THAILAND EVALUATION REPORT

World Wide Water Supply Study

EVALUATION OF COMMUNITY WATER SUPPLY PROGRAMS AND CAPABILITIES IN THAILAND

BY

HARRIS F. SEIDEL,
PAUL E. MORGAN,
HERMAN G. BAITY,
CONSULTANTS

November 12 - December 10, 1967

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
PUBLIC HEALTH SERVICE
WASHINGTON, D. C.

PREFACE

As a team of consultants to conduct the study reported herein, the United States Public Health Service obtained the services of the following persons: Harris F. Seidel, Director of Water and Pollution Control for the City of Ames, Iowa; Paul E. Morgan, Professor of Civil Engineering and Assistant Dean of the College of Engineering of Iowa State University; and Herman G. Baity, Emeritus Professor of Sanitary Engineering of the University of North Carolina and former Director of Environmental Health of the World Health Organization.

These consultants were briefed in Washington from November 5th to 10th and on November 12th arrived in Bangkok to undertake their assignment. They were met by the Chief Sanitary Engineer of USAID, who had arranged for their accomodation in the comfortable Chao Phya Hotel. The following week was spent in consultation with the various divisions of USOM, with the several agencies of the Thai Government that have a responsibility for public water supply, with representatives of international organizations having an interest in this field and with the officials and consultants of the City of Bangkok who are concerned with water supply and sewerage.

With the fortunate facility of an 8-place turbo-prop aircraft, the consultants departed from Bangkok on November 19th for a 4-day visit to the Northern and Northeastern Regions of the country, accompanied by representatives of USAID, the World Health Organization and the Sanitary Engineering Division of the Thai National Ministry of Health. On this trip visits were made to the municipal water works of the cities of Chiang

Mai, Khon Kaen, Nong Khai, Udorn, and Ubon. At Khon Kaen the party had the pleasure of seeing the headquarters of the Potable Water Project of the Accelerated Rural Development Program (ARD) and conferring with the staff. The Changwat (provincial) offices of this organization were visited in other cities, and inspections were made of new rural water supply installations of this agency in the villages of Ban Phon, Ban Kong Nang, Ban Nong Sawan, Ban Naka and Posri. In the extensive travel by earth roads in reaching these remote settlements, and especially from the clear panoramic vistas in flying over much of the country, the consultants feel that they obtained in a short period of time a reasonably good understanding not only of water supply needs, development and problems, but of the social and economic conditions of these parts of the country.

Because of the general reputation for good nature and friendliness which the Thai people enjoy, the consultants had expected a pleasant visit to their country. But the warm reception and patient helpfulness have exceeded all expectations. Equally generous have been the hospitality and assistance given by the representatives of American and international agencies. All in all, the stay in Thailand has been a rewarding and happy experience for these three people, and they wish to express gratitude to all who have helped them.

TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS AND CONVERSION FACTORS

ARD	Accelerated Rural Development Program
MRD	Mineral Resources Department
NEDB	National Economic Development Board
PWWD	Provincial Water Works Division, Public and Municipal Works Department
RTG	Royal Thai Government
RID	Royal Irrigation Department
SED	Sanitary Engineering Division, Department of Health
MG	Million gallons
cmd	cubic meters per day
cm/hr	cubic meters per hour

1 cubic meter = 264 gallons

US $1.00 = 20.80 ฿, or Bahts

฿ Baht

At present Thailand has a population of about 33,200,000, twelve per cent of whom are in cities and towns, with the remainder living in about 45,000 rural villages. Metropolitan Bangkok has about 2.5 million people, but the next 10 cities range in size from 40,000. to 75,000. Programs of water supply for the provincial towns and larger villages are being actively prosecuted by eight agencies of the national government which, in coordination, exercise planning, designing and construction functions, with some of them performing operational and managerial responsibilities. One gets the impression that these organizations are staffed by competent and dedicated people and, in spite of difficulties inherent in implementing such programs from Bangkok headquarters in a country deficient in materials and equipment, transport and communication facilities, that satisfying progress in planning and building is being made. However, in the provincial and rura areas there are serious deficiencies in operation, maintenance and managemer of the facilities, which negate much of the initial effort. The situation i better with the Bangkok water works although there is room for much improvement.

Under present policies, rate structures and management all of these water systems fall woefully short of being self-supporting, but the government chooses to make up the deficits from other sources.

The Thai nationals are competent to plan and design the usual water works installations, but they still desire to call in foreign consultants to handle the more complex problems, such as those of metropolitan Bangkok. There are serious shortages of manpower in engineering and technology, as well as skilled labor, but these are being alleviated by stepped-up program

of education. Many of the basic construction materials are available in the country, but others, such as steel, cast-iron pipe and fittings, pumps, motors, equipment and machinery, have to be imported. Heavy construction and automotive equipment is imported, but it is available in impressive quantities. Thai contractors are able to accomplish successfully all but the largest and most complex undertakings.

The economy of Thailand is thriving, the trade balance is favorable, the gross national product is mounting rapidly and the currency is stable. The government is able to operate and expand its facilities and services impressively within its own resources. Except for the Accelerated Rural Development Program of the Northeast, which is based upon particular economic and insurgency conditions in that region, the country does not appear to require grant assistance for its water supply programs. It will probably require international loan assistance for its larger programs and projects.

At present there are no integrated sewerage systems in the country.

CHAPTER I

OBJECTIVES OF STUDY

Recognizing the vital importance of a safe and adequate supply of water to good health and economic development, the USAID and its predecessor agencies have included community water supply programs in their assistance to the under-developed countries. This experience has led to an awareness that in this field the needs of these countries extend substantially beyond the provision of physical facilities. In the past it was generally assumed that poverty or the lack of foreign exchange was the principal obstacle to the provision of water supply services in the developing countries. It has now become apparent that this is not always the case; it seems that in a majority of situations other deterrents may be of even greater importance. The recognition of such factors led the President of the World Bank, in an address to the United Nations Economic and Social Council on March 26, 1965, to make the following summary of his views regarding support of community water supplies: "Neither general programs nor even generous supplies of capital will accomplish much until the right technology, competent management and manpower with the proper blend of skills are brought together and focused effectively on well-conceived projects".

With the objective of detecting and appraising such shortcomings in the developing countries, as well as discovering and evaluating the factors having positive effect, the Public Health Service of the Department of Health, Education and Welfare and the U.S. Agency for International Development late in 1966 signed an agreement under which the USPHS would provide the services of teams of consultants who would examine information available in AID and elsewhere, and make field visits to developing countries in order to provide:

"(1) An evaluation of the ability of a host country to plan and design water supply facilities; to construct water supply facilities, giving consideration to conformance with specification and schedules of work, quality of work, contracting procedures, and other factors affecting construction; and to operate existing water supply systems, giving consideration to the quantity, quality and continuity of water services provided, the number of persons served by water on premises and from public taps; the fiscal viability of the water supply agency, the operation and maintenance of physical facilities, administration and management. Those factors which contribute to a successful operation and those which limit success will be determined. Attention will also be given to the legal authorizations for operations and the relationship of other agencies to water supply operations. The evaluation will be summarized and presented with emphasis on those factors which have global or regional significance.

(2) Based on the evaluations, the USPHS will prepare a manual for the evaluation of water supply projects and project proposals, to be used by AID, other lending agencies, by host country personnel, engineering consultants and others in the conduct of their water supply activities. The manual shall provide guidelines and criteria, with appropriate comments and explanations for evaluating all aspects of community water supplies, including, but not limited to, standards of quality and quantity of water, extent of service, finance, water service rates and other sources of income, legal authorizations and regulations, personnel, design standards and specifications and overall management.

International travel for the collection of personnel, training and performance data will be to approximately 12 countries of all AID regions".

More succinctly stated, the primary purpose of the consulting teams, such as the one now in Thailand, is to determine the capability of the national governments to plan, design, finance, construct, operate and manage adequate water supply facilities within their own resources.

The consulting teams have been instructed to give first attention to the water supply practices and problems of the larger centers of population. For two reasons a departure from this instruction becomes necessary in Thailand:

(1) Except for Bangkok-Thanburi there are no large cities in the country and

(2) Due to the economic distress and political unrest in the Northeast region, an accelerated development program is now under way in that area

in which water supply to small communities is an important element.

As stated in the terms of the PHS-AID agreement, the end-product of the studies made by the several consulting teams is desirably a single manual useful to many agencies, which would contain uniform criteria and guidelines applicable to all developing countries. Due to the wide differences in conditions found in the several countries under study, this process of combining 12 to 15 reports into a single meaningful manual may be found to be a difficult, if not impossible, task. If such is the case, and a single common denominator cannot be found, perhaps the countries could be divided into categories according to their special conditions, needs and stage of development, with the manual correspondingly divided into sections with different criteria and guidelines. If the measures for such differentiation are made sufficiently clear, a country might be placed in an appropriate category without too much difficulty.

CHAPTER II

BACKGROUND INFORMATION

A. THE COUNTRY

Geography. The Royal Kingdom of Thailand is bordered on the west and north by Burma, on the north and east by Laos and Cambodia and on the south by Malaysia and the Gulf of Siam. It embraces an area of 518.000 square kilometers (198,456 square miles) and lies between 5^{o}-$40^{'}$ and 20^{o}-$30^{'}$ North Latitude and 97^{0}-$30^{'}$ and 105^{o}-$45^{'}$ East Longitude. A popular visualization of the shape of the country is that of the head of the symbolic white elephant. Viewed as such, the widest part of the head is 750 km. The length from ears to snout 1,620 km. and the narrowest part of the trunk only 10.6 km.

The country has four main geographic regions, each with different natural resources and economic and social development. Rice is cultivated throughout the country, on a subsistence basis in the higher areas, but in bountiful commercial quantities on the well-watered, low-lying plains.

The Northern Region, which lies against Burma and Laos and covers 55,000 square miles is mostly mountainous and forested, with agriculture and settlements limited to the valleys. Teak is the region's principal export. The principal city is Chiang Mai, some 400 miles north of Bangkok. The Chao Phraya, Thailand's major river, is fed by the mountain tributaries of this region.

The Northeast Region comprises the Khorat Plateau, has an area of about 62,000 square miles and lies against Laos and Cambodia, between mountain ranges on the west and the Mekong River on the north and east. The terrain is flat to rolling, with some hills and small lakes. Over much of the area

severe water shortages during the dry season alternate with floods in the rainy season. Farming is difficult because of the generally infertile soil and the inequable rainfall. Consequently there is widespread poverty, a paucity of communication and transportation facilities and austere condition of life that invite insurgency from across the nearby national boundaries. It is in this region that the Government is now making a desperate effort to provide facilities that have been long neglected.

The Central Region, with an area of about 63,000 square miles, is Thailand's geographic and economic heart. It comprises the vast flood plain of the Chao Phraya River, flat as a table, stretching 200 miles along the river and varying from 30 to 90 miles in width. Its paddy fields stretch as far as the eye can see like a vast mosaic carpet of emerald green. It is the granary of the country, produces most of the exported rice, contains most of the industry and supports the greatest concentration of people at the highest standard of living and the highest level of culture to be found in the country Bangkok is the gateway to this lush region, and serves as the country's port, its capital and its center of finance, commerce and industry.

The Southern Region is that part of the country that extends far south ward in the form of a narrow panhandle to the Malaysian border. It has an area of 20,000 square miles and is paralleled for most of the length by a strip of Burmese territory. The western side of the peninsula is mountainous while the east coast is indented with many small harbors. Some coastal plains exist, permitting rice culture, but more important is the production of rubber and tin. Of secondary significance as exports are cattle, timber lignite and iron ore.

Geology: The geology of Thailand is too varied and complex to be summarized within the scope of this report. The geologic

features have been well explored, and much literature on the subject is available. A particularly comprehensive report on the ground-water geology of the Northeast Region is to be found in the publication entitled: "Ground Water Resources Development of Northeastern Thailand" by Howard F. Hayworth, Pongp Na Chiengmai and Charoen Phiancharoen, published as Ground Water Bulletin No 2 (1252 pp.) by the Department of Mineral Resources, Ministry of National Development of Thailand, 1966.

Climate: Thailand has a tropical monsoon climate. From November to February or March the northeast monsoon prevails, with dry air from China bringing generally clear weather without rainfall, and with cooler temperatures. From May to September, or later, the southwest monsoon brings warm moist air from the Indian Ocean, with warmer temperatures and abundant rainfall to all of the country. The amount of rainfall varies considerably throughout the country, from a maximum of 120 inches annually to as little as 30 inches. The national average is probably about 50 inches/yr. The mean annual value for Bangkok is 59 inches.

Over most of the country the temperature rarely falls below 59 degrees F. nor rises above 90 degrees F. At the higher elevations of the hill and mountain country the temperatures are naturally lower than in the flat regions near sea level, as are also the relative humidities. In any given locality, however, there is a surprisingly small difference between the maximum and minimum daily temperatures and between those prevailing during the Northeast and Southwest monsoons. At Bangkok the difference between mean maximum temperatures for "summer" and "winter" seasons is less than 5 degrees F. This city has an average mean temperature of 83 degrees F. and a mean relative humidity of 73%.

Political Organization: In Thailand the Changwat (province) is the primary unit of territorial administration, and is under the authority of a provincial governor appointed by the King. Each such province is divided into Amphurs (districts) headed by a district office responsible to the governor. Large Amphurs may be divided into King-Amphurs (sub-districts) headed by a sub-district officer. At present the kingdom comprises 71 Changwats, 509 Amphurs and 26 King-Amphurs.

For administrative purposes Amphurs are divided into Tambons (communes) which are further divided into Muh-Bans (villages). A Tambon is headed by a Kamman (head-man) and the Muh-Ban head-man is known as a Poo Yai Ban. Both of these are elected officials. At present there are 4,888 Tambons and 41,537 Muh-Bans. The usual population of a Muh-Ban is 200 persons or more.

B. THE PEOPLE

Population: The population of Thailand, by the official census of 1960 was 26,257,860. This is increasing at a rate of 3.3 per cent annually, and the population at mid-1967 is estimated at 33,200,000. Only 12 per cent of the people live in cities and towns; the remainder are in the rural areas, living in about 45,000 villages. The nine largest citie and the 1960 population of each are:Bangkok (including Thonburi) 1,704,774; Songkhla, 70,035; Chiang Mai, 63,464; Nakorn Rajsima (Khorat), 50,438; Cholburi, 48,112; Ubon Rajadhani, 45,439; Nakorn Srithamaraj, 45,341; Rajburi, 42,691; and Nakorn Sawan, 41,083. Due to their compact settlement these places give the impression of being much smaller than they really are.

Ethnic Derivation: The population is a composite of different ethnic groups, but approximately 85 per cent are of Thai origin. The 1960 census reported only about 500,000 persons with foreign

citizenship, of whom 410,000 were Chinese, about 5,000 Westerners (mostly in Bangkok) and the balance from Southeast Asia. Considerable numbers of other ethnic groups who hold Thai citizenship (Chinese, Indians, Malays, etc.) speak their native languages and follow native customs. There are currently about 50,000 refugees from North Viet Nam in the Northeast region. The Thai language, in three dialects, is spoken by more than 90% of the adult population. The Chinese element is largely bilingual. English is taught as the secondary language in many high schools and colleges, is employed widely in commercial and government publication and is spoken by most educated nationals

Religions: Thailand is a very devout Buddist country, and this religion infused with Hinduism and animism, pervades the entire culture, serving as a stabilizing force which promotes national unity and provides a focus for community life. According to faith, the percentage distribution of the population is approximately the following: Buddhists, 93.4%; Muslims, 3.9%; Confucians, 1.7%; Christians 0.5%; Others, 0.5%.

C. THE ECONOMY

The economy of Thailand is primarily agricultural, supplemented by activity in fishing, forestry and mining. About 80% of the population are actively engaged in agriculture (including fishing and forestry). Rice is the main crop, to the extent that Thailand is the world's foremost exporter of rice. Rice and rubber exports alone produce over half the country's foreign-exchange earnings. Tin is the third most important export.

Industrial development, on the other hand, has been rather modest. Among the factors responsible have been natural limitations of fuel and raw materials, power and transportation shortages and limited technical and managerial know-how. Major strides are currently being made, however, in highway

and road construction and in electric power generation and distribution. For example, actual power use doubled from 1964 to 1966, and is expected to double again in the ensuing three-year period. Although the Government is full or part owner of much of the country's industry today, there is a pronounced shift in emphasis toward encouragement of the private industrial sector.

Unemployment exists, but apparently to a rather modest extent. A recent survey in the Bangkok metropolitan area concluded that approximately 2 to 3% of the labor force were "actively seeking work" and another 5% might be categorized as unemployed but not actively seeking work (further proof of the general local good humor and inner peace so evident to the worried wayfaring Westerner). The situation is undoubtedly more serious in the rural areas where there is a substantial amount of under-employment and what is termed "disguised unemployment", or worse, at certain seasons.

The currency of Thailand has been stable and freely exchanged for more than 10 years, being considered a relatively "hard" currency in international finance. The country has enjoyed a favorable balance of payments position, and a steady growth in international reserves to a level above U S $ 800 million at the end of 1966. Thailand's gross national product (GNP) has also been growing at the rate of 7 to 9% per year in real terms. Although per capita GNP is low by western standards (US$134 in 1966) it is at least increasing faster in real terms than the current population growth rate of "only" 3.3% annually.

In 1961, Thailand formulated a six-year plan as the first coordinated program for economic development of the country. By the end of the plan period (September 30, 1966) almost all sector targets had been achieved, a many exceeded. The country is now well into a second plan (1967-1971 fisc years) prepared by the National Economic Development Board (NEDB). The goals

of the second plan are higher, including an average annual growth in GNP of at least 8.5% in real terms. The second plan specifically recognizes the need both for increased spending on potable water supplies throughout Thailand, and for an attack on the sewerage and drainage problem of metropolitan Bangkok. Some of the details of the support for these programs are presented in a later section of this report.

One of the major emphases of the Second Plan is a concentrated attack on current severe regional inequities, particularly the hardships, isolation and lack of opportunity characterizing the Northeast region, which quite surprisingly not only constitutes one-third of Thailand's area but also is home to one-third of her population. This is important to the purpose of this report because this region is the focus of both a growing agitation and insurgency problem, and of a concerted Thai-US effort to bring a minimum level of amenities and opportunities (roads, water supply, schools, clinics) to this region as the best and most lasting of counter-insurgency campaigns.

D. TRANSPORTATION AND COMMUNICATION

Transportation: Railways are the most important means of transport in Thailand and carry most of the long-haul freight. The Royal State Railways have a network of about 2,250 miles of one-meter gauge lines, most of which is single-track. The services radiate north, east and south from Bangkok to provide connections with important administrative and commercial centers.

The highways were constructed initially as feeders to the railways, and consequently do not provide an integrated network. They are used mostly for short hauls and are as yet unsuitable for heavy traffic and all-weather service. Since 1950 road transport has tripled, but highway construction and

maintenace have not kept pace. The highway network in 1964 totalled 5,770 miles of trunk roads, of which 2,834 miles were paved with concrete or asphalt, and 2,172 were of gravel type surface. The provincial highway system, mostly unpaved, totals about 3,600 miles. These roads, 3 to 6 meters wide, have a loose laterite surface, normally full of pot-holes, and are muddy in the wet season and produce clouds of stifling red dust in the dry season. In 1964 there were 261,000 motor vehicles registered in the country, of which only 56,800 were private passenger cars.

Inland waterways carry much of the local agricultural produce, but this transport is confined mostly to the Bangkok area. The country has about 3,700 miles of navigable waterways, comprising an elaborate system of canals, dams and locks which insure year-round navigation to shallow-draft craft. Sea transport is not well developed, and most cargoes are carried in foreign vessels. The country has one principal port, Bangkok, which lies 28 miles from the sea on a channel that suffers severely from siltation, and which can accommodate only vessels below 10,000 tons. There are 19 minor ports.

Bangkok has become the leading port of call for international airlines operating in Southeast Asia. Twenty of the leading international lines now serve the city, and its modern airport in 1964 accommodated 143,375 passengers. Thai Airways operates internally and connects Bangkok with 21 provincial airports. Two other national companies operate on international schedules.

Communications: Communications within Thailand are by mail, telegraph, radio-telephone and teleprinter services. Internationally the means of communication are surface and air mail, radio-telegraph, and teleprinter. All of these services are inadequate. Only three zones of a proposed 5-zone microwave system for interregional communication have

been completed. There are 68 telephone exchanges in the country, 8 of which are in the Bangkok area. The capital city has only 1.7 telephones per 100 people, as compared with 7.3 for Manila and 90 for Washington. Telegraph service reaches only the principal provincial centers. There are 1,148 post offices of all classes in the country, of which only 215 were actually operated by the Post and Telegraph Department in 1963. There are still many communities which do not have postal service.

By contrast, Thailand is well served by radio stations. There are about a hundred broadcasting stations scattered over the country, of which 4 FM stations and over 30 AM installations serve the Metropolitan area of Bangkok. More than 1,750,000 radio receiving sets were in use in 1965. Five government-owned television stations, 2 in Bangkok and 3 in the provinces, with modern studio and technical facilities, broadcast more than 100 hours per week.

The most surprising medium of communication is found in motion pictures. The Thais are avid moviegoers. Some of the largest and most spectacular movie theatres of the world are to be found in Bangkok. In this city it is reported that 70 per cent of the people attend a show at least once a week. Even in the provinces 50 per cent of the population are said to go to a movie house once a week or oftener.

E. HEALTH CONDITIONS

The general health of the people of Thailand has improved markedly in recent years, due to improved control of malaria and other tropical diseases, to better sanitation and to more competent and more extensive medical care. The birth-rate per thousand increased from 27.5 to 34.8 over a recent 10-year period, while the death rate dropped from 9.1 to 7.9 per thousand over the

same period. The life expectancy has now been raised to a point barely above 40 years - a value shamefully low compared to the 69-72 year value now attained in some of the western countries.

Until 1963 malaria took the greatest toll of vitality and life in Thailand. Now first place as a killer has been taken by the diseases of infancy, followed closely by the enteric diseases of adults. In a recent six-year period there were reported 95,329 infant deaths and 80,061 child and adult fatalities from dysentery, enteritis and thyphoid. Since 1934 there have been three epidemics of cholera, each of 2 to 5 years' duration, with peaks of 5,000 to 6,000 cases and 3,000 to 4,000 deaths per year. Thes statistics are of particular significance because they relate to disease and death that are preventable. In both categories above, which represent both the first and second causes of death in this country, the suffering and destruction are due primarily to infection of water and food. The pathetic figures have a special meaning to the members of this mission, whose ultimate objective is to better the water supply and sanitary conditions of the country.

Statistics of the Royal Thai Department of Health indicate that 90% of the rural population is infected with water-borne intestinal parasites, and approximately 60% of the morbidity and 40% of the mortality of the country i attributable to the enteric diseases. These maladies reduce greatly the vigor, productivity and efficiency of the people.

F. WATER SUPPLY DEVELOPMENT

Historical: In Sukothai, the capital of Thailand (about 1300 A.D.) can be seen the ruins of a water system consisting of a dug well and a reservoir which were built during that era.

It is recorded that the first piped water supply in Thailand was constructed at Lopburi in the seventeenth century, although it served only the royal palace. Succeeding ones came slowly. The first public water system for Bangkok was established by royal proclamation in 1908. The first provincial water development was at Khorat in 1940. As late as 1956 there were only 22 waterworks in the kingdom. As of 1967 there are 130 public water supplies serving the municipalities of the country, in addition to those serving the Bangkok-Thonburi metropolitan area and a large number of villages and institutional supplies that will be discussed later.

Perhaps one of the greatest stimuli to the rapid developments of recent years has been the assistance of the U.S. Government, which from 1951 to the present time has supported many water supply projects and programs. Among them the following are noteworthy:

> From 1951-53 village sanitation and training programs costing $812,000 resulted in wells serving 50,000 people and the training of about 1900 sanitation workers.
>
> From 1956 to 1961 a local health development program carried out at Khorat, Bhuket and Cholburi at a cost of $3,028,000, which emphasized water supplies for villages, schools and health centers, is reported to have influenced similar programs in 40 or more villages in 15 provinces.
>
> From 1956 to 1962 a Bangkok city planning project was supported to the extent of $1,400,000, which had a primary objective a study of the improvement of the municipal water supply. As a supplement to this project, and as an emergency measure to curb a cholera outbreak, 20 additional wells were constructed in 1958-59 within the Bangkok-Thonburi area to augment the two water supplies.
>
> From 1955-62 an extensive ground water exploration project was prosecuted, at a cost of $2,902,000 to develop and publish basic geological data essential to the utilization of the ground water resources of Northeast Thailand.
>
> From 1960-66 a village health and sanitation program costing $1,849,000 was conducted on a national basis. As of September 1962 it was reported that 275 sanitarians and 86 observers had been trained, that sanita

tion programs were under way in 3,100 villages, that 2,380 old shallow wells had been made sanitary or new ones provided, and that 42,000 householders had installed sanitary privies. As of September, 1964, programs were reported to be in progress in all 71 provinces, involving the construction of 108,000 sanitary privies and 4,720 sanitary wells in more than 4,000 villages, and with training provided for 1729 health workers.

Beginning in 1966, a program, designed to run for 5 years, was institut for the provision of potable water to 600 villages in water-scarce, poverty-ridden and security-sensitive areas in the North and Northeast Regions. This project will ultimately affect 1.8 to 2.0 million persons. The USAID contribution to the program will amount to about $4,500,000.

→ Rural Projects

Sewerage: There is no community, town or city in Thailand, including the capital city of Bangkok, which has a public system of sanitary sewers, in the usual sense of that term.

G. WATER RIGHTS:

In Thailand there is an absence of statutory law relating to basic water rights. Such legal provisions as exist concerning water resources conservation, development and use derive either from common law or from special laws regulating or limiting water utilization. The ownership of all water resources, by generally accepted principles of law and by tradition, is vested in the Kingdom. The use of water for various purposes may be exercised freely and without particular formality by the individual users subject to the limitations of certain laws and regulations. No specific laws or regulations seem to exist with respect to the allocation of water for various uses, or for establishing an order of priorities among various uses. It is reasonable to suppose that these liberal, or indifferent, policies result from the abundance of water that is usually available in the vicinity of the nation's capital.

CHAPTER III

AGENCIES OF THE GOVERNMENT ACTIVE IN WATER SUPPLY

The number of RTG agencies actively involved in water supply is quite surprising. At this writing the list includes, but may not be limited to:

	Ministry
- Provincial Water Works Division (PWWD), Public and Municipal Works Department	Interior
- Bangkok Water Works (now Metropolitan Water Works Authority)	Interior
- Sanitary Engineering Division (SED), Department of Health	Public Health
- Ground Water Division, Department of Mineral Resources (MRD)	National Dev't.
- Royal Irrigation Department (RID)	National Dev't.
- Department of Local Administration	Interior
- Department of Community Development	Interior
- Border Police Patrol	Interior

Other governmental authorities such as the National Economic Development Board and the Office of Technical Planning are also concerned with water supply, but at the top levels of planning and coordination rather than in implementation.

A. PROVINCIAL WATER WORKS DIVISION (PWWD), PUBLIC AND MUNICIPAL WORKS DEPARTMENT

Scope of Responsibilities: The Provincial Water Works Division (PWWD) has responsibility for municipal water works system in cities over 10,000 population, excepting metropolitan Bangkok, as described in another section of this report. Actually, the 10,000 lower limit is not hard and fast; some of the important district cities have been inclu even though their populations have not yet reached 10,000.

Statistics on number of water systems are somewhat conflicting; however, from several sources, the following generalized tabulation tells much about the recent and rapid growth in organized municipal water service in Thailand.

Year	Number of Water Systems	Approximate Treatment Capacity
1956	22	
1962	Approx. 75	150,000 cmd
1967	Approx. 130	220,000 cmd

(Note: Metropolitan Bangkok not included).

No attempt will be made here to report population served by these water systems, because of circumstances best illustrated in Table 1. (page 26) / It is not unusual to find less than one quarter of the homes connected to the water utility, and it is unusual to find appreciably more than half connected. This is due partly to recent construction of some of these systems. The most important factor, however, is the ready availability of "free" water many months of the year from a shallow dug well in the backyard, a rain water cistern, or the neighborhood pond or canal. In fact, the situation is further complicated by the seasonal nature of the climate; many consumers vary their demand on the water utility with the availability of other

sources, even to the point of dropping off entirely during wet months.

A distinction needs to be made at this point between "provincial" water systems which have been built and are operated entirely by the government (actually government-owned); concession and "sanitary district" water systems operated under local municipal control; and "private" water utilities which are under true private ownership, with a degree of technical and management assistance from PWWD.

At the end of calendar 1967, there are 93 provincial water works under the direct management of PWWD serving in the range of 65,000 to 70,000 connections. The following discussion is concerned with the operation of the provincial systems only, except for brief sections specifically concerned with the 37 concession, sanitary district and private water systems.

Organization: PWWD has gone through several major transitions. Before 1956, it served in somewhat of a consulting engineering capacity to those municipalities constructing their own water systems. At that time, the law was changed with the result that the national government entered directly into the design and construction (by contract) of water systems, retaining full control of those built in this manner. As a concession, cities owning their water systems in 1956 were permitted to keep control of them if desired; hence the origin of the "concession" label still applied to locally owned water utilities.

The Division is currently organized into these sections:

- Planning and Design, or Technical
- Construction Supervision
- Administration and Clerical
- Provincial Water Works Management
- Concession Water Works Management

For provincial systems, PWWD performs the full spectrum of engineering services from preliminary survey and planning through preparation of detailed plans and specifications, contract letting and supervision of construction. After the plant is built, it is staffed by Division employees, of whom the key personnel have already received some training at a similar plant. Management of the system remains completely in the hands of PWWD; there is no local participation. The current year's program for this Division includes 11 new systems and 22 extensions to existing utilities.

Coordination is necessary with respect to source of supply. PWWD does not attempt to develop surface sources for large projects but instead works with the Royal Irrigation Department (RID) in its program of canals and reservoirs, participating in some instances through a transfer of funds to the RID budget.

Deep Well Division: For ground water development, PWWD can turn to the Deep Well Division of the Public and Municipal Works Department. This Division has 9 well rigs, drilled some 70 wells last year, and has an anticipated budget of 14 million ฿ year for its work over the next several years.

Administrative and Materials Control: Management of the provincial water works is highly centralized at the present time. Service supervisors from the Bangkok office, each responsible for 9 or 10 systems, routinely travel from Bangkok to their respective service areas to visit and assist the local managers. Other than this, the administrative channels extend from the local utility direct to the central office. Operating and financial information is accumulated there in great volume; revenue collected is deposited daily in a local

branch bank for credit to the national water works account. Although local contractors are normally the successful bidders on plant or distribution construction work, tenders are sent to Bangkok for evaluation and letting.

From the standpoint of physical property, essentially all new materials replacement units and spare parts are procured and warehoused in Bangkok. The exception will be an occasional stock of a few pipe lengths, a valve or two, or a few meters or meter parts for simple repairs. Generally, all meters as well as diesel engines, pumps, motors, valves, etc. are sent to a central repair shop in Bangkok.

The present PWWD warehouse and repair facility, located in the heart of downtown Bangkok, is pitifully inadequate to serve the needs of this Division. However, this has already been recognized by construction of a new service facility on a site within 2 miles of the airport. The move to the new site is not yet complete; in fact, both are currently in use; but this represents a giant step ahead in the potential for maintenance service to the local water utilities.

PWWD officials are also considering the establishment of perhaps 5 regional service centers for decentralization of all facets of their operation. Each regional center would have not only administrative and engineering offices, but a modest warehouse and repair capability, to provide maintenance or replacement service in a fraction of the time which appears to be consumed or lost in this process now.

Customer Service: The original distribution system, and main extensions thereafter, are constructed somewhat after the fashion of a "prudent venture". A member of the water works staff surveys the proposed street or area, talking to many of the residents who could be served

If enough of them (in his judgement) indicate willingness to connect, the project will be included in the next planning budget, and eventually built. No assessment or frontage charge is made to the abutting property then or later, nor is a tapping or connection fee made when a new customer connects to the distribution system.

House connections, on the other hand, are laid by the local water works service crew but the complete cost (average approximately 750 ฿) is charged to the customer. The service line thus built normally stops just inside the compound. If the customer wishes additional plumbing or extensions within the compound, this too can be done by the water works crew and charged to him, or can be done for him by a private plumber.

Nominally, water service is only by house connections. In the early years of PWWD management, public taps were also provided for the poor people, but in the words of one official "soon all the people became poor people!" Service connections were discontinued, revenue fell, and the long lines at the public taps in dry seasons actually created a problem for the local police in some instances. As a result, public taps are no longer provided, officially speaking, although a few still may be seen. An eminently practical compromise was noted in Chiang Mai, where a limited number of public taps remain. Water from them is free for the taking, but is metered, and the bill paid by the municipality to the water works.

In certain cities there are licensed water vendors, permitted to buy water from the utility at a reduced rate and sell it to their customers at a specified mark-up over cost.

Metering: It is the policy of PWWD that all service connections be metered, and apparently this policy is followed. The water

utility provides the meter, and its cost (220 to 250 ₿) is included for installation of the service line. The meter is usually placed just inside the compound, or mounted on the building wall, and vandalism is thus an additional problem in keeping the meter operating properly.

Except for the most minor adjustments, all meter maintenance is now done in one small repair shop in Bangkok. A profusion of meters is in use; German, Japanese, French, Belgian, British; turbine type and oscillating piston type; some of recent manufacture, some very old and probably obsolet Output of the repair shop is quite limited because of lack of spare parts and lack of adequate space and facilities; only two single-bay test benches are available. The planned move to the new warehouse and repair facility near the airport should prove a major blessing to the meter maintenance section.

Water Use: Current data on water use in Thailand are necessarily base on incomplete information and judgement estimates. It is indicated that unaccounted-for water runs from 12 to 20% in some of the better systems, to as much as one-third and perhaps far more in some of the less well managed.

From the production standpoint, master metering is the exception rather than the rule. More often production will simply be calculated from plant design rate or nominal nameplate pumping capacity times hours of operation, with or without adjustment for actual rates or conditions.

Distribution or actual water use is even more difficult to assess. Although all services are metered, many meters are inoperative and their use must be estimated for billing purposes. Added to this are the usual problems of leaks, free service, unauthorized connections, meters which

run slow or only spasmodically, and similar problems.

For design purposes, PWWD uses a range of from 100 lpcd in the south (heaviest rainfall) to 200 lpcd in the Northeast where the dry season dominates design. Apparently water use habits are changing toward greater dependence on piped water and less on the rain-barrel and the canal. The interesting comment was made that, while a new 40 cm/hr plant would once serve a city of 10,000 for the next 10 years, now it is likely to need help (usually in the form of a matching 40 cm/hr installation) within 2 or 3 years!

Finance: In general terms, any capital construction from a major work to a main extension is a direct grant from RTG budget funds, which is not expected to be repaid. Thus, none of the provincial water utilities are concerned with debt service, either in actual or accounting terms.

Revenue from all the provincial water works is pooled, and from this fund the current expenses for all of them are paid. Approximately three-fourths of the systems (including most of the larger ones) more than meet their own operating expenses, which allows a margin for carrying those which do not, and for system growth. Additional details are included in Chapter IX on financial management.

Concession and Sanitary District Water Works: In essence, most of the 22 water works built before 1956 and thus owned by the local municipalities, remained under local control following the entry of PWWD into the construction and operation field. Since then, one or two more systems a year have been added to this category, while several have been turned over to PWWD by

the cities. The result is a present total of 17 "concession" water works serving approximately 6,000 connections, fully under local control. This category also included Thonburi until its recent absorption into the Metropolitan Authority.

Municipalities without a water system are free to construct their own, and a few do so if the waiting line for a government grant appears too long. In that case, a fair amount of local capital is necessary, but the cities may also borrow from the RTG Savings Bank at regular commercial loan terms (8% interest, 15-year repayment) to help finance construction.

It is also possible for a city to work out an agreement to purchase its water system from the government.

In any case, the concession and sanitary district water utilities must stand on their own feet financially. No capital grants or operating subsidies are available to them from PWWD. Their water rates vary, but must be approved by the Ministry. In general terms, some are thought to be essentially self-supporting, while others receive a subsidy from other local municipal revenue sources.

In all but financial control, the relationship of PWWD to these water works is much the same as for the provincial systems. The same engineering and technical help is available to them, they submit the same sort of operating and financial information to PWWD's administrative section, and receive generally similar management and logistical support.

Private Water Works: There are also 9 "private" water works systems in Thailand, but not in the usual private enterprise utility sense. Rather, these are mostly very small systems, some merely well supplies, which typically were developed to serve a private industry and then

expanded to provide water for an adjacent housing area or village. Several of these have been offered to the government as a gift, but have not been accepted thus far because of their limitations. The total number of connections served is only about 1,200.

Evaluation: It is important to stress here that the following comments are based on a very brief and perhaps almost superficial contact with personnel and operations of the Provincial Water Works Division. However, two general impressions stand out very sharply.

First, the organizational structure and concept of operation of this Division appear eminently sound. There are leadership and spirit in the upper echelon; machinery apparently exists for field supervision, reporting of results, centralized supply and maintenance, etc. The technical staff is growing coincident with its increasing responsibilities, and the government has shown its confidence in the provincial water works program by providing a very substantial increase in capital funds for construction in the current economic development plan.

However, the second impression must be that the actual functioning of many phases of this program is desperately weak. Particularly with respect to maintenance, the Division lacks "the tools to do the job". Further, there is gross evidence that the job is not being done even within the capability of the tools and hands available. At one plant, filter backwashing was physically impossible because of sheared valve stems on the backwash valves. Pump repair and replacement are in such a state of neglect that the breakdown of just one more pump at several of the plants visited would bring a sudden end to water distribution.

The organization is there; at this writing, the execution is not.

TABLE 1

REPRESENTATIVE PROVINCIAL WATER WORKS IN THAILAND

POPULATION AND SERVICE CONNECTIONS

City	Census Population (Presumably 1965	No. of Houses Census)	No. of Water Connections (1965 Operating	Treatment Plant Capacity, cmd. Data)
Khan Kaen	24,945	4,404	2,047	4,200
Udorn Thani	41,129	7,227	2,597	3,200
Chiang Mai	77,858	10,958	2,077	2,400
Ubon Rajathani	31,189	4,761	1,690	2,400
Nong Khai	26,271	3,911	1,068	1,600
Roi-et	12,864	2,239	725	800
Krabi	3,548	585	202	400
Nara-Thi-Wat	20,338	3,513	251	1,200
Ram Phoon	11,085	2,032	415	800
Pathum Thani	4,174	741	186	800

B. BANGKOK WATER WORKS

Organization: Until recently, the Bangkok water works was a relatively independent entity, operating as an agency of the Ministry of Interior. In late summer 1967, the "Metropolitan Water Works Authority" was constituted to include not only the sister cities of Bangkok and Thonburi, but also two other suburban cities which are contiguous. At one time Thonburi was served primarily from the Bangkok system by trunk mains across the river. These mains are still in existence but little or no water moves through them because of rising demand and decreasing pressures on the Bangkok side.

Characteristics of the other three systems, in capsule form, are as follows:

- Thonburi: approximately 75,000 connections, served by a recently built 80,000 cmd Degremont treatment plant, supplemented by roughly 30,000 cmd from 25 deep wells; formerly a "concession" water works.
- Nontaburi, to the northwest: approximately 2,000 connections, served by deep wells; formerly a "provincial" water works.
- Samutprakarn, to the southeast: approximately 2,000 connections, served by deep wells; formerly a "concession" water works.

Previous organization of the Bangkok water system has been along the lines of conventional water utility practice, with administrative and technical major divisions, divided into engineering, production and

distribution branches, and further subdivided as might be expected. No information is yet available on the new organization structure, except that the Authority will have full Division status within the Public and Municipal Works Department of the Ministry of Interior.

The remainder of this section will be concerned only with the Bangkok water utility.

Source of Water: Bangkok draws primarily on a canal and reservoir complex which all depends basically on the Chao Phraya river as the original source. From a point approximately 30 km north of Bangkok, the raw water is channeled, then pumped to a group of treatment plants in the Samsen district in the northern part of the city. A branch from the pumping station also crosses the river to serve the Thonburi treatment plant. Because of chronic shortages, the surface supply has long been supplemented by deep wells throughout the city, pumping directly into the distribution system. In 1958 and 1959, a "crash" program of well drilling to meet crisis conditions and to help stem a cholera epidemic was said to have increased the available supply by one-third. At present 86 wells contribute some 150,000 cmd to the supply in Bangkok.

Treatment: In 1912, a treatment plant of 27,000 cmd capacity was built. This plant continues in service today, supplemented by eight 40,000-cmd "plants" added at various intervals before 1960, and 160,000 cmd Degremont turn-key project completed in 1962. The total present treatment capacity is thus just over 500,000 cmd, based on a nominal filtration rate design basis of 2 gpm/sq ft. Local engineers are well aware of the increased treatment capacity which

might be gained from higher filtration rates and are interested in studies in this direction.

The present treatment plants provide conventional alum coagulation settling and rapid sand filtration, followed by chlorination. Turbidit of the raw water source is generally in the range of 50 to 100 units, although it does flash up to 150 or higher during flood periods. This is actually a rather modest variation, dampened materially by the system of storage reservoirs which provide some holding time for the raw river water. Plant capacity is affected by these variations however, dropping off as much as 10% under monsoon conditions but also rising to as much as 10% above rated capacity when raw water turbidity is in the range of 10-20 units during the late fall dry season.

Distribution: This is one of the most difficult and troubled aspects of the Bangkok water utility. With a steadily accelerating pace of growth of the metropolitan area, the distribution system has radiated outward rapidly with insufficient strengthening by trunk feeder mains. The result has been lower pressures almost everywhere, giving rise to the iniquitous practice of installing private booster pumps and storage tanks on the premises of the larger homes and commercial buildings in order to assure a water supply.

With the very high water table in Bangkok, construction conditions are quite difficult. Coupled with indifferent inspection, this has resulted in a distribution system generally conceded to be plagued with severe leakage problems, even at present low pressures. It is not possible at present to do more than speculate on water lost by main leakage.

The distribution system consists primarily of cast iron pipe, except for increasing use of asbestos cement pipe for the smaller (4" - 10") sizes. House services are generally of galvanized iron pipe, even though it is recognized that these have a rather short service life. Plastic pipe is being considered for service lines, but has not been used to date. Except for a few small extensions, all distribution work is done by private contractors. The house connection is paid for by the customer, but then becomes the property of the water works. Distribution service crews are over-burdened with repair work on mains and service lines, with inadequate staff and tools to keep pace with the growth of the utility.

Although a high percentage of the population depends on service lines into the building or compound, there are 170 public taps strategically located in various parts of Bangkok to serve those who would otherwise have no access to potable water.

Metering: It is the policy of the Bangkok water works that all service connections be metered, and this policy is followed, but the results are far less than might be hoped. It is the obligation of each new customer to purchase a meter for his own service which he fulfills by acquiring the cheapest model currently on the market. Once installed, the meter becomes the property of the water works, to maintain, repair and replace when necessary. A meter service charge of 1 ฿ per month is collected along with the water bill.

A great variety of meters are in service; both turbine and displacement types from Germany, Britain, Japan, US, France, Belgium, Italy, Taiwan and possibly other countries. Because of lack of either

adequate meter maintenance facilities or personnel, it is estimated by those close to the situation that probably two-thirds of the 140,000 meters in the Bangkok system are not working.

As a point of beginning, the utility recently adopted a standard, limiting future meter installations to the oscillating piston type, produced by one of 3 manufacturers: Kent (British), Aster, or CDC (both French). The reasons given for abandoning the turbine meter are very interesting. First, the accuracy is poor at very low flows, which are too often the case at very low pressures. More important, however, is the fact that the oscillating piston type of meter will not pass more than a trickle of water if it becomes clogged or stuck for any reason. Thus, the customer is sure to call for service and the utility at least has the opportunity to restore the meter to operating condition or replace it, thus maintaining not only service but the billing for water service as well. The turbine meter, on the other hand, will pass water about equally freely whether the vane is rotating or not; consequently, service continues, often while the customer is paying only a minimum bill or nothing at all for the water.

Operating Results: A detailed and well-illustrated annual report is published in the Thai language, giving operating and financial results for the water works. Representative data are summarized in Table 2 (page 34). Another useful source of information is a report prepared by Henry Graeser of Dallas, Texas, following an AID-sponsored study of the Bangkok Water Works in the spring of 1961.

For reasons already described, it is not possible to determine

meaningful statistics on per capita water use, percent of water unaccounted-for, and similar criteria.

Financial Position: The Bangkok Water Works has been operating as a separate financial entity, but only by virtue of massive subsidies from the national budget. Far from being self-supporting, total water utility revenue is only half enough to meet current operating costs. This stems partly from a rate structure less than one-fourth of what provincial water works customers throughout Thailand are paying, and partly from gross under-billing of customers with faulty or dead meters. Further information on rates and finances is presented in Chapter IX.

Planning for the Future: Negotiations are currently well advanced for selection of a consulting engineering firm to provide a broad program of technical and management assistance to the Metropolitan Water Works Authority. The general scope of services to be provided includes:

- long-range master plan
- management reorganization
- plant improvements
- distribution system strengthening
- evaluation of other specific needs and assistance in meeting them

In the meantime, the utility is by no means standing still. For example, 20 additional deep wells are scheduled for the current year. Also, an additional pumping station is under construction which will raise the delivery capacity of the raw water canal and pumping system to 1,000,000 cmd by April 1968.

Evaluation: As for so many metropolitan utilities, Bangkok is in the position of having to "run very hard simply to

stand still" in terms of keeping pace with demand. This utility simply does not now have the physical, professional or financial resources to keep pace, even though there is spirit and leadership in the upper echelon. The rate structure must surely be one of the most unrealistic in the world, and the meter maintenance backlog is astronomical.

Yet, there is keen awareness on the part of both the present water utility management and the national government that the situation is critical and that substantial improvements must be made. There is a willingness to secure consulting assistance of the highest calibre, and presumably to make best possible use of it. Thus, it is hardly fair at this time to make any judgment other than to observe that the utility is in need of much help, but is currently taking the first giant steps toward improvement.

TABLE 2

BANGKOK WATER WORKS

REPRESENTATIVE OPERATING DATA

Fiscal Year	Population of Service Area millions	No. Service connections, thousands	Water Produced Wells	Plants	Total
			million c.m./year		
1917 (2460)		1.2			
1926		5.7			
1937	.53	10.0			
1946	.57	20.0			
1957 (2500)	1.20	67			
1958	1.28	75			
1959	1.37	85			
1960	1.42	92	25.5	62	88
1961	1.49	98	30.2	46	76
1962	1.55	105	N.A.	71	
1963	1.63	113	N.A.	88	
1964	1.67	120	52.2	141-1/2	194
1965	1.87	129	9.5	175-1/2	185
1966	1.93	135	33.9	177	211
1966-67 (2510)			57.3		

Notes

The population figure is for the city of Bangkok. A varying proportion of the population depends in varying degree on other water sources as well.

"Water Produced" is total delivered to the distribution system from treatment plants (metered) and deep wells (largely estimated). New treatment plant put in service in 1964.

C. SANITARY ENGINEERING DIVISION (SED) DEPARTMENT OF HEALTH

Background: As early as 1952, the Department of Health became active in a well-drilling program to supplement the water supplies of rural villages. This program progressed and expanded to the point where the Department of Mineral Resources assumed all responsibility for rural well-drilling in 1963, and retains it to date.

In 1960, a strong village health program was initiated with US assistance, centering on privy construction, water supply (shallow wells and hand pumps) and basic rural sanitation. Through this program, thousands of sanitarians have been trained and over 7,000 shallow wells and 140,000 privies have been built.

Along with this achievement, the shallow well program produced some disappointments. One was that great numbers of those supposedly "served" were not using the wells during seasons when a nearby pond, canal or a backyard dug well had plenty of water at shorter carrying distance; or were not using the well water at all because of taste, iron or simply a preference for another traditional family source. Breakdown of the hand pumps too often rendered the wells useless. In the words of one local observer of long experience, "the maintenance of hand pumps has so far proved to be an insurmountable problem".

With this sobering experience, the emphasis has shifted to piped potable water systems, including distribution of good water at least to convenient public taps in the village, and beyond this to individual service connections inside the compound for those consumers who can afford it.

Scope of Responsibility: At present, SED has full responsibility for potable water supply systems in rural communities; this requires further definition. When the supply is from a deep well, MRD does the drilling and development. If the supply is from any surface source, SED brings the supply to a treatment plant, provides both ground and elevated storage reservoir, the necessary pumping installation and a distribution system to the extent the project permits or the people can afford.

The definition of "rural" normally includes established communities varying in population from 500 to 10,000, although the lines are not rigidly drawn. The Department of Public and Municipal Works while nominally concerned only with cities larger than 10,000, does build water systems for some important district towns which have not yet reached this population level. Villages under 500 population receive some assistance from local health and community development agencies, but this is limited to simple sources and seasonal storage of water supply, and does not include any sort of treatment or distribution.

The enormity of the task ahead is almost impossible to grasp. There are some 45,000 villages in Thailand in the category above 500 population, thousands of which have 2,000 or more inhabitants. To meet this need, a national potable water supply effort is currently underway, although operating under two "name-plates" with respect to rural communities.

Accelerated Rural Development (ARD) Program: This program is not an entity with its own staff and budget, but rather a broad, coordinated effort

at overall village and rural community development in the security-sensitive provinces of Northeast Thailand. The ARD Committee is established at the highest level, in the Prime Minister's office, to pull together and direct efforts of office and field staffs in agriculture, irrigation, roads, schools and all aspects of health and sanitation including water supply.

The water supply sector of the ARD program is identified separately because it is being financed approximately 50% by USAID, and the administrative requirements are thus somewhat different. An engineering firm (TAMS) was contracted by USAID in mid-1966 to assist SED in carrying forward a project intended to provide potable water systems to 600 Northeast communities. The population to be served was estimated in the order of 2 million, at an anticipated total cost of approximately $10 million. Construction of these systems began in late 1966. This project is being administered by SED, under priority guidelines of the central ARD Committee.

National Rural Community Water Project: Building upon the previous experience of SED in potable water supply systems, the RTG also formally launched the National Rural Community Water Project in 1966 to carry on a comparable program in all other regions of Thailand. This project is planned to serve some 300 communities over the 6-year period 1966-72 at an anticipated total cost of approximately $30 million. Present financing for this project is coming entirely from RTG budget funds, spread among the four Departments of Health, (SED), Mineral Resource Local Administration, and Public and Municipal Works. It is planned

that this will be only the first phase of a continuing program, with the long-term goal of providing potable water to all rural communities.

It is important to point out that, from the standpoint of the SED role in rural water supply, these two projects (ARD and National) are separate only for certain administrative purposes. Otherwise, the two programs can be considered one in concept, basic objectives, planning, design, and construction. The same professional and supporting staffs work on both, or are exchanged freely between the two to gain broader experience. This of course has merit, particularly in the event of consolidation of the two programs at some future date. It is hoped that the design, construction and administrative experience gained from the present intensive ARD water supply program can be put to good use in the continuing long-term National project.

Procedures: For both of the programs, the procedure is essentially the same, as described in a recent paper by Mr. Somnuek Unakul and Mr. William A. McQuary, as follows:

> "The selection of participating communities is made in the following manner. Project proposals are submitted by the various Provincial Governors' Offices to the ARD Committee of the Prime Minister's Office, for communities that have indicated a need for water and a willingness to contribute funds or assistance-in-kind toward the project. The ARD Committee's approval of each project is based on population, per capita costs, accessibility by road, economic and industrial potential, political and sociological patterns, and other factors effecting these communities. The final selection of the community is made by the Sanitary Engineering Division of the Department of Health. The criteria of selecting villages by the SED is based on the principle of "self help." A village committee is appointed with authority to negotiate with officials to construct a water system. Upon receiving notice of approval of a community, an engineering team is sent to conduct feasibility surveys and collect pertinent engineering data. The engineers estimate the

extent of the assistance which is needed and make their recommendations to the Health Department. A priority list is set up by the Department according to the degree of necessity from a health standpoint and the extent of the villagers' contribution and participation in the proposed plan. A contract is signed in which the villagers agree to operate and maintain the system under the technical supervision of health department engineers. However, it remains under the administrative direction of the provincial governor who may subsidize the project as needed. It is necessary to train at least one villager in operation and maintenance of the system. All plant operators are paid a moderate salary. Rate structures are developed in order for the system to be self supporting not only for operation and maintenance but for future expansion as well."

For each community the major source of capital funds is an outright grant from the project, for which no repayment is expected. Most villages participate to the extent of their capability in both labor and cash, with a contribution of 300,000 ฿ ($15,000) having been made in one case. Responsibility for operating costs rests entirely on the local village.

Results to Date: SED had developed a modest capability in water supply planning and design even before the present large programs. The first complete water system, including rapid sand filtration, was built for a village near Korat in 1961. Since then, more than a dozen water systems of various kinds have been designed and built by SED, prior to the inception of the new programs in 1966.

Under the TAMS-ARD project, 18 new systems were completed or nearly so by the end of calendar 1966, and 31 more are expected to be completed by the end of 1967. Planning and design are already well along for letting of contracts for roughly 50 more systems in early 1968. Under the National Rural Community Water Project, an

additional 13 systems are currently under construction in other parts of the country, with a greater number planned for 1968 under this program also. Average size of all systems constructed thus far has been in the range of 2,000 to 3,000 population, with the largest project designed to serve 7,000 people. In several instances, one water system is so located and designed as to serve two or even more close-lying communities from a single source.

Evaluation: The SED water supply staff, except for a few experienced "veterans", is composed of recent graduates with very limited experience but a proven willingness to work hard and to learn. This group is clearly past its most difficult year or two, and is settling down to a production pace which apparently will be supported by increasing RTG budget funding.

SED has demonstrated its ability to plan, design and construct. The most important question now is whether it can also manage and motivate local manpower and resources consistently and successfully to operate and maintain these water systems. Thailand has an opportunity to avoid the tragedy of rural water supply programs in virtually every other country: a construction effort which has left behind it primarily a trail of crippled or totally defunct facilities -- simply for lack of maintenance.

D. DEPARTMENT OF MINERAL RESOURCES (MRD)

Background: As early as 1952, a cooperative ground water development program was begun in the Northeast by the Department of Health, assisted by USAID (then ECA). The original equipment consisted of jeep-mounted augurs limited to a drilling depth of 80 to 100 feet. In 1955, the Royal Irrigation and Mineral Resources Departments were also brought into the program, and better progress was made with deep well drilling rigs. From 1958 to 1963 a private contractor (DMJM of California) was brought in to further accelerate the program. The joint efforts of DMJM and MRD resulted in the drilling of just over 400 holes, of which approximately two-thirds were finished as producing water wells. Since 1963 MRD has had full responsibility for ground water development in the Northeast It also carries on a limited program of exploration and well development in other parts of Thailand.

Present Capability: The Department now has 10 deep well drilling rigs operating in the Northeast which produced 250 holes last year, 4 rigs in the rest of the country which drilled a total of 94 holes, and has just received delivery of 2 new rigs bringing the total to 16 units. The goal has been set at 25 hol per drilling rig per year.

Up to the present, approximately 2,000 water wells have resulte from this program, not all usable or in use, as will be discussed below. Average depth several years ago was 240 feet, but is now less than that because many of the wells in the Northeast are being developed to depths of only 150 to 200 feet. Diameter of most of the

producing wells is 6" or 8". The practice has been to use slotted pipe rather than well screens, which has been successful in good sandstone formations but less than successful in certain others.

Procedures: After the site is selected, a hole is put down and a water sample taken for analysis. If the water is potable, a hand pump is installed and the project is considered completed, at least for the time being.

If the villagers proceed to erect a simple elevated storage facility, MRD will then return and replace the hand pump with a deep-well turbine pump and diesel engine. This equipment is provided by MRD, and the villagers are expected to provide fuel and lubricants for engine operation at their own expense. The department is currently buying 250 to 300 hand pumps per year; last year it purchased 60 diesel engine and turbine pump sets and intends to purchase 80 this year.

Although MRD has thus far built neither elevated storage towers nor any distribution systems, it has recently begun to design and build small aeration-filtration iron removal units in some villages where iron problems have been so severe that little use was being made of the well water.

The Department of Mineral Resources is funded entirely from RTG budget appropriations, and collects no revenue from any of the consumers of the water it produces.

Problems: The geology and underground formations of the Northeast region have not been excessively kind to a ground water effort. In some areas, there is no ground water, or it

does not last through the dry season. Often the quantity is small; 70% of the wells drilled in the Northeast yield less than 30 gallons per minute. Underlying a broad central area of this region is a rock salt formation which contributes chloride concentrations which are sometimes beyond normal tolerance limits. Added to this are other localized problems of high iron content (5 to 10 ppm), low ph (5.0 to 5.5) and poor taste characteristics.

In certain formations, sand pumping is a serious and continuing problem, but one which normally could be solved by the use of proper well screens and gravel-pack construction, a technique in which MRD has already demonstrated its competence. Some of the holes drilled have required re-development before turbine pumps could be installed.

Perhaps the most serious problem from the standpoint of effecti use of these wells has been the breakdown of pumping equipment. Other than the most minor adjustments, the villagers look to MRD for maintenance. A recent survey indicated that over half of the hand pumps in one province were not in condition to be used. Similarly, maintenance of turbine pumps falls entirely on MRD. The department has only one mobile repair crew, and it was immobilized for some tim recently due to lack of funds for repair of its heavy duty truck. There are 4 hand-pump repair teams, but each is expected to cover an average of some 4 provinces.

As a result of the various natural and maintenance problems described, in the judgment of officials close to the situation not over 1,000 of the wells are actually in service, serving a total of perhaps one million people at this time.

Evaluation: Clearly, the Department of Mineral Resources has the technical know-how, the physical capability and the budget support to carry on a strong and growing ground water development program. Its emphasis has shifted from the more general survey and exploratory outlook, to one of commitment to the overall water supply effort and better coordination with the Accelerated Rural Development (ARD) program in the Northeast.

Just as clearly, it is not equipped, staffed or organized to carry on the maintenance and repair obligation which has devolved upon it in recent years. It is only natural that an organization of this type is not particularly keyed to maintenance of hand pumps and diesel engines; yet, if that burden is not carried and carried efficiently by some agency, an increasing percentage of what MRD could accomplish will be wasted and lost to a rural region which is critically in need of better water supply.

E. ROYAL IRRIGATION DEPARTMENT (RID)

With its more than 40 years of experience, its approximately 80,000 employees, including a strong professional corps, and its very large budget, the Royal Irrigation Department must be recognized as the key factor in water resources development and use in Thailand

As would be expected, the Department's primary emphasis is directed toward irrigation to support and increase the nation's agriculture. It is also deeply involved in hydro-power production and flood control. By circumstance more than by design, the Royal Irrigation Department is also a factor in potable water supply, through withdrawal for water supply from its canals and reservoirs. Metropolitan Bangkok, for example, draws a substantial portion of its raw water supply from an irrigation reservoir and canal complex. Certain other cities are similarly served, and the Department of Public and Municipal Works at times participates in RID projects which will provide some potable water supply, through a transfer of part of its funds to the irrigation budget.

Within the last decade, RID has been engaged in a program of construction of "tanks", or earth-dam reservoirs across natural stream-flow channels. This program has been concentrated almost entirely in the Northeast, where not only does the topography lend itself to such construction, but the need is greatest because of the shortage of other water sources during the long dry season. The embankments of these dams range from 5 meters to 10 or 15 meters in height, and the reservoirs are said to range from 40 to 4,000 acres in size, impounding from several hundred thousand to many millions

cubic meters each.

The original purposes of these "tanks" were flood control and irrigation, although water supply has become a consideration as well. In fact, about 30 of the roughly 200 tanks now in existence are used for domestic water supply only (animals as well as people), and some of the others serve all the purposes mentioned, and fish propagation as well!

A supplementary program, also in the Northeast region, is the construction of excavated "ponds" of only several acres size and 3 to 5 meters depth. These are not in stream channels, but rather depend on catchment of surface runoff from a small collection area. When completed, they are fenced for protection. By means of percolation through sand to an outlet pipe, the ponds provide a relativel clean domestic water supply at a concrete dipping well outside the fence. Only about 10 of these have been completed thus far, but it is anticipated that this effort will continue. Thus far, RID has not become in any way involved in water treatment or distribution, nor does it intend to.

F. DEPARTMENT OF LOCAL ADMINISTRATION

This department works with provincial and local administrative agencies in providing many services for villages which may range from a few hundred population to towns of five to seven thousand or even larger. Among these services are roads, bridges, small dams and/or canals to assist in extending irrigation benefits, and, quite recently, water supply. During the 1967 fiscal year, this

department distributed its first annual appropriation of 20 million ฿ specifically for water supply assistance. Because of the critical nature of that region, approximately two-thirds of this sum was expended in the Northeast.

Before distributing any funds, a rapid survey was made by means of a questionnaire to the villages to determine the relative urgency of their water supply needs and the most practical measures for meeting them. The responses were directed through local administration channels up to the provincial level, from which point priority lists were forwarded to the Department of Local Administration in Bangkok. The following table indicates the extent of the requests received for the first year of this program and the extent to which the requests could be met:

Type of Facility	Requested	Financed
Dug well and hand pump	4,291	1,946
Excavated storage pond	1,611	410
Concrete reservoir	656	128
Galvanized iron "biscuit" tank	11,662	3,992

For the dug well and hand pump, 2,000 ฿ are given; for the excavated pond, 4,000 ฿ is the amount of the grant. The pond is the alternative selected where there is no shallow water or where it is of such poor quality or taste that few will use the water. For a concrete reservoir of 150 cubic meters capacity, 60,000 ฿ are given. Where the 400 gallon "biscuit" tanks are considered to be most practical for potable water storage, an appropriate number of tanks are financed at a cost of approximately 1,200 ฿ each.

In each case, the money is simply disbursed to the provincial or local agency responsible; the rest is up to the agency and the village, which must then come forth with the additional money needed and often local labor and/or material contributions to see the project to completion. Construction is by contract or local labor; the Department of Local Administration is not involved in either the construction of these water supply facilities, nor their maintenance after completion. It functions simply as a selection and disbursing agency in this regard.

The emphasis here is more on quantity than on quality, but it must be kept in mind that the Department of Local Administration is concerned primarily with stepping in quickly where the need is most urgent, and providing funds for at least short-term or temporary relief in the form of water storage against the vicissitudes of the dry season.

G. DEPARTMENT OF COMMUNITY DEVELOPMENT

This department carries on a broad program at the local village level of training local leaders and organizing self-help efforts toward improved community living standards. There is a strong emphasis on health, with improved water supply being one of the activities. Shallow dug wells and small ponds have been the usual extent of the water supply facilities provided, through a combination of government assistance and self-help. Some of the larger ponds and small dams are intended to provide water supply through the dry season for animals as well as domestic use.

The emphasis has been more on quantity than quality, since many of these are hardship cases where any supply is an improvement over former conditions. This program has been most active in villages ranging in population from several hundred to two or three thousand, and averaging approximately 1,000 population. It has been concentrated in the Northeast, with some activity also in the southern border provinces and a lesser amount in other regions of the country.

H. BORDER POLICE PATROL

This agency digs and jets shallow wells for small villages (under 500 population) of the Northeast and for the hill tribes of the North. The emphasis is on quantity rather than quality, again because of the urgent need for improvement over present hardship conditions.

CHAPTER IV

PROGRAM PLANNING AND BUDGETING

A. THE PLANNING PROCESS

Planning is a semi-science in which technical specialists and economists are wont to sit down together and think deeply about their country's capabilities, needs and goals. The statistics of natural resources, manpower, manufacturing capability, money and similar factors are skillfully interwoven with other data on production targets, exports, imports, taxes, revenues, social values; the private and public sectors are examined in detail; the country's foreign exchange position receives due weight; the result hopefully is a well-balanced plan under which the nation can not only live within its means, but also can spread those means most equitably among its people and steadily improve their standard of living. The results of competent planning (and good execution) are those favorable GNP and balance of payments figures and the social and politica stability so prized by bankers and planners alike.

B. NATIONAL ECONOMIC DEVELOPMENT BOARD

In Thailand, the central planning agency is the National Economic Development Board (NEDB), which managed the very successful First Plan (1961-66) and mapped out the current Second Plan (1966-1971). The full 32-member Board does not meet often; instead, the real work is done by a 13-man Executive Board which meets weekly. All projects proposed for development fund support are first reviewed by the Executive Board; those which survive have a good chance of approval by the full NEDB, and inclusion in the national plan.

C. EXECUTIVE COMMITTEE FOR NATIONAL RURAL COMMUNITY WATER PROJECT

For the very important purpose of coordinating the national potable water supply effort, assigning priorities and minimizing duplication, the following 11-member committee was formed in 1966:

- Director General, Department of Local Administration
- Representative of Royal Irrigation Department
- Representative of Community Development Department
- Chief, Sanitary Engineering Division (SED), Dept. of Health
- Director General, Department of Mineral Resources
- Chief, Provincial Water Works Division (PWWD), Dept. of Public and Municipal Works
- Chief, Local Administration Division, Dept. of Local Administrat.
- Chief, Ground Water Division, Dept. of Mineral Resources (MRD)
- Representative of the Budget Bureau
- Representative of National Economic Development Board (NEDB)
- Permanent Under-Secretary, Ministry of Interior; who acts as Chairman of the Executive Committee.

The full committee above meets irregularly, but its work is carried on through monthly meetings of the first seven members listed, constituted as a "Research Subcommittee". The chief of the Local Administration Division, Department of Local Administration, serves as Secretary of both the subcommittee and full committee.

D. PLANNING FOR WATER SUPPLY

Capital expenditures for water supply (and sewerage) fall almost entirely in the category of public sector development expenditures, because their construction by local agencies from local revenues or any other type of self-financing is negligible -- almost certainly less than 1% of the total amount.

Therefore, proposals or requests for new water systems or appreciable enlargement of existing facilities must make their way up through the amphur (district) level to the changwat (province) capital. After screening and priority assignment in the office of

the provincial governor, project data and cost estimates are prepared within the Ministries for submission to the NEDB and review as previously outlined. Those approved are incorporated in the national plan, and have a fairly strong assurance of implementation in their turn, as funds become available.

The place of water in the Second Plan is detailed in a later section. However, it is worth mentioning here that the proposed distribution of RTG's own budget funds for water supply is fairly evenly divided among the three major categories of village water supplies, provincial water works, and metropolitan Bangkok. More specifically, program goals for the 1966-1971 period were to:

a) bring potable water to 30,000 more villages;

b) construct 225 more provincial water works, providing a total capacity of 260,000 cmd; (and duplicate this effort during the 1971-76 period); and

c) increase treatment capacity by 200,000 cmd for metropolitan Bangkok as well as strengthen the distribution system and reduce water losses.

A related goal was to proceed in an orderly manner with the sewerage - drainage - flood protection project already initiated with local funds and proceeding under the direction of Camp, Dresser and McKee, Consulting Engineers. It is hoped that international lending support can be secured for the very substantial construction costs of this project.

E. THE BUDGET PROCESS

The fiscal year commences on October 1 and closes September 30. Government agencies normally begin budget preparation in January. By law, all economic development expenditures must be cleared first by the NEDB before they may be included in a departmental budget. Early in April the proposed budget (having already received a preliminary review by the Bureau of the Budget) is submitted to the Cabinet. The result is a semi-final document which establishes budget ceilings for each department. Within these ceilings, each department then proceeds to work out detailed spending plans for approved programs and projects.

In June, the detailed budgets are reviewed finally by the Bureau of the Budget, balanced against expected revenues, and then drafted in the form of an Annual Appropriation Bill. Following Cabinet approval and hearings in the National Assembly, the budget is approved and formally enacted in September as the Annual Appropriation Act.

During the fiscal year, the Bureau of the Budget maintains watch and control over expenditures by means of standard pre - and post-auditing and reporting procedures. If the total budget allotment is not spent, the remainder reverts to the Treasury, with the exception that a 3-month carry-over period is allowed for disbursement of funds committed before the fiscal year-end deadline.

CHAPTER V

CAPITAL FINANCING CAPABILITY

A. PROPOSED CAPITAL SPENDING

On October 1, 1966, Thailand embarked on its second 5-year plan for the economic and social development of the country. From the plan, it is possible to obtain a general over-view of the role which water supply is intended to have in future development.

In general terms, the national government budget is divided into these two major categories:

-- Non-development expenditures, such as defense, debt service, government salaries, and maintenance of existing programs;

-- approximately 17,000 million ฿ per year

-- Development expenditures, such as irrigation, power, schools, transportation; and including a category defined as "community facilities and social welfare", under which are grouped water supply, sewerage and drainage, streets, low-income housing and similar community development programs;

-- approximately 11,000 million ฿ per year

Anticipated Total Public Spending:

approximately 28,000 million ฿ per year

The plan document gives the following breakdown of development funds by source:

Government revenues and taxes	--	7,000 million ฿
Foreign loans and grants **	--	3,000 million ฿
Local gov't. revenues and contributions	--	1,000 million ฿
Total, all sources (rounded)		11,000 million ฿ per year

(** including foreign exchange loans from Bank of Thailand)

Planned capital expenditures for water supply and sewerage during the 1966-1971 period are summarized in Table 3, (page 57) which also serves to illustrate the number of agencies actively working in the water supply field at present.

B. COMMITMENT TO WATER SUPPLY

Assuming that the major projects and programs develop as planned, and that financing also materializes as anticipated, several interesting generalizations can be made. First, the proposed commitment of some 330 million ฿ per year of its own funds to water supply represents 3% of that part of the national budget available for development purposes; it represents 1.2% of the total public expenditure budget of 28,000 million ฿ per year. The commitment of 330 million ฿ per year is rather evenly divided among support for village water systems and metropolitan Bangkok.

Second, the commitment of approximately 460 million ฿ per year from foreign loans and grants represents about 15% of anticipated foreign support. This amount includes planned construction funds for the metropolitan sewerage drainage-flood protection project (about 1/5 of the total); for metropolitan water supply (2/5); and for all other water supplies, primarily the provincial systems (2/5). The funds committed for water supply alone from foreign loans and grants (of which loans constitute roughly 90%) represent an additional 1.3% of the total public expenditure budget.

The third source of funds, local revenue, is of negligible effect in water supply, apparently contributing not more than 3 to 5 million ฿ per year in capital additions. A good deal of the local revenue does go into streets, drainage and similar community improvements.

Thus in very general terms, and again based simply on original projections of the published second 5-year plan, the government has committed approximately 2-1/2% of total public spending to the capital growth of water supply. In other terms, it is committing better than 6% of available development spending to this important purpose. This is substantially more than in many other countries today.

TABLE 3

SUMMARY OF PROPOSED CAPITAL SPENDING FOR WATER SUPPLY AND SEWERAGE
Source: Second National Economic Development Plan
(million bahts)

Department	Project Description	Source of Funds	Fiscal Year 1967	1968	1969	1970	1971
Health	Village Water Supplies	RTG	18	18	18	18	18
	Village Water Supplies	F. Grant	27	27	25e	25e	25e
Mineral Resources	Surveys and Wells	RTG	31	35	35	30	30
	Surveys and Wells	F. Grant	-	-	10e	10e	10e
Local Administ'n.	Village Water Supplies	RTG	20	20	20	20	20
	Village Water Supplies	F. Grant	-	-	10e	10e	10e
	Metro. Bangkok Sew. & Drainage (prelim.)	RTG	10	10	-	-	-
	Metro. Bangkok Sew. & Drainage (construction)	F. Loan	-	-	100	100	100
Public & Munic. Works	Village Supplies and Well Drilling	RTG	11	11	14	14	14
	Village Supplies and Well Drilling	F. Loan	-	16	12	12	12
	Provincial Water Works	RTG	115	125	125	125	125
	Provincial Water Works	F. Loan	-	125	125	125	125
	Metro. Bangkok Water Works Authority	RTG	40	120	120	120	120
	Metro. Bangkok Water Works Authority	F. Loan	-	20	100	180	180
SUB-TOTALS by Source of Funds							
RTG - National Dev. Budget			244	339	332	327	327
Foreign Loans			-	161	417	417	417
Foreign Grants			27	27	45	45	45
GRAND TOTAL:			271	527	794	789	789

Caution: The above figures are subject to correction, reflecting adjustments in the Development Plan, project changes, budget shortfalls, etc., and should be considered as indicative only.

CHAPTER VI

ENGINEERING SERVICES AND STANDARDS, DESIGN AND CONSTRUCTION PROCEDURES

A. ENGINEERING SERVICES

As mentioned in Chapter III, there are eight separate departments at the National level that have some type of water supply program. The major programs are administered by the Department of Public and Municipal Works, the Sanitary Engineering Division (SED) of the Department of Health, the Department of Mineral Resources and the Royal Irrigation Department. With only one exception, all of the engineering work being done at the present time is handled by their own departmental personnel. The Provincial Waterworks Division of the Department of Public and Municipal Works has 8 engineers to plan, design, operate and maintain their 93 water systems. The SED of the Department of Health has about 30 engineers in its potable water program. The Department of Mineral Resources has 4 engineers and 2 geologists while the Royal Irrigation Department has over 250 engineers to carry out its broad-based program.

In 1962, the Department of Public and Municipal Works hired a Thai contractor to design and build 62 water treatment plants and distribution systems. This contract took five years to complete and since that time the Department has maintained its own engineering staff to carry on and expand the original contract program.

In August 1966, the Department of Health retained a consulting engineer, Tippetts - Abbett - McCarthy - Stratton (TAMS), to furnish technical and advisory service to assist the Royal Thai Government and USOM in the implementation of the ARD water supply program in the Northeast. The TAMS

firm has been given the responsibility of advising the SED of the Department of Health in the planning, design, award and administration of contracts, supervision of construction and operation of the potable water projects in the Northeast.

This joint effort is used as a vehicle for further training of RTG engineers, technicians, administrative and managerial personnel. Approximately 150 SED personnel are receiving, or will receive, in-service training, and a total of ten engineers will be given academic training in the United States during the life of the project. Approximately 35 engineers and technicians will be given observational training in countries other than the United States. Additional training is accomplished by actively involving community residents during the construction phase, and in this way they become interested in assuming the operational and maintenance responsibilities of the system after construction. Also, formal courses of instruction are given to plant operators and maintenance personnel.

It is anticipated that the consulting firm's contract will terminate by the end of FY 1969 at which time the RTG will phase in and assume the entire responsibility for continuing the project as a part of the National Water Program.

Material and equipment which are manufactured in Thailand, such as asbestos cement pipe, galvanized steel pipe and PVC pipe, are being utilitzed to the fullest extent. Material and equipment such as chemicals, pumps, engines and etc., not manufactured in Thailand are being procured as US-funded commodities.

The ARD Potable Water Project is a counter-insurgency-oriented demonstration and training program. It was originally set up as a three

year project, however, the original plan was found to be unrealistic and was extended for two additional years for a total of five years.

It was necessary that the 250 treatment plants in the original plan be changed to 500. Originally, it was thought that the ground water would receive no treatment other than chlorination. However, it was found that almost all of the ground water supplies must be treated because of the high iron content. The table below summarizes the original and revised estimate of construction. (TP - Treatment Plant; Res. - Reservoir; DS - Distribution System)

Project Year	Original Plan			Revised Plan		
	TP	Res.	DS	TP	Res.	DS
FY 67	24	60	60	40	50	20
FY 68	96	220	220	90	100	60
FY 69	130	312	100	125	120	120
FY 70	-	-	-	120	150	150
FY 71	-	-	-	150	175	250
TOTAL	250	600	600	500	600	600

This project will effect directly the lives of between 1.8 and 2 million people in the security sensitive area of North and Northeast Thailand. It will effect indirectly the lives of many more Thais since the experience in planning, developing standard designs, construction, operation and maintenance being acquired in this project is also being used in the National Rural Community Water Project and will continue to be used in the future program.

The TAMS contract is scheduled to expire on August 17, 1969. The consultant feels confident that the Thais will be in a position at that

time to set up an organization to complete the proposed program and to manage, maintain and operate the resulting systems.

The early phases of the SED-ARD-TAMS program were not as productive as had been anticipated. This was due to several things, including lack of communications, under-staffing by the consultant and the primary use of the consultant as a detailed designer rather than in an advisory and educational role.

It appears these shortcomings are being overcome. The consultant is strengthening his staff with well qualified personnel. The SED is handling more of the detailed design and supervision of construction so that TAMS can spend more of its time on the training aspect of its contract. In addition, the two organizations, along with USOM representatives, are getting together once a month in Khon Kaen to discuss the program and any problems or misunderstandings that may arise.

The water system for Metropolitan Bangkok has just recently been given departmental status in the Ministry of Interior.

The Bangkok Water Works maintains about 10 engineers for routine design work and small projects. For any major projects involving plant construction or main extensions they have always used the services of a consultant, and expect to do so in the future. When the present water treatment plant was under consideration, they hired Degremont, a French engineer-contractor, to design, build and equip the facility. They are now seeking a consultant to study their entire water facility and to make recommendations for its management and long range development. A great number of consultants are interested in such work as evidenced by the fact that more than 50 consulting firms from 13 countries are seeking the

contract.

The Bangkok sewerage system is currently being studied by Camp, Dresser and McKee. This study will determine the alternate methods of providing sewers in Bangkok and set up a priority as to which areas should be sewered first.

As far as this team could determine, there are not any sanitary engineering consultants in Thailand. Therefore, each agency must depend upon its own engineering staff or international consultants for its sanitary engineering designs.

From the information collected and the observations made during this study, it appears the Thai government engineers and their consultants are competent and capable of planning, designing and constructing facilities for a limited national water supply program. If the program is to be expanded as fast as the need dictates, the responsible agencies will need to hire more staff engineers, make additional use of private consulting firms and allocate a larger percentage of their budget for operation and maintenance.

B. DESIGN DATA AND STANDARDS

Sources of Data: Prior to the design of any water supply system, certain background data must be obtained to assure an adequate design that will provide a sufficient quantity of potable water to the community for the period of design. These data include population estimates, geological information, hydrologic studies, predicted water demand and the raw water quality.

The National Statistical Office publishes a quarterly bulletin and other statistics that give the past and present estimate of the popula-

tion of the changwats and most of the cities and villages. The present overall population growth rate in Thailand is 3.3% annually; however, the growth rate in the villages and cities is estimated to be 4% per year.

The Royal Irrigation Department and the Ground Water Division of the Department of Mineral Resources have accumulated a great deal of valuable information for the development of surface and ground water supplies in all of Thailand. Prior to the development of any new source of water supply, these two departments should be contacted for their recommendations. These departments also have some information on water quality throughout Thailand. This information is not completely accurate, however, and each new source should be analyzed prior to initiating the treatment plant design.

Several departments have water laboratories that are capable of running a complete mineral analysis on water samples. The SED of the Department of Health has two water laboratories, one in Bangkok and the other in Khon Kaen. The Royal Irrigation Department, the Department of Public and Municipal Works, the Department of Mineral Resources and the Bangkok Water Works all maintain water laboratories in Bangkok.

The demand for potable water in Thailand varies widely with the type of community served. A village entirely served with public fountains will use from 15 to 40 liters per capita per day (lpcd) depending upon the availability of other sources of water; i.e, private wells, close-by streams or ponds, In a village with about 50% public fountains and 50% private house connections, the consumption is between 40 and 60 lpcd, A village with 80% house connections and only 20% of the popula-

tion served by public fountains the consumption is about 80 lpcd. The Department of Public and Municipal Works reported that they have experienced consumption rates as low as 15 lpcd in rural villages in the Malaya Peninsula to as high as 200 lpcd in some of the larger cities under their jurisdiction.

With the exception of Metropolitan Bangkok, water for fire fighting is not considered by any of the agencies with water supply programs.

Design Standards and Standard Designs: The SED of the Department of Health and the Waterworks Division of the Department of Public and Municipal Works are the two major agencies that are involved in the design of water treatment plants. It was encouraging to note that both of these agencies have established design standards and have developed standard designs and specifications for various sizes of treatment plants for surface and ground water supplies.

The SED, with the assistance of TAMS, has adopted the following design standards:

Plant design period - - - - 10 years
Maximum day demand - - - - 1.5 x Average day demand
Peak hour demand - - - - - 4.0 x Average day demand
Average pumping day - - - - 10 hours
Maximum pumping day - - - - 15 hours
Rapid sand filtration filter rate - - - - 2-1/2 to 3 gpm/sq. ft.
Rapid sand filtration backwash rate - - - 10 to 15 gpm/sq. ft.
Slow sand filtration rate - - - - - - - - 250,000 g/ac/day (iron removed)
Sedimentation rate - - - - - 2 hrs for iron removal
4 hrs for surface water

Population growth	3% per annum
Total storage	Approximately 70% of average day supply
Elevated storage	Approximately 20% of average day supply
Fire protection	None

*Per Capita consumption
Type 'A' Village ----- 80 lpcd
Type 'B' Village ----- 50 lpcd
Pipe material - - - - - - Asbestos Cement, PVC, Galvanzied Steel
Distribution system life - 15 years

*Villages are classified into one of two categories depending upon geographic location, economic situation, sociological conditions and growth potential. Initially both class 'A' villages and class 'B' villages will be served with 100% public fountains. At the end of the design period, class 'A' villages will contain 80% private house connections and 20% public fountains. The weighted average consumption figure will be 80 lpcd. The class 'B' villages will contain 40% private house connection and 60% public fountains at the end of their design period. The weighted average consumption figure for a class 'B' villages will be 50 lpcd.

Using these design standards and standard designs, plans and specifications have been prepared for elevated tanks, clear wells, pump houses and treatment plants. Treatment plants of 10 cu.m./hr., 20 cu.m./hr., 30 cu.m/hr. and 50 cu.m./hr. capacity have been designed. The drawings are numbered in such a manner that they can be interchanged and incorporated into designs fitting the requirements of the community. Even though these standards were developed for the ARD program in the Northeast, the SED is using them in its potable water program throughout the country.

As mentioned previously, the Department of Public and Municipal Works hired a Thai engineer-contractor to design and construct 62 water treatment plants. This consultant developed standard designs for various size communities, and now that the contract has terminated the staff engineers are continuing the program. The basic design standards used by the Department of Public and Municipal Works are as follows:

	Size of City	Water Use
Water demand	up to 5,000	60 lpcd
	5,000 - 10,000	100
	10,000 - 25,000	140
	25,000 - 50,000	200
Design period	10 years	
Sedimentation	4 hour detention	
Filtration Rate	2 gpm/sq.ft. + 25% overload	
Back wash rate	15 - 20 gpm/sq. ft.	
Clear Well	1/4 - 1/3 days consumption	
Elevation storage	120 or 250 cu.m. depending on size of town	
Fire storage	None	

While the standard designs are continually up-dated and adjusted to fit the local conditions, these basic design standards are adhered to by the Department of Public and Municipal Works.

In 1965, a cost survey was made by PWWD of the Department of Public and Municipal Works for plants of various capacities. Partial results of this survey are given below:

Plant Size	Source	Total Cost
40 cm/hr	River	1,976,000 ฿
40 cm/hr	River	1,320,000
80 cm/hr	River	3,220,000
80 cm/hr	Pond	2,580,000
80 cm/hr	River	3,447,000
160 cm/hr	River	6,000,000

The average distribution of costs for these plants has been broken down as follows:

- Distribution system -- 30%
- Pumps, chemical feeders, and all other mechanical equipment -- 25%
- Treatment plant, including land, intake, warehouse, clearwell, elevated tank and housing -- 45%

C. CONTRACT PROCEDURES

The use of a "turn-key" engineer-contractor appears to be a thing of the past in Thailand. A new policy requires a public letting on all public construction projects. For this reason, all work being let at the present time is advertised and competitive bids received from interested contractors on the basis of detailed plans and specifications. On the large projects, international bidding is encouraged in order to receive the best price. A typical procedure for such a letting for a SED project in the ARD program is given below:

1. After the Budget Bureau approves the SED budget, the Director General of the Ministry of Health sends a letter to each Changwat Governor advising him the money is available for the approved projects and giving him authority to let the contracts

2. The Changwat Governor appoints a committee from 3 to 5, including the health officer, the changwat engineer and usually the deputy governor.

3. The health officer and changwat engineer prepare the notice advertising for bids which is posted on the bulletin board at the Governor's Office. The advertising period varies from 7 to 15 days.

4. The Khon Kaen office furnishes the changwat engineer a set of standard plans and Bangkok furnishes the changwat engineer or health officer a set of specifications. The contractor must buy plans and specifications from the health officer.

5. Site plan prints must be sent from Khon Kaen to the health officer at least two days before the letting because it is the duty of the changwat engineer to accompany contractors to the proposed site two days before bid opening.

6. The public letting is held at which the committee presides, opens the bids and selects the contractor. If the bids are above the engineer's estimate they negotiate with the lowest bidder since they can't let a contract for more than the engineer's estimate.

7. The committee prepares the contract for the Governor's signature (as owner) and the contractor must sign the contract within 7 days. The contract specifies the completion date and the

committee sets the per diem penalty for failure to complete the work within the specified time.

8. Progress payments on completed work are made to the contractor by the Governor after approval by the committee.

While this procedure may vary in detail from department to department, the general philosophy must be followed on all public construction contracts.

This public letting procedure is now made possible, since the plans are prepared in detail and the specifications are clear, concise and complete. The contractors know exactly what they are bidding on when they seek the job.

The typical specifications being used by the SED of the Department of Health include the following topics:

1. General Information to Bidders
2. Supervision of Construction (by Changwat Engineer)
3. Concrete
4. Masonry
5. Earth work
6. Carpentry
7. Piping
8. Chemical Feeders
9. Mechanical
10. Painting
11. Filter Sand
12. Miscellaneous
13. Plant Start up (Contractor must start plant operation and guarantee it for a period of six months)
14. Acceptance - the construction must be approved by the Supervising Engineer prior to final payment.

In reviewing the above content, it is apparent that these specifications are complete and similar to specifications used for public letting of work of this type in the United States.

With the expanded use of competitive bidding, the overall cost of water systems should decrease and the uniformity of design and quality of construction should improve.

CHAPTER VIII

CONSTRUCTION RESOURCES

A. CONTRACTORS

The Thailand contractors do not have an organization similar to the Associated General Contractors (AGC) found in the United States and some other countries of the world. The contractors in Bangkok are reported to be well qualified and capable of doing good work. The observation of public and private construction verifies this report, since high quality construction work was noticed through the city.

Bangkok contractors are kept busy in the Metropolitan area and do not like to bid on the rural work, such as the numerous public lettings for the work taking place in the Northeast. To date, all of the SED-ARD water projects in the Northeast have been built by local contractors. In general, they are doing satisfactory work and it was reported that the quality of construction is improving from job to job. Many of the contracts in this program have been grouped in geographical areas so that one contractor can bid on several jobs at once. This tends to get a better unit plant cost and enables the contractor to do a more efficient job in procuring equipment, men and materials. The general appearance of the rural construction work is good. The placement of reinforcing steel and the general concrete work appeared to be very well done. The recent building construction is excellent and the mechanical work, piping, valves, equipment installation, etc., appears to be satisfactory. This good quality of work is due to the integrity of the contractors and the competency of the supervising engineers, the changwat engineers and inspectors.

B. CONSTRUCTION EQUIPMENT

Little, if any, heavy construction equipment is manufactured in Thailand; however, considerable quantities are imported from Japan, Germany and the United States. There are heavy equipment rental agencies in Bangkok that are available to contractors as the needs arise. On the large jobs in Bangkok it was noted that the contractors were using imported cranes, bulldozers, power shovels, pile drivers, cement mixers, pavers, batch plants and other equipment necessary to do a quality job with the minimum amount of labor. This situation does not exist in the rural areas. The only power equipment noted on these jobs was the cement mixer. The excavations for the tower footings, clear well and filter structure were all dug by hand. The concrete was carried in buckets and lifted to the elevated tower by means of a rope and bicycle-wheel pulley. These rural jobs are relatively small and in remote areas of the country. It is questionable if it would be feasible or economical to bring in heavy construction equipment to reduce the amount of labor involved, since labor is readily available, easily trained and inexpensive.

C. MATERIALS AND SUPPLIES

Camp, Dresser and McKee, Consulting Engineers on the Bangkok sewerage project, reported that a concrete pipe firm in Bangkok is capable of producing reinforced concrete pipe meeting all of the A.S.T.M. standards. This pipe is available in all sizes up to two meters in diameter. In some cases, however, the contract documents do not call for a pipe meeting ASTM requirements and the resulting pipe quality is

only good enough to "get by".

An excellent cement-asbestos pipe manufacturing plant is also located in Bangkok. This plant produces high pressure water pipe ranging in size from 4 to 12 inches. Pipe from this plant was observed in use in Bangkok and throughout the northern and northeastern sections of Thailand.

There is a plastic pipe firm about 20 kilometers north of Bangkok. This plant produces PVC plastic pipe up to 8 inches in diameter with future plans to obtain dies to produce pipe up to 20 inches. This is a high quality plastic pipe, and Camp, Dresser and McKee engineers reported that it is quite possible some of it will be used for sanitary sewers as well as water mains. Since the organic strength of the Bangkok sanitary wastes is expected to be quite high and the flow rates quite low, plastic pipe may be desirable since it would not be affected by the resulting septic conditions.

Two firms manufacture steel pipe in Bangkok. They import steel plate and roll and weld the pipe into 6 and 8-inch diameters. Most of the galvanized steel pipe observed in storage in Bangkok and during the field trip to the north and northeast was imported from Japan.

An excellent foundry is located in Bangkok that is capable of producing almost any type of casting. They do not produce any cast iron pipe, however, and the majority of it also is imported from Japan.

Valves, fittings, pumps, electric motors, diesel engines, meters, and all treatment plant equipment also must be imported. It appears that the majority of the valves and fittings come from Japan, the pump

from England, United States, Germany, Italy and Japan, the electric motors from Germany, Italy, England and the United States, the diesel engines from Germany, United States and Australia, the water meters from England, Japan, Italy, Germany and France and the water treatment plant equipment from France.

There are two Portland cement mills in Bangkok that produce a high quality product. No shortages of concrete aggregates were reported and the majority of the observed concrete work was excellent.

Filter sand was reported difficult to find in some areas of the northeast; however, with a considerable amount of screening it is possible to meet the design specifications.

A heavy duty hand pump has been designed for use on many of the wells drilled and dug by the Departments of Mineral Resources, Local Administration, and the Border Police Patrol. This pump is manufactured in Thailand and reported to be quite satisfactory.

Alum is produced by the Science Department, Ministry of Industry, and sold to the various water utility agencies. Lime is commercially produced locally and is readily available. Chlorine must be imported. It may be purchased as hypochlorite or in the liquid from Singapore, Australia and Japan.

Thailand is increasing its manufacturing capabilities for the development of the national water supply program; however, it still must import a large quantity of the necessary materials and supplies from foreign markets.

CHAPTER VIII

OPERATION AND MAINTENANCE

A. GENERAL CONDITIONS

The problems of planning, designing, financing and construction of new water systems are on their way to being solved in many developing countries. However, the problems of operation, maintenance and plant control of completed facilities have not been fully appreciated nor are solutions apparent. At the present time, Thailand fits this general pattern.

This team visited several water supplies, treatment plants and systems constructed by the Department of Mineral Resources, the Department of Health and the Department of Public and Municipal Works, and also the Bangkok Water treatment plant. With the exception of the Bangkok plant and two or three of the others, it was apparent that the problems of operation and maintenance remain to be solved. Some of the observations made on this inspection trip are as follows:

1. Chemical feeders were functioning properly in less than 50% of the plants.

2. Although chlorine feeders were generally available, only 20% of the plants visited were actually feeding chlorine.

3. In 30% of the plants, the filters were so dirty that the plant was overflowing hydraulically. There were 8 employees at one of these plants and only one man knew how to backwash the filter. He was not at the plant on the day of the team's visit.

4. At another plant, less than 3 years old, four of the six valves used in backwashing had broken valve stems and were inoperative

5. Still at another plant, with split flow to an old unit and a newer unit about two years old, seven of the eight high-service

pumps were out of order. Some of the engines, motors and pumps had been completely removed while others were torn down with parts scattered throughout the plant.

6. A few laboratories were provided and appeared to be well equipped; however, there was not any evidence that they were being used. Jar tests and other plant control tests were not used at any of the plants visited.

7. The only operational records observed were those required to be sent to the Department headquarters in Bangkok concerning income and expenses. Basic plant operational records were non-existant; however, one plant did record pH and chlorine residuals.

While these conditions exist today, it is encouraging to note that the Departments of Mineral Resources, Health and Public and Municipal Works realize that operation and maintenance are the biggest problems facing them today. A representative of the National Economic Development Board went so far as to say: "Even the maintenance of hand pumps has so far proven to be an insurmountable problem". With this realization, it is quite possible that additional funds and effort will be put into this work and that progress will be forthcoming in upgrading the operation and maintenance of their water supply works.

The Department of Mineral Resources reported that out of the 2,000 wells they have drilled to date, only about 1,000 are in operating condition. This is due to a number of things such as broken pumps, clogged screens, pumping of sand and high iron and salt content of the water. The problems with pump maintenance, however, are paramount and difficult to solve.

The Department of Mineral Resources has the responsibility for maintaining the well pumps, while the local village must provide fuel and maintain the engine. The Department used to have 5 repair trucks available to maintain its wells and pumps. Due to budget limitations this has been cut to two and it is not now possible to provide the necessary maintenance force

Both of these repair trucks are located in Khorat, one for hand pumps and the other for deep well pumps. The Department admitted that more maintenance crews were needed and hoped they could get more money for vehicles in the near future. The officials felt the crews could be trained if additional transportation were available. The Department also stated, however, that it prefers being in the well drilling business; not the repair business.

The Department of Public and Municipal Works has a proposed plan that should help in the maintenance and operation of the 93 waterworks under its jurisdiction. It proposes to construct warehouses in each of its five districts throughout the country. Each warehouse will have a supply of pipe valves, fittings, chemicals, pumps, etc. These materials and supplies would be made available to the treatment plants within each district as required. Each warehouse will also house operator training personnel and mechanics who will assist the local plant personnel. It is proposed that these people will travel from plant to plant in their district to check on plant maintenance and operation and to be of service whenever possible.

At the present time, the Department of Public and Municipal Works is completing a new warehouse in Bangkok. This warehouse is ideally located near the airport, a railroad and the major north-south highway. When this facility is completed, it will be not only an equipment and materials storage warehouse but will also contain facilities for a new meter shop, a motor repair shop, pumping equipment repair and chemical feeding repair facilities. Along with this new warehouse, there are new housing facilities for 17 families. The old warehouse presently houses the meter shop employing six employees capable of repairing 25 to 50 meters per day. It also has an engine and pump repair shop with 16 workmen and an electric motor repair

shop with 16 workmen and an electric motor repair shop with 8 employees. Some of these mechanics are dispatched to the field to take care of minor repairs. Since Bangkok is presently the only center for such repair crews they have great difficulty in covering the entire country and the 93 waterworks they are responsible for. If and when their decentralization plan is completed, they should be able to provide much better service to their water supply systems.

With the exception of the ARD program in the Northeast, the plants constructed under the Potable Water Program of the Department of Health are operated and maintained by the local people. The SED of the Department of Health has a sanitary engineer in each changwat in the northeast to assist and train the local operators of these plants as they may request.

In the future, SED hopes to pattern its entire Potable Water Program after the plan being developed in the Northeast, with USOM assistance. This plan includes a Deputy Director in each of 5 districts throughout the country and a maintenance center in each changwat. Under this proposed plan, the District Deputy Director would be under the Director in Bangkok and have the following responsibilities assigned to his office:

1. Training

    a) operators
    b) mechanics
    c) prepare manual of plant operation

2. Administration and Finance
3. Operations

    a) Engineer and Operator in each changwat office

4. Maintenance and Repair

    a) Vehicle, engine and equipment.

Each changwat office would maintain a master operator and a mechanic to make routine visits to all of the SED water systems in its changwat. They would assist and help train the local operators and mechanics to take care of their day-to-day routine problems. If major repairs were necessary, the traveling team would replace the faulty piece of equipment and take it back to the district office for repair. The necessary materials for routine plant operation and repair parts for equipment would be available from the warehouse at the district office.

This type of maintenance and operation program is currently being initiated for the 18 changwats in the Northeast with the district office and central warehouse in Khon Kaen. As mentioned before, the Department of Health hopes to pattern the operation of its entire potable water program after this pilot plan. If it does, and if adequate funds and competent staff are made available, along with sufficient supplies, the problem of good operation and maintenance should be well on the road to being solved.

B. WATER LOSSES

Water losses were difficult to ascertain for most systems in Thailand because they have no master meter or because they have a high percentage of their service meters out of order. Bangkok reported a high of 40 to 50 percent water loss while Chiang Mai reported a low of 12 to 20 percent loss The lack of information on this item indicates that a greater effort should be made to account for all water going into the system and that being withdrawn. This necessitates better control over the water meters and quick replacement and repair of all meters that have stopped recording. While Bangkok is entirely metered, it is doubtful if over 50% of the meters are functioning properly. When a utility can account for all of the water bei

used, both sold to customers and provided for free service, it will be in a better position to determine if a leak detection survey is worth while. If 80 to 90 percent of the water produced can be accounted for, it would indicate a fairly good system. If no more than 75 percent of the production can be accounted for, a leak detection survey is in order.

C. CONTINUITY OF SERVICE

From the brief survey made of operating plants, it appears that an effort is made to maintain pressure on the distribution systems twenty-four hours a day. The new plans being developed and the existing plants are all designed for this type of operation. However, due to long lines of inadequate size, the pressure in some parts of many systems often falls to zero, or below, during periods of high demand. Other causes of low pressures or intermittent service may be lack of plant capacity, faulty operation or power and equipment failure.

CHAPTER IX

WATER RATES AND FINANCIAL MANAGEMENT

A. RATE STRUCTURE

Water rate schedules throughout Thailand are very simple; except for the new rural community systems, the charges are on a uniform rate, based on metered consumption. There are no blocks or steps through which larger consumers pay a lower unit rate; no differentiation is made for type of use, such as domestic, commercial or industrial.

When the Provincial Water Works Division (PWWD) assumed management control of certain water systems in 1956, the rate for all provincial systems was established at 2 ฿ per cubic meter by the Prime Minister, and remains so today. The "concession" or locally-managed water utilities establish their own rates (with approval of the Ministry of Interior) which currently range from 1.25 to 4 ฿ per cubic meter, with a few at 5 or higher These, too, are uniform rate schedules without exception. Minor variances include free water to water works employees, and a one-third reduction in billing to Korean War veterans throughout the country. A costly "social" feature of the Bangkok rate is the grant of the first 6 cubic meters per month free to all consumers. The Bangkok rate is said to have been the same for more than 25 years. Bangkok also charges a meter maintenance fee of 1 ฿ per month.

For the new rural community systems, rates are being set by the villag committees ranging from 5 to 10 ฿ per month per family. This is considered to be well within their ability to pay, and is intended to cover the operator's salary, fuel and supplies, and to leave a small margin for equipment replacement and system growth. Operating costs of these systems have been

estimated at roughly 0.25 ฿ per cubic meter. It is too early to judge how these systems will work out in the profit-and-loss sense.

B. BILLING AND COLLECTION

Water utility employees read the meters monthly, although bills are prepared only every 2 months. Bills are then carried to the customers and most of the money is collected directly in this fashion. If the customer is not at home or unable to pay, the policy varies; either a printed bill is left, which is to be paid at the water works office or at a branch agency within a specified time, or the collector continues to call back until payment is made. The policy on overdue bills is to send a second notice upon 30 days' delinquency, and to cut off the service after 60 days. Indications are that this policy is followed with varying degrees of tolerance.

If the meter is found to be out of order, the bill is estimated from the record of recent use, also taking into account the value of the property and size of family. In Bangkok, there are at least some instances in which only the 1 ฿ per month meter maintenance charge is being collected when the meter stops registering. Both Bangkok and the provincial systems have the practice of collecting a deposit from each new customer, which is held for an unlimited time as a guarantee in case of non-payment. The deposit is returned only when the customer moves or otherwise terminates service. The amount of the deposit may range from 60 to 500 ฿, depending on size of service and type of use.

C. PROVINCIAL WATER WORKS FINANCES

With the 2 ฿ per cubic meter rate, approximately three-fourths of the provincial water systems, including most of the larger ones, are able to show a surplus of revenue over current operating costs. Water sales and charges for recovering the cost of new service connections make up almost

all revenue, which is deposited daily in local banks, credited to the national Revolving Fund of PWWD. Thus, the surplus produced by any one system does not specifically benefit that municipality, but will be used in the Division's overall program.

Table 4 (page 84) gives revenue and expense totals for 5 large and 5 small systems, considered to be representative of the 93 water works operated by PWWD. Table 5 (page 85) provides some additional finance detail for Chiang Mai, one of the newer systems and one which is presently generating a cash surplus.

The PWWD's Revolving Fund is the budget vehicle for all curent receipt and expenditures for the 93 systems. The summary in Table 6 (page 86) indicates revenue to be rising sharply in recent years, in fact more rapidly than current operating costs. The difference, usually plus a modest government subsidy, is constantly plowed back into small extensions, replacement equipment, meters and similar materials for the very good reason that any unspent balance reverts to the Treasury at the end of each fiscal year.

Recent PWWD capital budgets are summarized in Table 7, (page 87) and show a rather remarkable jump in capital grants for new water works construction from 41.5 million ฿ in the 1966 fiscal year to 143.9 million ฿ in the current (1968) fiscal year. It should be noted that, under previously described budgeting procedures, this is not merely window-dressing but actually represents the sum of preliminary cost estimates for a list of specifically approved projects.

D. BANGKOK WATER WORKS FINANCES

For the 1966 fiscal year, total revenue (more than 90% from sale of water) was somewhat more than 36 million ฿. Operating expenses alone were

70 million ฿. The difference, plus the cost of all new construction (51 million ฿), plus debt service on outstanding government loans (58 million ฿), plus the contract payments for the recent Degremont project (183 million ฿), necessarily came from a direct national government subsidy. This means that in 1966 those served by the Bangkok Water Works paid (in the form of water use charges) only 10% of the cost of serving them. Another measure of the "water gap" is that the revenue collected, calculated back to the volume of water it represents, amounted to only 36% of the estimated total water delivered to the distribution system from both surface and ground sources. A summary of recent financial results in given in Table 8 (page 88).

Provisions of the Degremont contact are of more than passing interest. Payment for this project, final cost of which was something over US $50 million, is being made in semi-annual installments due in April and October of the years 1964 through 1969. Payment is required to be made to Degremont in New York in US dollars!

E. PROJECT READINESS

Both PWWD and the new Metropolitan Authority intend to seek international loans in the near future, and in fact the Second Plan (Table 3) anticipates foreign lending support for the major construction programs of both.

Among the key criteria of international lending agencies in project evaluation are:

-- the existence of a viable institution or management entity capable of receiving the loan and capably administering the project;

-- technical soundness of the project in terms of serving its

intended purpose and doing so at reasonable cost;

-- financial integrity and viability of the project; for a utility, this particularly involves payment for the service by those served, on an equitable basis.

The latter factor re-emphasizes the first: the existence of an Authority or Department with both the power and the demonstrated willingness to raise rates to the level necessary to support the project.

Based on very brief, possibly even superficial, contact with both institutions, it appears that neither PWWD nor metropolitan Bangkok are ready for serious consideration for international loans at this time. Bangkok is at present agonizingly far from financial integrity in its water works operation. However, with the establishment of the Metropolitan Water Works Authority, a very important first step has been taken toward eventual project readiness.

TABLE 4
WATER DISTRIBUTED AND FINANCIAL RESULTS
REPRESENTATIVE PROVINCIAL WATER WORKS IN THAILAND
(annual basis, rounded, 1965-66)

	Water Distributed, 1,000 CM	Revenue, 1,000 B	Expense, 1,000 B	Revenue less Expense, 1,000 B
Khan Kaen	980	1,600	870	730
Udorn Thani	835	1,800	740	1,060
Chiang Mai	640	1,370	640	730
Uban Rajathani	640	1,090	510	580
Nang Khai	205	400	300	100
Roi-et	175	327	370	(-43)
Krabi	80	150	152	(- 2)
Nara-Thi-Wat	65	128	142	(-14)
Ram Phoon	52	113	100	13
Pathum Thani	33	74	64	10

Notes

For data on plant capacity and service connections, see Table 1. "Water Distributed" is based on billing records, rather than output to the mains. The water rate is uniformly 2B per cubic meter.

"Revenue" is primarily from water sales, but also includes repayment to the water works for labor and materials used in installing customer service connections; and miscellaneous income.

"Expense" includes the usual utility operating and maintenance items, such as labor, chemicals, power, local overhead; also the cost of service connection materials, including meters.

For a detailed breakdown of revenue and expense for Chian Mai, see Table 5.

TABLE 5

REVENUE AND EXPENSE DETAIL FOR CHIANG MAI
October 1965-September 1966 Fiscal Year
(1,000 B, rounded)

Revenue		
Water Sales	1,079	
Service Connections	222	
Labor	24	
Maintenance	23	
Inspection	7	
Transportation	6	
Miscellaneous	9	
TOTAL		1,370
Expense		
Electric Power	203	
Alum	130	
Hypochlorite	13	
Lime	1	
Fuel and lubricants	3	
Rent of land	4	
Labor	137	
Meters	77	
Pipe and fittings	10	
Maintenance	6	
Transportation	34	
Office supplies and miscellaneous	22	
TOTAL		640

TABLE 6

PROVINCIAL WATER WORKS DIVISION (PWWD)
SUMMARY OF REVOLVING FUND
(Million B, rounded)

Fiscal Year	Expense	Subsidy	Expense	Net Available
1962-63	16.2	1.5	14.7	3.0
1963-64	19.6	-	19.0	0.6
1964-65	24.6	1.0	19.9	5.7
1965-66	31.4	1.0	23.0	9.4

Notes

"Revenue" is primarily from water sales, but also includes repayment to the water works for labor and materials used in installing customer service connections; and miscellaneous income.

"Expense" includes the usual utility operating and maintenance items, such as labor, chemicals, power, local overhead; also the cost of service connection materials, including meters.

Net Available = (Revenue and Subsidy) - (Expense). This amount is "plowed back" in the same fiscal year in the form of small construction projects, supplies, meters and replacement equipment.

TABLE 7
PROVINCIAL WATER WORKS DIVISION (PWWD)
SUMMARY OF CAPITAL BUDGETS
(Million B, rounded)

	1965-66 (2509)	1966-67 (2510	1967-68 (2511)
Provincial WW Division, Bangkok	2.0	6.1	8.7
Principal and interest payment to RTG Savings Bank	22.0	112.0	(See note)
Carryover projects and previous construction contracts	24.5	25.6	18.7
New construction program	41.5	63.2	143.9
Subsidy for Revolving Fund	1.0	1.0	2.0
Total Budget Appropriation	91.0	207.9	173.3

Notes

PWWD had been making regular repayment of a previous Savings Bank loan (15 years, 8% interest) for plant construction. During the 1966-67 fiscal year, the Treasury provided 112 million bahts to PWWD for payment in full of the remaining principal amount of this loan.

TABLE 8
BANGKOK WATER WORKS
RECENT FINANCIAL RESULTS
(Million ฿, rounded)

	1961-62 (2505)	1962-63 (2506)	1963-64 (2507)	1964-65 (2508)	1965-66 (2509)
Revenue					
Sale of water			26.8	28.5	33.3
Materials and labor for service connections			2.2	2.4	2.5
Meter maintenance charge	.5	.6	.67	.73	.78
TOTAL	26.6	28.1	29.7	31.6	36.6
Expense					
Salaries and wages, including extras, benefits and misc.	12.6	13.2	14.1	13.6	14.8
"General Expense;" more than 80% represents power cost	11.3	13.1	18.3	29.9	24.6
"Material;" mostly chlorine and alum; also constr'n. materials	10.0	13.1	16.4	15.9	26.7
"Machinery and supplies;" mech. and elec. equip. and repairs	0.6	2.6	2.9	3.3	3.9
New construction, including land purchase	7.3	7.2	20.3	6.0	50.8
Debt service	2.9	2.7	74.1	147.8	241.1*
Assistance payments	-	8.8	16.6	0.5	0.2
TOTAL	44.7	60.7	162.7	217.0	362.1

*Note: Of this amount, 183 million ฿ is the contract payment to Degremont.

CHAPTER X

EDUCATION AND MANPOWER

A. EDUCATION

General Education: Until recently school attendance was compulsory for all Thai children from grades 1 to 4; now it is required for all children between 8 and 15 years of age, or from grades 1 to 7. For ages 10 and over illiteracy was reduced from 46.3% in 1947 to 29.2% in 1960. For the younger age-group of 10-14 illiteracy had dropped in this same period from 39% to 14%.

As of 1966 there were 31,301 public and private elementary and secondary schools in the country, with 215,327 teachers and with an enrollment of 5,188,878 pupils. It is discouraging to note, however, that of this number only 345,502 students were at the secondary school level.

In 1966 two hundred government and private vocational schools of various kinds were in operation, with 4,800 teachers and an enrollment of 42,600 students. In that year more than 10,000 certificates were granted upon the completion of programs of instruction.

In 1966 there were thirty institutions engaged in teacher training, with 1890 teachers and 19,776 students..

As of 1966 there were seven public technical institutes in operation with faculties numbering 727 and with enrollments totaling 8,460.

In 1966 the number of educational institutions of college or university grade was seven with faculties totaling 3,056, of whom 2,047 were full-time and 1,009 were part-time. The total enrollment of students in this year who were seeking bachelor's degrees was 33,531. Since 1961 two

additional national universities and one internationally - supported institute of technology have been established. By 1971 the total university enrollment is expected to exceed 43,500 students.

Technical and Engineering Education: As noted above, there are seven technical institutes in various parts of the country with an enrollment of about 8,500 students. This training fills a vital need in the country and supplements the vocational training given in the secondary schools. Within 5 years it is expected that the enrollments will exceed 19,000. The programs of these institutes extend over a 3-year period and usually include the disciplines of automotive mechanics, electricity, metal work, electronics, drafting and building construction. The offerings sometimes extend to the industrial arts, printing, photography, surveying, tailoring, etc. The admission requirements are high and the instruction is thorough. The graduates have made good records both in government service and in private enterprise. This training is obviously important in the water works field, for the graduates are eagerly sought for services in design, construction, operation and management of these facilities. Due to the scarcity of engineers in the country, these technicians are often called upon to perform elementary engineering functions.

As is the case in all of the developing countries, engineering talent is at a premium in Thailand. The number of engineers is wholly inadequate to supply the need, and the rate of their production cannot keep pace with the accelerating demand. This is particularly true in the field of sanitary engineering. In 1966 the total enrollment of engineering students in the country was 1,961, most of which was accounted for by Chulalongkorn University at Bangkok, which until recently was the only university having

an undergraduate offering in engineering. For several years the SEATO Graduate School of Engineering has operated in coordination with Chulalongkorn University, but it has now been renamed the Asian Institute of Technology and will operate independently on a graduate basis. Within the last year or two new universities have been established at Chiang Mai, Khon Kaen and Pattani, each with a Faculty of Engineering, and Kasetsart University in Bangkok has been authorized to add engineering to its several present curricula.

During the five-year plan period ending in 1971 it is expected that the increase of enrollment in these engineering institutions will be about 1600 per year, and that the total engineering graduates during the period will be about 1500.

Contrary to experience in Western universities, the student enrollment in civil engineering at Chulalongkorn University in proportion to enrollments in some of the more exotic branches, has remained high. However, there will probably be no more than 400 to 500 civil engineering graduates in the next five years. This institution also offers an undergraduate program in sanitary engineering, in which 12 students are now matriculated. It is obvious that this meagre supply of civil and sanitary engineers is woefully inadequate to meet the needs of this rapidly developing country.

The former SEATO Graduate School of Engineering, now the Asian Institute of Technology, promises to exert great influence in Southeast Asia, particularly to Thailand, in raising the standards and prestige of engineering as a profession. Since its beginning in 1958 to 1966 it had enrolled 352 students, 186 of whom were Thai. In the present year the enrollment is 64, distributed among Hydraulic, Public Health, Structural, Soil and Transportation Engineering, with 29 from Thailand and the remainder from four other

countries. It is interesting to note that during the time a program in Sanitary Engineering was offered, there were no applicants. The title was changed to Public Health Engineering and this year seven are specializing in that field, two of whom are from Thailand.

In addition to the students studying in Thai institutions there are currently about 4,000 students studying abroad at various levels, about 1,700 of whom are in the United States. It is likely that a considerable number of these are following engineering courses.

B. MANPOWER

The labor force of persons 15 years of age and over is estimated at about 15 million, and is increasing at the rate of a half-million persons annually. About 12 million are employed in agriculture and 3 million in other pursuits. Unemployment is very low - about 20% of the active population; but under-employment is extensive, due to the seasonal nature of agriculture and intermittant employment in construction and certain industries. The low average life-span results in a young labor force. It is estimated that about 300,000 workers are engaged in industrial production with about 10% of these in the skilled-labor category. As of 1966 there were about 200,000 engaged in professional and technical pursuits, about 70,000 in administrative, executive and managerial functions and approximately 190,000 clerical workers. By 1971 the augmentation of manpower required in these three groups will be 111,700, 44,500 and 92,700 respectively.

Due to the rapid development of industry and public services in the country, there is a greatly increased demand for professional, technical and skilled personnel. This has resulted in serious shortages in such

categories as physicians, nurses, economists, agronomists, administrators and executives, engineers, professors and teachers. In the middle-level, skilled-worker category the shortages are equally critical, and are apparent in the under-supply of skilled mechanics, electricians, carpenters, welders, surveyors and foremen of all types.

In the technical realm, despite the efforts being made to increase output, it is estimated that during the next 5-year period there will be need for 2,200 additional engineers versus an expected supply of 1,890, or a deficit of 310. In the technical trades 45,000 additional trained persons will be required during this period versus an anticipated supply of 35,000, with a deficit of 10,000. In science 3,300 additional persons will be needed, against an expected supply of 1,700, with a shortage of 1,600.

Sanitary Engineering: In the field of sanitary engineering there is a considerable number of well-qualified young professionals in the country, estimated at about 200. Most of these have received their specialized training abroad on a post-graduate basis, and many of them now occupy responsible posts in the governmental agencies. The programs which they direct are extensive and impressive in concept, but suffer from their centralization in the nation's capital in a country which is so large and ill-provided with transportation and communication facilities.

All of the designing of water supply works for the smaller cities, towns and communities has been done in these central offices, mostly in the form of standard plans, and it appears that the engineers so engaged are reasonably competent. From all of these bureaus there is complaint of a shortage of engineers, due either to lack of budget or difficulty in finding qualified men. In the large cities, such as Bangkok and Thonburi,

the water supply works have been designed by foreign consultants and contructors. It is reported that there are in Bangkok two consulting engineering firms competent to handle the structural and mechanical features of water supply projects of considerable magnitude and complexity, but they have never had the opportunity to demonstrate their ability, due to the policies mentioned above.

There has recently been organized the Engineers' Association of Thailand. It embraces all branches of the profession, and has as its objectives the improvement and dissemination of technical knowledge, the better utilization of engineering talents, the enhancement of the status and dignity of the engineering profession and a better acquaintance among members of the group. A law providing for the licensing of engineers has been enacted, which is now in process of implementation.

Operating Personnel: As stated previously, the water treatment plants which were visited in Thailand are not being properly operated or reasonably maintained. This is probably true for the water systems as a whole, and for the installations throughout the country. It is obvious that the weakest link in the country's water supply chain lies in operation and maintenance. Vital equipment is usually out of operation and new plants rapidly become a shambles. These conditions can have but one explanation: The people who operate the works do not understand their facilities, their processes and their responsibilities, nor are they receiving instruction and supervision in these matters. Operating personnel for the municipal water systems and plants are supposed to be drawn from the trained graduates of the technical institutes, but it is obvious that few of them are

so placed. As viewed from every standpoint - economic, public health, aesthetic, pride - improved operation and maintenance of these facilities are the most crying needs. These can be accomplished only by personnel who know their job.

If such deficiencies exist in the larger municipal installations, one shudders to contemplate the state of operation and upkeep that may be experienced on the hundreds of small water supply works that are being provided in the villages, where the villagers themselves are largely responsible for keeping them going. Will they soon become inoperative due to the breakdown of a pump or motor, or even the lack of petrol, a bolt or a leather washer? In the ARD Potable Water Project in the Northeast a training program for operators of these small installations is being conducted. This involves the selection of persons having interest and aptitude, ten for each class, from technicians who have been engaged in the construction of the various plants, and giving them an intensive 10-day course of instruction in operation, maintenance and management of the small village facilities. It is hoped that this project may be helpful in showing the way to better operation of small installations throughout the country.

Management Personnel: An important, and often overlooked, aspect of a successful water supply program lies in the capabilities of the personnel responsible for its management. The major water supply agencies in Thailand appear to have able management people at the top level; however, they do not have many well trained people under their direction to help carry out a sound management program - especially at the local level. This is probably due to the low salary scale of the average government employee, since there are five universities in Thailand offering majors in commerce, business and

public administration and economics. It is estimated that over 3,500 students will graduate in these fields between 1966 and 1971.

The water supply agencies must compete for these graduates to insure the sound management of their water supply programs.

CHAPTER XI

FORECASTS

A. POPULATION GROWTH

In its Second National Economic and Social Development Plan for its period 1967-1971 the National Economic Development Board predicts that the population of Thailand will rise from its 1967 value of 33.2 million to 39.2 million in 1971, 46.6 million in 1976 and 55.9 million in 1981. This represents a population growth rate increasing from 3.3% to 3.5% during its 15-year period. The labor force aged 15 years and over would increase from the present level of 14.8 million to 17.1 million in 1971, 20.2 million in 1976 and 23.8 million in 1981.

B. EDUCATION

To meet this situation in population growth, and the shifting from a predominantly agricultural economy to one in which manufacturing, commerce and public services assume greater importance, the Government has modernized and reshaped its educational system. It has given particular attention to the rapidly-increasing demands for engineering and technical services. Instead of a former single university in the country which offers engineering instruction there are now five authorized to give undergraduate programs in this field, plus the newly reorganized Asian Institute of Technology which operates on a graduate basis and makes a significant contribution to the country and region. During the next five-year period it is expected that about 1,800 degrees in engineering at the bachelor level and 750 at the

master level will be awarded by these institutions. Additional technical institutes will be established and by 1971 it is expected that the enrollment in these schools will surpass 19,000 students.

C. VILLAGE SANITATION

Through programs for the provision of safe drinking water, the proper disposal of refuse and excreta, and general sanitation, which have been previously mentioned, about 8,400 villages with a total population of about 3,000,000 have received benefits. Approximately 7,775 water wells and storage units have been provided. In the next 5-year period such services will be provided to an additional 12,000 small villages. The program will concentrate on the digging of wells, the provision of sanitary privies, the installation of school and health-center water supplies and general sanitation, with emphasis upon the rural areas along the borders of the country.

D. VILLAGE WATER SUPPLY

This program applies to communities larger than the ones mentioned above, which justify the provision of piped water under pressure and simple distribution systems. It has been under way on a national basis for several years and many such water supplies are in use. During the 5-year period of the Second Plan a target of an additional 50 units per year has been set for the national program, plus an additional average 100 units per year for the Accelerated Rural Development Program of the Northeast Region. If accomplished, this program should result in an additional 750 piped water supplies during the next 5 years, serving villages in some of the most distressed areas of the country.

E. MUNICIPAL WATER SUPPLY

These installations comprise the category of water supplies for the larger towns and cities which come under the jurisdiction of the Department of Public and Municipal Works of the Ministry of Interior. There are now in existence 130 water supplies of this type, exclusive of metropolitan Bangkok, with a daily capacity of approximately 200,000 cubic meters (53 M G) and serving a population of about 2,650,000. Within the period of the Second Plan it is intended that new supplies of this type be constructed at the rate of about 45 units per year. If this goal is realized, it will result in 225 more installations with a daily capacity of 260,000 cubic meters (69 M G) and serving about 3,000,000 additional people.

F. BANGKOK METROPOLITAN WATER SUPPLY

During the past six years the capacity of the water supplies of the twin cities of Bangkok and Thonburi has been increased from 510,000 to approximately 770,000 cubic meters (203 M G) per day. Due to the meteoric rise in water consumption in this rapidly growing area this augmentation of supply and treatment facilities is now on the verge of inadequacy to meet the demand. In this connection it is interesting to note that in the 25-year period from 1917 to 1942 the number of water services in the City of Bangkok increased from 1,209 to 16,789, while the 23-year period from 1942 to 1965 showed an increse to 128,912 connections - or an average annual rate 8 times as high. The water supplies of Bangkok and Thonburi and two suburban communities, previously separate entities, are to be combined into a metropolitan system, and a leading firm of consulting engineers will be employed to make studies and plans for the future water requirements of the area. During the next 5-year period

it is expected to augment the capacity of the water supply works by 200,000 cubic meters per day, bringing it to a total daily capacity of 970,000 cubic meters (255 M G).

G. BANGKOK METROPOLITAN SEWERAGE

As pointed out previously, no town or city in Thailand is provided with an integrated system of sanitary sewers. It is difficult to imagine how an urban area of more than 2,000,000 people, such as metropolitan Bangkok, could exist without such a facility. The lack of it undoubtedly has its effect upon the health of the people, but the conditions to which they have been so long accustomed are taken for granted. The liquid wastes - and much of the solid wastes - find their way into the numerous klongs and the Chao Phyraya River. The recent filling of some klongs to make roadways has increased the pollution load on the remaining ones. All premises are supposed to be provided with septic tanks, but their effect is usually nominal. The whole flat area is subject to tidal influence, as well as flooding during the rainy season; so, at best, the land surface is barely above the water level, with much of it often below it. With tidal fluctuation there is perceptible movement of the water in the klongs, but most of the pollution remains there to settle to the bottom as sludge and to support a luxuriant growth of algae. To the visitor the whole city seems to be floating on a vast lake of pollution. While this is visually evident, it is unusual to detect it by smell. It appears that the numerous quiet klongs are behaving as oxidation ponds, while those that are whipped into frenzy by the propellers of boat traffic act like oxidation ditches.

To study and ameliorate this aggravating and complex problem of drainage, sewerage and flood protection, the Government has employed a well-recognized American firm of consulting engineers. The study and design phases of the work will occur during the first part of the Second Plan period, and it is hoped that construction may be started within the same 5-year period. This is a mammoth undertaking which, due to the physical conditions and long neglect, borders upon nightmare. Sympathy and best wishes are extended to those who undertake the commission.

CHAPTER XII

OBSERVATIONS AND CONCLUSIONS

While its time in the country has been very short and its observations quite limited, the team believes that it has had the opportunity of conferring with the people most responsible for the planning and prosecution of the water supply programs of the country and of seeing representative installations. Due to its extensive travel by air over much of the country, it was able to view and appraise not only the geographic and hydrologic features of the land, but to judge the general social and economic conditions of the people. The consultants feel that they have acquired information and understanding that give a fairly good picture of the water supply situation in Thailand, and which warrant the following conclusions and suggestions:

1. The country is under dedicated, effective and progressive leadership, and its development within the last several years has been remarkable.

2. It has accepted and used to good effect the rather large amounts of foreign aid that have come to it in the past 15 years. This acceptance has been with gratitude and graciousness, and the assistance has been employed in the best spirit in which it was given.

3. The country is rapidly developing its resources and institutions to the point of self-sufficiency, and looks forward with pride and confidence to the time when it can stand alone, with all the personnel and facilities to meet its needs.

4. The Thai people manifest such good nature, kindness, ebullience of spirit, friendliness and natural urbanity that it is a genuine pleasure to deal with them. No one of them is ever too preoccupied to smile; no public

official is ever too busy to drop everything to receive and help the visitor, even though he may come unannounced.

5. As in all developing countries, there is in Thailand an abundance of unskilled labor, but a scarcity of skilled labor and professional personnel to meet the needs of a country now undergoing rapid change and development. This shortage is particularly acute in the realms of engineering and technology, but efforts are being made to alleviate the situation.

6. All aspects of the nation's economy and social welfare are constantly under study by the National Economic Development Board. The objectives of its first 6-year plan were generally attained, and the Second Plan, covering the 1967-1971 period and all phases of the country's life, is now the guide for further progress.

7. Many RTG agencies are now active in the field of water supply. Bangkok, Thonburi and two nearby suburban cities have just recently been included in a new "Metropolitan Water Works Authority" which will operate as a separate Division of the Department of Public and Municipal Works. Within this same Department, the Provincial Water Works Division (PWWD) operates 93 government-owned water systems serving cities of 10,000 population or larger. A smaller number of systems are under either local municipal or private ownership.

8. In rural communities ("villages") under 10,000 population, the Sanitary Engineering Division (SED) of the Department of Health has a growing program of piped water systems, most of which include some type of treatment. This effort is being supplemented by a number of other agencies which are providing dug wells, shallow wells, ponds, reservoirs, and dry-season storage

facilities of many kinds. Most of this rural activity is concentrated in the Northeast region, as an important element of the Accelerated Rural Development (ARD) counter-insurgency program in the security-sensitive border provinces.

9. Coordination of this and similar work throughout the country has been assigned to an eleven member Executive Committee for the National Rural Community Water Project.

10. The customary yardsticks of population served and per capita water use are not easy to determine, for a number of reasons. Quite generally, less than half the population in the provincial cities are connected to the water system at all. Of those, the majority continue to get at least some of their water from other sources, and this in turn varies with the season. Although all connections are metered, many meters are inoperative (particularly in Bangkok) and the percentage of water accounted for can only be a judgment guess.

11. A strong program of water supply planning and construction is underway at all levels, from Bangkok down to the rural villages, with some US assistance, but fueled primarily by RTG national budget funds. For this, the sanitary engineering and public health leadership of the country deserve much credit, since this kind of acceptance comes only as the result of long, hard and effective "selling."

12. The reverse of the coin is a most distressing picture of miserably poor operation and maintenance of many present water works systems. For example, only token meter maintenance is being performed throughout the country. Much of existing treatment plant capacity is simply not in condition to treat water.

13. The real challenge, then, is no longer one of water supply construction, but rather of motivation and organization successfully to operate and to maintain the many systems built and being constructed.

14. Thailand is now well into its Second Plan (1967-1971) for economic growth under the guidance of the National Economic Development Board (NEDB). Planning for water supply projects originates with local requests, which must survive screening at the district and province level before NEDB review. The final result appears in the form of annual departmental appropriations, listing specific projects and their estimated construction cost.

15. The Second Plan proposes capital spending for water supply from RTG own funds of some 330 million per year, fairly evenly divided among metropolitan Bangkok, provincial water works and rural village systems. In addition, foreign loan and grant support of approximately 460 million per year is anticipated, primarily for metropolitan water and sewerage, but also for provincial water systems. Taken together, these proposals represent a commitment to water supply alone of two and one half percent of total public spending, and more than six percent of available development spending, which is substantially higher than in many other countries today.

16. Thailand does not have any private sanitary engineering consulting firms. The agencies involved in the national water supply program must depend upon their own sanitary engineering staff or hire international consultants for their designs. If the program expands as fast as the need dictates, the responsible agencies will need to hire more engineering staff, make additional use of private consultants and allocate a larger portion of their budget to the operation and maintenance of completed systems.

17. Thailand has considerable resource data available to assist in the planning of water supply systems. These data are available from the National Statistical Office, the Royal Irrigation Department and the Ground Water Division of the Department of Mineral Resources. In addition, the Departments of Health and Public and Municipal Works have established water demand criteria for different types and sizes of communities.

18. The Departments of Health and Public and Municipal Works have also established design standards and standard designs for various sizes of treatment plants for surface and ground water supplies.

19. A new policy in Thailand requires a public letting of contracts on all public capital improvements. Bids are received from interested contractors on the basis of detailed plans and specifications.

20. The quality of the construction of the municipal and rural water systems observed throughout Thailand appeared satisfactory.

21. The majority of all heavy construction equipment must be imported. Considerable quantities of such equipment are available and in wide use in the Bangkok area. In contrast, the rural water supply projects are constructed almost entirely by hand.

22. Thailand must import the majority of the materials and supplies necessary to construct, operate and maintain its water supply systems. The country is increasing its manufacturing capabilities in this field.

23. The greatest problem threatening the success of the national water supply program is the lack of operation and maintenance of the completed facilities. Additional budget funds and administrative emphasis must be given to this problem, and better qualified personnel obtained or trained.

24. Water treatment plants in Thailand have been designed to provide 24-hour service. However, due to long lines of inadequate size, the pressure in some parts of many systems often falls to zero, or below, during periods of high demand. Other causes of low pressure or intermittent service are lack of plant capacity, faulty operation or power and equipment failure. Steps should be taken to correct these shortcomings so that all systems will have adequate water at adequate pressures at all times.

25. Water rate schedules throughout Thailand are exceptionally simple; except for the few rural systems, the charges are on a uniform rate, based on metered consumption. For all provincial water works, the rate is 2฿ per cubic meter. For Bangkok, the rate is only 0.5฿ per cubic meter, after an allowance of the first 6 cubic meters at no charge.

26. Approximately three-fourths of the provincial water works systems collect sufficient revenue to match or somewhat exceed their current operating costs. All such revenue goes directly into the PWWD Revolving Fund, from which operating expenditures for all systems are paid. The result is a modest margin which is continuously plowed back into the systems in the form of small extensions and replacements. All capital construction funds for provincial water works come from national budget grants. There is no repayment of these grants at either the local or PWWD level. The amount of these grants to PWWD has increased very sharply in recent years.

27. The Bangkok Water Works is agonizingly far from financial self-sufficiency. With the 0.5 -฿ water rate, the revenue collected is only half enough to meet operating costs, and only one-tenth enough to meet the total of current expenses, new construction and debt service on recent construction.

The deficit must be met by national government subsidy. Thus, in terms of project readiness for international loan assistance, Bangkok has far to go, although the recent formation of the Metropolitan Water Works Authority is an important first step toward improvement, and the imminent selection of a top-level consulting firm is another.

APPENDIX A

PRINCIPAL SOURCES OF INFORMATION

(Addresses are Bangkok unless otherwise noted)

UNITED STATES OPERATIONS MISSION TO THAILAND (USOM)

Mr. Martin Tank, Deputy Chief of Mission
Mr. Osborne I. Hauge, Chief, Office of Capital Development
Mr. Dallas D. Fowler, Acting Chief, Capital Projects Division, CD
Mr. William McQuary, Sanitary Engineer, Capital Projects Division
Dr. William Smith, Acting Chief, Office of Public Health
Mr. Frank Sheppard, Chief, Office of Field Operations
Mr. Philip Lewis, Office of Field Operations

MINISTRY OF PUBLIC HEALTH

Phra Bamras Naradura, Minister of Public Health
Dr. Chitt Hamachudha, Deputy Under-Secretary of State for Public Health
Dr. Erb Na-Bangxang, Deputy Director General, Department of Health

SANITARY ENGINEERING DIVISION (SED), DEPARTMENT OF HEALTH

Mr. Somnuek Unakul, Chief, Sanitary Engineering Division
Mr. Manop Subhabhandhu, Deputy Chief
Mr. Praphorn Charuchandr, Chief, Design and Construction Section
Mr. Lert Chainarong, Sanitary Engineer
Mr. Ekapop Setapan, Assistant Changwat Engineer, Potable Water Project, Nong Khai
Mr. Veerusa Mahakapong, Changwat Engineer, Potable Water Project, Udorn Thani
Mr. Chatphong Chucharoen, Changwat Engineer, Potable Water Project, Ubon

PROVINCIAL WATER WORKS DIVISION (PWWD), PUBLIC AND MUNICIPAL WORKS DEPARTMENT

Mr. Kasien Anambutr, Deputy Director
Mr. Kamsingha Purabha, Deputy Director for Administration
Mr. Sawasdi Orvichial, Chief, Engineering Staff
Mr. Ananda Tantidhama, Chief, Engineering and Planning Section
Mr. Swasde Theichantara, Warehouse Supervisor
Mr. Kamthorn Nagalak, Meter Shop Supervisor
Mr. Viroon Rungrongthamin, Manager, Water Utility, Chieng Mai
Mr. Praves Buaphaun, Manager, Water Utility, Khon Kaen

BANGKOK WATER WORKS

Mr. Pracha Tunsiri, Chief, Engineering Division
Mr. Pol Silapun, Chief, Treatment Division
Mr. Chanvit Suebsa-Nguan, Chemist, Treatment Division

GROUND WATER DIVISION, DEPARTMENT OF MINERAL RESOURCES (MRD)

Mr. Sanoh Buasap, Chief, Ground Water Division
Mr. Charoen Phiancharoen, Chief, Ground Water Exploration and Development Project

ROYAL IRRIGATION DEPARTMENT (RID)

Mr. Chamlong Attanatho, Deputy Director General

NATIONAL ECONOMIC DEVELOPMENT BOARD (NEDB)

Professor Chamras Chayabongse, Deputy Secretary General, NEDB, and Professor of Sanitary Engineering, Chulalongkorn University
Mr. Charan Burapharat, Public Utility Sector, Social Projects Division

DEPARTMENT OF LOCAL ADMINISTRATION

Mr. Samran Busapavanit, Chief, Local Administration Division

TIPPETTS-ABBETT-McCARTHY-STRATTON (TAMS)

Captain Clifton B. McFarland, Project Manager, Khon Kaen
Mr. Angel E. Martin, Assistant Project Manager, Khon Kaen
Mr. James Parker, Construction Engineer, Ubon

CAMP, DRESSER AND McKEE (CDM)

Mr. Roland Burlingame, Resident Partner
Mr. Donald E. Cullivan, Sanitary Engineer
Mr. Charles E. Kline, Sanitary Engineer

WORLD HEALTH ORGANIZATION (WHO)

Dr. J. J. Alcocer, Representative to Thailand
Mr. Z. J. Buzo, Consultant, Community Water Supply Program, Thailand

ASIAN INSTITUTE OF TECHNOLOGY (AIT); formerly SEATO GRADUATE SCHOOL OF ENGINEERING

Mr. Milton Bender, President
Professor Aroon Sorathesn, Professor of Public Health Engineering