WORLD HEALTH
ORGANIZATION

الهيئة الصحية العالمية
المكتب الاقليمي لشرق البحر الابيض

ORGANISATION MONDIALE
DE LA SANTÉ

REGIONAL OFFICE FOR THE
EASTERN MEDITERRANEAN

BUREAU RÉGIONAL DE LA
MÉDITERRANÉE ORIENTALE

REGIONAL COMMITTEE FOR THE
EASTERN MEDITERRANEAN

Eighth Session

Agenda item 16

TECHNICAL DISCUSSIONS

EM/RC8/Tech.Disc./6
27 August 1958

ORIGINAL: ENGLISH

BILHARZIASIS AND ITS CONTROL

A SMALL TREATMENT PLANT FOR SUPPLYING RURAL COMMUNITIES WITH WATER FROM IRRIGATION CANALS*

by

Joaquin de Araoz, C.E., M.S.S.E.
WHO Public Health Engineer
Bilharziasis Control Project Iraq 15

1. BASIC CONSIDERATIONS

Generally, in countries in course of development rural environment is characterised by isolated communities scattered among open spaces used for agriculture and cattle raising. The houses, built with local materials, are inadequate and in poor hygienic condition. Sanitation, with respect to water supply, excreta and waste disposal, is a family problem of difficult solution that is usually disregarded or neglected. The inhabitants live in direct contact with domestic animals that move freely in yards and living quarters, manure is an important asset as fertiliser and fuel. Isolation and deficient means of communication make the people self-dependent as to food and other essentials. The economic level of the peasant is very low. Ill-health and illiteracy are prevalent among the population. These characteristics illustrate clearly the difficulties involved in the improvement of sanitary conditions in rural areas.

With regard to the provision of a safe water supply for rural communities there are many problems to overcome. Irrigation water has always been the main source of supply for the domestic needs of the people living on the banks of canals, in many instances this is the only source available.

* For design, see Annex.

The peasant ignores the inherent dangers from polluting water used for drinking; the canal water serves for all purposes, including the disposal of all wastes, and the most rudimentary precautions are disregarded. The construction of satisfactory installations is often too great a burden on the people, and funds have to be provided from government budgets. Operational expenses are not always accepted as a liability by the users. Voluntary participation in the construction is limited to the execution of rough work by unskilled labourers. Electricity or other mechanical power and reliable technicians are seldom found in rural areas. Trained personnel for the adequate care of the installations are not available and maintenance is usually neglected. The construction, supervision and administration of collective systems is more expensive and difficult in areas of scattered houses than in urban communities.

In view of these problems, the design of an installation for the supply of potable water for rural communities is limited by the following requirements:

a) The basic design should be flexible so as to cover communities varying widely in population by increasing or reducing the general dimensions.

b) The construction should be simple and standardized as far as possible to reduce the initial cost. Full use should be made of the voluntary help of the users by simplifying methods of construction and planning work that can be carried out by unskilled workers.

c) Operation and maintenance work should be minimized. No mechanical equipment can be considered where the possibility of its proper operation and maintenance is uncertain.

d) The care and routine attention of the installation should be simplified so as to enable one of the users, with a minimum training, to undertake this task without regular supervision, which cannot always be available due to the isolation and bad roads in rural areas.

In areas where underground water is unsuitable for domestic consumption, due either to contamination or to excessive salinity, the treatment of surface water is the only practical method for supplying the people with safe water; this being the case in most rural areas in Iraq.

This report deals with the design of a small plant for treating water from irrigation canals or other similar watercourses. To comply with the above mentioned limitations, it was necessary to restrict the installation to its essential components and to modify the standard layout for this type of plants; the design, however, is in conformity with established specifications for more conventional designs used in more developed communities under better conditions.

2. DESCRIPTION OF THE PLANT

The main feature of the design is the location of the whole installation within the watercourse, source of supply of the plant. In this way raw water is not diverted from the stream and only the amount demanded by the population enters the plant for treatment, thus obviating the problems created by excess water and its disposal. No space is occupied on the margins of the canal, and the filter structure is isolated from the direct approach of the public. The water flows by gravity to the settling basin and into the filter with a minimum loss of level.

The conventional type of plant installed at one side of the water source requires an intake structure, a diversion close conduit, or open channel with a culvert for crossing the road that generally runs along the bank of the canal, to convey water to the plant site, pumping equipment is required for filling the settling tank and filter, for cleaning purposes and for elimination of waste water; all these works and installations affect the initial cost of the construction and demand experienced and careful attention for their proper operation and maintenance.

The plant described in this report consists of a diversion channel, a settling basin and a slow sand filter, with the necessary piping, service tanks and hand-pumps for serving the public.

The diversion channel and settling basin are formed by gradually widening the section of the canal on both banks at the plant site, so as to increase its final water carrying capacity to double the normal amount when the filter structure is built in mid-stream. This gradual enlargement prevents the formation of eddies and cross-currents in the canal near the filter structure. The enlarged section of the canal at the plant site is trapezoidal, with horizontal bottom and sloping sides at an inclination of 45 degrees. A brick pavement laid on the bottom and banks of the canal in the widened section, the transition portions and at the beginning of the undisturbed part of the stream, prevents erosion, assures the regularity of the cross-section and makes easier the removal of deposited silt and debris with rakes and wire brushes. Periodic cleaning, at convenient intervals, will prevent the growth of weeds and aquatic vegetation.

The structure that holds the filter is built along the centre-line of the enlarged section of the canal and divides the stream longitudinally into two equal portions so that the water may flow on both sides of the structure. As the water carrying capacity of each of these two portions is equal to that of the canal, one of these can be shut off so as to allow the total water discharge in the stream to flow through the open portion on the opposite side of the structure. Thus a settling basin is formed in the closed side, while the open one acts as diversion channel. The filter structure forms a partition wall between the diversion channel and the settling basin.

Both portions on the sides of the structure can operate alternatively as diversion channel and settling basin by changing the position of the flashboard at the downstream end of the filter structure.

A baffle and screen in front of the structure diverts the surface water in the canal to the diversion channel and prevents the entrance of floating matter and debris into the settling basin. The height of this baffle can be adjusted by means of a pulley to the required water level in the canal, which may vary in accordance with the rotation service of irrigation water. The baffle swings round a pivot fixed to the filter structure so that it can be set in position on either side at the entrance of the portion of canal functioning as settling basin.

The filter structure consists of a hollow concrete box shaped as a bridge pier with boat-like ends. The lower part of this box is embedded in the soil of the stream to a depth of 0.80 m. so that its foundation rests on compact and dry material that assures proper anchorage and stability against uneven settlements. The top part of the box extends above the maximum water level in the canal, and it is covered by thin concrete slabs to prevent the entrance of dust, insects, leaves, etc. These slabs are removed for the periodic cleaning of the filter.

Two small valve chambers are built in the pointed ends of the structure by partition walls that separate these chambers from the filter. The inlet valves control the amount of water passing from the settling basin into the filter; two valves are required for the alternate operation of either side of the enlarged section of canal as settling basin. The outlet valves supply the service tanks with filtered water.

At the end of the settling basin water is conveyed to the filter through a floating strainer connected with the intake pipe by a flexible hose. The design of this device resulted from the need of extracting a uniform amount of water from the top of the settling basin, where the water is clearest, without being affected by the variation of water level in the canal. The strainer is mounted on legs so that when the water depth in the basin is 0.20 m. the inflow to the filter is automatically stopped, thus heavily silted water from the bottom cannot enter the sand filter.

The water, after passing through the intake device, flows along a metallic trough of semicircular section on the centre-line of the filter at the level of the top of the sand bed. Water overflowing from this trough is uniformly distributed over the filter bed without disturbing the sand, it passes through the filtering material, and filtered water is collected by an under-drain running lengthwise to the filter on the bottom of the concrete structure. From the under-drain, water flows to the outlet pipes and valves and is distributed to the service tanks.

Small concrete tanks provided with adequate hand-pumps, conveniently located in the village, serve the population with treated water from the plant. The number and capacity of these tanks should be such that sufficient water within a reasonable distance is provided for the domestic needs of the people, considering that the water supply in the canal may be temporarily interrupted, as it happens during the closing periods of irrigation service.

The type of filter designed for this plant is the slow sand filter which requires no mechanical equipment for its operation and cleaning. The maintenance work is reduced to periodic scrapings of the surface of the sand bed, where dirt accumulates and obstructs the passage of water through the filter, and the replacement of the top layers of the bed with clean sand.

The greatest advantage of the slow sand filter is its high efficiency in the removal of bacteria. Although the spaces between sand grains are large when compared with the size of bacteria, about 99% of these micro-organisms are held in the superficial layers of the filter. This is due to the formation of a gelatinous and adhesive film of bacterial origin that coats each sand grain and develops into a carpet-like mass on the top of the filter which holds back bacteria and other micro-organisms present in the water.

The specified load for slow sand filters varies between 2 and 10 million gallons of water per day per acre of filter surface, according to the turbidity of the inflow water. Considering an average load for the filter of this plant of 5.35 mgd per acre (5.00 cu.m. per day per sq.m. of filter bed), one square metre of sand area will filter 5000 litres per day; if the filter bed is 1.00 m wide, 50 persons can be supplied with a water dotation of 100 litres per head per day for each metre length of the filter area. Thus a village of 200 inhabitants will require a filter 4.00 m. long, and a village of double the population requires twice this filter length.

The length of the settling basin increases simultaneously with the enlargement of the filter structure, consequently the basin's capacity is increased proportionately. The same basic design of the plant can be adapted to a wide variation in population served by increasing the length of the filter at the rate of 1.00 m. for each 50 inhabitants.

In more developed rural areas with a higher standard of living, where mechanical equipment can be properly operated and maintained, the treated water from the plant may be discharged into an underground reservoir, pumped to an elevated tank and distributed to the population through pressure pipes that supply public fountains and service connections to the houses. A chlorination device for final disinfection of the treated water can be connected with the discharge pipe of the plant or the suction pipe of the pump.

General data of the performance of a plant for 200 inhabitants (20,000 litres per day) are summarised as follows:

Settling basin

Detention period, time taken by a drop of water to flow through the basin	12 hours
Load, working capacity of basin per unit surface area ----------------------	1.10 cu.m./day/sq.m. = 1.03 mgd per acre
Horizontal velocity of water flowing through basin -------------------------	60 cm. per hour = 1.97 ft. per hour
Vertical settling velocity of particles --	4.6 cm. per hour = 0.15 ft. per hour

At this settling velocity 75% of the particles 0.005 mm in diametre will settle on the bottom of the basin.

Slow sand filter

Filtering period, time taken by a drop of water to pass through the filter bed -------------------------------------	4.8 hours
Load, working capacity of filter per unit surface area --------------------	5.00 cu.m./day/sq.m. = 5.35 mgd per acre
Vertical velocity of water through filter bed ----------------------------	22 cm. per hour = 0.69 ft. per hour

General Dimensions

Settling basin.-	Length - - - - - - - - - - -	=	6.00 m.
	Depth - ruled by dimensions of canal	=	Depth of canal
	Width - " " "	=	3/5 of width of canal
Filter bed.-	Length - - - - - - - - - - -	=	4.00 m.
	Depth - - - - - - - - - - -	=	1.00 m.
	Width - - - - - - - - - - -	=	1.00 m.