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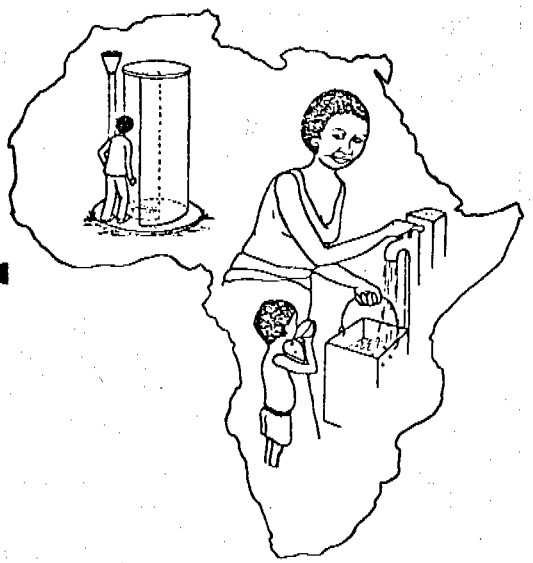
Water and waste engineering for developing countries

9th WEDC Conference

12-15 April 1983



sanitation and water for development in Africa

at the University of Zimbabwe, Harare, Zimbabwe

Proceedings

edited by Andrew Cotton and John Pickford

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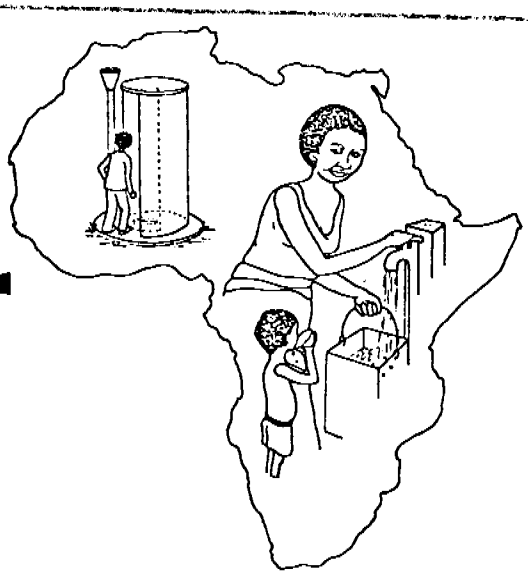

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OPENING ADDRESS

Cde. Minister MSIPA
Minister of Water Resources & Development

Professor Mackechnie, Mr Pickford, Mr Hall, distinguished delegates, ladies and gentlemen, on behalf of the Government of Zimbabwe and on my own behalf I would like to offer a warm welcome to everyone attending this Conference, particularly those who have joined us from outside our borders. This is an occasion which I regard as having particular importance for those of us working in the fields of water and sanitation. For no matter how diligently we may apply ourselves to the problems of our countries, possibly thinking that we have found the best solutions, there is always more that we can learn from others. I am very pleased that the Water and Waste Engineering for Developing Countries Group in the United Kingdom and the Department of Civil Engineering at the University of Zimbabwe have decided to hold this ninth WEDC Conference here in Harare.

Amongst developing countries, Zimbabwe has a unique position. It has a relatively highly developed industrial and commercial infrastructure. Therefore many of the materials and skills required for the implementation of water supply and sanitation programmes are available locally. On the other hand, we have achieved our independence only recently, following a protracted liberation war. We then faced the massive tasks of reconstruction and development which were essential for the transformation of our society.

In the urban areas, water and sanitation facilities had been well developed. However, for the majority of the population living in the rural areas, the situation was quite different, with perhaps less than ten per cent having access to adequate supplies of clean water.

The rural areas naturally became a focal point of the liberation war, with the result that many water points were deliberately sabotaged. At Independence over half the boreholes in the rural areas were out of order. The previous governments did not supply traditional villages with piped water - the only government schemes in operation being those installed during the war to supply the so-called "protected villages".

Over the last three years, 6 250 unserviceable boreholes, 280 dams and 20 piped schemes have been rehabilitated and over 1 000 new boreholes have been drilled by the Government. We have installed 60 piped water schemes in rural villages, with a further 27 at various stages of development. Plans are also under way to construct piped supplies to 70 Rural Service Centres and 6 Growth Points.

Despite the unique aspects of Zimbabwe's situation, we face many of the same problems as other developing countries. Probably 75 per cent of the rural population are still without access to adequate supplies of clean water, and a higher proportion do not yet have acceptable sanitation facilities. Traditional sources of water such as rivers, sand-beds, ponds and waterholes are the normal source for most people. These sources are inevitably contaminated and a hazard to health and are unreliable particularly during a period of drought such as one we are experiencing.

The consequences of poor water supply and sanitation are well known. These include poor health, high infant mortality, high morbidity, reduced life expectancy and a lack of time and energy for productive work and education. It is estimated that 80 per cent of illness in developing countries is related to deficiencies in water and sanitaton. Standards of living thus remain low and development of all kinds is constrained.

Women and children are the people most affected. They are the ones who traditionally have the task of carrying heavy loads of water over long distances, sometimes several times a day. Women have to prepare the food in unsanitary conditions and then nurse the sick. The hours and energy that will be released by the provision of proper facilities could be spent on more productive, educational or income-earning activities. Women will thus be the ones to benefit most from this Decade and should be directly involved. Without their support and participation the programme will achieve little.

What then is to be done? A major initiative has been taken with the declaration of the period 1981 to 1990 as the International Drinking Water Supply and Sanitation Decade. More important than the declaration itself are the ideas behind it, and the actions resulting from it. The slogan of the Decade is clean water and adequate sanitation for all by the year 1990. The approach that must be adopted by each country will obviously depend very much on their specific conditions, and cannot be dictated from outside. However, at the same time I would argue that there are ideas that do have wide relevance to solving these common problems.

Fundamental to the Decade is the need for structural and institutional changes to ensure more equitable distribution of resources and wider population participation. Programmes must be people-orientated and people-based, rather than seeing solutions simply in terms of finance and technology (although these of course are also required). Programmes must therefore involve people, rather than being carried out in a paternalistic fashion; hence the communities concerned must be involved at every stage of projects.

Without necessarily neglecting the better-served sectors of society, the Decade is a time to emphasise the development of those sectors which have been most neglected previously. A fundamental aspect is that development must have an integral approach. It is not a matter of simply providing drinking water. The title of the Decade itself includes sanitation. This is because health impact of clean water alone is small. Clean water may easily become contaminated before drinking if hygiene is poor - and experience shows that the greatest health impact results from a comprehensive programme of clean water, improved sanitation (including refuse disposal), and health education.

In Zimbabwe we formed a National Action Committee for the International Drinking Water Supply and Sanitation Decade in November last year. It consists of 16 ministries and para-statal bodies concerned with achieving the Decade's goals. The major roles in the Decade as far as Government is concerned will continue to be undertaken by the Ministry of Water Resources and Development as far as water supplies are concerned, and by the Ministry of Health as far as sanitation and health are concerned. However, it is clear that if the objectives of the Decade are to be achieved, the actions of individual ministries or even the Government as a whole will not be sufficient. What is required is to mobilise the resources of the Government and the communities concerned, as well as other sectors of the society, including non-governmental organisations, industry and agriculture and also take advantage of overseas sources of aid.

The Committee is encouraging the formation of grass-roots development committees to organise local water and sanitation projects in co-ordination with other development activities. Such projects could include well-digging, well-protection, digging of trenches, laying of pipes, installation of rainwater collection tanks and construction of Blair ventilated improved pit latrines. Such projects have been undertaken in many parts of the country already with the assistance of extension workers of various ministries. However, by taking an over-view of the situation it is planned to improve the effectiveness of these activities through improved training of extension workers, provision of more technical back-up and the supply of essential materials such as cement, hand-pumps and ventilation pipes for pit latrines.

There are many reasons for encouraging community participation. On the one hand, Government resources are limited in terms of finance, manpower, equipment and materials. The greater the community contribution, the further these resources will reach, and the more the people who will benefit. Even with generous amounts of overseas aid the results that can be achieved will be very limited unless the people become directly involved.

Secondly, community participation is an essential part of people's political development. We need to destroy the paternalistic attitude of previous governments which led people to believe they were not capable of doing things for themselves.

Schemes that are undertaken without community involvement may suffer many problems. They may not suit the requirements of the people and therefore be ignored, mis-used or vandalised. People will have little sense of responsibility for something which is installed without consultation, or else they will believe that if it breaks down then it is only the Government that can fit it up again.

Technological problems also arise. The equipment that is installed needs to be appropriate for community operation and also, if possible, community maintenance.

The costs of having mobile repair crews attending to breakdowns of handpumps at isolated boreholes is very high. This is the system we use in Zimbabwe now, and it works well. However if the same system is to be used when the whole population has proper facilities, the cost may become prohibitive, resulting in prolonged periods with equipment out of order.

One of the essential requirements for the success of the Decade is information. We need to collect information on the existing situation in order to plan appropriate programmes. The National Action Committee is organising a Baseline Evaluation which is being carried out by extension workers of the ministries of Health, Local Government and Town Planning, Agriculture, and Community Development and Women's Affairs. This is to provide basic data on the number and condition of existing water supply and sanitation facilities in the rural areas. This will be incorporated into a National Rural Water Supply and Sanitation Master Plan.

There is also a strong emphasis on the flow of information to the community. The National Action Committee is preparing a programme of publicity and dissemination of information about Decade activities, with an emphasis on the Youth of Zimbabwe via schools and Youth Brigades. It aims to create an awareness of the need for clean water and sanitation as well as giving information on the ways in which people may participate in the provision of these facilities.

Let us now look at ways in which we can provide clean water supplies in the rural areas. Groundwater is the preferred source, from properly protected wells, springs or boreholes. If properly designed and located, then in most cases no treatment will be required and costs are then kept to a minimum. Construction of wells and the protection of springs can be undertaken by community groups. However, there are many places in Zimbabwe where the groundwater is at such depths that boreholes are required.

A major constraint here is the availability of sufficient drilling rigs and suitably trained personnel to operate them. Most of our drilling is still done using cable-tool rigs which, although slow, have proved their reliability and durability over many years. We are also using some light-weight down-the hole hammer drills ourselves. Most of Zimbabwe's rural population is in scattered settlements, making the cost of piped water supplies prohibitive. Hence the emphasis is on providing many primary water supplies within reasonable distances of the settlements. The preferred method of pumping is by means of hand-pumps where the daily requirement is a few cubic metres. Where quantities in excess of say ten cubic metres a day are required from one source then diesel-powered pumps are normally used. Consideration is being given to the use of solar powered pumps and, in suitable locations, to the use of windmills.

Where groundwater supplies are inadequate, then other methods, such as sand abstraction from river beds and the construction of dams, are used. Where treatment is required this is normally carried out by sedimentation, filtration and chlorination. However, work has been done on the development of slow sand filters and these may find an increasing role in small community water supplies from surface sources.

Zimbabwe is fortunate in being able to manufacture the hand-pumps it needs. For boreholes we use a very old but well-proven design known as the Bush Pump. While being somewhat crude in appearance perhaps, its ruggedness and reliability are well-known. Its main drawback is the great weight of the below ground components that have to be lifted out to carry out repairs to the valves or cup washers. This design feature will have to be changed if it is to be suitable for village-level maintenance.

For shallow wells, we have designed the Blair pump which uses mainly plastic components below ground. This is designed for installation and maintenance with the minimum of hand tools.

Zimbabwe has a well-developed Primary Health Care Programme, which is the responsibility of the Ministry of Health. Its extension workers are involved in the prevention of disease, especially those associated with lack of adequate water and sanitation facilities, with the ultimate aim of improving the quality of life of the whole population.

The main elements of the Primary Health Care Programme are:-

- promotion of personal and community hygiene
- provision of safe drinking water supplies
- protection of water sources and surveillance of drinking water quality
- provision of safe excreta disposal
- linkage with other related sectors.

By being prepared to challenge the established wisdom, Zimbabwe has developed the Blair Ventilated Improved Pit Latrine

which represents a significant advance over the normal pit latrine. By incorporating a vent with an insect screen, problems of odour and fly-breeding are eliminated. The concept is very flexible, and Blair latrines can be built for an outlay of as little as $7 for essential materials. So far, more than 60 000 have been installed in Zimbabwe.

Zimbabwe has had a late start in the task of providing water and sanitation facilities, having been independent for only three years. However, we do have the advantage of being able to look at the mistakes of others who have gone before us and learn from them. Expensive water supply schemes have fallen into disuse or dis-repair within a short period of completion. We know of cases where millions of dollars worth of machinery are standing idle. The reasons may be lack of spare parts, of fuel or of qualified technicians. In some cases new water supplies that do not suit the requirements of the people are ignored in favour of traditional but polluted sources.

Persuasive salesmen of sophisticated equipment and consultants who do not understand the concept of appropriate design are other hazards that have to be avoided. Even grant aid can cause more problems than it solves. At a recent conference one delegate referred to these as "Poisoned gifts". However, a judicious combination of local and international resources will undoubtedly be an essential element of achieving success in this Decade.

This conference will be a useful forum for the exchange of ideas and discussions of problems, both within and outside the formal sessions. I am pleased to see the wide representation that has been achieved (although it is unfortunate that there are still so few women participating). I would like to thank the organisers for the work they have put in, and wish the participants success in this most vital area of development. It is my sincere hope that participants from other countries will find time to see a bit of our country so that you may have first hand knowledge of Zimbabwe.

I now declare this conference open, with a final reminder that this International Drinking Water Supply and Sanitation Decade is not for technocrats, or even politicians, but for the people. It is only by working with such an attitude that the Decade can be made to succeed.

KEYNOTE ADDRESS

JOHN PICKFORD
WEDC Group Leader

Comrade Minister, Ladies and Gentlemen, I must firstly say that I consider myself to be extremely fortunate in being in Harare. I am fortunate to be involved with the Water Supply and Sanitation Decade, and I am fortunate to be involved with Africa.

Our subject area of water supply and sanitation provides such a tremendous variety of interesting ideas; for example, Professor Oluwande suggests some interesting types of latrine; Engr Milne proposes sewered sanitation in Bulawayo; Engr Keeling is dealing with toxic industrial wastes; and Mrs Cox is going to tell us about a waste-water treatment plant which is so sophisticated that I cannot understand it! In the water supply sector, Mr Bridger has been working with a fully metered supply with relatively little unaccounted-for water, whereas other authors are used to dealing with simple pumps such as the Blair pump, and with donkey water carriers.

Part of this variety is the unexpectedness of the ideas and solutions resulting from people's varied experiences. Mr Ashworth advocates the use of private contractors for an urban sanitation scheme; Mr Binnie quotes the use of direct labour in Nigeria; Mr Wilson has produced some interesting cost figures for latrine construction in Botswana.

Another fascination with our work is the fact that it is on-going. Compare this with structural engineering, which I find boring; once the structure is built, that is it! With water supply and sanitation schemes, we are only just beginning once the scheme has been constructed. Treatment plants and equipment must be kept working, latrines must be used regularly; these factors are the real test of the success of a scheme. Mr Chimbunde emphasizes the fact that people's motivation can be short lived, and so we must be prepared to move quickly to make the most of their enthusiasm.

We must never forget that projects involving water supply and sanitation must be implemented WITH people, and FOR people. Several papers cover the health aspects of programmes; there are most interesting papers by Sister Walsh and Mr Msukwa on aspects of community involvement with projects.

We must take account both of the habits of people, as Mr Wilson illustrates, and the ideas of the people themselves. Women often hold the key to the success of water supply and sanitation projects; it is most interesting to hear from Mr Te Velde that in the area of Zimbabwe in which he works, the local water committee consists of two women and one man!

We must never forget that we have to work with people; as engineers, scientists or sociologists we are not up on a pedestal; we have to appreciate, and be sensitive to the real needs of those for whom we are working. We have to be flexible in our approach, use what is most appropriate, and motivate people, not impose that which they do not want.

9th WEDC Conference: Sanitation and water for development in Africa: HARARE: 1983

WATER SUPPLY FOR GEDAREF; ARE INFILTRATION GALLERIES THE ANSWER?

by A COTTON and M A SANOUSI

Summary

A number of technical alternatives for improving the water supply to Gedaref, Sudan, are investigated. Of the short term improvements proposed, none is likely to improve upon the present system of continual digging of a channel to convey river water to the silted intakes. In the long term, construction of a radial collector well infiltration gallery system appears to offer advantages over a new surface intake and improvements to the existing treatment plant.

1. Introduction

This paper investigates some of the problems associated with the water supply for Gedaref in South Eastern Sudan. The aim is to review some of the technical solutions and provide a basis from which a more detailed technical and economic analysis could be carried out. Due largely to the lack of field data, the calculations are by no means exhaustive, and economic analysis has not been attempted.

The present population of Gedaref is about 150 000; improvements to the traditional water supplies from shallow wells and rain water storage tanks were made in 1960 when a number of boreholes were sunk to the south west of the town (8,13). The supply was further increased in 1970 when a river intake and treatment works were constructed on the Atbara river at El Showak, 70 km north east of the town. The treatment comprises coagulation using alum and lime, rapid sand filtration and chlorination. Treated water is pumped through a 500 mm spun iron pipeline to Gedaref. The works provides about 8200 m^3/day, although the design capacity is about 12 500 m^3/day (13).

2. Problems at El Showak

Major problems have arisen due to the high suspended solids load in the Atbara river in the wet season. Deposition caused radical changes in the river channel geometry, with the result that after less than two years the intake works had silted and ceased to be used; over 6 metres of silt had accumulated. Two pumps were then sited on the river bank, and a channel dug from the low flow channel across to the pumps, figure 1; maintaining this channel requires fifty men for eight months of the year, at considerable cost. The high suspended solids load causes problems in the clarifier, and the rapid gravity sand filters clog up very rapidly. The treated water still contains some silt, and to add to the problems, the transmission main to Gedaref was not provided with washouts. Due to lack of spares, pumping and mechanical equipment does not function adequately. There is no shortage of raw water; in 1980 the discharge ranged from about 15 m^3/s to 3100 m^3/s.

3. Remedies for the problems

A number of remedies have been proposed by different organizations; to overcome short term problems they include:

(a) construction of a causeway across the river to carry the pumps to the low flow channel;
(b) continuous dredging by excavator;
(c) construction of a low diversion wall in the river;

and for long term problems:

(d) construction of sedimentation tanks and additional filters;
(e) a new intake works;
(f) rehabilitation and expansion of the borehole system;
(g) construction of an infiltration gallery.

4. Assessment of short term remedies

4.1 Causeway and excavator

A causeway to carry the pumps to the low flow channel could suffer serious damage during the wet season. The proposal to sink two rows of piles across the river, along which an excavator would run is frought with practical difficulties. Neither proposal is considered realistic.

4.2 Diversion wall

The object of constructing a low diversion wall out of gabions is to divert water from the low flow channel to the intakes. The effects of such training works on unstable rivers in alluvium are unpredictable, and the proposal was investigated using a hydraulic model. A distorted scale Froude number model having horizontal and vertical

scale ratios of 200 and 50 respectively was used (1). The prototype hydraulic characteristics and sediment loads, table 1, were estimated from Lacey's regime equations, and Petersons universal flow charts (6); the cross section of the main river channel is shown in fig 1b. The model was run using the minimum 1980 discharge of 15 m^3/s, and an intermediate flow of 300 m^3/s, at which it was estimated that the diversion channel would flow bank-full. The resulting cross sections and longitudinal section are shown on figs 2 and 3. The main problems found were:

(a) severe scour around the intake house, with holes up to 7m below original bed level, and possible collapse;

(b) severe recession of the river bank where the abstraction pumps are placed;

(c) scour in front of the gabion wall which may lead to its collapse, even at minimum flow;

(d) the system is highly unstable at a flow of 300 m^3/s;

(e) the gabion wall is unlikely to survive at 3100 m^3/s.

The gabion diversion wall seems to create more problems than it solves, and is not recommended.

5. Assessment of long term remedies

5.1 New intake works

The Atbara river is clearly unstable, and there is no guarantee that a new intake further upstream would not suffer the same fate as the existing one.

5.2 Improving the treatment works

During and after high river flows, sediment loads in excess of 1000 ppm may well be common, and values as high as 16 000 ppm have been known. If sedimentation tanks providing up to 2 days retention are provided, sludge may accumulate at rates between 200 and 2500 m^3 per day, assuming 80% solids removal (4). At least three tanks of 15 000 m^3 capacity, and further pumping, would be required. If smaller horizontal flow tanks having a retention time of about 4 hours were used sludge would accumulate rapidly, requiring either mechanical cleaning or a large number of tanks in parallel. Whilst reducing the sediment load, operation and maintenance requirements would be increased. The benefits from these proposals cannot be realized until the basic problem of the intake works has been solved, given that the gabion wall is unlikely to survive the wet season.

5.3 Borehole rehabilitation and extension

Eight boreholes south west of Gedaref could be rehabilitated to provide about 10% of the demand (8). Unconfirmed pump tests in the region of the El Showak works indicate that a further 18 boreholes may be required to supplement them. The running costs of such a large number of pump sets could prove prohibitive.

5.4 Infiltration galleries

Infiltration galleries are horizontal permeable conduits which intercept and collect groundwater which is often principally derived from infiltration of nearby surface water; they have been widely used in India and USA (10). Galleries can be constructed within a river, or along the banks, with open jointed or perforated pipes projecting under the river bed, fig 4. If the river bed is coarse sand or gravel the potential yield may be high; the 'rule of thumb' used in South India is 20 m^3/day per metre of gallery. The advantages offered include (9,10):

(a) the recharging river water is effectively filtered by sand or gravel, reducing turbidity, colour, organic and bacterial pollutants;

(b) comparatively little skilled supervision is required during operation;

(c) running costs involving chemicals and mechanical and electrical plant are low;

(d) disinfection is usually the only treatment required.

Preliminary calculations indicated that a gallery may need to be 15 m to 20 m below the Atbara river bed level. Indian practice (12) is to lay open jointed pipes in a manually excavated trench up to depths of 8 or 10 metres below bed level. When the depth has to be greater, perforated steel pipes are jacked out radially from a concrete caisson sunk into the river bed, fig 4. This radial collector well system is also known as a Ranney well. A graded gravel pack is usually placed around the gallery pipes; this is not usually feasible with pipe jacking, but as the pipe is jacked into position, fine materials are removed from the vicinity of the pipe, and a natural pack tends to develop. (9,11, 14).

The following calculations are based on the design procedure used in South India (12). The system is designed to provide 12 500 m^3/day (the capacity of the treatment works) which should be sufficient to provide the existing population with 50 litres per person per day.

If the entrance velocity of the water through the perforations is limited to 6 mm/s (2,12), the required open area of pipe is 24.1 m^2; if the pipes have an open area of 18%, and operate with 40% blocked, the required length of 300 mm diameter pipe is

$$24.1/(0.18 \times 0.60 \times \pi \times 0.3) = 237 \text{ metres.}$$

Thus 4 N° 60 metre lengths would be required; for optimum yield, the angle between pipe centrelines should be greater than 20°; in this case, 30° would be adequate, as shown in fig 4.

In order to fix the invert level of the radial collector pipes, the lowest water table level in the dry season, and the drawdown resulting from abstraction from the aquifer must be known. Estimation of the drawdown is extremely complicated, but in practice a reasonable result can be obtained empirically from using the Theiss equation for unsteady flow in an unconfined aquifer, assuming that the system behaves as a vertical well with an effective radius 0.75 times the length of the radial collector pipes (12). The unconfirmed pump tests and preliminary geophysical survey indicate that the sand and gravel aquifer has a transmissivity of about 2880 m^2/day, and a minimum dry season water table 14 m below existing bed level. The maximum drawdown will occur if there is little or no recharge from the river in the dry season. Data on recharge are not available, and so a 90 day period without recharge is assumed.

Thus $y = \frac{Q}{4\pi T} W(u)$ where $u = \frac{r^2 s}{4Tt}$

and Q = abstracted flow (12 500 m^3/day), T = transmissivity, r = effective radius (45m), t = pumping time (90 days) S = aquifer specific yield (assumed to be 0.2) and y is the drawdown estimated for the effective radius r. Thus:

$u = 4 \times 10^{-4}$ and w(u) = 7.25, obtained from standard tables (5); the drawdown is hence about 2,5 metres. Allowing for the pipe thickness of 0.3 m, and a "safety" allowance of 0.5 metres (12), the invert level of the radial collector pipes should be 17.3m below river bed level (fig 4). It must be stressed that these calculations are based on inadequate data, and only serve to indicate a possible design method.

A problem with infiltration galleries and radial collector wells is the possible reduction in yield over a period of time due to clogging, and organic growths and inorganic encrustations around the perforations. However, such systems have operated satisfactorily for many years (10).

6. Conclusions

(a) None of the short term proposals appear to offer advantages over the present system of digging a channel through to the pumps.

(b) There is no obvious solution regarding improvements to the silted intake house. There is no point in improving the treatment works unless this problem can be satisfactorily resolved. Cleaning out new sedimentation tanks and overloading of the clarifiers and filters is likely to continue to cause operational problems when the sediment load in the raw water is high.

(c) Boreholes could satisfy the water demand, but initial indications are that the number required may be prohibitively large.

(d) A radial collector well consisting of 4 No. 60 metre lengths of 300 mm pipe jacked into the aquifer beneath the Atbara river bed would appear to satisfy the present water demand. The only treatment required is likely to be disinfection; equipment is available at the El Showak treatment plant. Other units in the plant are unlikely to be necessary. A detailed site investigation of the aquifer is required to enable more accurate calculations to be performed.

(e) There is ample scope for increasing the supply by installing more radial collector pipes to the well. In a more detailed design, the population projections and per capita water consumption for the design life of the project must be carefully considered.

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Table 1: Hydraulic characteristics

	Diversion channel		Main channel
Discharge (m^3/s)	15	300*	3100
Flow depth (m)	2.3	4.5	6.8
Mean width (m)	20	75	280
Sediment load (kg/s)	0	30	3100

*Estimated bank full discharge

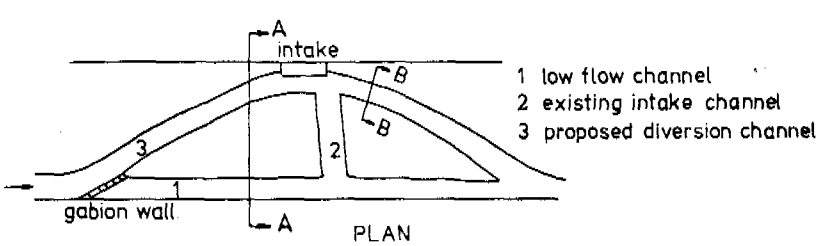

FIG 1 EL SHOWAK INTAKE WORKS

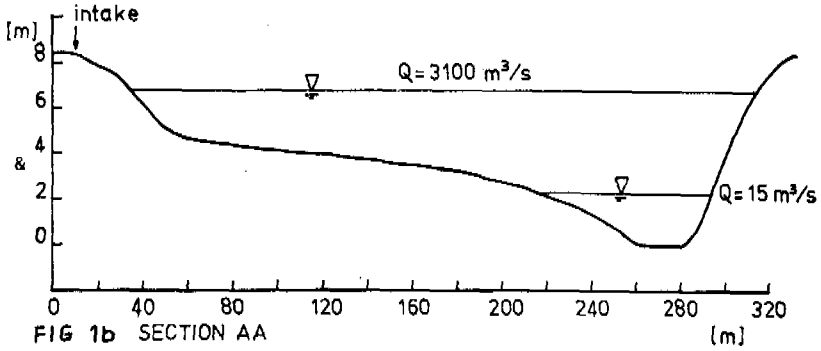

FIG 1b SECTION AA

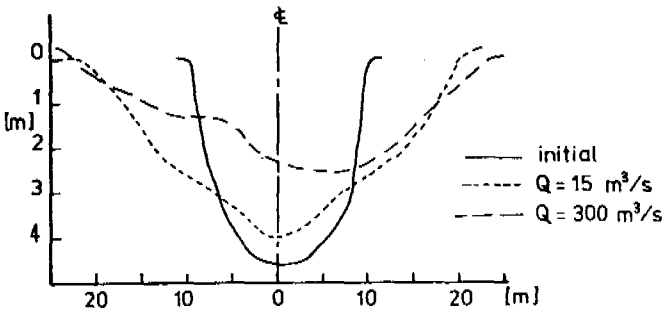

FIG 2 SECTION BB

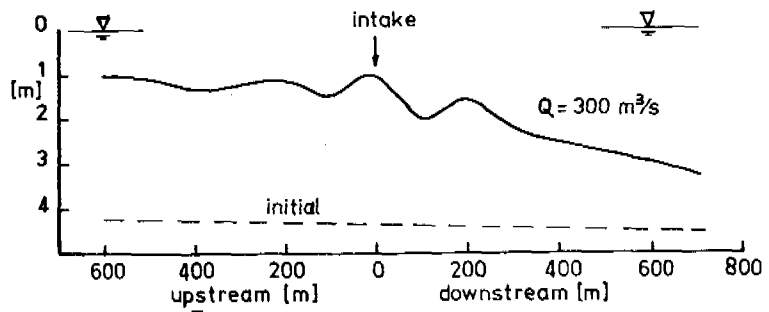

FIG 3 LONG$^{T.}$ SECTION OF DIVERSION CHANNEL

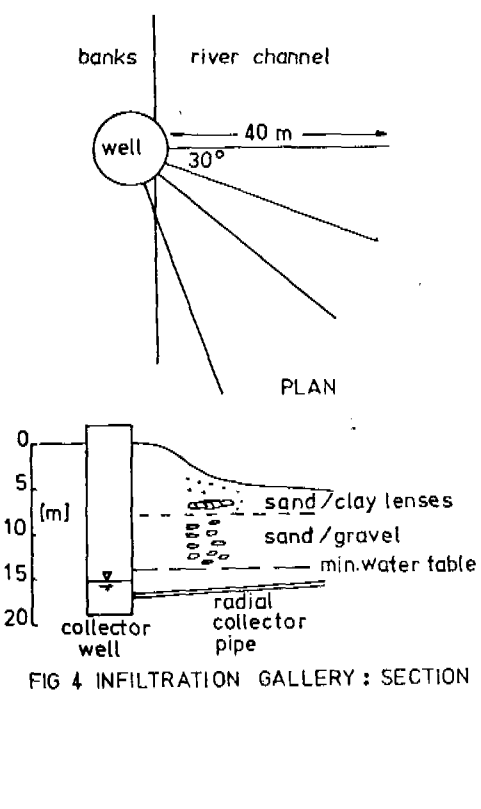

FIG 4 INFILTRATION GALLERY : SECTION

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RURAL WATER SUPPLY IN AYANGBA AREA, NIGERIA

by G SMETHURST, C J A BINNIE and R E ASHFORD

1. GENERAL

1.1 Introduction

In the development process one of the first aims is the establishment of reliable water supplies in rural areas. With this in mint the Ministry of Agriculture in Benue State, Nigeria, commissioned us as consultants to undertake a survey for the Ayangba Agricultural Development Project in the western part of the state. The aim of the survey (1980/81) was to examine the water resources and requirements for improving water supplies in the project area. The following conditions were given:-

- The survey to be of short duration and based as far as possible on existing information.

- An effort should be made to implement any proposals within three years.

- The conflicting interests of settled and nomadic population should be considered.

- Local resources and materials should be used.

- The use of the limited funds available should be confined to rural communities and urban centres should be excluded.

- The cost effectiveness of existing structures and supply systems should be investigated and their future usefulness assessed.

1.2 General Description of Area

The project area covers approximately 3000 sq. kilometres in which it is estimated that there is a rural population of about 1 million people. There are about 1800 communities. The settled populations are cultivators, but there are significant numbers of Fulani cattle folk who are nomadic. The country is fairly well watered but the need to protect the interests of both types of inhabitant is an added factor.

The area is bounded on the west by the River Niger and on the north by the River Benue, a major tributory of the Niger.

1.3 Method of Investigation

The study comprised three overlapping phases:

- orientation and data collection.
- field surveys.
- report production.

Existing mapping was used. Aneroid surveys were made. Stream gauging and well levels were recorded. Field appreciation of villages and their existing water supplies was made.
All data published by Government and Provincial agencies was collected.

2. WATER RESOURCES GEOGRAPHICAL CLASSIFICATION

2.1 Geological Study

Examination revealed that the area falls naturally into five water resource units, some of which could be further sub-divided:-

i) River Alluvium
ii) South-west Lowlands
iii) High Plateau
iv) Cretaceous Piedmont
v) Crystalline Lowlands

i) River alluvium. These consisted of sands yielding small supplies of clean water from shallow wells.

ii) Lowlands. These were mainly on clay and were crossed by streams draining from the Plateau, which had become polluted in transit.

iii) High Plateau. This covered a high proportion of the area and contained plentiful supplies of water at depth in the underlying sandstone. From the escarpment springs emerge which carry away water spilt from the sandstone and these form the streams which traverse the lowlands.

iv) Cretaceous Piedmont. These sandstones and sills lie to the north and west of the Plateau. Small springs can be used locally, but most communities use the surface streams originating from the escarpment of the Plateau.

v) Crystalline Lowlands. These are of laterite and contain little underground water. As in the case of the Piedmont local supplies are taken from surface streams.

3. EXISTING WATER SOURCES AND USAGE

3.1 Sources

Although not immediately apparent, the area is fairly well off for water.

In the Plateau area the Ajali sandstones can be tapped by boreholes of up to 70 metres depth to yield water of good quality.

The springs of the escarpment form streams flowing radially away towards the great rivers. These streams become polluted as they get further from source but are widely used by villagers and tanker lorries.

Peculiar to this part of Africa are excavated holes of large size called taphis which drain water from the silt in which they are dug to form stock-watering points.

The total amount of water used is small in relation to the large quantities available. The problems therefore are of distribution, quality and cost.

3.2 Cost

Most of the water used is abstracted from surface springs and streams and head-carried by village women, often for quite considerable distances, although the average would rarely exceed 2 kilometres. This is a chore often performed by elder daughters before going to school, and after their return.

A smaller, but still significant, amount is distributed by tanker lorry to outlying villages who store it in old oil drums placed on the roadside convenient to their houses.

In some of the bigger villages on the Plateau water is pumped from boreholes to public standpipes, and distributed free.

To the extent that head-carrying might be regarded as a household duty, water obtained this way is also free, but the cost of lorry borne supplies is extremely expensive and at the time of the survey was estimated to cost anything up to Naira 300 per annum per family according to their needs and location.

3.3 Social Usage and Quality

Head-carrying and the washing of clothes at the sources provide a daily opportunity for the exchange of views on village affairs, but it is noticeable that as progress is made, first to communal taps, and later to individual services, village women are pleased to be relieved of head-carrying duties.

Both villages and tankers take water from unprotected sources, the latter generally from the larger, more accessible sites.

Little effort was made to protect or organise abstraction although at any given point, as a matter of common sense, clothes were washed below the point where drinking water was abstracted.

However, villages in the lower reaches of the stream were bound to accept water polluted by those nearest to the spring.

Water from boreholes, and initially from springs, was of high quality. There were few dug-wells in the area but where these were to be found they were often polluted.

4. POPULATION AND PROJECTED REQUIREMENTS

No exact figure for the population was available but it is believed that upwards of 1 million people inhabit the area. The scattered nature and small size of many of the communities precluded the possibility that all could be served. The basic minimum supply envisaged was 25 litres per capita per day. The funds available were to be expended to give the maximum betterment of supply to as many people as possible.

5. GENERAL RECOMMENDATIONS

5.1 Scope of Timing

It should be accepted this scheme is a first step only towards improvement of the general water position, and is limited by the practical use of the funds available. The natural sequence of events is expected to be:

Present. Improvement of existing facilities for head-carrying and distribution by tanker.

Near Future. Supply by public tap to central points.

More Distant Future. Supply of treated water by individual service pipe.

At all times the need to look ahead should be observed. Any new boreholes should be constructed so as to remain effective at a later stage. Sectional steel plate reservoirs should be used. At some future time they can be pulled down and used elsewhere. In these days of mounting inflation it is often the case that a sectional steel tank

can be purchased, serve ten or more years in some village, and when at last it becomes too small it can generally be sold to a smaller place for more than it originally cost!

As living standards rise and there is demand for full treatment of the raw water, the accompanying rising prosperity will take care of the costs.

5.2 Present Improvements - General

The immediate objective was to improve present arrangements. An initial step was to reduce the distance villagers had to walk by increasing the number of watering points, and this in turn would reduce the number of those being forced to use expensive tankered supplies. A further consideration of utmost importance was that of quality. Where new boreholes were a practical possiblity high natural quality could easily be achieved. Simple protective measures could be introduced at springs. Lower down the river, treatment being out of the question, concrete troughs and hard standings were provided, and areas for various usage were defined and railed off.

It had been noted that in parts of the Plateau, women had to walk as much as 8 kilometres for water. New watering points were to be established to ensure no villagers would have to walk more than 2 kilometres.

5.3 Types of Improvement

Boreholes - storage tank - common taps. where possible, in areas of favourable hydrogeology and larger communities, were ideal. It produced pure water in centres of population and it was the type of scheme that could be expanded. The problem was cost. In 1979 it was expected that each installation would cost Naira 67,000, and that as many as 120 might be needed. (March 1980 1 Naira = £0.81)

Spring protection, pumping and improvement of existing supply. There were many springs at the foot of the escarpement and it was already possible to fence these off and instal a diesel driven pump which would lift water by pipe to a row of common taps in the village.

Spring and stream improvement of local bucket filling facilities. A large number of bucket filling points existed. Water is used sequentially for drinking, bathing and laundry purposes. The weaknesses are that the water slope is flat and soap suds may be projected upstream, and the sandy bottoms get churned up by users and silt is thrown into suspension. The action proposed was to create concrete lined channels with concrete aprons for the villagers to stand on. The cost per installation was estimated to be Naira 8500.

These installations have a life limited by the future provision of any form of piped supply.

Flowing borehole and bucket dipping point in parts of the alluvium deep artesian boreholes from which hot water flows. There would be no running costs but the capital cost of Naira 1300 was too high.

Repairs of existing pumps and boreholes. There were many existing borehole installations and a high percentage of these were not operational. A quick survey indicated that most of the problems were due to minor mechanical deficiencies.

Piped extensions. Certain big villages with rudimentary pipe systems had outlying appendages which could be served by minor extensions to the pipe system. Twenty such cases were located and the average cost of the pipework and common taps amounted in each case to about Naira 15000.

5.4 Pumping Plant

Power. Power is not available and any form of electrically driven pump would have to be accompanied by a diesel engine driven alternator.

5.4.2 Alternative pumping methods.

Hand pumps could be used, but the cost would be high. No cheap form of boring can be used and the cost of individual boreholes would be high per unit of water raised. The water lies at considerable depth and much physical effort would go into filling a bucket.

Hydraulic rams and air lifts are not suited to local groundwater conditions. The ground is too flat for the former, and the latter cannot operate with the high lift/immersion ratios in the local boreholes.

Windmills are not popular in Nigeria for two reasons :

- They are bolted structures and the nuts and bolts tend to get stolen. This could be cured by welding.
- The water is far below surface so the pump rods are long and heavy. Therefore much of the energy generated by the windmill is employed in lifting the rods.

5.5 Cost of Water

The cost of water varies according to the sophistication of the methods proposed. Each cost quoted was calculated in 1979 and includes both capital and running costs.

Types of Installation	Cost per m^3	Yearly cost per head
Borehole & filling points	30 kobo	Naira 2.72
Improved spring filling points	21 kobo	Naira 1.90
Bucket dipping point on stream	11 kobo	Naira 1.00
Flowing borehole with filling points	41 kobo	Naira 3

(1 Naira = 100 kobos = US$ 1.25)

The costs per unit of water delivered appear to be high because they are related to the very small quantities used. The cost of giving one person a year's supply of water at a dipping point would only amount to Naira 1 per annum.

All the above should be compared with the average cost of buying tanker-truck delivered water (Naira 2.75 per m^3.)

6. CATTLE REQUIREMENTS

Eight cattle reserves were proposed. Each reserve was divided into four quadrants, watering points being provided in each quadrant. Stock were rotated between quadrants for grazing purposes. Dipping points were also provided in each quadrant. It is expected that up to 3000 cattle could be accommodated in each reserve.

In every case surface water sources were used.

The dipping points were of 20 m^3 capacity.

Flumes and drinking troughs sited away from the stream and fed by a shadoof were proposed. The object was to keep the cattle away from fouling the stream, and this cannot be done without extensive fencing. The cost of the concrete facilities was Naira 6600. There were no running costs.

Keeping the cattle away from the streams depends mostly on the herdsman. It is clearly easier for him to let the cattle go into the stream and relieve him from operating the shadoof.

6.1 Organisation

The main problem of water supply in developing countries is of maintenance. There are innumerable examples of competently constructed works falling into disrepair and disuse.

In considering how to implement the project the Ayangba Agricultural Development Project staff chose to proceed by direct labour not only because of the greater flexibility this would permit in meeting the needs of hundreds of local circumstances but because the presence of skilled permanent employees would ensure constant back-up maintenance, and provide training for local personnel.

It was decided to use two drilling rigs and planned to sink 15 boreholes per rig per annum.

Quite apart from the merit of having staff and equipment available, it could be shown to be cheaper than employing a contractor.

6.2 Rate Collection

Water is given free throughout the supply area but in some of the bigger towns, not included in the survey, more standard supplies have been established and charges are made. Working on the assumption that running costs will be incurred on the borehole installations for power and for attendance, thought was given to the need for some form of annual levy to be made. It was suggested that any form of control and book-keeping would be uneconomic and where no annual running charges would arise it would be cheaper to continue to give the water away freely.

Where running costs indicated the need for water charge collection it was recommended that a levy should be made on each community on an annual basis, and that its collection should be a local responsibility.

9th WEDC Conference: Sanitation and water for development in Africa: HARARE: 1983

ORGANISATION AND IMPLEMENTATION OF A DUG WELLS PROGRAMME

by PIET Te VELDE

INTRODUCTION

This paper is based on experience gained in the Water programme of the Lutheran World Federation (L.W.F.), initiated 2 years ago at the request of the Lutheran Church of Zimbabwe and presently covering 5 districts in Southern Zimbabwe, namely Gwanda, Beitbridge, Mberengwa, Zrishavane and Mwanezi.

The dual aims of the project are:

1. To assist in improving the water supplies for domestic use, both in quantity and quality.
2. To assist in improving, expanding and establishing vegetable gardens and small irrigation projects, which also include the construction of small dams.

The scope of this paper is limited to the first aim, i.e. water supplies for domestic use.

ORGANISATION

In the organisational structure of the L.W.P. Water Programme which gradually evolved during the first year of operation, Community Organisms (C.O.'s) have come to play an important role.

Sixteen C.O.'s are employed in the Project presently, who are local residents recruited through the recommendations of pastors and councillors. Each C.O. covers an area that varies from 800 to more than 2 000 km², by using a bicycle provided by the Project. Most C.O.'s hold no special qualifications, but have been trained on the job. Their educational standards vary from Grade 6 to Form IV. It was considered more essential that they be resident in their area of duty, where they are well known and respected. Their duties include:

1. To carry out a water sources and population survey.
2. To organise and address local meetings at various levels.
3. To identify possible projects.
4. To encourage and organise the participation of the communities in the implementation of the projects.

The technical implementation of the projects is supervised by District Supervisors (and/or Assistant Supervisors) who have a motor vehicle at their disposal. The Supervisors and C.O.'s are both directly responsible to an expatriate Water Engineer. The Supervisors oversee the digging of wells, and the technical staff such as pump-fitters and wellsinking foreman. The actual digging of wells is done by local wellsinkers, who have been trained under the project, on the basis of a simple contract agreement. Wellsinking equipment, tools and materials are provided by the L.W.F.

The wellsinker is usually paid once a month for the number of metres he has dug. The labourer, 3 or 4, are employed by the wellsinker and therefore paid by him, and not by the L.W.F.

Wellsinker-trainees are assisted by the L.W.F. to obtain a blasting licence after they have worked for at least 2 months under the direct supervision of a qualified wellsinker. A blasting licence is a pre-requisite before a wellsinker is considered qualified. Approximately 120 wellsinking gangs are working under the project presently.

SURVEY AND COMMUNITY PARTICIPATION

The Community Organisers carry out a "water sources and population survey" to obtain information about the names and locations of the communities, the number of families per community and about the existing water sources. At the same time, meetings are organised with Community leaders at ward level to explain and introduce the Water programme. After the introduction of the project to the Community leaders, the C.O. starts organising meetings with the communities usually in consultation with the councillor and the representative of the church.

At these meetings the following points are discussed and explained:

- Wells are to be spaced approximately 2 Km apart (up to 1 Km apart in densely populated areas) and each well is to serve about 10 families.
- The community is advised to elect a Water committee comprising of two female

members and one male member, which will liaise with the project officials and look after the well when completed and handed over to the community.

- The community is invited to select a well site/s which is to be inspected and approved at a later stage by an employee of L.W.F. usually the well sinking foreman. Mapping of approved wellsites is usually done by the Supervisor.
- The required contribution by the community consists of:
  (a) Provision of accommodation and mealiemeal for two wellsinkers.
  (b) Supply of river sand and aggregate for lining the well.
  (c) Erection of a fence around the wellsite.

In addition, the community may be requested to carry the wellsinking equipment to the wellsite.

A higher priority is given for the implementation of certain wells where the people are prepared to start digging voluntarily.

WELL CONSTRUCTION

The method of well digging is largely based on a technique developed by the then Rhodesian Government about 25 years ago. A circular hole with a diameter of 1.5m is dug manually, with pick and shovel and if necessary a miner's bar. When the hole is 2-3m deep further digging is done with the aid of a 50 l. mining bucket and a simple windlass. The bucket serves to lower and lift the wellsinker in or out of the well and also takes out earth, stones and water. The windlass is operated by one man on either side.

In rocky formations the diameter of the well is reduced to 1.20 m thus providing a foundation for the concrete lining. There is usually no need to line a well all the way up from the bottom. The wells are lined by casting concrete rings in situ, with the aid of a circular steel mould of 1m height, consisting of four pieces. While pouring concrete behind the shuttering, the well-sinker stands on a wooden platform that is suspended in the well and kept in position by four long sisal ropes. The lining protrudes 30 cm above the surface to prevent dirt or surface water leaking into the well.

When the material is too hard to use with pick and shovel, usually after 2-5m, explosives are used. The charge holes, which vary from 3 to 10 in number, depending on the hardness of the formations, are drilled manually to a depth of about 60 cm, using 60 and 90 cm long mild drill steel and 4lb hammers. For hard stone, it is preferred to use tungstan tip reinforced steel, although these cannot be sharpened by the local blacksmiths. All well sinkers have been provided with portable explosives boxes to store a small stock of explosives, enough to last for a month. After reaching water, digging or blasting continues until about 4m below the water table. Water is bailed out with the mining bucket every morning. When the amount of water to be taken out every day is at least 100 buckets i.e. approximately 5 m^3 the depth is considered to be sufficient. Two compressor teams are available to increase the depth of wells wherever necessary.

In certain areas, wells sometimes cave in before they are lined. Prefabricated concrete rings, (diam. 1.20, height 1m, wall thickness 6 cm, reinforced with chicken wire) are then lowered into the well. Several rings are placed on top of each other, while digging inside the rings continues until the amount of water is sufficient.

The well-cover consists of two semi circular slabs of 8 cm thick reinforced concrete.

If the well is shallow and to be equipped with a Blair pump, a small concrete block is cast on one side of the slab with a hole to fit the internally threaded PVC socket of the Blair pump. The wall top is then sealed and an apron is made sloping towards a drain. When pumping, the bucket is placed on top of the well while the person pumping stands beside the well.

However, wells that are to be equipped with deep well handpumps, require a slightly different well-cover and a different layout. The pumpstand is concreted-in beside the well, while the pipe assembly is bolted on to the side of the well cover, thus making it possible to open the wall by removing the other half of the well cover without having to pull out the pump. This eliminates the need for a special manhole. The well does not need to be sealed as the water is pumped through a 2m long delivery pipe into a trough.

EPILOGUE

The L.W.F. well-digging project is scheduled to be phased out after 4-5 years of operation in any given area. To encourage the continuation of well sinking activities, whether for private individuals or for communities, after the L.W.P. has withdrawn, the well sinking equipment will be made available to well sinkers who want to set up

their private well sinking business. On the other hand it is hoped that the Government (D.D.F.) will also continue to use the hand-dug wells technique.

As indicated above, the well-digging technique was borrowed from the former Rhodesian Government, although it was more or less abandoned years ago in favour of mechanically drilled boreholes. However, wells appear to have a number of important advantages compared to boreholes:-

- A well can be maintained and deepened, if necessary by the users themselves.
- Water can be drawn from a well, even when the pump is out of order.
- Well-digging is a labour intensive method that provides much needed employment in the rural areas.
- The equipment and materials used in well-digging are almost entirely locally made.
- Wells are considerably cheaper than boreholes.
- Community participation is relatively easy in a well sinking project.
- Rural people are thus provided with skills and tools that enable them to improve their own situation with their own means if necessary.

A disadvantage of a hand dug well is that its yield is usually, but not always, less than that of a borehole. However, if a well can yield 4-5 m^3 daily, then the water requirements of 10 families and their livestock can be met adequately. Only where yields of over 5 m^3 per day are required, a borehole might be more appropriate than a hand dug well. But even then one could consider digging two wells instead of drilling one borehole.

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WATER LEAKAGE IN ADDIS ABABA

by G A Bridger

INTRODUCTION

A water leakage study was carried out in Ethiopia, between October 1980 and June 1982, by Associated Engineering Services Ltd (AESL) of Canada under a contract for consultancy services with the Addis Ababa Water and Sewerage Authority (AAWSA). Principal funding was by African Development Fund loan.

The objectives of the study were to evaluate losses due to leakage and billing errors and to make recommendations on the most cost-effective methods of minimizing these losses.

Addis Ababa,the capital city of Ethiopia, has a population of approximately 1.3 million. Average water production is 69,500 m^3/d, compared with a potential demand of about 95,000 m^3/d. A substantial water shortage therefore exists and there is great incentive to locate and reduce unaccounted-for water, which past records indicated to be in the order of 40% to 50% of water produced. Unaccounted-for water is defined here as the difference between the volume of treated water produced and the volume of water sold to customers.

The Addis Ababa distribution system is unusually complex for its size, having some 15 separate pressure zones,or subsystems. Serviced elevations range from 2730 m to 2220 m. The system comprises nearly 300 km of pipeline over 100mm diameter,18 service reservoirs and 17 pumping stations. There are currently 80,000 connections, all metered.

Implementation of the study was divided into four phases:appraisal, on-site investigation, final report and follow-up. Canadian staff included an engineer, assisted by up to two senior technicians. Ethiopian counterpart staff, supplied by AAWSA, included an engineer, two engineering aides, and up to eight technicians of various grades. Training of the counterpart staff was an important aspect of the work program.

The overall approach to the study was as follows:

(a) To assess and measure the various forms of unaccounted-for water.
(b) To assess the unit costs of water.
(c) To assess possible loss control programs.
(d) To assess the costs and select optimum programs to reduce losses.

The following sections describe the procedure and results under each of the above steps:

UNACCOUNTED-FOR WATER

Statistics

From updated AAWSA statistics of monthly water production it was apparent that unaccounted-for water had been declining considerably over the past few years, from 46.5% of production in 1975/76 to 30.3% of production in 1980/81. Some reasons for such a marked improvement were evident: there had been changes in management and organization, technician training and regrading, improved computer billing, and a program to replace older meters. In addition, the commencement of the leakage study had given management and technicians a greater awareness of the problem of losses, and a greater priority was being assigned to leakage repair work.

However, the records of treated water production were suspect, since the three main venturi meters had never been checked for accuracy.

Measurement of production

One of the primary tasks, therefore, was to accurately measure treated water production. This was done using pitometers, inserted through 25mm corporation stops installed in the pipelines by under-pressure tapping machine. It was found that all three meters were over-registering by up to 32.5%. Production had therefore been substantially overestimated and overall losses in 1980/81 were not 30.3% of production but actually only 22.0%. This value was considerably less than had been expected at the commencement of the study.

Forms of unaccounted-for water

The 22% of production unaccounted-for was considered under two main sub-headings, namely system losses, and metering and billing losses. Both categories of loss have different costs associated with them and require entirely separate measures to reduce them.

System losses consist of:

- supply main leakage,
- service reservoir leakage,
- pumping station leakage,
- distribution main leakage,
- service connection leakage, and
- unmetered use of water.

Metering and billing losses are due to:

- meter inaccuracy,
- incorrect sizing of meters,
- meter reading errors,
- incorrect assessment of consumption where meters are not working, and
- consumption through unauthorized connections.

The steps taken to estimate the contribution of each of these forms of loss to the overall total of unaccounted-for water are briefly described as follows:

Supply main leakage, from pipelines of 150mm diameter and over, was found to be relatively small. A survey was conducted,during the dry season, by a small team of technicians walking all supply main routes, inspecting the surface for signs of leakage and, where possible, sounding the main at regular intervals.

The main causes of loss were found to be leakage from air valves, washouts, and valve spindles, leaking joints, corrosion, and traffic damage. Loss reduction requires regular surveys, prompt repairs, improved security at valve chambers, improved access to pipe routes, regular maintenance and exercising of valves, and attention to pH control at the treatment plants.

Service reservoir leakage. A survey of reservoir leakage was carried out on only 14 out of 37 tanks in the system, limited firstly due to problems with valves (i.e.siezed or not closing tight), and secondly due to time constraints, since testing had to be carried out during the rainy season owing to supply difficulties. Leakage tests on reservoirs were carried out over 12 or 24 hours, with the tank full and all inlet and outlet valves shut tight. Where leakage was significant, as it was in 4 of the tanks tested, the tanks were drained, cleaned out, carefully inspected, and repairs made if possible. Problems found included cracked floor slabs and porous foundation concrete.

Loss reduction requires replacement of faulty valves, thereby allowing all reservoirs to be tested, annual maintenance of valves and float valves, and periodic testing, cleaning and inspection every 5 years.

Pumping station leakage was limited to excessive pump gland leakage at a number of pumping stations. Regular pump maintenance would reduce these losses.

Distribution main and service connection leakage. Various surveys and investigations were undertaken to locate leakage in distribution mains and service connections, and to estimate the total volume of system leakage.

The main source of data was from leak detection areas set up in 15 representative sections of the system. The areas varied in size from 22 to more than 500 properties and were selected so that they could be isolated from the adjoining system, with total flow to each area metered. Several problems were encountered with these surveys, the most serious being the difficulty of isolating some areas. Distribution plans were often incomplete and in some areas daytime pressures were almost zero, thereby making it impossible to check for leakage or non-registering meters.

Other surveys consisted of inspections throughout the system of visible leakage and analysis of leak repair records.

The main causes of leakage were corrosion of small diameter steel pipe, insufficient laying depth and, in some areas, unnecessarily high service pressures. Reduction of leakage requires regular sounding surveys to locate leakage, prompt repairs, reduction in corrosiveness of the water, improvements in pipelaying practices, greater use of pvc and cement-lined ductile pipe, proper recording of leak repairs and planned replacement of old lines.

Unmetered use of water in Addis Ababa is essentially zero due to the fact that fire hydrants, public fountains and park supplies, which usually contribute to unmetered use, are all metered.

Losses due to meter inaccuracy. During the investigation phase study staff assisted with the reorganization and rehabilitation of the AAWSA meter repair shop, and carried out training in meter repairs and testing. Following this, records were kept of the accuracy of meters coming into the shop. Average accuracy was very close to 100%, indicating that meter inaccuracy did not contribute to unaccounted-for water.

Losses due to incorrect sizing of meters occur when meters are installed that are too large for a customer's water demand. It was found during surveys of large meters(over 25 mm) that as many as 55% may be oversized. The remedy lies in instituting a program of regular reassessment of large meter size, based on each customer's water usage.

Losses due to meter reading errors. Particularly with the older style clock-dial meters, reading errors are common in Addis Ababa. However, since there is no reason to suppose that under-readings are any more prevalent than over-readings it was considered that such errors would ultimately cancel out and have little effect on unaccounted-for water.

In common with meter inaccuracy, however, this problem does affect individual consumers and should therefore be tackled by a meter maintenance and replacement program and by continued training and supervision of meter readers.

Losses due to incorrect assessment of consumption. Whenever a meter is not read for any reason, or is stuck, consumption is in theory assessed as the average of several past month's consumption. From the results of surveys of meter condition, and from computer print-outs of monthly billings, it was evident that 10% of meters in the system are unreadable, for one reason or another, and it was also clear that many of these connections are consistently under-billed, or billed at zero consumption. The solution to this problem is again one of meter maintenance and repair, since if meters are working and legible, assessments will not be required.

Consumption through unauthorized connections is a problem which does exist in Addis Ababa but, according to surveys carried out, is of very minor proportions.

Summary of unaccounted-for water

Table 1 summarizes the losses under the various forms of unaccounted-for water described above.

Table 1

	Loss as % of production	
	Existing	Target value
System losses from:		
Supply mains	0.50	0.25
Service reservoirs	0.40	0.20
Pumping stations	0.10	0.05
Distribution mains	5.60	2.80
Service connections	8.40	4.20
Unmetered use	0	0
Total system losses	15.00%	7.50%
Metering/billing losses:		
Meter inaccuracy	0	0
Incorrect meter sizing	2.0	0.50
Meter reading errors	0	0
Assessment losses	4.50	1.50
Unauthorized connections	0.50	0.50
Total metering/billing losses	7.00%	2.50%
Total losses	22.00%	10.00%

UNIT COSTS OF WATER

The unit cost of system losses is the marginal cost of producing one additional unit volume of water. The unit cost is made up of firstly, operational costs for production and distribution and secondly, the value of deferring future demand-related water schemes. These were calculated, for Addis Ababa, as follows:

Unit operational cost:	Birr 0.090/m^3
Unit capital cost:	0.323/m^3
Total unit cost of leakage:	Birr 0.413/m^3

(The Ethiopian Birr is presently 3.00 to the £ Sterling).

For metering and billing losses, the unit cost of unbilled consumption is simply equal to the water tariff, which at present is Birr 0.5/m^3 (regular rate). A proposed new tariff would raise the average cost to Birr 0.87/m^3.

LOSS CONTROL PROGRAMS

Following the assessments of unaccounted-for water and unit costs, it was then necessary to establish what loss control programs are called for and estimate what effect they would have on reducing losses. Two programs are required, a leakage control program to tackle system leakage, and a separate program to tackle metering and billing losses.

Leakage control

There are various established methods of leakage control which have been adequately described in the literature (see Bibliography) and may be summarized as follows:

Regular or intensive sounding surveys, involving systematic sounding and inspection, by special crews of technicians, of all mains, valves, hydrants, consumer services and meters. The method is flexible and effort may be intensified or reduced as the need of a particular area requires. Instruments are required to locate pipelines so that they can be closely followed, and leak detection is based on electronic or mechanical amplification of the noise of the leak.

District or subsystem metering, consists of metering flows into districts, usually of 2000 to 5000 properties. By reading district meters weekly or monthly it is possible to note any increases in flow which may be due to leakage, and to intensify the sounding surveys in those districts. In Addis Ababa the system is conveniently divided into 15 sub-systems which form a very suitable basis for district metering.

A number of subsystem meters already existed in the system and during the study considerable effort was put into repairing meters, installing new ones and isolating subsystems in order to upgrade the level of subsystem metering. A monthly meter reading program was commenced and by the end of the study some useful statistics were being produced on the monthly supplies to all subsystems. It was also possible, using the monthly computer billing statistics, to compare total supply with total consumption in each subsystem, thereby obtaining a monthly record of unaccounted-for water, by subsystem.

Waste metering involves the division of the city into a number of small metered areas, consisting of from 1000 to 3000 properties, which can be isolated from the adjoining distribution, with flow into the areas measured by a recording waste meter. This technique is not suitable for use in Addis Ababa at the present time owing to the extreme difficulty of isolating areas to be fed through one meter. Other disadvantages are the necessity for extensive night work and the high cost of

providing meter installations for each waste meter area.

Summary of leakage control programs considered

(a) Regular sounding: comprising a small central loss control data and advisory section, with annual surveys of all consumer connections and main pipelines conducted by crews from the AAWSA small and large lines sections. (Estimated leakage reduction from 15% to 12.5% over 3-year period).

(b) Intensive sounding:as program (a) but with 6 monthly surveys. (Estimated leakage reduction from 15% to 10% over 3-year period).

(c) Intensive sounding and subsystem metering: comprising a larger loss control data and advisory section,with surveys as program(b) combined with a full subsystem metering and efficiency assessment program. (Estimated leakage reduction from 15% to 7.5% over 3-year period).

Meter maintenance program

Since unaccounted-for water due to metering and billing losses is largely due to inadequate meter maintenance, a program is required which involves increased staffing and effort, directed towards recalling and replacing old and defective meters. Assistance and support would be required from the loss control section. In the program, costs are included for replacement meters and spare parts, and for regular computer listings of meters requiring servicing. Costs of operating the meter shop would continue as before and are therefore not included. It is estimated that the program could reduce billing losses from 7.0% to 2.5% over a 3-year period.

SELECTION OF OPTIMUM PROGRAM

The costs of the various leakage control programs are given in Table 2, together with an estimate of the longer term annual water savings.

Table 2

Program	Annual cost (Birr)	Annual water saved (m^3)	Unit cost of water saved(Birr/m^3)
(a)	101,000	634,000	0.159
(b)	154,000	1,269,000	0.121
(c)	182,000	1,903,000	0.096

It may be seen that the greatest benefit (or saving in leakage costs) is obtained by the implementation of program (c)--intensive sounding and subsystem metering. The unit cost of water saved must be compared with the unit cost of leakage of Birr 0.413/m^3 to illustrate the benefits of the programs.

The important effect of the capital cost portion of the unit cost of leakage can be seen by the fact that on the basis of operational costs alone, none of the programs would be worthwhile economically.

Costs and benefits associated with the proposed meter maintenance program are as follows:

Annual cost:	Birr 293,000
Annual increased billings:	1,142,000/m^3
Unit cost of increased billing:	Birr0.257/m^3

This unit cost must be compared with the water tariff of Birr 0.50/m^3 (average) to illustrate the benefit of this program.

It was therefore concluded that the introduction of both the leakage control program (c) and the meter maintenance program is fully justified on economic grounds, and would result in reduction of losses to the target values shown in Table 1. In addition, there are numerous other benefits which would accrue from the successful implementation of the programs such as improved public relations, knowledge of the water system and distribution operation, and reduced disruption of utilities and damage to roads from leakage.

In future, if the recommended programs are carried out successfully, it should be possible to reduce unaccounted-for water in Addis Ababa to a level of 10% of production. A major portion of the losses remaining would be leakage, undetectable by normal methods.

The study Final Report included recommendations regarding the organization of the loss control programs, other AAWSA management and organization problems, stores practices and procedures, maintenance practices, and operation of the distribution system.

ACKNOWLEDGEMENTS

The authors wish to thank the General Manager of Addis Ababa Water and Sewerage Authority for assistance and cooperation extended during the study, and for permission to present this paper.

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Session 1

Chairman: Professor R Mackechnie
University of Zimbabwe

Discussion

A P Cotton and M A Sanousi
Water supply for Gedaref, Sudan

1. Dr COTTON highlighted the problems associated with a conventional river intake structure on the Atbara river, Sudan, and suggested that infiltration galleries offered the best technical solution to the problem.

2. Mr FAULKNER asked whether the hydraulic model tests described truly represented the river's behaviour, and if prototype to model similarity was achieved.

3. Dr COTTON replied that a distorted Froude number scale model was constructed, and that the results were essentially qualitative, but could nevertheless highlight problem areas in terms of scouring and silting.

4. Professor OLUWANDE suggested that a floating intake may work; he asked what was responsible for the high silt load, whether it could be reduced by reforestation, and commented that clogging of the gallery pipes may make the infiltration gallery inefficient.

5. Dr COTTON felt that deforestation may be responsible for the high silt loads, but that the problem was outside the scope of this paper. A floating intake may well help in the short term, but is susceptible to damage during flash floods. As to the problem of clogging, the yield of some galleries may reduce in time, due to clogging of the natural gravel pack around the collector pipes by fine material; this would be more common if the gallery were overpumped. It was assumed in the design that the gallery would operate with a blockage ratio of 40%, and providing that the gallery is correctly installed with a good natural gravel pack developed, it is likely to perform well for a long period.

6. Dr NYUMBO requested further comment on the location of the collector well on the alluvial berm, and suggested that it was potentially unstable.

7. Dr COTTON felt that although the concrete caisson which formed the collector well may suffer slight erosion during high flows, it is unlikely to be a serious problem. The erosion problems with the causeway proposal were due to physical restriction of the river channel width.

8. Engr LOCK thought that pipe jacking was a specialized technique not available in Zimbabwe and enquired whether the authors were aware of systems which did not require specialist contractors and plant.

9. Dr COTTON thought that this was the single most important factor relating to the adoption of the scheme. In this case, open trench construction would be impractical because of the large depth involved; it would thus depend upon the priority given to the scheme, because scarce foreign exchange would be required. However, the great advantage of this scheme is that once capital costs have been met, the operational and maintenance costs should be very low, in terms of both money and manpower.

G Smethurst, C J A Binnie and R E Ashford
Rural water supply in Ayangba Area, Nigeria

10. Mr BINNIE presented the paper, which covered aspects concerning the geology and existing water resources of the area, and made recommendations on improvements to water supplies, and on costings and revenue collection.

11. Dr ADEYEMI wished to know whether the authors had considered a plan for regional water supply, as a long term solution, rather than purely local supply.

12. Mr BINNIE replied that discussions with the client had revealed that regional water supply was not appropriate, and that they required supplies for scattered rural communities which involved minimum capital investment and could be implemented within 3 years of submission of the report.

13. Dr ALUKO asked whether the 3 year implementation period was imposed by the client, and commented that problems could arise through the failure of the client to make decisions during the period of the work, and through failure to pay the consultant at a particular stage of the project.

14. Mr BINNIE stated that the terms of reference specified the 3 year period. He thought that obtaining the necessary decisions from the client was often a problem, and had to be approached with tact and judgement. Clients now seemed to be

slower at paying, which placed an added financial burden on the consultant. A solution would be for the client to be required to pay interest charges, and ultimately for consultants to boycott bad paying clients; however, it was hard to foresee this occurring.

P Te Velde

Organization and implementation of a dug wells programme

15. Mr TE VELDE outlined the experience gained by the Water program of the Lutheran World Federation (L.W.F.) with reference to organization, community participation, and construction of dug wells.

16. Miss SMITH-CARINGTON offered the following comments: the author had pointed out several advantages of dug well programmes but had not brought attention to some of their disadvantages. These included reduced drought resistance because of the low aquifer penetration, less protection from pollution, and generally lower yields than from bore-holes. There was often much argument over the relative merits of boreholes and dug wells; in Malawi, the "Integrated Groundwater Projects" were attempting to combine the advantages of both by placing both types of water-point in the same area, and if possible the same village. The depth to the water table was the criterion used to determine the type of water-point.

17. Engr OBADINA thought that the use of explosives for sinking wells would be hazardous to property.

18. Mr TE VELDE replied that extensive information on blasting technique was provided by the L.W.F.

19. Mr TUMBARE asked three questions: how was the well sited, was it dug to a depth that would provide water throughout the year, and were geological conditions carefully considered; what problems had been encountered using the Blair pump; and would it not be cheaper for well sinkers to be trained to fit pumps?

20. Mr TE VELDE replied that the community selected the site, sometimes with the advice of a diviner; geophysical techniques were not used due to their cost. The main problems with the Blair pump included the connection between the steel head and PVC pipe; foot valves jammed, and some PVC parts wore very rapidly. Although well sinkers could install Blair pumps, but not deep well pumps, the pump fitter's role included repair, and was thus a full-time occupation.

21. Ms HAMPTON wished to know how the L.W.F. program overcame the problem of the provision of wells encouraging local inhabitants to increase their number of livestock, leading to over-grazing, and soil erosion.

22. Mr TE VELDE stated that the yields were so low that it was hardly likely to result in an explosion of the livestock population, and that available grazing was the limiting factor in this case.

23. Mr KUYATEH asked how continuity in the maintenance of supplies was provided for, and commented that contamination was possible between a safe water source and the time and place of consumption.

24. Mr TE VELDE answered that after L.W.F. involvement, trained well sinking gangs were encouraged to continue on a commercial basis. A local committee selected five men to help with pump installation; in addition, the local district development group would buy the pump, which gave a more positive feeling of involvement.

Contamination away from the source was largely an educational problem, for which there were unfortunately very few field workers.

G A Bridger

Water leakage in Addis Ababa

25. Mr BRIDGER described the quantity of unaccounted-for water from a variety of sources, and described the loss control programs carried out in Addis Ababa.

26. Mr BINNIE raised five points for consideration; the author had mentioned that he had tried to carry out waste metering but had not had time to describe the system. Atkins had recently carried out a waste survey in UK, and had used the method of successively isolating the system at known times in the night and noting the change in waste meter flow for each step. Was this the method tried?

27. Having identified the general area of leakage it was then necessary to locate the leak itself. In the past, methods had been too inaccurate and resulted in excessive lengths of trench excavation. This had been overcome in the UK by the development and use of the leak noise correlator. This measured the time difference of the leak noise to get to two different geophones attached to the pipe. By taking two or more readings it was possible to predict the location of the

leak. Success on excavating a single hole was about 90%. The system had proved very effective.

28. Concern was expressed that the author may have implied that household meters were generally accurate. During a study at Palembong in Indonesia it was found that one third were not recording, one third were outside 15% accuracy, and one third were within 15% accuracy. This was not good.

29. Regarding water fittings, were the toilet fittings of the British syphon type or the French rubber cone type? Whilst the French type were cheaper they wore and leaked badly. A test was done on an office block in Cairo where it was found that consumption on a public holiday was 95% of that on a working day. This was due primarily to leaking fittings of the French type.

30. The author's figure of 15% mains leakage for Addis Ababa was reasonably low. Atkins had just completed a study for Algiers, a similar town, where the mains leakage was assessed at 36%. Many other major towns were similar.

31. Mr BRIDGER replied that the method of waste metering as described by Mr Binnie was well known to him and he had used it successfully both in UK and Zambia. This method was considered for Addis Ababa but was found unsuitable for a variety of reasons, as stated in the paper. It should also be noted that the method was ideally suited to detecting waste on consumer's premises which could be a major factor in unaccounted-for water in cities without customer metering. In Addis Ababa, all connections were metered and generally consumers would attempt to minimise waste which they were paying for. In this situation it was more advantageous to direct effort towards maintaining the meters and ensuring they were read regularly.

32. Mr BRIDGER stated that he had not had the opportunity to use the leak noise correlator but it would undoubtedly assist in locating leaks more accurately in the paved downtown core of Addis Ababa. However, it was also more sophisticated in design, more expensive and more complicated in operation than ordinary electronic or mechanical leak detectors, and local servicing would not be available. For these reasons the instrument was not suitable for use in Addis Ababa at the present time.

33. The author was surprised by the accuracy of meters in Addis Ababa. Following rehabilitation of the meter shop and training of the meter technicians, analysis of the test records of meters coming into the shop showed that 73% of all working meters tested were within the prescribed error limits of ± 5%; there were more high-reading than low-reading meters and average accuracy was 101.4%. For large meters (over 50mm) tested only one out of 23 had greater error than ± 5%, average accuracy being 98.5%; there were twice as many high reading as low reading meters. There were, however, an estimated 10% of meters in the system not working.

34. In Addis Ababa toilet fittings were normally of the rubber cone type. As previously noted though, such losses would be minimised by the consumer, providing his meter was working and he was being billed for consumption.

35. It was agreed that 22% unaccounted-for water (15% of it leakage), was a relatively low figure for a large city but that did not imply that it could not be reduced, or that it was uneconomic to attempt to reduce it. It was interesting to note that the loss in Harare was reported to be only 9.1% which would suggest that the 10% target value for Addis Ababa was not an impossible objective.

9th WEDC Conference: Sanitation and water for development in Africa: HARARE: 1983

PHOREDOX ACTIVATED SLUDGE UNIT AT THE FIRLE SEWAGE DISPOSAL WORKS HARARE

by Mrs F C COX

INTRODUCTION

A modified activated sludge unit designed on the Phoredox principle of Barnard (ref.No.1) was installed at the Firle Sewage Disposal Works, Harare, especially to produce an effluent which would satisfy discharge standards (ref.No.2). Several similar plants are operating in other countries but, from results seen so far, not all of them are producing an effluent which would meet the high Zimbabwean standards, particularly with regard to phosphate and ammonia.

Because uncertainty still exists over the exact mechanism involved in biological phosphate removal, definite operating parameters for efficient removal have not been determined, though basic guidelines have been established.

Siebritz et al (ref.No.3) have stated that failure of the Phoredox process to remove phosphate is due to the TKN:COD of the feed being $\leq$0,08; this means that denitrification is incomplete and the return sludge contains nitrate which causes a reduction in effectiveness of the anaerobic zone. The TKN:COD ratio at Firle is normally $<$0,08 and, furthermore, at no time was any nitrate found in the return sludge; yet in the first few months of operation the P. removal was variable, unpredictable and usually insufficient.

However, after considerable trial and error, a pattern emerged and an operating procedure has been established which consistently produces the desired standard of effluent.

OPERATIONAL PARAMETERS

The following controls may be employed in the operation of the works:

Feed

The volume and ratio of raw to settled sewage of the feed, depending on the strength of the sewage.

Sludge Recycle Rate

A sludge recycle rate of 1:1 has been found to be satisfactory. It has been suggested (ref.No.3) that a higher recycle rate is conducive to better P removal but this would reduce the effective retention time in the anaerobic zone. Lower recycle rates were found to cause blocking of the clarifier telescopic valves.

Dissolved Oxygen Level

It was recommended that the DO level be kept at about 1 mg/ℓ in the centre of the main aeration basin, tapering off to $<$0,5 mg/ℓ at the entrances to the two anoxic zones, in order to assist denitrification. Because of poor performance of the aerators and the fully-mixed aspect of the basin, this DO profile was unobtainable. In addition, the recording DO meters installed were so unreliable that control of the system by DO levels was impossible.

Solids Retention Time

Initially a SRT of 29 days was maintained but this has had to be dropped gradually to 20 days in order to keep the MLSS at a reasonable level. This short SRT does not produce a truly stable sludge, suitable for drying beds.

Mixed Liquor Suspended Solids

By keeping a constant SRT, the MLSS is supposed to vary automatically to suit the strength of the feed sewage. In fact at a SRT of 25 days the MLSS increased to over 6 000 mg/ℓ and the aerators could not cope with this mass of sludge. With improved aeration and a SRT of 20 days the MLSS remains fairly constant at 4 500 mg/ℓ .

Mixed Liquor Recycle

The average internal recycle rate is 2,8:1. Denitrification in the first anoxic basin is good regardless of the recycle rate, which can be as high as 4:1 if all the pumps are operable at one time.

RESULTS

Typical analysis results of the raw sewage and final effluent are given in Table 1, together with relevant discharge standards.

Nitrification-Denitrification

Nitrification began on the 20th day after commissioning and was complete by the 25th day; the final effluent having a total ammonia content of 0,24 mg/ℓ N. temperature of the ML at this time was 19-20^{o}C.

Considerable denitrification occurs simultaneously with nitrification, mini-anoxic zones forming between the aerators. Nitrates are detected only occasionally in the main aeration basin.

Nitrification has always been good, provided the loading is kept within the capacity of the aerators. Denitrification is total on leaving the anoxic basins, even at times

when nitrate in the aeration basin rose to 6 mg/ℓ .

TABLE 1: TYPICAL ANALYSIS RESULTS (mg/ℓ)

Parameter	Raw Sewage	Final Effluent	Discharge Standard
4 Hour O.A.	70	8	10
C.O.D.	800	45	60
Suspended Solids	350	18	25
pH	7,0	7,6	6-9
Total Ammonia as N	32	2,4	-
Free Ammonia as N	-	0,06	0,2
Nitrite as N	-	0,04	-
Nitrate as N	-	< 0,5	-
Kjeldahl Nitrogen	42	8	-
Total Nitrogen	42	< 8,5	10
Soluble O-Phosphate as P	5	0,1	-
Total Phosphate as P	9	0,6	1,0
Detergent LAS	4,5	0,1	1,0

Phosphate Removal

Soluble phosphate dropped to between 1 and 2 mg/ℓ P within a few days of start-up. After three weeks it was down to 0,2 mg/ℓ P where it stayed for another two weeks. Then because of problems with rags, the feed was changed to settled sewage alone (COD 370 mg/ℓ , TKN:COD 0,07) and the phosphate slowly rose over the next two weeks to a peak of 7 mg/ℓ P.

As the Siebritz theory did not apply, it seemed to be the total COD loading that was important. In retrospect, the initial good P removal was probably due to the addition of 900 m^3 raw sludge over the start-up period.

It became apparent that peaks in soluble P occurred simultaneously or about a day after peaks in DO and nitrate in the main aeration basin. P removal was found to improve on days after there had been a power cut or shut-down for repair work. The feed was therefore changed back to raw sewage alone and certain aerators were switched off, some only at night, some constantly; the number in use being determined by the ammonia level at various points. By adjusting the aeration in the main basin to get a total ammonia between 1 and 4 mg/ℓ and nitrate < 1 mg/ℓ N, it was found possible to attain consistently high P removal rates. Soluble P is now frequently < 0,1 mg/ℓ P. The ammonia discharge standard is still reached as long as the peak total ammonia in the main aeration basin is kept below 7 mg/ℓ N, this ammonia being further nitrified and largely denitrified in the re-aeration basin. The large clarifiers have a buffering effect on ammonia peaks. If the ammonia peak is allowed to rise above 7 mg/ℓ N, not only is the free ammonia in the final effluent too high but phosphate uptake is reduced due to lack of oxygen.

Another useful parameter for phosphate control is the soluble P level in the anaerobic basin; if this drops below 20 mg/ℓ , trouble ahead is indicated. Unfortunately it is sometimes too late by then to avert the impending rise in P in the effluent.

COD Removal

Because it is necessary for good P removal to run the plant in a slightly overloaded mode, the COD of the final effluent is sometimes over the limit of 60 mg/ℓ but on average is less than 50 mg/ℓ .

CONCLUSIONS

Very good results can be achieved with a Phoredox type nutrient removal plant providing oxygen input is carefully balanced against oxygen demand. Sludge must be kept somewhat under-oxidized to obtain good anaerobic conditions on recycling. Satisfactory DO concentrations are barely over zero and very difficult to monitor. Recording ammonia meters would probably be more suitable than DO meters for control purposes.

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WATER AND SEWERAGE IN HOUSING DEVELOPMENT

by J D MILNE

INTRODUCTION

Water borne sewage disposal was initiated in Bulawayo in 1931. Prior to that date sanitary facilities had consisted of earth closets or a bucket system.

However it was not until 1956 that there was instituted a policy of providing all new high density housing with individual water connections and flush toilets. At that date there were 12 000 high density houses with communal water supplies and communal toilet blocks or individual aqua privies. In 1959 a programme was begun to provide all existing houses with individual water connections and flush toilets and this was virtually complete in 1982.

Between 1956 and 1975 an additional 17 000 high density houses or flats were built but with an estimated back log of housing in excess of 10 000 units it was decided in 1975 to speed up the housing programme and between 1975 and 1982 a further 24 000 houses have been built.

WATER SUPPLY

All individual water connections are metered as this is considered necessary to avoid excessive use of water. Each household is entitled to either 9 or 14 m^3 per month depending on whether the occupier is a Council tenant or private owner and the cost of this allowance is included in the monthly rent or service charge respectively.

Additional consumption as recorded on the meter is charged for at the standard tariff.

Actual domestic consumptions range between 8 and 16 m^3 per month but mains are designed for an average use of 1 m^3/day. (Total use averages 22 m^3 per house per month).

To limit the cost of meter installation water meters are fitted to an outside wall and general use is made of the Kent PSM water meter which has proved least liable to wilful damage.

WATER MAINS

Water mains consist of asbestos cement Class 18 piping in diameters 50 mm and above which are manufactured to CAS 113 : 1974 and are supplied in 4 metre lengths. Below 50 mm diameter galvanised steel piping is used.

Pipes are laid on a bedding of 75 mm of decomposed granite or similar selected suitable material with a gap of 450 mm length left at each joint which is maintained until the pipelines have been successfully tested under pressure.

Jointing is generally by means of "Fluid - title" sleeve joints but cast iron short collar detachable joints are used for the installation of fittings. Pipes are laid with a cover of 900 mm but this is increased to 1 200 mm under roadways.

Backfilling to a height of 300 mm above the crown of the pipe is carried out with selected material placed in 100 mm layers and well and carefully rammed around the pipe. The remainder of the back filling is carried out in 300 mm layers with boulder free material. Where possible water mains are installed in a 2 m servitude at the rear of the stand with control valves fitted at convenient places. Fire hydrants of the standard screw down type pattern are installed only in the vicinity of important buildings such as schools. Connections are made by fitting a malleable iron saddle to the main and drilling and tapping for a 20 mm galvanised pipe to supply one house or a 25 mm pipe with branches to supply up to four houses.

SEWERS

Sewers are designed for an average daily flow of 0,3 m^3/house and a peak flow of 1,5 m^3/house/day.

Sewer pipes of 100 mm and 150 mm diameter are manufactured of earthenware in accordance with C.A.S. A16/1973. Pipes are supplied in 1 m and 1,5 m lengths with lipseal rubber sleeve joints.

Sewer pipes of 225 mm diameter and above are manufactured of concrete made from dolomitic aggregate and a 12 mm thick sacrificial layer in accordance with C.A.S. No. A17. Pipes are supplied in 2,44 m lengths with rolling rubber ring O-joints.

LAYING OF SEWERS

Sewers are laid in a 2 m servitude at the rear of the stand and trenches are excavated to grade and level using profiles at manholes and to a depth 75 mm below the invert of the pipe.

Pipelaying is commenced from the lower end of the section and proceeds up hill with each socket being supported at its correct level on a heap of selected material seived through a 25 mm screen.

Bedding is carried out immediately behind the pipelaying by filling beneath the barrel height with selected material thoroughly compacted by well ramming on either side of the pipe. When laying and bedding of the sections is completed it is tested by air. Thereafter the section is backfilled to a depth of 300 mm above the crown of the pipe with selected material placed in 100 mm layers and well and carefully, tamped around and over the pipe. The remainder of the backfilling is carried out in 300 mm layers with boulder free material after which the testing is repeated.

Sewers having less than 300 mm cover over the socket within stands and sewers having less than 900 mm cover in road ways are protected by encasing in concrete 100 mm thick.

MANHOLES

Manholes are located at 80 m maximum distance and at each junction and bend and are constructed of precast reinforced concrete rings manufactured to comply with C.A.S. A17/1973 for Class 'S' - Standard Reinforced Pipes. Rings are made in 610 and 305 mm lengths with ogee type joints.

Gradients are continuous through the manhole and a smooth flow is ensured by constructing the channels of half round earthenware supported by concrete benching.

Manholes are of 675 mm minimum diameter. Within stands covers are of precast reinforced concrete but in roadways cast iron covers and frames are used.

SEWER CONNECTIONS

Connections are made to junction pipes installed when the sewer is laid. Both the outlet from the lavatory pan, through an 'S' trap, and the gulley which receives the discharge from the kitchen sink and the shower drain are connected by 100 mm diameter, earthenware piping in which an inspection eye is installed. A vent pipe is fitted to the connection at the last house at the head of each sewer branch line.

MATERIALS

Asbestos cement water pipes are manufactured in Bulawayo using locally produced asbestos fibre and cement.

Earthenware pipes are manufactured in Bulawayo using locally excavated clay.

Concrete pipes are manufactured in Bulawayo using locally produced dolomite and cement.

Rubber rings for pipe joints are manufactured in Bulawayo but imported rubber is used.

SEWAGE PUMPING STATIONS

An undesirable feature of recent high density housing schemes has been the need for reasons of topography to provide a considerable number of sewage pumping stations - approximately one station for every 1 500 houses. These have been constructed mainly to avoid expensive outfalls and although they add only $20,00 approximately per stand to the costs of sewerage they are not favoured as the pumping machinery has to be imported and they are subject to breakdown due to mechanical or electrical faults with the subsequent nuisance of sewage overspill.

To keep down costs the design has been standardised using electrically driven submersible pumps with screening, balancing chamber and pumps in duplicate. The rising main is constructed of asbestos cement piping and terminates in a velocity reducing chamber.

COSTS

Experience showed that the greatest opportunity for saving in the cost of services existed in the cost of installing sewers and ways were investigated of making savings on this item. The following measures have been adopted in consequence :-

1. Manholes at the head of sewers have been replaced by rodding ways.
2. Depth of sewers were reduced to a minimum of 800 mm.
3. 100 mm diameter pipes were used at the head of sewers for the first 50 houses.
4. Gradients were reduced to a minimum of 1 in 100 for 100 mm pipes and of 1 in 200 for 150 mm pipes.
5. Manholes were reduced to 675 mm diameter and step irons eliminated.
6. Cast iron covers for manholes within stands were replaced by precast concrete covers.

As a result of these economies the latest cost of providing sewerage for a house on a 200 m^2 stand is $210 per stand.

IMPROVING EXISTING HOUSES

In many cases where houses had been provided with aqua privies their replacement eventually became a necessity.

The ground on which they were built was not permeable and through time the water table rose to the extent that the houses were surrounded by springs of sewage effluent. When eventually excavation for the installation of sewers was carried out it was under the most unpleasant conditions.

Initially it was intended to retain the privy structures and dispose of the liquid only via the sewers but the residents complained and new detached toilets were built.

Communal toilet blocks were generally unsatisfactory. Cleanliness was difficult to maintain particularly as the toilets served as public conveniences. Also their use at night was hazardous and many legitimate users were assaulted.

Water consumption was high as automatic flushing devices operated day and night and manual flushing cisterns were repeatedly vandalised.

Individual detached toilets are still being built and one doubts the mentality of the architect who designs an outside toilet with shower facilities and no changing room.

Communal water supplies through a stand pipe with a "waste - not" self closing tap were unpopular.

Apart from disputes over priority in queuing, water had to be carried in containers and most householders were unable to carry out cultivation around their properties.

However some enterprising people who lived near the standpipe devised irrigation schemes by tying back the handle of the tap and delivering through a hose to their property.

An individual water supply including water meter costs $50 and for the benefits derived therefrom not least the beautification of the housing surrounds by the cultivation of fruit trees etc. it is a worth while expenditure.

SEWAGE TREATMENT WORKS

Three types of sewage treatment works have been constructed and are in operation in Bulawayo - oxidation ponds, biological filtration plants and more recently extended aeration activated sludge plants. From a capital cost point of view oxidation ponds are the ideal solution for the treatment of sewage if plenty of ground is available for their location and construction. We have had the unfortunate experience that a works which was built in isolation in 1963 was surrounded by housing in 1978/1979 and is now a subject of complaint when it malfunctions.

The biological filtration plants produce a good quality effluent and cause little nuisance. The effluent does not meet pollution control regulations standards for river discharge in respect of nitrogen and phosphorus but it is used for irrigation of pastures and crop lands and with tertiary treatment for the irrigation of sportsfields and public openspaces.

Our first extended aeration activated sludge plant was completed in August 1982, so there is little experience of its operation but it is hoped that it will produce an effluent fit for river discharge.

Following the gazetting of the Water (Effluent and Waste Water Standards) Regulations 1977 the Ministry of Water Development issued a publication "Guidelines for the disposal of sewage and sewage effluent during wet weather".

Regrettably most engineers responsible for sewage disposal in Zimbabwe took fright at these regulations and considered that the only way to comply was to construct "extended aeration activated sludge plants".

These works are very expensive to construct, have a very high import content and require skilled and sophisticated operation.

The unfortunate position has now been reached where such a works is to be built at a growth point in the communal areas where space is no problem and the nitrogen and phosphorus removed from the effluent could be used profitably in farming

operations. The effluent may yet be used for irrigation but the nitrogen wasted to atmosphere will have to be replaced by expensive fertiliser probably imported.

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URBAN SOLID WASTE: APPROPRIATE TECHNOLOGY

by Professor K J NATH, P K CHATTERJEE, S K DASGUPTA and D M DE

1. INTRODUCTION

The Solid Waste Management services can absorb upto 1% of the G.N.P. and is one of the most expensive city services. At 3 to 6 workers per 1000 population, solid waste workers may represent about 1 to 2% of the total national work force in the developing countries. In order to optimise return from this huge public expenditure, every country must evolve an indigenous technology for Solid Waste Management based on the quantity and character of the wastes, the level of national income, wage rates, equipment manufacturing capacity, energy costs and various social and cultural factors typical to the community. A careful analysis of the present status of solid waste management in the cities and towns in India would lead one to the inevitable conclusion that better sanitation standards could still be achieved in most of the third world cities and towns by prudent and well planned allocation of available resources through the application of appropriate technology. The All India Institute of Hygiene and Public Health is presently carrying out a pilot study sponsored by the Calcutta Metropolitan Development Authority and financed by the World Bank on various technical and managerial aspects of municipal solid waste management and the experience of the project team strengthens the above view points.

2. EXISTING STATUS OF SOLID WASTE MANAGEMENT IN SMALL AND MEDIUM TOWNS IN INDIA

The collection and disposal of refuse within an urban area has been, traditionally the responsibility of local self Government Bodies. These bodies, except in the cases of a few large Metropolitan Cities, do not have adequate managerial and technical manpower at their disposal to plan and operate the Solid Waste Management programme at the desired level. Most municipalities spend a sizable portion of their annual budget for Solid Waste Management and for the maintenance of surface drains. But in absence of adequate planning and management and as a result of inappropriate technology, much of the municipal expenditure and efforts in this direction have gone waste. In a sample survey conducted by the All India Institute of Hygiene and Public Health in 34 municipal towns with varying levels of urbanisation and socio-economic circumstances, population varying between 20,000 to 3,50,000 and density of population varying between 5000/sq.KM. to 30,000/Sq. KM, it was observed, -

(i) In more than 60% of the municipalities surveyed, less than 40% of the solid wastes are collected daily. Against an average generation of 400 to 500 gms/capita/day average collection is mostly less than 200 gm/capita/day.

(ii) In absence of any house to house collection system and adequate no. of community containers, collection is from open on-road dumps. These dumps are invaded by scavangers and animals which scatter the wastes, the rats have access to food, and fly larva migrate and pupate in the vicinity. Leachate from decomposing and putrifying garbage percolates into soil and nearby water sources. Resultant contamination of food, water and soil has caused frequent epidemics of cholera, jaundice, typhoid and other pest borne diseases.

(iii) Uncollected solid waste finds its way into the open drains meant for rain and sullage water, thus blocking flow and creating water logging. This has created acute mosquito problems in most municipal towns. Moreover removal of solid waste from these unlined open drains results in wastage of much labour.

(iv) The handling process involves collection from the street into ill-designed hand carts which again dumps them on the ground to be picked up by rakes and baskets and put into trucks. This results in wastage of labour and waiting time for vehicles apart from the great health risk that the workers and public at large are exposed to.

(v) More than 80% of the collected solid waste in municipal towns are disposed off by filling up private lands scattered all over the town in most uncontrolled hap-hazard and insanitary manner which is a potential health risk for the community. Municipalities possess less than 0.32 hectares of land for every 10,000 persons for disposal of solid waste as well as night-soil.

The above observations though based on a sample survey in 34 municipal towns in India, by and large reflects the general level of Solid Waste Management in many of the Asian and African towns, which could be attributed primarily to the failure of the authorities to develop a Solid Waste Management System appropriate to the socio-economic circumstances of the community and its available financial resources. Expenditure on Solid Waste Management varies between Rs.8/- to Rs.20/- per capita per annum in India (£1=18 at 1981 level). Man-power employed varies between 3 to 6 persons per 1000 population. The quality of services provided in most urban areas, particularly in small and medium towns, in terms of quantity of solid waste collected and environmental protection provided to the community, does not justify this expenditure.

3. PILOT STUDIES

3.1. Project Objective

(a) Development of a fully/partly containerised collection and transportation service which would not allow the waste matters to touch the ground during the collection and transportation process.

(b) Technical and financial feasibility of simple labour intensive, low cost yet hygienic methods of solid waste disposal and resource recovery.

3.2. Pilot Project Areas

Six municipal wards, in two municipal towns, with varying socio-economic circumstances and different levels of urbanisation were chosen as the pilot areas where alternate methods were studied. They covered a total population of about 50,000.

3.3. Alternatives in Methods and Materials.

3.3.1. Collection and transportation System:

(a) House to House collection by light weight manually tipping auto-vehicle ($2M^3$/1.2T) and 12/18 litre plastic/G.I.domestic bins were supplied to each family.

(b) The same system as in (a) with pedal-tricycles, carrying 4/6/8 nos. of 50/ 100 litres G.I. containers.

(c) Same system as in (b), but collection from community containers, provided for every 10/20 houses.

(d) Collection from community containers by pedal tricycles and direct transfer into $4M^3$ skips in primary transfer stations. The skip is hauled by 35 H.P. tractors to disposal grounds.

(e) Same system as in (d) but with house to house collection.

3.3.2. Disposal techniques

(a) Mannually operated sanitary land filling.

(b) Mannually operated aerobic (Windrow method) composting.

Each system was first optimised through the optimal combination of men and materials, before their comparative evaluation. Each system were run for daily as well as alternate day collection. Criteria for evaluating system-efficiency were cost, environmental protection and public acceptance.

Mode of operations tried in different areas and optimal design parameters for them are shown in Table-1.

3.4. Findings of the Study.

In table-2, and 4 a comparison of pilot project systems is made with the existing systems in various categories of towns in India, in respect of manpower requirement, O & M Cost, vehicle and fuel requirement and quality of service as indicated by per capita waste collection per day, frequency of collection etc. It could be seen that under the pilot project systems, average O & M cost is considerably less than what is presently being spent in most Indian cities and towns. At the same time the level of services in terms of per capita refuse collection per day is much higher. Table 3 clearly demonstrates that the existing system of solid waste management in the municipalities is counter productive and wasteful in respect

Table-1: Pilot Operations

Pilot Area Characteristics	Mode of operation		Optimal Design parameters
	Collection & Transportation	Disposal	
P-I. Population Density /10,000/KM^2 Disposal site /3KM Semi Urban; Average income level /Rs. 2500 per capita per annum	As in (a) under 3.3.1.	Mannually operated sanitary landfilling	12/18 litres plastic/ G.I. buckets as domestic container per family per annum One dumper per 5000 people. Two crew collection.
P-II. -Do-	As in (b) under 3.3.1.	-Do-	-Do- One tri-cycle (600 litres) per 1200 people.
P-III. -Do-	As in (c) under 3.3.1.	-Do-	One Community Container/ 10 houses. One tri-cycle per 1500 people.
P-IV. Population Density >20,000/KM^2 Disposal site 8KM Highly urbanised. Average income level. /Rs. 3500 per capita per annum.	As in (d) under 3.3.1.	Mannually operated wind-row composting	One Community-Container/ 20 houses. One tri-cycle per 2500 people. One Primary Transfer Station per 15000 people. One tractor-4 skips set/ 45000 people.
P-V. -Do-	As in (e) under 3.3.1.	-Do-	12/18 litres plastic/G.I. buckets as domestic containers. One tricycle per 2000 people. One Primary Transfer Station per 10,000 people. One Tractor-4 skips set/30000 people.

Table-2: O & COSTS

	Level of Service	O & M.Cost Rs. per capita per annum.
Calcutta Corporation	500 gm/capita/day collection. Roadside open storage and Double Handling, Daily collection. Uncontrolled disposal.	Rs. 20.00
34 Municipal Towns in Greater Calcutta	200 gm/c/d. Irregular collection. Roadside open storage and Double Handling uncontrolled disposal.	Rs. 6.00 to Rs. 10.00
Pilot - I	250 to 350 gm/c/d. daily collection. No double Handling. Sanitary Disposal	Rs. 6.00(Rs.4.00
Pilot - II	- Do -	Rs. 7.00(Rs.4.50)
Pilot - III	150 to 200 gm/c/d	Rs. 6.00(Rs.4.00)
Pilot - IV	300 to 400 gm/c/d - Do -	Rs. 4.50(Rs.3.00)
Pilot - V	350 to 450 gm/c/d - Do -	Rs. 5.50(Rs.3.50)

*Figures in bracket indicate O & M cost for alternate day collection.

Table-3: VEHICLE, FUEL AND STAFF REQUIREMENT

	No. of vehicles needed (Per million people)	Fuel consumption per annum (Per million people)	Oil consumption per annum (Per million people)	Staff requirement (Per 1000 people)
Existing System	100 Trucks	1,25,000	1500	3 to 7
Pilot Project System	40 Tractors and 100 trailors /skips.	50,000	600	1 to 1.2

of utilisation of man-power. Method studies also revealed that for towns with density of population less than 10000 persons/Sq.KM, house to house collection with pedal tri-cycle would be more effective. For towns with pop-ulation density more than 20,000/Sq. KM, collection from community contain-ers would ensure almost the same level of collection but at a much lower cost.

Pilot studies on low-cost disposal techniques revealed that,

(i) Small mannually operated sani-tary land filling sites, could be operated fairly satisfactorily by cut and cover method upto 15 tons of refuse per day (Population 40,000). The O & M cost for such operations was found to be much lower that what many municipalities spend on crude dumping.

(ii) Mannually operated wind-row compost plants could be operated efficiently upto 30 T per day capacity i.e. upto a population of 60,000. At this level the transportation cost of refuse and compost would also be minimal. O & M cost would be about Rs.20 per ton of solid waste as against Rs.50 per ton in larger mechanical plants. Inorganic rejects (which could be 30 to 50%) could be recycled for private land filling within the town without caus-ing much health hazards. Chemical quality of finished compost-manures from mannually operated plants, with nutrient (NPK) content of about 20 Kg. per ton and carbon to Nitrogen ratio being 15 to 20, are comparable with that from the mechanical plants.

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DISPOSAL OF TOXIC AND INDUSTRIAL LIQUID WASTE IN THE CITY OF HARARE, ZIMBABWE

by J B KEELING

Disposal of industrial liquid waste, specifically of wastes which, due to their content, could not be put to sewer. Historically these wastes were either admixed with domestic refuse or deposited into a separate area.

In the early 1970s, admixture of domestic waste and liquid industrial waste provided a low-cost disposal system. Problems arose with the admixture of various liquids, the creation of ponds, the difficulties in backfilling, particularly in the rains, and their close proximity to residential areas.

The by-laws contained no provision whereby the Amenities Department could refuse industrial waste, liquid or solid, and no charge was made for disposal. Certain sections of Industry made it quite clear that they felt Council was obliged to take without question whatever Industry chose to give them.

Within the then Amenities Department and the City Engineer's Department it was admitted that qualified control was necessary, but little transpired until 1976 and 1977, when attempts were made to dry diatomaceous earth slurry on drying beds at Western Sewage Works. Though initially successful, they were discontinued as impractical, mainly through a lack of liaison.

In 1973, industrial liquid waste disposal and its impact on the disposal site along the Mukuvisi River made a move to some other site necessary. The possibility of using Campbells Quarry off Hatfield Road as a solid waste disposal site had been raised in 1972. The site was initially accepted, but turned down later because of the possibility of seepage. However, under pressure of necessity and lack of funds for other sites or methods of disposal, the quarry was used first for industrial solid waste, but by 1977 it was also being used for liquid waste disposal.

The final depth of twenty metres of this old granite quarry were filled with soap and fat wastes, tannery waste, acid sludge from mineral oil refining, metal plating waste, garage waste, plus much else. A backfill of wood waste and boiler ash was attempted. Much of this backfill was burnt away in July, 1981, when the "hole" caught fire.

Liquid disposal to this site had been stopped some two weeks before the fire, following seepage through an ash retaining wall on the western edge of the hole. The edge was strengthened and backfilling began with plant financed by Council, through a special grant of $25 000. ($100 = £74,14 August, 1981).

Although by 1981 efforts had been made to seek for and survey alternative sites, few sites were available for solid waste, and none for liquid waste disposal. The possibility of admixing or ponding on the Kelvin Road disposal site was ruled out mainly for reasons of smell, but further pollution of the Mukuvisi and the general problems posed by scavenger control weighed against this disposal method.

A temporary site was found off Austin Road in Workington, the site of Council's disused Western Sewage Disposal Works. This site had been so effectively demolished by the contractor that no brick stood on another, no tank or pond was left unfilled. However, the area was known to have a level of reasonably impervious clay which it was felt aided the prevention of seepage and the pollution of the nearby stormwater canal.

Ponds were dug, the first to a depth of one metre, a width of ten metres and a length of sixty metres. This was filled in two weeks with the admixture as before, and a second larger pond was excavated. This admixture of liquids into ponds could not be maintained for long; both land and money for ponds were limited.

The question of separation and treatment of liquids was no longer a matter for speculation, but one of immediate practical necessity, particularly so after attempts to acquire a further quarry site were turned down. With no other site available, this small site had to deal with an average of 150 000 litres per week of liquid waste as well as the prospect of rain. The Chief Chemist and the Noxious and Toxic Wastes Officer worked to devise a series of ponds with specific uses.

Earth removed from the existing two ponds was compacted into a double-ended ramp 60 m. long, 20 m. wide and 2 m. high. Two ponds 6 m. x 10 m. x 1,5 m. deep were cut in this and two sections of 75 mm.

steel pipe with valves inserted to provide outlets. It was intended that these ponds be used for garage waste containing water, silt and oil. Oil and silt interceptors are required on garage foul-drainage systems from vehicle wash and parts cleaning bays. The valves were to drain off water to an adjacent area either to soak away or evaporate. As the separated oil level was reached it was intended that the oil be drummed for possible sale. This oil has found a ready market with one of our local manufacturers as a furnace fuel.

Adjacent to the area created to contain the water from the garage waste, a small pond was created to receive those aqueous wastes which did not contain significant quantities of oil and which might, with safety and benefit, be mixed. Such wastes as printers ink, resins, some chemical wastes, acidic and alkaline wastes and food manufacturing waste were permitted to mix and dry together.

Four shallow 0,3 m. deep ponds, 10 m. x 15 m., were created to accommodate the liquid diatomaceous earth from one of our oil/soap manufacturers, the expectation being that evaporation could provide the answer by allowing each pond a week to fill and two weeks to dry before being dug out. In the event, the rains put paid to this idea although the ponds have since proved fairly effective in the dry weather.

Two other small ponds were created to accommodate tannery waste. These were effective but the company discontinued deliveries due to cost.

There remained two materials the nature of which constituted the Liquid Waste Disposal Site's biggest problem.

Acid Sludge from a re-refining process for mineral oil

Basically, concentrated sulphuric acid filtered through used engine oil. The acid sludge contains waste solids and some oil fractions. This is discharged into a skip holding 2 000 litres. Deliveries for disposal average three skips per week. This material thickens due to a polymer reaction and gives off sulphurous fumes which add considerably to the noxious and toxic nature of any mass with which it is admixed.

One of the two garage waste ponds was used to hold the deliveries of acid sludge. A test using some of this material seemed to indicate that it could be used to fuel Council's Bitumen Unit. The thickening of the acid sludge due to polymerization made this impracticable. Similarly, the draw-off valve proved ineffective when attempts to drain off and burn some of the material from the acid sludge-filled pond were made. This pond was backfilled and capped with boiler ash.

Having failed to deal with this material and not wishing to have a permanent acid sludge pond or to admix the sludge with other liquids, deliveries were redirected to Campbells Quarry. Here backfilling had continued to close in and cover the liquid waste, but there still existed a large area of hole. This provided a limited life site, an existing and relatively isolated one.

Whereas this first problem child was only delivered at an average rate of 4 to 8 000 litres a week, the second was a problem by sheer size.

Cotton seed acid oil A dark brown oil and water residue from edible oil manufacture. This liquid waste constituted the largest single waste disposed to the waste site - some 400 000 litres per month. On average 60% of the liquid waste delivered for disposal. It was to provide holding capacity for this waste that a further pond 40 m. x 60 m. x 1,5 m. was created. With the creation of this pond sufficient capacity for immediate needs was provided.

In September, 1981, with the introduction of a charge for liquid waste disposal ($1 per 100 litres), it was hoped to introduce a realistic disposal cost into the thinking of Industry and provide finance for future development.

Further methods of disposal were examined and actively pursued. Oily waste from the first and second ponds, and cotton seed acid oil from the third large pond were shown to be combustible. Due to the open nature of the burning tests, the temperature required for a clean burn was not obtained, and an unacceptable black smoke given off. The water content and low temperature caused the expansion and contraction of a water content bubbling effect across the oil surface which extinguished the flame. Where the burning continued, a crust of unburnt carbon gradually formed which also acted to extinguish the flame. An experimental incinerator was considered necessary.

Those liquid wastes containing high solids but little fat were capable of dewatering on either evaporation ponds or sand filter drying beds. From 1976 and perhaps earlier, diatomaceous earth slurry was the largest single waste of this kind, approximately 40 000 litres

per month being delivered throughout the period. In September, 1981, the company said it was their intention to dewater by filter-press; this process has been operational since October, 1982. The liquid waste disposal site continues to receive periodic loads of a similar waste from our other oil expressor.

Large consignments of tannery waste had been received containing various mineral and metallic salts, skinfibre, hair and fat. With the introduction of the disposal charge the company attempted to dry the waste in their own premises but the results were not very satisfactory. Delivered as dry waste to the Kelvin Road disposal site it was complained of as being too wet and smelly. The waste fat, skin and larger solids have been redirected for burial in the detritus trenches at Firle Sewage Works. The fibrous waste dries well in evaporation ponds and some possibilities for re-use either as fuel, humus, or in the creation of leather paper are being examined by the company and the department.

Council receives quantities of liquid waste from a food processing company. It is highly organic and has a solids content well in excess of Council's limits which may be put to sewer. Evaporation or filtration of this waste could prove satisfactory. The possibilities of burning the dried waste or using it as an animal feed are to be examined. By admixing this liquid waste in the Western Evaporation Pond with inks and solvents, it was found that no fly breeding took place in what was highly organic matter.

The problems posed by the cotton seed acid oil have been actively pursued with the company. Their use or sale of it as a fuel or fuel additive and the reduction of volumes delivered by the introduction of a dewatering process resulted, in June 1982, in a successful attempt to reduce volume.

By boiling off the acid oil and removing the water to sewer, the company has effectively reduced deliveries by 60%. The cotton seed acid oil presently delivered contains between 3 and 15% water by mass, as opposed to 60 to 70% previously. The water content varies with production throughput, where time and available plant require the curtailing of the dewatering process. It is envisaged that within the next two years the dewatered cotton seed acid oil will be used as a boiler fuel if not required in soap manufacture.

The question of volume reduction was first tackled as one of necessity at Western Liquid Waste Disposal Site. Deliveries as well as rain filled the first and seconds ponds to unacceptably high levels. The partial emptying of these ponds became vital to the life of the site during the latter part of the rains in March, 1982.

Incineration of the fatty matter had proven to be impracticable. Dry material in the form of cotton seed hull had failed to soak up sufficient surface oil, or sink to form a solid mass, which might be removed. However, at the edges of these ponds where several loads of hull could compact, it was found that water was permitted through to a hole dug in the hull, whilst the hull prevented the oil and fatty matter from penetrating to this pumping hole. What had happened was the separation of the solids, water and oil within these ponds. The water had a highly organic content, and the surface oil seal created conditions similar to those in an anaerobic pond or septic tank. The active organic content in the water meant that under the surface crust of fat, the oil was being agitated. It was realized that any attempt to drain the water must be carefully monitored for oil content, if put to sewer.

The draining and emptying of the first pond was agreed. Water from this pond was to be pumped into the second pond. Plant and vehicles were brought in, and as the water was pumped out at one end, earth and hull were mixed with the oil and solids at the other. These mixed solids were dug out and taken to the solid waste site.

Pumping the second pond was done to sewer. Its size, and the lack of plant and finance meant that no removal of fats by admixture of dry solids was attempted. The pond level was reduced by 0,5 m. or approximately 1 200 000 lt. of water put to sewer. The third pond was reduced by a similar amount a month later. This third pond had received only materials delivered from edible oil/soap manufacturers, i.e. cotton seed acid oil, gum residues, interceptor wastes and some diatomaceous earth slurry.

The second and third ponds were re-filled by November, 1982, mainly with cotton seed acid oil and have proved incapable of being pumped to sewer due to their high oil/fat content.

The mineral oil refinery acid sludge, which had been deposited in the back-filled Campbells Quarry until August,1982, was added to the refilling of the second pond. This simply added to the speed of fill, and final closure of the large ponds

at Western in November, 1982.

Addressing ourselves to the problem of the disposal of "acid sludge", a number of methods have been investigated.

Neutralisation, which the company regards as too expensive, but which could give Council an acceptable waste for disposal continues to be a last resort.

Incineration, admixture with other materials, a straight disposal to land with the addition of lime, are alternatives used elsewhere in the world. Selling the waste acid back to be used in fertilizer is apparently a non-starter. Incineration has been tried by Council, and should the present experimental incinerator prove successful in burning the acid sludge, the company have offered a material in a holding tank, which would break up any polymerisation thus giving the Department a thin liquid to burn.

Admixture with asbestos concrete waste has been found practicable in New Zealand. There, a company of the same group contracts to combine their acid sludge with asbestos concrete slurry from a nearby plant. This is not possible here since the asbestos fibre waste from the local company is both dry and has no concrete content. Acid sludge has been admixed experimentally with boiler ash, cotton seed hull, and dried diatomaceous earth waste. With none of these local wastes did it form more than a partial amalgam.

Disposal to land with the addition of lime is unacceptable. The consequences of large deposits of acid sludge can neither be assessed nor easily controlled.

Since November, 1982, the acid sludge and all the edible oil and soap wastes have been admixed with dry waste deposited at Council's new solid waste site at Pomona. Hopes have been expressed that the sulphurous content of the acid sludge may combine with the ironstone content of the soil. It must be stressed that the disposal of acid sludge by adding it to landfill is very short term. This admixture of materials is considered as regrettable but necessary, since alternative disposal methods are yet to be found or become operative. The liquid waste is being backfilled load by load and cover applied immediately; smell is thus eliminated. There are risks of both surface and sub-soil water contamination but these appear minimal in the present disposal area.

Council has constructed a small incinerator, two evaporation ponds, two sand filter drying beds and a garage oil and water separator at the Southern Sewage Works off Cripps Road. Preliminary tests and experimental loads have already been examined, and the facility should begin to provide further answers to liquid waste disposal in December, 1982.

Since September, 1981, it has been part of the function of the Noxious and Toxic Wastes Officer to assist in the disposal of chemical wastes. A number of these have fallen into the category of re-usable materials.

Outdated herbicides and insecticides have been collected and used by Divisions within the Department. By increasing the dosing rates they have been effective, and saved Council funds.

Waste acid containing ferrous sulphate has been utilized in separating the mineral oil from the water of garage wastes. The same material was used to render waste cyanide innocuous by the creation of ferrous salts.

Companies wishing to rid themselves of old or spoilt stocks of copper, sulphur and mercuric compounds have been found companies willing to buy these "wastes" or to take them at no cost for re-use.

It can be fairly said that Council's approach to the disposal of liquid waste, and indeed to all hazardous materials, is now a positive one. That facilities for disposal should be improved is undeniable, and given time, finance and expertise Council, in co-operation with Industry, will provide them.

9th WEDC Conference: Sanitation and water for development in Africa: HARARE: 1983

FISH PRODUCTION IN WASTE STABILIZATION PONDS

by BRIAN S MEADOWS

INTRODUCTION

Algal stabilization ponds are now being adopted as the main method of sewage treatment for water-borne sanitation in most tropical and subtropical countries wherever feasible. The adoption of ponds for treatment has been particularly marked over the past two decades - in Kenya, for example there were four systems in 1962, seventeen in 1972 and 52 in 1982. Algal ponds offer the possibilities for the intergration of aquaculture and sewage treatment. Reports of fish surviving in ponds, either occurring accidentally or deliberately introduced are numerous but the commercial exploitation of fish for human consumption grown in algal stabilization ponds, built on basic public health engineering designs for sewage purification, has never beer exploited to any significant extent despite the fact that, albeit outside of Africa, sewage is recycled to fertilize fish ponds in many parts of the world - and has been since antiquity. The practice of building latrines over ponds or the addition of sewage-enriched flood waters to commercial fish ponds are cases in point.

Reports of fish surviving in maturation ponds are frequent in the literature. The majority of published papers, however, are reports of studies to assess the effect of introduced fish on water quality improvement (1) but some relevant fish production data is available - for example Sreenivasan et al (2) indicates possibilities of producing 9500 kg/ha/yr (Common Carp Cyprinus carpio and Tilapia sp.) in India from a maturation pond. More recently Edwards et al (3) have obtained extrapolated yields approaching 20 tons/ha/yr in fish ponds receiving the effluent from a high rate stabilization pond over a 3-month growing season. Both the last two studies were, however , carried out at institutional establishments; there is a dearth of information on survival of fish in facultative ponds, as distinct from maturation ponds, and in municipal ponds. Until such data becomes available public authorities will be unwilling to design works capable of combining fish culture and sewage purification. As part of a wider study on the evaluation of pond design criteria in Kenya - mainly carried out between 1977-80 - some observations on fish survival in ponds was also obtained. An outline of the data obtained is followed by a discussion.

MATERIAL AND METHODS

Ponds in Kenya are normally built in series with primary facultative ponds, which may or may not be preceeded by anaerobic treatment, designed to give a pond Biological Oxygen Demand at 25°C, inclusive of algae, never exceeding 75 mg/l, secondary facultative ponds give a pond B.O.D of 25 mg/l and followed by maturation ponds to produce an effluent with a faecal coliform count of less than 1000 per 100 ml.

At the town of Thika (1°03'S, 37°05'E) sewage is treated by anaerobic, primary facultative (dissolved O_2 range 0-20 mg/l), secondary facultative (O_2,1.2-26 mg/l) and maturation ponds. Further technical data is given elsewhere (4). Tilapia nilotica, which is an algal feeder, and a highly suitable fish for African aquaculture, were introduced into secondary facultative ponds as fingerlings. They were cultured in cages in order to ease sampling and to eliminate predation. Each cage, which had a metal framework, measured 90cmx90cmx100cm. Survival rate was over 95%. Figure 1 shows the results of growth rate at two stocking densities during 10 week growing season. At the lower stocking density growth data is available for up to 20 weeks.

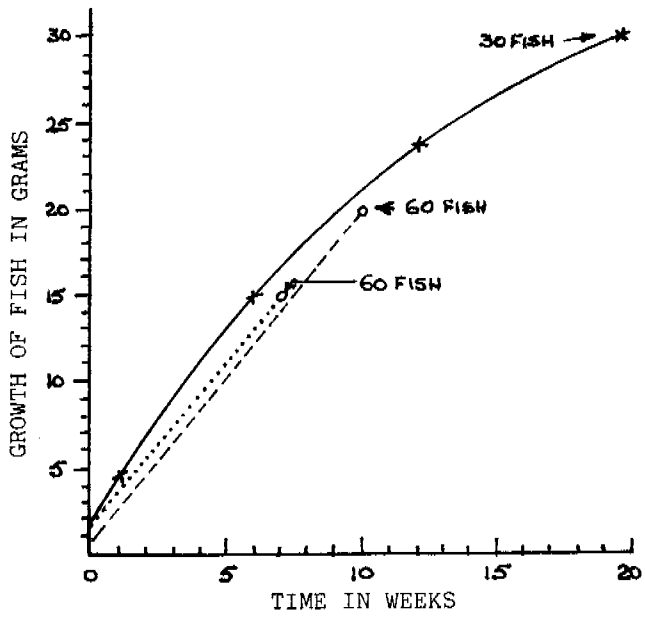

Figure 1: GROWTH RATE CURVE FOR TILAPIA NILOTICA IN SECONDARY FACULTATIVE POND

In addition to the Thika site fish were introduced also into the secondary facultative and maturation ponds at Kisumu (0°06'S34°45'E) At both sites fish were screened for chlorinated pesticides and heavy metal residues and

compared with levels from natural waters.* Fish, particularly those from stabilization ponds contained D.D.T. and metabolites D.D.E. and D.D.D. Trace levels (max 0.011 mg/l) were found in fish tissues from natural sources, and at a fish hatchery (max.0.026 mg/l). In contrast, levels of D.D.T. in fish from Kisumu stabilization ponds were significantly higher (0.06-0.3 mg/l = 17-48 mg/l on fat basis). No significant levels of other pesticides were detected. Fish livers from ponds ranged from 39-199 mg/l Zn and 0.6-2.6 mg/l Cd. Lake Victoria sample also contained 45 mg/l Zn, 3.1 mg/l Cd and possibly Hg at 0.45 mg/l. No Cr, Pb or Hg was detected in samples from stabilization ponds. Liver-weight ratios from fish in Kisumu ponds averaged 0.9 (as % liver/total wt.) and 0.5 from Lake Victoria.

DISCUSSION OF RESULTS

Fish at Thika and Kisumu have grown satisfactorily and background levels of D.D.T., although elevated, are still within acceptable limits. The influent to both pond systems is predominantly domestic (currently 100% at the Kisumu ponds). The possible sources of D.D.T. which appears to have accumulated in fish from the ponds could arise from excreta, waste water washings from vegetables and fruit, and from laundry wash waters. A sample of maize meal purchased in Kisumu was found to contain 2 mg/l of D.D.T. and another sample collected at Nakuru (0°22'S, 36°05'E) 1 mg/l.

The liver/weight ratios do indicate that the fish growing in ponds are slightly more stressed than those in natural waters; this could be an effect of dissolved oxygen levels.

At Thika (Common Carp Cyprinus carpio) and Tilapia sp.were kept in continuous culture in the maturation ponds at Thika for over 7 years; there have been two fish fills involving up to 50% of the carp population but never Tilapia. Tilapia have similarly been stocked for a six year period in the secondary facultative and maturation ponds at Kisumu without any reported mortalities. If Tilapia and especially Tilapia nilotica can be grown apparently successfully in ponds; what is holding up further development?

Allen and Hepher (5) in a global review listed the following restraints for wastewater fish culture: dissolved oxygen levels in ponds, toxic materials in wastewaters, tastes and odours in fish, fish parasites and diseases, public health problems, pond effluent standards and public acceptance. In an African context and specifically for algal stabilization ponds, and particularly with current and planned municipal schemes in mind, the following will be important:-

Human disease transmission.
Poor operation and maintenance of sewerage systems.
Difficulties in obtaining good fish stocks.
Public acceptance.
Frustrations with existing pond designs.

Human disease transmission.

This is probably not a problem but to convince public health personnel that it is not will be difficult; it must rank as the main constraint.

Janssen(6) reviews a considerable amount of literature dealing with this subject. All the available evidence indicates that, unlike warm blooded animals, fish normally do not suffer from infections of Salmonella, Shigella or other enterobacteriacea. The problem, however, is the risk that pathogens may be carried passively by the fish and so serve as vectors. By allowing a depuration period the risk can be minimized; Buras (7), however, working in Israel, found that despite a 7-day depuration period there was no reduction in the faecal coliform concentration in the flesh of the fish grown in ponds fed with raw sewage although there was a significant reduction in blood and a slight reduction in organs. Nevertheless she was not able to identify any human enteric viruses in fish flesh. It is quite clear, however, that public health authorities in Africa will insist on data being carried out in their own region rather than rely on overseas work. At present there appears to be a complete absence of such information. A major constraint to obtaining it is the lack of laboratory facilities, especially for virus identification in many countries.

Standards based on faecal coliform levels have been suggested; for example Shuval (8) quotes a figure of 10 faecal coliforms/100ml for fish culture but for most countries in Africa such a standard cannot be enforced and without other background information, such as the existing health of the population, this standard becomes meaningless anyhow. Buras (7) found no correlation between faecal coliform bacteria, salmonella or human enteric viruses in raw sewage. Since most rivers in Africa are faecally polluted the risk of eating fish grown in treatment plants, where the water has already undergone settlement and, in the case of ponds, several days' retention, may perhaps be less than taking fish from rivers: although often unrecorded in statistics riverine fisheries are probably significant on the African continent.

The attitude of some donors has also been extremely conservative to wastewater reclamation.

*Analytical procedures and detailed results are available from the author.

To overcome the disease risk it has been suggested that fish from waste stabilization ponds should be used only as animal food, e.g. to chickens, or as a feed for "luxury" fish or crustacea.

Poor operation and maintenance of sewerage systems.
In the immediate future the economic situation for most African countries is bleak and the expense of maintaining, operating and augmenting existing water-borne sewerage systems may prove extremely difficult. In addition policies of governments, such as the desire to distribute industries outside of the capitals, is leading to a situation where few municipality works are now treating solely domestic sewage. Algal stabilization ponds are suitable for purely domestic sewage (4) but are proving far from ideal for industrial effluents and especially for industries, such as tannery and textile mill wastes, which are two types of industries being rapidly developed in Africa. In Kenya the number of tanneries and textile mills established in the country - and both industries produce a wide range of waste flows - has doubled in the past decade and most have been established in the smaller towns. In Kenya trade-effluent control within the sewerage system is the responsibility of the local authority albeit this is currently under review; few local authorities in Africa will be able to recruit the calibre of manpower needed to effectively control trade-effluent discharges. Most of the problems at present, are arising from pond overloading and the adverse effects of sulphides in the case of tanneries; as far as textile mill wastes are concerned the effects of dyes are serious. One case in Kenya showed that although the dye waste was less than 5% of the total flow this inhibited photosynthesis by over 70%; the dye waste was non-toxic but partially inhibited light penetration in the water columns. Non-point pollutant sources - detergents being the obvious ones - are generally not a problem in developing countries although in Israel they have mitigated against utilization of sewage effluents in some situations. *In the writer's view if fish culture could be successfully exploited, say by a co-operative or private organization, paying a rent to a local authority the incentive to maintain municipal sewerage systems in the future could be assured.*

Obtaining fish stocks.
Obtaining good stocks of fish is likely to be a problem in many African countries. Regretably, many Government fish farms do not supply healthy stocks of fish and cannot maintain hybrid or unisex stocks. Reliable commercial suppliers are, however, available in some countries.

Public acceptance.
This certainly does not appear to be a problem in fish-eating communities in Kenya, even amongst the well-educated strata of the population who are well aware of the source of the fish. At the experimental site at Thika and at a pond system in Kisumu, which is adjacent to Lake Victoria, it has been extremely difficult to stop local fishermen from seine-netting the ponds at night. Many African communities are, however, not yet adapted to a fish diet and it would probably not be wise to introduce sewage-grown fish at the outset.

Frustrations with existing pond designs.
The message of this paper is to utilize *existing* pond systems for fish culture and this does seem feasible.
It must, however, be recognized that to a fish farmer the existing designs are far from optimum for such a purpose.
Economic assessment will have to be undertaken to decide if additional construction costs are merited: this will include options for draining and providing fish collection basins in the centre of ponds and the provision of aerators with sensors to detect abnormal dissolved oxygen levels. Most fish culturalists would also like to see larger ponds than the present sanitary engineering designs allow.

CONCLUSIONS.
Preliminary studies indicate that the survival and growth rates of Tilapia nilotica in secondary facultative and maturation ponds now merits a detailed assessment of the possibility of combining fish food production and sewage purification.
The main constraint at present to any form of further development of utilizing sewage for fish culture is the lack of data on possible human disease transmission in an African context and until this is obtained public health personnel will not officially endorse the practice.
There is, in the author's opinion, a real and serious possibility that in the future local authorities will be unable to effectively maintain the many sewerage schemes which have been constructed during the past two decades or so. The possibility for collecting a substantial revenue from fish production could be the financial incentive to an improved operation and maintenance.

ACKNOWLEDGEMENTS.

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Mr. E.O. Nyaga, Project Hydrobiologist, was responsible for collecting data on fish survival and pond performance, and Miss M. Keating, Consultant Analyst, for the pesticide residue analysis. Mr. D.M.Kirori, Director of Water Resources, Ministry of Water Development, Kenya, facilitated the work programme to be undertaken.
Views expressed in the paper are those of the author.

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Session 2

Chairman: Mr R D Faulkner, WEDC, Loughborough University of Technology, U.K.

Discussion

F C Cox

Phoredox activated sludge unit at the Firle sewage works, Harare

1. Engr LONGLEY, by way of introduction to Mrs Cox's paper, presented the following comments on the operational advantages and experience of wastewater nutrient removal plants in Zimbabwe.

2. When water pollution control regulations were introduced into Zimbabwe some years ago it was found necessary to dispose of sewage effluent by irrigation onto land as none of the existing methods of treatment could economically provide a standard of effluent which could be returned to streams and dams. The introduction of biological nutrient removal by the modified activated sludge process has changed the situation quite dramatically.

3. It was at once obvious that the ability to return effluent to public streams would be a big advantage over disposal by irrigation but some of the indirect advantages are only now coming to light.

4. One major advantage is the increased effective yield of a river system which can be obtained by recycling. This is not just a once through process; ie. if 50% of water abstracted is returned as effluent then that also can be abstracted, 50% of that returned and so on. Mathematically this is equivalent to the sum to infinity of a geometric series, $1/(1 - r)$ for the conditions under consideration. The benefits are therefore:-

Recycling Ratio, r	Yield Ratio
0,0	1
0,25	1,33
0,50	2
0,75	4

5. There are insufficient long term records in Zimbabwe for a reliable value to be placed on r but indications are that it could be of the order of 50%, giving an effective doubling of the yield if the effluent is returned into a storage dam of adequate size upstream of the abstraction point. This yield increase is obtained without appreciable additional storage costs and without appreciable evaporation losses. It can almost be looked on as doubling the catchment rainfall with the added advantage that it is reliable and not subject to vagaries of the weather. Most large towns in Zimbabwe lie on the watersheds. New water sources are therefore usually located long distances away involving not only long pipelines but very much higher pumping heads. An increase in yield approaching 100% is "manna from heaven" indeed. It radically changes development planning trends too in that objections to effluent disposal within the water supply catchment are now not only nullified but reversed.

6. Another advantage of a completely different nature which has come to light is that it is no longer necessary to site sewage works where there are large amounts of vacant land available for effluent irrigation or alternatively to build long effluent pipelines to suitable irrigation sites. A sewage works situated within an urban area can now discharge effluent into a public stream safely and without causing nuisance. One Zimbabwean town has found that by doing this with a sewage treatment works which is situated within the industrial sites the present heavily loaded effluent outfall sewer can be released to carry new raw sewage loadings, thereby avoiding the cost of duplicating the trunk sewer through urban areas. Effluent from the works will now be disposed of to a public stream without fear of eutrophication and consequent problems. The same applies to other municipalities in Zimbabwe where the construction of nutrient removal plant within urban areas will reduce the loads on existing sewers.

7. These two examples illustrate that it has been found possible to introduce a new dimension in water supply and wastewater planning in order that infrastructure growth does not place a crippling load on capital availability. Previously effluent was a necessary evil which had to be disposed of somehow at minimum cost. The ability to construct and operate reliable and economic nutrient removal works now makes it a by-product which can be disposed of without much difficulty and in many cases even a resource which can be very profitably recycled.

8. Mrs COX described the operating principles behind the modified activated sludge unit and presented results, paying specific attention to the removal of ammonia and phosphate.

9. Mr WHITE commented that although most of the nutrients were removed from the effluent, a small quantity remained; would this cause algal blooms downstream of the discharge point in the reservoir?

10. Mrs COX replied that previous problems in the reservoir were due to the discharge of percolating filter effluent. Very little phosphorous was contained in the effluent from the present plant, and input from run-off was likely to be the main source of phosphorous.

11. Engr KEELING asked whether the process was effective in removing worms from the sewage.

12. Mrs COX did not know, and it was suggested that the veterinary services could be of assistance in this matter.

13. Dr ADEYEMI enquired whether the F : N ratio caused many problems.

Mrs COX confirmed that the fact that the F : N ratio was too low may well have contributed to operational problems.

J D Milne

Water and sewerage in housing development

14. Mr MILNE described the background to housing development in Bulawayo, the provision of water, and the disposal of wastewater via a sewerage system and treatment works. Some design criteria were presented.

15. Mr DYER asked whether the high construction rate of 5000 houses per year could be continued, and if not, what sanitation provisions could be made for squatter areas.

16. Mr MILNE replied that the present construction rate could be continued with the aid of a World Bank loan; sewerage would continue to be used.

17. Engr OBADINA stated that Mr Milne's paper had been of great interest to him, and made the following observations: the Town Planning Authorities should have ensured that no houses could be constructed within a certain distance of the waste stabilization problems, to avoid odour nuisance. This problem occurred in several countries. It was unfortunate that in many cases designers were recommending sophisticated treatment processes, often as a result of legislation; the capital and operational costs were high, and spare parts may not be readily available. A recent survey in Nigeria (1982) revealed the following maintenance costs:

stabilization ponds	Naire	0.70	/head/annum
percolating filters	"	4.28	"	"
activated sludge	"	5.25	"	"
package plants	"	7.17	"	"

(1 Naire = US$ 1.50)

18. Mr MILNE thanked Engr Obadina for his comments, with which he concurred. The Bulawayo Town Planning Branch were carried away in their zeal to provide housing sites, and forgot about the atmospheric pollution problem from the waste stabilization ponds. There was a place for all types of sewage treatment, and providing that land was available, ponds could treat the sewage from up to 10,000 houses; the effluent could be absorbed in tree plantations which provide a useful source of firewood and fencing posts.

19. Mr HARRIS commented that waste stabilization ponds could be used successfully to treat sewage from populations of hundreds of thousands; he did not agree with the comments that the maximum population was about 60 000.

20. Professor NATH added that the relevant factor was competing land use, in view of the large land requirements of waste stabilization ponds.

21. Mr WILSON asked whether the Bulawayo housing program catered for all of the population, and if not, how were the lowest income people housed? Were rents affordable to all, or were subsidies provided, and what was the default rate in payment? He also wished to know if non water borne forms of sanitation were considered for high density low income housing areas.

22. Mr MILNE stated that the housing programs covered the whole population. The lowest income groups were allocated older houses which had cheaper rents, and tenants were encouraged to sub-let rooms. There was no subsidization, but default rates were low. Water borne sewerage was considered to be the only satisfactory answer to sewage disposal in high density housing.

23. Mr SPENCER referred to statements about squatting pans no longer being popular; how had this information been obtained and from whom?

24. Mr MILNE stated that the views of the people were considered.

K J Nath, P K Chatterjee, S K Dasgupta and D M De

Urban solid waste: appropriate technology

25. Professor NATH presented the paper in

which he highlighted the existing status of solid waste management in small and medium towns in India, and described the results of pilot schemes carried out in six municipal wards of Calcutta, and recommended suitable collection and disposal methods.

26. Dr ADEYEMI asked whether the waste had been analysed, and how this affected the costings, bearing in mind that disposal methods and sites may be different for different types of waste.

27. Professor NATH answered that the physical and chemical characteristics of the waste were assessed, and that composting and sanitary landfill were felt to be the most cost effective treatment alternatives.

28. Professor OLUWANDE thought that the simplified approach for the collection, transportation and disposal of solid waste outlined in the paper was appropriate, but would it be cost effective in countries where labour costs were high? Would it be possible for householders to deposit waste directly into transfer depots, from where mechanical devices could be used, to reduce the labour costs?

29. Professor NATH replied that the collection and transportation were aimed at reducing the labour requirement, but that the labour intensive disposal methods may not be cost effective in countries where labour costs were high. Communal containers must be near to dwelling places in order to be used; even if the number of transfer points were considerably increased, thereby adding to vehicle and fuel costs, they could not serve the purpose of communal containers as suggested.

J B Keeling

Disposal of toxic and industrial liquid waste in the city of Harare, Zimbabwe

30. Engr KEELING described methods of disposal for a variety of industrial wastes, including sludge from mineral oil re-processing, and cotton seed oil, and outlined some of the problems of dealing with the waste material, and emphasized the requirement for positive attitudes on behalf of both the Council and industry.

31. Mr BALL observed that whole seed cotton and cotton seed hull were good for stock feeds; he asked how much unneccessary waste occurred, and how much muscle the council had to stop it.

32. Engr KEELING agreed, and said that persuasion often limited waste, with a little muscle being used in difficult cases.

33. Mr UNDERWOOD asked what impact the waste dumps had on the surrounding area, for example ground seepage and evaporation on nearby crops and vegetation. He also wished to know what measures were taken to prevent children and onlookers from coming harm, especially in the case of the acid pits.

34. Engr KEELING replied that test holes had been dug but not extended due to the proximity of plots, which had shown no noticeable deterioration. A nearby canal had shown no signs of pollution to date. The area had been fenced in securely, and the site which was now no longer used for liquid waste was being backfilled with solid waste.

B S Meadows

Fish production in waste stabilization ponds

35. The author had not been able to attend the conferences and the paper was not presented.

9th WEDC Conference: Sanitation and water for development in Africa: HARARE: 1983

THE IMPLEMENTATION OF URBAN AND RURAL SANITATION PROGRAMMES IN BOTSWANA

by JAMES G WILSON

1 INTRODUCTION

Over the past few years many papers have been published and presented which have focused upon the merits and demerits of various low cost sanitation technical options. Quite a few have been based solely upon theory and therefore this paper has been written to redress this situation by concentrating upon the existing and proposed methodology, costing and experiences gained by the Botswana Government in implementing both urban and rural low cost sanitation programmes since 1980.

2 URBAN SANITATION PROGRAMMES

In 1979 the Building Research Establishment in the UK developed an experimental double ventilated improved pit latrine which was referred to as the "PIP latrine" (Permanent Improved Pit latrine) (ref. 1). Subsequent discussions with the Ministry of Local Government and Lands in Botswana led to its adoption as the sanitation unit in an urban squatter area upgrading programme in Gaborone. In Botswana this type of latrine is referred to as the REC II (Revised Earth Closet II) (ref. 2). The construction of some 1700 REC II units as part of this upgrading programme proved invaluable in the subsequent implemention of site and service sanitation programmes. The features of the REC II have been referred to in the past in other publications (ref. 1, 2 & 3). The main advantage from the recipients point of view is that it allows continuous sanitation facilities even though one pit may be full by alternating to the second pit and from the local authorities point of view it allows flexibility in emptying and the handling of a harmless and inoffensive content.

The cost of constructing the REC II substructure in 1980 was comparable to the existing ROEC latrines at P275 (1 pula = £0.60 or US $ 0.95, December 1982) and considered technically superior to them. It was also considerably less expensive than the aqua privy which was being introduced at that time.

Early observations indicated that there was a need for both health and user education campaigns together with suitable legislation and improvements to the design before further implementation of similar sanitation programmes could take place.

It was seen for instance that even though a REC II Substructure had been constructed on each plot there was a very slow response from the plot-holders to complete the superstructure and use the latrine (ref. 2). It was decided that a health and user education campaign be started by the Self Help Housing Agency (SHHA) to overcome this problem. Other problems to be overcome by this means were (a) claims that the pits were too shallow and would therefore fill too quickly (b) the misuse of the unit mainly by children who would remove the cap and defecate in the unused pit and (c) the habit of pouring wash water into the pits and thereby flooding them (ref. 2). At the same time the latrine slab was altered to incorporate fixing points for a gum pole framed superstructure. The purpose of doing this was to encourage superstructures to be built of materials which the plot-holder might find more financially attractive. To underline the importance of completing and using the sanitation units it was also decided to introduce as part of the agreement between the plot-holder and the SHHA the legislation that the plot-holder had to complete the superstructure to SHHA's approval within three months of signing the certificate of rights or face the possibility of repossession of the site. This had to be carried out in advance of the construction of the house though the construction of temporary accommodation was permitted.

A building materials loan is available from the SHHA and currently the materials cost of a cement brick latrine superstructure is approximately P185. This compares with P564 for the cost of materials to build a basic one room house. The plot-holder is limited to a maximum building materials loan of P800 which must be payed back at an interest rate of 9% over 15 years. The sanitation superstructure at P185 will therefore represent a repayment of P1.90 per month.

Monitoring of the original REC II substructures has revealed that it is essential that they are block lined except

when constructed in hard pickable material. A subsequent redesign of the substructure has resulted in both the lined and unlined substructures costing approximately the same amount. This has been achieved by slightly reducing the plan area of the lined version and at the same time it has also been found that the increased costs due to the lining has been offset by savings made by omitting the reinforced concrete ring beam which is now used only on unlined versions. The current (November 1982) lined REC II substructure costs P310 in Gaborone (see table 1) to construct and this represents a repayment by the plot-holder of approximately P3.00 per month or approximately 25% of his monthly levy rate which represents SHHA capital and recurrent costs which are recovered at a rate of 8% over 25 years. It does not include repayment of the building materials loan but the total monthly levy rate of approximately P12.00 does include a service charge of P0.75 to cover the cost of emptying and maintaining the REC II substructures.

One successful method that has been introduced to reduce the overall total cost of the REC II substructure has been to split the contract into two distinct parts. The excavation or groundwork is let out in 50 or 100 unit lots to small contractors. They usually employ manual labour as opposed to expensive machinery and have very low overheads. Incentives or targets are introduced to encourage these contractors to vie for additional contract lots. A very realistic contractual price is usually achieved. The second part of the contract is tendered for by larger contractors who have precast concreting facilities. They tender to precast the latrine slabs and deliver to site where the small contractor will place them. This is an attractive contract to the larger contractor and is usually let in units of 1000 or 1500 at one time. Again a realistic contractual price is usually achieved and by employing this method construction rates of 12 complete slab units per day and 18 complete ground work units per day have been achieved. Over a sixteen month period in Selebi Phikwe for instance some 3500 complete REC II substructures have been constructed.

A high rate of construction is essential to prevent potential squatter development as it is also a legislation that no plot will be allocated unless there is already an approved sanitation substructure constructed on it.

At this rate of construction it is also essential that proper supervision of the contractors is maintained. In order to achieve this the SHHA technical assistants responsible for contractor supervision attend periodic construction training

TABLE 1 COMPARATIVE COSTS OF REC II SUBSTRUCTURES

LOCATION OF REC II SUBSTRUCTURES	TYPE	LOWEST TOTAL COST OF SUBSTRUCTURE			
		NOV 1980 Pula	NOV 1981 Pula	MAY 1982 Pula	NOV 1982 Pula
GABORONE	Lined				310
	Unlined	275			
FRANCISTOWN	Unlined			314	
SELEBI PHIKWE	Lined		286	322	
	Unlined			302	
JWANENG	Lined				556

1 Pula = £0.60 or US $ 0.95 December 1982.

NOTE: 1) The current 23% increase in cost at Francistown, some 450 km to the north of Gaborone, is due to transportation costs.

2) The current 79% increase in cost at Jwaneng, some 200 km to the south west of Gaborone is due to a combination of both transportation and contractors localised increased costs.

courses held in conjunction with the local Polytechnic.

3. RURAL SANITATION PROGRAMMES

Approximately 80% of the population of Botswana (936,000 preliminary figures 1981 National Census) live in the rural areas. The average population density is 1.5 persons per square kilometre. To implement successful rural sanitation programmes in these conditions calls for considerable planning. This situation is aggravated even greater by the rural tradition whereby the villagers leave their villages for the "lands" for approximately two thirds of the year. The "lands" may be up to 30 km away and distributed around the village. Timing is therefore very important if one is to initiate any sort of campaign otherwise one may find if one mistimes the commencement of a programme that there are no recipients. To locate the recipients and initiate campaigns at the "lands" is not feasible.

A rural pilot project was initiated in six villages which was aimed at improving public health through multi-media health education and improved sanitation systems. It was found that in order to initiate a successful project great emphasis must be placed upon social acceptability, affordability, and a willingness by the recipient to participate on a self help basis.

The villagers were involved from the commencement of the project with decisions relating to social preferences and acceptability of technical options. A variation of the ZIMVIP (ref. 5) latrine was used and it was interesting to note that contrary to findings in Zimbabwe the social preferences in Botswana were for square shaped superstructures with doors and the use of a seat rather than squatting.

Social surveys were carried out to establish the maximum level of affordability of the majority of recipients. This was found to be in the order of P26.00. The real total cost of the latrine, including all materials, labour and transportation was estimated to be in the order of P190.00 which could only be afforded by 3% of the rural population (ref. 4). It was therefore established that a large subsidisation element must be present in order to successfully carry out rural sanitation programmes.

Another key factor to the successful implementation of rural sanitation programmes has been the use of existing cadres such as the village based family welfare educators and assistant community development officers. Being village based their advice is far more readily acceptable to the potential recipient that say a representative from the District Authority or Central Government.

Current Government policy states that rural sanitation programmes will be implemented on a district by district basis and when the individual district feels that it is capable of carrying out the work.

The implementation procedures have now been drawn up in the form of a District handbook based upon the findings of the initial pilot project. To date three of the ten districts have put forward their sanitation proposals and implementation plans covering the next five years. This it is hoped will cover 40% of the rural population and multi lateral donor funds have been secured to subsidise and assist these proposals. It is anticipated that the other districts will follow suit in the near future provided suitable funds can be made available.

Only now, having established the capabilities of the districts, the acceptable technical solutions, the level of affordability and an efficient delivery system, can long term rural sanitation programmes be implemented with confidence.

CONCLUSIONS

In both the urban and rural cases it is believed that the correct technical and socially acceptable sanitation solutions have been adopted. The question mark however lies over affordability. The Author firmly believes that an equitable sum must be payed by the recipients for their sanitation units. This will lead to a commitment on their behalf which, provided prior consultation with them regarding social acceptance has already been made, will be an important factor in the continued correct use and maintenance of the units. Obviously health and user education are also very important but is has been seen in some countries that where the sanitation units have been constructed at no cost to the recipients they have quickly fallen into misuse and disrepair even though health and user education campaigns have been carried out.

Surveys have shown (ref. 4) that in the rural areas the maximum amount that people are prepared to pay for their sanitation units lies between P20.00 and P30.00. The current real full cost of the rural sanitation unit is in the order of P200 and therefore the difference must be subsidised by Government and or a donor agency. As domestic funds are becoming scarcer in Botswana a greater burden is being placed upon the donor agencies

to increase their proportion of the subsidy. The fact that a proportion of the real cost is recovered from the recipient and also that a self help element is introduced into the construction of the units shows a willingness and commitment by the recipient which might encourage the donor agency to think that its funds will be well spent.

In the comparatively more affluent urban site and service areas the situation is completely different. To date all the urban site and service sanitation projects apart from upgrading ones have been funded from domestic funds. The policy has been one of total cost recovery. The only form of subsidisation to the recipients has been the levying of a lower than economic rate of interest on the capital and building loans. Clearly, as construction costs of sanitation units increase together with the increasing costs of the other components parts making up the monthly levy rate, the ability of full cost recovery from the recipients in site and services areas becomes more difficult. Having standardised upon the type of sanitation unit to be used in site and service areas the Government is very reluctant to lower that standard.

An example of the lowering of standards would be the introduction of the single pit latrine to replace the double pit latrine. Government could justifiably be criticised by recipients for being discriminatory. From the technical point of view there are advantages to the local authorities in continuing with the double pit latrine, the main one being its flexibility with regards to emptying. Having allowed the contents of the full pit to mature and decompose for one year the local authority still has a further three years during which time it can empty the contents before the alternative pit is full. Even with limited resources and taking into account the inevitable mechanical breakdowns the local authorities will be able to maintain an efficient emptying service and at the same time always provide the recipients with sanitation facilities, using the second pit.

The situation will not occur if the single pit is reintroduced into the urban areas. When these pits are full the responsibility is placed immediately upon the local authority to empty them otherwise the recipient has no alternative sanitation facilities. Inevitably this form of emptying procedure will be on an ad hoc basis and will lead to an inefficient use of labour and plant and possibly the purchase of an excessive number of emptying tankers than required in order to compensate for mechanical breakdowns. The alternative is to dispose with an emptying service all together and to place the responsibility of relocating the sanitation unit when full on the recipient. This will not work in an urban environment. It assumes that all the recipients are capable and have the resources to carry out this relocation. It further assumes that those that are not capable of doing so, do have the funds available to pay others to do it for them. It does not take into account local ground conditions such as rock, sand or high water table levels which will require special skills to overcome. It further places unacceptable responsibilities upon the local authorities to supervise this work which is bound to be on a piece meal basis.

In conclusion there are still some problems to overcome in Botswana if the correct methods of implementation of sanitation programmes are to be maintained, taking into account current technical options, social acceptability and above all affordability. This is under constant monitoring and review by Government in order that an equitable solution is found and standards are maintained.

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WASTE MANAGEMENT IN URBAN SLUMS

by S A AMOANING-YANKSON

ABSTRACT The high rate of population growth in developing countries in recent times has created intricate sanitation problems which Governments can no longer ignore. The problem is further ascentuated by the constant drift of rural dwellers to the few Urban centres in search of jobs and other opportunities offered by Urbanization.

Urbanization and its concomitant housing problems have created the situation where Urban slums have become a regular feature of most Urban Centres. High population density, temporary structures used as living quarters and lack of proper sanitation are conspicuous features of these slums. The predominant method of excreta collection known to these slum dwellers is the night soil system. This paper examines some popular methods of excreta collection and puts forward another possible method of excreta Management in high density Urban slums.

INTRODUCTION

The Tema District Council in Ghana covers an area of 720km^2 and is not only one of the largest district council areas in Ghana, but also includes Ghana's only planned industrial city, in addition to extensive rural areas most of which serve as "domitory towns" for the cities of Tema and Accra. While Tema, the administrative centre has a central sewerage system, the high population density in the unsewered surrounding satellite slums create many problems for the District Council, among which is that of excreta management.

Various excreta collection systems have been tried and considered unsuitable for the type of urban slums the council has to deal with. For example, the aqua privy system has the disadvantage of limited capacity, while the night soil collection system, apart from the unacceptably high health hazard, tends to be rather expensive to operate, mainly on account of shortage of labour. Experiences both in Tema and elsewhere in Ghana have also shown that water closet system is unsuitable in the particular situations under consideration. The water closet system requires an expensive maintenance programme on account of improper use, particularly in respect of use of improper anal cleansing material. This system also requires imported items too delicate for use in such slums.

In its desire to improve sanitation in these slums, the Tema District Council in conjunction with a private contractor developed the Automatic Flushing Toilet. The salient features of this system are discussed in this paper.

FEATURES OF THE SYSTEM

Figure one shows details of the system, which consist mainly of a conduit serving various squating chambers, an automatic flushing device at one end of the conduit, and the superstructure.

The conduit consist of 200 mm bore precast concrete segments which are assembled on site. The upper arm of each segment leads to a squating hole. The flushing unit is a trapezoidal bucket, hinged near its centre of gravity into which water is allowed to flow. The bucket when full tilts and discharges its contents through a chute into the conduit. The rate of flow of water is regulated to ensure flushing once in every half hour.

Other features include a trap gulley which is provided to trap flushed solid particles and a syphon which ensures that odour gases are excluded from the squating chambers. A substantial part of the cost of the unit is invested in the superstructure. Current attempts at reducing cost include proposals to use mud-bricks for construction of the superstructure.

LOCATION OPERATION AND MAINTENANCE

Location of these units is so planned that each 20 - hole unit serves approximately fifty compound houses, each of which may contain as many as twenty people. This means that about a thousand people use one such unit. In the present areas of operation, walking distances are less than three hundred metres.

Routine maintenance consist mainly of the toilets being cleaned daily with hosed water. The tilting mechanism of the bucket also requires greasing once in every three months. It is proposed to incorporate a rack in the trap gulley which will require daily cleaning.

MERITS AND DEMERITS OF THE SYSTEM

The main disadvantage of the system is that it can only be operated in areas served by pipe borne water. The system may also be criticised in that, the automatic flushing device operates even during periods when the unit is not subject to extensive use, such as night hours. However, with an average daily water consumption of 1.2 gallons per capita, the system is clearly more efficient in water usage than the conventional water closet system. Difficulties arise during periods of water shortage since the conduit becomes clogged, necessitating roding and flushing when regular supply is restored. The tilting bucket, which is made of

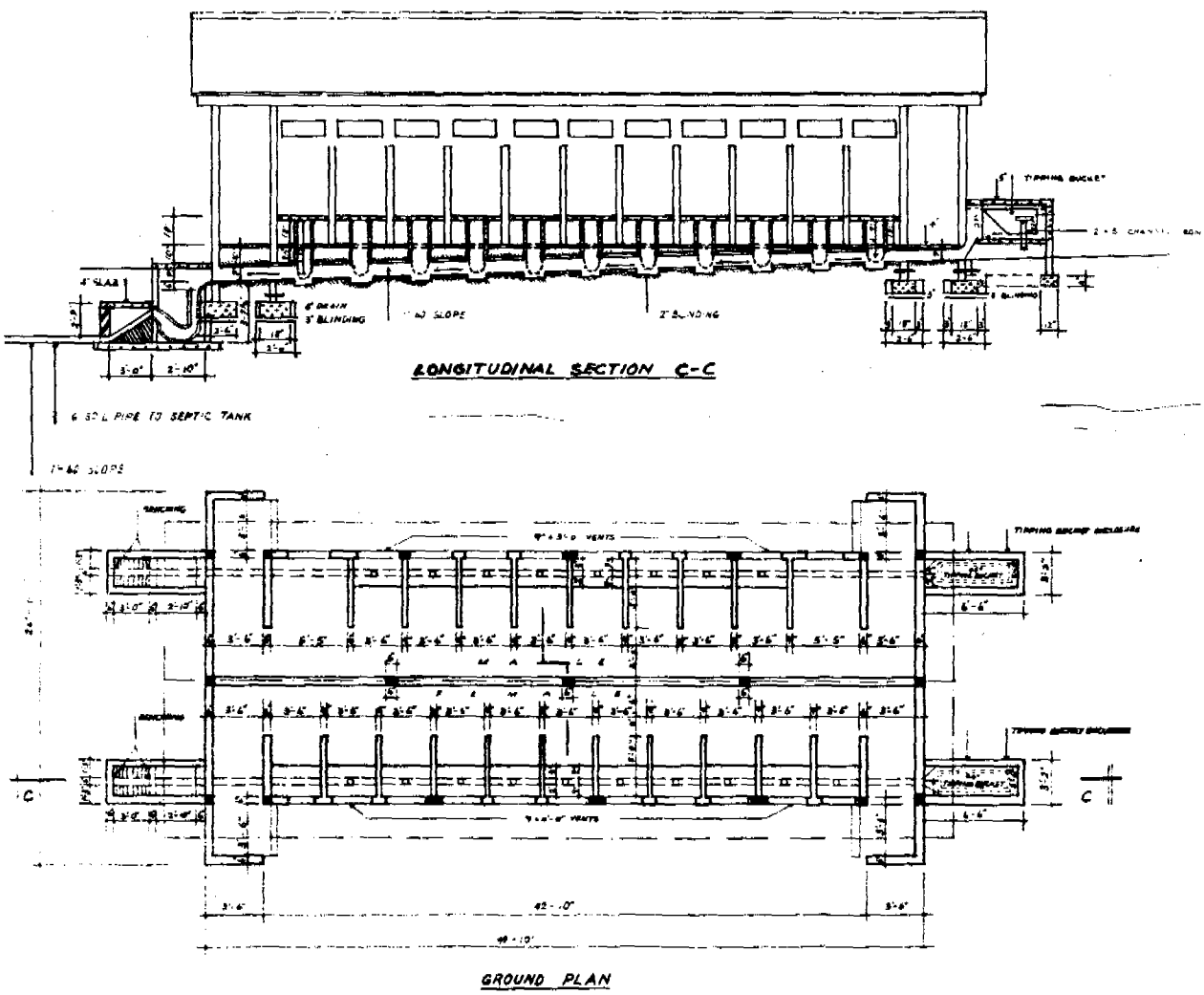

Fig. 1 Details of the Automatic Flushing Toilet

TABLE 1
COST COMPARISON OF ALTERNATIVES
FOR A THIRTY YEAR PERIOD

ALTERNATIVES	PRESENT WORTH ¢ (CEDIS)		
	1%	3%	8%
Automatic Flushing System	101,896	84,759	58,385
Night Soil System	1,092,104	850,013	516,546
Water Closet System	195,410	155,007	99,992

¢2.75 = ₵1.00

steel is also subject to corrosion over relatively short periods. Studies are underway to replace the tilting bucket with a concrete tank operated by a syphon, as a way of overcoming this problem.

On the credit side, the automatic flushing toilet has been found to have low initial and maintenance costs compared with the water closet and night soil collection systems. Table one gives a summary of economic analysis using the discounted cash flow technique. A thirty year life span, and interest rates of 1%, 3% and 8% were adopted for units serving a population of one thousand each. The system is found to be more hygenic. There is no odour and no contact with faecal matter, it has a long life and there is no reliance on imported materials. The technology is simple and suited to any locality, privacy is ensured and it has a capacity to withstand heavy loads. There is no pollution of soil and groundwater and no access to excreta by flies and rodents.

Abolition of Pan Latrines

Other merits of the system can be seen in its adoption as a practical way of abolishing pan latrines, particularly in sewered areas where landlords refuse to connect to central sewers. The respective council can provide such public units and pass by-laws abolishing the use of pan latrines. The conservancy labourers so affected may be re-deployed. Landlords who still prefer home units will have no alternative but to connect their houses to central sewers.

Home units of the automatic flushing toilets can easily be made without use of imported items. An interesting feature is that, in villages, untreated water may be fetched from streams and wells to operate the units as and when required. Effluent discharged may be treated by any of the known on-site treatment methods.

CONCLUSIONS

The object of presenting this paper is not only to stimulate discussions which might in turn be of help in our future improvements, but also to introduce the system to other areas having similar collection problems. As mentioned the major disadvantage of the system is the fact that it is waterborne, and therefore may not be in line with current trends in this field. However, for an urban Community that uses drinking water for watering of lawns and garden, provision of 1.2 gallons per capita per day for its socially deprived people for proper

sanitation is not asking for too much.
Finally mention must be made of benefits to the nation as a whole namely:-
(a) benefit accruing to the user in terms of an easy access to good sanitary facilities, which may be-related to his willingness thereafter to pay his taxes
(b) benefits accruing to the user and non-user in terms of improved health and productivity, savings in medical expenses, an enhanced social status of the community and an improvement in the economic potential of the area.

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LOW-COST SANITATION IN NIGERIA

by PROFESSOR P A OLUWANDE and A ONIBOKUN

INTRODUCTION

" Get mobilized, pay attention to hygiene, reduce disease, improve the health conditions"

Mao Tse-tung.

This quotation from the great Chinese leader is very appropriate for all other developing countries today as it was for China during the period before Chinese revolution of 1949. In order that any environmental sanitation programme may have noticeable impact on the health of the people in the developing countries it is necessary that the people must be involved through aided self-help approach (Oluwande, 1969 ref.1, 1975 ref.2, 1976 ref.3, Oluwande and Onibokun, 1976 ref. 4). As rightly pointed out by Chambers ref.5 (1974), Feachem at al ref.6 (1978), Holmquist ref.7 (1970), Lamb ref.8 (1974) and Schaffer ref.9 (1969), to advocate mere self-help for people without adequate mobilization and necessary imput assistance will make programmes get out of hand and eventually lead to frustration for all parties concerned. Feachem al ref.10 (1980) also outlined some of the factors which lead to failure of self-help schemes and how to overcome the difficulties.

In Nigeria, the only lowcost sanitation method commonly employed by the people is the conventional pit latrine as illustrated in fig 1. However, the simple latrine is not popular among the people partly because of the well known shortcomings of the method and partly because of defective siting, construction and maintenance practices (Oluwande, 1969, ref.11, Oluwande 1979 ref.13) The commonest sanitation method in the urban areas are the ubiquitous septic tanks and the soakaway pits as illustrated in fig II. All"modern" houses, even those in communities where there is no pipe borne water system and those houses occupied by those who cannot operate the system properly are provided with septic tank systems. For most of the systems the tanks receive only sewage from the water closets, while sullage from the kitchens, bathrooms and wash-hand-basins is discharged either into the soak-aways or into the open gutters (Oluwande et al 1978 ref.12, Feachem et al 1980, ref.14). The bucket latrines of the type illustrated in fig III are also common in urban and rural areas.

In recent years, much attention has been drawn to the need for lowcost sanitation devices for the developing countries which are effective and sanitary without being dependent much on water. The developments were aimed at reducing the bad features of the conventional pit latrines. Among the modified forms of latrines being introduced in different parts of the developing countries are:

(a) the ventilated latrine,
(b) the RDEC
(c) the water seal and the composting latrines (Wright, 1977, ref.15 Winblad et al, 1978, ref.16). In the pilot project being reported in this paper these various modified forms of latrines and the conventional type were investigated.

2. Material & Method

Prior to the construction of the latrines, preliminary surveys were carried out in each of the study areas to find out the types of latrine best suited for various households selected. The study areas include parts of Ibadan city (Population 2 million); Ilesha (Population 4000,000), Oyo (Population 300000), Osu (Population 20,000), Sekona (Population 10,000) Ijaye (Population 5,000) and Ibarapa Division (Population 150,000). The various types of latrines provided and investigated are illustrated in fig.IV. The distributions of the sanitary appliances are given in table I.

In Ibarapa division, the landlords provided the pits and the parts of the material costs. The remaining costs for materials, carpenters and bricklayers were provided by the University. In order areas, the entire costs were provided by the Nigerian Institute of Social and Economic Research (NISER). The average costs for each type are given in table II.

TABLE I

Distributions of the latrine types

Types of latrines

Location	ROEC	Ventilated pit	Water seal direct pit	Water seal offset pit	Aqua prioy	Conventional pit
Ibadan	-	1	-	1	-	3
Ilesha	1	1	-	1	1	1
Oyo	1	1	1	-	-	1
Osu	1	1	-	-	1	-
Sekona	-	-	1	-	1	-
Ijaye	1	1	-	1	-	-
Ibarapa Division	-	-	-	1	4	6

TABLE II

Cost of different types of latrine in Nigeria (1980)

Costs per one unit in Naira

Latrine type	Pit	Floor slab		Piping	Superstructure		Total
		Material	Labour		Material	Labour	
Conventional latrine	50	50	40	-	123	70	333
Ventilated pit latrine	50	50	50	30	125	70	375
Water seal direct pit	50	70	50	-	123	70	363
Water seal offset pit	60	100	80	45	123	70	478
ROEC latrine	60	100	80	35	125	70	470
Aqua Privy	80	150	120	60	123	70	603
Septic Tank	120	180	150	150	?	?	600

Note: ? (a) 1 Naira = 0.76 Pound Sterling (Oct. 1982)
(b) Normally the septic tank is not built under a separate superstructure.

Questionnaires were prepared for research assistants to complete when they made monthly visits to each of the units. The typical questionnaire is given:

Low Cost Sanitation Pilot Project Monitoring Programme Questionnaire

1. Type of Project .....
   (a) Aqua privy
   (b) Conventional pit latrine
   (c) Ventilated pit Latrine
   (d) ROEC latrine
   (e) Offset water seal latrine
2. Location.....
3. Name of Landlord.....
4. Date visited.....
5. Time visited.....
6. Number of users.....
7. Numbers of adult users .....
8. Number of children users..... (those under 10 years)
9. State of the floor of toilet:
   (a) clean
   (b) dirty
   (c) dry
   (d) wet
10. Intensity of smell:
    (a) None
    (b) Slight
    (c) Strong
11. Intensity of Fly breeding:
    (a) None
    (b) Slight
    (c) Heavy
12. Position of the cover for the latrine
    (a) Properly kept in position
    (b) Not in position
    (c) Not available
13. State of maintenance of the inside of the inlet pipes:
    (a) Clean
    (b) Dirty with excreta sticking
14. Any other operation-maintenance problem observed:
    Specify: (a) (b) (c)
15. Any other operation-maintenance problem indentified by the users:
    Specify: (a) (b) (c)

Discussions

From this pilot project, the following observations were made for the parts of Nigeria concerned:

(i) Generally, people are found to be eager to help themselves to provide sanitary facilities once they receive some form of encouragement from the authorities. Such encouragement may be in different forms, like provision of technical supervision during construction, assistance in procuring imported materials or provision of skilled labour by carpenters and bricklayers. This type of aided self-help approach goes a long way. It is not enough for authorities to ask the people to participate in self-help projects. The people must be aided to help themselves.

(ii) The reactions of the people to new sanitary facilities depend on many factors like the level of formal education, the socio-economic status and the previous experiences with similar facilities in the past. From this study, it was observed that many were eager and willing to accept the use and maintain the new types of sanitary facilities even though they regarded the facilities as special gifts from the government. They regard themselves as being very lucky and that they must use and take proper care so as to please the government. Some refused to use the facilities because they are not familiar with them. Even after they had been educated on the use and maintenance they still refused to use then. There is a particular chief who will not permit his tenants to use the aqua privy built for them because he wants them to use only the pit latrine. Another will not allow his household to use the offset water-seal latrine because he fears it cannot be properly used by them no matter the amount of education on the use and the maintenance. However, this type of oppositions to the new types of sanitary facilities were deliberately invited because the facilities were provided to find out to what extent can people who are used to one type can be educated to use new and different types. This study reveals that it is easier to educate the simple and illiterate families with low socio-economic status than the educated or half educated ones, who feel they know what is good for their people.

(iii) Initially, it was observed that in those houses where there are many children, the concrete floors of the latrines were being fouled without maintenance. In most of such houses the women responded to the advise of the research assistants on the

need for proper maintenance. Once the women were talked to and they realised that the research assistants can call any time without notice, the standard of maintenance improved.

(iv) For the components of the latrines to be properly constructed, the local bricklayers require close supervision. If this is not done, special components like the vent pipe, the seal for the pour flush and the slanting inlet for the ROEC are likely to be misplaced. Among the common mistakes observed are: placing the vent pipes inside the latrine when they should be outside for optimum effects (Morgan 1979 ref.17) and making the slanting angle of the inlet pipe in the ROEC too big or the length of the pipe too long. It is therefore concluded that in the parts of Nigeria involved in this project, the local bricklayers and carpenters who are able to build septic tanks systems correctly and atimes without supervision cannot construct the modifications desired for the conventional latrines without close supervision. This situation is likely to be the same for other parts of the developing countries.

(v) The costs of the latrines are dependent on many factors like the method of executing the project (whether by direct labour or by contract); the location of the site (materials & transportation) and the number of latrine units (economy of scale). The costs given in table II are for "semi-contract" approach. This was due to the fact that the bricklayers and the carpenters were invited to a meeting where the prices quoted by them were haggled and reduced. The modifications make the latrines more expensive than the conventional ones. Also, it is not easy to obtain the ideal size (15cm diameter) of the vent pipe (Morgan 1979 ref.17). Therefore, 10cm asbestos cement or PVC pipes commonly employed for the septic tank systems were used. Also, the 15cm diameter pipes which are ideal for the inlets of the ROEC, the waterseal type and the aqua privy are very difficult to obtain.

(vi) It is very difficult, especially in the urban centres, to know the number of people using each sanitation unit. This is because the people are unnecessarily suspicious that a form of sanction which depends on the number of users will later be imposed on them.

Conclusions

The low cost sanitation appliances most appropriate for Nigeria are the various type of the pit latrines. The ventilated pit and the ROEC types are best for households where paper and other solid materials are used for anal cleaning while the water seal types are suitable for moslem households where water is used mainly by adults. In many houses, where the use of the latrine unit is restricted to one family, the conventional pit latrine is effective. This is because, it is easy to use and maintain such latrines properly.

The modifications to the conventional latrines, though desirable, make the construction difficult for the local bricklayers and carpenters. Also, the materials required for the modifications are not available locally. The people will have to be aided to obtain them.

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COMMUNITY PARTICIPATION IN WATER AND SANITATION

by SISTER PATRICIA WALSH

INTRODUCTION

There is an almost unanimous general agreement to support the proposition that extensive community participation is indispensable to the success of any broad-gauged effort to transform a rural society and to meet the basic needs of its poorest families (ref. 1).

Pieno et al. define 'community participation' as "serving the interests of villagers and helping them to cooperate and be involved in the planning and implementation of water and sanitation or other local programs." They then go on to describe the different degrees and types of participation which they say will "vary from situation to situation." (ref. 2)

Concepts and characteristics of community participation will be discussed in some detail throughout this conference and it is not the intention of the author to go into much detail in defining this concept further here. However, for the sake of clarity, a brief outline of 'community participation' as applied to the project discussed in this paper will be given.

1. COMMUNITY PARTICIPATION

Since Independence great stress has been placed on community participation at all levels of decision making in Zimbabwe. The President, Prime Minister and various Cabinet Ministers have on numerous occasions emphasized the importance of involvement by all the people, all the time, in all decisions concerning their everyday lives.

Since the inception of the water and sanitation programme in the Takawira District, community participation has been a 'built-in' feature of the programme, as it was felt that the local community has an important role to play in rural water-sanitation programmes. The 'community' for the purpose of this project comprised of:

(1) Individuals - women in particular
(2) Local leading citizens
(3) Local Government officials
(4) The Mission Hospital staff and Ministry of Health staff.

This 'community' gradually overcame many 'teething' problems through a careful, patient and at times slow process.

This paper is concerned with the 'individual household' and 'community' aspects of participation in water and sanitation programmes. Participation for basic sanitation - involved mostly only 'households' in the construction of individual family pit-latrines, for the water supply the community consisted of a group of 'households' or an entire village.

2. BACKGROUND

A brief background will be given to the geographical position of the area described in this project and also to the introduction of the programme.

2.1. Geographical Area

The area that this project was carried out in is the Takawira Communal Area (formerly known as Chilimanzi Tribal Trust Land). It is situated south of Mvuma in the Midlands area of Zimbabwe. The District has a total area of 104 207 hectares. The main water supplies of the area are two rivers on the east and west boundaries. There are four main dams, used mainly for irrigation purposes.

The population as per Takawira District Council Development Plan for 1981 is 55 000 (ref. 3), giving an approximate population density of 52 people per km^2.

2.2. Introduction of Project

The protected well and sanitation project was started in the District as a result of an evaluation/follow-up on children who had been discharged from the Nutrition Rehabilitation Centre (N.R.C.) at the District Hospital (St. Theresa's Mission Hospital). On visiting the homes of these children it was soon realized that most of the teaching/discussion on sanitation, hygiene, gardening etc., which had been undertaken at the N.R.C. was more or less ineffective because the parents of these children had neither pit latrines or protected water supplies at their homes. In many instances the water that was available had to be collected some kilometers away from the village, with the result that it would be used only for purely domestic purposes and not for vegetable gardens.

The majority of the parents interviewed stated that their greatest need as far as their family's health was concerned was to

have 'clean water'. At this time (late 1975) there were very few protected wells in the area despite the tireless efforts of the local Health Assistants. There was no felt need among the people for latrines at this time, despite the fact that they had been exposed to a considerable amount of Health Education on the matter.

As a follow-up to this evaluation, the hospital staff discussed the findings with the Hospital Health Advisory Committee (this committee comprised of the following representatives - Senior Hospital Staff, Government Health Assistants, Local Councillors, School Teachers and Local Leaders including Religious Leaders). There was general agreement among the committee members that the time was now 'ripe' to initiate a 'clean water project' as there was a felt need for it in the community. It was also felt that the introduction of the idea combining the construction of latrines with the protected water supply should not be introduced at this time as it was not felt necessary by the community at village level.

3. IMPLEMENTATION OF PROJECT

Over a period of about six months a number of meetings were held with various community leaders to try and plan a suitable, acceptable programme. Many factors had to be taken into consideration in this planning, i.e. time of year when people are available for such a programme, where there were existing 'open' wells already, what type of pumps to be used, degree of involvement and contribution by the local village community etc.

3.1. Health Education for Project

As previously stated there had been an 'expressed need' by certain members of the community (parents of children discharged from the N.R.C.) for such a project. It was felt by the Hospital Committee that this was probably a good reflection of the feelings of the community as a whole; nevertheless it was considered to be of paramount importance to mount a District Health Education Programme in preparation for the project.

Every opportunity was taken to inform the entire population of the District about the proposed project. The two Chiefs in the District gave their full support and encouragement and spoke at gatherings about the proposal. The hospital staff concentrated all their Health Education efforts on water-borne diseases. They used every opportunity, i.e. talks/discussions in the hospital, at the mobile M.C.H. clinics, at Parent/Teacher meetings, council meetings, religious gatherings, clubs - no opportunity was missed to discuss the project.

3.2. Financing the Project

Finance of any project is always an important issue and in particular in a rural Third World Country where there was a war as was the situation in Zimbabwe in 1976.

As the majority of the people in the District were subsistence farmers struggling with the harsh realities of a war situation and very poor soil and trying to provide the basic minimum amount of food for their families, it was decided after consultations with various community members that the hospital (which was run by Dominican Sisters from Europe) would be responsible for trying to raise funds from their home countries for the materials needed for the project.

The community at village level offered as a contribution to the project that they would provide their labour for the digging of the well, the lining of it, and where possible they would collect the pumps and slabs from the hospital in order to keep transport costs to a minimum. The labour of the community was approximately equal to the labour of two adult males working for two weeks (6 day week) in cash terms (based on the minimum wage). This would mean a contribution of about 60% of the total cost of the project. The remaining 40% covered cost of the pump and transport, these being provided by the Hospital. The cement (in part) was given by the Provincial Health Inspector from the Ministry of Health.

3.3. Technical Assistance

It was decided that the most suitable type of pump for the Takawira project was the 'Blair Hand Pump'. This simple hand pump was the result of research and technology carried out by Dr. Peter Morgan of the Blair Research Institute in Harare. The technicalities of the pump will not be described here. It suffices to say that the pump was meant to be 'durable, low cost and easy to assemble and install'. In its original design it was meant primarily for shallow well operation (approximately 6m) which was suitable for the Takawira District as it has a relatively high water table.

This district was one of the first areas to use this pump on a wide scale, resulting in Dr. Morgan visiting the project as often as he could. The project benefited from his technical expertise while he in turn did some 'on the spot' research which resulted in various alterations to the pump.

The assembling of the pumps was carried out by metal-work trainees at the Mission workshop under the guidance of Brother Charles. This workshop was also responsible for making the cement slabs, and for the repair of the pumps when they broke down; the pumps were brought

to the workshop by the villagers for repair.

The siteing of the well was carried out by the Health Assistants at the request of the villagers. The actual digging of the well, carrying of stones for the lining, sand etc. was carried out by the villagers. When the well was completed the Health Assistant sent the measurements to the Mission workshop and the villagers collected their pump which was then installed under the guidance of the Health Assistant.

The three Health Assistants in the District were inundated with requests from villagers to site wells for them and to protect wells once dug. In order to relieve the Health Assistants, the Hospital employed and trained 13 Village Health Workers (V.H.W.s) to assist and work with the Health Assistants. (The V.H.W. project was financed by OXFAM - the water project was part of their work which included an integrated approach to 'total health'.) There were some 'teething' problems initially between the Health Assistants and some of the V.H.W.s as there was no definite 'job description' for the V.H.Ws but this was quickly and effectively sorted out. However it is worth mentioning as it could cause great problems in such a project. It is of the utmost importance to have a clear 'role description' of all participants in such a programme before the programme is commenced.

3.4. Present Situation

As far as was known to the Hospital authorities there were 4 protected wells in the area before the commencement of this project. At the time of this report 302 Blair Hand Pumps have been installed and four boreholes throughout the District as part of the project. The District Administration has agreed to be responsible for the maintenance of the boreholes as the Ministry of Water Development has also installed others in the area during the past year.

It was felt that the time was 'ripe' for some evaluation of this project. A student from the University of Zimbabwe (Matindiki) evaluated this programme and submitted the results as a dissertation in partial fulfillment of the requirements of the degree of Bachelor of Social Work. His findings and suggestions will now be studied as they bring out some very important 'gaps' in the community participation of this project (ref.4).

4. EVALUATION OF WATER PROJECT

This project which was commenced in 1976 was discontinued temporarily in mid-1979 due to the deteriorating security situation in the District. By this time, however, it became apparent that there had been no provision made in the project as to who would be responsible for the maintenance and repair of these pumps. Villagers started bringing broken pumps to the Mission workshop for repair and in some cases pumps were just removed from the well and not brought for repair as people were expecting the Health Assistants or V.H.W.s to go to the villages and do the repairs.

After Independence the project recommenced and it was hoped that villagers would begin to feel responsible for the maintenance but this did not happen. Early in 1982 consideration had been given to the idea of having courses for training villagers to do their own repairs but this did not materialize until the findings of Matindike's report were made known to the Hospital Authorities.

The following are some of the suggestions which Matindike (ref. 4) makes. They are of interest to the Hospital and all participants in the project and also may be of help to others considering such a project.

(i) "There should be short courses on how to maintain water pumps." These have already been commenced but there were problems in this area in so far as that the commercial firm now supplying the pumps wants to sell the pumps assembled which means that they are glued together which makes for 'local repairs' a complex problem.

(ii) "There should be specific water committees to supervise proper use of the protected wells and also to repair the pumps promptly." For the first part of this suggestion it may be possible to get the local (village) health committee interested.

(iii) "The communities should be encouraged to save some money for buying spare parts for the water pump or for buying a new pump when the first one provided by the Hospital is completely worn out." This too is a very important consideration and it is the plans of the education committee to try and integrate this project with other 'community projects' i.e. the co-operative buying of fertilizer etc.

The community participation aspect in the maintenance of the pumps had not been seriously considered at the time of the implementation of the project, but it is a most important area which should not be left out in any planning. It will now be more difficult to introduc e this new concept of community responsibility for maintenance and repairs; nevertheless it is seen as an absolute necessity so that the community feels

totally responsible and 'self-reliant' in this project. Plans are under way to prepare the ground for this important phase which should have been a built-in part of the project right from the time of its inception.

5. LATRINE PROJECT

As mentioned at the beginning of this paper the water project was meant to be part of an 'integrated health and sanitation programme' in the minds of the authorities concerned with the health of the local population. However due to the apparent lack of interest by the community in the latrine aspect of the programme it was felt that the introduction of one concept - the water project - at any one time was sufficient.

Early in 1981 when the majority of the villages had a protected water supply with a simple hand pump installed it was felt that the time was 'ripe' to introduce this next phase of the programme. The same methods as used in the water project were used in motivation, creating an awareness of the importance of latrines etc. As the country was now Independent and people were building up their homes with the hope of a brighter future this new concept of having a latrine quickly caught on. However, it was soon apparent that people were only interested in 'household latrines'. They were quite explicit that 'village' or communal latrines would not be acceptable, mostly from a cultural and hygienic point of view. With this in mind the construction of the 'Blair Ventilated Privy' was commenced with the family providing the labour in digging. Construction was carried out with the aid of the Health Assistants, V.H.W.s and the raw materials were provided by the Mission Hospital.

At the time of writing this paper 580 latrines have been completed in the District. As this project is still in its 'infancy' no evaluation has yet been undertaken but from 'on the spot' checks it would seem that the problems of maintenance etc. of the water project will not be a problem in this case. The community is aware of the fact that the initial material help in this project is a 'one time only' contribution and that for the future, latrine construction will be entirely the responsibility of the family, consequently they must consider this as an integral part of their home budgeting and planning for the future.

CONCLUSION

With the party political structure of Government in Independent Zimbabwe 'community participation' and 'self-reliance' is part and parcel of the everyday life of the people. The party structure includes District Health Committees where the members are appointed by the community. This structure and these goals can be a most important vehicle in the future for all health programmes and in particular for such projects as described in this paper.

Despite the failure of community participation in the maintenance aspect of this project we are hopeful that in future programmes this problem can be prevented by foresight and careful planning.

It has been said that "Women hold the key to the success of new water supply and sanitation projects in much of the developing world" (ref. 5). The scope of this paper has not permitted general comment on the degree of participation by the men and women as groups. However as a final comment I would like to note that without the enthusiastic support and hard work of the women of Takawira District this project would not have gotten off the ground.

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COMMUNICATION SUPPORT IN SANITATION DEVELOPMENT

by E P W Cross

1. INTRODUCTION

> "Listen you ... fools, it's a simple problem. Let us engineers solve it and come back with what we've been able to do ... But don't bring up these goddamn silly questions about politics and local psychology" (Ref 1).

The starting point of the paper is this quote from an exasperated fictional American water engineer struggling to mount a rural water supply project in South East Asia in the 1950's. The paper's premise is precisely the reverse to that of the Ugly American: local involvement in project planning and implementation, and considering the cultural context and the villagers' viewpoint are essential preconditions for success in the sector. Technological solutions and educational campaigns which neglect the user and community viewpoint court disaster. In the past the failure to consider this perspective has been one of the primary reasons for the poor performance of sectoral programmes in Africa. Examples of socially inappropriate programmes in the sector are spread the breadth of the continent, from the banks of the Nile to the squatter camps in the Cape Flats.

Two years into the International Drinking Water Supply and Sanitation Decade the importance of the viewpoint is more widely recognised. The technical literature is now interspersed with pledges to social appropriateness, community participation, "bottom-up planning", the integration of "hardware" and "software" components, communications support, etc. Despite the development of this new language in public health planning, few African countries have transformed such concepts into practical proposals for programme design. The aim of this paper is to outline activities and methods for establishing socially sound sanitation programmes in Africa.

2. PRINCIPAL SOCIOLOGICAL ISSUES

The sociological issues that need to be addressed in sanitation development are a piecemeal collection of factors and are not derived from one coherent theory of social change. A useful distinction is that between cultural and social issues. Cultural factors refer to local understandings, values, beliefs, preferences and customs affecting technology adoption and usage, and the transmission of water- and excreta-related diseases. The social issues refer to the social organisation and local level management of the projects.

Cultural factors

Like other human activities, human excreta disposal is culture bound. The act of defecation is both a physiological process and a social fact, and preferences in defecation differ between social and cultural groups. Failure to take into consideration cultural preferences will lead to misuse and under-usage of latrines.

Some of these cultural preferences are obvious: most rural African communities do not cleanse themselves with water after defecation; the majority of the rural population (except in Southern Africa) prefer to squat; privacy of access is important; and the use of human faeces is culturally unacceptable in much of Africa. Other preferences are less obvious: communities may have preferred locations for latrines which need not necessarily agree with optimum technical choices; the use of latrines may be subject to avoidance rules and preferences in sharing arrangements which may, for example, prohibit sharing between social categories. Mundane local preferences in building styles and materials may also be important. Defecation training is moreover a fundamental activity in personality development and even a minor change in cultural habits may be difficult to achieve. The topic of human excreta disposal is highly sensitive in many cultures and in general it is a difficult area in which to attempt behavioural change.

There are essentially two basic approaches to ensure that sanitation technologies are culturally acceptable:

a. adapt local behaviour to technologies by health education;
b. adapt the technology to local preferences

Health education: In the past the problem has been approached with a simple deductive logic: if the technology fails then the fault must lie with the user. Despite the failure of unimaginative and paternalistic

health education programmes, clearly educative components are essential supplements in sanitation development. There is a lack of expressed demand for sanitation in comparison with other sectors and the health benefits of sanitation are not immediately apparent.

Socio-technical design: The other approach is to design sanitation technologies in the knowledge of local preferences. Since health education has at best a limited effect on behaviour change a socially sound technology is a vital component of sanitation development.

Social factors

Despite its importance cultural appropriateness in technical design constitutes the more manageable part of the spectrum of sociological problems in the sector. Like other developmental activities, sanitation development implies a change in systems of management and control, in other words a change in social organisation. The sociological consequences of a Government's benevolence in implementing a sanitation programme may be quite different from that expected. Whereas administrators may see the supply in terms of services and benefits it is also likely to be seen by rural communities in the context of local dynamics of prestige, authority and alliance. Even where project implementation does not directly require a change in the structure of local authority, it can add to the influence of those in control, and shift the balance of power in a community precipitating local resentments, political disputes, non contribution to communal projects, or even, in some instances, sabotage of projects. The principal sociological tasks in the sector are: to generate user enthusiasm for a project; to develop and sustain real community dialogue and support; to establish an effective system of project management; to ensure that maintenance is carried out; and that facilities remain in use in the long term.

3. COMMUNICATIONS SUPPORT IN SANITATION DEVELOPMENT

How can administrators and sector planners concern themselves with these sociological issues?

One approach is for technical units implementing sanitation programmes to be complemented by units of communication support. Communication support activities have been defined as those concerned with sociological and educational aspects of sanitation development during programme planning and implementation. A communication support unit would ideally contain personnel with skills in design, implementation and analysis of sociological studies; design and implementation of promotional and educational programmes; community liaison and administration. The unit would service and support cadres of field workers. Principal communication support responsibilities are:

a. Pre-planning and pilot project assessment of socio-cultural data;
b. Socio-technical design;
c. Local level management design;
d. Planning and implementing sanitation promotion, education for construction, maintenance and use, and hygiene education;
e. Managing community participation;
f. Monitoring and evaluation.

The following paragraphs outline recommended methodologies employed in undertaking communication support activities for sanitation development.

Data Collection

Sociological data is generally necessary for the following aspects of programme design: general programme design; socio-technical design; local-level management design; and the design of promotional/ educational programmes. General points to be considered in data collection are: limit the scope of data collection since the information is invariably needed rapidly and in a form that is easily digested by planning authorities; where possible integrate data collection into pilot implementation; alongside objective sociological measures the beneficiaries themselves should be brought into the data collection and planning process.

The socio-cultural data required in sanitation planning necessitates a variety of data gathering techniques. The following mix is recommended: field observation studies are important to investigate beyond normative behaviour to understand what people actually do as opposed to what they say they do; in-depth interviews of key informants is especially useful for gathering information on culturally sensitive issues; open-ended questionnaires can provide a mixture of quantitative and qualitative information in a short space of time; closed questionnaire surveys are easy to administer and can validate results over a large population, but careful design is necessary and questionnaires are generally poorly suited to the collection of attitudinal data; community meetings or workshops can be a means of involving a community in programme design as well as checking information obtained from other sources.

Promotion and Education

A promotional or educational component may be necessary to promote sanitation adoption; to explain methods of construction; to achieve effective local level project management and maintenance; to ensure usage; to improve hygiene or change behaviours transmitting water and excreta-related disease; or to educate regarding disease transmission.

A great range of media, materials and techniques are available for promotional and educational activities. Categories of approaches include mass media activities (radio, newspapers, cinema, wall-paintings and billboards, etc) community based activities (public meetings, group discussions, role-playing, home visits, etc) and a variety of other media and materials (including leaflets, slides, flannelboard, flip charts, models and exhibitions etc) (ref 2).

An effective promotional and educational component will combine several of these methods. Optimum combinations will differ according to circumstance. General considerations in planning a promotional or educational programme include the following points.

Mass media generally reach an audience wider than programme beneficiaries and are best used to pave the way for more specific approaches. Mass media are difficult to co-ordinate precisely with construction schedules, if used in the initial stages of programme development may create expectations which cannot be fulfilled, and are unlikely to effect specific behaviour changes, especially in diverse cultural environments where a single message will have limited relevance.

Community based approaches in contrast are more flexible and direct. Several techniques are available which assist extension workers in the field. Traditional methods of communications in specific cultures (such as songs, stories or drama) may also be adapted for sanitation development.

Keep plan simple Institutional arrangements in low cost sanitation development are often in a formative stage, are already spread across several departments and are unable to undertake a managerially complex task. Simpler educational strategies are more likely to work.

Timing of promotional activities needs careful integration with other programme components to achieve maximum impact without raising expectations which may not be met.

Focus on Action not Knowledge An initial focus on affecting action by whatever means, is likely to be more effective than teaching the medical model of health knowledge. The desire for comfort, privacy and status are far more potent forces in sanitation promotion than are knowledge of the transmission routes of excreta-related diseases.

Identify specific behavioural risks User education is most effective when a short list of specific behaviours are identified as target issues.

Use existing communication networks The design of culturally-specific promotional or educational component needs to be based on a detailed knowledge of local communication methods and networks. Where appropriate the desired behaviour change should be expressed within the context of local knowledge.

Monitoring

Monitoring is the regular collection and interpretation of data carried out by programme staff. The purpose of monitoring is not only the control of project activities but also the provision of information on the basis of which improvements can be made. Monitoring is an especially important though often neglected activity in communication support, since there is a need for regular information on the impact as well as the execution of project activities. While the workload is especially high in pilot stages of project implementation, the function continues through the life of a project, and is of particular importance in projects involving community participation, in which the technology is not fully developed, and which are undertaken in culturally diverse societies.

Generally speaking the following issues require monitoring by communications support staff: the social soundness of technical design; the effectiveness of promotional and educational activities; procedures in community liaison and project implementation; local-level project management; and latrine usage.

Two types of data need to be collected: information on project activities, such as staff movements, the scope of communications support activities etc, and information on community response to the project. Monitoring community response can become a complicated and time-consuming task without

careful planning. One method involves annual rapid appraisals, using a mix of data collection techniques to collect different types of information. These 'objective' mini-studies are interpreted alongside information gathered in a community data file recording minutes from community meetings, site visits etc.

4. CONCLUSION

The social, cultural and educational issues in sanitation development constitute a diverse field, multidisciplinary and often difficult to classify. Activities addressing these issues are defined as communications support. Communications support in sanitation development remains a neglected area and one which demands considerably more attention if the goals of the International Drinking Water Supply and Sanitation Decade are to be met.

The paper has outlined the role of communications support in sanitation development, defined project functions and suggested methods for carrying out some of these functions.

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COMMUNITY PARTICIPATION IN RURAL WATER SUPPLIES IN KENYA

by S I KABUAGE

COMMUNITY PARTICIPATION IN RURAL WATER SUPPLIES IN KENYA

The Kenyan Government embarked on a programme to supply potable water to every household by the end of this century. To this end in the last decade, the Ministry of Water Development was created to realize this goal. This target has been enhanced by the launching of the desirous and ambitious: "International Drinking Water Supply and Sanitation Decade" by the United Nations.

Kenya has a population of 16 million people distributed in both the rural areas and urban centres. Due to the location of industries in Urban Centres, emigration from rural to urban areas has been higher with a growth rate in population of 6% - 14% p.a. in many centres. This contrasts sharply with the national average rural population growth rate of just under 4% per annum. This tremendous population growth, as shown by statistics, is among the world's highest. This has made it necessary to constantly upgrade the development plans for urban centres as well as set new guidelines for both short and long term development for individual towns.

Due to the obvious unhealthy conditions and nuisance prevailing in densely populated urban areas devoid of water and sanitation facilities, the need for these services has been recognised and funds allocated to remedy the situation.

The cost implication per capita for the urban dwellers for provision of these services are minimal and the revenue collection has been fairly simple and effective compared to the rural areas. This makes it easier for municipalities to have ready and adequate funds or show viability in terms of cost to benefit ratios for both national and international aid agencies and therefore making it easier to procure development capital. This paper does not dwell on provision of the said services to urban population which are well served but instead dwells on rural areas where the price per capita is high and sometimes is not economically feasible.

Kenya being economically agriculturally based, the rural areas have been classified in terms of their agricultural potentials either as high, medium or low. For those who are not aware, the desertification process is a reality in the over-grazed northern semi-arid and arid parts of Kenya. The country has only 25% of its land mass available for agriculture, and the rest being the great wastelands of northern frontier which have massive irrigation potential but are presently unproductive in terms of crop production.

In the rural areas the government has initiated national projects funded locally through the Ministry of Water Development and the Ministry of Local Government. There are also projects funded through International Aid Agencies such as The World Bank, African Development Bank, Kreditanstalt Fur Wiederaufbau, Overseas Development Administration to name but a few and other Bilateral aid agencies.

These projects are mainly designed by engineers in the government ministries or by Local or Foreign Engineering Consultants. They have boosted the number of people supplied with piped potable water to their homes. The concentration has mainly been in the high potential agricultural areas where the demand for this service was desired and the population density higher - exceeding about 150 persons per square kilometre. This brings the cost of supply per capita to about £Stg 150 - £Stg 400 per person in capital expenditure compared to £Stg 50 - £Stg 100 in urban areas.

The per capita cost increases tremendously in the arid areas with a density of less than 10 persons per square kilometre and the cost is in excess of £Stg 600, per person making it necessary to review the target of supplying the country by the year 2000. In such semi-arid areas the population is basically pastoral and nomadic in nature. It would be poor economics to use borrowed prime capital investment to this extent to achieve supply of such costly waters. In such cases, only communal water points along trade and pastoral routes should be established. The sources should include: shallow wells, boreholes, etc. as good alternatives as these may be left idle during

the period of migration. The water demand of such pastoralists who live in more or less similar conditions as their forefathers before them, does not exceed 1 - 4 litres per capita per day compared to urbanite counterparts who demand 150 litres per capita per day. It is therefore clear that in rural areas local conditions best dictate the demand and therefore the appropriate level of services and technology. Due to hardships of nomadics lifestyles, some of these pastoralists are settling and changing to mixed farming due to community services and other advantages accrued when they settle.

Prior to embarking on community participation in rural water supply, it is fitting to give a brief history of water supply in Kenya.

The early settlers of the 20th century in Kenya embarked on their own water supply for domestic consumption and where warranted irrigation, this being with the assistance of government subsidies. It is therefore obvious that organized piped water supply was started by the white settlers. They had awareness of potable water as day to day essential commodity. There was no community participation at all. There were only individual settlers with their own water and the local people depended on natural, surface sources.

The early settlers as compared to the locals had an awareness of hygiene and had the economic means to supply their domestic water of 250 - 400 litres per person per day.

In contrast to menial workers, who although had a piped supply in labourlines did not have the financial means had therefore a basic demand of 25 - 100 litres per capital day dependent on status i.e. labourer to foreman. It is that awareness of the relationship between potable water and the knowledge of water borne diseases that increased the demand of this service as a preventive measure.

The community participation can therefore be viewed simply as an individual enterpreneur, a group of farmers, a local water supply with communal facility, or an abandoned system which requires maintenance and upgrading etc. On the other hand, the development aspect of mordern rural water supply requires high capital investment which almost always the rural communities cannot afford.

It therefore becomes imperative to look into ways and means of reducing the capital and recurrent costs of such water schemes. To this end the workability, and environmental, and long-term effects of the schemes, its economies and social factors should be assessed.

In order to achieve this, the design criteria should commensurate with the communities income, affordability i.e. lower the design criteria such that instead of a design based on 150 l/p/d to have say 30 l/p/d and which brings the cost level to an acceptable level or more appropriately "affordable level". It would serve no purpose to have a water scheme which the population served cannot afford to pay for.

The community may also assist on a heave-ho "Harambee" basis as it is known in Kenya where only funds for materials are sought from donor agencies and labour provided free to the project by the beneficiaries, inexcept for the necessary skilled artisans i.e. masons, carpenters, pipefitters, welders, etc who are tradesmen and seek payment. Effective savings up to 30% of project costs have been made this way in some rural water supply projects.

In rural communities collection of funds through mass meetings has met with success. In some cases the funds are misappropriated but we shall not dwell on this. This has enabled the collection of 40% - 60% of the project funding in some of the best case histories. This has however, occurred in areas where the administration, political and local elders are agreeable on the necessity of the project and project definition. In such cases the government has created an incentive scheme by instituting a self help subsidy section where such projects are designed to save the additional funds required for completion of the project. This section also caters for up to 80% of recurrent expenditure. The section is also entrusted with the mammoth tasks of feasibility, survey and conceptualisation of the design. Such projects require careful monitoring to ensure that the implementation is according to the design; especially the distribution system which may be used for political ends to boost potential votes. The administration in this case acts as the corrective arm to calm the political aspirants' ambitions by ensuring that the systems are constructed as designed.

When the populace is made aware of the benefits of the projects, the contributions in terms of labour can save 10-20% of project costs. However, such saving exposes the project to abuse if the project schedule should lag behind the peoples' expectation; malicious damage and vandalism become rampant and in some cases render the entire project useless. This is usual as

the locals become too familiar with the installations.

The need for community participation as a means of saving must then be viewed with the caution it deserves, though it is doubtless, such saving would be effected. In real terms a contractor keeps the works safe by watching and taking steps against vandals as is required by the conditions of contract at an early stage. This instills a sense of discipline and responsibility in the locals as third parties.

Thus it can be seen that the value consciousness of the water supply as a service must be fully appreciated by the community before they accept it wholesomely, and an effort by authorities to this end is essential. Each household is required to pay £Stg 1.00 for a connection.

Some non-profit making Organizations such as CARE have assisted local projects with technology and funds for development; others such as the National Christian Council are committed to financial assistance and making such that the receipients are informed of the importance and necessity for this service.

The rural women's awareness of lessened work where there is a piped water supply makes them more willing than men to contribute both financially and to provide free labour.

At this juncture, it is necessary to evaluate the performance of such projects whereby the intended beneficiaries are not fully aware of the potential and have no demand for the service provided. In some cases the lack of such awareness is so endemic that they would prefer to go to nearby water courses or neighbouring homes for water as they cannot afford or do not see the need to pay for having a connection installed.

This attitude makes the project benefits to accrue only to a small portion of the community, sometimes as low as 10% of the total population in the scheme area.

In conclusion it can be summarised that community needs and awareness have always contributed to water supply in Kenya and indeed all parts of the world. Community participation can also be used to great advantage to reduce capital cost and recurrent cost of water schemes and subsequent sanitation be creating public awareness and participation. Other advantages include extending use of existing facilities with subsequent reduction in the incidence of waterborne diseases. The water supply must however, ideally be coupled with proper sanitary disposal to avoid nuisance.

It is however, imperative that the knowledge of this awareness be disseminated at all levels of education and through social media.

Session 3

Chairman: Mr C Davey, Halcrow and Partners Zimbabwe

Discussion

J G Wilson

The implementation of urban and rural sanitation programmes in Botswana

1. Mr WILSON described experience in Botswana using different types of pit latrines; comparative substructure costs were presented. A rural pilot project was discussed, and the problem of affordability of latrines was emphasized.

2. Mr HARRIS asked two questions; he wished to know the range of monthly repayments for material costs for different types of latrine superstrucutre, the average income of a typical plot holder, the percentage of total sanitation costs to average income; and the default rate on loan repayments which was found during the early stages of a project.

3. He was interested to note that upgrading had been recognized as a future possibility, and asked the author to expand on the progressive steps he envisaged, and whether small bore effluent systems were seen as a method of upgrading pit latrines to pour flush septic tanks.

4. Mr WILSON furnished the following information: the maximum monthly repayments of material costs for the superstructure was approximately £1.20, which included the cost of the concrete block structure with galvanized iron roof, metal door frame, wooden door, two PVC vent pipes and a GRP seat unit. The monthly repayment represented a loan being repaid at an interest rate of 9% over 15 years. The average total family income of a plot was £900, and the maximum monthly sanitation costs represented 7.7% of family income in Gaborone, which included approximately £1.20 for the superstructure, £1.80 for the substructure, and £0.45 for the emptying service. At present, the average 30 day default rate was 70%, but this reduced to 30% after 90 days. Legislation had recently been introduced to enable the local authority to repossess the plot if the plot-holder was in continual default. It was anticipated that this would reduce the 90 day default to a more acceptable value.

5. The layout of site and service areas, and the use of the twin pit latrines had been deliberately adopted with eventual upgrading to a water-borne sewerage system sometime in the future when it is affordable. All the plots could be drained to omit existing sewerage systems. The twin pit latrine could be converted to a low volume flush (say 6 l) toilet system with the minimal of structural alterations. In Botswana, plot holders' aspirations to improve their standard of living was high and it was the opinion of Government that the upgrading sequence would be directly from the pit latrine to the flush toilet, omitting all theoretical stages in between. The use of small bore effluent systems was currently being considered; however it was foreseen that it would not be used as an intermediate stage of upgrading but as a solution to particular problems. It could successfully be used for instance in areas of high rock horizon where it was originally anticipated that pit latrines were to be constructed. A communal septic tank say for six houses coupled to a small bore effluent system could overcome the problem of the frequent emptying of pits situated in impervious soil or rock conditions. However adequate water supply must be available, preferably to each plot.

6. Mr CHIBANDA observed that the REC II latrine was chiefly for the urban population, and the Blair latrine for the rural people; given that both were odourless and fairly cheap to build, he asked what were their relative advantages and disadvantages in relationship to the two types of community? Was their any difference in their operation?

7. Mr WILSON replied that in the urban areas, the REC II was the preferred option because when full, its superstructure need not be moved, i.e. it was permanent. The removed contents were odourless and free from most bacteria and viruses, which was advantageous to the pit-emptiers. As the emptying period was flexible, this gave the local authority advantages in planning the pit-emptying service. The REC II was also suitable for eventual upgrading to a low volume flush system with the minimum of alteration; it was more expensive than the Blair latrine, but the cost was repaid at a low rate of interest on a monthly basis, which was not possible in rural areas. The population was considerably poorer in rural areas, and self-help projects were more appropriate, and hence the Blair latrine was used. These latrines could be easily moved when the existing pit was full. There was virtually no difference between the two types of latrine from the users viewpoint; however with the REC II, the user had the responsibility of changing the unit over to the second pit when the first was full, and of informing the local authority, who would empty the full pit. The user of the Blair latrine must prepare an alternative site when the existing

pit was full.

8. Mr NGCOZANA commented that in Zimbabwe, contractors who were rushing to make profits did not comply with the specifications for the Blair latrine, and he very much appreciated the author's comments concerning the need for continuous supervision of the contractor.

9. Mr WILSON replied that in Botswana the need to properly supervise contractor built substructures had been recognized. In order to do this it was decided that all the Self Help Housing Authority technical assistants in the country attend one week training courses at the Polytechnic. These courses had covered all aspects of the latrine construction and involved the technical assistants constructing a latrine themselves during the course. These courses had greatly assisted in the proper supervision of the contractors by the technical assistants.

10. Miss SMITH-CARINGTON asked whether there were cultural difficulties in using the pit contents as fertilizer.

11. Mr WILSON stated that the contents removed from a full twin pit latrine consisted of dry humus, free from odour, viable bacteria and viruses. However, because of the known cultural difficulties experienced with regard to reuse and handling of excreta, it had been decided that the latrines would only be emptied using mechanical methods and that the contents would initially be used by the local authorities to improve the soil conditions of their parks, gardens and nurseries. On a long term basis it was hoped that the plotholders would recognise the advantages that the Local Authorities were getting from this and would request that the contents be dumped on their own plots to improve their gardens and vegetable plots.

12. Engr OBADINA commented on the use of aqua privies in the centre of Ibadan, Nigeria. They were constructed in public places, and in large family compounds serving populations of between 200 and 1000. Each structure consisted of between 8 and 32 units, with about 30 people using each unit. There were no waterseals, and the odour problem had been avoided by good ventilation of the tank. They were designed so that the drop pipe penetrated the water level by about 200 mm; the units were connected to the city water and electricity supplies. Why would such units not work in Botswana?

13. Mr WILSON thought that the use of aqua privies as described was not really applicable to the Botswana context. The urban population density was considerably lower than Ibadan and it was not the Government policy to introduce communal toilets in these areas, nor would it be the inhabitants choice to use them. The problem of aqua privies in the urban areas of Botswana was that they were not connected to individual water supplies. This required the plotholder to fetch the necessary water to top up the water seal from a standpipe. Because of embarrassment the plotholders did not do this on a regular basis and consequently the water seal was often broken resulting in unacceptable odour and subsequent rejection of the aqua privy.

14. Mr UNDERWOOD wished to know if the impact of VIP latrines had been assessed in terms of smell and seepage into water courses when used in large numbers in confined urban areas, and if there had been problems of acceptability, because people wanted a more sophisticated system.

15. Mr WILSON replied that being properly ventilated there was no problem with smell. In urban areas, water was supplied from dams whose catchment areas were outside the area of urbanisation. There was therefore no potential of contamination of the water source. In rural areas however they were aware of the fact that there was the danger of polluting boreholes. Monitoring of the water quality from the boreholes was carried out before and after sanitation schemes were implemented. There was cooperation between the relevant authorities, and boreholes were usually located outside villages. There were very few shallow wells in Botswana, and pollution problems would not arise.

16. No problems regarding acceptability had been found; politicians and community leaders had been involved in discussions regarding the implementation of sanitation projects from the beginning. Plot-holders' views were taken into account, but they, in turn, understood the meaning of "affordability". The Government did not believe in subsidizing sanitation in urban areas, and although plot-holders might have higher aspirations, they were aware that they had to be paid for.

17. Professor OLUWANDE observed that the latrines were located some distance away from the houses; he wished to know why this was so, given that they are nuisance free, and could therefore be part of the house.

18. Mr WILSON stated that although the type of latrine being used was nuisance free, there remained a cultural belief that anything in direct contact with the latrine superstructure became "contaminated". It was thus to assure cultural acceptance that latrines were built away from the house.

In addition, care must be taken regarding the house foundations, as seepage from a nearby pit could adversely affect the bearing capacity of the soil.

S A AMOANING-YANKSON

Waste management in urban slums

19. Mr AMOANING-YANKSON explained the sanitation problems in slum areas of Tema, Ghana, and presented information on an automatic flushing communal toilet which had been installed in an attempt to alleviate the problems.

20. Mr MAKHETHA said that he was impressed by the units, and the ability of each to cope with about one thousand people. He asked for details concerning the institutional arrangements for daily cleaning and maintenance, and their efficiency.

21. Mr AMOANING-YANKSON replied that the units replaced the labour intensive conservancy system, with consequent reductions in council expenditure on highly paid labourers. Some of these redundant labourers had been employed for cleaning, and were supervised by the Medical Officer of Health's department. Maintenance was the responsibility of the District Engineer's office. The aim was to involve the community, but until the authorities were confident in their ability to operate and maintain the facilities, their taxes would be used to employ people for this work.

22. Dr GONDWE commented that the author had suggested that people could obtain the necessary water from nearby streams in the event of a cut in the water supply; he suggested that in this case, the latrines would block, and many people may choose to excrete by the streams, and that this form of sanitation may need re-examining.

23. Mr AMOANING-YANKSON referred the speaker to page 2 of his paper, and stated that in the case of water shortages, the unit was closed for use, as would be a water closet unit. He added that experiments were underway with smaller "home units" in rural areas, in cases where a perennial water source was nearby, and could be used to provide water, which would be carried to the unit. It had smaller buckets for flushing, dependant on the required tractive force in the conduit.

24. Mr WILLIAMS commented that he was aware of a tradition of communal latrines in rural areas of Ghana, and asked why communal latrines were chosen for urban areas, whether charging was proposed, and who would use them. He also asked if the double pit ventilated latrine developed at Kumasi had been considered, and commented on the communal aqua privy units used in Bangladesh which had between 1000 and 2000 users.

25. Mr AMOANING YANKSON stated that communal latrines were the cheapest way of discouraging indiscriminate defaecation. About 98% of the community would use the units, since only 2% had adequate sanitation facilities. The 23% of people served by aqua privies would also use the units, because the aqua privies had all failed due to the lack of availability of trucks for desludging the tanks. There was no direct charge for using the units, and the Kumasi latrine was being used in the villages of the district.

26. Dr COTTON requested an explanation of how the effluent from the units was disposed of; if it was via a septic tank system, what happened to the subsequent effluent?

27. Mr AMOANING-YANKSON replied that on site treatment was provided by a combination of an Imhoff tank, with the tank effluent being disposed of via field tile drains and a sand trench.

28. Mr BOCARRO asked whether communal washing facilities were provided at the toilet units, and if so, could the water be used for flushing purposes, and what volume of water was used to operate the system. He commented that the tilting steel bucket used in the flushing system could be replaced by a syphon operated concrete tank, but this might be more expensive. Corrosion problems could also be reduced if a glass fibre tank were used.

29. Mr AMOANING-YANKSON thought that the provision of washing facilities was to be considered at the next stage of the program; the volume of water used depended upon the population served. Experiments using syphons had been carried out, but proved unsuccessful due to difficulty in removing the air pocket at the top of the syphon, resulting from very low inflow rates to the tank. Concrete was very cheap, and locally available, but glass fibre was not available.

30. Mr UNDERWOOD had found that communal latrines were unpopular in Zimbabwe, and wondered why this did not appear to be the case in Ghana.

31. Mr AMOANING-YANKSON replied that communal toilet facilities existed in many villages; people in the slums had often migrated from villages, and were thus familiar with the system. In many areas, existing communal toilet facilities had been converted to the automatic flushing system, thereby reusing an abandoned superstructure.

32. Mr NGCOZANA posed a number of questions relating to the operation of the units; he wished to know if there were odour and fly problems in between flushing, the rate at which excreta accumulated, and what measures were taken to ensure that there were no blockages of the chute, and that the flushing water had sufficient carrying capacity.

33. Mr AMOANING-YANKSON said that odour and flies were not too much of a nuisance; flies rarely went from areas of light into darkness. He estimated that the conduit was adequately designed to cope with the likely excreta load of 0.03 m^3 from each squatting hole; the appropriate tractive force in the conduit could be achieved by using a steep slope and sufficient quantity of water.

34. Professor OLUWANDE reported that the "comfort stations" in Ibadan were similar to the units described by the author; he wished to know how many such units had been built, and whether there had been problems with maintenance.

35. Mr AMOANING-YANKSON stated that twelve such units had been built, eight being in slum areas, two in schools, and two in the market place. Maintenance problems arose when supervision of the cleaners was relaxed, leading to filthy conditions.

P A Oluwande and A Onibokun

Low cost sanitation in Nigeria

36. Professor OLUWANDE presented the paper, and outlined the types of sanitation available and their application to Nigeria; the local costs of the various systems were given.

37. Dr ALUKO asked how the latrines described could be modified to be used in the Lagos area of Nigeria, bearing in mind the heavy concentration of population and the high water table.

38. Professor OLUWANDE said that there was no one solution which was appropriate. In areas where the water table was high, the pit could be raised, or lined aqua privy or septic tanks used, although this would increase the costs. For high density areas which currently use bucket latrines, communal facilities such as the "comfort station", which is a combined communal latrine and washing place could be used. Although very expensive, a central sewerage system may be appropriate to lower density areas.

39. Mr KUYATHEH wished to know how the situation of some people, such as chiefs, who benefit from new techniques and yet do not use them, was reconciled with the author's statement that regardless of the level of health education, people would not change unless they were aided in the procurement of materials.

40. Professor OLUWANDE replied that the chief who did not allow his people to use sanitary facilities was likely to be an exception, perhaps because he feels that he alone knows what is best for his people.

41. Professor NATH asked whether any attention was paid to pollution risks from the various types of low cost sanitation alternatives which were monitored and evaluated, particularly under adverse hydrogeological conditions. In densely populated urban areas leaking water mains may be contaminated during low pressure periods, particularly when the ground is waterlogged during the wet season.

42. Professor OLUWANDE replied that none of the latrines had been sited such that this was likely to be a problem.

43. Dr ADEYEMI asked whether the top slab of the pit should be independently supported to avoid collapse of the pit, and if the pit should be hopper bottomed to facilitate sludge collection.

44. Professor OLUWANDE thought that it was perfectly adequate to support the slab on the pit lining where ground conditions required it. Independent support would only lead to more complex construction and greater expense. There would not appear to be any good reasons for having a hopper bottomed pit.

Sister P Walsh

Community participation in water and sanitation

45. The paper considered the importance of community participation in water and sanitation programs, and described the background, implementation and evaluation of projects in Takawira, Zimbabwe.

46. Brother CHARLES submitted the following discussion in relation to Sister WALSH's paper.

47. By participation we take it for granted that several people are involved. How do we involve people? Who should be involved? We all are concerned with sanitation and water development in Africa. From the beginning we would expect all the people to give top priority to both of these, especially to water development. Is it like

this? Everyone knows that there is a real need to have an adequate supply of water, be it for human consumption, animals or irrigation. Often people will agree with this, but when it comes to the realisation of a concrete project they are hesitant. It is a new idea which needs to be explained, especially to the older and conservative people. Why this discrepancy? Is it just pure laziness? Was it always like this? What made our people into such individualists, even within their own villages? Has the meaning of extended family, which was so important to our culture, been lost? The need for money brought about great changes in our society. It became a competition to have more money available and by this more security. Security in the old days was there if you had your wife, children and certain possessions. Only if people feel secure will they be eager to participate in community affairs. To solve this deep-rooted problem we do need a political solution.

48. Being aware of this, how do we go about in involving many people to participate in our rural areas? You might find some men who are very eager to get involved. They, however, are not the whole community. You give to these men a project, like building a protected well and they are eager to go ahead. What about the others; do we know that by imposing things on the masses, you break an old tradition? For centuries the girls and women of this area might have gone to a river to fetch water and for washing. This might have been the occasion for their daily gossip and exchange of ideas. Your pump water might be clean, but not as tasty as the water which they used to fetch from the river. Someone might know some reasons why they never tapped water at the spot you choose. They might enjoy letting you make mistakes on your own. From these observations we see how very important it is to get all the people involved.

49. Without someone with technical 'know-how' the people might still put a lot of effort into their venture, but they will be very disappointed if it is going to be a failure. People must feel that it is themselves who are undertaking the project. The technical adviser should stay in the background, but still must know where to come in with his suggestions. We are dealing with adults and not with children, he should never split the Community by taking sides. We are tempted to treat adults as children, as soon as we feel that we are superior in our knowledge. It might even give us temporary success, but will frustrate further involvement in similar projects.

50. Keeping these points in mind, we have to consider the following points if we start such a community project; is there really a felt need for it and if so, are the people convinced of it? Who will benefit from it? Do all of those who will benefit from it agree to become involved in it? Are the people willing to contribute, be it in labour or cash? Is the local council aware of it, as they might have other suggestions. Do you have a coordinator who acts between the local council and your community? Did you ask for technical advice? Is the material you will need available? Should your project be a protected well, have you decided what kind of pump you need? Who is responsible for maintenance. Never accept generalised agreements where everybody is supposed to care for it.

Never forget that any pump can break down.

Are you aware that you will have to educate your people how to use the pump and even the latrine? Should sanitation be provided for a single family or a whole village? In the first instance the owner of the house should consult the health worker from whom he will get the needed advice. It is his responsibility to acquire the necessary advice and material.

Have the women been consulted? It is they who might benefit most from the new project and who will be expected to look after it. In the local culture it is the mother who is closest to the small children; she must be consulted in everything, and very often gets the blame if things go wrong. Her involvement is often deeper-rooted as she is the heart of the family; without the willing involvement of the women in community projects and family projects, very little will be achieved. This is an observation which has always seemed important to me. The men's world seems to have no boundaries but the woman's world is still her home.

51. Some further personal observations are: If we do not have a homogeneous community any project will have difficulty in succeeding at our local level, this means that the healthworker and the representative of the local council responsible for health must be able to cooperate well, so that such a project does not split up the local community. Political affiliation should remain in the background.

As soon as people have done their preparation, like digging, carting stones, lining etc. they want the project to go

ahead. Do not let them wait unnecessarily. They soon get tired of empty promises and if you expect them to be involved in a later project you will have opposition.

If you have succeeded in motivating one family to build a decent latrine it will act as an incentive for others. I have noticed how latrines mushroom round a well-built one; people like to see progress and not long speeches on progress. Very much depends on the Coordinator and his approach. If a project is tackled in the spirit it deserves, they do appreciate it very much. They show their appreciation and joy spontaneously by offering some food, beer and by dancing. Ideally the Project should be coordinated by medical staff, as it is part of health service. This however does not mean that a doctor himself should supervise the construction of wells and latrines; with their personal connection and experience they will be able to assist in coordinating and by giving advice as to where best to acquire the needed materials. Most of the doctors I know take the government policy of "prevention is better than cure" very seriously. They see the benefits from these projects, as so much depends on clean water and sanitation.

There must be a very close cooperation between health service and local council. Ideally the material needed would be acquired and stored by the local council. Very strict control will be needed as who gets what and how much. Only written duplicated requests should be accepted by the councillor in charge. Should you intend to start a crash program, for example building a few hundred latrines in a specific area, it might be advisable to employ a builder who would go round and supervise the building. This of course would add to the cost and arrangements must be made first as to how much and to whom each participant has got to pay.

Whoever gets himself involved in any project should remember: Let's not so much work for the people, but with the people.

52. Mr MARAMAH commented that in his work with agricultural peasant communities "awareness" courses involving films and demonstrations on the need for safe water and sanitation were run. If the local people were willing to dig a well, and a pit for a latrine, and collect stone, aggregate and sand, his organization provided cement, vent pipes and well pumps.

53. Mr CHAZOBACHII replied that it was important to get the community or family to carry out their part of the program beford providing cement, lest it be used for other purposes. Latrine building was a more personal thing, and the approach to the family had to take account of this. It had been found that one family could often motivate another to construct a latrine.

54. Professor NATH thought that an integrated approach to water supply and sanitation was more beneficial in the long term. Indian experience showed this to be the case in so far as health benefits were concerned. The rural health centre of the All India Institute of Hygiene and Public Health maintained about 500 handpumps; two mechanics were chosen from the local people and trained. They attended requests for breakdown repairs; unless it was a major breakdown, labour and materials were provided by the local people, and preventative maintenance was taught to the people by these workers as they travelled around.

55. Brother CHARLES said that he agreed with the integrated approach, which they had found worked better if the water supply was provided first. Village health workers had to advise on the maintenance of pumps and latrines; they were hoping that village councils would soon take over certain projects.

56. Dr LAING commented that in his experience, the presence of sanitation had a far more signigicant effect on health than did the presence of a water supply alone. He had not found that communal latrines worked in practice, and considered that latrine superstructures should be constructed from the same materials as other local buildings. Health education should be considered as a part of development as a whole, rather than training in new techniques. He had found that giving lectures to villagers was a useless way of imparting information, and had used an acted drama with more success.

E P W Cross
Communication support in sanitation development

57. Mr CROSS discussed the principal sociological issues involved in sanitation development, and considered means of data collection, promotion and education, and monitoring; he suggested that these areas of communication support required more attention if the aims of the International Water Supply and Sanitation decade were to be met.

S I Kabuage
Community participation in rural water supplies in Kenya

58. The author had not been able to attend the conference, and the paper was not presented.

9th WEDC Conference: Sanitation and water for development in Africa: HARARE: 1983

HOUSEHOLD WATER SUPPLY - A USER'S OR A SUPPLIER'S PROBLEM?

by P A and R U M LINDSKOG

1. INTRODUCTION

Provision of water for household consumption is vital in Third World countries. Apart from tedious work connected with the drawing of water from far away sources, the situation is characterized by human sufferings in terms of poor health. According to a WHO survey of 91 developing countries in 1970, 1 100 million or 86% of the rural population in these countries were without "reasonable access to safe water" (ref 1). The situation was worst in South-East Asia and Africa with 662 million or 91% and 136 million or 89% people respectively affected. By 1980 it was estimated by ECOSOC on the basis of country reports, that 29% of the rural population in the Third World were served with safe water within a "reasonable" distance to safe water (ref 2).

In Malawi piped gravity water has played a significant role in providing improved water in rural areas since the end of the 1960's. These projects have involved the population to be served not only in digging trenches and laying pipes but in all stages from the original initiative, the planning and implementation to finally the operation and maintenance of the project. Thus, the involvement and participation of the people is not only in order to reduce costs (ref 3).

A recent WHO/World Bank Report found that "excellent progress has been made during the past few years in the provision of rural water supplies and there is every indication that the impetus generated, principally through the success of the Ministry of Community Development and Social Welfare self-help gravity (water) supply programme, will continue. This programme is undoubtedly the most impressive of its kind encountered by the mission members and depends very largely on the involvement of the potential beneficiaries through the whole cycle of planning, construction, operation and maintenance". (ref 4). As a result of this involvement "a genuine sense of pride and ownership in the projects is generated within the local communities. This is reflected by the fact that in all of the schemes visited by the mission an extremely high level of maintenance was observed" (ref 5).

Concerning groundwater supplies, the shallow wells programme has since the 1970s had a similar approach as the piped water programme. The borehole programme has been extremely expensive compared with the two others. Recently, a new low-cost groundwater approach has been launched, integrating boreholes and wells (ref 6).

Apart from the study by Glennie, comprehensive evaluations of the functioning and the utilization of water supplies have been done by the Christian Service Committee (ref 7) and the Centre for Social Research of University of Malawi (ref 8), while there has been no evaluation of the health impact of improved water supplies. The authors of this paper are in cooperation with researchers in Malawi at present carrying out such an evaluation one year before the intervention with improved water and one year after in three areas each with around 150 households. One of the areas will get improved water as well as hygiene education and sanitation promotion. The second area will get improved water only, while the third will act as a control area and will get no intervention.

2. WATER SUPPLY AND HUMAN HEALTH

The impact of water supplies on the health status of the recipients is based on their potential capacity to control water-related diseases. These have been divided into four main categories: water-borne, water-washed, water-based and spread by insect vectors (ref 9). Of these the first two are more directly related to poor and scanty household water supply than the last two. Water-washed diseases are divided into two groups: infections that affect eye and body surface with a limited epidemiological importance and diarrhoeal diseases, the most important of water-washed diseases because they constitute a leading cause of childhood morbidity and mortality.

The most important benefit anticipated when improving water supply is improved health. However, it has been maintained that the recent popularity for support to rural water supply projects among donors and recipient governments is due to the

increasing general interest in rural development. "For the aid donors - national, international and voluntary agencies - rural water supplies are visible evidence that their money reach the rural poor" contrary to much of capital investment and technical assistance (ref 10). Further, "the current enthusiasm has led to a certain amount of wishful thinking about the benefits of village water supplies, to the extent that rural water supply is sometimes seen as promoting development on its own, and not as part of an integrated rural development programme ... although water supplies are probably a necessary condition for achieving improvements in the rural economy and the public health, they are by no means a sufficient condition" (ref 11).

Therefore, what are the minimum requirements to achieve better health? It is now widely acknowledged that not only water, but also sanitation and hygiene, are important in order to reduce water-related diseases (ref 12). This would certainly be the case if complete water and sanitation facilities were installed in every house. However, the available resources will only allow limited improvements. Relatively few studies (in Hughes's review (ref 13) four studies in Africa) have evaluated the impact of improved water supplies upon health with studies both before and after intervention.

Of the 43 studies reviewed by Hughes (ref 13), several have shown that improved water supplies have some effect on diarrhoeal disease (see also McJunkin (ref 14). This suggests that "previous attitudes concerning the lack of documentation of health benefits associated with water and excreta disposal projects may be unnecessarily pessimistic" (ref 15). Young children are those who benefit most. When improved water is combined with improvements in hygiene and sanitation, reductions of 20 to 40 percent in diarrhoeal morbidity among children are not unusual (ref 16). Often the effect of increased water availability may be more pronounced than the effect of improved water quality.

The minimum amount of water for daily consumption, which is required to prevent illness is not yet known. Hughes notes that data from the several studies included in his review "suggests that volumes in the range of 20 - 30 litres per capita per day may be a minimum required to yield reductions in diarrhoeal disease morbidity" (ref 17). On the other hand, McJunkin in his literature review concludes that "fifty litres per capita per day should be a minimum goal" (ref 18).

Where water of good quality is provided it is often contaminated during collection and storage. Therefore, a good knowledge about the relationship between water and health, attained by hygiene education, may be as essential as water-quality in reducing water-related diseases. It is then important to determine the significance of inputs like improved water, organisation and management of water projects, participation, hygiene education and sanitation promotion and food-intake, upon health and social conditions in order to find the most cost-efficient solutions.

3. FACTORS TO BE ASSESSED WHEN EVALUATING HEALTH & SOCIAL IMPACT OF IMPROVED WATER SUPPLIES

As pointed out recently in a draft on "Minimum evaluation procedure for water supply and sanitation projects" (ref 19), evaluation of water supply and sanitation projects should be done in three stages, ie firstly, assessing whether the facilities are functioning in the correct way, secondly assessing whether they are utilized by the population and thirdly assessing the impact.

If there are deficiencies in one of the earlier stages there is no reason to expect that the subsequent stages will have any successful performance, as both functioning and utilization are necessary (but not sufficient) conditions for the following stages. Therefore, it is no point to evaluate the utilization until the functioning is satisfactory and evaluation of impact will not be worthwhile until the facilities are properly utilized.

If, however, the functioning and utilization are known to or could be expected to be satisfactory, the evaluation could aim at assessing the health and social impact of improved water supply, hygiene education and sanitation promotion. A proposal for a number of hypotheses to be tested concerning which factors, according to the present state of knowledge, are thought to be of importance for attaining health and social impact of improved water-supply and sanitation projects are given in fig 1. It also indicates (with arrows) the relationships to be tested.

4. HEALTH IMPACT

Health is a broad phenomenon with many aspects to evaluate. For an impact study some indicators must be chosen, which

have as close relationship as possible to the environmental and behavioural changes to be studied. In the above referred draft "Minimum evaluation procedures for water supply and sanitation projects" (ref 19) some recommendations are given: "A good indicator should:

- be a significant public health problem in the project area;
- be likely to change substantially as a result of the project;
- be easy to measure.

The following are recommended as meeting these criteria:

- diarrhoeal disease;
- infection by common gut nematodes such as Ascaris;
- nutritional status of young children;

and in some regions - Guinea worm".

To the above mentioned indicators might be added skin-and-eye infections and in addition to nematodes the total parasite load.

Children are those suffering most under poor conditions. A high percentage of diseases is associated with bad hygiene, inadequate water for personal use and lack of sanitation (about 80% related to the lack of safe water (ref 20). In the figure 80% malaria is included, which has little association with drinking water supply, hygiene and sanitation. Therefore, it is appropriate to assess the health impact as improved health of children.

Diarrhoeal disease

This is the most important water-related disease to be studied. The age group under five is chosen because diarrhoeal disease is most common and has the most vital importance in this group, especially under the age of two. It is a well recognized disease among villagers and it can be studied through interviews and histories from the mothers.

Diarrhoeal diseases are a heterogeneous group of diseases caused by different infectious agents, bacterias, viruses and protozoas. These agents are faecal-orally transmitted but the modes of transmission and the relative importance of different routes varies (eg waterborne, food-borne, person-to-person, animal contact). So the impact of any change in environment or behaviour upon diarrhoea will be different for diarrhoeas of different etiology.

Skin-and-eye infections

Skin infections, such as bacterial skin-infection and scabies, and eye infections, like conjunctivitis, are conditions which are often associated with dirt and bad hygiene (ref 21). Moreover, the duration of skin and eye infections seems to be good indicators of routine child care (ref 22).

In the present study the morbidity in diarrhoeal disease and skin and eye infections is studied through fortnightly visits to the homes and interviews with 24 hours recall carried out by non-medical personnel.

Parasites

Intestinal parasites are common in developing countries. With a safe excreta disposal (if latrines are used also by children) and good hygienic practices in and around the home a reduction in hookworm disease, ascariasis and trichuriasis can be expected. Dracunculiasis is essentially waterborne and the prevalence may be affected by the introduction of safe water. Improved water supply will not bring about any immediate change in the schistosomiasis prevalence. However, with a sanitation promotion programme and health education, a reduction of the prevalence should be achieved.

Nutritional status

The nutritional status is an important measure of the general well-being of a child. The main factors that interfere with a child's growth potential are infections, especially diarrhoeal disease, and a deficient diet. Diarrhoea seems to be the most important factor behind malnutrition except in situations when food availability is extremely low (ref 23). Attempts have been made to find a relationship between water supply and malnutrition. However, the situation is complex and it has not been possible to draw any conclusions. It is uncertain whether water purity alone matters or whether the more complex relationship of unhygienic practices is the most important (ref 24).

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PARTICIPATION IN RURAL WATER SUPPLY - THE MALAWI EXPERIENCE

by L A H MSUKWA

1. INTRODUCTION

It is generally accepted that community participation in water supply projects greatly strengthens the community's commitment to the supply and encourages better operation and maintenance. During the past fourteen years, Malawi has made remarkable progress in the provision of potable water to its rural population. It has been estimated that by 1980, 50% of the country's rural population had access to a water supply service (1). This has been achieved through three programmes, Boreholes, Wells and Gravity Fed Piped Water Schemes. The Wells and Piped Water Programmes have been implemented through self-help and an element of community participation has just been introduced in the Borehole Programme.

The purpose of this paper is to briefly describe Malawi's experience with community participation in the Gravity Fed Piped Water Programme. The paper is based on the experience I have gained by participating in two surveys. The first one was a survey of all funded water programmes by the Christian Service Committee of the Churches in Malawi (CSC) which included 8 piped water schemes throughout the country. The second survey was carried out by the Centre for Social Research in the Zomba East Piped Water Scheme which was aimed at finding the socio-economic impact of the project on the people. Both these surveys looked at several aspects including water collection and water use, quantity and quality of the water, repair, maintenance and up-keep, economic benefits and community participation. In this paper only one aspect, community participation, will be considered.

Historical Background

The first ever piped water scheme was started in 1968 by the Department of Community Development in the Chingale area of Zomba District. The area had been designated as a Community Development Project area and staff from the Department, including an engineer, were posted to the area to assist the local people in identifying possible community construction projects. From discussions with the local population, it became clear that one of the major problems the community was facing was water supply.

The traditional sources of water, unprotected hand-dug wells dried up during the dry season and women had to walk long distances to fetch water. However, there is within the area, a stream which had water on the slopes of the mountain all the year round.

Led by the community leaders, the engineer went to the slopes of the mountain and found that there was enough water in the stream to supply people living in the valley with clean tap water. A proposal was put to the local leaders to the effect that Government would assist the people to instal a piped water scheme in the area provided that the people agreed to dig the trench. A few days later, a public meeting was convened at which the proposal was made known to the community and reluctantly, the people agreed to the proposal. In 1969, the Chingale Piped Water Project was completed at a cost of about US $6,000 ($2 per person). The people themselves had dug 25 km of trench, laid the pipes, backfilled the trench and installed 25 stand pipes. This project is still working today and is being operated and maintained by the people with some assistance from the Government (2).

This was the beginning of one of the most interesting Community Development Projects in the country. By 1982, over 640,000 people in Malawi's rural areas were being served by 4,160 village taps which they themselves had installed after digging and laying over 3,000 km of trench line. All this has been achieved at an average cost of only $5.00 per head of population (3).

The over 33 projects that have been installed range from small projects covering only one village with only six taps to large schemes involving over 100,000 people and 800 stand pipes. A small project might take only a few months to complete while large projects can take up to four years of construction.

We will look at the role the community plays in piped water schemes at two stages, the construction stage and the maintenance stage.

II. THE ROLE OF THE COMMUNITY DURING CONSTRUCTION

In the early years of piped water schemes in the country, the principal motivating force was the Government which took the initiative by inviting the community to participate. However, the Government made sure that the Community got involved at an early stage. Thus as soon as a project has been announced in an area and the community agreed to take part, a Project Committee is elected at a public meeting to supervise the work. Once a pilot project is successfully completed in an area "it becomes a potent advertisement for the programme and thus genuine popular demand becomes the principal motivating force" (2). Today most of the schemes are started at the request of local leaders through the District Development Committees.

The value of the local community input in rural piped water schemes has been estimated at 30 per cent of total construction and maintenance costs. The local people are responsible for marking the pipelines, clearing temporary access roads to storage tank sites, digging the trenches, excavating tank sites, loading and unloading pipes, collecting local materials, laying the pipes, back-filling the trenches and planting grass to mark completed pipelines. They do all this so that in the end they can have clean tap water near their homes for which they do not have to pay.

To carry out such work successfully a high degree of organisation is required at the community level. The role of the community organisation is to set up and maintain the self-help labour programme. Table 1 gives the organisational structure for a major project and related levels of project (Government) Organisation. The success of any project depends upon the authority of the various committees. This authority is derived from the local leadership ie the Chief and Malawi Congress Party leaders and not from the project staff who are there to provide technical expertise and to advise the local committees. Each committee has distinct responsibilities:

The Main Project Committee

The Main Project Committee is responsible for the overall management of the self-help programme. The initial work programme is organised by this committee and is also responsible for setting up the main line trench digging programme.

Section Committees

Villages involved in one section of the pipeline elect a Committee whose immediate task is to draw up a daily programme of villages to work on the trench. The committee is provided with a list of villages and populations so that a balanced work programme can be made. Committee members supervise the trench digging on rotational basis. If any problems arise regarding the progress of the work, the committee calls a public meeting where such problems are discussed and if this committee fails to solve the problem it is referred to the Main Committee.

Branch Committees

Once the digging and back-filling of the main line is completed, the main committee meets to call upon the villages of each branch line to form Branch Committees which are responsible for organising labour on branch lines.

Village Committees

The Village Committee is responsible for supervising the village labour on its appointed day of work and for ensuring that village attendance is maintained. It is also responsible for selecting the sites for all standpipes in the village.

III THE ROLE OF THE COMMUNITY IN MAINTENANCE, REPAIR AND UP-KEEP

Community involvement as described in II above is expected to make the people feel the project is theirs and that they will take care of it. In the two surveys, respondents were asked the question "to whom does the water supply belong?" In the Zomba East Survey, 60% of respondents said it belonged to the community while 29.5% said it belonged to the Government. In the Nationwide Survey by CSC, 83% of the respondents said the Scheme was theirs and only 9.6% said it belonged to the Government (4). It should be pointed out that the CSC Survey included a number of schemes in the Northern and Central Regions which had been completed several years back and whose maintenance was completely in the hands of the local people unlike Zomba East which at the time of the evaluation was not fully completed.

In an evaluation of the Wangingombe North Water Supply Project (NWSP), Tanzania, by the Bureau of Resource Assessment and Land Use Planning, a similar question was asked. In this survey, 89% of respondents said the Government was responsible for the project and only 2% said the village. The authors of the report observe that the people's participation is "reduced to manual labour... villagers do not know how the water schemes function and in case of breakdown it is only the experts from the headquarters who can

do the repairs" (5).

The situation in Malawi is certainly different from that observed in Tanzania. Not only that people have some knowledge of how the system works but also, a big part of maintenance work is done by local people.

Prior to 1980, the maintenance of completed schemes was completely in the hands of the local people. For each completed project, a few people were given training in repair and maintenance and these people were responsible for overall maintenance of the scheme. At the local tap level, the tap committee was given responsibility for the replacement of a damaged tap head, repair of apron, drain and soakaway. The Government only provided materials such as tools, pipes and fittings and the community was responsible for the purchase of a tap head.

It was revealed during the CSC evaluation that this arrangement was not completely successful. The main problems observed were:

(a) spare parts were not readily available to people who were given responsibility for maintenance. In some cases, several weeks could pass before the Government could send the necessary materials especially for schemes in the Centre and North.

(b) the system relied too much on individuals which meant that if they happened to leave the community temporarily or permanently, the scheme would have nobody to maintain during their period of absence.

(c) tap committees which were responsible for maintenance at tap level were found to be inactive.

In an effort to solve problems, a new system was introduced in 1980. Under this system, the Government has employed monitoring assistants responsible for overseeing about 200 taps each. The duty of the monitoring assistant is to monitor the functioning of the scheme and advise repair teams, which have also been introduced. One person from each village is appointed by the village headman to be trained by the DLVW in simple maintenance like joining PVC pipes, repairing breaks in the line as well as cleaning the tank. All people thus trained coming from villages served by a branch line form the "Repair Team" for that branch with a Chairman who keeps the spares. These teams are responsible for the maintenance of the Scheme while the tap level maintenance still remain a responsibility of the tap committees. The Teams are supposed to work closely with the tap committees and members of the general community. Each member of the community is supposed to report to the team member any faults he/she notices in the scheme.

The Functioning of the New Maintenance System in Zomba East

The new system of maintenance is fully established in Zomba East Project. One of the aspects we looked into during the Survey was to determine the quality of community participation in the maintenance. At the tap level the problem observed in the CSC evaluation still remains. Committees are active just after the tap has been installed but die soon after as some members of the committee leave the area and are not replaced while others become disinterested. In spite of this the standard of up-keep in Zomba East was found to be very high but this is more as a result of the work of a few key individuals than that of the community. Vandalism in the scheme is non-existent.

Formation of Repair Teams in Zomba East was completed by April, 1981 and the Survey was carried out in August 1981. In our Survey, people were asked whether they had ever heard of a repair team and if so who the members of the team were. As shown in Table 1 below, about 62% of those interviewed had never heard of a repair team.

Table 1 Have you ever heard of a Repair Team?

Area	Total No. of Hh's	Yes %	No %
ZA.E.North	180	38.89	61.11
ZA.E.South	176	37.5	62.5
All ZA.E.	356	38.2	61.8

Source: Water by the People p.35.

In another question, respondents were asked what action they took the last time they realised there was no water at the tap. The majority (81%) said they did nothing and just went to draw water from the traditional source. The majority thought that whenever there was no water, the tank was being cleaned. One would expect that if the tank is to be cleaned, not only should the community be informed but that they should take part. "... we fail to see how the community can be expected to cooperate with the Tap Committee or Repair Team when they do not know the members of the Committee or the Team are. We feel

that if the community is to take charge of the maintenance of the Scheme, their continued participation in the affairs of the project is important.....involving the community in all major decisions concerning the project like what rules are to be introduced, who is to be trained as a member of the repair team, who is to be a member of the tap Committee, etc might not be the quickest way of doing things but it is the surest way of ensuring proper future maintenance and care of the Scheme" (Water by the People p 44).

Efforts are now being made to involve the people more and steps are being taken to keep tap Committees active.

IV CONCLUSION

Despite the weaknesses pointed out through the Zomba East Evaluation on Community Participation in maintenance, Malawi's experience in this field could be of interest to other countries. By 1982 about 33 piped water schemes of varying sizes had been installed throughout the country. There are a number of factors that have contributed to the relative success of the programme in Malawi. The following are, in my opinion, the most important:

(1) A Long History of Self-Help

The people in Malawi have had a long history of self-help which has constantly been encouraged by both the Government and the Party.

For example the construction of primary school classroom block and teachers' houses has always been the responsibility of the local community. Other community construction projects on self-help have included things like postal agencies, health units, roads and bridges. The creation of District Development Committees, Area Action Groups, Village Development Committees and the introduction of Youth Week have all helped to enhance the spirit of "help yourselves" among the people.

It was, therefore, not strange to the population to be called upon to participate in the improvement of their water supply.

(2) The Evolution of the Programme

The piped water programme in Malawi has grown through a cautious approach. Local people are always suspicious of new ideas. Although local leaders had agreed to the proposal for a piped water scheme in Chingale, they were not convinced that water would ever flow through taps in their villages. This first project was small enough as to be completed within a relatively short period.

A year after the Chingale project was started, a much bigger project was started at Chambe in Mulanje District. The project was designed to serve 30,000 people in 60 villages through 180 stand pipes. Before the actual digging of the project started, local leaders were taken to Chingale to see the completed work people of this area had done. Work at Chambe got off to an enthusiastic start with all villages digging the main line and as work started on the branch lines, the initial enthusiasm started to wane.

People began to doubt as to whether they would ever have piped water in their villages. Rumours began to spread to the effect that Government planned to take land from the people and establish estates once piped water had been installed. The people completely stopped going to dig the trench. Although the project was eventually completed after people's fears had been allayed, important lessons were learned. There was a credibility gap between what the local leaders had seen at Chingale and what they were able to convey to the people. The people were asked to make "an act of faith" by committing their labour for a cause whose motives they doubted. A smaller project would have been much more appropriate (2).

One of the most important outcomes arising out of the problems faced at Chambe is that no major project was introduced in a new area before the Government could demonstrate that piped water was possible through a small project. Thus each time the programme was to be introduced in an area for the first time, a sort of pilot scheme would first be installed.

(3) Genuine Popular Demand

The programme, which started through Government initiative has great appeal to the population. Before piped water schemes were known throughout the country, local people nearly always asked for a borehole whenever they had a water problem. These days the demand is for piped water. The people ask for these schemes knowing fully well what is expected of them.

(4) Proper Community Organisation

Another reason for the success of self-help piped water schemes in Malawi is the high level of organisation that has evolved in which both the Party and Traditional Leadership are used. Government officials have no direct contact with the community except through the leaders and the Committees.

(5) Controlled Growth of the Programme

Lastly, the rural piped water programme has grown or rather evolved, through a small non-technical Department of Community Development. With one engineer, and a number of multi-purpose Community Development Assistants, the Department could embark on only one major project and a few smaller ones at any one time". After the first pilot projects in the South, requests from District Development Committees in other parts of the country were expressions of general community interest rather than genuine popular demand. It was clearly beyond the resources of the Water Projects Section of the Department to embark on numerous pilot projects all over the country. With insufficient supervision, such projects would have been excessively prone to failure, and even if, by good fortune many succeeded, the resulting popular demand would have been politically impossible to resist and yet beyond the capacity of the Department to satisfy. The decision to select a few focal areas for the expansion of the programme ensured adequate supervision and limited the stimulation of popular demand to an acceptable rate" (Glennie, 1979, 41).

The above five factors have been crucial in the success of the programme in Malawi. The first one might not be applicable to all countries in Africa and it would be difficult for a government which has been doing everything for the people to say that they have to provide free labour for water supply projects. The "Philosophy" of self-help has to apply to all aspects of rural development if it is to be successful and not just to one sector.

I will conclude this paper by adding a word of caution to the Department of Lands, Valuation and Water. Self-help piped water as well as the Wells Programme grew out of Community Development, a non-technical department which had very limited resources. Both these activities have moved into a technical department which has relatively more resources in terms of personnel and finance. Piped water schemes should not only be looked at from the technical aspect to the neglect of the vital element in the success of the programme so far, genuine community involvement. Neither should the community be looked at just as a source of cheap labour, however important this might be in itself. The aim of community participation should be to give chance to the people to play a role in shaping their own future, give them personal dignity, self-confidence and a sense of responsibility (6).

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LOW COST IN RURAL GROUNDWATER PROJECTS IN MALAWI

. by A Smith-Carington

INTRODUCTION

The concept of Integrated Projects for rural groundwater supplies has been developed in Malawi since the introduction of low-cost boreholes in 1980.

The need for a low-cost efficient approach was clear because it is estimated that about 75% of the 1990 rural population of about 7 million people will need to be served from groundwater. The very successful gravity-fed piped water programmes can only serve the remaining proportion of the rural areas due to the limited number of protected perennial sources.

The integrated approach aims to provide complete coverage of an area with waterpoints such that the walking distance is less than 500m for the great majority of the population to be served. This is achieved by:

a) rehabilitation of existing boreholes where feasible
b) construction of new well-designed low-cost boreholes
c) protection of suitable existing dug wells
d) construction of new dug wells
e) establishment of a maintenance structure for all waterpoints

Full details of the programme are given in a comprehensive manual (Chilton, Grey and Smith-Carington, 1982).

There are two Integrated Projects currently being implemented, one in the Livulezi Valley in Ntcheu District and the other in Dowa District, and several more are planned. Both of those under construction will serve projected 1990 target populations of about 60 000, each borehole serving a design population of 250 and each dug well 125 people, with a design abstraction of 27 litres/head/day.

Hydrogeology

The waterpoints are being constructed in the weathered Basement aquifer which is widespread over the plateau areas of Malawi, although it is relatively thin (commonly 10-30m). The extent of weathering and and unconsolidation increases from the fresh bedrock upwards. It grades through a zone of broken and hydrated rock where the surfaces are chemically weathered, into a zone of crumbling and decomposed bedrock, often of sandy texture, which is the main aquifer. The weathering processes result in increasing clay content upwards and the more permeable layers are partly confined by an overlying thickness of compacted clays and latosols (commonly 5-20m thick).

Potential borehole yields are low (usually less than 60 litres/min) but these are sufficient for handpump supplies where typical abstraction rates are 20 litres/min. Dug well abstraction rates are in the order of 10 litres/min. The weathered basement is thus an important source for rural domestic water supplies.

The water table is shallow and groundwater is usually first struck at depths of less than 20m. The choice of waterpoint depends on the depth to water and is the unique decision of the Project Hydrogeologist. Where the water table is less than 4m below ground level a dug well is constructed; where it is more than 6m deep a borehole is drilled, and where it is 4-6m deep either type of waterpoint is constructed.

Project Implementation

In each area there are 4 cable tool drilling rigs and 2 well digging teams. Keeping them in close proximity allows greater supervision of the construction by professional staff and considerable reduction in the transport costs. Motor cycles are used by professional staff, bicycles by drilling crews, a tractor and trailer for moving the rigs from site to site, and a small pick-up truck for transporting materials. There is thus a high operating efficiency whilst keeping overhead costs as low as possible.

Borehole Designs

Most of the existing old-design boreholes in Malawi are very inefficient, and expensive to construct and maintain. The majority are drilled very deep (40-60m) into hard fresh bedrock, with the more

porous, and permeable water-bearing weathered zone cased out. Expensive steel lining (commonly 150mm diameter) is installed and the screened sections of this are usually only short lengths at lower levels in the hole. These sections have relatively few torch or hacksaw cut slots of large diameter. Together with the thin, ineffective pack of very coarse crushed roadstone (6-12mm) these allow the ingress of sand into the borehole. As a result there is often rapid wear on pump components, frequent breakdown of handpumps and high maintenance costs.

An understanding of the hydrogeology has led to the matching of the borehole design to the aquifer. The improved design low-cost boreholes are drilled only as deep as is necessary for the required yields (30 litres/min for rural domestic supply) and they tap the weathered basement aquifer. Borehole depths are commonly only 20-30m and they require only about 4-5 days for construction. This is between about a third and a half of the time taken for old-design boreholes in the dispersed drilling programme.

Locally manufactured PVC pipe (110mm diameter) is used to line the boreholes. Slotted pipe is installed below the depth where water is first struck. There is a much greater open area of the screened sections (9%) although the slot sizes are only 0.75mm diameter. Coarse sands (1-2mm) from the shores of Lake Malawi are used as a pack to fill the annulus between the lining and the walls of the borehole (drilled at 200mm diameter). Development by overpumping is carried out until the discharge is clear to remove the fines and increase borehole efficiency.

Dug Well Designs

Dug wells are at present being constructed at 1.5m or 2m diameter and are being lined with porous concrete rings and/or bricks. They are protected by a concrete top slab and equipped with handpumps. Tests are being carried out on other lining materials eg sisal cement and different dug well designs in order to improve the sanitary completion, increase the ease of construction and minimise costs. Digging takes place during the dry season, and aims to reach depths of 4m below the minimum water level although this cannot always be achieved. A pump is used to dewater the well for digging below the natural water table.

Backfilled wells have been tried in order to increase the protection from pollution; however there are difficulties of access if deepening or pump repairs are required. As a result, this design is likely to be superseded.

Waterpoint Surrounds

All waterpoints are completed with the construction of an apron to prevent water collecting around the pump pedestal and its ingress into the borehole or dug well, and to ensure good drainage away from the area. A washing slab is incorporated into the apron and this has proved to be very popular with the communities, encouraging the use of the clean protected water rather than traditional water sources in the rivers.

Target Costs

Using the integrated approach the target cost for borehole construction has been reduced to MK 1500, and for dug wells it is MK 750. These represent MK6 per capita, and are inclusive of handpump, waterpoint surround and Project overheads.

*MK1 is approximately equivalent to US$1.

Community Participation

Community participation is considered to be vital to the long term success of the rojects. The involvement of the local people in as many activities and decisions as possible is important in order to build up a feeling of ownership of the waterpoint, even where it may reduce the efficiency of the construction. It must be remembered that the implementation phase is only the start of the Project, and smooth operation and maintenance will hopefully continue for many years.

Local meetings are held with community leaders to explain the aims of the Project and what tasks the villagers will be expected to carry out. A water committee of 4-5 people (if possible including some women) is formed in each village; these are responsible for organising all the duties carried out by the community.

The waterpoint sites are chosen by the village themselves after advice from the hydrogeologist. Detailed geophysical surveys are not usually necessary because the yields required for handpumps are very low and available over widespread areas. Guidance over siting in relation to existing pit latrines and cattle kraals is important to avoid risks of water pollution. Seasonally waterlogged ground and areas near the outcrop of fresh bedrock are avoided.

The community also pays in kind by the provision of bricks, stone, sand and water, and by their own physical effort in digging the wells, crushing stone for the aprons and providing labour to help wherever possible in the construction of the water-point. A sense of village ownership is thus created, and as a result there is likely to be more care of the pump and surroundings and the possibility of village level maintenance.

Handpumps

The locally manufactured lever-action Maldev handpump has been developed in Malawi with ease of maintenance as a major design feature, and has been installed on the majority of boreholes in the Integrated Projects. Preventive maintenance by village caretakers is commencing in the Livulezi Project with regular tightening of nuts and bolts. The downhole components can be removed through the cover plate on the top of the pump without any dismantling. This offers scope for simple repairs at village level, but this is dependent on the development of easily replaceable, cheap downhole components, which is currently under research in Malawi and also by the Consumer Association in UK and the World Bank Global Handpump Testing Project.

It should be noted that the key to good handpump performance is good borehole design. Good pumps cannot function well on boreholes which allow sand ingression and wear on pump components. On the other hand, none of the 24 well-designed boreholes of the Livulezi Feasibility Project fitted with conventional pump cylinders have required replacement of the cup leathers over a period of 1½-2 years.

The dug wells are equipped with locally manufactured, shallow-lift, direct-action handpumps. The designs are still being improved to allow village level maintenance.

CONCLUSIONS

In summary, the Integrated Project approach has resulted in low-cost groundwater supplies in the following ways:

a) boreholes drilled only as deep as is necessary for handpump supplies and constructed in a shorter period.
b) use of locally available materials wherever possible
c) site selection by the communities
d) considerable reduction in transport costs
e) greater supervision resulting in high standard and high success rate of water-point construction
f) labour and materials provided by the community.

The involvement of the community during the implementation stages is seen as the vital factor for the successful long term operation and village level maintenance of the Project.

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WATER SUPPLIES FOR RESETTLED POPULATIONS

by Dr B H KINSEY

INTRODUCTION

The recently published first volume of the Transitional National Development Plan (TNDP), covering the period 1982/83 to 1984/85, defines the national objective of transforming Zimbabwe into a dynamic, equitable society and spells out the strategies to be followed in effecting this transformation. Central to the theme of this conference are the plan's overall emphasis on rural development, in which resettlement, improved water supplies and preventative health are key strategic elements. This paper will examine the planned resettlement of large numbers of rural households in terms of its implications for and place in Government's overall water programme, which aims at providing all the people of Zimbabwe with safe water supplies for domestic and other uses by 1990. In this context, the programme to supply water to resettled areas will be reviewed, and accomplishments and difficulties to date will be outlined. Only limited attention, however, will be directed to what will over time become an increasingly important concern: water for use in small-scale irrigation, not only to promote continuing growth in agricultural output but also to permit limited land resources to absorb more settlers in such productive agriculture.

BACKGROUND

Water resources

Zimbabwe experiences a mean annual rainfall of some 675mm, but the distribution of water resources available for utilization varies significantly both spatially and temporally. Taking into account actual and potential stored surface water and extracted ground water, there is thought to be a maximum total of some 10,000 million cubic metres of water per annum available for use, some 15 per cent of which is currently utilized--mainly in agriculture. It is estimated that over the next 20 years the demand for water available from internal resources may increase to an annual utilization level of between 3,340 and 5,000 million cubic metres (1, p. 61; 2, 24/1/83). In addition, Zimbabwe is entitled to a share of the waters of the Zambezi and Limpopo Rivers, however these sources have competing claims and are far from the major centres of population.

Because of the frequency and severity of droughts, the urban, agricultural and mining sectors are largely dependent on the storage of water in dams. Some 7,400 dams of varying sizes have been constructed, with a total storage capacity of some 4,700 million cubic metres. About 85 per cent of the total storage capacity is in the 100 largest dams, and sites have been identified for another 300 large dams (3, p. 9). The rural sector relies for its water supplies on comparatively low-yielding boreholes, shallow wells, small dams, seasonally flowing rivers and streams, pools and sandbeds in rivers, and springs and waterholes. The source used typically varies with the time of year and the intended use. These sources are generally unprotected and, with increasing population densities, surface supplies in particular have tended to become polluted.

The data base covering water supplies and use in the underprivileged rural sector is very weak, and estimates of the number of people who have access to water vary accordingly. The total rural population is some 5.6 million, of whom some 3.9 million reside scattered across the communal areas, 1.0 million in the commercial farming areas and another 0.7 million in small rural centres. One recent estimate suggests that only about 10 per cent of the rural population has an 'adequate' water supply (3, p. 5), while an earlier figure cited for the proportion of the population with 'adequate access to safe drinking water' was 20 per cent (2, 20/10/81). A third estimate--and the most recent located--indicates, however, that some 2.0 million rural people are served by boreholes, 0.2 million by piped water supplies in villages and 0.4 million by piped supplies in rural centres, while 2.0 million have no access to potable water supplies (2, 23/12/82). This last source implies that anything from 35 to 47 per cent of the rural population lack access to clean water.

National water policy

The Government is committed to ensuring that the entire population of Zimbabwe is supplied with clean water by the end of the International Drinking Water Supply and Sanitation Decade in 1990 (2, 16/1/83). Government intends to ensure the optimum utilization of water resources through the preparation of development plans for each of the major river systems and catchment areas. These area-based plans will constitute part of a national water master plan, which will also investigate the total demand for and supply of water and the most economical ways of providing it.

The rural areas are to receive particular attention. In order to remedy years of neglect in the communal areas, Government intends to provide the larger villages with storage reservoirs from which water can be reticulated to communal standpipes or individual connections for community facilities. In the more sparsely populated regions, supplies will be provided from boreholes or wells. Water supplies for agricultural purposes, such as stock-watering and irrigation, are to be developed as part of the programmes for integrated rural development (1, p. 62). Aid funds and technical assistance to facilitate water development are currently being provided from a number of countries and agencies.

Even at its most economical, meeting the growing national demand for water and improving distribution of supplies will not come cheaply. By way of illustration, it has been estimated that the policy of providing pumped and reticulated supplies to the population of the communal lands alone would cost in total some Z$650 to 1,000 million, figures which suggest a per capita cost of some Z$150 (3; 4). Expenditure on water supplies can therefore be expected to increase substantially. From 1981/82 to 1982/83, for example, the expenditure estimates for the Ministry of Water Resources and Development (MWRD) increased by some 128 per cent--from Z$18 to Z$42 million (£1 = Z$1.48 in January 1983). Well over 93 per cent of this increased expenditure was allocated to the construction of water supplies, water conservation works and rural water supplies (5, pp. 130-32).

The resettlement programme

In September 1980, the Government embarked upon a programme of agricultural resettlement which 'will occupy a central place in the social, political and economic life of the country' during and beyond the 3-year period covered by TNDP (1, p. 66). This programme, ambitious not only in its wide scope but also in the capacity of a new administration to implement it, is a key element in the Government's pledge to restructure rural society and economy and to improve rural welfare. The target rates of resettlement designed into the original programme were subsequently multiplied some ninefold by the addition of a second, parallel programme, which makes resettlement now and into the foreseeable future the major rural development activity in Zimbabwe; indeed, it is currently the major public sector programme with the potential to affect fairly immediately and significantly the economic welfare of large numbers of rural dwellers.

The consequences of a basically inequitable distribution of land per se before independence have been exacerbated by underlying differences in land quality. Agricultural land is classified into five agro-ecological zones, known as natural regions. More than half the large-scale, commercial farming land is in the more favourable areas: natural regions I, II and III, which by definition enjoy more greater and more reliable rainfall. In contrast, three-quarters of the communal area land is in natural regions IV and V, which are considered marginal or unsuited for cropping. It should be noted, however, that natural regions I and II--those best-watered and suited for intensive farming--comprise only 17 per cent of the entire country. There is thus an absolute shortage of good, naturally watered farming land which does not reflect the relative shortages caused by colonial land distribution patterns. Land in the communal areas is under serious to severe population pressure, and in 1981 these areas were estimated to be accommodating some 219,000 households in excess of their carrying capacity (6, p. 147).

SCALE OF THE RESETTLEMENT WATER PROBLEM

The number of people to be resettled under Government's programmes is not known with precision but is estimated at 170,000 families, the great majority of whom Government hopes to settle by mid-1985 (7, p. 10). Assuming a family size of five, resettlement must therefore supply the water requirements of some 850,000 persons. Settlers are moving onto land that was formerly commercial farms, where water supplies usually exist but where they were installed to support the pre-existing pattern of family or corporate farming with its relatively small and clustered residential labour force. Moreover, many of these water supplies were badly damaged and rendered useless during the war.

Settlers are to be grouped into villages which are to be supplied with water at a service level of one borehole, fitted with a handpump, to about 25 farm families. The budgeted cost is Z$5,000, or about Z$30-40 per capita. In cases where surface water is not available for stock-watering, a borehole equipped with a windmill, storage tank and trough will be provided at a budgeted cost of Z$20,000. The administrative centre which houses resettlement and other Government personnel is to be supplied by an engine-driven pump mounted on a borehole if possible; otherwise supplies will come from surface water via a small treatment plant (8, Appendix E). Costs are budgeted at Z$25,000 per installation. Since these administrative headquarters are expected to grow into rural service centres, supplies will be reticulated.

Resettlement on the scale indicated above implies a need for some 2,000 boreholes or other water sources a year (not all of which would be new) which in turn implies the need for 120-130 drilling rigs. In mid-1982, there were only 65 rigs in Zimbabwe, 16 of which were government-owned. The capital cost of a single new percussion drilling rig is estimated at Z$45,000 while running costs are Z$4,500 per month, or some Z$52,000 a year, but a number of aid donors are providing increments to the national stock of drilling equipment. The shortage of rigs is not the only problem however. The geophysical surveys needed to select drilling sites are also being impeded because of a shortage of engineers and inadequate knowledge of ground water resources.

INSTITUTIONAL FRAMEWORK

With the exception of water supplies, all infrastructure in settlement schemes is the responsibility of the Chief Development Officer, under the Director of Rural Development in the Ministry of Lands, Resettlement and Rural Development (MLRRD). Teams working under the Chief Development Officer construct internal roads, cattle dips, health clinics and staff housing (through supervised contracts), install fencing, coordinate school construction and demarcate land and arrange for initial ploughing. Responsibility for water supplies in the settlement schemes lies with the Ministry of Water Resources and Development through its Division of Water Development (DWD), which acts as a service agency to MLRRD.

IMPLEMENTATION OF THE RESETTLEMENT WATER PROGRAMME

Resettlement is currently being implemented as a tactical exercise, with great pressures being placed on the institutions and personnel involved to speed up the programme because of its political, economic and social importance. The problem of water supplies is the major constraint currently affecting both the pace of resettlement itself and the follow-up to settlement, and a solution to the problem is currently MLRRD's number one priority. Until recently, relocation of settlers had been proceeding whether or not boreholes or wells existed at the settlement site on the assumption that settlers could use alternative sources of supply. This assumption proved valid during the earliest stages of resettlement. For example, in 1981/82, MLRRD received only 30 per cent of anticipated installations from DWD but managed to get away with nearly a full resettlement programme because of the previous good rains. Two consecutive seasons of drought, however, have had severely adverse effects on resettlement planned for those areas where reliable water supplies do not exist. Moreover, where resettlement has already taken place, there can be no consolidation or secondary development until water supplies are provided. Housing for extension, health and educational staff, for example, cannot be constructed until water points have been sited. Even before water supplies for drought relief became the major preoccupation, however, resettlement was only the third priority for DWD after the reconstruction and school-building programmes.

Even without the expansion of its activities to include resettlement, however, MWRD was already fully stretched by its nationwide programme of repairing war damage to boreholes, wells, dams and pumping equipment. Moreover, the ministry is being required to expand its activities in communal areas, and the continuing drought has necessitated the deferral of some water projects while MWRD concentrates on drought relief to the hardest-hit areas, mostly in the southern half of the country. The water programme has been further impeded by the resignation of 65 per cent of the ministry's water engineers (2, 18/1/83).

Because of these problems, the Development Branch of MLRRD, which already handles other physical infrastructure, is attempting to establish a well-digging unit in order both to overcome the shortage of drilling rigs and to reduce the time and costs involved in the drilling programme.

As a consequence of the difficulties outlined above, the major infrastructural problem facing the resettlement programme relates to the limited ability to install water supplies fast enough. The delays in installing water supplies severely constrain the implementation of other components of infrastructure, such as the construction of dips, clinics and staff houses and offices, and these aspects are slipping well behind the present pace of resettling families.

In addition to affecting the subsequent ability to construct facilities needed by both settlers and administrative staff, other consequences also arise from the delays in providing water supplies. The delays are a bottleneck to resettlement itself in that settlers are expected to take up permanent residence in new villages without any--or only inadequate--water for domestic use, for constructing their own houses or such facilities as cooperative schools, or for agricultural use such as watering stock or mixing crop sprays. In the worst drought-affected areas, resettlement schemes have at present only seven per cent of the total number of settlers they can accommodate, and in other areas settlers have temporarily had to abandon the schemes due to insufficient water (2, 24/1/83).

CONCLUSIONS

Bad luck, in the form of two successive years of drought, has diverted resources from planned programmes of water supply to emergency relief measures. The adequate provision of water supplies is clearly one of the major constraints to the speedy and successful implementation of Government's efforts to resettle large numbers of families from the communal areas into former commercial farming areas. In addition, the currently limited capacity to provide new supplies impedes the national objective of ensuring clean water to the entire rural population by 1990. The international community has responded generously with equipment and technical assistance, and solutions are also being sought which will utilize local knowledge and institutions. Perhaps most encouraging for the future is the recognition that rural people should be actively involved, through village water communities, in planning and implementing water supply projects. Such an approach not only can reduce the rising costs of providing water but also can harness Zimbabwe's most potent force for development: her people.

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9th WEDC Conference: Sanitation and water for development in Africa: HARARE: 1983

URBAN LOW COST SANITATION

by J DE B ASHWORTH

URBAN LOW COST SANITATION:
SELF HELP, GOVERNMENT DIRECT LABOUR OR CONTRACTOR BUILT?

1. Summary
Contractor built latrines located in urban developments are more likely to lead to the success of a pit latrine project than either direct labour or self help construction. Contractors are not constrained by government regulations and can often, for example, use alternative methods to obtain materials in short supply, or pay incentive wages to the labour force for work not just attendance.
A self help construction project is likely to be successful in a rural environ where the community is united under a central figure - the village elder. But the fight to survive in an urban habitat often results in materials being sold for more important things such as food and medicine, and not the construction of the latrine.
Urban Government direct labour built latrines can suffer from the severe restrictions of government rules and regulations which dictate the purchasing procedures, but not how much is necessary to bribe store keepers to release materials to the project.

2. Introduction
You are the Town Engineer: The town's population has doubled in the last 8 years, but the supply of housing has failed to keep up with demand. The rural migration has moved into slum (squatter) quarters along the river banks where the town council has not financial interest because it is waste land. There has just been an outbreak of cholera. The daily papers are clamouring for somebodys blood and blaming the Government for failing to implement election promises of providing sanitation to all people. You are perilously close to being sacked in order to assuage a political blunder and allow the government to be seen to take action. In the meantime, by working through the nights with the Ministry of Health you manage to contain the cholera out break.
A court of enquiry, after the cholera out break, establishes poor sanitation and the public's poor personal hygiene to be the main contributory factors. The enquiry established cholera to have a minor contributor to the mortality rate far outstripped by gastroenteritis, measles and malaria as infantile killers. In addition the Ministry of Health point out that clinic and hospital records indicate only the "tip of the iceberg".
An inspection of the squatter areas shows bare footed children walking through pools of sewage, sullage and surface water, only a token water supply and refuse in partly covered pits with flies buzzing around the decaying matter.
The politians authorize finance for consultants to study the water and sanitation problems. Bilateral agencies support the project and eventually, years later, the detailed designs are underway. However, the lending agencies are short of money and have limited the Projects to a standpipe water supply, sewerage for the town centre, latrine project. It is agreed that the Health Education Unit of the Ministry of Health will join forces with the Sanitation Extention Unit under the Town Engineer, and under their combined umbrella oversee the construction of the pit latrines. But how? Self help, Government Direct Labour or Contractor built?

3. Self Help Latrine Construction?
Since independence, the country's philosophy and policies have been based on socialist ideology. Great emphasis has been placed on self help and this has worked well. Village water supply schemes have been constructed under the authority of the village elder, with technical assistance from central government. The personal relationship the villages hold with the construction works has resulted in continuing interest in maintaining the plant to a high level. From a financial view, the village self help projects are very effective. Not only are the labour costs practically nil, but the indirect foreign exchange element is low. Little imported machinery is needed to undertake the works; diesel fuel is only required to transport materials to site and for the technical design and supervision staffs' transport.
The reason that self help philosophy does not work for an urban project is not technical, but human. The village elder is a paternal figure. He knows by name and personality everyone in his village. In turn he is respected by the villagers; his advice

and arbitration is sought after. A misdemeanour by a villager is soon brought to the attention of the village elders and dealt with. In fact, it is a "close-knit" society working for a common good - socialism at its most successful.
In an urban environment these village attributes are quickly lost and scorned in the daily battle to survive. The dream of streets "paved with gold" is rapidly dispelled by the lack of work, food and housing the lot of too many rural migrants. The problems are compounded by disease, most of which is water related - children that might survive measles in their home village die in an urban community , as they are, in addition, fighting diarrhoea,ascaris (round worm), fevers and malnutrition etc.
In the past, "Sites and Service" projects have occasionally been implemented on a self help basis. The problems encountered are along the lines that "if it can happen it will happen". For example, one individual used his loan for a luxurious week in the country's best hotel. Others sold part of their cement allocation to buy food for the children. It was not long before sites and services projects we contractor built.

4. Government Direct Labour?

The direct participation of the town or governments' public works department in a latrine construction programme seems very attractive. It should be possible to save, at least, the contractors' element of profit in addition to savings on Costs incurred in tendering and administering the works. But, to operate the project by complying with all government regulations can lead to an expensive latrine.
The hiring of a direct labour force is often at the mercy of the regulations: Governments commonly pay labourers the minimum wage: sufficient for the man to arrive each day, but not to do a days work. Overtime rates are pityfully small unless the supervisor awards four to five hours as an inducement for hard work.
Many financial regulations for example restrict the employment of casual labour to three months. After the three months period, labourers become full time government employees and are entitled to redundancy payments. Often after this three month period the labourer or craftsman has become effectively trained when the regulations require him to be sacked. The supervisor then has the dilemma of retraining a new labour force or "bending" the regulations to maintain the present one.
The financial accounting procedures can effect the output of the labour force. Wages are paid weekly and once the total bill is more than, say, US $ 100 some financial regulations require a police escort! It can be very difficult to arrange and may result in the work force spending half a working day in collecting their wages from the central office.
Financial regulations on the purchase of materials and equipment are often very frustrating. Local purchasing orders must be placed with government parastatal bodies. If the parastal is unable to provide the requisite materials, than a proforma must be obtained from three private establishments and the purchase placed with the lowest tender. Even after payment for the goods failures can still occur, especially with scarce and valuable commodities such as cement. The delay between obtaining a proforma and presenting the money for payment can take weeks because of all the necessary authorization signatures, by which time the materials may have been allocated elsewhere. And for cement, which is often in short supply, it is nearly always necessary for the allocation officer in the cement works to be bribed - very difficult word to use on your government expense sheet!
In developing country, government transport is a highly valued commodity as public transport is often on point of collapse. Cars and Landrovers are used to ferry workers to and from work by which time the weekly quota of petrol is half consumed or has been syphoned off by the driver in order to pay for his food. Thus, the use of a government car to supervise a construction project is often not available. To borrow a lorry to transport cement materials is arranged in advance of the day for cement allocation, only to be foiled by the cement works who default on supplying either because of non payment of the bribe or a mechanical breakdown of the plant. The author knows of occasions where three attempts had to be made to obtain 7 tons of cement from a parastal cement works, although all payments had been made and the highest authorities given had priority clearance.
Two other areas affecting government transport are the purchase of fuel and repairs to the vehicle. Addtional petrol to the weekly quota (often 70 litres), requires the authorization of the department's director and the most senior civil servant in that Ministry - no mean feat to obtain these approvals. But then the ration must be drawn from the Government fuel depot. Which can entail queues of upto a mile long-more wasted time and energy. Repairs and servicing of vehicles with a few exceptions have to be undertaken by the government garage. Spare parts require money which is the reason why a vehicle can be laid up for months to the detriment of the project.
The cost of educating and training professional and technical staff in a developing country is a great burden on the economy. In some cases this has suffered from Britain's dramatically increasing overseas students fees. The limited number of qual-

ified professional staff are rapidly promoted to high positions where they are enmeshed in administration and have little chance in controlling the engineering projects. This is left to inexperienced staff who can often be daunted by the administrative procedures, let alone the technical requirements.
But a latrines project, constructed by direct labour will require full time engineers to supervise the works. However a degree of the routine work can readily be undertaken by IVth and VIth form leavers, if given the appropriate induction course.

5. Contractor Built?
Contractors have the reputation of making large profits, which is considered consistant with a capitalist and not socialist ideology. But, by open tendering procedures it is possible, in many cases, to keep the profit percentage low.
The advantage of a contractor over a Ministry direct labour force is that he is not confined by the government financial arrangements that are long overdue for revision. The purchase of materials can be completed in a pragmatic manner, where necessary by paying the appropriate bribes - in other words the free market price. Petrol and vehicles are rarely a constraint to a contractor.
A great advantage of a contractor over a Ministry labour force is that he is not confined by the government financial arragements that are long overdue for revision. The purchase of materials can be completed in a pragmatic manner, where necessary by paying the appropriate bribes - in other words the free market price. Petrol and vehicles are rarely a constraint to a contractor.
A great advantage for a latrine construction project is the hiring of local labour to undertake the works. Labourers and craftsmen are employed for the duration of the works. They will learn new skills, such as precasting latrine floor slabs on leveled ground rather than insitu floor slabs that require detailed shuttering. At the completion of the labour force will be disbanded but the acquired skills will remain within the district. A few craftsmen and labourers are likely to establish a latrine construction service to satisfy the demands of the area. Once this process has been successfully operated throughout the district the private "entrepeneur" craftsmen are in a position to undercut a contractor's price for any future works. It may not be by direct tendering, as that requires the formal establishment of a company, but by the refusal of the people to pay the higher price.
Supervision of the latrine construction by government or town council employees will still be required. But, the frustrations should be grately reduced and confined to paying the contractor for satisfactorily performed work. But a word of warning, contractors are better equipped than private citizens to use inferior quality materials than those Specified. Unless there is satisfactory supervision of the works the contractor will profit to the detriment of the works.

6. Cost Comparison
It is extremely difficult to compare the costs of building a pit latrine by self help, direct labour or a contractor. There has never been a project where all three approaches have been fully tried under identical conditions. Often, the government supervision and administrative costs are excluded in the analysis.
The average cost of a direct labour built pit latrine was obtained from a recent construction project in Africa and calculated to cost US $ 610 including government supervision and transport costs. The break down of costs is given in Table 1

Table 1

The cost of a Single VIP Latrine

(January 1981 prices)

		US $	
a)	Materials:		
	Cement	126	
	Steel	12	
	u PVC pipe	16	
	Timber	34	
	G.I. roof	22	
	Miscellaneous*	28	
		238	: 39%
b)	Labour	372	: 61%
		US $ 610	

Or, if the black market (ie free market) exchange rate is used : US $ 226. The above costs take account of labour, standing time when materials were not available and cover the half a day's working time a week to collect wages.
A contractor built latrine should be financially more expensive than the US $ 226 and a self help built latrine cheaper. If there is no wastage of materials. But as with cost comparison between all systems the results will depend upon circumstances within each country.

* covers a proportion of tools and equipment such as steel squat plate moulds.

Session 4

Chairman: Dr M A Coad, WEDC
Loughborough University of Technology, U.K.

Discussion

P A Linskog and R U M Linskog
Household water supply - a user's or a supplier's problem?

1. Dr LINSKOG discussed the problems of assessing the health and social impact of improved water supplies, with particular reference to the situation which existed in rural Malawi.

L A H Msukwa
Participation in rural water supply - the Malawi experience

2. Dr LINSKOG presented the paper, in the absence of Mr MSUKWA; he covered the background to the self-help water supply schemes in Malawi, and discussed the role which local communities had played in construction, maintenance and repair of the systems. The functioning of the new maintenance system in Zomba East was outlined.

3. Dr LINSKOG agreed to answer questions on both his own, and Mr MSUKWA's papers.

4. Mr BALL asked how the problem of unfair distribution of water along the length of a pipeline, whereby users at the end of the pipeline may receive little water, could be avoided. He also enquired as to whether the enthusiasm of people for having a piped water supply could be used as a "carrot on a stick" for obtaining their cooperation in less glamorous but equally important developments such as conservation, grazing control, and latrine construction.

5. Dr LINSKOG suggested that the pipeline could be designed to provide the required amount of flow at the end of the system, assuming that the source was adequate, by careful choice of pipe size. He felt that "carrots" only worked if the taste was sweet, and water supplies could only be used to promote other development activities if they functioned properly, and gave a satisfactory service to the users.

6. Dr NYUMBU asked whether a one or two year period was sufficient time for the impact of water supplies to be observed and evaluated, and requested more details on maintenance schemes.

7. Dr LINSKOG agreed that one or two years was not sufficient, but that obtaining funds for such an evaluation beyond a two year period was difficult. The maintenance schemes were outlined in Mr MSUKWA's paper, and he added that the villagers regarded the water as belonging to them, and they had to raise money through their committees if repairs were required.

8. Mr BINNIE stated that the improvement of water supplies often led to increased population growth rates, and asked whether the interrelationship between land, food, water and population had been studied.

9. Dr LINSKOG replied that their piped water supply schemes allowed for a population increase, but felt that it had not been established that improved water supply necessarily led to an increase in population growth rate.

10. Mr AMOANING-YANKSON thought that the selection of three nearby sites, to which were given different facilities, would make evaluation very difficult, because of the additional variables involved; he asked whether surveying villages on a "with" and "without" basis could be used, rather than on a "before" and "after" basis.

11. Dr LINSKOG said that when an area received water, there would be standposts or pumps all over it, as it was both politically and ethically impossible to do otherwise. If a "with" and "without" basis were used, the areas must be randomly selected otherwise it would be impossible to determine whether the impact was due to the water and sanitation improvements, or to other changes in society.

12. Mr WHITE asked whether the health impact surveys had taken account of the availability of health services in the area.

13. Dr LINSKOG replied that they had done so.

14. Professor NATH asked how the author allowed for variations in nutrition, and socio-economic conditions when comparing different groups in an impact survey, and how changing standards of living during the project period would affect community health.

15. Dr LINSKOG stated that no communities were identical, but providing that these factors were measured, they could be used in standardization, and that indicators of the standard of living were continuously noted.

16. Engr KEELING considered areas in which no improvement to water supply was envisaged

until 1985, and asked how far away such areas were from those areas already served, and how much monitoring of population movement on both a daily and a permanent basis was to take place.

17. Dr LINSKOG answered that such areas were usually more than 4km distant, and that during health surveys, population movements were recorded fortnightly, whereas water collection patterns were recorded for at least eight weeks per year.

18. Mr CROSS wished to know how the author proposed to measure water and sanitation useage, and vitally important details such as hand washing, tolerance of flies and the method of scooping up water, which were critical in assessing health benefits. He asked how data were collected, bearing in mind the limitations of the questionnaire.

19. Dr LINSKOG answered that there were numerous indicators, too many to list at the present, but the major ones were included in his paper. The methods used to collect data included closed and open-ended questionnaires, unstructured "chatty" discussions, in-depth discussions with key informants, and observation.

20. Dr LAING offered the following comments. Evaluation should include the effect on community dynamics, including the mobilization of the community. Werner had described development projects as community supportive and community oppressive. Community oppressive, while giving lip service to community input, were fundamentally authoritarian, paternalistic, or were structured in such a way that they encouraged greater dependancy, servility, and unquestioning acceptance of outside regulations which in the long term were crippling to the community. Community supportive schemes were those which favourably influenced the long term welfare of the community which help it stand on its own feet, generally encourage responsibility, initiate decision making and self reliance at the community level, and build on human dignity. True development thus occurred from community supportive projects, and any evaluation should include an assessment of how supportive or oppressive the project was.

21. Dr LINSKOG replied that in Malawi, people had been involved in self help schemes for a long time, and were used to making their own decisions in a number of ways, which facilitated implementation of water supply projects.

22. Mr BALL stated that piped water schemes in Zimbabwe often had a good supply of water near the intake point, and only a dribble at the end of the pipeline, and asked if this was the experience in Malawi.

23. Miss SMITH-CARINGTON, replying on behalf of Dr LINSKOG, answered that the piped water schemes in Malawi have a series of storage tanks at intervals along the main pipeline. These served to ensure that sufficient head was maintained at the furthest points, and that storage was provided by the tanks filling up at night.

A Smith-Carington
Low cost rural groundwater projects in Malawi

24. Miss SMITH-CARINGTON described the hydrogeology of the relevant parts of Malawi, and discussed the design of boreholes and dug wells. Community participation was presented as the vital factor for the successful long term operation and village level maintenance of the project.

25. Mr KANDWE thought that the provision of wash slabs at the boreholes was a good idea, but asked for details on how wastewater and litter were disposed of; he also asked for more information on the Malawi pump.

26. Miss SMITH-CARINGTON replied that initially, soak pits were provided to remove wastewater, but these rapidly became infilled due to very low permeability of the surface clays, which were widespread in weathered basement areas of Malawi. The channelling of water to small irrigated gardens was now being encouraged, and any income generated from cash crops could be used to purchase spare parts. Each waterpoint had a pump committee of three women volunteers, whose duty it was that the surroundings were kept clean, and that users removed their rubbish from the area. Detailed drawings of the Malawi pump could be found in the Manual for Integrated Projects for Rural Groundwater Supplies; important features of the pump included: ease of maintenance; local manufacture; reliability; and low cost.

B H Kinsey
Water supplies for resettled populations

27. Dr KINSEY discussed the national water policy in Zimbabwe, the resettlement problem, and the scale of the water supply problem for resettled populations, including the institutional framework and programme implementations.

J de B Ashworth
Urban low cost sanitation

28. Mr PEACOCK stated that he would be presenting the paper due to the absence of Mr ASHWORTH; he had stepped into Mr ASHWORTH's place at less than 24 hours notice, and although he had little direct experience in the topic under discussion, his experience working in African developing countries, supervising both direct labour work and contractors, was relevant.

29. Mr ASHWORTH's paper was intended as an attempt to save developing countries from adopting idealistic social approaches at the expense of the people they are trying to serve. It was based on his first hand experience of working for the sewerage and sanitation department of the Government of a developing country in Africa, where he spent 15 months formulating urban low cost sanitation policies and undertook a pit latrine demonstration project. Conditions he experienced there were probably not unique to that country and in many ways similar to those found in other developing countries in Africa.

30. He believed that criticism was rightly levelled at engineers for being careless of the needs of the people they were supposed to serve. Engineers could not always blindly follow their governments' policies and expect not to be held to account at the end of the day if the project failed.

Mr ASHWORTH echoed a familiar cri-de-coeur : projects take too long to fund and get under way. However, having reached the point of take-off, how to implement the work? - Self help, Government Direct Labour, or Contractor built?

31. Self help schemes had been effective in the rural areas; not only were the labour costs practically nil, but the indirect foreign exchange cost element was low. There were of course many other positive points for this mode of development. But the self help concept was difficult to translate to the urban situation.

32. Government Direct Labour seemed attractive as it would appear possible to save at least the contractor's element of profit and some of his overheads. But the 'hidden' costs of direct labour work in many African countries were becoming more and more significant. Moreover, the administrative constraints which were placed on government direct labour organizations often led to considerably longer implementation periods than planned.

33. Contractors had to allow for an element of risk in their prices but tried to keep them as low as possible in competitive bidding, and still make a profit - the latter being anathema to some policy-makers. However contractors were usually possessed by the incentive of wanting to complete the work as quickly and economically (to themselves) as possible.

34. It was difficult to compare the costs of the alternative means of implementation, but it appeared at first sight that the most expensive was a contractor built latrine. The comparison would depend on circumstances in a particular country but would inevitably involve a trade-off between apparent high costs and the cost of delay in providing the facilities to the people - less easy to put a price on.

35. The costs quoted in Mr Ashworth's paper were high, and "low cost" certainly could not be confused with "no cost". The costs should be regarded cautiously as it was probably unrealistic to compare prices across national boundaries when some developing countries jack up their exchange rates for political and other reasons.

36. Mr KUYATHEH observed that there appeared to be some confusion between direct self help labour obtainable within socialist orientated rural areas, and indirect self help labour with the same orientation applicable to urban areas. The author mentioned the need for contractors in urban zones with the view to replacing village direct self help labour without explaining the source of finance for the contractor; in urban areas contributions could be obtained communally to meet the contractors' costs without nullifying the original socialist principles of self help.

37. Mr PEACOCK replied that there was no confusion in Mr ASHWORTH's paper, and apologised if he had created an incorrect impression; the author was drawing a comparison between urban and rural situations, and was not advocating abandonment of rural self help schemes. Previous authors had told of the success of such schemes in Malawi, but it was the author's opinion that

success with self help, particularly in direct labour schemes was difficult to achieve in urban situations. There was no suggestion in the paper of utilizing contractors to construct low cost sanitation measures in rural areas; this would not appear to be attractive. The use of contractors in urban areas would require funds from government, raised locally through rates or other means, or from donor agencies.

38. Dr ALUKO drew attention to the unusual population distribution in south western Nigeria; the U.N.O. demographic yearbook of 1963 indicated that of the 23 towns in Nigeria having a population of at least 100,000, 16 were within a 160 km radius of Ibadan in the south west of the country. The inhabitants tended to be more sophisticated and educated to a higher level, and were thus less amenable to self help schemes involving manual labour. Much of the region, apart from the coastal areas, was on the base complex, where wells and boreholes were not very successful. Government agencies had thus opted for large surface water supply schemes designed by consultants and constructed by contractors in many instances. The control of direct labour in government departments of works had become more and more difficult.

39. Mr PEACOCK thought that it would be nice if urban communities could be more involved in developments which had such profound effects as water supply and sanitation, and wondered how this particular mode of development would lead to problems in operating and maintaining the schemes. Greater community participation at the development stage may lead to different approaches and greater success, although there would be problems. He felt that more thought should be given to this matter.

40. Dr LAING made a general comment relating to improvements in water supply and sanitation. He thought that the existence of diarrhoea and skin disease were good indicators by which to evaluate health improvements due to water supply and sanitation, with any improvements being obvious in one or two years. Diarrhoea morbidity and mortality were good indicators of nutritional levels, that is, high rates reflected poor nutrition. Very few people died directly from malnutrition, but many died from diarrhoea due to weakness from malnutrition.

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INSTITUTION BUILDING FOR THE DECADE: THE ROLE OF CONSULTANTS

by P A BATCHELOR, K STARKEY and D PARISH

1. The investment programme now being planned and implemented, in pursuit of the goals of the UN Water Supply and Sanitation Decade, are, by their very scale, giving rise to an urgent need to strengthen the institutions responsible for planning, developing, operating and maintaining water supply and sanitation schemes. In some cases it is necessary to create entirely new institutions to carry out these tasks.

2. The terms institution building and institutional strengthening provide a convenient umbrella for much of the work management consultants carry out in water utilities. They are terms coined by the major lending agencies to cover our work as advisers, analysts and catalysts for change.

3. The nature of the institutional problems varies widely. In the case of small rural supply schemes or basic sanitation programmes, the emphasis is often on the achievement of grassroots community participation, the development of simple but effective measures to ensure the proper maintenance and protection of facilities once built and, in some cases, the identification of some means of cost recovery or cost sharing to cover on-going operating and maintenance costs. At the other end of the spectrum, in dealing with large scale urban schemes, the range of technical options involved may extend from low-cost technology sanitation programmes to complex modern water treatment and distribution and piped sewerage with full treatment and disposal. The institutional and management framework will need to match this and may necessitate the adoption of sophisticated management systems and procedures, including, increasingly, the use of computers.

4. In tackling these problems we have to avoid pre-conceptions. While technology transfer, in a management sense, may be important we cannot impose pre-packaged solutions derived from experience in Europe or North America. It is necessary to understand local circumstances and to derive appropriate management solutions, tailored to local cultures, manpower availability, political and social objectives and financial constraints.

5. We do not offer an off-the-shelf package because, despite superficial similarites, each situation is different and our work has to be tailored accordingly. We are not retained to provide instant solutions but to bring to bear techniques and experience to tackle institutional problems and to find solutions. We attach great importance to the process of gaining acceptance for and commitment to the solutions proposed and to the provision of assistance in implementation. In order to achieve this, we have developed a step-by-step approach in which we aim to understand the problems involved, develop solutions and help carry them out in a practical way.

6. Accordingly the remainder of this paper can be divided into three parts dealing in turn with the DIAGNOSIS of institutional problems, the DESIGN of new or improved arrangements and the steps needed for IMPLEMENTATION.

7. The approach and techniques we shall be discussing apply broadly both to situations in which we are called upon to help design new institutions and to those where we are required to reorganise or strengthen existing ones. What varies very much, from case to case, is the balance between diagnosis, design and implementation and the relative importance of different techniques depending on the local situation, the time available and the amount of detail required.

Diagnosis

8. Experience has taught us that effective diagnosis is the key to success. Our approach to diagnosis has four key elements:

- understanding the environment
- defining institutional objectives
- estimating available resources
- reviewing existing institutional capacity.

9. We attach great importance to careful diagnosis since this lays the foundation for subsequent work. Understanding the environment in which water utility services must operate and unravelling the complex interrelationships often involved is particularly important. We are also specially

concerned to ensure that institutional objectives are defined in a way which is compatible with the financial and human resources available. Many of the institutions we have been asked to help face an acute shortage of skilled manpower; very often the scarcity is most acute, not in engineering but in planning, finance and other management skills. Moreover, since water and sanitation utilities are so often 'the poor relation' they find it difficult to attract and retain good quality staff even when such skills are available.

10. In assessing the capacity of existing institutions we are very often concerned not only to evaluate their current performance (using a variety of performance measures and efficiency audit techniques) but also to estimate their capacity to adapt to change, to take on new responsibilities and to face new challanges.

11. In comparing the efficiency and effectiveness of one institution with another, either within the country or elsewhere, it is never sufficient to adopt a merely mechanistic approach. Informed judgement and a keen awareness of political, social and economic factors are essential; this frequently calls for a blend of local and international expertise. The former bring a close understanding of local culture, expectations and constraints; the latter can bring relevant experiences from other countries who have tackled simmilar problems in the past.

12. What we try to achieve, during the course of the diagnosis, is a detailed understanding of the current situation and a realistic interpretation of what objectives are being pursued and what can realistically be achieved. We need to know what capacity exists for absorbing institutional change and what basic constraints will limit the rate and direction of such changes. Many ambitious development programmes have foundered not so much for lack of funds as for lack of manpower and difficulties in adapting to the demands of a major investment programme.

Design

13. Institutional design has become all-embracing. It involves far more than the design of a suitable organisation structure. A sound legal framework is needed to provide the foundation and, in addition to recommendations for organisation structure (organisation charts, job descriptions etc), the design should also encompass the specification of management systems, the development of appropriate schemes and conditions of service and the recruitment, deployment and training of manpower.

14. The approach to institutional design therefore needs to be a multi-disciplinary one. It frequently involves several individual specialists with skills in drafting legislation, designing organisation structure, manpower planning, personnel policy, management information, systems design, stores and procurement, operational management and training. The process of specifying and designing management systems should go hand in hand with the definition of the legal framework and organisation structure; the three elements are closely interrelated.

15. In defining an appropriate legal framework, organisation structure and management systems for water utilities a number of key issues repeatedly arise:

- how much institutional change can be accomplished within a given time span?
- should all aspects of management of the water cycle be integrated?
- is there a case for greater decentralisation?

16. Our experience suggests that there is no universal blue-print for success and that imported solutions to institutional problems rarely work. Our search often leads us to narrow down the options to seeking local solutions which have proved workable but which demonstrate the capacity to adapt to change. The needs of large scale urban systems and small informally-managed rural systems differ dramatically but similar basic techniques can be applied in designing suitable management systems so long as needs and objectives have been thoroughly understood.

17. We attach particular importance to ensuring that the institutional arrangements we propose fit the institution into its environment and do not attempt to isolate it from it. Effective mechanisms must be established for the management of external relationships and steps must be taken to obtain commitment to and appropriate influence for the institution.

Implementation

18. Successful implementation must be based on general acceptance of the validity of the proposed changes and whole-hearted commitment of those who are charged with piloting them through. A careful balance must be struck between the need to prepare thoroughly for the changes to take place and the need to keep up momentum once a decision to make changes has been taken.

19. In an effort to manage the implementation of major projects, frequent use is made of Project Implementation Units

as a means of short-cutting some of the bureaucratic obstacles to change. Our experience suggests that they are by no means an unmixed blessing and may create new problems of coordination or even invite obstruction from existing institutions.

Some Key Lessons

20. Our work in institution building in the water sector has enabled us to grasp some of the complexities of managing change. In order to achieve success, institutional issues should be addressed as early as possible in the planning cycle. This enables options to be fully explored, allows account to be taken of alternative levels of resources and gives recognition to the fact that institutional design is an iterative process. It also provides time to design institutional arrangements which are compatible with the environment in which they must work and which can secure the acceptance and commitment of those who must make them work.

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PROJECT IMPLEMENTATION MANAGEMENT AND COMMUNITY PARTICIPATION

by EPHRAIM M CHIMBUNDE

Project implementers must choose Technologies that are acceptable to the user. In most cases people will have seen ideas that have not worked and implementers should demonstrate the viability of the Technology in question.

Implementation embraces socio-cultural and socio-economic aspects and therefore cannot be discussed in isolation of Technology options.

While this topic is very often discussed in general it is very important to remember that very often the exercise may need to be project-specific. Equally important is that the implementers must have the goals and objectives of the programme very clear from the beginning, eg is the programme fully funded by the Government or other Agencies or orientated towards self-reliance?

Training

Training is an essential component of any programme. People who are going to be involved in the programme should be acquainted with the technology to be used in the exercise and very often the training is project specific.

Motivation

The success of any sanitation programme depends to a large extent on how motivated the community is and how much awareness has been created in the community about the sanitation programme.

Awareness is achieved in many ways. Normally information is communicated to the people by radio or television. Very often films and videos are used to convey information. This method can be very effective although not all the necessary details can be included. Information can also be passed through political channels by asking politicians to promote sanitation during their rallies.

By far the most effective method of convincing the people is by setting demonstrations in central positions and asking local people to take part in these demonstrations. Demonstrations have many advantages attached to them. They convincingly show the simplicity of the design and its adaptability. Motivation is a temporary factor which will not last long unless there is quick response while it is still burning. Once lost it takes a lot of effort to be regained.

It is extremely important to be able to demonstrate the diversity of the Technology, showing how materials available locally are made use of. Equally effective is to demonstrate how Technologies locally known to the people are harnessed into the programme.

In a way of persuasion people should be made aware of the relationship between certain diseases and unsanitary conditions, and be enlightened on the health benefits connected with technologies being advocated.

Community Involvement

Community or individuals should be involved in the programme from its onset. People must feel it is their programme or their installation and the success of a programme hinges very often on this point. Trained personnel must play the roll of advisers, the local people playing their part as implementers even in the Administration and Management of the programme.

The involvement of local people at all levels also helps to ensure continuation of the programme.

Incentives

Incentives are an essential component of any programme and very often they help to speed it up. These incentives should be provided by Governmental Agencies in the form of imported materials that are not available locally.

Ideally people should be involved in planning and implementing programmes, as well as using and evaluating any improvements in water supply and sanitation.

Maintenance

Constant supervision should be maintained during the course of the programme. This is afforded by making frequent visits to ensure that implementers are not going astray with the technology.

There should never be a breakdown of communication between technologists and implementers during the course of a programme as this may cause unnecessary delays.

Obviously no technology is designed to be maintenance free. It is therefore advisable to choose technologies that work with the minimum of maintenance and have a long life. Maintenance must be at least affordable by the user.

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TRAINING OF TREATMENT PLANT OPERATIVES

by J McKENDRICK

INTRODUCTION

Local authorities, governments and international funding agencies throughout the world have in the past spent, and will in future spend, vast sums of money on the design and construction of water and sewage treatment plants both in urban and rural areas. Now that we are in the "Water Decade" more interest is being shown and funds being made available to provide developing countries with satisfactory and hygienic water supplies and safe waste water treatment systems, especially in rural areas.

Notwithstanding past developments and future proposals, the sums of capital money spent on these systems have very often been negated both in developed and developing countries. This has not been because of the lack of professional staff and skills but because of a severe shortage of trained and certified operators capable of understanding and carrying out the day-to-day routine functions necessary to maintain and operate such plants in an efficient manner so that the plants produce the goods for which they are designed, and ensuring that the capital money spent is not wasted and that the public are assured of a safe, hygienic supply of water, a safe and hygienic waste water treatment system and a healthy environment where people can carry out their normal duties in life without fear of disease.

HISTORICAL DEVELOPMENT OF TRAINING IN ZIMBABWE

Training of sewage works attendants was introduced into this country in 1962 by the then Institute of Sewage Purification (Southern Africa Branch). The parent institute is a United Kingdom-based organisation with world wide recognition for the high standards of its aims and objectives in this field.

The system of staff engagement in those days was to employ an artisan qualified in mechanical skills and train him on site to operate a sewage or water treatment plant. The proposed course in 1962 adhered to this principle but the course aimed at giving those employed in the field of sewage treatment the opportunity of formal training on a national basis resulting in the certification of successful students. Unfortunately, a similar course for training attendants in the water treatment field was not available at that time.

The Institute selected various centres throughout Southern Africa where professionally trained and experienced members of the Institute were willing to offer their services in the training of sewage treatment plant attendants. Harare was chosen as one of the centres and the offer was snapped up because of interest in the training and certification of attendants both in the fields of sewage treatment and water treatment.

Local authorities, government agencies and mining companies were then informed of the proposed training scheme and asked to submit the names of potential candidates to the Institute as well as the name of the training centre of their preference for the training of their staff. In that first year, nine attendants chose to be trained in the then City Engineer's Department of this City.

Upon registration, the candidates were sent a training handbook for sewage works attendants compiled by associate members of the Institute. After some six to nine months of home study they then spent one week in the Department where they were given formal tuition in theoretical and practical aspects of sewage treatment. At the end of that week the candidates were given an oral examination by the local centre and approximately one month later were required to sit a written examination which was sent to and marked at the Southern Africa Branch Headquarters. Those who were successful were issued with a certificate signed by the President of the parent body in London.

This system of training sewage works attendants continued until 1972. The pass rate during this time varied from 40% to 60%, with many First Class Passes being recorded in this country.

In 1972 The Institute of Water Pollution Control (Southern Africa Branch) decided that future training in South Africa would be done through technical colleges and that training in sewage treatment would be combined with training in water treatment. Although we agreed that the proposals were basically sound, they would not have been practical in this country for the following reasons:-

(1) Many of the smaller works in this country were controlled by only

one attendant and it would have been impossible to release them from their duties as would have been required by the technical college system.

(2) There were only two technical colleges in this country at that time and these colleges felt that the numbers involved were too small for them to consider this type of training.

(3) There were no experienced or qualified lecturers in this field to lecture to students on a full-time basis.

Because of this, an approach was made to the Institute by the Department for permission to continue the Sewage Works Operators Course in this country based on the past system. This request was granted and since then this course has been held every eighteen months or two years with the examinations being set and marked by the Chief Chemist in the Department, the results being sent to the Branch Headquarters who then organises the certificate signed by the President of the parent body in London to be sent to successful candidates.

MINISTRY OF WATER DEVELOPMENT: SUB-COMMITTEE - OPERATOR TRAINING

In the mid-1970s concern was felt in the Department about the lack of qualified artisans applying for posts as attendants in Council's water and sewage treatment plants. Enquiries showed that the same pattern was emerging in other local authorities where the same concern was being expressed.

An approach was made to the then Ministry of Water Development which resulted in the formation of a sub-committee in 1978 to study the problem and attempt to find satisfactory training and certification of operators and attendants both for employees on sewage treatment plants and water treatment plants. Enquiries were made locally and as far afield as the United States of America. No definite conclusions were reached by this committee and because of pressure of work, shortage of staff, emigration and the war the sub-committee ceased to exist in 1979.

TRAINING OF WATERWORKS ATTENDANTS, CITY OF HARARE.

Since the inception of a training scheme followed by certification for sewage works attendants, it was noted that the turnover of staff on Council's sewage treatment plants fell considerably, while at the same time it was noted with concern that the turnover of staff on Council's water treatment plants remained alarmingly high.
It was obvious that the training and certification of sewage works attendants was providing job satisfaction, and a survey confirmed this and also highlighted the fact that the attendants no longer considered themselves to be uninterested, unskilled workers but now looked upon themselves as highly-trained, skilled workers within the community, akin to any artisan. A similar survey carried out among waterworks attendants produced exactly opposite results, and it was felt that training and certification of waterworks attendants on a par with sewage works attendants had now become a necessity.

Enquiries throughout the world for such a training and certification programme for waterworks attendants failed to produce any positive results at that time. Undeterred, however, the staff in the Chemical Treatment Section of the laboratory set about the long and arduous task of preparing a syllabus and course for waterworks attendants based on the same standards as that operated by the Institute of Water Pollution Control for sewage works attendants. Unfortunately, a recognised certificate could not be found for this course; however, a certificate was designed and issued under the auspices of the City of Harare, signed by the Chief Chemist and the Director of Works. At least now the waterworks attendants had a tangible goal to look forward to which had not existed for them in the past.

The first examinations were held in 1979 but had only one successful candidate. Further examinations were held in 1980 but, again, produced only one successful candidate. Because of the apparent lack of results, it was decided to run a series of lectures and demonstrations for a period of nine months before the next examinations. This appeared to be the answer to the problem, as when the next examinations were held in 1982 three out of seven candidates were successful.

IMPORTANCE OF TRAINING AND CERTIFICATION OF ATTENDANTS IN THE CITY OF HARARE

Apart from the obvious advantage of more efficient operation of Council's Water and Sewage Treatment Plants, a certain degree of job satisfaction and standing in the community was given to the attendants. Successful attendants were awarded an upgrading of their posts thereby creating financial stimulus at the same time. It is now laid down in Council's employment regulations that Superintendents and Assistant Superintendents of Council's Water and Treatment Plants must be in possession of a recognised certificate, thus adding another incentive for the attendants to sit and pass these examinations.

IN-SERVICE TRAINING SCHEME, DEPARTMENT OF WORKS

Towards the end of 1979 it was forecast that a critical situation regarding trained and qualified staff would arise in the Department in 1982 due to resignations and retirement of superintendents and attendants employed on Council's Water and Sewage Treatment Plants.

With the failure of the sub-committee in the Ministry of Water Development to produce an approved scheme for the country as a whole, it was decided that plans for an in-service training scheme be made within the Department. This scheme got off the ground in 1981 when Council agreed to increase the establishment in the Water and Sewerage Branch of the Department of Works by fifteen posts, Grade 22, to be used solely for the purpose of training.

SELECTION TESTS

Because of the lack of skilled mechanical artisans, the entire scheme was based on the training of existing operators and labourers to bring up to the standard of attendants' training and certification those who proved to be capable. Throughout the works there were over four hundred employees and the selection of those capable of advancing themselves proved to be extremely difficult, so it was decided that every one of these employees should be given a chance. Selection tests based on basic mathematics, basic use of tools and a simple aptitude test were devised and these were given to all workers on 30th June, 1981. 150 marks were awarded for this series of tests and those obtaining 70 marks or over were selected to participate in the Part 1 of the actual In-Service Training Scheme. Although 21 candidates obtained the necessary number of marks, i.e. approximately 5,0%, it was felt that the number to be trained was enough for the first part of the exercise, as everything being done was purely experimental, no qualified training officer in this field being available. Also, under these circumstances those selected were considered to have the ability to be trained at a faster rate.

At this stage no advice could be obtained as to what subjects should be on the syllabus for Part 1 of this training. Past experience with the training, examination and certification of attendants had shown that the weakest points of even the most skilled artisan had been mathematics, chemistry and biology. It was therefore decided that Part 1 of the training would consist of these subjects, thus enabling successful candidates of the In-Service Training Scheme as a whole to be better prepared for examinations in the future. Suitable lectures in these subjects were prepared and issued to the selected candidates. At this stage the scheme was in danger of falling into difficulties because of a rapid loss of trained staff in the Department over a short period and candidates could not be given the amount of tuition intended. To their credit, the students continued the course, receiving tuition in a very haphazard manner.

Examinations for Part 1 of the training were held in February, 1982, and those obtaining an average of over 45% were selected to participate in Part 2 of the training scheme. Nine candidates were successful, representing 42,8% of those who participated in Part 1 of the scheme, and approximately 2,5% of the total work force. The nine successful candidates were immediately upgraded to Grade 22 and withdrawn from their normal duties to commence intensive training in Part 2 of the above scheme. At this stage it was realised that it would be impossible to carry out the training as envisaged without the assistance of a training officer. The Department was fortunate in obtaining the services of a retired sewage works superintendent to assist with the training. The syllabus drawn up for Part 2 of the training was as follows:-

Unity Operation (Theory); First Aid; Unit Operation (Practical); Sources of Water; Workshop Practice; Characteristics of water; Applied Mathematics; Trade Effluent Control; Applied Chemistry; Water Cycle; Applied Biology; Safety.

As can be seen, this part of the training laid emphasis on practical training.

Every student was asked to operate each unit on a sewage or water works ranging from raking screens to anaerobic digester control and from chemical dosing to pump-house control respectively for at least two months. At the same time they were given lectures on the theory of each unit. Lectures and practical training were also given on the other subjects on the syllabus. Because of the ability and aptitude of the students, the assistance given by a person with a practical bent, and taking into account the worsening situation of certified attendants on the works, Part 2 of the training scheme was conducted intensively and final examinations in all subjects were carried out in December, 1982. During the training period one of the students dropped out because of illness, but of the eight who sat the examinations seven were successful, representing 87,5% of those who participated in Part 2 of the scheme and approximately 1,75% of the total work force. Three of the candidates obtained over 70%, thus gaining First Class Passes, which was a very pleasing feature of the training scheme.

Certificates have been designed by the Dept. for presentation to the successful trainees and a plaque has been designed which will be presented to the trainee with the best overall performance.

An interesting aspect of the selection methods and the training scheme is that apart from one trainee, the performance of the trainees participating in the scheme was uniform throughout each section of the scheme, as is shown by the positions of each trainee at the end of each section:-

Trainee	Position Selection Tests	Position Part 1	Position Part 2
A	3	2	1
B	1	1	2
C	5	7	3
D	5	5	4
E	3	3	5
F	6	6	6
G	6	4	7
H	2	8	8

These results confirm that the selection and training methods used in the In-Service Training Scheme were successful and could be used to supply the City with suitably-trained staff to operate water and sewage treatment plants efficiently in the forseeable future. The seven successful candidates will be upgraded to Grade 18 and should be able to carry out the duties of a works attendant. They will be encouraged to study for certification examinations with the Institute of Water Pollution Control in the case of sewage works attendants, and with a recognised institute (the matter is currently being negotiated) in the case of waterworks attendants.

THOUGHTS FOR THE FUTURE

Now that the first part of the In-Service Training Scheme has been successfully completed, it is the intention of the Department to look again at the employees who scored between 60 and 70 marks in the original selection tests. Already the lectures have been distributed to fifty-six employees who obtained the above marks. It has been found necessary to move this second phase of training at a much slower pace, and the training officer has given them more lecturing and coaching than the first group.

This phase 2 of the training scheme is now in progress and it is hoped to examine the new Part 1 candidates sometime in January or February, 1983, and repeat Part 2 of the scheme with the successful candidates.

After the second phase has been completed it is felt that the source of material in the Department capable of being trained to this level will have been exhausted. In this event consideration will be given to advertising training posts within the Department so that training in this field will become a continuing exercise, thus providing the City Council and even the entire country with a pool of trained and qualified attendants and operators.

CONCLUSION

Because of the difficulties experienced in obtaining the services of skilled artisans as sewage and waterworks attendants and because of the failure to establish a national training scheme in 1978, the Department of Works in the City of Harare decided to establish its own In-Service Training Scheme designed to produce its own skilled manpower so that capital expenditure spent in the past and that to be spent in the future will be protected by efficient operation of Council's sewage and water treatment plants.

Although some difficulties have been experienced it is felt that the scheme has been successful, and because of it it is hoped that the citizens of Harare will continue to receive a safe supply of water for both domestic and industrial use and that all waste water produced by the City will receive efficient treatment and that a healthy environment will be maintained within the City.

ACKNOWLEDGEMENT

Thanks is given to the Director of Works and the City Council of Harare for assistance in the formation of the In-Service Training Scheme and for permission to present this paper.

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TRAINING THROUGH WORK EXPERIENCE

by W K TAYLER

INTRODUCTION

The goals of the Water Decade are very ambitious and considerable commitment and careful planning will be required if they are to be even approached. It is important to identify the factors which inhibit development and to allow for these factors in Decade programmes. Two common inhibiting factors are lack of finance or material resources and the shortage of trained personnel. These factors present a serious obstacle to the development of water services in urban areas in Southern Sudan. The present paper argues that attempts to tackle the problems posed by the lack of material resources and the shortage of trained personnel separately have been unsuccessful. It describes the Author's experience in working with a small team of Sudanese engineers on works to improve urban water supplies, points out the drawbacks encountered because of lack of resources and suggests an approach to aid which will result in improved water supply facilities and at the same time provide Sudanese staff with valuable work experience. A proposed development programme is outline , which will give work experience to water engineers and maintenance technicians. It will also make correct operation of water supply systems possible and hence prepare the way for on-the-job training programmes for operational staff.

THE BACKGROUND SITUATION

It is necessary to give some background information on Southern Sudan and its urban water supplies in order to put the ideas and arguments presented in the paper into perspective. Sudan is the largest country in Africa and the Southern Region, with an area of approximately 650,000 square kilometres, includes about a quarter of the land area and has a population of about 4 million. The population is predominantly rural but Juba, Wau and Malakal, with approximate populations of 120,000, 80,000 and 60,000 respectively, are sizeable towns. Several other towns have populations in the range 10,000 to 20,000. Juba, the seat of the Regional Government, is over 1200 km from Khartoum and communications are difficult, both within the Region and with the rest of the country.

Like other African countries, Sudan has been adversely affected by the recession in the world economy and it is currently faced with severe financial problems. At the same time, there is a shortage of trained manpower, particularly in the Southern Region where development was seriously set back by the civil war that ended in 1972. In view of these facts, it is inevitable that the Region relies heavily on the assistance of aid organisations and this is certainly true in the case of urban water supplies.

Urban water supply facilities

The water supply systems at Juba, Wau and Malakal are based on river abstraction with rapid gravity sand filtration and were originally designed to serve populations of around 10,000. Although there have been additions to the original systems, facilities have failed to expand to match the growth of the towns so that large areas in each are without piped water. The systems are in a poor state of repair, due partly to the difficulties in obtaining parts and materials and partly to the lack of well trained maintenance staff. Some, but not all, of the smaller towns have piped water supplies. In areas without piped water supplies, a variety of water sources is used, ranging from boreholes to rivers and streams. Water carriers operate extensively in Juba and Malakal and the price of water from these carriers is up to fifteen times the official rate for piped water.

Consultants have prepared reports on water supplies to Wau and Malakal which will lead to large reconstruction schemes if finance can be arranged. The reports recommend measures to be taken to improve water supplies to the towns in the interim period. A feasibility study is also planned for Juba where GTZ, the German technical aid agency are carrying out a programme of interim measures. GTZ have also been involved with water supply schemes for Yambio and Maridi, two of the smaller towns.

Organisation of urban water supplies

Until recently, urban water supplies were the responsibility of the Public Electricity and Water Corporation (PEWC), a public corporation based in Khartoum. The southern area of PEWC was based in Juba and covered the whole of the Southern Region. Water and electricity services are in the process of being decentralised but the new arrangements have not yet been finalised. The Regional Ministry of Housing and Public Utilities (RMH&PU) has been involved with the schemes for water supply improvements, particularly those funded by GTZ. The Southern Area has an operational deficit which has been met partly by PEWC, Khartoum and partly by the Regional Government. A priority of any development programme must be to take measures to reduce this deficit.

EXISTING FORMS OF ASSITANCE

Assistance to Sudan in the fields of urban water supply and sanitation has until now taken two forms. The first is the provision of finance for consultants to carry out feasibility studies, intended to lead to the detailed design and then construction of new facilities. A consultant's report can provide a useful statement of the overall strategy to be followed but the procedure has drawbacks for a poorly developed area like Southern Sudan. It tends to concentrate development into discrete periods of intense work at widely spaced intervals, precluding the substantial involvement of local institutions and ensuring heavy dependency on expatriate personnel. Thus, the procedure does nothing to build up local expertise and increase a country's self-reliance. The concentration on construction also tends to push the need for correct operation and maintenance procedures and training into the background. Two effects of this approach are that local engineers and technicians are underworked, quickly becoming demoralised and losing interest, and that the inflexibility of the procedure leads to delays in execution while problems remain unsolved and water services deteriorate.

The second form of assistance, scholarships for academic study abroad, has little relevance in a situation such as that described above. All technical disciplines require a combination of practical experience and theoretical knowledge and the knowledge gained through study is rapidly lost if not put into use. Lasting development can only occur if steps are taken to fully involve local personnel in schemes to improve water and sanitation facilities. Aid programmes must operate as far as is possible through local institutions which must be strengthened and supported where necessary to enable them to function effectively.

THE SOUTHERN SUDAN PROGRAMME

The programme which is the subject of this paper is an attempt to apply the principles suggested in the previous paragraph. The first stage has been to set up a small team of engineers within the RMH&PU to work on the planning, design and construction of water supply projects. Support and guidance is provided by an experienced engineer recruited by VSO, the British volunteer organisation, and employed by the RMH&PU. The Author, the first such engineer, started work in March 1981 and is due to be replaced in early 1983. There will be an overlap period of at least two months to ensure continuity. Both the Author and his replacement have been recruited from British water authorities.

Plans are in hand to extend the programme to include the training of mechanical and electrical maintenance technicians. VSO or the organisation Water Aid, based in the British water industry and intended as a response to the Water Decade, will be used to recruit experienced technicians to assist in this part of the programme. The first priority will be to improve and repair existing facilities. This will enable correct operational procedures to be introduced so that the training programme can be extended to include operational staff. As the reliability of water services is increased, their profitability will improve and it should be possible to reduce the operating deficit. Some attention will also have to be given to the training of accounting and administrative staff. Once the present position has been consolidated, it will be possible to start to expand services. The various elements in the programme are described in more detail below.

New works team

The team is directly responsible to the Director of the RMH&PU and consists at present of the Author, two graduate civil engineers and a draughtsman. All the Sudanese members of the team have previous engineering experience but none directly related to water. One of the engineers attended a water resources course in Britain in the first half of 1982 and it is hoped to send the second engineer to Loughborough for the MSc course in 1983. The aim of the team is to give engineers and technicians a grounding in the principles and practice of water supply work and, at the same time, improve the state of water supplies in the

Southern Region. Training is given as far as is possible through the work of the team but inevitably there are gaps in the knowledge gained in this way and directed reading and design examples are used to fill these gaps. A task which has been carried out by one member of the team may be repeated by another if it illustrates important principles. The intention is to cover a range of subjects including the planning of overall water supply strategy, hydraulic design of waterworks units and water mains, the layout of waterworks and distribution systems, a knowledge of the available plant and materials, preparation of working drawings, drawing office procedures and construction techniques.

To date (October 1982) most of the work of the team has concerned Juba. The immediate needs are largely covered by the GTZ interim measures programme, for which a German firm of consulting engineers is responsible for supervision and procurement of materials. The work in hand also includes the installation of three pre-fabricated steel sedimentation tanks. The team has taken over responsibility for this work and it is also planned to involve team members in the GTZ programme.

The disadvantage of working alongside an already established programme is that work cannot be followed through from beginning to end. The important decisions as to which work is required, how it should be executed and which materials are required have already been made. A more comprehensive approach is possible for Wau and Malakal. Programmes of essential work are being prepared by the team, based on the consultant's immediate measures proposals but including other items, identified after examining the water supply system in each town.

A good example of a measure to improve the functioning of a system without incurring a large expenditure occurs at Malakal. The town is flat and extends about 5 km along and an average of 1 km back from the River Nile. At present, the distribution system is fed by gravity from a 15 metres high tank at the waterworks. The main features of the original distribution system were 4" and 6" mains running paralled to the river. An 8" main, laid in the early 1970s also runs the length of the town but the number of connections to it are not in proportion to its size. Water pressures throughout the town are extremely low. Approximate calculations indicate that they can be improved by dividing the distribution system into two zones, that nearer the waterworks served by gravity from the high-level tank while new pumps with a delivery head of around 40 metres supply the further zone directly via the 8" main. Some new connections will be required, both at the waterworks and in the distribution system. This improvement provides a useful exercise, requiring estimates of demand, approximate hydraulic design, pump selection and some detailed design. If implemented successfully it will also provide greater income since improved pressures will bring an increased demand for house connections and public water points.

Operations and maintenance

At present, water operations in Southern Sudan are affected by a serious shortage of maintenance technicians and well trained staff for the day to day supervision of water treatment and distribution operations. If the proposed programme is to be effective, it is essential that it includes provision for the training of operations and maintenance staff. As a first step, agreement has been reached with the British Council to provide funds to enable up to six students to attend technicians courses. The Kenya Polytechnic runs sandwich courses for water, electrical and mechanical technicians and it is hoped that Sudanese students will be accepted for these courses. The required practical work experience will be given partly through the improvement programme and trainees will also spend some time working in a programme to improve and standardise operational procedures. Some specialist assistance will be required and discussions have been held with Water Aid on the possibility of providing both short term and longer term assistance.

Operator training As a first step, Water Aid is recruiting for an experienced waterworks superintendent to visit the Southern Region to advise on operational and maintenance procedures. Part of his task will be to put forward ideas on an overall training programme for operations staff which will be implemented when some steps have been taken to facilitate the correct operation of existing systems. The training programme will include a sizeable element of training at the workplace. Part of the practical work experience of the water engineering technicians will be to assist in this training and to implement and record improved operational practices.

Electrical installation The electrical arrangements at the Juba, Wau and Malakal waterworks are inadequate and there is considerable scope for improvement and standardisation. In each case, a complete re-wiring is probably advisable. The

proposed improvement programmes will include provision for this work which will be carried out by Sudanese trainees in conjunction with an experienced electrical technician recruited through VSO or Water Aid.

Mechanical maintenance Mechanical work requiring attention includes the repair of pumps, filter control mechanisms and bulk meters and the maintenance of tools and vehicles. Routine and maintenance schedules must be established. As with the electrical installation work, it is planned that this work will be carried out by Sudanese trainees working alongside experienced expatriate volunteers.

PROBLEMS AND POSSIBLE SOLUTIONS

The most obvious problem in Southern Sudan is the difficulty experienced in obtaining materials for even the most basic improvement schemes. Apart from the physical fact of distance when ordering and transporting materials, there is the problem of lack of finance which is particularly acute because many materials require foreign exchange for their purchase. Manufacturer's catalogues and other technical information are being gathered in the Juba design office to assist in ordering equipment and materials but there remains the problems of financing and transporting purchases, particularly those which must be imported. One attractive possibility is that of providing imported materials through commodity aid, the materials required being specified by the new works engineers or maintenance personnel in accordance with their own plans and estimates. Several aid donors have been approached about the possibility of making a small amount available each year to assist the proposed work programme. An initial materials and equipment expenditure of perhaps £100,000 per annum is envisaged, increasing as the capability of the implementing personnel increases to a ceiling which might be set at about £250,000 per annum. Locally available materials and labour would be supplied by the Regional Government so that the rate of progress would very much depend on Sudanese commitment. The first work to be implemented if some assistance is forthcoming will be the immediate measures at Wau and Malakal.

The problems caused by inadequate finance will undoubtedly continue to occur in many countries through the Water Decade and beyond. Repayment of interest on large loans may be difficult and hence there will be a reluctance to implement large scale projects. Changes should be made in the terms of reference for feasibility studies so that consultants are asked to produce proposals which can be implemented over a period as a series of small contracts combined, where appropriate, with the use of direct labour. This will ensure development, albeit at a slow rate. If arrangements are made for the supply of imported materials such as pipes and fittings, much of the work can be carried out by local contractors, thus adding to the knowledge and experience available for continued development. Unless there is this emphasis on starting in a small way and involving local institutions and manpower, the Water Decade will fall far short of its aims in urban areas in many countries in Africa.

Session 5

Chairman: Mr John Pickford,
WEDC Group Leader,
Loughborough University of
Technology, U.K.

Discussion

P Batchelor, K Starkey and D Parish

Institution building for the decade: the role of consultants

1. Mr PARISH explained that the investment program envisaged in the International Water Supply and Sanitation Decade was giving rise to an urgent need to strengthen the national institutions responsible for implementation of the programmes. He looked at important factors, and concluded that institutional issues must be approached as early as possible in the planning cycle.

2. Professor OLUWANDE observed that many developing countries tended to over departmentalize activities which made coordination extremely difficult. He quoted the example of a city in which one department was responsible for removing solid waste from surface drains, and another department for collecting and disposing of the waste; such an arrangement was totally ineffective. He asked which type of institutional structure promoted maximum coordination.

3. Mr PARISH replied that it was most important to take account of existing institutional arrangements, as excessive change may not produce the desired result. In Tanzania, institutions were parastatal, and therefore the water utility was set up along parastatal lines.

4. Engr OBADINA quoted at length from an unfortunate experience he had with one group of management consultants who had not performed along the lines suggested by the authors. He found it heartening to hear the authors state that pre-packaged solutions from the West should not be imposed.

5. Mr PARISH responded by suggesting a better firm of consultants.

E M Chimbunde

Project implementation management and community participation

6. Mr CHIMBUNDE discussed aspects of project implementation in Zimbabwe, with special reference to the problems of training, motivation, community involvement and incentives.

7. Mr PICKFORD suggested that a more general discussion of motivation might be appropriate after the formal presentations and questions had been completed.

J McKendrick

Training of treatment plants operatives

8. Mr McKendrick outlined the historical development of training in Zimbabwe, and explained how training programs for operators and waterworks attendants were run. The scheme operated by the Department of Works was described, including selection procedures and performance.

9. Professor OLUWANDE asked what were the basic qualifications for accepting people on the training programs, and whether school and university graduates were accepted.

10. Mr McKENDRICK replied that no basic educational qualifications were required; every operator and labourer was permitted to attempt the selection test, although all successful trainees had Form 11 or better education. Secondary school and university graduates were employed by the Council from time to time and were trained in the field of water and sewage treatment. It was envisaged that when no more suitable candidates were available as operators, secondary school graduates would be employed as trainees within the training scheme.

11. Engr OBADINA asked whether the excellent training scheme was only available to Zimbabwean staff, and commented that he thought it would be better to split the superintendent level into grades 1 and 2 corresponding to levels 17 and 18.

12. Mr McKENDRICK replied that the present scheme was exclusively for employees of the city of Harare. The Department of Works was appointing a training officer, and at a later date, the scheme might perhaps be more generally available. The training scheme for operators was run under the auspices of the IWPC, and was open to other institutions within Zimbabwe.

W K Tayler

Training through work experience

13. Mr TAYLER described the situation in Juba in Southern Sudan regarding water supply, and suggested that aid programs should operate as far as possible through local institutions. He listed training requirements for operations and maintenance, and for electrical and mechanical installations.

14. Engr KEELING asked whether there was anyone within the appropriate institution who could motivate organization and training.

15. Mr TAYLER replied that lack of motivation was probably one of the biggest problems in Southern Sudan. The waterworks was almost inoperable in Juba, and it would be better for morale if people could see things actually working correctly; younger people from school were often keener.

General Discussion

16. Mr McKENDRICK observed that little advice was provided by consultants and suppliers on operating equipment, and there were rarely, if ever, follow up visits to see whether the system worked.

17. Mr BINNIE emphasized that the terms of reference were important; many clients accepted the lowest priced tender, and it was up to the client to make certain that money was available for follow up.

18. Mr HARRIS thought that it came back to cost constraints; for example, the World Bank recommended the evaluation of bids on a cost basis; it was difficult to predict costs two years ahead, and clients preferred fixed costs and not inflation linked packages.

19. Mr BINNIE stated that a wide range of complexity could be built into design; there were insufficient talks between client and consultant, and more feedback from clients on the availability of staff to operate the works was necessary.

20. Mr GREENACRE asked why consultants did not design for the lowest level of operation.

21. Mr BINNIE suggested that if clients did not automatically choose the lowest cost bid, this would be possible.

22. Mr FAULKNER noted that the client often demanded a high technology solution; hitherto, this had been the case with the World Bank.

23. Brother CHARLES wished to know of any information which delegates had on the use of biogas.

24. Mr McKendrick said that some units had worked for a time in Zimbabwe but stopped because of the lack of back-up facilities.

25. Mr WILSON reported that composting latrines in Botswana did not work because it was difficult to get the correct carbon to nitrogen ratio; there was one biogas unit which required one expatriot to run it.

26. Professor NATH said that sewage sludge could be digested to produce methane, and that in rural India, there were many biogas units which used cow dung as a fuel, some of which worked. There were some pilot scale studies using solid waste and excreta.

27. Mr PICKFORD told a cautionary tale from India concerning biogas. The peasants used to use cow dung as a fuel, which they were allowed to have free of charge. After the introduction of a biogas unit, which the landowner possessed, he then commandeered all of the cow dung for his unit, leaving the poorer people with no source of fuel at all; it had, in such cases, benefited the rich at the expense of the poor.

28. Mr JOGI, as a planner, thought that there should have been a much larger contingent of planners attending the conference, so that all of the ideas could be shared, as engineers and planners were often working towards the same goal, but without sufficient communication.

29. Mr PICKFORD thought that in its closing stages, the conference should consider the problem of how people could be motivated in practice.

30. Dr CUBAJEE said that in Ghana, the health programs with which she worked had used the media, posters, visits, and the selection of influential groups, with some success.

31. Engr KEELING wondered if seminars would work in a more formal setting.

32. Mr TAYLER replied that to be effective, motivation had to be on a long term basis. Such techniques would work with individuals, but not with governments and institutions. He felt that one must encourage people rather than order them, and look at reasons for the lack of motivation. It could be very difficult when plant never worked; it was much harder for local people who had to live with such situations, compared with expatriots who could come and go.

33. Mr GORASIA thought that a severe

problem was that people were never sacked for incompetence, and also that it was difficult to sustain interest when things did not work.

34. Professor OLUWANDE said that lack of promotion prospects reduced incentives.

35. Mr JOGI thought that in addition to salary motivation, good deployment of staff was essential; one should find out what people liked doing best, and give them plenty of it to do.

36. Engr KEELING said that there was too little opportunity to transfer across to provide movement of jobs within an organisation.

37. Mr BINNIE quoted the problem of many months salary arrears causing lack of motivation.

38. Mr TAYLER concluded by stating that many agencies now by-passed government institutions; this was an undesirable development. Government institutions should be worked with and be strengthened so that people could see things which were happening. Although corruption was sometimes stated to be a problem, he personally had not encountered it in Sudan.

VALEDICTORY ADDRESS

Dr PSWARAYI
Deputy Minister of Health

I am most grateful for the honour you have conferred upon me in asking me to be your Guest Speaker on this important occasion. But I am unhappy that I might spoil an excellent dinner by an unsatisfactory speech on an out-of-place subject - Sanitation. Brevity should therefore be the watchword for me. But I am told that an after-dinner speech should be like a lady's dress - short enough to be interesting yet long enough to cover the essentials.

As you know water and sanitation always go together so in discussing one I shall have to discuss the other as well, since like Siamese twins the two are difficult to separate.

It is because of this complementarity between water and sanitation (certainly as far as health is concerned) that the decade we talk about is not, as it is often wrongly called, the Water Decade, but the Water and Sanitation Decade. Also it does not seem to be generally known that the Ministry of Health has the same great interest in water as in sanitation. Perhaps this is why I was asked to speak on Sanitation! Actually I am conscious of the fact that a couple of years ago it would have been unusual for a Minister of Health to be a Guest Speaker on such an occasion as this, with an engineering bias. But now when health is understood as something positive and not the mere absence of disease; and it is fully realised that, in the final analysis, all the varied efforts of mankind have only one goal - that mankind should live healthily - it may seem right and fitting that I should be here after all.

Indeed the greatest goal that international community has set for itself this century is health for all. It is in this context that I speak to you this evening.

It is also in pursuance of this line of thinking that when the Decade was to be formally launched in Zimbabwe by the Hon.Cde. Prime Minister in November last year, my Ministry was rightfully given the leadership role in this multisectoral activity. The Secretary for the Ministry of Health was selected as the Chairman of the National Action Committee. It has been said that Zimbabwe has been unusually logical (if not the only logical country) in giving the leadership role for the decade to the Ministry of Health.

We in Zimbabwe are doubly happy that we were called upon to host this conference so soon after the launching of the Decade.

Firstly we are honoured and secondly I am sure this will give a great impetus to our Decade programme. Though we are a young nation we have, I am sure, contributed more than our share towards the development of appropriate technology in Africa, and may I make bold to say, in the world. Our Blair Pump and our Blair Latrine are by now household words in the Third World technical circles. Many may not be aware that the Blair Institute falls under the jurisdiction of the Ministry of Health.

I realise that I owe you an apology for bringing up subjects such as pit latrines around a banquet table. But we are professionals and, despite the glamour and glitter around us and the scrumptious food within us, it should not be inappropriate for us to discuss sanitation and water.

A further token of my Ministry's interest in your workshop was the large number of participants we arranged to come in for it. I am sure they have benefited tremendously from the exposure to the great wealth of international expertise you have made available to them. I would like to think that, at the same time, our participants too may have made some contribution towards the success of the workshop.

Before I close let me suggest one thing, I have already referred to Siamese twins. Let me now refer to a Trinity. Please do not be alarmed that I am going to launch on a sermon. The Trinity I am referring to is the composite feature of water, sanitation and hygiene education. From the Health point of view the provision of water and sanitation would of themselves be ineffective unless hygiene education makes the people appreciate the need to use these amenities properly. I referred, at the beginning of my speech, to the lady that I had to clothe. Let me conclude with

reference to her. You may wash this lady in scented water and clothe her in sanitary garments but if she does not have the culture and poise that comes from proper education she will not be fit company around this table.

We in Zimbabwe are following a vigorous effort of separating man from his waste; providing clean potable water and maintaining an aggressive Health Education Programme. Already, in certain areas, our efforts are bearing fruits in that the Communities themselves are clamouring for further aid to complete their sanitation and protected-wells programmes. The severe drought covering more than 50% of the country does not help, but it means we must dig deeper wells to reach the depressed water-table and so in future better rainfall years our wells should never run dry. We are proving that with better understanding our rural people are able to appreciate what is in their best interests and respond with enthusiasm and eagerness that sometimes outstrips our ability to provide the materials needed for our programmes.

Finally let me propose a toast to the organisers of this workshop. In doing so I request you not to raise your wine glasses but those that contain the elixir of health - good clean water. Ladies and gentlemen - with water, sanitation and hygiene education, towards health for all.