WATER SUPPLY IN MALAYSIA

General Information

Cover photograph : View of Semenyih Dam, Selangor Darul Ehsan.

CONTENTS

1. MALAYSIA IN BRIEF

THE COUNTRY

Malaysia is a Constitutional Monarchy comprising 15 states including Wilayah Persekutuan Kuala Lumpur and Wilayah Persekutuan Labuan.

Federal Capital – Kuala Lumpur.

THE LAND

Total land area -- 330,433 sq. km.

The eastern and western halves of Peninsular Malaysia (formerly Malaya) are effectively separated by a range of mountains known as the Main Range.

Sabah's Crocker Range boasts the highest peak in Malaysia, the majestic Mount Kinabalu (elevation 4,100 m).

THE CLIMATE

Average temperature – 21°C to 32°C.
Average annual rainfall – 3540 mm.
Humidity – 85% to 95%.

North-East monsoon – November to April
South-West monsoon – May to October

THE ECONOMY

GNP (1991 prices) – M$122,189 million

Per capita GNP – M$6,716.00

GDP (1991 prices) – M$85,963 million

Annual GDP Growth Rate - + 8.3%

THE PEOPLE

Malaysia is a multi-racial society with a diverse cultural and religious background.

Population – 18.0 million (1990)

Figure 1.1 : Malaysia

2. HISTORICAL DEVELOPMENT OF WATER SUPPLY

Although the use of slow sand filters began in 1829, it was the infamous London Broad Street water well epidemic in the early 1850s which showed that sewage contamination was related to human disease. After this there was a general international movement in develcped nations to require all potable water to be filtered, generally using slow sand type filters. The Germ Theory of disease developed by Pasteur and others in the 1860s and 1870s led to the development of rapid sand filters in the late 1890s. In the period between 1900 and 1915, the technology of disinfection of water, first with hypochlorites and then with gaseous chlorine, was developed. Modern water treatment technology was thus born.

Against this world historical background, the first formal arrangement for a water supply system in this country began in Penang in 1804. Clear stream water from the hills was brought along a brickwork channel to the town where earthen pipes were laid through the streets and tin pipes conducted water to the houses. In Sarawak, Kuching had its first water supply in 1887 serving then about 8,000 people. However modern rapid gravity filtration plants were only introduced in this country in the 1930s. Since independence in 1957, the number of treatment plants in this country has increased from 150 to more than 400 reflecting the tremendous sosio-economic change in this period of 34 years.

3. INSTITUTIONAL ASPECTS OF WATER SUPPLY MANAGEMENT

Under the federal constitution of Malaysia, water supply matters are the responsibility of the states. The state governments are responsible for the development of water resources, production, operation and maintenance of public water supplies. The states operate the supplies through either the state Public Works Department (PWD), state Water Supply Department (WSD) or state Water Board (WB). The Federal PWD is the federal agency for consultation and technical advice for the state PWDs and state WSDs, as well as a coördinating agency for all water supply projects funded by the federal government.

The types of organisation under which water supply in the states is managed and operated are listed in Table3.1.

	TYPE	STATES
1.	Water Board (WB)	Melaka, Pulau Pinang, Perak and Kuching and Sibu in Sarawak
2.	Water Supply Department (WSD)	Selangor (including Wilayah Persekutuan Kuala Lumpur), Negeri Sembilan, Johor, Terengganu and Sabah
3.	Public Works Department (PWD)	Kedah, Kelantan, Pahang, Perlis and Sarawak (except Kuching and Sibu)
4.	Federal PWD Headquarters	Wilayah Persekutuan Labuan

Table 3.1 : Types of Water Supply Authorities

Legislatively, all states have their own water supply enactments which were passed by the respective state legislative bodies. Currently, the Federal Government has drafted a new water supply act for providing a uniform framework to be adopted by the states. The act contains, inter alia, new provisions for protection of water supply catchment areas, privatisation of water supply activities, stiff penalties on consumer offences and the power to declare a water supply emergency.

4. ENGINEERING STANDARDS, SPECIFICATIONS AND PRACTICE

The Water Supply Branch of the Federal PWD plays an important role in maintaining engineering standards as well as in standardisation of practice in the country. This role includes the provision of consultancy and leadership on technical matters to water authorities in the country, setting of standards and criteria for design as well as for proper operation and maintenance of water supply systems, and standardisation of water supply specifications for use by the PWD/WSD/WB in the states.

4.1 Publications

The Water Supply Branch of the Federal PWD has published several guidelines and technical notes which set the engineering standards for water supply practice, materials, workmanship and design criteria. These include the following:

a) Design Criteria and Standards for Water Supply Systems: Volumes 1, 2 and 3.

b) Guidelines on the Design of Water Supply Plumbing Systems

c) Guidelines for Uniform Application for Water Supply to Housing Schemes in Malaysia

d) Explanatory Handbook on Water Supply Rules.

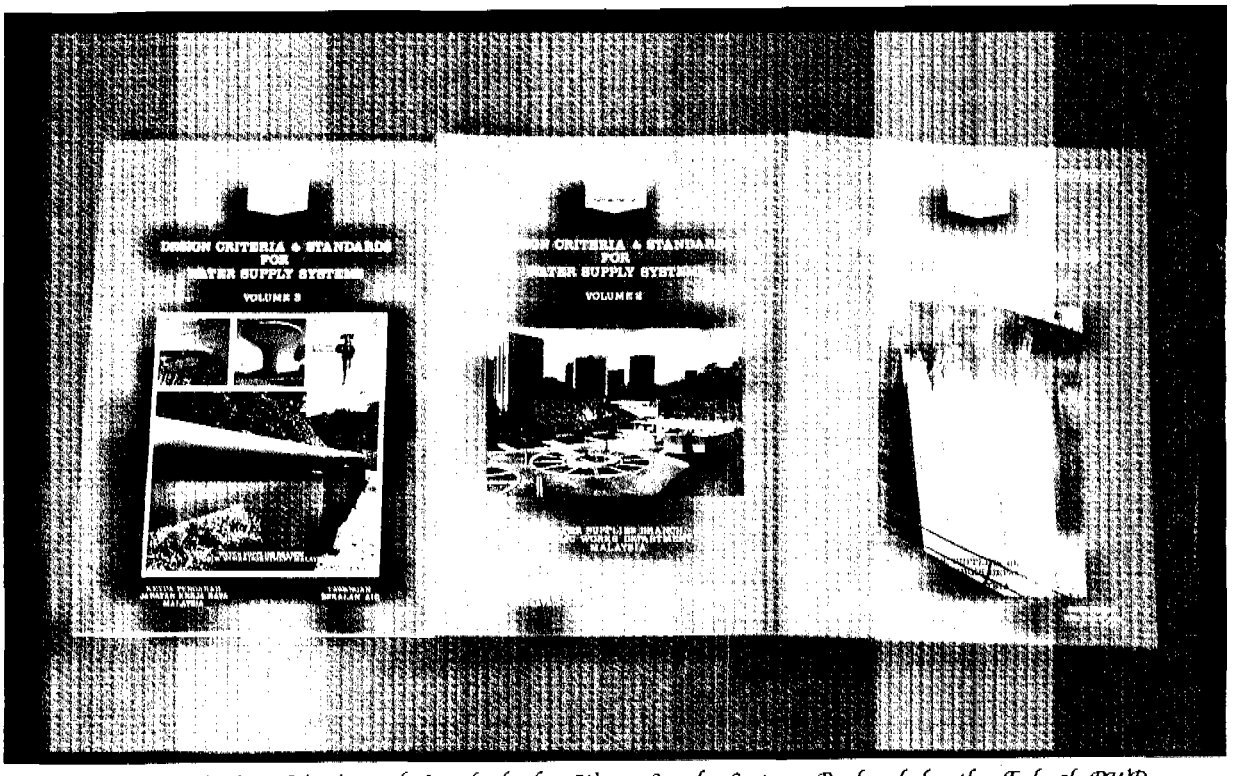


Figure 4.1 : Design Criteria and Standards for Water Supply Systems Produced by the Federal PWD.

4.2 Planning of Development

Generally, water supply development is planned with a planning horizon of at least 20 years but its implementation is carried out in phases. The first phase of development is implemented to meet water demand, usually, for a 10-year period. Review of the planning is done just before launching of the next phase of development.

4.3 Water Sources and Treatment Process

Surface water constitutes about 97% of the sources of water supply in the country whilst the remaining 3% is from groundwater. The reliability of surface water sources was traditionally based on a design drought of 1 in 25 years but this has been upgraded to a more severe drought of 1 in 50 years.

The conventional method of treatment processes is normally used. Some typical design criteria used for the various treatment processes are given in Table 4.1.

CESS	PARAMETER	CRITERIA
Flocculation	Detention Period	20 - 30 min.
Sedimentation	Surface Loading	1 – 2 $m^3/m^2/h$
Filtration (Rapid Sand Gravity)	Filtration Rate	5 - 10 $m^3/m^2/h$
Disinfection	Contact Time	30 min.

Table 4.1 : Design Criteria for Treatment Process

4.4 M & E Plant

A standby pumping capacity of 50 - 100% is provided. The power supply is usually 3 phase, 50Hz, 415V but for very large installations, high voltages of up to 11kV is used. In remote areas where permanent power supply is not available, diesel generators with 100% standby are provided.

Operational control of plant is manual or semi-automatic but protection control for motors is automatic. Booster pumping direct into distribution and reticulation mains is rarely used as water is usually supplied under gravitational head.

4.5 Storage and Distribution

A 24-hour storage of water is provided where the topography allows reservoirs to be sited on the ground. In flat areas, a minimum of 8-hour storage is provided.

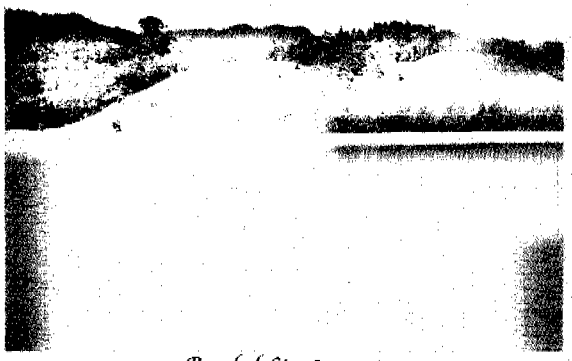
The pipe diameter in the reticulation system is not less than 150mm though the older pipes may be as small as 75mm in diameter. The pressure at point of supply is generally not more than 60 metres head of water. This maximum pressure is reduced to 40 metres for Felda schemes. The minimum pressure is 10 metres for rural areas and 22 metres for urban areas. The pressure requirements are summarised in Table 4.2.

The daily peak factor used in design is 1.2 and the hourly peak factor is 2.5. However a hourly peak factor of 3.0 is used for Felda schemes. Table 4.3 summaries the peak factors used in design.

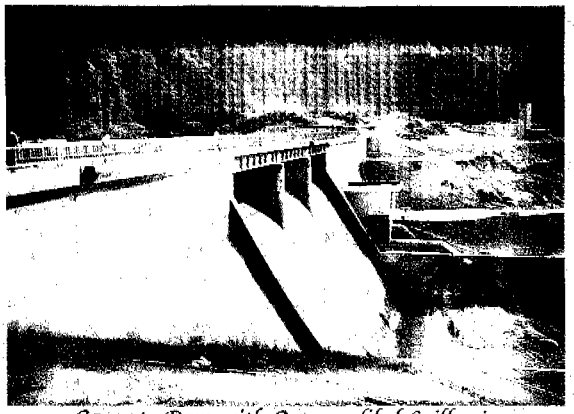
The reticulation network for new housing schemes is designed to meet fire demand requirements.

RESIDUAL PRESSURE	URBAN	RURAL	FELDA
Minimum	22	10	10
Maximum	60	60	40

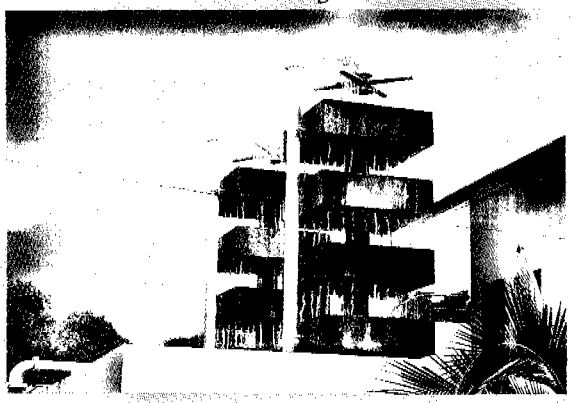
Table 4.2 : Residual Pressure Requirements



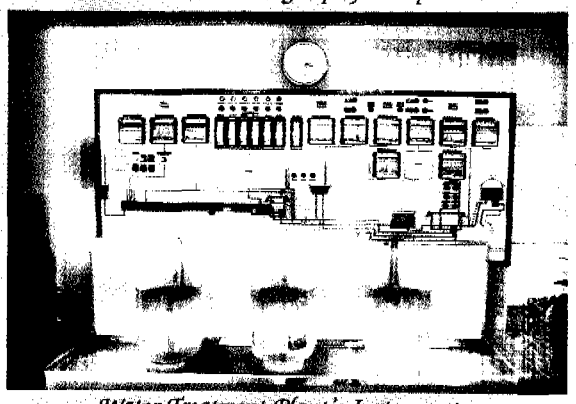
Bunded Storage



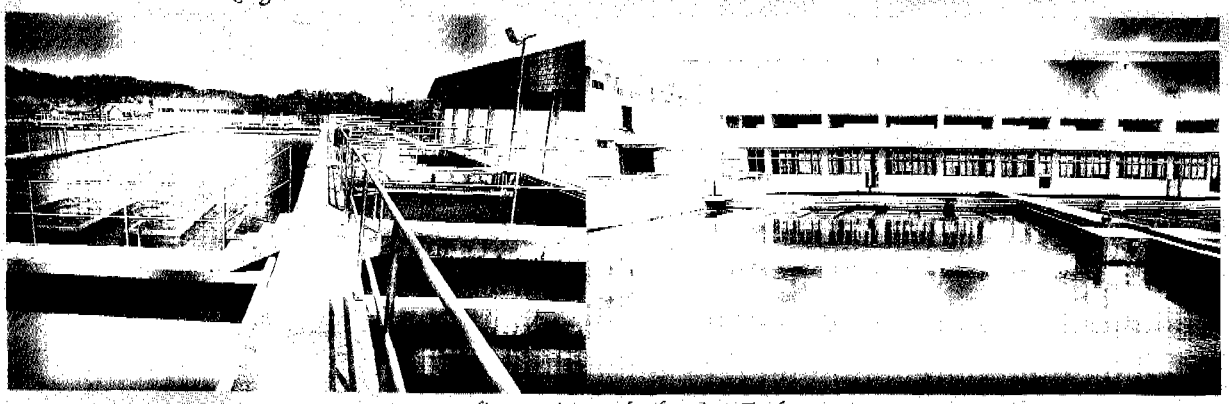
Concrete Dam with Ogee-profiled Spillweirs



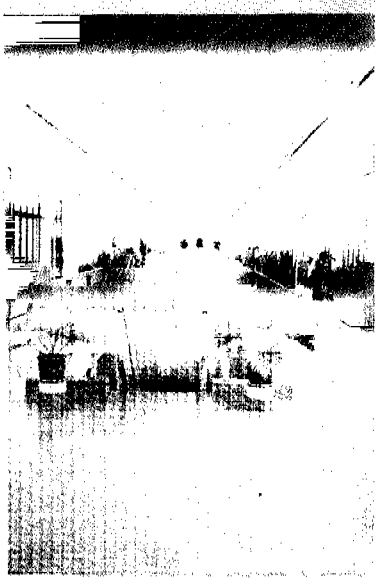
Trickling Aerator



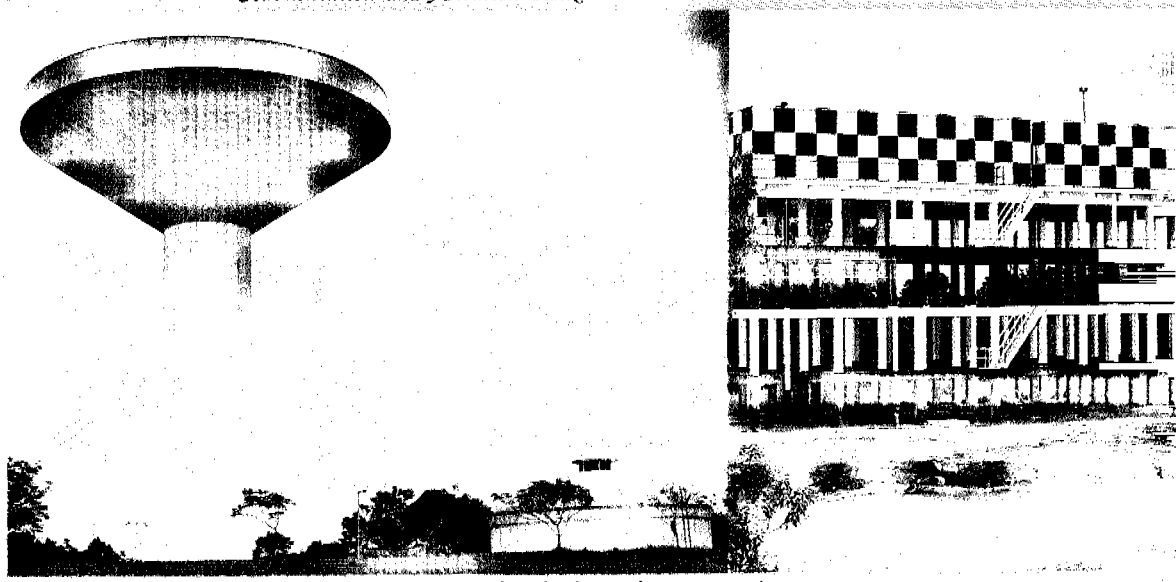
Water Treatment Plant's Instrument



Sedimentation and Filtration Tanks



Filter Gallery



Ground and Elevated Water Tanks

Figure 4.2 : Typical Water Treatment Components In Malaysia.

AREA	PEAK FACTOR	
	DAILY	HOURLY
Urban	1.2	2.5
Rural	1.2	2.5
Felda	1.2	3.0

Table 4.3 : Peak Factors

4.6 **Materials and Workmanship**

The standards of materials and workmanship in water supply are specified in the standard specifications issued by the Federal PWD. Materials used in water supply installations are specified to comply with the relevant Malaysian Standards, British Standards, ISO Standards and other national standards of international standing.

4.7 **Pipes and Tanks**

The various pipe materials used are concrete-lined steel pipes, uPVC pipes, ductile iron pipes, polyethylene pipes, cast iron pipes and asbestos cement (AC) pipes. Presently, AC pipes constitute about 80% of all pipes used in water supply installations in the country.

Many types of storage reservoirs and tanks are used. These include reinforced concrete tanks, fibreglass reinforced polyester tanks, galvanised pressed steel tanks, glass-fused steel tanks and prestressed concrete reservoirs.

4.8 **Water Supply Plumbing System**

The water supply plumbing systems are designed to meet the requirements of the respective State Water Supply Rules. However with the publication of the Uniform Water Supply Rules, the states have either adopted the rules or used it as guidelines.

5. WATER SUPPLY DEVELOPMENT

5.1 **Objective**

The objective of the government is to provide its population with adequate and safe water supply to meet the growing demand for domestic and industrial consumption with the aim of improving public health and supporting industrial development. Figure 5.1 shows the comparison between water supply capacity and the water demand.

5.2. **Water Supply : The past and the future**

Over the past decade (1980 - 1990), there has been a rapid growth in water demand due to the rapid development of the country and the accelerated water supply expansion to the rural areas.

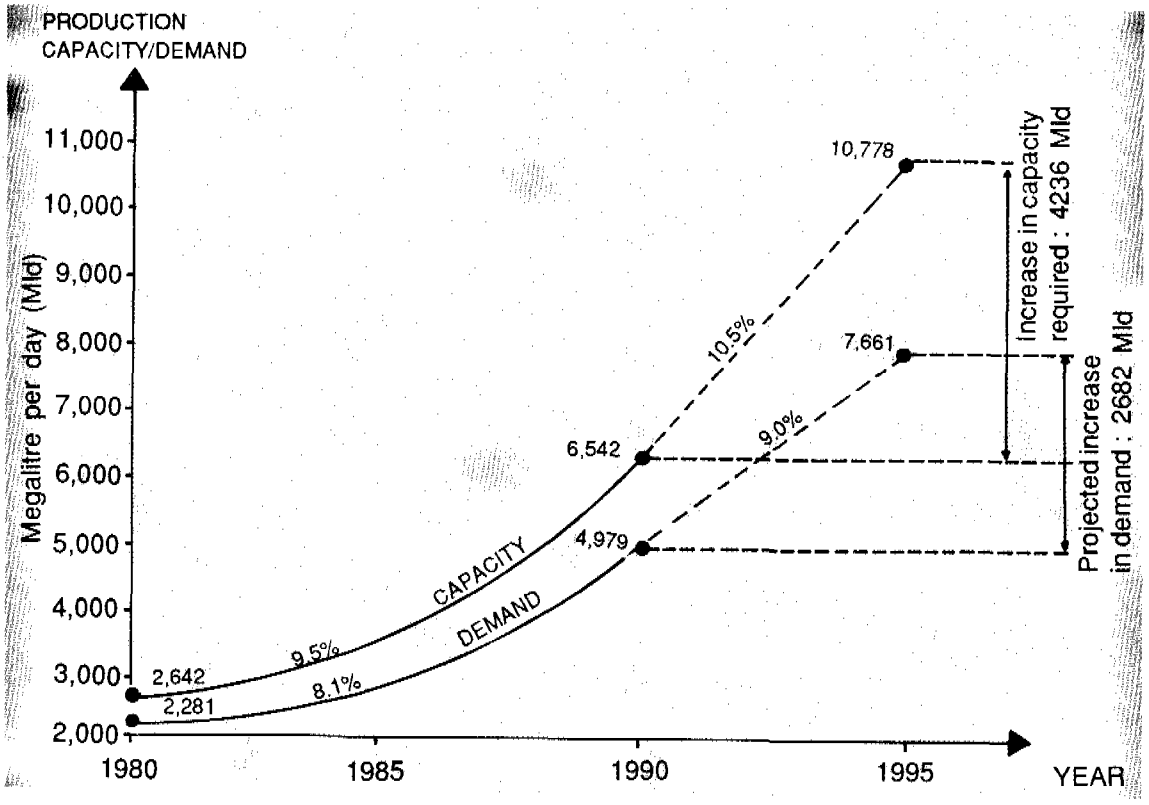


Figure 5.1 : Supply Capacity and Demand in Malaysia.

Over the years, the Malaysian Government has accorded high priority for water supply development since water is a basic need for the growing population and essential for the growth of the various sectors of the economy.

Over the next five years, the thrust of the country's water supply programmes is on the prudent use of water and financial resources. In line with this, priority will be focused on improvement in the efficiency and effectiveness of the water supply authorities and making more efficient use of existing assets. This is also in response to a growing pressure for an improvement in the level of service in terms of quantity, quality, realibility and price. Table 5.1 shows the water supply expenditure in 5-year Malaysia Plans.

5 - YEAR PLAN	PERIOD	WATER SUPPLY EXPENDITURE (MILLION $)	% OF TOTAL BUDGET
Third Malaysia Plan	1976 - 80	538	2.2
Fourth Malaysia Plan	1981 - 85	2,085	3.5
Fifth Malaysia Plan	1986 - 90	2,467	6.3
Sixth Malaysia Plan	1991 - 95	2,854.5*	5.2

* Budget allocation

Table 5.1 : Water Supply Expenditure in 5-Year Malaysia Plans

Development programmes under the Sixth Malaysia Plan include:-

(i) reduction and control of non-revenue water through rehabilitation and upgrading of existing distribution systems.

(ii) rehabilitation and upgrading of existing water treatment plants.

(iii) improvement of water supply systems to the existing industrial areas.

(iv) development of new water supply projects in areas of importance in term of promoting industries, tourism and socio-economic development.

5.3 Water Resource Development

Though the country can be considered rich in water resources with an average annual rainfall of 3540 mm, available water resources for direct abstraction has been constrained by uneven distribution of resources in term of space and time. About 97% of the raw water for water supply is by means of direct surface abstraction, with or without dam impoundment and the remaining 3% from groundwater, principally in the state of Kelantan. The growing and competing demand from various sectors for water supply has begun to strain the available water resources. Future water resource development will place more emphasis on the more efficient and coordinated water resource development plans, such as the construction of multipurpose impounding dams and inter-state water transfer schemes. Water resource development will also be complemented with more effective management and control of water quality.

5.4 Water Supply Financing

Capital investment in water supply systems is funded by the state governments, as well as by the federal government by means of low interest loans and grants depending on the financial ability of the states. Table 5.2 indicates generally the types of projects and the mode of funding provided by each financing agency.

FINANCING AGENCY	TYPE OF PROJECT	SOURCE OF FUNDS
1. Ministry of Works	1. Major Water Supply 2. Antah Biwater Rural Water Supply	1. Federal Loan 2. Federal Grant
2. Ministry of Rural Development	1. Rural Water Supply	1. Deficit Budget State:- Federal Grant 2. Non-Deficit Budget State:- 2/3 Federal Grant 1/3 Federal Loan
3. Ministry of Land and Cooperative Development	1. Felda Water Supply 2. Regional Development Authority Water Supply	1. Federal Grant 2. KEJORA,KESEDAR, DARA, JENGKA, KETENGAH i. Treatment Plant:- Federal Grant ii. Distribution System:- Federal Loan
4. Ministry of Health	1. Community Water Supply	State Government
5. State Government	1. Other Water Supply Projects 2. Privatised Projects	State Government
6. Estate Owner	1. Estate Water Supply	Estate Owner

Table 5.2 : Financing of Water Supply Development

6. OPERATION AND MAINTENANCE

6.1 Funding

Except for Wilayah Persekutuan Labuan which comes under the jurisdiction of the Federal PWD, operation and maintenance of water supply systems, as in all other matters of water supply, are the responsibility of the respective State Governments. A yearly allocation is allocated by the State Governments to the respective state water supply authorities to operate and maintain their facilities. Figure 6.1 shows the operation and maintenance cost of water supply systems for Peninsular Malaysia.

6.2 Guidelines for Operation, Maintenance and Surveillance of Dams

The "Guidelines for Operation, Maintenance and Surveillance of Dams" was prepared by the Malaysian Inter-Departmental Committee on Dam Safety which has its secretariat in the Water Supply Branch of the Federal PWD. It provides general guidelines on the proper safety management of dams in Malaysia. Water supply dam owners who own a total of 25 dams are currently using these guidelines which were issued in late 1989.

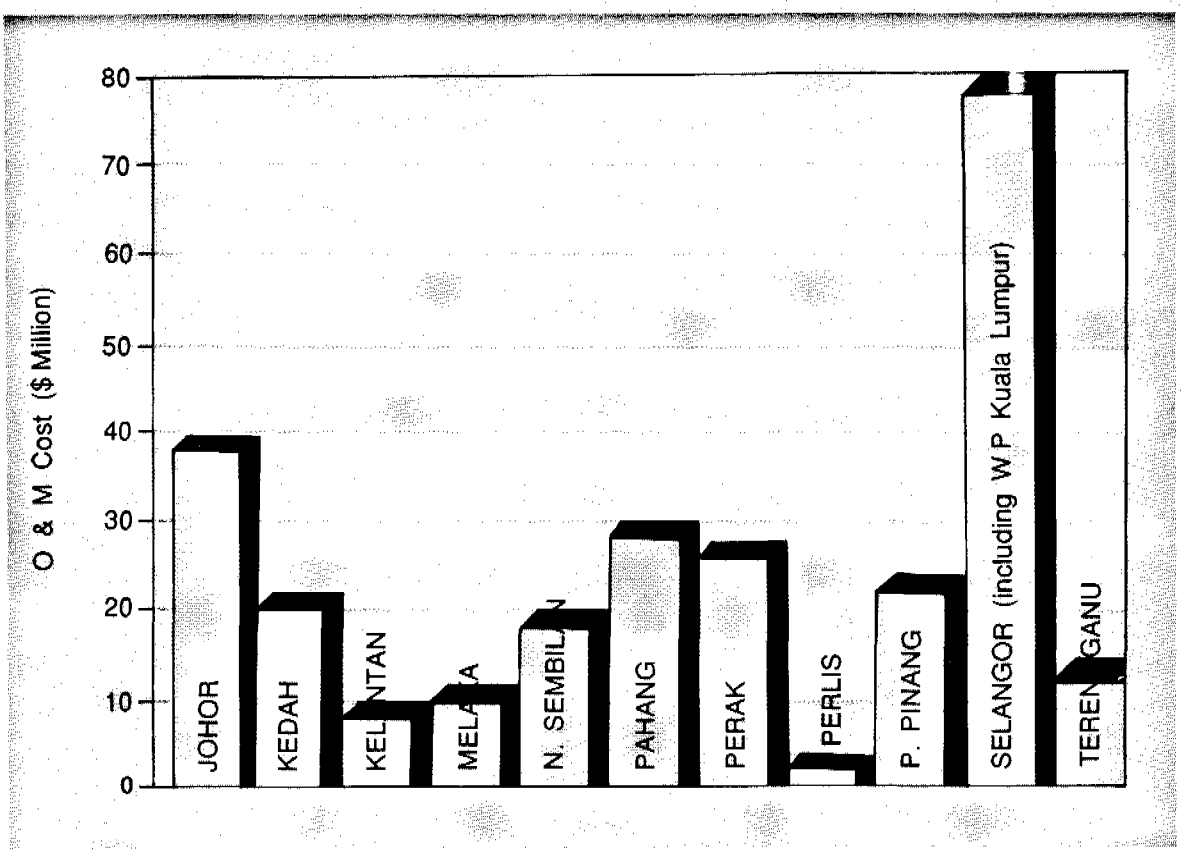


Figure 6.1 : Operation and Maintenance Cost of Water Supply Systems for Peninsular Malaysia (1988)

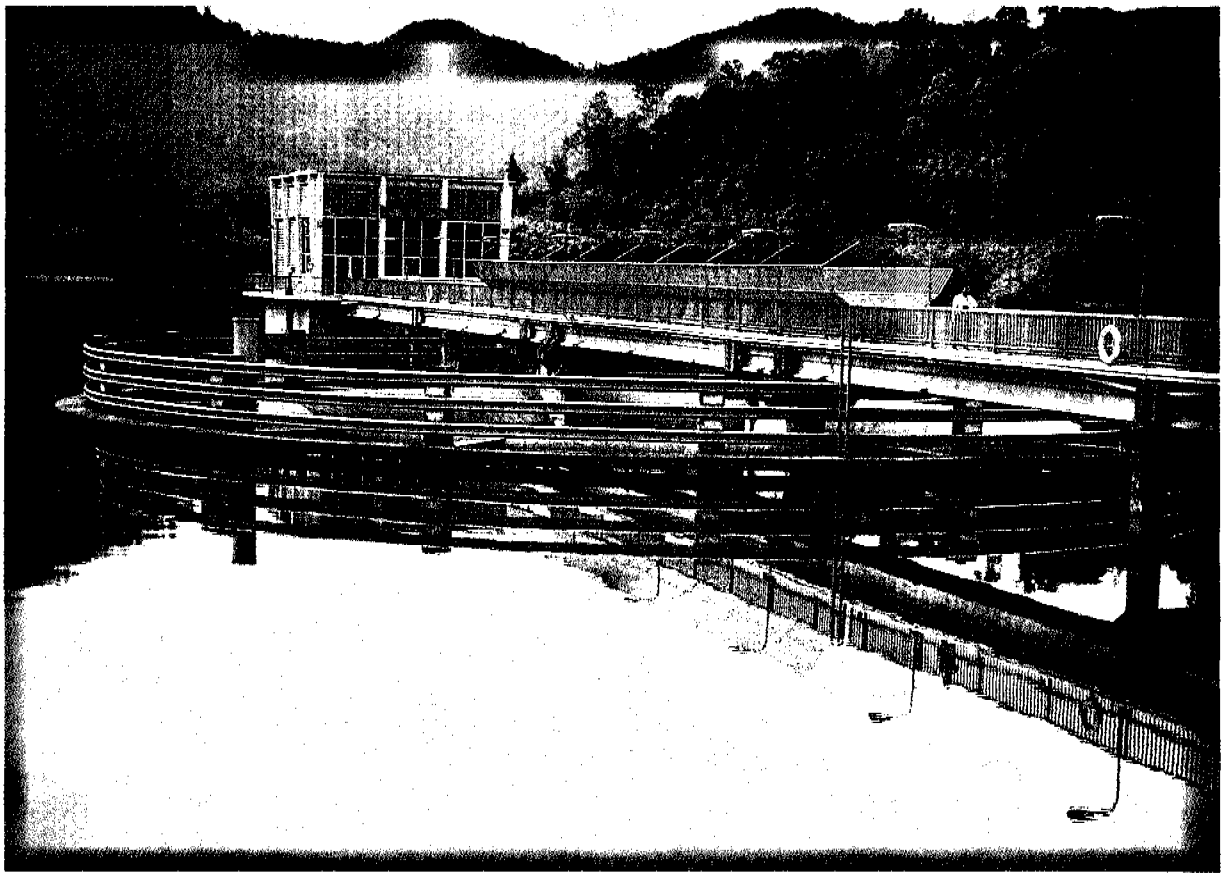


Figure 6.2 : View of Sungai Terip Dam, Negeri Sembilan Darul Khusus

In 1990, a Dams Surveillance Unit was formed in the Water Supply Branch of the Federal PWD to assist the water supply dam owners in implementing an effective dam safety programme to ensure that the dams are properly operated and maintained and continuous surveillance carried out so that the risk of dam failure is minimised.

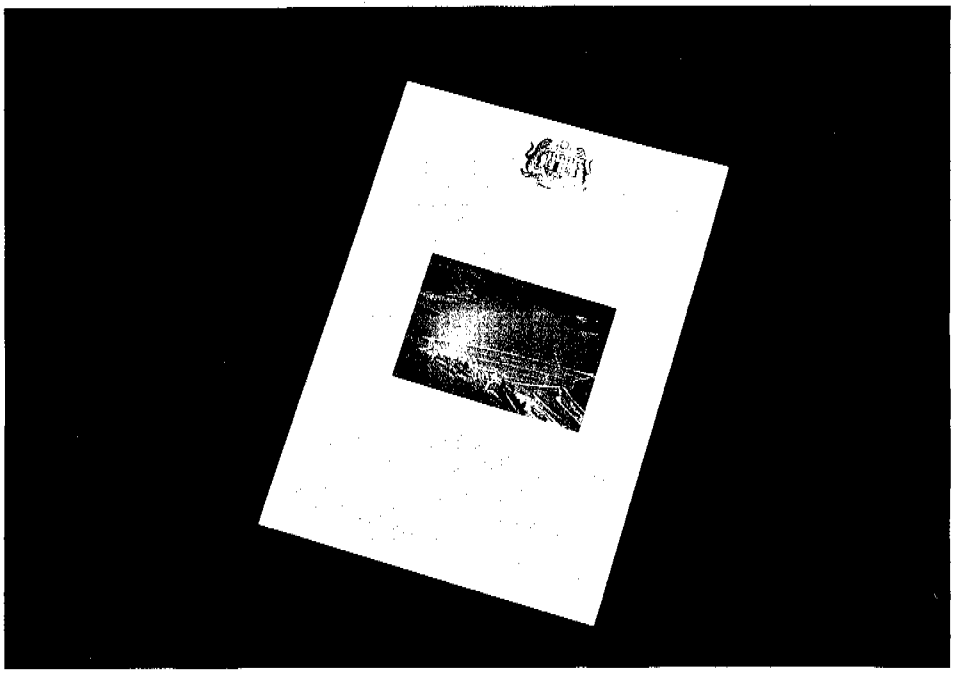


Figure 6.3 :

Guidelines for Operation, Maintenance and Surveillance of Dams

6.3 **Guidelines for Operation and Maintenance of Treatment Plants**

The "Guidelines for Operation and Maintenance of Treatment Plants" was prepared by the Water Supply Branch of the Federal PWD to assist the district water supply engineers in the proper operation and maintenance of the treatment plants. The guidelines list down routine procedures and tests to be carried out by the treatment plant operators to ensure that the treated water produced will meet the WHO Standards for Drinking Water. The guidelines recommend the preparation of a daily report. These reports will assist the district engineers in monitoring the quality of treated water, the level of maintenance and the overall performance of the treatment plants.

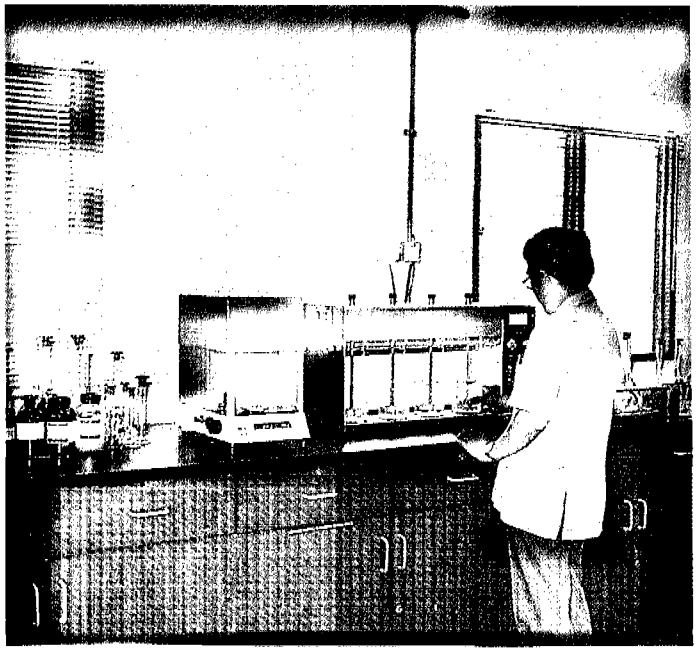


Figure 6.4 :

A jar test being carried out in the laboratory. The test result is used to determine the optimum chemical dosing rate to achieve efficient coagulation and flocculation.

Figure 6.5 :

General view of Bukit Nenas Treatment Plant situated in the heart of Kuala Lumpur. The treatment plant has a maximum capacity of 190 Mld.

6.4 Non- Revenue Water (NRW)

A joint study by the Federal PWD and a private consultant carried out in 1988/1989 found that, nationwide, 43% of treated water produced is unaccounted for. Figure 6.6 gives the breakdown of NRW by region. Through this joint study, an NRW unit was set up in the Water Supply Branch of the Federal PWD to implement and coordinate NRW control programmes countrywide with the aim of reducing the countrywide NRW level to about 25% by the end of 2000.

An NRW control programme and distribution system study is currently being jointly carried out by the NRW Unit and a local expert for the State of Perlis. Apart from NRW reduction, the study is being used as a pilot for the Federal PWD to develop standards of service criteria such as pressure, flow and realibility.

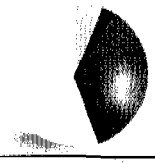
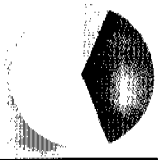
WATER BALANCE ($x10^3$ m^3/d)	PENINSULAR MALAYSIA	SABAH, SARAWAK & LABUAN	COUNTRYWIDE
			
SUPPLY ($x10^3$ m^3/d)	3,588	319	3,907
Average metered consumption ($x10^3$ m^3/d)	2,041 (57%)	205 (64%)	2,246 (57%)
Meter under registration ($x10^3$ m^3/d)	312 (9%)	23 (7%)	335 (9%)
Other losses ($x10^3$ m^3/d)	72 2%	6 (2%)	78 (2%)
Estimated leakage ($x10^3$ m^3/d)	1,163 (32%)	85 (27%)	1,248 (32%)

Figure 6.6 : Breakdown of Non-Revenue Water

7. WATER QUALITY AND CONTROL

Water supply produced by the state water authorities are geared to meet criteria as spelt out in the World Health Organisation's "Guidelines for Drinking Water" and the "National Guidelines for Drinking Water Quality" in order to ensure a safe public water supply. With the joint cooperation of the Ministry of Health and the Department of Chemistry, efforts in sampling and testing of drinking water have been jointly carried out as far back as the early years of water supply development. In 1983, the Ministry of Health formulated a revised National Drinking Water Quality Surveillance Programme which is aimed at improving the earlier programme as well as to include remedial and corrective actions. Figure 7.1 shows the number of bacteriological and chemical samples taken in the joint effort by the various government departments in the past few years.

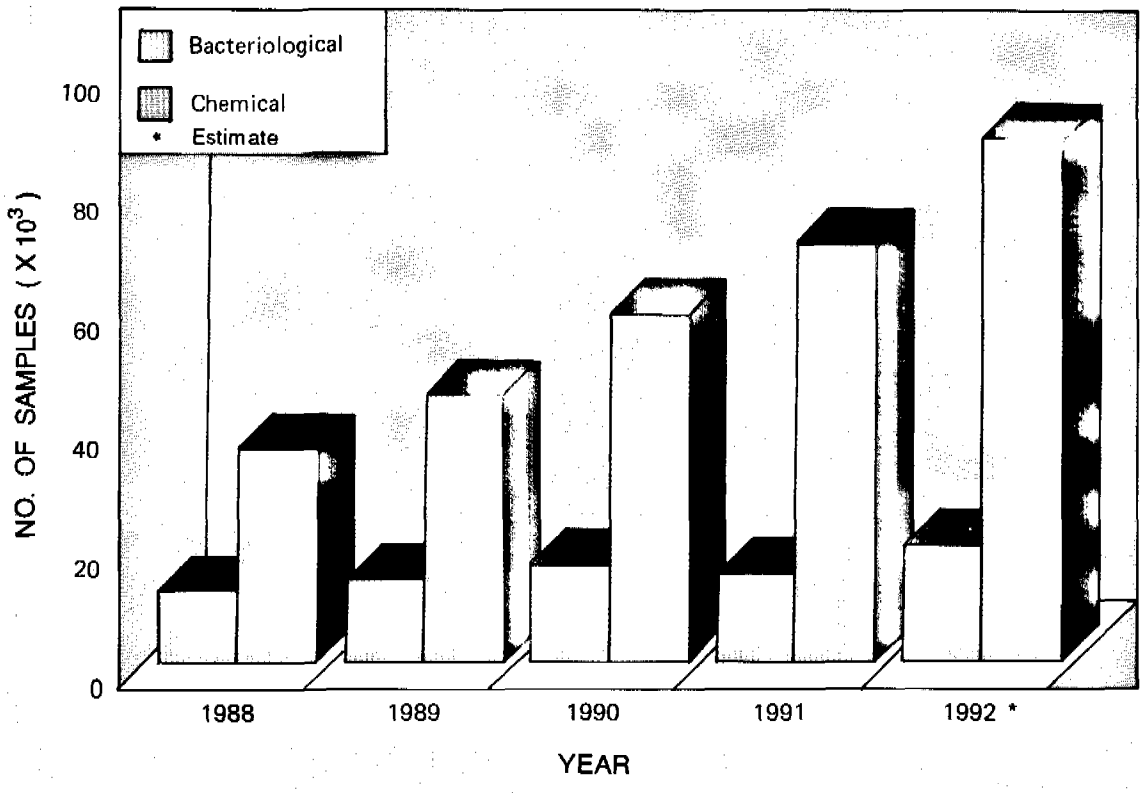


Figure 7.1 : Total No. of Samples Taken

The task of meeting drinking water quality criteria is becoming increasingly more challenging. In recognising the challenges, the Water Supply Branch of the Federal PWD Headquarters has set out a two-prong strategy in water quality control. The first prong is to review inplant testing and controls with the objective of further improving the frequency of water sampling as well as increasing the list of parameters to be tested within treatment plants. The second prong is to strengthen the surveillance programme by increasing the number of samples taken as well as to provide a wider coverage of sample distribution. Also, together with the assistance of the Department of Environment, further action is being taken to protect water catchment areas.

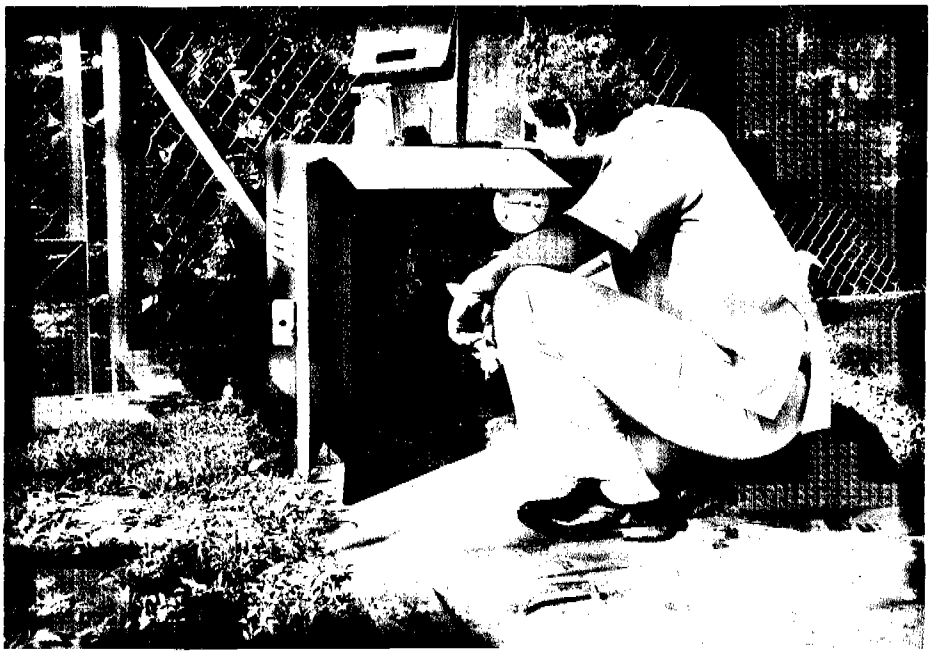


Figure 7.2 : Taking Water Samples from A Sampling Point

8. STATISTICS ON WATER SUPPLY

8.1 Coverage, Supply and Demand Statistics

The coverage of population supplied with drinking water in Malaysia is very high with an overall coverage of 80%. Great efforts are being made by the government to supply drinking water to nearly all the population by the year 2010.

During the 1980-1990 period the average growth in demand and increase in production were 8.1% and 9.5% per annum respectively.

Figure 8.1 shows the overall, urban and rural coverage of population supplied with drinking water.

In 1990, the demand and production capacity were 4979 Mld and 6542 Mld respectively. By 1995, the demand and production capacity is expected to be 7661 Mld and 10778 Mld respectively.

As can be seen in Figure 8.2, state-wise, the supply capacity usually exceeds the demand. Only a few localised areas are found where the supply capacity may not meet the demand during drought periods, but this will be decreasing rapidly in time to come.

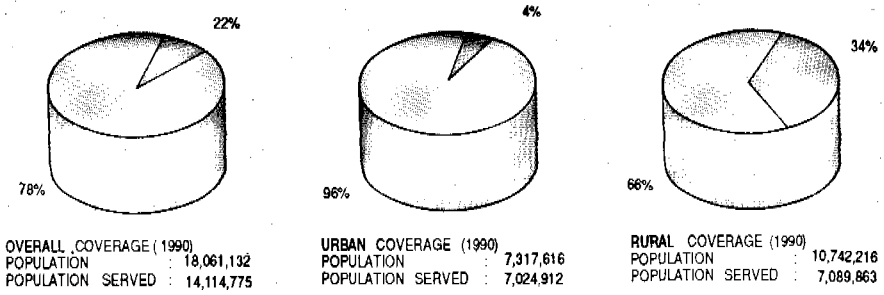


Figure 8.1 : Water Supply Coverage

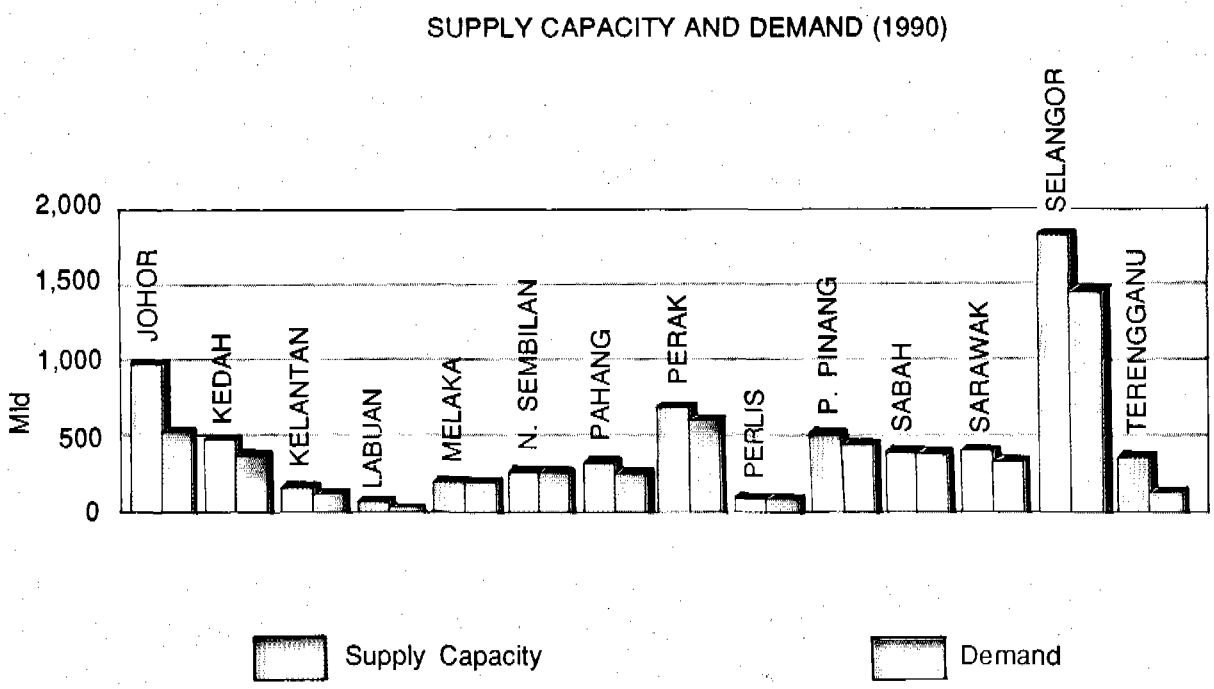


Figure 8.2 : Supply Capacity and Demand

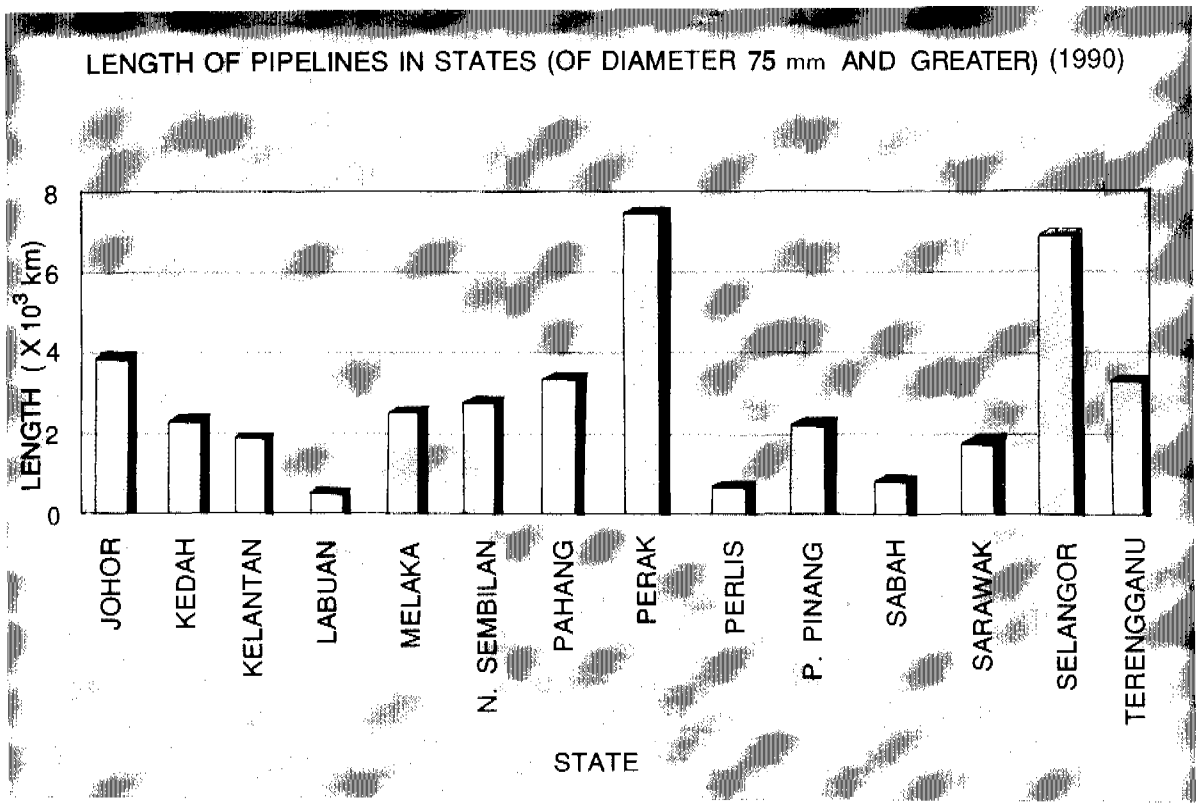


Figure 8.3 : Length of Pipelines

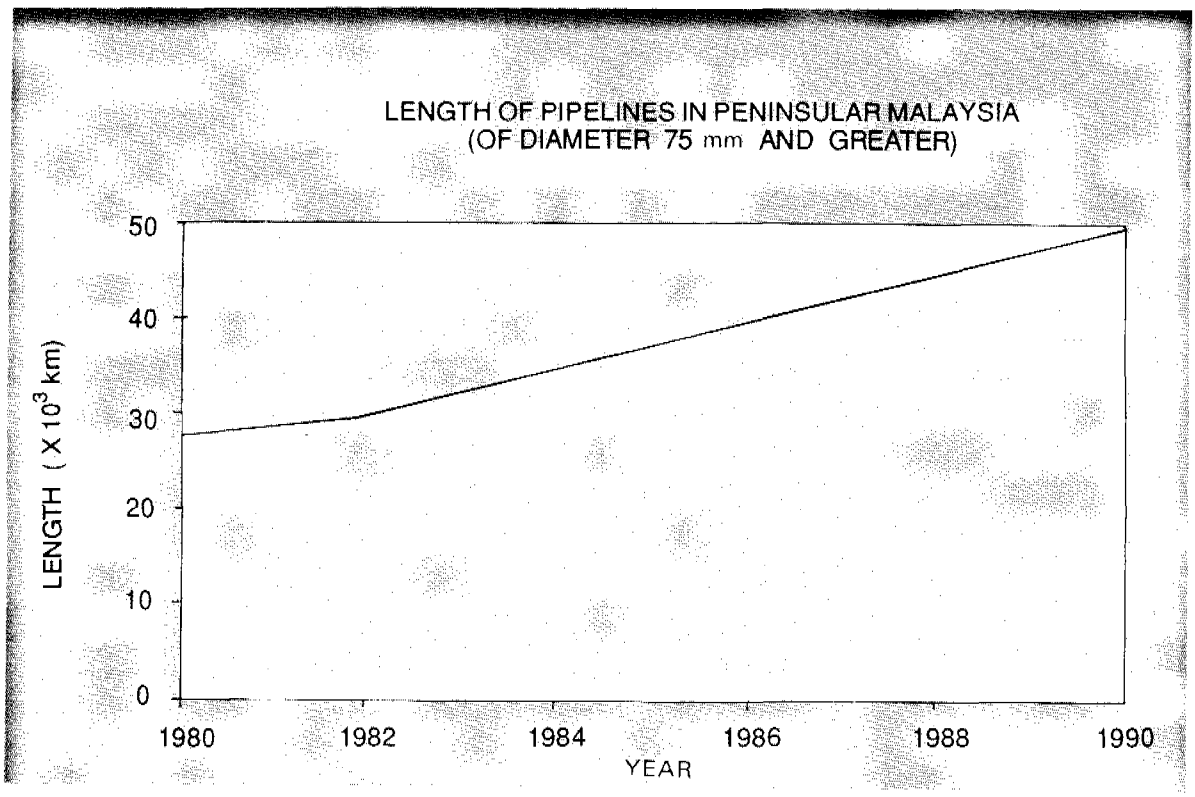


Figure 8.4 : Length of Pipelines in Peninsular Malaysia

8.2 Pipelines

Various types of pipes are used in the distribution systems viz. mild steel, cast iron, spun iron, uPVC, AC and lately ductile iron and high density polyethylene.

The length of pipelines above 75 mm diameter in all the states are indicated in Figure 8.3 and the length of pipelines in Peninsular Malaysia over the period 1980-1990 is shown in Figure 8.4.

8.3 Tariffs

The main source of revenue for the water authorities is from the sale of water. Other sources of income are from connection fees, interest on deposits, etc. All supply except for fire fighting are metered and water consumed is charged according to the type of usage. Water rates vary from state to state. Table 8.1 gives an indication of the range of water rates in Malaysia.

TYPE OF SUPPLY	CONSUMPTION m^3/month	RATES $ / cu.m
DOMESTIC SUPPLY		
Residential	0 - 10	0.20 - 0.90
	10.1 - 50	0.35 - 0.95
	> 50	0.52 - 1.15
COMMERCIAL SUPPLY		
Industrial	Bulk supply rate	0.42 - 1.60

Table 8.1 : Range of Water Rates in Malaysia (as of 1.11.1991)

9. TRAINING AND RESEARCH

The Federal PWD has long recognised that an efficient organisation is based on well-trained and motivated people and the need to establish research and development in the field of water supply engineering. With this in view, the Public Works Institute of Malaysia (IKRAM) in Kajang, Selangor was established in January 1988 and the Johor Water Training Centre in Sungai Layang, Johor was established in 1989. Three new training centres, one each at Bukit Sagu in Pahang, Kuching in Sarawak and Kota Kinabalu in Sabah have also been built.

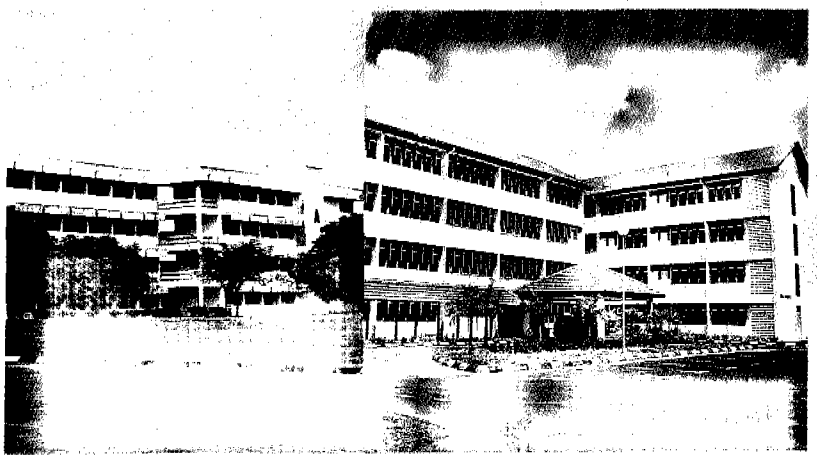
9.1 Training

During 1991, 28 courses were conducted to cover various aspects of water supply engineering, including the design of water supply systems, supervision of construction, operation and maintenance of water treatment plants and distribution systems, leakage control, etc., for various grades of staff. A thorough study of existing manpower and an assessment of overall training needs was carried out by the Federal PWD with the assistance of WHO experts. It was found during the survey carried out in 1988 that 12,128 posts have been approved for water supply personnel and out of this, 10,338 posts have been filled up.

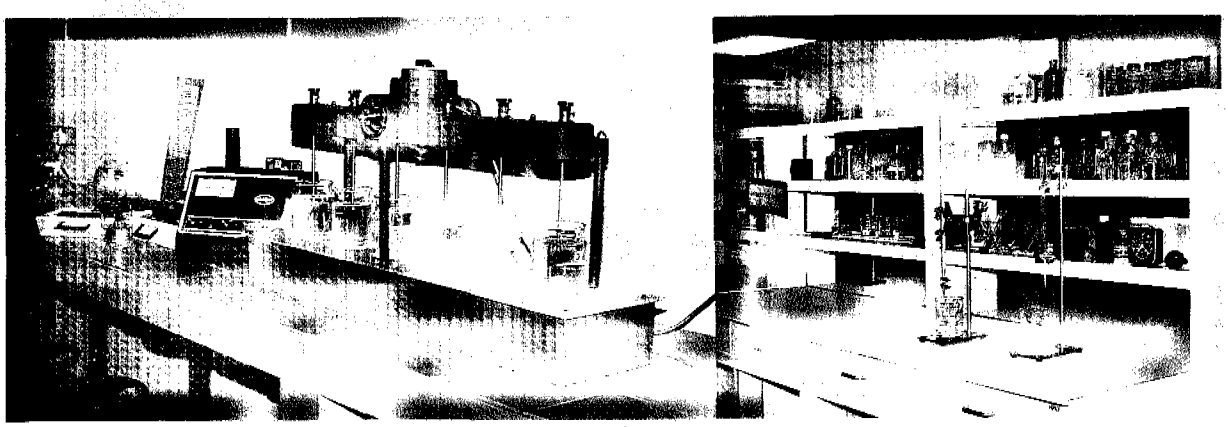
9.2 Research

The proposal for the establishment of the Water Research Unit at IKRAM was approved in principle in 1990.

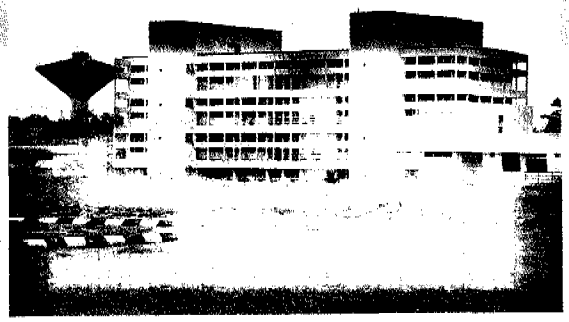
A request for allocation amounting to $1.6 million to carry out research under the Sixth Malaysia Plan has been forwarded to the Ministry of Science, Technology and Environment. The Intensification of Research in Priority Areas



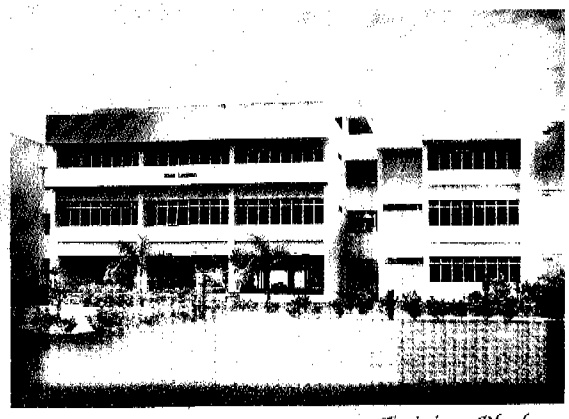
Hostel Blocks



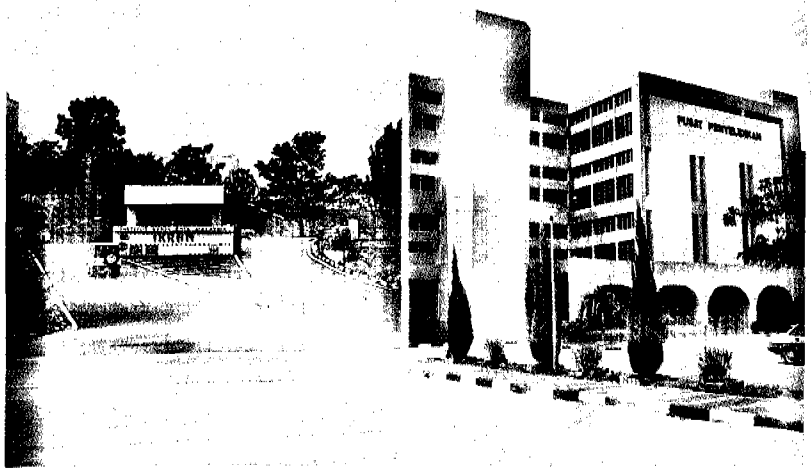
Water Testing Laboratory



Research Laboratory



Training Block



Entrance to IKRAM

Research Block

Figure 8.5 : The Public Works Institute of Malaysia (IKRAM).

(IRPA) panel has reviewed and supported an allocation of $1 million.

A paper has already been submitted to the Public Services Department to establish the posts required for the Water Research Unit at IKRAM.

The research to be carried out will focus on application and problem-related research and will cover the following areas:-

* Water Resources
* Water Treatment
* Water Distribution Systems

10. GENERAL APPLICATION PROCEDURES FOR WATER SUPPLY

The application procedures for water supply to housing development differs slightly from one state water authority to another. To facilitate the process of application, it is advisable to engage consulting engineers who are registered with the state water authority concerned and are familiar with its procedures and requirements.

However, efforts have been made to streamline the application procedures among the various state water authorities and a guideline for uniform application for water supply to housing schemes in Malaysia has been published.

Basically, the application for water supply goes through the following stages namely:-

i) submission of application and proposal

ii) construction, inspection and testing of water supply installations

iii) commissing/testing and handing-over of the water supply system to the state water authority

iv) application for service connections

The procedure for application of water supply is summarised in the flow chart shown in Figure 10.1.

11. LOOKING INTO THE FUTURE

The current policy of the Government is to privatise as many services as are practicable in order to:-

i) relieve the Government of the financial and administrative burden in undertaking and maintaining a vast and constantly expanding network of services and

ii) capitalise on the efficiency of the private sector to increase productivity.

In line with the policy outlined in the Economic Planning Unit circular of 1985 on privatisation, the Government has successfully privatised a number of services such as telecommunications, power, highways, port container services and water supply. Privatisation of water supply in Malaysia includes the Labuan Water Supply Project and the operation of treatment plants at Sungai Semenyih, Sungai Terip and five major plants in Kedah. The Greater Ipoh II Water Supply Scheme and the Kerian/Larut and Matang Water Supply Scheme have also been privatised recently. In the Sixth Malaysia Plan (1991 - 1995), the Government plans to spend about M$2.8 billion for the development of water supplies to meet urban and rural water demands with special emphasis on industrial water needs as well as upgrading of existing treatment plants. Greater attention will also be given to non-revenue water reduction along with rehabilitation of the distribution systems to ensure an improvement of the level of service to the public in the 1990s.

The 1990s will be full of challenges for the enterprising Malaysian in general and the water supply engineer in particular as privatisation will be the trend in the coming years coupled with continued development to meet increasing demand.

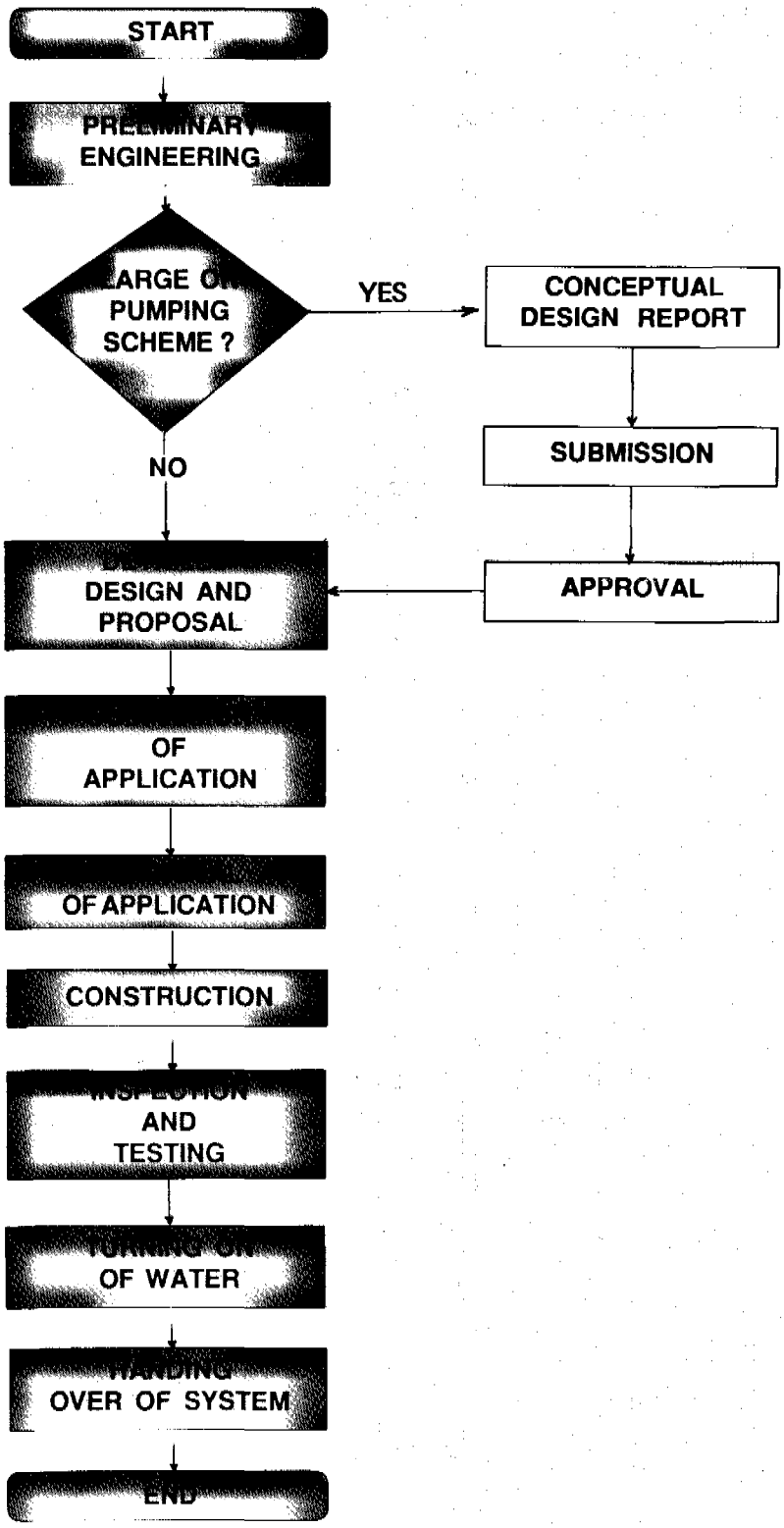


Figure 10.1 : Procedure For Application for Water Supply

ACKNOWLEDGEMENTS

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- *All PWD staff, especially Water Supply Branch, who have contributed directly or indirectly towards producing this edition*
- *All but eight photographs are by courtesy of Dr Mohamad bin Abd. Ghani.*