WORLD HEALTH ORGANIZATION
REGIONAL OFFICE
FOR THE EASTERN MEDITERRANEAN

ORGANISATION MONDIALE DE LA SANTE
BUREAU REGIONAL
POUR LA MEDITERRANEE ORIENTALE

SEMINAR ON SANITATION PROBLEMS
OF RAPID URBANIZATION

Lahore, 7-14 October 1971

EM/SEM.SAN.PROB.URB./8
15 July 1971
ENGLISH ONLY

PLANNING FOR OPERATION AND MAINTENANCE OF COMMUNITY WATER SUPPLY

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1. Background

1.1 The very word rapid urbanization indicates a community in which the migration from rural areas has already commenced in the search for jobs in the industrialized areas of the towns and cities.

1.2 We are not considering communities of basically rural people living in rural surroundings but the same people transported to the crowded conditions which may be seen outside nearly any town throughout the world.

1.3 Conditions may be so bad that those living in high class residential areas may be shocked on exposure to the conditions prevailing. The life pattern of the community is not changed very much from those formerly practised in the relatively spacious surroundings of a rural community. Houses are constructed of any material to hand, on the limited space available. Streets are narrow and winding, the drainage is in the middle of the street, and low places become quagmires of mud and filth. Often there are no latrines in the houses, and any vacant land is likely to become fouled with human wastes, and the breeding ground of hookworm, dysentery and diarrhoea. There are often no schools, or those available are overcrowded and insanitary. Medical facilities are likewise either lacking within the new community, or inadequate. Consequently the new arrivals go to and throw great burdens on the main hospitals.

1.4 Conditions within the newly constructed houses are similarly appalling. Often, up to seven persons share a house which may consist of only one room. Ventilation is inadequate and sanitary facilities limited. Livestock is often kept in the area and may even be brought into the house during the night.

1.5 It is to these conditions that we are requested to bring sanitation measures, water supply, drainage or a system of pit latrines.

1.6 The alternative is the complete demolition of these areas and the building of new well planned residential accommodation. However this measure is not often possible due to the great cost involved and often where new accommodation is provided and people move from the slum areas, the population of the slum is not decreased due to the ingress of more immigrants and the excess of births over deaths.

1.7 In some countries a serious effort has been made to prevent these migrations by providing better facilities in the rural food producing areas. Such amenities as street lighting, sanitation works, water supplies, etc., together with adequate road network to enable the villagers to obtain quick marketing of their produce. Rural Health Centres cater for medical requirements and visiting doctors attend clinics to assist local staff.

1.8 These and other facilities no doubt slow down the migration to the town, but with the incentive of high wages which come with industrialization, the flow cannot be stopped.

1.9 The requirements for a pure and wholesome water supply are abundantly clear in the above circumstances and following the water supply the second most important function of the public health engineer is the provision of adequate sewage disposal. These facilities can improve not only the health but the well-being and wealth of a community.

2. Preamble

2.1 It is assumed for the purpose of this paper that the Government have decided to embark on a water supply programme to provide a pure and wholesome supply of water free from contamination for the health, well-being and wealth of these people.

2.2 This may be part of a general policy covering the broader aspects of improving health conditions in the community or more related to particular on-going requirements for a developing community.

3. Government Overall Planning

3.1 Before any Government embarks on a water supply programme it is necessary to consider the operation and maintenance of the schemes and to make provision for future recurrent costs to be incurred. Also to ensure the greatest benefit to the community is derived from the heavy investment to be made in the project.

3.2 Government planning should not only cover such items of policy relating to the construction of schemes but should also consider and lay down the policy for operation and maintenance of the works.

3.3 Government planning should include :

a. Long range planning covering 10 to 15 years and including total investment to be made over the period of development. A period usually consists of a 5-year plan.

b. Division of capital costs between the local population and the Government. How the Government funds are to be provided is by grant or loan.

c. How schemes are to be operated, by local authorities or by Government, or partly by both.

d. How operation and maintenance is to be financed and if operation is to be subsidized from Government funds. To enact the necessary legislation covering the making of by-laws for collection of rates.

e. Preparation of legislation to define the responsibility for operating the supply and for the protecting of the source from pollution and depletion, also to prevent contamination and waste of water.

f. If necessary a recommended rating structure should be incorporated in the legislation proposed in section d.

g. Drinking water quality (often WHO standards are adopted)

h. For the continued assistance to local authorities by the Constructing Department in the development, operation, maintenance and management of the supply.

i. How supplies shall be afforded either by house connection or public standpost. (The natural development in a developing country is to provide a number of stand posts for the general use of the population, say 1 per 200 population, and provide house connection as and when requested by the house owners. The objective is to provide 100 per cent house connections but in an area of random low class development drainage would cause too much of a problem, and controlled standposts provided with adequate drainage are all that can be provided. These facts must be fully considered and provision made accordingly.)

4. Planning by Executive Department

4.1 Sociological Problems

4.1.1 The executing department would be responsible for detailed planning and at this stage it is necessary not only to take into consideration the pure engineering requirements but several sociological problems must also be considered.

4.1.2 Instances have occurred in the past where it has been the hopeful policy of the Government to assume that the public will gladly welcome the completion of the

works they have so labourously planned, designed, and constructed. This is often not the case and the pride of some engineers has no doubt been somewhat hurt when they discover that the local population reject the scheme as being unnecessary, extravagant, and a burden on their already overstrained resources.

4.1.3 The tendency is to treat those who have rejected the schemes as people with insufficient foresight to see the value of a pure and wholesome water supply, whereas the fault lies with the administration, for not having carried out some pre-construction motivation of the population to be benefitted.

4.1.4 It is necessary to realize that there are two reasons for providing a water supply to a community :

a. to quench a thirst
b. to provide a pure and wholesome health giving supply

4.1.5 A polluted water containing the virus of infective hepatitis and bacteria of intestinal groups will effectively satisfy the first requirement and that is as much as many consumers may require. As a consequence any old and traditional source of supply will appear to suffice. Also open wells, streams, springs, rivers, canals, etc.. may be used.

4.1.6 It is necessary at the planning stage of any scheme to consider these fundamental problems. A motivation programme for those to benefit from the scheme, will be necessary in the case of communities of these educational standards.

4.2 Objectives of motivation programme

4.2.1 The objectives of the motivational programme should be directed at the requirements for good health to be obtained from a pure and wholesome supply. Typical subjects for this programme are as follows :

a. the traditional sources of water are polluted;
b. polluted water contains the germs of water-borne disease;
c. by consuming polluted water man becomes sick and remains unhealthy;
d. unhealthy persons are less productive and even rely on others for food;
e. low productivity is an impediment to the gaining of wealth by individuals, towns and whole countries;
f. good pure and wholesome water is therefore worth paying for;

4.2.2 If these propositions are fully accepted then the population of a community will accept any new water supply scheme and will be making repeated requests to the Directorate of the Water Authority to implement their scheme at the very earliest. If not, the population will remain adamant in using old traditional sources and the engineer had best pass on to the next village or town leaving some health educators to continue their motivational work.

4.3 Economy of Operation

4.3.1 As soon as the necessary technical data is collected to enable the planning of the scheme to be commenced, it is necessary to prepare detailed costs of operation and maintenance of the scheme. It will be necessary to prepare detailed estimates of running costs and to investigate the cheapest method of supplying power to run the works.

4.3.2 At this stage considerable thought should be given to any measures likely to reduce the operating costs of the scheme. The cheapest in capital cost is by no means the cheapest in the long run and good quality plant and equipment are a sound investment requiring little upkeep maintenance and requiring little attention from mechanical specialists.

4.3.3 Think of the water supply as a commercial enterprise and consider that to build the works money has to be obtained by borrowing at the rate of interest applicable in the country at that time. The problem then becomes simplified and we may think of the purchase and installation of any piece of equipment to be made up of two components :

a. the capital costs, and
b. the operating costs

Funds are required for both these two cost components and the second may be converted to a capital sum by considering what amount of capital would be required to provide the operating costs on an annual basis at the rate of interest applicable at the time of borrowing. This is called capitalizing operating costs.

4.3.4 On this basis it is often found that it will pay the utility manager to make a greater capital outlay on pumping equipment in order to obtain a better efficiency pump with much lower running and maintenance costs.

4.4 Standardization

4.4.1 At this stage it is also necessary to consider how plant component can be reduced to the very minimum to avoid maintenance costs bearing in mind the difficulty of obtaining spares for delicate imported equipment. For instance :

a. mixers and floculators can at times be eliminated by using the water power readily available on any water works FOR THIS DUTY.
b. Wherever possible, chemical dosers should be gravity fed, and not pumped.
c. Pumps and plant can be standardized if a number of schemes are taken in hand at one time.

4.4.2 When capital and running costs have been prepared it will be necessary to approach the local authority with a view to their deciding how the operating costs are to be raised and pass through their council the necessary by-laws enabling them to collect rates. Considerable guidance by the water authority may be necessary.

4.5 Operation and Maintenance Policy

4.5.1 It is important at this stage to determine who should take the responsibility for the operation , day to day running and maintenance of works, pump and other equipment. Though it is good policy to hand over completed works to the local council who then feel it their responsibility to maintain the works, it may be beyond their ability to maintain these in good order.

4.5.2 It is the duty of the constructing department to satisfy themselves that the local council, who are to take over, are employing the necessary qualified engineers or technicians to maintain the plant in good order. It is also important to ensure that those to be put in charge understand the requirements to maintain a pure and wholesome supply.

4.5.3 If the council are not able to carry out these functions it is better that the Government continue to maintain the supply but the council provide the operating costs.

4.5.4 However, there is no doubt that the best method to be adopted is for the council to take over the operation and maintenance together with the financing of such, wherever this is possible.

4.5.5 If the motivation programme has been effective it should be apparent that the new scheme can only bring health, prosperity and happiness and the cost of operation and maintenance will be willingly accepted.

5. Construction Phase

During the construction of the water supply scheme it is necessary to commence planning for the taking over by the operations section.

It is necessary to consider :

a. Training and selection of operators
b. Method of supplying consumable stores.
   - fuels
   - oils
   - chemicals
   - electricity
c. Method of routine inspection of plant and equipment and the carrying out of preventative maintenance and repair of plant.
d. To ascertain if the local body have completed the necessary by-laws procedure for collection of rates.
e. to assist local bodies to set up a satisfactory accounting system for collection of rates
f. To continue with motivation.

It will be necessary to develop local interest in the scheme and induce in the people a growing sense of possession of a desirable asset. The importance of visits to the works should not be under-rated, and school children are particularly receptive subjects for motivation.

5.1 Training and selection of Operators

5.1.1 Operators are required to take the responsibility for keeping the town reservoirs full of water and arranging pumping hours so that water is always available at times of maximum demand. It is not thought desirable that unskilled operators be allowed to start dismantling plant or meddling with delicate chemicals dosing equipment. This is the duty of the maintenance gang which may be resident or touring from a central headquarters.

5.1.2 The main training of operators should then be directed, in addition to technical subjects, at indoctrination towards their duty and responsibility in serving the public. The importance of a 24-hour supply must be stressed and it is necessary to educate these men in the simple elements of health and the prevention of disease. Particularly, attention should be paid to the teaching of the particular aspects of water borne disease.

5.1.3 It is all too often found that operators consider themselves to be some kind of police who allow the public to take the water at some closely controlled hours and consider a pumped water supply as merely a convenient method of quenching a thirst.

5.2 Supply of Consumable Stores

5.2.1 Consumable stores such as fuels, oils, and chemicals should be supplied on an annual bulk agreement covering a number of schemes or perhaps the whole country. In this way, a supplier is assured of a long-term market for his products and the most advantageous terms can be obtained. This is of great importance to keep operating costs to the minimum.

5.2.2 A satisfactory bulk supply agreement may obtain reductions in prices of up to 25 per cent.

5.2.3 In regions where access is difficult for motor transport in monsoon period it may be necessary to store up to six months supply of consumable stores etc.. In this case sufficient accommodation must be made to house the chemicals in the dry to prevent deterioration or if liquid storage of chemicals is used tanks should be made proportionately larger.

5.2.4 Indenting and stores procurement procedure must be made as simple as possible to avoid undue delay in obtaining replacements. On no account should works be closed down due to administrative difficulties in obtaining stores. Health comes first and the administrative procedure must be drafted with this in mind.

5.2.5 It should be sufficient for a purification works manager to obtain stores of chemicals by presentation of a funded requisition to the bulk stores depot. If on the other hand a contractor has been employed to supply chemicals in detail to each works it should then be necessary for the manager at any works to request supplies by telephone, the receipt obtained forming sufficient justification for payment.

5.2.6 These remarks apply equally to the supply of fuels, oils and chemicals required to run a works.

5.3 Supply of electricity

5.3.1 As regards electricity supplies, very favourable terms can be negotiated on a bulk supply agreement for the supply of electricity to a number of pumping stations. Under these terms the cost of electricity may be so low as to encourage the extensive use of electric power throughout the province or area.

5.3.2 In addition if it is possible to co-operate with the electricity department and utilize power when other consumers shut down or at "off peak" times as it is called, it may be possible to obtain even more advantageous rates for electricity. Any electricity authority which is aware of commercial factors governing its supply would welcome any consumer of electricity who will assist in stabilizing its load factor. Any water authority with better water utility management and service to the public in mind should take any advantageous terms offered to reduce the cost of its supply.

5.4 Routine Inspection

5.4.1 It is most important that a system of routine inspection be carried out regularly on all plant and equipment. This can also become a check on the operation of the whole supply system. The actual mechanical plant should be inspected for signs of defects and for this purpose it is necessary to keep log books of hours of operation of each item of plant with quantities pumped consumption of oil or voltages and amperes consumed. With these figures it will be possible for visiting inspectors to identify any plant defects which are developing.

5.4.2 However large the works, it is unlikely that specialist technicians are readily available for maintenance of every item of plant. It is usual therefore to set up mobile repair teams with mobile workshops who are capable of dealing with any emergency.

5.5 Routine Maintenance

5.5.1 If tubewells are the source of supply it is desirable to employ a mobile rig mounted on a lorry to effect quick withdrawal and re-insertion for both shaft and submersible pumps. In this instance the writer has found pump houses

over tubewells such a nuisance that in several countries he has abandoned these, leaving the tubewell access free for emergency repairs.

5.5.2 Routine inspection should therefore precede routine maintenance and the two should go together. It is important however that the pump operator be trained to identify the signs of impending plant failure and to take action to call the repair team before serious damage occurs. Cases have occurred where an operator of a 300 horsepower diesel engine carefully recorded a seriously declining oil pressure on the main bearings until the engine finally stopped, doing considerable damage. On enquiry of the operator why he had not taken any action he stated he had been worried about it but had no instructions as to what to do in the case of a drop in oil pressure.

5.5.3 It should beremembered therefore that such items as failing oil pressure on engines and increase in amperage on electrical pumps mean serious consequences to a skilled engineer but may mean nothing to a pump operator. Operating instructions should be drafted accordingly.

5.6 Operating Instructions

Operating instructions and the proforma of records and logs to be maintained should be prepared during the period of construction and not left until the works are ready to be commissioned. These instructions should be in the simplest form bearing in mind the educational standard of the operators and should cover such items as cleaning, greasing and engine oil checking and filling. It is important to give clear instructions how to contact the maintenance Superintendent, should certain signs of break-down occur. On larger works with resident mechanics or electricians, more authority may be given to the works staff. Log books should be prepared so that they give a clear picture of the situation with regard to any piece of equipment. Most plant suppliers include a proforma log book with their equipment.

5.7 Adoption of By-laws

5.7.1 Before the works are commissioned it is necessary for some responsible officer from the Government to ensure that the local body has adopted by-laws for the use, financing, and operation of the works to be taken over by them at some stage after the commissioning as may be agreed.

5.7.2 By-laws should cover the authority to collect rates from the consumers, it should lay down in detail how various consumers are to be rated either by meter or on a charge based upon rotable value, or, in the case of a standpost supply, the rate to be paid per property supplied. It is usual to lay down in these by-laws a system of penalities for the non-payment of rates, but in the writer's opinion it is better to set up a system of warning the customer for non-payment of rates, followed by the cutting of the supply in the case of house connections. In the case of a general rate for standpost supplies a list of defaulters can be put up at the council offices and this is nore effective than serving notices.

5.7.3 The by-laws enabling the authority to collect rates are somewhat different from by-laws framed for the prevention of contamination, misuse and waste of water. These latter deal mainly with plumbing requirements and may not be as sophisticated as those adopted in more developed countries. It is necessary, however, to cover the prevention of pollution of the source particularly where this is a spring, well or stream. With deep tubewells the question of pollution does not usually arise, even where this is situated in a built-up area.

5.7.4 Where trunk supply mains pass through scattered villages to reach larger towns it is difficult if not impossible to prevent tampering with pipelines by villagers to get water

and no legislation can be effective. In this case it is better to provide these villages with a water supply and pass by-laws accordingly.

5.8 Fiscal management

5.8.1 The local authority will probably have an accountant responsible for keeping the council's books, however it is desirable that an accountant from the Government visit the local authority and advise on the setting up of an accounting system.

5.8.2 From the books it should be possible to ascertain the cost of water produced so that monthly totals may be compared and variations recorded, and if necessary, investigated.

5.9 Ongoing Motivation

5.9.1 It is important that at this stage the motivation programme be continued since construction may well take over a year to complete and the memories of the public are particularly short.

5.9.2 Motivation at this stage should take the form of teaching in schools, and the continued display of posters in clinics, health centres, hospitals, and also at the Council's offices.

5.9.3 Visits to the works by various bodies are very helpful when the lay-out of the scheme, technical details, rating charges, etc.. can be discussed and explained.

5.9.4 The peak of the motivation programme should be reached at the time of the commissioning of the work. It is important that the most senior authority available be induced to open the works. An exhibition showing the wholesome quality of the new water compared to the old polluted sources will assist the Council in collection of rates later, by convincing the population that "the water is worth paying for".

6. Operation and Maintenance after Commissioning

6.1 Smooth transition from construction to operation

6.1.1 If all the actions specified above have been satisfactorily carried out, the transition period from the construction period to the operation stage should proceed smoothly from the very beginning. Personnel should be aware of their duties and responsibility. Supplies should be adequate and readily available. The public who are the customers who will buy your commodity are aware of the value of a water supply and will require connections and be willing to pay the charges.

6.1.2 However things seldom work out that way. Collection of rates is most difficult and this in most cases can be accounted for by lack of determination on the part of the management and staff. If the community find that the water authority is determined to collect rates or discontinue the supply, then the rates are generally forth-coming.

6.2 Twenty-four hours supply

It is most important during the early month of operation to provide a satisfactory supply. Supply can only be considered satisfactory if it is available 24 hours per day, i.e. whenever required. One oftem hears the old cry "we cannot afford to operate the supply for 24 hours per day". Medical history and plain facts prove that a community cannot afford to operate a scheme for anything less. If the reservoirs have been designed to provide for the peak periods of maximum demand and mains have been designed accordingly, a 24-hours per day supply should not cost much more than a restricted supply, say of 8 hours per day. The health hazards of an intermittent supply with the risk of waste-water entering the supply mains during periods of low or no pressure far outweighs the small

additional cost of supplying water for the full 24 hours with mains under pressure. The cost of one course of antibiotics may cost up to five times the monthly rate for a piped water supply.

6.3 Constant vigilance during early operation

During the transition period, the construction unit must still be in charge of the operation of the plant and must ensure that everything is operating as planned. Water must be checked for bacteriological and chemical purity frequently, say, every three days, and possibly, every day during the first month of service. Pumps engine and electrical equipment must be constantly checked over for efficient operation and any fault brought to the notice of the manufacturers.

6.4 High Degree of Civic responsibility required from Operators

If the operators or, in large works, the station manager have learned the high degree of responsibility they have assumed, as mentioned in section 5.1.1 , it will be possible to maintain the high quality of service required to the public. The health of the community should rapidly improve and the risk of epidemics and outbreaks of serious water-borne diseases should be removed. However, it is difficult in many developing countries to maintain the constant degree of responsibility required, and any lowering of vigilance, or negligence, may easily turn the water distribution system into a disease-distributing system to the detriment of all concerned. Though works may be designed to be fool-proof, in operation, it is ultimately the water works staff who are responsible for the quality of water supplied. Their responsibility therefore goes much further than that of keeping the reservoirs full.

6.5 Measurement of Success

It is not generally possible to measure system performance in monetary values as a cost : benefit ratio, although in developing countries, it may be noted that a reduction in Government spending in hospitals, clinics, medicines and doctors may be expected with the advert of a water supply to a rapidly developing urban or rural community. However, it is possible to assess the success of a supply scheme by expressing the utilization of the scheme as a percentage of the facility it was designed to provide. The facility may be assessed in terms of benefits provided to the consumer, such as standposts, house connections, and gallons of water supplied, also supplies to hospitals, schools and clinics may be included. This percentage may be considered a factor to indicate how the investment in the supply is being utilized. If the motivation programme has been satisfactory, the utilization should rise to about fifty per cent of the facility provided within a year of inception. If there are other factors such as water scarcity or diseases which the motivation programme has made abundantly clear, the factor may rise to ninety per cent within the year. This may be considered a great success with a large measure of reduction in disease, poverty and hunger.