WATER FOR PEACE

VOLUME 7

PLANNING AND DEVELOPING WATER PROGRAMS

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Planning and Developing Water Programs

Water Supply

FORECASTING URBAN WATER DEMANDS IN DEVELOPING COUNTRIES

Edward A. Bryant

Introduction

A large portion of the world suffers from water shortages. Major causes are (1) lack of natural resources, (2) lack of financing and proper management, and (3) limited water handling facilities. In the latter case the goal of the water-supplying agency should be to meet all demands. For the purposes of this paper, "Demand" is the amount of water which would be used if it were available at a reasonable cost. This will be compared with "Use" or the actual quantity which passes to the consumer. The necessary advanced planning to meet all demands requires a reliable estimate of the future water demands.

Components of total demand, i.e., domestic, commercial, industrial demands and unaccounted-for water are affected by many conditions. Each of these components and the conditions which affect them must be analyzed to obtain a reasonably accurate forecast of water demand. This paper describes the components of demand and some of the conditions which affect them. It also provides data which may be used to determine future water demands.

Growth of the City

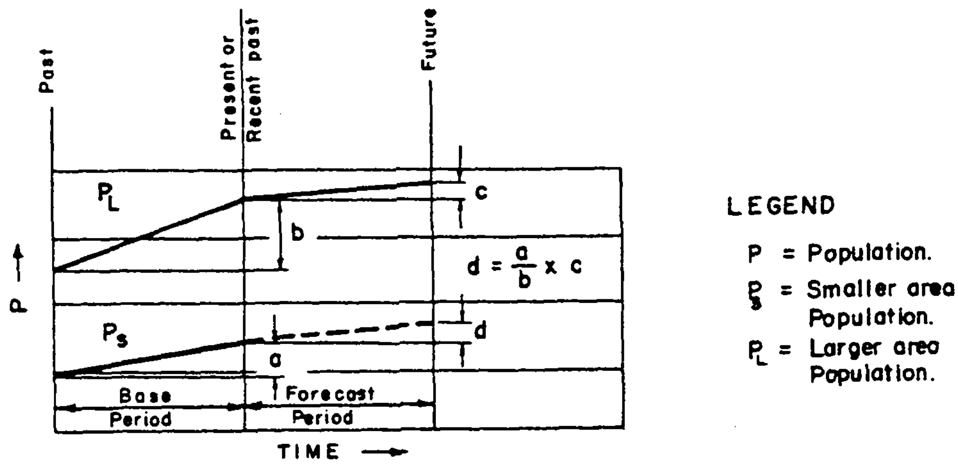
Growth of the city is the most important condition affecting water demand forecasts. There are two basic approaches to forecasting urban growth:

1. The economic analysis of the effect of a variety of conditions most likely to influence a city's growth. These include availability of land, availability of natural resources (including a good water supply), accessibility to marketing areas, and government plans for the future of the study area. This approach requires a complete economic study of the area and its environs and is carried out principally by economists.

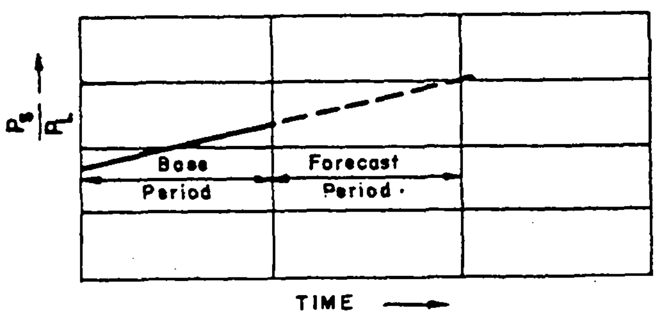
2. The statistical analyses using projections of past population data. This approach, which deals exclusively with numbers, is commonly used by engineers since the basic data are more readily available.

The most frequently used statistical method is to extend the population growth rate using either a straight line projection or a log projection. However, the average inaccuracy of these methods can be expected to exceed 10% for ten years of forecast and may exceed 60% for twenty years.[1]

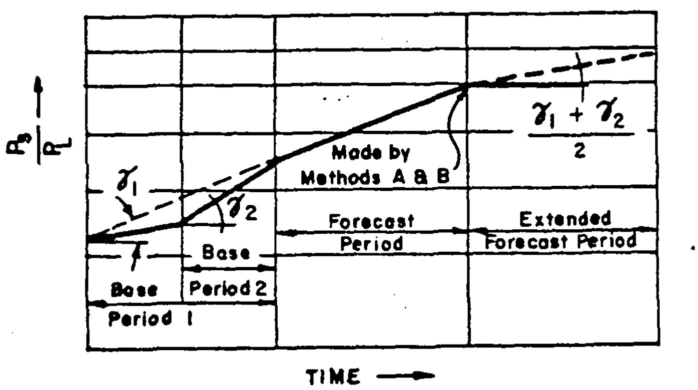
Other statistical techniques project the past relationship between the population of the study area and the population of a larger area of which the study area is a part. Three methods for projecting this relationship are (1) apportionment, (2) ratio, and (3) trend. Figure 1 shows



A. APPORTIONMENT METHOD



B. RATIO METHOD



C. RATIO-TREND METHOD

POPULATION FORECASTING TECHNIQUES

FIGURE I

hese methods graphically.

1. The apportionment method assumes that the population distribution within an area will remain constant and therefore, if the study area has 10% of the population of the next larger political entity, it will have 10% of the population of this larger area in the future.

2. The ratio method assumes that the changes in population distribution will continue in the same pattern. Therefore, if a study area's population increased from 5 to 7 percent of the larger area's population in the last ten years, it will increase to 10% in the next ten years.

3. The ratio-trend method is a graphical method using a semi-log plot. It averages the slopes of changes in population distribution for two overlapping periods. This average slope is used to forecast population of the study area into the extended future.

A proper statistical forecast will use a combination of such techniques and several base periods. The particular combination depends largely on the areas considered, the length of forecast desired and availability of past population data.

Water Demands In General

Once the population trends have been determined, it is necessary to estimate the future average demand of each person. For smaller villages and towns this is quite often done by comparing the water use with villages having similar supplies, distribution systems, and charges for water. Dividing the total amount of water use in the village by the total population results in the total unit use in gallons or liters per person per day. However, it is difficult to use these procedures for larger urban areas. Figure 2 shows total unit use in 50 cities in the temperate zone. The rates of use are compared with the size of the city. It is pretty obvious that relatively accurate unit demands cannot be forecasted based on these data.

The reason for the great divergence of data is not necessarily that the people in one city use three times as much water as in other cities but that other components of water demands vary considerably. Therefore, to properly forecast water demands requires that the components making up the total demand be studied individually.

Domestic - Commercial Demands

Domestic and commercial water uses usually can be considered as one because the conditions which affect domestic demand usually affect commercial demand in a similar manner.

Among the conditions affecting domestic-commercial demands for water in a specific area are its socio-economic status, distribution conditions and weather. The socio-economic conditions affecting the water demand of a city are interdependent. They include population density, availability of water-using devices, such as dishwashers, washing machines, garbage disposals, presence of public sewers and economic status of the inhabitants. Density of population affects the demand for irrigation of lawns and gardens. Many old cities have little land available for landscaping. When distribution systems are extended to newer, less-dense residential areas, irrigation becomes an important factor. The widespread availability of water-using devices on the world market is a relatively recent condition. In the past, economic status had little effect on water-use because there were few water-using devices available. Now that these devices are available, their use gradually will increase as they can be afforded.

An illustration of the increased use as a result of economic changes and availability of water-using devices is shown in Table 1. This table shows total domestic use and individual domestic use for several cities in Great Britain. The individual use in these relatively stable cities has been increasing at a greater rate each year.

Figure 3 shows the past domestic and commercial water use for various cities in the temperate zone. The United States' past and projected use represents conditions where there is a high utilization of water-using devices. The Barcelona-Bogota-Osaka-Istanbul data indicate the rate of use in areas where the economic status, as well as the availability of water-using devices is changing. As a result, the demand rate is increasing faster in these latter areas than the rate of the United States and Great Britain.

A more detailed analysis has been made of the Istanbul domestic use. In 1935, over 70 percent of the population of Istanbul was using public taps. In 1965, 40 percent of the population was using public taps with an estimated daily use of about 4 gallons per person. The portion of the population living in houses connected directly to the public system has a daily use of about 45 gallons per person. The predicted per person water demands for Istanbul are shown on Figure 2. These demands are based upon the assumption that by the year 2000, 10 percent of the population will be using public taps with water demand of 10 gallons per day and the remaining population will require 75 gallons per day from individual house connections. This gradual increase in demand by persons using public taps is assumed because convenience and waste will increase as the number of persons using each tap decreases. Of course, these assumptions presuppose that the water will be available. At present, the Istanbul water use is depressed by a critical shortage of water handling and sewage disposal facilities which causes Istanbul use to be less than that of the other cities shown on Figure 2.

Two characteristics of the distribution system which affect domestic demand for water are the method of determining payments and the cost per gallon of water. The use of meters greatly reduces household waste. When there are no meters, widespread waste results from letting water run to keep it cool, lack of washers in faucets, leaving faucets open during low-pressure periods, etc. A study made by TAMS in Honduras indicates that present domestic use in one city in Honduras could be reduced by more than 70 percent if meters were installed. In Kingston, Jamaica the metered household use is about half the unmetered use.[2] Barcelona, Bogota, Osaka and Istanbul have metered services. Therefore, it is necessary to greatly increase the unit consumptions shown on Figure 2 if they are to be used as a basis for estimating domestic demand for an unmetered city.

Metering will have little effect unless it is accompanied by a reasonable charge for the water. An increase in the cost of water will reduce water demand. No specific amount can be attributed to this but the effect will be greater as the water bill becomes a more substantial part of the cost of living.

Weather affects water demands mainly through the use of air conditioning and landscape irrigation. In most developing countries, water used for air conditioning will be of little consequence initially and lawn sprinkling will be limited to newer portions of the cities. However, as the economy rises and newer, less-dense areas are served by the distribution system, the effect of weather may be one of the largest single determinants of water demand. A study made in 1955 in the United States compared domestic consumption in various temperate areas.[3] While the data on which this study is based are scanty, they indicate that the western areas used about twice as much water for domestic purposes as did the eastern areas. It was concluded that this difference might be caused by the long-hot-dry periods in the west as compared with short-hot-humid periods in the east.

Industrial Demands

There is a wide variation in the industrial portion of a city's total water demand. In the cities listed in Table 2, the industrial use varies from one percent to fifty-five percent of the total consumption. In smaller cities one large industry may use ten times as much water as all other water users. Therefore, a forecast should include the probable development of hospitals, tourist hotels, and manufacturing processes which use large quantities of water. The future water demand for these large users should be estimated separately and then added to the total of the domestic-commercial demands.

Unaccounted-for Water

Water demands from watermain flushing, water lost by distribution leaks, pipeline breaks, fire use and water treatment plant must be included in estimates for planning water-handling

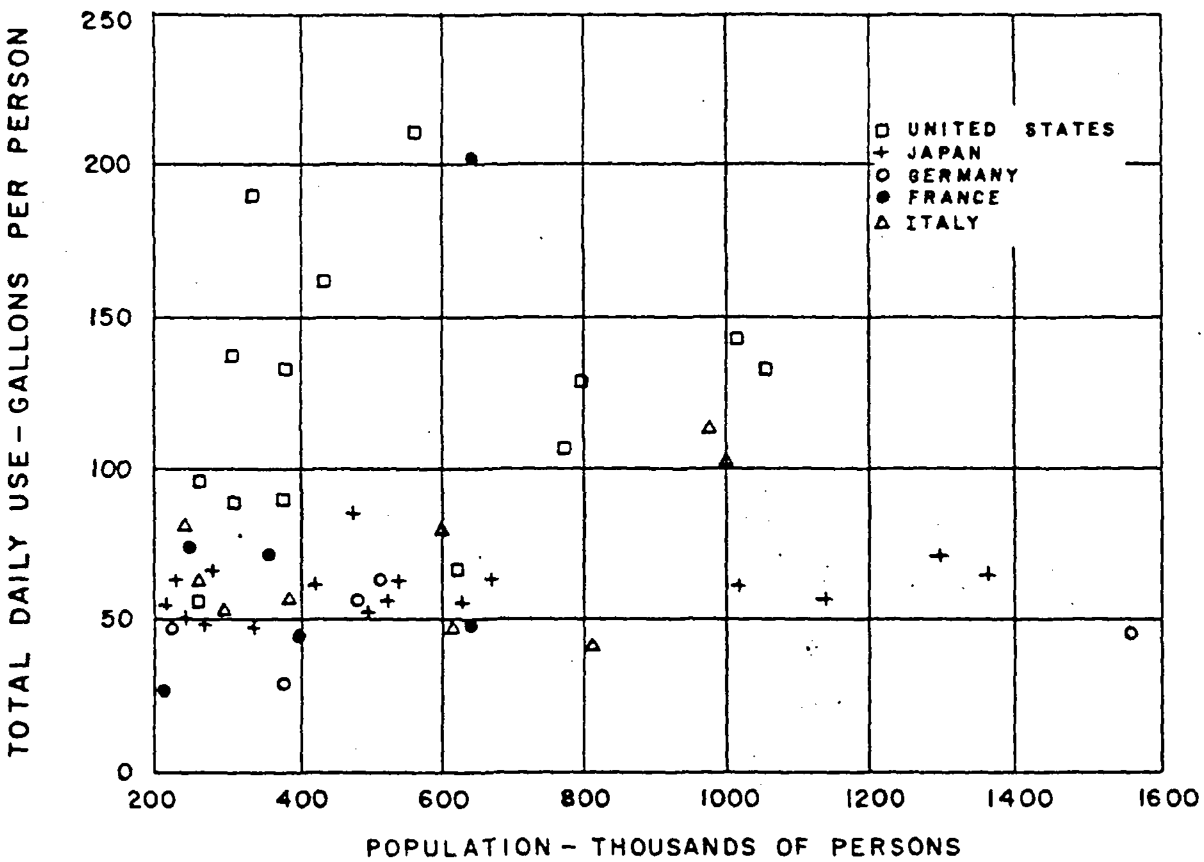


FIGURE 2 - COMPARISON OF TOTAL WATER USE

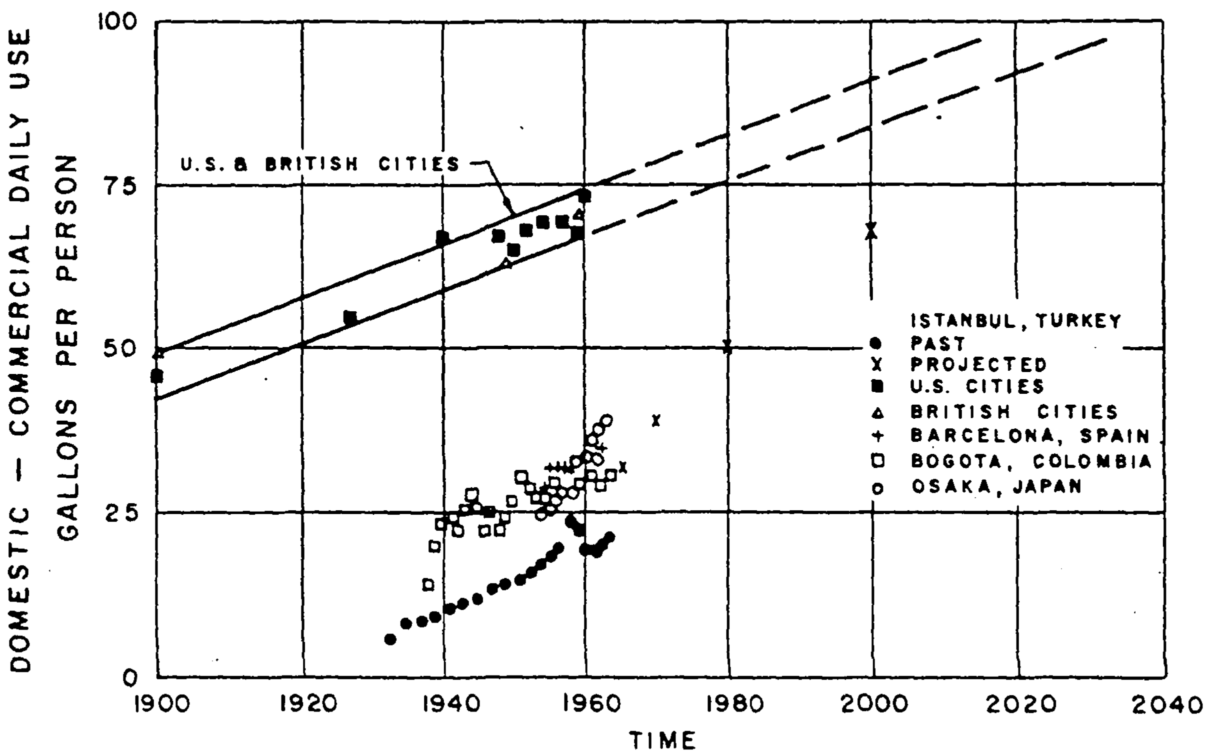


FIGURE 3 - COMPARISON OF DOMESTIC-COMMERCIAL WATER USE

facilities. In old systems which have no meters and do not have an average maintenance program, unaccounted water can amount to 60 to 75 percent of the domestic-commercial-industrial demand. If the distribution system is surveyed for leaks on a regular basis, a good maintenance program can reduce this amount to about 25 percent of the demand.

Summary

The conditions which affect total demand include real and potential growth of the area, socio-economic status of the residents, weather, density of population, use of water meters, cost of water, and the availability of natural resources which will attract industry or other heavy water users. After the effect of these conditions has been analyzed, the water handling facilities should be designed to meet the projected domestic-commercial-industrial demand and unaccounted-for water.

Acknowledgements

The consumption data for Istanbul, Barcelona, Bogota and Osaka were supplied by their local water-supply agencies. I wish to thank these agencies for supplying the data and also for their farsightedness in keeping the data in a form which allowed water-demand data to be divided into domestic-commercial and industrial categories.

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TABLE 1 - CHANGES IN DOMESTIC AND COMMERCIAL WATER USE FOR CITIES IN GREAT BRITAIN

CITY	Year	Population 1000's	DAILY DOMESTIC USE: Millions Of Gallons	DAILY DOMESTIC USE: Gallons Per Person	DAILY DOMESTIC AND COMMERCIAL USE*: Gallons Per Person
Glasgow, Scotland	1900	1,000	41	41	69
	1949	1,223	59	49	81
	1959	1,213	69	57	95
Liverpool, England	1900	857	18	22	36
	1949	1,097	32	30	50
	1959	1,111	38	35	58
London, England	1900	5,900	195	33	55
	1949	6,453	260	40	67
	1959	6,270	270	43	72
Manchester, England	1900	907	19	20	35
	1949	1,200	36	30	50
	1959	1,276	44	34	57

*Estimated

TABLE 2 - INDUSTRIAL WATER USE FOR SELECTED CITIES

CITY	Year	Population 1000's	Industrial Consumption: Gallons Per Day	Industrial Consumption: Percent Of Gross
Glasgow, Scotland	1949	1,223	1,500,000	1.5
	1959	1,213	850,000	0.75
London, England	1949	6,453	9,500,000	2.4
	1959	6,270	9,500,000	2.2
Barcelona, Spain	1960	2,139	6,600,000	6.9
Bogota, Columbia	1961	1,207	10,000,000	15.
Liverpool, England	1900	857	1,550,000	4.7
	1949	1,097	11,500,000	17.4
	1959	1,111	12,500,000	16.0
Manchester, England	1900	907	7,150,000	19.
	1949	1,200	16,500,000	18.5
	1959	1,276	17,000,000	15.
Dublin, Ireland	1900	290	3,200,000	19.5
	1949	603	6,300,000	18.
	1959	709	6,900,000	15.
Istanbul, Turkey	1960	1,450	14,500,000	21.
Osaka, Japan	1960	2,966	155,000,000	55.

PREVISION DES DEMANDES D'EAU URBAINES DANS LES PAYS EN VOIE DE DEVELOPPEMENT

Résumé

Introduction

Une grande partie de la planète souffre de pénuries d'eau. Les causes principales en sont: 1) le manque de ressources naturelles; 2) l'absence de financement et la gestion impropre des ressources; et 3) les installations limitées d'exploitation des eaux. Dans ce dernier cas l'objectif du service d'alimentation en eau doit être de satisfaire toutes les demandes. Au sens que lui donne le rapport, la demande correspond au volume d'eau qui serait utilisé si on pouvait l'obtenir à un prix raisonnable. Ce facteur est comparé à celui de "consommation", c'est-à-dire au volume réel d'eau qui va à l'utilisateur. La planification nécessaire à la réalisation d'un tel objectif exige l'établissement d'une évaluation sûre des demandes d'eau futures.

Cette partie du rapport décrit les composantes de la demande et certaines des conditions qui les affectent. Elle fournit également des données pouvant servir à déterminer les demandes d'eau futures. De nombreuses conditions influent sur les composantes de la demande totale, c'est-à-dire la demande pour les usages ménagers, commerciaux et industriels. Chacune de ces composantes est analysée, ainsi que les conditions qui influent sur elle.

Accroissement démographique urbain

Le rapport étudie diverses méthodes d'établissement des projections démographiques applicables aux pays en voie de développement et compare les méthodes statistiques et les méthodes économiques. Il traite brièvement des projections démographiques statistiques et des projections des rapports démographiques.

La demande des ménages et la demande commerciale

Les projections de la demande par habitant sont examinées en prenant pour base l'analyse de données relatives à la consommation d'eau des villes suivantes: Barcelone (Espagne); Bogota (Colombie); Osaka (Japon) et Istanbul (Turquie). Ces données sont comparées aux courbes de la demande des Etats-Unis et de la Grande-Bretagne. Les effets de l'usage du compteur d'eau sont également décrits.

La demande industrielle

Les données relatives au pourcentage de la demande d'eau que représente l'usage industriel dans un certain nombre de villes du monde sont comparées entre elles et analysées.

Pertes et fuites

Le rapport traite également des études relatives aux pertes et aux fuites et des répercussions de celles-ci sur la courbe de la demande totale.

LA PREDICCION DE LAS DEMANDAS DE AGUA DE LAS GIUDADES EN LOS PAISES EN DESARROLLO

Resumen

Introducción

Una gran parte del mundo sufre escasez de agua. Las causas principales son: (1) la falta de recursos naturales; (2) la carencia de financiación y de administración apropiada; y (3) el número limitado de instalaciones de manejo del agua. Con respecto al último punto, la meta del organismo encargado del abastecimiento de agua debe ser la de satisfacer todas las demandas. Para los propósitos de este informe, "demanda" es la cantidad de agua que se usaría si se la tuviera disponible un costo razonable; y "uso" es la cantidad real de agua que recibe el consumidor. La planificación previa necesaria para llegar a esta meta requiere un cálculo fidedigno de las futuras demandas de agua.

Este informe describe los componentes de la demanda y algunas de las condiciones que los afectan. También proporciona datos que pueden usarse para determinar demandas futuras de agua. Los componentes de la demanda total, por ejemplo las demandas doméstica, comercial e industrial, están bajo la influencia de muchas condiciones. Se analizan cada uno de estos componentes y las condiciones que los afectan.

Crecimiento de la Ciudad

La discusión de varias técnicas de proyección de la población aplicadas a los países en desarrollo incluye la comparación entre los métodos económicos y los estadísticos. Se examinan brevemente las proyecciones de la población desde el punto de vista estadístico y la proyección de las relaciones de la población.

Demandas Doméstica y Comercial

Se discuten las proyecciones de la demanda por persona, basadas en análisis hechos tomando las informaciones de consumo de agua de Barcelona, España; Bogotá, Colombia; Osaka, Japón; e Istambul, Turquía. Estos datos se comparan con los regímenes de la demanda en los Estados Unidos e Inglaterra. También se hace referencia al efecto de la instalación de contadores de agua.

Demandas Industriales

Se dan las comparaciones y los análisis de la parte de la demanda total de agua usada por las industrias en varias ciudades del mundo.

Desperdicio y Filtraciones

El informe también trata de las investigaciones sobre el desperdicio y las filtraciones de agua y sus efectos sobre los regímenes de la demanda total de agua.

LOW COST DISTRIBUTION SYSTEMS

E.K.G. Borjesson

Twentieth century man, for all his vaunted achievements on the many frontiers of science, is only recently re-learning the simply but profoundly basic tenet of life that holds the consequences of living in his own filth to be inevitably fatal. Milleniums ago the ancient civilizations were well aware of the pertinence and intimate relationship that water has to public and personal health. Herodotus tells of Eastern nations, such as Persia, where it was customary to drink only boiled water from selected sources, and Crete has well-preserved remains of impressive water supply installations over 4000 years old. But with the Romans the dedication to the cause of rational water use was not only thoroughgoing, it was spectacular! Even today their structures and appurtenances, too numerous to list, remain in service everywhere between what were once the extreme limits of the empire at its peak.

It seems incredible that the extensive body of knowledge relating to the significance and use of water, so vital, so well understood, so widely disseminated and with innumerable impressive reminders ever within sight should disappear and be lost to mankind with the political collapse of Rome. From that time until the early part of the last century, the world lived and died with plagues and epidemics, unable to remember these traditions that served their ancestors so eminently and so long.

The awakening came none too soon. The astonishingly rapid growth in the world population that became impressively evident in the 1940's, and still continues, is presenting problems, all distressingly acute, at a rate that is challenging man's capacity to surivive. So all-pervasive has this self-contamination become that the vehicle now includes air as well as water.

DEMOGRAPHIC AND FAMILY STUDY OF PEOPLE NEEDING LOW COST WATER

Communities under 2000 Population

By definition we have eliminated small manufacturing centers, dormitory towns, institutions or the rare center of this size in a predominantly commercial or industrial zone. Therefore a community in this category would be agricultural in nature. Depending on the geographic location and cultural orientation the center will vary as to population, type and volume of production and relative economic capacity. The accidents of geography offer great disparities. For the village situated in the Magallanes Provence of Chile, compared to that nestled in the foothills of Jebel Druz in Syria, neither the matter of supply nor that of the individual or collective utilization has many specific aspects in common. Yet when the basic demands are reduced to the least common denominator, which includes only water for drinking, cooking and personal hygiene, the quantity and service requirements of one will not differ materially from the other.

Customs and religion, while not affecting the per capita use to any significant extent, may have influence on the value that any community places on the quality and accessibility of supply. There are examples of relatively expensive water being preferred to free well or river water simply because it washed clothes whiter. Conversely, a municipal supply may be rejected by a community, which sumply returns to its old sources because it can or will not get used to a high CO_2 content. Yet water containing many times more CO_2 may be consumed or used without question in many other parts of the globe.

The barter system is by no means obsolete in many parts of the world nor is the custom of paying for services in kind. Therefore, the actual cash in circulation in these small and relatively isolated centers tends to be low.

This is not necessarily an index to the real economic capacity of the citizens. Quite to the contrary, money, except for minimum quantities, is merely out of sight. Further, the absence of tempting luxuries that fill the supermarkets of the more developed countries tends to limit outlays that are not for comestibles, drink, articles of clothing and utensils. No community is averse to living better. How this is achieved is not always well understood. Most basic needs of a small community are attainable by soliciting contributions or by collecting small fees or taxes on indispensable goods or services. For improvements that serve both physical comfort and community pride, it is not particularly difficult to generate the necessary funds, providing the initiative and long term direction are given.

Populations of 2000 - 25,000

Communities of this size still needing low cost water supply are certainly neither industrial nor extractive; that is to say, they are overgrown farm villages or agricultural commercial centers. A modern phenomenon to be observed in many parts of the world is the gradual stagnation of these towns as both their commercial and cultural functions are being absorbed by the nearest megalopolis. This is one of the results of improved transportation and communication.

Although the gross average family income is apt to increase with the size of the community, the net tends to shrink because of decreasing self-sufficiency and consequent greater dependency on cash.

Under these conditions an inverse ratio of economic capacity to need arises which is aggravated by a tendency to look more to a central authority than to local sources for support and assistance. Actually there develops a "What are you going to do for me?" attitude. The problem becomes magnified because it is common for these entities to make efforts, financial or otherwise, only in proportion to the political returns they bring. The result is a stalemate and the losers are the middle-sized commercial towns.

The most effective remedy, and one that has been successfully employed on several occasions, is the provision of the basic services, including water, through national or regional programs. With sufficient backing to arrange group financing, the task of self-support of each utility can be taken up under better conditions, when the population has learned to appreciate the results of improvement.

Metropolitan Centers

In all metropolitan centers there exist population pockets that vary in size from a few hundred inhabitants to many hundreds of thousands. All have several features in common. The inhabitants are heterogeneous, with little or no civic pride. The family organization is matriarchal, with every member contributing through the means within his reach or capacity. Only in very small zones, where the population is numbered by the hundreds, can the problem now be approached through the users. Elsewhere it must be dealt with by a central authority as the primary public health menace it is.

This problem may have been solved somewhere in the world, but if so, it has been kept a well-guarded secret. It is present in some degree on every continent. Although it is fairly obvious that a central authority can cope with the financial and technical problems, the present philosophy of administration of public water supply systems needs reshaping in order that at least as much dividend as possible, in the form of public health, can be extracted and that the threat of epidemics due to self-contamination may be lessened. Routine attention to the problem of slum areas will result in the collapse of the service in a relatively short time due to abuse and vandalism by the very people who have the most to gain from the operation. Therefore, the utility or agency undertaking a program of this kind should consider setting up a separate management from the one attending to the normal, domestic, commercial and industrial services. This is essential to watch over the physical property and possible revenue but also to apply the stick when the carrot fails and meanwhile to undertake the difficult task of educating the masses to a new and different level of life.

CUTTING THE CLOTH TO FILL THE NEED

When designing low cost water distribution systems, the principal difficulty rests in fixing a realistic per capita consumption value. A choice must be made between what is indispensable and what is desirable, without permitting the perfect to drive out the good.

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The minimum requirements for personal hygiene include only enough water to drink, cook and to wash the hands and face periodically during the day. However, an important point that has been lost or only very partially conceded is that this water, small in volume as it is, should be accessible at a tap on the premises, not in a fingered semi-washed bucket filled from a public fountain. Every drop beyond the essential minimum is luxury, however relative. There is a reluctance to come to grips with reality and abandon the heavy surcharges the conventional utility must carry to serve purposes other than human survival. These include a part for domestic use, commercial use in hotels, offices, stores, restaurants, laundries, industrial use according to location and public use in buildings, street washing, sewer flushing, hospitals, cemeteries, parks and fires.

To contend that the provision of limited supply condemns the neighborhoods or communities to a permanent and hopeless state of inferiority is also unrealistic: first, because it takes time to train a population in the use of water; second, this training should start at the beginning because there are no societies in which stages, either cultural or economic, may be by-passed successfully; and third, because a modest program that can be executed is to be preferred to an elaborate one that never gets off the paper. Average consumption rate in areas of the type under discussion will not vary much from between thirty to fifty liters per capita per day if the utility is well managed.

CLASSICAL SOLUTIONS

Since time immemorial the portion of the urban population that could not afford to pay for regular service, or lived in areas where this service did not reach, has been supplied from public fountains, water carriers, water carts or individual shallow wells, often with great irregularity. These marginal supplies are everywhere very sensitive to seasonal fluctuations and often in an abidingly precarious state of repair.

Of the various sources mentioned, the most reliable, both in quantity and quality, is probably the public fountain. The chances, as a rule, are somewhat better that the materia prima is less questionable and that it has undergone less alteration prior to delivery at the spout. It should not be the solution of choice in modern communities, particularly in overcrowded urban centers.

CONTEMPORARY SOLUTIONS

Some years ago, Dr. James Watt of the United States Public Health Service and Dr. T. Hardy of the Florida State Public Health Laboratory, in a full-scale experiment, demonstrated the importance of having running, versus carried, water in the dwelling. Literally, water must be on tap on the premises and then it becomes a safeguard against waterborne disease, providing a degree of assurance that can only be approximated with other forms of delivery. Under these conditions the reduction of waterborne disease carries with it a bonus in the form of the Mills-Reincke phenomenon by causing a parallel reduction in the apparently unrelated non-waterborne diseases.

Water to Economically Depressed Pockets in a City

In Asuncion, Paraguay, a series of quarters densely populated by citizens of less than moderate means has been furnished with a service that provides all the water they can use commensurate with their standard of living, under service conditions that virtually eliminate waste. The problem was resolved in two steps: first, by developing the Fordilla to control, without unduly restricting consumption; and second, by a minimum distribution system (minigrid) designed to realistic specifications that admitted economies of starting magnitude.

The combined use of the Fordilla with the minimum grid made it possible to install the system, including house connection, for a price as low as $4 60 per capita, which, combined with low operating cost due to controlled use and elimination of waste, permitted a fixed rate that was equally satisfactory to the consumer and the utility. This rate amounted to 25 percent of the popular rate in the conventional system and 33 percent of the minimum rate in the same area.

It has been the universal experience of water works operators that any house connection that is not metered or in some other way controlled, so that it is to the interest of the client to shut it off when not in use and make repairs when leaking, is from the management standpoint excessively costly. The Fordilla essentially solves these two problems of the utility without prejudice to the consumer.

The Fordilla has the appearance of a slightly oversized faucet. It is designed to discharge a predetermined quantity of water per operating cycle, normally one liter. The time consumed in completing one cycle is controlled by the artifact, not by the operator. A downward push on the top buttom starts the water flowing and it stops when the designed quantity has been discharged. The button must then be released to allow the Fordilla to re-arm itself. To complete a cycle requires from six to eight seconds.

The Fordilla has, in addition, two other characteristics that mitigate for the low cost or minimum system. First, the time of discharge varies with the residual line pressure, delivering constant volume, automatically compensating itself during peak hours by extending the delivery time from about 2 to 11 seconds over a range of from 3 to 120 pounds. Second, the shutoff is automatic and positive; the line pressure seats the valve, which prevents waste and minimizes leakage.

Water to a Small Community

The village of Bahia Negra is located on the upper Paraguay River where Bolivia, Brazil and Paraguay meet in a region of splendid isolation. As befits a border community, it boasts a small garrison, a hundred or so naval persons, who provide tone, social discipline and certain more tangible accommodations such as dental service and several forms of communication. Of the 107 buildings, including the Naval Station, that constitute the settlement, more than 100 are built from foundation to roof of split palm. The gray palm slats, blending with the sun-baked grassless lateritic soil and straggling mesquite trees, conspire to accentuate everything negative in the preconceptions or first impressions a visitor may enter with.

The economy rests solely on ranching and palm logging, both activities being carried out in highly unsophisticated form. In consequence, at any one time, a large portion of the 1200 inhabitants are absent from the town. There are no motion picture theaters, night clubs, drug stores, bars or other media by which developed man tries to escape from reality. Here reality is immediate; commerce is in items that will help cope with it - flour, clothes, weapons, ammunition, kerosene, etc.; and social life is in the home.

Waterborne epidemics have for years been regular visitors to Bahia Negra, and in 1965 one passed through that afflicted every single household, taking the lives of fourteen infants in a matter of days. As the 1966 season approached, the Central Government instructed Corposana, the national entity in charge of water and sewers in Paraguay, to examine the possibilities of helping the community, offering certain cooperation from the armed forces in the form of transport, equipment and the use of their facilities on the site. In two days, detailed construction plans, material, staffing and procedures were prepared. One day later, the decision to proceed was taken. Everything for the first stage was airlifted in three DC-3 planes and the balance was shipped by boat. The difference in time en route is roughly two hours versus two weeks.

The installations at Bahia Negra are representative of a minimum system designed to provide water to every dwelling of a small community. The plant consists of a raw water intake, pump, pressure filter and chlorinator with a capacity of 200 liters (about 50 gallons) per minute. The water is pumped through the filter and through the distribution grid to an elevated tank of 30,000 liters (about 7500 gallon) capacity. All piping is polyethylene plastic, manufactured nationally to DIN specifications 8074. The grid is made up of pipes in the following lengths and sizes: 760 m. of 3"; 1100 m. of 2"; 1200 m. of 1" and 700 m. of 3/4" and 1/2" for service. there are 25 metered connections and the balance are all Fordillas. The total cost was ₲ 925,094 or $6820, $5.70 per capita.

In the case of Bahia Negra there was no advance propaganda, nor were any comments solicited from the people to gauge the temper of the community vis-a-vis the project. The night before construction was to start, with all materials and key personnel on the site, the Executive Director of the Corporation de Obras Sanitarias (Corposana) called the population to a meeting, described the background and objectives of the undertaking and explained the financial and operational obligations that the community would be expected to assume. Thirty minutes after the opening speech, ₲ 350,000 ($2778) in cash were in the hands of a provisional treasurer and an additional ₲ 300,000 ($2381) pledged, plus commitments from the heads of households and the Navy to furnish all labor and material locally available. At the close of the session, the first Manager and the Board of Directors had been appointed and installed. The people of Bahia Negra apparently rapidly assessed their situation, reached a consensus and then proceeded to settle the issue with truly impressive spirit and dispatch.

It is possible and even likely that this is an unusual case. Nevertheless, in looking back with the deepened perspective that a year provides, it remains a convincing example of how substantial funds can be raised in a community that to all appearances is devoid of any resources.

The minimum system is composed of a sterile source of supply, small diameter pipe grid and controlled services to all households. The reduction in pipe sizes made possible through the elimination of waste and excess capacity is at times truly phenomenal. One pocket of nine blocks in Asuncion is being supplied through 3/4" mains. The effective use of small diameter pipe widens the choice of materials to include plastics. With these materials and an adequate familiarity with the correct practices relating to their use, really rock-bottom installation prices are attainable. The control is usually achieved through a device such as the Fordilla, although, as was the case of Bahia Negra, a small percentage of metered services may be needed to meet the exceptions to the rule.

With the economics in installation on the order of 1 to 5 and 1 to 10, in operation of 1-3 and 1-4, the minimum system offers 100 percent service to a community under conditions that conform to the best usage in modern public health practice.

MANAGEMENT

Management of a minimum system, either communal or as part of a large urban utility, must maintain a client relationship that is more intimate than necessary under ordinary circumstances. In small communities, ideally all operating positions should be filled with local talent backed up by close technical and administrative direction. Inspection must be regular and frequent to maintain quality service. A particular sharp surveillance is often necessary to insure the timely application of administrative regulations governing payment, disconnection, tampering or general abuse to relieve the management of the necessity for making too many emotional decisions.

In metropolitan slum areas where human warrens are the norm, the utility client is not the user. Nevertheless, if water and environmental sanitation are going to fullfil their missions, any pleas must be addressed to the latter. Years ago when flat rate service was in vogue, it was customary for the utility to send inspectors from house to house, not only to count the fixtures but to verify their state of repair and to convince the occupant, possibly because there was no way of forcing him, of the desirability of timely maintenance. The modern world is somewhat changed and, therefore, today it would be more effective to institute a procedure that combines the skill of the old plumbing inspector with that of the contemporary health educator.

FUTURE

There are thousands of towns in the world like Bahia Negra that regularly face decimating epidemics. Every continent has vast metropolitan centers with proliferating slum areas where the most elementary sanitation is nonexistent. For financial as well as cultural reasons it is impossible to think of relieving these conditions by the installation of conventional facilities. Yet the population concentrations, left to themselves, are centers of endemic disease from which epidemics may issue at any time. They are a health menace to the world at large that becomes increasingly acute as populations grow.

In small communities the minimum system can be highly effective. Designed to rational dimensions and specifying materials and equipment in terms that take optimum advantage of all that modern technology has to offer, the costs can be kept within reach of all but the most primitive and remote hamlets.

The minimum system of a small community can be used, varying only the managerial approach, in metropolitan centers made up essentially of simplex dwellings. In huge multiplex units the basic principles still apply. However there application is somewhat complicated by the existing limitations of plumbing fixture design.

SYSTEMES ECONOMIQUES DE DISTRIBUTION DE L'EAU

Résumé

Le document rend compte des études relatives à la démographie et au revenu familial des tranches de population qui ont besoin d'être approvisionnées en eau à bas prix.

Communes de moins de 2.000 habitants

Dans le cadre de l'étude, pratiquement tous les centres entrant dans cette catégorie seraient des centres agricoles. Selon la situation géographique de chaque centre et le genre de culture auquel il se livre, ses caractéristiques seront variables en ce qui concerne sa population, le type et le volume de sa production et son potentiel économique relatif. En général, le volume des échanges monétaires sera peu élevé. Toutefois, le potentiel économique que permettent d'atteindre un bon encadrement et une bonne organisation est en général surprenant.

Population comprise entre 2.000 et 25.000 habitants

Les communes de cette importance, ayant encore besoin d'être approvisionnées en eau à bas prix, ne sont certainement ni des communes industrielles, ni des communes de mineurs; en d'autres termes ce sont de gros villages agricoles ou des centres commerciaux ruraux. Le revenu familial moyen sera peut-être plus élevé dans une grande ville, mais les capitaux auront tendance à être d'une obtention plus difficile, bien que la nécessité de l'approvisionnement en eau soit généralement plus aiguë.

Centres urbains

Dans presque tous les centres urbains il existe des communautés dont l'importance peut varier de quelques centaines à plusieurs milliers ou à des centaines de milliers d'habitants. La plupart ont plusieurs caractéristiques communes. La population est généralement hétérogène, l'organisation familiale du type matriarcal, la plupart des membres de la famille travaillant quand ils le peuvent, mais l'argent y est très rare. C'est le type d'opération le plus difficile à financer et à administrer.

Lorsque l'on élabore un système économique d'approvisionnement en eau, la principale difficulté consiste à déterminer de façon réaliste le volume de la consommation par tête d'habitant. Il faut choisir entre ce qui est indispensable et ce qui est souhaitable, sans perdre de vue que le mieux est parfois l'ennemi du bien.

Le minimum nécessaire est simplement ce qu'il faut pour boire et pour se laver les mains et la figure. Dans toute la mesure requise pour maintenir le prix dans les limites réalisables, toute l'eau dont a besoin une société à revenus élevés pour les bains, les chasses d'eau, le lavage, l'arrosage des plantes et des rues, la lutte contre l'incendie et l'agrément des jardins publics sera réduite ou éliminée.

De temps immémoriaux certains éléments de la population des villes se sont approvisionnés aux fontaines publiques, aux porteurs d'eau ou aux tonnes ambulantes, et rarement 24 heures sur 24. L'analyse des expériences effectuées par Watt et Hardy pour déterminer les effets qu'aurait l'installation de l'eau courante dans toutes les maisons sur l'élimination des maladies transmises par l'eau, combinée avec les effets du phénomène de Mills-Reincke, attestera la valeur d'un réseau minimum d'approvisionnement et de distribution d'eau.

Dans la ville d'Asunción, au Paraguay, un groupe de quartiers à forte densité de population constituée par des habitants ayant des moyens moins que modérés, a été doté d'un service qui leur fournit toute l'eau qu'ils peuvent utiliser, dans la mesure compatible avec leur niveau de vie, ce service étant assuré dans des conditions qui éliminent pratiquement le gaspillage. Grâce à la mise au point du Fordilla, qui contrôle la consommation sans la restreindre indûment, le système de distribution a été conçu selon des spécifications qui ont permis de réaliser des économies d'une importance stupéfiante. Ce résultat a permis à son tour de fixer un taux de consommation qui donne également satisfaction aux consommateurs et au service des eaux.

Le Fordilla est un appareil de la taille d'un gros robinet, conçu de façon à laisser couler une quantité prédéterminée d'eau par cycle de fonctionnement. Le temps nécessaire à l'achèvement d'un cycle, ainsi que le volume d'eau obtenu chaque fois, sont contrôlés par l'appareil et, dans une certaine mesure, par la pression, mais non par l'utilisateur. Le principe de base consiste à empêcher tout gaspillage, sans pour autant restreindre la consommation d'eau plus qu'il est nécessaire.

Le village de Bahía Negra est situé sur le cours supérieur du Paraguay, à l'endroit où les frontières de la Bolivie, du Brésil et du Paraguay se rejoignent, dans une région totalement isolée. La population était régulièrement frappée par des épidémies transmises par l'eau, qui faisaient périr un pourcentage anormalement élevé d'enfants. Environ 1.200 habitants y vivent dans 82 maisons. L'utilisation de conduites en matière plastique dont le faible poids s'allie à un prix de revient et à des frais de pose peu élevés, a permis de construire en 8 jours un réseau complet, avec station de filtrage, qui a coûté 600 guaranis par habitant; la population du village a fourni la totalité des fonds et de la main-d'oeuvre.

Les relations entre le service des eaux et l'usager doivent être plus intimes que dans les circonstances ordinaires. L'idéal serait que l'encaisseur et l'inspecteur deviennent des personnages familiers du quartier. Il est d'importance capitale que les encaissements s'effectuent de façon régulière, de préférence à date fixe chaque mois, et que l'on n'hésite pas à suspendre le service en cas de non-paiement, de manipulation illicite ou d'abus. Le pire ennemi de la direction du service des eaux risque d'être sa propre indécision, ses hésitations et toute attitude tendant à faire naître le doute.

Du fait du développement ininterrompu des centres urbains, les systèmes économiques de distribution n'ont qu'une solution. Faute de l'adopter, on permettra le développement de zones où les maladies régneront de façon endémique, et à partir desquelles celles-ci risqueront de se propager périodiquement. Nombreux sont les exemples historiques qui démontrent les effets de la négligence dans ce domaine, à commencer par les épidémies du Moyen Age.

SISTEMAS DE DISTRIBUCION DE BAJO COSTO

Resumen

En este trabajo se informa sobre estudios demográficos y de ingresos familiares realizados respecto a las personas que necesitan abastecimiento de agua a bajo costo.

a. Comunidades de menos de 2.000 habitantes

Prácticamente todos los centros que caen dentro de esta categoría son de naturaleza agrícola. De acuerdo con la situación geográfica y la orientación cultural, sus características varían en cuanto a la población, tipo y volumen de producción y capacidad económica relativa. Generalmente el volumen de dinero en circulación es bajo. Sin embargo, usualmente es asombroso el potencial económico que pueden desarrollar si cuentan con buenos líderes y con una buena dirección.

b. Población de 2.000 a 25.000

Las comunidades de este tamaño que todavía necesitan abastecimiento de agua de bajo costo no son, por cierto, ni industriales ni extractivas; es decir, son más bien poblados agrícolas que han crecido mucho o centros comerciales agrícolas. El ingreso familiar medio tiende a ser mayor en los pueblos más grandes, pero el capital tiende a ser más difícil de obtener a pesar de que la necesidad de disponer de servicio de agua es usualmente mayor.

c. Centros metropolitanos

En prácticamente todos los centros metropolitanos existen núcleos aislados de población que varían en tamaño desde unos pocos cientos de habitantes hasta varios miles o cientos de miles. La mayoría de estos núcleos tienen varios rasgos comunes. La población es generalmente heterogénea; la organización familiar, matriarcal; la mayor parte de sus miembros trabajan cuando pueden, pero el dinero es muy escaso. Este es el tipo de operación más difícil de administrar y financiar.

Cuando se proyecta un sistema de distribución de agua de bajo costo, la dificultad principal consiste en fijar un valor de consumo por persona ajustado a la realidad. Hay que escoger entre lo indispensable y lo deseable, y evitar que la aspiración de lograr lo perfecto impida realizar lo bueno.

Los requerimientos mínimos incluyen solamente el agua para beber y para lavarse las manos y la cara. Las necesidades de las sociedades de altos ingresos--de agua para bañarse, usar en los inodoros, lavar, regar, limpiar las calles, apagar los incendios y adornar los parques--se eliminan o se reducen en la medida que sea necesario para conservar los precios dentro de los límites aceptables.

Desde tiempos inmemoriales, algunas porciones de la población urbana han sido abastecidas con el agua de las fuentes públicas, de los cargadores y de las carretas de agua, y pocas veces este abastecimiento se ha mantenido las 24 horas del día. El análisis del experimento llevado a cabo por Watt y Hardy para probar el efecto de la disponibilidad de agua corriente en cada domicilio sobre la eliminación de las enfermedades hídricas, combinado con los efectos del fenómeno Mills-Reincke, demuestran la importancia de los sistemas mínimos de abastecimiento y distribución de agua.

En Asunción, Paraguay, una serie de barrios densamente poblados por personas de recursos menos que moderados, han sido provistos de un acueducto que les ofrece toda el agua que pueden usar en proporción con su nivel de vida, bajo condiciones que prácticamente eliminan el desperdicio. Con la introducción de la Fordilla para controlar el consumo, sin restringirlo indebidamente, se diseñó un sistema de distribución sometido a especificaciones que permiten hacer economías de una magnitud sorprendente. Esto, a su vez, hizo posible establecer una tarifa igualmente satisfactoria para los consumidores que para las empresas de servicio público.

La Fordilla, un dispositivo del tamaño y la forma de un grifo abultado de agua, está construida de manera que descarga una cantidad predeterminada de agua en cada ciclo de operación. El tiempo consumido en completar un ciclo, así como el volumen distribuido, son controlados por el artefacto y, hasta cierto punto, por la presión, y no por la persona que lo usa. El objetivo básico es eliminar el desperdicio sin restringir innecesariamente el uso del agua.

La aldea de BahíaNegra está situada en las márgenes del alto Paraguay, donde se unen Bolivia, Brasil y Paraguay, en una región completamente aislada. La comunidad sufría regularmente de epidemias de enfermedades hídricas que diezmaban desproporcionadamente la población infantil. Hay alrededor de 1.200 personas que viven en 82 casas. Usando tuberías plásticas para combinar el poco peso con los bajos precios de compra y de instalación, se construyó en 8 días un sistema completo, con estación de filtración,a un costo de 600 guaraniés por persona; la población local contribuyó con el 100 por ciento del dinero y el trabajo.

Las relaciones entre las compañías de servicios públicos y el cliente deben ser más estrechas que en circunstancias normales. Lo ideal sería que el cobrador y el inspector se convirtieran en figuras familiares al vecindario. Es de primordial importancia que los cobros se efectúen con regularidad, preferiblemente el mismo día de cada mes, y que la suspensión del servicio por falta de pago, consumo ilegal o abuso se realicen también sistemáticamente. El peor enemigo de una administración puede ser su propia indecisión, vacilación o actitud que tienda a crear dudas.

La expansión contínua de los centros metropolitanos hace que sea imperativo el desarrollo de sistemas de abastecimiento de bajo costo. La alternativa es permitir el desarrollo de centros donde la enfermedad se hace endémica y desde los cuales se propaga periódicamente. Abunda la evidencia histórica que demuestra el efecto de la negligencia; las epidemias de la Edad Media son un ejemplo destacado de esta verdad.

THE DEVELOPMENT IN ONTARIO OF REGIONAL WATER SUPPLY AND SEWAGE SYSTEMS FINANCED BY THE ONTARIO WATER RESOURCES COMMISSION

D.S. Caverly

Down through the years man has used the water about him without any serious concern that existing supplies might run low. In the past, his water needs, of course, were limited but those days have now gone forever. Today, the average family uses as much water in a 24 hour period as was formerly used in a week. To this increased domestic use of water has been added the tremendous demands of industry - demands which are staggering in comparison with those of a couple of generations ago!

In the face of this increasing demand for water we have come to realize that existing supplies are not inexhaustible. Certainly, there is an abundance of water in Ontario, but often this is not distributed in such a manner as to meet expanding needs. As a result, the growth and development which has taken place within this Province has outstripped the natural water resources of several areas and it has been found necessary to transport water (at considerable expense, needless to say) from areas of plenty to areas of need.

This was one of the tasks facing the Ontario Water Resources Commission when it was brought into being in 1956. Under the OWRC Act of 1957 the Commission was authorized to construct, operate and maintain water works and to develop and make available supplies of water to municipalities and persons. A similar authority included the construction, operation and maintenance of sewage works. The carrying out of this function has constituted a major portion of the Commission's activity during the past ten years, and has involved it in the construction of facilities, the estimated value of which is now slightly in excess of $150 million.

In such water and sewage construction projects, the Commission has more than one procedure which it may follow. It may, for instance, enter into direct agreement with municipalities, on an individual or area basis, to arrange, on their behalf, the financing, construction and operation of works on terms satisfactory to them. The capital debt is repaid by the municipality over a certain number of years. Under this arrangement, municipalities are enabled to take an active part in the operation of these projects through the appointment of local advisory committees, and Commission supervisory personnel consult regularly with both the project operating staff and these local officials.

Another procedure which may be followed by the Commission is the undertaking of the construction of a facility, again on an individual or on an area basis, with provincial funds being used, and with the facility continuing to be owned by the Province. In such cases the services are provided at cost, with the municipality being charged according to the volume of water supplied or the sewage treated.

Using the latter method of financing, the Ontario Water Resources Commission has undertaken a program of pipeline construction to meet the needs of certain areas in the Province where water is in short supply. Two major pipelines under construction at the present time will, on completion, serve the London and St. Thomas areas.

In the case of London, the city has been depending on ground water supplies for many years. However, its rate of industrial and population growth rendered this source unreliable, and, as a result, this City of some 176,000 people began looking for another water supply. The result has been the multi-million dollar Lake Huron Water Supply System which will stretch approximately 31 miles from Grand Bend on the eastern shore of Lake Huron to Arva which is situated just north of the City of London. Using provincial funds for its construction, the project is expected to cost in the vicinity of $18.5 million and will be completed this spring.

Initially, 22 million gallons per day will be pumped through the 48-inch steel-reinforced concrete line, and delivered to the 12 million gallon storage reservoir at Arva. While the reservoir is being built by the OWRC as part of this provincial project, the City of London will be responsible for municipal distribution. The flow will be increased in stages until the full capacity of 67 million gallons per day is reached.

As in the case of all pipeline studies, the OWRC carefully considered area requirements when constructing the Lake Huron Water Supply System and sized the line so that it would meet long-term regional water needs. Proposals have been presented to municipalities along the pipeline route which might want to use the system as a source of supply. At the present time a number of municipalities are considering these proposals.

The other pipeline project, referred to above, is the Lake Erie Water Supply System which will meet the water requirements of municipalities in the St. Thomas area. This $11 million line is being designed to meet initial short-term requirements of 10 million gallons per day with provision for oversizing to accommodate anticipated development. The pipeline became necessary in view of the increasing residential and industrial water demands of the area. This, coupled with the construction of an assembly plant by the Ford Motor Company of Canada, will create a demand for water beyond the capability of existing local sources of supply. It is expected that the system will provide untreated water to the area municipalities by the fall of this year.

The Lake Huron and the Lake Erie projects are the only OWRC provincially-financed water pipelines schemes presently under way, but others have been proposed for various other areas of the Province as well. Altogether, some 125 provincial projects were under development as of the 31st of December 1966. Included in these is a large sewage treatment plant for the City of Cornwall.

It should also be mentioned that three other OWRC water supply pipelines are in actual operation at the present time. However, these are operated directly under OWRC-municipal agreement. Under the system of financing outlined earlier in this paper, the municipalities involved repay capital costs plus interest rates and operating charges on an annual basis for the period of the agreement. The largest of these, 30 miles in length and known as the Essex County Union Water System, supplies Lake Erie water to two towns (Leamington and Essex), four townships and one major industry in the area. Another line from Lake Erie, four miles in length, supplies the Town of Dunnville, and industries in the Port Maitland area. Another three-mile line was built from Lake Erie some years ago to provide the Village of Harrow with a satisfactory water supply.

The development of provincially-financed projects follows a certain procedure.

If, from information on hand, the Commission is of the opinion that a pipeline would be the most feasible solution to area problems, it calls a meeting with the municipalities concerned. If sufficient interest is shown at this meeting, the OWRC authorizes a detailed engineering study of the area, including the estimated costs which will be involved in such a scheme. Further meetings are then held with the municipalities at which time firm proposals and costs are submitted. If the municipalities are agreeable to these proposals the project is then undertaken by the Commission after the signing of appropriate agreements.

It will be appreciated that, before proposals of this nature can be submitted to municipalities, extensive studies on a regional or watershed basis must be undertaken, and the Commission has been very active in such undertakings during recent years. These include a study of population and land use trends (utilizing planning and development information to provide projections), the compilation, evaluation and interpretation of surface and ground water resources, the evaluation of existing water supply and pollution control facilities, the determination of future water supply and pollution control requirements, and the consideration of alternate schemes supported by engineering and economic evaluations.

A number of these regional studies have been carried out to date. For example, in Lincoln County the Commission has proposed sewage services based on watershed units, whereby sewage will be collected from developed areas within the various watersheds and treated in plants servicing, in some instances, more than one watershed unit. Similarly, it is proposed to service the Southern Peel County Area with trunk sewers that will convey sewage from the municipalities to sewage treatment plants located on Lake Ontario.

Area sewage schemes provide an opportunity for the removal of sewage effluents from streams with insufficient ability to assimilate the wastes and, by proper planning, dispose of them in waters more able to cope with them. Included in such proposals is the oversizing of such water and/or sewage works so as to provide for the future growth of an area. The recovery of the cost of oversizing is eventually worked out as the facility comes more and more into full use.

While individual water and sewage projects will continue to be developed to meet the needs of growing municipalities, it is to be expected that more and more emphasis will be placed upon the development of regional systems. In this way a more accurate determination can be made of the diversified demands being placed on our available water resources not only for the immediate future but also for as much as fifty years ahead. The same can be said with respect to planning for adequate sewage treatment facilities. This will include, of course, the development of alternative plans which appear to be economically feasible and, at the same time, show promise of being acceptable to the local people. After careful analysis of these various alternatives the optimum plan for the most comprehensive development of an area may be evolved.

This broad concept of water management is presently being adhered to, and undoubtedly will account for a major portion of the Commission's activities in the years ahead.

LES RESEAUX REGIONAUX D'ADDUCTION D'EAU ET D'EVACUATION DES EAUX USEES (PIPE-LINES) DANS L'ONTARIO

Résumé

En ce qui concerne les projets de construction d'adduction d'eau et de réseaux d'égouts, la Commission emploie différentes méthodes. Elle peut passer des accords directs avec les municipalités, sur une base individuelle ou régionale, aux fins de prévoir en leur nom, le financement, la construction et l'exploitation d'ouvrages selon des conditions acceptables par les municipalités intéressées. Dans ce cas, les municipalités peuvent jouer un rôle actif dans l'exploitation de ces projets par l'établissement de comités consultatifs régionaux. Les cadres de la Commission ont des consultations périodiques avec le personnel de direction affecté aux projets et ces fonctionnaires locaux.

Une autre méthode employée est celle qui permet à la Commission d'utiliser des crédits du Gouvernement provincial pour construire de tels ouvrages à l'intention des municipalités, des redevances étant perçues en fonction de l'utilisation effective des services rendus.

La Commission des ressources en eau de l'Ontario a récemment inclus dans son programme la construction de pipe-lines d'adduction d'eau pour satisfaire les besoins des régions de la province qui souffrent d'une pénurie d'eau. Cette façon d'aborder les choses est relativement nouvelle et a été élaborée afin de faire face aux besoins immédiats de certaines régions du sud de l'Ontario.

Le premier pipe-line de ce genre est en cours de construction entre Grand Bend, sur le lac Huron, et Arva, juste au nord de London. Il fournira l'eau à la ville de London et aux autres municipalités situées le long de son parcours de 51,2 km.

A la suite d'une étude régionale, effectuée dans le comté de Lincoln, la Commission a proposé d'assurer des services d'égouts à la région, en fonction des unités situées dans le bassin hydrographique. L'effluent urbain sera collecté dans les régions développées des divers bassins hydrographiques et traité dans des stations desservant, dans certains cas, plus d'une unité de bassin hydrographique.

On propose de desservir la région méridionale du comté de Peel au moyen de collecteurs d'égout qui achemineront l'effluent des municipalités jusqu'aux stations de traitement situées sur le lac Ontario. Des plans régionaux sur les effluents ont permis de détourner les effluents des cours d'eau incapables d'assimiler les déchets et, grâce à une planification judicieuse, de déverser ces déchets dans un cours d'eau mieux à même d'assimiler les effluents.

De grandes régions de la province peuvent être desservies par les ouvrages d'adduction d'eau et les réseaux d'égout, des dispositions ayant été prises pour tenir compte de la croissance future de la région. Le remboursement des frais entraînés par la construction d'ouvrages dont les dimensions dépassent les besoins actuels est calculé en fonction de l'utilisation ultérieure des installations.

SISTEMAS REGIONALES DE ABASTECIMIENTO DE AGUA Y ALCANTARILLADO (TUBERIAS) EN ONTARIO

Resumen

Para los proyectos de construcción de abastecimientos de agua y alcantarillado, la Comisión sigue diversos procedimientos. Puede suscribir convenios directos con las municipalidades, a título individual o por zonas, para concertar, a nombre de ellas, el financiamiento, la construcción y la operación de obras en condiciones satisfactorias para las municipalidades interesadas. En esos casos, las municipalidades pueden tomar una parte activa en la operación de tales proyectos mediante el nombramiento de comités consultivos locales. El personal supervisor de la comisión consulta periódicamente con el personal de proyectos y con estos funcionarios locales.

Otro método consiste en que la Comisión haga uso de fondos del Gobierno Provincial para construir esas obras para uso de las municipalidades, con créditos relacionados con el uso real de los servicios proporcionados.

La Comisión de Recursos de Agua de Ontario incluyó recientemente en su programa la construcción de tuberías para abastecimiento de agua a fin de cubrir las necesidades de zonas de la Provincia donde hay escasez de agua. Este procedimiento es relativamente nuevo y se concibió con el objeto de llenar necesidades inmediatas en algunas zonas meridionales de Ontario.

Se está construyendo la primera de esas tuberías desde Grand Bend, en el Lago Hurón, hasta Arva, inmediatamente al Norte de London; esa tubería abastecerá de agua a la ciudad de London y a otras municipalidades a lo largo del trayecto de 32 millas que tendrá.

En el Municipio de Lincoln se ha realizado un estudio regional, como resultado del cual la Comisión ha propuesto que se proporcionen servicios de alcantarillado para la zona, fundados en unidades de cuencas hidrográficas. Las aguas residuales se reunirán de zonas desarrolladas dentro de las diversas vertientes y se tratarán en instalaciones que, en algunos casos, prestarán servicios a más de una unidad colectora.

Se propone prestar servicios a la Zona Meridional del Municipio de Peel con alcantarillas maestras que transportarán las aguas residuales desde las municipalidades a instalaciones de tratamiento de aguas servidas situadas en el Lago Ontario. Los programas de alcantarillado de la zona han proporcionado una oportunidad para eliminar efluentes de aguas residuales de corrientes con capacidad insuficiente para asimilar los desechos y, mediante una planificación adecuada, para depositar los desechos en una corriente receptora efluente más apropiada.

Pueden prestarse servicios a grandes zonas de la Providencia mediante obras de abastecimiento de agua y alcantarillado, o una de las dos, con planes previstos para el crecimiento futuro de la zona. La recuperación del costo que entraña el mayor tamaño de las obras está calculada en relación con el uso subsiguiente de las instalaciones.

International Conference on WATER for PEACE

Canada Water Supply

INTERIM STUDY ON MEASURES TO SUPPLEMENT LOW FLOWS ON THE SOURIS RIVER IN MANITOBA

V.M. Austford

INTRODUCTION

The Souris River Basin in Manitoba occupies approximately 3,467 square miles in the southwestern corner of the Province, as shown on Figure 1. This portion of Manitoba is classed as a semi-arid grassland. The surface soil characteristics vary from boulder till plain material in the west, to out-wash gravels in the centre, to light-textured lake-bed deposits in the eastern part. The land has been extensively cultivated and is characterized by periodic drought. Average annual precipitation totals 18 inches.

The Souris River rises in the Province of Saskatchewan, crosses the International Boundary into the State of North Dakota and then returns across the International Boundary into the Province of Manitoba through which it flows northward for about 170 miles to join the Assiniboine River near Treesbank. Flow across both boundary crossings is controlled under international agreement. North Dakota is directed to deliver 6,069 acre feet of water to Manitoba during the months of June to October except under periods of severe drought, in which case the responsibility of North Dakota is limited to the provision of such flows as may be practicable.

Through past years of experience it has been found that Manitoba requires approximately 20 c.f.s. in order to maintain a live stream throughout the Souris River in Manitoba. In the past few years considerable local interest has been expressed in supplemental irrigation in the valley flats. The Town of Souris directly, and the Town of Melita indirectly, obtain their water supply from the Souris River. A preliminary appraisal of present and projected uses on the main stem indicates that approximately 50 c.f.s., during the months of June to October inclusive will be required by 1975.

A study of water resources development of the Souris Basin in Manitoba including all aspects of watershed planning is being undertaken. However, due to the lengthy nature of a complete planning study and due to the acute water shortage in the area, it was decided to determine a project for initial completion which would fit the plan of overall development. As a large portion of the demands are in the upper watershed, any initial project must satisfy these as well as other demands. Therefore, only projects which would augment flows in the Souris River downstream from a point above Melita were considered as being suitable for any initial development. As a basis for project evaluation and comparison, the minimum flow which could be maintained in the Souris River during the months of June to October, including the flow crossing the International Boundary, was determined for each proposed project. Several projects in the upper watershed have been advocated from time to time. Some of these have been studied in detail by the Canada Department of Agriculture, Prairie Farm Rehabilitation Administration, and others by the Manitoba Water Control and Conservation Branch.

EXISTING WATER SUPPLY

Stream flow in the Souris River entering Manitoba is controlled under international agreement. The report of the International Joint Commission to the governments of the United States and Canada dated March 19, 1958, stated that except during periods of severe drought, the State of North Dakota is directed to deliver to Manitoba "from any available source during the months of June, July, August, September and October of each year, six thousand and sixty-nine (6,069) acre feet of water at the Westhope Crossing regulated as far as practicable at the rate of twenty (20) cubic feet per second .....". "In periods of severe drought when it becomes impracticable for the State of North Dakota to provide the foregoing regulated flows, the responsibility of the State of North Dakota in this connection shall be limited to the provision of such flows as may be practicable, ...".

Since adoption of this agreement the Souris River Board of Control has adopted tentative drought criteria and set the reduced release from Westhope during severe drought conditions at 10 c.f.s. Therefore, the firm summer flow in the Souris River crossing the International Boundary at Westhope is 10 c.f.s.

During the severe drought period, 1930 to 1941, several dams were constructed in the Souris Basin in North Dakota. Filling of these reservoirs affected stream flow in the Souris River at the Westhope Crossing. Therefore, in order to undertake a water supply study of the Souris Basin in Manitoba, it was necessary to reconstruct stream flow at this station taking cognizance of United States storages and the existing international agreement.

In 1956, the Hydraulic Division, Water Resources Branch, Canada, computed the flows that would have crossed the International Boundary into Manitoba during the critical period 1930 to 1942 under the agreement then being considered (the third Canadian Revision of United States Draft). This information was revised in relation to the present agreement. Reconstructed flows at the Westhope Crossing during the period 1930 to 1942 are shown in Table I and were used for the purposes of this study.

TABLE I

Reconstructed Flows - Souris River at Westhope

	June ac./ft.	July ac./ft.	August ac./ft.	September ac./ft.	October ac./ft.	Yearly Total ac./ft.
1930	1200	1200	1200	1200	1200	6000
1931	1200	1200	1200	1200	1200	6000
1932	1200	1200	1200	1200	600	5400
1933	1200	1200	1200	1200	1200	6000
1934	1200	1200	1200	1200	1200	6000
1935	600	600	600	600	600	3000
1936	1200	1200	1200	600	600	4800
1937	600	600	600	600	600	3000
1938	600	600	600	600	600	3000
1939	1200	1200	1200	1200	600	5400
1940	600	600	600	600	600	3000
1941	600	600	600	600	600	3000
1942	1200					

Average June to October flow, 1930 to 1941 inclusive - 15 c.f.s.
November to May flow, 1930 to 1941 inclusive - nil.

The late 1950's and early 1960's were also a period of severe drought in the Souris Basin. However, the length of the drought period was much shorter than that of the 1930's. On the major tributaries, the Antler River and Gainsborough, Graham and Jackson Creeks, there was little or no flow from June 1960 until March 1964 and hence on these streams this drought was more severe than that of the 1930's.

FUTURE WATER DEMANDS

To assist in the evaluation of a project for initial construction, future water demands on the main stem of the Souris River in Manitoba were estimated for the year 1975. Assumptions used in this study and results obtained are discussed as follows:

Population Estimates

Population projections were made of the four major urban communities along the main stem of the Souris River in Manitoba. These are as follows:

	1961 Population	Estimated 1975 Population
Melita	1038	1300
Hartney	600	700
Souris	1841	2200
Wawanesa	459	500

Municipal Water Supply

The Town of Souris obtains its water supply directly from the Souris River. The Town of

Melita receives its supply from wells that are located in an aquifer which is situated near the Souris River and which receives a greater part of its water from this source. The Village of Wawanesa does not at present have a municipal system but it is anticipated that it will have one by the year 1975. Ground water supplies in the Wawanesa area are quite limited and, therefore, it will no doubt obtain its supply from the Souris River. A figure of 80 gallons per capita per day has been used to estimate water requirements. This rate of consumption includes an allowance for a minor amount of industrial development. It is not anticipated that any industry requiring large amounts of water will establish in the area prior to 1975. On this basis the estimated annual municipal water requirements for the year 1975 are as follows:

Melita		140 acre feet
Souris		236 acre feet
Wawanesa		54 acre feet
	Total:	430 acre feet or 1.4 c.f.s. for five months.

Stockwatering and Channel Losses

Through past years' experience, it has been found that Manitoba requires 20 c.f.s. during the months June to October in order to maintain a live stream. This flow provides for stockwatering and channel losses due to seepage and evaporation. It is not anticipated that this requirement will change appreciably prior to 1975.

Irrigation

Detailed studies have not been made of irrigation potential in the Souris Valley. However, there are at least 15,000 acres of land in the Souris Valley which would be suitable for sprinkler irrigation of forage crops from the Souris River assuming a maximum pump lift of fifty feet. It is anticipated that 5,000 acres will be irrigated by 1975. On the basis of two acre feet of irrigation water per acre, the annual irrigation requirement would be 100,000 acre feet or a flow of 33.3 c.f.s. for a five month period.

Sewage Dilution

To maintain aquatic life in the Souris River, a flow of 1.23 c.f.s. is required per thousand population for sewage dilution. On this basis it is anticipated that the sewage dilution requirement in the year 1975 will be as follows:

Melita	1.6 c.f.s.
Hartney	0.9 c.f.s.
Souris	2.7 c.f.s.
Wawanesa	0.6 c.f.s.

This, however, is not a consumptive use and is, during the summer months, incidental to other demands. During the winter months, a flow of 2.7 c.f.s. would be required for sewage dilution. On a five month basis, the flow required would amount to 3.8 c.f.s.

Recreation, Fish and Wildlife

It is anticipated that water requirements for recreation, fish and wildlife will be incidental to demands listed above.

Summary of Anticipated Water Demands

The following is a summary of anticipated water requirements in the Souris Basin by 1975. The largest of these demands, namely stockwatering and irrigation, would occur during the five summer months. The other demands have, therefore, also been expressed in terms of flow in this five month period.

Municipal water supply	1.4 c.f.s. for five months
Stockwatering and channel losses	20.0 c.f.s. for five months
Irrigation	33.3 c.f.s. for five months
Sewage dilution	3.8 c.f.s. for five months
Recreation, fish and wildlife	--
	58.5 c.f.s. for five months

Return flow from irrigation, although difficult to estimate, will reduce this anticipated water requirement to some extent. For this study, it is sufficiently accurate to say that from 40 to 50 c.f.s., during the months of June to October inclusive, will be required by the year 1975.

PROPOSED PROJECTS

Proposed Tributary Projects

The major tributaries to the Souris River in Manitoba are the Antler River and Gainsborough, Graham and Jackson Creeks. These streams have their source in Saskatchewan in an area that is east of the Moose Mountain Provincial Park and flow southeast into Manitoba to join the Souris River between the International Boundary and the Village of Napinka. The flow is intermittent in each stream with the main runoff occurring during the snowmelt period in the spring. For most of their length the channels are wide, shallow and strewn with boulders of glacial origin. Proposed projects on these streams have been studied and reported on by the Canada Department of Agriculture, Prairie Farm Rehabilitation Administration in an unpublished report.

Proposed Coulter Dam: The proposed Coulter Dam would be located on the north boundary of Section 15-2-27 W.P.M. on the Antler River, two miles upstream of its confluence with the Souris River, near Coulter, Manitoba. The proposed dam would be a zoned, rolled earth embankment, having a maximum height of 65 feet and a total length of 1640 feet. The spillway would be a reinforced concrete chute, 70 feet wide and 273 feet long. The conduit would be a 48 inch diameter corrugated metal pipe controlled by a slide gate in a reinforced concrete gatewell. The estimated cost of the proposed Coulter Dam is $1,520,000.

The reservoir formed by this project would be seven miles long, 55 feet deep at the dam and, on the average, one-third of a mile wide. The storage at full supply level would be 26,500 acre feet. Releases could be made from this reservoir to increase the flow in the Souris River during the five summer months. Operating the reservoir in this manner would provide a firm summer flow of 36.0 c.f.s. in the Souris River at Coulter, including Manitoba's entitlement from the United States.

Proposed Patterson Dam: The proposed Patterson Dam would be located in the S.E. ¼ of Section 29-2-27 W.P.M. on Gainsborough Creek. The proposed dam would be a zoned, rolled earth embankment, having a maximum height of 48 feet and a total length of 830 feet. The spillway would be a timber chute, 68 feet wide, controlled by five overflow radial crest gates. The conduit would be a 36 inch corrugated metal pipe controlled by a slide gate in a reinforced concrete gatewell. The cost of the proposed Patterson Dam is estimated at $539,000.

The reservoir formed by this project would be seven miles long and 44 feet deep at the dam. The storage at full supply level would be 12,600 acre feet. Outflow from this reservoir could be regulated to maintain a flow of 22.5 c.f.s. in the Souris River, June 1 to October 31.

A combination of the proposed Coulter and Patterson reservoirs would provide a firm June to October flow of 44.0 c.f.s. in the Souris River at Coulter. Again, this flow includes Manitoba's entitlement from North Dakota.

Proposed Reddaway Dam: The proposed Reddaway Dam would be located in the N.E. ¼ of Section 35-3-27 W.P.M. on Graham Creek about a mile from the Town of Melita. The proposed dam would be an earthfill, with a drop inlet pipe spillway supplemented by a grassed emergency spillway. The riparian outlet works would consist of a 36 inch diameter gated conduit. The proposed Reddaway Dam is estimated to cost $316,000.

The reservoir created by this dam would have a length of five miles, a maximum depth of 31 feet and a capacity of 2320 acre feet at full supply level. Releases could be made from this reservoir to maintain a flow of 11.25 c.f.s. in the Souris River during the months of June to October.

Proposed Rawlinson Dam: The proposed Rawlinson Dam on Jackson Creek would be located in the S.E. ¼ of Section 21-4-26 W.P.M. and would be of earthfill construction, with a drop inlet pipe spillway and an emergency spillway to pass the project design flood. The cost of this project is estimated at $289,000.

The Rawlinson Dam would create a reservoir having a maximum depth of 34 feet, a length of 7 miles and a capacity at full supply level of 3550 acre feet. This reservoir could be operated to maintain a summer flow of 12.0 c.f.s. in the Souris River.

Proposed Blind Souris Projects

The Blind Souris Valley is a former valley of the Souris River, probably formed by the Souris River during the glacial period. The Valley is located east of the Souris River between Coulter and Melita. It is a well-defined channel about one mile wide, between 50 and 75 feet deep, and about ten miles long. A more easterly abandoned channel exists along the northern five miles of the Blind Souris. It is not as deep or as well-defined as the main channel. The soils in the Blind Souris Valley are generally saline and not suited to agriculture. The land is used for pasture except for a small portion at the north end which is cultivated. In view of the topography and the fact that the valley land is not productive, it has been suggested that a large water storage basin could be developed in the trench, the stored water being used to supplement Souris River flows during low flow periods. Surveys undertaken during the 1930's indicate that the bottom profile of the valley rises from the Souris River at the south end for about four miles to elevation 1425, then falls to the north to the Souris River near Melita. Since both ends of the valley are connected to the Souris River it has been suggested that in addition to the natural flow into the Blind Souris it would be possible, during periods of high water on the Souris River itself, to divert water by gravity or pumping into the Blind Souris Valley to be stored and released when required.

The total gross drainage area of the Blind Souris Valley is about 110 square miles. Waskada Creek, the main tributary, which drains into the southern portion of the valley has a drainage area of 75 square miles. No records of runoff in the Blind Souris watershed are available, and hence it was necessary to estimate mean monthly runoff from the tributary drainage area from records on adjacent watersheds.

Flows in the Souris River in Manitoba are controlled to a large extent by storage in the United States. Flow in the Souris River at the North Dakota-Manitoba Boundary is controlled by International Joint Commission agreement, as stated previously. For the purpose of this study an attempt was made to augment these flows during the five month period June to October by utilizing the storage available in the Blind Souris Valley.

Proposed Blind Souris Project A: This project would utilize only the southern portion of the Blind Souris Valley as a storage reservoir to store natural inflow supplemented by Souris River water during sufficiently high river flows. This section of the Blind Souris Valley commands the major portion of the drainage area but the available storage capacity is fairly small. The average annual inflow is estimated to be about 110 acre feet. The maximum feasible storage capacity is about 6000 acre feet which would be attainable at a full supply level of 1430. Reservoir routing studies were undertaken using natural inflows, supplemented by gravity diversion of Souris River water during sufficiently high river flows. These studies indicate that this reservoir could supplement Souris River flows during low flow periods to provide a minimum June to October flow of 12 c.f.s. in the Souris River at Coulter.

The natural height of land between the two natural basins in the Blind Souris is at elevation 1425, five feet lower than the proposed full supply level. It would, therefore, be necessary to provide an artificial plug with a height of about ten feet to prevent the stored water from escaping into the uncontrolled north section of the Blind Souris Valley. This project is estimated to cost $315,000.

Proposed Blind Souris Project B: This project would utilize only the northern portion of the Blind Souris Valley as a storage reservoir to impound natural inflow. Waskada Creek enters the Valley south of the height of land in the valley bottom and would be diverted to flow into the reservoir. The storage draft curve indicates that no significant increase in dependable yield would be obtained by providing storage above 15,000 acre feet. This storage capacity could be obtained with a full supply level of 1416. The reservoir would not necessitate a dam at the south end since the height of land is 1425, nine feet above the full supply level. The cost of this project is estimated to be $860,000.

The dependable supply from this reservoir would be 500 acre feet per year. This could be regulated to add to the summer flow of the Souris River to provide a total firm flow of 11.7 c.f.s. in the Souris River at Melita during the months June to October inclusive.

Proposed Blind Souris Project C: This project would involve closing off both ends of the Blind Souris Valley with earthfill dams and providing a gated conduit through the south dam to divert Souris River water by gravity, during sufficiently high flows, into the Blind Souris Valley in addition to natural inflows and to allow releases out of the reservoir. A spillway to discharge flood flows out of the Blind Souris would be provided in the north dam. Examination of the storage curve of the Blind Souris Valley and the estimated available flow indicates that a full supply level of 1420, which represents a storage capacity of 28,100 acre feet, would be a practical maximum. Since this elevation is below the divide between the north and south ends of the Blind Souris, some channel excavation would be required to allow both reservoirs to function as a unit. Cost of Blind Souris Project C is estimated at $1,080,000.

Natural inflow into the reservoir, coupled with water taken into the reservoir by gravity whenever the Souris River at Coulter is higher than the water level in the reservoir, could be released to supplement low river flows and thus provide a firm total flow of 18.5 c.f.s. in the

Souris River during the five month period June to October.

Proposed Blind Souris Project D: Proposed Project D would consist of closing off both ends of the Blind Souris Valley with earth dams and in addition to collecting the natural tributary inflow, would involve pumping water into the reservoir during periods of high runoff. A multitude of alternative pump capacities, reservoir sizes and operations are possible. For this project a pumping plant with a capacity of 50 c.f.s. would be used. The pumping plant would be located at the north end of the reservoir and would utilize the pool formed by Melita Dam No. 2. A reservoir of 75,000 acre feet could maintain a firm flow of 34.0 c.f.s. in the Souris River at Melita during the months June to October inclusive.

The construction cost of this project is estimated to be $2,110,000. In addition, it is estimated that the annual operating cost would be $6,000.

Proposed Blind Souris Project E: Project E would be essentially the same as Project D except that it would utilize a pumping plant of 100 c.f.s. capacity rather than one of 50 c.f.s. capacity. A reservoir of 105,000 acre feet capacity could maintain a firm flow of 43.75 c.f.s. in the Souris River at Melita during the months June to October inclusive, including the regulated flow from the United States.

The construction cost of this project is estimated to be $3,000,000 and the annual operating cost $8,000.

Proposed Blind Souris Project F: This scheme would augment flows into the Blind Souris Valley, and thereby increase its yield, by diverting excess water from the proposed Coulter Dam. Any water that would be spilled at the proposed Coulter Dam could be diverted, by gravity, into the Blind Souris Valley. The diverted water would have to be flumed for about three miles across the Souris River Valley and into the Blind Souris Reservoir. This additional water could increase the firm flow into the Souris River from 18.5 c.f.s. as could be obtained by Project C, to 20.0 c.f.s. In conjunction with the proposed Coulter Dam, which is an integral part of this scheme, the combined firm flow in the Souris River at Coulter during the months June to October would be 41.0 c.f.s., including the regulated flow in the Souris River from North Dakota.

The cost of the proposed Blind Souris Project F is estimated to be $2,000,000 in addition to the cost of proposed Blind Souris Project C and the proposed Coulter Dam, making a total estimated cost of $4,484,000.

Proposed Blind Souris Projects D and E would not be compatible with development on the Antler River, Gainsborough and Graham Creeks, since these proposed projects would use the same water. However, other schemes involving a combination of Blind Souris and tributary development could be considered.

Proposed Souris River Main Stem Projects

Proposed Coulter Bridge Dam: The proposed Coulter Bridge Dam would be located in the Souris Valley six miles north of the International Boundary on the north boundary of Section 31-1-26 W.P.M. The valley in this reach is about one mile wide and is cut into the shale. It is characterized by the absence of trees and by the presence of alkali tolerant grasses and herbs growing on heavy alkalinized clays. The valley is, for the most part, not cultivated and is used primarily as pasture land.

The upper level of storage of a reservoir at the proposed site would have to be lower than that of Dam No. 357 in the Lower Souris Refuge approximately one mile south of the International Boundary. The full supply level of Dam No. 357 is 1414.25. Therefore, an elevation of 1414.0 was selected as the maximum storage level for the proposed Coulter Bridge Reservoir. The live storage at this proposed full supply level would be 10,000 acre feet.

Inflow into the reservoir during the critical period was determined by adding the estimated local inflow to the reconstructed Souris River flows shown in Table I. The firm annual draft from the Coulter Bridge Reservoir would be 3,600 acre feet or a firm five month flow of 12 c.f.s. in the Souris River at Coulter. A comparison with the flows shown in Table I will indicate, that although the minimum June to October flow in the Souris River at Coulter would be increased from 10 c.f.s. to 12 c.f.s., average flow during the critical period, i.e. June to October inclusive from 1930 to 1941, would be reduced from 15 c.f.s. to 12 c.f.s.

The proposed dam would be a stop log structure located immediately above the existing Coulter Bridge. The abutments would be tied to the existing highway fill to reduce embankment quantities. The estimated cost of the proposed Coulter Bridge Dam is $525,000.

A combination of the proposed Coulter and Coulter Bridge projects would provide a firm June to October flow of 33.0 c.f.s. in the Souris River at Coulter whereas, as previously stated, the proposed Coulter Project would provide a firm June to October flow of 36.0 c.f.s., including the regulated flow from the United States. This reduction in flow would result due to evaporation losses from the proposed Coulter Bridge Reservoir. Therefore, the Coulter Bridge Project is not compatible with other developments in the Souris Basin in Manitoba.

Proposed Lauder Dams: In order to compare main stem storage to tributary storage, it has been suggested that the feasibility of a storage dam in the vicinity of Lauder be investigated. Such a storage project would collect runoff from the Antler River and Gainsborough, Graham, Jackson, Waskada and Medora Creeks, in addition the Souris River flows from North Dakota. To maximize storage, a site has been selected in Section 18-6-23 W.P.M. Three different size reservoirs were investigated at this site. These projects would not be suitable for initial development as they would not meet demands in the watershed above Melita.

Above Melita, the Souris River Valley is about one and one-half miles wide and from 80 to 100 feet deep. The river itself follows a winding course through the valley and is bordered by a broad flat river terrace which extends to the main valley banks. Below Melita the main valley widens and becomes less pronounced in form, with the land rising in irregular slopes from the flats bordering the river. This condition holds beyond the proposed Lauder Dam until the river approaches Souris. The Souris River Valley downstream from the confluence of the Souris and Antler Rivers is covered with highly fertile river terrace and flood plain deposits. It is estimated that in the reach of the valley above the proposed Lauder Dams, there are about 10,000 acres of land which would be suitable for sprinkler irrigation of forage crops from the Souris River assuming a maximum pump lift of fifty feet. A good portion of this potentially irrigable acreage would be in the reservoir area of the proposed Lauder Dams.

The upper level of storage of a reservoir at the proposed site which could make use of an uncontrolled spillway without causing backwater into the United States would have to be lower than that of Melita Dam No. 1 located in Section 33-2-7W. The full supply level of Melita Dam No. 1 is 1404.0. Therefore, an elevation of 1400.0 has been selected as the maximum storage level for the proposed Lauder Dam A.

The proposed Lauder Dam A, located in Section 18-6-23 W.P.M., would be an earth embankment having a maximum height of 35 feet and a total length of 5,800 feet. The spillway would be an uncontrolled reinforced concrete chute, 135 feet wide and having a crest elevation of 1400.0. The conduit would be a 48 inch diameter corrugated metal pipe controlled by a slide gate in a reinforced concrete gatewell. The cost of the proposed Lauder Dam A is estimated to be $4,200,000.

The reservoir formed by this project would extend back to Melita Dam No. 1. The storage at full supply level would be 50,000 acre feet. This reservoir would have a net annual draft of 12,750 acre feet. This could be released at the rate of 42.5 c.f.s. during the period June 1 to October 31.

With the use of a gated spillway, a reservoir at the proposed site could store water to elevation 1404.0 without causing backwater into North Dakota. This is the full supply level of Melita Dam No. 1. This elevation was selected as the maximum storage level for the proposed Lauder Dam B.

The proposed Lauder Dam B, located in Section 18-6-23 W.P.M., would be an earth embankment identical to that of the proposed Lauder Dam A. The spillway would be a reinforced concrete chute controlled by nine taintor gates, 10 feet high and 19 feet wide. The crest elevation of this spillway would be at elevation 1394.0. The estimated cost of this project is $4,700,000.

The reservoir formed by the proposed Lauder Dam B would extend to the International Boundary. The storage at full supply level would be 79,000 acre feet. This reservoir would have a net annual draft of 15,000 acre feet. This could be released at the rate of 50.0 c.f.s. during the period June 1 to October 31.

Assuming that backwater into the United States could be tolerated, the upper level of storage of a reservoir at the proposed site would have to be lower than that of Dam No. 357 in the Lower Souris Refuge approximately one mile south of the International Boundary. The full supply level of Dam No. 357 is 1414.25. Therefore, an elevation of 1410.0 was selected as the maximum storage level for the proposed Lauder Dam C.

The proposed Lauder Dam C, located in Section 18-6-23 W.P.M., would be an earth embankment having a maximum height of 40 feet and a total length of 7,900 feet. The spillway would be a reinforced concrete chute controlled by nine taintor gates, 10 feet high and 19 feet wide. The crest elevation of this spillway would be at elevation 1400.0. The cost of this scheme is estimated to be $5,400,000.

The reservoir formed by this project would extend to Dam No. 357 in North Dakota. The storage at full supply level would be 170,000 acre feet. This reservoir would have a net annual draft of 18,000 acre feet or 60.0 c.f.s. for the five summer months.

Proposed Souris High Dam: In order to further compare main stem storage to tributary storage, the feasibility of a storage dam in the vicinity of the Town of Souris was investigated. This project would not be suitable for initial development as it would not meet demands in the watershed above Melita. The feasibility of this project was, therefore, considered in combination with the proposed Coulter Dam on the Antler River and with the proposed Patterson Dam on Gainsborough Creek. In order to determine the feasibility of storage on the main stem of the Souris River at Souris in combination with tributary storage, it was assumed that there would be full utilization of the regulated Souris River tributary flows above Hartney.

The proposed Souris High Dam, located in Section 28-7-21 W.P.M., would be an earth embankment having a maximum height of 40 feet and a total length of 1320 feet. The spillway would be a reinforced concrete chute, controlled by nine taintor gates, 10 feet high and 19 feet wide. The crest elevation of this spillway would be at elevation 1365.0. The conduit would be a 48 inch diameter corrugated metal pipe controlled by a slide gate in a reinforced concrete gatewell. The cost of the proposed Souris High Dam is estimated to be $2,180,000.

The reservoir formed by this project would extend back to Hartney Dam. Considered by itself, the reservoir would have a net annual draft of 10,350 acre feet or 34.5 c.f.s. for the five summer months. Considered in combination with the proposed Coulter Dam on the Antler River, the project could yield an additional 3,750 acre feet per year making a total firm flow of 48.5 c.f.s. in the Souris River at Souris during the period May 1 to October 31 inclusive. Considered in combination with the proposed Patterson Dam on Gainsborough Creek, the project could yield an additional 6,150 acre feet per year making a total firm flow of 43.0 c.f.s. in the Souris River at Souris for the same period.

COMPARISON OF PROPOSED PROJECTS

In order to compare proposed projects it is necessary to make some estimates of benefits. In this study it was assumed that benefits are uniform for each increment of firm flow in the Souris River up to a firm flow of about 50 c.f.s. As a major portion of the benefits would be from valley irrigation it was decided to use these benefits as a yardstick.

In the Pembina River study, preliminary estimates of annual direct irrigation benefits are approximately $33 per acre. On this basis a total annual direct and indirect irrigation benefit of $40 per acre was assumed for the Souris River Valley. The Souris River Valley has a climatologic and soils disadvantage compared to the Morden-Winkler area, but this may be offset by the fact that the Melita area is naturally drier and, therefore, is more likely to derive greater benefit from supplemental irrigation.

It was assumed that in this area two acre feet of water per acre would be required annually. On this basis, annual benefit per c.f.s. of firm flow in the Souris River during the months of June to October, above the existing firm flow of ten c.f.s. would be $6,000.

$$\text{i.e.} \quad \frac{300 \text{ acre feet}}{2 \text{ acre feet per acre}} \times \$40 \text{ per acre} = \$6{,}000.$$

Annual cost was determined for each project assuming a 50 year life and a five percent interest rate. Annual benefits, annual costs and benefit-cost ratios for each project are shown in Table II and illustrated graphically in Figure 2.

By reviewing Figure 2 it may be seen that all projects and combinations of projects, when compared to point 16 (combination of proposed Coulter and Patterson Dams), yield incremental benefit-cost ratios of less than unity. It must, therefore, be concluded that the most desirable scheme of development in the upper watershed of the Souris River in Manitoba is a combination of the proposed Coulter and Patterson Dams.

Similarly, also from Figure 2, it may be seen that all individual projects, when compared to point 1 (Coulter Dam), yield incremental benefit-cost ratios of less than unity. It must, therefore, be concluded that the Coulter Dam is the most desirable project.

CONCLUSIONS

The proposed Coulter Dam would be the most attractive project in the upper watershed of the Souris Basin in Manitoba as a means of supplementing low flows in the Souris River. Development of storage on Gainsborough Creek in conjunction with the proposed Coulter Dam would also be attractive.

TABLE II

Comparison of Proposed Projects

No.	Project Name	Annual Benefit	Annual Cost	Benefit Cost Ratio
1	Proposed Coulter Dam	$156,000	$ 83,260	1.87
2	Proposed Patterson Dam	75,000	29,520	2.54
3	Proposed Reddaway Dam	7,500	17,310	0.43
4	Proposed Rawlinson Dam	12,000	15,830	0.76
5	Proposed Blind Souris Project A	12,000	17,250	0.70
6	Proposed Blind Souris Project B	10,200	47,200	0.22
7	Proposed Blind Souris Project C	51,000	59,160	0.86
8	Proposed Blind Souris Project D	144,000	121,580	1.18
9	Proposed Blind Souris Project E	202,500	172,330	1.18
10	Proposed Blind Souris Project F	186,000	251,970	0.74
11	Proposed Coulter Bridge Dam	12,000	28,760	0.42
12	Proposed Lauder Dam A	195,000	230,060	0.85
13	Proposed Lauder Dam B	240,000	257,450	0.93
14	Proposed Lauder Dam C	300,000	295,800	1.01
15	Proposed Souris High Dam	147,000	119,410	1.23
16	Combination of Proposed Coulter and Patterson Dams	204,000	112,790	1.81
17	Combination of Proposed Coulter and Souris High Dams	231,000	202,670	1.14
18	Combination of Proposed Patterson and Souris High Dams	198,000	148,940	1.33

This data is shown graphically in Figure 2.

Projects involving storage on Graham and Jackson Creeks and in the Blind Souris Valley were found to be not economically feasible as a means of supplementing flows in the main stem of the Souris River, at least until the value of water in the Souris Basin is greater than estimated herein. Projects on these streams for stockwatering or other local uses may be economically feasible. Such increased local use of the stream flow of these tributaries would not significantly affect water supply in the main stem of the Souris River and hence any such local water use projects would have insignificant effect on the overall plan of water resources development and uses from the main stem of the Souris River in Manitoba.

Development of storage on the main stem of the Souris River in Manitoba above its confluence with the Antler River was found to be incompatible with future development in the Souris Basin. Due to evaporation losses from the proposed Coulter Bridge Reservoir, a combination of the proposed Coulter Dam on the Antler River and the Coulter Bridge Project would yield a smaller annual benefit than the Coulter Project by itself.

Development of storage on the Melita-Souris reach of the main stem of the Souris River would not be suitable as the first phase of development of the Souris Basin in Manitoba as it would not satisfy demands above Melita. Projects on the main stem of the Souris River above Souris were found to be less attractive economically than projects on the Antler River and Gainsborough Creek.

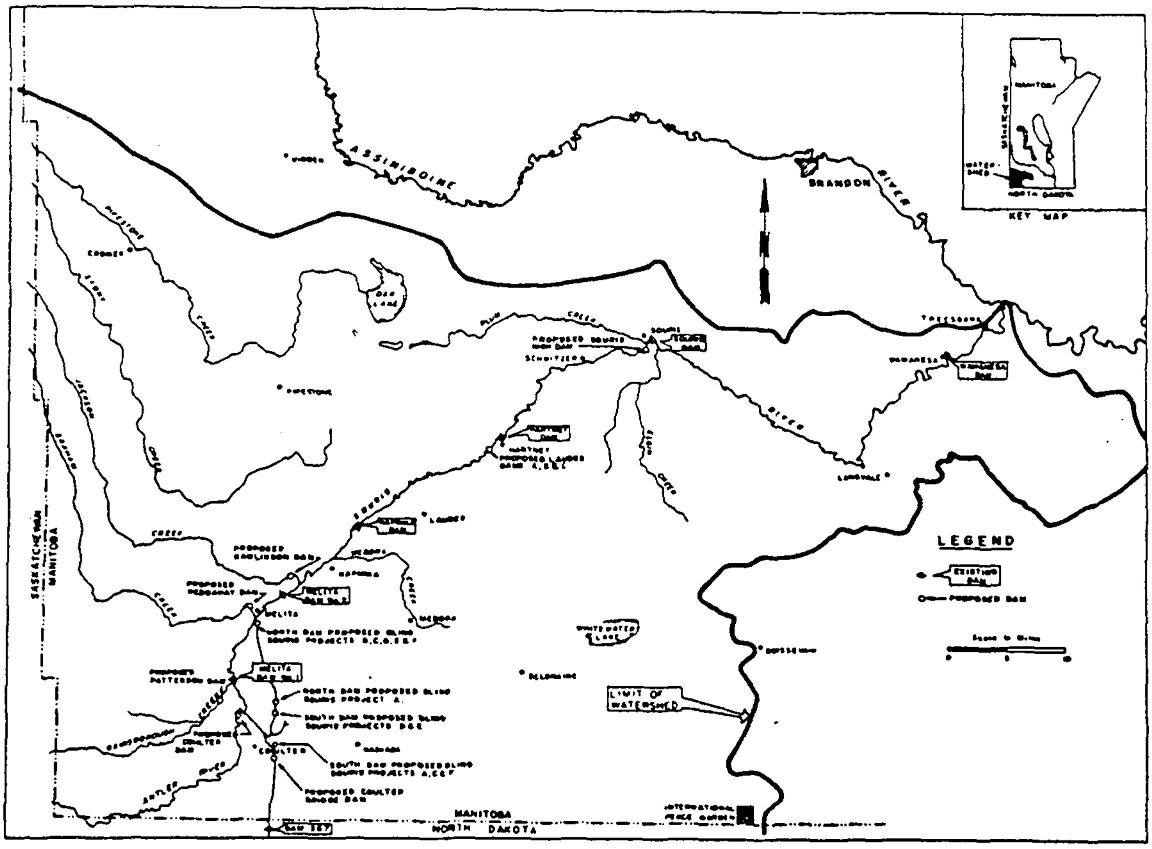

Figure 1. Souris Basin in Manitoba.

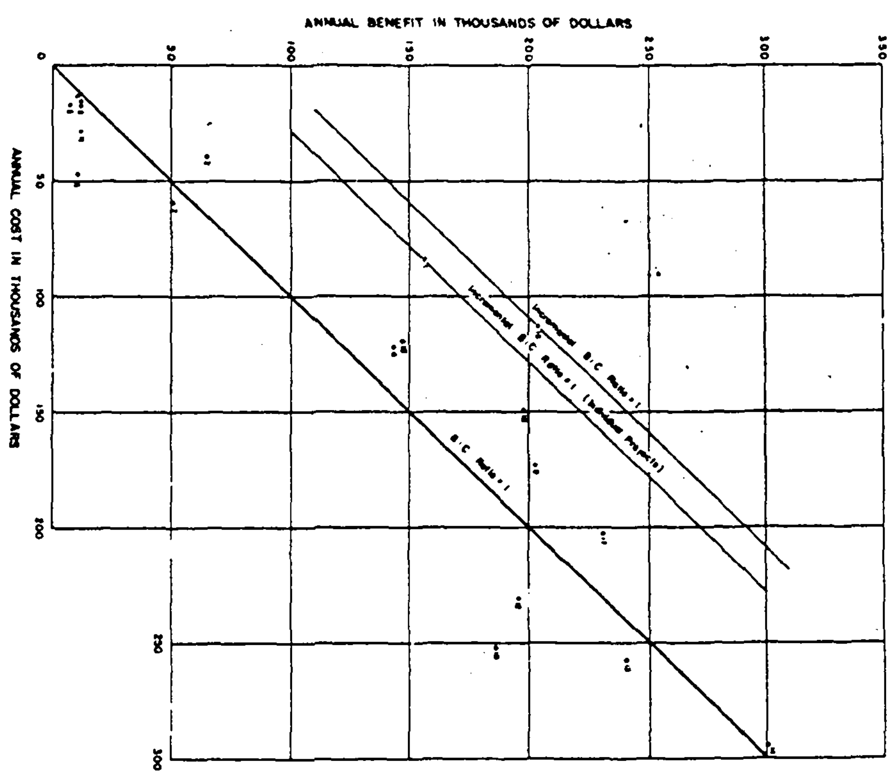

Figure 2. Comparison of proposed projects.

ETUDE INTERIMAIRE DES MESURES VISANT A SUPPLEER AUX FAIBLES DEBITS DE LA SOURIS, DANS LE MANITOBA

Résumé

La Souris prend sa source dans la province de Saskatchewan, traverse la frontière et pénètre dans le Dakota du Nord, puis retraverse la frontière, entre dans le Manitoba à travers duquel elle coule vers le nord sur près de 270 km jusqu'à ce qu'elle se jette dans l'Assiniboine. Le bassin de la Souris occupe l'extrémité sud-ouest de la province. Cette partie de la province souffre d'une pénurie d'eau constante, ce qui nuit à son développement. On a entrepris une étude de la mise en valeur des ressources en eau du bassin de la Souris dans le Manitoba, et portant sur tous les aspects de la planification du bassin hydrographique. Cependant, étant donné le temps qu'exige une étude complète de ce genre et la gravité de la pénurie d'eau dont souffre la région, on a décidé d'entreprendre un projet qui puisse être terminé avant les autres et s'insérer dans le plan de développement général. Comme une grande partie des besoins du Manitoba se situent dans la partie supérieure du bassin hydrographique, tout projet initial doit répondre à ces besoins en même temps qu'à d'autres.

Le débit de la Souris à son entrée dans le Manitoba est réglementé par un accord international. Le Dakota du Nord est tenu de livrer environ 7.483.000 m^3 d'eau au Manitoba pendant les mois de juin à octobre, sauf en période de forte sécheresse, auquel cas la responsabilité du Dakota du Nord est limitée à la livraison des quantités qui sont possibles.

Durant des années d'expérience, on a constaté que le Manitoba a besoin d'environ 0,56 m^3/sec pour l'abreuvage du bétail et les pertes normales du lit de la rivière, afin de maintenir un courant vivant sur tout le cours de la Souris dans le Manitoba. Au cours des dernières années, un intérêt considérable s'est manifesté sur le plan local pour l'irrigation d'appoint des plaines de la vallée. La ville de Souris tire son eau directement de la Souris, alors que la ville de Melita obtient la sienne indirectement de la même rivière. Une évaluation préliminaire des utilisations actuelles et projetées du cours principal indique qu'il faudra près de 1,4 m^3/sec pendant les mois de juin à octobre d'ici 1975.

Plusieurs projets dans le bassin hydrographique supérieur du Manitoba ont été préconisés de temps à autre. Certains d'entre eux ont été étudiés par la Prairie Farm Rehabilitation Administration du Canada [Administration du réaménagement agricole des prairies], d'autres par la Branche de la régularisation et de la conservation des eaux. Ils comprennent des projets d'emmagasinage naturel et des installations de pompage le long du cours principal et de ses affluents. Pour chaque projet, on a déterminé le débit minimum qui pouvait être maintenu pendant les mois de juin à octobre dans la Souris, y compris le débit traversant la frontière, et ceci a servi de base à l'évaluation et la comparaison des projets.

Dans le cadre de cette étude, on s'est fondé sur l'hypothèse selon laquelle les avantages sont uniformes pour toute augmentation du débit ferme de la Souris, jusqu'à concurrence d'un débit ferme d'environ 1,4 m^3/sec. Etant donné qu'une grande partie des avantages proviendront de l'irrigation de la vallée, on a décidé d'utiliser ceux-ci comme critères. Les avantages annuels ont été déterminés en fonction de 1,4 m^3/sec de débit ferme de la Souris pendant les mois de juin à octobre, au-dessus du débit ferme existant de 2,8 m^3/sec.

Le barrage Coulter, dont la construction est envisagée sur l'Antler, est le projet le plus intéressant du bassin supérieur de la Souris dans le Manitoba en tant que moyen de suppléer aux faibles débits de cette rivière. On estime que ce projet assurera, dans le cas de la Souris, un débit estival ferme d'environ 1,13 m^3/sec, compte tenu des obligations des Etats-Unis. Un projet d'emmagasinage sur le Gainsborough Creek, dans le cadre du barrage Coulter, est également réalisable du point de vue économique et permettra un débit estival ferme de la Souris dont le total sera d'environ 1,416 m^3/sec.

ESTUDIO PROVISIONAL DE LOS MEDIOS PARA COMPLEMENTAR
LAS CORRIENTES BAJAS DEL RIO SOURIS EN MANITOBA

Resumen

El río Souris nace en la Provincia de Saskatchewan, atraviesa la Frontera Internacional y, pasando por el estado de Dakota del Norte regresa de nuevo por esa frontera a la Provincia de Manitoba por la cual corre unas 170 millas hasta llegar a la confluencia con el río Assiniboine. La cuenca del río Souris en Manitoba ocupa el ángulo Sudoeste de la Provincia. Esta parte de la Provincia es una zona donde hay una escasez crónica de agua, lo cual ha retardado su progreso. Sin embargo, ya se ha procedido a iniciar un estudio acerca del desarrollo de las aguas aprovechables de la cuenca del Souris en Manitoba, en cuyo estudio se incluyen todos los aspectos del proyecto de una cuenca hidrográfica. Sin embargo, a causa de la magnitud de un estudio completo de planificación y a la escasez crítica de agua en la región, se resolvió tomar en consideración un proyecto para su consumación inicial, el cual se ha de ceñir al plan general de desarrollo. Como una gran parte de las necesidades de Manitoba se origina en la cuenca hidrográfica superior, todo proyecto inicial debe satisfacer esas y otras necesidades.

El caudal del río Souris que entra en Manitoba es regulado por un acuerdo internacional. El estado de Dakota del Norte se obliga a suministrar 6.069 acre-pies de agua a Manitoba durante los meses de junio a octubre, excepto en las épocas de mucha sequía, en cuyo caso la obligación de Dakota del Norte se limita al abastecimiento del caudal de agua que sea posible.

Por experiencia en los años pasados se ha podido comprobar que Manitoba requiere alrededor de 20 p.c.s. para el ganado y para reponer las pérdidas de agua en el cauce, a fin de mantener una corriente activa en todo el curso del río Souris en Manitoba. Durante los últimos años se ha dejado sentir mucho interés en la localidad por el riego complementario en las zonas planas de los valles. La ciudad de Souris, directamente, y la ciudad de Melita, indirectamente, se abastecen de agua proveniente del río Souris. Una apreciación preliminar de los usos actuales y proyectados en el cauce principal del río señala que para el año 1975 se necesitarán alrededor de 50 p.c.s. durante los meses de junio a octubre, inclusive.

De tiempo en tiempo se ha favorecido la construcción de varias obras en la cuenca hidrográfica superior de Manitoba. Algunas de ellas fueron estudiadas en el Canadá por la Dirección de Rehabilitación de Praderas y otros por la Water Control and Conservation Branch. Entre estas obras figuran las de embalses naturales y de bombeo de agua en el cauce principal del río y en sus tributarios. Como base para el estudio y la comparación de los proyectos, se calculó en cada uno de ellos el caudal mínimo que podría mantenerse en el río Souris durante los meses de junio a octubre, inclusive el caudal de la corriente al atravesar la Frontera Internacional.

Al efectuarse este estudio, se dió por sentado que los beneficios son uniformes en relación con cada incremento del caudal constante del río Souris hasta un caudal estable de aproximadamente 50 p.c.s. En vista de que gran parte de los beneficios se derivarán del riego del valle, se resolvió usar esos beneficios como norma de medida. Los beneficios anuales se calcularon a base de pies cúbicos por segundo de corriente estable en el río Souris, durante los meses de junio a octubre, por encima del caudal estable actual de diez p.c.s.

El dique Coulter en el río Antler, cuya construcción se propone, es el proyecto más interesante de la cuenca hidrográfica superior del río Souris en Manitoba, destinado a complementar los bajos caudales del río Souris. Se calcula que por medio de esas obras se mantendrá en el verano un caudal estable de unos 40 p.c.s. en el río Souris, incluso el caudal asignado a Manitoba por los Estados Unidos, según el respectivo convenio. La construcción de embalses en el arroyo Gainsborough, conjuntamente con el dique Coulter que se propone, también es factible desde el punto de vista económico y dará por resultado un caudal estable de unos 50 p.c.s. en el río Souris durante el verano.

International Conference on WATER for PEACE

United States Water Supply

PLANNING AND DEVELOPING WATER SUPPLY PROGRAMS IN DEVELOPING COUNTRIES

Daniel A. Okun, Frederick E. McJunkin

Introduction

The relationship between man and water is long, intimate, even mystical. Romantic evolutionists explain the mystique between man and water as his heritage from a time before he was even man, perhaps a single-celled creature born in the sea. Or in the words of the lyric poet, Walt Whitman, "Out of the cradle endlessly rocking." Langdon Smith put it more humorously, "When you were a tadpole and I was a fish in Paleozoic time." Since the coming of man upon the planet, drinking water has been indispensable. The earliest people lived beside readily available water which had not yet become fouled by man's indiscretions, and the great civilizations of history developed alongside the rivers and lakes. However, with increasing growth and dispersion of population, people found themselves far removed from drinking water sources adequate for all seasons or were forced to use water which had become dangerously contaminated. The widespread inadequacy of drinking water supplies is responsible for perhaps 500,000 cases of debilitating illness per year, perhaps 5 million infant deaths each year [1]. For ages it has been traditional for women to carry water for family use, a duty which takes much of their time and involves many miles of weary walking. It is ironic that a necessity of life obtained with such effort and devotion may carry the germs to destroy the objects of that devotion.

Everywhere the picture is not the same. In the United States as in other highly industrialized countries of the world, although constant vigilance is required to assure continuous safety, and momentary local shortages may arise, the provision of community water supply has been so successful as to have it taken for granted. Wherever the delegates to this conference travel in the United States, they will have full confidence in the water available in their hotels. In England as in the Netherlands, more than 97 per cent of all the people, including those in rural areas, are served by piped water from public supplies. Many lessons can be learned from the experiences leading to this high level of accomplishment [2], but it is fallacious to believe that the available technology needs only to be exported to the developing nations to solve their problem. It is also fallacious to believe that engineering efficiency goes hand in hand with sophisticated mechanization and instrumentation.

Economic, labor, and resource conditions in developing countries are generally so different from those in industrialized countries that the technical solutions may not be the same. Conditions characteristic of many of the developing countries include: limited financial resources, particularly foreign currency; limited manufacturing capacity; limited skilled labor but ample unskilled labor; scarce engineering manpower resources for conceiving, planning, constructing and operating works; and a concurrent need for many other facilities such as schools, roads, hospitals, houses, etc. These factors must be considered in establishing the nature of the water supply needs in developing countries and how these needs can be most expeditiously and economically met.

In addition to these influences, there is the more important consideration of the people to be served. Less than 10% of the population in developing countries are supplied with piped water in their homes, and this very commonly on the basis of an intermittent service lasting only a few hours each day and with inadequate supervision of quality [3]. It is questionable if new construction is keeping pace with population growth - much less reducing accumulated backlogs. Under these conditions, Dr. H. G. Baity, formerly Director of the Division of Environmental

Health of the World Health Organization (and Professor Emeritus at the authors' University), has so aptly stated [4]: ". . . it becomes logical to give (some) water to as many of the people as possible rather than to give a perfect supply to a few." In a highly developed country, a sanitary engineer can cloak himself in the respectably conservative (and safe) mantle of "standard practice" and be a useful servant of society. If one accepts Dr. Baity's argument, the same engineer, applying the same "standard practice" within developing countries, would be a wastrel where needs are so great that any waste is inequitable - perhaps even immoral.

Let it be understood that in no way are we suggesting that crude engineering or crude solutions are good enough in developing countries. But we are suggesting that the proper measure of good engineering is how well, both functionally and economically, it serves the needs of the populace and not how elaborate it may be. Results are the proper criteria for judging success, and no particular technology, regardless of its sophistication, has superior virtue in and of itself. The result sought is an adequate amount of safe water for people - the more people, the better result.

The designer and developer of community water supplies in developing countries even more than his counterpart in developed countries, must be inquisitive of the basic reasons behind "conventional" or "textbook" designs, and be prepared to challenge sacrosanct standards. He must be imaginative and exercise the ingenuity demanded by limited resources.

Relationship of Planning Policy and Design Criteria

By virtue of his education, background and experience, the sanitary engineer is the professional most qualified to translate the need for water into the physical need for pumps and pipes. However his freedom of action is infringed upon by many others -- government leaders, financiers, planners, etc. At the same time his technical decisions may well have considerable impact on the economy of the community and the nation, its employment and manpower problems, and on the welfare of the community as a whole. Some of the spillover effects of water supply projects include:

(1) Imported materials and equipment and their effect on balance of payments and currency reserves. Funds for water supplies must be obtained in competition, of course, with alternative investments.

(2) Effects on local industry of using local materials and equipment. Where the appropriate local industry is non-existent, it may be that serious consideration should be given to stimulation of such industry even though short-run costs may be higher. For a centralized, continuing program, establishment of joint ventures between local and external manufacturers may be a feasible means of rapidly establishing local capability, both financial and technical. Benefits to village schemes should not be overlooked.

(3) Effects on plant reliability resulting from maintenance, repair and replacement of imported equipment. Closely related is the availability (or non-availability) of centralized procurement and warehousing of critical inventories.

(4) Effects on local employment, again, both long-run and short-run.

(5) Availability of construction and operating personnel. If the plant cannot be operated, it has failed as surely as if it were ineptly designed.

(6) Training of skilled personnel where few or none had previously existed. This may affect equipment selection and design. Such training should be considered in project planning. The recently created Department of Water Supply and Sanitation of the Yemen Arab Republic, established with the assistance of the U.S. Agency for International Development, is an excellent example [5]. Over 250 employees have been trained from the inception of the program in 1962, in this, a relatively underdeveloped country.

(7) Effects of financing policies on design. "Textbook" design periods reflect the time value of money within developed countries which is generally lower than in developing countries.

(8) Effects of stage development. What level of service and to whom? And when? Compatibility of system stages?

(9) The uncertainty of economic and political environment.

(10) Uncertainty due to lack of data on consumption and future demand. Cost and uncertainty are directly proportional.

(11) Social acceptance by the water users and development of community support.

(12) Community organization created for providing water supply may in many small communities be the first significant community-wide activity. Few other facilities enjoy a higher priority on a community-wide basis.

The above factors, vital in their impact on design practices, are matters of policy as well as technical criteria. Conversely feedback from policy makers is essential to the design and establishment of technical criteria. For example the aforementioned statement that "the limited funds available be used to give (some) water to as many of the people as possible rather than give a perfect supply to a few" is a policy statement with profound implications in establishing design criteria. To the extent that the above factors suggest alternative strategies, amenable to conscious choice, they can be further developed as planning criteria, not only for water supplies, but for all investments in the public sector of the economy.

The remainder of this paper is principally devoted to examining some of these factors, particularly the use of imported versus local materials and equipment, the design of labor-intensive, as opposed to capital-intensive, facilities, and the design problems attendant to the availability of skilled operating personnel.

Development of Local Design Standards

There is a need for design standards developed for developing countries and not derived from developed countries. This was very aptly expressed by the Fifteenth Session of the Regional Committee for Southeast Asia of the World Health Organization [6] in its conclusion that:

> "In the present stage of development of the majority of communities of this region, the methods, equipment, and the basic design factors commonly used in the highly developed and wealthier countries are often economically and technically beyond reach. There is a great need to devise and develop systems of water treatment and distribution and of preservation of water resources which are inexpensive to construct and simple to operate and maintain. To this end there is a concurrent need for research and development and for realistic re-appraisal of the fundamental bases of engineering design. Measures must be found to make full use of local materials, local skills, and the principles of self-help. Research and development should lead to standards for design, determination of design periods, maintenance, operation and management applicable to the conditions in the different countries of the region."

This may seem very self-evident, yet violations of these precepts abound, even within the nations represented at the meeting which adopted the above conclusion [7].

For example, in an important capital city, a new water treatment plant has recently gone into operation. This is a country where skilled labor is scarce and unskilled labor is plentiful and low in cost. Mechanization was carried to an extreme, with mechanical coagulation devices and mechanical sludge-removal equipment. Almost two years after operation, the sludge-removal equipment in one settling tank was not operating because a part was broken and had not been received from Europe where the equipment was designed and manufactured. After 18 months of operation, this settling tank was manually cleaned and was found to have accumulated less than two feet of sediment - certainly no indication that mechanical sludge-removal equipment had been necessary. Most incongruous of all, a large sampling table permitted samples to be taken from any one of dozens of points throughout the plant by merely flicking a switch. This expensive sampling table, also purchased from Europe at considerable cost, was of doubtful value because actually few samples were being analyzed.

In another important capital city, a new water treatment plant was built using literally hordes of men and women carrying baskets of earth on their shoulders and their heads from the excavations for the settling tanks. The plans for this plant as well as for plants already serving the city include modern, expensive, mechanical equipment for removing the sludge from the settling tanks without the need for manual labor. Apparently manual labor is adequate for the construction of the plant by local contractors, but the designing engineers must have felt that manual labor is not satisfactory for the removal of sludge and thus scarce foreign currency was expended on the importation of such equipment from abroad. One wonders about the reasoning that encourages such labor saving devices when labor is so abundantly available. The foreign currency might better have been used for supplying piped water to more homes.

In still another capital city, a water filtration plant was recently constructed. During construction, laborers in great number could be seen pouring the concrete, carrying in the sand for the filters on their shoulders, and manually performing many other of the construction tasks. This plant has automatic filter controls and in addition is provided with a complex chemical feed system with stainless steel pumps with electric motors installed in a sub-basement. However, in this city the distribution system is often without water and under vacuum, and because the sewerage system is not adequate, the water supply is frequently contaminated. Cholera is an annual visitor. One wonders why automatic equipment and complex chemical handling systems are required. It cannot be to save labor because labor is a plentiful resource in that country. One of the reasons given for providing such equipment is that local operators cannot be depended on and the equipment can decide better, for example, when a filter needs to be washed. This argument is not valid as the maintenance of such equipment is generally more difficult than the operation it is to perform.

The above examples illustrate several points. First, water works are being constructed in increasing numbers serving increasing millions of people throughout the world. This is good. The greatest need, however, is not for incorporation of the most complex mechanical and electronic devices into treatment plants, but rather to bring water of adequate quality and quantity to as many people as possible. Design practice in any locality whether it be the United States or in developing countries should strive for the most economic application of available capital, material, and human resources. Certainly where manual labor is plentiful, where electronic specialists are few, where money for purchase of equipment abroad is limited, and where the greatest need is to serve as many people with water as possible, it does not make engineering sense to invest limited resources in labor-saving equipment. Perhaps more important than cost, reliability of the supply may actually be decreased. This is particularly true where adequate maintenance of such equipment cannot be assured.

Some economists have suggested that developing nations in their striving for industrialization "leap frog" more developed countries by installing the very latest automated equipment, thus enabling them to compete more readily with nations with large fixed capital costs in older equipment. This has been the case to some degree in those countries whose industries were devastated in World War II. This argument may or may not have validity for industries operating in international markets. However it is certainly not true for water supplies since they are monopolistic and do not compete in international markets.

Lest the foregoing comments be interpreted as a brief for no equipment, we hasten to add that there is a place for equipment or instruments that can do things better than they can be done by men. For example, the use of float switches for starting and stopping of pumps is superior to manual control. Remote control dials may be appropriate where distances are great. Equipment manufacturers have made a considerable contribution to water supply practice in the developed countries, and they also can in the developing countries. However, even if no currency problem exists, the equipment provided should be suited to the local situation.

In the majority of cases, the above examples do not reflect upon the competence or judgment of a country's own engineers. On close investigation, it was found that many of the fundamental decisions were made by consultants or equipment manufacturers from other countries. In other instances, the local engineers were not consulted or their opinions were disregarded. In some instances, the lack of local engineers has permitted projects to be conceived and executed by equipment manufacturers from the developed countries through so-called "turn-key" contracts where the contractor is primarily interested in the sale of equipment. Such equipment may be, from a functional point of view, quite efficient. In the developed country of the equipment's origin, where wages are high, interest rates low, and full employment prevalent, such equipment may also be efficient in an economic sense. But its use in situations where labor costs are low, unemployment is rampant, interest on capital high, and foreign exchange funds limited would seem to be, at best, questionable.

Engineers also need not discard a good solution just because it was perfected before their time. For example, the slow sand filter was highly developed before the end of the last century. For years slow sand filters have provided safe and reliable water supplies for many of the cities of Europe and the United States. Many are still in use in the northeastern United States; new units have recently been installed in Europe and England. One might be inclined to think that tradition is at the root of this practice; however, an extensive engineering and economic study, conducted by the London Metropolitan Water Board in the 1950's indicated that it was economical to continue to incorporate slow sand filtration in the treatment of Thames River water [8]. If slow sand filters have a place in Britain, a country with advanced technical and manufacturing resources, this type of treatment cannot be ignored when considering feasible alternatives anywhere. The very factors which weigh against the use of slow sand filters in an industrialized economy, namely, high land costs, high capital construction costs, and high labor costs, are not applicable in developing countries. Furthermore, slow sand filters are reliable and require a minimum of mechanical equipment and chemicals for sound operation.

The limited use of equipment and instruments does not keep the work from being attractively built and a proud monument to the community and its engineers. For example, because concrete service reservoirs are often more economical than those of imported steel, they have in general been more attractive by far in the developing countries than in industrialized areas. The waterworks built for Manila in the 1930's continues to be far more attractive than more recent highly mechanized additions.

Some recent developments are indicative of the type of thinking that will be required in solving sanitary engineering problems. The development of large (1.5 Ton/Hour), but simple alum-cake solution feeders in Santiago, Chile [9], the Fordilla Service hydrant used on portions of the distribution system in Asuncion, Paraguay [10], the modification of the aqua privy as developed in East Africa [11] for use in low-cost, high density residential areas, and the mono-valve filter developed in Taiwan [12], are examples of what can be accomplished.

Use of Consultants

A major technical resource available to developing countries is the use of consulting engineers from developed countries, many of whom are making a major contribution to the global water supply effort. They have long experience in the preparation of feasibility reports and in the design of waterworks. They have specialists in many fields upon whom they can draw as a project develops. The best and most economical use of such consultants is when they provide this type of "know-how" but depend upon local engineers for services that can be handled best locally. The local engineers can collect data, make surveys, do drafting, supervise construction, and in general perform engineering services on the job at a much lower cost than can foreign consultants imported for these tasks. As local engineers gain experience in the specialty of water supply, the responsibility of outside consultants can gradually be reduced. Often, a consortium of a local and foreign engineer may be the best arrangement.

Lending agencies often require that a reputable and experienced consultant be employed on a project, and such experienced engineers may not be available locally.

It is extremely valuable that one of the responsibilities of a foreign consulting engineer, and this should be written into the contract, be the employment of local engineers and their training in an organized fashion. Projects of this type are now under way in Pakistan and Thailand.

Just as with imported equipment, the use of imported engineers has certain disadvantages. In designing a water supply system, it is necessary that the load on the system be established. An outsider, particularly one from another culture, labors under a handicap in this regard. How many people will use the water? Should they get the water from a public fountain, a yard tap, or indoor plumbing? What is the per capita consumption? What is the population of the city? How is it changing from a rural- to a city-centered population? For all these data the outside engineer must depend upon local information which the local engineer is better prepared to both gather and evaluate. Overdesign from a capacity viewpoint can be just as expensive as overdesign from an equipment standpoint.

In many developing countries little data exist on groundwater. Therefore outside consultants may be biased towards "safe" sources, that is, surface water, although groundwater may be more economical. Groundwaters have certain advantages which should not be ignored. Some of these are:

(1) Water systems obtaining raw water from wells can be more readily developed by stages.

(2) Wells can be closer to served areas generally than can surface water sources thus reducing pipe and pumping costs.

(3) Groundwater is less turbid reducing capital requirements for treatment.

(4) Groundwater quality is more uniform throughout the year.

Another area in which outside consultants are at a disadvantage is in preparation of cost estimates. Outside consulting engineers are often very much in the dark as to the cost of local materials and labor, especially labor. These estimates are particularly important in estimating local currency requirements. Oftentimes, consultants are instructed to keep that cost to a minimum. If by this is meant an economical design, that is satisfactory, but if it implies an arbitrary cut in the estimates including elimination of contingencies and profits, it is a mistake that will be costly in the long run.

Development of Personnel

The comments on local engineering personnel touch on what is perhaps, after finances, the most serious present deficiency in community water supply programs, that is the shortage of trained local personnel. As a matter of fact, the problems of finance and personnel are very closely related. For example, at the Seventh International Water Supply Congress in Barcelona, a World Bank (International Bank for Reconstruction and Development) engineer stated that loan funds for water supplies are available at the present time but that there is a shortage of sound water supply projects. This shortage of "good" water supply projects is not due to lack of need, but rather to lack of personnel to formulate projects and to prepare project applications. Other engineers also have observed that some countries are reaching their capacity to use funds effectively, again not because of lack of need, but because of lack of personnel. Or as the senior author has commented elsewhere [13]:

> "It has already become evident, however, that the "bottleneck" in providing community water supply systems is not lack of water, because ample water resources for municipal supply are generally available, not lack of money, as the lending agencies are looking for sound water supply projects in which to invest, not lack of materials, because pipes and pumps are generally readily available at reasonable cost, and not lack of interest on the part of the people of the communities, who have demonstrated their need and desire for public water supply systems. The difficulty is the shortage of qualified engineers in the developing countries to conceive, investigate, promote, design, construct and manage water supply projects."

Inadequate engineering leads to delays, waste, poor construction, poor operation, and inefficient use generally of available resources.

One remedy for these problems is a large-scale effort to recruit more engineers for work in water supply and to provide specialized training for those already in the field. This requires many approaches, all taken simultaneously:

(1) Prepare more engineers by increasing the educational facilities and using those that exist more fully.

(2) Create graduate sanitary engineering curricula in local engineering institutions.

(3) Create intensive short courses for specialized training in the capital and in provincial centers. Educational institutions can help.

(4) Send engineers abroad for long and short-term specialized training. A word of caution is in order here: the conventional academic and M.S. programs in sanitary engineering in the developed countries are generally not appropriate for practicing engineers from developing countries, because the emphasis tends to be theoretical and directed to problems and solutions which must seem esoteric indeed when observed from these countries. While such courses might be suitable for engineers preparing for teaching careers in their own educational institutions, practicing engineers need training more specifically directed to their own practice.

Among the training centers in the industrialized countries is the International Program in Sanitary Engineering Design at the University of North Carolina at Chapel Hill. Some 50 engineers from more than 20 developing countries have completed 9 - 12 month programs of study which combines work at the University, in municipal water works, and in the offices of consulting engineers. They now occupy key positions at the local and national level, and some of them are responsible for organizing local training programs. Most important, these engineers are helping to establish a setting in which the technical resources of the industrialized sectors of the world can be adapted to the local resources in the developing countries to provide adequate water supply for the greatest number of people at reasonable cost.

In ten years, an estimated third of a billion people in urban centers in the developing countries will be needing water supply facilities that are not now available [3]. These projects will be competing not only for funds but for the engineers to conceive and design the projects.

It is not always realized that in addition to design engineers and system operating personnel, that successful water supply systems require support and participation from numerous other professional groups. These include health agencies, which monitor water quality, develop support, promote improvements, and educate the public; state or federal financing agencies, which regulate governmental borrowing; bonding agencies, which keep an eye on rates, repayment of debt, credit, etc.; consultants, either available on retainer or special commission; equipment manufacturers and distributors, available for parts and product information; and centralized data collection services, e.g., hydrological surveys.

Central Water Authorities

It may be advantageous in many countries to create a central water authority with limited or general powers. For example, a central agency could:

(1) Establish standard specifications for water supply equipment, e.g., pumps, and maintain a stock on hand. This action could (a) reduce the size of the total parts and equipment inventory needed within the country, and (b) stimulate local production.

(2) Prepare estimates of future demand as an aid to planning and as a stimulant to local industry.

(3) Centralize problems of foreign exchange. Often the tendency is to do without, as for example, publications, laboratory reagents, etc.

(4) Provide expert consultation to smaller communities on a "circuit-rider" basis.

(5) Develop central registers of qualified contractors and engineers.

(6) Encourage professional development through sponsorship of training programs, short courses, fellowships, etc.

(7) Conduct research and experimental investigations with applicability throughout the region.

(8) Maintain centralized data collections.

A system of fact recording and data collection reveals present conditions, reveals progress achieved in waterworks construction, and leads to improvement of water supply operation. Facts are a very powerful tool in obtaining support from the general public. They also help to reduce overdesign due to uncertainty.

For smaller communities within the country, or for the entire country in the case of smaller countries, the central authority could also take advantage of scale economies by constructing and/or operating water supply systems as well. This is particularly advantageous if surface water storage must be required. Such organizations are widely used in Central America, e.g., SNAA (Costa Rica), ANDA (El Salvador), SESP (Guatemala), SANAA (Honduras), and IDAAN (Panama).

Research and Development

Many problems of community water supply have yet to be explored scientifically. Although much of the research needed in developing countries can and should be borrowed from the literature published in the United States and Europe, much applied research can be conducted most efficiently in the country of need. This work need not be elaborate to be useful. For example, by operating a filter plant treating well water for the removal of iron and manganese, without the flocculation and sedimentation tank in front of the filter, investigators in Taiwan demonstrated that for the water in question, the resulting quality of water with the filters operated in such a manner was equivalent to that with the filters operated with flocculation and sedimentation. The obvious import of this research was that in constructing new facilities to treat water from this particular source, no investment in new flocculation and sedimentation basins was needed.

Some engineers have the mistaken notion that research and development is confined to universities and government laboratories. The above example shows that useful, inexpensive studies can be done in the field. Other non-university works of significance on filtration that readily come to mind include those of Bayliss [14], a plant operator, and Hudson [15], a design engineer.

Developments of this nature may very well be useful in more than one developing country. A new publication, Water Supply and Sanitation in Developing Countries, sponsored by the Community Water Supply Section of the United States Agency for International Development and published at the University of North Carolina has been established to report on such developments. Some examples of items published to date include:

(1) The use of constant-flow valves in Zambia [16]. These are inexpensive valves, installed in water service lines, which yield a constant rate of discharge regardless of pressure, thereby reducing waste and insuring even distribution of water between users at high and low elevations.

(2) Water supply in Indonesia using bamboo pipe [17]. Procedures for design and construction are outlined.

(3) A proportional chemical feeder developed in Swaziland [18]. This feeder uses a paddle-wheel for dosing control and requires no source of power other than the paddle-wheel.

(4) Alum-cake feeder developed in Chile [19]. A simple and inexpensive but highly effective alum-cake feeder for a large water plant is described.

The problem of research and development in developing countries is closely related to the problem of imported equipment described earlier. Water supplies, in comparison with other items of social overhead, such as highways, contain a very large percentage of non-labor items - materials and equipment. This is especially true of pipe installations. Although the cost-ratio of labor to non-labor items varies from country to country, it is essential that materials and equipment used within the individual country be produced within that country if major savings in hard currency requirements are to be realized.

This line of reasoning invites attention to pipe, since pipe of one type or another is usually the most important single non-labor cost item in water supply construction. This means then that study of pipe materials could have potential rewards. Looking at the most common diameters for smaller systems, ranging from say 2 to 6 inches in diameter, the most promising alternative to present use of galvanized or cast iron pipe is plastic pipe. Such pipe offers or would seem to offer certain advantages in developing countries: First, low capital investment is required for production equipment. Henderson [20] has indicated that an extruder machine capable of producing 2700 to 3100 feet of two-inch pipe in a six-hour day could be purchased in New York City in 1961 for $27,000. Such a plant would require a 25 horsepower motor plus a small heating load to warm the resin. Based on average U.S. labor and energy costs, the total cost of conversion from raw material to finished pipe is about 3 1/2 cents per foot for 2-inch pipe. Second, the light weight of plastic pipe which reduces transport costs of both raw material and finished product and lowers installation cost. And third, widespread availability of the basic materials in industrialized countries. Of course, disadvantages exist too. No brief for plastic pipe is intended, rather we are attempting to show a reasonable example of the type of investigation which could be made without great difficulty or expense by such a central agency as previously proposed.

Such investigations might also be made by an appropriate university. The newly established Regional School of Sanitary Engineering at San Carlos University in Guatemala is an excellent example of an institution which is making such studies on a regional basis, in this instance, for Central America. Where a Common Market exists, as in Central America, planning new water industries can be carried still further by distributing manufacture of various items among the participating countries.

The National University of Engineering of Peru has established a Center of Investigations to undertake the type of studies described herein [21].

These two University programs are assisted by the University of North Carolina and the U.S. Agency for International Development.

Justification of Community Water Supplies

In the competition for limited funds available for public investment, it has become more and more necessary to provide "hard" data on the desirability of a water supply improvement. This is somewhat disconcerting to the public health worker who no more needs an economic analysis to show that water supplies are desirable than does he need a precise measure of luminosity to assure him that the sun has passed below the horizon. Res ipsa loquitor. Nonetheless, such data are becoming virtually mandatory in order to compete for limited funds. The traditional justification has been improvement of health and its accompanying increase in productivity of the working population.

Nearly every successful water utility operates on the principle that it pays its own way. Problems of equity abound in establishing rate structures. However, for most of the water systems of consequence, it has been demonstrated that a structure capable of recovering the full operation and debt service charges is feasible. Where public hydrants exist, they may require a charge against another governmental agency. Although in a sense this is borrowing from Peter to pay Paul, empirical observation has indicated this practice to be far superior to simple subsidy. Continued operation and growth of water supply systems depend upon local interest and initiative, and this can only be represented through continuing contributions of funds.

The notion that water is, or should be, free unfortunately lingers on. In this regard, it is interesting to note that throughout the world, individual water carriers have a good market where piped supply is not available, and in every case they collect much more per gallon by several-fold than the highest charge made by a water utility anywhere. And of course, the quality of such service is deplorable.

These remarks suggest several favorable aspects of water supply as a public investment, i.e., it can and should be self-sustaining, and secondly it has widely distributed benefits.

Water supply also has certain other advantages: it has visibility and can be dramatically sold; successful completion and operation can be reasonably expected; it offers a high rate of return as a health expenditure in developing countries; the technology is ready now; and minimal education of the public is needed to derive the benefits.

Water Supply and Sewerage

Provision of piped water within densely populated areas, of necessity, requires concomitant consideration of sewers. Unfortunately some central water authorities are hesitant about providing funds for sewers, feeling that they are unproductive investments [22]. The notion persists that water supply and sewerage are two separate entities. This is inevitable perhaps when local authorities have had to fight long, lonely battles to secure even a water supply system, and where elements of subsidy blurred the financial perspective even in respect to the water supply project.

In urban towns in India where water supply was long since installed and a sewer system held up for want of adequate "subsidy," the delay is costing dearly. Insanitation and mosquito nuisance have taken root and filiariasis is becoming endemic over an ever widening urban area in the entire country [23]. "Ironically enough, filiariasis control is fast assuming an increasing importance as a health measure with prophylactics pressed into service - This is but fighting the shadow and not the substance [23]."

The visible return from sewerage is not so attractive as a water supply or an electrical project. But the provision of sewerage will eliminate the need for maintaining an army of people engaged in the unpleasant task of night soil conservancy, transport, and disposal; maintaining cesspools; and maintaining crews to combat nuisances. Savings on anti-mosquito measures can be anticipated. Mortality and morbidity rates will decrease.

The cost of not providing water and sewerage facilities is inevitably greater than the cost of providing them.

Summary

Our principal argument has been that standards and policies for community water supplies should be developed within their own environmental framework. Although considerable assistance, guidance, and information are available from the more developed nations, the development of appropriate standards and policies ultimately would seem to be a task of local engineers and administrators. Although outside expertise is available, this is a situation where money cannot buy everything. The development of at least a cadre of local talent is necessary if local objectives are to be efficiently met. It should be noted that this is pertinent regardless of the source of funding.

May we also suggest that the attitude of the engineer and the administrator should be one of open-minded and continuous questioning of alternative means of achieving realistic goals,

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and that results are the proper criteria for judging success - results in water for people, water for peace.

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PLANIFICATION ET MISE EN OEUVRE DE PROGRAMMES D'ADDUCTION D'EAU

Résumé

La présente communication concerne la planification et la mise en oeuvre de programmes communau-
aires d'adduction d'eau dans les pays en voie de développement. Ses auteurs insistent surtout sur
es aspects politiques et techniques des travaux de génie hydrologique mais aussi sur d'autres ques-
ions connexes. Ils ne s'adressent pas seulement aux ingénieurs des bureaux d'étude mais plutôt
ux administrateurs et aux autorités qui doivent guider l'activité des services du génie dans les
ys en voie de développement.

Nombreux sont ceux qui estiment que les pays industrialisés possèdent toutes les techniques et
u'il suffit seulement de les exporter vers les pays en voie de développement pour que ces derniers
uissent résoudre leurs problèmes. Une autre fausse idée est que l'efficacité va de pair avec les
echniques très élaborées. Nombreux aussi sont ceux qui, poussés par le sentiment du devoir civique
parce qu'ils aspirent à l'admiration publique, ont tendance à trouver des vertus dans l'émulation
travagante de leurs voisins plus riches.

Ces facteurs sont à la source même de l'erreur par trop commune qui consiste non seulement à
porter des ingénieurs occidentaux dans les pays en voie de développement mais aussi leurs techniques.
urtant, la situation dans ces pays est tellement différente de celle des pays industrialisés que
s solutions satisfaisantes dans ces derniers peuvent fort bien être sans valeur aucune dans les
emiers, où la limitation des ressources financières et des capacités industrielles sont la règle,
la main-d'oeuvre qualifiée est rare et la main-d'oeuvre non qualifiée surabondante, où le climat
t habituellement tropical et où les installations les plus élémentaires sont celles qui manquent
plus. Ces facteurs doivent dicter les solutions recherchées pour les pays en voie de développe-
nt.

C'est pour toutes ces raisons que l'ingénieur chargé de la conception et le constructeur des
tèmes communautaires d'adduction d'eau dans les pays en voie de développement, encore plus que
ns les pays industrialisés, doivent faire preuve d'imagination et de curiosité pour remettre en
estion les raisons fondamentales qui régissent l'exécution des projets "conventionnels" ou
lassiques", être prêts à défier des normes sacro-saintes, et exercer l'ingéniosité qu'exige la
nitation des ressources financières.

Les décisions de l'ingénieur chargé de la conception de systèmes d'adduction d'eau dans les
s en voie de développement ont des répercussions qui dépassent le simple cadre immédiat de
usine de traitement et qui sont rarement prises en considération dans les pays industrialisés.
mi ces décisions, citent les suivantes:

(1) l'utilisation de matériaux de construction importés, avec les incidences qui en découlent sur la balance des paiements, les réserves en devises, etc.;

(2) l'entretien, la réparation et le remplacement de l'équipement importé. L'existence de services centraux de fournitures et d'entreposage;

(3) l'utilisation de matériaux et de la main-d'oeuvre de provenance locale;

(4) la disponibilité de personnel pour la construction et l'exploitation;

(5) la formation d'un personnel qualifié là où il n'en existait pas du tout ou peu précédemment. La nécessité d'utiliser un matériel simple. Une conception tenant dûment compte de la pénurie en personnel d'exploitation;

(6) la qualité du matériel et la compétence du personnel, même dans des conditions défavorables;

(7) les répercussions des politiques du financement sur la conception et la mise en oeuvre des projets. Leurs effets sur la durée de la période de conception et de remboursement, l'importance du développement par paliers. La limitation maximum du coût annuel global de l'amortissement <u>et</u> de l'exploitation;

(8) l'acceptation sociale par les utilisateurs de l'eau. L'appui de la communauté.

Les auteurs présentent des exemples de l'influence favorable ou défavorable que peuvent exercer
facteurs.

Ils étudient aussi le problème des normes de conception en tant que directives politiques plutôt que comme impératifs techniques. Par exemple, une politique en vertu de laquelle "les fonds limités disponibles doivent être utilisés pour fournir de l'eau de qualité supérieure à un nombre limité de personnes" influence beaucoup l'adoption des critères de conception. L'applicabilité de certaines normes existantes dans les pays en voie de développement est aussi discutée: protection contre les incendies, réservoirs privés, réservoirs principaux surélevés, etc.

Le reste de la présente communication est consacré, avec des exemples à l'appui, à des considérations d'ordre administratif et technique relatives aux réserves d'eau communautaires dans les pays en voie de développement qui pourraient être considérées comme s'écartant des normes de la conception "traditionnelle" des pays industrialisés. Dans la conclusion, les auteurs décrivent la formation du type d'ingénieurs nécessaires dans ces pays et le genre d'assistance technique qu'ils peuvent obtenir dans les pays industrialisés.

En résumé, la présente communication décrit, à l'aide d'un certain nombre d'exemples réels puisés dans l'expérience de divers pays en voie de développement, l'état d'esprit ou la théorie que les ingénieurs devraient adopter lors de la conception des systèmes d'adduction d'eau des pays en voie de développement. Les auteurs insistent sur le fait que les administrateurs devraient faire preuve d'une grande largesse d'esprit et continuellement envisager des moyens de rechange pour atteindre des objectifs réalistes; que les résultats sont les seuls critères valables pour juger du succès d'un projet et qu'aucune technique particulière, quel que soit son état d'avancement, ne possède en soi des vertus supérieures.

PLANIFICACION Y DESARROLLO DE PROGRAMAS DE ABASTECIMIENTO DE AGUA

Resumen

Esta monografía versa sobre la planificación y el desarrollo de los programas de abastecimiento de agua a la población en los países que están en vías de desarrollo. Confiere especial importancia a las cuestiones teóricas y prácticas de ingeniería, pero incluye asuntos afines. No está dirigida sólo al ingeniero que traza los planos, sino más bien al que administra y toma las decisiones que deben orientar la actividad de los ingenieros en tales países.

Muchas personas creen que las naciones desarrolladas poseen toda la tecnología necesaria, y sólo hay que exportarla a las que están desarrollándose para resolver sus problemas. Otra idea errónea es la de que la eficiencia acompaña siempre a la tecnología altamente desarrollada. Y hay muchos cuyos ideales de bien público y cuyas aspiraciones de lograr la aprobación de los demás los lleva a creer que es una virtud imitar sin prudencia a sus vecinos más ricos.

Estos factores son la base del engaño demasiado común que encierra el envío a los países en desarrollo, no sólo de ingenieros occidentales, sino también de las prácticas de ingeniería occidentales. Sin embargo, las condiciones reinantes en los países que están desarrollándose son tan diferentes de las de los países desarrollados que las soluciones eficaces en éstos tienen poco valor en aquéllos, donde por lo general hay limitados recursos financieros y limitada capacidad industrial, escasez de mano de obra calificada y abundancia de mano de obra no calificada, clima por lo común tropical y necesidad apremiante de los servicios más elementales. Estos factores deben ser tenidos en cuenta al buscar soluciones para los países en vías de desarrollo.

De ahí que el encargado de proyectar y desarrollar los servicios de abastecimiento público de agua en los países que están en desarrollo, más aún que sus colegas de los países desarrollados, debe tener imaginación y curiosidad para buscar las razones básicas en que se apoyan los diseños "convencionales" o "de manual", estar dispuesto a desafiar normas consideradas sacrosantas y aguzar el ingenio como lo exige la limitación de los recursos financieros.

Las decisiones que toma el proyectista de obras de abastecimiento de agua para los países en vías de desarrollo tienen repercusiones que exceden el recinto mismo de la central de tratamiento y que reciben escasa atención directa en tales países. Entre los que se estudian figuran:

1) uso de materiales de construcción importados, con los consiguientes efectos sobre la balanza de pagos, las reservas de divisas, etc.;

2) conservación, reparación y renovación de equipo importado. Existencia de departamento de compras y depósitos centralizados;

3) uso de materiales y mano de obra del país;

4) posibilidad de disponer de personal para la construcción y el funcionamiento;

5) formación de personal calificado cuando no lo había o era muy escaso. Conveniencia de un equipo sencillo. Trazado que tenga en cuenta las limitaciones del personal encargado del funcionamiento;

6) capacidad de continuar prestando servicios bajo condiciones adversas;

7) efecto de la política de financiación en los planos y la ejecución de la obra. Efecto en los plazos de la planificación y en las fechas de amortización; importancia del desarrollo por etapas. Reducción al mínimo posible del costo total anual de la amortización y la explotación;

8) aceptación pública de los usuarios del agua. Fomento del apoyo de la población.

Se presentan ejemplos, tanto buenos como malos, de lo que precede.

Se trata la cuestión de normas de diseño como líneas de orientación de política y no mandatos técnicos. Por ejemplo, la política de que "los limitados fondos disponibles sean usados para dar agua al mayor número posible de personas, en vez de suministrar agua perfecta a unos pocos" tiene importantes repercusiones cuando se trata de formular el criterio al que se ha de ajustar el diseño. También se examinan algunas de las normas que se aplican en los países en desarrollo, como, por ejemplo, protección contra incendios, tanques domésticos privados, tanques principales elevados, etc. para ver si son apropiadas.

El resto del trabajo expone, con ejemplos, consideraciones administrativas y técnicas relativas al abastecimiento público de agua en los países en vías de desarrollo que podría considerarse que se apartan de las normas de diseño "normales" en los países desarrollados. En una nota final se describe la formación de este tipo de ingeniero y las formas de asistencia técnica que él puede obtener de los países desarrollados.

En resumen, la monografía describe, con ayuda de varios ejemplos concretos recogidos en países en desarrollo, el estado de ánimo o punto de vista que los ingenieros deberían adoptar al proyectar instalaciones de abastecimiento de agua en dichos países. Se aboga en favor de un espíritu abierto en el administrador de obras de ingeniería, con una búsqueda continua de los distintos medios que podrían ponerse en juego para alcanzar metas ajustadas a la realidad, y se afirma que los resultados constituyen el criterio acertado para juzgar el éxito de una labor y que ninguna tecnología determinada, por más perfeccionada que sea, posee por sí misma virtudes superiores.

United States Water Supply

OBJECTIVES AND CRITERIA FOR WATER SUPPLY PLANNING

Jabbar K. Sherwani, Donald T. Lauria

Abstract

Well-defined objectives for the planning of water supply projects and programs are lacking. As a result, governmental agencies charged with the responsibility of investment in water supplies must often make decisions on the basis of pure value judgment or political pressure. An examination of water supply objectives employed at present reveals certain platitudes serving as objectives which have no operational content and fail to provide a meaningful guide for investment. Often there are multiple, overlapping, competing, and inconsistent objectives. Health considerations fail to provide clear-cut investment guidelines in all cases because most health standards are relative rather than absolute, and cannot be divorced from economic considerations. Perhaps the most formidable problem in establishing objectives for water supply planning stems from the difficulty in isolating and defining the effects which flow from such projects. Another serious problem which troubles those who must set objectives for planning is that the role of water supply projects in economic development has yet to be articulated.

The dearth of meaningful criteria arises from the fact that most of the objectives in water supply development elude complete quantification; the effects are only partially measurable. Alternative costs as a measure of benefits have been used indiscriminately without any consideration of their applicability. The limitations and validity of alternative costs as a ranking device are examined. Priorities determined on the basis of rate of return criterion and repayment ability are critically reviewed.

To gain insight into existing practices, water supply programs and projects in the United States, Turkey, Pakistan, and Guatemala are studied for any stated or implied system of priorities.

To devise meaningful criteria which will ensure fairly consistent investment behavior, the potential of the following approaches is explored:

(a) Correlation of the level of service provided and population size.
(b) Ranking according to design features of projects.
(c) Minimum per capita costs
(d) Imputed costs of providing water supply service as an amenity or as a national policy objective. A promising approach is to incorporate the level of service as a constraint in an optimization problem and calculating the cost of constraint for different levels to facilitate value judgment.
(e) Consideration of health benefits as a joint product of water supply and other complementary investments and devising means to apportion benefits to water supply.
(f) Treating water supply as a part of social overhead capital for evaluating its effects on economic development.

OBJECTIFS ET CRITERES POUR LA PLANIFICATION DES SYSTEMES D'ADDUCTION D'EAU

Résumé

Des objectifs précis pour la planification des projets et programmes d'adduction d'eau font défaut. En conséquence, les organismes gouvernementaux anxquels incombe la responsabilité des investissements dans ce domaine sont souvent obligés de prendre des décisions en se fondant sur leur propre jugement ou en cédant à des pressions politiques. L'examen des objectifs en matière d'adduction d'eau, utilisés à l'heure actuelle, révèle certains lieux communs servant comme objectifs, qui ne contiennent aucun élément fonctionnel et ne fournissent aucun critère précis pour l'investissement. Ces objectifs sont souvent multiples, contradictoires, font double emploi et sont en concurrence directe les uns avec les autres. Les considérations sanitaires ne suffisent pas pour fournir dans tous les cas des directives nettes pour les investissements, du fait que la plupart des normes sanitaires sont relatives plutôt qu'absolues et ne peuvent être dissociées des considérations économiques. Le problème le plus formidable, lorsqu'on établit les objectifs de la planification des systèmes d'adduction d'eau, provient peut-être de la difficulté qu'il y a d'isoler et de déterminer les effets qui découlent de ces projets. Un autre problème grave se posant à ceux qui doivent fixer les objectifs pour la planification est le fait que le rôle des projets d'adduction d'eau dans le développement économique n'a pas encore été défini.

Le manque de critères précis est dû au fait que la plupart des objectifs en matière d'adduction d'eau échappent à une quantification complète; les effets ne peuvent être mesurés que partiellement. Les différents coûts possibles en tant que mesure des avantages offerts ont été utilisés sans discernement sans se soucier de leur applicabilité. Les auteurs examinent les limitations et la validité des différents coûts possibles en tant que système de classement par ordre d'importance. Ils examinent également de près les priorités déterminées d'après le critère du taux de rémunérations et la capacité de remboursement.

Afin de pouvoir évaluer les pratiques existantes, les auteurs étudient les programmes et projets aux Etats-Unis, en Turquie, au Pakistan et au Guatemala en ce qui concerne tout système de priorités établi ou implicite.

En vue de déterminer des critères précis pouvant assurer un comportement cohérent de l'investissement, les auteurs examinent les possibilités des méthodes suivantes:

a) Corrélation entre le niveau du service fourni et l'importance de la population;
b) ordre d'importance selon les caractéristiques techniques du projet;
c) coûts minimums par habitant;
d) coûts imputés de l'approvisionnement en eau en tant que service public ou en tant qu'objectif de politique nationale. Une méthode intéressante consiste à incorporer le niveau de service en tant que contrainte dans un problème d'optimisation et à calculer le coût de la contrainte pour les différents niveaux en vue de faciliter l'évaluation du projet.
e) considération des bénéfices dans le domaine de la santé en tant que produit commun de l'adduction d'eau et d'autres investissements complémentaires, et détermination des moyens permettant de déterminer la proportion de ces bénéfices imputable à l'adduction d'eau;
f) traiter l'adduction d'eau comme faisant partie de l'infrastructure sociale pour évaluer ses effets sur le développement économique.

OBJETIVOS Y CRITERIOS DE LA PLANIFICACION DEL ABASTECIMIENTO DE AGUA

Resumen

Se advierte la falta de objetivos bien definidos en la planificación de obras y programas de abastecimiento de agua. Como consecuencia, los organismos oficiales encargados de invertir fondos con este propósito se ven obligados a menudo a basar sus decisiones en juicios de valor puro o en presiones políticas. Un examen de los objetivos que hoy rigen el abastecimiento de agua demuestra que muchos de los formulados como tales carecen de contenido concreto y no sirven para orientar eficazmente esas inversiones. A menudo se ven objetivos múltiples, que se superponen, que chocan y que son incoherentes. Las consideraciones de orden sanitario no proporcionan una orientación clara en todos los casos porque la mayoría de las normas sanitarias son relativas y no absolutas y no pueden ser desvinculadas de las consideraciones de orden económico. El problema más formidable en la fijación de objetivos para la planificación del abastecimiento de agua es quizá la dificultad que hay para aislar y definir los efectos de esos proyectos. Otro serio problema que preocupa a quienes deben establecer dichos objetivos es que todavía no se ha definido el papel que le incumbe a los proyectos de abastecimiento de agua en el desarrollo económico.

La escasez de criterios racionales se debe a que la mayoría de los objetivos del abastecimiento de agua no pueden ser reducidos a términos cuantitativos y sus efectos sólo son parcialmente mensurables. La formulación de series de costos optativos para calcular los beneficios ha sido usada sin discernimiento y sin tener en cuenta su aplicabilidad. En la monografía se examinan las limitaciones y la validez del método de costos optativos como sistema de clasificación y las formas de establecer un orden de prioridad sobre la base del índice de beneficios y la capacidad de amortización, con un juicio sobre su eficacia.

A fin de ahondar el conocimiento de las prácticas que se siguen, en el trabajo se estudian los planes y obras de abastecimiento de agua en Estados Unidos, Turquía, Pakistán y Guatemala, en relación con los métodos de fijar el orden de prioridad expreso o implícito.

A fin de formular normas de criterio que sean garantía de una aplicación coherente de la política de inversiones, se analizan las posibilidades que ofrecen los siguientes enfoques:

a) Correlación entre el nivel de servicio prestado y el número de habitantes.
b) Clasificación según las características del diseño de los proyectos.
c) Costos mínimos per capita.
d) Imputación de los costos del servicio de abastecimiento de agua al concepto de comodidad para la población o el de objetivo de la política nacional. Un criterio promisorio es el de incorporar el nivel de servicio como un factor forzoso en un problema para hallar la mejor solución posible y calcular el costo de ese factor en diferentes niveles a fin de facilitar el juicio de valor.
e) Consideración de los beneficios sanitarios como producto conjunto de las inversiones en abastecimiento de agua y otras inversiones complementarias y la formulación de arbitrios para establecer los beneficios que proporcionalmente emanan del abastecimiento de agua.
f) Tratamiento del abastecimiento de agua como una parte del capital social general para evaluar sus efectos sobre el desarrollo económico.

CUENCA ARTESIANA DE BAHIA BLANCA

José García

En el Sur de la Provincia de Buenos Aires, norte de Río Negro y este de La Pampa se encuentra una importante cuenca sedimentaria, conocida como cuenca del Colorado. En su flanco norte, y en los niveles superiores por encima de los 1000 de profundidad se ha constatado la existencia de una cuenca hídrica artesiana de singular importancia, comocida como "cuenca de Bahía Blanca".

Cada una de las formaciones sedimentarias de edad Terciaria - Cuartaria que la componen, es portadora de uno o más niveles acuíferos, de los cuales el más importante, es el que se explota con éxito en varios localidades de los partidos bonaerenses de Coronel Rosales, Bahía Blanca y Villarino.

Se trata de un complejo acuífero de regular espesor, del orden de los 300 metros, de granulometría variable entre arenas finas y rodados con intercalaciones arcillosas variables en número en cortos trechos.

Las profundidades extremas a que se lo ha alumbrado hasta el momento son 500 metros en Laguna del Chasicó y 1086 metros en Puerto Belgrano, mientras que en localidades intermedias, Argerich, Cuatreros, Bahía Blanca y Grümbein, se encuentra alrededor de los 700 metros de profundidad.

El agua es surgente con presión actual de 4 atmósferas en boca-pozo, registrándose caudales iniciales variables en las distintas perforaciones (alrededor de 30), pero por lo general superiores a los 100 m3/h, siendo el máximo conocido 1000 m3/h en Chasicó Nº 1 (INGM).

En todos los casos el agua resulta de buena calidad para distintos usos, incluída utilización industrial dada su temperatura de alrededor de 60oC.

Dentro de la zona de influencia de Bahía Blanca considerando a esa ciudad como centro de un área que abarca alrededor de 37.000 Km2 comprendidos entre las sierras de La Ventana por el noroeste y las sierras de Pichimahuida por el suroeste, existen recursos de agua subterránea de diferentes características.

Haciendo abstracción de la capa libre (freática), la cual en ciertas zonas es el único recurso hídrico disponible, se presentan en el subsuelo varias capas de agua bajo presión, cuyo número varía de uno a otro lugar, razón por la cual su numeración es de valor local, a lo sumo zonal, resultando entonces el método más apropiado para su descripción el considerarlas incluídas dentro de determinadas formaciones sedimentarias, a saber:

a) Capas de Agua en el Plioceno

Los sedimentos de edad pliocena llevan intercalados niveles acuíferos, cuyo número es variable, notándose que éste disminuye en sentido norte-sur y oeste-este, es decir, desde La Vitícola y desde la Laguna Colorada Grande (Pcia. La Pampa) hacia Bahía Blanca. En esta última zona (Argerich, Bahía Blanca, Puerto Belgrano) existe un sólo nivel hídrico ubicado en la base de la formación alrededor de los 200 metros de profundidad.-

Son acuíferos de poco espesor entre 1.000 y 10.000 metros que llevan aguas ascendentes, a veces surgentes, con caudales escasos, entre 500 y 4.000 litros por hora.

El agua es clorurada sulfatada-sódica, excesivamente mineralizada, con residuo seco a 110ºC, comprendido entre 3 y 8 gramos por litro. Se explotan en pequeña escala destinando el agua para bebida del ganado.

b) Capas de Agua en el Mioceno Superior

En el Paranense (conjunto de sedimentos finos, arcillosos, de origen marino, de coloración verdosa) se encuentran acuíferos surgentes, los cuales sólo han sido ensayados en las perforaciones más antiguas practicadas en la región.

La profundidad de estos acuíferos es variable, por ejemplo: Laguna del Chasicó 350 metros, Bahía Blanca 424 metros, Argerich 530 metros, Pedro Luro 948 metros.

El espesor de los acuíferos varía entre 0,30 y 24,0 metros, desconociéndose su espesor en Pedro Luro. Los caudales específicos registrados son escasos, entre 55 y 4.200 litros por hora; siendo también en Pedro Luro donde se han registrado caudales importantes (22.000 litros por hora).

El agua resulta clorurada sódica, excesivamente mineralizada, habiéndose registrado residuos secos a 110ºC comprendidos entre 8 y 124 gramos por litro.

Por sus características (profundidad relativamente grande, agua muy salinizada) estos acuíferos sólo son aptos para su explotación con fines industriales, dado su elevado tenor en Bromo. Al respecto, existe un trabajo especial publicado en 1948 por la entonces Dirección General de Industria y Minería, titulado: "El surgente termal de Pedro Luro (Provincia de Buenos Aires)", por E.F. Rubio y C.I. de Pandolfi.

c) Capas de Agua en el Mioceno Inferior

Son las acuíferas más importantes de la región explotadas en diversos puntos de la misma, especialmente en la ciudad de Bahía Blanca.

Sus características conocidas hasta el presente son:

1) Extensión comprobada hasta la actualidad alrededor de 2.000 Km2.

2) Profundidad del techo del acuífero, variable, siendo las profundidades extremas a que se lo ha alumbrado, las registradas en la Laguna del Chasicó y en Puerto Belgrano con 500 y 1.086 metros, respectivamente, registrándose profundidades intermedias en Bahía Blanca (670 ms.), Argerich (710 ms.), Grümbein (712 ms.).

Se ha comprobado un hundimiento a partir de la Laguna del Chasicó hacia el este y el sur.

3) Constitución y espesor

El acuífero está constituído por arena, gravilla, grava y rodados de cuarcitas y granito, con intercalaciones de capas de arcilla rojiza que lo dividen en varias capas, las cuales sólo pueden ser identificadas mediante el perfilaje eléctrico de cada pozo.

El espesor total sólo se conoce en la ciudad de Bahía Blanca, único lugar donde se lo atravesó totalmente en las perforaciones denominadas Bahía Blanca Nº 8 (D.N.G. y M.) y Bahía Blanca Nº 9 (D.N.G. y M.) en las cuales se registraron 382,50 metros y 283,00 metros, respectivamente. Se ha comprobado que en el primer caso el acuífero está integrado en un 76,36% por material permeable, mientras que en el segundo caso el material permeable representa un 54,78% del espesor total.

En las demás perforaciones practicadas dentro y fuera de la ciudad de Bahía Blanca, sólo se han penetrado los niveles más altos del acuífero, desconociéndose por lo tanto, las variaciones en el espesor que presenta el mismo.

4) Producción Actual y Usos del Agua

En todos los casos conocidos el agua es surgente y, en las distintas perforaciones, mediante las cuales se explota el acuífero, se han comprobado caudales iniciales, importantes, los cuales según consta en los perfiles correspondientes a cada obra varían entre 50.000 y 500.000 litros por hora, habiéndose apreciado en un caso excepcional, Laguna del Chasicó Nº 1 (D.N.G. y M.), alrededor de 1.000.000 de litros por hora.

Estos caudales iniciales han sufrido mermas importantes, atribuibles a diversas causas, que no hacen al rendimiento del acuífero.

Se ha calculado que actualmente, en toda la región, este acuífero provee alrededor de 45.000 metros cúbicos diarios (24 horas).

El agua es utilizada principalmente en el abastecimiento de la ciudad de Bahía Blanca y la Base Naval de Puerto Belgrano, sometiéndola a un proceso de enfriamiento previo a su distribución.

La temperatura elevada, alrededor de 60ºC han permitido su uso industrial, en lavaderos de lana, frigoríficos y calefacción en un edificio central de la ciudad de Bahía Blanca.

En la ciudad de Bahía Blanca, donde la explotación es intensiva, se han comprobado interferencias entre las distintas obras, fenómeno causado por la cercanía de una a otra perforación.

5) Capacidad de Producción

El rendimiento del acuífero sigue siendo importante, como lo demuestran aquellas perforaciones alejadas de la ciudad: Spurr Nº 1 (D. N. G. y M.) Sansinena Nº 1 (Pergeo) Grünbein (D. N. G. y M.), etc.

Con los datos actuales se ha calculado que la reserva en agua recuperable de este acuífero es del orden de los 100.000 hectómetros cúbicos.

6) Temperatura del Agua

El agua proveniente de este acuífero presenta en todas las obras de captación temperaturas que varían entre 55 y 72ºC, las cuales resultan ser muy elevadas en relación con la profundidad a que se encuentra el techo del acuífero.

Se ha calculado que el exceso de temperatura varía entre 9,8ºC y 26,7ºC, resultando el mayor exceso en la temperatura, el correspondiente a la perforación Laguna del Chasicó Nº 1 (D. N. G. y M.), y los menores, los correspondientes a Puerto Belgrano.

Se considera que la temperatura elevada del agua se debe a un recorrido en profundidad.

7) Composición Química del Contenido Salino del Agua

El agua puede definirse como bicarbonatada clorurada sódica.

Los distintos iones se encuentran en todos los casos dentro de los límites establecidos en las normas de Obras Sanitarias de la Nación, para aguas destinadas al consumo humano.

Cabe destacar que en todos los análisis químicos realizados sobre muestras de agua provenientes de distintas perforaciones, se ha constatado la presencia de Fluor; en un 65% de estos análisis la cantidad de este elemento es ligeramente superior a 1 mg/l; se han comprobado valores mayores (3 mg/l) en las perforaciones de ubicación austral (Puerto Belgrano).

8) <u>Origen del Agua - Posibilidad de Alimentación</u>

Por diversas razones se considera que son mayores las posibilidades de que el agua sea de origen superficial, ya sea fósil o meteórica, vale decir, que el agua en el primer caso haya cumplido su ciclo atmósférico en un período geológico lejano, y en el segundo, que aquella haya cumplido este ciclo hace poco tiempo (geológicamente muy moderna).

En caso de tratarse de agua fósil, la producción sería limitada, resultando como se ha hecho notar en el punto 5, de alrededor de 100.000 Hm3 la cantidad total de agua explotable.

En caso de existir alimentación, la extracción resultaría ilimitada en una explotación racional. Con los datos actuales se supone que existe alimentación y que ésta proviene de regiones alejadas, ubicadas en el centro del país. En este sentido se están realizando estudios y obras de perforación en la Provincia de La Pampa.

En résumen, el acuífero profundo de la región de Bahía Blanca, se encuentra en condiciones de proveer agua de buena calidad para todo uso, en cantidades grandes y con temperatura elevada, que la hacen aprovechable industrialmente.

THE ARTESIAN BASIN OF BAHIA BLANCA

Abstract

In the Bahía Blanca region there is a large artesian basin which is being successfully tapped at various localities in the districts of Coronel Rosales, Bahía Blanca and Villarino.

The largest aquifer, and hence the one being utilized, is contained in the redstone formation of the Miocene, according to borings carried out to date.

The depth at which it is found varies between 500 meters (Chasicó lagoon) and 1086 meters (Puerto Belgrano), while at Argerich, Cuatreros, Bahía Blanca and Grümbein it has been tapped at 700 meters.

The initial flow rates recorded in the different borings tend to vary, but on the whole they are in excess of 100 cubic meters per hour. The maximum known flow rate is 1000 cu. m. per hr., recorded in the Chasicó 1 borehole (Instituto Nacional de Geología y Minería).

In all cases the water is artesian, at a pressure of 4 atmospheres, and of faultless quality for human consumption. Moreover, on account of its high temperature, about 60ºC, it is suitable for industrial use.

LA STRATE AQUIFERE ARTESIENNE DE BAHIA BLANCA

Résumé

Il y a, dans la région de Bahia Blanca, une importante strate aquifère artésienne exploitée avec succès en diverses localités des arrondissements de Coronel Rosales, Bahia Blanca et Villarino.

La strate aquifère la plus importante et, par conséquent, la plus exploitée est située dans la formation miocène rougeâtre, selon les sondages effectués jusqu'à présent.

La profondeur à laquelle elle se trouve varie de 500 m (lagune de Chasicó) à 1.086 m (Puerto Belgrano), alors qu'à Argerich, Cuatreros, Bahía Blanca et Grümbein on l'a atteinte à 700 mètres.

Les débits initiaux enregistrés au cours de divers forages sont variables mais en général supérieurs à 100 m^3/h, le maximum connu étant de 1.000 m^3/h au forage de Chasicó nº 1 (Institut national de géologie et d'exploitation minière).

Dans tous les cas, l'eau jaillit à une pression de 4 atmosphères et sa qualité pour la consommation ne peut être meilleure. De plus, en raison de sa température élevée (environ 60º C), elle peut être utilisée à des fins industrielles.

EL PROBLEMA DEL AGUA EN EL MEDIO RURAL

Direccion de Saneamiento Ambiental

1 - Planificación y Aspectos Económicos

Introducción

El concepto de comunidad rural no ha sido perfectamente definido: en las modernas corrientes sociológicas se ha abandonado ya el primitivo criterio según el cual se tomaba la idea de aldea como primer elemento constitutivo de la sociedad rural, considerando como tal a la comunidad en que los hombres viven aún arraigados a la naturaleza y a la tierra, sobre la base de la labor agrícola. Hoy en día se admite que abarca también a grupos demográficos no agrícolas, o sólo parcialmente agrícolas, con la condición de no exceder un número determinado de habitantes. Esa cifra tope varía en los diferentes países, fundamentalmente con sus modalidades topográficas y demográficas, oscilando entre 2000 y 5000 habitantes.

En nuestro país se ha estimado conveniente fijar el término máximo de lo que debe entenderse por comunidad rural en la cantidad de 3000 habitantes, cifra que responde a la realidad media de nuestra vasta campaña a través de su dilatada latitud.

Estas comunidades, en países que como el nuestro están en proceso de desarrollo se encuentran en un periodo de transición, ya que si bien la tradición es importante en la vida comunitaria, comienzan a sufrir la influencia de la tecnología moderna y el atractivo que ofrece la comodidad de la vida en las ciudades.

Ese atractivo, unido muchas veces a las mayores oportunidades de trabajo, se traduce en los conocidos movimientos migratorios del campo a la ciudad, tan característicos en nuestro país en los últimos años.

En lo referente al abastecimiento de agua potable, la situación desventajosa del medio rural se pone bien de manifiesto con los siguientes valores estadísticos disponibles, según la información de Obras Sanitarias de la Nación en el año 1963:

Población	urbana	total	15.100.000
"	"	servida	11.360.000
"	"	a servir	3.740.000
Población	rural	total	4.720.000
"	"	servida	320.000
"	"	a servir	4.400.000

Resulta de estos valores que sólo un 6,7 % de la población rural está abas tecida con agua potable y aún esta cifra pierde su significación si se tiene en cuenta que los abastos que comprende, corresponden en su mayor parte a los llamados "servicios reducidos" en que la provisión de agua se hace mediante surtidores públicos que no aseguran que el agua llegue a cada domicilio libre de contaminación.

1.1 -Significación económica

Los fenómenos migratorios internos que normalmente deberían ser la expresión del crecimiento económico, deben constituir un proceso ordenado, para lo cual el desplazamiento hacia lo urbano debe ser proporcional al aumento de las oportunidades de trabajo y a la capacidad de absorción de las ciudades y siempre que en el campo se mantenga un número adecuado de trabajadores para abastecerse de alimentos a sí mismos y a la creciente población urbana.

Sin embargo, las migraciones internas se han producido a un ritmo más rápido que las posibilidades de trabajo y viviendas de las grandes ciudades y sus alrededores, dando origen a viviendas inapropiadas, condiciones deficientes de saneamiento, aumento de enfermedades y desasosiego social.

En el medio rural en tanto, se ha producido un evidente desequilibrio entre las fuerzas económicas activas y no activas; la población activa y particularmente los jóvenes, han partido en busca de mejores horizontes, resintiendo sensiblemente la capacidad productiva del agro y dejando así una típica serie de comunidades rurales de "niños y viejos".

Resulta entonces evidente la importancia que económicamente tienen todas aquellas medidas conducentes a la incrementación del bienestar en el medio rural directamente, en cuanto contribuyen a restablecer el equilibrio demográfico entre las fuerzas activas y no activas de la comunidad, indirectamente, por cuanto el mejoramiento de las condiciones ambientales repercute en la salud de la población rural y un mejor standard sanitario se traduce de inmediato en un incremento de la capacidad productiva.

1.2 -Relación con el saneamiento

La falta de un adecuado abastecimiento de agua potable a través de cañerías en el medio rural, es causa entre otras razones, de los elevados índices de morbimortalidad en las provincias, particularmente por la incidencia de las llamadas "enfermedades de origen hídrico" o más precisamente de aquellas en que el agua actúa como vehículo de transmisión.

El agua potable además de contribuir a la higiene personal y doméstica, es factor preponderante en la disminución de la morbidad y mortalidad (especialmente entre los 0 y 4 años de edad) causadas por enfermedades de transmisión hídrica como el cólera, las fiebres tifoidea y paratifoidea, disenterías amebiana y enfermedades diarreicas producidas por diversos gérmenes patógenos.

Esos índices son particularmente elevados en algunas provincias de nuestro territorio, tales como por ejemplo, Jujuy, Neuquén, Río Negro, Catamarca y Salta.

Esa situación, que por lo demás es común a diversos países latinoamericanos y la trascendencia que el saneamiento ambiental y en particular el aprovisionamiento de agua potable, reviste para la salud y el desarrollo social y económico de la población rural, fueron reconocidos en la Reunión Extraordinaria del Consejo Interamericano Económico y Social al nivel ministerial celebrado en Punta del Este, Uruguay, del 5 al 17 de agosto de 1961, estableciendo explícitamente entre los objetivos de la Alianza para el Progreso, aumentar en 5 años la esperanza de vida al nacer y mejorar la salud individual y colectiva, para lo cual se requiere, entre otras medidas, suministrar en el decenio siguiente, agua potable a no menos del 50 % de la población rural.

2 - Enfrentamiento del Problema

2.1 - La decisión de solucionar el problema

El Gobierno Nacional ha demostrado su preocupación por resolver el proble ma dando cumplimiento a la recomendación formulada en Punta del Este.

A tal efecto, se designó por Resolución 1282 del Ministerio de Asistencia Social y Salud Pública, una primera comisión de técnicos a nivel ministerial, para realizar los primeros estudios. Este comité, interministerial, recopiló los antecedentes necesarios, y en base a ellos, bosquejó un plan provisional, expresado en un primer documento, del que surgieron, fundamentalmente:

a) que el objetivo expresado en la Reunión de Punta del Este es suceptible de ser alcanzado.

b) que el programa producirá rendimientos en materia de salud, bienestar social y desarrollo económico.

c) que para su financiación es conveniente recurrir a agencias financieras internacionales.

d) que en programas de este tipo es importante la participación activa de la comunidad.

Planteada en el primer documento la factibilidad de la solución del problema, el Gobierno Nacional, concretó su decisión de llevar a cabo un programa al efecto, con la creación por Decreto Nº 9762 del 2 de diciembre de 1964, del Servicio Nacional de Agua Potable y Saneamiento Rural, dentro del esquema administrativo del Ministerio de Asistencia Social y Salud Pública.

2.2 - El planeamiento

El nuevo organismo, tomando como base las recomendaciones del primer documento producido por la Comisión, se abocó al planeamiento definitivo para lo cual encaró la recopilación de antecedentes, en parte realizado por la Comisión anterior, el estudio de los recursos materiales, humanos y financieros y las distintas alternativas que se ofrecían en cuanto a la administración del programa, a la financiación, etc.

2.2.a - Recopilación de antecedentes

La necesidad de establecer una idea aproximada del costo de los sistemas a construir, obligó a buscar los antecedentes disponibles en materia de abastos de agua, y particularmente en relación con las fuentes de agua, cuyas características (facilidad de acceso, calidad, distancia a la población) determinan en buena medida, el monto a invertir.

Afortunadamente, se disponía de información adecuada en algunas zonas del territorio, obtenida a través de los trabajos de diversos organismos técnicos especializados, tales como Obras Sanitarias de la Nación, Agua y Energía Eléctrica, Yacimientos Petrolíferos Fiscales, el Comando de Ingenieros del Ejército, el Consejo Federal de Inversiones, y diversos organismos análogos en las provincias.

La recopilación del material existente, complementada por la asesoría de los técnicos de los departamentos correspondientes de la Universidad de Buenos Aires, permitió formar una base sólida para el planeamiento. La experiencia de organismos internacionales en programas similares en otros países latinoamericanos y particularmente la activa colaboración y asesoría de la Oficina Sanitaria Panamericana (oficina regional de la Organización Mundial de la Salud) permitieron simplificar la tarea y llegar en el mínimo tiempo a una solución que entendemos ha sido ampliamente satisfactoria.

2.2.b - Recursos materiales

El Servicio Nacional de Agua Potable y Saneamiento Rural consideró los diferentes recursos materiales implicados en la construcción de las obras, para lo cual disponía de elementos de juicio suficientes. En efecto, la incidencia de los factores económicos en la construcción de sistemas rurales determina, a priori, en cierta medida, las características de estos sistemas. Desde el comienzo se descartó la posibilidad de encarar complejos (y en consecuencia costosos) tratamientos; se preconizó por el contrario, la construcción de sistemas sumamente sencillos, en lo posible consistentes en captaciones de agua subterránea, en la misma localidad, constituído por una perforación y un equipo de bombeo, tanque de reserva y regulación y red de distribución.

Se admitió también el uso de agua superficial, en lo posible con un tratamiento reducido a una filtración lenta, o bien sedimentación y filtro lento. En todos los casos se decidió la desinfección con cloro como medida de seguridad.

En base a tal suposición que, prácticamente, permite determinar los elementos necesarios (con bastante aproximación) se llegó a la conclusión que para la construcción de los servicios, la enorme mayoría de los equipos y materiales necesarios eran producidos o podían ser fabricados en el país en caso necesario (caso de medidores de caudal y válvulas de entrega intermitente). La posibilidad de tener que recurrir a plantas de tratamiento (plantas de desalinización, filtros de intercambio iónico, plantas compactas de tratamiento) se consideró como una situación especial sin peso decisivo en el total de los equipos requeridos por el programa y que se resolverían individualmente.

2.2.c - Recursos humanos

Los recursos humanos fueron también cuidadosamente analizados, pues de ellos dependía, en cierta medida, la posibilidad de poner en marcha de inmediato el programa o, por el contrario, la necesidad de dilatarlo hasta contratar o adiestrar el personal necesario.

Se llegó a la conclusión de que no era necesaria ninguna dilación del programa, pues en tal estado de la tramitación se contaba con personal adecuado, tanto en los niveles directivos como en el nivel técnico, de subprofesionales y obreros.

Sin embargo, fue conciencia de la mayoría que era necesaria una capacitación específica en los niveles, directivo, técnico y subtécnico, para la adecuación a la administración de sistemas de abastos de agua. Por lo demás, la idea ya latente de la participación de la comunidad en la ejecución del Plan, planteaba asimismo la necesidad de adiestrar personal en técnicas de promoción y organización de la Comunidad, para lograr materializar la participación antes mencionada. De allí que, en todo el proceso de planeamiento, se diera especial énfasis a los programas de adiestramiento, en el entendimiento de que eran indispensables para complementar y adecuar los recursos humanos existentes.

2.2.d - Recursos financieros

Se ha definido ya la incidencia de los factores económicos en los abastos de aguas rurales. Esta circunstancia, y la magnitud del problema, habrían llevado ya a la primera Comisión Especial Permanente, a aconsejar la financiación parcial de las obras mediante créditos de agencias internacionales. El Servicio Nacional de Agua Potable sostuvo, con la asesoría de la Oficina Sanitaria Panamericana las primeras conversaciones con representantes del Banco Interamericano de Desarrollo, con el propósito de hacer uso del Fondo Fiduciario para el Progreso Social, creado por el Presidente John Fitzgerald Kennedy, de créditos a largo plazo y bajo interés.

2.2.e - Estudio de alternativas

Durante el planeamiento y antes de llegar a la solución definitiva, se plantearon una serie de alternativas en diferentes aspectos del programa esbozado.

Así, por ejemplo, un primer estudio de alternativas surgió al plantear la conveniencia de una centralización o descentralización total del programa. Este planteo que, por otra parte, ha sido y sigue siendo motivo de polémica en lo que hace a la administración de los sistemas de abastecimiento de agua en el país, motivó la exposición de diferentes puntos de vista.

Si embargo, de ese estudio previo surgió la idea de que uno y otro sistema, centralización o descentralización total, debían descartarse. La centralización total imponía la creación de un organismo gigantesco que, por otra parte, la Nación, a través de sus organismos normativos y asesores, se manifestaba contraria a crear una organización (Empresa) de esa naturaleza y envergadura.-

La descentralización total, dejando en manos de organismos provinciales el manejo del programa, no era por cierto una garantía de uniformidad de criterios, de adecuada coordinación y ni siquiera de facilidad de operación. Trabajar con 22 programas inconexos, no uniformes ni equilibrados, parecía ser la consecuencia lógica de adoptar tal sistema, y por ello, se decidió también descartarlo.

Se optó pues, por una solución mixta centralizando el planeamiento, las tareas de normatización y la supervisión de las obras, tareas que quedaban a cargo del Servicio Nacional de Agua Potable y Saneamiento Rural.

Los organismos provinciales tendrían a su cargo, en cambio, la ejecución de las obras. Hay pues planeamiento y supervisión centralizada y ejecución descentralizada.

Las alternativas posibles en cuanto a la financiación no plantearon disyuntivas difíciles de resolver; descartada la financiación exclusiva por la Nación, se decidió en un todo, conforme con lo aconsejado en el primer documento, la financiación mixta, con participación de agencias internacionales. Más aún, se decidió que la comunidad, cuya intervención activa se preconizó a través de diversas agencias y, particularmente, por la Oficina Sanitaria Panamericana, debía participar en la financiación de la obra mediante contribución directa y, más adelante, a través del pago de tasas o tarifas.

Con ésto, quedaban fijadas las bases del plan a establecer.-

3 - La Solución del Problema

Plan Nacional de Abastecimiento de Agua Potable a Comunidades Rurales

3.1 - Financiación

Se ha calculado, como costo total de las obras previstas como objetivo a madiano plazo, la suma de 40.000.000 de dólares.

La financiación se llevará a cabo con recursos que provendrán de tres fuentes distintas: a) el 50% o sea 20.000.000 de dólares mediante un crédito que se ha solicitado al BID en tres etapas; la primera de las cuales por un valor de u$s. 5.000.000 ya ha sido otorgada; el 20% será aportado por el Gobierno Nacional a fondo no recuperable; el 10% será aportado por las provincias en las mismas condiciones y el 20% restante correrá por cuenta de las comunidades beneficiarias, cuyo aporte podrá ser en efectivo, mano de obra y materiales de la zona.

Los fondos procedentes del BID y los aportados por el Banco de la Nación, serán depositados en una cuenta especial que será administrada por la Comisión Ejecutiva del SNAP. Los recursos serán entregados a las provincias a medida que las obras se vayan realizando. La autorización se hará efectiva en 20 años mediante cuotas iguales que cubrirán la amortización e intereses, siendo estos últimos del 6% anual sobre saldos. Por ello, se fijarán tasas que deberán abonar los usuarios suficientes para cubrir los gastos de operación y mantenimiento, las reservas por depreciación de instalaciones y la cuota de amortización del crédito e intereses.

Se ha previsto la formación de un Fondo Rotatorio Nacional, con los saldos positivos de las cuentas especiales que funcionarán a nivel del SNAP y de los servicios provinciales, lo cual permitirá realizar reinversiones para financiar la instalación de nuevos servicios o la ampliación de los existentes. Se ha calculado qué, en mérito al funcionamiento de este fondo, al cabo de 52 semestres se habrán invertido en obras el equivalente de 16.924.724 dólares, de los cuales 9.461.362 dólares serán aportados por la Nación, las provincias y las comunidades beneficiarias; 5.000.000 provenientes de la primera etapa del crédito del BID y 3.462.362 por acrecentamiento del Fondo Rotatorio.

Es previsible que lo mismo ocurrirá con las dos etapas restantes, por lo cual, en definitiva, el monto total de las inversiones tendientes a cubrir el ojetivo a largo plazo, alcanzarán el equivalente de más de 67.000.000 de dólares

3.2 - Objetivos a cumplir

Se ha planteado el cumplimiento de objetivos a corto, madiano y largo plazo. La figura 1 pone de manifiesto las metas parciales a alcanzar en dos, seis y veinte años, tanto expresados en número de habitantes a servir, como costo total de obras en dólares.

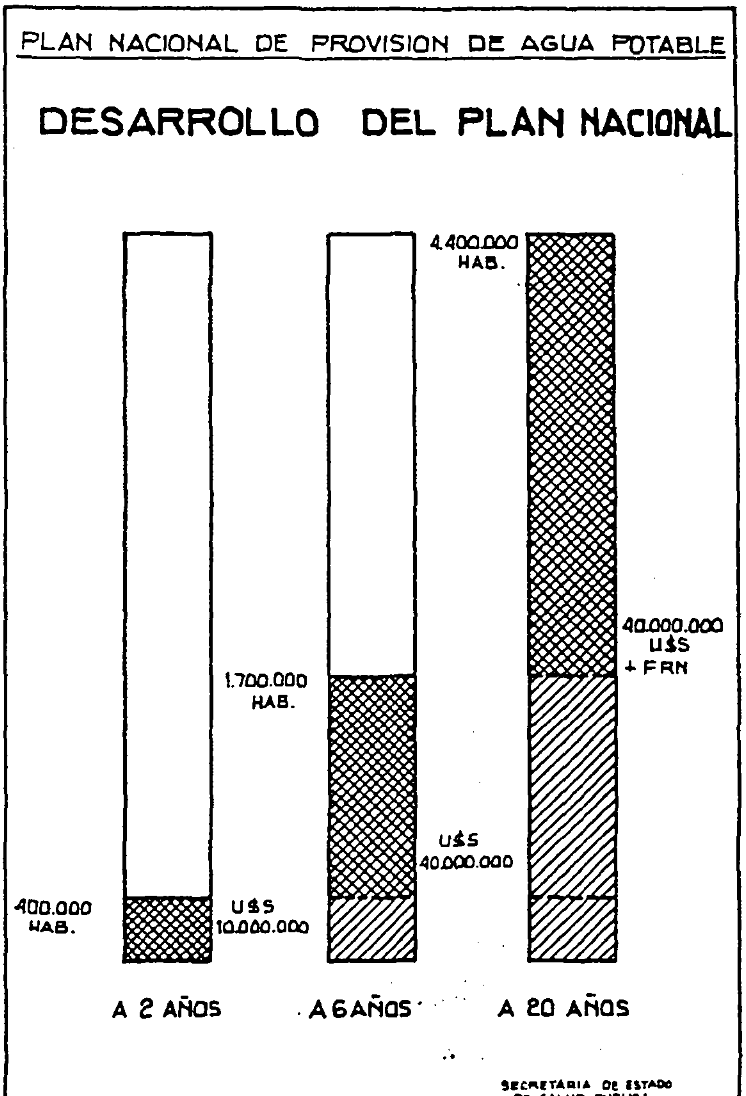


FIGURA 1

3.3 - Niveles funcionales y organismos creados

Al estudiar la conveniencia de adoptar un sistema centralizado, se mencionó como solución la de crear un organismo central nacional, encargado de la normatización, supervisión del programa, administración de los fondos y evaluación, mientras la ejecución de las obras queda a cargo de organismos similares a crearse en las provincias, que designamos en lo sucesivo como "Servicio Provincial de Agua Potable Rural" (SPAR). Se decidió, además, que la operación y mantenimiento correrá por cuenta de las comunidades organizadas. Surgieron así tres niveles funcionales administrativos, Nacional, provincial y comunitario, cuyas funciones se esquematizan en la figura 2.

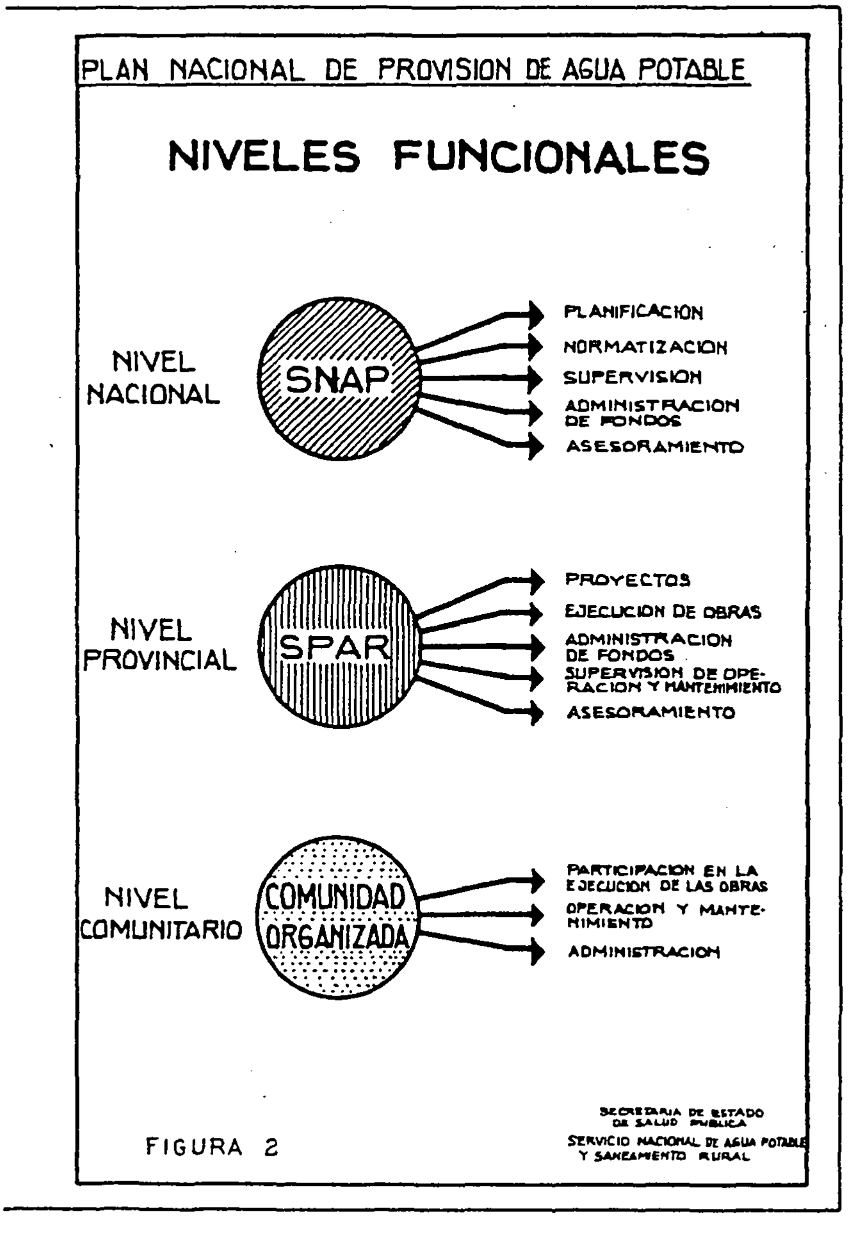


FIGURA 2

3.4 - Actividades a desarrollar

Dentro de cada uno de los tres niveles esbozados en el parágrafo anterior, surgen en el desarrollo de sus tareas específicas, tres aspectos distintos: el de ingeniería, el administrativo-contable y el de promoción de la comunidad. De allí que dentro de cada organismo, a nivel nacional o provincial, se ha planeado crear tres sectores de trabajo, ligados con cada uno de los tres aspectos mencionados.

El Servicio Nacional de Agua Potable y Saneamiento Rural(SNAP) tiene a su cargo, según dijimos, la redacción de las normas técnicas a que deberán ajustarse los proyectos de obras, la ejecución y la administración ulterior, así como las tareas de motivación y organización de las comunidades, a desarrollar a lo largo de todo el proceso de estudio y construcción y más allá, durante la operación y mantenimiento de los servicios.

La ejecución de las obras, es responsabilidad exclusiva del Servicio Provincial (SPAR) pudiendo hacerse directamente por los organismos técnicos corres dientes si tuvieren la capacidad requerida - en personal y equipos - o bien mediante contratos con terceros.

Incluso, los proyectos correspondientes pueden ser contratados, pero siempre es el SPAR el organismo responsable ante el SNAP por la adecuación del proyecto a las normas técnicas y por la correcta construcción del sistema. Las tareas de supervisión se hacen a nivel provincial y nacional, tanto el SPAR debe supervisar la ejecución de las obras (o aún el proyecto si fuera contratado con terceros) como el Servicio Nacional. Más aún, el contrato con el Banco Interamericano de Desarrollo acuerda a este organismo internacional la facultad de ejercer tareas de supervisión. En el planeamiento del programa se ha establecido, asimismo, que deberá desarrollarse tareas periódicas de evaluación a cargo del Servicio Nacional de Agua Potable y Saneamiento Rural.

3.5 - Desarrollo de los programas provinciales

El Plan Nacional resulta de la integración de los programas provinciales;de allí que se haya puesto particular atención en el planeamiento provincial.

A tal efecto, se ha supuesto cinco etapas en el desarrollo del programa provincial.

1) Estudios previos: en la que se reúne y clasifica toda la información disponible y que culmina con la elaboración de una lista provisional de localidades a servir en períodos definidos, ordenados de acuerdo a criterios de prioridad.

2) Trabajos de campo: en la cual se inician tareas directas en la comunidad y que, a través de una etapa intermedia de elaboración de un anteproyecto, conducen a la preparación del proyecto definitivo.

3) Etapa de construcción: de acuerdo a un esquema de trabajos y bajo la supervisión del Servicio Provincial, el Servicio Nacional y el BID.

4) Operación y mantenimiento y administración: comienza aquí la tarea del Ente Comunitario Organizado, que se encarga de operar y mantener los servicios, así como de recaudar las tasas y llevar los registros contables mínimos para la supervisión del Servicio Provincial.

   La eficiencia de esta tarea estará ligada, naturalmente, al éxito de los trabajos desarrollados en todo el período previo por el sector de Promoción de la Comunidad.

5) Evaluación: periódicamente, el Servicio Nacional, a través de la información suministrada por los Servicios Provinciales u obtenida directamente, procederá a evaluar la marcha del programa en una provincia o el proceso global en todo el país.

RURAL WATER SUPPLY IN ARGENTINA

Abstract

Planning and Economic Aspects

1. The water problem in rural areas.

The present situation.
Definition of rural areas in our program.
Situation of rural as opposed to urban areas with regard to potable water supply.
Statistical information available.

2. Economic significance.

Migratory movements; destruction of balance between active and non-active economic forces in rural populations.

3. Connection with sanitation.

Sanitation problems stemming from Argentina's water shortage.
Disease and mortality indices in the provinces.
Recommendations of the interministerial meeting at Punta del Este.

Approach to the Problem

1. The decision to solve the problem.

Appointment of an interministerial committee of technical experts. The initial document. Establishment of the National Potable Water and Rural Sanitation Service (Servicio Nacional de Agua Potable y Saneamiento Rural).

2. Planning.

(a) Data collection.

Advisory assistance from domestic organizations associated with the problem. The university's activities.
International advisory services.

(b) Physical resources.

Estimate of materials needed for civil engineering works: pipe, tanks, equipment, special treatment plants.

(c) Personnel.

Managerial staff; availability of managerial staff at ministerial levels.
Technical personnel; adequate technical skills in Argentina; existing organizations at the provincial level.
Semiskilled personnel and laborers; different situations in the various provinces.
Need for training programs.

(d) Financial resources.

Importance of the financing problem.
Use of funds from international lending agencies.
The Social Progress Trust Fund set up by President John F. Kennedy.

(e) Study of alternatives.

In program execution:

Centralization of planning, standardization, execution and supervision.
Decentralization of planning, execution and supervision.
Centralization of planning, standardization and supervision; decentralization of execution of works projects.
Alternative adopted.

In financing:

Entirely government-financed, without international loans.
Joint, with assistance from international lending agencies.
Alternative adopted.

In community participation:

Without assistance from the community.
With active participation by the community.
Alternative adopted.

<u>The Solution to the Problem</u>

National plan for potable water supply to rural communities.

1. Joint financing.

   IDB: 50 percent.
   Government: 20 percent.
   Province: 10 percent.
   Community: 20 percent.
   National Revolving Fund: creation and objectives.

2. Objectives.

   Short-term: population supplied and investments scheduled.

   Medium-term: " " " " " .

   Long-term: " " " " " .

3. Functional levels and organizations established.

   National: SNAP
   Provincial: SPAR
   Community: community bodies

4. Activities to be carried out.

   (a) Standardization: engineering standards.
       Standardization: administrative standards.
       Standardization: promotional standards.

   (b) Execution.
   (c) Supervision.
   (d) Evaluation.

5. Handling of the provincial programs.

   (a) Preliminary studies.
   (b) Field work.
   (c) Construction of works.
   (d) Operation, maintenance, and administration.
   (e) Evaluation.

APPROVISIONNEMENT EN EAU SUR LE PLAN RURAL DANS LA REPUBLIQUE ARGENTINE

Résumé

Planification et aspects économiques

Le problème de l'eau en milieu rural

La situation actuelle.
Le concept du milieu rural dans notre programme.
La situation du milieu rural par rapport au milieu urbain en ce qui concerne l'approvisionnement en eau.
Renseignements statistiques disponibles.

Signification économique

Mouvements migratoires, destruction de l'équilibre entre les forces économiques actives et non actives dans les agglomérations rurales.

Relation avec l'assainissement

Problèmes sanitaires résultant du manque d'eau dans notre pays.
Taux de la mortalité causée par la morbidité dans nos provinces.
Recommandations de la réunion interministérielle de Punta del Este.

Comment faire face au problème

Décision en vue de résoudre le problème

Désignation d'une commission interministérielle de techniciens. Le premier document. Création du Service national d'eau potable et d'assainissement rural.

L'établissement des plans

Compilation des antécédents. Consultation d'organisations s'occupant du problème de l'eau dans le pays. L'action de l'Université. Les consultants internationaux.

Ressources matérielles. Evaluation du matériel nécessaire à l'exécution de travaux publics. Conduites, châteaux d'eau, équipement, usines spéciales de traitement.

Ressources humaines. Personnel de direction: disponibilité du personnel de direction à l'échelon ministériel.
Personnel technique: Capacité technique adéquate dans le pays.
Organismes existants au niveau de la province.
Personnel sous-professionnel et manoeuvres: différentes situations en différentes provinces.
Nécessité de programmes de formation professionnelle.
Ministère de l'Assistance sociale et de la Santé publique

Ressources financières

Importance du problème de financement.
Utilisation des ressources d'organismes financiers internationaux.
Le Fonds monétaire pour le progrès social créé par le Président John F. Kennedy.

Etude des possibilités

Dans l'exécution du programme:

- Centralisation en matière de planification,de standardisation et de contrôle.
- Décentralisation en matière de planification, d'exécution et de contrôle.
- Centralisation en matière de planification, de standardisation et de contrôle.
- Solution adoptée.

En matière de financement:

- Totalement à la charge de l'Etat, sans ressources financières internationales.
- Mixte: avec la participation d'organismes financiers internationaux.
- Solution adoptée.

Participation de la communauté:

- Sans participation de la communauté.
- Avec la participation active de la communauté.
- Solution adoptée.

La solution du problème

Plan national d'approvisionnement en eau potable des communautés rurales

Financement mixte
BIRD: 50 pour cent
Etat: 20 pour cent
Province: 10 pour cent
Communauté: 20 pour cent
Fonds national de roulement: création et objectifs.

Objectifs à atteindre
A court terme: agglomération approvisionnée et investissements à effectuer.
A moyen terme: " " " " " "
A long terme: " " " " " "

Echelons de fonctionnement et organismes créés
National: SNAP
Provincial: SPAR
Communautaire: Entreprises communautaires

Travaux à exécuter
Standardisation: normes relatives aux travaux techniques
" " à l'administration
" " à la promotion

Exécution
Contrôle
Evaluation

Développement des programmes provinciaux
Etudes préalables
Travaux sur place
Construction des installations
Fonctionnement, entretien et administration
Evaluation.

International Conference on WATER for PEACE

NEW DEVELOPMENTS IN CEMENT USE FOR WATER FACILITIES

James D. Piper

INTRODUCTION

Water serves mankind in a variety of ways. It can be either man's best friend or his worst enemy. Controlled, water serves the increasing needs of civilization in a greater measure than any other natural resource. Uncontrolled, it can create havoc.

There are surpluses of water in some areas of the world and deficits in others. For the next several decades, however, more facilities must be provided to store, treat, and distribute water, and to dispose of watery wastes. To do this engineers will rely on concrete structures and pipelines for long-lasting and economical facilities.

Concrete provides every advantage desired in a construction material. It is strong, watertight, and durable. It is low in first cost and requires practically no maintenance. It can be shaped to any functional or aesthetic configuration that the engineer desires. Of all the materials consumed by mankind throughout the world, only water is used in greater quantities than concrete.

ADVANCES IN CEMENT AND CONCRETE USE FOR CONTROL, CONSERVATION AND USE OF WATER RESOURCES

Dams

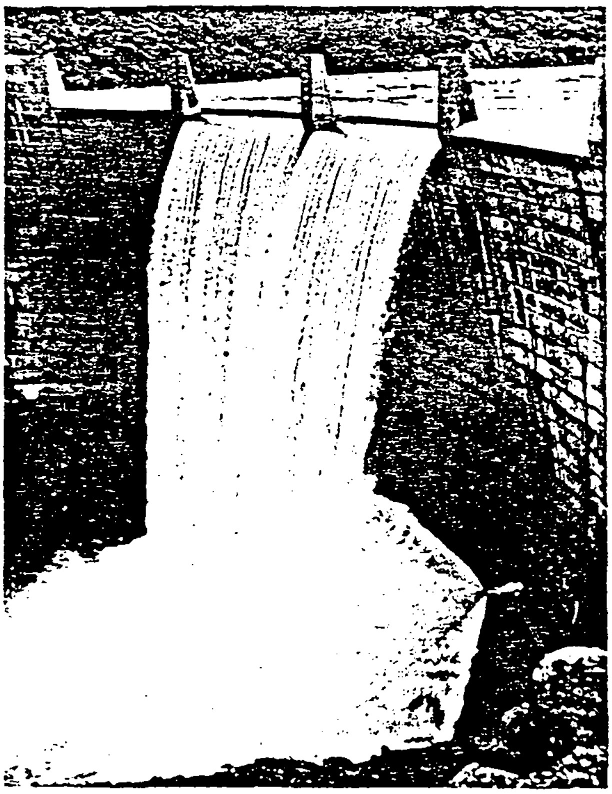
In any comprehensive plan for utilizing water resources, the dam is the principal structure. Which type of dam is best suited for a particular application is governed by the topography, foundation conditions, required height and length, proximity of construction materials, safety requirements and completion time.

Concrete always has been an important material in dam construction. The type of dam used most frequently in the United States has been the solid gravity dam. Use of computers and development of a time-saving method of establishing a preliminary design for arch dams have resulted in more economical and efficient structures of this type.

The Portland Cement Association, vitally interested in simplifying computations to establish the feasibility of various types of concrete dam structures, has developed a simplified method of establishing a preliminary design for an arch dam. This approach is presented in an Association publication, Arch Dams with Arches of Variable Thickness.

This publication describes methods of designing a dam with arch elements of uniform thickness. It also shows how significant savings in material can be effected by employing arch elements of varying thicknesses.

To assist in use of this design method, computations to arrive at the stresses in the dam have



Advances in arch dam design make structures of this type more economical than massive embankments for many sites. Spillways are a large cost item in most dams, but the cost of this overflow spillway was nominal.

been programmed for an electronic computer. The time required has been reduced in this manner from four man-weeks to 45 minutes. A program also has been prepared which in effect prepares a preliminary layout for an arch dam, based on allowable working stresses and dam site topography. These programs are described in PCA publications: Computer Program on Variable Thickness Arch Dam, and Arch Dam Layout Facilitated by Computer Usage. The Association also has prepared computer programs for solid gravity and massive-head buttress dams.

Another much used method of analyzing arch dams is known as the "trial-load" method of analysis. The time required for this method has been substantially reduced by a computer program prepared by the U. S. Bureau of Reclamation.

Soil-Cement Slope Protection for Earth Dams

Slope protection for earthfill dams traditionally has been "riprap," a blanket of loosely placed rocks. The development and use of soil-cement as an alternative to riprap is fully described in another paper prepared for this conference.*

Water Storage Facilities

The design and construction of reservoirs for the storage and control of water is of vital importance both to human welfare and the national economy. Surface reservoirs are constructed to store water for domestic, industrial, irrigation or power purposes, or to equalize flow in water-supply systems. They may range in capacity from less than a million to hundreds of million gallons. In recent years a variety of designs have been developed to fit specific needs.

Underground Storage Reservoirs

An important recent consideration has been the conservation of valuable land area. This has resulted in plans to cover existing open reservoirs and in the design of new reservoirs with roof cover. Many reservoir roofs perform other functions, providing space for parking, playgrounds, tennis courts, and the like.

Underground storage reservoirs range in capacity from a few thousand gallons to more than 50 million gallons. Concrete tanks of small capacity consist of flat slab floors and roofs that are either cast in place or precast. Larger-capacity tanks may require columns to support the roof. Dome or folded-plate roofs are frequently used. Prestressing of precast roof sections permits longer span lengths, reduction or elimination of the need for supporting columns, and savings in material.

Concrete Lined Reservoirs

Generally, concrete linings for reservoirs are designed for one or more of the following purposes:

1. To form an impervious barrier to the passage of water.
2. To facilitate cleaning the reservoir.
3. To protect the quality of stored water.

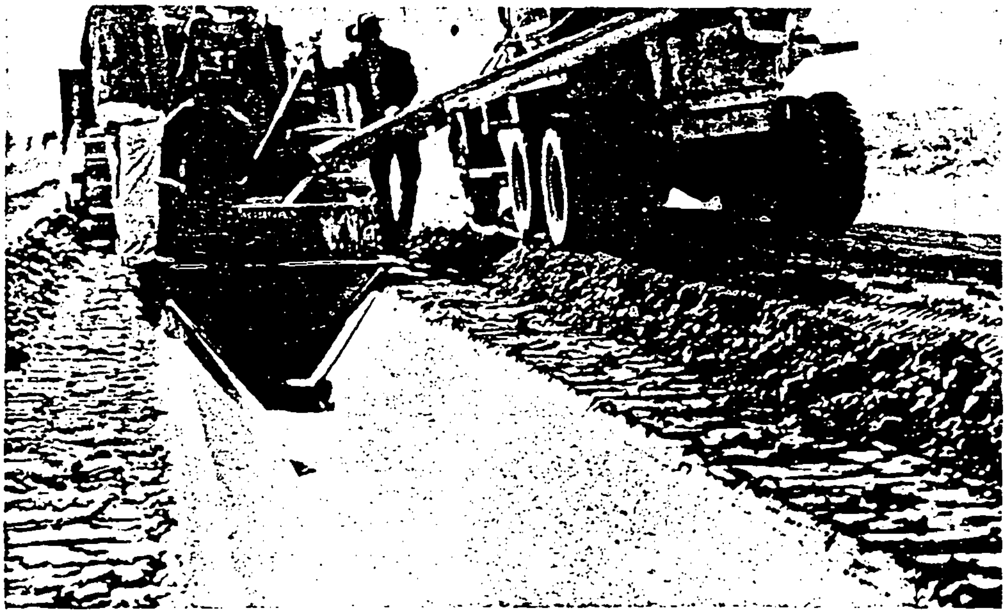
* Wilder, Carl R., Wagner, William V., Jr., and Koller, Earl R., "Soil-Cement for Water Resources Projects"

Surface reservoirs ordinarily are rectangular in plan and have sloping sides and horizontal bottoms. Concrete linings can be placed without face forms by using conventional paving equipment and special screeds.

Soil-cement linings for reservoirs are discussed in the paper referenced on page 2.

Concrete Linings for Irrigation Canals

For many years, concrete canal linings were cast in forms. Today they generally are installed by a method known as slipforming. This method is described in detail in the PCA publication Lining Irrigation Canals. Through mechanization, a water-saving lining is produced quickly and at lower cost.*



Small canals can be concrete-lined with a minimum of manpower and equipment. The concrete lining prevents erosion and seepage losses.

Records of the Bureau of Reclamation and of independent irrigation districts in the United States indicate that almost 40 percent of the water entering a distribution system of unlined canals never reaches the farm ditches. These losses include evaporation, water transpired by uncontrolled vegetation in and near canals, unavoidable spilling and waste of excess water, and seepage. Loss by seepage in canals and laterals averages about 25 percent of the total water diverted, and represents the greatest loss of all. Losses in some systems are as much as 60 percent.

Concrete linings have these advantages: they reduce seepage losses; need less width than unlined ditches of the same capacity; may be placed on steeper and more direct routes without danger of erosion damage; and reduce irrigation costs up to 75 percent in time and labor.

In short, concrete-lined ditches pay for themselves by savings in water, right-of-way, irrigation and maintenance costs, and through prevention or elimination of waterlogging of adjacent fields.

Shotcrete Linings

Shotcrete is a term that designates pneumatically applied portland cement mortar. Because of the small amount of construction equipment required and its mobility, the shotcrete process is

* Wilder, Carl R., "Lower-Cost Canal Linings Through Mechanization", Civil Engineering, June 1961

well suited to construction or repair work on small or widely scattered canal lining jobs. A discussion of shotcrete use in canals and ditches is contained in the PCA publication Shotcrete Canal and Ditch Linings.

Concrete Pipe

Concrete pipe is a basic conduit material for irrigation, water supply lines, sewers, and drainage systems. Pipe for such use may be plain, reinforced, or prestressed concrete. It can be produced to fulfill specific functions. For some uses the pipe must be dense and impermeable; for other purposes, such as draining saturated subsurface strata, a porous or perforated concrete pipe may be specified.

A wide range of sizes and types of concrete pipe is being produced. Pressure pipe as large as 15 ft. in diameter is in use as well as smaller pipe capable of withstanding up to 300 lb. of pressure per square inch, a pressure equivalent to a 700-ft.-high column of water.

Concrete pipe has been used to irrigate thousands of square miles of cultivated land in the United States. Irrigation water is carried through long transmission pipelines of large diameter, and then distributed through small-diameter local laterals, generally under low pressure.

Today many of the large cities of the United States and other countries must transport their water supplies a long distance in closed conduits. Concrete pipe is an excellent means of conveying potable water under the pressure required to force it through the conduit to the home, business, or industry where it is needed. To withstand this internal pressure, the pipe is reinforced with steel bars or wires, and some types include steel cylinders.

Vertically-Cast Concrete Pipe

The vertical-casting process is usually reserved for pipe sizes several feet in diameter or for noncircular shapes. Such pipe may be used for storm drains, culverts, underpasses, and utility tunnels. Forms to shape the interior and exterior faces of the pipe wall are erected. Any required reinforcement is placed in the proper position between forms and the concrete is cast.

Machine-Compacted Pipe

Machine-compacted concrete pipe is usually produced vertically. In this process the concrete is inserted at the top of the form, as in the cast process, and is compacted either by tamping, pressure and vibration, or the "packer-head" process. The concrete contains less mixing water than is required for cast pipe and is sometimes referred to as a "dry mix."

Spun Concrete Pipe

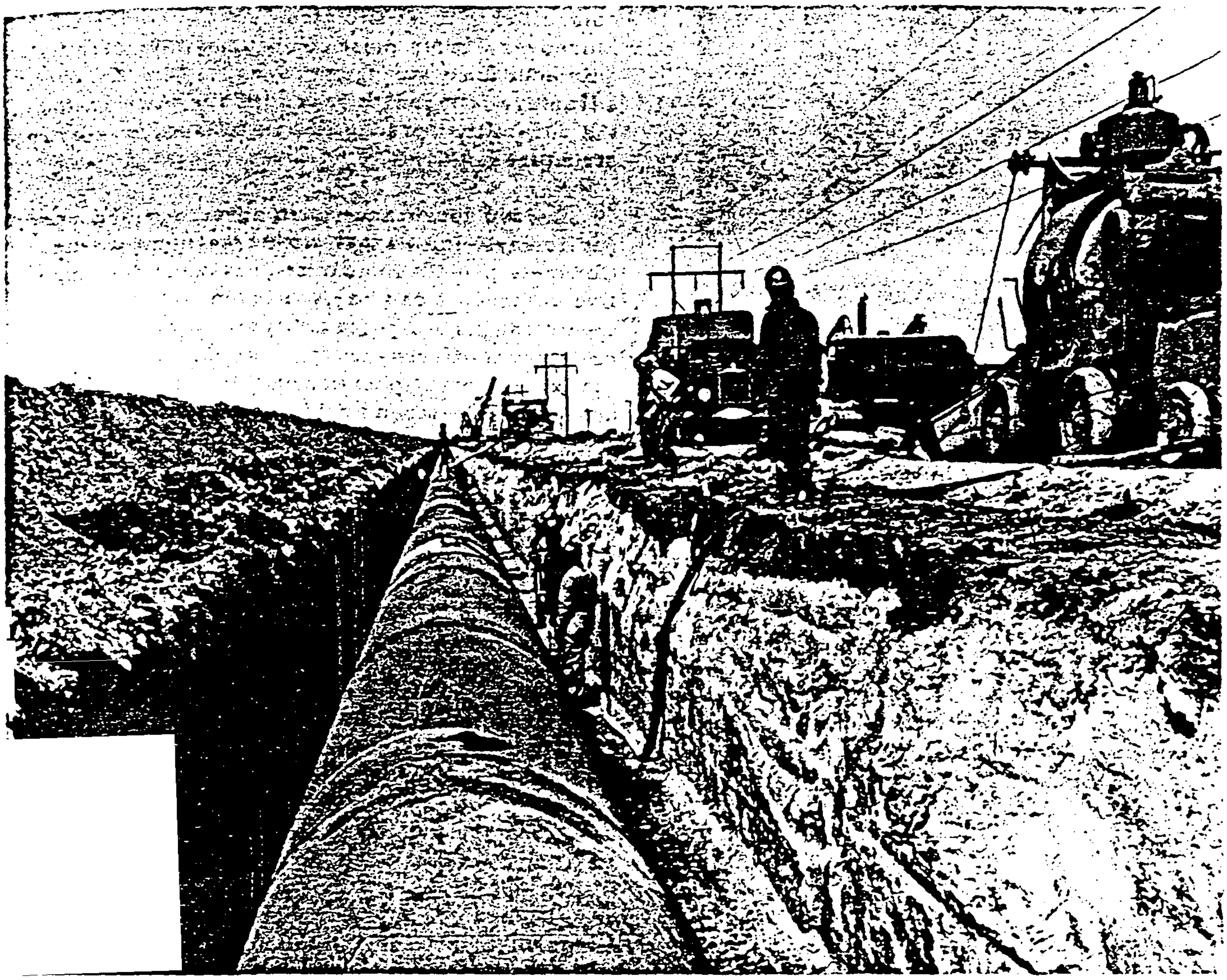
Spun concrete pipe is made in a horizontal rather than vertical position. There are several processes, but essentially all use a cylindrical form rotated on various types of drive wheels or shafts. The concrete mix is inserted into the form and spun by centrifugal force to the outside wall. Such spinning produces a dense consolidation of concrete that is literally wrung dry of excess mix water.

Other Types

Modern concrete pressure pipe may be prestressed or not, and may or may not include a steel cylinder between inner and outer faces. In making prestressed concrete cylinder pipe, the concrete-lined steel cylinder or concrete core containing an embedded cylinder is wrapped with high-strength reinforcing wires under tension and coated with pressure applied mortar.

Non-cylinder prestressed concrete pipe has been manufactured to a limited extent in the United States. Longitudinal reinforcement is embedded in the concrete; subsequently the cured pipe core is wrapped with steel wire at high tension and covered with pressure applied mortar.

Concrete pipe that does not contain a steel cylinder and is not prestressed has been widely used for low pressure applications. It may have one or more cages of reinforcing steel and may



Plastic soil-cement is being pumped under this 72-in. prestressed concrete water supply pipeline. This new technique costs about 40 percent less than usual methods.

·e spun, tamped, or vertically cast. Such pipe generally has been made in diameters of from 12 ɔ 108 in. with larger sizes for special applications. Pipe lengths have ranged from 12 to 32 ft.

DESIRABLE QUALITIES OF CONCRETE FOR WATER FACILITIES

Concrete is an ideal material for construction of water facilities of all types. Properly de-ıgned and constructed concrete has certain inherent advantages: durability, watertightness, .rength, good appearance, versatility, and economy.

The durability of a concrete water facility is its resistance to the deteriorating effects of ezing and thawing, wetting and drying, and chemical attack. Also, because durability and long e are closely related, concrete can be expected to last throughout the life of the facility. While e life of a waste-water treatment works, for example, may be limited to decades because of chanical obsolescence or overloading caused by population increases, the life of concrete may reckoned in terms of generations.

Watertightness is a necessary requirement for any water facility structure. It is axiomatic ıt tanks in waste-water treatment plants particularly must be watertight. Watertightness of the ncrete, or its degree of impermeability, is the most important single factor influencing its rability.

Cast-in-place unreinforced concrete pipe provides an economical conduit for gravity or low-pressure flows of water or waste-water. Several firms have developed special equipment for this type of construction. The "No-Joint" process is illustrated here.

Strength of concrete can be predicted and controlled to meet any given set of requirements. Moreover, under most conditions, concrete will gain additional strength with age. This inherent advantage of strength gain with age contributes to the durability and long life expectancy of concrete structures.

Good appearance is an advantage of concrete, particularly for waste-water treatment works. Concrete provides unlimited horizons for imaginative design. It can be used to impart to each treatment plant a personality of its own. The architectural effects may be designed to blend with the locale, or a special motif may be created to achieve any desired architectural effect. Such aesthetic considerations can make a waste-water treatment plant an asset instead of a detriment to the neighborhood in which it is located.

Versatility is an important advantage of concrete. As used by a skillful engineer, concrete can be likened to marble in the hands of an experienced sculptor. The engineer must first visualize the functional treatments of the structure involved, and then, by using concrete as his sculpturing material, design and mold the structure to meet those requirements. Certainly, the versatility allowed by the use of concrete provides an ease of construction not inherent in other materials. Concrete may be molded to any desired shape or form to fit any need.

The economy of concrete serves to supplement its other advantages for a water facility. Economy plays a dual role in the use of concrete for such projects: low initial cost and minimum maintenance costs for the structures and appurtenances.

FACTORS IMPORTANT IN ATTAINING GOOD CONCRETE FOR WATER FACILITIES

The principles of designing and producing a good concrete mixture for the specific construction purpose intended are well established through long experience and extensive research and testing. An extensive collection of literature on this subject is constantly being augmented by civilian and military agencies of the government and by private organizations. Attention is called particularly to the PCA publication Design and Control of Concrete Mixtures, and to the U. S. Bureau of Reclamation's Concrete Manual.

In general, a good concrete mixture is one that produces concrete that most nearly meets the requirements of the specific project. For example, concrete must have sufficient strength to carry the loads imposed. It must be able to endure under the conditions of exposure to which it will be subjected and it must be produced economically. Thus the major requirements may be stated as strength, durability, watertightness and economy.

Durability of concrete is defined as its resistance to deteriorating influences of the environment to which it is exposed. This is of prime importance, since more often than not adequate durability will also provide adequate strength. The converse is not always true.

Water-Cement Ratio

The most important single factor affecting the durability, strength, and overall quality and performance of concrete is the quantity of mixing water used per unit of cement. This was one of the earliest and most significant findings of cement industry research. Called the "water-cement" ratio, it is commonly expressed as a decimal, or as the number of U.S. gallons of water per 94-lb. bag of cement.

The lower the ratio (i.e., the lower the proportion of water), the greater the strength of the concrete, provided the mixture is workable. If the paste is thinned out with water, its binding quality is lowered. It has less strength, is more permeable, and is less resistant to the elements and the wear to which it will be subjected.

To illustrate how experience and testing have shown the desirable water-cement ratio for various types of construction, one might consider structures built in and near waterways. For concrete at the waterline of a structure and only intermittently submerged in water, a water-cement ratio of no more than 5 to 6 gal. per 94-lb. bag should be used, depending upon whether the concrete is in a thin, moderate, or mass section. For concrete that is continuously submerged in water, a water-cement ratio of not more than 6 to 7 gal. per bag is used, with increases of 1/2 gal. as the section increases in thickness.

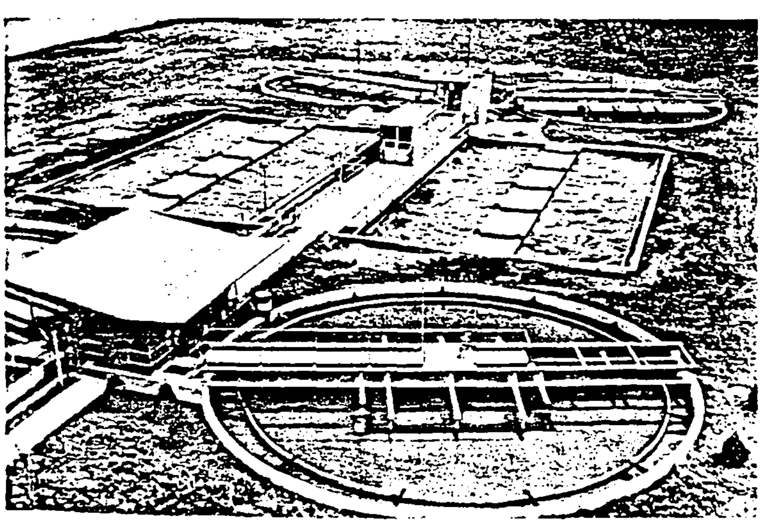
After the establishment of maximum water-cement ratio for specific exposure conditions, the water-cement ratio for the desired strength is determined from trial batches, or selected from a table. Once the water-cement ratio is established, the procedure for selecting exact quantities of aggregates for proper workability is essentially one of trial mixtures with small batches. Sand frequently contains some moisture that must be considered when computing the amount of mixing water to be added.

Mixing Water

Water to be used for mixing concrete should be reasonably free from objectionable quantities of silt, organic matter, acids, alkalies, salts and other detrimental substances. In general, water that is suitable for drinking purposes may be used.

Aggregates

The commonly used aggregates are sand, gravel, crushed stone, and blast-furnace slag. Aggregates serve as a filler material in concrete and may provide as much as 75 percent of the volume of concrete. Proper selection and efficient use of the aggregates will impart economy to the concrete mix. Aggregates for quality concrete should be clean, hard, strong, and durable, and should meet the requirements set forth in ASTM Standard Specifications for Concrete Aggregates, Designation C33. The aggregate should be graded to the largest size that can be practically used on the job. The maximum size of coarse aggregate should not exceed about one-fifth the minimum dimension of the member or three-fourths the clear spacing between reinforcing bars. Long, slivery, or flat pieces of aggregate should be limited to about 15 percent of the total amount of the aggregates.



Water pollution is one of the basic problems in water supply. This compact sewage treatment plant prevents stream contamination. Concrete's applicability for both water and waste-water treatment plants is illustrated here by its use in all of the treatment units.

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Air-Entrained Concrete

Entrained air in concrete is the intentional inducing of tiny, well-distributed, and separate air bubbles. Billions are contained in each cubic foot of concrete. They serve as minute air reservoirs that provide relief from the expansion pressures built up by the freezing of free water in the capillaries, thereby preventing damage to the hardened paste. Entrained air may be induced by using air-entraining portland cement or by adding an air-entraining admixture at the mixer.

The only difference between these test slabs is that the ones in the left photo contained six percent entrained air while the ones in the right photo contained no air-entraining agent. They are shown at the Skokie, Illinois, test plot of the Portland Cement Association after both had received 65 applications of salt over a five-year period. Almost all of the non-air-entrained slabs in the plot have scaled. None of those containing air has shown any scaling after five winters of severe weather exposure and heavy salting. This testing is equivalent to many more years of exposure without salting.

Advantages of air-entrained concrete, in addition to increased resistance to freeze-thaw action, include increased resistance to sulfate attack, improved watertightness, improved workability, and reduced bleeding (appearance of free water on the surface of fresh concrete). The air bubbles impede the settling of aggregate particles that characterize the bleeding action. All these advantages result in more durable and more watertight concrete. Therefore, all concrete for water facilities should contain entrained air.

Placing Concrete

Proper distribution practices must be strictly enforced to obtain durable and watertight concrete. Dense concrete is necessary for water facilities. That portion of a treatment plant from the water line to the top of the wall is usually subject to severe exposure conditions and care must be taken to assure uniform high-quality concrete.

Concrete should be placed in the forms as near as possible to its final position to prevent segregation during distribution and consolidation. In general, it should be placed continuously in horizontal layers of uniform thickness. Consolidation of the concrete should be accomplished by internal vibration. The concrete should not be vibrated long enough to cause segregation of the aggregate.

Curing Concrete

To obtain maximum durability and watertightness, concrete must be properly cured. Curing means keeping water within the concrete for as long as possible so that hydration of the cement will progress to a satisfactory stage. Concrete continues to hydrate for years if moisture is present, but hydration is very rapid during the first week. Concrete for use in water structures should be cured for a minimum of seven days.

CONSTRUCTION PRACTICES FOR WATER FACILITIES

Dams

The cost of a dam is determined by many factors: the size of the structure; the character of the foundation; the structure type; and the proximity of natural building material, to mention a few. Another important factor is the method of construction. Such items as aggregate preparation, handling, and storage; size of the concrete batching and mixing plant; equipment for placing and consolidating concrete; type of forming; and temperature control can substantially affect costs.

For example, in constructing massive concrete structures, it formerly was common practice to limit the concrete placed at one time to a height of 5 ft. In constructing Glen Canyon Dam on the Colorado River in Arizona, the Bureau of Reclamation permitted the contractor to place concrete in lifts 7-1/2 ft. high. This reduced forming and concrete placement costs. Experience gained on this job is being applied to other projects.

Canal Linings

Methods developed in recent years for placing concrete linings in small laterals and farm ditches with mechanized equipment have kept costs at low levels despite a rising price index. With this modern machinery, less labor is required and more lining can be placed each day.

The subgrade-supported slipform for placing and finishing concrete canal lining is the most effective equipment developed for increasing production and reducing labor costs. No side forms or rails are required and the finished surfaces need little, if any, hand-finishing. Slipforms of various designs have been used with excellent results.

Slipforms are propelled in various ways. In a small ditch, a tractor that straddles the ditch is satisfactory; in larger ditches, two tractors, one on each side, or a single tractor with outrigger may be more desirable. Some larger slipforms are self-propelled.

Several methods of mixing and depositing the concrete in the slipform may be used, depending on the type of equipment available -- transit-mix trucks, conventional paving mixers, or traveling mixing plants.

Concrete for irrigation ditch linings should be so proportioned that it is workable enough for thorough consolidation and stiff enough to stay in place on the side slopes. Because concrete lining is not intended to act as a structural member, its strength usually is not of primary importance. It must be sufficiently durable to resist the wetting and drying and freezing and thawing to which a canal is exposed. Proper curing is necessary to obtain full strength and durability of the concrete. Prompt application of a membrane sealing compound prevents rapid drying of the concrete, thereby reducing the possibility of shrinkage and cracking.

Water Treatment Works

The present high development of water supply and treatment facilities has occurred because of vastly increased technical knowledge, most of which has been accumulated during the past century. Concurrent with the development of better methods of water treatment has been the improvement of materials and methods for waterworks construction. Use of the mix-design principles mentioned above and entrainment of air in the concrete have greatly improved its durability, watertightness, and strength. These are all highly desirable qualities for waterworks structures.

The water treatment plant is a marvel of efficiency in the handling and processing of raw water into a safe and potable product. The efficiency developed in the methods of supply, treatment, and distribution of this essential makes possible its sale in most localities at a price per ton about equal to the cost of an air-mail stamp. As in other water facilities, concrete used in the construction of water treatment works must be of the highest quality, as outlined in the previous section.

Concrete Pipe Irrigation Systems

A typical irrigation system consists of mainlines and laterals, both of which may be open canals, pipelines or a combination of these. Many distribution systems are built entirely of underground concrete or asbestos-cement pipe. The desired quantity of water at the desired operating level is supplied economically through a pipe distribution system.

The basis for design of any irrigation system is the quantity of water to be delivered at each individual turnout, the required pressure head at that point, and the rotation of deliveries to the several delivery points.

As pointed out earlier, concrete pipe are manufactured by three processes which are usually described as (1) vertically-cast-and-vibrated, (2) centrifugally spun, and (3) machine-compacted.

Concrete used in the cast-and-vibrated process is quite similar to high-strength structural concrete but of somewhat lower slump. Density is obtained by high-frequency vibration, applied either to the concrete or to the exterior of the forms.

The slump of concrete for machine-made pipe often is zero, and sometimes the concrete is even drier than required for zero slump.

In the centrifugal process, density is obtained by centrifugal action, sometimes accompanied by rolling or vibrating. Concrete used in this process should have near-zero slump to prevent segregation.

Curing of concrete pipe is essential. Curing usually involves sealing the concrete surface with a membrane, applying moisture continuously for at least seven days, curing by moist steam, or by some combination of these. Drying out of the pipe immediately after casting and before curing is started must be prevented.

Gradation of the aggregates and the proportion of fine to coarse aggregate probably affect the economy and quality of concrete pipe more than any other step in their manufacture.

Conformation to the applicable ASTM or federal specification, the use of a properly designed mix, and adequate curing will ensure satisfactory pipe.

Conclusion

The finest legacy that Man can bequeath to future generations is a plentiful supply of clean water. Users have a right to make maximum use of the water available to them, and, after using it, a moral obligation to return it to mankind in such condition that it will continue to be of beneficial use. No water user is exempt from this obligation.

NOUVELLES UTILISATIONS DU CIMENT POUR LES INSTALLATIONS HYDRAULIQUES

Résumé

Le document étudie le rôle du ciment et du béton dans les installations intéressant les ressources hydrauliques. Il décrit les méthodes modernes permettant de déterminer la composition des mélanges et de la contrôler, et notamment ceux qui sont conçus en vue de leur imperméabilité et d'autres propriétés particulières, indépendamment de leur solidité. Il explique l'intérêt de l'occlusion d'air pour des motifs autres que la résistance au gel et au dégel. Il décrit des applications du béton moulé au préalable, du béton précontraint, ainsi que des traitements esthétiques peu coûteux. Le document est illustré par de nombreux exemples d'innovations récentes quant à l'utilisation du béton pour les constructions hydrauliques telles que barrages, aqueducs et pipe-lines, réservoirs, stations d'épuration et autres ouvrages.

NUEVOS ADELANTOS EN EL EMPLEO DEL CEMENTO EN INSTALACIONES DEL AGUA

Resumen

Se examina la función del cemento y del hormigón en instalaciones para el abastecimiento de agua. Se describen métodos modernos para el diseño y la inspección de la mezcla, inclusive el diseño para lograr impermeabilidad y otras propiedades requeridas como así también la resistencia. Se explica el valor de la oclusión de aire para lograr otros fines que los de la durabilidad frente al congelamiento y descongelamiento. Se describen aplicaciones de pre-fabricación y pre-tensado, y tratamientos estéticos de bajo costo. El trabajo se ilustra con numerosos ejemplos de innovaciones recientes en el uso del hormigón en instalaciones para el abastecimiento de agua, incluyendo represas, acueductos y cañerías, embalses, plantas de tratamiento y otras estructuras.

International Conference on WATER for PEACE

United States Water Supply

PACKAGE APPROACH FOR DEVELOPMENT OF VILLAGE WATER SUPPLY SYSTEMS

Harvey F. Ludwig
Alfred W. Jorgensen

The object of the proposed program is the development of a "standardized" method for the engineering, installation, and operation of water suppy system for smaller villages and communities in developing areas, which can be applied on a mass scale (in terms of hundreds or even thousands of communities). The need for engineering design would be reduced to the simplest possible basis, the need for specialized equipment virtually eliminated, and installation and maintenance accomplished by local community resources with a minimum of outside help. The initial product of the program is envisioned as a three volume manual, (one on design, one on installation, and one on operation and maintenance), together with a "catalog" of standardized items of equipment and supplies to be drawn upon as needed in the design, installation, or operation processes.

It is intended, with this manual, that the design of a large number of systems can be accomplished by engineers working in a central office with a minimum of field work, for example, working only from aerial photographs at various scales (showing details both of the community and surrounding environment including the sources of water supply). This procedure would greatly reduce engineering design costs by eliminating the need for detailed field surveys and complex design analyses. The systems could be standardized packaged modules designed on the basis of area and population, thus eliminating judgment decisions based on demand requirements, storage, types of materials, sizes of pipe, and other conventional engineering criteria. Following completion of the layout of the water supply system for a given community, the engineer would then prepare a list of selected modules consisting of standardized equipment and supplies needed for that particular design, which items, after assembly, would be shipped to the village as a package.

At the village the installation would be made primarily by village personnel, using the standardized instruction data. Similarly, maintenance would be accomplished primarily by local resources. It is envisioned that the need for specialized assistance from the outside (say, from the provincial capital) would be held to a minimum, and that the problem of furnishing even this minor assistance would be greatly simplified due to the standardized approach. This standardization would vastly reduce the overall cost of facilities and would provide for the mass development of water supply systems.

NEED FOR PROGRAM

Safe drinking water is a basic health essential. This recognition has given the impetus and the urgency for aggressive action for the development of a global community water supply program. The world situation, especially in developing nations, is further aggravated by mass migration from rural to urban areas. The widespread occurrence of enteric infections reflects the ross deficiencies in water supply and related community sanitation facilities. he lack of water supplies actually prevents any reasonable economic growth and mproved standards of living. What has not been sufficiently recognized is the ,ecessary sequence, i.e., that community water supply is an essential first step, ,fter which general good health and economic growth logically follow. This 'irst step means providing water to the people which is reasonably available, :easonably adequate, and safe, all at a reasonable cost.

Another fact that has not been adequately recognized is the importance and urgency of rural village water systems. While the problems of the big cities ıre obviously paramount in the developing nations, if there is to be a successful overall national program, attention must also be given to furnishing reasonable minimum water services in the numerous small communities which, in many ways, make up the "backbone" of these countries. Logically, the two objectives are compatible and complementary. As competent water supplies are established in the urban centers, these systems, with their sizeable resources in personnel and equipment and know-how, can become "nuclei" for assisting and guiding the development of village systems in the surrounding countryside. Each major system could be given responsibility for planning and implementing village systems for an assigned area. This would work especially well if the economies of the city and surrounding villages were co-dependent.

Situation In India

The situation in India illustrates the need for the "package" approach as the only practicable method for solving the massive village water supply problem in the developing countries. Discussions with the regional engineering staff of the World Health Organization (WHO) at Delhi have indicated that the rate of progress in developing rural community water supply systems is slow, and that the most responsible factor (other than that of financing) is the mass of complexities involved in the current approach to the problem. In 1963, for example, WHO/Delhi had under consideration a proposed rural community water supply pilot program (developed pursuant to the "Proposal for UNICEF Assistant Rural Water Supply Projects") entitled "Providing Water Supply Scheme in Group Villages in Kahnuwan Block Tehsil and District Gurdaspur," prepared by the Public Works Department of the Government of Punjab and approved and transmitted by the Central Ministry of Health. This proposal provided for establishment of systems in 24 villages in its first stage (total population 25,000) at a cost of Rs. 11,97,387, and for a second stage for another group of villages. These systems are all simple in nature, involving tubewells at similar depths and the usual facilities for pumping, storage, distribution, and chlorination. Review of the detailed engineering report, however, shows that this proposal utilized the conventional engineering approach, with each design tailored to the specific situation, and hence its implementation requires all the specialized attention characteristic of such projects.

Discussions with the WHO/Dehli staff indicated a principal reason for this approach is the reluctance of Indian officials to approve any expenditure for materials and equipment without thorough study and justification of each and every item, in order to avoid criticism of waste of funds, particularly foreign exchange. In other words, the economies which could be realized through the standardized package approach have not been analyzed nor convincingly demonstrated. Along the same lines, the Indian officials are reluctant to set any general standards for design, e.g., on per capita needs, or on the use of substitute materials such as galvanized iron or aluminum in place of cast iron, until actual experience has demonstrated solid bases for such standards. This makes it difficult to proceed by any but conventional means. The matter of pipe materials is especially pertinent in India in that orders for cast iron pipe may be backlogged for several years; but, nevertheless, there is reluctance to consider the use of substitute materials.

GENERAL PLAN

In reviewing the situation in the developing areas, it becomes apparent that a major deterrent to progress in establishing village water supply systems has been the lack of simple, practicable, and uniform methods by which such systems can be readily designed, constructed, and operated within the limitations of the resources of the area. In most villages the types of complex mechanical gear and equipment which are common in the big cities simply are not available, and even if they could be made available, the local resources in trained personnel are not sufficient to maintain such gear and equipment. A standardized type of water supply system which can be assembled from standard units of equipment and readily installed and maintained with local talents and materials is needed. Such a system would probide the basic domestic water supply and would incorporate an element of fire protection as an integral part of the system by placing several standpipes with valves in the system which would allow water to be obtained quickly and at locations near the fires or other emergencies. The "fire hydrants" would be limited in their use to emergency situations. The system should be simple enough so that, literally, its procurement, installation, and operation would pose no particular problems with respect to the country's resources. Such a "packaged" system would include standardized mechanical equipment selected for ruggedness and simplicity in maintenance, standard instructions so that installation could be accomplished largely with local unskilled labor, and similar instructions together with a supply of essential materials so that maintenance and operation can likewise be easily accomplished.

All mechanical gear would be standardized for maximum interchangeability of parts, so that new parts could be readily obtained from the "central" storehouse located, for example, in the "sponsoring" major city. The plan would be suited equally well to rural communities in a wide range of sizes, in that the same modules or unit items would be repeatedly used. The unit systems would be placed at strategic locations, using as many as needed to service the entire community area. The sponsoring city would also make available a "core" group of trained technicians who, by periodic visits to the rural areas could inspect and provide technical assistance toward improving the managing the village water programs, working in collaboration with local officials.

The proposed plan is based on the assumption that simplicity is essential in all aspects of the work if continuing success is to be assured on any sizeable scale. It is recognized that the mechanics of the proposed program must be simple enough to be suited to the local resources with only periodic help and guidance needed from the outside. The recommended approach would be similar to that utilized by the U. S. Army in preparing training manuals for use during World War II. This approach assumes that personnel involved in installation and operation may have little background in the subject area, and that the instructions on installation and operation should be so prepared to be easily followed by persons with limited education and training.

To summarize, a manual would be prepared for design, installation, and operation and maintenance, including (as an appendix) a "catalog" of standardized items of equipment and supplies (including tools and other equipment needed for installation and for operation and maintenance). These standardized items would either be items available from existing items already being manufactured or proposed new items developed in consultation with manufactuers, where it is felt that existing items are not sufficiently applicable and where the availability of a mass market would make it feasible for manufacturers to produce such new items. Specifications and profuse illustrations would be included to give essential descriptions of such items.

DEVELOPMENT OF MANUAL

Development of the desired manual, adapted to the various regions of the world, would be the initial product of the proposed program. This in itself will be a sizeable undertaking, with costs estimated to be of the magnitude of a million dollars or more. Following is a discussion of the intended scope and content of the manual, comprising three volumes, including those on design, installation, maintenance and operation, together with the catalog of equipment and supplies.

Design

This volume would be for the use of the local engineer who would have the responsibility of preparing the design and construction of the standardized packaged modules for a given village. Its purpose would be to provide simplified basic design standards, procedures, and guides in a clearly understandable step by step manner. Some fundamental design concepts and philosophies would, of necessity, be presented in a simple, practical, and straightforward manner, setting forth specific instructions and avoiding vague generalities. It would be prepared in a manner that would practically preclude the necessity of sophisticated engineering judgment in preparing the design.

By preparing the volumes in loose-leaf form, two important advantages would be gained : (1) periodical updating would be possible, and (2) only those sections of each volume pertinent to the conditions of a given country or region would need to be inserted from the master stock of such sections which would be conveniently stored at some central agency headquarters (perhaps the provincial capital). As an indication of format, a general outline of the organization and contents of the design volume might be as follows:

Introduction

Basic Design Considerations and Engineering Data

- Type of Source--Groundwater or Surface Water
- Selection of Materials and Equipment
- Maps
- Aerial Photographs

Design of System

- Determination of Minimum Domestic Water Requirements (Graph of Population vs. Daily Water Demand)

Source Development

- Determination of Type, Location, and Yield
- Types of Wells
- Minimum Distance from Potential Contamination
- Well Covers and Seals
- Reconstruction of Existing Wells
- Sanitary Development of Springs
- Cistern Supplies
- Pump Types, Sizes, and Capacities
- Surface Water Sources

Transmission Mains

- Route and Size (Nomograph: Demand/Length/Diameter)
- Required Appurtenances
- Pumping Facilities

Treatment Facilities

- Raw Water Quality
- Requirements for Groundwater
- Requirements for Surface Water
- Chemicals and Materials Required
- Chlorinators and Sedimentation Tanks

Distribution System

- Storage Facilities (Table of Demand vs. Tank Size)
- Pipelines (Table of Diameter/Length/Demand)
- Required Standard Appurtenances
- Required Distribution Points

Adequacy of Design (Simplified Performance Scoring Procedure)

By utilizing the design volume, a simple set of plans could be prepared which would show and identify each part of the system by a code number corresponding to an identical number in the equipment catalog. For example, such a plan could be developed for a small village of, say, 3000 people living in approximately 600 separate housing units. The designer might have at his disposal a general knowledge of the village, an aerial photograph to a suitable scale, and some historic water source information for the area from which he could, for example, reasonably predict that a system of wells could be developed as a supply source. Utilizing the aerial photograph, he could pick a site for the wells or stream diversions, and then, with the aid of the design volume, choose the pumps and appurtenance equipment from several optional modular sizes and also determine the appropriate size of the transmission line to convey the water to the village. Next, he would establish the size and location of a distribution storage tank and lay out the simple grid system for the distribution lines, choosing appropriate equipment and pipe sizes from elementary tables and charts. Finally, he would establish points of service based on the number of houses in the village. These data could be tabulated, and a bill of lading prepared, indicating what standard system components would be necessary to make up the particular package unit. The system would allow for improvements and extensions as required for the future.

Installation

The second volume of the manual would be for the use of the technician in charge of local workers during the construction of the system. A step-by-step set of instructions for the installation of the facilities would be included, explaining in detail (using illustrations) how to assemble and install the system. Each step would refer to a specific piece of hardware by a number keyed to the equipment catalog.

The installation volume would be prepared for each specific project (from a stock of standardized instruction sheets) to insure a minimum of confusion on the part of the technician and indigenous laborers.

The following is a general outline of the possible form and contents of this volume:

- Introduction
- Training of Local Workers
- General Construction Practices
- Protection During Construction
- Methods of Scheduling
- Well Drilling, Digging, Boring or Driving Procedures
- Installation Instructions
- Inspection Techniques
- Final Operational Testing
- Disinfection After Construction and/or Repair
- System Start-Up
- Use of Plans and Equipment Catalog
- Preparation of Final As-Built Location Diagram

Included in the standardized packaged module of system components shipped to the village would be simple basic tools and construction equipment appropriate for use by unskilled workers. The creation of this package of tools and equipment is obviously necessary because of the complete lack of such items in rural villages. The tools and equipment would be designed to complement the standardized system components and installation procedures. Wrenches could be designed to fit in special slots or notches (which perhaps could be color coded), thus eliminating any question of what tool to use in connecting a given system component. Selected tools would be retained at the village after construction to be used for subsequent maintenance of the system.

Operation and Maintenance

This volume would be prepared for use by local personnel responsible for operating and maintaining the system and would consist of simple and definitive instructions for techniques and procedures to be followed in the repair of system components. An elementary check list or schedule of normal maintenance items would also be presented, including valve maintenance, cleaning of sedimentation tanks, lubrication, basic chlorination, etc.

Following is an outline of operation and maintenance volume to indicate its potential general form and content:

- Introduction
- Importance of Good Maintenance
- Maintenance and Check List for System
- Cleaning System Components
- Normal Chlorination Procedures (Including Residual Determinations)
- Emergency Chlorination
- Algae Control
- Filtration
- Maintenance of Tools and Materials
- Indicators of Potential Problems
- Control of Watershed

Equipment Catalog

This appendix would be prepared in close cooperation with equipment manufacturers, and its final development would provide impetus to the creation and/or development of simple and rugged products designed especially for use in rural communities of developing areas. Each standard item of equipment or hardware would be fully illustrated and given a code number for purposes of identification. The cost of each item would be listed along with a table of estimated transportation rates to allow the system designer to make a reasonable estimate of costs.

In the development of the equipment catalog, the goal of standardization would be paramount. For example, only two or three sizes of hand pumps, distribution storage tanks, pipes, valves, etc., might be shown. Aluminum pipe with quick coupling connections might be used (similar to existing irrigation pipe). If more capacity were required, multiple units would be used. Standard system components would also allow potential savings in manufacturing costs due to mass production techniques. Possibly more important, however, is the gain in simplicity and the elimination of sophisticated engineering alternatives which could lead to potentially confusing technical design or installation decisions. The standardization of these items of the articles would reduce the total number of possible components; thus, detailed descriptions (both in narrative and pictures) could be provided, thereby leading to a clearer understanding of their function and manner of use by the local technicians and workers.

IMPLEMENTATION OF PROGRAM

As previously noted, development of the desired manuals adapted to the various regions of the world will be a sizeable project, costing an estimated million dollars or more. To initiate the program, and to demonstrate its feasibility, an initial demonstration project could be conducted, with the scope limited to a single region or country involving a limited number of villages, say ten. This project would involve design of water supply systems for these villages employing conventional methods, re-analysis to show how these same systems would have been designed using the "standardized" approach, together with development of the series of volumes to the extent possible from these experiences, which would be usable for design, installation, and operation and maintenance for systems in general throughout the area.

The initial project would involve detailed field examinations, to be followed by (1) office studies for developing a preliminary draft of the manual, including periodic reviews with government representatives and including consultations with interested manufacturers; (2) further reviews in the selected country; (3) preparation of a "trial" manual draft, together with trial application of the manual to the ten trial villages (design phase, including designation of the standard packages); and (4) preparation of the final manuals. More specifically, the initial project would include the following work components:

(1) Creation of the design volume and the catalog of standard equipment in preliminary form for the selected region.

(2) Preparation of design for ten trial villages utilizing:

  (a) The preliminary form of the design volume and catalog of standard equipment.

  (b) Aerial photographs of the villages.

  (c) General knowledge of characteristics of the area which are pertinent to the design along with other commonly available data.

(3) Preparation of design for ten trial villages using conventional design methods including detailed site investigations and definitive engineering data.

(4) Comparison of the results of the "standardized" method of engineering (Step 2 above) with the design developed using conventional methods and techniques (Step 3 above).

(5) Evaluation of the results of Step (4) and revision of the preliminary form of the design volume and catalog of standard equipment as necessary to optimize the usefulness of standard criteria and provide for the range of situations found.

(6) Preparation of the installation and operation and maintenance volume for the selected region.

A possible second phase of the project would include:

(1) Installation and operation of the ten systems using local labor guided by a technician.

(2) A revision of the manuals, as required, based on experience gained during installation and operation of ten village systems.

(3) Training of a selected group of personnel in a selected country or area, including training in the engineering for design of systems (including tailoring of the packages of equipment and supplies) and in the field aspects (installation and operation and maintenance).

It is estimated that the costs of performing the engineering and developmental work on the initial phase would be on the order of $100,000, which does not include the costs for the actual construction of the facilities.

The manuals developed from the initial project would obviously not be universally applicable, but it is expected that the results would demonstrate the applicability and value of the "standardized" method for the country or region concerned, and hence set the stage for extension of the method for worldwide use under varying conditions.

The ultimate phase of the proposed program would include selection of the appropriate geographical areas followed by the preparation of manuals and catalogs for each area. This would involve consultation with foreign governments and engineers, establishment of a worldwide coordinating agency (or possibly utilizing an existing one such as WHO), and further coordination and planning with the manufacturers.

SUMMARY AND CONCLUSIONS

In the development of global water supply programs, attention has been focused on urban problems, and there is a significant "gap" in solving the problem of furnishing water to the multitudinous towns and villages making up the rural population. There are large numbers -- hundreds of thousands -- of these villages, and it does not appear feasible to solve their water supply problems using conventional methods for design, installation, and operation and maintenance. The conventional methods utilize a piece-meal approach which is both painfully slow and expensive.

A standardized packaged module approach should be established whereby village systems can be established on a mass basis, in groups of hundreds or even thousands, employing manuals developed to permit standardized design, installation, and maintenance. This would vastly simplify all steps involved and greatly reduce both time requirements and costs. The designs, for example, would be prepared utilizing aerial photographs, perhaps without the design engineer even having to visit the village concerned. Installation and operation and maintenance could be accomplished with local resources, assisted by a visiting technician operating out of the region's urban center. All materials and equipment needed for a given village would arrive at the village as a complete package, ready for local assembly and installation. The approach would employ the same concept used by Sears Roebuck by which farmers install their own water supply systems, working from a Sears catalog. This principle would be expanded to the community scale. Also, the manuals for design, installation and operation and maintenance would be developed following the pattern successfully utilized by the U. S. Army in World War II, so that they could be used by persons having limited background in this field.

A program for preparing a series of manuals adapted to the various regions of the world should be implemented. A suggested first step, for demonstrating the feasibility of the method, would be a trial program in a selected region or country involving a group of ten villages.

It is believed that the availability of the standardized packaged module approach would make it possible for international agencies (including the lending agencies) to make realistic progress in this difficult problem area.

METHODE GLOBALE DE DEVELOPPEMENT DES SYSTEMES D'ALIMENTATION DES VILLAGES EN EAU

Résumé

Il est de plus en plus admis que le fait de disposer de ressources hydrauliques suffisantes est une condition essentielle à la croissance et au développement d'une commune, non seulement pour des raisons d'hygiène, mais également pour promouvoir son industrie et sa situation économique en général. Depuis une vingtaine d'années, l'amélioration des systèmes d'alimentation en eau des grands centres urbains et des zones métropolitaines, qui constituent évidemment les principaux pôles d'attention, a fait de grands progrès. En revanche, la solution des problèmes qui intéressent les milliers de communes ou de villages qui constituent l'arrière-pays des grands centres n'a guère progressé.

En ce qui concerne l'organisation technique des systèmes hydrauliques, la méthode technique classique, comportant une première analyse technique de la situation particulière de chaque ville et la préparation d'un plan spécialement conçu pour chaque situation particulière s'est révélée d'une application satisfaisante aux systèmes importants desservant les grandes villes. Toutefois, lorsqu'il s'agit de petites communes et de villages qui se comptent par milliers, la méthode classique consistant à étudier chaque cas particulier s'est révélée inapplicable en raison des délais et des dépenses qu'elle entraîne. Au lieu d'établir des plans spécialement conçus pour chacune des petites communes, on se propose de mettre au point une formule "globale" qui permettra de concevoir des centaines et même des milliers de systèmes, de les construire, de les entretenir et de les faire fonctionner en utilisant un équipement, des matériaux et des procédures standardisées.

La technique de la formule globale serait mise au point pour un pays ou une région donnée, et consisterait à élaborer les plans concernant le réseau destiné à un village en réduisant au minimum les études techniques (qui seraient dans bien des cas effectuées par un ingénieur travaillant sur photos aériennes, installé par exemple dans une ville au centre de cette région) et se traduirait par l'élaboration d'une liste d'articles standardisés qui pourraient être rassemblés et expédiés vers ce village. De même, la construction, l'entretien et l'exploitation seraient confiés au premier chef à du personnel local, avec l'assistance d'un nombre aussi restreint que possible d'experts techniques (provenant également du centre urbain) utilisant un jeu de manuels standards relatifs à la construction, à l'entretien et à l'exploitation.

Le document propose un programme de démonstrations destiné à "prouver" que cette nouvelle technique est réalisable, en effectuant une étude sur un groupe de villages d'une région déterminée.

EL DESARROLLO DE LOS SISTEMAS DE ABASTECIMIENTO DE AGUA DE LAS ALDEAS MEDIANTE PROGRAMAS INTEGRALES

Resumen

Se reconoce cada vez más que la disponibilidad de un abastecimiento adecuado de agua es una base esencial del desarrollo y crecimiento de la comunidad, no sólo para fines sanitarios sino para la promoción de la industria y de la economía en general. En los últimos dos decenios se ha realizado un gran progreso en las mejoras de los sistemas de abastecimiento de agua de los principales centros urbanos y de las zonas metropolitanas, las cuales son, como es natural, zonas de atención primordial. Sin embargo, mucho menos progreso se ha logrado en la solución del problema de las miles de pequeñas comunidades o aldeas que forman el "interior" de los países.

El enfoque usual de la ingeniería de los sistemas de abastecimiento de agua -- que requiere un análisis preliminar desde el punto de vista de la ingeniería de la situación específica de cada ciudad y la preparación de un diseño ajustado a las necesidades de cada situación -- ha resultado satisfactorio para aplicarlo a los sistemas que abastecen las grandes poblaciones. Sin embargo, para los millares de pequeñas comunidades y aldeas, se ha demostrado que el enfoque convencional del sistema "hecho a la medida" no es aplicable por el tiempo y el costo que requiere. Se propone que, en vez de prepararse diseños individuales, "hechos a la medida", para cada una de las comunidades pequeñas, se desarrolle un enfoque general de sistemas "prefabricados", ajustados a normas uniformes, mediante los cuales cientos y aun miles de sistemas particulares pueden ser diseñados, construidos, mantenidos y operados utilizando equipos, materiales y procedimientos normalizados.

Esta técnica sería desarrollada para un país o región dados, y su aplicación permitiría que el diseño del sistema de una aldea se realizara con un mínimo de labor de ingeniería (en muchos casos, un ingeniero basándose en fotos aéreas, podría hacer el trabajo desde su oficina en la principal ciudad de la región), de la cual se derivaría la preparación de una lista de los artículos, ajustados a una norma uniforme, que podrían ser enviados a la aldea. De la misma manera, la construcción, mantenimiento y operación se realizarían principalmente por personal local con un mínimo de asistencia técnica de expertos (también proporcionados por la ciudad principal), que usarían un juego de manuales uniformes sobre construcción, mantenimiento y operación.

Se ha propuesto un programa de prueba para comprobar la viabilidad de la nueva técnica mediante un estudio realizado en un grupo de aldeas en una región determinada.

WATER SUPPLY IN THE NETHERLANDS BY THE GOVERNMENT INSTITUTE FOR WATER SUPPLY.

Government Institute for Water Supply

INTRODUCTION

The population of the Netherlands grew from 3,000,000 in 1850 to the current figure of 12,500,000. This implies that the population of this country, which has a land area of 12,850 miles, is denser than the populations of far bigger countries such as Sweden, Austria and Australia. It is expected that the number of inhabitants will increase to about 20,000,000 by the year 2000.

The rapid growth of the population was accompanied by the development of industries, especially after World War II. Actually about 43 percent of the inhabitants derive their income from industry while the corresponding figure for agriculture is about 8.

At present the Netherlands is a highly industrialized country: so the increase of industrial water demand and the pollution of surface waters by industrial waste cause considerable concern.

One-fifth of the Netherlands lies below mean sea level and nearly half of the country has to be protected against flooding. As a consequence, the battle against water has been a real problem from time immemorial. The efforts to obtain good drinking water supplies started a good deal later.

Only somewhat more than a century ago the population was satisfied with a drinking water that - according to modern standards - was unacceptable in many cases.

The surface water was polluted by night-soil as well as by other waste materials. The shallow groundwater from open wells in many parts of the country was no better. The introduction of primitive pumps during the seventeenth century did not markedly improve the hygienic conditions. This situation lasted until the second half of the nineteenth century. Within the rather short period of some hundred years this situation changed to the present state where about 99 percent of the population is provided with an ample supply of wholesome drinking water.

THE DEVELOPMENT OF PIPED WATER SUPPLY

The first central water-supply in the Netherlands, established on behalf of the city of Amsterdam, was completed in 1853, and a few years later Den Helder followed suit (1856). After the establishment of these undertakings by private companies, it was not until 1874 that the municipal water works of Rotterdam and the Hague were put into operation. Undoubtedly these last two supplies were intended as a safeguard against the cholera that repeatedly visited he Netherlands. The big epidemics of 1866 and 1867 particularly affected the opulation in a hard way. After the Hague, other towns followed in rapid uccession and, as a result, most urban communities of 10,000 inhabitants and ore could boast their own central water-supply by the turn of the century. ural towns and villages, however, and isolated farms and buildings still lacked piped water-supply.

This development was a logical result of the policy followed by the water ompanies. The private businessmen who originally took charge of the water-upply carried out their undertakings on a profit basis and connection of the emaining rural regions would certainly not be profitable. This situation id not change when several private companies were taken over by municipal uthorities (Amsterdam, 1896) who also held that water works should at least e self-supporting. As things were at the first decade of this century, nearly 0 percent of the population could not be connected to a piped supply and, as result of this, hygienic conditions in many rural districts left much to be esired.

In order to make a study of the pending problems, a Government Commission or Drinking Water Supply was established on April 24, 1910. After three years, y July 1, 1913, this Commission was transformed into the Central Commission nd the Government Institute for Water-Supply which continued the original tudy and mapped out an extension programme for rural water-supply.

The relatively dense population made it possible to realize rural water upplies by the establishment of regional systems that offered a guarantee or good technical and hygienic management as well as a possibility for an conomic combination of profitable and non-profitable regions. The first big istrict supply system, in which 24 municipalities participated, was completed n 1913 at the isle of South-Beveland. At present there are 33 district water-upplies, but Government support was given in several ways, viz, by:

- contributing towards the cost of drawing up plans;
- advancing building capital;
- contributing towards the payments of interest in a period when rates of interest were high;
- granting aid in case of working losses.

All in all the financial participation by the Government in water-supply nterprises before the Second World War remained limited; most services were et up in such a way as to be self-supporting. As a result of this policy, he self-supporting undertaking were practically completed by 1940 when an stimated 78 percent of the population was connected to some central water-upply system. The high costs of investment per connection prevented central elivery of drinking water to the remaining 22 percent. For further progress o be made - and for the benefit of public health this was considered urgently esirable - the requirement of self-support had to be dropped. Connection of he remaining nonprofitable premises could only be achieved with the aid of overnment subventions. Because of the war conditions a subvention programme, ccepted in 1940, was only partly executed, but shortly after the Second World ar the problems were diligently attacked. In regions damaged by the war, bout 80,000 nonprofitable premises were connected to a central supply system. he total working deficit of these connections was carried by the Government, hich pays in the form of annual contributions to the undertakings concerned. or nondamaged districts with nonconnected premises, a ten-year water-supply rogramme was set up. It included the connection of all premises which could e connected at an investment cost not exceeding fl.1000. (£ 100). Two-thirds f the theoretical exploitation deficit of these connections (calculated from n empirical formula) is carried by the Central Government, the remaining part s supplied by provincial and municipal funds. Thanks to this programme, just ow completed, 250,000 unprofitable premises have been connected. It has raised he connection rate to about 98 percent of the population. The remaining 2 per-ent of the population live in scattered farms and cottages. The costs of in-vestment per connection of these houses amount to an average of fl. 3000. (£ 300). The first houses of this group of "super-unprofitable" premises are to be con-nected in the course of this year and it is to be expected that by working along these lines the connection-rate in the Netherlands will be raised to nearly 100 percent by 1973.

Until about 1920 municipalities and others needed no special authorization for the establishment of a water undertaking. In view of the promotion of the establishment of rural district water-supplies, the provinces then promulgated ordinances requiring the approval of the provincial government for new water supplies to be established in their territory.

The first state law in the field of water supply was the Act on Ground Water Abstraction by Public Water Supplies (1953). In 1957 the Waterworks Act was promulgated. This Act deals with the hygienic aspects of public water supplies and makes a reorganization of water undertakings possible.

ORGANIZATIONAL PATTERN

The general national policy with regard to water resources is the responsibility of the Minister of Public Works. For many centuries the main water problems were the prevention of floods, the removal of superfluous water and land reclamation.

On the other hand water was consider a valuable matter by people concerned with drinking water supply, which is the responsibility of the Minister of Social Affairs and Public Health, who issues licenses for the abstraction of groundwater to water undertakings. As for drinking water supply (until today) mainly groundwater is being used.

The Minister of Social Affairs and Health is responsible for the national policy with regard to water supply. His advisor for technical, chemical, hydrogeological, economic and other aspects is the Government Institute for Water Supply. The primary task of this institute is to advise the government on questions of water supply. The services of the Institute are also available to provincial and municipal authorities, as well as for private persons and corporations, to carry out technical, chemical, biological and hydrogeological investigations and evaluations, both for problems in the Netherlands and abroad. The Institute employs 125 people, 25 of them graduated engineers, chemists, lawyers, biologists, mining engineers and some 30 other technicians.

On hygienic aspects the Chief Public Health Officer and the Public Health Officers for Environmental Hygiene are his advisors.

At the beginning of 1967 there were 158 water undertakings of which 105 were municipal undertakings and 34 district undertakings.

The responsibilities for planning, design, construction, operation and administration are centered in the water undertakings. The bigger undertakings have a technical staff able to deal with the planning and design of new works. If such a staff is lacking or if special problems arise, e.g., in the field of hydrogeology, the water undertakings often make use of the services of the Government Institute for Water Supply, which in this respect acts as a consulting engineer.

Shortly after World War II the Institution for the Testing of Waterworks Articles (KIWA) was established through cooperation between the Netherlands Waterworks Union and the Netherlands Waterworks Engineers Association. These two organizations realized the need for a body which could expertly and impartially carry out a central examination of materials and apparatus being used in house installations by waterworks and related institutions. At the same time the Institute was intended to be active in the field of research and to promote coordination between water developers.

The KIWA organized cooperation between all water supply laboratories, headed by a university trained chemist-bacteriologist. At present these laboratories not only take care of the water undertakings they belong to, but also the water supply systems of undertakings which could not afford their own laboratory facilities. The hygienic supervision of waterworks is carried out by the

Public Health Officer of the Section for Environmental Hygiene. However, according to the Waterworks Act, the responsibility for the water quality remains with the water developer who has to provide for periodic examinations of the water. The rather high frequency of these control examinations is prescribed by the Waterworks Ordinance and the results of the analyses have to be shown to the Public Health Officer.

This arrangement simplifies the task of the Public Health Authorities who are concerned in the water quality. They can confine themselves to checking the water composition by means of a few samples taken at random. These random tests are carried out by the Government Public Health Institute.

EFFECT OF COMMUNITY WATER SUPPLY ON PUBLIC HEALTH.

Undoubtedly, the rapid development of community water-supply had a favorable effect on the health of the people. Since 1909 cholera asiatica has disappeared from the Netherlands and the morbidity of febris typhoidea is so low that the rare cases reported (0.4 per 100,000), only exceptionally bear a waterborne character. However, a constant alertness with regard to this disease is still imperative at present, because of the rather high number of human typhoid carriers that occur. Special attention should be given to dangerous cross connections permitting waste water to enter the potable public supply. Generally, there is a correlation between the decline of typhoid and the decreasing percentage of the population not connected to a central water-supply. Although the relation between typhoid fever and drinking water-supply is not always too clear, it seems justified to state that the decrease of typhoid and other "waterborne diseases" must be attributed first of all to the improvement of the drinking water quality which, also in other respects, contributed much to the framing of a favorable environment for the dense population.

It might be mentioned as a special feature that since 1935 piped water has been used as a means of distribution of iodide in a number of endemic goitre regions. However, because of a shortage of potassium iodide during the Second World War, the addition to the water was discontinued. In its place iodide is presently distributed by adding it to the salt used for the baking of bread.

After the favorable results of a comparative investigation on the effect of fluoride on the prevention of caries executed at Tiel (fluoridated water) and Culemborg (nonfluoridated water), the Minister of Social Affairs and Public Health recommended the addition of fluoride to drinking water. On this recommendation many municipalities and district water-supplies decided to fluoridate, whereas a few rejected the proposition. It is hoped that these can be won over by intelligent health education. The number of people supplied with fluoridated drinking water at present or in the near future amounts to 6 million, about half the population of the country.

FUTURE DEMAND

The fact that the present state of drinking water supply is not unsatisfactory does not imply that the responsible authorities are free of care. They are, among other things, concerned about covering the water demand in the years to come. This problem has been studied by the Central Commission for Water Supply. As a result of the steady growth of the population, the improving living conditions and the rapidly increasing industrialization, a constant rise of the water consumption is to be expected. At a rough estimate the total demand at the end of this century will be about a fourfold of the consumption of the year 1960, which was used as a starting point by the Central Commission. This is illustrated by the following figures.

	Water consumption in 1960	Estimated requirements in 2000.
Domestic:	360 million m^3	1050 million m^3
Industrial:	700 million m^3	2700 million m^3
Total:	1060 million m^3	3750 million m^3

In the year 1965 the total consumption was about 1400 million cubic meters, the domestic consumption in that year amounted to about 450 million cubic meters.

WATER RESOURCES

The sources of water are groundwater and surface water. A part of the abstracted surface water is being used for the artificial replenishment of groundwater, mainly in the dune areas of the North Sea coast.

The abstraction of water in the year 1965 is shown by the following figures.

Abstracted by water undertakings:

groundwater	440 million cu. m.
surface water	145 million cu. m.
artificial groundwater	100 million cu. m.

Abstracted by industries:

groundwater	500 million cu. m.
surface water	225 million cu. m.
Total	1,410 million cu. m.

The total amount of groundwater which annually can be abstracted without damage to agriculture and forestry is estimated at 1500 million cubic meters. As the actual abstraction of groundwater is about 1000 million cubic meters only 500 million cubic meters annually are available for future needs. As the future demand is estimated at about 4000 million cubic meters, it must be envisaged that 2500 million cubic meters surface water will have to be utilized.

The main sources of surface water are the rivers Rhine (average annual discharge 70,000 million cubic meters) and Meuse (average annual discharge of 8,000 million cubic meters).

As the main source of surface water is the Rhine, it follows that the quality of drinking water in the future will be increasingly dependant on the composition of Rhine water. It is common knowledge that the composition of this water leaves much to be desired. The Rhine carries so many organic and inorganic waste materials that this river is sometimes referred to as the "biggest sewer in Europe". Although such a designation might be considered somewhat exaggerated, it is a fact that during periods of low flow the Rhine water is unfit for drinking water production. The problem of the pollution of the Rhine is a rather critical one and it is to be hoped that the "International Commission for the Protection of the Rhine", which has been set up in 1950 by the five riparian states (Switzerland, France, Luxemburg, the Federal Republic of Germany and the Netherlands) will find ways and means to improve the condition of the Rhine water. The river Meuse has not the degree of pollution of the river Rhine. It is, however, characterized by periods of extremely low flow.

So from both rivers no water can be abstracted during certain periods of the year. An uninterrupted supply of water, derived from those rivers only, can be obtained by water storage. This may be done by artificial replenishment of groundwater or by the construction of storage reservoirs, surrounded by dikes.

In both cases considerable capital expenditure will be necessary.

FUTURE GOVERNMENT MEASURES

At present it is felt that the administration of ground and surface water, both in quantitative and qualitative aspects, is not supported by legislation to the degree that a national water resources policy can be realized in the best way. New legislation is being prepared for the protection of surface water against pollution and for the abstraction of groundwater.

The ever-increasing water demand, the difficulties of obtaining enough water of good quality and the problem of attributing water and storage capacity to the most appropriate demand require a national policy aiming at an efficient use of the available water resources.

This implies that decisions on the national level will have to be based on a master plan for future water supply. The Minister of Social Affairs and Public Health therefore ordered the Government Institute for Water Supply to prepare such a plan. This plan will mainly deal with the abstraction of ground and surface water, the storage of water and its transport. The Institute created a special section for dealing with this matter and gratefully accepted the co-operation of distinguished specialists in the field of water supply not on its own staff, and of the Netherlands Water Works Union.

The Institute started its work about two years ago and expects that in 1969 a draft plan will be completed.

L'ADDUCTION D'EAU AUX PAYS-BAS

Résumé

Introduction

La population des Pays-Bas est passée de 3 millions d'habitants en 1850 à 12.500.000 à l'heure actuelle. La population de ce pays, dont la superficie des terres est de 31.400 km^2, est donc plus dense que celles de pays beaucoup plus étendus tels que la Suède, l'Autriche et l'Australie. Il est prévu qu'elle atteindra quelque 20 millions d'habitants en l'an 2000. L'accroissement rapide de la population s'est accompagné du développement de l'industrie, surtout après la Seconde Guerre mondiale. En fait, 43% environ des habitants tirent leur revenu de l'industrie, contre 8% pour l'agriculture.

La progression démographique et l'expansion industrielle ont eu pour effet d'augmenter considérablement la demande en eau. Alors qu'au cours des siècles précédents les principaux problèmes que posait l'eau avaient trait à la prévention des inondations et à l'assainissement, à présent, il faut en outre obtenir de l'eau de bonne qualité pour la consommation humaine et les utilisations industrielles.

Développement de l'adduction d'eau

Les premiers aqueducs, construits pour la ville d'Amsterdam, ont été achevés en 1853.

Dès le début du siècle, la plupart des collectivités urbaines de plus de 10.000 habitants étaient dotées de leur propre réseau d'approvisionnement en eau, lesquels étaient tous financièrement rentables. Les perspectives financières étant moins favorables dans les zones rurales, l'approvisionnement en eau y resta en retard. Toutefois, la densité relativement élevée de la population permit d'assurer l'approvisionnement des zones rurales grâce à la construction de réseaux régionaux garantissant un niveau technique et hygiénique satisfaisant et combinant de façon économique la desserte des régions rentables et celle des régions non rentables. Les réseaux rentables d'adduction d'eau étaient pratiquement achevés en 1940, et l'Institut public d'adduction d'eau (créé en 1913) a beaucoup contribué à l'accomplissement de cette tâche.

Après la Seconde Guerre mondiale, le taux de raccordement, grâce aux subventions publiques, atteignit son niveau actuel d'environ 98%.

Il est prévu de le porter à près de 100% en 1973.

Le développement de l'alimentation en eau des collectivités a eu un effet favorable sur la santé publique. Depuis 1909 le choléra asiatique a disparu et la morbidité de la fièvre typhoïde est si faible que les rares cas déclarés ne sont qu'exceptionnellement dus à l'eau.

La demande future

En raison de l'accroissement de la population, de l'amélioration des conditions de vie et du développement rapide de l'industrialisation, il faut s'attendre à ce que la consommation d'eau augmente de façon continue. On a estimé que la consommation domestique et industrielle, qui est actuellement d'environ 1,4 milliard de mètres cubes, passera à 4 milliards en l'an 2000.

La consommation domestique qui s'élève actuellement à environ 450 millions de mètres cubes devrait atteindre environ 1,1 milliard au cours de la même année.

Ressources hydrauliques

Les ressources hydrauliques ont une double origine: les eaux souterraines et les eaux de surface. Le volume total des eaux souterraines qui peuvent être prélevées sans dommage pour l'agriculture et les forêts est estimé à 1,5 milliard de mètres cubes. A l'heure actuelle, les services d'alimentation en eau livrent environ 450 millions de mètres cubes d'eau potable puisée aux nappes souterraines, soit les deux tiers de leur production totale. L'industrie utilise pour sa part 500 millions de mètres cubes d'eau souterraine.

En fait, les services d'alimentation en eau utilisent 225 millions de mètres cubes d'eaux superficielles, dont 100 millions pour la recharge des nappes souterraines.

L'industrie utilise environ 225 millions de mètres cubes d'eaux de surface, non compris les eaux servant au refroidissement.

La demande future évaluée à 4 milliards de mètres cubes nécessitera donc l'utilisation de 2,5 milliards de mètres cubes d'eau superficielle.

Les principales ressources en eaux de surface sont le Rhin et la Meuse, qui ne peuvent ni l'un ni l'autre être utilisés en permanence pour satisfaire les besoins en eau potable. En période d'étiage, la qualité de l'eau du Rhin est altérée sous l'effet d'une forte pollution, tandis que l'eau de la Meuse est quantitativement insuffisante. Il faudra donc construire d'importants ouvrages d'emmagasinage de façon que l'alimentation en eau puisse se faire de façon ininterrompue.

Plan global d'adduction d'eau

L'augmentation incessante de la demande en eau et les difficultés qu'il y a à obtenir une eau de bonne qualité et à l'attribuer à la demande la plus appropriée exige une politique nationale visant à assurer l'utilisation efficace des ressources disponibles en eaux souterraines et superficielles.

A cette fin, les décisions prises à l'échelon national devront s'inscrire dans le cadre d'un plan d'ensemble.

En conséquence, le Ministre des Affaires sociales et de la Santé publique a chargé l'Institut public d'adduction d'eau d'établir un tel plan. L'Institut s'est mis à l'oeuvre il y a environ deux ans et compte terminer un plan en 1969.

ABASTECIMIENTO DE AGUA EN LOS PAISES BAJOS

Resumen

1. Introducción

La población de los Países Bajos ha aumentado de 3 millones de habitantes en 1850 a un total de 12.500.000 en la actualidad. Esto significa que la población del país, que tiene un territorio de 33.281 km², es más numerosa que la de naciones mucho más extensas como Suecia, Austria y Australia. Se espera que el número de habitantes alcanzará a unos 20 millones en el año 2000. El rápido crecimiento demográfico ha ido acompañado por el desarrollo de las industrias, sobre todo después de la Segunda Guerra Mundial. En realidad, alrededor del 43% de los habitantes obtienen sus ingresos de la industria, mientras que en la agricultura la porporción respectiva es del 8% más o menos.

El aumento de la población y el crecimineto de la industria han provocado un considerable incremento de la demanda de agua. Mientras en los siglos pasados los principales problemas relacionados con el agua consistían en la prevención de las inundaciones y en el avenamiento, en el actual se plantea además el de obtener agua apta para el consumo humano y para la industria.

2. El desarrollo del abastecimiento de agua por tuberías

El primer sistema de abastecimiento de agua por tuberías, instalado para servir a la ciudad de Amsterdam, terminó de construirse en 1853.

Al iniciarse el siglo XX, la mayoría de las poblaciones urbanas de 10.000 habitantes o más tenían su propio servicio de abastecimiento de agua y todos ellos se financiaban por sí mismos. Las perspectivas financieras para el establecimiento de servicios de agua en las regiones rurales fueron menos favorables, por lo que éstas quedaron retrasadas. Con todo, la densidad relativamente grande de la población permitió el establecimiento de servicios rurales de provisión de agua mediante redes regionales que ofrecían garantías de una buena administración técnica y sanitaria así como la posibilidad de combinar económicamente los servicios de las regiones económicamente ventajosas y las que no lo eran. La instalación de sistemas de abastecimiento de agua de propio mantenimiento fue prácticamente terminada en 1940 y a ella contribuyó considerablemente el Instituto Gubernamental de Abastecimiento de Agua, establecido en 1913.

Después de la Segunda Guerra Mundial, la proporción de conexiones aumentó, con ayuda de subvenciones oficiales, al 98% más o menos y se espera que llegará a cerca del 100% en 1973.

El desarrollo de los sistemas de abastecimiento de agua ha tenido efectos favorables sobre la salud de la población. Desde 1909 ha desaparecido el cólera asiático y la morbilidad de la fiebre tifoidea es tan baja que los pocos casos registrados sólo por excepción tienen su origen en el agua.

3. Demanda futura

Como consecuencia del constante aumento de la población, el mejoramiento de las condiciones de vida y la industrialización en rápido ascenso, es de esperar un incremento constante del consumo de agua. Se calcula que el consumo doméstico e industrial, que es hoy de unos 1.400 millones de metros cúbicos, se elevará a 4.000 millones en el año 2000.

Se estima que el consumo doméstico, actualmente de 450 millones de metros cúbicos, ascienda a aproximadamente 1.100 millones en dicho año.

4. Recursos de Agua

El abastecimiento se obtiene de fuentes de agua subterránea y de agua de superficie.

El total de agua subterránea que puede extraerse sin perjudicar a la agricultura y la silvicultura ha sido calculado en 1.500 millones de metros cúbicos. En la actualidad las empresas que prestan esos servicios suministran alrededor de 450 millones de metros cúbicos de agua potable de origen subterráneo, o sea dos terceras partes de su producción total. La industria utiliza aproximadamente 500 millones de metros cúbicos de aguas subterráneas.

Las empresas abastecedoras utilizan 225 millones de metros cúbicos de agua de superficie, de cuyo total corresponden 100 millones a la reposición de aguas subterráneas.

Las industrias usan alrededor de 225 millones de metros cúbicos de agua de superficie, con excepción de la utilizada para enfriamiento.

La futura demanda de 4.000 millones de metros cúbicos hará necesario usar 2.500 millones de metros cúbicos de agua de superficie.

Las fuentes principales de agua de superficie son los ríos Rin y Mosa, que no pueden ser utilizados en forma continua para la obtención de agua potable. Durante los períodos de estiaje, la calidad del agua del Rin sufre deterioro a causa de una fuerte contaminación, en tanto que la cantidad de agua del Mosa no es suficiente. En consecuencia, será preciso construir grandes obras para el almacenamiento de agua a fin de mantener una provisión ininterrumpida de agua.

5. Plan maestro de abastecimiento de agua

El aumento siempre creciente de la demanda de agua y las dificultades que hay para obtenerla de buena calidad y destinarla a la demanda más apropiada exigen la formulación de una política nacional encaminada a la utilización eficiente de los recursos de agua subterránea y de superficie existentes.

Esto implica que será precisa la preparación de un plan maestro para que las autoridades nacionales puedan tomar las decisiones convenientes.

Por lo tanto, el Ministro de Asuntos Sociales y Sanidad ha ordenado al Instituto Gubernamental de Abastecimiento de Agua que prepare dicho plan. El Instituto ha iniciado esa labor hace alrededor de dos años y espera tener completado un plan en 1969.

Japan Water Supply

DEVELOPMENT OF SEASIDE RESERVOIR MODEL INVESTIGATION

Otoya Nagaoka

I. Introduction

The recent rapid development of seaside industrial areas has presented the great problem of meeting ever-increasing demands for industrial water, especially for the steel and petro-chemical industries that consume especially large amounts of water. For industrial purposes, both ground and surface waters are used. The former has advantages over the latter in regards to quality and temperature of water. It also can be obtained comparatively cheaply.

But when groundwater is pumped up in large quantities from a limited area, it will cause the groundwater level to lower, creating the possibility of its being replaced by saline water, and bringing about land subsidence due to soil consolidation. Thus, the limitless use of groundwater is prevented by the possible occurrence of these public nuisances.

On the other hand, utilization of expanded surface water sources---mostly near rivers---can not be expected to come from those rivers that are left in a natural and unimproved state. To obtain river water, the usual way is to construct dams to retain temporary surplus waters during wet periods and release it in a dry season. In this way, the stabilization of river flow and a higher rate of river water utilization can be realized.

These dams have hitherto been constructed in series in the middle and upper reaches of rivers. However, it has recently become harder to obtain in the upper as well as middle parts of streams suitable sites both for dams and reservoirs. In addition, difficulties in purchasing the project land and in compensating the displaced, people have made it more and more arduous to plan new dams.

Confronted with these obstacles, attention has been directed to the river mouth where a flow of fresh water empties uselessly into the sea. A tremendous quantity of flood water is being wasted every year, while it has become feasible to use streams in the estuary, provided that a so-called "river mouth dam" is constructed. Adopting a method to retain water in the river channel, in case of a large river, and, in case of a small river, a river mouth reservoir is created by dredging the neighboring seacoast and building dike around it.

Up to now, however, there has been no example of such seaside reservoir construction for the impounding of industrial water. Economic questions aside, this may be attributed to the fact that some technical items remained unclarified, and that the requirement of industrial water was not so great as it is fast becoming.

This new method, which has some aspects common to the reclamation projects of Kojima and Hachiro-gata in Japan, Zuyder Zee and Delta Plan in Holland, and Plover Cove Dam in Hong Kong, recently employed to provide domestic water supplies. The Prefectural Governments of Chiba, Kagawa and Shizouka are now sparing no pains to draw up this sort of project to supply their seaside industrial areas with sufficient water for their developments.

The Seaside Reservoir Development Committee (S.R.D.C.) organized by the Japan Industrial Water Association is engaged in the investigation of construction of seaside reservoirs, making studies and on-site tests of the phenomena of seepage and dispersion of saline water with large scale models equipped in the field.

II. Scale of Models

1) Test Basin

A circular test basin has been constructed near the mouth of the Obitsu River, Chiba Prefecture. It has a storage capacity of 12,000 m^3, and the upper diameter, the lower diameter, water depth and the slope are 63^m, 10^m, 10^m, and 1:2.5, respectively. A plan of this test basin is shown as Figure 1.

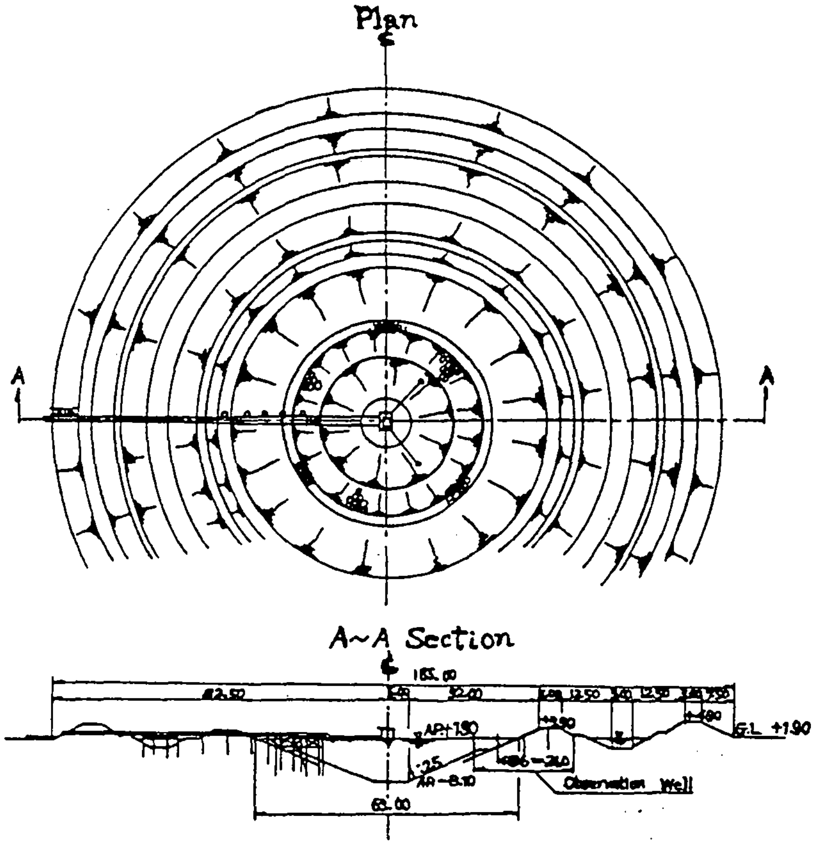

Figure 1. Test Basin

2) Dispersion Test Channel

In order to observe the dispersion rate of salinity from the bottom soil, the dispersion test channel was constructed. It was built of reinforced concrete according to the plan shown in figure 2; the length, width and height are 50, 2, and 3 meters respectively.

3) Synoptic view of the site

According to soil studies, the surface of the site is rather flat and is covered with alluvial soil about 30^m thick. Below this stratum there exists a diluvial stratum. Generally speaking, from 10 to 15 m below the ground surface there lies a sand stratum, below which there is a silt stratum of low permeability. The soil profile of the ground is shown as figure 3.

The coefficient of permeability of sand stratum is 4 x 10^{-3}cm/sec which was obtained from the results of pumping tests using the test basin.

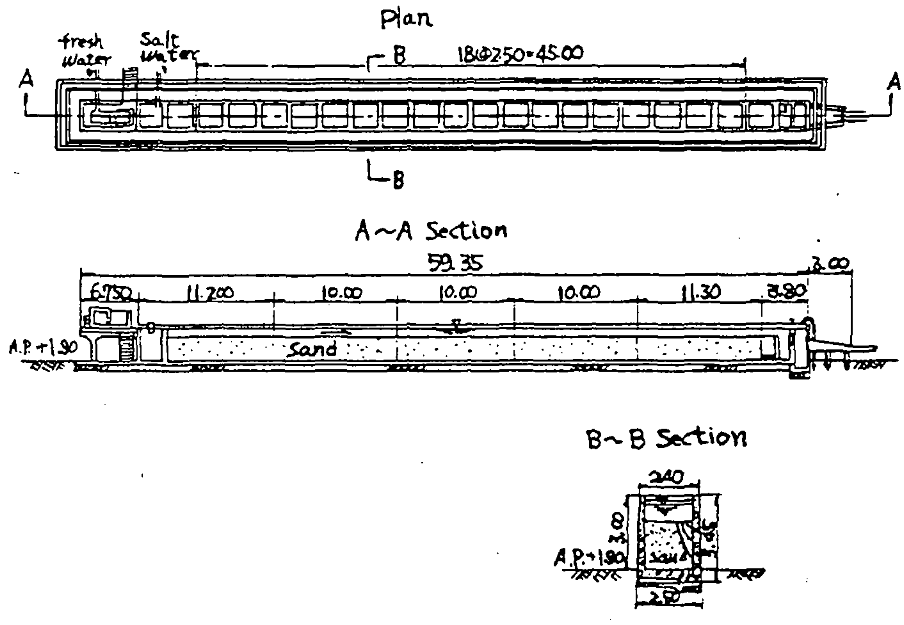

Figure 2. Dispersion Test Channel

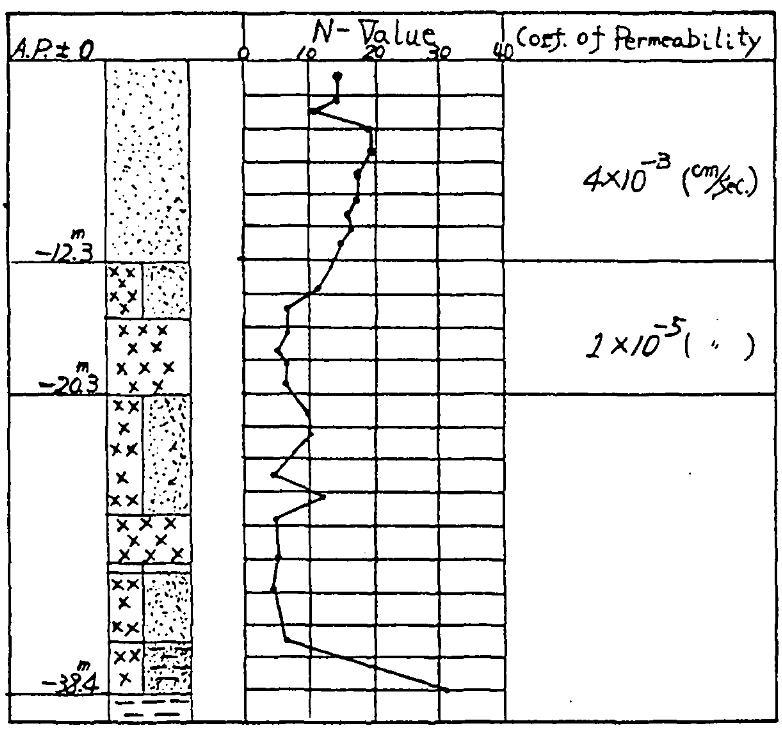

Figure 3. Soil Profile

III. Budget of investigation

1) Time Limitation

5 years, from 1964 through 1968

2) Budget (over 5 years)

Ministry of International Trade and Industry	55 million
Chiba Prefectural Government	38 million

Japan Industrial Water Association (JIWA)	60 million
Total	153 million

Allotment to JIWA is to be shared by the Prefectural Governments of Nagasaki, Shizouka, Fukuoka, Yamaguchi, Kagawa, Kyogo and Fukuoka Municipality.

IV. Intermediate Results of the investigation.

1) Seepage through dikes

In order to prevent the intrusion of salinity into the seaside reservoir, the necessary width of the dike was investigated by means of a Hele-Shaw viscous fluid model. According to the results of experiments, the effect of rainfall on the seepage flow was important. If there is rainfall, the pollution of the reservoir caused by the intrusion of salt water through the dike seems to be almost completely controlled by a dike of 800^m width, as in figure 4. However, without the effect of rainfall, the pollution cannot be prevented within even 1000^m of the dike.

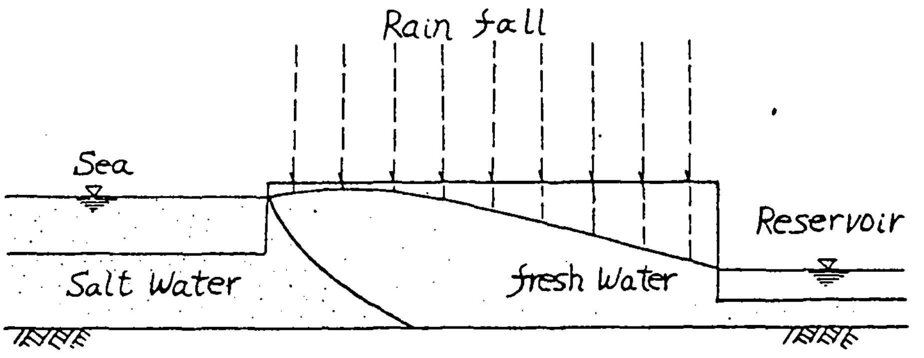

Figure 4. Seepage through the wide dike.

2) Waterproof effect of sheet pilings as cut-off wall.

For field tests of the sheet piles, several wells framed with sheet pile were dug. The relation between the discharge and the head loss for various sheet piles was investigated. It was found that the waterproof effect of sheet piles depends on the permeability and grain size of surrounding sand as well as the condition of the piles, the shape and type of joint, compactness of joint, etc.

A new type of thin sheet pile was developed as a reliable barrier. It was hammered, with vibrating and jetting, in the sand layer and its joints were packed with cement paste. As results of pumping tests, its specific coefficient of permeability is about 1×10^{-7} sec^{-1} and corresponds to 100^m in width of the dike, if the coefficient of permeability of the sand is 1×10^{-3}cm/sec.

3) Prevention of the intrusion of the sea water by a recharging channel

This is a kind of pressure ridge method. An open channel is constructed on the top of the dike and the fresh water infiltrated from the channel creates a water table to repel the sea water. Hele-Shaw viscous fluid model tests were carried out. They are shown as figure 5.

The following conclusions were obtained:

When the water surface is 40cm higher than the sea water level, the salt water wedge is repelled from the reservoir.

The discharge rate of the fresh water being wasted to the sea is only 1.2% of the design water supply.

It is not necessary to construct an infiltration channel of such a large sectional area. An experiment for the infiltration channel, 5m wide and 1.5m deep, shows that the repulsion of the sea water is completed in one year. Another advantage of this method is that it is undisturbed by earthquakes.

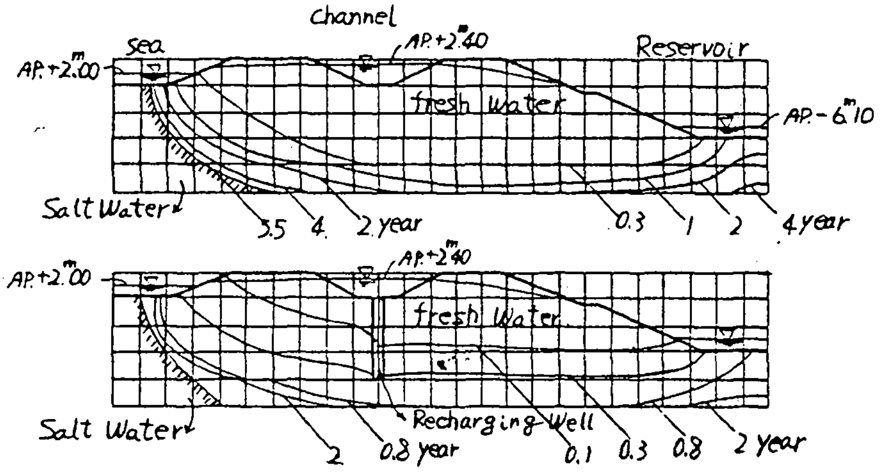

Figure 5. Recharging Channel

4) Dispersion of salinity from bottom sand

The seaside reservoir is to be constructed on a bed that was originally under water, so that the salt in the underground strata of the reservoir would disperse into retained fresh water due to the difference of density, the action of wind and waves, the flunctuation of ground water and other reasons.

The results of investigations into the dispersion rate of salinity were reported by S.G. Elliott and S.E.H. Ford in connection with the Plover Cove Water Scheme in Hong Kong.

The S.R.D.C. carried out experiments using a dispersion test channel and laboratory test. H. Yamaguchi reported the coefficient of salinity dispersion to be 1 x $10^{-4} cm^2/S$, ten times that of the molecular diffusion of salinity.

The condition of desalting in the bottom sand is shown as figure 6.

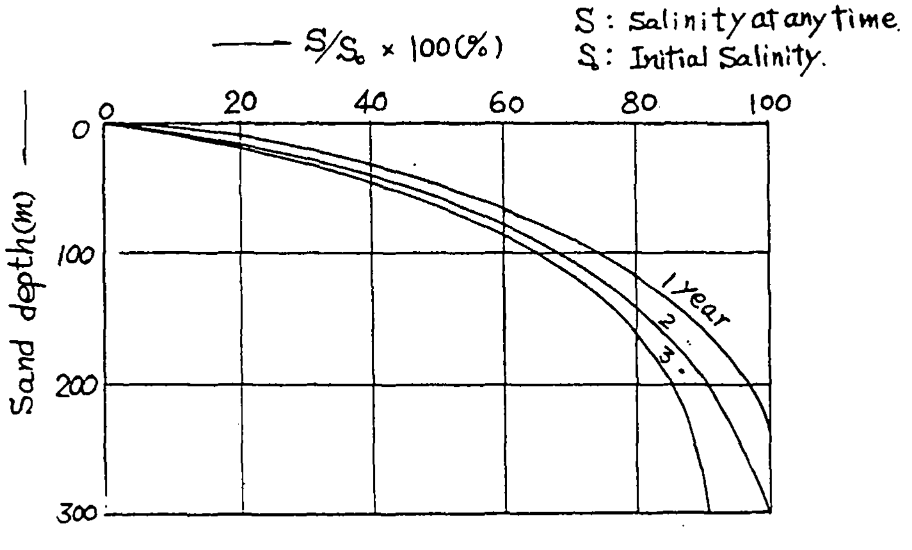

Figure 6. Distribution of salinity in the bottom sand.

According to figure 6, the dispersion rate of salinity decreases with time. The allowable salinity of industrial water can be insured without special prevention methods for about two years. This period is not too long, since two years will be necessary to complete the seaside reservoir construction.

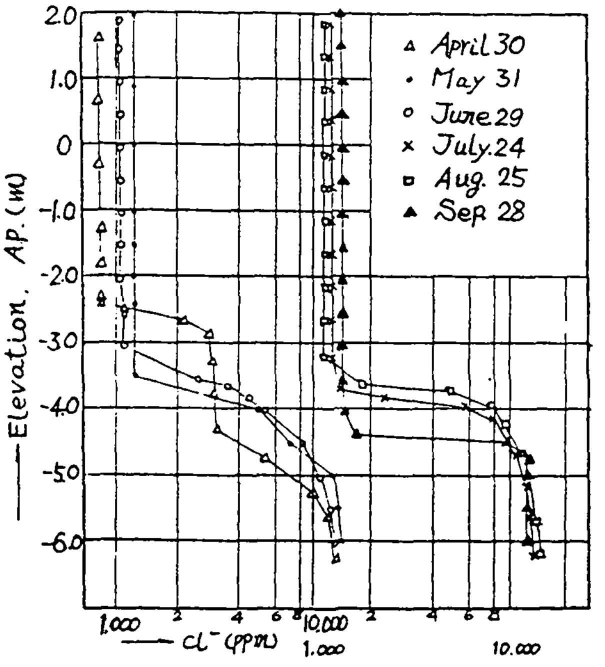

Figure 7. Distribution of Chlorinity

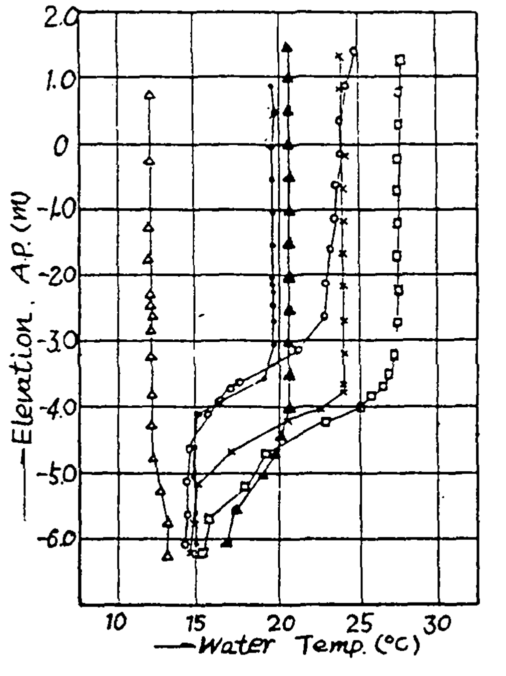

Figure 8. Distribution of Temperature

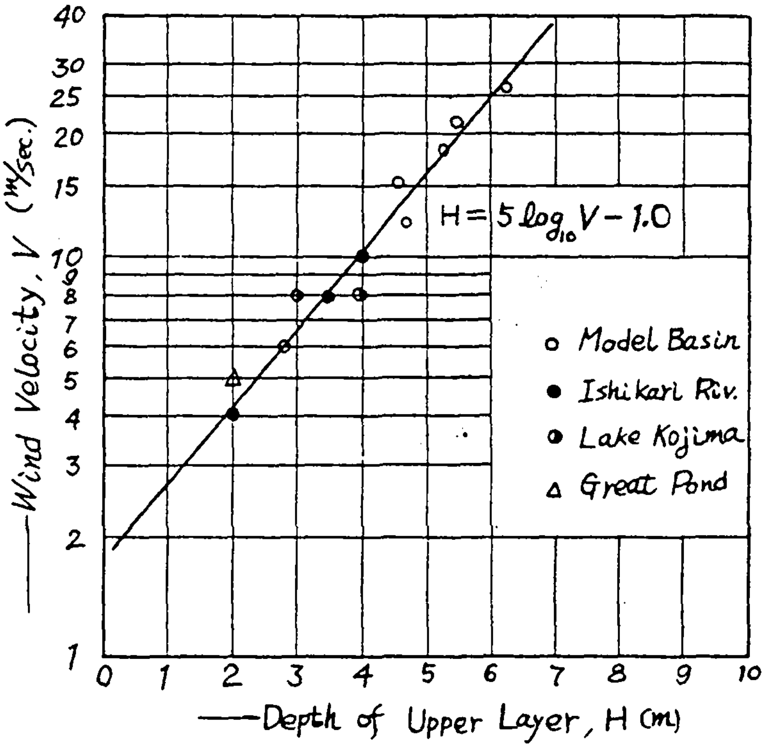

Figure 9. Relations between the depth of the test basin and wind velocity

The strait line in Figure 9 gives

$$H = 5 \log_{10} V - 1.0'$$

Where: H: the depth of the surface layer (m)

V: wind velocity (m/sec)

5) The effect of wind on the stratified test basin

In April, 1965 the fresh water was poured on the surface of the test basin and the salt water was sucked out of the bottom to create the fresh water layer of 3.5m depth on the salt water layer below. Then, the mixing of the stratified fluids was observed continuously until November. From field measurements, Kishi and Miyake analyzed the mixing process of the salt and fresh water observed in the test basin. During the observations remarkable changes in the elevations of the salinicline and the thermocline were observed, as shown in figures 7 and 8.

From measurements, the relationship between the depth of the surface layer and the wind velocity were obtained as shown in figure 9.

6) Exchange of fresh and salt water

When the test basin consisted of two layers of different density, the experiments have shown that pumping from the lower layer water could be carried out without disturbing upper layer water.

That is to say, it is possible to exchange salt for fresh water and it is easy to maintain the seaside reservoir after dam completed.

7) Gates

The gates are one of the seaside reservoir's most important accessory structures. The intrusion of sea water through the gates can be prevented by operations and structures. Yokota reported to the S.R.D.C. that the bubbling on the front of the gates are very effective as a positive prevention method of sea water.

V. References

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DEVELOPPEMENT D'UN RESERVOIR LITTORAL – RECHERCHES SUR UN MODELE

Résumé

Depuis quelques années, la demande d'eau à usage industriel augmente rapidement au Japon. Cependant, la plupart des rivières dont les ressources hydrauliques sont exploitables sont déjà utilisées à l'extrême pour l'irrigation et d'autres usages. Pour fournir d'autres eaux à l'industrie, il est donc nécessaire de prendre des mesures, consistant par exemple à retenir l'eau des crues ainsi que les excédents disponibles au cours des saisons où l'on ne procède pas à l'irrigation, en créant un réservoir dans le cours supérieur des rivières.

Toutefois, dans certains districts, il n'est pas possible de disposer d'eau en quantité suffisante à des fins industrielles et autres, même en construisant des digues sur tous les emplacements convenables. En fait, les droits existants à l'utilisation de l'eau s'y opposent fréquemment, et il est donc nécessaire de créer des moyens d'irrigation. Même dans ces conditions, il devient de plus en plus difficile de trouver des sites qui conviennent, du point de vue économique, à la construction de digues.

Dans ces conditions, il est apparu souhaitable d'essayer de construire un réservoir d'eau douce dans la mer ou près de l'estuaire d'une rivière. Ce plan comprend la construction d'un barrage de retenue, pris sur la mer, et le dragage de la zone ainsi enclose. La création d'un réservoir de ce type nouveau pose évidemment de nombreux problèmes; en particulier, la pollution par l'eau de mer est une question très importante et très grave à l'égard d'un réservoir d'eau douce situé sur le littoral.

En revanche, ce réservoir présente de nombreux avantages.

1) Il est exempt des difficultés relatives aux droits existants en matière d'utilisation des eaux.

2) Il peut emmagasiner l'excédent d'eau de rivière, une fois satisfaits les besoins agricoles et autres; il peut être construit sur une aussi grande échelle que possible, l'étendue de la mer étant infinie, et permet de diminuer le coût des travaux nécessaires à l'adduction des eaux, les usines étant situées à proximité du réservoir.

3) Ce grand réservoir pourra être utilisé à des fins touristiques et il sera favorable au bien-être du public en formant une zone tampon entre les zones industrielles et les zones résidentielles.

Toutefois, jusqu'à présent, il n'y a pas eu d'exemple qu'un réservoir littoral de ce genre ait été construit au Japon pour retenir l'eau à usage industriel. Le Comité de développement du réservoir du littoral (SRDC) a été créé par l'Association d'hydraulique industrielle du Japon. Ce Comité est constitué de professeurs des universités, de chercheurs et de savants, de fonctionnaires du Ministère du Commerce et de l'Industrie, et de fonctionnaires de la préfecture intéressée.

Le SRDC a entrepris des recherches sur la construction de réservoirs littoraux, procédant à des études et à des essais in-situ des phénomènes d'infiltration et de dispersion des eaux salines, utilisant à cette fin d'importants modèles à grande échelle montés sur le terrain.

Les résultats provisoires des études de laboratoires et des essais effectués sur les lieux ont permis de constater que les nouveaux types de palplanche et une méthode de rechargement du chenal étaient très efficaces pour l'imperméabilisation de la digue. Lorsque la valeur du coefficient de dispersion de la salinité est de 1×10^{-4} (cm^2/S) on peut obtenir une eau à utilisation industrielle ayant un degré de salinité acceptable, sans méthode spéciale de protection, pendant deux ans environ. Le SRDC procède actuellement à l'étude de nombreux problèmes relatifs aux réservoirs littoraux.

DESARROLLO DE UN DEPOSITO LITORAL
- INVESTIGACION MODELO -

Resumen

En el Japón la demanda de agua para la industria está aumentando rápidamente en la época actual. Sin embargo, la mayoría de los ríos que pueden usarse como recursos de agua ya se han utilizado en una medida extremada para el riego y otros usos. Por lo tanto, para obtener agua adicional para la industria, es necesario adoptar medidas tales como la retención de agua de las crecidas y del excedente disponible en las estaciones en que no se riega, mediante la creación de un depósito en las cabeceras de los ríos.

En algunos distritos, sin embargo, no hay suficiente cantidad de agua para la industria y otros propósitos ni siquiera mediante el uso de represas construídas en todos los lugares posibles. En rigor de la verdad, frecuentemente hay casos de interferencia ocasionados por los derechos del agua existentes y, por lo tanto, es necesario establecer instalaciones para el riego. Además, se hace cada vez más difícil encontrar lugares económicamente favorables para la construcción de represas.

En tal estado de cosas, es sumamente aconsejable intentar la construcción de un depósito de agua dulce en el mar o próximo al estuario de un río. Este plan incluye la construcción de un vertedero de entrada, cercamiento de un área del mar, y dragado del área cercada. Por supuesto, en la construcción de un tipo tan nuevo de depósito, surgirían muchos problemas, pero la contaminación por agua de mar sería uno de los problemas más importantes y serios de un depósito litoral de agua dulce.

Por otra parte, este depósito ofrece diversas ventajas.

1) Está exento de los inconvenientes relacionados con otros derechos de agua.

2) Puede almacenar el excedente de agua de río no utilizada para la agricultura u otros fines; puede construirse en una escala tan grande como sea posible dada la amplitud del mar, y puede ahorrar el costo de la construcción de obras para el abastecimiento de agua porque las fábricas están situadas en la vecindad del depósito.

3) El gran depósito puede utilizarse como centro de esparcimiento y será de utilidad para prevenir las molestias públicas al formar una zona de neutralización entre la sección industrial y la residencial.

Hasta el momento, sin embargo, no hay ningún ejemplo de depósitos litorales construídos para el almacenamiento de agua para uso industrial en el Japón. La Comisión de Desarrollo de Depósitos Litorales (C.D.D.L.) fue organizada por la Asociación del Agua para la Industria del Japón. La Comisión está compuesta por profesores universitarios, hombres de conocimientos y experiencia, funcionarios del Ministerio del Comercio y la Industria, y funcionarios del Gobierno de la Prefectura.

La C.D.D.L. ha emprendido investigaciones para la construcción de depósitos litorales, realizando estudios y pruebas <u>in-situ</u> sobre los fenómenos de la infiltración y la dispersión de agua salina con un número considerable de modelos en gran escala equipados sobre el terreno.

En los resultados intermedios del laboratorio y de las pruebas sobre el terreno, se encontró que los nuevos tipos de tablestaca y un método de recarga de canal resultaban muy eficaces para la impermeabilización del malecón. Cuando el valor del coeficiente de dispersión de salinidad es 1×10^{-4} (cm^2/ S), la salinidad permisible del agua industrial puede asegurarse aproximadamente por dos años sin necesidad de un método especial de prevención. La C.D.D.L. actualmente está estudiando muchos problemas relacionados con la construcción de depósitos litorales.

WATER FOR SAIGON, VIET NAM

Walter T. McPhee, Nguyen Huu Tuan

The water supply system for Saigon, South Viet Nam, presented a distinct challenge for the designing engineers because of the lack of information on which to design the system, and because of the political turmoil which arose during the construction stage. Nonetheless, the project has been substantially completed, and the populace is enjoying good potable water.

HISTORY OF SAIGON

At the time of the French occupation in 1862, Saigon was a marshy area adjacent to the bustling Chinese trading center of Cholon. The French converted the marsh into a European-type city, the "Paris of the East," while Cholon remained a congested marketing center. Today, Saigon and Cholon are truly twin cities known as Saigon; references to Saigon in this article refer to the twin cities, Saigon-Cholon.

The pre-World War II population of Saigon is estimated at 450,000. In 1954, following five years of World War II and some eight years of civil strife, Viet Nam was partitioned by an agreement in Geneva, and Saigon became the capital of South Viet Nam.

Refugees from the north swelled the population. The water system was soon too small to serve this increased number of people. Water service had been continuously improved to meet the demands of a fairly small and uniform growth in population, but when masses of refugees moved in, it was just impossible to expand the service fast enough.

The South Viet Nam mission of the International Cooperation Administration (ICA), forerunner of the present Agency of International Development (AID), was concerned with the severe shortage of water so they retained Hydrotechnic Corporation of New York in 1958 to prepare a feasibility report on the problem. Two problems Hydrotechnic faced were to determine the population of Saigon and to determine the per capita usage of water.

POPULATION

Fortunately, ICA, in preparing to take a census, had drawn up a demographic map of the city. This showed the predominant nature of each area -- high-class residential, commercial, middle-class workers' dwellings, and rural. On-the-spot checks revealed the number of persons per unit area, and as the net area of each section could be obtained from the map, a population of some 1,600,000 persons in Saigon proper, and 200,000 more in adjacent areas, was estimated. This figure checked very closely with census figures obtained in 1960. Not only were the total figures obtained, it was also possible to isolate the number of persons in each economic category and the areas in which they lived.

WATER CONSUMPTION

Saigon, in 1958, was supplied with water from a system of thirty-six or more deep-drilled wells and three shallow, dug-well systems. The amount of water available varied with the wet and ıry seasons, and as was evident from chronic shortages in many parts of the city, the supply was ıever adequate to meet the demand.

In 1957, about 11,000 metered services were in use for the high and medium-class residential ,reas, and for the commercial zones. Industrial use of municipal water was relatively light. It was ısed chiefly by beverage manufacturers and ice plants. Many industries had their own wells.

The poorer sections of the city are served by public "fountains." Theoretically, these disıense water only when the control is operated, but the Saigonese women appear to be born mechan-.cs; a tamper-proof valve has yet to be invented. From these fountains, shaped like a hydrant and ısually with a one-inch spout, water is carried to the home in a pair of 20-liter (44-lb) containers suspended over one shoulder on a flexible bamboo slat.

The problem then was to estimate how much water would be required daily by the metered services and the fountain users, plus allowances for fire service, irrigation, various public works, and for the future.

In 1957, water use in Saigon was estimated as follows:

	m^3d	Mgd	Percent
Domestic:			
Private meters	60,000	15.8	39
Public fountains	42,400	11.2	26
Administration and military	25,900	6.8	16
Industrial	5,600	1.5	4
Losses	24,000	6.3	15
Totals	158,800	41.6	100

To predict future requirements, a map was divided into twelve districts for the city, plus two for suburban areas. Each district, as far as practicable, included one type of economic category. Each area was analyzed according to the existing and projected use of meters and public fountains. A figure of 40 liters per capita per day (11 gpcd) was used in the areas served by fountains because of the physical limitations in carrying more water. In the metered districts, a figure of 350 liters per capita per day (93 gpcd) was used, based on past records and expectation of increased demand when water was available. Thus, the average daily demand was expected to be some 280,000 m^3 (73 mgd) when the new system was placed in operation, as opposed to a daily use of less than 159,000 m^3 (42 mgd) with the old system.

Once the existing demand had been established, the water demand had to be projected into the future. There was no reliable growth factor for population as the country had had eight years of unnatural conditions. After consideration of what might be expected for population growth and of increased water usage as the people became accustomed to a reliable supply, the average daily demand in 1980 was estimated at 400,000 cubic meters per day (m^3/d), with the demand for the maximum day reaching 480,000 m^3/d. These were the design figures for the new water supply system.

Fire demand was negligible as most structures are made of stone. It was found that tin roofs on straw huts prevented fires in these highly-flammable homes. There was an average of one minor fire a day.

Once the design figure had been established, it was necessary to select a source of the water. Two possibilities were open -- a surface supply or wells.

GROUND WATER STUDY

Deep wells, which constituted the mainstay of the old system, had an average life of about ten years. Many had to be cleaned and rehabilitated within five years. Excessive iron in the water, up to 75 mg per liter in one case, and high acidity make the water very unattractive and cause high maintenance costs for the wells and distribution system.

The auxiliary shallow well supplies were unusual. Each consisted of some twelve dug wells surrounding a central pumping station, from which the water was drawn through a network of siphon pipes connected to the central station. A vacuum system made the withdrawal possible.

In the original study of the supply source for the long-term requirements of Saigon, serious consideration was given to reliance upon ground water alone. A separate well water collection system and expensive iron removal units would be needed if wells were used. Salt water intrusion had already affected some wells in Cholon and further large-scale well development could accelerate the salt problem. Also, the dependable yield of the ground water in the area was insufficient for the future demand of 400,000 m^3/d.

An expanded ground water development would have required a large number of new wells spread over a vast area north of the city. This is Saigon's most important truck garden region, and intensive abstraction by such wells would dry up the shallow wells on which the farmers depend. This would aggravate the economic and social problems which the country is faced with already. For these reasons, it was evident that wells would not be a suitable source of potable water for the long-term demands of the metropolitan area, and it was decided to use a surface water source.

To take care of increased demand during the years required for the construction of the new surface water system, an interim improvement program was carried out. Five new wells were installed and many existing wells and pump houses were rehabilitated. Also, because of the heavy buildup of iron oxides on the walls of the old cast iron distribution pipes, the pipes in the existing distribution network were systematically examined and cleaned. This restored their initial hydraulic capacity and brought up the pressures, which in many areas had dropped below one atmosphere.

SURFACE WATER SOURCE

Saigon is about 50 km (31 miles) from the South China Sea, on the west bank of the Saigon River. The river could not be used as a water source because it is badly polluted and has a high salt content during certain seasons of the year. It is not economically feasible to construct a salt-water barrier as there is considerable small-boat traffic, and the river banks are much too low. The safe yield, at a point where salinity is not a problem, is too low to furnish enough water for the Saigon Metropolitan Area.

For the water source, it was necessary to go to the Dong Nai River, 22 km (14 miles) from Saigon. The raw water intake is located near the town of Bien Hoa. This water has been treated successfully at the water works there for many years. At Bien Hoa, the Dong Nai has a watershed of 23,000 sq km and a minimum dry-season flow of 200 m^3 per sec (7,063 cfs). This is quite sufficient to supply Saigon with the maximum expected demand of 6 m^3 per sec (212 cfs).

The water supply system consists of a pumping station at the river, a raw water transmission line, a treatment plant with some storage of treated water, a treated water transmission line, and the distribution system and elevated storage in the Saigon area. Nominal system capacity is 480,000 m^3 per day (127 mgd).

ECONOMICS OF THE SYSTEM

Like most engineering projects, there was no question that it could be built; the question was, "Who is going to pay for it?" The answer to this is as important as the engineering details.

This was a major undertaking, and it was clear that money would have to be borrowed to finance it. Presumably, the money could be borrowed by the National Government, the Province, the City, or by some autonomous body set up to run the water system and be responsible solely for rates, income, expenditures, loan repayment, etc. The last-named meets with much favor by lending institutions because it inspires confidence that the investors will be repaid with a minimum of political interference.

The initial step is to develop the first costs of the system in the feasibility study. A source of funds, either from within or without the country, must be found to lend the money on the same basis as any business loan, with schedules of interest and amortization. The feasibility study ot only develops the first cost, but considers financing during the construction period and operat-ıg, maintenance, and improvement costs during the loan period. All this discussion finally winds n with a figure representing the minimum annual income required from the system. Unless the sys-.m is subsidized by a governmental agency, and this was not considered in Saigon, receipts from onsumers must pay this annual cost.

In 1957, there were only 11,000 metered connections. Of the roughly 160,000 cubic meters f water furnished daily, some 60,000 cubic meters were sold. This is less than 40 percent. It 'as obvious that metered connections had to be increased during the construction period so the ercentage of water sold would also increase, or the project would be in jeopardy. There was a arge demand for meters, especially from lower income families who could afford to pay for water, ut who could not pay the required large initial lump-sum charge to install the meter.

After considering the existing but unfilled applications for meters, and the estimated number of additional meters that would be installed if the process was made less expensive, a water rate of 6 piastres per cubic meter was set for the construction period. This rate provided sufficient in-come to make the project feasible, and it was believed the rate could be reduced after the new sup-ply system was placed in operation. Depending on what exchange rate is used, the water rate is bout 25¢ per 1000 gallons.

The total cost of the Saigon water supply improvements was estimated at 27 million dollars, of which 17.5 million was in hard currency, and the remainder in local money. The Development Loan Fund was approached for funds and after study of the feasibility report, DLF agreed to lend the hard currency for repayment at 3 1/2 percent interest over twenty years. They required that an utonomous agency be set up to operate the water system, and that the rate structure be such that the loan could be repaid.

When the loan was negotiated, the Vietnamese government organized the Saigon Metropolitan Water Office (SMWO) under the Ministry of Public Works. The Office was concerned solely with water supplies in the Metropolitan Saigon Area, and not with any other systems in the country.

DESIGN OF THE SYSTEM

The SMWO retained Hydrotechnic Corporation to design, supervise construction, and to train local personnel in operation and maintenance of the completed facilities.

The system consists of an intake and pumping station on the Dong Nai River, a 72-inch diam-eter raw water transmission line to the treatment plant, a water treatment plant including a clear water reservoir and pumping station all located on a high point near Thu Duc, a 78-inch treated wa-ter line from the treatment plant to the edge of Saigon, about 25 km of 24-inch to 36-inch concrete main feeders within the City, 20 km of 12-inch to 20-inch cast iron pipe (CIP), 25 km of 6-inch to 10-inch CIP, and eight elevated storage tanks ranging from 500,000 gallons to two million gallons capacity. The project covered all aspects of water supply from minor distribution piping to a treat-ment plant complex. Nominal system capacity is 480,000 m^3/day (127 mgd).

Under the provisions of the loan agreement, world-wide bidding, except for Iron Curtain countries, was permitted. All design, however, had to be according to American standards. World-wide bidding meant that the plans and specifications, and the construction contracts, had to be flexible enough to cover equipment and methods from many countries.

Each section of the project differed in complexity and in the time it would take to complete. The construction contracts had to be written and let so each contract would be completed at the same time, so far as was possible. A modified Critical Path analysis was made and based on this, it was concluded that the manufacture and installation of the 72-inch and 78-inch transmission lines would take the longest time, followed by the construction of the intake and treatment facili-ties. First priority was given to getting water to Saigon; there was an existing distribution system that needed rehabilitation and reinforcing, but there wasn't adequate water to distribute.

Work was divided into the following steps:

A. Plans and specifications for the interim well system and some distribution piping.

B. Procurement of C.I. pipe and fittings for the distribution system.

C. Manufacture and installation of large diameter concrete transmission and distribution piping.

D. Construction of the intake and raw water pumping station and the treatment plant including clear water reservoirs and treated water pumping station.

E. Installation of the C.I. pipe and the large diameter concrete distribution piping.

F. Construction of elevated storage for the distribution system.

Cast iron pipe was used for diameters up to 24 inches, concrete pipe for pipe 24 inches and larger. The prestressed concrete pipe was manufactured in Viet Nam. An economic study of pipe costs proved that cast iron pipe was cheapest in the smaller diameters.

Local contractors could handle the smaller projects, such as the installation of the C.I. pipe and some of the smaller diameter concrete pipe. Out-of-country contractors had to do the major, large contract jobs. As there was some political turmoil in the country when bids were invited, the contracts were written with terms that would be more than ordinarily attractive. Financial assistance was offered at the onset of the work to help contractors obtain equipment and set up their plant. This meant the contractor had a minimum of his own money invested. Dollar payments were guaranteed by the DLF through the Water Office, and cost escalation on certain items was included. There was also a clause protecting the contractors against devaluation of the currency.

A revolving fund of local money was established so contractors could purchase local material and labor. At the end of each month, all costs were tabulated in U. S. dollars. Funds from the revolving piastre account were converted to dollars at an agreed-on rate. The difference between the total costs less the amount retained under the terms of the contract and the money advanced to the contractor was paid to the contractor in dollars through the Chase Manhattan Bank of New York. All contracts were of the unit price, lump-sum type, none were cost plus. Contractors were required to give regular estimates of their dollar and piastre requirements.

The Saigon Metropolitan Water Office obtained bids well within the engineer's estimates. Virtually all the loan money has been expended at this time. There was some increase in costs because of escalation and war impact, but this amounted to less than 15 percent of the contract price.

There was one major problem during construction as crushed stone aggregate became in short supply because of the war impact. Other than that, there were only delays because of shipping and crowded port conditions. The original date for completion was September, 1964, and the plant was actually completed in June, 1966.

WATER SYSTEM OPERATION

This is the first large water supply facility in Viet Nam, so local personnel were not available to operate and maintain it. Men could have been trained in either of two ways: bring them to the United States for training on similar type installations, or bring a crew of U. S. experts to Viet Nam to start up the new facilities and train their Vietnamese counterparts. The latter scheme was selected as the most practical.

Hydrotechnic recruited and sent to Saigon eleven men with a wide range of water supply experience, from operation to maintenance and chemistry. They had from six months to a year to organize and conduct instructional classes for Vietnamese personnel, prepare and conduct on-the-job training programs, initially operate and maintain the facilities, and prepare operating manuals.

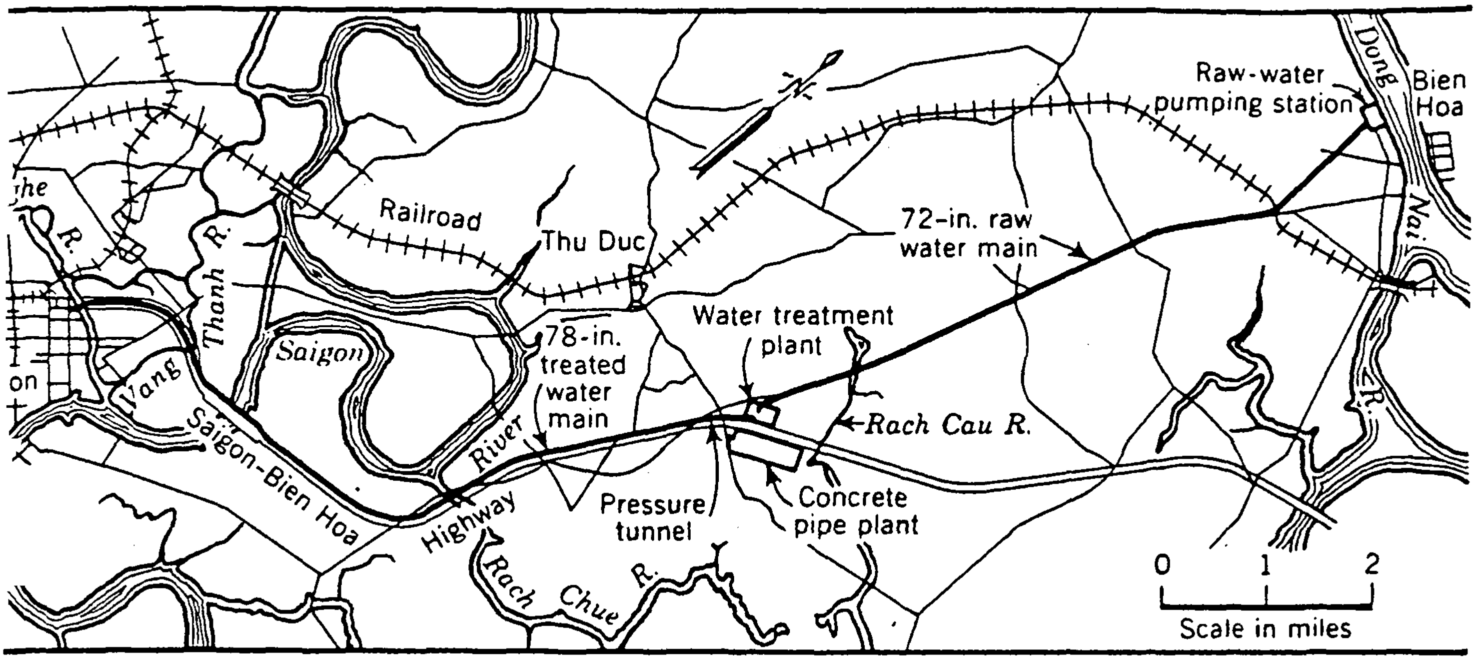

Figure 1. Plan of Saigon Water Supply System.

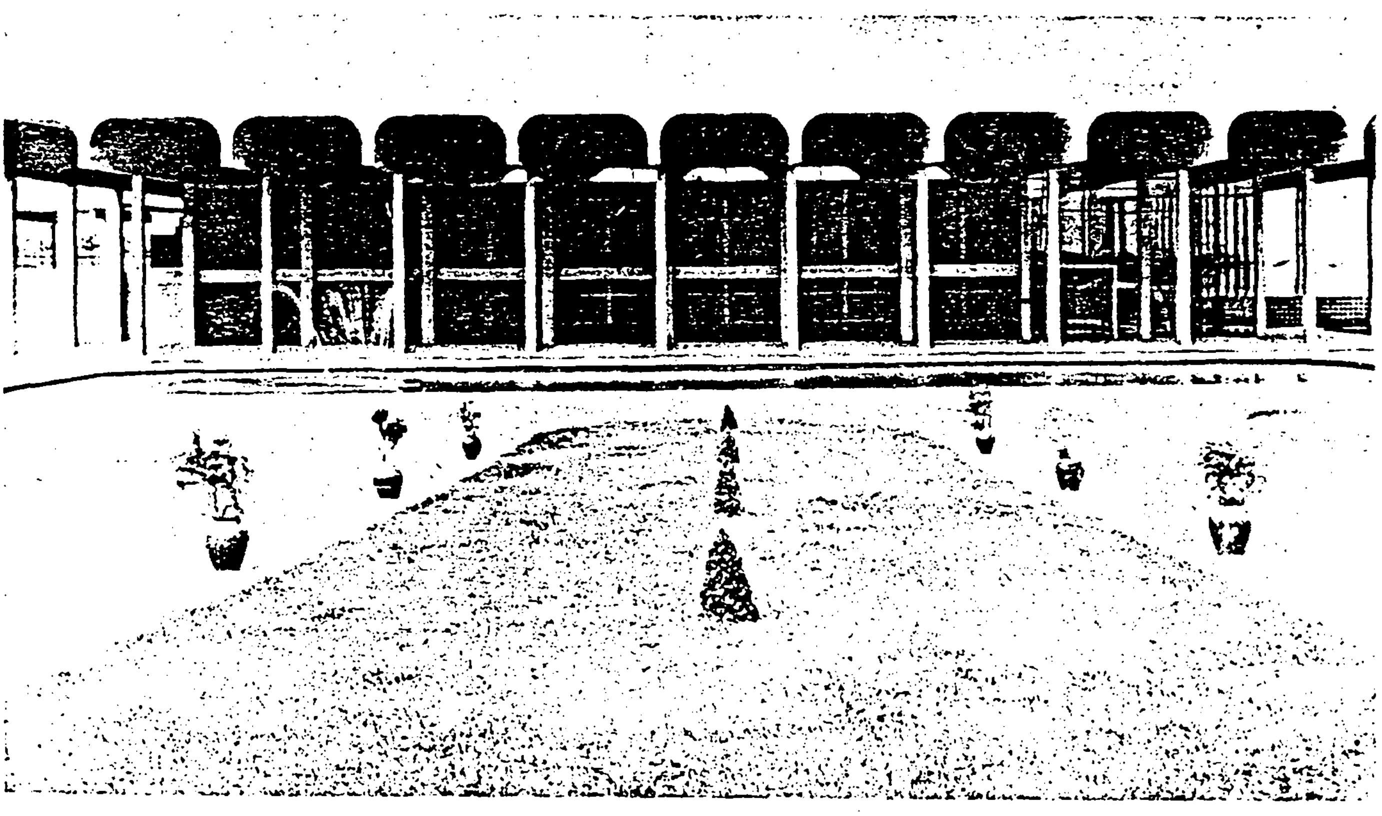

Figure 2. Front view of main building at treatment plant.

The training went smoothly and at this time, the Vietnamese have taken over all operation and maintenance.

CONCLUSION

This story illustrates, I believe, that a water supply facility can be constructed despite formidable problems. For the feasibility report, the engineers had almost literally to go out and count heads. Construction was delayed by political turmoil. But today the people in the Saigon Metropolitan Area have good potable water and will have it for many years.

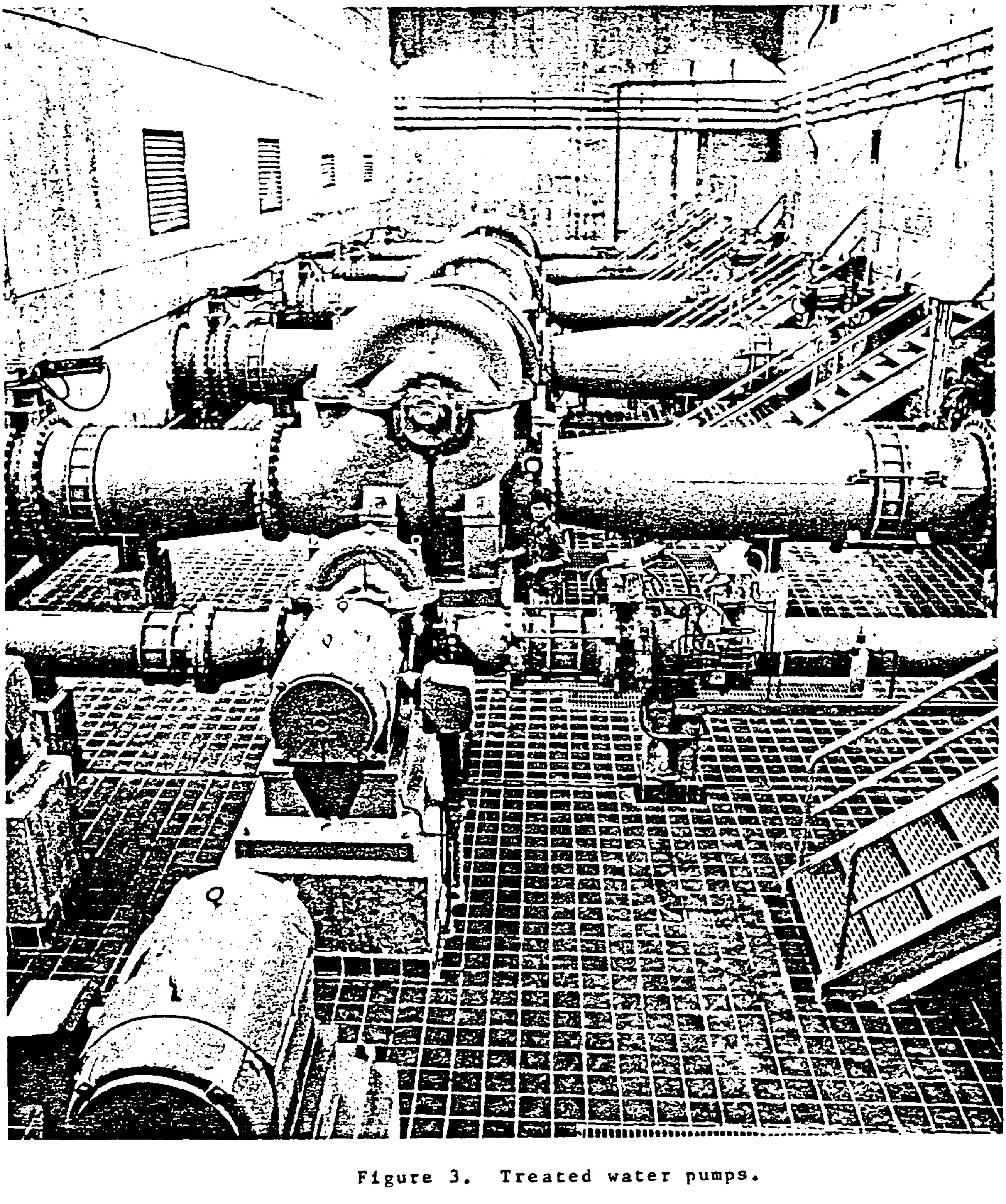

Figure 3. Treated water pumps.

APPROVISIONNEMENT EN EAU DE SAIGON (VIET-NAM)

Résumé

Historique

Ce projet d'adduction d'eau est l'un des projets à long terme dont le Viet-nam a entrepris la réalisation avec l'aide du Gouvernement des Etats-Unis, et n'est pas en relation directe avec l'effort militaire dirigé contre le Viet-cong. Il remplace un système de puits périmé et insuffisant qui desservait les deux villes jumelles de Saigon et de Cholon.

Lorsque les Français débarquèrent en 1862, la région de Saigon n'était qu'un marécage situé à côté de la ville chinoise de Cholon, centre commercial grouillant d'activité. Les Français transformèrent ces marais en une ville du type européen. Aujourd'hui, ces deux villes n'en font qu'une seule, dont la population atteint presque 2.500.000 habitants.

Planification

La Société hydrotechnique se trouvait en présence de multiples problèmes lorsqu'elle entreprit en 1957-1958 le recueil de données en vue de l'établissement d'un rapport sur les possibilités techniques de réalisation du projet. Le chiffre exact de la population de la zone à desservir était inconnu, de même que la demande en eau par tête d'habitant, puisqu'il y avait pénurie d'eau continuelle et que la possibilité de vendre l'eau pour assurer le financement du nouveau système était également inconnue. Le rendement normal des ressources hydrauliques souterraines était inconnu, de même que les possibilités de ravitaillement au moyen des eaux de surface existant à une distance raisonnable de la ville.

En 1958, il existait 11.000 points d'eau munis de compteurs, et ce système desservait environ 1.600.000 personnes.

Le projet

Au mois de novembre 1958, la Société hydrotechnique, sous les auspices de l'Administration de Coopération Internationale du Département d'Etat des Etats-Unis et du Ministère vietnamien des Travaux publics, établit un rapport sur la possibilité, du point de vue technique, de réaliser ce projet. Ce rapport recommandait qu'un système d'approvisionnement en eaux de surface soit réalisé pour l'ensemble de cette zone. Initialement, la capacité du réseau de distribution devait être de 480.000 mètres cubes par jour. Le rapport indiquait que ce système pourrait être financé par la vente de l'eau, à condition de mettre également en oeuvre un plan d'augmentation du nombre de points d'eau munis de compteurs. Le coût estimatif de la réalisation de ce nouveau réseau de distribution et du renforcement du système existant de distribution était de 26.000.000 de dollars.

Le projet prévoyait l'extraction de l'eau de le rivière Dong Nai, en un point situé à 25 kilomètres environ au nord-ouest de Saigon. La capacité de la prise d'eau et de la station de pompage était prévue pour permettre l'installation de six pompes d'un débit de 85.000 mètres cubes par jour. L'eau brute était acheminée par un pipe-line de 1,80 m à une station de traitement située sur une hauteur, à 10 kilomètres de Saigon. Une station moderne de traitement par coagulation chimique, flocculation, sédimentation et filtration rapide sur sable, fut construite sur cette hauteur, ainsi que des réservoirs pouvant contenir 150.000 mètres cubes et une station de pompage pour l'eau traitée. Cette eau était ensuite acheminée sur Saigon par un pipe-line de 2 mètres.

Programme des travaux

En raison de l'ampleur du projet, il était évident que certaines parties devraient faire l'objet d'appels d'offres dans le monde entier, tandis que d'autres pourraient être exécutées uniquement sur appels d'offres locaux.

Le projet fut subdivisé en une opération d'achats et plusieurs marchés de construction dans les conditions suivantes:

1. Achat de tubes de fonte, de raccords et de clapets (appels d'offres internationaux);

2. Fabrication et pose des pipe-lines de 1,80 m et de 2 m (appels d'offres internationaux);

3. Fabrication d'une canalisation de distribution en béton de grand diamètre (appels d'offres internationaux);

4. Pose de la canalisation en fonte, etc. (appels d'offres locaux);

5. Pose de la canalisation de béton (appels d'offres locaux);

6. Construction du dispositif de captage et de la station de traitement des eaux (appels d'offres internationaux);

7. Construction des réservoirs de stockage et de distribution en béton précontraint (appels d'offres internationaux).

Les études techniques du projet furent entreprises en mai 1961, et l'achèvement des travaux était prévu pour 1964. En raison de retards résultant des opérations militaires, le projet fut achevé pour une large part en juin 1966.

Formation du personnel d'exploitation

Un marché fut conclu avec la Société hydrotechnique en mars 1966 pour l'entretien et l'exploitation du système, et pour la formation de personnel d'entretien et d'exploitation, pour une période d'un an.

D'ordinaire le client, qui est généralement une municipalité ou une entreprise industrielle, dispose de personnel qualifié prêt et tout disposé à prendre en charge et à faire fonctionner une nouvelle installation. Le Service des eaux de la ville de Saigon n'était pas en mesure de le faire, et fut donc obligé de peser les mérites de deux solutions possibles pour faire face à ce manque de personnel.

La première solution consistait à choisir du personnel, et à l'envoyer en stage aux Etats-Unis dans une installation semblable. La deuxième formule consistait à envoyer à Saigon une équipe d'experts. C'est cette formule qui fut choisie.

Conclusion

Il est possible de construire un réseau complet et important d'adduction d'eau dans des conditions difficiles, en utilisant des matériaux et des entreprises de plusieurs pays. La planification pose des problèmes dans certains domaines en raison du manque de renseignements, mais il est possible de préparer et de financer un projet si toutes les parties intéressées déploient toutes ensemble les efforts nécessaires.

AGUA PARA SAIGON, VIETNAM

Resumen

. Antecedentes

Este sistema de abastecimiento de agua es uno de las pocas obras de largo lcance emprendidas en Vietnam con ayuda del Gobierno de los Estados Unidos y ue no están vinculadas directamente con la campaña militar contra el Vietcong. iene a reemplazar a un sistema anticuado e insuficiente de pozos que abastecía las ciudades gemelas de Saigón y Cholón.

Cuando se inició en 1862 la ocupación francesa, la zona de Saigón era un antano vecino al activo centro comercial chino de Cholón. Las autoridades fran-esas convirtieron aquel pantano en una ciudad de tipo europeo y hoy forman entre mbas una sola unidad urbana de cerca de dos millones y medio de habitantes.

. Planificación

Se presentaron muchos problemas a la Hydrotechnic Corporation cuando inició a reunión de datos para preparar un estudio técnico de viabilidad en 1957-1958. lo se conocía el total exacto de la población de la zona, la demanda de agua per apita -- dado que se sufría en forma permanente escasez de ella -- ni las posi-bilidades de obtener pago por el agua suministrada, a fin de financiar el nuevo sistema. También se ignoraban el rendimiento cierto de las fuentes de agua sub-terránea y el grado en que podía obtenerse agua de superficie dentro de una dis-tancia razonable de la ciudad.

En 1958 había 11.000 medidores de agua instalados y la red abastecía más o menos a 1.600.000 personas.

C. El Proyecto

En noviembre de 1958 la empresa preparó un informe técnico de viabilidad, ba-jo los auspicios de la Administración de Cooperación Internacional, dependiente del Departamento de Estado de los Estados Unidos, y del Ministerio de Obras Públi-cas de Vietnam. En él se recomendaba la explotación de las aguas de superficie para abastecer a toda la zona, con una capacidad inicial de 480.000 m^3 diarios, que podría financiarse con el pago del servicio siempre que se ejecutara también un plan para aumentar el número de medidores. Se calculaba que el costo de uti-lización de la nueva fuente de abastecimiento y la ampliación de la red distri-buidora existente sería de 26 millones de dólares.

En el proyecto se preveía la extracción de agua del río Dong Nai en un punto situado aproximadamente a 25 kilómetros al Noreste de Saigón. La toma de agua en estado natural y la estación de bombeo fueron proyectadas para seis bombas de 85.000 m^3 diarios. El agua sería enviada por una tubería de 1,8 metros de diáme-tro a una central de tratamiento situada en terreno alto, a 10 kilómetros de Saigón. En dicho lugar se construyeron una central moderna de tratamiento para la coagulación, la floculación, la sedimentación y la filtración rápida con arena, embalses para almacenar el agua tratada y una estación de bombeo de ésta, que se envía a la zona de Saigón por una tubería de 2 metros de diámetro.

D. Fases de la Construcción

Dada la magnitud de la obra, era evidente que si bien algunas partes de ella podrían ejecutarse llamando a licitación en el país, para otras sería pre-ciso invitar a que fueran presentadas licitaciones de todas partes del mundo.

La obra fue subdividida en una operación de compra de materiales y varios contratos, como sigue:

1. Compra de tuberías de hierro fundido, juntas y válvulas (licitación mundial);

2. Fabricación e instalación de tuberías de 1,8 y 2 metros (licitación mundial);

3. Fabricación de tuberías de hormigón de gran diámetro para la distribución (licitación mundial);

4. Instalación de las tuberías de hierro fundido (licitación en el país);

5. Instalación de la tubería de hormigón (licitación en el país);

6. Construcción del sistema de toma y tratamiento del agua (licitación mundial);

7. Construcción de tanques de depósito para la distribución, de hormigón precomprimido (licitación mundial).

Los trabajos de ingeniería fueron iniciados en mayo de 1961 y la construcción debía quedar terminada en 1964. Debido a demoras causadas por la campaña militar, los trabajos quedaron prácticamente concluidos en junio de 1966.

E. Formación de Personal

En marzo de 1966 se firmó con Hydrotechnic un contrato por el término de un año sobre mantenimiento y funcionamiento, y formación de personal para ambas operaciones.

Por lo común, el cliente, generalmente una municipalidad o una empresa industrial, tiene personal capacitado pronto y deseoso de tomar a su cargo las nuevas instalaciones y hacerlas funcionar. La Oficina Metropolitana de Agua de Saigón no estaba en condiciones de hacerlo y por lo tanto la alternativa que se le presentaba era la de enviar a los Estados Unidos cierto número de empleados seleccionados para adquirir formación en el empleo, o bien llevar a Saigón un grupo de expertos. La última solución fue la adoptada.

F. Conclusiones

Es posible construir un sistema amplio y completo de abastecimiento de agua, bajo condiciones difíciles, si se emplean materiales y contratistas de varios países. La planificación plantea un problema en algunas zonas por la falta de datos técnicos, pero hay la posibilidad de proyectar y financiar una obra de ese carácter si todas las partes que intervienen en la tarea colaboran de manera eficaz.

COMMON SENSE DESIGNS FOR RURAL WATER SYSTEMS

Cecil W. Rose

The need for good quality drinking water is unchallenged.

The World Health Organization estimates that 13,000 babies die each day as a result of the use of polluted water.

This is an appalling loss.

Of even greater importance is the loss of creativity by those people who are continually sick as a result of the use of polluted water. A person continually ill because of some waterborne disease cannot work effectively when his stomach is racked with pain. His thoughts seldom go beyond his immediate needs of an adequate, pure water supply. Because there are millions of people who are sick due to a lack of pure water, the economic and social development of a country may, undoubtedly, be retarded, and the peace and prosperity of the world threatened.

The magnitude of the problem is overwhelming. From a cursory observation, it might be concluded that the worldwide water emergency in rural areas could only be solved by massive infusions of capital from highly developed nations. The pragmatic idealist recognizes, however, that capital alone is not the answer.

Technical direction from the providing nation and the willingness of recipient nations to accept change are integral ingredients to a solution.

In the United States, there are many thousands of small rural communities which do not have an adequate or a safe supply of water. For over five years the U. S. Department of Agriculture, through the Farmers Home Administration, has made loans and provided engineering and other technical assistance to help rural communities develop safe and adequate water supplies.

Let's look at some of the symptoms of a rural community without an adequate water supply. Often the income of families of the communities is low. The distance between homes is usually great. There may be rock in the pipeline trenches or water development costs are high.

In the Farmers Home Administration, each problem was approached with the philosophy that solutions existed, that it was only necessary to find these solutions. The aim was to make projects economically feasible. Our experience has led to the development of some design criteria which we believe should be adaptable to rural areas in many parts of the world. Before delving into the design of these water systems, let me share with you some of our observations, gleaned out of the experience of financing and constructing more than 2,000 successful rural water systems.

For the development of successful projects, the full support of the entire community should be enlisted from the outset. The community leaders should be led to understand early in the planning stage that if successful projects are to result most of the effort must originate with them. Too frequently those of us who work with depressed rural communities conclude that these poorly educated rural people lack the required engineering and management skills to arrive at the required decisions regarding the construction and operation of their water system. We have learned these rural people can perform the required tasks if the various alternatives are carefully explained. With sympathetic guidance, community leaders can make the correct choices, motivate the other people and continue to provide the necessary leadership that is the key ingredient of a successful rural water system.

From our experience, we have found that projects will not be adequately maintained or the loans repaid unless leaders of the community are made to believe that the new system is their pet project and that its success should be one of their prime goals as community leaders.

We have also found that the leadership should be selected by the rural people. In this way, full support of the people to be served by the system is obtained.

All major decisions should be left up to local community leaders, including such concerns as the size of the community to be served. Far too often, the technician, unfamiliar with local conditions, determines that for best results a very large system serving several rural communities will be most efficient. This is not necessarily true. The most desirable and efficiently operated water system may serve only a few rural families or a few hundred families or a few thousand families. Our records do not show that the larger, more complex systems are consistently less costly initially or that they can be operated and maintained at a lower per capita cost. We believe it is a fundamental error to force two or more communities with divergent points of view to cooperate if they do not choose voluntarily to do so. The size and scope of the community water system should be left to the local communities. Bigness in the case of a water system does not necessarily mean that there will be greater efficiency of operation or lower initial cost.

In my country, many water systems have been feasibly financed to serve rural families where the average distance between homes is more than a quarter of a mile. These principles of design, we feel, can be satisfactorily utilized to develop water systems in many parts of the world where the families could be expected to pay less than one dollar a month for water.

There is no engineering design technique, to our knowledge, that has been developed that is suitable for all rural communities.

I should like to mention a few of the techniques which the Farmers Home Administration has satisfactorily utilized. In each rural community it is necessary to carefully evaluate the amount and extent of fire protection that is to be provided. We recently had an opportunity to review a design of a water system that would serve a small rural community consisting of adobe or mud houses. The amount of fire protection tentatively specified consisted of 500 gallons of water per minute at each fire hydrant located on a 6- or 8-inch line with 60 pounds per square inch residual pressure. The frequency of multi-home fires in communities of adobe houses, spaced a considerable distance apart, is nil. Similar conditions exist where masonry type construction is primarily used. Five hundred gallons of water per minute at a pressure of 60 pounds per square inch would knock down the walls of most of the houses in tropical areas where construction is not necessarily formidable. Such firefighting capacities constitute an extravagant waste of resources.

Along with the need to take a more careful look at the amount of fire protection to be provided is the need to take a careful look at the design of the entire water system. By carefully checking the size of lines, and designing each carefully, our engineers have reduced the cost of projects by millions of dollars with no reduction in the ability of the system to serve adequately. Properly balancing the size of pipelines, valves, pumps and other equipment in relation with the entire system can reduce the cost of the facility by thousands of dollars yet not reduce the flow of water at the tap or the amount of working pressure at any point.

We strive to take the guesswork out of the design of rural water systems. Some engineers look upon overdesign of a water facility as a means of adding a factor of safety, others call it adding a factor of ignorance. We try to eliminate this factor of ignorance.

In the development of a water supply to serve a rural community, wells should be considered. The selection of the water supply is as important as the system that delivers the water. This decision will directly control the adequacy and dependability of the supply and the costs of operation and maintenance. Although the first cost of the water development is important, the operating and maintenance costs should be considered with equal significance.

Selecting the site for the rural community well is another important consideration from the standpoint of maintaining a water supply of acceptable quality and developing a water system that will continue to perform satisfactorily. Well sites should be selected at an elevation as high as possible within the rural community so that proper drainage will prevent flooding or contamination. The higher elevation will also increase the dependability of the system by providing some pressure from gravity when the pumps are not working satisfactorily.

The well should be located at least 50 feet upgrade from any possible source of contamination. The site should be selected so the well will not only afford some degree of protection from existing pollution but allow for changes in land use which might increase the chances of pollution in the future. Wells should be strategically located so that they discharge directly into ground storage reservoirs. These reservoirs should have elevation differential sufficient to provide pressure by gravitational force alone if possible. This is probably the ultimate in economical design.

The well should be located some distance, say 15 feet, from existing buildings, treatment facilities or storage tanks so that a well-drilling rig may be set up over the hole for deepening the well or pulling out pumps or well casings when necessary.

When it is possible to locate a well or wells in alluvial valleys that may be subject to infrequent flooding, submersible pumps protected with a pitless adapter should be considered. Under these conditions, the well should be covered with a concrete slab. The well casing should be grouted to prevent the intrusion of flood water into the well. The entire installation can be so installed that the well will operate satisfactorily when the entire area is covered with water. Electrical lines running to the pump should be encased in some watertight conduit such as polyethylene plastic pipe.

The dependability of geologic information on acceptable underground water supplies varies widely. In any event, the best geologic information available should be obtained and evaluated.

When there are questions concerning the quality of water that may be derived from a well or where it is necessary to determine the productivity of the well, the small diameter test well will frequently prove advantageous.

Where the geologic investigations do not conclusively indicate the presence of an ample supply of water, it will prove to be more economically feasible to drill small diameter test wells for the purpose of determining whether an adequate water supply may be developed. This is especially true of the waterbearing strata underlying a stream or river where the successive layers of sand and gravel may meander from one side of the alluvial valley to the other.

Although the change in well location of a few hundred feet can profoundly affect the amount of water that may be developed from such wells, these alluvial valleys offer exciting possibilities for the development of excellent quality, low-cost water which will frequently prove to be the most desirable supply for many rural communities. The tremendous possibilities of these underground streams should not be overlooked even though they are located some distance from the rural community in need of water. It has been observed that such supplies can be piped several miles more economically than other sources of supply can be developed.

A change of a few hundred feet may so profoundly affect the production of such wells that it is in these locations that test wells will prove to be an invaluable tool. The number of test wells that are required will be governed by the uncertainty of the estimate of the water-producing aquifer and the size of the community that is to be served with water.

After the well has been pumped continuously for a period of time, the shape of the hydraulic radius resembles an inverted cone. The flow of water into the well depends upon the size of the well, the amount of drawdown and the permeability of the gravel or sand. This permeability may vary widely. For example, a fine gravel may be 100 times more porous than a fine sand.

In some localities, it is erroneously believed that large diameter hand dug wells or even large sumps would be worth the additional cost due to the additional capacity because of the increased well diameter. Actually, any additional capacity gained above a well large enough to keep the velocity of water below 3 feet per second entering the well screen is insignificant. A small diameter well properly constructed will produce nearly as much water as one many times larger.

The well should not be excessively pumped. The quantity of water needed by the community should be carefully estimated and well pumps should be sized accordingly. The well should not pump sand. Where a fine, uniformly graded sand is encountered, a well screen should be provided that will allow the water to enter the casing with a minimum of head loss while filtering the sand from the well.

Good engineering design calls for the development of a well or wells that will meet the needs of the community in an 8-hour pumping day.

Springs and infiltration galleries offer exciting possibilities for the development of low-cost water supplies to serve the needs of rural communities, particularly springs located at an elevation where the required pressure can be provided by the difference in elevation of the terrain. This technique will offer a low-cost water supply that will have few operational and maintenance problems.

Only after it has been concluded that springs, infiltration galleries or wells will not produce adequate supplies of acceptable quality water should attention be given to the development of surface water supplies to satisfy the needs of rural communities.

Most small rural communities do not have nor can they afford to install, operate and maintain the elaborate treatment equipment that is required to remove the human, chemical and industrial wastes that are found in our rivers, streams or lakes. For small watersheds, it may be possible to store water during the rainy season in earth-filled dams. In some cases, adequate treatment may consist of fine filtration and chlorination from controlled watersheds. In such installations, all filters, chlorinators and other treatment works should be located above the flood plain.

Water may require treatment for a number of reasons; the most important is the removal of organisms which cause diseases. The water must be free from excessive amounts of toxic chemicals. The water supplied should be pleasing in appearance, free from undesirable odors, colors or tastes which would make the water objectionable. When a rural community is dissatisfied with either the quality of the water or the dependability of the service, the system is not successful.

Probably the most frequently encountered elements that must be removed from a water supply are excessive iron, manganese or hydrogen sulfide. These can ordinarily be removed by aeration, chlorination and filtration.

High concentrations of nitrates in the water supply can cause infant cynosis (blue baby disease). The frequency of high nitrate water supplies is increasing due primarily to the increased use of nitrogen fertilizers. Where the nitrate content is on the increase, caution is essential.

The addition of small quantities of fluoride - approximately 1 part per million - to the water supply can be of great importance in the reduction of tooth decay. It has been roughly estimated that the required quantity of fluorides added to a rural water supply to assure good teeth in children costs about 10 cents per child per year. This may be a real bargain. We encourage communities to add both chlorine and fluoride to water supplies where the chemical or bacterial analysis indicate that they will improve the quality. Gaseous chlorine is preferred by most rural communities because it does not create a storage problem, can be handled easier and is relatively trouble free.

In the common sense design of rural water systems, the distribution systems come under close scrutiny. Low-income groups and sparsely settled rural areas are usually the most in need of an acceptable water supply system. Unfortunately, these groups are the ones least able to pay for such a system. Under these circumstances, it is necessary to reconcile customary engineering practices with the limitations in the ability of these families to pay for such service.

The demand by rural communities for good quality water at a reasonable price continues to strain the imagination and ingenuity of all of us who are charged with the responsibility of seeking solutions to these critical water supply problems. It was with this in mind that the Farmers Home Administration commenced to seek new answers to the age old problems of adequate water supply and feasibility.

While new methods and new techniques have substantially reduced the cost of providing adequate facilities, we have as yet not scratched the surface. The water distribution system could be construed as a hopelessly complicated design problem were it not for historical data which has been developed for water consumption under a fairly rigid set of conditions.

We have found that rural families will consume approximately 35 gallons per capita per day when the system is metered and the average pressure on the system is 50 psi. Also, the relationship between the average use and the maximum use has been variously set at about five times the average use. Thus, the maximum consumptive use for a community where the average number of people per tap is 3.5 would be 700 gallons or 1/2 gallon per minute.

When the increased consumptive use is considered, and some growth of the community provided, it becomes apparent that the system design, based on a maximum simultaneous use of 1 gallon per minute per tap, is realistic. The distribution system is the most vital and most costly part of a rural domestic water system. It must, therefore, be calculated with extreme care. The design and layout of the distribution system will usually be the most time consuming part of the design of the entire distribution system. It is also where the greatest savings can be realized so that all of the component parts of the system are in balance.

The procedure for the design of the distribution system should be as follows. Calculations for the design of the distribution system should start with the group of users or families located the greatest distance from the well, reservoir or pumping station. All pipelines should then be sized by computing the size of the pipeline necessary to satisfy the maximum instantaneous use which may be as low as one gallon per tap. New pipeline materials such as plastics should be considered for the small diameter pipelines and cast iron, asbestos-cement or reinforced concrete should be considered for the larger mainlines. The selection of the pipeline materials for rural water systems is a matter of balancing the most economical material with sound engineering design.

Rural water systems often serve scattered customers rather than densely settled areas served by urban systems. Although this factor accentuates the need for economy, it also dictates the need for consideration of long-lived materials. These rural communities can ill afford short-term replacement caused by failure or deterioration of pipeline materials to be considered in the design of rural water systems. Although long life and low first cost are the most important considerations in the selection of the material used for rural water systems must also be influenced by the pipe's ability to carry quantities of water through long stretches of pipe with low friction losses. We have found that plastic pipe offers many advantages in the development of a rural water supply system. It is very effective when small size pipe is needed. When it is used properly, it offers low first cost, long life, and excellent friction characteristics. Because of its relative short history of use, plastic pipe has not always been selected and used within its capabilities. Under these circumstances, it has sometimes failed to perform satisfactorily.

The hydropneumatic pressure system is a modification of the old concept of elevated storage. Instead of pumping the water into an elevated tank it is pumped against pressure. When the hydropneumatic tank system is properly designed it can have the dependability characteristics of the elevated storage tank and a substantially lower first cost. This is particularly true where inexperienced rural families may construct concrete or masonry storage tanks which are located on the ground.

Ordinarily, we believe that the most economical yet practical design calls for storage tanks with a capacity equal to two days' average use. Since the hydropneumatic system is often a less costly method of providing adequate pressure, no rural water system should be judged infeasible until all of the possibilities have been fully explored for utilizing the hydropneumatic pressure system. If the source of supply of water is inadequate in quantity to satisfy the maximum needs of the community, then the water supply source should be complemented with a ground storage reservoir. Many hydropneumatic systems have been successfully constructed when the tank design was based on 35 gallons per family served. In addition to low first cost, the hydropneumatic system has the advantages of being placed at strategic locations. Hydropneumatic tank systems have frequently been used to maintain pressure at the end of long lines, thus reducing the size and cost of the transmission line.

In conclusion, the USDA has financed many rural water systems where the average quantity of water pumped from the well equalled .6 gallon of water per minute per family served. The amount of storage provided equalled 300 gallons per family served. The hydropneumatic system was based on a pump capacity of 2 gallons per minute per family served. The tank size was based on 35 gallons per minute per family served or 10 times the pump rate pumping through the tank. Air compressors designed to maintain an equal balance of air and water were based on 3/4 cubic feet per minute per 1,000 gallons of tank capacity. By designing systems on the basis of a simultaneous use of 1 gallon per minute per design tap, distribution systems have performed satisfactorily. Depending on the topography and distance between homes, we found that 11/4-inch pipe would adequately provide water for 5 to 10 families; 11/2-inch pipe 15 to 18 families; 2-inch pipe 25 to 30; 3-inch pipe 60 to 70; 4-inch pipe 100 to 120; and 6-inch pipe 250 to 300 families. When rural families were spaced an average of one-fourth mile apart, many systems have been designed and financed in which the average user charge was $6.50 per month. By using the same design criteria, the average user cost can be reduced to 60 cents or less per family for small compact rural communities.

Although these methods of design have been developed for use in the rural areas of the United States to provide adequate water supplies for rural families who live considerable distances apart, the same design criteria can be utilized to satisfy the low-income people of the rural areas of large portions of the world. In the beginning of this paper, I said that good quality water could be piped into the homes of a large segment of the rural areas of the world. To accomplish this herculean task will require the leadership of the community leaders. New methods of financing will be needed for some areas, coupled with self-help and common sense designs for rural water systems.

In calling for the Water for Peace program, President Johnson said the conference would and I quote "focus universal attention on mankind's need for water and to stimulate practical cooperation among the nations of the world in meeting these goals."

There is no single enterprise in a nation's socioeconomic environment more important than a safe, economical water supply. The well being of the peoples of the world rests solidly upon our ability to solicit support and motivate public understanding of this urgent need. This adventure will be both exciting and rewarding.

In the last analysis, we are deeply committed to the effort to bring water to rural communities all over the world. We feel this is an essential step in the universal quest for human betterment.

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CONCEPTION DES SYSTEMES D'ADDUCTION D'EAU DANS LES CAMPAGNES

Résumé

Le document expose les critères utilisés avec succès pour la réalisation de plus de 2.000 réseaux d'eau dans les campagnes. Il passe en revue les techniques et les matériaux ayant donné de bons résultats pour la construction de réseaux d'adduction d'eau à usage domestique dans les campagnes des Etats-Unis. Il expose également divers problèmes de conception que l'on rencontre lorsqu'il s'agit de fournir à la population agricole de l'eau pure qu'elle ne peut pas se permettre de payer plus de 8 dollars environ par mois. De nombreux systèmes ont été conçus, dans lesquels les usagers résidaient à plus de 400 mètres les uns des autres.

Le document fait l'historique de l'utilisation de ces critères et de leurs incidences sur les 2.000 réseaux hydrauliques ruraux financés avec succès par la Farmers Home Administration (Office chargé de l'administration des prêts aux fermiers) au cours des cinq dernières années. Il explique les méthodes de fonctionnement de ces systèmes et montre de quelle façon elles peuvent être adaptées afin de répondre aux besoins de communautés rurales situées dans d'autres parties du monde, où la capacité de remboursement ne dépasse pas de 2 à 3 cents par jour.

Le document porte également sur l'utilisation de critères révolutionnaires qui permettront de fournir de l'eau de bonne qualité en quantité suffisante à la plupart des régions rurales du monde entier, tout en demeurant dans les limites des moyens financiers de leur population.

DISEÑOS SENSATOS DE SISTEMAS RURALES DE ABASTECIMIENTO DE AGUA

Resumen

Este trabajo examina los criterios de diseño que se han utilizado provechosamente en el desarrollo de más de 2.000 sistemas rurales de abastecimiento de agua. Pasa revista a las técnicas y materiales que han dado buenos resultados en los Estados Unidos en la construcción de sistemas rurales de abastecimiento de agua para consumo doméstico. El informe también trata sobre los problemas típicos de diseño que se presentan cuando se proporciona un servicio de abastecimiento de agua pura a familias campesinas que no pueden pagar más de unos 8 dólares mensuales. Se han diseñado muchos sistemas en los cuales los usuarios vivían a más de un cuarto de milla unos de otros.

El trabajo presenta los antecedentes históricos del uso de estos criterios de diseño y sus efectos sobre 2.000 sistemas rurales de abastecimiento de agua que han sido financiados con éxito por la Administración de Asistencia al Agricultor (Farmers Home Administration) durante los últimos cinco años. Explica los métodos de operación de estos proyectos y muestra como pueden adaptarse a las necesidades de las comunidades rurales de otras partes del mundo donde la capacidad económica permite el pago de sólo dos o tres centavos diarios por el agua.

Este trabajo también detalla la explicación del uso de estos criterios revolucionarios de diseño que pueden hacer posible el abastecimiento adecuado de agua de buena calidad a la mayor parte de las zonas rurales del mundo, manteniéndose, sin embargo, dentro de los límites de la capacidad de reembolso de las mismas.

LOW COST DISTRIBUTION SYSTEMS IN GUATEMALA

Danilo Aris

Guatemala is one of the five Central American Republics which, together with El Salvador, Honduras, Nicaragua, and Costa Rica compose the Isthmus of Central America and a group of young nations, to which Panama should be added because of geographical and economic reasons.

Guatemala has a population of 4,284,473 inhabitants, according to the census of April, 1964, distributed over 131,800 square kilometers (50,927 square miles). Guatemala is the largest of these Central American nations in population and the second largest in size. According to the census of 1964, 2,800,000 inhabitants live in rural areas; this is to say, 65.9 percent of the inhabitants of the country live away from the cities, in small villages or in the countryside, totally dedicated to agricultural labors. There are 6924 rural communities registered with less than 2000 inhabitants each.

The remainder of the population of the country lives in 345 towns, of which each is the county-seat of the various counties in the provinces of the Republic. It should be noted that many of these county-seats are growing cities, especially Guatemala City, capital of the Republic, but a good many of these cities have rural characteristics.

As an important part of the present program actually underway for the integral improvement and the social-economic development of Guatemala, multiple activities have been put into effect to protect and improve the health of the inhabitants of the country. These projects are some of the responsibilities of the Ministry of Public Health. One of these projects, which is considered of primary importance, is to provide potable water to the rural communities of the country. This is the responsibility of the Sanitary Engineering Department of the Ministry of Public Health.

It is necessary for us to explain briefly what is meant in Guatemala when we speak of a rural aqueduct. Our large and medium sized cities generally have been supplied by the most practicable technical resources of this era. In all our cities, the water is provided under the best standards and the network of distribution is made as complete as possible. Water is distributed to the homes on a permanent basis and the water consumed is controlled by means of meters. As far as the quality of the water is concerned, when needed, the necessary water purification plants are built to protect the health of the inhabitants of the urban areas. To summarize, we can say that our cities are being supplied with urban aqueducts in which modern requirements are taken into account for the supply of potable water.

Nevertheless, in the rural areas, even though they form the major part of the populated areas, even though they form the major part of the populated areas of the country, we have been less strict, providing only safe potable water to an easily accessible point for our rural inhabitants. Generally the systems are built to supply a small amount of water for the people of each village, which is obtained at public faucets or taps and then carried to their homes. The rural aqueducts do not provide water for each home, nor do they comprise a complete water distribution system. We repeat, it only supplies running water to one easily accessible supply point for these rural inhabitants.

To guarantee good quality water, it has been customary to build these rural water systems in such a way that the water is piped directly from the natural springs, so that the water is protected throughout the overall length of the system. It is fortunate that Guatemala is a mountainous country where natural water springs can be ducted in a gravity system, gathering the water in catchment boxes that meet the sanitary requirements, avoiding, in the rural zones, the necessity of water purification plants. The gravity systems are simpler operating systems than those that must include pumping equipment.

Occasionally, water is supplied by means of drilled wells.

The principal basis of these rural aqueducts can be summarized as: that they should be able to provide 60 liters per person per day; that the factor of maximum daily consumption varies between 1.2-1.5, that, generally, the minimum diameter pipe used is 1"; and that public taps be built to supply water to a maximum of 100 persons.

According to the information that we have, this same method is followed through out the other countries of Latin America, and as far as we know, the interpretation of the paragraph, "to give potable water to 50 percent of the rural areas," of the Charter of Punta del Este, is to build the type of systems we are describing.

On the other hand, some countries are doing precisely the opposite, and the rural systems are always designed and built in a way similar to the urban aqueducts. Consequently, they have a higher cost and considerable difficulties trying to carry forth a program of this type.

In Guatemala, a general rule has been set, which has always been carried out; namely, that no project should amount to more than an initial investment of fifteen Quetzales, equivalent to fifteen United States dollars, per person, and in practice the actual cost very seldom amounts to over twelve Quetzales (twelve dollars) per person.

Our experience indicates, as well, that when a rural town is provided with a number of public taps, it is given a public service that fulfills the ambitions of a community that formerly had to transport impure water from a river or a spring generally far away and very inaccessible. Therefore, our communities feel very satisfied with the system of potable water provided by means of public taps. In their continuous demand for these water systems, they always include details about the number of public taps they desire to be built in their towns. This positive attitude of the communities toward this program allows us to affirm that we can always count on their outstanding collaboration. With a minimum of organization and orientation, we are generally provided with local materials and labor, as well as other resources found in the community; this in some cases, helps us to save up to 30 percent of the total cost of the construction.

We have always had the feeling, as we have expressed before, that the work that we have done in the past in rural areas was incomplete, not only in terms of health (since we have heard many times that the water that does not go directly inside the houses is not satisfactory) but it should also be considered incomplete if we think in terms of the facilities that should be given to the inhabitants of these regions for the use of water, and also in terms of the higher standards of living due to modern techniques. Unfortunately there are many difficulties that prevent construction of similar urban systems for our rural inhabitants, primarily expense.

Most of our rural towns are very scattered, and for this reason, any system that provides complete distribution with a more ambitious design, naturally has a higher cost per person. In many of these rural areas, it is almost impossible to count on a sufficient water source, directly from springs, for a complete distribution system; thus, it would be necessary to provide water purification plants similar to those used in the urban zones, but, as is known, these are harder to operate and maintain.

There is also another important problem that concerns the difficulties that have always been inherent for the adequate operation of the aqueducts in small towns. We believe that if we took these problems to the rural zones, there would not be any possibility that a pumping station, a water purification plant, a network of distribution with meters, or other parts of a modern water system, could be adequately operated and administered by a community with insufficient resources.

Finally, if an urban system were provided, whose initial cost is very high, whose operation is complicated, together with the difficulties already mentioned, it would be necessary as a logical consequence to set higher water rates for the inhabitants of the rural zones than they are in a position to pay, considering their economic level. To summarize, there have always been important reasons to continue the construction of rural rudimentary aqueducts.

The subject we are covering, "Low-cost Distribution Systems," suggests the necessary solution that should be found in order to make a significant change in the characteristics of rural aqueducts. This means that rural aqueducts must fulfill all the possible technical requirements and not be limited to just rudimentary systems, but at the same time, all the improvements should have, as a principal basis, a low installation cost.

It is undeniable that our experiences cannot be exactly applied to other Latin American nations or to other regions of the world, but we hope that they will serve as a constructive example toward the solution of our common problems. At the same time, we look with interest at all the efforts that are being made in other developing countries. Basically, the problems of mankind in all the regions of the world are always the same.

Complete programming and planning has become more and more important in finding an adequate solution to the problem of uniting all the necessary factors involved in supplying water to rural areas. The term "programming" in its different aspects is not necessary to be defined, since this theme, in the last number of years, has been the subject of constant interpretation and analysis.

In relation to rural aqueducts in the past, in Guatemala, we used to act in a very simple form. If the total number of villages that actually have a rudimentary aqueduct (approximately 400), is compared with the total number of rural communities (6,924), it appears that the situation is a complete lack of service. If such circumstance was compared with the available resources, always lacking, we found ourselves with a very discouraging panorama; the number of people supplied was, annually, less than the growth of the population in these rural areas.

Nevertheless, a more detailed study has made it possible for us to observe that a good number of communities, although of incipient development, are located in important zones from the economic point of view, and the growth of the population, the agricultural development in charge of other governmental organizations, the laying out of the streets, the type of houses, and other factors, make us hope for a better future for those villages, and a more complete aqueduct can accelerate the economic and social development for them.

Another case we frequently find in the selection of the communities is that those located close by large public works projects, especially new highways, are helped in their development by this proximity, and should be given the priority they deserve in relation to water supply.

On the other hand, the study of the rural communities of the whole country has permitted the selection of towns formerly established, and in which a more complete aqueduct is, at this time, an urgent necessity.

In contrast, we have been able to locate isolated villages, without adequate roads and without the possibility of immediate improvement, and with an uncertain future. In these villages the scarcity of water is more dramatic. Without counting on the analysis that we are now describing for the adequate selection of places to work, it is possible to face the error of supposing that these deserve the highest priority.

In other words, working programs must be prepared after an adequate selection of the communities. It is convenient to think in terms of complete aqueducts for those places where the investment is more valuable and opportune; and, at the same time, a rudimentary emergency system for other villages may be enough.

From the information about the state of potable water programs in the Latin American countries, presented by the Pan American Health Organization in the 10th Congress of the Inter-American Association of Sanitary Engineering (AIDIS), in San Salvador, in December, 1966, we have noted that in Latin America, in 1961, 50 percent of the population was rural. In 1965, this figure was reduced to 48 percent; and by 1971 it is expected to be 43 percent.

This phenomenon, which shows that development reduces the rural population, can also be observed in other regions of the world.

On the other hand, the paper already mentioned shows that one of the problems that worry our nations is the tremendous increase of the big cities, almost all of them surrounded by unhealthy zones, which lack proper facilities. That is, from the small villages that do not progress and even disappear, people move to these suburban areas, creating new and greater economic and social problems.

The adequate selection of these rûral communities, which we have referred to, can contribute to help avoid this problem, and a wisely designed water system, together with other activities can, and should, provoke the strengthening of medium-sized towns which, many times, is the only choice between the small village without a future and the slums around the large cities.

In Guatemala, efforts are being coordinated among different institutions so that a better programming of labor can be realized, and among other benefits, the selection of communities permits the low cost in the construction of a complete potable water system, the theme we are now considering.

One of the factors that we indicated at the beginning as a reason for not improving the rural systems is the control of the use of water which is always necessary when it is provided to all the buildings; and the necessity of having easy methods for administration and operation of the system, which should never be complicated.

Water meters are not practical in our rural areas for obvious reasons. Experiments with other methods of water control have been made, such as calibrated orifices, but they have never given us the desired result.

In 1965 we started to use a new type of faucet that regulates the flow and has an automatic shutoff. With the experience acquired we are now sure that it can advantageously substitute for any other method.

In places where we have installed such faucets, we have found the following advantages:

a. There exists an adequate control of consumption with an easy administration.

The engineers of the Sanitary Engineering Department have been observing with interest the systems already built. One of them made a series of observations, pointing out that in practice, in towns where all the houses have these new faucets, the consumption was never over 50 liters (15 gallons) per person per day.

b. Modern systems in rural areas can be of low cost.

We have built a good number of public tap systems at an average cost of Q 12.00 (U.S. $12.00) per person.

Each public tap can be substituted by 20 private connections. The cost of each one of these is Q 14.00 (U.S. $14.00), including the new type faucet, the necessary pipe, fittings and all additional expenses.

The cost of 20 private connections, consequently is of Q280.00. From this cost, we have to subtract Q25.00 out of the public faucet that is not in use any more. This means that the additional cost for 20 houses or 100 persons is of Q255.00 or Q2.55 per person.

If this additional cost is added to the cost of the rudimentary systems (Q12.00 per person) we get a total cost of Q14.55 per person, which is under our own limit, as it was stated before.

c. It is not necessary to change our present standards.

It has already been stated that for the rudimentary systems we design on the basis of 60 liters per person per day. Since, with the new method we have always obtained smaller figures, we can continue to use the same standards and also the actual designs may be used without any modification.

More ample experience will probably permit us to reduce our standards and thus, reduce the size of the pipe, the volume of the storage tanks, the necessary flow from the water source. This is to say, reduce the cost.

d. It is feasible to obtain a reimbursement from the beneficiaries which permits us to cover the minimum expenses for operation and maintenance, and to contribute to the financing of the program.

Thanks to the system we are mentioning, it is possible to fulfill the requirements established by the financing institutions, especially the Inter-American Development Bank. In 1967, we have started in Guatemala a new program of Q2,100,000.00, using a loan of the IDB of Q1,300,000.00 plus the national resources.

Now we are in a position to fulfill the loan contract requirements:

- 70 percent of the houses should be connected to the system.
- The beneficiaries should pay for the operation and maintenance expenses.
- The beneficiaries should also pay the interest on the loan.

e. With a small additional investment it is possible to modernize many of the existing rudimentary water systems.

This is quite evident, and it is enough to point out that many of these communities are applying for a modern system when they know the advantages of the new faucet that regulates the flow.

f. We are promoting a better health and a higher standard of living.

As is known, one of the most significant factors in the cost of a water distribution system is that of the pipe. We have always used galvanized steel in the rural aqueducts. Such pipe is bought in foreign countries.

In the previous paragraphs we have indicated the possibility of building more complete systems, without increasing the consumption of water and, for this reason, we would use the same pipe diameters and, thus, maintain the same cost.

In addition to what has been previously stated, we have been experimenting with the use of plastic PVC pipe that advantageously substitutes for the metallic pipe saving as much as 40 percent of the cost. With the use of PVC pipe, the available economic resources will permit us to help more villages. We think that it is unnecessary to detail the characteristics of such plastic pipe. We are using it now in several places in order to have enough experience with it to make this a general practice. It should be pointed out that the use of PVC pipe has become a very important factor in our program of rural aqueducts since, even though it is not made in Guatemala, it is manufactured in other countries of the Central American Common Market.

This way, the economic integration of the five Central American nations, which is an example for all the groups of countries all over the world, is helping to make it easier to have low-cost distribution systems. If we do the same in the five countries permanently, we could increase the actual advantages and would contribute to the social and economic development of the regions in two different ways.

Finally, the momentum that this program has received in the last year has permitted us to think of prefabricated storage tanks, of contracting private companies, and other technical resources which are not necessary to be described.

Water, the most important natural resource, when used properly by man, contributes without doubt to obtaining peace which, for us, is an evidence of the well being and happiness that all people in the world have the right to attain.

Water for human consumption, the basis of health and individual welfare, contributes to peace and also to liberty which, for many, is the difference between being half-men and men without physical, social and moral limitations, with the possibility of enjoying the collective well-being and happiness.

RESEAUX ECONOMIQUES D'ADDUCTION D'EAU AU GUATEMALA

Résumé

Au Guatemala, comme dans plusieurs autres pays, nous devons résoudre deux problèmes pour assurer l'approvisionnement en eau potable. Dans les grandes villes et dans les villes moyennes, nous pouvons assurer cet approvisionnement en utilisant toutes les techniques et ressources disponibles à l'heure actuelle. Mais nous avons aussi à faire face à un autre problème qui est l'alimentation en eau potable d'un grand nombre de petites communautés rurales, où les solutions traditionnelles ne sont pas applicables.

Soixante-quatre pour cent de la population guatémaltèque vit dans de petites communautés rurales dont le nombre d'habitants est inférieur à mille, dans de vastes régions où les maisons sont éloignées les unes des autres. On a pensé que la solution la plus économique était de construire des réseaux d'adduction d'eau les plus simples possible du point de vue technique, et permettant à la population de s'approvisionner en eau aux fontaines publiques. Les ressources financières disponibles ne permettent du reste que cette solution. Dans notre pays, nous avons envisagé d'approvisionner en eau potable environ deux millions de personnes en utilisant ce type de réseau d'adduction simple. Le coût par habitant serait de 15 dollars; par conséquent, la solution du problème exigerait trente millions de dollars de dépenses (environ 20% du budget annuel du gouvernement national).

Il n'est pas nécessaire d'insister sur les divers problèmes de santé publique résultant de la pénurie d'eau potable qui, comme nous le savons tous, est une des causes du taux élevé de mortalité dans le pays. Au surplus, il s'en faut de beaucoup que la meilleure solution soit la mise en place de réseaux d'adduction d'eau ruraux approvisionnant la population au moyen de fontaines publiques.

Nous devons aussi prendre en considération le niveau de vie de la population rurale, dont la plus grande partie sont des agriculteurs qui ont à faire face à de graves problèmes économiques et sociaux, tenant au manque d'une éducation minimale (70% sont analphabètes); à la faiblesse du niveau de revenu (dans les fermes rurales, il est d'environ 70 dollars par personne, par an); et à plusieurs autres facteurs. A tous ces problèmes, il faut en ajouter un autre, à savoir le taux élevé de croissance démographique (3% par an) qui complique encore davantage les choses.

En examinant l'aspect économique des programmes d'adduction d'eau, il est facile de comprendre qu'il est impossible de recouvrer une fraction considérable des fonds investis quand les usagers n'ont pas un embranchement particulier. En dépit de tout ce qui a été dit, nous avons pensé qu'il n'était pas facile d'appliquer dans les zones rurales les méthodes qui sont employées dans les zones urbaines, car, outre les problèmes techniques posés par la distribution de l'eau à des maisons éloignées les unes des autres, nous aboutirions à gaspiller nos efforts et nos ressources.

Il a été envisagé d'attendre, avant de prendre une décision, que ces communautés améliorent leurs services de planification ainsi que leur développement économique et social. Nous pensons, au contraire, que les réseaux d'adduction mis en place actuellement favoriseront le développement de ces communautés si nous pouvons arriver à élaborer les plans et à définir les caractéristiques les plus appropriés à chaque réseau particulier.

Du point de vue strictement technique, le problème peut être posé en quelques mots en disant que le véritable besoin est de construire des réseaux d'adduction d'eau comportant des embranchements particuliers, assurant un approvisionnement suffisant en eau au foyer même, à peu de frais, et permettant une exploitation et un entretien faciles. Finalement, notre expérience nous enseigne que l'un des plus importants problèmes à résoudre est la lutte contre le gaspillage de l'eau.

Solutions essayées

Le Service du génie sanitaire du Ministère de la Santé publique du Guatemala procède actuellement à la mise en oeuvre de plusieurs mesures en vue de résoudre les problèmes mentionnés plus haut. Nous citons ci-après certaines de ces mesures:

a) une étude approfondie des collectivités à approvisionner a été faite, en vue de choisir celles où les conditions se prêtent le plus à la transformation de ces collectivités en petites agglomérations;

b) les méthodes traditionnelles de travail ont été profondément revisées, et présentement, nous utilisons dans nos régions rurales sous-développées des techniques de construction plus modernes, qui aideront à gagner du temps et à économiser les ressources locales et nationales. A cet égard, nous pouvons mentionner l'emploi de réservoirs d'eau métalliques préfabriqués au lieu de réservoirs en maçonnerie;

c) les techniques modernes et les industries spécialisées auxquelles nous pouvons recourir grâce aux facilités offertes par le Marché commun centraméricain, nous ont permis d'utiliser des matériaux bon marché de fabrication locale. Nous voulons ici mentionner spécialement les tuyaux en plastique PVC que nous employons au lieu et place des ruyaux ordinaires en fer;

d) pour lutter contre le gaspillage de l'eau, nous avons adopté une valve spéciale (La Fordilla) qui a donné les meilleurs résultats. Notre expérience nous a appris que l'emploi de ces valves est le meilleur moyen d'installer des embranchements pour l'approvisionnement en eau des particuliers et d'obtenir le remboursement de l'investissement.

Plans pour l'avenir

L'installation de réseaux d'adduction prévoyant des embranchements destinés aux particuliers:

1) accélèrera le processus de rénovation des collectivités rurales (nous avons déjà plusieurs bons exemples);

2) rendra possible l'élargissement de nos programmes (les nouvelles méthodes nous ont permis d'obtenir un prêt de la Banque interaméricaine de développement);

3) contribuera à améliorer la santé et à accroître le bien-être des populations vivant dans nos régions rurales.

SISTEMAS DE DISTRIBUCION DE BAJO COSTO EN GUATEMALA

Resumen

En Guatemala, al igual que en varios otros países, tenemos que resolver dos problemas para poder suministrar agua potable. Para llevar a cabo este propósito en pueblos medianos y grandes, tenemos a nuestra disposición todas las técnicas y los recursos disponibles hoy día. Pero tenemos también que suministrar agua potable a un gran número de pequeñas comunidades rurales, y a este problema no son aplicables los soluciones tradicionales.

El 64% del pueblo guatemalteco vive en pequeñas comunidades rurales con menos de mil habitantes, en vastas zonas en las cuales las casas están muy distantes unas de otras. Se ha pensado que la mejor solución económica es la construcción de sistemas de abastecimiento de agua con el trazado más sencillo posible, que permitan que el pueblo obtenga el agua que necesita en grifos públicos. Esta solución ha sido la única posible con los recursos económicos disponibles. En nuestro país hay aproximadamente dos millones de personas para las cuales se han hecho los planes de abastecimiento de agua potable mediante esta clase de sistema incompleto. El costo por persona es de alrededor de 15 dólares. Por lo tanto, la solución del problema requiere el gasto de 30 millones de dólares (cerca del 20% del presupuesto anual del gobierno nacional).

No es necesario hacer hincapié en los numerosos problemas de salud pública a que da lugar la falta de agua pura; todos sabemos que ésta es una de las causas de la alta mortalidad que existe en el país. Por otro lado, el abastecimiento de agua a las zonas rurales por medio de grifos públicos no es, de ninguna manera, la mejor solución definitiva.

También tenemos que considerar la situación económica de la población rural, constituida en su mayor parte por agricultores que tienen que enfrentar serios problemas sociales y económicos debidos a la falta de una educación mínima (el 70% de ellos son analfabetos); los bajos ingresos (en las zonas rurales el ingreso anual es de alrededor de 70 dólares por persona), y varios factores más. Además de todos estos inconvenientes, la alta tasa de crecimiento demográfico (3% anual) hace la situación aún más difícil.

Además, contemplando el aspecto económico de los programas de abastecimiento de agua, es fácil darse cuenta de la imposibilidad de obtener una amortización considerable de los fondos cuando no existen conexiones con las casas. A pesar de todo lo dicho, siempre hemos pensado que no es fácil aplicar los mismos métodos que se usan para las zonas urbanas ya que, además de los problemas técnicos que hay que resolver en la distribución de agua a casas muy distantes entre sí, se desperdiciarían los esfuerzos y los recursos.

Se ha discutido la posibilidad de esperar hasta que estas comunidades mejoren sus planificaciones a la vez que su desarrollo social y económico en un futuro cercano. Pensamos que, al contrario, los sistemas de abastecimiento presentes favorecerán el desarrollo de estas comunidades si encontramos el trazado y el diseño apropiados para cada sistema en particular.

Desde un punto de vista estrictamente técnico, el problema se puede expresar en pocas palabras diciendo que lo que realmente se necesita es construir nuevos sistemas de abastecimiento con conexiones a las casas, que proporcionen cantidades suficientes de agua y que sean al mismo tiempo de bajo costo y de fácil operación y mantenimiento. Finalmente, nuestra experiencia nos demuestra que uno de los problemas más importantes que hay que resolver es el del control del desperdicio de agua.

Soluciones que se han ensayado

El Departamento de Ingeniería Sanitaria del Ministerio de Salud Pública de Guatemala ha probado la aplicación de varias medidas para resolver los problemas que hemos discutido. Mencionaremos algunas de ellas:

a) Ha hecho un estudio cuidadoso de las comunidades que van a recibir el abastecimiento, para seleccionar aquéllas en las cuales las condiciones sean más apropiadas para que se conviertan en pueblos pequeños;

b) Ha realizado una revisión completa de los métodos de trabajo tradicionales, para usar en nuestras regiones rurales subdesarrolladas técnicas de construcción más modernas que ayuden a ahorrar tiempo y recursos locales y nacionales. A este respecto, podemos mencionar el uso de tanques de agua metálicos prefabricados en vez de los de albañilería;

c) Las técnicas modernas y las industrias especializadas nos han permitido usar materiales de bajo costo y hechos en el país, aprovechando las ventajas provistas por el Mercado Común Centroamericano. Nos referimos en este caso al uso de tuberías plásticas de CPV en vez de tuberías de hierro corriente;

d) Para el control del desperdicio de agua estamos usando en forma permanente una válvula especial (la fordilla) con los mejores resultados. Según nuestra experiencia el uso de estas válvulas es la manera más conveniente de proveer conexiones con las casas y de obtener un rembolso parcial de la inversión.

Planes para el futuro

La construcción de sistemas con conexiones con las casas:

1) Acelerará el proceso de transformación de las comunidades rurales. (Ya tenemos varios buenos ejemplos.)

2) Permitirá la ampliación de nuestros programas. (Los nuevos métodos ya han hecho posible la obtención de un préstamo del Banco Interamericano de Desarrollo.)

3) Ayudará a mejorar la salud y el bienestar de los habitantes de las zonas rurales.

CONSTANT FLOW WATER SYSTEMS

Cecil W. Rose
Ralph Johnson

In the quest for human betterment and world peace, the development of adequate supplies of good wholesome water is of paramount importance.

At the beginning of civilization, man recognized the importance of a good supply of water. Water makes life not only more enjoyable; it also makes life itself possible. Without water in its three physical forms, life on earth would be impossible. If only a slight change were made in the molecular structure and the maximum density were changed, there could be no life on this planet. This peculiar molecular structure keeps the oceans turning over and moderates our climate so that life is possible. Without rain, our civilization and our rivers and forests would perish.

Water is our most precious natural resource. Development of water has proceeded with the advancement of civilization, but now the rate of development must be accelerated. Progressive development, through the use of ingenuity and new technology, is the thesis of this discussion.

In the United States there are thousands of small rural communities which do not have adequate water systems. For thirty years, the U. S. Department of Agriculture, through the Farmers Home Administration, has attempted to assist these small, often isolated rural communities in developing adequate water supplies through loans and technical assistance.

Today, new design criteria are making it possible to serve thousands of these communities with water. Frequently the distance between homes in rural or farming communities is substantially greater than in urban areas. The small size of the community often results in higher water development costs. Other physical factors contribute to make the systems excessively costly, if they are designed by conventional methods. It was absolutely necessary to formulate new design criteria if these rural communities were to be served water at a reasonable cost. Most of the changes in design criteria have come about as a result of the advent of new materials and new techniques.

The underlying principle of these new systems is that pipelines are designed to flow continuously rather than intermittently. These low-cost water systems, designed with this principle in mind, are called "Constant Flow."

Early history reveals that communities became more stable after the cultivation of crops had been perfected. This caused increased numbers of people to concentrate in smaller and smaller areas. Early years of concentrated living undoubtedly created their share of waterborne diseases that plagued many small communities. But the muddy, septic or anaerobic conditions of the spring or stream with their resultant odors first motivated communities to develop these springs or perfect new sources of supply.

Western civilization bases its foundation solidly on the tri-cornerstones of cooperation, progress and water development. A thousand years before Christ, man put aside individual selfishness and joined together in efforts to harness water supplies. During this period, the far-sighted Solomon erected aqueducts to carry water. The Ceasars of Rome built the magnificent stone aqueducts to quench their thirst 2,000 years ago. They encountered their share of complex design and construction problems in these water development projects.

Today, as with the Ceasars of that era, we are still confronted with new and challenging problems. Unlike forward-looking Solomon or Ceasar, our present generation has taken the development of water too much for granted. Far too often, water development has been postponed in hopeful anticipation that the problem might become less acute.

These delays have now created a huge backlog of unstarted water development projects. The magnitude of the impending water crisis forbids further delay. If we are to meet the needs for water, action should be initiated now. Far too often, the fallacious assumption has been made that water is both limitless and free. It is hoped that these remarks will help to erase this misconception. We need imaginative development coupled with the full support, both financial and physical, of each rural community that is in need of an improved water supply system. What we need now is development rather than conservation. We need action more than words.

Generally there is water shortage or scarcity only where there is shortsightedness. Certainly there are isolated areas of the world where it is physically impossible to develop water. There are other areas where water at a reasonable cost is going to be particularly difficult to obtain.

The methods at hand today include the use of huge earth-moving equipment and sophisticated pumps. For example, in my country, we use approximately six percent of the water that falls on the land. This figure is misleading because we use some of the water up to five times. We are not confronted with any impending water crisis or even severe water shortages, if we do not become filled with lethargy. The danger is shortsightedness and complacency. A similar picture exists in much of the world.

It has been estimated that eighty percent of the world's population does not have a safe, adequate water supply. To correct this situation might involve a cost of five hundred billion dollars. Solving this gargantuan task will require the combined technical and physical efforts of a large portion of the world's people. If these efforts are to be properly guided, if vast quantities of resources are not to be wasted or at least used unwisely, then one must direct these efforts competently.

Water is neither inexhaustable nor free. In most places of the world, feasible water supply systems can be developed. Yet, this will require motivation and effort. Water is not free. Even the people from the poorest rural communities have ability to pay for water. They must be required to pay for water in accordance with the quantity used at a reasonable rate.

Present technology makes it possible for the first time for us to provide good quality water at a reasonable cost to most of the rural families who live in this country. Millions of other rural communities in other places can similarly be provided water at a reasonable cost. While the techniques that are presently being used to distribute water to rural areas originated in rural sparsely-settled communities, these same principles apply to many other communities in the world. Some of these rural communities may have a lower monthly repayment ability, but they live in more concentrated areas.

The underlying principle behind this low cost water system, which is the subject of this discussion, lies in the ability of very small water pipelines to carry surprising quantities of water if the water is allowed to flow continuously. We have found here that one-eighth of a gallon of water per minute will adequately serve the needs of a rural family. A dripping faucet may discharge this much water. Some engineers have thus called these systems "dripping" or "trickling water systems." This constantly flowing pipeline flows into a tank near the point of use. The amount of flow is regulated by a small inexpensive constant flow valve. These valves may be purchased from several manufacturers in an assortment of sizes. Normally they can be expected to regulate the flow through a wide range of pressures. Most of these valves are quite accurate within a pressure range varying from 15 pounds per square inch to 115 pounds per square inch.

The key to the success of a constant flow water system rests with a good approximation of the quantity of water that will be utilized by the rural families that are to be served. We have observed that the average rural family consists of 3.5 people and utilizes an average of 35 gallons per capita per day of 140 gallons per day per rural family. One-eight gallon of water per minute will provide 180 gallons per day of 5,400 gallons in a 30-day month if allowed to flow continuously.

In the usual distribution system, the water storage reservoir is placed near the water supply which most often will be a well. In the constant flow system the process is reversed. The storage tanks are placed near the user's homes. In this way, it is not necessary to design the system for peak or maximum use. The demand on the system is nearly constant, thus making it possible to utilize much smaller pumps and distribution systems.

If storage is provided on the farm or at the rural home, it is conceivable that the system may be constructed for a very low cost. The individual storage tanks may consist of cisterns or roof tanks, but for best results pressure tanks should be encouraged. The design of the pumping plant and distribution system follow the conventional methods of design.

If a constant flow system were to be designed to serve a rural community consisting of 400 families, and 5400 gallons of water per month would satisfy their water requirements, a well with a capacity of 50 gallons per minute would be required. This would provide each of the families with a maximum of 180 gallons of water per day. There would be no great fluctuations in demand, so the pumps could be designed to meet the cumulative total quantity of water determined by adding the number of families served. This quantity of water would be measured by the constant flow valves. Similarly, the distribution system would be designed on the basis of satisfying the maximum average use of the families. The largest flow in the transmission system would be one-eighth gallon for 400 families or 50 gallons per minute. In most rural communities this quantity of water could flow through a 3-inch plastic pipeline with allowable headlosses. The terminal and distribution lines of the system would be smaller with some of the lines as small as one-half inch in diameter.

The size of the distribution system should be calculated as follows. Starting with the group of users located the greatest distance from the well and pump, compute the quantity of water that will flow through each line. Estimate the size of the pipelines that will be required. Using these pipe sizes, calculate the pressures at each control point on the distribution system, considering differences in elevation and friction losses. Adjust the pipeline sizes and recompute hydraulics.

The residual pressure calculated when all of the constant flow valves are in operation should vary from a minimum of 20 pounds per square inch to a maximum of 40 pounds per square inch. A "C" factor in the Hazen-Williams Formula of 150 may be used with confidence in computing friction losses in semirigid plastic pipe.

In most cases, storage is provided by the individual family, but in some cases it may be more feasible to provide larger storage which would serve the instantaneous needs of a cluster of houses. Pressure tanks constructed from steel, asbestos-cement, reinforced concrete or fiberglass should be considered. Pressure tanks should be considered when the pressure on the distribution system has been calculated to vary from 20 to 80 pounds per square inch. These pressure tanks do not need any additional pressure pumps. They are more sanitary, and their performance is better for most rural communities. Some problems have arisen in maintaining an equal balance of air and water in the tanks. If an air valve is provided in the tank, air can be supplied with a hand pump periodically.

Thus far, there has been insufficient data accumulated from experience to determine the exact size of these tanks. This would vary with the individual needs of the family, the pressure in the tank, and the quantity of water flowing into the tank. There is need for additional research in this field. We have assumed that the tank capacity should be equal to one-half day's average use, but there may be justification for decreasing the size of these tanks.

To overcome the nuisance of waterlogged tanks, some communities are considering the use of a tank constructed with an elastic membrane separating the air and water in the tank. These tanks are still rather expensive. An actual cost comparison can best be illustrated by describing an actual case.

Rural Water District Number 8 of Allen County, Kansas, was built to serve 45 farm families who used water for both domestic and livestock watering purposes. This constant flow system was built with a loan from the Farmers Home Administration in the amount of $50,000. The system involved 33 miles of pipeline distribution. A conventional system, designed by the most meticulous methods, would have cost $197,000, and the average cost per user would have been more than $20 per month. The constant flow system costs roughly one-fourth as much as the conventionally designed system, and the average cost of water per family was reduced accordingly. A user of this system can obtain 5400 gallons of water for $4 per month.

It becomes evident that if we compare this design with a design to serve a more densely-settled community having homes located on each 50-foot lot, the 400 families mentioned previously could be served with 12,000 feet of pipeline. If 50 gallons of water per minute were pumped through a 500-gallon hydropneumatic tank and into a distribution system designed on the basis of one-eight gallon per tap, a system could be constructed to serve such a community for approximately $40,000. The average water bill per family for 5,400 gallons of water per month would be about 60 cents.

Today - as with the Caesars - imagination, ingenuity, and resourcefulness will play vital roles in the development of adequate potable water supplies to serve millions of people who live in rural areas. We feel that the constant flow system is a step in that direction.

PLANIFICATION ET CONCEPTION DES RESEAUX D'APPROVISIONNEMENT EN EAU DOMESTIQUE A DISTRIBUTION CONTINUE

Résumé

Lorsque les familles sont installées trop loin les unes des autres ou que leur faculté de remboursement est si faible qu'un réseau classique d'alimentation en eau n'est pas économique, on peut appliquer le principe de la "distribution continue" pour mettre en place un réseau central et pratique d'approvisionnement en eau.

Le principe sur lequel se fonde la conception de la distribution continue consiste à maintenir un débit permanent dans les conduites. Cette communication traite de l'histoire de cette technique, de ses avantages et de ses inconvénients. Elle indique comment un réseau reposant sur le principe de la distribution continue peut efficacement fournir de l'eau de bonne qualité aux familles rurales pour moins d'un dollar par mois et par famille desservie, et explique également comment concevoir un réseau de façon à desservir des familles rurales très éparpillées, installées à plus de 1.500 mètres les unes des autres, pour une redevance moyenne de 8,50 dollars par mois.

PLANIFICACION Y TRAZADO DE SISTEMAS DE ABASTECIMIENTO DOMESTICO DE AGUA DE FLUJO CONSTANTE

Resumen

Cuando las familias están tan apartadas unas de otras o su capacidad de pago es tan baja que no resulta económico usar el sistema corriente de abastecimiento de agua, se puede utilizar el principio de "flujo constante" para establecer un sistema central de abastecimiento de agua que sea práctico.

El trazado se basa en el principio de la circulación continua del agua por las tuberías. En el trabajo se exponen los antecedentes del empleo de ese método de trazado, sus ventajas e inconvenientes y la forma en que un sistema así trazado puede suministrar agua de buena calidad a las familias de las zonas rurales, a un costo inferior a un dólar mensual por familia. También se explica la manera de hacer el trazado para que el sistema sirva a familias campesinas muy dispersas, con más de un kilómetro y medio de distancia entre sí, a un costo medio de 8,50 dólares mensuales para cada una.

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HOW TO SUPPLY THERMAL STATIONS WITH WATER

M. Lefevre

INTRODUCTION

In order to produce electric power both a hot source and a cold one are necessary. For the hot one, any of the many known fuels may be used including nuclear power; for the cold one, water has always been used.

To produce electricity under economical conditions, it is preferable to locate a power plant where water and fuel are available at close range and not too far away from the consumers' area, to avoid transportation of either the produced power or the fuel. This becomes more important with the increasing capacity of the new power stations.

At present, modern power stations are equipped to produce over 2000 mw. Such station needs approximately 300,000 cubic meters per hour (1,300,000 U.S. gpm), of water for the condenser cooling circuit.

In many cases, it is not possible to meet both requirements: to provide water and fuel on the same spot. It is then absolutely necessary to use artificial refrigeration of the circulation water for the condenser. An artificial refrigeration process is any process which evacuates heat directly to the atmosphere without using a natural source of cool water, such as a stream, river, lake or even seawater.

It may be useful to note that even in the case of natural cooling, heat is still transferred to the atmosphere, for if a river is warmed up above its natural equilibrium temperature, evaporation occurs with cooling in order to restore this equilibrium temperature after a flow of varying length.

Following are the various artificial cooling processes presently used in thermal power plants for which we will then attempt to make a brief economic comparison.

THE COLD SOURCE: THE ATMOSPHERE

Whatever the considered cooling process may be, natural or artificial, heat to be evacuated will always be transferred in the last stage to one of the two infinite cold sources we have, the atmosphere or the ocean. In order to evacuate directly or artificially into the atmosphere the heat originating in the condensation of the vapor exhausted from the turbines, there are three important processes which we will describe before comparing them.

1) The wet cooling tower with evaporation.
2) The dry cooling tower - Heller process.
3) The air-cooled condenser.

THE WET COOLING TOWER

We will not review all types of cooling towers used in industry. We will limit our survey to those presently operating in the thermal power plants and more specifically to the larger units now in operation which give the best picture of what may be built in the future.

Principle, Cooling Limit

To obtain a close contact and a rational relative movement between the water to be cooled and the cooling air, one of two techniques is used; the counterflow or the crossflow.

In the first case, the water flows downward by gravity onto the contact surfaces called filling and meets the air that moves upward. This is called the genuine counterflow. In the second case, to the contrary, the air circulates horizontally and crosses the trajectory of the water. This is the crossflow.

To move the air, in one case as in the other, large propeller-type fans may be used or a large chimney which creates a sufficiently important natural draft to produce the air flow necessary for the cooling.

In both cases, counterflow or crossflow, natural or forced draft, the theoretical cooling limit is the same. It is the temperature which corresponds to the wet bulb thermometer of a psychrometer placed in the given atmosphere.

The practical cooling limit is, however, sizeably different from the theoretical one. The crossflow tower is disadvantaged with regard to the counterflow. In the case of the counterflow, the coldest air is in contact with the coldest water; and, in addition, water is cooled in a uniform manner throughout the cooling tower. This is not true with the crossflow. By referring to Figure 1, which represents a section in a crossflow cooling tower, it is evident that the cold air is in contact at the same time with the water that has been cooled the most in (C) and with the water which is the warmest in (A). Consequently, the temperature of the cold water in CD is not uniform. The extremes are 22.6°C and 28.6°C.

These figures are even more eloquent if they are given in terms of approach. The approach is the difference between the temperature of the cooled water and the wet bulb temperature, i.e., the cooling limit. In this case, we may say that the approach varies from 2.6°C to 8.6°C, for an average of 6°C. Finally, a much larger heat transfer surface is necessary for cooling in this scheme than in the counterflow scheme, with a constant 6°C approach.

This handicap is greater if the average required approach is low, so that if it is as theoretically possible to reach an approach of 0 in one case as in the other, it may be said from an effective and economical point of view that the limit for the crossflow varies from 4° to 5°C, whereas the limit of the counterflow is of 2°C.

These figures are given for summer conditions when the wet bulb temperature is approximately 20°C and the cooling range approximately 10°C.

Presently, in the field of power stations, the approaches which prove economical are higher than these limits, so that both techniques are fully justified. This practical limit is however, sometimes sufficiently close so that the crossflow handicap becomes stronger and materializes by the sizeably greater dimensions of the cooling towers.

Natural Draft and Mechanical Draft

As already noted, there are two ways to move the cooling air. The first uses large propeller-type fans and the second a plain chimney which envelops all or part of the filling.

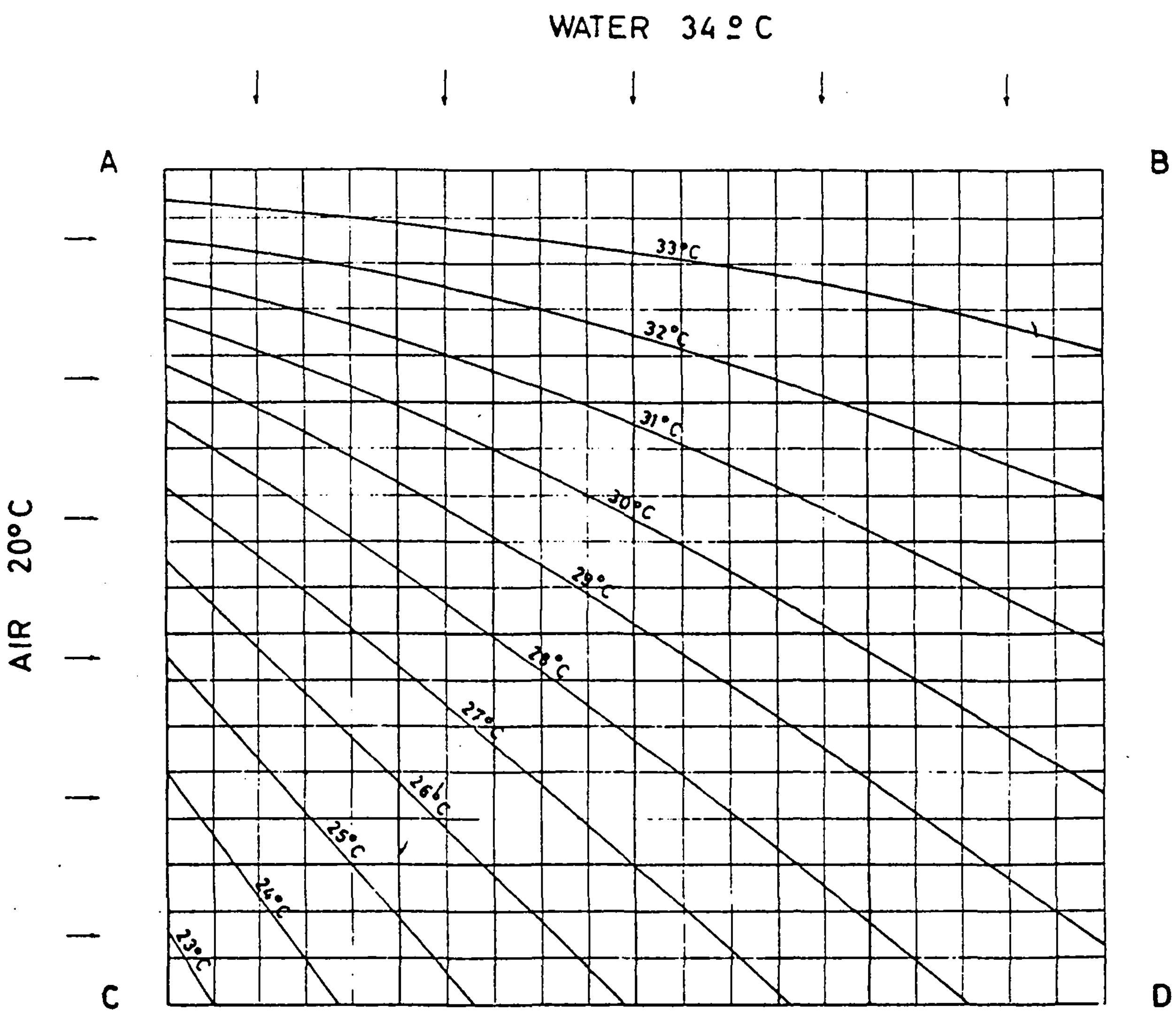

Figure 1.

The choice between these techniques is mainly economical. The initial investment cost is definitely higher for a natural draft than for a mechanical draft tower but it uses no fan power. In addition, from a cooling point of view, the natural draft tower performs better at a low ambient temperatures and vice versa.

There are however, numerous and very important advantages in favor of the natural draft which are in many cases sufficient to tip the balance. We will mention the total operating reliability, as there is no working mechanical part and hardly any maintenance, especially when using filling made of a permanent material such as asbestos cement. Finally there is the considerable exhaust height which cancels all problems of air pollution. This last point, which seems to be at first sight a small detail, is, on the contrary, of cardinal importance when dealing with power stations which produce powers of about 2000 mw, and which reject about 300 millions m^3/hr of moist air in the atmosphere. It is absolutely impossible to reject this moist air at a low height without causing unsolvable problems - not only recirculation problems but also drizzle precipitation problems due to the unavoidable condensation of part of the vapors. These problems must be added to those of ground fogging to which we have referred when speaking of air pollution.

In Europe for a long time and for a shorter time in the U.S.A., the natural draft has become more and more prevalent. Most of the power stations equipped with wet cooling towers have adopted this solution. The increasing power of installations increases the economical and working advantages of the natural draft, so that this solution will continue to be used more and more.

In this connection, it is interesting to note the very recent evolution which has occured in the U.S.A., where the economic conditions are less favorable to the natural draft than in Europe.

The main reason rests in the low cost of fuel, which reduced the importance of the economical advantages of the natural draft: fuel savings and absence of fan power. Nevertheless, due to the increase of power, the situation has changed in favor of the natural draft. This is why seven new power stations now under construction will be equipped with natural draft cooling towers.

In England, France and Belgium, the practical advantages of natural draft has been obvious for a long time. In the warmer countries of Southern Europe, such as Spain and Italy, the climatic conditions have often acted in favor of induced cooling towers. However only small units are still being built. For the large units to come, natural draft towers should be used.

As an example, large natural draft cooling towers serve thermal stations in Greece, a hot climate if any is, as well as in the South of France, the Arjunzanx power station in the Landes and the Gardanne power station in Provence.

Germany seems to have remained an exception to this rule. However the last [illegible]ree great power stations under construction in the country will be equipped [illegible]th natural draft cooling towers. They are the Niederaussem, Weisweiler and [illegible]uxel power stations.

<u>[illegible]illing</u>

The various types of filling used fall in two great groups: the film type fillings and the splash type fillings. In the first case, the heat transfer surface is essentially formed by a water film spreading over a tangible surface which is parallel to the air flow direction. The second process consists of breaking the water to be cooled into very small droplets which fall and split successively on laths, forming the filling. In fact, the choice of the type of filling is bound to the cooling method chosen, for the counterflow perfectly adjusts itself to the film type filling while the crossflow is more adapted to the splash type filling.

Another important item is the nature of the filling materials. Ten years ago, wood was used almost exclusively. Presently asbestos cement is generally used and stipulated in the specifications of many clients using cooling towers in France, Belgium and the U.S.A. Actually this material has 25 years of industrial application, as the first uses go back to 1941-1942. These towers are still in perfect working condition. We may say that the use of asbestos cement for fillings has completely eclipsed other techniques. In addition to maintenance charges which are practically nonexistent, the asbestos cement filling offers the advantage of reducing the cost of water treatment for the cooling towers.

Without dwelling on this subject too much, let us say that the wooden filling is very vulnerable to the chemical and biological attack of water. In order to avoid a more or less rapid destruction of this filling, the circulation water may not have a pH exceeding 7 to 7.5 nor a high bicarbonate content non-oxydizing algicide reagents, such as cholorine and its derivatives. This last requirement induces the use of much more expensive reagents than chlorinated compounds in order to control algae. For instance, we may use as replacement products quaternary- ammonium, chlorinated or nitrated by-products and particularly tri- or pentachlorophenate of sodium or mercury compounds, etc.

With asbestos cement, these difficulties are reduced. This material conveniently admits a pH from 6.5 to 10 and the carbonate content of water has no influence on the filling durability. The same applies to chlorine and chlorinated compounds which may be used safely in order to control algae formation. As an additional advantage of asbestos cement, it is possible to adopt a high pH in the circuit, which is very useful to protect the metallic parts of the circuit against corrosion.

Another important item: the fact of avoiding algicides, such as those which are based on chlorinated or nitrated compounds of phenol or mercury, often eliminates very difficult problems concerning the toxicity of blowdown to be rejected into natural streams. Finally, some algicide products are extremely dangerous to handle, such as pentachlorophenate of sodium.

THE DRY COOLING TOWERS, "HELLER PROCESS"

From the point of view of water consumption, the use of wet cooling towers in thermal plans for artifical refrigeration already represents very large savings. Let us mention some figures.

In order to produce 1kw/hr, a power station equipped with a wet cooling tower consumes about 2kg of water while the open circuit cooling of river water requires about 80 times more water.

A complex of 125 mw only consumes 250 m^3/hr. These 250 m^3/hr can compensate the water losses by evaporation and the blowdown. In a power station with four similar groups, this means 1000 m^3/hr. In the same way, a power station of 2000 mw will require 4000 m^3/hr for the sole purpose of compensating the evaporation losses and the blowdown. There are many places in the world where people dispose of cheap fuel, but it is impossible to find such water quantities in order to build a thermal power station.

There is fortunately another well-known process which enables operation without water. It is called the Heller process after the name of its inventor, Professor Heller.

This process is not new as its application in Hungary on a condensation plant of 5 T/hr dates back to 1954. Since then, the Heller process has proved successful, having been applied to a large modern unit. This is one of the 120 mw units built at the Rugeley thermal power station in England. This unit was commissioned in December 1961. Another plant of the same type is in the process of completion at the Iebenburen Power Station in the Federal Republic of Germany. This will have a power of 150 mw.

The whole process is sketched in figure 2. It consists mainly of condensing the exhaust steam in a jet condenser and cooling the circulation water in fin-tube heat exchangers where the water has no direct contact with the atmosphere. Numerous details complete this process, the application of which has become easy, safe and economical.

Many economical studies have shown that the best arrangement of the exchangers is to place them vertically at the base of a hyperbolic tower of the same type as those used for natural draft wet cooling towers. This solution has also been chosen for the Rugeley power station where the tower equipped with the Heller process is only different from the four others in its greater dimensions and in the absence of plume.

The Heller process thus enables the installation of a power station where water would not be sufficiently available to install one without it. One must consider this new possibility when seeking locations for the installation of new power stations.

In some cases, the dry towers will permit the expansion of an existing power station where no additional water resources are available.

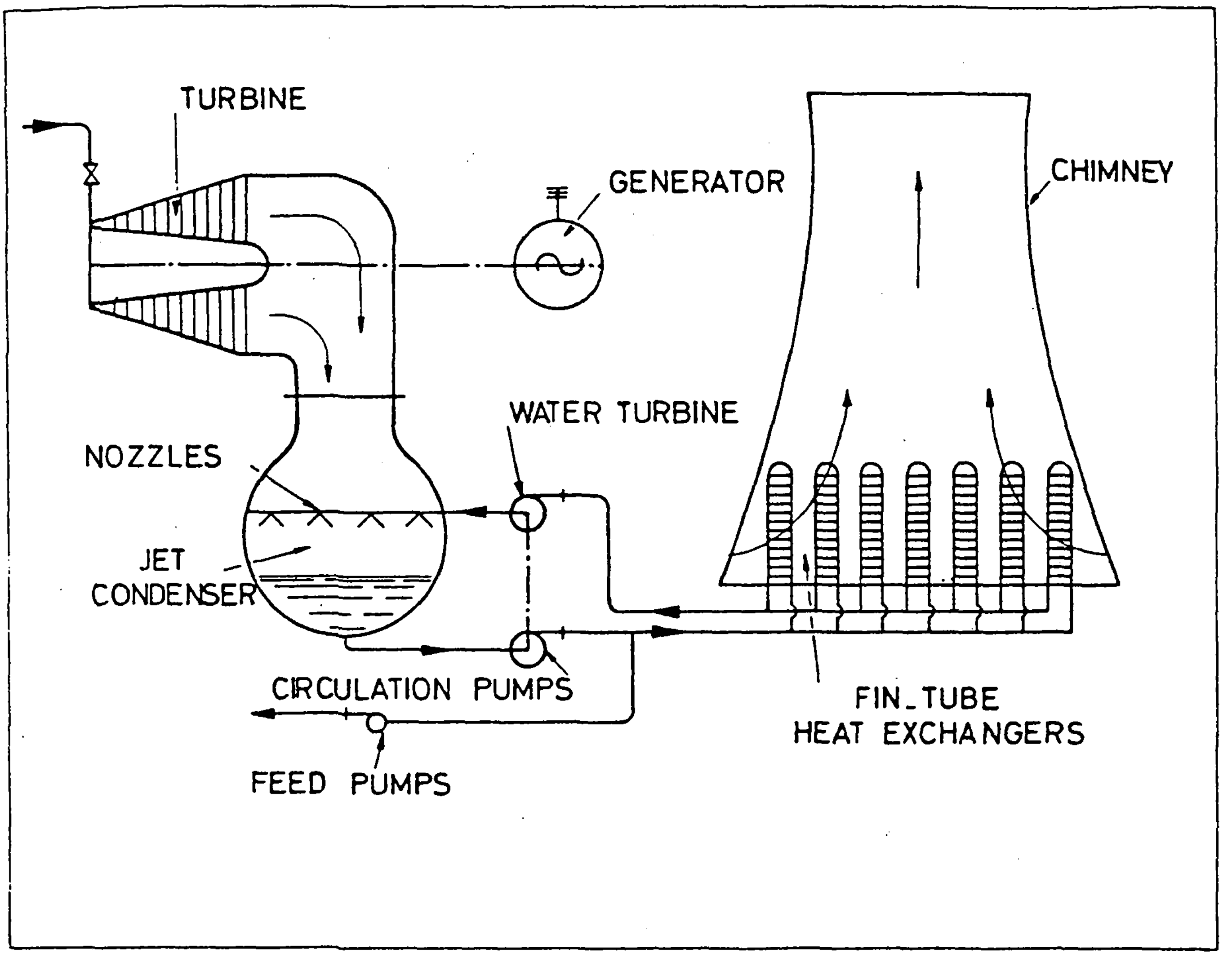

Figure 2.

THE AIR-COOLED CONDENSER

This process is the only one which does not use water for the cooling circuit of the condenser.. The steam is directly condensed in fin-tube exchangers. It is not used much for big units. It is, however, appropriate for smaller units, of which there are many, mainly in West Germany.

However, as far as we know, no large unit is equipped this way. The main reason is the necessity of bringing to the exchangers all the exhaust steam, which represents a very large volume and requires huge pipings if one wants to reduce head losses which are prejudicial to the efficiency of the installation.

The objection has been raised against this that it is difficult to maintain all the piping and the exchangers under vacuum; as well as that is difficult to locate quickly and easily the incidental air leaks.

The future application of this process to large units seems quite unlikely to us.

ECONOMIC COMPARISON BETWEEN THE HELLER PROCESS AND THE WET COOLING TOWERS

It is, unfortunately, impossible to make a general economic study showing absolutely which process is obviously the best in one or in the other case. Numerous factors are, moreover, very difficult to express in figures.

Investment Cost

It goes without saying that the initial investment expenses for the Heller process are higher than those of a conventional, wet, natural draft cooling tower. The main point lies in the fin tube-exchangers, the exchange surface of which must be high (approximately 2 m^2 per installed kw). Moreover, the tower having to induce the draft must also be much larger. Only the jet condenser is at an advantage in terms of the investment, for its price is about four times lower than that of a classical surface condenser.

It is estimated in France that a complete cooling tower, including accessories etc. costs approximately F 115 per installed kw for the Heller process and F 50, in the case of the classical process with a wet tower plus surface condenser (Figure 3). These figures were evaluated for units of 125 mw and more.

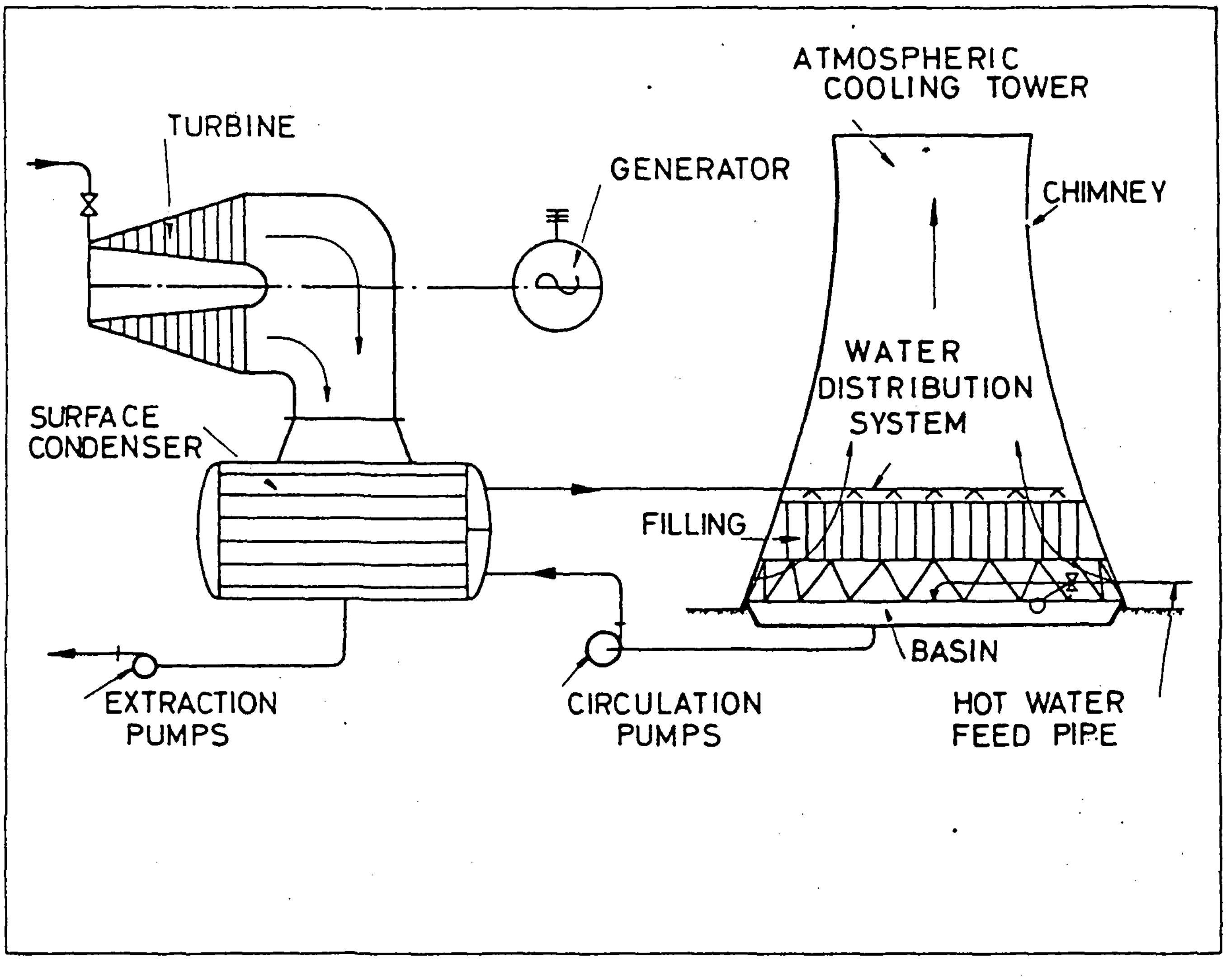

Figure 3.

Make-up Water

Under the present circumstances, the make-up water is already very expensive to the power stations. The water must be collected and treated, requiring investment and working expenses. In some cases, the cost of make-up water reaches F 0 35 to 0.50 per m^3. On the basis of a water comsumption of 2 kg per kw.hr produced, the capital expenses for make-up water are approximately F 70, to 100, per installed kw. Needless to say, this amount is considerable since it is higher than the initial investment costs of the cooling tower and condenser together.

Consumption of the Auxiliary Equipment

This is nearly the same in both cases owing to the use of a recovery turbine in the case of the Heller process. However a slight advantage applies to the wet cooling towers - about 0.5 percent of the installed power in lieu of 0.8 percent for the Heller process. Assuming an energy price of 5 centimes per kw.hr for the power required by the auxiliaries, this leads respectively to F 25, and 40, per capitalized kw.

Let us note that the Heller process with fans would require approximately 2 percent consumption for the auxiliaries, which penalizes it with about F 60 per kw with respect to the day natural draft solution.

As the first investment savings are far from reaching this amount, this explains why the natural draft has been chosen until now and will be adopted widely in the future.

Fuel Consumption

The economical working point of dry towers corresponds to a temperature of 5° to 6°C higher than that of wet towers. That means about 1 percent less efficiency, 20 cal/kw.hr more consumption. Capitalized, it leads to a loss of F 20, per kw. Other factors must also be taken into account but we will avoid presenting figures which would not be precise.

First, there is a loss of capacity at very high ambient temperatures. This results from low turbine efficiency due to poor vacuum. It becomes impossible to deliver the maximum capacity of the turbo-generator set, or at least that which could be produced if the generating equipment were associated with a wet cooling tower. This is deterimental, especially if total production capacity is needed.

This is the case in hot areas where air conditioning is generally used and consequently where the peak load coincides with these high ambient temperatures. In economic studies, the possibility must be considered of receiving assistance from generating units which could supply the necessary additional power at these times.

On the other side, let us mention some of the advantages of the dry process:

1. There is no risk of condensation pollution by the circulation water in case of leaks in the condenser tubes. Such leaks seldom occur nowadays, but the risk remains and is all the more serious because the boiler pressures are high. The Heller process thus enables economies on the polishing filters of the boiler feedwater.

2. The elimination of problems and vacuum losses resulting from the fouling of the surface condenser tubes. The efficiency of the jet condenser is invariable and requires no cleaning.

3. The turbine is cheaper because the optimum vacuum is higher. (The additional fuel consumption has been evaluated above.)

4. The savings on the engine room are appreciable, for the weight and the floor space occupied by the jet condenser are considerably smaller than those of the surface condenser. Moreover, it is not necessary to have clear space for cleaning and loading the tubes.

5. One has complete liberty in the choice of the power station locations. As already stated, when erecting a power station, one must always try to be as near as possible to the fuel and the consumption centers - in order to avoid expensive transportation charges - and also to the cold source, i.e., water.

The locations of fuel, water and consumer areas are not always close, and the possibility of eliminating one of these - water will almost always permit placing the power station close to one of the two others, and consequently to save on the transport of power or fuel.

Comparison

If we sum up the figures mentioned, we obtain in F per kw installed and capitalized, the data in Table I.

Table I. Comparison between the Wet Cooling Tower and the Heller Process

	Wet Cooling Tower	Heller Process
Investment.........	50	115
Consumption of the auxiliaries........	25	40
Make-up water......	70 to 100	0
Additional fuel....	base	20
TOTAL..............	145 to 175	175

CONCLUSIONS

The most economical process of artificial refrigeration of the circulation water for modern thermal power station condensers remains the natural draft, wet cooling tower. Close behind comes the dry Heller process, the advantages of which become greater as the water resources become more scarce.

Therefore it seems to us that in the near future the number of wet natural draft cooling towers will increase, but little by little, because as water becomes scarce and more expensive, more and more dry towers will be built.

L'ALIMENTATION EN EAU DES CENTRALES THERMIQUES

Résumé

La production d'énergie électrique est probablement l'industrie qui utilise le plus d'eau et cette situation n'est pas en voie de s'améliorer à l'avenir. Dans la plupart des pays industrialisés, la consommation d'énergie double tous les dix ans et l'avènement de l'énergie nucléaire n'apporte aucune solution au problème : bien au contraire, les réacteurs atomiques fournissent de la chaleur sous des caractéristiques telles que la partie conventionnelle "Centrales Thermiques" demande plus d'eau.

Aujourd'hui, une centrale thermique classique a besoin de 0,I5 m3 d'eau de refroidissement pour produire 1 kw/h.
On installe déjà des supercentrales qui totalisent en puissance installée plus de 2.000 MW.
Ces centrales ont besoin de 83 m3/seconde ou plus pour refroidir leurs condenseurs.

Il devient de plus en plus difficile de satisfaire aux besoins en eau froide de ces centrales et l'on atteint le plafonnement des possibilités naturelles de refroidissement.
Les pouvoirs publics en ont pleinement conscience et dans de nombreux pays, une règlementation sévère a vu le jour, à ce sujet.

De plus, il est le plus souvent purement et simplement impossible de trouver en toute saison une telle quantité d'eau.

Comme il est impossible, également, de produire l'énergie électrique sans posséder une source froide, la seule solution au problème consiste à remplacer l'eau naturelle par l'atmosphère qui est, avec la mer, la seule source froide inépuisable dont nous disposions.

Cette communication expose précisément les différents procédés, connus ou nouveaux, pour assurer l'évacuation vers l'atmosphère de l'énorme quantité de chaleur de condensation provenant des centrales.

Sans s'attarder aux solutions n'ayant aucun intérêt pratique, l'exposé décrit d'abord l'emploi du réfrigérant atmosphérique à tirage naturel qui utilise un prélèvement d'eau 80 fois inférieur qu'un refroidissement en circuit ouvert sans recirculation.

Pour les cas plus draconiens encore où l'on ne dispose même pas d'assez d'eau pour assurer l'appoint nécessaire au réfrigérant atmosphérique, on examinera les possibilités du procédé dit "tours sèches" ou système "HELLER" qui n'utilise pas d'eau du tout.

Nous passerons en revue l'aspect économique du choix de la meilleure solution en mettant l'accent sur les différents éléments entrant en ligne de compte dans une telle étude, parmi lesquels des points aussi importants que le choix du site d'installation des nouvelles centrales thermiques.

La conclusion justifiera pleinement le choix des solutions en faveur actuellement et s'efforcera d'envisager l'avenir compte tenu de l'accroissement incessant de l'acuité du problème de l'eau.

ABASTECIMIENTO DE AGUA DE LAS CENTRALES TERMOELECTRICAS

Resumen

La producción de energía eléctrica es tal vez la industria que utiliza más agua, situación que no tiende a mejorar en el futuro. En la mayoría de los países industrializados, el consumo de energía se duplica cada diez años y la introducción de la energía nuclear no trae solución al problema; por el contrario, los reactores atómicos suministran calor en condiciones tales que las centrales térmicas de tipo corriente requieren más agua.

Hoy una central termoeléctrica de ese tipo necesita 0,15 m^3 de agua de enfriamiento para producir 1 kw/h. Además, se han instalado ya supercentrales que en conjunto representan una potencia instalada de 2.000 Mw y necesitan 83 m^3 por segundo, o aún más, para enfriar los condensadores.

Se está haciendo más difícil satisfacer las necesidades de agua fría de dichas centrales y ya se ha alcanzado el límite de las posibilidades naturales de enfriamiento.

Los gobiernos tienen plena conciencia del problema y en muchos países se han dictado reglamentaciones severas al respecto. Además, a menudo resulta lisa y llanamente imposible hallar tales cantidades de agua en todas las estaciones del año.

Como igualmente es imposible producir energía eléctrica sin contar con una fuente de abastecimiento de agua fría, la única solución consiste en reemplazar el agua natural por la atmósfera, que es, junto con el mar, la única fuente de enfriamiento inagotable con que contamos.

La monografía expone los distintos procedimientos, conocidos o nuevos, para obtener la evacuación hacia la atmósfera de la enorme cantidad de calor de condensación procedente de las centrales termoeléctricas.

Sin detenerse a analizar las soluciones que carecen de valor práctico, el trabajo describe primero el empleo del refrigerante atmosférico de tiro natural, que necesita tomar 80 veces menos agua que un enfriamiento en circuito abierto sin recirculación.

Para los casos más difíciles todavía, en que no se dispone siquiera de agua suficiente para asegurar el aporte necesario al refrigerante atmosférico, se examinan las posibilidades del procedimiento llamado "de torre seca", o sistema Heller, que no utiliza agua.

Se analizan los aspectos económicos que presenta la busca de la mejor solución, subrayando los distintos elementos que deben tenerse en cuenta, entre ellos puntos tan importantes como la elección del emplazamiento de las nuevas centrales termoeléctricas.

La conclusión del estudio justifica la elección de las soluciones hoy preferidas y trata de dirigir una mirada al porvenir, teniendo en cuenta la gravedad cada vez mayor del problema.

WATER SUPPLY IN RURAL AREAS

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This work attempts to set forth some of the more outstanding theoretical and practical conclusions reached in the course of a careful study of the problems involved in supplying water to sparsely populated centres located in rural areas.

The subject is interesting for two reasons in particular. The first is that, regardless of the degree of development most countries have attained, the rural areas still need to be provided with modern equipment for water supply. It is therefore necessary for all countries to adopt a general policy of increasing their efforts for improvement in the fields of hygiene, sanitation, and public welfare.

The second reason is that, in trying to solve the problems of rural water supply, we are faced with a situation very different from the problems of supplying densely populated urban area, and which, therefore, seem to call for equally special solutions. In other words, we believe that the technological and organizational advances made in the last few years have been more intensely centered on the supply problems of the large urban areas and that they are still some basic aspects of the problem of supplying drinkable water to rural areas which have not yet been sufficiently explored and solved.

It should be pointed out at the start that this work is a summing up of a series of results obtained exclusively in Spain, the conclusions of which may not be applicable to other countries with different economic, politico-economic and administrative structures, and different cultural characteristics. On the other hand, it is quite possible that, in the same sense, they may clarify problems in countries of similar structure.

DEFINITIONS

The main source of confusion in technical literature on the subject is in the earlier definitions. Where are we to draw the mental line of differentiation between urban and rural areas (and supplies)? The statistics used in the different countries are often based on population, but in such cases there are frequent differences between the levels adopted (2000, 3000 or 5000 inhabitants). Some countries employ administrative criteria in their population figures, depending on what authority controls or gives social assistance to the various centres.

In other countries, among the municipalities considered as urban or rural in character merely because of a given population level, there exists a zone (from 2000 to 5000 inhabitants in France, for instance) in which the assignments to one or another category depends on factual characteristics (the housing concentration index, among others). In Spain the various, though not very numerous, statistics deal with this subject, but do not employ the same kind of differentiation.

The National Statistics Institute (in accordance with the recommendations made by the Conference of European Statisticians of the Economic Commission for Europe of the U.N.O.) uses the following tripartite distinction:

a. Urban population centres: those above the figure of 10,000 inhabitants

b. Interurban or semiurban: between 2000 and 10,000 inhabitants

c. Rural: below 2000 inhabitants

The term population center "means the whole of inhabitated or inhabitable buildings, whether grouped together or separated, with precise traditional or geographic limits."

Nevertheless, the statisticians in Spain have not used these distinctions in work relating to water supply. But the problem of definition does not seem to be confined to Spain. There does not seem to be any one uniform definition of the term "urban centre." The definitions of the national censuses of the different countries may be reduced to three main types:

1. Classification of the smaller administrative centres on the basis of criteria which may include, among others, (a) the type of local government, (b) the number of habitants, and (c) the proportion of the total population engaged in agricultural employment.

2. Assignment of the administrative centres of the rural districts to the "urban" category, the rest of such districts being considered "rural."

3. Classification as "urban" of certain population groupings, without taking into account their administrative limits.[1]

In any case, "an urban area, for the purposes of water supply, may also be defined as a district sufficiently populated and with the necessary density to permit the supply of water by pipes to its inhabitants."[2]

The concentration index of a population centre is evidently one of the essential data if we are to focus the problem in terms of the supply of drinkable water by means of a centralized piping system. In this aspect we consider that the "Community Water Supply Programme" of the W.H.O. has been right to include, in the concept it has formed of the centres which are its object, those "whose dimensions and geometric lay-out permit the supply of drinkable water to the majority of their inhabitants,"[3] without accepting the less flexible criterion of population figures.

This method seems to be the most practical way of looking at the problem. The numerical approach, though suitable for politico-administrative distinctions, is irrelevant to the statistic problems of water supply. What does seem essential is the population density, and also the "shape" of the centres; and what does appear possible is that in the future we may consider as urban centres only those provided with public services (among them drinkable water distributed by piping) which can be centrally exploited. We may also see that the quality of the public service equipment of a country will depend finally on the social customs of its population.

The question, however, remains: What are the problems to be faced, and what solutions exist, for these centres which are so widely separated and sparsely populated, and whose future development cannot be stated in terms of a transformation into more densely populated centres?

SPANISH STATISTICS

The statistical knowledge of these problems in rural areas in Spain is now much greater than it was some years ago. The variety of statistical approaches and the different criteria used make it impossible for us to compare the data from different sources and obtain definitive results. Below, however, we give the data that we have found most reliable.

The data afforded by the Rural Inquiry carried out by the Trade Unions in 1961,[4] with respect to 7429 Spanish municipalities[5] of 3000 inhabitants or less, based on the 1960 census, give us the following results:

Percentage of the sample taken out of the total of Spanish municipalities	80%
Number of families in the sample out of the national total	22%
Total number of families in the sample	1,721,669
Number of families with water in the home	309,156
Number of families without water in the home	1,412,513

The data from the inquiry conducted on behalf of the Sociological Report on the Social Situation of Spain[6]:

Total number homes in the sample	2,456
Rural areas[7]	1,296

Tap water in the dwelling:

In the total number of homes in the sample	62%
In the rural areas	37%

In order to compare these results with the supply situation in Spain for larger urban areas, we give below the following figures:

Total number of homes in municipalities of 10,000 or more inhabitants	4,212,642
Homes with tap water in the building or in the dwelling	2,897,252
Homes without tap water	1,315,390

The above data is from the 1960 Census, affecting 401 municipalities, which represent 57 percent of the Spanish population and 55 percent of Spanish families.

It is necessary to obtain statistical knowledge of Spanish population centres and, especially, of such growth tendencies as may be foreseen for the coming decades, in order to rationally plan a sanitary equipment policy and, more precisely, the development of the supply of drinking water. This has led the Ministry of Public Works to undertake a most valuable study which is now being carried out and is known as the "National Water Supply and Sanitation Plan." The objectives and progress of this plan are summarized in Appendix 1.

There is no doubt that this Plan can definitively calculate the real issues of the problem and be the basic instrument for the implementation of a water supply policy, tracing the lines of greatest efficiency for both short- and long-term investments.

It is possible that the rural areas, by definition the least suitable for the establishment of modern water-distributing services through pipes, may later be as fully equipped with public services as the more densely populated areas. But not to allow such a situation to develop could prove dangerous for the socio-economic structure of a country in terms of the tendency to emigrate to big cities and to change the population distribution. A national policy of water supply must take into account the need to establish suitable public services in rural centres, within the definitive socio-economic and demographic structure of a country.

THE BASIC PROBLEMS OF WATER SUPPLY SERVICES IN RURAL AREAS

Describing the problems of water supply in rural areas is a difficult task, considering the complexity, variety and interplay among them. The question is aggravated by the fact that along with them, and closely connected, there are the problems which derive from the general development of water supplies, a question especially basic in underdeveloped countries. Appropriate solutions to these problems must be found before a plan for promoting rural supplies can be formulated.

There also exists a problem which we consider an important antecedent to action in this field. We refer to the need for fostering the growth of information media and the creation of suitable and reliable statistical material. A good statistical basis seems to be absolutely indispensable. Among other basic data necessary for action on a national scale we should like to mention the following:

- Knowledge of the population figures relating to a water-distributing network
- Figures of daily per capita consumption
- Future demand for water
- Costs of constructing water supplies, per capita or per daily water volume

Even at the risk of dividing a series of phenomena which are, by definition, indissolubly united, below are listed the problems which we consider typical of the exploitation of water supplies in rural areas, and in which may be found a reason for the comparative backwardness of the water supply programs in rural areas in comparison with the supplies in more densely populated urban areas.

Sanitary problems

In recent years the World Health Organization has emphasised the extraordinary importance of supplying piped water to people in suitable quantities and quality for the national health of a country. In the most backward countries, it has been possible to calculate with great precision the expense incurred due to hydric diseases and, in parallel fashion, the way in which they operate to obtain a rapid amortization of the water-supply installations[8].

In this sense, the introduction of a modern water supply is in fact an advance which is not only important but even basic to the sanitary condition of a given area. The problems we refer to here are precisely those deriving from the difficulty of suitably controlling the potable conditions of water and the direction of treatment operations in rural areas, where the smallness of the plant frequently does not permit the employment of the appropriate, technically qualified staff.

Financial problems

We have already referred to the need for statistical knowledge of the cost of rural supply services in order to plan and develop them.

Here we should emphasize the problem produced by the low income level of rural areas and the necessity of foreseeing rather high charges per consumer in order to cover the costs of amortization and maintenance of the installations. In other words, the problem of the cost of running a perfectly equipped supply service in a small municipality consists in knowing whether it can be paid for by the users of the service or must be subsidized in one way or another.

Our experience shows that, if the operations are to be properly carried out, the running of a water-supply service requires that the user of the service be capable of bearing the financing of the project, and that indirect financing of the supply, without being based on cost prices, tends in the long run to ruin the first installation and to jeopardize the technical and sanitary quality of the water-supply service.

Technico-administrative problems

Enumerated below are those problems which, in our opinion, arise in almost all population centres in rural areas and which have a cumulatively deteriorating effect on the service:

Relatively low consumption per user

Important variations due to seasonal utilization of the service

Difficulty in the upkeep of the installations inherent in the extension of the networks and the dispersion of the consumer

Lack of suitable and sufficiently numerous staff to attend to running the operations at a low cost

Disorganized administration

Small and irregular income

In Spain most municipalities are managed by direct administration. On the principle of direct management, the municipality guarantees the service on its own account and with its own staff, and only in municipalities of a certain size is there a Chief of Technical Services. Even in such cases, he is responsible not only for the water supply service but also for many other activities in the municipal domain: sewage, building maintenance, lighting, roads, etc. That is to say whatever his degree of suitability and willingness to work efficiently, he can never be a specialist because of the wide range of different jobs he is called upon to do. In smaller municipalities this official does not even exist. The office work falls to the secretary and with him, for the actual running of the supply, we find a plumber for looking after the network and/or an electrician, who takes care of the pumping stations.

As the township is built up, the distributing network grows without any previous study, simply by joining the new pipes to the existing network. Some years after the initial laying and entering into service of a new network, one which, let us suppose, is well conceived and carried out, the electric and mechanical installations are usually in bad condition and have to be entirely renovated. Leaks occur in the network, and then studies have to be made which involve substantial expense in order to launch new catchments and use them to compensate for the losses in the network. The valves get blocked up; the piping becomes stopped up or corroded; the meters give false readings or are no longer installed in the new service connections; the inhabitants, in short, begin to show signs of dissatisfaction. They are told, however, that water is not expensive. That is true enough, but what has happened is that the expenses of the distribution service have by now passed into the general budget of the Municipality, and they have reached a situation of total ignorance with regard to the cost prices of the service[9].

Legal problems

We believe that, at present, legislation is not flexible enough to permit new forms of water supply services, for the existing laws in Spain are based on the unsound assumption of self-service or direct administration. A study should be made of legal formulas which could be rapidly applied and would permit forms of association or technical collaboration within the municipal framework for the operation of the water supply services. Governments have hitherto laid emphasis on their policies of fostering and developing the existing supplies, and that is why almost all countries possess a high degree of legislation with regard to the provision of state aid for the construction of new water supply networks and base installation. But in addition to this, the State must forsee a rational utilization of these installations, which, in most countries, later escapes from its control.

At the international level, experts have frequently expressed their opinion as to the absolute uselessness of spending substantial sums by international development agencies on construction programs for water supply services if,

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at the same time, there is no assurance of a proper running of such installations. We quote below two of the factors indicated in the World Health Organization report "Urban Water Supply Conditions and Needs in Seventy-Five Developing Countries." According to the experts these factors, among others, exercise a more noticeable influence on the deficiencies of urban water-supply services in developing countries:

> "Inept and inadequate operation and management, and lack of an effective administrative machinery and of technical staff to promote and design new urban water supplies or to improve existing schemes, are other factors to be added to the handicaps already listed. These result mainly from a lack of training facilities, but they are frequently due to the influence of conflicting local interests and politics. Without independent and self-sufficient management most water supplies cannot be maintained."
>
> "Inadequate legislation, poorly defined water rights and failure to clearly delegate responsabilities are additional drawbacks in urban water supply. In many developing countries outmoded water laws hamper, or even obstruct, practical measures, create uncertainty and sometimes prevent positive action. Also, old-fashioned organizational structures fail to meet modern demands for efficient licensing, supervision and, possibly, financial support." [10]

ESSENTIAL IDEAS FOR THE REFORM OF THE EXISTING SYSTEMS

The interplay of such problems in rural water supplies seems to produce the following consequences:

- Smallness of the exploitations
- Tendency to avoid self-financing of the service
- Lack of promotion of the proper technicians
- Low quality in sanitary control
- Nonexistence of long-term planning
- Deficiencies in the upkeep of the first installations

Faced with these consequences, we may well ask ourselves what possibilities they suggest for the proper management of supplies in rural areas. It is our opinion that the first point to remember should be the need to envisage the problem on a national scale, not only in order to bring the question nearer to the more essential one of the entire administration of hydraulic resources, but also to reach a better estimate of insufficiencies and investment planning. What needs to be done first here would seem to be the preparation of the statistical material necessary for such an estimate, material which, in our opinion, should coincide with, or be usable for, other directive tasks: demographic plans, land management and settling, irrigation and agricultural development plans, etc.

Secondly, we must face the factual reality of the smallness of the supply services in rural areas and base all solutions for their management on this reality. It is evident that we must deal with three fundamental ideas: 1) grouping by aones; 2) joint management of common services; 3) division of work. At present there seem to be two clearly defined ways of putting these ideas into practice:

a. Association of supply services. (By this we mean the planning and execution of catchment, elevation and distribution works common to various population centres.)

b. Centralized management of individual supplies. We mean by this term the action of organizations or companies whose mission would be to organize teams of technicians and highly specialized staff, whose services could be profitably used in an area in which there would exist a given number of water supply installations which could not individually afford such services so essential for the good technical management of the base installations.

This kind of management may affect only certain services (quality control, invoicing, important repairs, apparatus repair workshops, etc.) or the whole of the supply. In the latter case there is an end to direct administration on the part of the local municipalities, and an organization or company takes over all the water-supply operations by means of a contractual act which should be provided for in administrative law.

Finally, one should remember the need to make a decision with regard to financing the public supplies of drinking water. In this respect we think it worthwhile to quote another paragraph from the WHO study referred to above:

> "The factor which is probably the most significant cause of world-wide deficiencies in community water supply is inadequate financial support. An urban water scheme without adequate revenues even for effective operation and maintenance (as is the case in many cities in the countries covered in this report) necessarily will also lack financial resources for expansion, and the physical condition of the existing system will inevitably deteriorate. Revenues, in this sense, means all financial resources directly or indirectly available to meet the costs of operation and capital investment."[12]

There seems to exist, in fact, a certain correlation between the appearance of dificiencies in a water-supply service and the management of same which is not based on terms of costs and self-financing. The implanting of a new way of thinking, both in the organizations which direct and are responsible for public services and in those who utilize such services, may prove to be, sooner, or later, an essential phychological element in facing the kind of problems we are speaking of in many countries.

CONCLUSIONS

1. National planning, zonal exploitation, centralized management of individual services, self-financing: these would seem to be the outstanding directive elements of a modern approach to the problem of operating supply services of drinkable water in rural areas in which we may observe inefficiencies when compared with the supply services of large urban areas.

2. Moreover, the nonexistence of such elements of modern management may be one cause of the lack of development of urban supplies in rural areas, since public investments cannot count on any expectation of a yield which would be socially or economically comparable to that obtained in urban areas or in other spheres of governmental activity.

3. Considering the question on a higher level, the development of water supply in rural areas may constitute a fundamental element, not only in the improvement of the sanitary level of the country, but also in the application of principles of demographic policy and of socio-economic administration of the territory involved.

   We have yet to see what future tendencies may be in the establishment of the population in any one territory. For the moment, there is an evident and dangerous movement towards the constitution of gigantic urban centres, the formation of which comes basically from the absorption of masses of people from rural centres with deficient public services. The control of these tendencies seems to be the task of governments. In any case, the search for suitable management formulas for the running of public services in sparsely populated areas seems to be an essential antecedent to the planning for the establishment of any future society in a given territory.

NOTES

1. Hauser, P.M., "Urbanization in Africa and the Far East," Proceedings of the Joint UN/UNESCO Seminar on Urbanization in the ECAFE Region (Bangkok 8-18 August, 1956) UNESCO, Calcutta.

2. Dietrich, B.H., and Henderson, J.M., "Urban Water Supply Conditions and Needs in Seventy-five Developing Countries." WHO, Geneva, 1964, page 70.

3. Ibid.

4. Data quoted in the "Caritas Espanola - C.C.B. Plan," Madrid, 1965.

5. The administrative division of Spain is based on the municipality, the lesser administrative body, of which includes 9200. There are 1700 municipalities in Spain of over 3000 inhabitants and the province, based on the historical-traditional division of national territory, which numbers fifty and includes all the municipalities in the area. The number of population centres amounts to 69,458. Annual Directory of the Spanish Market, "Banco Espanol de Creditor," 1965.

6. "Informe sociologico de las situaction social en Espana," Fomento de estudios rurales y de sociologia de Espana, Madrid, 1966, page 211.

7. See the above-mentioned "Informe sociologico," p. 31, for the method employed for determining rural areas.

8. Table V. Approximate Cost Per Inhabitant of Rural Water-Supply Services and the Installation of Latrines; Expenses Caused by Typhoid Fever, Diarrhoea, and Enteritis per 100,000 Inhabitants in Some Countries, in 1949.

Country	Cost of the supply service per inhabitant ($)[a]		Cost of the installation of latrinas per inhabitant ($)[a]		Total cost per 100.000 inhabitants ($)	Expenses caused by fever, diarrhoea and enteritis per 100.000 inhabitants ($)	Years needed to amortize the installations with operating profits.
	Installation costs	Running costs	Installation costs	Running costs			
U.S.A.	17,00	0,55	14,00	5,57	3.730.000	55.720	68
France	5,25	0,17	4,35	1,80	1.157.000	73.000	16
Portugal	1,65	0,05	1,35	0,55	360.000	191.230	2
Japan	1,15	0,04	0,95	0,40	254.000	57.750	5
Colombia	2,35	0,08	1,95	0,80	518.000	195.775	3
Ceylon	0,98	0,03	0,80	0,33	214.000	49.130	4
Dominican Republic	1,10	0,04	0,94	0,38	246.000	86.900	3
India	0,63	0,02	0,52	0,21	138.000	58.265	3

[a]This includes salaries, material and equipment. The cost is considerably reduced if labour is free and if use is made of materials easily obtainable locally.

Source: Wagner, E.G., Lanoix, J.N., "Water supply in rural areas and in small communities." O.M.S., Geneva, 1961.

9. Rabourdin, G., "El abstecimiento de agua en los municipios rurales franceses." Sociedad de Abastecimientos Urbanos y Rurales, Estudios (1), Barcelona, 1965.

10. Dietrich and Henderson, _op_. _cit_.

11. In France there are many municipalities with association-type supplies. (Rural municipalities, 48%: Supplied, 27 percent; non-supplied 21 percent. Of the 27 percent of municipalities supplied, 25 percent are by association and only 2 percent by individual distribution. See Rabourdin, _op_. _cit_., page 8.)

12. Dietrich and Henderson, _op_. _cit_.

APPENDIX

The General Office of Hydraulic Works, in accordance with the Ministerial Decree of May 14th, 1965, began the necessary steps for carrying out an ambitious plan, which includes all Spanish centres of over 50 inhabitants. Below this figure remains only the most widely dispersed population.

It was immediately decided to organize the Supply and Sanitation Planning Section in the General Office, to which, with the Regional Services of the General Office of Hydraulic Works, would be entrusted the carrying out of the National Supply and Sanitation Plan. The first objective was to issue general instructions for drawing up a project for the provincial supply and sanitation plans; these were approved in September of 1965. In the plans the hypotheses and directives to be adopted are given definite form in an attempt to unify criteria and action for the whole of Spain, despite the obstables and differences in the different zones.

Three phases were fixed for this work: research, follow-up, and implementation. The research phase, now completed, consisted of a demographic study of all population centres of over 50 inhabitants to determine their projected populations after 25 and 50 years. It was assumed that population increase and decrease would take place according to compound interest rates, given the percentage of growth in the periods 1900-1960, 1930-1960 and 1950-1960.

One hypothesis was that independent of other factors, the most significant percentage in indicating the present growth rate is that of the last decade a weight of two and the percentage of the next nearest decade a weight of one, the latter being a stabilizing addend. In the study close attention was paid to the tourist factor and the summer holidays, which have a great effect on the population of some zones in some seasons.

Certain town-planning levels based on population were established in order to study population centers on a bsis other than consideration of their economic characteristics (industrial, touristic, agricultural, etc.). The levels are as follows:

Level A: up to 1,000 inhabitants

Level B: from 1,000 to 6,000 inhabitants

Level C: from 6,000 to 12,000 inhabitants

Level D: from 12,000 to 50,000 inhabitants

Level E: from 50,000 to 250,000 inhabitants

Level F. over 250,000 inhabitants

The demographic study showed, with some exceptions, that Level A showed an index of rapid decrease, Level B was still decreasing, Level C was the zone of stable centres, and from D on there were very few centres with decreasing population, the increase being much more noticeable in the last levels.

Assuming that the minimum urban water consumption is 150 l/h/d and bearing in mind the rapid decrease in the centres in Level A, the following figures have been established as the necessary supplies for 1960:

Level A: 100 l/h/d
Level B: 150 l/h/d
Level C: 175 l/h/d
Level D: 200 l/h/d
Level E: 300 l/h/d
Level F: 400 l/h/d

Given the volumes necessary for the present population, we may obtain the requirements for 25 and 50 years after in the future by applying the coefficient of population increase previously explained and the coefficient of increase due to better living standards. The latter has the following values: 1.45 for 25 years in rapidly growing centres; 2.13 for 50 years in slowly growing centres; 2.65 for 50 years in rapidly growing centres. By rapid growth is meant an annual growth percentage higher than 0.5. The plan deals with figures for 25 and 50 years because the plan will establish the budget for the works necessary after 25 years and for the reserve of volume after 50 years. Another objective of the first part of the plan was to compile the dispersed data of supply and sanitation.

The second phase of the plan, follow-up to basic research, consisted of checking the basic data directly by visiting and investigating all the centres in order to determine their present condition and needs. A study was also made of currently available supply resources. A study was carried out on all springs and other surface waters to gauge their volume and to determine precisely the areas which might require later hydrogeological study. The purpose was to analyse not only the volumes but also the quality of the waters. To this end analysis was made of all the above-mentioned waters, in an attempt to achieve a clear idea of the cost of their use to produce potable water, taking into account the necessary degree of purification, action on pipes, etc.

All such data is to be taken on all supply and sanitation that indicates clearly the present supply, and for this purpose a pre-project study was made of all the projects necessary to permit all the centres to meet their established requirements in the matters of catchment, piping, purification of white waters, reservoirs, distribution networks, sanitation networks, purification of residuary waters, and emptying and utilization of residuary waters.

In principle, for financing purposes, the plans will be based on the establishment of contributions by the beneficiaries and the local authorities, the minimum contribution of the former being 15 percent of the cost of the works, and the minimum contribution of the latter being a minimum of 35 percent.

At present work is rapidly going ahead on this second phase and very shortly it will be submitted for approval. Once the plan has been approved, the third phase, consisting of the drawing up of the projects, works, conservation, and running of the services, will begin.

(Plan Nacional de Abastecimiento y Saneamiento, Aurelio Hernández, Revista Agua, Sept.-Octubre 1966).

APPROVISIONNEMENT EN EAU DANS LES ZONES RURALES

Résumé

Définitions

La présente étude pourrait porter sur la distinction, quant au concept, entre les centres (ou systèmes d'approvisionnement en eau) urbains et ruraux. Il n'existe apparemment pas de définition uniforme du concept "urbain" et "rural" appliqué à l'approvisionnement en eau. La distinction est habituellement fondée sur les classifications démographiques nationales. En Espagne, le niveau de 3.000 habitants semble avoir une certaine importance statistique. Quoiqu'il en soit, même les agglomérations rurales doivent présenter des caractéristiques telles que "leur nombre d'habitants et leur plan d'urbanisme rendent matériellement possible la construction d'un système moderne de distribution d'eau potable à l'intention de la majorité de leurs habitants." 1/

L'aspect qualitatif est également important. En fait, une agglomération ne peut être considérée comme telle que dans la mesure où elle dispose de services adéquats pour la collectivité. Il conviendrait d'apporter quelques précisions à ce sujet.

Statistiques

Nécessité de disposer de statistiques exactes pour la planification des ouvrages en rapport avec les grandes lignes de la politique hydraulique et de la politique économique générale du pays.

Le Plan national espagnol d'adduction d'eau et d'assainissement peut être, à cet égard, d'une importance capitale.

Manque de données et de précisions. Nous avons retenu les données résultant de l'enquête rurale effectuée par l'Organisation syndicale 2/ relative à 7.429 municipalités espagnoles comptant 3.000 habitants ou moins, laquelle a donné les résultats suivants:

Pourcentage du sondage par rapport au total des municipalités espagnoles: 80%

Nombre de familles ayant fait l'objet du sondage par rapport au total national: 22%

Nombre total des familles ayant fait l'objet du sondage: 1.721.669 (recensement de 1960)

Nombre de familles ayant l'eau courante: 309.156

Nombre de familles n'ayant pas l'eau courante: 1.412.513

Examen de la situation statistique dans d'autres pays.

1/ Dietrich-Henderson, Urban Water Supply conditions and needs in 75 developing countries, O.M.S., Genève 1963, page 70.

2/ Etude Caritas Española - Plan C.C.B.

Différents types d'adduction d'eau

A) 1. Systèmes d'adduction individuels.
   2. Systèmes d'adduction coordonnés (collectivités, syndicats).

(Examen de la situation en Espagne et en France)

B) 1. Administration directe du service.
   2. Syndicats d'exploitation provinciaux ou départementaux.
   3. Gestion effectuée par une entreprise privée.

Les problèmes de base relatifs à la distribution d'eau en milieu rural

Problèmes financiers: coût élevé du service par abonné afin de faire face à l'amortissement des installations.

(Problème du coût des services. Coût par habitant. Chiffres existants. De tels chiffres ne sont pas disponibles en ce qui concerne l'Espagne.)

Problèmes sanitaires: Le point de vue de l'O.M.S.

Problèmes techniques et administratifs: Consommation relativement basse par abonné.

Variations importantes en raison du caractère saisonnier de l'utilisation.

Difficultés en matière d'entretien des installations inhérentes à l'extension des réseaux et à la dispersion des abonnés.

Difficultés d'entretien dues aux circonstances socio-économiques du milieu rural. Le problème relatif aux techniciens. L'ingénieur sanitaire.

Difficultés s'opposant au maintien d'une gestion administrative et technique compétente en raison du caractère limité du pouvoir économique des centres ruraux. Recettes limitées et irrégulières.

Problèmes de nature juridique: Caractère inadéquat de la législation en vigueur et de la réglementation administrative appliquées aux problèmes actuels.

Les conséquences:

- Charges élevées par abonné.
- Rareté de l'autofinancement du service.
- Manque de techniciens qualifiés.
- Faible importance des exploitations.
- Médiocrité du contrôle sanitaire.
- Inexistence de plan de développement à long terme.
- Mauvais entretien des premières installations.

L'importance de l'adduction d'eau en milieu rural dans la politique nationale en matière d'assainissement et de démographie. Le développement régional (social et économique) par rapport au niveau des services publics dans les petites agglomérations.

Recommandations:

- Planification nationale.
- Exploitations régionales (collectivités).
- Aide financière (autofinancement)
- Exploitation technique compétente: Le rôle de l'entreprise privée.

ABASTECIMIENTO DE AGUA EN EL MEDIO RURAL

Resumen

Definiciones

El estudio podría abordar el tema de la distinción conceptual entre núcleos (o abastecimientos) urbanos y rurales. Parece no existir una definición unitaria del concepto "urbano" y "rural" aplicado al abastecimiento de agua. La distinción suele basarse a menudo en las clasificaciones demográficas nacionales. El nivel de los 3.000 habitantes parece tener cierta virtualidad estadística en España. En todo caso, incluso los municipios rurales deben presentar características tales que "su cifra de población y su geografía urbanística hagan materialmente posible el tendido de una red moderna de agua potable para la mayoría de sus habitantes". (1)

El aspecto cualitativo es importante: De hecho sólo puede considerarse núcleo de población el que disponga de los servicios adecuados para la comunidad. Alguna precisión en este sentido podría ser interesante.

Estadisticas

Necesidad de un conocimiento estadístico exacto para el planning operativo de obras, en relación con las líneas generales de la política hidráulica y económica general de un país.

El Plan Nacional español de abastecimiento y saneamiento puede ser en este sentido de capital importancia.

Escasez de datos y poca precisión. Destacamos los procedentes de la Encuesta Rural efectuada por la Organización Sindical (2), relativa a 7.429 Municipios españoles de 3.000 o menos habitantes, de la que se desprende lo siguiente:

Porcentaje de la muestra sobre el total de Municipios españoles: 80%

Nº de familias en la muestra sobre el total nacional: 22%

Nº total de familias de la muestra: 1.721.669 (censo 1960)

Nº de familias con agua domiciliar: 309.156

Nº de familias sin agua domiciliar: 1.412.513

Exámen de la situación estadística en otros países.

Tipos de Abastecimiento

A) 1.- Abastecimientos individuales.
2.- Abastecimientos coordinados (mancomunidades, sindicatos).

(Exámen de la situación en España y Francia).

B) 1.- Administración directa del servicio.
2.- Sindicatos provinciales o departamentales de explotación.
3.- Gestión por empresa privada.

Los Problemas Basicos del Servicio de Abastecimiento de Agua en el Medio Rural

Financieros: Importantes cargas por abonado para hacer frente a la amortización de las instalaciones.

(El problema del coste de los servicios. Coste por habitante. Cifras existentes en la actualidad. Desconocemos la existencia de cifras relacionadas con España).

Sanitarios: El punto de vista de la O.M.S.

Técnico/adm.: Consumo relativamente bajo por abonado.

Variaciones importantes por la utilización estacional del servicio.

Dificultades de entretenimiento de las instalaciones inherentes a la extensión de las redes y a la dispersión de los abonados.

Dificultades de entretenimiento por las circunstancias socio-económicas del medio rural -El problema de los técnicos-, El ingeniero sanitario.

Dificultades de mantener una gestión adm. y técnica de calidad, por la poca entidad económica de los núcleos rurales.

Ingresos poco importantes e irregulares.

Legales: Inadecuación a los problemas actuales de la legislación existente y de la reglamentación administrativa.

Las Consecuencias

- Cargas elevadas por abonado.
- Tendencia a no autofinanciar el servicio.
- Falta de técnicos apropiados.
- Pequeñez de las explotaciones.
- Baja calidad del control sanitario.
- Inexistencia de previsión a largo plazo.
- Mala conservación del primer establecimiento.

La importancia del abastecimiento rural en la política sanitaria y demográfica de lo desarrollo socio/económico, regional y su relación con el nivel de servicios públicos cleos de población de poca entidad demográfica.

Recomendaciones

- Planificación nacional.
- Explotación por zonas (mancomunidades).
- El soporte financiero (autofinanciación).
- Explotación técnica de calidad: El papel de la empresa privada.

NOTAS: (1) Dietrich - Henderson "Urban Water Supply conditions and needs in 75 developing countries" O.M.S. Ginebra 1963, página 70.

(2) Estudio Caritas Española - Plan C.C.B.

POTABLE WATER PROBLEMS AND THE DEVELOPMENT OF RURAL-COMMUNITY WATER-SUPPLY IN THAILAND

Somnuek Unakul, William A. McQuary

For many years one of the most serious health problems in Thailand has been associated with "waterborne" diseases. Statistics of the Royal Thai Government (RTG) Department of Health indicate that over 90 percent of the rural population is infected with water-borne intestinal parasites. Approximately 60 percent of the morbidity and 40 percent of the mortality in Thailand is attributable to waterborne diseases such as cholera, typhoid fever and dysenteries. These diseases have reduced the vigor, productivity and efficiency of the people, thus resulting in tremendous economic and financial losses to them and to the country as a whole.

Traditionally, the rural dwellers have obtained water from unprotected ponds, wells, cisterns and sometimes streams. In most cases, these water sources are heavily polluted by human excreta and debris. In several villages, people have to walk great distances during the dry season to obtain water, which in most cases is unsafe for human consumption. Since this non-potable water is difficult to obtain it is sold at a high price; forty liters for two baht (10¢US) is quite common in many communities. Hence, water, a basic necessity of life, costs more in time and money to maintain the minimum hygienic condition than the people can afford.

Water systems have been constructed in Thailand for many years. In Sukothai, the first capital of Thailand (ca 1300 AD) ruins of a water system consisting of a dug well and reservoir which was constructed during that era can still be seen. Lopburi, a later capital of Thailand (ca 17 century AD), was the first city in the country to have piped water. The line, however, only went from a reservoir to the royal palace.

Modern potable water systems have been constructed in larger municipalities of Thailand for about sixty years. There are 87 larger municipalities and approximately 50 smaller communities which have potable water systems. However, little has been accomplished in rural areas. For several years a very active dug well and pond construction program has been carried out. Thousands of these have been constructed, but it is estimated that almost 45,000 communities still lack adequate potable water.

Only recently has the Royal Thai Government realized that potable water is essential to health as well as to the development and progress of the country. The "National Rural-Community Water Project" which aims to improve the coordination of the various agencies involved, was organized in 1966. The nature and the scope of this project is very extensive, and therefore cannot be easily accomplished in a short period of time. The Government has set the first phase of this project for six years (1967-1971), and has divided the responsibilities among the following national agencies:

1. The Department of Health is responsible for construction of all potable water-supply systems in rural communities.

2. The Department of Mineral Resources is responsible for drilling deep wells within the Northeast area of the country. It is expected that the number of deep wells to be drilled by this department will be approximately 2850 during the next six years.

3. The Department of Public & Municipal Works is responsible for well drilling outside the Northeast region.

4. The Department of Local Administration is to provide rural dwellers with water reservoirs and cisterns and assist in developing water sources for small communities.

The Government, realizing the necessity for accelerated development in cooperation with the United States Agency for International Development (USAID), has organized and implemented an Accelerated Rural Development (ARD) Project in North and Northeast Thailand. This program affects approximately three million of the eleven million inhabitants of the region. The area is located along the frontier between Thailand, Laos and Cambodia. Agriculture is the main occupation, although the soil is generally poor. The climate is extreme in that there is no rainfall for approximately three-fourths of the year. The inhabitants are poor and have the lowest per capita income of any area in the country. The incidence of morbidity and mortality is higher in this region than in the rest of Thailand. The government is trying to better the economy of the country and feels that the greatest improvement can be made in this area. The economic improvement will also help the social and political conditions in this area. It is realized that accelerated development cannot be attained without potable water. Therefore, a plan to relieve the critical water shortage in the area has been developed by the Department of Health and USAID.

The broad objective of this activity is to improve the general health environment and demonstrate the RTG's interest in, and concern for, the hitherto relatively neglected population in the North and Northeast of Thailand. In the process, a local contracting capability for this type of public works is being developed, and valuable training is being provided for RTG personnel in the development, construction, operation and maintenance of community water supply systems.

The following is a list of all agencies who are interested in the development of water supplies, although potable water is of secondary importance to some of of them.

1. Department of Health
2. Department of Mineral Resources
3. Department of Public and Municipal Works
4. Royal Irrigation Department
5. Department of Local Administration (Individual Province Administration)
6. Department of Community Development
7. Department of Public Welfare
8. Ministry of Defense
9. National Economics Development Board (Planning)
10. The Agency for International Development
11. South East Asia Treaty Organization (SEATO)
12. World Health Organization (WHO)
13. United Nations International Children Emergency Fund (UNICEF)

A cooperative groundwater program was started in Northeast Thailand in 1951 by ECA-MSA and the RTG Department of Health, Ministry of Public Health. This project was expanded in 1955 to include the Royal Irrigation Department and the Department of Mineral Resources. A private drilling company (Daniel, Mann, Johnson and Mendenhall) was contracted and brought into the organization. By 1963, all of the well rigs had been transferred to the Department of Mineral Resources. At the present time only the Department of Mineral Resources has a successful well-drilling program in that area and has drilled more than 1000 usable wells there to date, some of which can and should be used as a cheap source of supply. The Department of Mineral Resources does not construct distribution systems, but installs a pump on each well. Ninety percent of these are hand pumps. At the present time, they have fifteen rigs and the capability of drilling and developing more than 300 usable wells per year. The number of drilled wells can be increased by augmenting the budget of the Department of Mineral Resources since they have the technical capability. They plan to continue drilling wells in the Northeast, but do not plan to construct treatment plants or distribution systems.

The Department of Public and Municipal Works drills wells outside the Northeast and also constructs treatment plants and distribution systems in the larger cities on a limited basis. They need both financial and technical assistance to improve their program. They usually do not construct water systems in cities of less than 10,000 inhabitants. Therefore, they will not play an important role in developing water supplies in the North and Northeast.

The Royal Irrigation Department (RID) has constructed approximately 200 lakes and reservoirs in the Northeast, many of which would be suitable for domestic use if adequately treated. RID has not constructed any treatment plants or distribution systems and does not plan to do so. However, they plan to continue constructing surface water supplies as they have in the past, but they will leave the development of potable water to other agencies.

The Departments of Local Administration and Community Development have local people who are promoting dug wells and small ponds. They are more interested in quantity of water than quality. They each control a small amount of funds in each province which may be contributed to the development and each has village level organizers who work with the village committees in correcting undesirable conditions and in improving the standard of living.

Although there are nine RTG agencies interested in water resources, only one, the Sanitary Engineering Division, Department of Health, has constructed treatment plants; distribution system construction has not been extensive. They are staffed with more than twenty trained engineers, have recently hired fifteen newly graduated engineers and are gradually expanding the program by employing additional ancillary personnel.

The specific aim of the project is to assist the RTG Department of Health, Sanitary Engineering Division (SED), to construct during the next five years, potable water systems in approximately 600 communities in North and Northeast Thailand. The systems consist of sources of supply, pumps, elevated tanks, distribution networks and treatment plants, as needed. (Almost all of the water in Thailand must be treated since the surface water is polluted and most groundwater is high in iron.) Existing sources are used or new ones are developed by other agencies, since SED does not drill wells, build dams, dig ponds or wells.

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 affecting these communities. The final selection of the community is made by the Sanitary Engineering Division of the Department of Health. The criteria for selecting villages by the SED is based on the principal of "self-help." A village committee is appointed to make the necessary arrangement to construct a water system. They sometimes have the desire to construct the system by themselves, but not having the capability, they may seek assistance from the Health Department. Upon receiving notice of approval of a community, an engineering team is sent to conduct feasibility surveys and collect various pertinent engineering data and information so that the degree of necessity and expected benefits, as well as the construction cost, can be appraised. (In some instances a water system or a part of a system may have already been constructed by the villagers themselves. In such instances the engineer reviews the plan, gives advice and suggestions for further improvements as needed.) It has been found that in most cases the community does not have the financial or technical capability to complete construction of the system by itself and has to request additional pipes, fittings and/or pumps. The engineer estimates the extent of the assistance which is needed and makes his recommendation 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 the villager in operation and maintenance of the system. Rate structures must be developed in order for the system to be self-supporting, not only for operation and maintenance but for expansion as well.

Other RTG Departments and Ministries actively cooperate to encourage and support the program. For instance, the Department of Mineral Resources drills wells, and the Royal Irrigation Department develops and makes available surface water supplies to the project. The Department of Health's Comprehensive Rural Health Project and the Department of Community Development are actively engaged in educational and promotional work on community self-help programs.

USAID's role is to provide technical assistance in developing economically feasibe sources, distribution systems, and procedures for effective operation and maintenance of the systems when constructed. On August 17, 1966, a contract was signed with an American architectural and engineering firm to furnish technical and advisory service to assist USAID and the RTG in the implementation of this project. The Sanitary Engineering Division and the A&E jointly plan and design systems, award and administer contracts, and supervise construction of community potable water supplies. 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, a formal course of instruction is given to plant operators and maintenance personnel.

It is anticipated that the A&E firm's contract will terminate by the end of fiscal year 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 utilized to the fullest extent. Material and equipment such as chemicals, pumps, engines and generators, not manufactured in Thailand, are being procured as US funded commodities. All commodities which can be obtained locally are purchased with local currency.

Problems which have been encountered to date are as follows:

1. Lack of professional personnel. There is an acute shortage of graduate engineers, and the civil service salary scale does not permit the RTG to compete with private engineering firms for hiring those available. Inexperienced engineers may be hired but it is necessary to train them.

2. Lack of managerial and skilled personnel. Again, training is necessary.

3. Because of the remoteness of the sites and the small scope of individual projects, there is a lack of enthusiasm on the part of the local contractors to bid for the work and also a tendency to increase the price of construction.

4. Governmental procedures and restrictions make obligation and disbursement of funds difficult.

5. Lag time in obtaining imported items. It takes almost a year from the time a commodity is ordered until it arrives on the job site.

6. Transportation over great distances from provincial offices to construction site is required; the poor conditions of roads in the area hamper supervision and impede progress of construction.

7. Development of an interest on the part of the villagers, making them willing to pay for the construction costs instead of expecting the government to build the system and then maintain it as a government project instead of a community project. An early development of interest and village participation is one of the most essential parts of the program.

In spite of the fact that a bilateral agreement between USAID and RTG was not signed for this project until April 27, 1966, and a contract with the A&E firm was signed three months later, a great deal has been accomplished. Standard designs have been developed for elevated tanks, clear wells, pump houses and treatment plants. For example, 10 m^3/hr, 20 m^3/hr and 30 m^3/hr treatment plants have been designed. The drawings are numbered in such a manner that they can be interchanged and incorporated into designs of various systems.

In developing these designs the Thai and American engineers work together and in this way on-the-job training is given to the inexperienced engineers. Training of construction technicians is being carried out at the construction sites. Formal lectures are given by both Thai and American engineers. A curriculum for water works operator training has been developed and the first course is now in progress.

A regional field headquarters has been constructed in Khon Kaen, centrally located in the Northeast. This consists of engineering design and drafting facilities, offices, water laboratory and warehouse. Although the A&E and the Thai design engineers have their offices in Khon Kaen, there are a field engineer and several construction technicians in each province. The design engineer and the field engineer switch positions after a sufficient period of training so that all engineers may obtain experience in both design and construction work.

A system of warehousing for storage and distribution of commodities has just been completed. Almost 2 million dollars (U.S.) worth of commodities have been ordered and some of them have already arrived.

Eighteen potable water systems furnishing water to twenty communities are in the final stages of completion. These systems are being constructed at an average per capita cost of approximately ten U.S. dollars. Field surveys have been completed in more than fifty communities which have been tentatively selected as construction sites. It is expected that bids will be let and construction started on about thirty of these within the next few days. Construction is about on schedule. The following table has been developed as a goal.

PROJECT YEAR	TREATMENT	ELEVATED	DISTRIBUTION
First	40	50	20
Second	90	100	60
Third	100	125	120
Fourth	120	150	150
Fifth	150	175	250
	500	600	600

This is an exceedingly ambitious program but not an impossible one. Although the systems constructed will directly affect the lives of more than three million people, the program indirectly affects the lives of a large part of the population of Thailand, since the personnel who are carrying out the work of the National Water Program have been and are being trained through this program. It also encourages others to become interested in obtaining potable water for their communities.

LES PROBLEMES DE L'EAU POTABLE - REALISATION D'UN SYSTEME D'ADDUCTION D'EAU POUR LES COMMUNAUTES RURALES DE LA THAILANDE

Résumé

Depuis bien des années, l'un des problèmes les plus graves auxquels doit faire face la Thaïlande dans le domaine sanitaire est celui des maladies transmises par l'eau. Les statistiques du Ministère de la Santé publique du Gouvernement Royal Thaïlandais indiquent que plus de 90% de la population rurale est porteuse de parasites intestinaux transmis par l'eau. Environ 60% des cas de maladie et 40% des décès sont dûs à des maladies transmises par l'eau telles que le choléra, la fièvre thyphoïde et les diverses formes de dysenterie. Ces maladies réduisent la vigueur, la productivité et le rendement de la population active, et sont de ce fait à l'origine de pertes économiques et financières énormes pour cette population et l'ensemble du pays. De tout temps, les habitants des campagnes se sont procurés leur eau dans des mares non protégées, des puits, des citernes et dans les rivières. Dans la plupart des cas, ces sources sont fortement polluées par des débris et des excréments humains et animaux. Dans plusieurs villages, la population doit faire à pied de longs trajets pendant la saison sèche pour aller chercher de l'eau qui, dans la plupart des cas, est impropre à la consommation. Etant difficile à obtenir, cette eau, bien que non potable, se vend très cher: dans bien des communes il est courant de la payer 2 bahts (0,10 dollar EU) les quarante litres. Si elle veut maintenir les conditions hygiéniques à un niveau minimum, la population est donc obligée de consacrer à l'eau, qui est l'un des éléments indispensables à l'existence, plus de temps et d'argent qu'elle ne peut se le permettre.

La Thaïlande compte environ 50.000 communes qui peuvent être classées en deux catégories:

a. Communes disposant d'eau polluée et impropre à la consommation (environ 30.000).

b. Communes manquant d'eau potable pendant la saison sèche (environ 20.000).

Il existe à l'heure actuelle moins de 150 réseaux d'adduction d'eau en Thaïlande -- un ou deux par province. Seulement 10% de la population dispose d'eau à la pression. Ce chiffre est peu élevé, même si on le compare au chiffre correspondant dans d'autres pays en voie de développement.

La zone couverte par le "projet national d'adduction d'eau rurale" a été divisée en neuf régions. Pour la zone située au nord et au nord-est, dite zone de développement rural accéléré, et couvrant 14 provinces, l'Agence des Etats-Unis pour le Développement international aide le Ministère de la Santé publique à réaliser son projet d'adduction d'eau potable en lui fournissant assistance technique, matériel et équipement. Ce projet permettra d'approvisionner en eau potable quelque 600 communes situées dans les zones critiques du nord et du nord-est de la Thaïlande. Ces communes comptent de 500 à 10.000 habitants. Ces réseaux d'adduction d'eau se composeront d'une source d'approvisionnement, de réservoirs d'emmagasinage surélevés, d'une station de traitement si nécessaire, et d'un réseau de distribution. La construction de ces installations coûtera moins de 10 dollars EU par habitant, et l'eau qu'elles livreront coûtera de 0,3 à 0,5 dollar EU les mille gallons.

Les fonds nécessaires aux 57 autres provinces proviennent uniquement du Gouvernement thaïlandais. Ce dernier a reçu en 1966 plus de 70 demandes d'assistance pour la construction de réseaux d'adduction d'eau. Les critères utilisés par le Ministère pour choisir les villages bénéficiaires sont fondés sur le principe de l'auto-assistance. Un comité de village est désigné et doit prendre les dispositions nécessaires pour construire le réseau d'adduction d'eau. Désirant effectuer eux-mêmes ce travail, mais n'ayant pas les moyens nécessaires, les habitants demandent l'aide du Ministère de la Santé publique. Lorsque parvient une demande émanant d'une commune, une équipe de techniciens est envoyée sur place pour effectuer une étude de pré-investissement, et pour recueillir diverses données et informations techniques appropriées, visant à déterminer l'ordre d'urgence du projet, les bénéfices qu'on peut en attendre et le coût de sa réalisation. Il arrive parfois que l'installation a été déjà réalisée par les villageois eux-mêmes: dans ce cas les techniciens revoient les plans, donnent leurs conseils et leurs suggestions pour de nouvelles améliorations. On a pu constater que, dans la plupart des cas, la commune n'a pas les moyens financiers et techniques nécessaires pour achever à elle seule la construction du réseau d'adduction et doit demander un complément de canalisations, de joints et/ou de pompes. L'ingénieur évalue l'importance de l'assistance nécessaire et présente ses recommandations au Ministère de la Santé publique. Le Ministère dresse une liste de priorités fondée sur le degré d'urgence des travaux, du point de vue sanitaire, et sur l'importance de la contribution et de la participation des villageois à la réalisation du projet proposé. Ce dernier fait alors l'objet d'un contrat aux termes duquel les villageois s'engagent à exploiter et à entretenir le réseau d'adduction d'eau, sous le contrôle technique des ingénieurs du Ministère de la Santé publique.

En dépit du nombre élevé de demandes parvenues au Ministère, l'intérêt que présente, du point de vue sanitaire, un réseau d'adduction d'eau par canalisations n'est pas encore entièrement compris ni apprécié par la plupart des habitants des communes rurales. Ceci provient du fait que la plupart d'entre eux n'ont jamais connu l'eau courante ou n'ont jamais eu l'occasion de se familiariser avec son utilisation effective. Pour cette raison, les premiers réseaux d'adduction qui ont été construits permettront de faire connaître l'intérêt du système à la population des communes avoisinantes. Ils permettront également d'enseigner à des ingénieurs et à des techniciens sanitaires les techniques de l'adduction d'eau et du contrôle de la qualité des eaux. Ils pourront être utilisés également pour étudier divers critères tels que les caractéristiques de la consommation d'eau, les tarifs et la gestion des eaux, l'amélioration de la santé publique et les effets sur les taux de morbidité et de mortalité.

Le Ministère de la Santé publique est conscient que l'une des principales difficultés d'un programme de ce genre résulte des problèmes d'exploitation et d'entretien. Si le personnel chargé d'assurer le fonctionnement du réseau reçoit la formation voulue, ce problème sera grandement allégé. Le Ministère met actuellement au point un programme de formation pour cette catégorie de personnel.

On estime qu'au cours des six années à venir il sera possible d'achever la construction de quelque 900 réseaux d'adduction d'eau dans les villages, qui permettront d'approvisionner approximativement 3 millions de paysans. Ce n'est là qu'une partie du programme national d'adduction d'eau rurale, car d'autres organismes publics sont chargés de la construction de barrages, du forage et du creusement de puits et d'autres travaux de mise en valeur des ressources hydrauliques.

LOS PROBLEMAS DE AGUA POTABLE Y EL DESARROLLO DE LOS SISTEMAS DE ABASTECIMIENTO DE AGUA PARA LAS COMUNIDADES RURALES EN TAILANDIA

Resumen

Desde hace años, uno de los problemas de salud más serios de Tailandia es el relacionado con las enfermedades hídricas. Las estadísticas del Departamento de Salud del Real Gobierno de Tailandia (RGT) muestran que más del 90% de la población está infestada con parásitos intestinales trasmitidos por el agua contaminada. Aproximadamente el 60% de toda la morbosidad y el 40% de toda la mortalidad son atribuibles a enfermedades hídricas, como cólera, fiebre tifoidea y disentería. Estas enfermedades han reducido el vigor, la productividad y la eficiencia de las personas en sus trabajos, lo que produce enormes pérdidas económicas y financieras para ellos y para el país en general.

Tradicionalmente, la población rural obtiene el agua de estanques, pozos y cisternas sin protección y, cuando puede, de ríos. En la mayor parte de los casos, estas aguas están fuertemente contaminadas por desechos y por excretas humanas y de animales. En algunas aldeas, sus habitantes tienen que caminar largas distancias durante la seca para conseguir agua cuyo consumo, en la mayor parte de los casos, es peligroso. Por ser difícil de obtener, esta agua no potable se vende a precios elevados, en muchas comunidades es corriente pagar 2 bahts (10 centavos de los Estados Unidos) por 40 litros. Por consiguiente, mantener en condiciones higiénicas mínimas el agua, una de las necesidades básicas de la vida, cuesta más, en tiempo y dinero, de lo que el pueblo puede pagar.

Tailandia tiene aproximadamente 50.000 comunidades, las cuales se pueden clasificar en dos categorías:

a. Las que tienen agua contaminada, peligrosa de consumir. (Aproximadamente 30.000)

b. Las que carecen de agua durante la estación de la seca. (Unas 20.000)

Hoy día hay menos de 150 acueductos en Tailandia, es decir, uno o dos por provincia. Sólo el 10% de la población se abastece de agua por medio de acueductos. Esta cifra es baja, aun si se la compara con las de los otros países en desarrollo.

Actualmente la zona abarcada por el "Proyecto Nacional de Abastecimiento de Agua a las Zonas Rurales" está dividido en 9 regiones. Para la zona a lo largo del Norte y Nordeste, la llamada "Zona de Desarrollo Rural Acelerado" (DRA), que comprende 14 provincias, el Departamento de Salud está recibiendo ayuda de la AID en forma de asesoramiento técnico, abastecimientos y equipos para operar el Proyecto de Agua Potable de la DRA. Aproximadamente 600 comunidades en las zonas críticas del Nordeste y el Norte de Tailandia recibirán agua potable por medio de este proyecto. El tamaño de las comunidades varía entre 500 y 10.000 personas. Estos sistemas de abastecimiento de agua comprenderán una fuente de abastecimiento, tanques elevados de almacenamiento, instalaciones para tratar el agua cuando sea necesario y un sistema de distribución. Las instalaciones se están construyendo por menos de 10 dólares de los Estados Unidos por persona y proporcionarán agua a razón de 3 a 5 centavos de los Estados Unidos por 1.000 galones de agua.

Los fondos para las 57 provincias restantes son proporcionados exclusivamente por el Real Gobierno de Tailandia. En 1966 se recibieron más de 70 solicitudes de ayuda en la construcción de sistemas de abastecimiento de agua.

El criterio de selección seguido por el Departamento se basa en el principio de la "autoayuda". Se designa un comité de la aldea para que haga los arreglos necesarios en relación con la construcción del sistema de abastecimiento de agua. El comité tiene el deseo de que la propia aldea, por sí misma, construya el sistema de abastecimiento, pero como carece de la capacidad necesaria para hacerlo, busca la ayuda del Departamento de Salud. Al recibirse la solicitud de una comunidad, el Departamento envía un equipo de ingeniería para hacer la investigación de viabilidad y recoger la información pertinente de ingeniería para poder evaluar el grado de necesidad y los beneficios que se obtendrían, así como los costos de construcción. En algunos casos las instalaciones han sido ya construidas por los propios aldeanos. Cuando esto sucede, el ingeniero examina el plan y da consejos y hace sugerencias para mejorar la obra. En la mayor parte de los casos los hechos han confirmado que la comunidad no tiene la experiencia técnica ni financiera para terminar por sí misma la construcción del sistema y tiene que pedir tuberías adicionales, accesorios y/o bombas. El ingeniero hace una estimación del monto de la ayuda que se necesita y presenta sus recomendaciones al Departamento de Salud. El Departamento ha confeccionado una lista de prioridades basadas en el grado de necesidad desde el punto de vista de la salud y el monto de la contribución y participación de los aldeanos en el plan propuesto. Se firma un contrato mediante el cual los aldeanos se comprometen a operar y mantener el sistema bajo la supervisión técnica de los ingenieros del Departamento de Salud.

A pesar de que ha habido numerosas solicitudes, el valor de los sistemas de abastecimiento de agua mediante acueductos sanitarios aún no es comprendido ni apreciado plenamente por la mayoría de los aldeanos de las comunidades rurales. Ello se debe a que éstos nunca han visto un acueducto ni han tenido la oportunidad de conocer sus usos. Por esta razón, los pocos sistemas que se construyan al principio servirán de demostración para las comunidades circunvecinas. También se pueden utilizar para adiestrar ingenieros sanitarios y técnicos sanitarios en la supervisión de los sistemas de abastecimiento y control de la calidad del agua. Al mismo tiempo se pueden usar para estudiar distintos criterios, tales como las características del consumo de agua, las tarifas y la administración del agua, el mejoramiento de la salud y los efectos en las tasas de morbilidad y mortalidad.

El Departamento de Salud se percata de que una de las principales desventajas de este tipo de programa es el problema de la operación y mantenimiento. Si el personal a cargo del funcionamiento de las instalaciones del sistema de abastecimiento de agua está adecuadamente adiestrado, el problema se reduce en gran parte. El Departamento está preparando el programa de los cursos de adiestramiento del personal que se encargará del funcionamiento de los acueductos.

Se ha estimado que en el curso de los próximos seis años se terminarán aproximadamente 900 sistemas de abastecimiento de agua para las comunidades, los cuales servirán a alrededor de 3 millones de habitantes de las zonas rurales. Esta es solamente una parte del Programa Nacional de Tailandia de Abastecimiento de Agua a las Zonas Rurales, ya que otros organismos gubernamentales están a cargo de construir presas, perforar y cavar pozos, y de otros tipos de desarrollo de recursos de agua.

PUBLIC WATER SUPPLY IN THAILAND

Sakoljitt Panomvan

Thailand is located in a tropical zone with a hot climate favorable to the spread of water-borne disease, e. g., cholera, typhoid and paratyphoids, dysentery, etc. The establishment of water supply systems for public health purposes has been and will always be of paramount importance. During the past fifty years, quite a number of water supply systems in municipalities and sanitary districts have been completed and put into service to meet the demands of ever-increasing population as well as the requirements of steadily developing light industry and commerce. Thailand is in a hot, humid region, influenced by Asiatic Monsoon. The average annual rainfall is not less than 1,200 mm. The source of most water for water supply systems is surface water.

At present, there are 561 sanitary districts, 35 tumbon (township) municipalities, 82 muang (town) municipalities (population of at least 10,000 and average density of not less than 3,000 people per $km.^2$ Sanitary districts are responsible for the provision of potable water and local waterworks. The Provincial Water Supply Division, Department of Public & Municipal Works, Ministry of Interior, is responsible for development and operation of all water supply systems for sanitary districts, municipalities, government organizations, hospitals, land settlement communities, etc. It conducts physical surveys, draws detailed maps, develops projects, supervises construction, manages contract negotiation, grants water supply concessions, and controls the government-owned waterworks.

At present, waterworks concessions have been granted by Ministry of Interior to 19 municipalities, 11 sanitary districts, and 9 private organizations. There are 96 waterworks operated and supervised by the Department of Public and Municipal Works. A continuous effort has been made by the government, both financially and technically, to determine the best means for the future development and expansion of water supply schemes in Thailand.

There are many difficult problems relating to water supply development in Thailand. In general, the percentage of consumers is low because the educational level of the rural people is so poor that they do not understand the advantages of a safe and adequate water supply. The Royal Thai government is trying to increase awareness of water supply problems through education in the public schools and through enlisting the aid and interest of professional groups. By pointing out the value of a potable water supply, the government hopes to promote the cooperation of the people in preventing water pollution.

GUIDE FOR THE DESIGN OF WATER SUPPLY SYSTEMS IN THAILAND

Purposes and Intent

Guides for planning and design of water supply development projects are set up according to the best available information to fit the general economic capability of the Thai people.

It is recommended that each project be planned in terms of local conditions, and thoroughly studied individually. Changes and improvements will be made from time to time as additional information is available.

Basic Data

Period of Design. In fixing upon a design period, the following factors should be taken into consideration:

a) The useful life of the structure and equipment employed.

b) The ease of extending the works.

c) The anticipated rate of growth of local population, with an eye to projected increases in industrial and commercial demands.

d) Total budget estimates, including interest cash.

Each project is designed to accomodate local needs for at least 10 years in communities with a population of less than 10,000; 15 years for those with populations between 10,000 and 100,000; 20 years for those with populations between 100,000 and 500,000; and 25 - 30 years for those with populations more than 500,000. Where the source of supply is abundant, due consideration should be given to facilitating anticipated future extension as far as possible.

Population Growth. Reference has been made to statistical summaries made by the National Statistical Office. They show that the geometric rate of population growth per year in Thailand is around 3.2 percent, although there are some differences in different communities. For simplicity sake in estimating the future population in small communities where no reliable census is available, a 3 percent rate of population growth may be used.

For communities where reliable population data are available, the best basis to estimate their future population growth would be their past development. If the curve of population to the present time is comparatively smooth, and no major changes in factors affecting population growth are anticipated, the curve may be extrapolated into the future.

Per Capita Consumption. Per capita consumption of water varies with the size of the community, local living standards, types of service, the water rate, water pressure, availability of private water supplies, meterage, etc.

The following figures may be referred to as a basis for estimating water consumption.

Kind of Community	Average Daily Consumption in Liters per Capita
Population of less than 5,000, where water is supplied by both public service tape and individual house connections.	60 - 100
Population ranging between 5,000 and 10,000 where water is supplied by both public service taps and individual house connections.	100 - 150
Population ranging between 10,000 and 25,000, where water is entirely supplied by individual house connections.	150 - 200
Population ranging between 25,000 and 50,000, where water is entirely supplied by individual house connections.	200 - 250
Population ranging between 50,000 and 250,000, where water is entirely supplied by individual house connections.	250 - 300 (Cont.)

Kind of Community	Average Daily Consumption in Liters per Capita
Population of more than 250,000, where water is entirely supplied by individual house connections.	300-400

The rate of consumption varies widely. Generally, the maximum, daily consumption should be estimated individually.

Percentage of Population Served. By experience and from data already available, it is suggested that no figure less than 50 percent be adopted.

WATER SOURCE

Water Rights. Water rights should be carefully considered for each project. In some cases, it will be necessary to evaluate and purchase priority rights in order to secure an adequate and reliable source of supply.

Quantity. The order of choice should be:

1. Surface or ground water from a practically inexhaustible source distributed throughout the service district by gravity.

2. A gravity source of supply that is inadequate at times and requires reservoir storage.

3. A never-failing source that requires pumping.

4. A source that requires both reservoir storage and pumping.

Quality. The order of choice should be:

1. Requires no treatment or pumping.

2. Requires no treatment.

3. Requires both treatment and pumping.

Wells.

Location. All wells should be located at least 60 m from any source of contamination and shall not be located in areas subject to flooding, unless the casing terminates above known flood level, or unless an adequately sealed submersible type of pump installation is used.

Construction. All wells should be provided with an impervious casing which will effectively exclude surface or groundwaters that are known to be contaminated, suspected to be contaminated, or capable of becoming contaminated. If wells are due, they should be watertight for 3.50 m below the surface. The tops of wells should be well-constructed and protected against contamination.

All sources of supply should be free from pollution or, if subject to pollution, should be subjected to natural means of purification, such as dilution, storage, sedimentation, sunlight, and aeration, or to purification by filtration or chemical treatment.

INTAKE

Intake should be of sufficient capacity to meet the maximum demand. It should be so reliable that no conceivable interruption to any part of the facilities could cause an interruption or curtailment of water supply service to the community.

TREATMENT

Type of Treatment

Careful consideration should be given to the type of treatment to be used. A few of the important factors that influence the selection of the type of treatment are the location and topography of the plant site, plant cost, the characteristics of the raw water, operating cost, and the probable type of supervision and operation the plant will have.

Treatment Required

Bacteriological Quality. The bacteriological quality of the water is a chief factor in determining the type of treatment required. The minimum treatment permitted is given below for various conditions of bacteriological loading. Additional requirements for control of chemicals, physical quality, taste, and odor are also given below.

Underground water containing not more than 50 coliform bacteria (M.P.N.) per 100 ml and meeting in other respects the drinking water standards* will require only simple, continuous chlorination treatment.

Water containing not more than 5,000 coliform bacteria (M.P.N.) per 100 ml in more than 20 percent of monthly samples and meeting the other requirements of the drinking water standards should be treated by settling, sand filtration and continuous post-chlorination.

Water containing more than 5,000 coliform bacteria per 100 ml in more than 20 percent of monthly samples but not more than 20,000 coliform bacteria (M.P.N.) per 100 ml in more than 5 percent of monthly samples (and meeting other requirements of the drinking water standards) will require prechlorination and a minimum of 30 minutes of contact at a pH under 7.5 followed by settling, sand filtration, and post-chlorination.

Water containing more than 20,000 coliform bacteria per 100 ml (M.P.N.) in more than 5 percent of monthly samples considered unsuitable as a source of supply unless special methods of treatment are employed.

Chemical and Physical Quality. Water containing more than 125 p.p.m. magnesium or 1,000 p.p.m. total solids may have a laxative effect upon persons unaccustomed to their use. Therefore, softening should be considered.

Water containing more than 0.3 p.p.m. iron and manganese interferes with chlorination and produces staining of laundry and plumbing fixtures. Facilities for removal of these substances are desirable and in some cases essential for proper water quality.

Turbidity in excess of 10 p.p.m. and/or color greater than 20 p.p.m. are esthetically objectionable and require remedial treatment.

Taste and Odor Control. Surface water supplies may have occasional taste and odor problems. Attention shall be given to this problem in the design of a plant on the basis of past experience with the source of supply. Prechlorination and/or activated carbon treatment is desirable.

Finished Water. Finished water will meet the latest international standards for drinking water.

Rapid Sand Filter Plant and Slow Sand Filter Plant

A rapid sand filter plant is preferable.

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* The latest international standards for drinking water issued by the World Health Organization.

Plant Arrangement

All units, piping and conduits should be designed to carry the maximum expected flow. Each component should be designed for the greatest operating convenience, flexibility, and economy, in order to facilitate future expansion of the system.

No passage of raw or partially treated water through lines carrying fully treated water should be allowed.

Plant Capacity

The delivery capacity of the treatment plant, including finished water storage at the plant, should always be in excess of the maximum expected draft on any day of the year. Should pumps be used, the plant must be designed to accommodate their predetermined pumping rate.

Pre-Treatment

a) Aeration
For removal of carbon dioxide, hydrogen sulfide, inorganic iron, or manganese, either cascade aerators or coke aerators may be used. The rate of flow filtration through the aerator should not exceed 0.4 $m^3/m^2/min$.
The detention period varies greatly. The minimum should be 30 minutes.

b) Presettling
Detention time - 1.5 hours, minimum.
Overflow rate - 100 m^3/m^2/day, maximum.
Weir leading - 600 m^3/m/day, maximum.
Water depth - 2.50 m, minimum.
Drain - 200 m/m, minimum.
Length/width - 3:1, minimum.

c) Rapid mixing
Detention - 15-60 sec.
Velocity - 0.5-1.5 m/sec.

d) Flocculation
Detention - 20-30 min.
Velocity - 0.15-0.25 m/sec.
The flocculated water from basins should have a velocity ranging between 0.15-0.25 m/sec in the conduits.

e) Chemical feeders
For alum ferrous sulfate: 10-60 p.p.m. minimum range.
For lime, activated carbon, activated silica, soda ash, chlorine: to meet raw water requirement.

f) Settling
Inlets should be designed to dissipate the intake velocity, diffuse the flow equally across the entire cross section of the sedimentation basin, and prevent short-circuiting.

Weir loading shall not exceed 400 M^3 per linear meter per day. In general, on overflow rate less than 36 m^3/m^2/day and detention periods longer than 3 hrs. shall be employed.
Water depth - 3.00 m, minimum.
Drain-200 m/m, minimum.
Length/width-3:1, minimum.
Sludge storage--25% of volume.

Filter

The general features of rapid sand filter should be as follows:

Rate of filtration: 100-120 m/day

Depth of bed:	40 cm free board 120 cm water 45 cm gravel 75 cm sand 30-50 cm drainage 280-300 cm total
Size of gravel:	10 cm of 9.50 - 2.40 $\frac{3}{8}$in. - $\frac{3}{32}$ in. 10 cm of 12.70 - 6.35 mm $\frac{1}{2}$ in. - $\frac{1}{4}$ in. 12.5 cm. of 12.70 - 25 mm 1 inc. - $\frac{1}{2}$ in. 12.5 cm. of 38 mm - 25 mm $1\frac{1}{2}$ in. - 1 in.
Size of sand:	60 cm of 0.35 - 0.5 mm effective dize 15 cm of 0.8 - 1.2 mm effective size Uniformity Coefficient less than 1.80
Loss of head:	30 cm initial. 240 cm final.

Post-Chlorination

Each project should be provided with adequate facilities for disinfecting water. Either hypochlorites or liquid chlorine may be used. For communities with populations under 10,000, hypochlorites are recommended. The contact period for effective chlorination should be at least 30 minutes before delivering water to the distribution systems.

Laboratory

All communities with a population over 100,000, and with rapid sand filter plants, should equip laboratories for bacteriological, physical, and chemical tests.

Grading and Landscaping

Upon completion of a plant, the ground should be graded, concrete or gravel walkways should be provided for access to all units, surface water ot polluted water should not be allowed to drain or flow into any unit, and fences should be constructed to surround the plant. Provision should be made for landscaping, particularly when a plant is located close to a community.

PUMPING

The selection of the number and capacities of pumps should be designed in conjunction with storage facilities and/or the arrangement of the transmission main.

Raw Water Pump

If one motor driven pump and one dual motor and diesel engine driven pump are selected, each pump should have a capacity equal to 100 percent of maximum day draft. The period of operation of each pump shall be 14-24 hr/day.

Clear Water Pump

If one motor driven pump and one dual motor and diesel engine driven pump are selected, each pump should have a capacity equal to 75-100 percent of the maximum day draft, if the storage facilities are sufficient and friction loss through the transmission main is small. If two motor driven pumps and one dual motor and diesel engine driven pump are selected, each pump should have a capacity equal to 50 percent of maximum day draft, if the storage facilities are sufficient and if friction loss through transmission main is considerably igh. Where three or more pumps are provided they should be designed to fit actual low conditions and have such capacity that with any pump out of service, the emaining pump will have capacity to handle maximum daily flow. The period of peration of each pump shall be 14-24 hr/day.

entilation

Adequate ventilation should be provided for all pumping stations.

DISTRIBUTION AND STORAGE

ype of System

In practice, two or more directional flows are preferable because they can ake a great economy in the design of the distribution system. However, the ost of storage in some cases should be considered and analyzed.

apacity

The capacity of a distribution system should be designed to meet the maximum emand for domestic, industrial, and other general use.

ressure

The distribution system should be full of water and under positive pressure 4 hours a day. For delivering water to each customer, the residual pressure hroughout the distribution system during maximum hourly draft should be not ess than 1.5 kg/cm^2.

torage

For underground storage, a capacity of 20-50 percent of the maximum day draft r more should be provided. For elevated tanks, 10-15 percent of maximum draft r more should be provided. For an elevated tank underground tank complex, a ombined capacity of 20-50 percent or more shall be provided.

When the storage is far away from the pumping facilities, a remote water level ndicator should be installed. Water stored should be kept in impervious tanks rotected against contamination. All tanks should have water-tight covers and ll openings should be covered with screens capable of excluding insects, birds, nd rodents.

ype of Service Connections

Private service connections should be the goal for every project. For small ommunities where the living conditions are rather poor, temporary public taps nstead of private service connections may be considered. Small storage tanks ith several taps should be avoided, since they tend to contaminate water and educe pressure.

ipe Laying

Where the water main is to cross drains, sewers, pipelines, or similar installations, a minimum of 20 cm clearance should be provided between the water ain and the other installation.

Where the pipe is parallel to a sewer or storm drain, the water main should be placed at a minimum horizontal distance of 1.80 m from it. Where the water main crosses under a stream bed or any structure constituting a potential hazard to the main, the main should be jacketed with 1 x 3 x 6 concrete. The minimum thickness of the jacket should be 30 cm from the outside of the barrel of the pipe. Dead ends should be avoided except those caused by natural barriers, where a street will never be extended, or where topographical conditions make it impractical.

Valves and Hydrants

Gate valves should be installed at each intersection and at distances not greater than 200 m apart in commercial districts,300 m in other distribution system districts and 1,000 m for transmission mains.

Air relief should be installed at all summits; blow-off drains should be provided at all low points of the transmission main.

The best safeguard against conflagration is to provide ample water storage and sufficient water flow and pressure in the distribution system. The provision for water flow is very costly. In case fire hydrants are required in a project, no fire hydrant shall be installed in a distribution system on a pipe smaller than 100 mm. While some fire hydrants are better than none, they cannot be expected to provide full protection during fires. Each fire hydrant should be located in an accessible place. The distance between fire hydrants depends upon the characteristics and property of the district to be served. Generally, it should not be greater than 160 m.

Metering

A master meter or other suitable measuring device should be provided for each plant to register accurately the quantity of water delivered to the distribution system.

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ALIMENTATION EN EAU DE LA POPULATION DE LA THAILANDE

Résumé

Située en zone tropicale, la Thaïlande a un climat chaud favorable à la diffusion des maladies transmises par l'eau, telles que choléra, typhoïde et paratyphoïde, dysenterie, etc. La création de systèmes d'adduction d'eau en vue de sauvegarder la santé publique a toujours été et sera toujours d'une importance capitale. Au cours des cinquante dernières années, un grand nombre de réseaux d'adduction d'eau desservant des villes et des districts sanitaires ont été construits et mis en service afin de répondre aux besoins d'une population de plus en plus nombreuse et à ceux d'une industrie légère et d'un commerce en évolution constante. La Thaïlande est située dans une région chaude et humide, soumise à l'influence de la mousson d'Asie. La pluviométrie annuelle moyenne n'est pas inférieure à 1.200 mm. La majeure partie de l'eau des réseaux d'adduction provient des eaux de surface.

Il existe à l'heure actuelle 561 districts sanitaires, 35 communes, 82 agglomérations urbaines (population d'au moins 10.000 habitants et d'une densité moyenne supérieure à 3.000 par km^2); les districts sanitaires sont chargés de la fourniture d'eau potable et du fonctionnement des ouvrages hydrauliques locaux. La Division provinciale de l'adduction d'eau, qui relève du Département des Travaux publics et municipaux du Ministère de l'Intérieur, est chargée de la réalisation et de l'exploitation de tous les réseaux d'adduction d'eau des districts sanitaires, des municipalités, des organismes publics, des hôpitaux et des collectivités d'implantation rurale, etc. Elle procède à des levées géographiques; établit des cartes détaillées; élabore des projets et surveille leur réalisation; négocie des contrats; accorde des concessions pour la fourniture d'eau; et contrôle les ouvrages hydrauliques appartenant à l'Etat.

A l'heure actuelle des concessions d'ouvrages hydrauliques ont été accordées par le Ministère de l'Intérieur à 19 municipalités, 11 districts sanitaires et 9 entreprises privées. Il existe 96 services des eaux qui fonctionnent sous la direction du Département des Travaux publics et municipaux. L'Etat déploie des efforts ininterrompus, sur le plan financier et sur le plan technique, à la recherche des moyens qui permettront le développement et l'expansion ultérieure du système d'adduction d'eau en Thaïlande.

Le développement du système d'adduction d'eau se heurte en Thaïlande à des problèmes aussi nombreux que difficiles. La population ne s'intéresse pas à cette question. Le pourcentage de la population qui utilise les services d'eau est peu élevé. Le Gouvernement royal thaïlandais s'efforce d'enseigner à la population le rôle de l'eau dans la transmission des maladies et d'obtenir sa coopération pour protéger les sources d'eau contre la pollution. Il se propose également de promulguer des mesures législatives pour la protection des ressources hydrauliques.

EL ABASTECIMIENTO PUBLICO DE AGUA EN TAILANDIA

Resumen

Tailandia está situada en la zona tropical y posee un clima caliente que favorece la propagación de las epidemias causadas por la contaminación de las aguas, tales como el cólera, las fiebres tifoidea y paratifoidea, la disentería, etc. El establecimiento de sistemas de abastecimiento de agua para proteger la salud pública ha sido y siempre será de suprema importancia. Durante los últimos cincuenta años se han terminado y puesto en funcionamiento numerosos sistemas de abastecimiento de agua de municipios y de distritos sanitarios para hacer frente a las demandas de una población en continuo crecimiento, así como a las necesidades de la industria ligera y el comercio que están experimentando un desarrollo continuo. Tailandia está situada en una región caliente y húmeda, afectada por los monzones asiáticos. El promedio anual de lluvia no es menor de 1.200 mm. La mayor parte de las fuentes de agua de los sistemas de abastecimiento son de aguas de superficie.

Hoy día existen 561 distritos sanitarios, 35 municipios de tumbon (pueblos) y 82 municipios de muang (ciudades), con una población de 10.000 o más habitantes y una densidad media de no menos de 3.000 habitantes por kilómetro cuadrado. Los distritos sanitarios son los responsables del abastecimiento de agua potable y de los acueductos locales. La División Provincial de Abastecimiento de Agua, del Departamento de Obras Públicas y Municipales del Ministerio del Interior, tiene a su cargo el desarrollo y la operación de todos los sistemas de abastecimiento de agua de los distritos sanitarios, los municipios, las organizaciones gubernamentales, los hospitales, las comunidades de asentamiento de tierra, etc. La División realiza investigaciones físicas, traza mapas detallados, confecciona proyectos y supervisa su construcción, dirige las negociaciones de los contratos, otorga concesiones de abastecimientos de agua y controla los acueductos que pertenecen al Gobierno.

En este momento el Ministerio del Interior ha otorgado concesiones de acueductos a 19 municipios, 11 distritos sanitarios y 9 particulares. Existen 96 acueductos operados y supervisados por el Departamento de Obras Públicas y Municipales. El Gobierno hace esfuerzos continuos, tanto financieros como técnicos, para buscar el medio más apropiado para el desarrollo futuro y la ampliación de los planes de abastecimiento de agua de Tailandia.

Existen muchos problemas difíciles en relación con el desarrollo del abastecimiento de agua en Tailandia. Al pueblo no le interesa. El tanto por ciento de personas que usan los acueductos es bajo. El Real Gobierno de Tailandia está tratando de educar al pueblo sobre la propagación de las enfermedades hídricas, y de obtener su cooperación para proteger las fuentes de abastecimiento de agua contra la contaminación. El Real Gobierno de Tailandia sancionará una ley para la conservación de las fuentes de abastecimiento de agua.

ALIMENTATION EN EAU DES CENTRES URBAINS ET RURAUX DU MAROC

Khemmar Ouriagli

L'approvisionnement en eau abondante et potable constitue sans conteste l'une des plus importantes commodités dont on puisse doter une collectivité quelconque, grande ou petite.

Un tel approvisionnement joue un rôle majeur du point de vue de la santé, de la prospérité économique et du bien être des populations desservies. C'est ainsi que les services publics de distribution d'eau ne représentent pas seulement un avantage social mais un facteur de prospérité économique et industrielle.

Cela a été nettement compris au Maroc et le Gouvernement, indépendamment des perspectives propres de chaque organisme compétent en matière d'eau, donne aux adductions d'eau le rang prioritaire qu'elles méritent parmi les investissements intéressant les équipements édilitaires.

Avant de situer les problèmes se rapportant aux disponibilités actuelles en eau potable au Maroc, à leur utilisation à travers chacune des régions types du Maroc, et enfin aux besoins qui nous couvriront dans les années à venir, il serait utile de faire ressortir quelques généralités de tous ordres.

Généralités

En effet l'on ne saurait aborder le problème de l'approvisionnement en eau potable, une des premières conditions de la vie et de la santé, sans le situer par rapport à quelques caractéristiques d'ordre économique et social.

La carte économique et sociale du Maroc permet de relever en effet des disparités régionales qui apparaissent du reste sur le plan de la production et de la consommation d'eau potable.

I) du point de vue démographique

Il faut indiquer que le Maroc compte actuellement une population de 13 millions (71 % rurale et 29 % urbaine).

a) Plus de 45 % de la population du Maroc se regroupe sur une partie de territoire égale au 1/7 de sa superficie totale, cette concentration s'effectuant sur la bande des littoraux atlantique et méditerranéen qui ne dépassent guère 30 km de profondeur. A l'intérieur même de cette bande, le regroupement s'accentue autour d'une zone privilégiée comprenant les villes de Casablanca, Rabat et Kénitra, c'est-à-dire autour de la capitale économique, de la capitale administrative et d'un petit port qui jouit d'un des arrière-pays les plus riches du Maroc (Gharb).

b) Le reste de la population (55 %) se partage le Maroc, créant ainsi deux autres zones :

- plaines alluviales et vastes plateaux couvrant tout l'intérieur du pays jusqu'à Oujda (28 %)

- arrière-pays constitué par les zones situées au-delà des chaînes de montagne du Haut Atlas et du Moyen Atlas (27 %). Si l'on doit enfin déplorer la migration des populations rurales vers les centres urbains, il faut noter par contre que cette migration semble s'effectuer en 2 stades, le 1er concernant le passage des populations rurales aux petits centres rbains les plus proches et le second intéressant les petits centres urbains vers les grandes illes.

2) du point de vue économique

On constate qu'à l'exclusion des mines, l'ensemble de l'activité économique est centré ur le littoral atlantique.

3) du point de vue niveau de vie

Les niveaux de vie urbains semblent être assez homogènes; par contre les disparités éographiques de niveau de vie sont très importantes dans les campagnes.

ilan et disponibilités hydrauliques

Malgré une situation privilégiée de notre pays due :

) à l'existence de grandes plaines alluviales et des vastes plateaux dominés et encerclés par de hautes montagnes,

) à la proximité de l'océan Atlantique qui permet la précipitation des pluies relativement abondantes,

es ressources hydrauliques du Maroc sont irrégulières et leur répartition géographique est négale. En effet, les régions de montagnes, château d'eau naturel, ne jouent qu'un rôle de ourvoyeur aux eaux superficielles à cause de leur nature géologique qui ne renferment que très eu de terrains aquifères. En plus de ce rôle très limité, les débits des oueds ne sont pratiquement soutenus qu'en hiver d'où nécessité de recourir à l'accumulation des hautes eaux et quelqueois même à une régularisation interannuelle.

Il faut signaler par ailleurs un autre phénomène défavorable qui diminue les possibi-ités d'exploitation et d'utilisation à des fins urbaines, celui de la salure des eaux. Si cette oncentration est peu importante en général dans la zone intérieure du pays, elle est accentuée e long du littoral atlantique, méditerranéen, ainsi que dans l'arrière-pays (bassin de Ksar-Es-ouk et bassin de l'Oued Drâa). Cette concentration dépasse parfois pour ces zones, la teneur de g par litre.

L'ensemble des ressources hydrauliques sont réparties comme suit :

) eaux superficielles avec un débit fictif continu de l'ordre de 440 m3/s. L'aménagement maximum des fleuves du Maroc par des barrages de retenue ne permettrait de régulariser que 250 m3/s soit à peine 60 %. En outre le débit de ces fleuves est très irrégulier d'une année à l'autre, cette irrégularité allant en s'accentuant vers le cours inférieur. Quant à la période des hautes eaux, elle atteint son maximum en février pour les oueds du versant atlantique, en avril pour le versant méditerranéen.

) eaux souterraines avec un débit de 80 m3/s.

D'une façon générale, le bilan global des eaux disponibles permet de tirer les conclu-ions suivantes :

1) les eaux superficielles sont utilisées à 20 %

2) les eaux souterraines sont utilisées à 75 %

3) certaines nappes devant en principe satisfaire des agglomérations installées dans es plaines qui les couvrent se trouvent déjà surexploitées (Souss, Gharb) ce qui diminue encore lus le débit des eaux souterraines non utilisées.

. - ALIMENTATION DES CENTRES URBAINS

Une des particularités du mode d'alimentation des agglomérations à caractère urbain du aroc est l'existence d'un grand nombre de complexes adducteurs transportant les eaux captées ers plusieurs villes et centres situés le long de leur parcours.

Intéressant plusieurs localités, une telle conception a une portée économique très ppréciable.

Elle est provoquée simultanément par :

1) l'éloignement des zones de captages des eaux abondantes et de qualité

2) la population urbaine au Maroc ne cessant de croître à un rythme accéléré, la question de son alimentation s'est orientée inéluctablement vers la mise sur pied de vastes programmes exigeant des investissements importants.

Cette particularité est plus significative le long des littoraux atlantique et méditerranéen. En effet, la carte du Maroc permet de relever des zones de nappes saumâtres qui longent pour une grande partie les côtes atlantique et méditerranéenne et ce, sur une large bande de 100 km. C'est ainsi que des réalisation de grande envergure ont vu le jour au Maroc permettant aux agglomérations situées dans les zones névralgiques de jouir d'un taux de desserte satisfaisant. Pour n'énumérer que les plus importantes il faut citer :

1) adduction du Fouarat

Les villes de la zone côtière de Kénitra jusqu'à Casablanca sont à des titres divers, dépendantes, pour leur alimentation en eau, de l'adduction du Fouarat. Ce complexe, mis en service en 1933, se présente sous la forme d'une conduite de 140 km de longueur jouant le double rôle de collecter les eaux captées le long de son parcours (nappe de la Mamora et bassin de l'Oued Mellah) et de les transporter vers les villes et agglomérations situées entre Kénitra et Casablanca. Son débit moyen est de 1 m3/s et les diamètres sont de 1,5 m sur 40 km et 1,2 m sur 100 km.

La production de l'année 1966 a été de 28.044.000 m3.

2) adduction de l'Oum Er Rebia

Depuis 1944, la ville de Casablanca s'est trouvée dans une situation préoccupante pour son alimentation en eau potable. Si l'utilisation des eaux du barrage d'Oued Mellah a permis de rétablir une situation normale de 1947 à 1949, l'année 1950 a connu par contre une sécheresse particulièrement sévère. C'est à cette époque que la grande adduction de l'Oum Er Rebia qui consiste à prélever un débit de 2 m3/s à la sortie de la tête amont d'Im Fout (cote 180) et à le conduire jusqu'à Casablanca.

La ville d'El Jadida est alimentée par le même complexe.

3) adduction de Tétouan Restinga, en cours de réalisation.

Elle capte les eaux du battage de Nekhla pour les amener jusqu'à Restinga (L = 30 km) en alimentant en cours de route Tétouan, Martil, Mdiq, Cap Noir et Restinga.

4) adduction d'Agadir

Ce complexe, en projet, alimentera la ville d'Agadir ainsi que d'autres centres satellites tels que Inezgane, Aït Melloul, Ben Zergao, Béheira et Tikiouine.

A cela doivent s'ajouter d'autres adductions conçues dans la même optique et serpentant à l'intérieur du pays :

1) adduction de Sidi Slimane Sidi Kacem alimentant 2 villes industrielles (Sidi Slimane avec sa sucrerie de l'Oued Beth, Sidi Kacem avec sa raffinerie de pétrole) ainsi que des petits centres situés sur son parcours (Douar Jdid, Bou Maïz) (Q = 35 l/s L = 30 km).

2) adduction de Oued Zem, en projet, devant alimenter plusieurs centres dont les besoins en eau se font sentir de plus en plus tels que Boujad, Oued Zem et Khouribga (L = 20 km Q = 4.000 m3/j).

D'une façon générale, les agglomérations urbaines sont alimentées en eau potable suivant les caractéristiques ci-après :

1) La consommation moyenne varie de 100 l/j/ha pour les grandes villes à 55 l/j/ha pour les petites villes.

2) Le nombre d'habitants desservis par le même branchement varie de 12 pour les grandes villes à 19 pour les petites villes.

3) Les centres urbains sont dotés d'un réseau de distribution couvrant en général

tout le périmètre.

4) Tendance à la saturation en ce qui concerne l'utilisation des eaux souterraines.

5) Recours aux eaux de surface pour alimenter de nombreux centres.

Ces différentes caractéristiques permettent tant du point de vue orientation dans la conception du mode d'alimentation des villes, petites ou grandes, que réalisations à proprement parlé, de mesurer tout l'effort et le souci des pouvoirs publics de doter tous les centres urbains d'installations modernes et satisfaisantes.

II - ALIMENTATION DES CENTRES RURAUX

Le Maroc comprend 791 communes rurales, chacune comptant en moyenne un centre rural. L'étude et la répartition géographique des différentes dessertes font apparaître une extrême diversité des situations. Certaines collectivités bénéficient de taux de desserte rurale très satisfaisant plus particulièrement dans la région intérieure du Royaume. Mais d'autres centres n'atteignent que des pourcentages très faibles de desserte avec une alimentation à partir de bornes-fontaines (région de l'arrière-pays).

L'analyse de cette situation ne permet de lui trouver pour origine que le relief qui favorise une large proportion d'amenées d'eau par gravité dans les régions accidentées en même temps qu'un peuplement dense et concentré dans les vallées constitue un élément favorable.

En sens inverse, si certaines plaines favorisent la constitution de ressources aquifères, un relief atténué ne les rend accessibles que par pompage, tandis que la dispersion de l'habitat accroît les difficultés techniques et financières.

Autant de considérations qui situent l'alimentation des collectivités rurales à des taux de consommation variant de 10 l/j/ha à 45 l/j/ha.

PERSPECTIVES D'AVENIR

Les résultats ainsi exposés représentent la situation hydraulique telle qu'elle paraît actuellement aux autorités compétentes en matière d'alimentation en eau potable.

Cependant si l'ensemble de l'activité économique, à l'exclusion des mines, a été jusqu'aux dernières années centrée sur le littoral atlantique, l'atténuation des disparités régionales a été jugée nécessaire et le dernier plan triennal 1965 - 1967 l'a bien inscrit dans son programme.

Cette atténuation se fera sentir à coup sûr sur le plan économique et partant, sur le plan de l'alimentation en eau de ces mêmes régions. C'est ainsi qu'une récente étude orientée dans ce sens, a permis de déterminer :

1°) le degré de satisfaction de toutes les provinces du Royaume

2°) l'évolution des consommations dans l'avenir.

Les chiffres les plus significatifs touchent plus particulièrement les petites villes (régions côtière et intérieure) avec un degré de satisfaction évalué à 65 %.

Quant à celles de l'arrière-pays, ce pourcentage ne dépasse guère 53 %.

En ce qui concerne les besoins dans l'immédiat et dans l'avenir, ils ont été estimés à :

Année	Débit en m3/s
1965	8,6
1970	10,8
1975	13,7
1980	18
1985	22,5
1990	28,6

L'analyse de ces chiffres permet de faire les remarques suivantes :

a) les besoins actuels doubleront en 15 ans.

b) ces mêmes besoins représentent 5,3 % des eaux utilisées de nos jours et 2,6 % du bilan global des eaux disponibles.

c) les besoins de 1990 représentent 10 % de ce même bilan global.

d) ces pourcentages sont relativement forts en regard aux débits qui doivent satisfaire les besoins agricoles et en regard à la vocation agricole du Maroc.

e) la répartition des eaux souterraines utilisées ou à utiliser étant non encore définie avec précision et étant donné l'emplacement des grandes villes par rapport aux nappes souterraines exploitables, seuls les petites villes et les centres ruraux peuvent être satisfaits dans l'avenir à partir des eaux souterraines, le reste des centres devant puiser ses besoins complémentaires dans les eaux de surface.

En outre, il n'est pas illogique d'envisager dans un avenir relativement immédiat le recours à la solution du dessalement des eaux saumâtres ou directement de l'eau de mer.

En effet, la grande impulsion technologique qui explique les rapides progrès dans ce domaine laisse augurer l'éventualité de l'utilisation de l'eau douce extraite de l'eau de mer ou de l'eau des zones saumâtres.

Quoi qu'il en soit, l'analyse de la situation au Maroc sur le plan de l'hydraulique urbaine et industrielle permet de remarquer que les régions qui restent à desservir sont presque toujours celles qui ne disposent pas de ressources aquifères suffisantes c'est-à-dire celles pour lesquelles les investissements à consentir sont relativement élevés.

Pour ce faire, la formule la plus économique est d'intéresser plusieurs localités au même projet de prises de barrages et de faire jouer à ces barrages au moins un double rôle, celui de satisfaire et les besoins agricoles et les besoins industriels et domestiques.

Cette idée a été déjà mise en application au Maroc par la force des choses elle doit continuer à inspirer les pouvoirs publics.

International Conference on WATER for PEACE

United States | Water Supply

BENEFIT - COST ANALYSIS: A METHOD TO DEMONSTRATE THE IMPORTANCE OF WATER RESOURCES DEVELOPMENT

Carruth J. Wagner

The enormity of the needs to develop the world's human and natural resources for the betterment of all mankind excapes ordinary men. As world experts in water resources, you have a realization of that need as few men have. In your deliberations at this conference, you have explored means to obtain water in adequate quality and quantity to meet the needs of man. Admittedly, this is but one of the natural resources needing development if man is to extricate himself from disease, human suffering, impoverishment and a standard of living which all too often is below his basic dignity.

Unfortunately, but realistically, financial resources are too limited to meet fully all of these needs as rapidly and completely as desired. Therefore, competition exists now and will continue in the foreseeable future for financial support to develop the world's resources, including the water resource. To meet that competition you as experts in water resources must be prepared to present the full value of water resources development. The presentation should clearly identify the need for water resource development and benefits to be derived from such development. Equally as important is the need to present the facts in the language of the economist, financier or appropriating body. The presentation must be capable of withstanding comparison with requests for other resource development activities and to compete favorably in the process of adjudication. A failure to meet these criteria will quite likely cause unnecessary postponement of significant projects. One method of developing the case for water resource development projects is through benefit-cost analysis, which is but one step in the schema of planning. In that schema there are nine sequential actions which, in my opinion, must be considered for realistic health planning. These sequential actions are as follows:

1. Community status in terms of all major problem areas must be identified. Included will be health status in terms of health problems.

2. The community must establish an ultimate health goal, expressed in quantifiable terms; along with goals for other major problem areas such as transportation, education, housing, and the like.

3. There must be a determination made of the community attitudes, resources, and conditions.

4. Health problems must be analyzed in terms of causes and factors contributing to these causes concurrent with analysis of all other major problem areas. This must include quantification of health problems in respect to health status.

5. Alternate plans of action should be developed that will eliminate or modify health problem factors.

6. Performance of benefit-cost studies on alternate plans of action for the health program is the next sequential step.

7. Establishment of total community objectives and plans of actions on a short and long range basis follows. When this step is completed the entire "program package" is available.

8. The community must then analyze all problem areas using benefit-cost and cost effectiveness studies to develop trade-offs that will result in an integrated program designed to have the major impact on the established community goals and objectives.

9. The institution of a continuing program evaluation process completes the schema.

This entire planning system is being increasingly utilized by operating programs of the Public Health Service, the major health component of the U. S. Department of Health, Education, and Welfare. Returning to Step 6 - performance of benefit-cost studies on alternate plans for the health program - I would like to present to you a simplified example of such a study. This example was developed during the programming of health services for the American Indian and Alaska Native.

In 1955, the Division of Indian Health of the Public Health Service was assigned responsibility to "conserve the health of American Indians and Alaska Natives".[1] In carrying out that responsibility, a comprehensive program of normal development, repair, and containment activities was undertaken for these first Americans.

Diseases such as gastroenteritis, dysentery, diarrhea, typhoid fever, trachoma and other preventable illnesses were occurring among the service population at rates many times those of general population of the United States. The incidence and mortality rates were comparable in many instances to those found in developing nations of the world.

Surveys were conducted to determine environmental factors related to the high morbidity and mortality rates. Results indicated that over half of the Indian population lived in poorly constructed, dilapidated and crowded houses of two rooms or less. Over 80 percent of the families hauled or carried all water for domestic use, sometimes over long distances, and more than 70 percent of water used in the home was obtained from potentially contaminated sources. Waste disposal facilities for Indian homes were unsatisfactory or nonexistent for more than 80 percent of the families. Such gross environmental deficiencies were in large measure responsible for the high rates of incidence and deaths among Indians and Alaska Natives from certain preventable diseases.

Medical treatment and lost productivity due to premature deaths caused by these environment-related diseases produced an estimated annual liability of $11.2 million. Previous program activities had been restricted primarily to treatment with only a minimum education-motivation effort and few improvements were made to basic water supply and waste disposal facilities. Without major improvements to water and waste facilities, it could be expected that the annual cost of $11.2 million would continue indefinitely. Faced with this rather bleak outlook, the Division looked at other activities which, when performed in conjunction with treatment and education-motivation efforts, would reduce the future liability of the environment-related diseases.

A study [2] was conducted during 1954-1956 to determine the relationship between the incidence and prevalence of diarrheal diseases and the availability of running water supplies in homes and adequate facilities for excreta disposal. The study indicated a 50 percent reduction in the incidence of diarrheal diseases could be realized if safe running water was available in the home and an adequate earthen pit privy was provided for excreta disposal. It also indicated that when a water closet was substituted for the pit privy, the incidence of those diseases would be reduced by more than 80 percent. Similar findings were reported from a study made in the State of California.[3] These findings suggested that a permanent reduction of the high rates of incidence and mortality from diseases related to contaminated water supplies and unsatisfactory facilities for excreta disposal would be achieved if adequate and safe sanitation facilities were available and used.

The availability of safe running water in the home and of satisfactory disposal facilities is not an end in itself. The facilities must be properly used if the reductions in disease incidence and mortality are to be realized. Experience with the Indian culture had taught us that the people would not alter their beliefs and historical practices simply because proper facilities were available. It was recognized that an organized behavioral-motivation activity was required to assure the healthful use of available facilities.

Since it appeared that the construction of basic sanitation facilities offered a realistic and practical method of reducing the annual liability from certain diseases, total costs for the disease liability and for the construction of sanitation facilities were needed for comparative purposes. The normal useful life of water supply and waste disposal facilities is estimated to be 30 years; therefore the $11.2 million annual liability under the previous activities had to be considered for the same period of time. In addition, funds expended in any program would, if invested in the expanding economy of the United States, have an estimated annual return of 5 percent compounded interest. On this basis, the treatment and education-motivation program annual liability--$11.2 million for 30 years at 5 percent per annum compounded interest--produced a total liability of $744 million. That amount, $744 million, becomes the base for comparing liabilities of alternate program plans.

Reasonable and practical alternate plans of action were developed next. Of the total considered, there appeared to be three program plans which would lead to a reduction of future liabilities. To select the alternate plan that would provide the most efficient and effective program, a benefit-cost analysis was prepared. Analyses of these alternates are briefly as follows:

Plan of Action - Alternate 1

Continue treatment of persons who are ill with diseases associated with unsafe water supplies and unsatisfactory waste disposal facilities and seek improved sanitation facilities through an increase in behavioral-motivation efforts. The initial increase in these efforts would be substantial for the first 5 years, then gradually reduced to a maintenance level. This example would involve an average increase of $1.2 million per year.

Anticipated Results

A low average family income of $1500 per year was demonstrated through program experience to be inadequate to permit most families to construct their own basic sanitation facilities. Since life expectancy of sanitation facilities is 30 years it was estimated that during that period of time, improvements in water supplies and waste disposal facilities would produce an average 5 percent reduction in the annual treatment and productivity liability.

Anticipated Cost Over 30-Year Period

The behavioral-motivation activity cost of $1.2 million per year when compounded at 5 percent per annum for 30 years yields a total investment of $80 million. The reduction in the basic annual liability of 5 percent would result in a revised annual liability of $10.6 million. Thus, the revised 30-year treatment and productivity liability would be $704 million, a saving of $40 million when compared with the original liability of $744 million. The benefit-cost factor is determined by dividing the savings of $40 million by the investment of $80 million. The factor of Alternate 1 equals 0.5.

In the first alternate plan of action, the deterrent to major improvements in water supplies and waste disposal facilities was the limited resources available for most Indian families to make such improvement. Consequently, if additional resources were provided to build basic sanitation facilities for most families within a short period of time, then a substantial reduction in the annual treatment and productivity liability might be realized. Plan of Action - Alternate 2 considers the accelerated construction of water supply and excreta disposal facilities.

Plan of Action - Alternate 2

Continue treatment of persons ill with diseases associated with unsafe water supplies and unsatisfactory waste disposal facilities and obtain additional resources to construct sanitation facilities so at the end of the first 10 years of the 30-year period every family would have a safe water supply and satisfactory disposal facility. Behavioral-motivation activities would be maintained at the basic program level.

Anticipated Results

At the end of the first 10 years all Indian and Alaska Native families would have safe running water in their homes, and a satisfactory disposal facility would be available. With no increase in behavioral-motivation activities, the known cultural factors would prevent full acceptance and maximum use of installed facilities for healthful purposes. Therefore, it was estimated that the average reduction which would occur in the annual liability would be only about one-fourth the maximum reduction of 80 percent indicated by the previously cited studies, or an average reduction of 20 percent.

Anticipated Cost Over 30-Year Period

The cost to construct sanitation facilities was estimated at $138 million. Since it was anticipated that the amount was to be expended during a 10-year period, the total investment for construction, including 5 percent compounded interest, was considered to be $173 million. The 20 percent average reduction in $11.2 million annual treatment and productivity liability results in a revised annual liability of $8.96 million. When compounded at 5 percent per annum for 30 years the revised treatment and productivity liability would be $595 million, a saving of $149 million when compared with the original liability of $744 million. Thus, the benefit, $149 million, divided by the investment, $173 million, yields a benefit-cost factor of 0.86.

In the discussion of the anticipated results from Alternate Plan 2 it was mentioned that cultural factors would prevent full acceptance and maximum use for healthful purposes of installed facilities. Although the benefit-cost factor for Alternate 2 is better than for Alternate 1, it was felt that a third alternate designed to overcome both the economic and cultural factors would be more favorable. Therefore, Alternate Plan 3 was developed and evaluated on the basis of benefit-cost.

Plan of Action - Alternate 3

Continue treatment of persons ill with diseases associated with unsafe water supplies and unsatisfactory waste disposal facilities; construct basic sanitation facilities during the first 10 years of the 30-year period; and carry out a behavioral-motivation activity that is balanced with the construction effort.

Anticipated Results

At the end of the first 10 years all Indian and Alaska Native families would have safe running water in their homes and a satisfactory facility for excreta disposal would be available. A balanced behavioral-motivation activity coordinated with the construction effort would result in the majority of families accepting water closets in their homes. Also, the families would be given instructions in the maintenance and use of the facilities. An estimated 50 percent average reduction in the annual treatment and productivity liability would be expected to occur.

Anticipated Cost Over 30-Year Period

As in Alternate Plan 2, the total cost, including interest, to construct the sanitation facilities was estimated at $173 million. Although the major behavioral-education effort would occur during the construction period, it was estimated that the average cost per year would be 1.4 million. Projecting this average annual cost plus interest for the 30-year period, the investment would be $94 million. Thus, the total investment for Plan 3 would be $267 million. The original $11.2 million annual treatment and productivity liability reduced 50 percent, yields a revised annual liability of %5.6 million and a revised 30-year liability of $372 million, a saving of $372 million. Thus, the benefit, $372 million, divided by the investment, $267 million, yields a benefit-cost factor of 1.39.

The benefit-cost factor indicates the dollar return on an investment. For example, if a $100 investment is made and after a period of time the investment, $100, plus earnings, $50, is converted to cash, then the benefit-cost factor would be 1.5; i.e., for each dollar invested, 1.5 dollars were returned. To an economist, financier or appropriation group such a return of an investment is excellent. If the benefit-cost factor is 1.0, then the investment is equal to the investment plus the earnings which in this example was zero. If the object is saving human lives and making people productive members of the world society, such an investment might be acceptable. If, however, the object is to expand water resources for an industrial operation that is not beneficial in the world society, economists might conclude that a benefit-cost factor of 1.0 is inadequate to warrant their financial support.

Returning to the examples, it is noted that the benefit-cost factors were o.5, 0.86 and 1.39 for Alternate Plans 1, 2 and 3, respectively. Since Plan 3 demonstrated the most favorable benefit-cost factor it was adopted by the Indian Health program and was supported by the President and the Congress of the United States.

I have purposely oversimplified the analysis, constraints and judgments involved in this benefit-cost determination in order to illustrate the process. The total process is very complex and cannot be illustrated in this brief statement. However, the tool is within the reach of us all and with adequate information and assistance from the economists most health programs can be improved through such an analysis by the program operator.

In summary, fiscal resources are inadequate to meet all the current needs for natural and human resource development activities in the world. Consequently, there is and will continue to be much competition between all groups with responsibilities for making the world a better place to live. To make the most prudent use of available funds and to successfully compete with other programs will require (1) a clear identification of water resources needs and benefits to be derived therefrom, (2) presentation of the needs and benefits in the language of the economist, financier and appropriation-making agency, and (3) the demonstration that the water resources presentation will provide greater values to society than other resource development activities. The benefit-cost method of developing a program plan and justifying the water resources development request holds much promise in these activities.

1. Transfer of Indian Health and Hospital Facilities; 42 USC 2001-2004

2. "Relationship of Environmental Factors to Enteric Disease"; Public Health Monograph No. 54-1958 (PHS Publication No. 591).

3. "Influence of Water Availability on Shigella Prevalence in Children of Farm Labor Families"; Arthur C. Hollister, Jr., M.D., M. Dorothy Beck, Alan M. Gittelsohn, and Emmarie C. Hemphill; American Journal of Public Health, Vol. 45, No. 3, March 1955; pages 354-362.

L'ETUDE DE RENTABILITE, METHODE PERMETTANT DE DEMONTRER L'IMPORTANCE DE LA MISE EN VALEUR DES RESSOURCES HYDRAULIQUES

Résumé

Les ressources monétaires dont dispose le monde entier sont généralement insuffisantes pour qu'il soit possible de mettre pleinement en valeur toutes les ressources humaines et naturelles au cours d'une brève période de temps. La concurrence continuera donc à jouer lorsqu'il s'agira d'obtenir le soutien financier nécessaire à la mise en valeur de ces ressources, y compris les ressources hydrauliques. La mesure dans laquelle les responsables de cette mise en valeur pourront répondre à cette concurrence déterminera pour une large part la fraction de l'ensemble des ressources financières disponibles qui pourra être consacrée à la mise en valeur des ressources hydrauliques.

Le document présente un schéma de planification, consistant en neuf mesures successives. L'une de ces mesures, l'analyse de rentabilité, est étudiée sous une forme simplifiée de façon à illustrer la méthode. Trois types différents de plans d'action sont présentés et pour chacun l'auteur compare les bénéfices et les coûts de façon à pouvoir choisir le plan d'action le plus favorable. L'auteur cite des références à trois ouvrages.

EL ANALISIS DE BENEFICIO-COSTO UN METODO PARA DEMOSTRAR LA IMPORTANCIA DEL DESARROLLO DE LOS RECURSOS HIDROLOGICOS

Resumen

Los fondos monetarios disponibles en el mundo son generalmente insuficientes para desarrollar plenamente todos los recursos humanos y naturales durante un breve período de tiempo. En consecuencia, continuará existiendo la competencia para obtener el apoyo financiero necesario para desarrollar esos recursos, inclusive los hidrológicos. La capacidad de los encargados de desarrollar los recursos de agua para hacer frente a esa competencia determinará en gran medida la proporción de los medios financieros disponibles que se dediquen totalmente al desarrollo hidrológico.

Se presenta un esquema de planificación que consta de nueve etapas sucesivas. Una de ellas, el análisis de beneficio-costo, se examina en forma simplificada para mostrar cómo se lleva a cabo. Se presentan también tres planes de acción opcionales y se comparan los beneficios en relación con los costos de cada uno de ellos, a fin de seleccionar el plan de acción más favorable.

Se citan tres referencias.