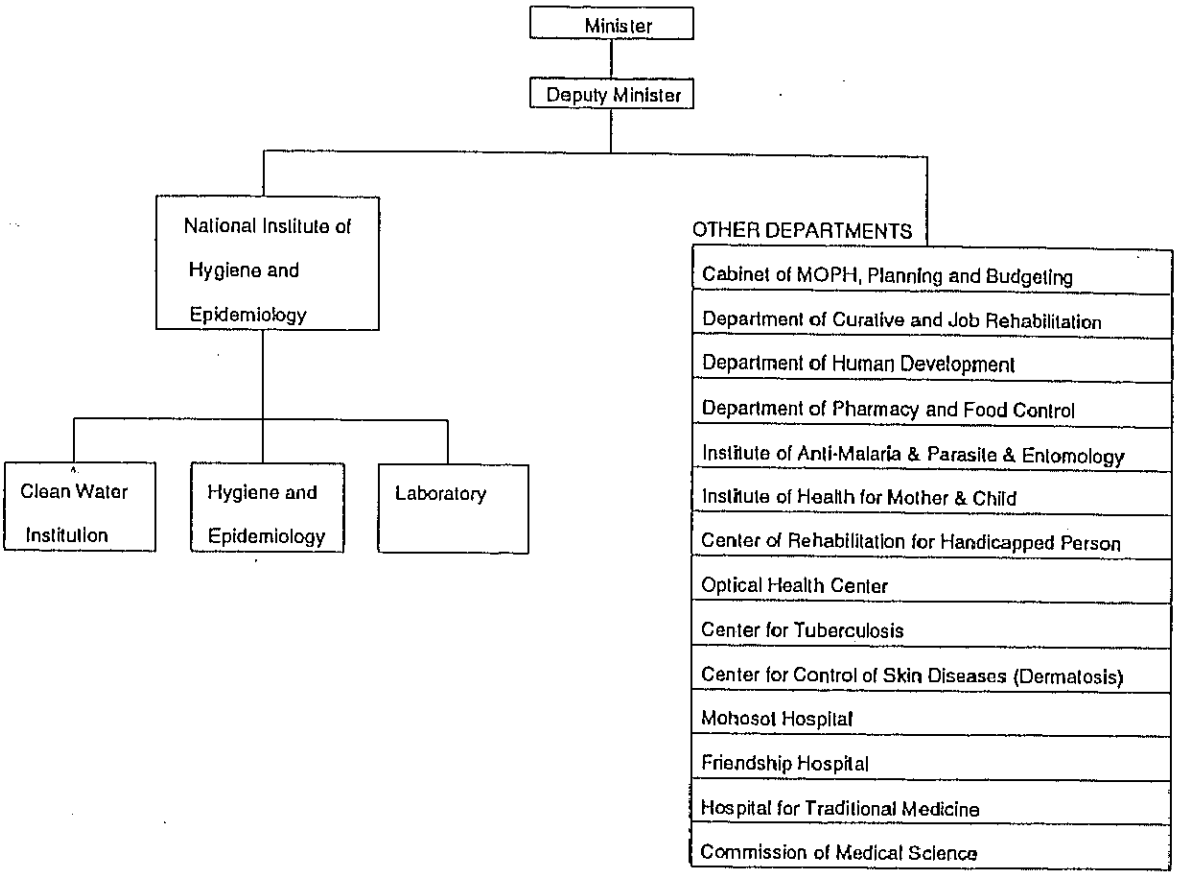
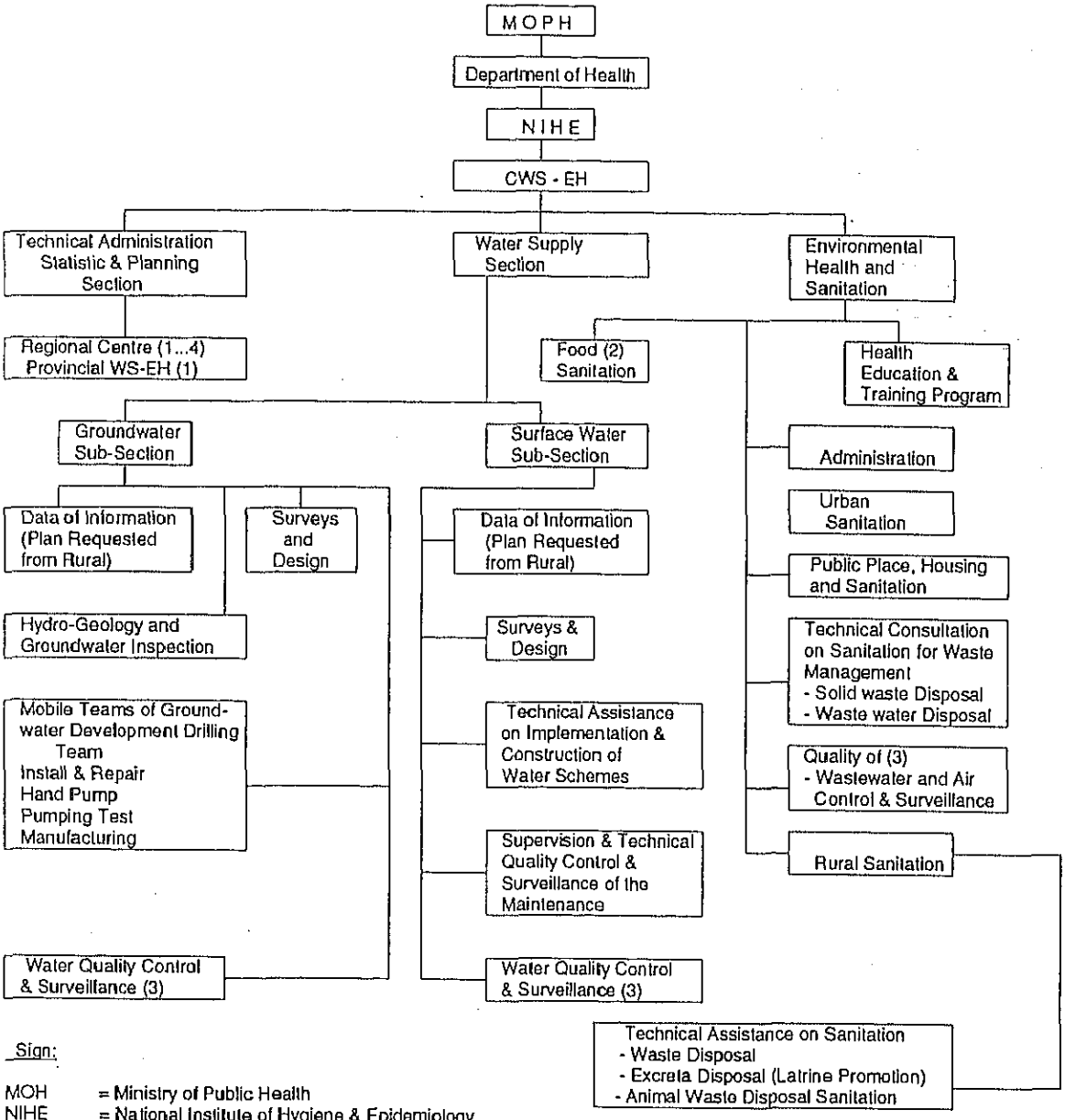


FIG. 2-2

ORGANIZATION CHART FOR MINISTRY OF PUBLIC HEALTH



Sign:

MOH = Ministry of Public Health
NIHE = National Institute of Hygiene & Epidemiology
CWS-EH = Centre for Water Supply & Environmental Health
WS-EH = Water Supply & Environmental Health

FIG. 2-3
ORGANIZATION CHART FOR CLEAN WATER INSTITUTE

assistance at the provincial and district levels, such as the survey of natural water sources and the design of piping systems. On the other hand, the primary duty and responsibility of the Groundwater Section, with a staff of five, is providing technical assistance regarding drilling techniques to the provincial and district technicians and supervising and consulting with the technicians at all levels on the installation of the different types of handpumps and their maintenance. This activity is directly relevant to the Project.

Another cooperation agency for the implementation of the Project is the Provincial Public Health, Water Supply and Sanitation Section. The Provincial Public Health conducts surveillance and control of diseases and promotes diseases prevention. There are about 45 persons working with the Provincial Health Office. The Water Supply and Sanitation Section has three engineers at the moment. Engineers/technicians are constructing wells and assisting in the maintenance of wells in the villages. Figure 2-4 presents the organizational chart of Vientiane Province, and Figure 2-5 shows the Health Organizational Structure of Vientiane Province.

2.2 Outline of the Request

This Project was requested to the Government of Japan for its grant-aid cooperation by the Government of the Lao PDR in June 1991, for the purpose of providing safe and sufficient water to the villagers in Vientian Province, who are suffering from a lack of water during the dry seasons, through the construction of water supply facilities utilizing groundwater resources. The request included the construction of 350 shallow wells, two deep wells with elevated tanks and distribution systems, and the provision of drilling rigs. After evaluating the requested components, the Japanese side determined to follow the recommendation of the preliminary study team that alternatives to the shallow wells requested by the Lao PDR be considered since the planned well sites potentially had the problem of salty water.

Soon thereafter, before the preliminary study team left for Vientiane province, the Lao PDR government reconsidered the perviously mentioned requested contents, and resubmitted a revised request, consisting mainly of deepwell construction, in August 1992. The contents included 100 deepwells with handpumps in 80 villages in the southern three districts.

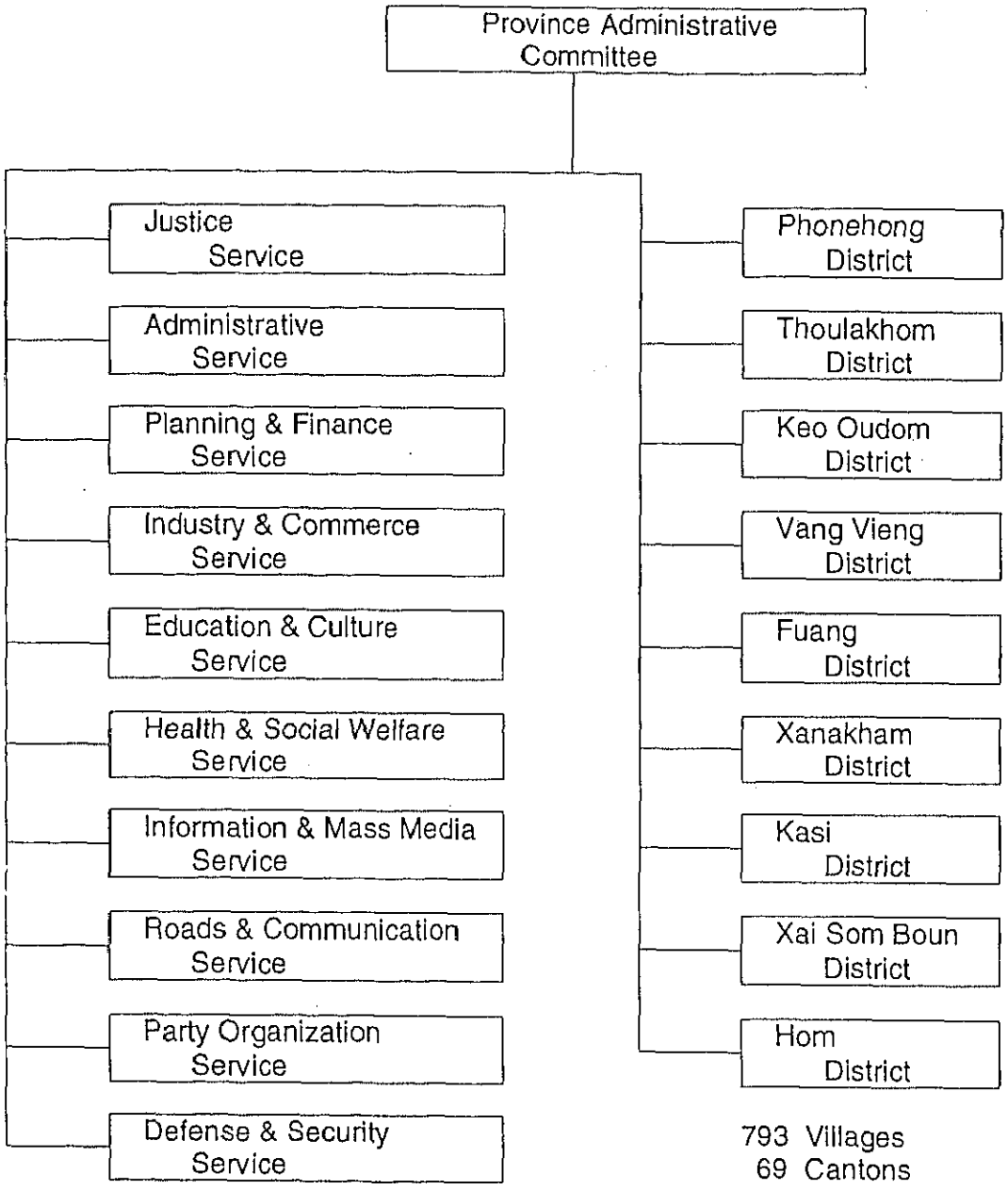


FIG. 2-4
ORGANIZATION CHART FOR VIENTIANE PROVINCE

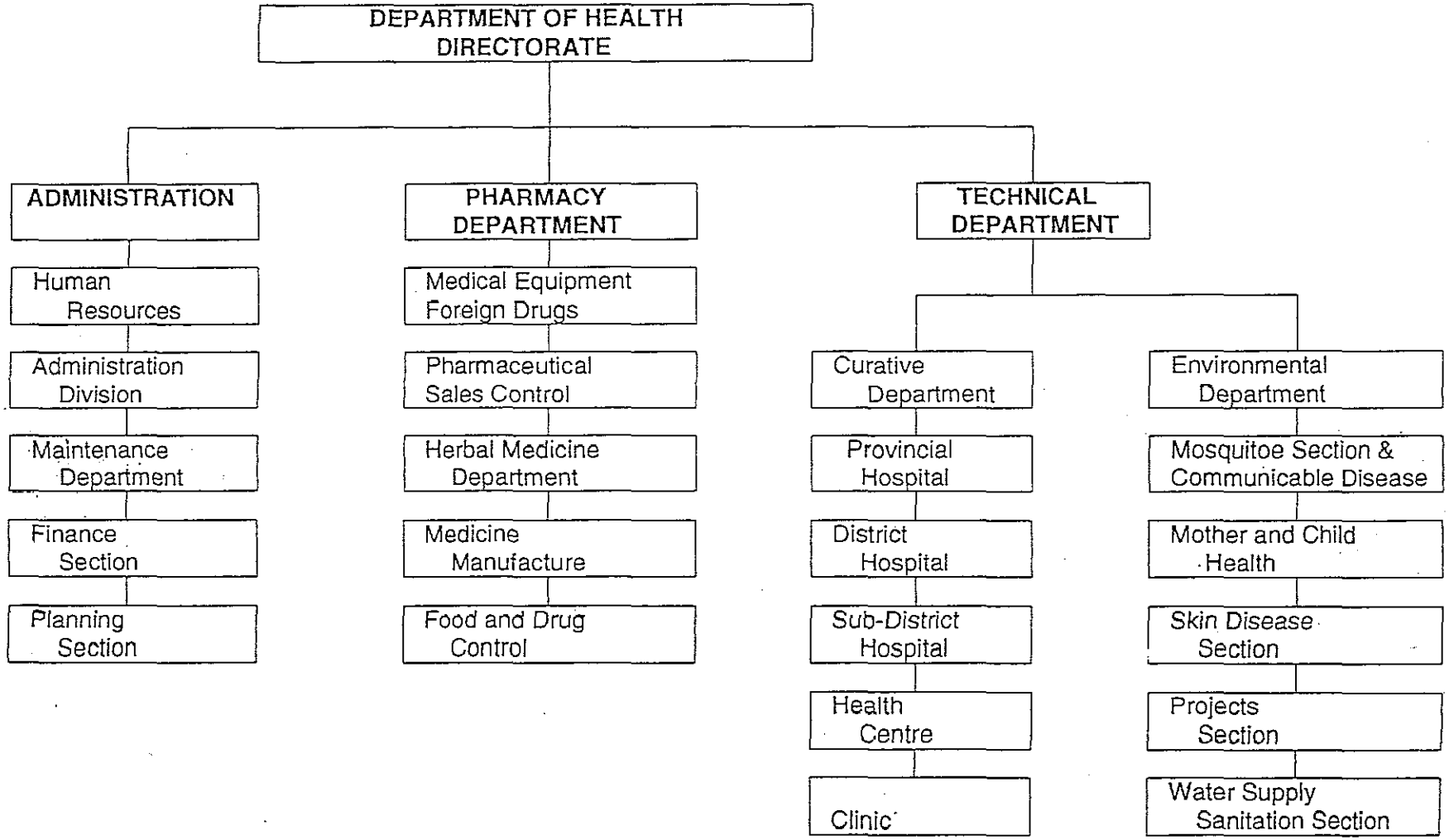


FIG. 2-5
ORGANIZATION CHART FOR PUBLIC HEALTH DEPARTMENT IN VIENTIANE PROVINCE

As the revised contents basically coincided with the recommendations of the Japanese side in terms of the employment of deepwells instead of shallow wells, the preliminary study was executed according to the revised request. Considering the current situation of water supply, the Lao PDR requested the Project for Groundwater Development in Vientiane Province, be based on the request for the project implementation listed 80 villages. The list categorizes each village in the priority of A,B,C,D due to the urgent necessity of water supply in certain villages. The requested villages' name for the Project are shown in Table 2-1, and their locations in Figure 2-6. The explanation of each priority level is as follows;

Priority A: Villages with few shallow wells. All of them will go dry during the dry seasons.

Priority B: Villages with mixed shallow wells. Most of them will go dry during the dry seasons, the rest will not be sufficient for use.

Priority C: Villages with a few shallow wells and some deep wells, but the water quality is very bad.

Priority D: Villages with some shallow wells which do not dry up in the dry season, but the water quality is poor.

As a result of the survey on village water supply conditions, these categories were confirmed to be reasonable.

In addition, based on the results of the preliminary study, the target area of the Basic Study was determined to be limited to the three southern districts of Vientian Province. The implementing agencies in the project (the Clean Water Institute (CWI) and Vientiane Province) do not include Vientiane City in their administrative area, and therefore the two districts north of Vientian City could not be included in the study. As an alternative, piped water supply systems with public faucets would be considered reasonable instead of deepwells with handpumps with a depths of 50 meters. When clarifying the size of the Project, it is necessary to prioritize the 80 villages based on the relative urgency of new water supply facilities during the dry seasons. This prioritization was made by the Lao PDR.

In the preliminary study, the Project was determined to be reasonable and the minutes of discussion was exchanged between the Lao PDR and the mission.

Table 2-1-A List of 80 villages requested by the Lao Government

No.	District	Village	Priority	Remarks
1	Phong Hong	Nam Tcheng	A	
2	—	Phonsi Tai	A	
3	—	Nam Linh	A	
4	—	Phon Hong	C	
5	—	Phon Kham	C	
6	—	Nong'Kork	C	
7	—	Phon Xay	C	
8	—	Phon Ngam	C	
9	—	Na Pho Neua	C	
10	—	Nam Chiim	B	
11	—	Phon Ho	B	
12	—	Na Moung	B	
13	—	Nong Tao	B	
14	—	Na Kaam	B	
15	—	Na Xom	B	
16	—	Sen Saat	B	
17	—	Phia	B	
18	—	Phon Si Neua	B	
19	—	Sen Xoum	B	
20	—	Phon Keo Phon Ngeun	B	
21	—	Kham	C	
22	—	Gnoat	C	
23	—	Na Song	C	
24	—	Si Boun Heuang	C	
25	—	Na Xou	D	
26	—	Na Lou Khoun	D	
27	—	Na Gnang	D	
28	—	Na Souak	D	
29	—	Phon Haii	B	
30	—	Phon Sawath	C	
31	—	Na Lao	B	
32	—	Phon Tha	C	
33	—	Phon	C	
34	—	Na Thong	C	
35	—	Sovalaii	B	
36	—	Maii	B	
37	—	Na Thep	C	
38	—	Phon Xaii	C	
39	—	Na Lao	C	
40	—	Ek Xang	B	
41	—	Phon Than	B	
42	—	Lak Hasiv Song	A	
43	—	Phon Kham	A	
44	—	Nong Nak	A	
45	—	Na Bon	C	

Table 2-1-B List of 80 villages requested by the Lao Government

No.	District	Village	Priority	Remarks
46	Phong Hong	Vang Konh	B	
47	—	Saka	B	
48	—	Phon Ngang	B	
49	—	Phon Savang	B	
50	—	Phon Ngeun	B	
51	—	Phon Kham	C	
52	—	Na Xay	C	
53	—	Phon Sida	C	
54	—	Phon Xong	C	
55	—	Phon Mii	C	
56	—	Na Pho Taii	B	
57	—	Samboun	B	
58	Thoulakhom	Hong Hien Sueb Thod	A	
59	—	Pakcheng Neua	B	
60	—	Moung Khao	B	
61	—	Pak Cheng	B	
62	—	Dong Koat	B	
63	—	Thin Gnung	C	
64	—	Vieng Kham	C	
65	—	Pak Ka Gnung	B	
66	—	Keun	A	
67	—	Nam Ang	C	
68	—	Na Xang Leuk	C	
69	—	Na Fay	D	
70	—	Na Kang	D	
71	—	Pak Hang	C	
72	—	Na Pheng	D	
73	—	Hai Gnon	B	
74	—	Dong	D	
75	Keo-Oudom	Napoune	A	
76	—	Thasun	A	
77	—	Thalat	A	
78	—	Thinkeo	A	
79	—	Phoukaokham	A	
80	—	Phonekham	A	

Priority : A=1st. priority 14 villages C=3rd. priority 28 villages
B=2nd. priority 30 villages D=4th. priority 8 villages

Total 80 villages

KEO-OUDOM

PHON HONG

THOULAKHOM

Nam Ngum

Nam Ngum

Nam Ngum

LEGEND	
Boundary of Province	—— - ——
Scope of Work	●
Other Project	○
Excluded due to geological condition	⊗

FIG. 2-6

LOCATION MAP OF REQUESTED 80 VILLAGES

In response to the result of the study, the Japanese Government decided to conduct a Basic Study and JICA sent a Basic Study Team in May of 1993. They were to discuss matters with the CWI (under the MOPH) and Vientiane Province, regardind the organizational set-up for the water supply project implemantation, the maintenance status and organizational set-up for the management for the existing water supply facilities, water quality, the operational status of existing well drilling equipment etc.. Besides this, a field survey, interviews and an investigation on the operational status of the existing wells were carried out in 80 villages within the proposed project sites. A core-sampling survey on 6 sites with depths of 50 m. Additionally, an electric resistivity survey was also performed to examine the hydrogeological conditions of the area. Using data from the Basic Study, the basic design was drawn up in Japan and therein established the proposed implementation plan of the project.

During the study period, an incidental request, including a maintenance center building, maintenance vehicles, maintenance tools, water analysis device, spares and spareparts was submitted to the Government of Japan from the Government of the Lao PDR for the operation and maintenance of the completed facilities. Accordingly, based on examination of the necessity of the additional request, these were included in the Project.

2.3 Outline of the Project Area

2.3.1 Water Supply Condition

(1) Water Supply Situation

The water service situation in the target area is not satisfactory and people mostly depend on open dug wells, rivers, and springs, all of which have problems in water quality. According to an interview survey conducted by this study, most of the villages have dry wells during the dry season and the villagers have to fetch water from a neighboring well or village. In addition to the lack of caution regarding microorganic contamination, the majority of the existing well water is of poor quality and is usually turbid. The fact that water-borne diseases were prevalent last year in some villages, is due to very poor water quality, causing some villagers to depend on bottled water for their drinking water. Table 2-2 tabulates

TABLE 2-2-A Summary Results of Village Level Survey on Selected Socio-Economic Indicators, June 1993

District/Village	Population	H/H	Institution	Main Product	Main Feature	Electricity	Density of Houses	Average Monthly Income (K/M/HH)	Affordability to Pay (K/M/HH)	Present Water Supply Condition & Need of Well Construction	Priority
PHONHONG											
1. Nam Tcheng	664	115	1 elem sch; 146 students	rice, textile	agricultural	yes – 3 phase	high	29,000	250	5 dugwells of 4–5 m, which reach rock villagers use infiltration water in dug holes during dry season because of dry dugwells.	A
2. Phonsi Tai	713	120	post ofc, communication, bank, construction 2 elem sch; 737 students 1 Jr. HS; 495 students 1–32 bed hospital	rice	agricultural, commercial, residential	yes – 3 phase	high	40,000 – 50,000	500 – 600	6 dugwells dry up during dry season; at the old time, there was a Level II system.	A
3. Nam Linh	687	115	village hall	rice, livestock, vegetables	agricultural, commercial, residential	yes – 3 phase	high	50,000 – 20,000	500 – 200	32 dugwells; drinking boiled water and bottled water.	A
4+6 Phon Hong, Nong Kork (1991 merged)	1,635	278		rice, livestock, vegetables	commercial, public building	yes – 3 phase	very high	100,000 – 40,000	500 – 400	18 dugwells, one dugwell completed by UNICEF in 1985 is operational.	C
5. Phon Kham	543	98	none	rice, livestock, vegetables	agricultural	yes – 3 phase	medium	40,000 – 20,000	400 – 200	4 dugwells dry up in dry season; villagers fetching water from nearby villages; drinking boiled and bottled water	C
7. Phon Xay	786	136	none	rice, livestock, vegetables, handicraft	agricultural, commercial, residential	yes – 3 phase	high	50,000 – 20,000	500 – 200	30 dugwells, quality–red color/turbid drinking boiled water (30% of villagers) and bottled water (70%).	C
8. Phon Ngam	350	59	1 elem sch; 199 students	rice, livestock, vegetables	agricultural, commercial, residential	yes– 3 phase	high	50,000 – 30,000	500 – 300	15 dugwells.	C
9. Na Pho Neua	385	62	1 elem sch; 57 students	rice, livestock, vegetables	agricultural	none	medium	20,000	20,000	28 dugwells, drinking boiled water	C
10. Nam Chiim	212	28	1 elem sch; 42 students 1 JR. HS; 252 students	livestock, vegetables	agricultural	none	medium	70,000	700 – 150	6 dugwells	B
11. Phon Ho	310	56	1 elem sch; 96 students	livestock, vegetables	agricultural	none	high	20,000	200	8 dugwells, drinking boiled water	B
12. Na Moung	502	62	1 elem sch; 90 students	rice, vegetable (melon, bean)	agricultural	none	high	33,000	200	24 dugwells	B
13. Nong Tao	256	35	none	rice	agricultural	yes – 3 phase single	high	25,000	200	23 dugwells	B
14. Na Kaam	275	42	none	rice, vegetable	agricultural	none	high	21,000	100	17 dugwells	B
15. Na Xom	446	64	1 elem sch; 74 students	rice, aquaculture	agricultural, aquaculture	yes	high	42,000	200	3 dugwells dry up during dry season; fetch water from nearby villages; quality– high turbidity	B
16 Sen Saat	187	32	1 elem sch; 220 students 1 HS; 300 students	rice, vegetables	aricultural	yes – 3 phase single	low	25,000	100	7 dugwells, existing deep well encountered to rock in a depth of 30 m	B
17. Phia	211	41	none	rice	agricultural	yes – 3 phase single	high	17,000	200	All dugwells dry up during dry season; villagers fetch water in villages located 600 m away.	B
18. Phon Si Neua	236	37	none	rice, fruits	agricultural	yes – single	high	13,000	100	All 2 dugwells dry up during dry season, it is serious in April & May	B

(Data sheets of interview survey)

TABLE 2-2-B Summary Results of Village Level Survey on Selected Socio-Economic Indicators, June 1993

District/Village	Population	H/H	Institution	Main Product	Main Feature	Electricity	Density of Houses	Average Monthly Income (K/M/HH)	Affordability to Pay (K/M/HH)	Present Water Supply Condition & Need of Well Construction	Priority
19. Sen Xoum	886	137	1 elem sch; 223 students	rice, vegetables, handicraft	agricultural (irrigation reservoir)	yes – 3 phase single	very high	25,000	200	63 dugwell	B
20. Phon Keo Phon Ngeun	461	85	1 elem sch; 160 students 1 Jr HS; 350 students	rice, vegetables, handicraft	agricultural	none	high	42,000	200	Dugwells dried up during dry season; 1 abandoned deep well due to lack of spare parts	B
21. Kham	600	130	1 elem sch; 258 students	rice, vegetable	agricultural	none	high	29,000	100 – 200	6 dugwells dry up during dry season; water quality at the beginning of rainy season – turbid.	C
22. Gnoat	209	33	none	rice, vegetable	agricultural	none	high	18,000	200	10 dugwells, lowering of well water level causes water shortage.	C
23. Na Song	221	34	none	rice, vegetable, livestock	agricultural	yes	medium	15,000	150	7 dugwells, a deep well completed by USAID in 1966 was abandaned due to broken of pumprod.	C
24. Si Boun Heuang	806	140	1 elem sch; 300 students 1 JR HS; 160 students	rice, livestock, vegetable	agricultural, commercial residential	yes – 3 phase	medium	70,000 – 30,000	700 – 300	50 dugwells. 2 deep wells were constructed in 1987.	C
25. Na Xou	545	88	none	rice, livestock, vegetable	agricultural	yes – 3 phase	high	10,000	100	36 dugwells, about 50 % of villagers drink boiled water.	D
26. Na Lon Khoun	460	53	none	livestock, vegetable, Lao vodka, handicrft	agricultural, commercial	yes – 3 phase	medium	40,000	400	All 7 dugwells dry up during dry season; villagers buy water from nearby village.	D
27. Na Gnang	593	85	1 elem sch; 160 students	rice, livestock, vegetable, handicraft	agricultural	yes – 3 phase	very high	30,000	300	2 dugwells, water level lowers to the well bottom during dry season. One of two deep wells dry up during dry season.	D
28. Na Souak	198	32	none	rice, livestock, vegetable, Lao vodka	agricultural	yes – 3 phase	medium	10,000	100	5 dugwells all dried up; villagers fetch water from nearby village; drinking boiled water (50 % of villagers)	D
29. Phon Hai	173	28	none	rice livestock, Lao vodka	agricultural	yes – 3 phase	low	15,000	150	17 dugweels, drinking boiled water (most villagers)	B
30. Phon Sawath	658	105	1 elem sch; 365 students	livestock, Lao vodka, handicraft	agricultural, commercial	yes – 3 phase	high	70,000 (40,000 – store; 20,000 – farmers)	700 – 200	3 dugwells all dried up; 1 deep well constructed by USAID in 1966 is operational.drinking boiled water(50%)	C
31. Na Lao	624	207	none	rice, livestock, vegetable	commercial, public building	yes – 3 phase	high	30,000	300	5 dugwells, 2 deep wells completed in 1966 are operational.	B
32. Phon Tha	333	38	1 elem sch; 84 students	rice, livestock, vegetable, Lao vodka	agricultural	yes – 3 phase	high	15,000	150	23 dugwells, a deep well completed by USAID in 1996 is operational. Villagers collect 100 kip/HH at the repair time.	C

(Data sheets of interview survey)

TABLE 2-2-C Summary Results of Village Level Survey on Selected Socio-Economic Indicators, June 1993

District/Village	Population	H/H	Institution	Main Product	Main Feature	Electricity	Density of Houses	Average Monthly Income (K/M/HH)	Affordability to Pay (K/M/HH)	Present Water Supply Condition & Need of Well Construction	Priority
33. Phon	693	105	1 elem sch; 91 students	rice, livestock, handicraft,	agricultural	yes – 3 phase	very high	30,000	300	All 15 dugwells dry up. 3 deep wells constructed by USAID in 1966 are operatioal. 50 kip/HH/month for repair	C
34. Na Thong	574	92	1 elem sch; 175 students	rice, livestock, vegetable, Lao vodka	agricultural	yes – 3 phase	very high	30,000	300	3 dugwells	C
35. Sivilai	449	80	none	rice	agricultural	yes	low – middle	people borrowing money and returning after harvest	---	Most of 13 dugwells dry up.	B
36. Mali	1,674	254	1 elem sch: 432 students	rice, timber, water factory,	agricultural	yes	low – middle	15,000	--- s	100 dugwells, diarrhea is prevalent during dry season.	B
37. Na Thep	200	33	public office	fruit, fish	rocky hill	none	low	30,000	---	3 dugwells dry up during dry season. they fetch water to a nearby irrigation dam with a distance of 500 m.	C
38. Phon Xai	1,507	269	1 elem sch: 375 students 1 JR HS; 226 students 2 bed hospital	rice	commercial center	yes	low – middle	10,000	65% of the villagers are poor	Most of 14 dugwells dry up during dry season. They go nearby dam site by tractor to dig and draw infiltrated water	C
39. Na Lao	1,284	211	1 elem sch: 800 students 2 JR HS; 344 students 2 HS; 433 students	rice, textile, labor	center of school education	none	high	6,000	100	9 dugwell dry up during dry season; fetching water to nearby villages and buying bottled water.	C
40. Ek Xang	941	184	1 elem sch; 215 students	rice	agricultural commercial	yes – 3 phase	middle	6,000	---	61 dugwells, water level lowers during dry season and diarrhea is prevalent.	B
41. Phon Than	495	165	1 elem sch: 234 students	rice, livestock	agricultural	yes – 3 phase	high	50,000	200	All 8 dugwells dry up during dry season; villagers fetch water to nearby village	B
42. Lak Hasiv Song	1,765	312	1 elem sch; 512 pupils	rice, vegetable, labor, commercial, labor supply	commercial	yes	very high	very much		All 4 dugwells dry up; villagers fetch water to a nearby village by tractor or buy bottled water.	A
43. Phon Kham	340	62	none	labor, farming, fruits	agricultural	yes	middle	3,000	200	10 dugwells but of poor quality; villagers fetch water to other villages 800 meters apart	A
44. Nong Nak	1,348	230	1 elem sch; 568 students	rice, livestock	agricultural	yes – single	high	10,000	1	Existing well broke down; 20% of villagers buy water from others; selling price: 500 kip/200 lit	A
45. Na Bon	605	104	1 elem sch; 60 students	rice, handicraft	agricultural	yes	middle	40,000	400	5 dugwells	C
46. Vang Monh	1,009	191	1 elem sch; 90 students	rice, handicraft, livestock, peanuts, pineapple	agricultural	yes – 3 phase	high	50,000 – 100,000	enough to pay	80 dugwells, 1 well is being used by 10–20 houses	B
47. Saka	564	86	1 elem scho; 684 student 1 JR HS; 187 students	rice, livestock	agriculture	yes – single	high	200,000 – 500,000	200	18 dugwells of poor quality; villagers fetch water from a spring of 500m distance; drinking raw spring water	B
48. Phon Ngang	700	102	1 elem sch; 637 students 1 JR HS; 245 students	rice, handicraft	agricultural	yes	high	50,000	100	44 dugwells, villagers dig deeper because water level fairy lowers during dry season.	B
49. Phon Savang	767	116	1 elem sch; 203 students	rice	agricultural	yes – 3 phase	high	3,000	100	3 dugwells, water level fairly lowers during dry season. Villagers use dam water but not for drinking.	B
50, 51 Phon Ngeun	629	127	1 elem sch; 130 students	rice	farming slush and burn farming	yes – 3 phase	middle	13,000	100	All 5 dugwells dry up during dry season, villagers fetch water from nearby village; quality – turbid during all season.	B and C
52. Na Xay	632	62	none	rice, vegetable, fruits, textile	agricultural	yes – single	high	100,000	2,000 – 3,000	All wells dry up during dry season; villagers fetch water from river. wall of dugwell apt to easily collapse.	C

(Data sheets of interview survey)

TABLE 2-2-D Summary Results of Village Level Survey on Selected Socio-Economic Indicators, June 1993

District/Village	Population	H/H	Institution	Main Product	Main Feature	Electricity	Density of Houses	Average Monthly Income (K/M/HH)	Affordability to Pay (K/M/HH)	Present Water Supply Condition & Need of Well Construction	Priority
53. Phon Sida	259	38	none	rice, livestock, vegetable, Lao vodka	agricultural	yes – 3 phase	high	30,000	300	Most of 10 dugwells dry up during dry season. A dugwell constructed by UNICEF in 1966 had operated until 1992.	C
54. Phon Xong	1,026	175	1 elem sch; 175 students	rice, livestock, vegetable, handicraft	agricultural, residential	yes – 3 phase	high	50,000 – 20,000	300 – 200	13 dugwells	C
55. Phon Mii	2,454	335	1 elem sch; 580 students 1 JR HS; 592 students	rice, livestock, vegetable	commercial, public building	yes – 3 phase	high	100,000 – 200	500 – 200	50 dug wells. 3 deep wells completed by USAID in 1966 are non-functioning.	C
56. Na Pho Tai	3,650	284	1 elem sch; 400 students 1 JR HS; 400 students	rice, fruits, livestock	agricultural	yes – 3 phase single	middle	7,000	300	71 dugwells	B
57. Samboun merged into Ban Nong Nak in 1989											
SUB-TOTAL	38,730	6,187									
THOULAKHOM											
58. Hong Hien Sueb Thod	student 400 villager 240	40	vocational and technical schools	---	educational area	yes – 3 phase	middle	---	---	Two deep wells functioning but insufficient.	A
59, 60. Pakcheng Neua	2,203	373	1 elem sch; 640 students	rice, vegetables	old village	yes	high	29,000	300; 2,000 – 3,000 for piping system	Most of 13 dugwells dry up during dry season, especially, increased their their depth in 1993.	B
61. Pak Cheng	669	110	1 elem sch; 91 students 1 JR HS; 229 students	rice, vegetables	agricultural	yes – single	high	58,000	200	34 dugwells; well wall apt to collapse due to nature of soil; water level links with river water level.	B
62. Dong Koat	370	114	1 elem sch; 195 students	rice, vegetable	agricultural	yes – single	low – middle	42,000	200	One dugwell; color – yellow or orange); use river water and drink after boiling	B
63. Thin Gnung	1,200	185	1 elem sch; 300 students 1 JR HS; 120 students	rice, vegetable, fruits	agricultural	none	low	25,000	200 – 300	40 dugwells but sometimes dried up during dry season; quality with iron content, sand or silt; villagers fetch water in river.	C
64. Vieng Kham	532	80	1 elem sch; 160 students	rice, vegetable	agricultural	none	low	17,000 – 25,000	100	33 dugwells, villagers hope deep wells are constructed in elementary school.	C
65. Pak Ka Gnung	1,896	314	1 elem sch; 462 students 1 JR HS; 171 students	rice, livestock, vegetables, fish, fruits	agricultural	yes – 3 phase	high	50,000 – 30,000	500	47 dugwells but all dry up during dry season; villagers fetching water boiled/ bottled water.	B
66. Keun village has been decided to be assisted by the French government, thus cancelled from the Grant aid of Japan. French project implementation willstart in 1994											
67. Nam Ang	350	53	1 elem sch; 102 students	livestock, vegetable	agricultural none	none	low	10,000	100	8 dugwells	C
68. Na Xang Leuk	292	40	1 elem sch; 100 students	livestock, vegetables	agricultural	none	low	20,000 – 15,000	200 – 150	1 dug well dry up during dry season. drinking boiled/ bottled water	C
69. Na Fay	545	87	1 elem sch; 396 students 1 JR HS; 175 students	rice, livestock, vegetable, handicraft, brick mfrg.	agricultural	none	high	30,000	300	Most of 19 dugwells dry up during dry season.	C

(Data sheets of interview survey)

TABLE 2-2-E Summary Results of Village Level Survey on Selected Socio-Economic Indicators, June 1993

District/Village	Population	H/H	Institution	Main Product	Main Feature	Electricity	Density of Houses	Average Monthly Income (K/M/HH)	Affordability to Pay (K/M/HH)	Present Water Supply Condition & Need of Well Construction	Priority
70. Na Kang	486	75	1 elem sch; 115 students	rice, livestock, vegetable	agricultural	none	medium	70,000 – 30,000	700 – 300	5 dugwells of 4-5 m, which reach rock. Most of 5 dugwells dry up during dry seeson.	C
71. Pak Hang	382	64	1 elem sch; 366 students 1 JR HS; 125 students 1 SR HS; 375 students	livestock, fish	educational	none	middle	50,000 – 20,000	500 – 200	Most of 8 dugwells dry up during dry seeson and well water become turbid.	C
72. Na Pheng	1,040	125	1 elem sch; 372 students 1 JR HS; 204 students	rice, fish, livestock, fruits, vegetable	educational, residential	yes – 3 phase	middle	100,000 – 20,000	500 – 200	20 dugwells, water of 50 % wells contains sand.	D
73. Hai Gnon	368	60	1 elem sch; 282 students	rice, livestock	agricultural	none	middle	100,000 – 20,000	500 – 200	Most of 9 dugwells dry up; villagers fetch water from nearby village.	B
74. Dong	564	96	1 elem sch; 267 students	rice, livestock	agricultural	none	high	30,000	300	7 dugwells	D
SUB-TOTAL	11,297	1,816									
KEO-DUDOM											
75. Nepoune	324	75	1 elem sch; 32 students	rice, livestock, vegetable	agricultural	yes – 3 phase	high	500,000	500	2 dugwells	A
76. Thasun	615	118	1 elem sch; 257 students 1 HS; 289 students	livestock, fish, fruits	agricultural	yes – 3 phase	middle	17,000	200	Most of 10 dugwells dry up. villagers fetch water fron river;	A
77. Thalat	1,346	217	1 elem sch; 307 students	rice, livestock, vegetables	commercial	yes – 3 phase	vert high	70,000 – 30,000	500 – 300	10 dugwells – all dried up; villagers fetch water fron river using booster pump and transport it to their village.	A
78. Thinkeo	1,860	315	1 elem sch; 280 students 1 JR HS; 317 students public hall; 1-466 people	rice, livestock, fish, vegetable	commercial, residential	yes – 3 phase	very high	50,000 – 20,000	500 – 200	14 dugwells, well water level lowers near the bottom during dry seeson. 50% of the population is supplied by province's Nam Papa but quality is not so good because of row water.	A
79. Phoukaokham	2,002	339	1 elem sch; 399 students 1 JR HS; 141 students public hall; 1-150 people	livestock, fish, handicraft	agricultural	yes – 3 phase	very high	20,000	200	no well; villagers fetch water from river; quality is turbid during rainy seeson.	A
80. Phonekham	466	75	1 elem sch; 40 students	livestock, vegetable, fish	agricultural	yes – 3 phase	medium	30,000	300	33 dugwells	A
GRAND TOTAL	56,640	9,142									

(Data sheets of interview survey)

the summary of the hearing conducted on the present water supply and socio-economic conditions of the requested 80 villages.

(2) Water Supply System

1) Dug Wells

The water supply for villages is mainly provided by dug wells. Wells dug by manual excavation are shallow ones. The list of existing shallow wells is shown in Table 2-3. There are two kinds of dug wells: 1) wells dug by manual labor only and 2) manually dug wells with a concrete lining. The ratio of unlined to lined wells is 2:1. Depth ranges from 4 m to 15 m and diameter from 0.8 m to 1.2 m. The depth of the dug wells is limited to the range to which villagers can dig during the dry season. Well water is scooped up from the dug wells using buckets or bamboo baskets. In many cases, the well water is mixed with clay and is therefore muddy.

2) Deep Wells With Handpump

In the project area, there are 24 public deep wells with depths of about 50 m. These wells were constructed by foreign assistance programs such as USAID or UNICEF.

Deep wells assisted by USAID were constructed in the period from 1961 to 1985. American handpumps are installed with the wells. These handpumps are made by casting and are very heavy. The rod of the handpump is easily broken. One example indicates that the handpump is broken yearly and has to be repeatedly repaired. Recently, USAID has not assisted the project fund, and new construction has not been done.

UNICEF has constructed deep wells with Indian Mark II handpumps since 1987.

3) Water Supply System with Public Faucets

These systems are constructed in only two villages. Such systems supply only special consumers such as public schools or specific private families. The details of these water supply systems are as follows:

Table 2-3-A List of Shallow Wells in Project Area

No.	Name of Village	No of Shallow Well SW	SW/L	Dia(m)	Depth(m)	Water Quality	Remarks
1	Nam Tcheng	3	2	1.2	5	Good	Phon Hong District
2	Phonsi Tai	0	6	1.0	6 - 8	Good	
3	Nam Linh	20	12	1.2	9	Good	
4	Phon Hong	0	13	1.0	7 - 9	Good	
5	Phon Kham	2	2	1.0	6 - 9	Good	
6	Nong 'Kork	0	5	1.0	7	Good	
7	Phon Xay	0	30	1.0	7	None	
8	Phon Ngam	0	15	0.8- 1	6	Poor	
9	Na Pho Neua	20	8	1.0	5	Good	
10	Nam Chiim	5	1	1.2	9	Good	
11	Phon Ho	6	2	1.2	6 -14	Good	
12	Na Moung	20	4	1.0	5	Good	
13	Nong Tao	20	3	1.0	3 - 7	Good	
14	Na Kaam	15	2	1.0	4 - 5	Good	
15	Na Xom	0	3	1.0	10	Poor	
16	Sen Saat	6	1	1.0	7	Good	
17	Phia	0	3	1.0	9	Poor	
18	Phon Si Neua	1	2	1.0	7.5	Good	
19	Sen Xoum	28	35	0.8-1	5	Good	
20	Phon Keo Phon Ngeun	4	4	1.0	7.5	Poor	
21	Kham	1	5	1.0	3-4.5	Good	
22	Gnoat	10	0	N/B	4.5	Poor	
23	Na Song	3	4	1.2	4	Good	
24	Si Boun Heuang	30	20	0.8-1	6	Good	
25	Na Xou	30	6	1-1.2	6	Good	
26	Na Lou Khoun	6	1	1.0	8	Good	
27	Na Gnang	0	2	1.2	10 -13	Good	
28	Na Souak	3	2	0.8-1.2	7	Poor	
29	Phon Haii	17	0	N/B	9 -10	Good	
30	Phon Sawath	0	3	1-1.2	6	Good	
31	Na Lao	0	5	1.0	14	Good	
32	Phon Tha	20	3	0.8-1	5	Good	
33	Phon	0	15	1.0	7 - 11	Good	
34	Na Thong	0	3	1-1.2	6 - 7	Good	
35	Sovali	13	0	N/B	7	Poor	
36	Maii	100	0	N/B	4 - 5	Poor	
37	Na Thep	3	0	1.0	5	V/Poor	
38	Phon Xaii	10	4	1.0	6	Poor	
39	Na Lao	0	9	1.0	6	Poor	
40	Ek Xang	60	1	1.2	7	Good	
41	Phon Than	0	8	1.0	7	Good	
42	Lak Hasiv Song	0	4	0.8-1	10 -12	Poor	
43	Phon Kham	3	0	N/B	4	Poor	
44	Nong Nak	0	2	1.0	8	Poor	
45	Na Bon	3	0	N/B	9	Poor	

Table 2-3-B List of Shallow Wells in Project Area

No.	Name of Village	No of Shallow Well SW	No of Shallow Well SW/L	Dia(m)	Depth(m)	Water Quality	Remarks
46	Vang Konh	50	30	1.0	6 - 9	Good	
47	Saka	1	17	1.0	6 - 9	Poor	
48	Phon Ngang	20	22	1-1.2	7 - 9	Good	
49	Phon Savang	3	0	N/B	10	Poor	
50	Phon Ngeun	3	2	1.2	7	Poor	
51	Phon Kham	0	0	—	—	—	
52	Na Xay	6	6	0.8-1	6	Good	
53	Phon Sida	6	4	1.0	7	Good	
54	Phon Xong	0	13	1.0	4 - 6	Good	
55	Phon Mii	50	0	N/B	7 - 8	Good	
56	Na Pho Taii	60	11	1.0	7 - 9	Poor	
57	Samboun	0	0	—	—	—	
58	Hong Hien Sueb Thod	0	0	—	—	—	Thoulakhom District
59	Pakcheng Neua	11	1	1.0	12	Good	
60	Moung Khao	30	4	1.0	8	Good	
61	Pak Cheng	30	5	1.0	12	Good	
62	Dong Koat	0	1	1.2	12	Good	
63	Thin Gnung	30	3	1.0	12	Good	
64	Vieng Kham	30	3	1.0	10	Good	
65	Pak Ka Gnung	40	7	1.2	10	Good	
66	Keun	0	12	1-1.2	12 -15	Good	
67	Nam Ang	5	3	1.2	4.5- 9	Good	
68	Na Xang Leuk	0	1	1.2	7	Good	
69	Na Fay	15	4	1.2	5	Good	
70	Na Kang	0	5	0.8	5	Poor	
71	Pak Hang	0	8	0.8-1.2	6	Good	
72	Na Pheng	10	10	1.0	6	Good	
73	Hai Gnon	5	4	0.8-1	9 - 12	Good	
74	Dong	4	3	1-1.2	6	Good	
75	Napoune	0	2	1.2	7 - 11	Good	Keo-Oudom District
76	Thasun	10	0	N/B	14	Good	
77	Thalat	10	0	N/B	12- 13	Good	
78	Thinkeo	7	7	1-1.2	7	Good	
79	Phoukaokham	0	0	—	—	—	
80	Phonekham	23	10	1.0	4 - 6	Good	

Note : SW indicates SHALLOW WELL WITH NO LINING

SW/L indicates SHALLOW WELL WITH LINING

N/B in "Dia" column indicates has NO DEFINITE BOUNDARY

i) Hong Hien Sueb Thod (No. 58)

Water supply system supplies water to the public technical school for construction and mechanics. The water source is a deep well with a depth of 40 m and with a casing size of 6". The deep well is located in low land and pumps up water to a concrete ground tank with a capacity of 50 m3 situated on a hill. The height difference is about 30 m. The system sends water from the ground tank to 6 concrete storage vessels of open type for utilization. The system was constructed by the Fund Assistance of Vietnam.

ii) Thalat (No. 77)

Water supply system sends river water from a facility floating in the Nam Ngum River to a concrete ground tank with a capacity of 200 m3 located on a small hill with a height difference of about 20 m. This supplies water to each house. The water is muddy but the system has no treatment plant. The system was privately constructed through cooperation with the District, and supplies water only for citizens who can pay the water rate.

2.3.2 Hydrogeology and Groundwater

(1) Present Condition of Existing Deep Well

In the project area, there are 24 existing public deep wells, together with many private deep wells. Most are in operating condition. The location and distribution of these deep wells are shown in Fig. 2-7. Deep wells are distributed throughout the area, except the southeastern area of the THOULAKHOM District and the Southern area of the KEO-OUDOM District. The details of structure, construction year, water quality etc. are shown in Table 2-4.

Public deep wells range from 25 m to 50 m in depth. However, the depth of 50 m is not permanent because these wells are drilled with no casings into mudstone and shale deposited in the Cretaceous period, Mesozoic era. There are many wells that become shallower than their original depth due to the inflow of sand and gravel stemming from the collapse of the well's wall.

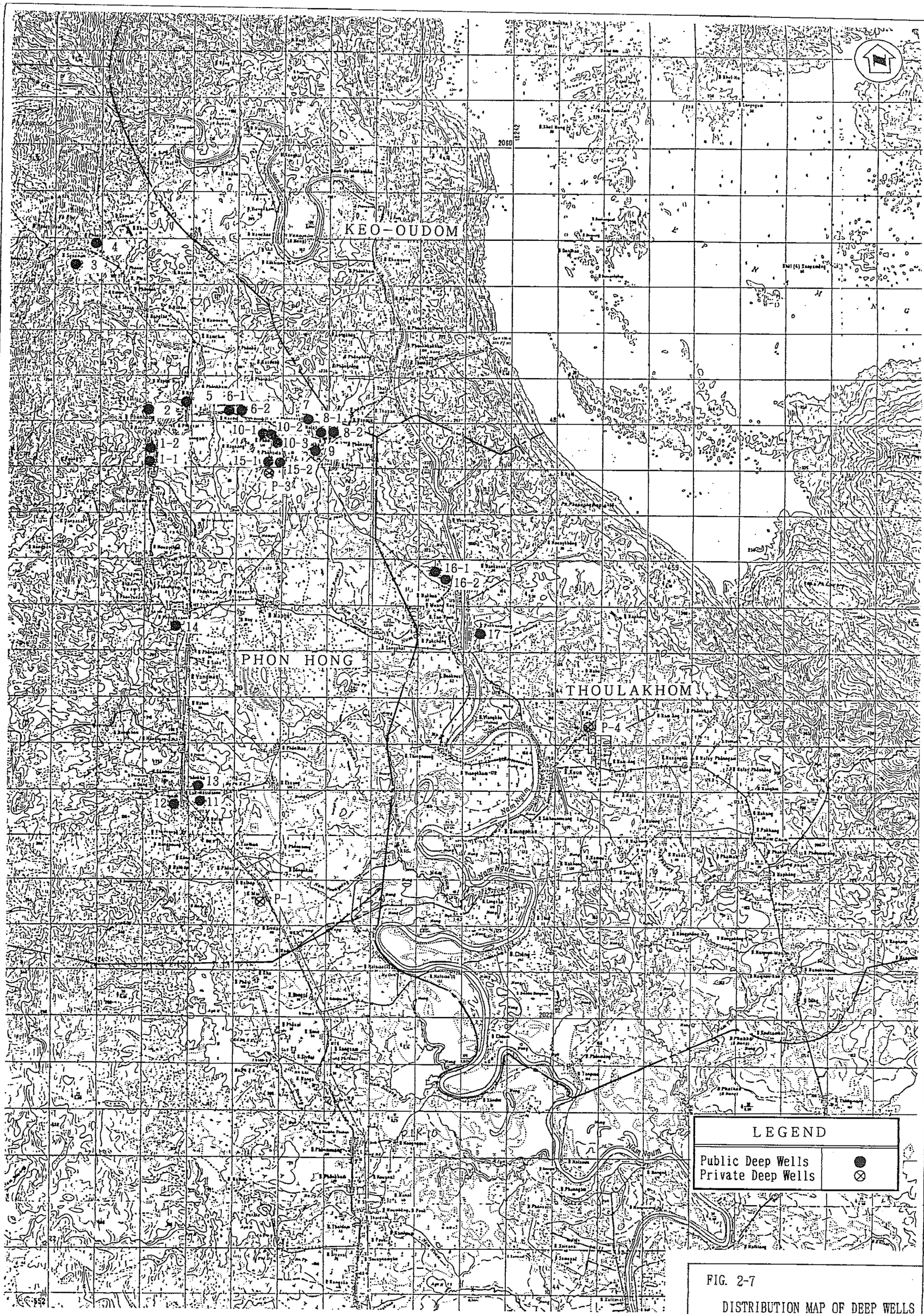


FIG. 2-7

DISTRIBUTION MAP OF DEEP WELLS

Table 2-4-A INVENTRY OF EXISTING DEEP WELLS IN PROJECT AREA (AS OF MAY TO JUNE, 1993)

Location		Name of	Land Use	Outline of Facility								Result of Water Quality Test								
Well	Vil.	Village		Depth	Casing Dia	S.W.L.	Discharge	C.Year	Pump Type	Setting Depth	Operational Status	E.C.	Cl	T-H	Ca-H	Alkali	T-Fe	NH_4	NO_2	Coliform
												s/cm	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	
1-1	2	Phonsi-Tai	Post Office	40m	4″			1986	Drain Pump	GL-5.83m	USSR Pump, PVC Casing, Operational, Constructede by Dep. of Irrigation	420	40	10	10	N.D.	<0.2	<0.5	<0.02	
1-2	2	Phonsi-Tai	District Office	25m	6″	GL-2.97m	8.2 ℓ/min	1992	Drain Pump				15	15	5	5	<0.2	<0.5	<0.02	—
2	4	Phon Hong	Public Land						Hand Pump		Dempster Hand Pump, Non-Operational, USAID Fund	Non-Operational								
3	19	Senxoum	Private Land	36m	6″			1993	Centrifugal Pump		Dempster Hand Pump(original), USAID Fund, Pump is replaced by Centrifugal Pump, Water quality is good, S.W.L. in dry season is GL-3m	1,850	165	105	95	410	<0.2	<0.5	<0.02	—
4	20	Phon Keo/ Phon Ngeun	Temple	40m	4″	GL-3.685m		1965	Hand Pump		Dempster Hand Pump(original), USAID Fund, Pump is replaced by Bangladesh assisted by Unicef Fund	1,250	160	180	65	160	10	1	<0.02	—
5	23	Na Song	Public Land	50m	6″			1966	Hand Pump		Dempster Hand Pump, Non-Operational(Breakage of Pump Rod), USAID Fund	Non-Operational								
6-1	24	Si Boun Heuang	Governmental Land	47m	6″			1988	Hand Pump		Indian Mark II Pump, PVC Casing, Operational, Constructed by Min. of Agriculture	6	15	205	110	230	10	1	<0.02	—
6-2	24	Si Boun Heuang	Governmental Land	50m	6″			1988	Hand Pump	GL-18 m	Indian Mark II Pump, Operational, Unicef Fund	650	10	355	205	305	10	<0.5	<0.02	—
7	30	Phon Sawath	Public Land	50m	6″			1965	Hand Pump		Dempster Hand Pump, Operational, USAID Fund	740	30	455	180	460	7	0.5	<0.02	
8-1	31	Na Lao	Private Land	50m	6″	GL- 5.93m		1965	Hand Pump		Dempster Hand Pump, Non-Operational(Breakage of Pump Rod and Cylinder), USAID Fund	740	15	315	165	390	2	<0.5	<0.02	
8-2	31	Na Lao	Temple	50m	6″			1961	Hand Pump		Dempster Hand Pump, Operational, USAID Fund	520	20	185	155	360	0.5	<0.5	<0.02	—
9	32	Phon Tha	Public Land	50m	6″			1965	Hand Pump		Dempster Hand Pump, Operational, USAID Fund, Not dry up even in dry season	650	30	225	125	365	0.3	<0.5	<0.02	—
10-1	33	Phon	Public Land	45m	6″			1965	Hand Pump		Dempster Hand Pump, Operational, USAID Fund, For washing/cocking only, not for drinking	670	150	835	570		0.4	<0.5	<0.02	
10-2	33	Phon	Public Land	40m	6″	Free Flowing		1965	Hand Pump		Dempster Hand Pump, Operational, USAID Fund	1,080	120	485	375	380	0.5	1	0.1	
10-3	33	Phon	Public Land	42m	6″	Free Flowing		1965	Hand Pump		Dempster Hand Pump, Operational, USAID Fund	650	35	460	150	455	0.5	<0.5	<0.02	
11	42	Lak Hasiv Song	Secondary School	50m	6″			1985	Removed		Thai PAT Hand Pump, Non-Operational(Breakage of Rod, Pump is removed already), Unicef Fund	Non-Operational								
12	43	Phon Kham	Public Land	20.17m	6″	GL -3.74m		1985	Hand Pump		Thai PAT Hand Pump, PVC Casing, Operational, Unicef Fund, Turbidity is observed in well water	590	20	300	265	370	3	0.7	<0.02	+
13	44	Nong Nak	Elementary School	50m	6″			1985	Hand Pump		Thai PAT Hand Pump, PVC Casing, Operational, Unicef Fund, Water quality is good	460	20	240	215	260	0.5	<0.5	<0.02	
14	49	Phon Savang	Temple	50m	8″			1972	Removed		Dempster Hand Pump, Non-Operational(Pump removed already), USAID Fund	Non-Operational								
15-1	53	Phon Sida	Private Land	50m	6″			1966	Centrifugal Pump		Dempster Hand Pump(original), USAID Fund, Pump is replaced to C.Pump by villagers' own expence	620	75	275	160	315	2	<0.5	<0.02	—

Table 3-2-B INVENTRY OF EXISTING DEEP WELLS IN PROJECT AREA (AS OF MAY TO JUNE, 1993)

Location		Name of Village	Land Use	Outline of Facility							Result of Water Quality Test								
Well	Vil.			Depth	Casing Dia	S.W.L.	Discharge	C.Year	Pump Type	Setting Depth	Operational Status	E.C.	Cl	T-H	Ca-H	Alkali	T-H	NH_4	NO_2	Coliform
												s/cm	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	
15-2	53	Phon Sida	Private Land	50m	6"	GL-1.52m		1966	Centrifugal Pump		Dempster Hand Pump(original), USAID fund, Pump is replaced to C.Pump by Villagers' own expence	660	60	405	205	335	2	<0.5	<0.02	−
16-1	58	Hong Hien Sueb Thod	Technical School	40m	6"				Submersible Pump		Submersible Pump, Galvanized Iron Pipe Casing, Vietnam Fund, Well water is pumped to ground reservior located on a hill and distributed by gravity	30	10	5	5	5	4	<0.5	<0.02	−
16-2	58	Hong Hien	Technical School	40m	6"			1987	Hand Pump		Indian Mark II Pump, Operational, Unicef Fund Turbidity is observed in well water	260	20			175	> 10	1.5	<0.02	+
17	65	Pak Ka Gnung	Temple	50m	6"			1965	Hand Pump		Dempster Hand Pump, Operational, USAID Fund	30	15	55	50	155	10	1	<0.02	+−
P-1	36	Mai	Bottled Water Company	40m	6"	GL-6 m	48 ℓ/min	1992	Submersible Pump		Pumped water is sent to elevated tank installed nearby and pours into purification plant, then bottled for sale		15	25	5	5	< 0.2	<0.5	<0.02	−
P-2																				
P-3	53	Phon Sida	Private Land	20m	3"			1993	Centrifugal Pump		Operational, Adjacent to Public Well No. 15-2	650	55	295	255	350	< 0.2	<0.5	<0.02	−
P-4			Salt Product Company	81m									>6,000							

Note : vil Village
S.W.L. Static Water Level
C.Year Completion Year
E.C. Electric Conductivity
Cl Chrolide Ion
T-H Total Hardness
Ca-H Calcium Hardness
Alkali Alkalinity
T-Fe Total Iron
NH_4 Ammonia
NO_2 Nitrous Acid

Diameter of these casings is 4" or 6", and the casing material is almost always made of PVC pipe. These wells were constructed or funded by USAID or UNICEF.

The most serious problem in this area is the occurrence of salty groundwater due to halite. Northern Thailand, as well as the southern part of Vientiane City has many deep wells which produce salty groundwater. The project area is located in a geographically similar area as Northern Thailand, where wells commonly produce salty groundwater. We feared that the newly constructed deep wells in the project area might produce salt water as well. In fact, the P-4 well of the salt production factory located at Bo village in Thoulakhom District produces salty water with a very high concentration of more than 6,000 mg/lit of chloride and its well depth is 81 m. The chloride concentration of the well is supposed to be the same as sea water and the water does taste quite salty.

However, the chloride concentration of the existing deep wells in the Project area, except that of the salt production factory, ranges from 10 to 165 mg/lit and is within the range of the WHO drinking water standard of 200 mg/lit.

Among these wells, about 30 % are determined to be polluted due to their high content of NH4 and NO2, which indicates water pollution.

It seems that the polluted wells take groundwater from the screen of the shallow portion or the wells do not have appropriate shield structures protecting against the infiltration of polluted water from the ground surface through the annular space between the bore hole wall and casing.

High iron content occurs in abondoned wells as well as wells with a low frequency of use. The iron concentration is different among wells with the same depth in the same area. This phenomenon is considered to be caused by the following process: ground water flows slowly or stagnates underground, allowing the stagnated water to dissolve the iron contents in the surrounding Laterite and add it to the groundwater, which is later pumped to the surface.

Shallow wells distributed in the project area nearly dry up during the dry

season or have only a shallow water level of about 30 cm from the well bottom. All of the deep wells, on the other hand, have water even in the dry season and are a stable water source.

(2) Pumping Test

The project includes two kinds of water supply system, consisting of 1) deep wells with handpumps and 2) water supply systems with a public faucet. Deep wells with handpumps supply a small quantity of water to a limited population and the handpumps have a small pumping rate. Water supply system with public faucets have a deep wells, a transmission pipe line, an elevated tank and a distribution pipe line. Such systems supply water to large numbers of consumers and the water demand is large in comparison to the deep wells with handpumps. Thus, it is necessary to pump up a large quantity of groundwater from a few deep wells, and it is very important to get a rough estimation on the possibility of pumping up an estimated discharge in the planned construction sites. In order to clear up this difficulty, a pumping test was done by the air lift method in two deep wells. A continuous pumping test and a recovery test were conducted. Pumping duration was a continuous 8 hours. The results of pumping test are shown in Fig. 2-8.

Two selected wells for the pumping test are located in Phonsi Tai village. Test results of the wells No. 1-1 and 1-2 are shown in Fig. 2-7 of the Distribution Map of Deep Wells. Both wells are located on the same hill: Well No. 1-1 on the lower portion and Well No. 1-2 on the higher portion. Height difference between Well No. 1-1 and 1-2 is about 10 m.

The pumping test was performed by pumping at a rate of 44 lit/min in Well No. 1-1. The pumping test resulted in a drawdown of about 5.8 m, with a stable dynamic water level after a pumping duration time of a continuous 8 hours. Results from Well No. 1-2 indicated that the drawdown in the pumping rate of 8 lit/min was 8.8 m in the continuous pumping test. In such case that water was pumped up at the same pumping rate in Well No. 1-2 as in Well No. 1-1, the drawdown was large and the dynamic water level could not be measured.

The above effect indicates that the wells located in the lower portion of the hill produce a lager volume of water compared with that in the higher

FIG. 2-8-A PUMPING TEST DATA

PUMPING TEST

WELL No : 01 (*POST OFFICE*) DATE : *10-11 /06/ 1993*

PHONHONG DISTRIC. VIENTIANE PROVINCE.

TIME (hh mm ss)	TOTAL TIME (hh mm ss)	WATER LEVEL GO UP (m)
03 h 00' 00" (12/06/93)	00' 00"	8.20
	10"	8.10
	20"	7.60
	30"	7.20
	01' 00"	7.00
	02'	6.80
	03'	5.60
	05'	5.00
	06'	4.80
	07'	4.70
	08'	4.50
	09'	4.30
	10' 00"	4.10
	15'	3.50
	20'	3.00
	25'	2.80
	30'	2.70
03 h 50' 00" (11/06/93)	50'	2.40

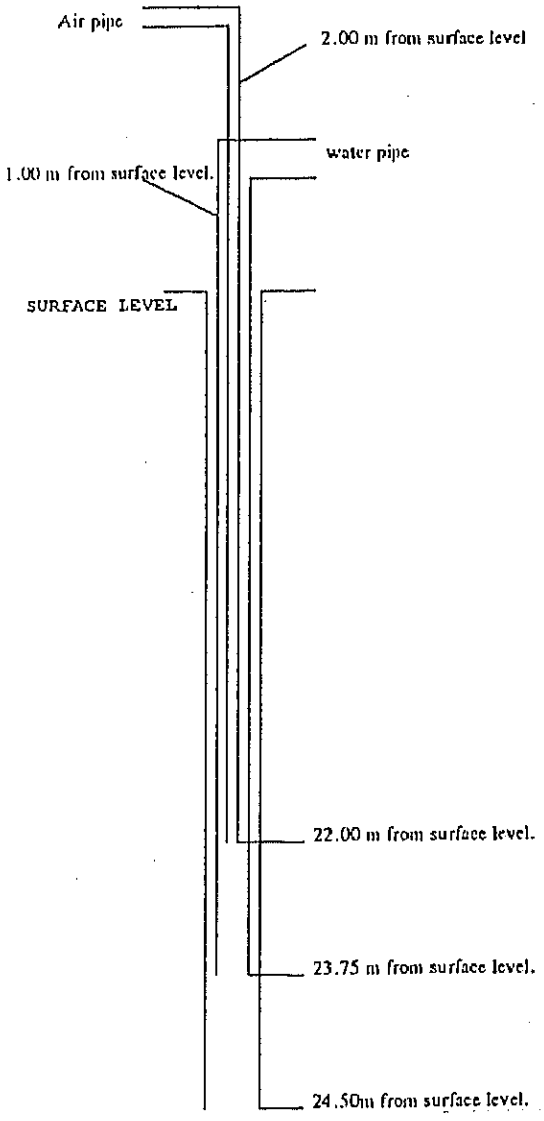


FIG. 2-8-A' PUMPING TEST DATA

PUMPING TEST

WELL No : 01 (*POST OFFICE*) DATE : *10-11 /06/ 1993*

PHONHONG DISTRIC. VIENTIANE PROVINCE.

TIME (hh mm ss)	TOTAL TIME (hh mm ss)	WATER LEVEL (m)	VOLUME (l/min. sec.)
19H 00' 00" (10/06/93)	0' 00"	2.41	
	10"	3.45	
	20"	3.80	
	30"	4.10	
	40"	4.20	
	50"	4.40	
	01' 00"	4.50	
	01' 30"	4.90	
	02' 00"	5.00	
	03' 00"	5.10	200 l / 03'
	04' 00"	5.20	
	05' 00"	5.25	
	10' 00"	5.70	
	20' 00"	6.50	
	30' 00"	7.05	200 l / 05'
	01 h 00' 00"	8.10	200l / 4' 30"
	02 h	8.40	200 l / 4' 30"
	03 h	8.45	200 l / 4' 30"
	05 h	8.40	200 l / 4' 30"
03 h 00' 00" (11/06/93)	08 h	8.20	200 l / 4' 25"

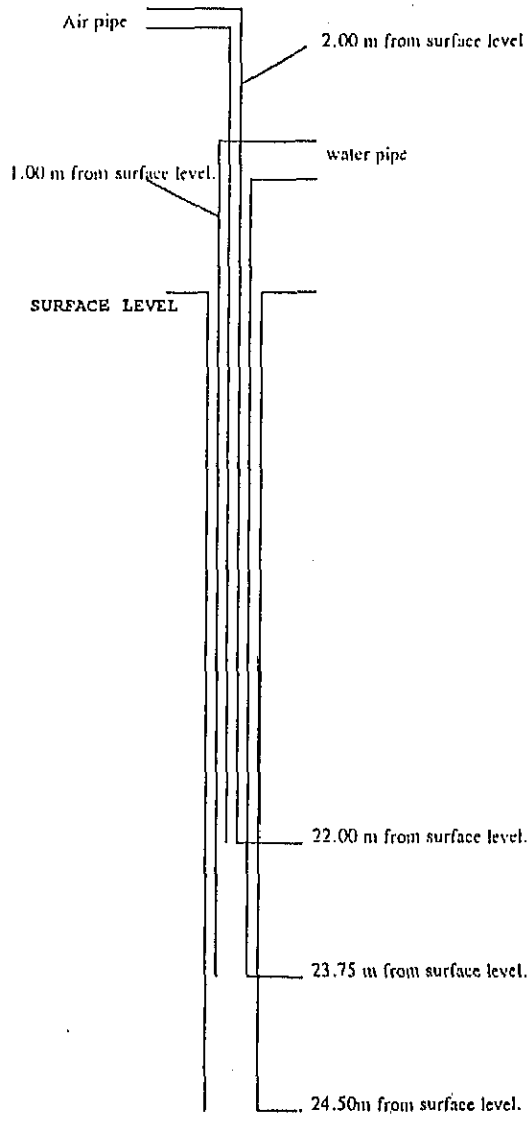


FIG. 2-8-B PUMPING TEST DATA

PUMPING TEST

WELL No : 02 (*NEAR POST OFFICE*) DATE : *11-12 /06/ 1993*

PHONHONG DISTRIC. VIENTIANE PROVINCE.

TIME (hh mm ss)	TOTAL TIME (hh mm ss)	WATER LEVEL (m)	VOLUME (l/min. sec.)
14H 00' 00" (11/06/93)	0' 00"	4.70	
	10"	5.00	
	20"	6.20	
	30"	7.30	
	40"	8.70	
	50"	9.50	
	01' 00"	10.80	
	01' 30"	11.80	
	02' 00"	12.40	
	03' 00"	12.50	
	04' 00"	12.55	
	05' 00"	12.60	
	10' 00"	12.70	
	20' 00"	12.90	
	30' 00"	13.30	200 l / 25'
	01 h 00' 00"	13.40	200l / 25'
	02 h	13.40	200 l /25'
	03 h	13.40	200 l / 25'
	05 h	13.43	200 l /26'
22 h 00' 00" (12/06/93)	08 h	13.45	200 l / 25'

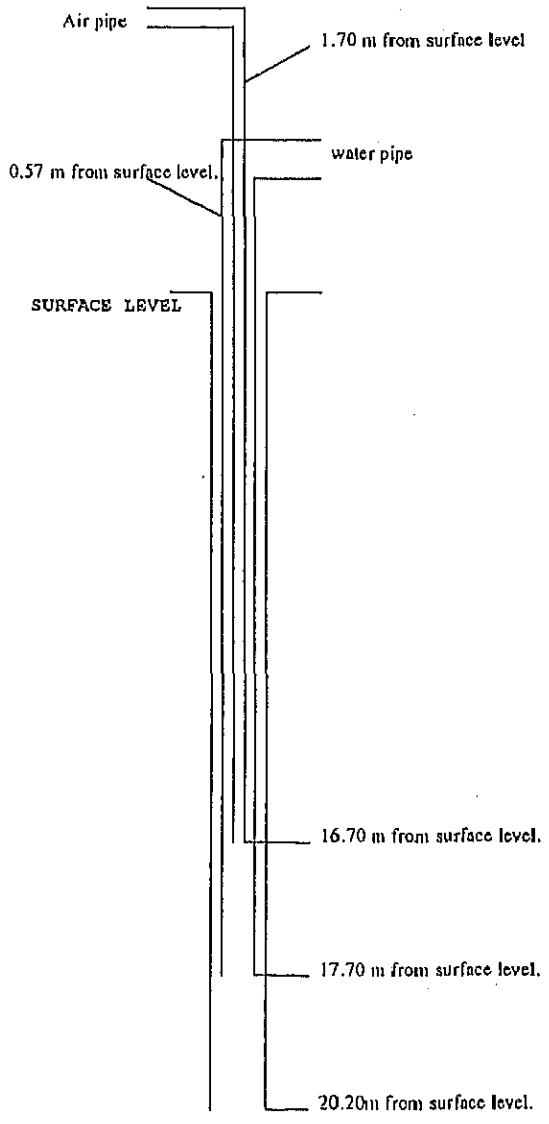


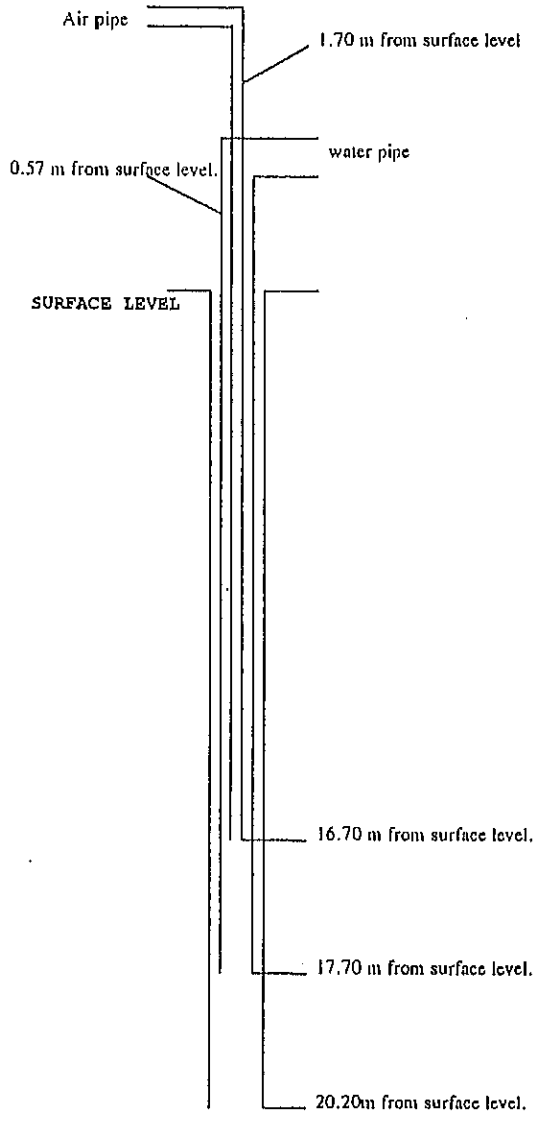
FIG. 2-8-B' PUMPING TEST DATA

PUMPING TEST

WELL No : 02 (*NEAR POST OFFICE*) DATE : *11-12 /06/ 1993*

PHONHONG DISTRIC. VIENTIANE PROVINCE.

TIME (hh mm ss)	TOTAL TIME (hh mm ss)	WATER LEVEL GO UP (m)
22 h 00' 00"	00' 00"	13.45
	10"	13.40
	20"	13.20
	30"	13.10
	40"	13.00
	50"	12.90
	01' 00"	12.80
	01' 30"	12.70
	02' 00"	12.40
	03'	11.70
	04'	11.10
	05'	10.40
	10'	8.40
	20'	6.80
	30'	6.20
	01 h 00' 00"	5.75
	01 h 30' 00"	5.00
00 h 15' 00" (12/06/93)	02h 15' 00"	4.70



portion. At the higher portion of the hill, the depth of the basement layer (impervious mudstone and shale deposited during the Mesozoic era) is shallow, and the aquifer is thin. While at the lower portion of the hill, impervious layers extend deeper and the aquifer, consisting of sand and gravel, is thick. Consequently, it is considered that the lower portion of the hill has a higher potential for groundwater development than the higher portion.

By the analysis of the test results, the wells constructed in the lower portion of the hills are estimated to have capacity of about 45 lit/ min.

(3) Core Boring Investigation

A core boring investigation was planned to check the identification of the geological structure and range of the underground halite. The investigation depth was 50 m and the number of sites was six.

The investigation sites are shown in Fig.. 2-9 and the columnar sections of core boring in Fig. 2-10. Based on the preliminary study and the results of field survey, the locations of five sites for core boring was determined in a straight line connecting between the towns of Phon Hong and Thalat, and between the villages of Phon Savang and Pakcheng. Since a columnar section, 38 m in depth, was obtained at the village of Phonsi Tai(one of the original target sites) by data collection, the remaining boring investigation was determined to be conducted in the village of Pak Hang instead, where there are existing deep wells. It is located in the southwestern area of the Thoulakhom District. The core boring sites were as follows:

No.	District	Village
B-1	Phon Hong	Phon
B-2	Keo-Oudom	Napoune
B-3	Phon Hong	Napho
B-4	Phon Hong	Phon Savang
B-5	Thoulakhom	Pak Cheng
B-6	Thoulakhom	Pak Hang

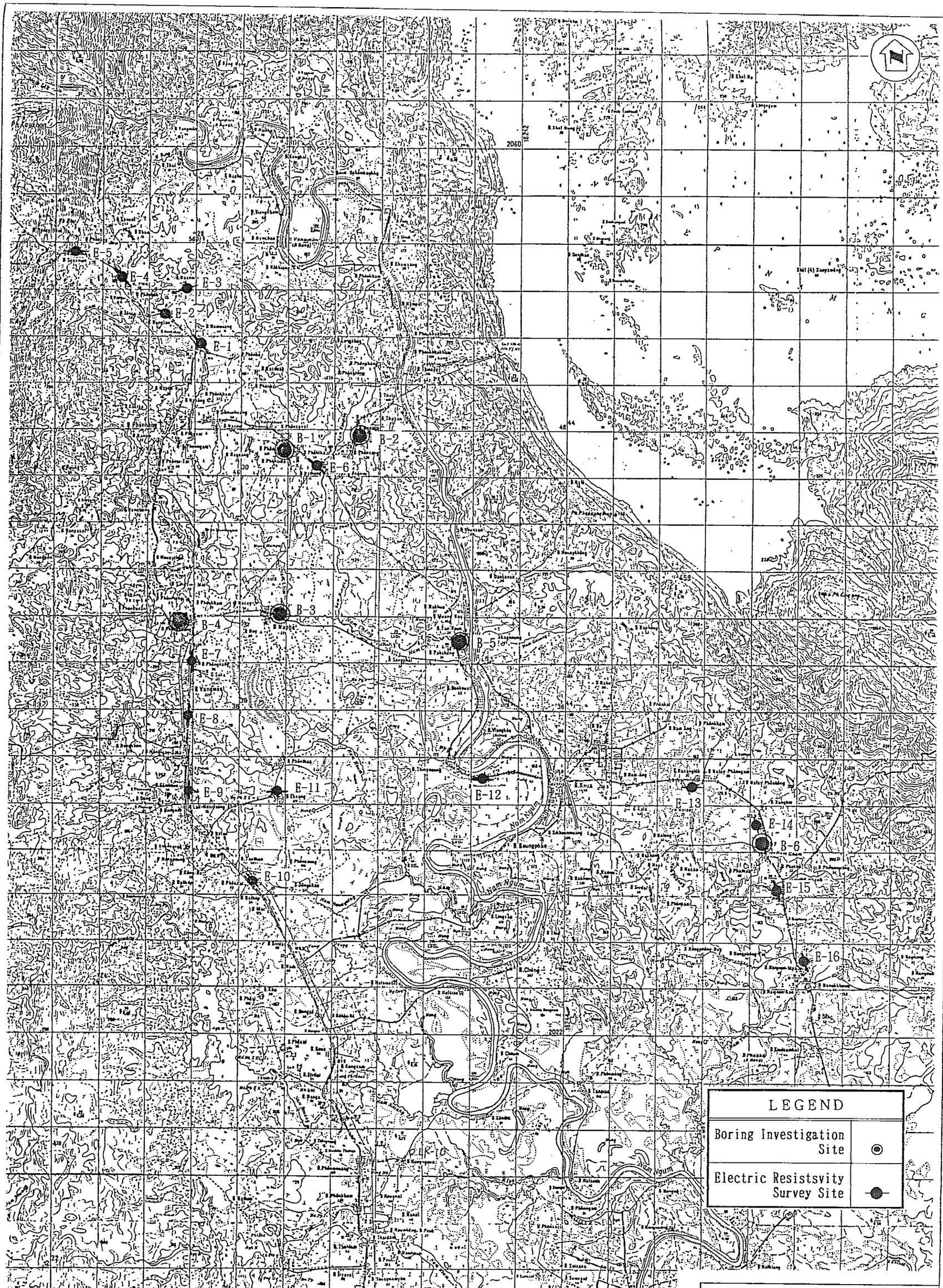


FIG. 2-9

SITE MAP OF BORING INVESTIGATION AND ELECTRIC RESISTIVITY SURVEY

FIG. 2-10-A Result of Core Boring Investigation

BOREHOLE LOG

Borehole No : 1
Location : Ban Phon
Ground Elevation :
Static water level : -1.50 m
Depth of drilling : 50. 9m
Hole diameter : 130 mm to 75 mm
Date of drilling : Commenced 14 June Finished 17 June 1993

Page 1

Depth	SWL	Stratigraphic Column		Petrographic Characteristic	Remar
0		0.60 m	Filling	Laterite and soil	
1	-1. 50m	2.20 m	Top soil	Red clay, stick	
2					
3				Red mudstone and shale, soft,	
4			Mudstone	strongly wheatered,	
5				easely broken by hand	
6					
7					
8					
9					
10					
11					
12				Red mudstone,fresh and medium hard	
13			Mudstone	crack plane 20 to 45 deg	
14				Presence of red clay in the joint	
15					
16					
17					
18					
19				Red claystone with reddish shale	
20				crack plane 20-30 deg	
21					
22					
23					
24					
25					

FIG. 2-10-A' COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No : 1
Location : Ban Phon
Ground Elevation :
Static water level : -1.50 m
Depth of drilling : 50. 9m
Hole diameter : 130 mm to 75 mm
Date of drilling : Commenced 14 June Finished 17 June 1993

Depth	SWL	Stratigraphic Column	Petrographic Characteristic	Remark
26			Reddish shale and red claystone,soft and	
27			easely broken by hand	
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43			Red shale with claystone,soft	
44			easely broken by hand	
45			crak plane 30 - 60 deg	
46				
47				
48				
49				
50		50. 9m		

FIG. 2-10-B COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No : 2
Ground Elevation :
Depth of drilling : 50 m
Date of drilling : Commenced 13 June Finished 17 June 1993

Location : Ban Napoun
Static water level : -8.0 m
Hole diameter : 130 mm to 75 mm

Depth	SWL	Stratigraphic Column		Petrographic Characteristic	Remark
0		0.70 m	Top soil	Sandy clay,yellowish color	
1			Terrace	Laterite and red clay	
2		2.60 m	deposit		
3					
4				red clay	
5					
6					
7					
8	-8. 00m			Red clay,moist	
9				Water lost at depth 9 m,mud water appears	
10				in a well beside	
11		12.00m			
12				Red clay ,soft and stick mixed with	
13				red claystone/mudstone,soft	
14					
15					
16		16.25 m		substick core,moist,at depth 15 to 20 m	
17		18.00 m			
18					
19					
20					
21					
22					
23				red mudstone,soft,crack horizontal	
24				cracked easely by hand	
25					

FIG. 2-10-B' COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No : 2
Ground Elevation :
Depth of drilling : 50 m
Date of drilling : Commenced 13 June Finished 17 June 1993

Location : Ban Napoun
Static water level : -8.00 m
Hole diameter : 130 mm to 75 mm

Depth	SWL	Stratigraphic Column	Petrographic Characteristic	Remark
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38			Red mudstone,soft,crak easely by hand	
39			Fragment core at depth of 30-35m.	
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				

FIG. 2-10-C COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No : 3
Ground Elevation :
Depth of drilline : 50 m
Date of drilling : Commenced 4 June Finished 8 June 1993

Location : Ban Napho
Static water level : -3.50 m
Hole diameter : 130 mm to 88 mm

Depth	SWL	Stratigraphic Column		Petrographic Characteristic	Remark
0		0.70 m	Overburden	Silty sand,contains clay,yellowish color	
1			River	Fine sand,contains clay,brown color	
2		3.00 m	deposit		
3	-3.50 M		River	Fine sand,brown color,contains tree	
4			deposit	fragments at depth 7 m	
5					
6					
7		8.00 m			
8			Terrace	Blackish clay,soft,high consistancy	
9			deposit		
10					
11			Terrace	Ligth brown graveled clay,contains sand.	
12			deposit	gravel about 40%,size 0.1-5 cm	
13					
14					
15					
16		16.25 m			
17		18.00 m		Yellow graveled clay, size 0.1-0.5 cm	
18					
19					
20				Graveled clay with fine sand.	
21				gravel about 30 %, size 0.1-0.5 cm	
22					
23		24.00 m			
24					
25			CORE LOSS	Red shale	

FIG. 2-10-C' COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No : 3
Ground Elevation :
Depth of drilline : 50 m
Date of drilling : Commenced 4 June Finished 8 June 1993

Location : Ban Napho
Static water level : -3.50 m
Hole diameter : 130 mm to 88 mm

Depth	SWL	Stratigraphic Column	Petrographic Characteristic	Remark
26				
27				
28				
29				
30			Red shale	
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				

FIG. 2-10-D COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No : 4
Ground Elevation :
Depth of drilline : 50 m
Date of drilling : Commenced 9 June Finished 13 June 1993

Location : Ban Phonsavang
Static water level : -9. 50m
Hole diameter : 130 mm to 75 mm

Page 1

Depth	SWL	Stratigraphic Column		Petrographic Characteristic	Remark
0		0.70 m	Top soil	Silty sand,blackish color	
1				Yellowish to red clay with laterite	
2		3.00 m		grain size 0.1 to 0.2 cm	
3			clay		
4			Fragment core	Yellowish to reddish clay with laterite	
5		6.00 m		Gravel about 60 %,size 0.1 to 0.2 cm	
6			clay	Yellowish clay,contains sand 20%	
7			Fragment core	gravel 10%,soft,sligthly moist	
8		9.20 m			
9	-9. 50m		clay	clay,yellowish and reddish color	
10		10.80 m		soft and stick,sligthly moist	
11					
12			Shale	Red shale,bedding plane 45-60deg	
13				soft,stick,sligthly oxidated	
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24				Shale, contains grey color clay	
25					

FIG. 2-10-D' COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No :4
Ground Elevation :
Depth of drilline : 50 m
Date of drilling : Commenced 9 June Finished 13 June 1993

Location :Ban Phonsavang
Static water level : -9. 50m
Hole diameter : 130 mm to 75 mm

Page 2

Depth	SWL	Stratigraphic Column		Petrographic Characteristic	Remark
26					
27			Shale	Shale	
28					
29					
30					
31					
32					
33					
34				Reddish shale,hard,contains blakkish	
35		36.10m		clay in the fractures	
36					
37			Gypsum	Gypsum,grey white color,	
38				mixed with blackkish clay	
39				bedding 10-15deg, fresh	
40					
41					
42					
43		43.90 m			
44		44.90 m	core loss	Transition Zone	
45					
46			Sandstone	Sandstone,gray color, fresh	
47					
48					
49		50.00m			
50					

FIG 2-10-E COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No : 5
Ground Elevation : 170.46 m ASL
Depth of drilling : 50 m
Date of drilling : Commenced 18 June Finished 24 June 1993

Location : Ban Pakcheng
Static water level : -8.0 m
Hole diameter : 130 mm to 75 mm

Depth	SWL	Stratigraphic Column		Petrographic Characteristic	Remark
0		0.50 m	Top soil		
1			Terrace deposit	clayed silt, stick when wet yellowish color	
2					
3					
4		5.00 m			
5				Silty clay,soft and stick when wet, medium hard when dry	
6					
7		7.50 m			
8			River deposit	Sand with gravel and clay	
9					
10		11.00 m			
11				sand with mud	
12		12.50 m			
13				sand with gravel	
14		15.00 m			
15				sand with gravel	
16					
17					
18					
19		20.00 m			
20			River deposit	Coarse sand with gravel	
21					
22					
23					
24		25.00 m			
25				Fine gravel with sand	

FIG 2-10-E' COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No : 5
Ground Elevation : 170.46 m ASL
Depth of drilling : 50 m
Date of drilling : Commenced 18 June Finished 24 June 1993

Location : Ban Pakcheng
Static water level : -8.00 m
Hole diameter : 130 mm to 75 mm

Depth	SWL	Stratigraphic Column		Petrographic Characteristic	Remark
26			River deposit	Fine gravel with sand	
27					
28					
29		30.00 m			
30			River deposit	Fine gravel dimension 0.2 to 0.5 mm with sand	
31					
32		32.20 m			
33				silty clay, hard when dry, stick when wet	
34		34.20 m	core loss		
35		35.00 m	Sedimentary	Siltstone,very soft	
36		36.20 m	rock		
37				siltstone,soft and easely cracked	
38					
39		40.00 m			
40					
41					
42					
43			fragment core	Siltstone, soft, easely crack	
44					
45					
46					
47					
48					
49					
50		50.00 m			

FIG 2-10-F COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No :6
Ground Elevation : 187.07 m ASL
Depth of drilling : 50 m
Date of drilling : Commenced 26 June Finished 30 June 1993

Location : Ban Pak Hang
Static water level : -8.00 m
Hole diameter : 130 mm to 75 mm

Depth	SWL	Stratigraphic Column		Petrographic Characteristic	Remark
0		1.0 m	Top soil	Gray sand with mud	
1					
2				Sandy silt,yellowish color	
3		3.50 m			
4		4.50 m		Laterite with red silt	
5		5.70 m		Reddih silt with clay and laterite	
6					
7	-8.00 m			Sand with clay and gravel	
8					
9					
10					
11		11.20 m			
12		13.00 m		Red silty clay, stick when wet	
13				and hard when dry	
14					
15				Silstone,red color,soft and wheathered	
16				stick with moist and hard when dry	
17				fracture angle 40 to 70 deg	
18					
19					
20					
21					
22					
23					
24					
25					

FIG 2-10-F' COLUMNAR SECTION OF CORE BORING INVESTIGATION

Borehole No :6
Ground Elevation : 187.07 m ASL
Depth of drilling : 50 m
Date of drilling : Commenced 26 June Finished 30 June 1993

Location :Ban Pak Hang
Static water level : -8.00 m
Hole diameter : 130 mm to 75 mm

Depth	SWL	Stratigraphic Column	Petrographic Characteristic	Remark
26				
27			Silstone,red color,soft and wheathered	
28			stick with moist and hard when dry	
29			fracture angle 40 to 70 deg	
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46		46.60 m		
47			Claystone,gray to dark red color	
48		48.95 m	have some gypsum	
49			Gypsum,blackish to gray color	
50			have some clay in the joint	

The results of core boring investigation are described below.

(i) Phon

Surface soil is distributed to the depth of 2.2 m, and mudstone and shale of Mesozoic era is underlain to the depth of 2.2 m to 50.9 m. Geological stratigraphy of the columnar section indicates that impervious layers of mudstone and shale cover the area near the ground surface.

The project area generally has a characteristic topography consisting of small hills of Tertiary - Quaternary and flat low land of alluvium. However, this site has an indefinite topography which is topographically difficult to divide into hill and alluvium, and there is almost no height difference between either topographies. As a result of a detailed survey of the topography, the village was revealed to be located on a hill that is continuously extended from the northern hills. Though the village has three deep wells, these wells are estimated to be drilled in the lower portion of a hill. According to the columnar section of the core boring, the pinpointed investigation site has no possibility of groundwater development because of its location on a higher portion of a hill.

(ii) Napoune

Surface soil and terrace deposit are distributed from the ground surface to 2.6 m and are underlain by a clay layer with a formation thickness of about 10 m. Core samples ranging from 12 m to 50 m in depth indicates a geology of mudstone and shale of the Mesozoic era. This formation is distributed in the adjacent area of the town of Thalat of the Keo-Oudom District and its outcrops were observed. The village of Napoune is located southwest of the town of Tharat.

Thus, the same formation of mudstone and shale is considered to be continuously extended from the town of Thalat. This area is judged to be inappropriate for construction of deep wells according to the results of core boring.

(iii) Napho

Surface soil, river deposit, and terrace deposit are deposited from the ground surface to 24 m in depth. These formations are underlain by mudstone and shale of a chocolate color of the Mesozoic era, and are continuous in depth from 24 m to 50 m. This site has the possibility of groundwater development. The planned well depth will be shallower than 24 m.

(iv) Phon Savang

Surface soil is distributed from the ground surface to 0.7 m and is underlain by a clay layer including sand and gravel to a depth ranging from 0.7 m to 10.8 m. Core samples in a deeper portion than 10.8 m indicate it to be a Cretaceous formation of the Mesozoic era. The formation is made up of mudstone and shale of a chocolate color ranging from 10.8 m to 36.1 m in depth and of sandstone from 36.1 m to 50 m. Considering the above geological condition, the possibility of groundwater development is estimated the low.

(v) Pak Cheng

The core section indicates different features in comparison to the other columnar sections of (1) Phon, (2) Napoune, (3) Napho, and (4) Phon Savang. The remarkable feature here is the occurrence of a thick river deposit. It is probable that the layer was formed by the old Nam Ngum River in the Alluvium or Diluvium geological age. In the columnar section, the river deposit ranges from 1.5m to 32.20 m and forms a good aquifer. The layer is underlain by a fairly impervious layer consisting of siltstone ranging 32.20 m to 50.00 m in depth. The area has some private deep wells and is estimated to have a high potential for groundwater development.

(vi) Pak Hang

This area has no deep wells. Thus, the possibility of groundwater development is judged by the samples of core boring and analyzed results of an electric resistivity survey. The results of core boring indicate that the aquifer consists of sand with clay and gravel is distributed to the depth ranging from the ground surface to 13.00 m. The underlain layer is siltstone of semi-impervious nature, ranging from 13.00 m to 46.00 m. Project wells may intake groundwater from this siltstone, together with the shallow aquifer mentioned above.

(4) Electric Resistivity Survey

An electric resistivity was carried out as a supplemental method to investigate the geological structure in the study area. There were 16 measuring points. The points are shown in Fig. 2-9. The measuring depth of the survey ranges from 15 m to 80 m. The Wenner measuring method is used in this investigation. The analysis of the survey results, namely the formation thickness in each site, are indicated in Table 2-5.

As a result of electric resistivity studies and field observations, Na Xom (village No. 15), Na Bon (No. 45), Na Kang (No. 70), and Phon Kham (No. 43) turned out to be inappropriate sites for the construction of new wells because of impervious layers which were wholly and widely distributed near the ground surface. Phon Si Neua (No. 18) and Na Thong (No. 34) also indicated the same results of impervious layers distributed near the ground surface. However, these sites were not excluded from candidate sites because of the existance of deep wells and their differences in topographic and geologic condition in comparison with the sites mentioned above. These areas are formed by small hills, and the areas are not directly covered by the impervious layers of mudstone and shale of Mesozoic era, but by the deposits of Neogene to Quaternary, overlaying the impervious layers. The upper portion of the small hills have generally shallow impervious layers and the aquifer layer is thin. In contrast to the upper portion, depth of the impervious layers in the lower portion is deeper and the aquifer layer is thick. Thus, the results are considered to indicate that the impervious layers are distributed near the ground surface. If construction of new wells is planned in this area, it should be drilled in the lower portion of the hills.

The results of the electric resistivity are added in the table of planned depth for deep wells as reference data, and consider the distribution situation and depth of the existing deep wells.

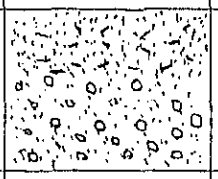
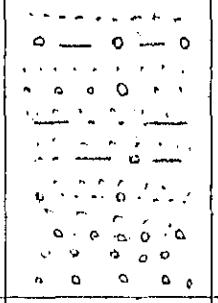
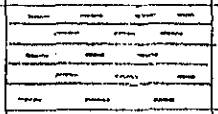
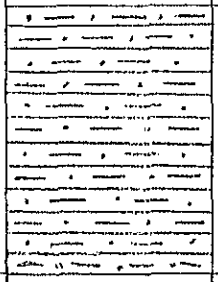
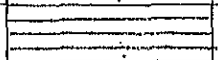
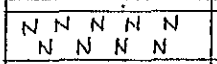
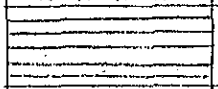
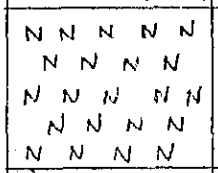
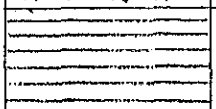
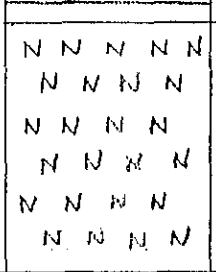
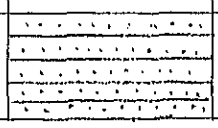
(5) Hydrogeological Condition and Groundwater

The geological map of the project area is indicated in the Vientian Plain Hydrogeological Map of Fig. 2-11. The hydrogeological map mainly indicates the difference of groundwater occurrence and classifies the project area

Table 2-5 Basement Depth of Main Aquifer Based on Electric Resistivity Survey

No.	Survey Point	Village No.	Basement Depth of Aquifer
E- 1	Nam Chiim	10	Basement depth:15 m, Aquifer is underlain by mudstone and shale.
E- 2	Na Kaam	14	Basement depth:15 m, Aquifer is underlain by mudstone and shale.
E- 3	Naxom	15	Mudstone and shale is distributed in the depth of 4 m or more.
E- 4	Phon Si Neua	18	Basement depth:5 m, Aquifer is underlain by mudstone an shale.
E- 5	Sen Xoum	19	Weathered layer and mudstone and shale are distributed in depth of 15 m or more.
E- 6	Nathong	34	Mudstone and shale is distributed in deeper portion than 2 m.
E- 7	Phon Ngang	48	Aquifer is distributed from ground surface to 32 m in depth.
E- 8	Nabon	45	Impervious layer of sandstone is distributed near ground surface. unappriate drilling p point
E- 9	Phon Kham	51	Mudstone and shale are distributed in the depth of 2 m or more. This layer is underlain by sandstone. Unapproriate well drilling point.
E-10	Phon Xaii	38	Basement depth:9 m
E-11	Ek Xang	40	Basement depth:14 m
E-12	Vieng Kham	64	Basement depth:40 m
E-13	Na Xang Leuk	68	Basement depth:16 m
E-14	Na Kang	70	Basement depth:4 m. Aquifer is underlain by sandstone (?).
E-15	Na Peng	72	Basement depth:10 m. Siltstone is estimated to be distributed from 10 m to 36 m in depth
E-16	Hai Gnon	73	Basement depth:20 m

FIG. 2-12 OUTLINE OF GENERAL STRATIGRAPHY
(Original source: Improvement Project of THANGONE Rice Field, Vientiane Province, 1987-1989)

ERA	PERIOD	EPOCH	Formation	STRATI-GRAPHIC COLUMN	PETROGRAPHIC CHARACTERISTICS
CANOZOIC	QUATERNARY	ALLUVIUM			Sand, silt, clay, and gravel
	TERTIARY QUATERNARY	NEOGENE-QUATERNARY			Sand, clay, pebbles, brown ash, and multicoloured several thin layers peat in some place
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	XAYSOMBOUN		Red-brown, light brown claystone
					Siltstone alternated with claystone, red-brown dark-brown violete, gray alaurolite the rocks are thick-bedded with carbonate.
			THANGONE		Red brown, dark brown clay, grey white in lower
					Brown milky white halite
					Reddish and dark-brown clay and lens of halite
					Halite colourless, milk, white, ash grey, medium to coarse grained alternated with some small nests and thin layers of anhydrite.in some place of upper part
					Reddish, brown clay with the alternation of thin halite layers
					Courless or light rose, ash-grey open to coarse grained, alomophic rock-salt aternated with anhydrite layers. They are strongly pressed.
					Arkosic-form sandstone, greenrish-grey, white-grey in the upper part and reddish brown in the lower part.

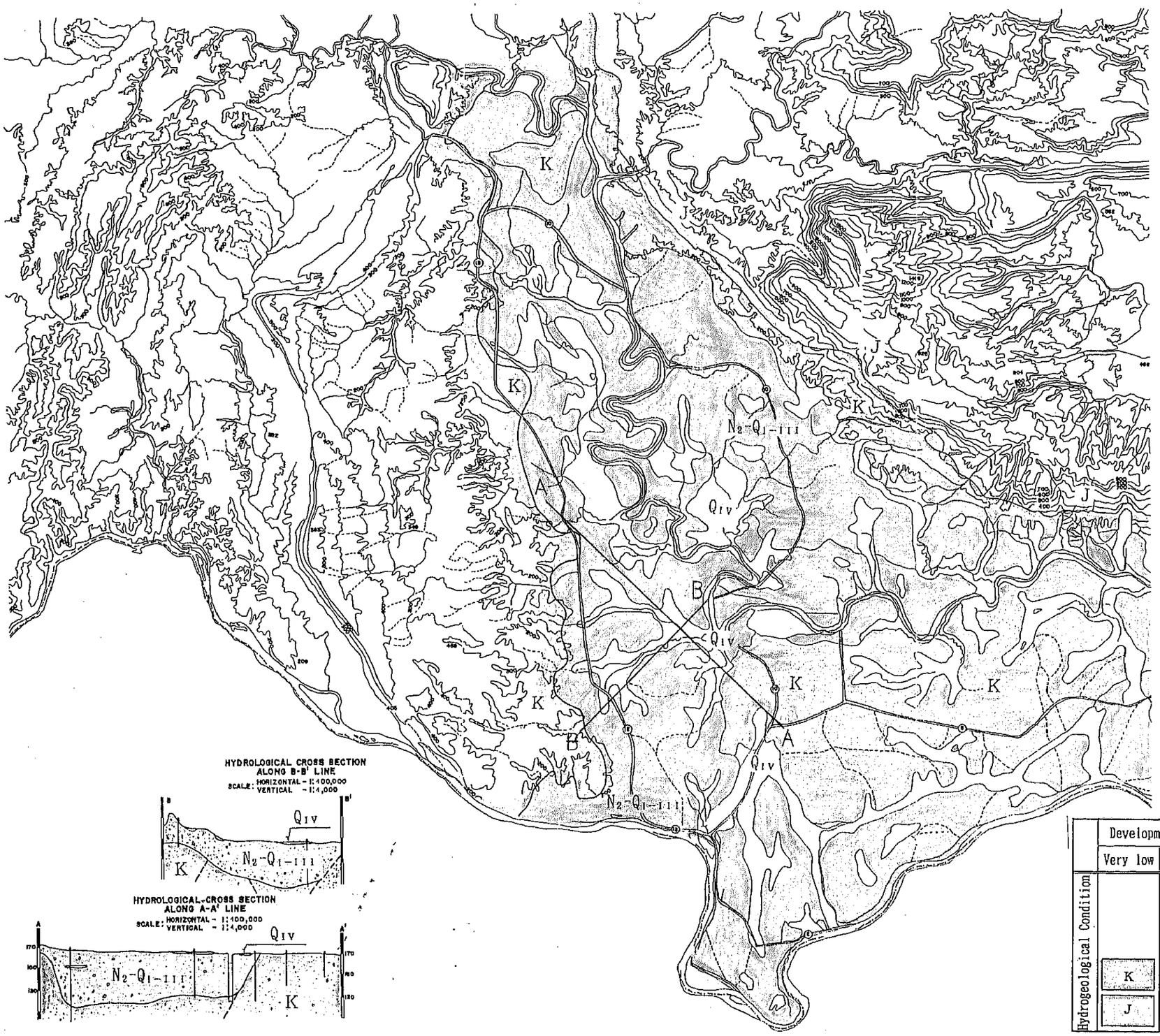
into three zones: Legend 1) QIV is estimated to be alluvium deposit which is in low land. The formation is made up of sand, silt, clay, and gravel. Legend 2) N2-QIV and N2-QI-III is considered to be Diluvium to Neogene deposit. The formation mainly forms many small hills with a height difference of about 30 to 40m distributed in the project area. Legend 3) K formation is estimated to be mudstone and shale or sandstone of the Mesozoic era based on the results of observations in the field. The formations are impervious layers. In the distribution area of this formation, groundwater will be able to be developed.

The stratigraphy of the formations are shown in Outline of General Stratigraphy of Fig 2-12. The stratigraphy is mainly divided into three stages; the upper most portion is distributed by Alluvium, the second one Diluvium, and the basement rock of the project area is Cretaceous Xaysomboun claystone and siltstone colored red-brown. This formation is considered to be the same as mudstone and shale which is observed in the project area. In the columnar section, the lower most formation is sandstone. The sandstone is generally observed in the western part of the project area. The sandstone is interpreted to be the same as the layer that Thagone Halite overlays. The sandstone is quartzitic and very hard. These basement rocks are the same as in the K formation mentioned above. In the project area, Halite of Thagone Formation was not observed in the field or in the results of core boring.

2.3.3 Situation of Well Construction

(1) Construction Sector of Deep Well

The construction of deep wells is almost always conducted by government agency or public corporation. The number of private contractors with an effective scale for the well construction is very few. The scale of most private contractors is very small and are usually family unit. Owned equipments are very scarce. In addition, the method of well construction is not skillful, and the completed wells have almost no gravel packing and no cement shield. The well construction in this country is generally done by the rotary method and the percussion method is not applied.



Hydrogeological Condition	Development Potential of Groundwater				Geology
	Very low	Low	Medium	High	
		Q_{IV}			Quarternary, Holocene
			N_2-Q_{I-III}	N_2-Q_{I-III}	Tertiary Pleistocene-Quarternary Pleistocene
	K				Mesozoic Era
	J				Mesozoic Era

(Source:Vietnam 1990?)

FIG. 2-11

GEOLOGICAL MAP

The following are governmental offices which posses their own drilling rigs. Type of each rigs are also described.

1) Clean Water Institute: Thai PAT Rotary Rig x 15 units (see Table 2-6)
2) Department of Geology under Ministry of Industry and Handicraft:
Rotary Rig x 1 unit, Russia
3) Irrigation Department under Ministry of Agriculture and Forestry:
Rotary Rig x 1 unit, Russia
4) Service of Provincial Public Work of Savanakhet:
Rotary Rig x 1 unit, USA
5) Service of Provincial Irrigation of Champsak:
Rotary Rig x 1 unit, USA

Although the CWI has maximum number of rigs, their drilling capacity is very small and insufficient.
Public corporations are as follows:

1) Geo-Mining Co. Ltd.,: Russia SKB-4 x 3 units, UGB-50 x 2 units
Rotary Rig x 1 unit, USA
Rotary Rig x 1 unit, Australia
2) Hydropower Engineering Consultants (HEC):
Koken KT-100 x 1 unit, Japan
Craelus 900 x 1 unit, Sweden

All rigs belong to Geo-Mining Co. Ltd., are already deteriorated and their operational status is doubtful and the number of rigs owned by HEC is few and their capability is small.

(2) Actual Situation of Deep Well Construction

1) Deep Wells Constructed by Private Contractor

There are some deep wells constructed by private contractors in some villages. These wells have no information on their well structure. As an example, the construction condition and well structure of a sample well is indicated as a reference. The well was completed by the fund of the Women's Union, and was constructed by a small private contractor using the jet drilling method of the manual type. This method drills formations by lower-

Table 2-6 List of Existing Drilling Rig(PAT Rig)
belong to Ministry of Public Health

Unit : Set

Name of Province	No. of Rig	Fund	
		Foreign	NGO's
1. Vientiane Municipality	2	Unicef ×1(1992)	CIDSE ×1(1991)
2. Vientiane Province	1	Unicef ×1(1993)	
3. Borikhamsay Province	1	Unicef ×1(1993)	
4. Khammouane Province	1	Unicef ×1(1992)	
5. Savannakhet Province	3	Unicef ×1(1992)	CIDSE, MCC ×1(1990)
6. Champsak Province	2	Unicef ×1(1992)	ADDRA ×1(1991)
7. Saravan Province	1	Unicef ×1(1993)	
8. Xiengkhouang Province	1	Unicef ×1(1993)	
9. Sayaboury Province	1	Unicef ×1(1993)	
10. Louang Namtha Province	1	Unicef ×1(1993)	
11. Oudomsay	1	Unicef ×1(1993)	
Total	15	11	4
Note	CIDSE : Cooperation International Development and Soridarity MCC : Mennoite Central Commitee ADDRA : Adventish Development Relief Agency		

ing drill pipes with a drive shoe driven by manpower and injecting mud water into the drill pipes by a small-engined pump. The depth of the well is about 28 m, but the casings(diameter 2-1/2") are only set to the depth of 12 m and are not installed in any deeper portion than that of 12m. In addition, the well structure is very simple and has no gravel packing or cement shield.

2) Deep Wells Constructed by Agency and Public Corporation

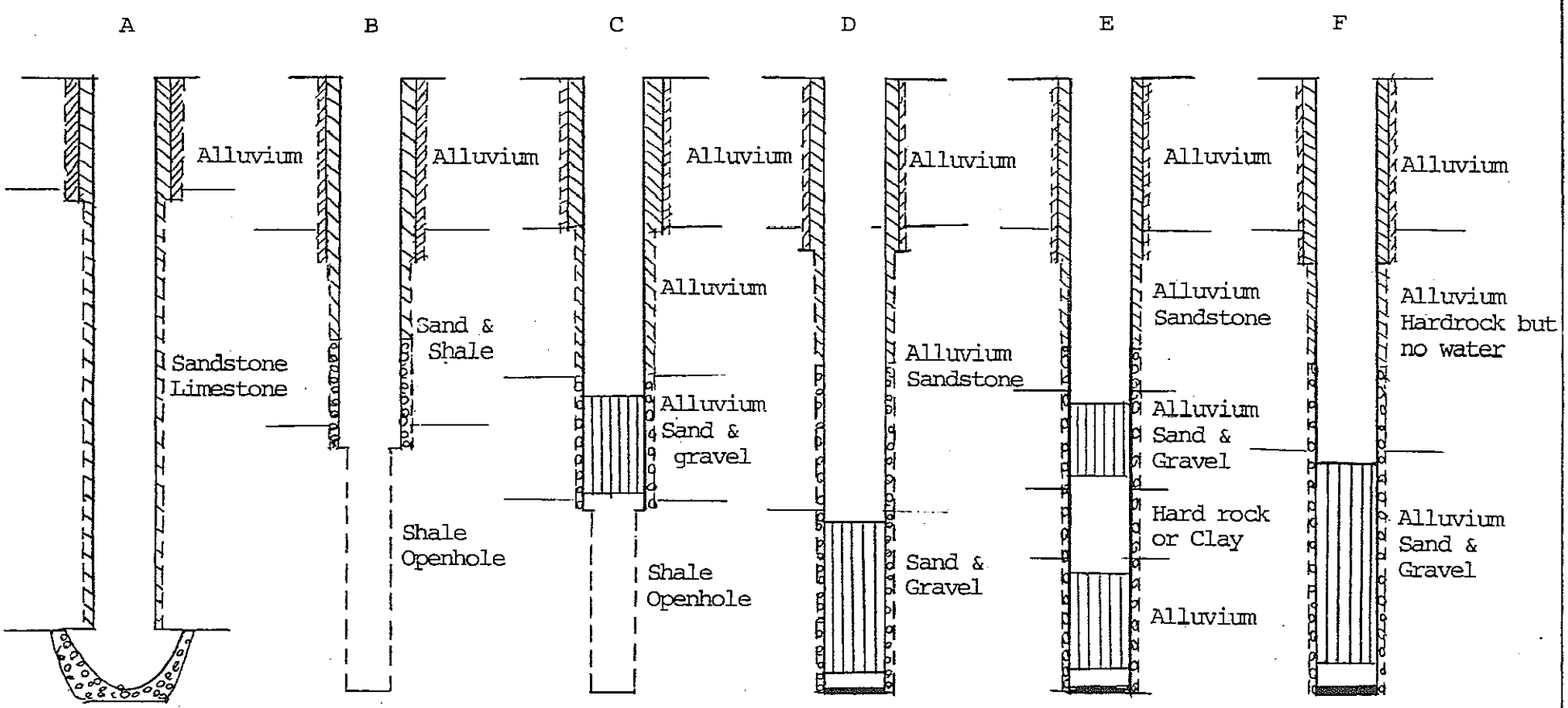
The old wells constructed by USAID and UNICEF in the past have no documentation. Thus, the existing well structures are almost indefinite. According to measurements of well depths in a number of existing deep wells, the well depth becomes shallower than that of original. Such result occured because the well was originally drilled into an impervious layer of mudstone and shale laying under the aquifer without a casing and the bore portion was buried by an inflow of sand and silt from the aquifer distributed in the upper portion of the bore.

In addition, clay is observed in some wells to be mixed with well water. This phenomenon is considered to be caused by such inappropriate well structures such as screens that set up in a clay layer. Moreover, there are many wells that have an inflow of fine sand due to the lack of gravel packing or insufficient well development.

The casing materials in some part of the existing deep wells are galvanized iron pipes, but the materials of most wells are PVC pipes. The casing diameter is usually 4" or 6". The casing materials are also the same as those of casing. The screens are horizontal wire wound or horizontal slit cutting types.

3) Standard Well Structures

At present, the standard well structure adopted for UNICEF and for foreign country assisted projects by the CWI are shown in Figure 2-13. The standard well structures differ among the six types, but all structures have a common characteristic in a base of gravel packing and a cement shield.



Source: Clean Water Institute, Lao PDR

FIG. 2-13
STANDARD DESIGN OF DEEP WELLS
ADOPTED BY CWI,
MINISTRY OF PUBLIC HEALTH

CHAPTER 3

THE PROJECT

CHAPTER 3 OUTLINE OF THE PROJECT

3.1 Objectives

Vientiane Province is using groundwater through shallow wells with depths ranging from 5 to 15m or river water as domestic water sources. However, most of these shallow wells dry up during the dry season, especially from February to April. Water quality during this season is also unfavorable due to contamination by seepage of domestic sewage and excreta of livestock. Such unsanitary drinking water causes water-borne diseases resulting to high rate infant mortality which has become a serious social problem in the Lao PDR.

Under these circumstances, it is the objective of this project to develop a plan to construct deep wells with depths of about 50m for the proposed 80 villages in 3 southern districts, namely: PHON HONG, THOULAKHON and KEO-OUDOM, all in Vientiane Province. The goal of the project is to contribute for sound social development and improvement in sanitary condition in rural areas through optimum groundwater development planning. The plan will suit the socio-economical levels of each village, based on the total evaluation of the information/survey results collected during field surveys.

3.2 Study and Ebamination of the Request

3.2.1 Needs and Appropriateness of the Project

The project area in Vientiane Province is composed of several small scale agricultural communities. Seventy one percent of the total villages has population of 800 or less. The main water supply sources in these villages are dug wells with depths ranging from 5m to 15m. The number of dug wells in each village is from 2 to 100. As was stated, these dug wells encounter serious problems during dry season when these dry up. Some villages have dug wells that do not dry up even during dry season, but these are very limited in number. These wells that do not dry up however have water levels of only about 30cm from the well bottom, and if the dry season period prolongs, these wells also dry up. When wells dry up, the villagers have to take water from nearby canals because the

location of dug wells with water is far or have to buy from private wells and carry water from adjacent villages. There are also some bottled water selling firms which fill plastic bottles of groundwater from deep wells. Since water quality of shallow wells is not suitable for drinking, villagers commonly buy water from these firms and are compelled to pay a great deal of expense. In some villages, the expense for this bottled drinking water represents from 15% to 30% of the villager's monthly income.

Other than the dug wells, the project area has 24 public deep wells with handpumps which are almost all in operation. These deep wells have depths ranging from 25m to 50m, and are used as stable water sources because these wells do not dry up even during the dry season. Also located in this area is a deep well with a depth of 81m owned by a salt production firm. Water from this well has a very high concentration of chloride. There is therefore a misconception that water from deep wells have high salinity level. The results of field survey, however, indicate that water quality of the existing deep well is potable and within WHO drinking water standard.

This project aims to construct deep wells with handpumps and water supply systems with public faucets in the project area in Vientiane Province. The project is part of a very important program and is expected to be implemented so that it can provide safe and stable water supply to the villagers even during the dry season.

3.2.2 Implementation Arrangement

The implementation of the Project is carried out through the initiative and leadership of the Clean Water Institute, Ministry of Public Health. The Provincial Water Supply and Sanitation Division, a subordinate organization, officially belongs to provincial organization, but it is directly and administratively supervised by MOPH. Budget of this division for the fiscal year 1993-1994 will be merged with MOPH. In addition, the Provincial Water Supply and Sanitation Division can only arrange to solve the problems on the Prcject by negotiating with the villagers. Thus, the planning and framing for the Project are implemented by the MOPH with the cooperation of the Provincial Water Supply and Sanitation Division. The

organization of the division is presented in detail in sub-section 2-1, Background of the Project.

The Project plans to construct a maintenance center in Phonsi Tai village which will take charge in the operation and maintenance of the completed water supply facilities. The projected total number of officials/staff to work in the center is 20 including the administration. It is planned that official will come from the Water Supply and Sanitation Division and the UNICEF Project Section of the Vientiane Province administration. Presently, there's three project implementing subsector in the provincial division namely, groundwater development subsector: the number of officials are seven, surface water development subsector: the number are three and latrine promotion subsector; the number are two. The project shall request officials/staff for the maintenance center to be assigned from the existing personnel belonging to the groundwater development subsector and UNICEF project sector.

Regarding the budget of the implementation agency the total budget of MOPH for the fiscal year, 1992-1993 is 262,041,000 kip broken down as follows: construction, 40,000,000 kip, rehabilitation, 50,000,000 kip; administration, 50,000,000 kip, together with the remaining amount of salary and social welfare. The budget of MOPH is anticipated to increase by 15% from the present level for the coming fiscal year 1993-1994. Small scale repair of handpumps shall as usual be done by villagers, collecting the repair fee by themselves after the training of handpump repair during implementation time, and if it is a large scale repair, it shall be done by MOPH. In this view of point, MOPH is considered to have enough budget for the implementation of the Project because the operation and maintenance do not need large amount of the budget. Moreover, the operation fee for electricity for the operation of submersible pumps in water supply systems with public faucets is planned to be shouldered by the consumers. It is not necessary therefore for MOPH to spend operation fee for this kind of system. The electricity cost for the Maintenance Center including its water supply system must be shouldered by MOPH. This amount is very small compared with the total budget of MOPH.

With the above mentioned consideration, the operation and maintenance of the completed water supply facilities shall be fully taken care of by the

Lao Government.

Table 3-1 MOPH Budget (October 1992 - September 1993)

Item No.	Description	Budget (Kip)
1	Construction	40,000,000
2	Rehabilitation	50,000,000
3	Administration	34,089,000
4	Salary	89,620,000
5	Allowance for Dependent Children	16,510,000
6	Social Welfare	39,570,000
	Total	262,041,000

3.2.3 Relationship and duplication with Similar Locally Funded and Foreign Assisted Projects

Villages which are planned to be included in the implementation of other foreign-assisted projects are excluded from this Project.

The Feasibility Study on the urban water supply system with house connections (Level III) covering 7 provincial capital cities was completed by Nam Papa Lao with ADB-fund assistance. Phon Hong town and 6 surrounding villages were included in this study. ADB is scheduled to appraise a short list of Consultants submitted by Nam Papa Lao, until the end of June 1993. Proposals will then be submitted by the Consultants after one month.

The proposed area coverage by this ADB-assisted project includes the following seven villages which were previously in the list of target sites for the JICA assistance. These are as follows:

Phon Hong District

Phonsi Tai (No. 2), Nan Linh (No. 3),Phon Hong (No.4)

Phon Kham (No. 5), Phon Xay (No. 7), Phon Ngam (No. 8)

These 7 villages will therefore be excluded from the scope of the Project given the following considerations:

(1) While the water supply system which involved ADB project is urban type, our project focuses on village type, namely Levels I and II.

(2) Nam Papa Lao is planning to construct an urban water supply system at all provincial capital cities according to Governmental policy.

(3) MOPH conforms with the ADB project which excludes Phon Hong Hospital and surrounding public facilities.

Keun village (No. 66) in THOULAKHOM District is assisted by the French fund, the basic design of which was completed in 1991. The detailed design will be finished by the end of 1993 and construction work is expected to commence in 1994. Water source is the Nam Ngum river and the system consists of a water purification plant, a pumping station, an elevated tank, and PVC distribution pipe. Thus, this village will be excluded.

There's one block in Phonsi Tai(NO.2) village where Hospital, Elementary School and newly build Maintenance Center are adjacent ech other and this village is already included in the aforementioned ADB project. Compared with general household, these facilities consume large volume of water. Presently, through ADB project, only Feasibility Studey is completed but project implementation schedule is still tentative. While Maintenance Building will be completed on January of 1995 by the Project and this building include water system also. Since it's risky to depend on such tentative project, an additional water system for exclusive use of the above-mentioned facilities should be involved in scope of the Project.

3.2.4 Composition of the Project

The Lao Government tendered the request for this Project to the Japanese government, wherein the Lao Government designed the project composition as consisting of the construction of water supply systems in three districts in Vientiane Province, construction of a maintenance center and

the supply of vehicles. The arrangement of this project is considered necessary and essential to improving the condition of rural water supply and the Project is seen to have an integral relationship with the well-being of the rural population.

This section details the project area, the composition and the quantity of construction facilities, and the supply of equipment and materials. The project proposal was examined from the view points of basic policy of the Japanese grant aid project, the planning of maximum project benefit, the quantity of supply facilities, and the problems in project implementation. The results of the examination are as follows:

(1) Project Area

The Project area requested by the Lao Government is composed of the three districts of PHONHONG, THOULAKHOM, KEO-OUDOM in Vientiane Province. These three districts are adjacent to each other and can be toured within half a day by car. The coverage of the Project area is ideal, in that it satisfies the condition of Japanese grant aid which requests that a project be completed within a short period of time.

(2) Project Policy

The Project's main goal is to construct water supply systems. It is reasonable that the Project includes equipment and materials needed for the operation and maintenance and not for construction since the provincial division owns a small drilling machine. Including drilling rigs in the Project is not appropriate from the standpoint of personnel capacity e.g., the number of engineers, technicians and their capabilities.

(3) Water Supply Facilities

It was decided that the water supply facilities will include deep wells with handpumps as well as water supply systems with public faucets. The plan proposes to construct wells with handpumps in as many villages as possible, and to construct water supply systems with public faucets only in large-scale villages with a fairly high population density. This was decided on the reason that small villages with a population of 800 or

less are predominant and comprise 71% of all target villages while large-scale villages are very few. There is an acute shortage of water supply during the dry season in the project area. Hence, all villages expect the completion of water supply systems with deep wells in their area.
The number on the project composition shall be examined in the CHAPTER 4.

3.2.5 Requirement for Facilities, Equipment, Materials and Service Vehicles

The Project includes water supply facilities, Maintenance Center and garage, vehicles, repair equipment and materials, water quality analysis equipment and reagent which needed for the operation and maintenance of the completed water supply facilities. The necessity and outline of these facilities, equipment and vehicles are indicated below.

(1) Water Supply Facilities

The requested facilities, deep wells with handpumps are the water supply systems which supply water at well point by handpump. The deep wells with public faucets are composed of deep wells with electric submersible pumps, a transmission pipeline a ground tank or elevated tank, a distribution pipeline, and public faucets. Though the original request for the Project is to construct 100 deep wells with average depth of 50m in 80 villages in the three southern districts of Vientiane Province, part of this proposal may be modified based on the results of the technological examination.

(2) Maintenance Center

At present, the Water Supply and Sanitation Division of Vientiane Province uses a room of the Provincial Public Health Building Located in Phonsi Tai village as its office. This office serves as a warehouse for the drilling rig and materials as well as an office. The office is small and although it has enough desks and chairs, it has no cabinets or typewriters. The room is in very poor condition. Also, the office has no repair shop or repair equipment and it lacks storage space for operation and maintenance equipment and materials.

After the completion of the Project, the operation and maintenance of the various completed water supply systems have to be performed by the Provincial Water Supply and Sanitation Division. Thus, a storage room for the repair equipment and materials will be necessary whether it is to repair the parts of the water supply systems in the maintenance shop or in the field. It is obvious that a garage to keep the vehicles to be used for operation and maintenance will be needed. Considering the above conditions, the Maintenance Center is judged to be necessary in order to operate and maintain the completed water supply systems of the Project in the future and ensure continuity of the systems.

(3) Vehicles Used for Operation and Maintenance

The Provincial Water Supply and Sanitation Division at present owns a truck and a motorcycle. The truck is used for transportation of equipment and materials, along with the necessary workers. The motorcycle is used for communication duties between the office and villages. These vehicles are used jointly among the groundwater development subsector, the surface water development subsector and the latrine promotion subsector, each with different priorities for usage. The number of vehicles at present is inadequate. Hence, the following vehicles for the exclusive use of the Maintenance Center will become necessary for the Project after its completion; a truck for transportation of repair equipment and materials such as tripods and handpumps; a pickup to transport small equipment and materials; workers as well as communication service between the office and villages; and a motorcycle for communication service.

(4) Repair Equipment and Materials

Repair equipment and materials are necessary to operate and maintain the completed water supply systems after completion of the Project.

(5) Water Quality Analysis Equipment and Reagent

Water quality analysis equipment and reagent are necessary to test water quality in the water supply systems in the Project area.

3.2.6 Needs of the Technical Cooperation

The Clean Water Institute of the MOPH has improved the water supply condition in Vientiane Province with the leadership and cooperation of UNICEF. However, there are many deep wells with non-operational handpumps in the villages because of the shortage of engineers and technicians, repair equipment and materials and in adequate technology. It is the objective of the Project that the villagers will be able to repair the handpumps by themselves in the Maintenance Center after the proper repair equipment and materials have been provided. Thus, the technical cooperation is necessary to transfer the repair technology to the villagers.

Water quality analysis equipment will also have to be supplied to facilitate the investigation of the water supply wells. As the CWI has no chemical laboratory and has not conducted any water quality analysis, the water quality analysis will be a first trial for the Institute. Consequently, the technology transfer of water quality analysis techniques is necessary.

Furthermore, the operation and maintenance of existing deep wells with handpumps in the project area is presently done only in few villages. Most villages have no operation and maintenance organizations nor do they have the training or experience in operation and maintenance methodology. It will be necessary to provide the information on the formation and function of the organization for operation and maintenance to the villagers.

Likewise, it will be necessary to store information on the locations, structures, and history of the deep wells that are to be constructed by the Project to assist in their operation and maintenance. At present, information about operational condition of existing public deep wells is not in the possession of the proper authorities. The establishment of a data base will be necessary to solve this problem.

3.2.7 Conclusion and Basic Policy in Provision of Grant Aid Program

The basic policy, including the conclusion and the results of the exami-

nation on the composition of the Project requested by the Lao government, was decided upon as follows:

(1) The Project is outlined as part of a water supply improvement plan carried out by the Lao Government. The Project aims at constructing water supply system with deep wells which have potable water and do not dry up in the dry season for inhabitants living in three southern districts of Vientiane Province.

(2) In the present management policy of the Lao PDR, the implementation agencies of the CWI and the Water Supply and Sanitation Division of Vientiane Province and related organizations have a distinct line delineating their functions and responsibilities. The implementation of the Project will have no organization problems because the personnel requirement for the operation and maintenance of the Project after its completion, have a great possibility of being secured, and the MOPH has enough budget for operation and maintenance activities.

(3) Although the villagers of the selected project sites may find it difficult to shoulder the cost for large-scale repairs under this Project, they will be able to pay a repair fee on small-scale repairs. From the viewpoint of self-assistance, the selected sites are matched for the policies of Japanese grant aid.

(4) The project area and project composition as requested by the Lao Government were examined based on the basic policy of Japanese grant aid. These were judged to be appropriate in each instance. This Basic Design Study follows the outlined requests, except for the number of necessary water supply facilities and the planned well depths of 50m, which will be determined later, based on the results of the study from the technological standpoint.

From the policy examination mentioned above, the project is judged to be appropriate to be implemented with Japanese Grant Aid Fund, by the reason of the project's effectiveness, the necessity of the project and capability of implementing agency.

The outline of the Project will be discussed in the succeeding sub-sec-

tions with the premise that the Project will be implemented with financing from the Japanese Grant Aid, and that the Basic Design phase has been executed. The project composition may be modified during the detail design phase which may differ from the original Lao Government request as stated in sub-sections 3.2.4 and 3.2.5.

3.3 Project Description

3.3.1 Excuting Agency and Operational Structure

The duties and responsibilities of related organizations which will be responsible for this project are mentioned in the preceding chapter. The relevant items for operation and maintenance stage, i.e., after the project completion are summarized as follows:

- Implementing agencies are directed by the MOPH in collaboration with Vientiane Province. Success in ironing out differences in opinions and issues has gone well and at present, relationship between both organizations is very smooth. Although this Project will be promoted through the Clean Water Institute, the CWI is a supervisory agency while Vientiane Province is the organization which directly contact inhabitants, conduct well construction, and assist in maintaining the wells in villages. Therefore, any policy making decisions and their management will require close and continuous adjustments between the CWI and the Vientian Province.

- Guidance and training for the operation and maintenance of wells and water supply facilities are to be executed by the CWI and this activity will be on a continuing basis. Although the establishment of regulations on the actual management and operation of the Project is entrusted to Vientiane Province, no regulations have yet been enacted at this time. These regulations are essential prior to the Project and for the preparation of its sustainable maintenance.

- Monitoring and supervising of the management of well and water supply facilities are the responsibility of the CWI. The CWI has experience and knowledge through exposure to other works of other

provinces and the UNICEF-assisted projects.

3.3.2 Plan of Operation

The water supply facilities, maintenance facility and the equipment included in this project are planned as mentioned below:

Design factors, such as the planned project villages design served population, levels of proposed water supply facilities, the data of institutions are summarized in Table 3-2. Deep wells with handpump are planned for 47 villages and water supply systems with public faucets are planned for four villages. The total planned population will be 42,460 persons with a target year of 1998. Among these, 4,900 persons are already equipped with existing deep wells. The number of elementary schools in the target villages is 40, junior high schools, 14 and senior high schools, four. the total number of students is 18,593. There is one big hospital with 32 beds in Phonsi Tai village while the number of people in the police office in Pak Cheng Neua is 240 persons. Meanwhile, the proposed Maintenance Center and vehicles correspond with the application of the Lao PDR. Locations of each of the facilities are presented on Figure 3-1.

The implementation time for the construction will be limited to one year. Exclusion of villages other than the above mentioned villages, are based on the following reasons:

1) Merged villages

2) The villages are already to be implemented by other foreign-funded projects.

3) The villages are located in areas where groundwater development will be impossible from the standpoint of hydrogeology.

4) The villages are found to have enough water from their existing wells.

The detailed reasons are described in Appendix B-5.

Table 3-2 SUMAMRY OF PHYSICAL TARGETS AND RELATED FACTORS

DISTRICT/VILLAGE	VILLAGE	WELL FACILITY LEBEL/ PROPOSED NUMBER OF WELL		SERVED POPULATION	SCHOOL/No. of (STUDENTS)	PUBLIC/ HOSPITAL
		Level I	Level II			
PHON HONG						HOSPITAL 121 (32 Beds)
Phon Hong Hospital			1	121	737 Elem. 2	
Na Pho Neua	9	1		447	66 Elem. 1	
Nam Chiim	10	1		246	341 Elem. 1 Jr. High1	
Phon Ho	11	1		360	111 Elem. 1	
Na Moung	12	2		582	105 Elem. 1	
Mong Tao	13	1		297	—	
Na Kaam	14	1		319	—	
Sen Saat	16	1 (1)		216	603 Elem. 1 Hi. Schol	
Phia	17	1		244	—	
Phon Si Neua	18	1		274	—	
Sen Xoum	19	2 (1)		1,028	259 Elem.	
Phon Keo Phon Ngeun	20	2 (1)		535	592 Elem. 1 Jr. High1	
Si Boun Heuang	24	2 (2)		935	534 Elem. 1 Jr. High1	
Na Xou	25	2		633	—	
Na Lou Khoun	26	2		534	—	
Na Gnang	27	2		686	186 Elem. 1	
Na Souak	28	1		230	—	
Phon Sawath	30	2 (1)		752	423 Elem. 1	
Na Lao	31	3 (2)		724	—	
Phon Tha	32	1 (1)		386	97 Elem. 1	
Na Thong	34	2		666	203 Elem. 1	
Sovalaii	35	1		521	—	
Maii	36		4	1,942	501 Elem. 1	
Phon Xaii	38	6		1,748	696 Elem. 1 Jr. High1	
Ek Xang	40	3		1,092	247 Elem. 1	
Phon Than	41	2		574	271 Elem. 1	
Lak Hasiv Song	42	6		2,047	594 Elem. 1	
Phon Kham	43	1 (1)		394	—	
Nong Nak	44	4 (1)		1,564	659 Elem. 1	
Vang Monh	46	3		1,170	104 Elem. 1	
Saka	47	2 (1)		654	1,010 Elem. 1 Jr. High1	
Phon Ngang	48	3		812	1,023 Elem. 1 Jr. High1	
Na Xay	52	2		733	—	
Phon Sida	53	1 (2)		300	—	
Phon Xong	54	4		1,190	201 Elem. 1	
Phon Mii	55		7	2,847	1,623 Elem. 1 Jr. High1 Hi. Schol	
Na Pho Taii	56	6		1,801	928 Elem. 1 Jr. High1	
THOLAKHOM						
Hong Hien Sueb Thod	58		1 (2)	240	400 Hi. Schol	
Pakcheng Neua	59, 60	9		2,555	742 Elem. 1	Police 240
Pak Cheng	61	3		776	452 Elem. 1 Jr. High1	
Dong Koat	62	1		429	226 Elem. 1	
Thin Gnung	63	4		1,392	487 Elem. 1 Jr. High1	
Vieng Kham	64	2		617	186 Elem. 1	
Pak Ka Gnung	65		5	2,199	734 Elem. 1 Jr. High1	
Nam Ang	67	1		406	118 Elem. 1	
Na Xang Leuk	68	1		339	116 Elem. 1	
Na Pay	69	2		632	662 Elem. 1 Jr. High1	
Pak Hang	71	2		443	1,005 Elem. 1 Jr. High1 Hi. Schol	
Na Pheng	72	4		1,206	668 Elem. 1 Jr. High1	
Hai Gnon	73	2		427	327 Elem. 1	
Dong	74	2		654	310 Elem. 1	
KEO-OUDOM						
Phonekham	80	2		541	46 Elem. 1	
Total Number	51villages & 1 area	47 villages ( ) indicates number of existing deep wells. New 109 Existing(14)	4 villages & 1 area ( )indicates number of existing deep wells. New 18 Existing (2)	42,460 pers. Among these, approx. 4,900 persons are using existing deepwell facilities.	Students 18,593人	Hospital 121pers. Police 240pers.

LEGEND

- Village with Handpump Well
- Village with Piped Water System of Public Faucets
- Proposed Site for the Maintenence Cenyer Building

Note: Numbers in circle presents Village Number

FIG. 3-1

LOCATION MAP OF PLANNED WATER SUPPLY SYSTEMS

Target villages for water supply systems with public faucets were chosen considering the following conditions:

1) The villages are located in areas where groundwater development is possible to produce ample supply of water.

2) The village population can provide sufficient fund for the maintenance of machinery such as pumps.

3) The villages have electric power supply.

4) The villages in which the average income of each family can afford to pay maintenance expenses including electric charges.

5) The villages with a density of houses that warrant the installation of water supply systems with public faucets.

A Maintenance Center building, vehicles and up-keep are included in this Project based on the application from the Lao PDR. In addition, training in operation and maintenance is planned for the implementation stage of this Project in Vientiane Province.

The present office of Water Supply and Sanitation Division of Vientiane Province is very small and is oftentimes filled with equipment and tools. Considering this present condition, the following have also to be taken into account:

1) the necessity to staff a personnel who is in charge of the custody of the funds collected from villager as a charge using public wells and facilities. The assigned personnel has to monitor the situation of well facility maintenance;

2) the necessity to staff a personnel who is in charge of managing the property and inventory control for spares and spare parts; and

3) to respond quickly to meet the needs of public wells located all over the province.

A new suitable building including an office room and storage room is planned.

As the storage room is also planned for the purpose of preventing against deterioration of spares and spare parts, it is recommended that distribution of spares or spare parts at the request of villagers be at the lowest prime cost possible in order to secure/set aside a revolving fund for sustainable development.

The maintenance building has an attached workshop in order to:

1) process and repair simple materials and drilling bits; and

2) secure tools to rent out to villagers and to assist in the repair of wells and water supply pipes at sites.

As to vehicles, the Division has only one 1.5 ton-truck and one motorcycle for liaison provided by UNICEF in 1993. When the Project is completed, necessity of new vehicles for forwarding or distribution of maintenance tools and/or study/inspection/communication with villages, will be vital. Hence, the provision of vehicles for exclusive use of the center is included in this Project. A garage space is also planned to accommodate these vehicles.

As mentioned above, the Maintenance Center will allow for future sustainable well development in the Lao PDR or specifically, the Vientiane Province. For the Japan side, it will also be a very effective concrete symbol of friendship between both countries.

The proposed construction site was designated by the Vientiane Province Public Health Department situated on official land in Phonsi Tai village.

3.3.3 Locations and Condition of the Project Sites

(1) Water Supply Systems with Public Faucets

The list of villages where water supply systems with public faucets are planned is tabulated in Table 3-2. The locations are shown in Figure 3-1.

The target villages are in an agricultural area producing mainly rice and is just one hour away by car from Vientiane City. Most of the villagers depend on dug wells. However, as 50 to 100% of the dug well dry up during the dry season, the villagers have to fetch water from neighboring wells or from neighboring villages. In addition, there ae many households which purchase water at a cost of 150 to 500 kips per one drumcan (average cost is 200 kips/200 lit). Households of eight persons can consume two drumcans per day. The daily average water consumption is 50 lpcd and the expenses of the household for water is 12,000 kips/household/month, while households which purchase bottled drinking water consume 20 to 30 lit/day on the average. The population of villages in the target area varies from 1,942 persons to 2,847 persons and the average monthly income is approximately 15,000 to 75,000 kips. The main income sources in the villages are rice, timber, vegetables, fruits, handicrafts and livestock. According to the chiefs of villages with an above average income level, it is estimated that households can pay from 100 to 500 kips per month for a water supply system with public faucets. In one village, it can afford to pay as much as 3,000 kips. Villages that can be planned for this type of system must have the following features:

1) availability of an electric power supply;
2) people can afford to pay electric charges and repair costs; and
3) the housing density is high enough.

(2) Deep Well with Handpump

Target villages for this system are indicated in Table 3-2 as Level I and their locations are shown in Figure 3-1. As with the villages with Level II systems, these villages are an hour by car from Vientiane City. The area mainly produces rice. Population of the villages varies from approximately 200 persons to approximately 1,700 persons. The average monthly income per household is about 3,000 to 100,000 kips. Affordability to pay per household is based on a village investigation, and is about 100 to 500 kips. These target villages consist of villages other than Level II target villages and include the villages without electric power facilities and those with low or middle income inhabitants.

3.3.4 Operation and Maintenance Plan

(1) Formation of Operation and Maintenance Organization

The Vientiane Province does not have any bylaws or regulations on the operation and maintenance for wells and water supply facilities. Therefore, enactment of such laws is necessary as soon as possible before the commencement of the project implementation. Establishment of a new organization other than the existing village organization is not recommended because it means two similar organization in each village. Therefore, for the operation and maintenance of the ells and water supply system, it is necessary to utilize the existing village organization and to determine that the chief of each village is the highest person in authority in charge of the water supply. The chief of the village should designate two caretakers, one for collection of the monthly contribution from each household; and the other one for inspection and repair of well facilities. In addition to this system, Vientiane Province has to strictly monitor/inspect and assist in the collection of this monthly contribution for the utilization of water and will be the custodian of spare parts and will rent maintenance tools to villagers. Even if well construction is done for the inhabitants by grant aid, it must require them to save money for the exchange of abraded parts, repairs, expenses of consumed electricity in case of water supply systems with public faucets, and for the reconstruction of a well due to the present life expectancy of the well. Therefore, it is recommended that all the applicants must submit applications including a written oath/contract in which they promise to pay the monthly average contribution before constructing a new well. By this contract, users will have a clear recognition that operation and maintenance of the water system is important and not free. Furthermore, the CWI will have to act as a competent authority for the requirements above.

The following bad examples of what happened in other countries. There are difficulties in the collection of the maintenance fees. sometimes inhabitants willingly promise to pay a monthly contribution for maintenance before project implementation, but once it is completed and the collection of the fees start, there is a negative attitude. On the other hand, however, the inhabitants often spend money for luxuries like cola

and cigarette. In order to avoid loss of interest, unwillingness to participate, the loss of the sense of responsibility and dependence on their government, the Government and the local organizations must construct sound and sustainable operation and maintenance systems and must always work to preserve such systems.

Other experiences in other countries are:

- As similar facilities like private wells exist, even if the water quality is not good, inhabitants are not willing to participate.

- Although equipment and tools such as tripod, winch, rope, pipe wrench, etc. are necessary to repair the handpumps of wells, these are not readily available to inhabitants.

- It is difficult to procure spare parts for cylinders of handpump, especially in provincial areas. These should be procured by local governments.

- The functioning of constructed well did not last long due to lack of any introduction of appropriate technology, with no effort to support an operation and maintenance organization.

- Effort to organize an O&M organization by the inhabitants were short-lived and the local government exerted no effort to assist this activity.

- In the case of deep wells with handpumped due to the absence of power expenses, the collection of monthly contribution was not conducted aggressively. As a result, the organization can purchase spare parts at necessary time.

The following O&M system regulations are recommended considering the possible problems aforementioned.

1) Operation and maintenance of the water supply facility shall be the responsibility of villagers headed by the chief of the village.

2) The chief of the village shall appoint an inspector in charge and a maintenance fee collector. The chief of the village shall get the approval of these appointments from a village assembly/committee..

3) Although public wells are for a public service, all villagers are not necessarily able to use the facilities. Only those villagers who have signed an application and written oath can use them and will pay a user charge (monthly contribution) to use the facilities.

4) When a user delays to pay a users fee, he/she shall be prohibited from using the facilities under the decision of the chief of the village.

5) When he/she who is prohibited to use the facilities has paid the arrears up to the time of the prohibition, he/she can use the facilities again after signing the application and written oath again. However,r even if he/she doe snot submit the reapplication form, the duty of the payment for the arrears up to the time of the prohibition shall not disappear.

6) The chief of the village shall deposit the remaining money collected from villagers after paying electric charges and other fees to Vientiane Province. Vientian Province shall pass a certificate of the deposit to the chief of the village.

7) Vientiane Province shall open accounts in a bank for the abovementioned money on behalf of the chief of the villages. Vientian Province can withdraw from the above mentioned account, for spare parts charges, rental charges of maintenance tools and actual expenses of repair by the province based on the certification issued by the chiefs of the villages.

8) Interest borne from the abovementioned account shall revert to Vientiane Province and all villagers represented by the chief of the village shall abandon the right to claim the interest.

9) Vientian Province shall make a fund using the spare parts charge,

the rental charge for maintenance tools and the actual expenses of repair by the province. The fund shall be used to procure new spare parts and tools for maintenance. Vientiane Province shall make an accounting for the exclusive record of the transactions mentioned above.

10) Both Vientiane Province and the maintenance fee collector in the respective villages shall make a financial record for the village and shall be responsible for its safekeeping. When an affiliated user or a chief of the village requests to examine the bookkeeping, it shall be opened to public.

11) Vientiane Province shall rent its maintenance tools for wells and water supply facilities at a charge when a villager requests to rent the tools. However, both the province and the villager shall not use them for other purposes.

12) The user's charge (monthly contribution) shall be classified into deep wells with handpumps and water supply system with public faucets and the water charge per household shall be fixed as a flat rate system. Revision of the charge shall be fixed by Vientiane Province provided that the revision shall not aim at any profit. Although a public faucet is equipped with a water meter, this is not for determination of monthly contribution for pressure adjustment in order to convey water to the pipe ends.

13) Water supply systems and public wells are constructed only for domestic use and does not include commercial or industrial users. Therefore, users for commercial and industrial purpose are strictly prohibited.

14) Public faucets shall not be constructed in a road area for the protection of the facilities. It shall be constructed on public land and the land donated to Vientiane Province by the inhabitants provided that the donation activity of the land does not release the duty to pay user's charge.

15) More than one organization for the maintenance of facilities in one

village shall not be established.

16) The chief of a village shall designate an auditor in order to have him/her audit the bookkeeping, the user charge collection situation, the expenses, the remaining money and the passbook of the bank once every six months. The auditor shall open the result to the public.

17) It the chief of a village, a village inhabitant or the auditor suspect an inspector in charge or a maintenance fee collector in charge of wrong doing, they can dismiss the inspector in charge or maintenance fee collector in charge after getting a majority agreement in the village community/assembly.

It is recommended that the first user jointly sign the application form indicating the above rules (refer to Appendix B-3 as an example) and after that well construction shall commence. The MOPH and vientiane Province are recommended to urgently draw up the bylaws as mentioned above.

(2) Estimate of Monthly Cotribution

As shown in Appendix B-4, the monthly contribution, in the case of a deep well system with a handpump, is estimated as 73 kips/month/household, while in tha case of piped water supply system with public faucets is estimated as 470 kips/month/household. As aforementioned, these costs are recognized as reasonable compared with the values obtained in the interviews with the chiefs of villages and fact-finding regarding the purchase of water(200 kips per one 200 liter drumcan, resulting in the expence of 12,000 kips per month per household).

(3) The Points of Maintenance Inspection

The following are the minimum recommended maintenance:

1) Deep Well with Handpump

Running the system itself generally entails simple procedures except when an electric/generator drien pump is involved. In essence, operation in

this instance means proper handling of handpumps, safeguarding from damage of the facilities like the handpump, transmission pipes and appurtenn\ance, preventing leakage and keeping well-drdained and clean the water source surroundings or fetching points.

A period check-up regimen to be carried out to determine required maintenance work is:

- Monthly observation of the contidition of the concrete well platform, water turbidity and sand content, as well as the tast e and odor of thewater, and that the well surroundings are in a clear\n codnition.

- Mandatory bacteriological examination once very six months todetermine the level of chloriantion requires routine chlorination once every six months. Water level measurement, total depth measurement and analysis of water levels determine the need for ehabilitaiton.

Hanpump maintenance activiites shall consist of:

- Monthly check-up of parts that are easily worn and detached like certain bolts, nuts, pins and bearings and for corrosioin of metal parts.

- Annual Check-up of all bolts, nuts, washers, and other major parts like the drop pipe and sucker rod, cylinder assemlbly, leather cup, handle crank plate bvearing and handle shake. Applicatkon of oil retightening of loose screws and replacement of damaged or missing parts, if necessary.

2) Piped Water Supply System with Public Faucets

Although it shares the same objectives as those of deep wells with handpumps, the operation and maintenance of water supply system with public faucets involve a more complicated process, as it entails the use of an electric driven pump. Additionally, proper valve operation based on initial trial runs to effect equiotable distributioin to users, togethwer with monthly contributions required for a water supply system with public

faucets.

Preventive maintenance activity for a submersible pump are:

- Read and record the pump opeating average, voltage and pressure, on daily basis;

- Observe and record vibration of pump and its accessories, pump and motor noises and any unusual heating of the motor, on daily basis;

- Measure and record static water level, pumping water level, and discharging and insulation resistance, on monthly basis;

- Checking/cleaning of well water level contacts and tank water level contacts, on monthly basis.

Maintenance schedule for a concrete ground level reservoir and elevated water tank consists of:

- Routine procedures like keeping the structure and its surrounding clean, making sure that the reservoir is tightly covered, checking/repairing loose ladder rungs and railings, and checking the pumping system on monthly basis;

- Flushing out collected silt, flushing out overflow pipe and checking the structure inclueing plumbing and valves for leakage, on monthly basis;

- Removal of accumulated silt and sand, on an annual basis; and

- Checking/testing for leakage int he reservoir and for differential settlement of the water tank, on semi-annual basis and after an earthqueake, etc.

Routine maintenance of pipeline and appurtenacnce shall include:

- Regular dialogue with the beneficiaries togather informationregarding the system;

- Checking wet spots along the pipeline route at least once aweek as these set spots may indicate leaks;

- Checking faucet, valve and water meter for leak and cleaning as needed;

Checking/cleaning public faucets concrete pdestal and its surrounding including drainage ditch; and

3) Monitoring

Monitoring and evaluation of the performance of the facilities constructed under the Project by the MOPH and the Vientiane Province according to each organization's scope of responsibilities to determine the extent to which the Project objectives have been attained. If problems are found warranted by the results of said undertaking, countermeasures shall be taken to maximize and improve expected benefits. This monitoring also enhances the following effects:

- Promotion of operation and maintenance participation by beneficiaries (inhabitants);

- Provision and dissemination of more intensive information to beneficiaries by the related officials; and

- Operation and maintenance for the improved facilities by beneficiaries.

Moreover, performance monitoring and evaluation outputs can help identify and rectify deficiencies in the implementation procedures, as well as to provide guidance for future planning, programming and budgeting activities.

Monitoring of the system will commence after the completion of the project and will entail an inspection after 3 months, after 6 months, after one year and after three years have passed (in both dry and wet seasons). Data monitoring shall include:

- Socio economic: family structure and income, increase n e economic

activities, improvement in public health and hygiene and improvement in living standard;

- Technical: water resource data, served population, distance and time spent for fetching, problems in water quality, problems in operation and maintenance, water consumption and data on repairs; and

- institution/management: status of the water supply facility management, users charge (monthly contribution), and sanitation improvement related to drinking water.

Final evaluation shall be made in five years in both the dry and the rainy seasons after the completion of the project, which will further increase the benefit of this Project and be a reference for similar projects in the future.

3.4 Technical Cooperation

Based on an assessment of the potential problems and needs of the Project, the items below are recommended as areas for technical cooperation. These are focused on operation and maintenance after local authorities take over the project because the Project consists mainly of the construction of well facilities.

- For officials related to these facilities in the CWI and the Vientiane Province:
  Repair methods for handpumps, water quality analysis, operation and maintenance organization and preparation method for a data base wells (existing and new).

- For inspector in charge of all the related villages:
  Repair methods for handpumps and organization and management for operation and maintenance.

- Preparation of manuals for operation and maintenance mainly consisting of illustrations.
- Through supervisory service and construction work for this Project,

for the related officials in provincial offices, technology transfer on general well construction methods will be conducted.

To establish sustainable management and an operational system, it is preferable that the technical cooperation mentioned above will be a help. In addition, technology transfer during the implementation stage will be a reference for well construction so as to promote long-lived wells producing the required water volume.

Training will be executed in two groups; one of about ten officials (five from the CWI and five from the Province), and the other, will be a group of inspectors/caretakers from the respective villages. The contents of the training are the same as mentioned above. Texts for the training will have to be prepared in Lao language. After that, the officials at the CWI who understand English will have to be lectured and the Consultant will support the lecture. Training will be held during Febrary and March on 1995 when Pump Installation Work will be finalized.

CHAPTER 4

BASIC DESIGN OF THE FACILITIES AND SPECIFICATIONS OF EQUIPMENT

CHAPTER 4 BASIC DESIGN

4.1 Design Policy

(1) Natural Conditions

The target area of this project belongs to a tropical monsoon climate zone and is characterized by two seasons of dry and rainy periods. The period from May to September is a rainy season and the annual precipitation is approximately 1,800 mm, and humidity is relatively high on average all the year round. The annual average temperature in Vientiane Province is 31°C. It ranges from 22°C to 40°C during the hottest peroid in April. In coolest period, January, ranges from 15°C to 28°C. Earthquakes have not been recorded and the typhoons usually weaken before they reach Vientian Province due to the landlocked nature of the country and as a result, do not damage the area. The implementation plan shall consider the work efficiency during the rainy season and building designs shall be reasonable taking such natural conditions into account.

(2) Socio-economic conditions

Taking into account the income level in the area and the procurement conditions in the Lao PDR, it is neither an economical nor practical policy to install expensive equipment. The design of the facilities therefore, shall be simple, durable, and the construction materials/equipments shall be easy to procur and maintain. Thus, the minimum necessary maintenance tools should be supplied in this project.

(3) Conditions in the Construction Sector

The capability and efficiency of engineers and the laborers, the customs, climate and local conditions of the area shall be fully taken into consideration. Expatriate staff in well drilling shall be assigned throughout the construction period to insure effective technology transfer. In addition, at a suitable time during the construction period, the consultant will conduct a training session, mainly consisting of maintenance-related items for the officials concerned with the well facilities at the provincial level. Indigenous materials will be used to the greatest extent possible. As to

handpumps, which are frequently in need of parts, the Indian Mark III will be employed because it is reported to be used in a CWI related project and the quality and distribution on the market in the Lao PDR poses no problem. However, others parts for the necessary equipment, such as submersible pumps etc., are not produced in the Lao PDR, and they will have to be imported from Japan, where the quality is assured.

(4) Scope and Level of Facility, Equipment and Vehicles

1) Well Facilities

In principle, the design standard of the well facilities shall be in compliance with the criteria of the Lao PDR. However, the well construction method shall be the open hole gravel pack method to ensure a well construction producing enough water and having a long life expectancy. Facilities are to be in such a level as to suit the local environment and to be low-cost in operation and maintenance.

2) Maintenance Center

The Maintenance Center shall provide an office for the Water Supply and Sanitation Division of Vientian Province and shall also include a storage room functioning as an inventory control point for spares and as a garage space. The design described above shall be considered. Furthermore, planning of this building shall fulfill the requirement for a symbolic gesture on behalf of this project.

(5) Condition of the Construction Method and Period

Common construction methods in the Lao PDR shall be employed for construction of the facilities. Transmission and distribution pipeline shall be buried with a covering depth of 1.2m under the crossing points at National roads, and 0.6m under general roads. The construction shall be completed within the time frame for this project under the Grant Aid scheme of Japan.

4.2 Study and Examination on Design Criteria

4.2.1 Water Supply System with Public Faucets

This water supply system includes well facilities, a transmission pipeline, a water tank, a distribution pipeline and public faucets. Public faucets are designed to furnish water to every five to six households.

(1) Design Criteria for Deep Wells

1) Considering the results of the electric resistivity survey and the depth of the existing deep wells, the design depths of the planned wells were determined in each sub-area. The results of the electric resistivity survey and these planned well depths are shown in Fig. 4-1 and Table 4-1.

2) The estimated pumping rate for the planned project wells was determined to be 45 lit/min by averaging out the pumping test discharge of 45 lit/min, as indicated in the paragraph of 2.3.2 and the operating pumping rate of 48 lit/min in the bottled water production company located in Maii village.

3) The number of planned wells was calculated by the design discharge of 27.6 m3 in 10 operation hours and the water demand in each village.

4) The project wells are planned to be constructed by an open hole method with the structure of gravel packing and cement shield.

5) The casing diameter was determined to be 6", based on the local standard design of deep wells and the outlet size of the submersible pumps.

6) The screen length per well is estimated to be 20% of total well depth.

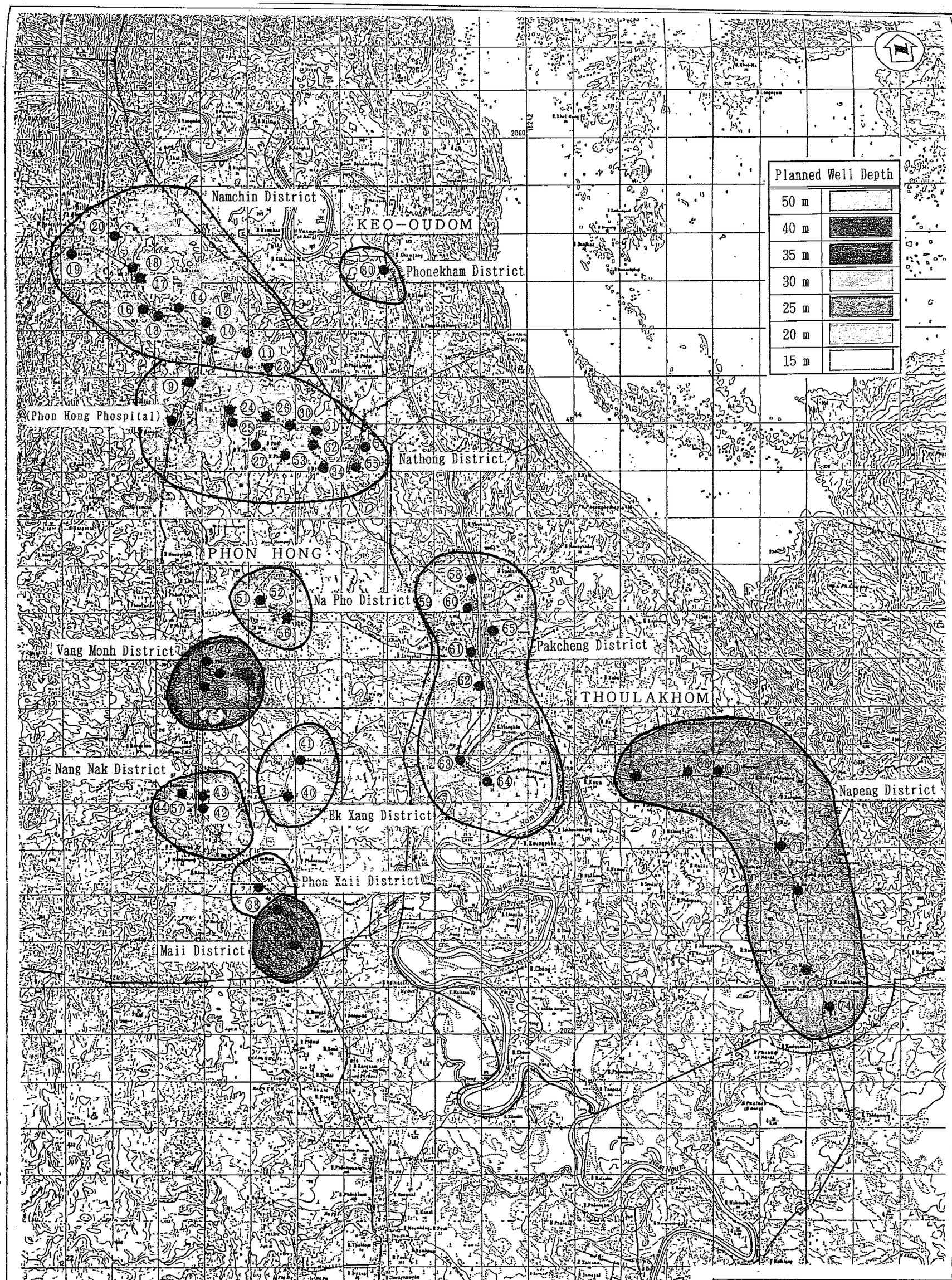


FIG. 4-1

AREA MAP ON PLANNED WELL DEPTH

Table 4-1 Planned Well Depth Based on Results of Electric Resisitivity Survey and Core Boring Investigation

Sub-Area	Village No.	Aquifer Depth	Depth of Public Deep Well	Planned Well Depth
Namchiim Area(I)				
Namchiim	10	15m (E.R.S.)		30m
Na Kaam	14	15m (E.R.S.)		
Sen Xoum	19	15m (E.R.S.)	Sen Xoum : 36m	
Na Pho Area(II)				30m
Na Pho Taii	56	24m (E.R.S.)	No Existing Wells	
Na Thong Area(III)			Phon : 40~45m Na Lao : 50m Phon Sida : 50m	50m
Pak Cheng Area (IV)				
Pak Cheng	61	32m (C.Boring)	Hong Hien Sueb Thod : 40m	50m
Vieng Kham	64	40m (E.R.S.)	Pak Ka Gnung : 50m	
Na Pheng Area(V)				
Pak Hang	71	13m (C.Boring)	No Existing Wells	25m
Na Pheng	72	10m (E.R.S.)		
Hai Gnon	73	20m (E.R.S.)		
Na Xang Leuk	68	16m (E.R.S.)		
Vang Konh Area (VI)				35m
Phon Ngang	48	32m (E.R.S.)	No Existing Wells	
Nong Nak Area(VII)				20m
			Phon Kham : 20m	
Ek Xang Area (VIII)				20m
Ek Xang	40	14m (E.R.S.)	No Existing Wells	
Phon Xaii Area (IX)				15m
Phon Xaii	38	9m (E.R.S.)	No Existing Wells	
Maii Area(X)				40m
			Maii : 40m	
Phonekam Area(XI)				20m
Phonekam	80			

(2) Water Demand

- Design Year : Five year period from Basic Design Stage, say 1998

- Design Population : 2.9% increase per annum based on the Basic Statistics 1992, resulting in a cumulative 16% increase of present population for design

- Daily Average Water Supply per Capita : 60 lpcd

- Daily Average Water Supply : (Design Population) x (Daily Average Water Supply per Capita)

- Daily Maximum Water Supply : 1.3 x (Daily Average Water Supply)

- Hourly Maximum Water supply : 2.5 x (Daily Average Water Supply)/24

- Hydraulic pressure: 3.5 m at end faucet

(3) Facility Design Criteria

- Reservoir (Ground or Elevated Tank):
  1/4 of Daily Maximum Water Supply

- Pipes : GI pipe is used for transmission pipeline. GI pipe is also used for river crossing and national road crossing on the distribution pipeline. PVC pipe is used for distribution pipe under the general condition. For well casing and screen, PVC is also used.

- Pump type and the Operation time:
  Submersible pump is used because operational water table will likely drop more than 8m from ground

surface. Operation of the pump is between 8 to 10 hours/day.

4.2.2 Deep Well with Handpump

(1) Design Criteria for Deep Wells

1) The planned well depth is the same as in paragraph (1) Design Criteria for Deep Wells of sub-section 5.2.1 water supply system with public faucets.

2) The served population per deep well with handpump is estimated to be 50 households based on the general standard of rural water supply projects.

3) The well structure is the same as in paragraph (1) Design Criteria for Deep Wells of sub-section 4.2.1. But the casing diameter was determined to be 4", considering the local standard design and the small discharge of deep wells with handpumps.

4) Materials: the PVC casings and screens are adopted.

(2) Handpumps

As shown in Table 4-2, nine kinds of hand pump have been imported and installed through foreign assistance agencies. During discussion with our counterparts in the CWI, they suggested that among the nine kinds of handpump, two of them are best suited for this Project due to their ease of maintenance and repair. They are: 1) the Tara pump; and 2) the Indian Mark III handpump. Comparing these two pumps, the most suitable handpump for this Project will be selected by examining the merits of each pump as discussed below:

1) Tara Pump

Only the pump stand, which is above ground, is made of steel. The underground portion, namely the pumprod, rising pipe, and foot valve, are made of plastic. The piston is aluminum. Therefore, this pump is corrosion-resistant. Pump installation can be done with ordinary tools

Table 4-2 List of Handpump

Unit : Set

Type of Pump / Name of Province	Bangladesh No. 6	Thai Rower	India Mark Ⅱ	Thai PAT	India Mark Ⅲ	India Tara	USA Dempster	Japan Sankyo	USA New Dempster
1. Vientiane Municipality	5	-	10	-	-	10	10	42	-
2. Vientiane Province	5	-	10	-	-	-	10	-	-
3. Borikhamsay Province	10	-	10	-	-	-	10	-	-
4. Kammouane Province	10	150	10	10	-	50	10	-	-
5. Savannakhet Province	20	50	30	80	10	150	20	-	-
6. Champsak Province	20	150	50	-	70	70	50	-	50
7. Saravan Province	20	-	30	-	70	70	30	-	-
8. Xiengkhouang Province	10	-	-	-	-	50	-	-	-
9. Sayaboury Province	10	-	10	-	-	50	10	-	-
10. Louang Namtha Province	10	-	10	-	-	50	10	-	-
11. Louang Prabang Province	20	-	10	-	-	20	10	-	-
Total	140	350	180	90	150	520	170	42	50
Fund Foreign	Unicef		Unicef	Unicef	Unicef	Unicef	UDAID	JICA	Private
NGO's		ADRA		MCC					
Year	1985	1991	1985	1991	1993	1992	1965	1988	1990
Note		Adventish Development Relief Agency		Mennoite Central Commitee					Villager's Private Fund

and since every part of the pump is light-weight, installation work is also easy. Manufacture of this pump does not require a developed industry or engineering skills, and thus, is suitable for developing countries. The maximum pumping head is 15m.

2) Indian Mark III Pump

Developed with the assistance of UNICEF, this deep well pump is a modified model of the Indian Mark II pump. Its most remarkable characteristic is that the piston and footvalve can be removed and fixed easily, as these parts are affixed to the pump by a threaded fitting. With this fitting, a clogged footvalve, which is one of the major reasons for malfunction in handpumps, can be easily repaired without removing the rising pipe. In case of clogging, one removes the pump cover, lever, and screw pump rod to fix the piston and footvalve using a rod wrench, and then withdraws them from the bottom. Since each piece is light-weight, repair work can be done by man-power and special tools, such as a tripod, pulley, rope, etc., are unnecessary. Repair work does not require any special technical ability and so it can be executed by villagers. Maximum pumping head is 40m.

Though the depth of each deep well, which is to be constructed through this project, differs due to hydrogeological conditions, they are estimated as being 15m to 50m. Comparing the two pumps, in terms of pumping head, ease of maintenance, reliability, product quality and their availability on site, the Indian Mark III pump is recommended for this project.

4.2.3 Maintenance Center

This Center consists of an office room, a conference room, a storage room, a workshop room and a garage space. Design bases of floor areas are as follows:

(1) Office Room

At present, the number of staff is 12 persons in the Water Supply and Sanitation Division. According to the staffing plan of CWI, staff arrangement is

as follows:

Manager	:	1 person
Assistant manager	:	1 person
Chief	:	2 persons for Water Supply Construction, Sanitation Promotion Section (These names are provisional)
Staff	:	14 persons in total
Total	:	18 persons

However, the plan does not include the Operation and Maintenance Section. As aforementioned, operation and maintenance is indispensable for sound operational status of completed facilities, the O&M Section should be added.

Thus, the total number will be 20 and their disposition is as follows:

Manager	:	1 person
Assistant manager	:	1 person
Chief	:	3 persons for Water Supply Construction, Sanitation Promotion, and Operation and Maintenance Section.
Staff	:	15 persons
Total	:	20 persons

Since there's no authorized design criteria in Lao PDR, required floor area will be calculated by the following equation which is adopted by Ministry of Construction in Japan:

3.3 m^3/person x (staff number x convertion factor) + 20m^2

Table for conversion factor

Classification	Manager	Assistant Manager	Chief	Staff	Draftsman
Conversion factor	6	2.5	1.8	1	1.7

Required floor area: 3.3x(2.5x1+1.8x3+1x15)+20 = 95.6 ——> <u>90m^2</u>

Note : Calculated floor area does not contain Manager's room.

(2) Conference Room

The space of the room in which the staff of about 20 persons can hold a meeting will be approximately 30m^2 (= 4m x 7.5m).

(3) Storage Room

The space will be an area in which the following materials can be stored:

- Shelves for PVC pipes and GI pipes (2.5m x 7m) and spare parts
- Handpump, connection rod, special tools : 100 sets
- Cement : 50 bags, Bentonite/clay : 100 bags
- Compressor : 3 units

(4) Workshop Room

The space will be 40m^2 (4m x 10m), as required for equipment used in repair and fabrication. The equipment include a washing counter, a welding table, oxygen and acetylene gas cylinder and an electric welding machine, a wooden working table, a threading machine, grinder, tool cabinet, compressor, etc..

(5) Garage Space

The space can park one 5-ton capacity truck (2.5m x 9.4m), one dual cab pick-up (1.7m x 4.9m) and 2 motorcycles.

4.3 Basic Design

4.3.1 Water Supply System

Design standardization is conducted as follows:

(1) Deep Well Facilities

Standard drawings which use the open hole gravel pack drilling method are presented in Figure 4-2 to Figure 4-3. The standard specification is shown in Table 4-3. Table 4-4 shows a summary of the number of wells by village.

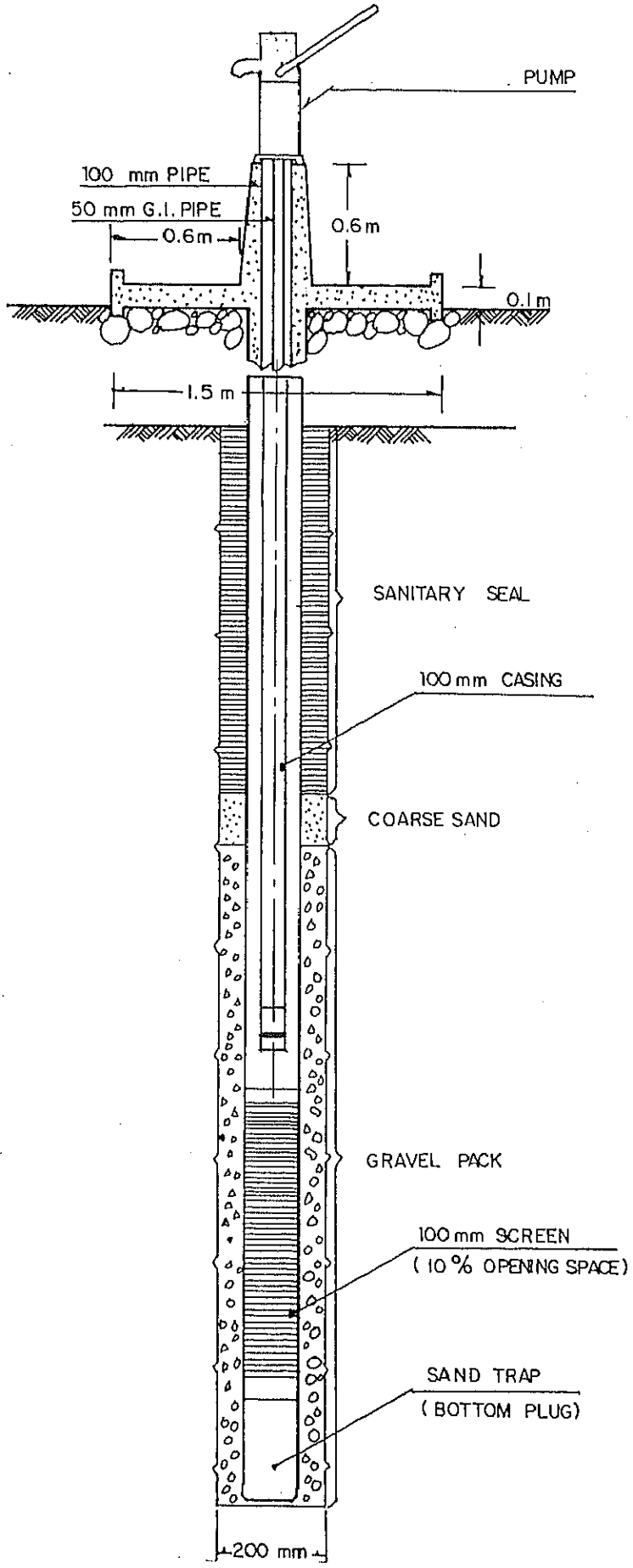


FIG. 4-2

STANDARD DESIGN FOR
LEVEL I DEEP WELL

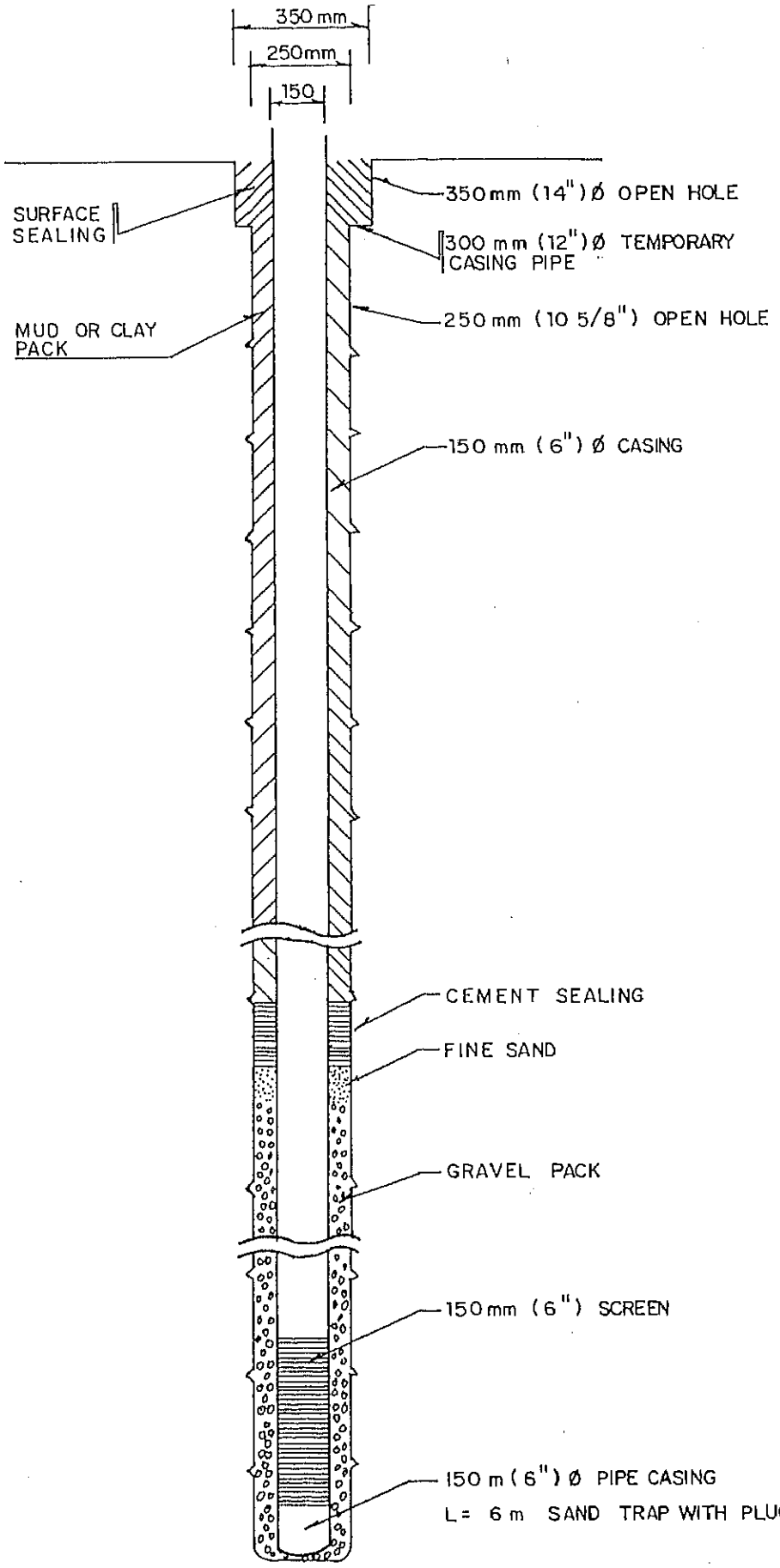


FIG. 4-3
STANDARD DESIGN FOR
LEVEL II DEEP WELL

Table 4-3-A STANDARD SPECIFICATION OF WELLS BY DEPTH (DEEPWELL WITH HANDPUMP)

Well Depth (m)	15	20	25	30	35	40	50
1. WELL DRILLING							
1) Borehole Dia. (mm)	200	200	200	200	200	200	200
2) Total Depth (m)	15	20	25	30	35	40	50
2. CASING							
1) Material	PVC	PVC	PVC	PVC	PVC	PVC	PVC
2) Diameter (mm)	100	100	100	100	100	100	100
3) Joint Type	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve
4) Unit Length	4.0	4.0	4.0	4.0	4.0	4.0	4.0
5) Required No. (pcs.)	3	4	5	6	7	8	10
6) Total Length (m)	11	16	17	22	27	32	38
3. SCREEN (8-12% opening)							
1) Material	PVC	PVC	PVC	PVC	PVC	PVC	PVC
2) Diameter (mm)	100	100	100	100	100	100	100
3) Joint Type	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve
4) Unit Length	4.0	4.0	4.0	4.0	4.0	4.0	4.0
5) Required No. (pcs.)	1	1	2	2	2	2	3
6) Total Length (m)	4	4	8	8	8	8	12
4. GRAVEL PACK							
1) Depth (m)	7	10	13	15	18	20	25
2) #5 Gravel Volume (cu.m)	0.20	0.28	0.37	0.42	0.51	0.57	0.71
5. SAND SEAL							
1) Depth (m)	4	6	7	9	11	12	15
2) Coarse Sand Volume(cu.m)	0.11	0.17	0.19	0.25	0.31	0.34	0.42
6. CEMENT SEAL							
1) Depth (m)	4	4	5	6	6	8	10
2) Cement (kg)	128	128	138	165	165	221	276
7. TYPE OF PUMP							
1) Shallow/Deep Well Hand Pump	D	D	D	D	D	D	D
2) Section Pipe (GI, 65mm, 3 m/pc)	3	4	5	6	6	7	7

Table 4-3-B STANDARD SPECIFICATION OF WELLS BY DEPTH (DEEPWELL FOR PIPED WATER SUPPLY SYSTEM WITH PUBLIC FAUCETS)

Well Depth (m)	15	20	25	30	35	40	50
1. WELL DRILLING							
1) Borehole Dia. (mm)	250	250	250	250	250	250	250
2) Total Depth (m)	15	20	25	30	35	40	50
2. CASING							
1) Material	PVC	PVC	PVC	PVC	PVC	PVC	PVC
2) Diameter (mm)	150	150	150	150	150	150	150
3) Joint Type	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve
4) Unit Length	4.0	4.0	4.0	4.0	4.0	4.0	4.0
5) Required No. (pcs.)	3	4	5	6	7	8	10
6) Total Length (m)	11	16	17	22	27	32	38
3. SCREEN (8-12% opening)							
1) Material	PVC	PVC	PVC	PVC	PVC	PVC	PVC
2) Diameter (mm)	150	150	150	150	150	150	150
3) Joint Type	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve
4) Unit Length	4.0	4.0	4.0	4.0	4.0	4.0	4.0
5) Required No. (pcs.)	1	1	2	2	2	2	3
6) Total Length (m)	4	4	8	8	8	8	12
4. GRAVEL PACK							
1) Depth (m)	7	10	13	15	18	20	25
2) #5 Gravel Volume (cu.m)	0.26	0.32	0.41	0.47	0.57	0.76	0.95
5. SAND SEAL							
1) Depth (m)	4	6	7	9	11	12	15
2) Coarse Sand Volume(cu.m)	0.15	0.23	0.26	0.34	0.42	0.46	0.57
6. CEMENT SEAL							
1) Depth (m)	4	4	5	6	6	8	10
2) Cement (kg)	177	177	185	222	222	296	369
7. TYPE OF PUMP							
1) Shallow/Deep Well Hand Pump	D	D	D	D	D	D	D
2) Section Pipe (GI, 50mm, 3 m/pc)	3	4	5	6	6	7	7

Table 4-4 Planned Number of Deep Wells in each District

Water Supply System	Deep Wells with Handpump							Water Supply System with Public Faucets							Remarks
Well Depth (m)	15	20	25	30	35	40	50	15	20	25	30	35	40	50	
PHON HONG DISTRICT	6	16	–	24	8	1	19	–	–	–	–	–	4	8	
Sub-Total	74							12							
THOULAKHOM DISTRICT	–	–	14	–	–	–	19	–	–	–	–	–	–	6	
Sub-Total	33							6							
KEO-OUDOM DISTRICT	–	2	–	–	–	–	–	–	–	–	–	–	–	–	
Sub-Total	2							0							
Grand Total	109							18							

(2) Transmission and Distribution Facilities

Pumped well water is served through transmission and distribution facilities, Figure 4-4, Figure 4-5 and Figure 4-6 show standardized drawings for these facilities.

4.3.2 Maintenance Center

The proposed site for this building is designated by the Provincial Public Health Department at an open area located in north of the Department building. The shape of the lot is a rectangle of 22m x 120m and one portion will be used for this building. The area has enough room to secure adequate parking space. The site, facing National Road No.13, has good access to the well sites and the ground soil formation is firm (lateritic gravel) which will not require a special foundation structure. This building has a reinforced concrete structure and the total floor area is 320m^2. Figure 4-7 shows the plans and Figure 4-8 shows the sections of the building. Structure and construction materials shall be based on local conditions and prevalent design, and in the case of internal and external finishing, local design standards shall be adopted.

4.3.3 Equipment and Service Vehicle Specification

Major items and specification of the equipment and vehicles are given below.

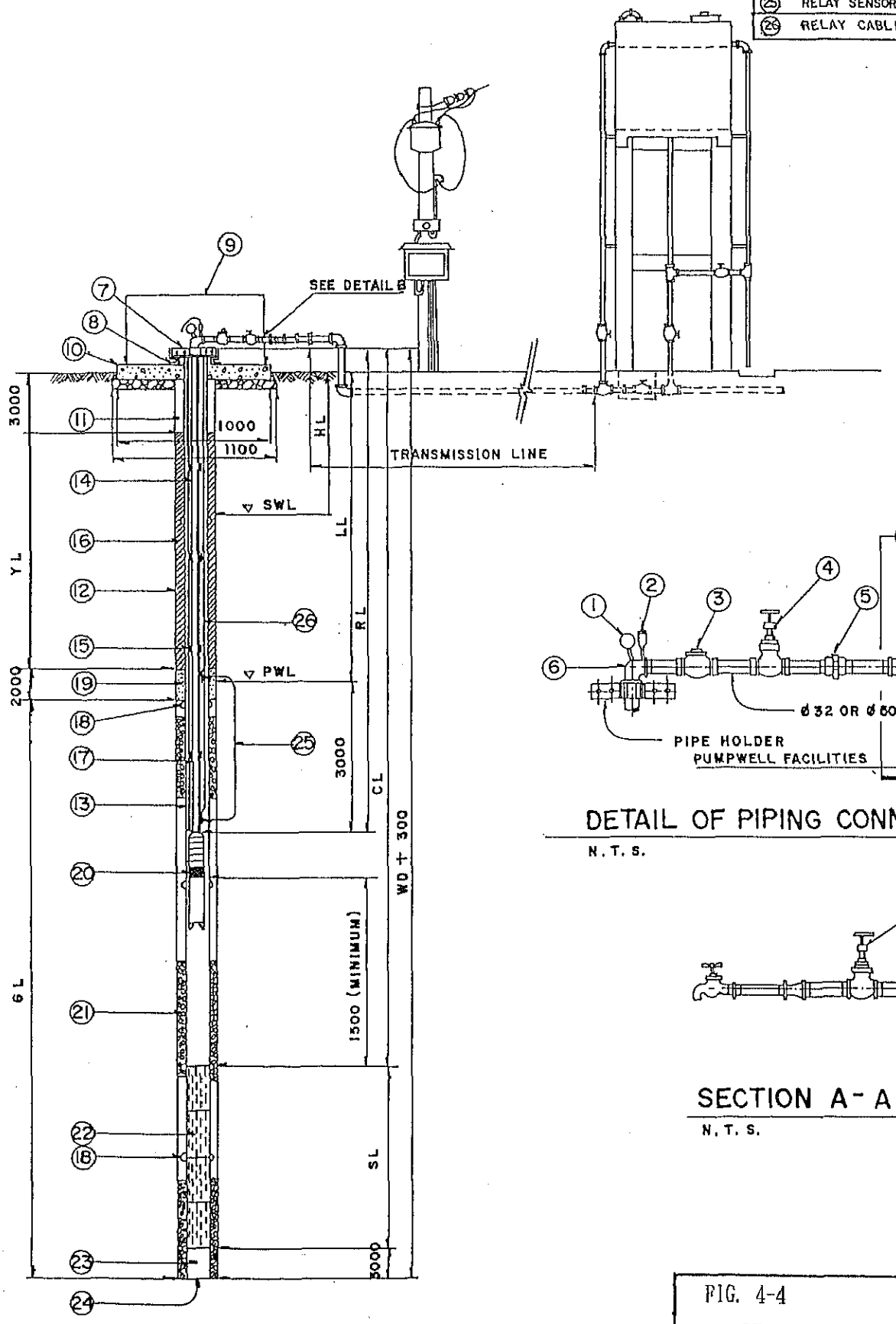
(1) Spares

PVC pipes, Fittings, Submerged motor pumps, Handpumps, Water meters, Faucets etc. ---------- lump sum

(2) Spare Parts

Handpump Spare Parts (Pump, Cover, Cylinder, Rod, Pumplever, etc.)--lump sum

NAME OF PARTS			
① PRESSURE GAUGE	⑦ RISER PIPE HOLDER	⑬ WELL CASING	⑲ FINE SAND
② AIR VENT VALVE	⑧ WELL COVER	⑭ RISER PIPE	⑳ SUBMERSABLE PUMP
③ CHECK VALVE	⑨ WELL BOX COVER	⑮ COUPLING	㉑ GRAVEL PACKING
④ GATE VALVE	⑩ PLATFORM	⑯ CLAY FILL	㉒ SCREEN
⑤ UNION PATENTE	⑪ SURFACE SEALING	⑰ SUBMERSIBLE CABLE	㉓ BOTTOM PIPE
⑥ 90° BEND	⑫ DRILL HOLE	⑱ CENTRALIZER	㉔ BOTTOM PLUG
			㉕ RELAY SENSOR
			㉖ RELAY CABLE



ELEVATION

N.T.S.

DETAIL OF PIPING CONNECTION

N.T.S.

SECTION A-A

N.T.S.

FIG. 4-4

STANDARD DESIGN FOR

LEVEL II WATER SUPPLY FACILITY

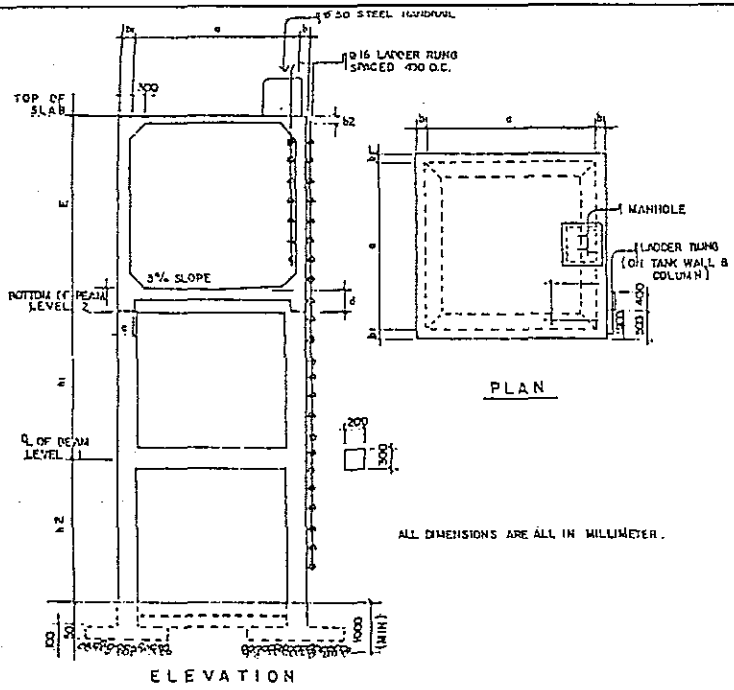
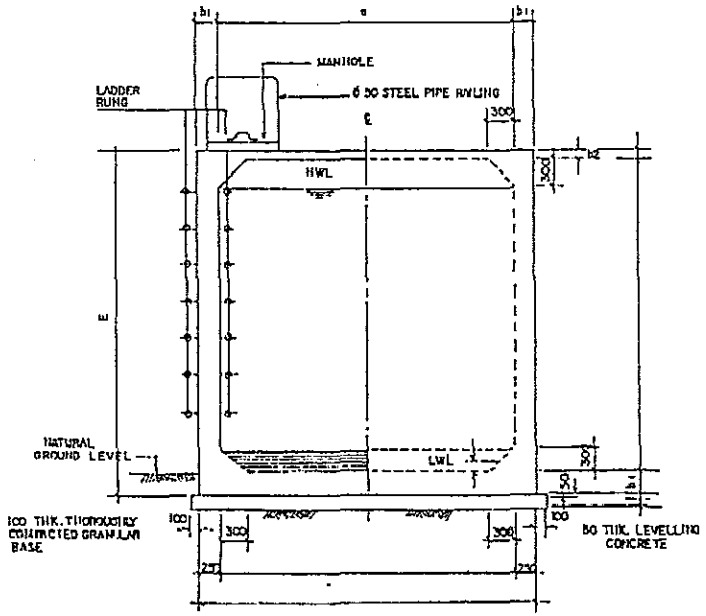


TABLE OF ELEVATED TANK CAPACITY AND DIMENSION
(DIMENSION ARE ALL IN MM)

V	TANK DIMENSION						COLUMN			FOOTING							
										SBP 120 KPa		SBP 144 KPa		SBP 168 KPa		SBP 192 KPa	
(cu m)	a	b1	b2	C	d	E	h1	h2	SECTION	SECTION	t	SECTION	t	SECTION	t	SECTION	t
2	1400	150	150	200	300	1650	2500	2500	250x250	830 x 830	200	760x760	200	700x700	200	660x 660	200
5	1850	150	150	200	300	2300	3000	4000	250 x 250	1110 x 1110	200	1010x1010	250	940x 940	250	880x 880	250
7	2050	150	150	200	300	2550	3000	4000	300 x 300	1190x1190	250	1090x1090	250	1010x 1010	250	940x 940	250
10	2300	150	150	200	400	2850	3000	4000	300x 300	1300x1300	250	1180x1180	250	1100x 1100	250	1030x1030	250
15	2600	150	150	200	400	3150	3000	4000	300x 300	1400x1400	250	1280x1280	250	1190x1190	300	1110 x 1110	300
20	2850	200	150	200	600	3600	3000	4000	300 x 300	1520x1520	300	1390x1390	300	1280x1280	300	1200x1200	300
25	3050	200	150	250	600	3800	3000	4000	300 x 300	1600x1600	300	1460x1460	300	1350x1350	300	1270x1270	300
30	3250	200	150	250	600	4000	3000	4000	300 x 300	1700x 1700	300	1550x1550	300	1440x1440	350	1350x1350	350
35	3400	250	150	300	600	4150	3000	4000	400x 400	1870x1870	300	1700x1700	300	1580 1580	350	1470x1470	350
40	3550	250	150	300	600	4300	3000	4000	400 x 400	1950x1950	300	1780x1780	350	1650x1650	350	1540 x 1540	350
45	3700	250	150	300	600	4450	3000	4000	400 x 400	2030x2030	350	1850x1850	350	1720x1720	350	1610 x 1610	400
50	3800	250	150	400	600	4550	3000	4000	400 x 400	2100x2100	350	1920x1920	350	1780 x 1780	350	1660x1660	400
55	3950	300	150	400	600	4700	3000	4000	400x 400	2240x2240	350	2040x2040	350	1890x1890	400	1770x 1770	400
60	4050	300	150	400	600	4800	3000	4000	400 x 400	2290x2290	400	2080x2080	400	1930x1930	400	1810 x 1810	400
65	4150	300	150	400	600	4900	3000	4000	400 x 400	2340x2340	400	2130x2130	400	1970x1970	400	1850x1850	400
70	4250	350	150	400	600	5000	3000	4000	450 x 450	2510x2510	400	2280x2280	400	2120x2120	450	1980x 1980	450
75	4350	350	150	400	600	5100	3000	4000	500x 500	2570x2570	400	2350x2350	400	2170 x 2170	450	2030x2030	450

ELEVATED WATER TANK
NOT TO SCALE

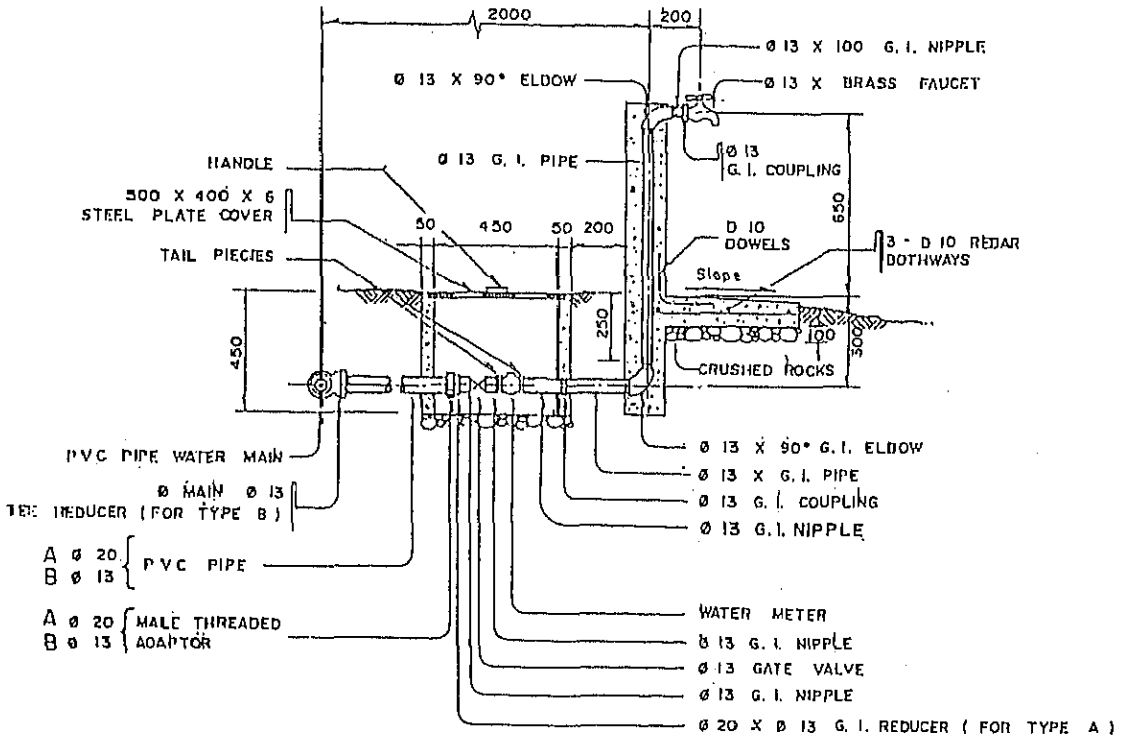


PROPOSED GROUND RESERVOIR

TABLE OF GROUND LEVEL RESERVOIR
(DIMENSION ARE ALL IN MM)

CAPACITY V (cu m)	TANK DIMENSION			
	a	b1	b2	E
2	1400	150	150	1700
5	1850	150	150	2150
7	2050	150	150	2350
10	2300	150	150	2600
15	2600	200	150	2950
20	2850	200	150	3200
25	3050	200	150	3400
30	3250	200	150	3600
35	3400	250	150	3800
40	3550	250	150	3950
45	3700	250	150	4100
50	3800	250	150	4200
55	3950	250	150	4350
60	4050	250	150	4450
65	4150	250	150	4550
70	4250	350	150	4750
75	4350	350	150	4850

FIG. 4-5
STANDARD DESIGN FOR ELEVATED WATER TANK AND GROUND RESERVIOR



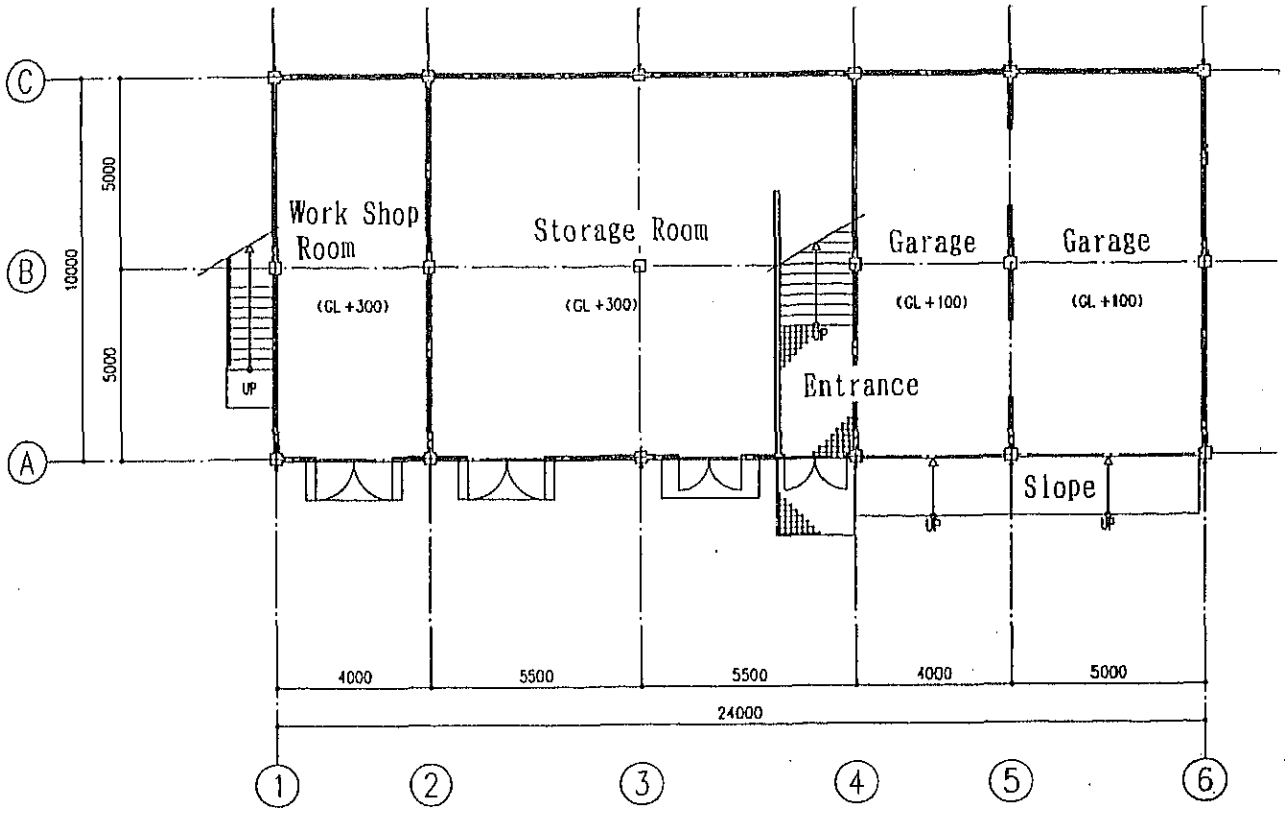
TYPE "A" & "B"

TYPE A - FAUCET TAPPED TO Ø 20 PVC LINE

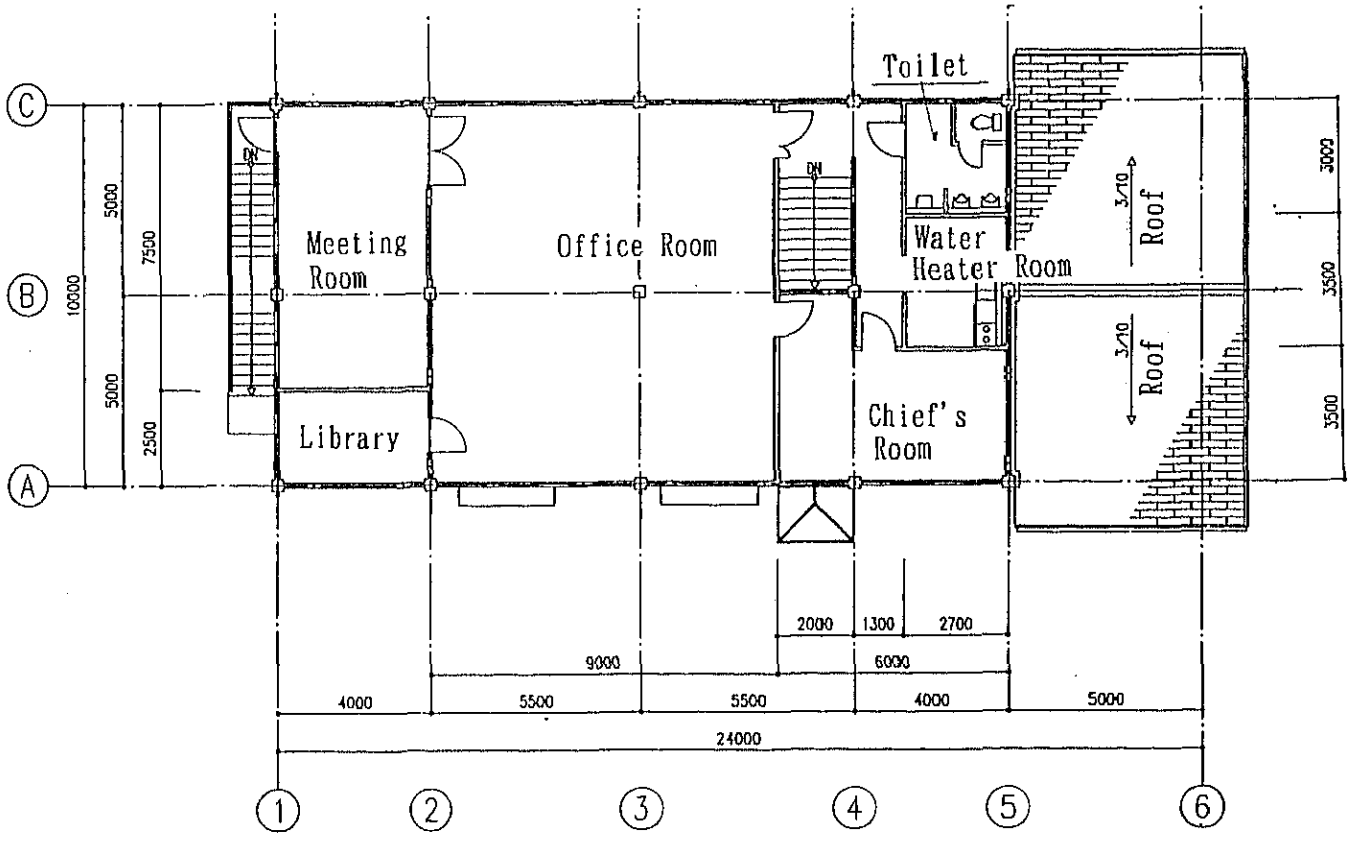
TYPE B - FAUCET TAPPED TO Ø 13 PVC LINE

FIG. 4-6

STANDARD DESIGN FOR PUBLIC FAUCET



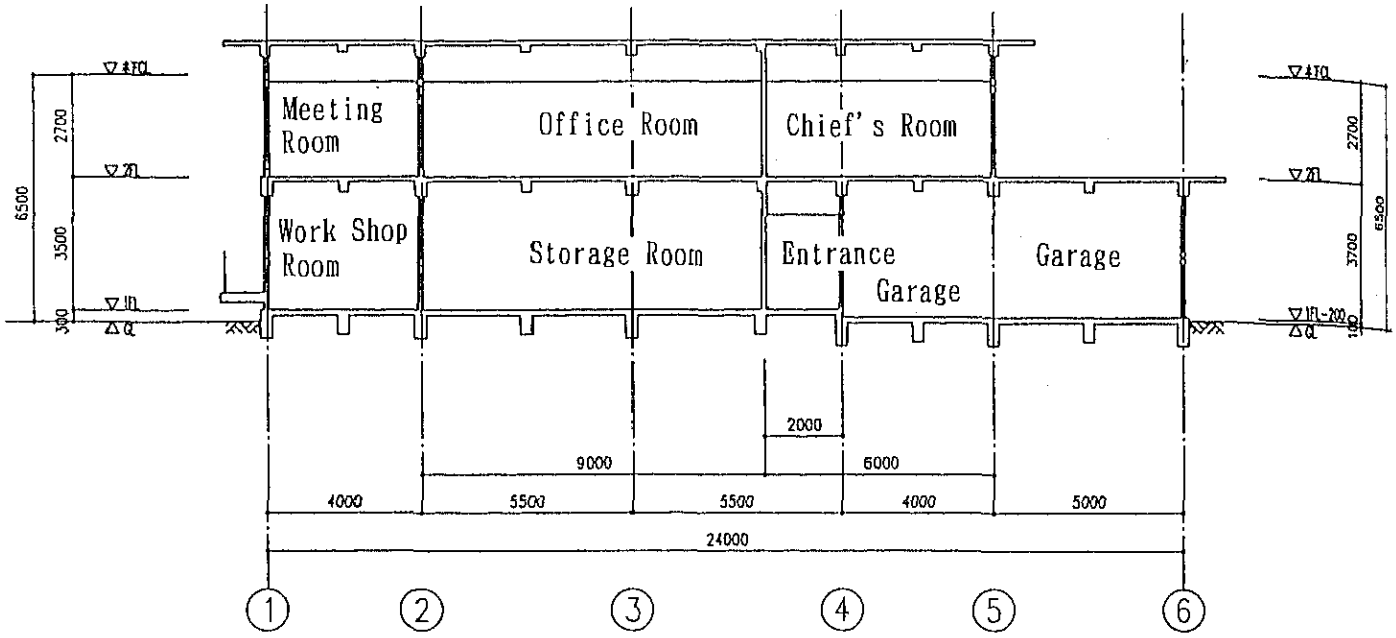
1F PLAN S=1/100



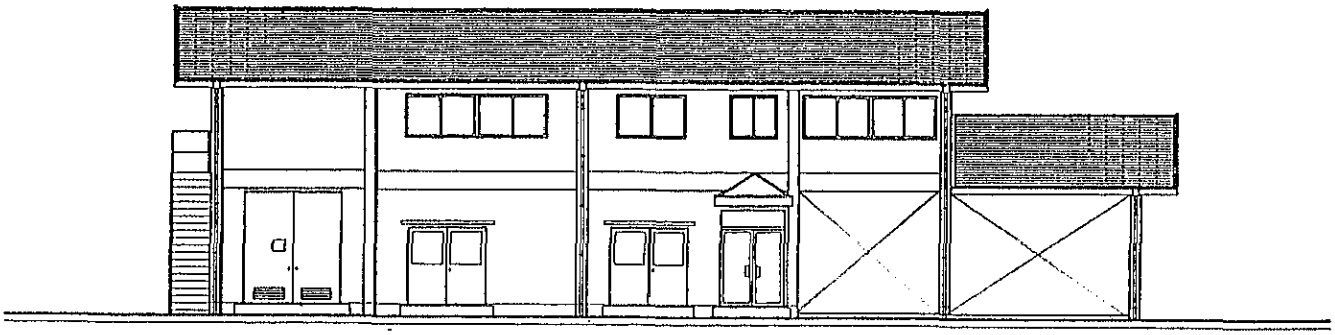
2F PLAN S=1/100

FIG. 4-7

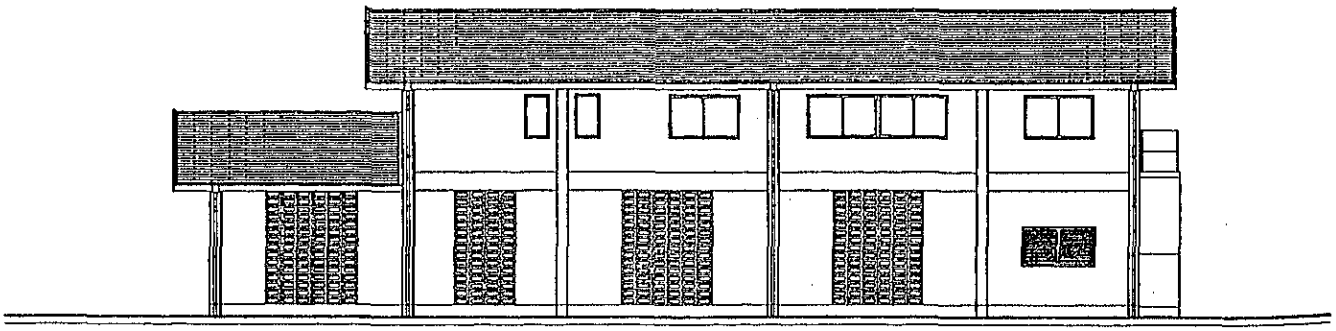
PLAN OF MAINTENANCE CENTER



SECTION S=1/100



1 SIDE ELEVATION S=1/100



3 SIDE ELEVATION S=1/100

FIG. 4-8

SECTION AND ELEVATION OF MAINTENANCE CENTER

(3) Machine Tool

An over head traveler with a chain block (2.0 ton), a gas cutter and appurtenance, an electric welding machine, a grinder, a vise, a pipe vise, a threading machine, an electric hand drill ---------- 1 set

(4) Maintenance Tools ---------- 3 sets

- Portable air compressor and rubber hose, PVC pipe for riser pipe
- Tripod made of GI
- Small chain-block
- Hand tools (vice, pipe threader, pipe cutter, openwrench, trowel, crowbar, ratchet threader, adjustable wrench, pipe wrench, screw driver, pliers, file chain wrench, cold chisel, caulking hammer, reamer and hand drill)

(5) Water Quality Analysis Kit and Reagent

The following will be provided one each to the CWI and Vientian Province for monitoring duties after completion.

- Simple Water quality analysis device
- Reagent (Pack Test)
- Electric conductivity meter

The following will be provided to Vientiane Province.

- Electric resistivity equipment and its appurtenance

(6) Vehicles

- Dual Cab 4 x 4 Pick-up with Diesel Engine ---------- 1 unit
- Five-ton Capacity Flat Tray Diesel 4 x 2 Truck fitted a dual side control hydraulic lifting apparatus of 1.5 ton capacity ------ 1 unit

- Motorcycle (125 cc) ---------- 2 units

4.4 Implementation Plan

4.4.1 Construction Condition

The implementation agency of this project is the CWI under the Ministry of Public Health. The organizational set up for project implementation is shown in Figure 4-9.

Although there are two water supply related subsections, namely the Surface-water Subsection and the Groundwater Subsection, the Groundwater Subsection will be in charge of this project because the focus of this project is groundwater development by deep well construction.

The Groundwater Subsection will take charge of the following duties:

(1) Management of the project.
(2) Coordination with other relevant agencies within the CWI.
(3) Coordination with any other governmental organizations concerned.
(4) Coordination with Consultants for preparation of detailed design and tendering procedure.
(5) Explain and instruct villagers in operation and maintenance methods which are prerequisite to preserving sound operational functions of the completed facilities.
(6) Periodical inspection and repairs for completed facilities.

The target number for well construction in this project is 109 Level I systems and 18 Level II systems. Considering the large number of wells, a regimented construction method that assigns several drilling teams comprised of one drilling rig, along with the related equipment, engineers, and laborers, should be utilized for efficient project implementation. The team shold be led by Japanese engineer. In case of the construction supervising stage, systems should be as follows: A Resident engineer to supervise the construction works, a Chief engineer to manage each of the construction schedules. The Resident and Chief engineer will then get approval from the Head chief engineer.

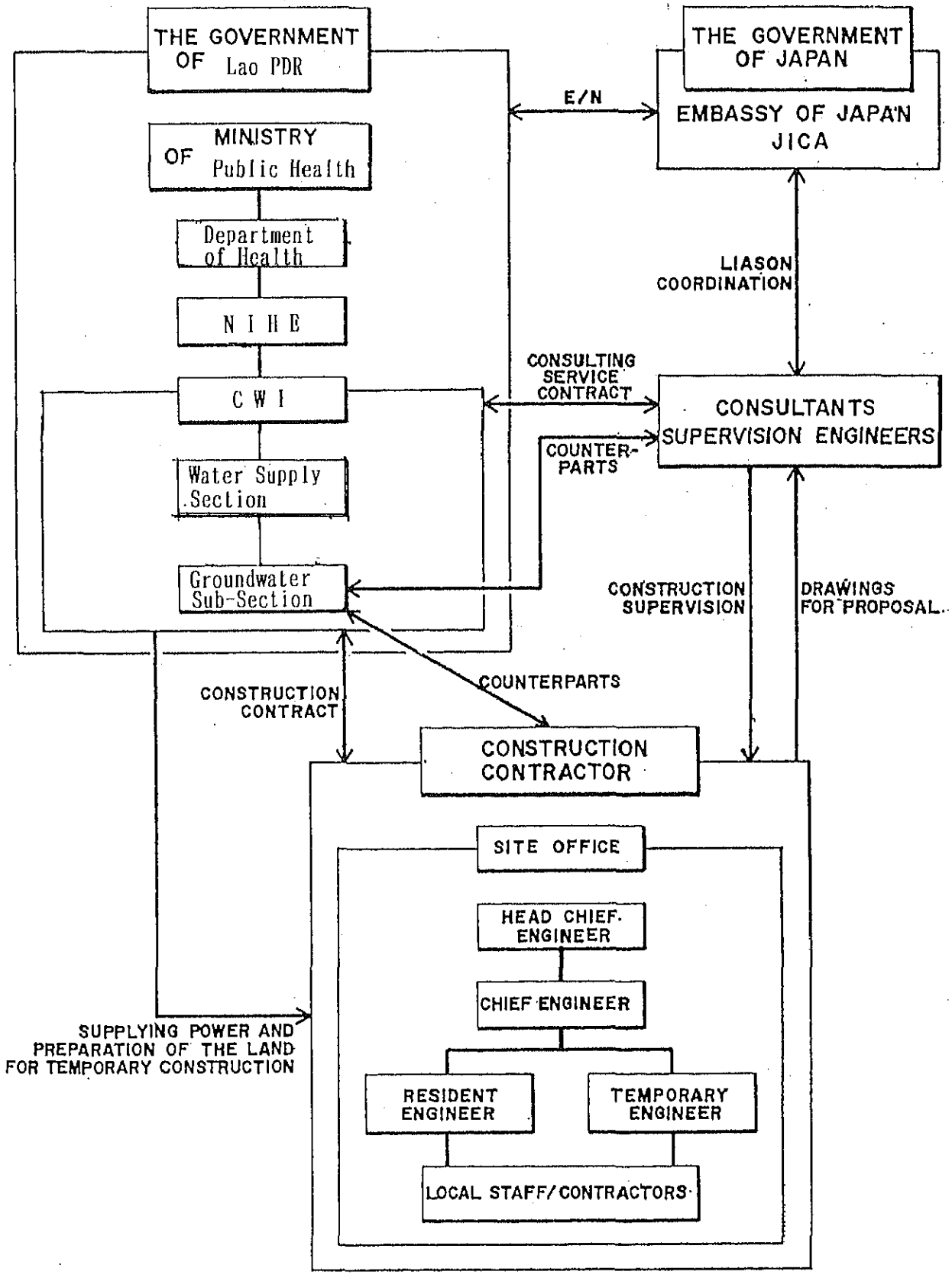


FIG. 4-9

Organization Chart for Project Implementation

4.4.2 Implementation Method

The rainy season at the project site begins in May and lasts until September, and often results in periodic, concentrated heavy rains. Thus, the project construction schedule should be planned taking into account the rainy season and the National holidays in Laos, such as January 1st (New Year's Day), the middle of April (Lao New Year's Day), May 1st (May Day), and December 2nd (Independence Day).

The sea transportation for materials and equipment from Japan will take one month to reach Bangkok, Thailand, whereupon they will be transported by land some 600 km to the Thai side of the Mekong River, at Nong Khai. The materials and equipments will then cross the Mekong River and reach Lao side, at Thadua for customs and immigration. The entire journey will take about 10 days. Materials and equipment should be packed with great care, and the transportation schedule should be planned in a manner that will minimize any possible hindrance to the project work schedule.

4.4.3 Construction and Superviory Plan

(1) Detailed Design

The detailed design will proceed after the E/N between the Government of Japan and the Government of Laos. The detailed design for the Project will be prepared based upon the Basic Design. The detailed design prepared by the Consultant will be approved by the CWI.

(2) Tendering

Contract documents for the Project will be prepared by the Consultant and will be approved by the CWI. The Consultant will assist the CWI in making the tender announcement, prequalifying tenderers, accepting tender application from tenderers, and evaluating the tenderers. After selecting a successful Japanese contractor, the CWI will enter contract agreement with the contractor.

(3) Construction Supervision

The Consultants will evaluate and approve the well drilling report, including soil formation, electric logging results, well design, well development, and the results of the pumping tests, etc., as submitted by the selected contractor, and serve as witness for the shipment of handpumps at the factory. The Resident engineer will be in charge of the construction supervision. There will be one engineer and his grade should be above third-grade.

(4) Training on Take-over

During the construction period, training which is needed for the sustained of a satisfactory function of the completed facilities will be carried out. The training (technical transfer) will include repair and maintenance methods for handpumps, and the formation and management methods for the water facility maintenance organization. For details, please refer to Chapter 3, 3.4

4.4.4 Procurement Plan

The materials and equipment necessary for this Project should be procured locally as much as possible. Items which are not available locally, either through scarcity, market inadequacies, or are of substandard quality, or do not meet project specifications, should be procured from Japan.

The following is the market status for materials and equipment in Vientiane, as observed during the field investigation:

(1) Cement
Domestic cement is available and it is of high enough quantity.

(2) Sand and Gravel
Local materials will serve adequately, and should be used.

(3) Reinforcing Bar
Mainly imported from Thailand and is of good quality, should be purchased in Vientiane.

(4) Lumber/Plywood

Local materials are available and should be used.

(5) Concrete Block

Domestic products are adequate and should be used.

(6) PVC Pipe, GI Pipe, and other Plumbing Materials

Mainly imported from Thailand and Vietnam. Should be purchased in Vientiane.

(7) Handpumps and Spare Parts

As mentioned in Item 4.2.2 in this chapter, the Indian Mark III handpump will be adopted. They can be locally procured from the manufacturer in New Delhi, India.

(8) Working Tools

Mainly imported from Thailand or China, but quality is unreliable. Thus, Japanese tools are to be used.

(9) Maintenance Tools

Mainly imported from Thailand or China, but quality is unreliable. Thus, Japanese tools are to be used.

(10) Water Quality Analysis Devices and Reagent

Not available locally. Japanese equipment should be used.

(11) Well Drilling Rig and Relevant Equipment

Well drillings are conducted by the following governmental agencies: Department of Geology under Ministry of Industry and Handicraft, Department of Irrigation under Ministry of Agriculture and Forestry. Independent corporation is also conducting well drilling works and they are implemented by Geo-Mining Co., Ltd. and Hydropower Engineering Consultants (HEC).

Although Geo-Mining Co., Ltd., has the largest number of rigs, all of the rigs have already deteriorated and their operational status is unfavorable. The remaining organizations mentioned above lack adequate equipment to undertake the drilling of 109 Level I systems and 18 Level II systems, as required in this project.

Since there is no lease system for well drilling equipment in the Lao PDR, this Project should be implemented by Thai contractor with capable drilling equipments and rich experiences.

(12) Vehicles

A truck and a pick-up will be provided for material and equipment hauling, repair and maintenance work. Motorcycles will be also provided for communication duties. For details, please refer to chapter 3, Item 3.2.5. There are no local manufacturer of vehicles in Laos and procurement from Thailand would be costly even compared with procurement in Japan due to high tariffs. Thus, Japanese vehicles should be adopted.

Summary of material procurement is shown in Table 4-5.

Table 4-5 Summary of Material Procurement

No.	Item	Laos	Japan	Third country
1)	Cement	X		
2)	Gravel/Sand	X		
3)	Reinforcing Bar	X		
4)	Lumber/Plywood	X		
5)	Concrete Block	X		
6)	PVC Pipe/Plumbing Mat.	X		
7)	Handpump/Spare Parts			X
8)	Working Tools	X		
9)	Maintenance Tools	X		
10)	Water Analysis Equipments		X	
11)	Well Drilling Equipments		X	
12)	Vehicles		X	

4.4.5 Implementation Schedule

The major undertakings by the Japanese and Lao governments for the implementation of the Project are indicated in Appendix A-2 and are arranged jointly with supplementary explanations.

(1) Responsibilities of the Government of Japan

The assigned Consultant or the Contractor of Japanese nationals will be responsible for the detailed engineering design, the procurement of materials and equipment, the supervision and management of construction, and the training of the Lao Government officials.

(2) Responsibilities of the Government of the Lao PDR

The obligation of the Lao PDR, which shall be undertaken through the Clean Water Institute, Ministry of Public Health and Vientiane province is to:

1) establish a liaison organization between Japanese nationals and the Lao PDR agencies for the implementation of the Project.

2) ensure required land for the construction of water supply and other related facilities and the right of way along pipeline routes and acquire a special budget for the extension of electric lines, considering the entire construction schedule.

3) provide all data and information necessary for the detailed design of facilities.

4) arrange for the exemption of Japanese nationals related to the implementation of the Project from customs duties, local taxes and other forms of fiscal levies which may be imposed in the Lao PDR with respect to the supply of products and services related to the project.

5) provide convienience for such as extention of VISA for Japanese nationals whose services may be required in connection with the supply of products and services for the Project in the Lao PDR.

6) facilitate the custom clearance at customs offices for disembarkation of products related to the Project in the Lao PDR.

7) operate and maintain properly and effectively the completed water supply system and the maintenance center and the provided equipments/ materials and vehicles for operation and maintenance. Train the caretakers of villages in the methodology of operation and maintenance.

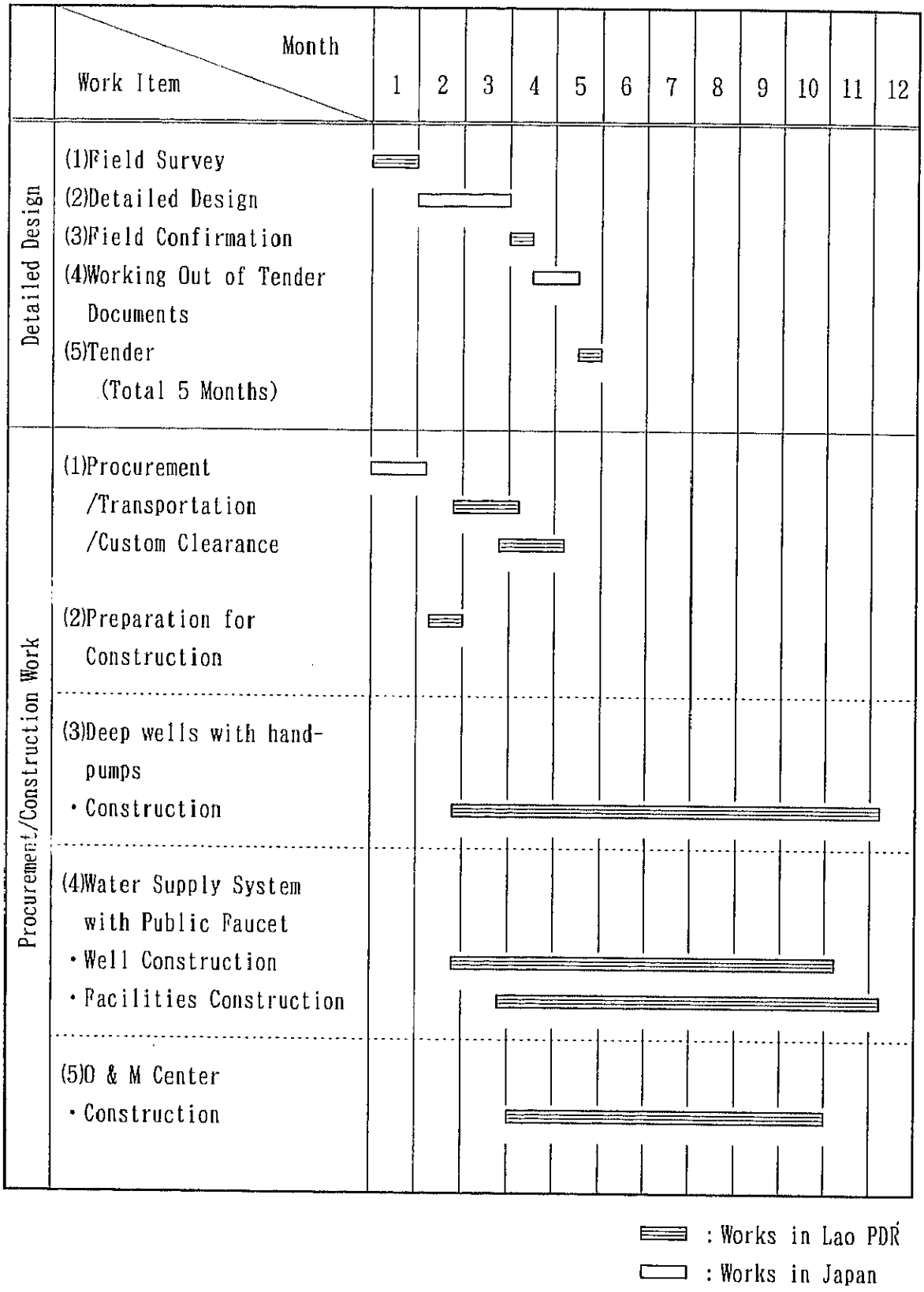
8) coordinate any training activities to be conducted by Japanese engineers during the construction of water supply system.

4.4.6 Scope of Work

(1) Construction Period

The project implementation schedule is shown in Table 4-6. The schedule was planned taking into account the procurement program of materials and equipments, the rainy season, as well as the economy and efficiency of the construction work. The entire construction period is estimated as 12 months.

Table 4-6 Implementation Schedule



(2) Scope of Work

The scope of work to be undertaken by each Government is shown in the table below:

Table 4-7 Scope of Work Undertaken by Each Government

No.	Description	Covered by Laos	Covered by Japan
1)	Secure land	X	
2)	Clear level and reclaim site when needed	X	
3)	Electric distribution line to site	X	
4)	Internal electric line within site		X
5)	Access road to site	X	
6)	Roads within site		X
7)	Main circuit breaker and transformer		X
8)	Telephone trunk line to main distribution panel	X	
9)	Panel and internal wiring		X
10)	General furniture	X	
11)	Inland transportation		X
12)	Construction supervision		X
13)	Maintenance of completed facilities	X	
14)	Maintenance of procured Equipment	X	

Lao Government will burden the expence for installation work of electric distribution line to site and it is estimated as 984,200 kips(159,000 yen).

CHAPTER 5

CONCLUSION AND RECOMMENDATION OF THE PROJECT

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

5.1 Benefits of the Project

The Project for Groundwater Development in Vientiane Province in the Lao PDR is expected to bring the benefits listed below to the recipient communities in the province. In addition, the Project is very important as it is the first rural water supply project financed by Japanese Grant Aid assistance and it is the first large-scale project in the provincial water supply improvement sector of the Lao PDR.

Present Status & Problems	Countermeasure in the Project	Benefits of the Project
-Most existing dugwells dry up in dry season	-Water source is planned to be converted to deepwell water	-Planned deepwells will be a stable water source which will not dry up during dry season
-Dugwell water is apt to be contaminated from surface	-Water source is planned to convert to deepwell water	-Planned deepwells will not easily be contaminated and will be safe water source
-Fetching water in dry season from neighboring well or neighboring village requires much energy and long travel times	-Water source is planned to convert to deepwell water	-Villages will have stable water resourses which will not dry up and the time required to fetch water will be shortened and can be converted to more productive activities
-According to the Third Five Year Plan of MOPH, half of the deaths in 1991 were estimated to be infants under 5 year-old The cause of death is diarrhoea In addition to this, maternal mortality is also high	-Water source is planned to convert to deepwell water	-Deep well water can provide safe water as it is rarely contaminated by surface pollution Accordingly, a deepwell water supply prevents the occurence of water-borne diseases and contributes to decreasing the infant and maternal mortality ratio
-Many villagers are purchasing water for drinking in dry season	-Water source is planned to convert to deepwell water	-By using well water furnished by the Project in the dry season, reduction of the expence for water will be possible
-There are inoperable wells due to lack of O&M	-During implementation of the Project, the Consultant will provide technology transfer to the officials of CWI and Vientiane Province on O&M methods	-O&M for completed facilities will be executed properly
-Although CWI has the responsibility to supervise the quality of water,it is not sufficient	-Provision of water quality analysis kits and related technology transfer will be conducted	-It will be possible to control water quality both of existing and new planned wells
-The existing office of the Water Supply and Sanitation Division (facilities for O&M activity) are insufficient. Accordingly there is no efficient O&M structure	-Maintenance Center consisting of an office, a conference room, a storage house, a workshop room and a vehicle garage space is planned	-Through the completion of the Maintenance Center, the structure for O&M will be strongthened

5.2 Conclusion

The Project's purpose is to respond to the basic human needs of the people in Vientiane Province and therefore belongs to the infrastructure sector. The completed systems will be maintained by the villagers. The collected user's charge (monthly contribution) shall be utilized for the repair of facilities and for electricity charges. The minimum water supply facilities will be provided for the recipient villages. The planned water demands were calculated as 40 liter per capita per day for the deepwell facilities with handpumps, and 60 liter per capita per day for the piped water facilities with public faucets.

The Project is comrised of the following: construction of water supply systems with deep well and a maintenance center, provision of vehicles for maintenance, tools, spareparts and a technology transfer.

Completion of this Project will benefit approximately 44,893 persons in 51 villages and one area (Maintenance Center) in the three districts of Vientiane Province.

5.3 Recommendation

This project targets many inhabitants in a broad area and contributes to the improvement of their living standard by providing a safe water year round as a basic human needs. In addition, the organization, management and financial conditions of the implementation agencies are adequate. Therefore, project implementation under the Japanese Grand Aid scheme is recommendable.

It is also recommended that the Project include an adequate training program for the sustainable operation and maintenance of the water systems in each village after the completion of this Project.

The following countermeasures should be taken for sound O&M of the completed facilities.

- After the completion of the Project, periodic inspection of the water systems and O&M method instruction for villagers should be undertaken by the Water Supply and Sanitation Division of Vientiane Province.

- Management methods will also be taught to each village and the Water Supply and Sanitation Division by CWI.

- Water charges, especially for the Public Faucet System, should be collected with certainty by establishing a reasonable water charge system.

- Workshop and vehicles should be utilized efficiently.

APPENDICES

Composition of the Study Team

Project Coordinator:	SHIGEKI, Kobayashi Office of the Deputy Director-General for General Affairs, Economic Affairs Bureau, Ministry of Foreign Affairs
Water Supply Planning:	MASAHIRO, Shimomura Planning Section, Engineering Department, Saitama Prefecture Water Supply Authority
Well Drilling Planning:	KENJI, Takayanagi NJS Consultants Overseas Services
Water Supply Facility Design:	SATOSHI, Kachi
	ditto
Equipment Planning:	TAKASHI, Watanabe
	ditto

MINUTE OF DISCUSSIONS
ON
BASIC DESIGN STUDY ON THE PROJECT
FOR
GROUNDWATER DEVELOPMENT
IN
VIENTIANE PROVINCE
IN
LAO PEOPLE'S DEMOCRATIC REPUBLIC

Based on the results of the preliminary study, the Japan International Cooperation Agency (JICA) decided to conduct a Basic Design Study on the Groundwater Development in Vientiane Province (hereinafter referred to as "the Project").

JICA sent to Lao People's Democratic Republic (the Lao PDR) a study team (hereinafter referred to as "the Team") headed by Mr. Shigeki KOBAYASHI, Grant Aid Division, Bureau of Economic Cooperation, Ministry of Foreign Affairs. The Team is scheduled to stay in the Lao PDR from 23th May to 24th June, 1993.

The Team held discussions with the officials concerned of the Government of Lao PDR (the Lao Government) and conducted a field survey at the study area.

In the course of discussions and field survey, both parties have confirmed the main items described on the attached sheets. The Team still proceed to further works and prepare a report of the Basic Design Study.

Vientiane, May 28th, 1993

Mr. Shigeki, KOBAYASHI
Leader
Basic Design Study Team
JICA

Dr. Champhone MONGKHONVILAY
Deputy Chief of Cabinet of
Ministry of Public Health,
Lao PDR

Mr. Mounekeo ORABOUNE
Governor,
Vientiane Province,
Lao PDR

ATTACHMENT

1. OBJECTIVE

The objective of the Project is to provide the people in Vientiane Province with adequate quantities or safe and easily accessible drinking/domestic water from wells, in order to promote public health and to improve living standards of inhabitants.

2. PROJECT AREAS

The Project areas are some villages in Phonhong, Thoulakhom and Keo-Oudom Districts in Vientiane Province.

3. EXECUTING AGENCY

Ministry of Public Health and the Vientiane Province are responsible for the administration and execution of the Project.

4. ITEM REQUESTED BY THE GOVERNMENT OF LAO PDR

After discussions with the Basic Design Team, the following item was finally requested by the Laotian side.

To provide villages with deep wells around 50m depth with necessary equipment such as pumps, spare parts and tools.

5. DISCUSSION FROM THE JAPANESE SIDE

The followings are pointed out by the Japanese side.

(1) The villages to be covered by Japan's Grant Aid, if any, would be selected taking the priority put by the Lao side and urgent needs for water in each village into consideration.
The urgency would be determined based on the present quality and quantity of water in dry seasons.

(2) Project management capability of the Lao side should also be taken into consideration when villages to be covered by Japan's Grant Aid are finally determined.

(3) System to supply water in each village would be selected among, but not limited to, the followings,

(a)To provide a village with deep well(s) with handpump(s).

(b)To provide a village with a deep well with an electric pump, and distribute water through an elevated tank to public faucets in several places.

6. JAPAN'S GRANT AID SYSTEM

(1) The Government of Lao PDR has understood the system of Japanese Grant Aid explained by the Team.

(2) The Government of Lao PDR will take the necessary measures, described in Annex I for smooth implementation of the Project on condition that the Grant Aid assistance by the Government of Japan is extended to the Project.

7. SCHEDULE OF THE STUDY

(1) The consultants will proceed to further studies in Lao PDR until 24th June, 1993.

(2) JICA will prepare the draft report in English and dispatch a mission in order to explain its contents around August, 1993.

(3) In case that the contents of the report is accepted in principle by the Lao side, JICA will complete the final report and send it to the Government of Lao PDR by October, 1993.

8. OTHER RELEVANT ISSUES

(1) On condition that Japan's Grant Aid is extended to the Project, the Government of Lao PDR will set a necessary organization and allocate necessary budget for operation and maintenance.

(2) The Lao side expressed that they would organize a technical staff group in the Project implementation stage, in order to upgrade its technical level concerning planning, implementation, operation and maintenance of groundwater development.

Annex I

Necessary measures to be taken by the Government of Lao People's Democratic Republic in case Japan's Grant Aid is executed.

1. To secure the sites for the Project.

2. To clear, level and reclaim the sites prior to commencement of the construction.

3. To undertake incidental outdoor works such as gardening, fencing and gate in and around the sites.

4. To construct access roads to the sites including test boring sites prior to commencement of the construction.

5. To provide facilities for distribution of electricity, drainage and other incidental facilities to the Project sites.

6. To bear commissions to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement.

7. To exempt taxes and to take necessary measures for customs clearance of disembarkation.

8. To accord Japanese Nationals whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into Lao PDR and stay therein for the performance of their work.

9. To maintain and use properly and effectively that the facilities constructed and equipment purchased under the Grant.

10: To bear all the expenses, other than those to be borne by the Grant, necessary for the implementation of the Project.

Field Work Schedule in the LAO PDR

May	22 (Sat)	Tokyo – Bangkok (Shimomura, Takayanagi, Kachi, Watanabe)	
	23 (Sun)	Bangkok – Vientiane (ditto) Joined with Kobayashi, Team reader, who previously arrived	
	24 (Mon)	Vientiane Mun.	Japanese Embassy Courtesy Call Ministry of Public Health Courtesy Call and Explanation of Inception Report
		Vientiane Pro.	Vientiane province Courtesy Call and Explanation of Inception Report
	25 (Tue)	Vientiane Pro.	Site Investigation
	26 (Wed)	ditto	ditto
	27 (Thu)	Vientiane Mun.	Discussion on draft for "Minutes of Discussion", Survey of existing Water Treatment Plant
	28 (Fri)	Vientiane Mun.	Discussion on draft for "Minutes of Discussion", Signing, Report to Japanese Embassy
	29 (Sat)	Vientiane – Bangkok (Kobayashi, Shimomura)	
		Vientiane Pro.	Survey for Core-Boring Site (3 members)
	30 (Sun)	Bangkok – Tokyo (Kobayashi, Shimomura)	
		Vientiane Mun.	Team Discussion
	31 (Mon)	Vientiane Pro.	Survey for Core-Boring site (Takayanagi)
		Vientiane Mun.	Data Collection (Kachi, Watanabe)
June	1 (Tue)	Vientiane Pro.	Interview 80 villages within Project Area (Kachi, Watanabe)
		Vientiane Mum.	Data Collection (Takayanagi)

2 (Wed)	Vientiane Pro.	Interview 80 villages within Project Area (3 members)
3 (Thu)	Vientiane Mun.	Data Collection and Arrangement (3 members)
4 (Fri)	ditto	ditto
5 (Sat)	Vientiane Pro.	Survey on existing deepwells (Takayanagi, Watanabe)
	ditto	Maping for major villages (Kachi)
6 (Sun)	Vientiane Mun.	Team Discussion
7 (Mon)	Vientiane Pro.	Survey on existing deepwells (Takayanagi, Watanabe)
	ditto	Maping for major villages (Kachi)
8 (Tue)	Vientiane Pro.	Survey on existing deepwells, Supervision on Core-Boring Work (Takayanagi, Watanabe)
	ditto	Maping for major villages (Kachi)
9 (Wed)	Vientiane Mun.	Data Collection and Arrangement (Takayanagi, Watanabe)
	Vientiane Pro.	Maping for major villages (Kachi)
10 (Thu)	Vientiane Pro.	Survey on private wells, Pumping Test (Takayanagi, Watanabe)
	Vientiane Mun.	Data Collection and Arrangement (Kachi)
11 (Fri)	Vientiane – Bangkok (Watanabe)	
	Vientiane Mun.	Data Collection and Arrangement, Pumping Test (Takayanagi, Kachi)

12 (Sat)	Bangkok – Tokyo (Watanabe)	
	Vientiane Mun.	Data Collection and Arrangement, Pumping Test (Takayanagi, Kachi)
13 (Sun)	Vientiane Mun.	Data Collection and Arrangement
14 (Mon)	ditto	Data Collection and Arrangement, Maping, Review deepwell data
15 (Tue)	ditto	Data Arrangement, Review deepwell data
16 (Wed)	ditto	Data Arrangement, Soil Formation Survey, Deepwell Survey, Supervision on Core-Boring work
17 (Thu)	Vientiane Pro.	Maping for Phon Hong Hospital and Interview, Preparation for Electric Resistivity Survey
18 (Fri)	Vientiane Mun.	Data Arrangement, Discussion with Counterpart (Takayanagi, Kachi) Electric Resistivity Survey (Takayanagi)
19 (Sat)	Vientiane Pro.	Maping for major villages (Kachi) Electric Resistivity Survey (Takayanagi)
20 (Sun)	Vientiane Mun.	Team Discussion on Design Criteria, Selection of Proposed Sites for Public Faucet Water Supply System (Takayanagi, Kachi, Electric Resistivity Survey (Takayanagi)
21 (Mon)	ditto	Data Preparation for Design Criteria, Selection of Proposed Sites for Public Faucet Water Supply System (Takayanagi, Kachi) Electric Resistivity Survey (Takayanagi)

22 (Tue)	Vientiane Mun.	Discussion on Project Implementation, Signing on Technical Memorandum, Well Data Collection
23 (Wed)	ditto	Report to Japanese Embassy, Data Collection and Arrangement
24 (Thu)	Vientiane – Bangkok	
25 (Fri)	Bangkok – Tokyo	

Local Agencies and Official Met With

1. Ministry of Public Health

- Vice Minister, Ministry of Public Health — Dr. Rasmy KHAMPHAY
- Deputy Chief of Cabinet, Ministry of Public Health — Dr. Champone MONGKHONVILAY
- Deputy Manager of National Institute of Hygiene and Epidemiology, Project Manager of Water Supply and Environmental Health, Ministry of Public Health — Dr. Nouanta MANIPHOUSAY
- Deputy Manager of Water Supply and Sanitation Project, Ministry of Public Health — Dr. Khumvieng VILAPHAN
- Head of Groundwater Section, Water Supply and Sanitation Project, Ministry of Public Health — Mr. Kongkhan MIBOON
- Officer of External Relation (Bilateral and NGO's), Ministry of Public Health — Mr. Phoukhong CHONMALA

2. Vientiane Province

- President of Vientiane Province — Mr. Mounekeo ORABOUNE
- Deputy Chief of Cabinet, Vientiane Province — Mr. Ling KHAM
- External Economic Relationship Bureau, Vientiane Province — Mr. Oudons PHONGPHAYPADITH

3. Embassy of Japan

• Ambassador Extraordinary and Plenipotentiary	Mr. Masao WADA
• First Secretary	Mr. Saburo SATO
• Second Secretary	Mr. Kiyoshi OMAMEUDA

Data Collection

Report,

(1) Northern Provincial Towns, Water Supply Development Project, TA 1607-LAO, Vol I,II,III, APPENDICES ADB, Nam Papa Lao-the Lao PDR, March 1993.

(2) Mid Term Review of the Programme of Cooperation Between the Government of the Lao People's Democratic Republic and the United Nations Children's Fund for the Programme Cycle 1987-1991, UNICEF, Vientiane, June, 1990.

(3) Rural Water Supply & Sanitation in the Lao PDR, A Framework for a New Decade, Volume I, II UNICEF, Vientiane, August, 1991.

(4) Third Five Year Plan, 1992-1996, Ministry of Public Health, Lao PDR, May, 1992.

(5) The Tha Ngon Rehabilitation and Rural Development Project, 1989, Ministry of Agriculture and Forest.

(6) Underground Water Development Program Research, Village Domestic Water Supply Project in the Southern Region of the Lao PDR, 1992, Ministry of Health.

(7) Dansavan Village Water Supply Project, Vientiane Province, February 1993, UNICEF

Statistics

(1) Basic Statistics about the socio-economic development in the Lao PDR, 1991, Committee for Planning and Cooperation, State Statistical Center

(2) Basic Statistics about the socio-economic development in the Lao PDR, 1992, Committee for Planning and Cooperation, State Statistical Center

Business Book

(1) Investment Opportunities in the Lao PDR, A Semi-Annual Publication of the Foreign Investment Management Committee and the Lao National Chamber of Commerce & Industry, June 1992.

Map

(1) Prefecture of Vientiane (1:125,000), 1990, Service Ge'ographique National, Vientiane

(2) Geological Map. Viet-Nam-Kampuchia-Lao (1:2,000,000), National geographic Directore of Vietnam-Dalt-1971

(3) Topographic map of B. Thangon, B. Samphanna, B. Napho, B. Thinkeo (1:100,000), 1985 and 1986, Service Ge'ographique D'etat.

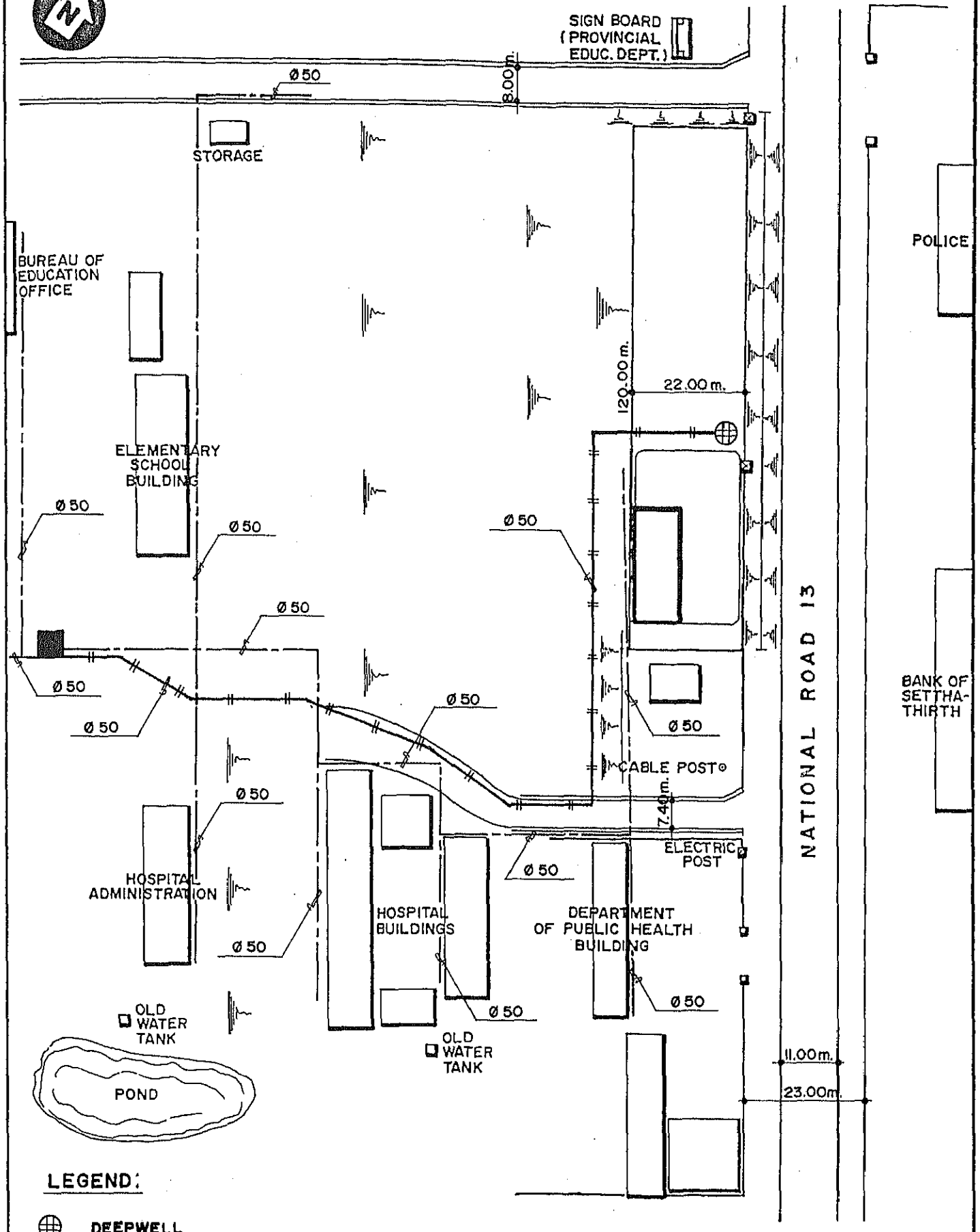


FIG. B-1-1

SAMPLE OF WATER SUPPLY FACILITIES

(PONG HONG HOSPITAL)

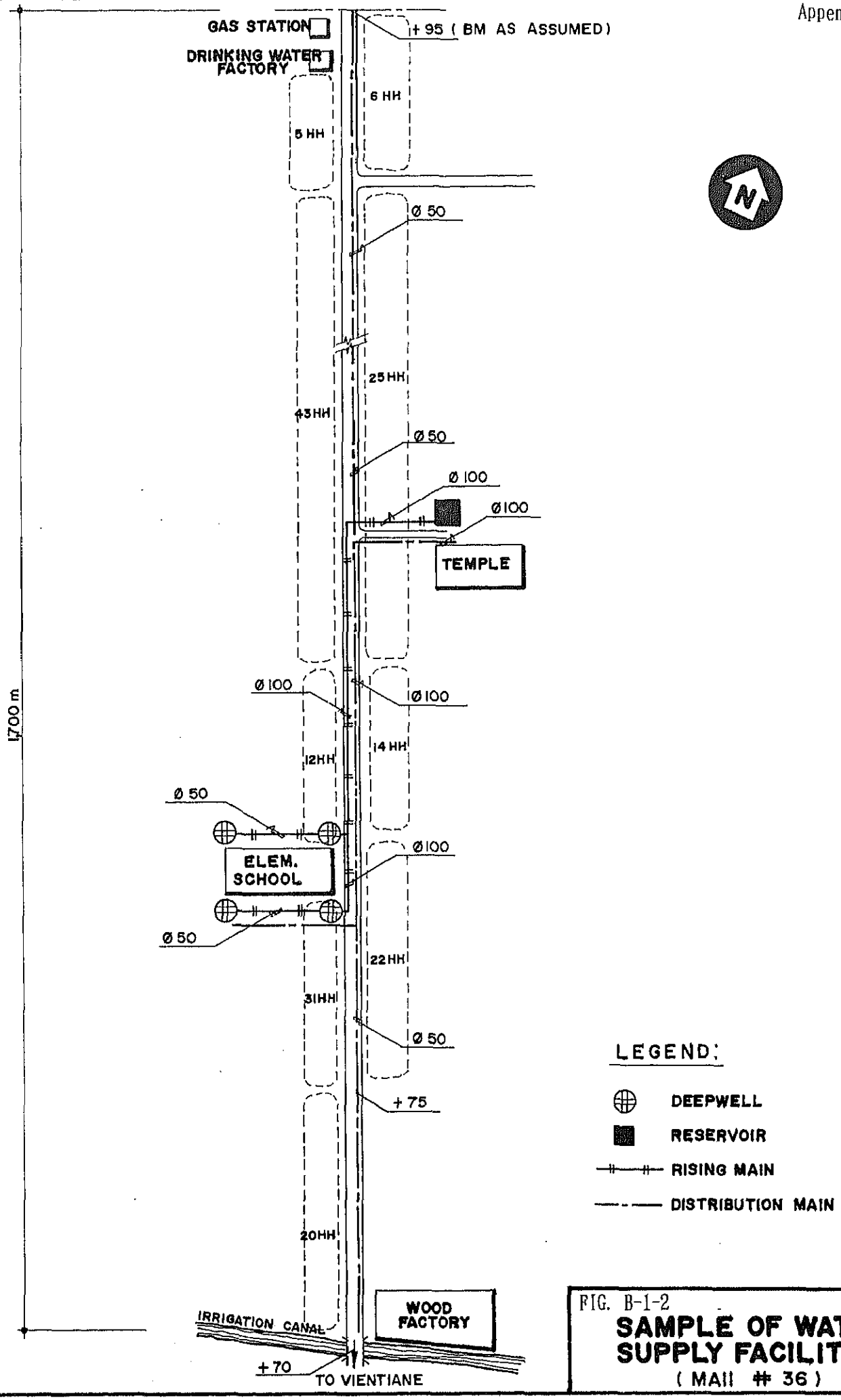


FIG. B-1-2

SAMPLE OF WATER SUPPLY FACILITIES

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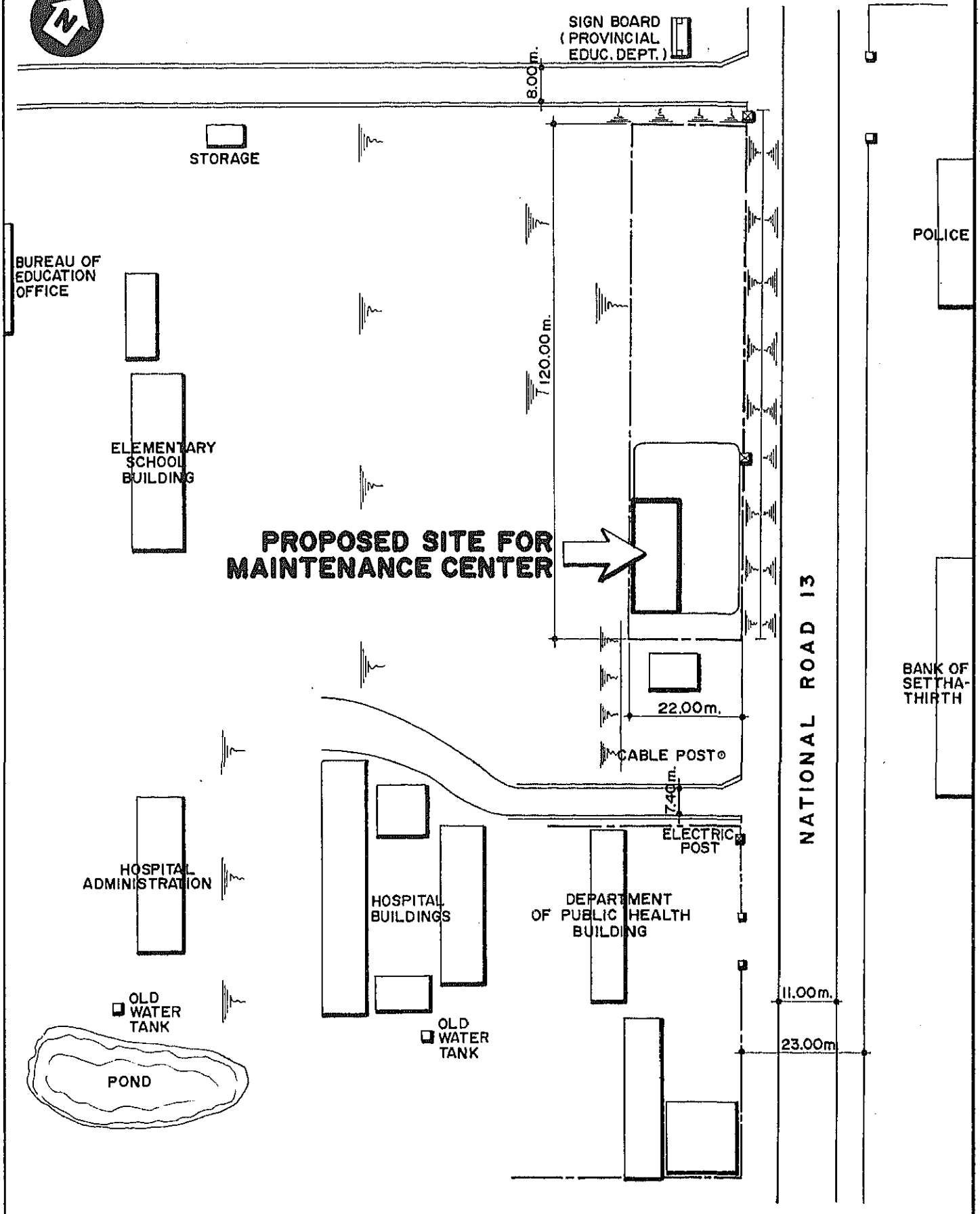

FIG. B-2

PROPOSED SITE FOR MAINTENANCE CENTER

APPLICATION FOR PUBLIC WATER SUPPLY FACILITY (CONTRACT)

We, household heads of the village _____
in the District of _____, in Vientian Province, seek the construction of public wells under the assistance of Vientian Province and the Ministry of Public Health in collablation with Japanese Grant-Aid.

Since we understand the rule mentioned below which is enacted to build sustainable operation and maintenance, we for apply the right to use the public water supply system and we take an oath to observe the rules mentioned below.

(1) We, the users, shall willingly take part in our responsibility to operate and maintain the public water supply facilities (hereinafter called the System).

(2) To ensure the construction, smooth operation and proper maintenance of the System, we shall bind ourselves to the following:

1) That we will secure a suitable site for the project.

2) That we shall pay a monthly contribution of _____ kip (hereinafter called the user's charge) to raise amount needed to maintain the System.

3) We shall support and cooperate our village chief, the inspector in charge (hereinafter called the Inspector) and maintenance fee collector (hereinafter called the Collector).

(4) Operation and maintenance of the System shall be the responsibility of villagers headed by the chief of the village.

(5) The chief of the village shall appoint the Inspector and the Collector. The chief of the village shall get of the approval of these appointments from a village assembly/committee.

(6) Although public wells are a public service, all villagers are not necessarily able to use the facilities. Only those villagers who have signed this a application (written oath) can use the System and shall pay the Users Charge (monthly contribution) to use the System.

(7) When a user delays to pay the User Charge, he/she shall be prohibited from using the System at the decision of the chief of the village.

(8) When he/she who is prohibited to use the System has paid the arrears up to the time of the prohibition, he/she can use the System after signing the application and written oath again. However, even if he/she does not submit the reapplication form, the duty of the payment for the arrears up to the time of the prohibition shall not disappear.

(9) The chief of the village shall deposit the remaining money collected from villagers after paying electric charges and other fees to Vientiane Province. Vientian Province shall pass a certificate of deposit to the chief of the village.

(10) Vientiane Province shall open accounts in a bank for the abovementioned money on behalf of the chiefs of the villages. Vientian Province can withdraw from the account, for spare parts charges, rental charges of maintenance tools and actual expenses of repair by the province based on the certification issued by the chiefs of the villages.

(11) Interest borne from the account shall revert to Vientiane Province and all villagers represented by the chief of the village shall abandon the right to claim the interest.

(12) Vientian Province shall make a fund using the spare parts charge, the rental charge for maintenance tools and the actual expenses of repair by the province. The fund shall be used to procure new spare parts and tools for maintenance. Vientiane Province shall make an accounting for the exclusive record of the transactions mentioned above.

(13) Both Vientiane Province and the Collector in the respective villages shall make a financial record for the village and shall be responsible

for its safekeeping. When an affiliated user or a chief of the village requests to examine the bookkeeping, it shall be opened to public.

(14) Vientiane Province shall rent its maintenance tools for the System at a charge when a villager requests to rent the tools. However, neither the province or the villagers shall not use them for any other purposes.

(15) The User's Charge shall be classified into Level I systems (point source) and Level II systems (piped water supply with public faucets) and the charge per household shall be fixed as a flat rate system. Revision of the charges shall be done by Vientiane Province provided that the revision shall not aim at any profits. Although a public faucet is equipped with a water meter, this is not for determination of monthly contribution but for pressure adjustment in order to convey water to the pipe ends.

(16) The System is constructed only for domestic use and is not intended for commercial or industrial users. Therefore uses for commercial and industrial purpose are strictly prohibited.

(17) Public faucets shall not be constructed in a road area for the protection of the facilities. It shall be constructed on public land i.e. the land donated to Vientiane Province by the inhabitants of the recipient villages. The act of donating the land does not release any person from the duty to pay the user's charges.

(18) More than one organization for the maintenance of the System in any village shall not be established.

(19) The chief of a village shall designate an auditor in order to have him/her audit the bookkeeping, the user charge collection situation, the expenses, the remaining money and the passbook of the bank once every six months. The auditor shall open the result to the public.

(20) If the chief of a village, a village inhabitant or the auditor suspects the Inspector or the Collector of wrong doing, they can dismiss

the Inspector or the Collector after getting a majority agreement in the village committee/assembly.

Now, therefore, we here on set our hands this _____ day of _____, 19__.

	PRINTED NAME	SIGNATURE	TIN OR RCN
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DETAILS OF COST ESTIMATES

(1) DEEPWELL WITH HAMDPUMPS

DESCRIPTION

Number of Villages	:	47
Number of Households	:	5,154
Number of Pump Units	:	109
Population	:	37,544

OPERATION AND MAINTENANCE COSTS

Item	Calculation	Amount
Depreciation	554,000k x 0.9 x 0.066 x 109	= 3,587,000
Transpotation	30km x 5times x 61/km / 235kip/l x 47/11	= 904,000
Total		4,491,000

Cost per household $\frac{4,491,000}{5,154}$ = 871 kip/y = 73 kip/HH/month

(2) WATER SUPPLY SYSTEM WITH PUBLIC FAUCETS

DESCRIPTION

Number of Villages	:	4 villages + 1 area (M. Center)
Number of Household	:	1,069
Number of Pumps	:	18
Population	:	7,349

OPERATION AND MAINTENANCE (Submerged Motor Pump)

Item	Colculation	Amount
Depreciation	3,090,000k x 0.9 x 0.066 x 18	= 184,000
Labor Cost	5persons x 2days x 5timesx 2000kip x 4	= 400,000
Transportation	30km x 5times x 2days x 61/km x 235 kip/l x 4	= 1,692,000
Electricity	10hrs x 2.2kw x 25kip/kwh x 365days x 18	= 3,614,000
Water Line Repair	14,736 m x 0.001% x 5800k/m	= 85,000
Total		5,975,000

Cost per Household $\frac{5,975,000}{1,069}$ = 5,600 kip/y = 470 kip/month

SELECTION OF PROJECT VILLAGES

The magnitude and scale of the Project was determined by the following methods and decreased to 51, plus one site from the 80 villages which were originally requested.

(1) Merged villages (exemption of two villages)

- Phon Hong (No.4) and Nong' Kork (No.6) were merged and unified into Phon Hong.

- Nong Nak (No.44) and Moung Khao (No.60) were merged and named Phon Ngeun.

- Tao Poune (No.59) and Moung Khao (No.60) were merged and named Pakcheng Neua.

(2) The villages determined already to be included in other-foreign-funded projects (exemption of 8 villages)

(a) Project area planned to be covered by the Asian Development Bank

Phonsi Tai (No.2), Nam Linh (No.3), Phon Hong (No.4)
Phon Kham (No.5), Nong'Kork (No.6), Phon Xay (No.7)
Phon Ngam (No.8)

(b) Project area planned to be covered by the France Grant Aid Project

Keun (No.66)

(3) The villages being judged to have difficult groundwater development from the viewpoint of hydrogeology as follows:
(exemption of 17 villages)

- Nam Tcheng (No.1)

  Field observation (outcrop of sandstone around the village)

- Na Xom (No.15)

  Distribution area of impervious layers shown in geological map and information based on existing wells (drilling of existing three dug wells encountered shale in the depth of about 8 m)

- Kham (No.21)

  Distribution area of impervious layers shown in geological map and information based on existing wells (drilling of existing dug wells encountered shale)

- Gnoat (No.22)

  Distribution area of impervious layers shown in geological map and information based on existing wells (drilling of existing dug wells encountered shale)

- Phon Haii (No.29)

  Distribution area of impervious layers shown in geological map and information based on existing wells (drilling of existing dug wells encountered shale)

- Na Thep (No.37)

  Field observation (outcrops of sandstone around the village)

- Na Lao (No.39)

  Field observation (outcrops of shale around the village)

- Na Bon

  Result of electric resistivity survey (distribution of impervious layer)

- Phon Savang (No.49)

  Result of core boring (distribution of clay and shale near ground surface)

- Phon Ngeun (No.50)

  Field observation (outcrops of sandstone around the village)

- Phon Kham (No.51)

  Result of electric resistivity survey (distribution of impervious layer)

- Na Kang (No.70)

  Result of electric resistivity survey (distribution of impervious layer)

- Napoune (No.75)

  Result of core boring (distribution of clay and shale near ground surface)

- Thasun (No.76)

  Distribution area of impervious layers shown in geological map

- Thalat (No.77)

Distribution area of impervious layers shown in geological map and field observation (outcrops of shale around the village)

- Thinkeo (No.78)

Distribution area of impervious layers shown in geological map and field observation (outcrops of shale around the village)

- Phoukaokham (No.79)

Distribution area of impervious layers shown in geological map

Sandstone and shale distributed in the Project area are very hard, consolidated rocks, impervious layers, and the geological formations which were deposited in Mesozoic era.

(4) The villages being judged to have enough water from their existing wells (exemption of two villages)

- Na Song (No.23)

Population and village's scale is fairly small. In addition, the villagers satisfy the present condition of water supply as all of the existing 7 dug wells doesn't dry up during the dry season.

- Phon (No.33)

The existing 3 deep wells constructed by USAID are operational and are used for water supply.

Number of villages exempted from the original requested Project are 29. This is summarized as follows: (1) decrease of two villages (Phon Hong and Nong' Kork are exempted to be included to Asian Development Bank project),

(2) decrease of 8 villages, (3) decrease of 17 villages, (4) decrease of 2 villages. Thus, the number of projected villages is 51, together with one site planning the construction of the maintenance center building and located near Phon Hong hospital.

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