SOUTHERN REFUGEE WATER UNIT

SOMALI DEMOCRATIC REPUBLIC

SLOW SAND FILTERS
FOR THE REFUGEE WATER SUPPLY

Description
Installation
Operation

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F I G U R E S

1. Introduction

There are 28 refugee camps in Southern Somalia with populations of between 8 000 and 25 000 people in each camp. These camps exist now (1985) for more than 5 years. All of them are situated close to the rivers Juba and Shabelle. Suitable groundwater has been found only in a few camps. All other camps rely on river water purification.

A purification system was set up within an emergency phase, based on chemical treatment of river water. It became soon obvious that this purification system had to be replaced. It was originally designed for an emergency not lasting more than half a year. Several tons of chemicals for flocculation alone had to be imported and distributed to the camps every month.

Criteria for a new purification system were set as follows:

- use no chemicals
- easy to erect
- easy to operate and maintain
- inexpensive
- medium term solution

At least major components should be movable to be operated at new locations, if refugees are shifted.

The system to meet all these criteria is the Oxfam Treatment Package. It is based on stock-piled modular equipment to be installed quickly at the place of need into an appropriate and working water treatment plant. Water purification is done by slow sand filtration. The high investment cost and long installation times usually connected with slow sand filters are eliminated by using a modular design.

When this purification system was installed, it became soon obvious that the previously used water system had to be changed completely. It was not only a matter of replacing chemical purification by sand filtration. This report wants to describe therefore a complete water supply system as it was developed for the refugee camps in Somalia as well as the experiences gathered in its installation and operation.

This water supply system is based on the Oxfam Treatment Package. The Oxfam manual should be consulted additionally when erecting the slow sand filter. This Oxfam manual was revised to include the many changes and adaptions made to suit the particular situation of the Somali refugee camps.

These camps are the first locations where this innovative water system was installed under the conditions it was designed for. Six plants are working at present (May '85), 9 more will be installed soon. (see Fig. 1)

2. Slow Sand Filtration

2.1 General Concept

Slow sand filtration is a purification process in which the water to be treated is passed through a porous filter bed. Sand is an ideal material for this process as it is cheap, inert, durable, widely available and gives excellent results.

During the passage through the sand,water quality improves considerably by reduction of the number of micro-organisms (bacteria, viruses, cysts) and by removal of suspended and colloidal material.

2.2 Purification Process

The purification starts already in the raw water layer above the filter sand (see fig. 2). Large particles will settle on the filter mat and smaller particles may agglomorate to settable flocks due to physical or biochemical reactions.

The major part of the removal of impurities and the considerable improvement of the physical and bacteriological quality of the raw water takes place in the filter sand and especially in the "Schmutzdecke" which forms on the top of the filter mat. In this top layer innumerous micro-organisms such as algae, plankton, diatoms and bacteria settle, which, through their tremendous biological activity, break down organic matter.

A great deal of inorganic suspended matter is moreover retained by straining.

As the water passes through the sand it is constantly changing direction so that particles carried by the water come into contact with the filter grains by various transport mechanisms. The grains become covered with a sticky layer of mainly organic material which in turn absorbs the passing particles. At the same time the active micro-organisms (bacteria, protozoa) in the sticky layer around the grain feed on the impurities caught as well as on each other. In this way, degradable organic matter, including bacteria and viruses of feacal origin, is gradually broken down and converted into water, carbon dioxide and harmless inorganic salts.

The life-filled zone where these purifications mechanisms take place extends to about 0.4 - 0.5 m down from the surface of the filter sand, but it gradually decreases in activity downwards as the water is purified and contains less organic matter and nutrients.

At greater depths in the filter, the products of the biological process are further removed by adsorption and chemical action (e.g. oxidation).

The result is clear water, virtually free from organic matter, viruses and bacteria.

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3. Description of Water Supply System

3.1 General Siting

A good choice of sites for river intake, sandfilter plant, CWPs and pipelines will save many problems afterwards and will minimize fuel costs for pumping. A general site plan of the water supply scheme is shown in Fig 3.

In order to reduce the number of pumps and fuel consumption, a strictly one pump system for the water supply scheme has to be adhered to. The water is only pumped once, e.g. from the river into the raw water storage tank of the sandfilter plant. From there to the consumer, the water will flow by gravity. This implies, that an elevated area for the sandfilter plant has to be chosen near where the water distribution will take place. If the surroundings are totally flat, the area has to be artificially elevated.

3.2 River Intake

Raw water has to be abstracted from a surface water source. Since all refugee camps are located near a river, water will be drawn from there. A suitable pump will be located on the riverbank. It will suck water from the river and push it through a pipeline to the treatment plant (see fig. 3).

Extensive experiments with subsurface sand abstraction have been made in order to prefilter river water. But it has been abandoned as a first stage for water treatment, since only a few locations in the river are suitable and no remarkable extensions of the filter runs could be observed.

Nevertheless, subsurface sand abstraction is still seen as a useful process for specific applications.

3.2.1 Pumping Unit

Past experience has shown that standardization of equipment is one important precondition for the effective operation of such a large sector as the Refugee Water Supply in Somalia. Standardization will reduce:

- stocks of spare parts
- ordering from different suppliers in different countries
- parts lists and technical information files

and optimize

- good and efficient servicing
- training for operation and maintenance

After long tests and discussions, one pumping unit was selected, which should pump in all the camps river water to the treatment plants. Some important prerequisites for such a pumping unit were:

- robust design, sturdy diesel engine, already introduced into the country with good success
- good suction ability
- available head up to 35 m
- discharge quantity up to 35 m^3/h
- portable, mounted on a trolley

There are basically two pump variations suitable for this application:

- self priming centrifugal pump
- normal centrifugal pump

The main advantage of a self priming pump is its safety against dry running (once the pump body is filled with water). It will prime itself so that a leaking foot valve will not matter. The main disadvantage is its low efficiency, resulting in a high fuel consumption. This determined finally the selection of a normal centrifugal pump (we chose a Lister ST1/3WHT, which is not optimum but a compromise). This pump has to be primed before (initial) starting. Its performance curves are shown in fig. 4.

When choosing a site for the river intake, many aspects have to be kept in mind:

- closeness to sandfilter plant
- good accessibility (for transport of pump, fuel, etc.)
- taking account of the reasonal water level fluctuations
- location if possible at inner bend or at a place, where there is water even if the river is at its lowest level

Usually, two locations for the pumping unit are dug into the riverbank (see fig. 5). This allows the pump to follow the fluctuating river level by keeping the suction height to a minimum. A shelter for the pumping unit is made out of local materials like wood and bushes. Since the unit is mounted on a trolley, it can be moved by people without difficulties up or down the riverbank, which is necessary only 2 or 4 times a year.

3.2.2 Hoses, Pipes and Connections

The connection between pump and river is made by 3" or 4" flexible suction hose. Good quality suction hose with high UV resistance and steel spiral reinforcement is essential. A suction basket with foot valve, supported by two floats ensures that the water is taken some 20 - 40 cm below the surface.

The pump discharges into a pressure hose, connected to the pipeline leading to the treatment plant. Hoses on both sides of the pump separate the engine vibrations from the pipeline and give flexibility to disconnect quickly the hoses when moving the pump up or down the river bank. The pressure hose can easily be checked to see, if the system is filled with water and thus can be started without priming (i.e. filling pump and suction hose with water).

Some lengths of suction and pressure hoses have to be kept in stock in order to extend the pipeline when the river level drops.

As pipe material, PE (polyethylene) has been selected. The pipes are joint by welding sockets. A generator and a special welding unit is needed to weld the sockets.

The pipe diameter is selected depending on the distance of the treatment plant from the pump. If the plant is closer than 250 m, a diameter of 3" is chosen; otherwise, the pipeline diameter will be 4".

The pipeline is dug 60 - 70 cm into the soil.

3.3 Treatment Plant and Storage

Drinking water quality is achieved by slow sand filtration. The basic unit consists of:

- 2 raw water tanks
- 2 sandfilter tanks
- 2 clear water storage tanks

All these tanks are easy and fast to erect. They consist of corrugated steel sheets, bolted together and lined with a flexible rubber membrane.

The design capacity for the unit is 120 m^3/day. The filter velocity at this water flow is 0.08 m/h. It is advisable to stay rather below this design capacity to increase times between filter cleaning and to have capacity for an increasing demand. If the water demand is higher, more tanks can be built.

The water demand per person in the refugee camps has been found to be around 10 l/day. This water is used strictly for drinking and cooking, since washing is done at the river.

3.3.1 Raw Water Tanks

The raw water tanks have two functions:

- storing the raw water, so that pumping only once a day is necessary. The raw water storage tank feeds then continuously the sandfilter tank
- getting the coarser sediments settled and thus reduce turbidity of the raw water

They consist-as all tanks in the treatment package-of corrugated steel panels bolted together. They are 6 m in diameter and 3 panels high, giving an overall height of 3.6 m. Figure 6 shows the hydraulic levels of the treatment and storage tanks. Elevating the raw water tanks will increase their usable storage capacity as can be easily seen in fig. 6. This elevation can be done by using a natural slope - if available - or raising the area artificially. Fig. 7 shows the treatment plant in Qorioley camp II, where this second possibility was necessary.

The pipeline coming from the river is passing a water meter and discharges the water into the top of the raw water tank. The tank outlet (see fig. 6) is above the settled sediments.

These accumulated sediments can be removed via a drain valve close to the bottom of the tank.

In order to increase turbidity reduction in these tanks, different connections are currently being tested as shown in fig. 8.

3.3.2 Sand Filter

The sandfilter tanks are 2 panels high, giving an overall height of 2.4 m. A float valve at the intake (presettled raw water from raw water tanks) maintains a constant water level at appr. 2.1 m. Clear water comes out of the drainage flange at the bottom of the tank.

The tanks contain sand of appr. 1.0 m thickness. To extend the time between filter cleaning (filter run) and conserve filter sand, an artificial fabric mat is placed on top of the sand surface The principal mechanisms of silt removal in this fabric are sedimentation and adsorption. This mat is not essential for the function of the sandfilters but facilitates their operation.

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The drainage system consists of special drain elements of an overall length of 20 m. These drain elements are made of 1 3/4" flexible drainage pipe, covered with a fine synthetic fabric (drain filter). The drain filter is stiffened by and connected to a plastic pipe, thus forming a drain element. Ten drain elements of varying lengths are connected to the collector pipe. This drainage system is installed on about 5 cm of sand at the bottom of the tank. Fig. C of the Annex shows the details and Fig. 16 the system being installed.

This drainage system has been developed within the Refugee Water Supply in Somalia. The use of gravel - very hard to find at our sand filter locations - is not necessary any more. The installation of the sand filters is greatly simplified.

Appr. 28 m^3 of sand are needed for one sand filter tank. The grade of sand is much less critical than was generally assumed. In our case, sand was either taken from the river near the water station or from the seashore in the case of Qorioley refugee camps. The specifications given by Oxfam are as follows:

- effective size between 0.15 and 0.35 mm
- uniformity coefficient less than 3
- maximum size 3 mm
- minimum size 0.1 mm

A simple analysis can be done by using sieves of 0.1 mm, 0.45 mm and 2.80 mm. An equal weight or volume should be retained by the 0.1 mm and 0.45 mm sieves to get an acceptable grade of sand.

The sand must be washed to remove fines, silt and organic contamination before it is placed in the sand filter tanks. This is achieved by means of a simple sand washing kit.

The sand is filled in plastic drums of 1 m diameter and 1 m height for washing. A 2" pipe with small holes (4 mm) is installed at the bottom of these drums. Clear water is pushed through this pipe and flows upward to wash out the fine particles. Fig. 10 shows sand washing in process.

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3.3.3 Storage

The storage tanks are 1 panel high and 7 m diameter. The clear water at the sand filter outlet passes a flowmeter to give information on the actual clear water flow (fig. 8). The storage tanks are filled from the top.

The outlet is at the bottom of the tanks and is connected to the pipeline going to the distribution points.

Since there were many storage tanks of a smaller diameter (5 m) still available in our project, they were used for the time being. But eventually, all of them will be replaced by the 7 m tanks as described above.

Attempts to cover these tanks have failed so far due to the strong winds in Somalia. Open storage tanks have the advantage of controlling the water level better as well as is the necessity for cleaning obvious to everybody.

3.4 Distribution

The clear water is distributed by gravity from the storage tanks to the community water points (CWP). CWP sites have to fulfill the following criteria:

- closeness to the population served
- lower elevation than storage tanks
- possibility for waste water drainage

Choosing large diameter pipes for the water distribution network (2", 3" or 4") makes it possible to work with limited elevations of only 1.50 m to 2 m. A comparison with resistance diagrams of pipes will help to choose the appropriate diameter. The flow for a CWP should be 1.5 l/s or more. If this flow cannot be realized, intermediate storage tanks at the CWP can be built.

Fig. 10 shows a standard design for a CWP. The height of the taps has to be adjusted to the containers in use for water drawing. It is 0.34 m in the Refugee Water Supply. No more than 10 taps should be provided per CWP.

When the installation has to be fast, supports made of plain steel are used instead of brick walls.

The ideal tap does not exist. We are still collecting experience with a number of types and makes. But there are very different experiences at different water points with the same type of tap. In some places taps almost never have to be replaced while in others, they are damaged shortly after their installation. Education on proper usage and careful supervision of water points is much more important. The ideal is watchpersons selected and paid by the users of the water. If this is not possible, the CWPs should be located close to the treatment plant so that they can be supervised from there.

A proper drainage of the CWP is extremely important. The waste water is used for many different purposes like

- animal watering
- tree nurseries
- growing trees around the CWP

or - if no uses can be identified -

- drained into soakage pits or
- drained back to the river

4. Installation

This chapter summarizes the installation of the water system, illustrated by some photos. It wants to point out critical parts and give a basis for planning installation time and manpower.

When the treatment plant is being installed, the Oxfam manual should be consulted. It has been revised to integrate all the modifications made to suit the particular situation of the Somali Refugee Camps.

4.1 Sand Filter Plant

Before starting any installation, a location for the required sand has to be found and its transportation to site has to be thought of. River sand can only be taken in the dry season, when the water level is at its lowest. Therefore it might be necessary to arrange the transportation of the sand from the river already prior to any installation of the plant.

In Lugh region there was only one sandbank in the river easily accessible by truck. Therefore all the sand for several sand filter plants to be built in the area was taken from this spot and transported to the nearest sand filter site to be stored there. One frontloader and two trucks were hired for this operation. In other regions, the river was easier accessible and a truck was loaded by hand to fill the sand filter plant nearby. In this case, the sand washing was done just beside the tanks, see figs 11 and 12. When installing other plants, the sand was filled into plastic drums, already set upon a truck (fig. 13). These plastic drums were then connected to a pump and the sand washed on the truck. Afterwards it was transported to the new site, where it was now easily shoveled into the sand filter tanks.

The erection of the tanks is straightforward and poses no problems. Fig 14 shows sandfilter and raw water tanks just after erection.

At two different sites, tanks just erected were damaged by strong winds. One tank was even moved by the wind more than 30 cm out of its original position. Therefore it was decided to build the tanks one after another. When one tank is finished, the liner has to be fitted the same day (see fig. 15) and some water filled in. This stabilizes the tank. If water cannot be filled in immediately, guy wires have to connect the top of the tank firmly to the ground.

The raw water tank flanges are fitted as soon as possible and these tanks should then never be without water of at least around 1 m depth. This will prevent the liner to be torn out between the flanges on very windy days. It is even better to fill the tanks completely, since water will always be needed during installation of the sand filter plant.

Before filling the sand filter tanks with sand, it is essential to check the outlet flange for any leaks. For this purpose, water is filled into the tanks to a level above the outlet flange. The outside surroundings of the flange are then carefully checked for any leaks. This will prevent a lot of work, if it should later turn out, that the flange is leaking.

After an initial layer of 5 cm of sand, the drainage is fitted (see fig. 16) and the rest of the sand is filled in and carefully levelled. Precautions not to damage the liner have to be repeated permanently to the workers involved.

The filter mat will be placed on top of the sand. The pieces should not be longer than 3.20 m, since the mats will be extremely heavy when full of sediments. When new, the mat will float on the water if it is not held down by stones, as shown in fig. 17.

There are several possibilities of connecting the tanks together:

- by hoses as Oxfam suggests originally. This is done very fast and should be used for shortterm installations (up to 1 year) only

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- by PE pipes and brass (or GI) fittings. This takes some more time to install and is meant for medium and long term solutions
- by GI pipe and fittings. If threading and bending equipment is already at site and used in the water supply, this might be most appropriate there. It is for long term installations

All connections are done in 2" diameter. The last two possibilities mentioned were realized in the refugee water supply project. Details are described in the revised Oxfam manual. Fig. 18 and 19 show some details of the tank connections. They have been done with PE pipe in this case.

4.2 Piping and Distribution

Piping and distribution depends obviously very much where the plant is installed. The drawings of the Annex should therefore be understood only as suggestions. Fig. A shows the connection from the river to the sandfilter plant. Provisions have to be made so that the second raw water tank can be filled when the first one is being cleaned or repaired. This can be done by installing the filling pipe so that the upper elbow can be turned around to fill the second tank. If necessary, temporary connections can be made easily. Fig. F shows the piping system after the water leaves the clear water tanks.

The general idea is to use - if possible - galvanized steel above ground and PE pipes below ground.

4.3 Installation Requirements

This paragraph deals with the installation of the sandfilter plant and our experience with it. The piping from the river to the plant as well as the distribution of the clear water depends very much on local conditions and is therefore not comparable. The example given below is taken from the installation of a standard sandfilter plant (2 raw water tanks, 2 sandfilter tanks, 2 clearwater tanks) in Ban Mandule refugee camp near Lugh on the Juba river. Installation

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took place in April '85. The skilled personnel (mechanics and supervisor) had already installed two other plants the year before. The time for the first installation was appr. 60 - 80 % higher than given below.

4.3.1 Required skills

The plant was installed with the following personnel (and their approximate wages):

- 1 supervisor (expatriate technician)		
- 1 mechanic/pipe fitter		350 SoSh/d
- 1 assistant mechanic		200 SoSh/d
- 1 truck driver		300 SoSh/d
- up to 6 helpers	each	50 SoSh/d

(exchange rate: 80 SoSh = 1 US $ in 4/85)

4.3.2 Installation Time

a) Fencing and site preparation	8 mendays
b) Erection of tanks	
- 2 sand filter tanks	14 mendays
- 2 raw water tanks	28 mendays
- 2 clear water tanks	10 mendays
Erection of tanks complete with liner and flanges	52 mendays
c) Sandfilters	
- washing the sand, filling it into the tanks, installing drainage and filter mats	70 mendays
d) Pipe connections	
- Installation inside the fenced area; durable PE pipe laid underground	8 mendays
Total installation time	138 mendays

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Some comments on the above:

- effective working hours per day: 6 h
- working days per week : 6 d
- fencing and site preparation was done by the future operators and watchmen of the plant. They also were the helpers for all other work
- erection of the tanks was done by the supervisor, mechanic, ass. mechanic and 4 helpers
- the sand was washed and filled independent of the other operation by 6 helpers and the truck driver
- the sand was taken from a sand storage place around 15 km away. It was shoveled into plastic drums on the truck, washed at a pumping station and unloaded into the sandfilter tanks. No time is alloted for transportation of the sand from the riverbed to the nearby storage place

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5. Operation

5.1 Pumping Unit Operation

5.1.1 Priming and Start-up

The pump selected is not self priming. Therefore suction hose and pump have to be filled with water before its initial start. After that, water will stay in the hoses, pipes and pump due to foot-valve A7 and valve A14 (see Annex, Fig. A). Before every start, valve A14 is opened to fill the pump up with water and thus compensate for leakages of footvalve and stuffing box. Air is released by a special plug at the pump. Only if it is made sure that there is no air in the pump any more, it can be started.

After stopping the pump, valve A14 will be closed again to retain water in the pipe line for next priming.

Before start-up, fuel and oil are checked for its correct levels. Correct procedures are described in the pumping unit manufacturers' manual and have to be observed.

Fig. 20 shows the pumping unit in a shelter made out of local material. Valve A14 (Annex) is positioned at the connection between discharge hose and pipe in this particular case and can therefore not be seen.

5.1.2 Normal operation

Some points to be considered:

- it is essential that the suction hose and its connection to the pump are airtight. Otherwise the pump will not be able to lift water. This is usually the cause, if the pump is running but no water comes out at the discharge
- the stuffing box at the pump should be tightened so that appr. 1 drop/second is dripping out. Water has to be dripping out since otherwise lubrication and cooling of the stuffing box are not ensured and it can burn out easily

- diesel engines are more efficient at low air temperatures. Running the pumping unit at night or early morning/evening will save fuel. This is one reson to install a shade for the pumping unit, too
- locating the pumping unit in the open puts extreme strain on the engine. Dust will be all around; therefore cleanliness is of extreme importance. Always check for
  - clean fuel. Watch for cleanliness when filling the fuel into the tank. Also fuel filters are important and have to be replaced at regular intervals
  - clean air. Normal airfilters require a lot of paper filter elements (often every 2 weeks). Preferable are air filters with oil (not as good cleaning effect as with the filter elements) or heavy duty cyclone filters. They have a filter element as well, but it has to be replaced very seldom only (1/2 year)
  - clean oil. Regular oil change is important and has to be observed, time intervals as given by the manufacturer

5.2 Sand Filter Operation

5.2.1 Start-up

The raw water tanks will normally be filled up right after their erection. Their water had time enough for all dirt particles to settle to the bottom. If this water is clear, it can be used to start up the sand filters. For the start-up as well as after cleaning, the sand filters always have to be filled with clean water starting from the bottom. Only after all sand and the filter mats are submerged with clean water, the direction of flow through the inlet float valve can start. When the water in the sand filter tank has reached its operation level, the outlet valve will be slowly opened and adjusted to the estimated water consumption. Since sand filtration is a continuous process that should not be stopped, a continuous water flow has to be found that matches the consumption.

This adjustment will take some days. Water consumption will be almost equal every day, but will be high in the mornings and late afternoons and nil during the night. At the same time, the sand filter flow rate should always be the same. The clear water storage tanks will even out these changes and a careful valve adjustment will not have to be altered for a long time.

This is a very crucial point for the sand filter operation and the operators have to comprehend this. It is not easy to understand; therefore the learning process may take weeks or months!

5.2.2 Normal operation

Once the outlet valve is set at the correct flow, there is little work for the operator. Pumping will be done once a day - usually in the early morning - to fill up the raw water tanks. Everything else will run by gravity. If the clear water tanks are not covered, they have to be cleaned twice a week and washed out with a week chlorine solution. While one of the tanks is cleaned, its water inlet will be be connected temporarily by a flexible hose (2") to the next tank.

We found algae growing in the sand filter tank water above the sand, but not in the raw water tank. They did not effect the functioning of the purification process. Algae will grow in the flow meter for the clear water. To stop this, we covered the flow meter with a piece of 4" hose, to be lifted in order to take readings of the flow. The continuous flow through the sand filter cannot be stressed enough. Changing the rate of flow might affect the bacterial quality of the water. The flow should never be turned off completely. Standing water in a sand filter tank will favour anaerobic processes and will lead after a while to bad smell/taste in the water. This taste will be very hard to get rid off even after the operation is back to normal again.

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In case the flow through one or more sand filter tanks has to be stopped for more than one day, it is best to drain the tank completely.

Different connections of the raw water tanks (fig. 8) are currently being tested. First results show that the turbidity removal increases when the tanks are connected behind each other instead of in parallel. If this will result consistently in longer filter runs (time between filter cleaning) this raw water tank connection will be adapted at all other stations.

Long term experience with the rubber liners and the filter mats still have to be collected. The rubber liners will stick after some months to the corrugated iron in the lower half of the tank. At this time, the liner might have to be released a bit from the top so that it does not stretch. The fix clips should not touch the liner since they would otherwise cut holes into it (Fig. 21). So far, liner and mats have successfully been in operation for more than one year.

5.2.3 Cleaning

Depending on water flow rate through the sand fliter and river turbidity, the intervals between sand filter cleaning vary between 1 and 4 months. Filter runs with our first installed plants are given in chapter 5.5.1.

The time when the filter has to be cleaned becomes very obvious. Less water is coming through the filter so that the outlet valve has to be opened more and more in order to keep the flow rate constant. This means that the pressure loss in the filter increases. It starts slowly but towards higher pressure losses the outlet valve has to be adjusted in ever smaller intervals. Very soon afterwards, the valve adjustment is not sufficient any more to keep the set flow rate. This is the time for filter cleaning.

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The water level is lowered appr. 10 cm below the sand surface. The filter mats are full of sediments and silt (see Fig. 21). They are now very heavy. It might be useful therefore to scrape the silt off the mats with a small piece of wood to reduce their weight. Then they are rolled to a bundle and taken to a washing pipe. This is a very useful device, which we install at every plant. Annex Fig. E shows the design and Fig. 23 shows its use for cleaning the mats. The water jet, connected to the raw water tank, cleans the filter mat from the outside while the water pressure on the cleaning pipe does the cleaning from inside. The mat shown in this foto is still 6 m long. When dirty, this mat is almost impossible to lift and therefore the max. length has been reduced to 3.20 m.

While the mats are cleaned, some work has to be done at the sand surface. A sand layer of 1 - 2 cm thickness has to be scraped off. This is the sand that looks very dirty. It is fairly obvious how much sand has to be removed. No sharp tools should be used - a bricklayer's trowel has been proven ideal. The dirty sand is filled in a bucket and either thrown away or stored so that the amount from many cleaning procedures may eventually be washed and reused.

This will only be necessary after the available sand layer (sand thickness above drainage pipes) is less than 0.50 m. It will be only after several years of operation! Then a thicker layer of sand (appr. 0.20 - 0.25 m) will be removed and the sand filter tank filled up to its original level. This can be done with either new or used sand that has been washed.

The level of the settled sediments in the raw water tank should be checked at least once a year. We found 33 cm of sediments (well above the sludge draw-off) after 1 year of operation at Maganey plant. Periodic drainage at the sludge draw-off valve of the raw water tank is not enough to take the sediments out. With a large paddle the sediments were mixed with some water so that the sludge could drain out.

5.3 Manpower Requirements

It was decided to employ 4 unskilled labourers for the daily operation and guarding of the plant. This is necessary when the pump can not be controlled from the location of the sand filter because of too great a distance.

Two people will be responsible for the pump, one operating the pump during the day and the other acting as a guard at night. They will switbh their duties acc. to their own decision.

The same system applies for the sand filter plant, where one person acts as operator during the day and the other one as guard at night. The operator should control the water points as well. In difficult areas it proved advantageous to have a separate guard responsible for the smooth functioning of the water point(s). He/she should be selected by the camp section where the water point is installed.

All operators/guards will assist with the filter cleaning. It is very helpful to integrate future operators/guards in the installation of the plant. This is a good opportunity to select the personnel acc. to their abilities. They among themselves will nominate the water foreman who is responsible for the smooth running of the whole plant. Periodic short training courses for pump and sand filter operation have proven rather helpful.

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5.4 Description of Treatment Plants in Operation

	Maganey	Horseed	Qorioley II	Bur Dhubo	Ban Mandule	Ali Matan
Intake	River	River	Reservoir, fed by canal from river	River	River	River
Distance from Intake	750 m	570 m	15 m	1000 m	650 m	150 m
Elevation of Plant above avarage water intake level	15 m	13 m	3 m	17 m	15 m	8 m
Number of Raw Water Tanks	2	2	2	2	2	2
Number of Sand Filter Tanks	2	3	3	3	2	2
Number of Clear Water Storage Tanks (20 m^3 tanks temporarily used)	2	3	3	3	2	2
Number of CWP's and Donkey Cart Filling Points	3	3+1	3+1	3+1	2+1	3+1
Avarage Water Production/ day (m^3)	60	50	100	150	60	
Installation Date/Time	6/84	7-8/84	8-9/84	2-4/85	4/85	5-7/85
Foto of Plant in		Fig. 24	Fig. 7		Fig. 25	

5.5 Performance Data

5.5.1 Filter Run Times

Maganey Camp

Filter hydraulic loading rate appr. 0.039 m/h

Date	Comment	Filter run time (days)
21/6/84	Filter 1 started	
25/6/84	Filter 2 started	
19/9/84	Filter 1 cleaned/restarted	90
23/9/84	Filter 2 cleaned/restarted	90
10/11/84	Filter 1 cleaned/restarted	52
26/11/84	Filter 2 cleaned/restarted	64
4/4/85	Filter 1 cleaned/restarted	145
*	Filter 2 cleaned/restarted	
6/5/85	Filter 1 cleaned/restarted	32
8/5/85	Filter 2 cleaned/restarted	
4/7/85	Filter 1 cleaned/restarted	58
8/7/85	Filter 2 cleaned/restarted	60

* Date not known

Horseed Camp

Filter hydraulic loading rate appr. 0.029 m/h

Date	Comment	Filter run times (days)
11/9/84	Filters started	
27/11/84	Filters cleaned/restarted	77 (1)
28/2/85	Filters cleaned/restarted	93 (2)
17/4/85 } 19/4/85 }	Filters cleaned/restarted	49

(1) River bed prefiltering used until 15/1/85

(2) Cleaning carried for demonstration reasons

.../26

Bur Dhubo Camp

Filter hydraulic loading rate appr. 0.075 m/h

Date	Comment	Filter run time (days)
12/4/85	Filters started	
2/6/85 } 6/6/85 }	Filters cleaned/restarted	53
2/7/85	Filters cleaned/restarted	28
23/7/85	Filters cleaned/restarted	21

Comments

As can be seen, the filter run times vary considerably. This is dependant on the turbidity of the river water, which varies with the water level. High water levels correspond generally with high turbidities while low water levels correspond with low turbidities. In Somalia, we have 2 periods with high water levels and 2 periods with low water levels within one year.

5.5.2 Fecal Coliform Concentrations (/100 l) in Water Samples

Nature of Sample	Maganey Camp				Horseed Camp			Bur Dhubo		Qorioley II
	10/4/85	3/4/85	4/4/85	6/4/85	10/2/85	5/4/85	6/4/85	8/4/85	9/4/85	7/7/85
River Juba	TNTC (1)	280			TNTC (1)			610		
Influent to Raw Water Tank										
- Tank 1		2400								250
- Tank 2						1080		1480		200
Influent to Sand Filter										
- Filter 1		820				600		240		100
- Filter 2		480				620				100
(Filter 3)								250		
Filtrate from Sand Filter										
- Filter 1	0	0		3 (2)	0	1	0	6	1	0
- Filter 2	0	1		15	0	6		4	9	0
(Filter 3)								0	7	
Clear Water Tank										
- Tank 1			192	6			6			
- Tank 2				57					1	
(Tank 3)									140	

(1) = Too numerous to count
(2) Filter cleaned/restarted on 5/4/85

Comment This table shows, that the filtrate from the sand filters is generally of acceptable water quality. Recontamination occurs in some clear water storage tanks, if they are not kept clean. A slight chlorination will eliminate recontamination (max. 50 gr. HTH hypochloride/10 m^3 water).

5.5.3 Turbidity values (NTU) in Water Samples

Nature of Sample	Maganey Camp				Horseed Camp			Bur Dhubo				Qorioley II
	10/2/85	3/4/85	6/4/85	23/6/85	10/2/85	5/4/85	23/6/85	8/4/85	9/4/85	20/6/85	13/7/85	7/7/85
River Juba		170						28				
Influent to Raw Water Tank												
- Tank 1	(17)			(15)	(20)	110	(15)		30	(16)		(10)
- Tank 2		250		(15)			(15)	28		(16)		(10)
Influent to Sand Filter												
- Filter 1	(12)	75	35(33)	(12)	(11)	63	(11)	5–10		(10)	(10)	(7.2)
- Filter 2		70	40(38)	(12)		60	(11)		–5	(11)	(9)	(7.0)
(Filter 3)								5–10	–5		(9)	(6.9)
Filtrate from Sand Filter												
- Filter 1	(0.85)	<5(1.4)	<5(1.5)	(0.56)	(1)	<5(1.4)	(0.42)	<5	<5	(2)	(0.9)	(0.9)
- Filter 2		<5(1.4)	<5(1.5)	(1)		< 5	(0.46)	<5	<5	(2)	(0.8)	(0.5)
(Filter 3)								<5	<5		(1.1)	

Turbidity determined in calibrated-tube technique

Turbidity values in brackets determined by meter

Comment: see 5.5.1

5.4 Electrical Conductivity (EC) and pH Values

ure of iple	Maganey Camp			Horseed Camp			Bur Dhubo Camp				Qoriolley II
	10/2/85	5/4/85	23/6/85	10/2/85	5/4/85	23/6/85	8/4/85	9/4/85	20/6/85	13/7/85	7/7/85
.ver Juba		1500					2290/7.7				
fluent to .w Water nk											
- Tank 1	840	1790/7.5	200	760		180		1890/7.6	800	198	900
- Tank 2			200			180	2190/7.7		800	198	
fluent to nd Filter											
- Filter 1	1100	3860	200	840		180			800	198	900
- Filter 2		4470	200			180		3880	800	198	
(Filter 3)										198	
.ltrate ·om Sand .lter											
- Filter 1	1100	4300	200	840	3020/7.5	200			800	198	900
- Filter 2			200			200	7590/7.6	4530/7.5	800	198	
(Filter 3)							4760	5700/7.5		198	

.ectrical conductivity in [mmhos/cm]
I given as second value

omment: Electrical conductivities vary very much during the year. Only a few days in the year are the J values as high as in 4/85. While the EC in the river already had decreased, the filtrate was still .gh since it was the water from 2 days before. This "wave" of high Ec values was travelling downstream nd was measured some days later in Bur Dhubo, 150 km downstream Maganey/Horseed Camp.

.6 Sand Filter Monitoring Sheet

sketch of plant
(number of tanks, indicate river, etc...)

lant:

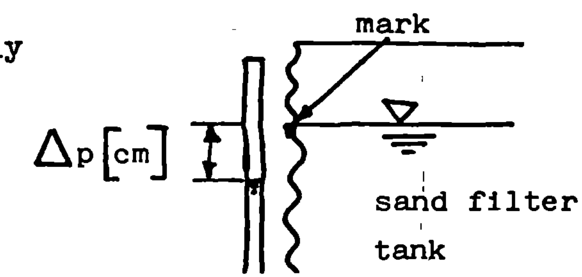
irst started on:

Date	Flowmeter reading [m^3]	Flow Rate [m^3/h] I	II	III	Filter cleaning	Turbidities (NTU)(1) Raw Water Intake	Sand Filter Intake	Clear Water	Remarks e.g. operational problems, replacement of parts, etc...

Filter Resistance Monitoring

Date	Sand Filter 1		Sand Filter 2		Sand Filter 3	
	Δp [cm]	flow rate [m^3/h]	Δp [cm]	flow rate [m^3/h]	Δp [cm]	flow rate [m^3/h]

Instruction: Indicate water level of sand filter tank on the outside with a piece of tape. Now measure periodically the distance between this mark and the water level at the clear hose level indicator and record.



6. Summary and Conclusions

- a complete water supply system for refugee communities is described, based on surface water treatment by slow sand filtration and a medium to long term operation period (more than 1 year)
- slow sand filters are a viable alternative for the water supply of refugee camps, if surface water has to be used
- constraints of high investment costs and long installation times have been overcome by a modular design
- refugee camps in Somalia are the first places where this new concept has been put into practise
- plants with this concept are operating for more than one year with good success
- to simplify installation and avoid the use of gravel, a new drainage system has been developed with good results
- getting the specified sand, washing it and filling it into the tanks has not been found difficult
- sand filter erection can be done with mostly unskilled personnel in 3 to 4 weeks
- pipe work connections can be made in different ways. In Somalia, PE and GI pipes were used to give a more permanent solution
- cleaning intervals for the sand filters are between 1 to 3 months only, dependant on seasonal turbidity variations of the river water
- problems exist with continuous operation of the plant. Personnel understands only slowly this crucial point
- bacteriological water tests showed generally high quality water
- advantages of this water supply system were found as follows:

    - moderate investment costs
    - easy and fast installation
    - simple operation
    - low operational costs
    - no use of chemicals

7. Acknowledgements

Oxfam U.K., the Public Health Engineering Section of Imperial College, London as well as the Dept. of Microbiology, Surrey University were instrumental in the research and development of this Water Treatment Plant. I got a lot of help from all these institutions. Especially Jim Howard of Oxfam should be mentioned here and Dr. Nigel Graham of Imperial College, whose visit to Somalia was very helpful for our project. Most water tests were done by him.

All this work would not have been possible without the support of Ecumenical Relief and Development Group for Somalia (ERDGS) and the Southern Refugee Water Unit (SRWU).

I want to express many thanks to my ERDGS collegues in the regions, whose enthusiasm carried us a long way into the successful installation of all the plants. The active participation of Mr. Paul Nerheim, ERDGS/SRWU supervisor in Lugh, and all his staff at the installation of the first plant led to many improvements in the whole system. In the same way, Mr. Arnold Gijsbers in Qorioley and Mr. Hidde Akkerman in Bur Dhubo and their staff helped with many suggestions.

Mr. Abdullahi Ali Obsie is responsible for many of the water tests, while Mr. Ali Mohammed Mahadalla and Mr. Mohamed Sahal Nur has been drafting the sketches and the figures of this report. I want to express my thanks to them as well as to Mrs. Marja Jansa, who did a great job in typing the manuscript.

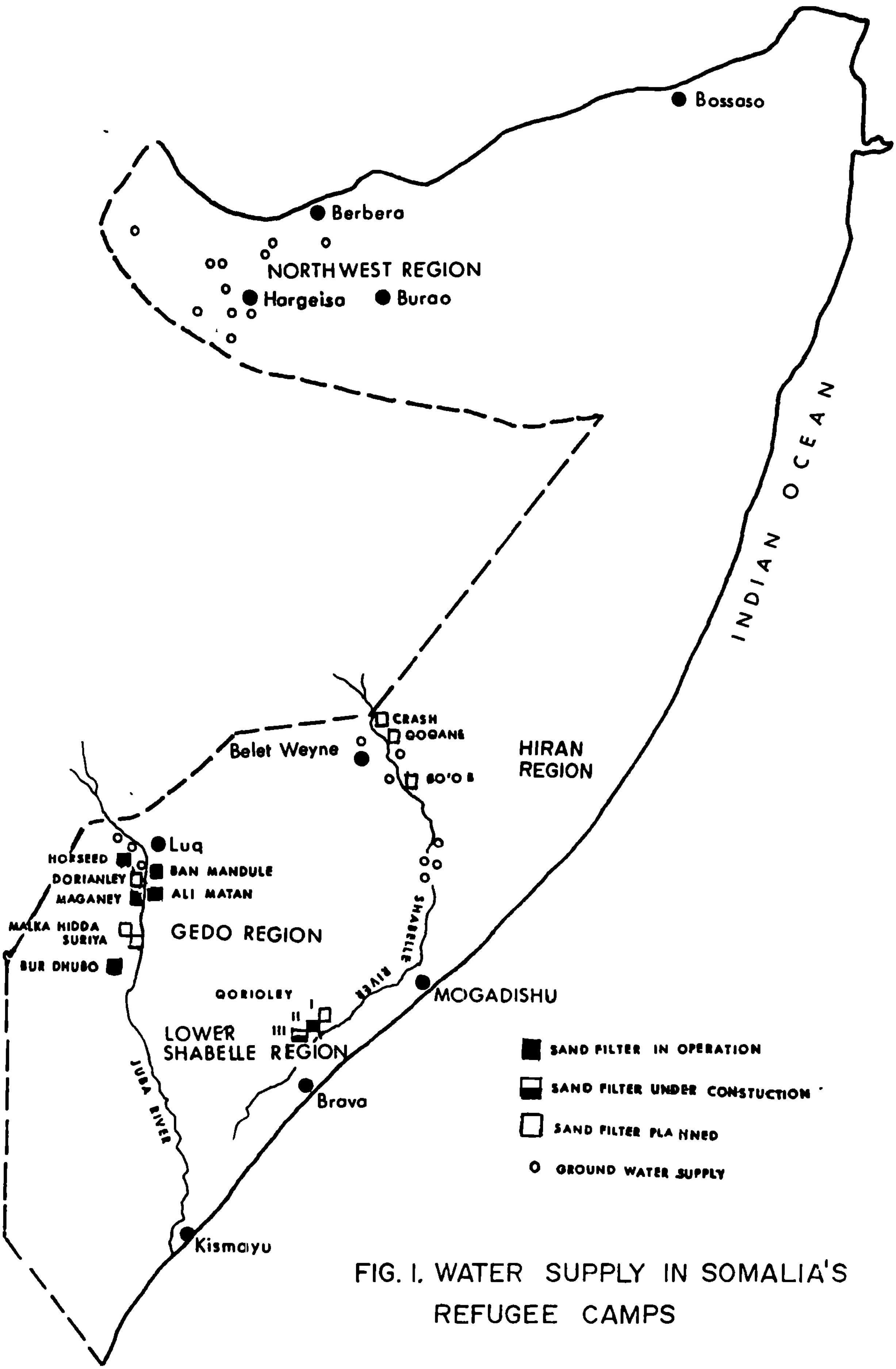


FIG. I. WATER SUPPLY IN SOMALIA'S REFUGEE CAMPS

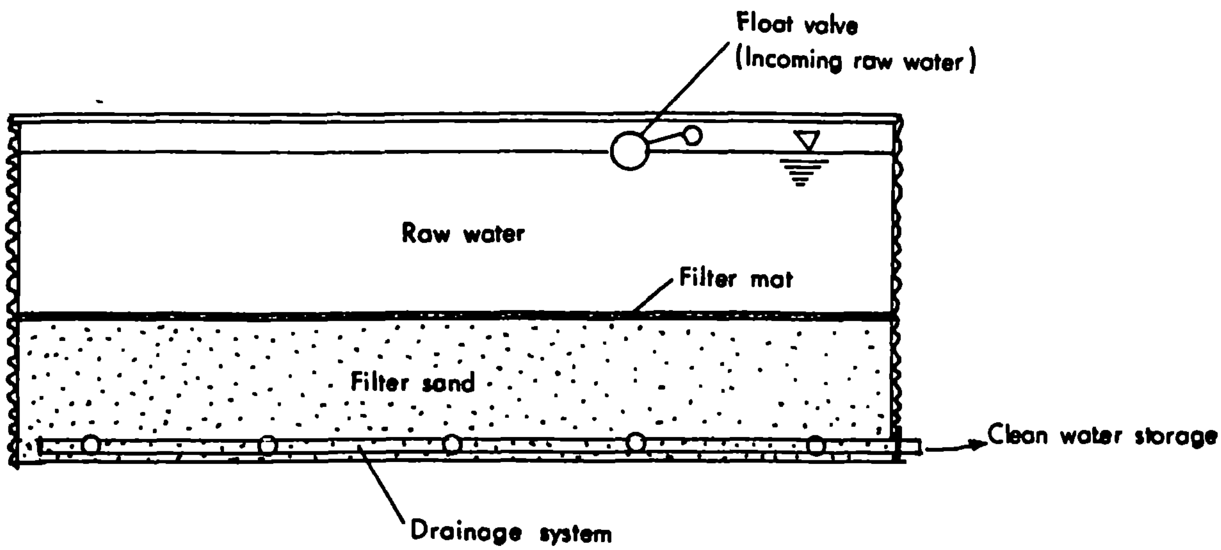


Fig. 2 Components of a Slow Sand Filter

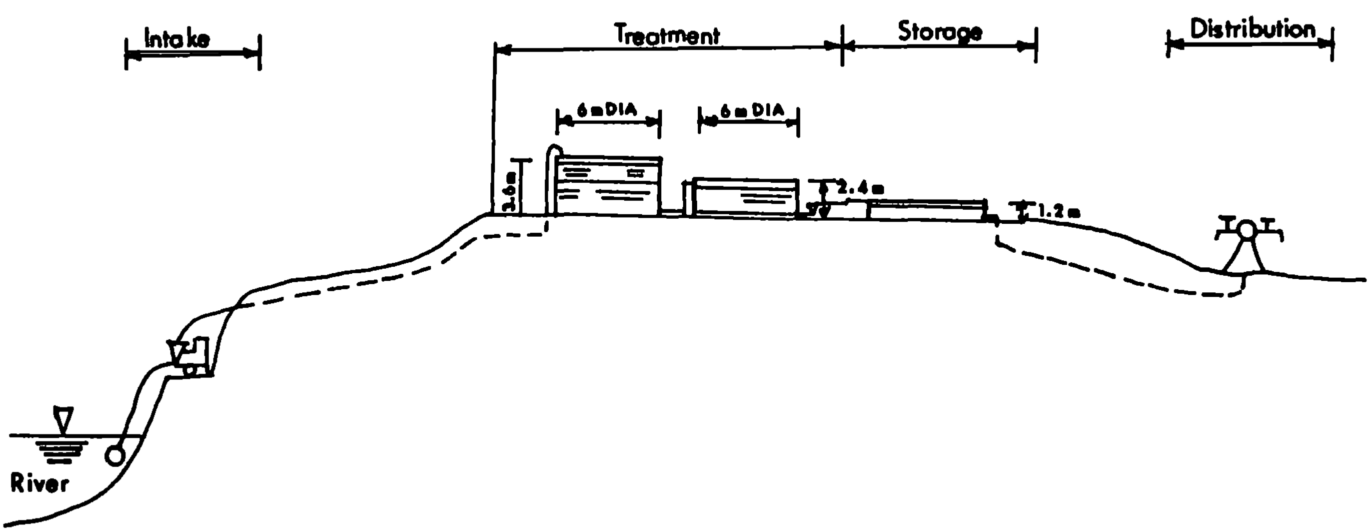


Fig. 3 General Arrangement of Water System

PUMP TYPE 3WHS/ST1 3WHT/ST1	IMPELLOR FULL DIA 229mm
SPEED r./min VAR.	IMPELLOR EYE DIA. 76·2mm
BRANCH SIZES 3"x2"	DATE 17. 7. 84.

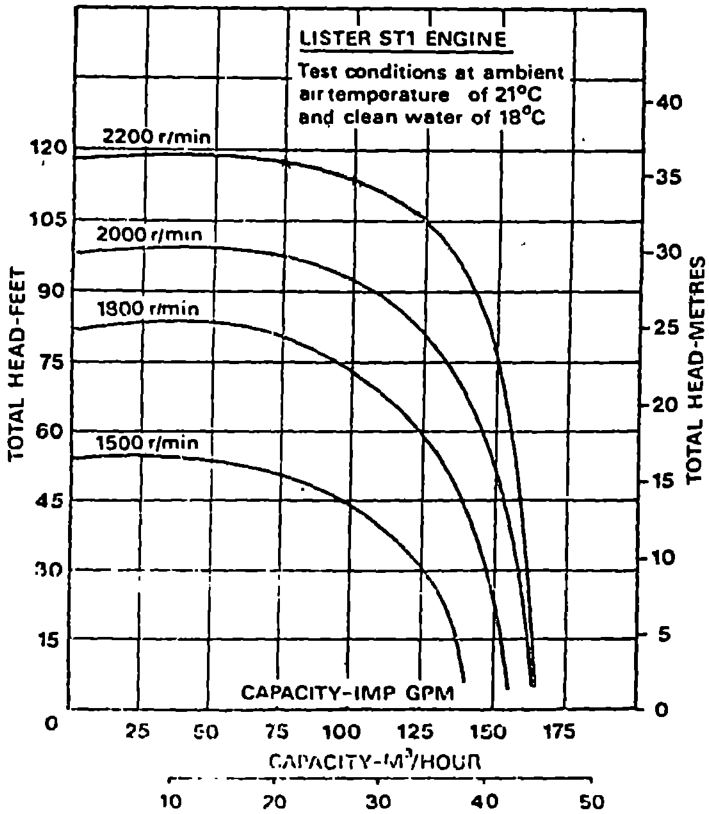
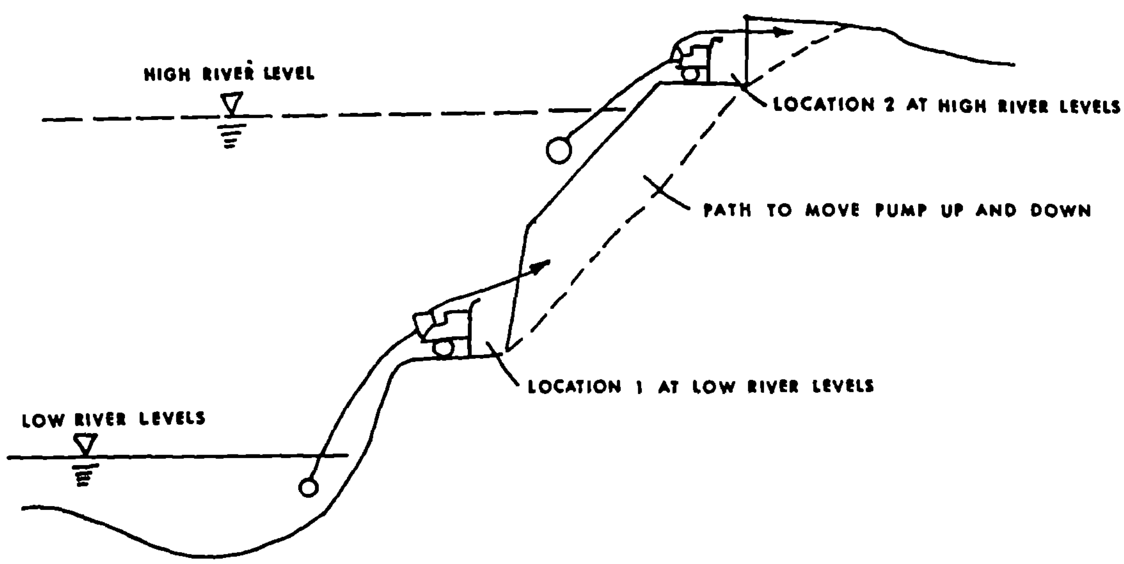


Fig. 4 Performance Curves of Pumping Unit



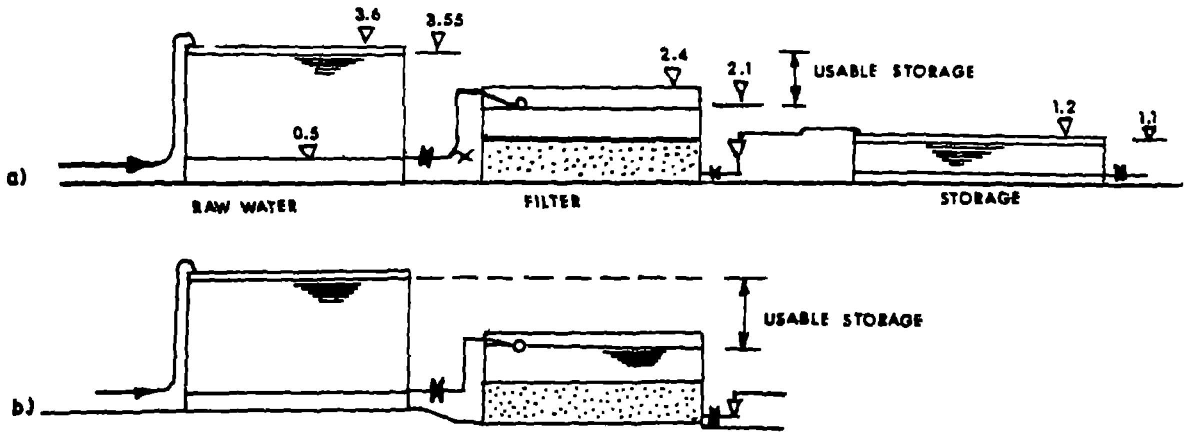


Fig. 6 Hydraulic Levels of Treatment and Storage Tanks
b) shows elevated raw water storage tank to increase usable storage

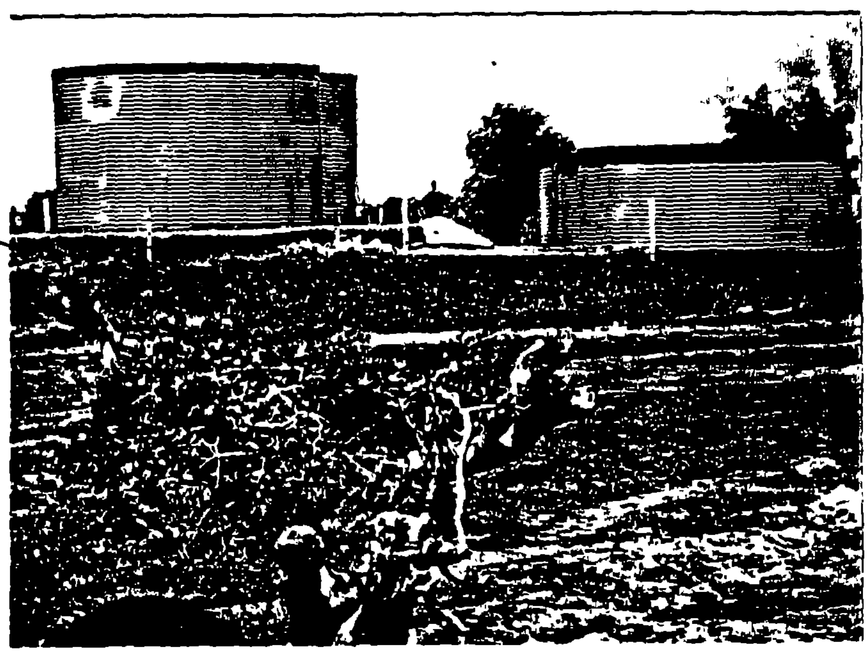


Fig. 7 Treatment Plant in Qorioley Camp II

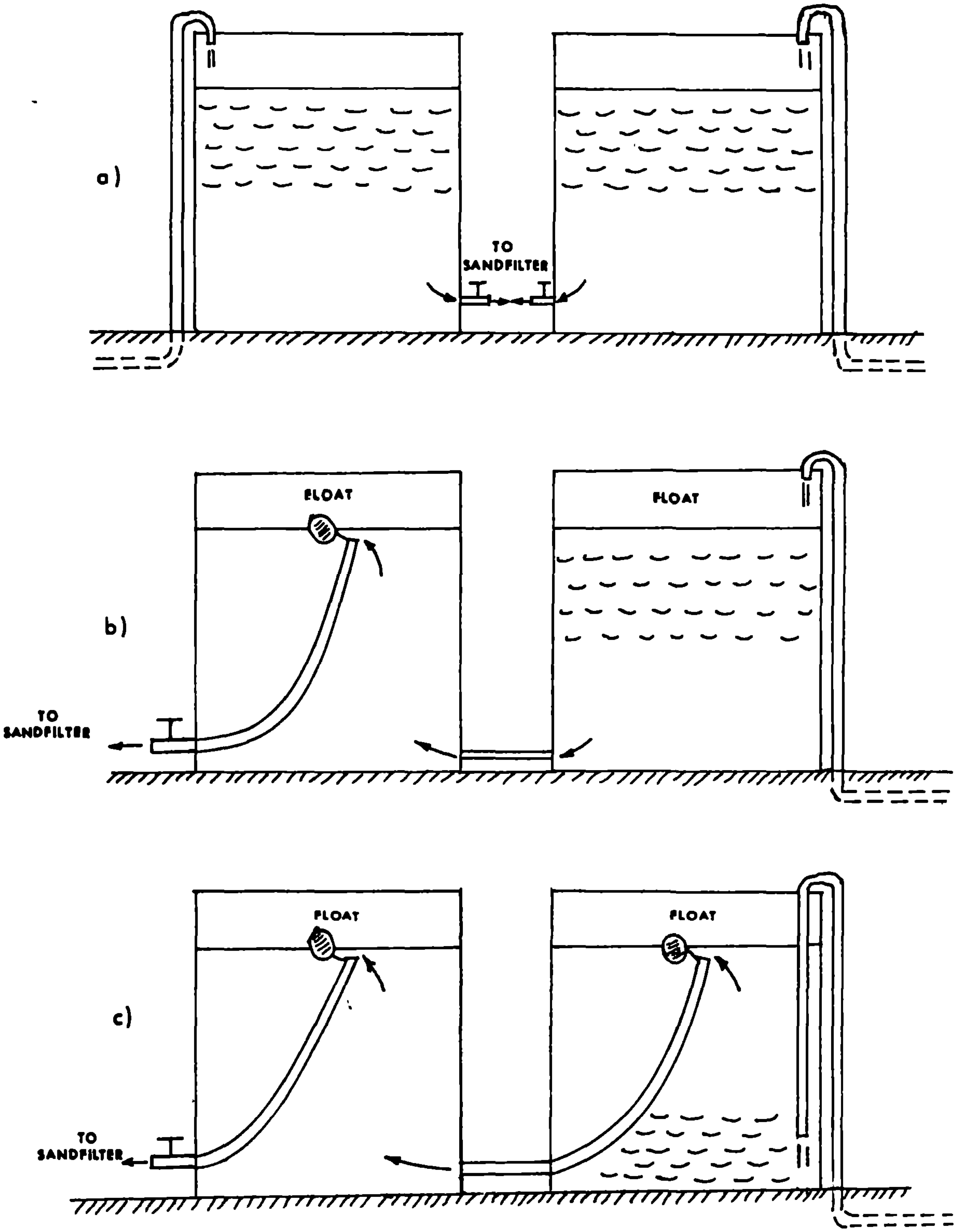


Fig. 8 Different Connections of Raw Water Tanks

a) normal operation in parallel

b) operation in series, Ban Mandule connection

c) operation in series, Ali Matan connection

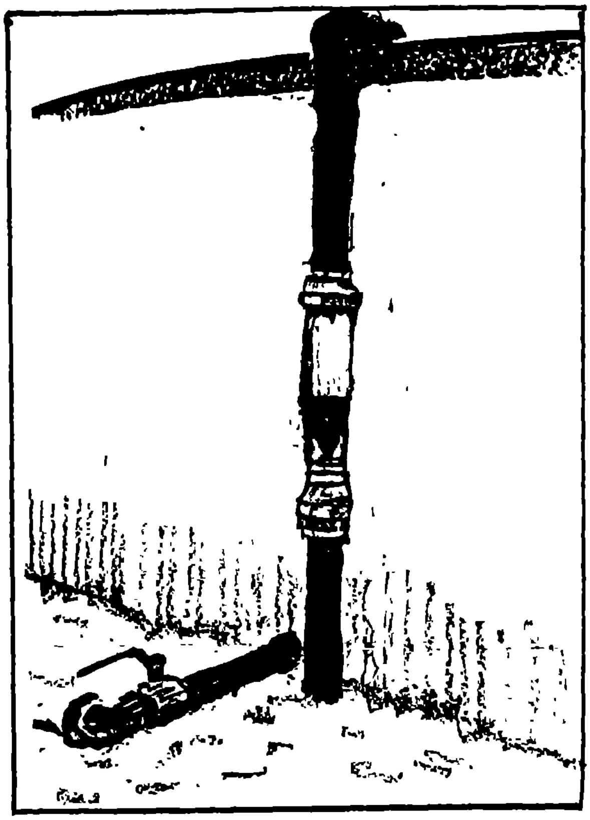


Fig. 9 Inlet, Clear Water Tank with Flow Meter (outlet at left with valve)

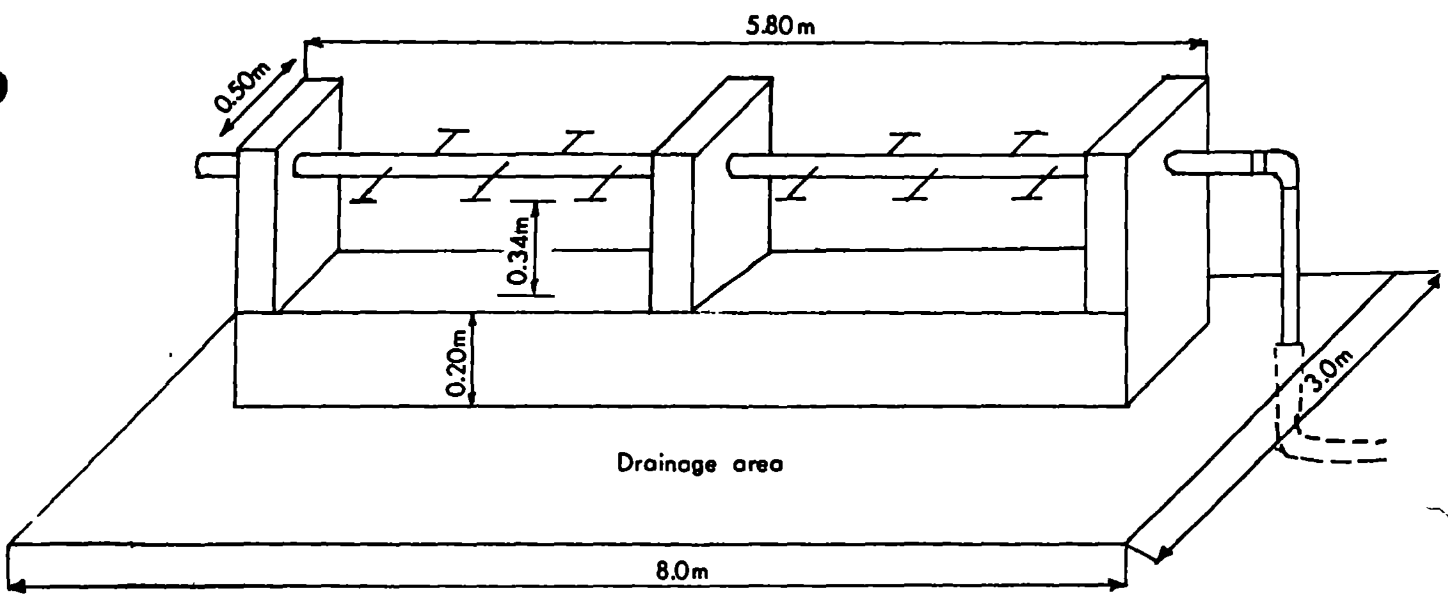


Fig. 10 Community Water Point

Fig. 11 Sand Washing

Fig. 12 Washed Sand is Shoveled into Sand Filter Tank

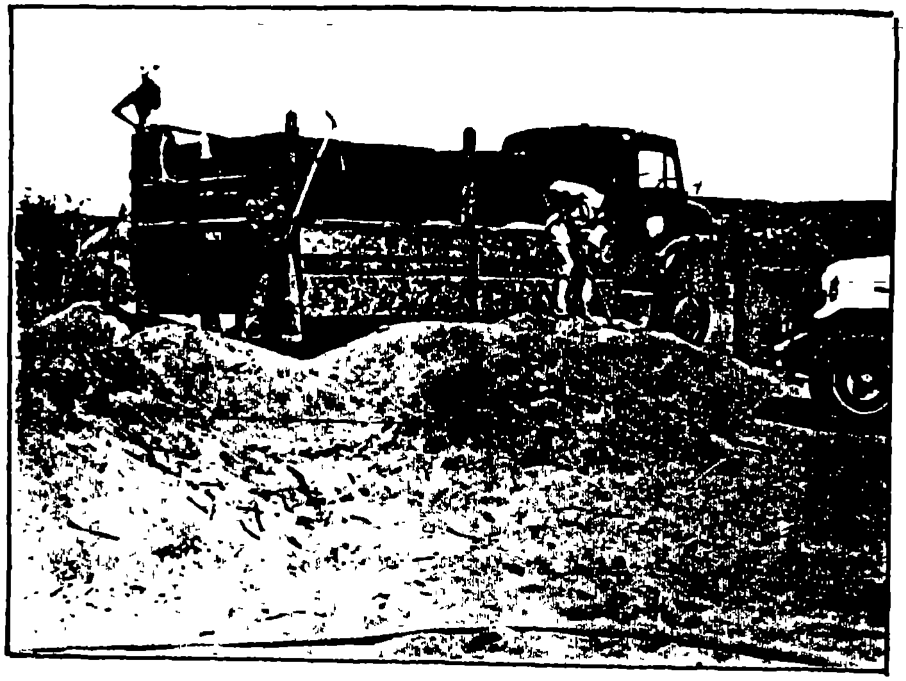


Fig. 13 Sand Washing Drums on Truck

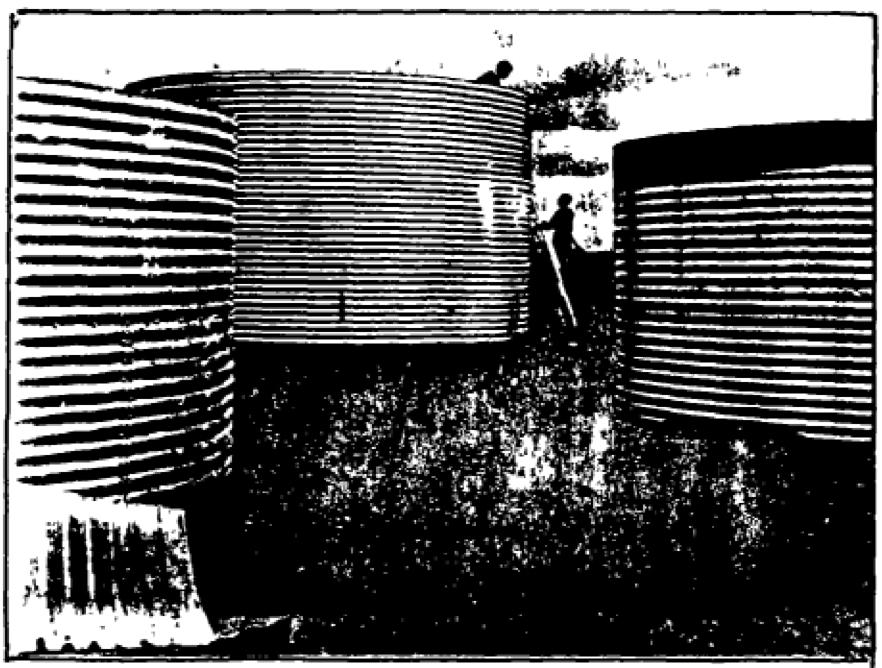


Fig. 14 Erection of Tanks

Fig. 15 Liner being Fitted into a Raw Water Tank

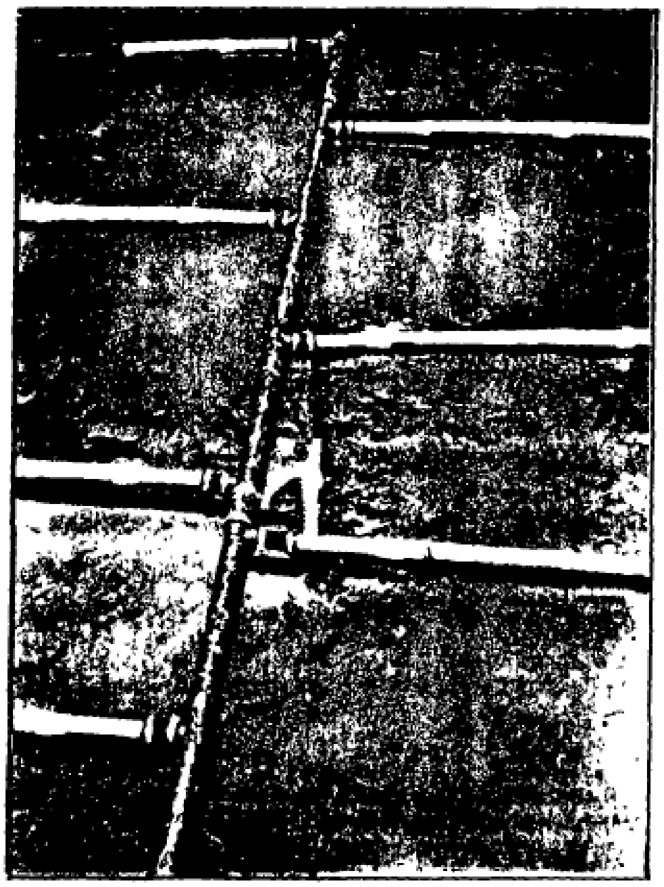
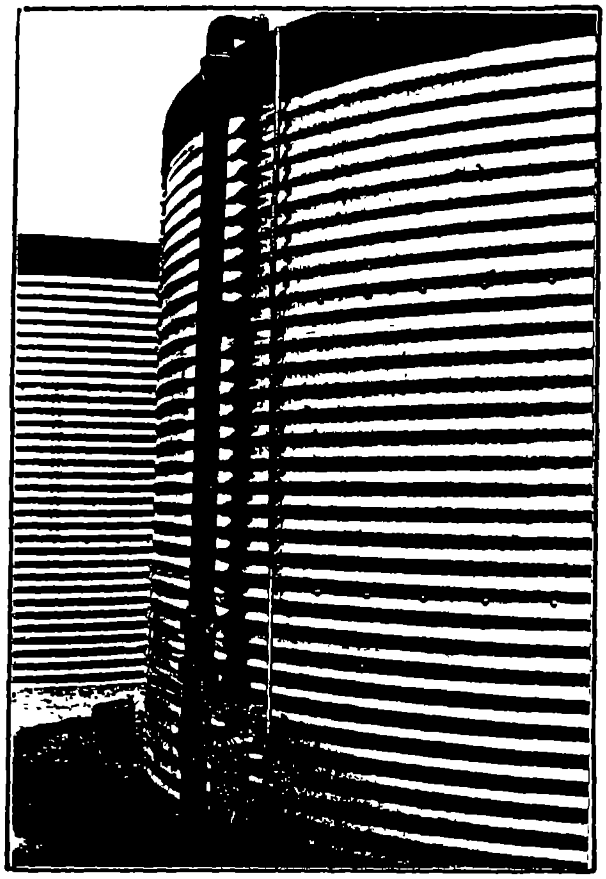


Fig. 17 Filter Mats Held Down by Stones



clear plastic
hose as level
indicator

Fig. 18 Inlet Raw Water Tank (4");
(outlet (2") can also be seen)

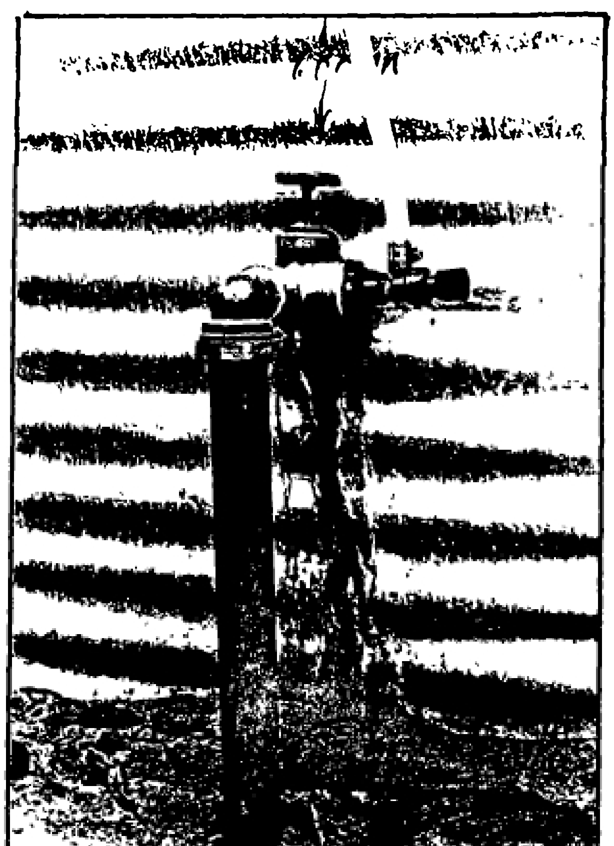


Fig. 22 These Filter Mats have to be Cleaned

Fig. 23 Cleaning the Filter Mats

Fig. 24 Treatment Plant in Horseed

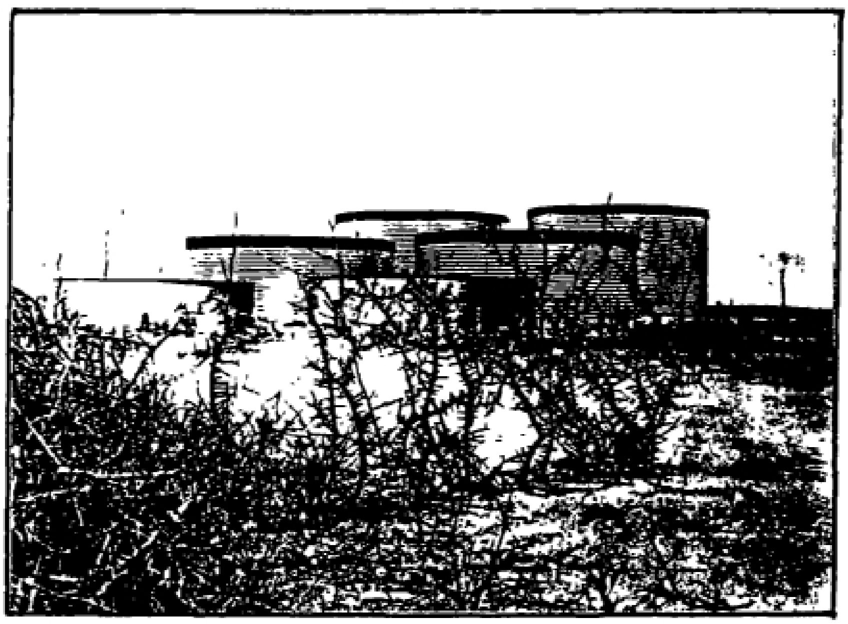


Fig. 25 Treatment Plant in Ban Mandule

Following is a complete parts list for a water supply system as is used for the Refugee Water Supply in Somalia. It is based on the Oxfam Treatment Package, but adopted to long term use.

A. River Intake, Pumping Unit and Piping to Treatment Plant (see Fig A)

No	Part Number Code	Description	Qty	Suppliers	Price US $
A 1		Lister type 3WHT/ST1 centrifugal pump, hand started, mounted on trolley, cyclopac air cleaner, 4"BSP male suction/3" male delivery branches, integrated fuel tank, with engine/pump spares for 5000 hours and operation/W'shop manuals, tool kit	1	2 (3)	1550,-
A 2		Adaptor 4" BSP female/firefighters coupling size A	4	3	70,-
A 3		Union, firefighters coupling size A for 4" hose	4	3	40,-
A 4		Suction hose, 4", UV-resistant, steel spiral reinforcement	20 m	3	260,-
A 5		Pressure hose, 4", synthetic fabric	10 m	3	50,-
A 6		Hose clamps, 4", sturdy	8	3	8,-
A 7		Suction strainer and foot valve,(ball type), 4" male BSP	1	3	70,-
A 8		Rubber float to hold foot valve (foot valve to be tied by rope H37)	2	3	20,-

A. (continuation)

No	Part Number Code	Description	Qty	Sup-liers	Price US $
A 9	GCJMZQQØØ	Adaptor JMZ 110-4" male	1	5 (3)	25,-
A10	GCJTFQQØØ	Tee JTZ, 4"	1	5 (3)	55,-
A11	GCJGZQQØØ	elbow 90°, JGZ, 110	3	5 (3)	135,-
A12	470.185	P.E. Pipe 4" S8(PN 6.3) Ø 110 mm, 5 m length	acc. to loca-tion	6 (3)	21,-/pc
A13	473.038	electro welding socket Ø 110 mm	"	6 (3)	7.50,-/p
A14		3" ball valve, 90°, female threaded ends	1	3	35,-
A15	(N8)	double nipple 4"/3", GI	1	3 (7)	3,-
A16	(N8)	double nipple, 3", GI	1	3 (7)	2,-
A17	(G1)	long elbow, 3", GI, female ends	1	3 (7)	4,-

.. /3

B. Tanks and flanged connectors (no Figure)

No	Part Number Code	Description	Qty	Suppliers	Price US S
B1		1mm Butyl Open Top Tank, complete with ancillary items, 6 x 3.60 m	2	1	
B2		1mm Butyl Open Top Tank, complete with ancillary items, 6x 2.40 m	2	1	
B3		1mm Butyl Open Top Tank, complete with ancillary items, 7x 1.20 m	2	1	
B4		Flanged connections to give 2" BSP outward projecting threaded spigot and a similar inward projecting spigot	8	1	
B5		Flanged connectors to give 3" BSP outward protecting threaded spigot	2	1	
		Above connectors complete with studs, nuts, gaskets and washers			
			TOTAL	PRICE	6.800

.../4

C. <u>Filter Fabric and Drainage</u> (see Fig. C)

No	Part Number Code	Description	Qty	Suppliers	Price US $
C1		22 m roll of Bondina Filter Fabric ref. P15/350, 1,6 m wide	2	1	370,-
C2		collectorpipe, 2", 5.6 m, delivered in two parts, acc. specification, galvanized steel	2	4	
~~C3~~		~~drain filter, 1 3/4"~~	~~50 m~~	~~4~~	
C4		cap for drain filter	22	4	
C5		roll coroplast PVC tape	4	4	
C6		PVC pipe, 3 m long, 1 1/2", type Aufsatzrohr	15	4	
C7		rubber hose, 40 mm	5 m	4	
C8		rubber hose, 60 mm	2 m	4	
C9		clamps 2 1/2"	10	4	
C10		clamps 2"	45	4	
			TOTAL PRICE US $		1020,-

.../5

D. Link pipe work (see Fig D1 and D2)

No	Part Number Code	Description	Qty	Sup-liers	Price US $
D1		2" Gate valve	6	1, 3	30,-
D2		ball valve, 90°, 2", female threaded ends	3	1, 3	30,-
D3		11/2" Equilibrium ball valve c/w copper float	2	1	150,-
D4		Gemu Plastic Flow Meter 250/2500 1/HR	2	1	300,-
D5	(N4)	reducing bush, 2 - 11/2, GI	2	7 (3)	2,-
D6	(B1)	T-piece, 2", GI	6	7 (3)	5,-
D7	(N4)	reducing bush, 2" - 1/2", GI	4	7 (3)	4,-
D8	(M2)	socket, 2", GI	6	7 (3)	3,-
D9	(N8)	double nipple, 2", GI	14	7 (3)	25,-
D10	(A1)	elbow, 2", GI	14	7 (3)	10,-
D11	AFV	hose nozzle 1/2" - 20 mm (FIP)	4	5 (3)	4,-
D12	PFV	plug 1/2" (FIP)	4	5 (3)	2,-
D13		400 mm long 2" CL/7 UPVC Pipe, THDS	4	1 (3)	8,-
D14	GCSMZLLØØ	adaptor JMMZ, 63 - 2"	10	5 (3)	50,-
D15	470 100	2" PE pipe, S8 (PN 6.3), 5 m long	6	6 (3)	60,-
D16	473 155	elbow 90°, PE, Ø63, S8	6	6 (3)	24,-
D17	473 085	T-piece, PE, Ø63, S8	2	6 (3)	10,-
D18	473 035	electro welding socket, Ø63	20	6 (3)	64,-
D19		30 m roll, 2", delivery hose	1	1 (3)	160,-
D20		30 m roll, 3/4" clear hose	1	1 (3)	75,-
D21		2" bolted hose clamps	6	1 (3)	8,-
D22		3/4" hose clamps	6	1 (3)	3,-
D23	ADV	hose nozzle 2"x 50 mm with nut and spigot	6	1,5 (3)	24,-

E. Sandwashing and filter mat cleaning (Fig. E)

No	Part Number Code	Description	Qty	Sup-liers	Price US $
E1		H/D Poly Tanks AX 100	6	1	300,-
E2		1 m length of 2" CL/7 Pipe THD	6	1	25,-
E3		2" UPVC Back Nuts	12	1	33,-
E4	(N4)	reducing bush, 2"-3/4", GI	1	7(3)	0.50
E5	(N8)	doubble nipple, 3/4", GI	1	7(3)	0.50
E6	ADV	hose nozzle 3/4" x 20 mm with nut and spigot, eg. FIP	2	5,1(3)	2,-
E7	GCJFZQQØØ	Adaptor socket JFZ, 110-4", female	1	5(3)	24,-
E8	(N4)	reducing bush, 4"-2", GI	1	7(3)	2,-
E9	(N8)	doubble nipple, 2", GI	3	7(3)	5,-
E10	(A1)	elbow, 2", GI	3	7(3)	2,-
E11	(B1)	T-piece, 2", GI	1	7(3)	1,-
E12	GCSMZLLØØ	Adaptors JMMZ, 63 - 2"	2	5(3)	10,-
E13		ball valve, 90°, 2", female threaded ends	1	3	10,-
E14		2" pipe, GI, 6 m long (if no possibility at site, cut one piece to 3.30 m, thread it at both ends and drill holes as in Fig. E; likewise, cut 2 pc of 2 m, thread at one end)	1	3	20,-

.../7

F. Clear Water Distribution (Fig. F)

No	Part Number Code	Description	Qty	Suppliers	Price US S
F1		3" Gate valve	2	1 (3)	30,-
F2	(N8)	double nipple, 3", GI	4	7 (3)	8,-
F3	(A1)	elbow, 3", GI	3	7 (3)	6,-
F4	(B1)	T-piece, 3", GI	2	7 (3)	4,-
F5	GCJMZPPØØ	Adaptor JMZ, 90 - 3"	5	5 (3)	75,-
F6	470 145	P.E. Pipe 3", S8 (PN6.3) Ø 90 mm, 5 m long	acc. to location	6 (3)	9.50/
F7	473 037	electro welding socket, Ø 90 mm	"	6 (3)	6,-/p

.../8

G. Community Water Point (see Fig. G)

No	Part Number Code	Description	Qty	Sup-liers	Price US $
G1		2" pipe, 6 m long, GI	1	3	20,-
G2	(T1)	2" cap, GI	1	7(3)	1,-
G3	(M2)	3" socket, GI	1	7(3)	2,-
G4	(M2)	3/4" socket, GI	10	7(3)	5,-
G5	(N8)	double nipple 2"	1	7(3)	2,-
G6	(N8)	reducer nipple 3"/2"	1	7(3)	2,-
G7	(A1)	2" elbow	2	3	8,-
G8		2" ball valve, 90°, female threaded ends	1	3	10,-
G9	GCSMZLLØØ	adaptor JMMZ, 63 - 2"	2	5(3)	10,-
G10	GCJMZPPØØ	adaptor JMZ, 90 - 3"	1	5(3)	15,-
G11		sturdy taps, 3/4"	10	3	150,-

.../9

H. Tools (No figure)

No	Part Number Code	Description	Qty	Sup-liers	Price US $
H1		Large steel Amun. Box with threadlock	1		10,-
H2		Tray tool box with lock	1		13,-
H3		Shovel	8		50,-
H4		Spade	4		50,-
H5		Pick axe	6		72,-
H6		Hand axe	1		11,-
H7		10 lb sledge hammer	1		16,-
H8		4 lb club hammer	1		8,-
H9		All steel claw hammer	1		6,-
H10		22" Teflon Wood Saw with Spare blades	1		10,-
H11		Hacksaw frame	1		4,-
H12		Hacksaw blade for frame	20		11,-
H13		Wrecking bar	1		3,-
H14		Holland water level, 30'	1		26,-
H15		30 m measuring tape	1		20,-
H16		5 m measuring tape	1		5,-
H17		12" HR Bastard File	1		4,-
H18		8" - " -	1		3,-
H19		12" Round File	1		2,-
H20		10" - " -	1		2,-
H21		17 mm Ring/ OE Spanner	2		4,-
H22		24 - " -	2		5,-
H23		17 mm Brace/Skrt Spanner	2		20,-
H24		Combination pliers	2		10,-
H25		12" long taper	2		5,-
H26		12" Ratchet Screwdriver	2		8,-

H. <u>Tools</u> (continuation)

No	Part Number Code	Description	Qty	Sup-liers	Price US $
H27		8" Ratchet Screwdriver	2		7,-
H28		18" x 1" Cold Chisel	1		2,-
H29		8" x 1" Cold Chisel	1		2,-
H30		Pipe wrench 2" - 3"	2		40,-
H31		Plastic buckets, strong, 10 l	10		20,-
H32		Stanley knife with spare blades	2		6,-
H33		Carpenter Pencil	2		1,-
H34		Marker Pen	2		2,-
H35		Alumn. Extending ladder	2		150,-
H36		5 kgs 1/8 Galv. Wire	1		7,-
H37		Coil 220 m Poly prop Rope 10 mm	1		15,-
H38		Paint brush 1 1/2"	4		2,-
H39		Set of tools for firefighters coupling, size A and B	2		4,-
H40	474 600	Polyethylene Welding Kit, complete with fixtures for 2", 3" and 4" PE pipes and pipe preparation tool	1	6 (3)	1800,-
H41		Zinc primer paint	4 kg		20,-
H42		Silicone pistol	1		5,-
H43		Silicone cartridge	4		12,-
H44		Rolls of PTFE tape	50		20,-

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I. Spare Parts for a 2 Years Operation Period (conservative estimate)

Ref. No.	Part Number Code	Description	Qty	Sup-liers	Price US $
A1		engine/pump spares for 5000 hours (included in original order)			
A2/ A3		seal rings for fire fighters coupling, size A)	6		
A4		suction hose	20 m		
A5		pressure hose	10 m		
B1		liner for open top tank 6 x 3.60	2		1 470,-
B2		liner for open top tank 6 x 2.40	2		1 140,-
B3		liner for open top tank 7 x 1.20	2		
C1		Filter Fabric, 22 m	4		
G11		sturdy taps	30		
H40		zinc primer paint	4 kg		
H43		Silicone cartridge	4		
D1		Gate valve, 2"	4		
		Liner repair kit	4		32,-

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K. Suppliers

No.	Name and address	Supplier/Manuf.
1	OXFAM (Mr. J. Howard) 274 Banbury Road OXFORD OX2 7DZ UK	Supplier: Sandfilter equipment, Storage, Distribution and Pumping Kits
2.	R.A. Lister R.G. Ltd. Dursley, Gloucestershire Gl 11 4HS, UK Telex 43261	Manuf.: Pumps, Engines
3.	WEM Mittelweg 143 D - 2000 HAMBURG 13 W.GERMANY Telex 214504 EWEMI	Supplier General
4.	GERD BRUNS GmbH D - 2935 BOCKHORN W.GERMANY Telex 251220 MUEBO D Attn Bruns	Manuf: Prefiltering systems, Sandfilter drainage Diaphragm Pumps
5.	FIP GmbH Weseler Str. 110 D-4330 MULHEIM/RUHR W.GERMANY	Manuf: PVC-fittings
6.	VON ROLL/Department ROHRE Sektor Rollmaplast CH - 4553 SUBINGEN SWITZERLAND Telex 34857 ROLSUCH	Manuf: PE Pipes + Fittings
7.	GEORGE FISHER (GF) CH - 8201 SCHAFFHAUSEN SWITZERLAND	Manuf: Fittings (GI)

L. Remarks

Piping

A12/13

If the treatment plant is close to the river intake, 3" pipe may be used (see chapter 3.2.2). This affects the following items:

A2 ...3" BSP female/fire fighters coupling size B
A3 ...size B for 3" hose
A4 ...hose 3"
A5 ...hose 3"
A6 ...clamps 3"
A7 ...foot valve 3"
A9 ...adaptor JMZ 90 - 3"
A10 ...Tee JTZ, 3"
A11 ...elbow 90°, JGZ, 90 mm
E7 ...adaptor socket JFZ, 90 - 3"
add: ...(N8) double nipple, 3", GI (1 piece)

F6/7 If the water points are close to the treatment plant, 2" pipe can be used (see chapter 3.4). In this case, 100 m rolls of 2" pipe should be used. This affects the following items:

add:
- 2 pc N4 reducing bush, 3" - 2", GI
- 3 pc adaptor JMMZ, 63 - 2"

Link pipe work

If the link pipe work is done in GI pipes, the following changes have to be made

D15 change in 2" GI pipe
D16 " " 2" GI elbow
D17 " " 2" GI elbow
D17 " " 2" GI, T-piece
D14 may be omitted

Filter Mat Cleaning

The connection of the filter mat cleaning stand with the raw water pipe line is facilitating the cleaning a lot. But if this is not possible, the cleaning can still be done just with the water jet.

D12, Plug

This plug will be fixed with some wire near reducing bush D7. It will be used to close D7 if the head indicator (clear plastic hose) has to be removed temporarily.

Community Water Point (G)

Materials are for one Community Water Point only.

Chlorinating Kit

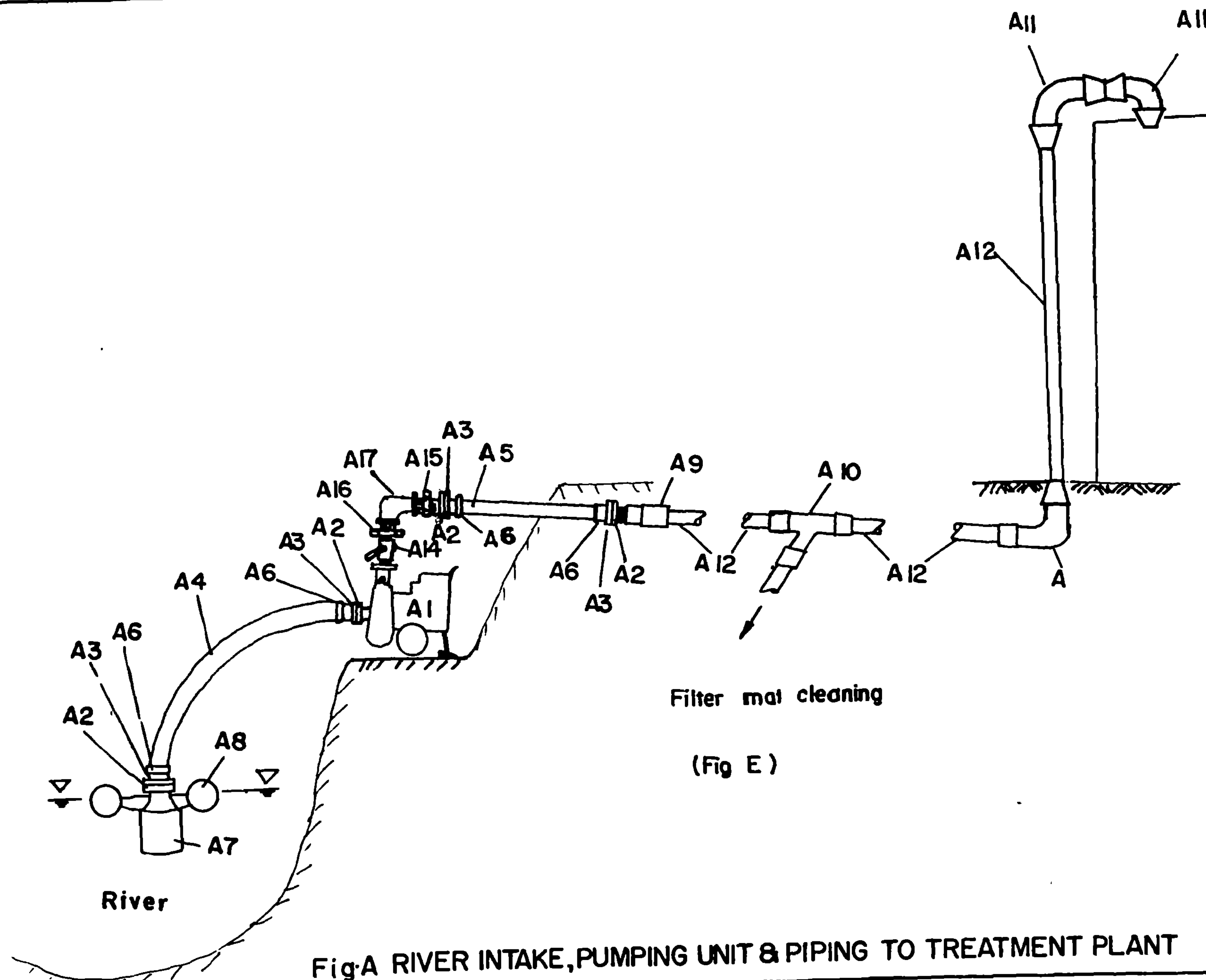
If chlorination is required, Oxfam's chlorinating kit of the "Storage Package" can be used.

Prices

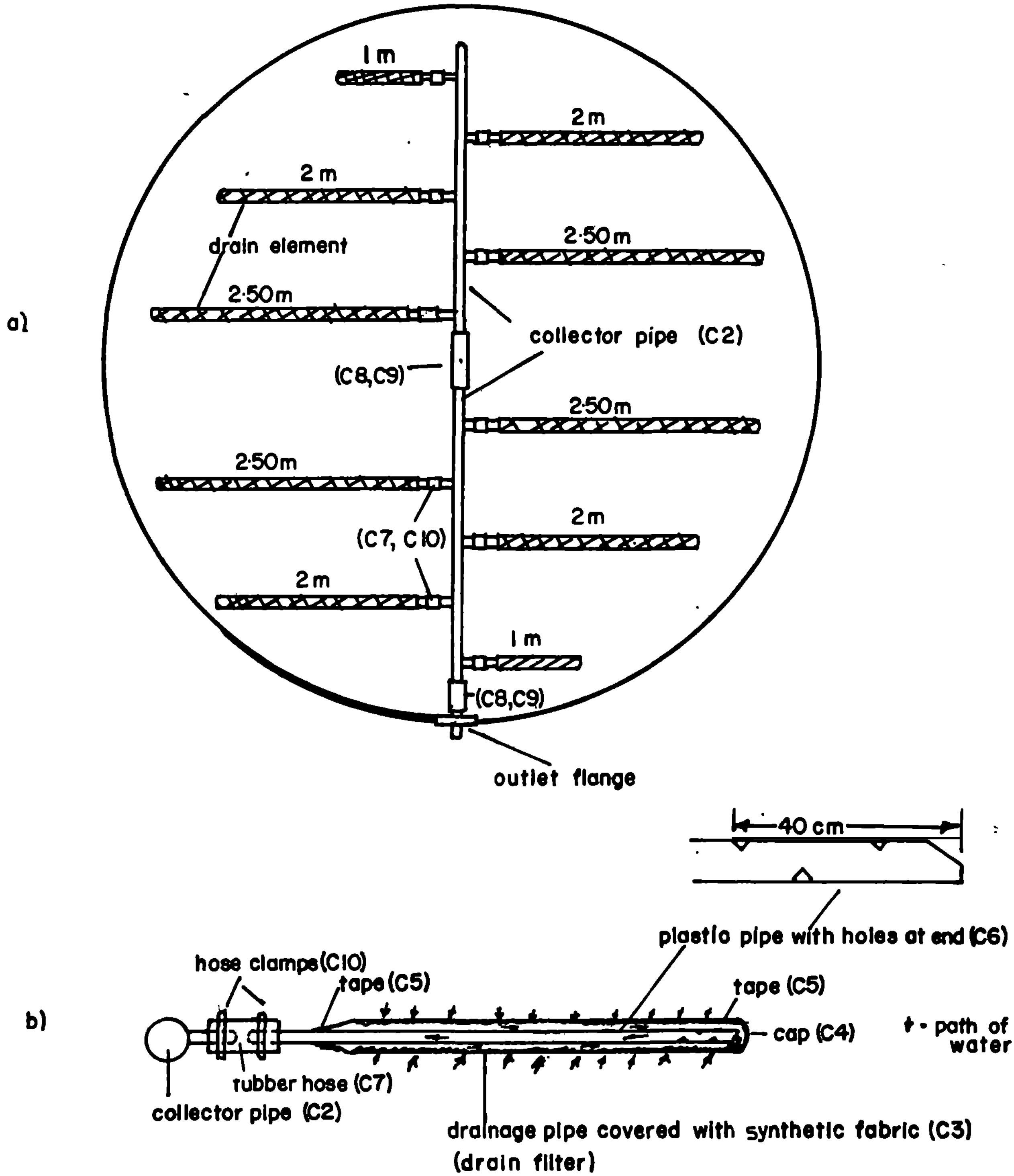
Prices are mentioned to give an estimate only. Price basis is end of 1984. The prices have been converted from several currencies into US $ and are therefore only approximate, since exchange rates are changing.

Suppliers (K)

The number of suppliers should be kept to a minimum. In the Refugee Water Supply Project, suppliers No. 1, 3 and 4 were used. Only one supplier for all the equipment should be aimed at.



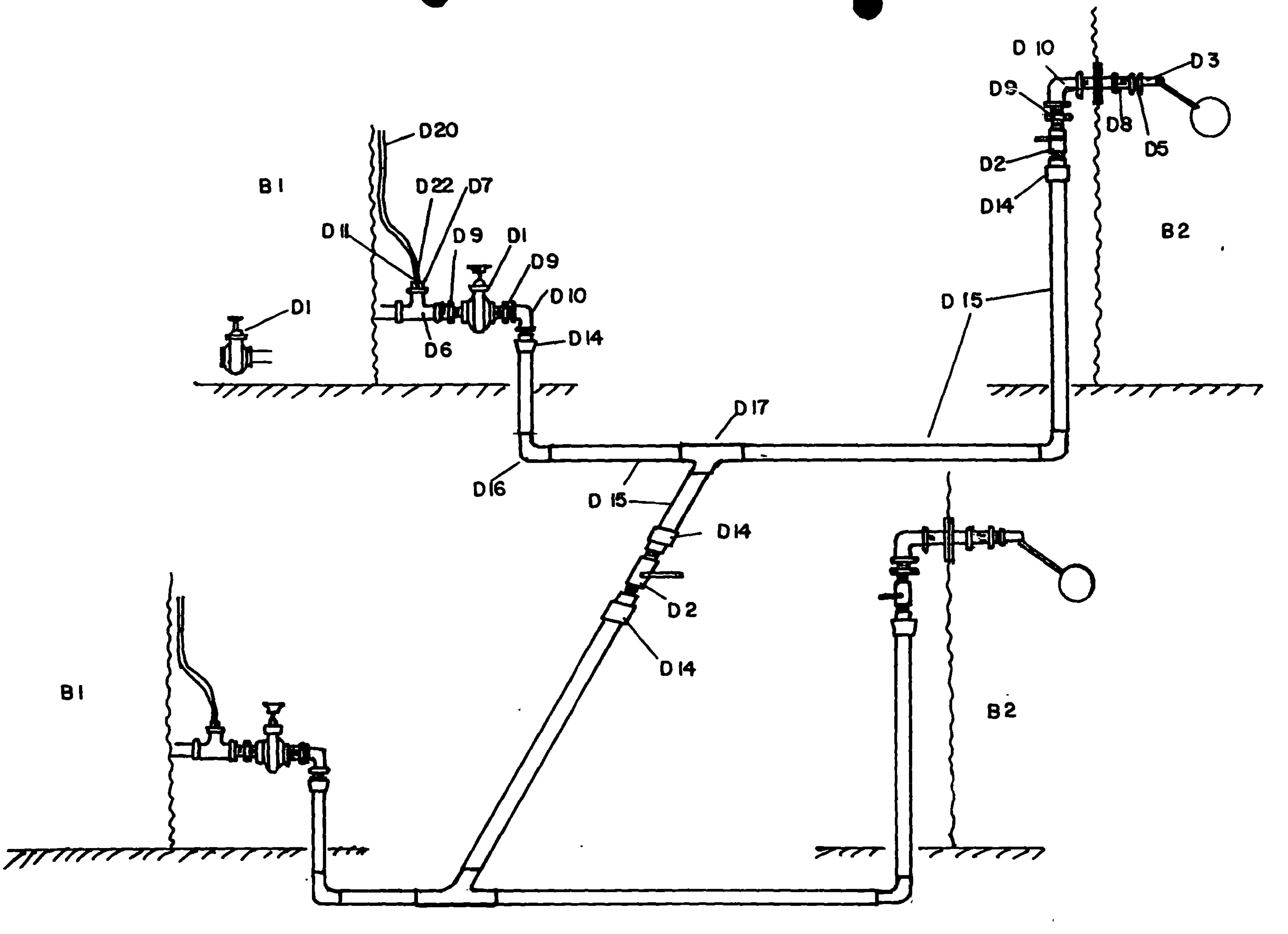
Fig·A RIVER INTAKE, PUMPING UNIT & PIPING TO TREATMENT PLANT



Fig· C Sandfilter drainage

a) Drain element arrangement in sand filter tank, total drain filter lengh : 20 m

b) Drain element



Fig·D1· Treatment plant link pipe work between raw water tank and sand filter tank

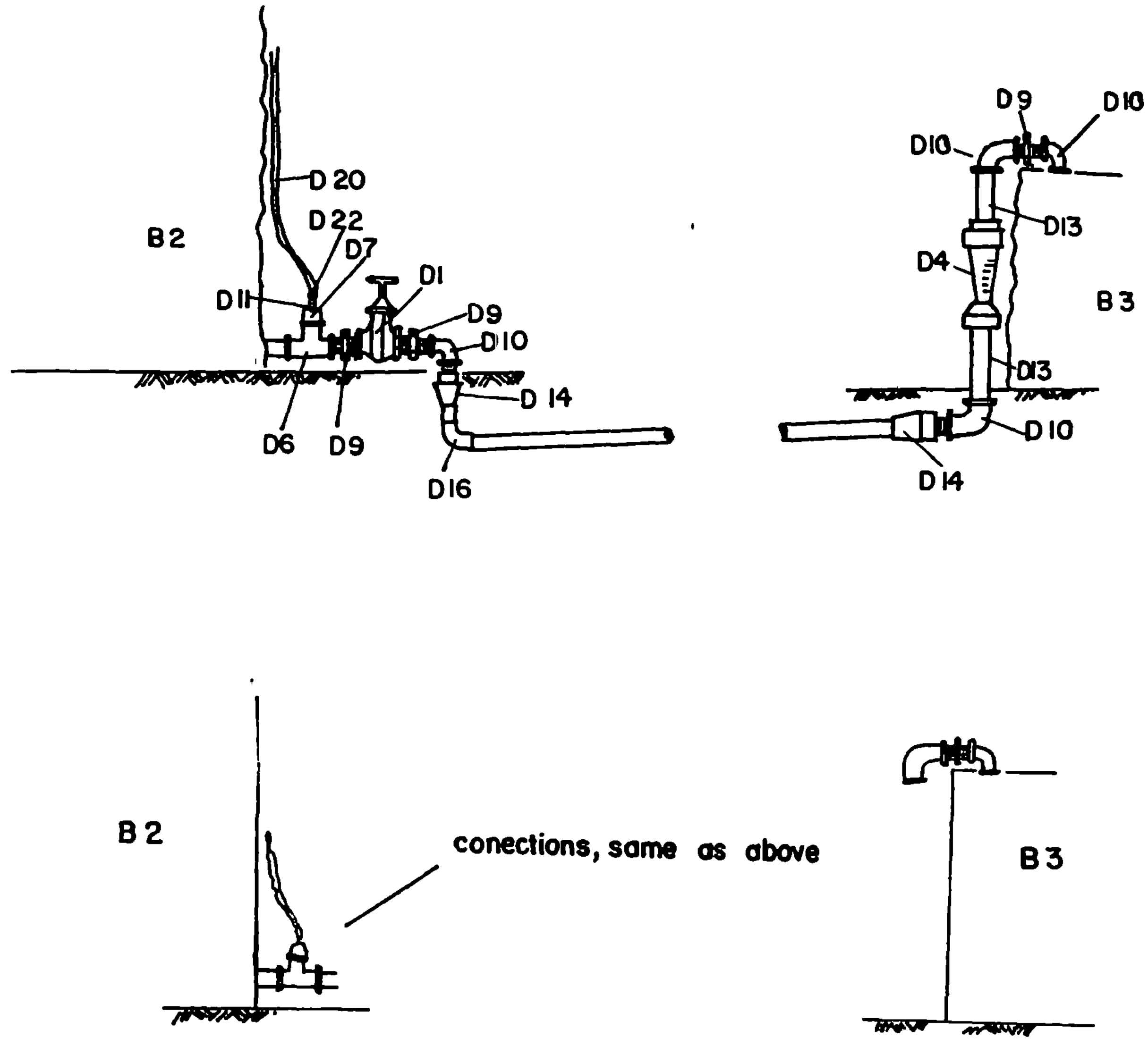


Fig. D2 Link pipe work between sand filter tank and storage tank

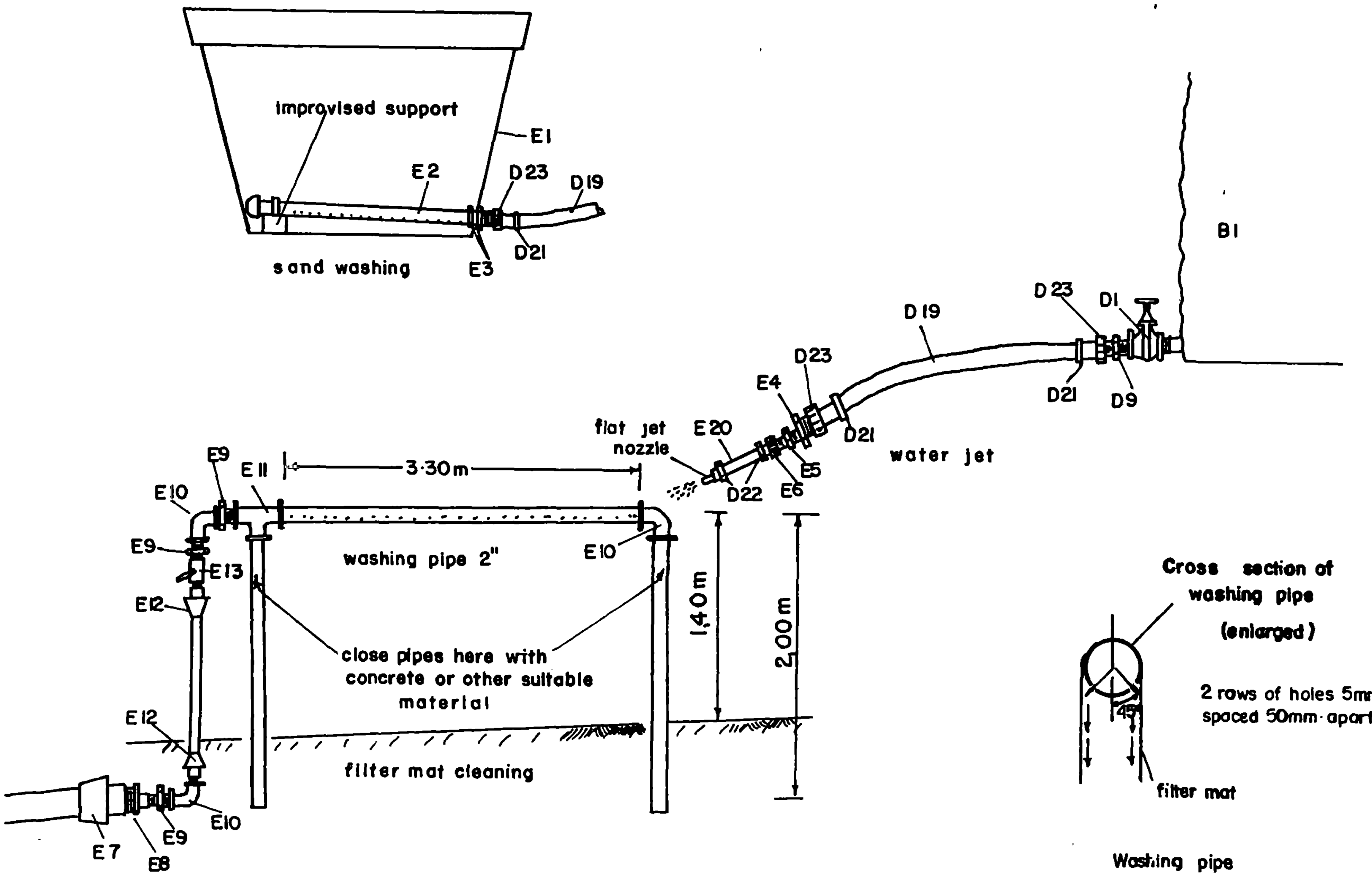


Fig E Sand washing and filter mat cleaning

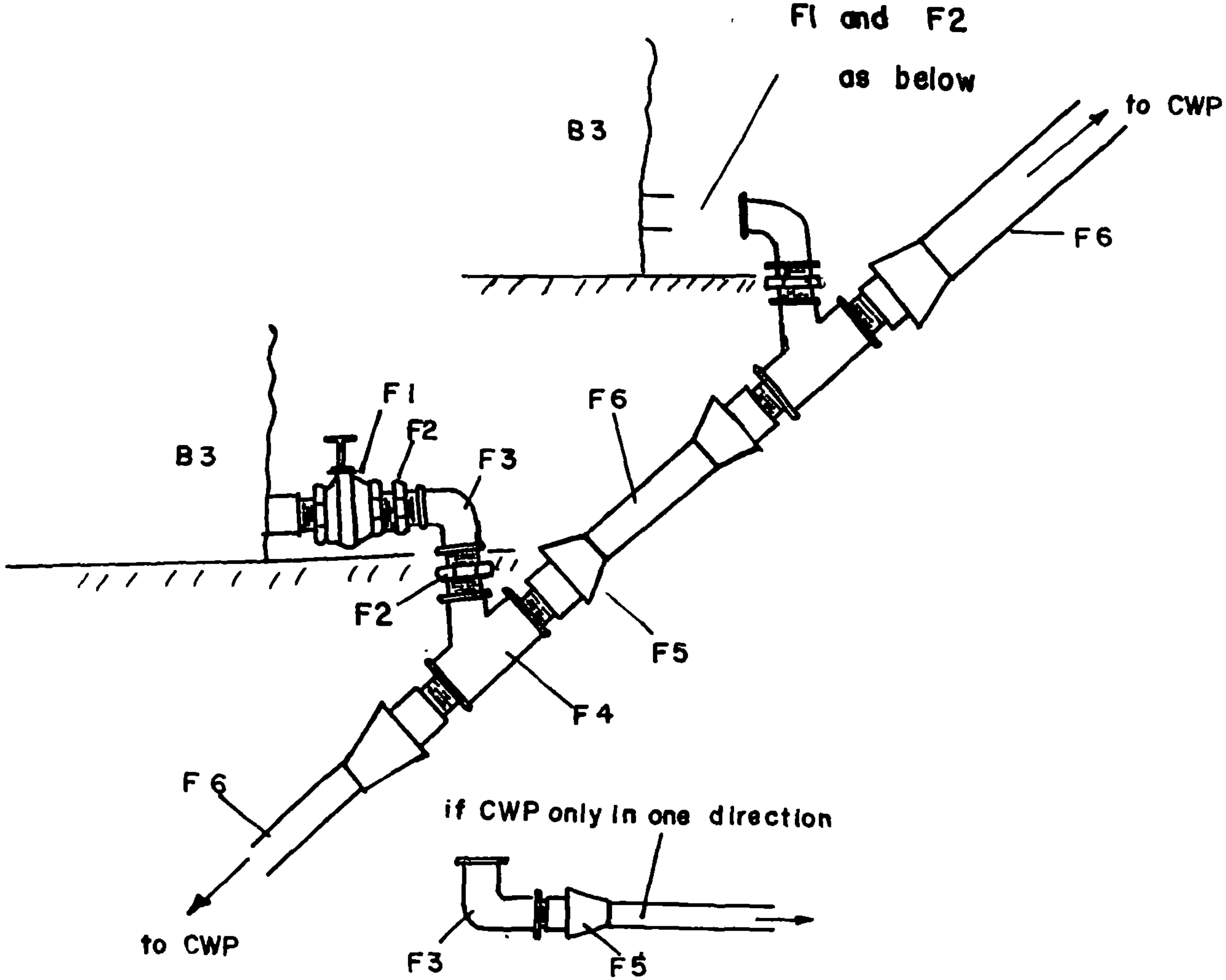
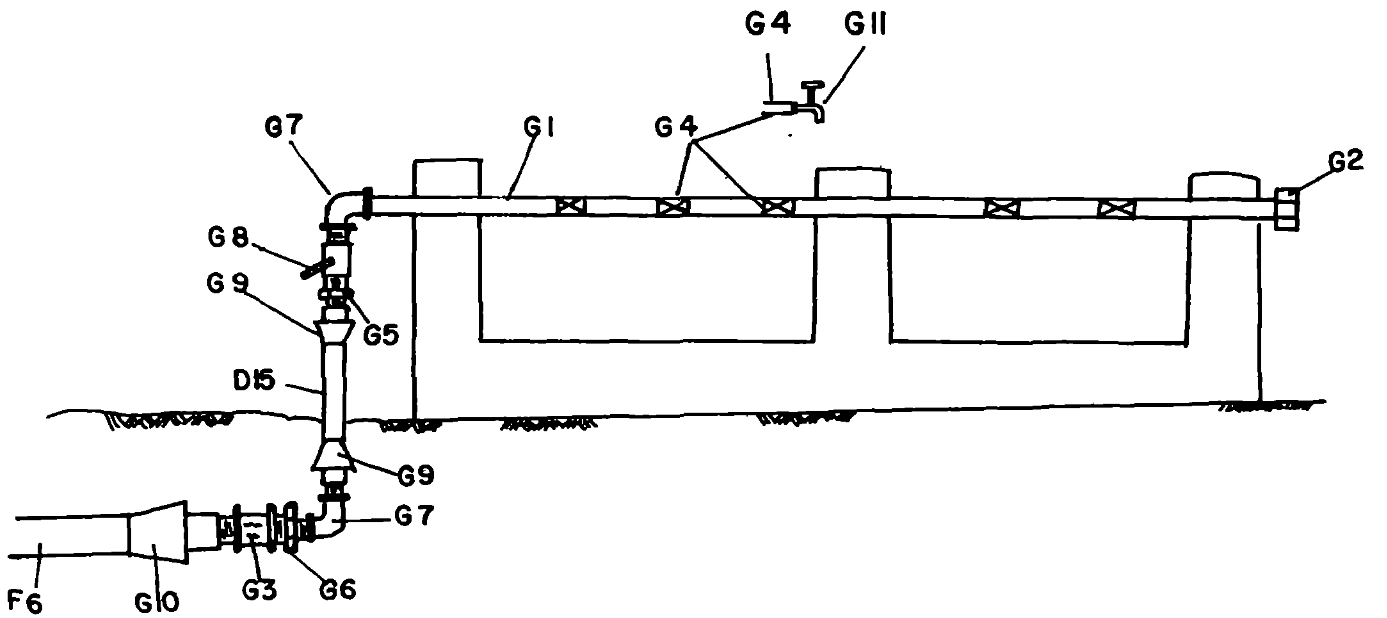


Fig. F Clear water distribution



Fig· G Community water point