IRC
International Reference Centre
for Community Water Supply
and Sanitation

WHO Collaborating Centre

March 1981

The Hague, The Netherlands

Slow Sand Filtration for Community Water Supply in Developing Countries

Report of an International Appraisal Meeting
held in Nagpur, India
September 15-19, 1980

Organised in collaboration with the
National Environmental Engineering
Research Institute, Nagpur, India

16

Bulletin Series

irc

IRC was founded in 1968 by an agreement between the World Health Organization (WHO) and the Netherlands' Government. It is an independent foundation. IRC's main purpose is to promote and support the creation of safe drinking water and sanitation facilities in the developing world. IRC works through national institutions, agencies and regional centres in the rural and peri-urban areas of Africa, Asia and Latin America. The Centre cooperates closely with United Nations organizations, such as WHO, the World Bank, UNDP and UNICEF and with other member organizations in the UN Decade Steering Committee. In addition, IRC acts as WHO Collaborating Centre for community water supply. It is assisted in its work by these organizations and by bilateral donors and institutions in the industrialized countries.

IRC's major programmes are in the fields of: (1) Information Support and Services; (2) Technology Development and Transfer; (3) Manpower Development and Training; (4) Community Education and Participation; and (5) Programme Planning and Evaluation. Support is provided by means of guidance and training material, seminars and workshops, research and demonstration projects, as well as by general support to the development of national facilities.

Requests for information on IRC, or enquiries on specific problems may be directed to IRC's Information Section, P.O. Box 5500, 2280 HM Rijswijk, the Netherlands.

For information on the National Environmental Engineering Research Institute address yourself to NEERI, TILE division, Nehru Marg, Nagpur 440 020, India.

irc
international reference centre
for
community water supply and sanitation

slow sand filtration for community water supply in developing countries

report of an
international appraisal meeting
held in nagpur, india
september 15-19, 1980

bulletin series 16
march 1981

J.C. van Markenlaan 5, Rijswijk (The Hague), The Netherlands
Postal Address:
P.O. Box 5500, 2280 HM Rijswijk, The Netherlands

abstract

"Slow Sand Filtration for Community Water Supply in Developing Countries, a report of an International Appraisal Meeting held in Nagpur, India, September 15-19, 1980.
International Reference Centre for Community Water Supply and Sanitation, Rijswijk (The Hague), The Netherlands, approx. 64 pp., March 1981.

This report reflects the discussions held on a variety of topics related to the introduction of a water supply system including Slow Sand Filtration into a community, contains a good number of practical observations with regard to - design, construction, operation and maintenance of Slow Sand Filters - training of operators for SSF -planning and execution of Community Education and Participation support programmes The report also comprises a summary of the activities undertaken in the SSF-projects in Colombia, Sudan, India, Jamaica, Thailand and Kenya.

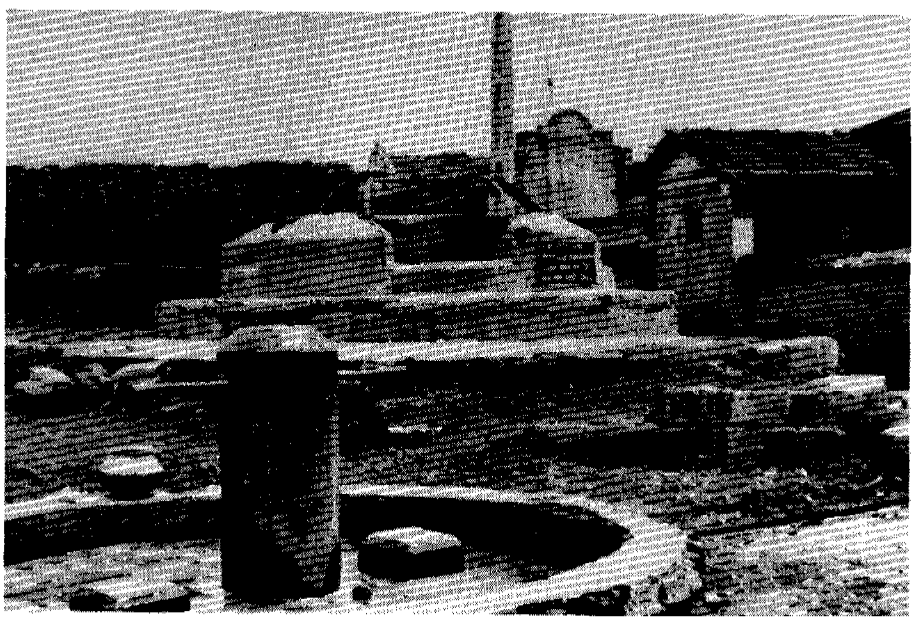
Key words: Slow sand filters, design of slow sand filters construction of slow sand filters, operation and maintenance of slow sand filters, rural water supply, developing countries, health education, health surveys, community participation.

UDC: 628.163.067 (035.5) (1-773)

table of contents

annexes

The Slow Sand Filtration Project is executed with financial support of the Directorate-General of International Cooperation of the Netherlands' Ministry of Foreign Affairs.



Old and new.

The motto on the well advises the people to use the purified water supplied by the standpost. Borujwada, India.

preface

The goal of the International Water Supply and Sanitation Decade programme is to provide safe water and effective sanitation for all the people of the world by the year 1990. To achieve this cherished goal in a time-frame of a decade as against a century or more taken by the developed countries needs political will, public support and massive mobilization of resources at all levels in developing countries. The strategies to be adopted would require planning of programmes and projects that are technologically appropriate, socially relevant and at a cost affordable by member countries. This has been focussed by the Conference on "Technical Cooperation among Developing Countries " (TCDC) in Buenos Aires (1978) and the UN Conference on "Science and Technology" in Vienna (1979).

Water purification by slow sand filtration has been successfully practised for over 150 years. The simplicity and reliability of this method makes it appropriate for small and village water supplies in tropical developing countries where land and labour are readily available. The IRC for Community Water Supply and Sanitation, The Netherlands, as part of its promotional activities, initiated an integrated research and demonstration programme on slow sand filtration in order to review the existing knowledge on the subject and to promote its large scale application in developing countries. India, Ghana, Kenya, Sudan, Columbia, Thailand and Jamaica, in close collaboration with the IRC, have been actively participating in the programme. A noteworthy feature of the demonstration project is the integrated multidisciplinary and collaborative approach by research scientists, field engineers, public health workers, government agencies and policy makers at local, national and international level. Health education and community participation have been effectively integrated in this programme.

This document is an appraisal of the results and experience of the participating countries in the development, implementation and evaluation of demonstration projects in selected villages on the basis of community participation. It not only outlines recommendations for design, construction and operation of village level slow sand filters, but also provides guidelines for planning and implementation of rural water supply schemes in general. In the context of the decade programme, the document will be of considerable interest and value to planners, water supply engineers, community development and health agencies as well as funding organizations.

NEERI and IRC are grateful to Shri Vasant Sathe, Central Minister for Information and Broadcasting, for his willingness to inaugurate the inter-country meeting on Slow Sand Filtration, and to Shri P.K. Chatterjee, Advisor CPHEEO, for the key-note address delivered at the occasion.

B.B. Sundaresan
Chairman

introduction

Slow sand filtration is a water treatment technique which can be used to advantage in many rural water supply systems in the developing countries. When surface water is the only available source of raw water, slow sand filtration will frequently prove the most simple, economic and reliable method to prepare safe drinkingwater. This may be illustrated by a brief description of the process.

In the slow sand filter the water percolates slowly through a porous bed of filtermedium. During this passage the physical and biological quality of the raw water improves considerably. In a mature bed a thin layer forms on the surface of the bed. This filter skin consists of a great variety of biologically active micro-organisms which break down organic matter, while also straining out a great deal of suspended inorganic substances. When after some months the filter gets clogged the filtration capacity can be restored by cleaning the filter i.e. by scraping off the top layer of the filter including the filter skin.

Design and construction of slow sand filters is fairly simple. The filters can be constructed with locally available material by local craftsmen. After some training, operation and maintenance may well be taken care of by a member of the community.

The cost of operation and maintenance of the system are low. Fuel or power are sometimes required for pumping, and a quantity of chlorine compounds for safety chlorination of the effluent of the slow sand filter plant, but no chemicals and hardly any spares are otherwise needed for prolongued functioning of the filter. The fact that slow sand filtration plants occupy a fairly large area of land and that the cleaning of the filters asks for an additional labour input, does usually not frustrate its application in rural areas in the developing countries.

In order to promote the application of slow sand filtration in developing countries the Integrated Research and Demonstration project on Slow Sand Filtration (SSF-project) was initiated a few years ago.

The SSF-project has been through two phases of development. In phase I applied research was done by five research institutes in India, Thailand, Sudan, Kenya and Ghana on the engineering aspects of the slow sand filtration process. After two years of investigations, a number of recommendations and adaptations were proposed to attune the SSF-system to the needs and circumstances in developing countries.

However, to convince both policy-makers and other professionals active in the water supply field in the developing countries of the positive impact the newly acquired knowledge could have, one also had to demonstrate the efficiency of the technique under normal working conditions. Phase II therefore focused on the implementation of Village Demonstration Plants: village water supply schemes using slow sand filtration to produce safe drinking water from surface water.

An extensive community education and participation programme ran concurrently with the various stages of implementation in the villages, which were selected by the participating countries as demonstration villages. This integrated approach in which the community, the public health department and the water supply agency closely collaborated with each other, was chosen in order to increase the commitment of the community to the project.

The operational objectives of the extension programme may be described as follows:

- To develop and maintain favourable attitudes throughout the community toward the water supply system being introduced, and toward cooperation to further it.

- To promote community organization to coordinate community efforts with respect to water supply, possibly including the use of communal labour in construction, and dealing with problems of finance.

- To train and supervise one or more community members as of the supply system; to settle the question of external and community support for them.

- To ensure through health education that the actions of community members:
  - Promote personal hygiene and sanitation.
  - Specifically, preserve the purity of water from delivery point to ingestion: use of clean receptacles, etc.
  - Avoid waste of water and nuisance (mud, etc.) around delivery points, and cause no damage to the water system.

Through the implementation of this community education and participation programme alongside the introduction of the water supply system an attempt was made to sustain the commitment of the community towards the water supply and thus enhance its lasting operation.

A number of participating countries have completed their Village Demonstration Plants and are in the process of monitoring the overall performance of the schemes under village-scale working conditions. At the same time, plans are being made for the evaluation of the strategy and methodology followed in the national SSF-projects.

To support these activities, as well as in preparation of the International Drinking Water Supply and Sanitation Decade, the International Reference Centre for Community Water Supply and Sanitation (IRC), in collaboration with its Indian counterpart, the National Environmental Engineering Research Institute (NEERI), organized a meeting of representatives of the institutions participating in this project.

The meeting which was held from September 15-19, 1980 at NEERI headquarters in Nagpur, India, had as general objectives:

- To review activities undertaken in Phase II of the slow sand filtration project.
- To develop guidelines for future implementation of slow sand filters and rural water supply schemes in general.
- To prepare an appraisal of the implementation of slow sand filters

with regard to technical, social and economic aspects.

Each country* participating in the SSF-project was invited to send two representatives to the meeting: an engineer, who has been actively involved in the design, construction, operation and maintenance of the Village Demonstration Plants; and a social scientist who has been responsible for project-related activities in the field of Community Education and Participation. The representatives of each country were requested to prepare a joint report on the state of affairs with regard to the technical and non-technical aspects of the slow sand filtration project in their respective countries.
A summary of each of these country reports is given in chapter III.

In workshops and plenary sessions country-reports and specific SSF-project related topics were extensively discussed. The frank exchange of views between engineers and social scientists on both technical and non-technical aspects of a rural water supply project was very instructive and certainly led to a greater understanding and appreciation for each others points of view. The positive attitude of the participants towards the objectives of the meeting has resulted in a very useful set of recommendations and conclusions which have been laid down in the next few chapters.

---

* In India each participating state

1. recommendations and conclusions*

Representatives of the countries participating in the Slow Sand Filtration Project agreed on the following recommendations and conclusions.

1.1. Planning in consultation with the community

1.1.1 Water supply planning should be a process that moves from the bottom up. The consumers as a community should participate in the planning of a water supply system.

1.1.2 Consultation should be maintained with the representatives of the community from the beginning and at all stages of the implementation of any programme.

1.1.3 All sections of the community should be kept informed on questions under discussion and their opinions sought.

1.2.4 Committees should be formed from the community to enhance effective participation. Such committees should be representative in character and also include nondominant groups.

1.1.5 A two-way communication with a genuine exchange and accommodation of views, for mutual understanding, should be established to gain confidence of the community.

1.1.6 In overall developmental planning, infrastructural arrangements should be established for ensuring that the community's priorities in the various sectors of development are adhered to as far as possible. Where these do not yet exist, community priorities established in discussions on water and health education should be communicated to be relevant agencies for action.

1.1.7 A basic set of regulations should be compiled including arrangements regarding water-usage, prevention of wastage and pollution.

---

* See Chapter 2 for a full discussion of the recommendations.

1.1.8 In the training of all levels of technical staff involved with community water supply, an orientation in the process of consultation with the community, and in health education, should be included.

1.1.9 Mutual understanding and cooperation between health and technical staff at all levels is vital.

1.2. Community contribution

1.2.1 A financial contribution from the community is highly desirable, but in the case of the poorest communities or groups this may be waived.

1.2.2 Community labour contributions to construction are appropriate where large amounts of unskilled labour are required. However, this may not be the case in all sociocultural circumstances, particularly where there are many unemployed labourers looking for paid work.

1.3. Design and construction

1.3.1 The design period of a slow sand filter should preferably not exceed 15 years to keep the initial investment to the minimum.

1.3.2 A minimum of two filter units should be provided for flexibility of operation to ensure uninterrupted supply

1.3.3 The minimum size of <u>one</u> filter unit should be 15-20 m^2. For still smaller plant sizes, a set of two prefabricated units, made of steel or fiber reinforced plastic, should be considered.

1.3.4 Wherever feasible gravity flow should be adopted. The siting and lay-out of the plant should be such that effective use is made of the local topography.

1.3.5 Locally available ungraded sand (builder grade sand) can serve very well as the filter medium.

1.3.6 In tropical and sub-tropical climates, the minimum depth of sand in the filter bed should be 70 cm. for ungraded sand (builder grade sand), while for graded sand, the depth could be reduced to 60 cms. An additional 30 cms. is required to provide for periodical cleaning.

1.4. Operation and maintenance

1.4.1 A manual on Operation and Maintenance of Slow Sand Filters should be prepared. At the national and local professional level this manual should be adopted to cover also the locally prevailing water supply practices.

1.4.2 Slow sand filters should be operated continuously for 24 hours a day. In case this is not practicable in certain local conditions, declining rate operation would provide water of acceptable bacteriological quality.

Intermittent operation is not advisable.

1.4.3 In case water is to be supplied during the ripening period after initial commissioning of the (resanded) filter, proper chlorination of the effluent has to be applied to ensure the

1.4.4 The interval between consecutive cleaning operations of well-run filters may be about 60 to 90 days, but it will vary depending on the seasonal variation in the raw water quality.

1.4.5 Proper backfilling arrangements should be incorporated in the design. Backfilling can be realized by using filtered water from the adjacent filter bed. If this method of operation leads to temporarily reduced output of the plant, the population should be informed in advance.

1.4.6 After the cleaning of a filter, a period of at least 24 hours is required to obtain an effluent that is bacteriologically safe and can be put into the supply.

1.4.7 It is advisable to measure the production of the plant by including a water meter in the outgoing main of the waterworks.

1.4.8 Daily testing of important water quality parameters will not be within the possibilities of many of the rural water supply schemes. However, simple routine tests for turbidity and residual chlorine can be performed by the operator after some training. Regular supervision is necessary to check and ensure the reliability of the results of these tests.

1.4.9 Complete physico-chemical and bacteriological tests of the raw and treated water should be carried out periodically.

1.5. The operator

1.5.1 The operator should preferably come from the community.

1.5.2 The salary of an operator is quite often very low and is not commensurate with the responsibility entrusted to him. Fair payment and other management incentives should make it possible for the operator to devote sufficient time to operation and maintenance.

1.5.3 The curriculum for the training course of the operator of a water supply system should consist of theoretical and practical training in operation and maintenance aspects as well as basic sanitation.

1.6. Health education and water-related behaviour change

1.6.1 For any health improvements to occur following the introduction of water purification, it is also necessary for changes to take place in the community's practices in relation to hygiene and sanitation. Health education should be an integral part of water supply programmes to (effectively incorporate hygiene and sanitation and) bring about a perceptible improvement in the health status of the community.

1.6.2 The health education programme itself should be planned in conjunction with the community.

1.6.3 Respect for the community's life style is the startingpoint for discussion about changes which may be needed for health improvement.

1.6.4 The health education process should be centred on dialogue and not on the one-way presentation of the recommended practices.

1.6.5 People who belong to the community are best suited to provide health education to others. Ideally community health workers will have been trained under a primary health care programme. Whether or not this is the case, orientation sessions should be held with other people, including formal and informal leaders.

1.6.6 The health education process should begin with a community and educational diagnosis, to establish essential data about the community and the aspects of health-related practices which need to be covered.

1.6.7 The diagnosis should be carried out together with members of the community and should be educative for all those taking part in it.

1.6.8 The essential methods to be employed are observation and interviews with key persons. A village schedule* should be used, covering the relevant topics.

1.6.9 Involvement of women in the health education process is essential.

1.6.10 Detailed discussions of the processes of disease transmission with the local population are certainly feasible; they are necessary to achieve a high level of understanding.

1.6.11 All primary health care staff should be trained and involved in health education.

---

* Schedule: a list of basic data required (about the community).

1.7. Impact study

1.7.1 When it is necessary, as in the pilot programme, to establish a before/after comparison for evaluation, a household questionnaire survey should be carried out; it should be brief but cover essential points of healthrelated, water and hygiene practices. This may be complemented by examination of any reliable morbidity and mortality records; by laboratory examinations (stool and blood samples); and by nutritional measurements (weight for age of young children).

1.8. Further research and development

Further research and development is required with regard to:

1.8.1 The economic and management implications of declining rate filtration.

1.8.2 Chlorine equipment which will be suited for operating under declining rate conditions.

1.8.3 The design of a suitable and fool-proof inlet control arrangement for slow sand filters.

1.8.4 The minimum thickness of the filter medium required to produce a bacteriologically safe water, in relation to the filtration velocity and the range of temperatures prevailing under (sub)-tropical climatic conditions.

2. proceedings

Introduction

During the meeting representatives of the countries participating in the Slow Sand Filtration project have presented country-reports on the implementation of the SSF-pilot projects. These reports brought out country-specific experiences gained in the planning, execution and management of the water supply system, and in particular the Slow Sand Filtration Plants, the health education programme and the community participation component. Important technological, socio-medical and participatory aspects of the project were subsequently discussed in detail in a number of workshops. The review and assessment by participants revealed positive gains in this unique attempt, identified weaknesses and suggested criteria for wider acceptance and adoption at national, sub-national and local level.

2.1. Planning in consultation with the community

ref. 1.1.1.* It is recognized that people should have a right to participate in decision-making over what effects them.

Consumers of other types of goods and services can choose between various alternatives offered on the market; where no market is possible the consumers should have the opportunity to state their needs, to know the alternative possibilities relevant to them (e.g. levels of service in relation to cost), and to have their views taken into account.

Where funding from outside the community is involved, financial constraints will often limit the degree to which the community's expressed needs can be met, also, there is an obligation to keep costs down in order to serve as many communities as possible. System design in itself must remain the responsibility of the qualified engineering staff. But the users have a legitimate interest both in the reasons for major choices and in more detailed questions such as the siting and number of standposts.

---

* These numbers refer to the recommendations contained in Chapter 1.

Planning in consultation with the community will result in a service which meets the needs of the users more closely and which will therefore be better appreciated, more carefully used, and protected against vandalism and other negative attitudes.

ref. 1.1.2. The cooperation of the community can best be gained through consultation from the very earliest stage. It might be that although a water purification plant is technically feasible and is desirable from a health point of view, it is not a community priority. If the community maintains this view after full discussion of its benefits and costs, it will be advisable to contact the relevant agencies which can assist the community in meeting its priority needs, before proceeding with the water project.

ref. 1.1.3. It is important to ensure that all sections of the community are kept well-informed of the proposed levels of any contribution expected from them at the time of construction, in terms of money, labour or materials. They should also be informed about any proposed charges for water, as well as of the expected benefits in terms of water accessibility and health. A realistic view should be presented of likely health improvements.
In general, a water supply project should not be implemented in a community where a substantial proportion of the population remains apathetic (or hostile) towards it even after full benefits have been explained to them.

ref. 1.1.4. Once, however, it has been decided to construct a water supply system, it will be necessary to work with a committee in the community which has detailed responsibility for the community's participation including its health education component. In small villages, this committee might be a general development committee, but in larger communities it will normally be a separate water committee, perhaps with responsibility for health also. Such a committee should represent all sections of the community, including non-dominant groups. Yet, it may still be difficult to ensure the representation of the true views of non-dominant groups, since they may be inhibited from voicing their opinion in the presence of members of higher status groups. Staff of the agencies involved should be aware of this problem and take whatever steps they can to take account of these views. The same may apply in the case of women, who are often excluded from community decision-making processes especially over developments involving a technical aspect. This is particularly inappropriate in domestic water supply, where women are the primary users.

ref. 1.1.5. Mutual understanding should be established between agency staff and the community. This will not be possible if staff members maintain a superior attitude towards the knowledge or intelligence of community members. Mutual understanding will only be achieved in an atmosphere of open dialogue in which all potential problems can be freely raised. Agency staff can help to establish this atmosphere in the way they discuss questions such as the siting and the type of user facilities (standposts and their surroundings; bath-houses or clothes-washing facilities).

The opportunity may also exist for spin-off gains to the community from the plant, apart from the provision of treated water. There may be some garden irrigation, or landscaping of the open space of the plant or limited fishbreeding. Such possibilities should not be rejected out of hand merely on the grounds that they are no part of the primary purpose of the plant; they might be of use to the community and this is the ultimate goal. The more benefits can be secured for the community, the more cooperation its members can be expected to show, provided only that the benefits are fairly distributed.

ref. 1.1.6. It must be recognized that few communities are totally united in terms of interests and opinions, and that the community leadership is often drawn from a better-off section. When a community project involves a financial burden which will fall on all community members, the less well-off may have good reason to fear that for them the cost will outweigh the benefit.

ref. 1.1.7. The cooperation of the community must be secured also in regard to the enforcement of measures to prevent damage, pollution of the supply and the wastage of water or its appropriation for stock-raising, minor irrigation, etc,. by some individuals at the expense of the domestic supply of others.

Rules may also need to be established to avoid muddy or unhygienic conditions around standposts and other facilities. For these reasons, a basic set of regulations should be compiled, stating the duties and rights of both users and producers, and implemented through local committees.

ref. 1.1.8. Consultation with the community needs to be an extensive and many-sided process. An orientation in this process should, therefore, be included in the training of all those technical and health staff involved with community water supply. Technical staff of all levels should also be aware of the health-related aspects of water purification and be able to advise the population accurately on the subject. For those levels of staff, where this is not already the case, the relevant training in health education should be given along with an orientation in approaches to consultation with the community. An alternative is to establish a separate unit or appoint certain officers within the water agency to be responsible for liasion with communities.

ref. 1.1.9. A health education programme specifically concerned with water, hygiene and sanitation should be carried out in each community over the same period as the introduction of the pure water supply: coordination and consultation between the agencies involved is clearly as important as consultation with the community. There is a need for informal discussion in which the relevant knowledge gained concerning the community and its needs can be shared. At the higher levels, also the approaches adopted by the two agencies must be compatible and complementary

2.2. Community contributions

ref. 1.2.1. A financial contribution should help to ensure that the community values the facility, has a sense of responsibility towards it and therefore plays its part in maintaining it and using it properly. The consumers should pay at least part of the cost of an installation which will benefit them and which other citizens elsewhere do not yet enjoy. However, ability to pay should also be taken into account in general policy formation or in relation to specific communities and/or individuals. The redistributive goals of social policy can usually be met very well by subsidising rural water supplies, especially by providing standpost supplies free of water rates. In that way, administrative costs will be reduced rather than increased and the benefit will certainly reach the poorer sections of the society for whom it is intended. In the case of the poorest communities, and also in case of some groups such as landless labourers with insufficient employment opportunities during the year, even the financial contribution to construction may need to be waived. Where there ary many under-employed or seasonally unemployed labourers, the same considerations prevent a labour contribution to the construction of a water supply. Instead, social considerations will require that they are employed and paid in cash or perhaps in food (food-for-work schemes). A labour contribution may also be inappropriate where almost all the work required is skilled, though some consideration may be given to the possibility of training. However, where large amounts of unskilled labour are needed, as for digging pipe line trenches, community participation in construction is appropriate.

ref. 1.2.2.

Where house connections are to be provided and water rates charged, then each household's labour and material contribution towards the construction can be valued and an appropriate reduction made in the water charges subsequently payable by that household. Where no water charges are to be made to individual households, it will be necessary for the community to organize its labour contribution in such a way that every household is assigned, and actually does perform, an equal or fair share of the work. Where some individuals begin to fail to turn out for such community labour, the enthusiasm of the others is rapidly affected. If the community is insufficiently organized to ensure this, then the strategy of labour contributions needs to be reconsidered.

2.3. Design and construction

The most essential information required for the planning and design of rural water supply schemes concerns the level of service and the size of the population to be served. As explained in section 2.2, the executing water agency should, in consultation with the community, decide upon the level of service. This will include decisions on the number and siting of standposts, the number of house connections and the quantity of water supplied per person per day. Population figures can be retrieved from the available national census data. However, care should be taken with regard to the general reliability of the census and it is also worthwhile to check whether the population covered by the village name in the census is the same as the population and area, that will be served by the new system. If doubts remain, the engineering department should try to gather its own data in order to avoid designing a plant which is out of tune with the requirements of the community. Since most rural communities do not comprise more than 5,000 people, this data gathering exercise is usually quite feasible.

The daily output of the plant can now be determined from the data collected. Additional information on the growth-rate of the community and the expected rise in drinking water requirements can be combined with the present demand in order to obtain an estimate of the future drinking water requirements of the community.

ref. 1.3.1.

Recent research has shown that there is little economy of scale in the design of a slow sand filter. Thus, there is little to be gained by increasing the size of a filter in order to provide service over a longer time into the future. Moreover in developing countries where governments have to be extremely thrifty and where capital is scarce, it is only sensible to reduce the initial investment in water works and so minimize the amount of money tied up in yet unused capacity.

If a design period of 10-15 years against one of 20-30 years can be adopted, the initial investment and consequently the interests due will be reduced thus allowing drinking water agencies to spread their funds more thinly and provide more communities with a SSF-water supply. It should be noted here however, that it is probably necessary to design the other elements of the water supply scheme for a design period of 20-30 years, while also the lay-out of the plant should allow for future expansion. The construction of an additional Slow Sand Filter is fairly simple and can easily be incorporated at the end of the 10-15 year period, assuming ofcourse that the increased drinking water consumption by the community justifies this course of action.

ref. 1.3.2. During the planning phase of the water treatment plant sufficient attention should be given to introduce such elements in the final design as to ensure safe and uninterrupted operation of the system. Hence at least two filter units should be provided. In this case, when one filter is taken out of service for cleaning purposes, the other filter will still be running at an acceptable filtration rate of 0.2 m/hr (i.e. twice the normal design rate of 0.1 m/hr).

ref. 1.3.3. The minimum size of one filter unit should be about 15-20 m^2. Depending on the mode of operation (ref: 1.5.2), a set of two of these filters would be able to supply a village of 800-1200 people. If one decides to supply smaller communities with slow sand filtration, the units will become very small and fairly uneconomical to construct. In such a case, two strategies are open. Either have a scheme in which a number of villages is supplied by a central water works or use a set of two specially designed, prefabricated units, for instance made from fibre reinforced plastic, for a remote settlement. In the latter case when the village expands so much that a permanent construction can be considered the prefabricated tanks can be taken away and reused in a similar situation somewhere else in the country.

ref. 1.3.4. Furthermore in order to enhance the simplicity, reliability and cost-effectiveness of the overall-treatment system, the possibilities for gravity flow should be exploited to the maximum. A gravity system allows filtration to take place continuously. This is the optimum mode of slow sand filter operation; it also leads to a considerable increase in reliability, since there are no pumps required which may break down or not run at all because of lack of fuel or power. Even if only a partial gravity system can be designed, preference should be given to such a design over that a fully-pumped system.

In general, one should make a cost-comparison between the gravity system which might be possible at the initial expense of an extra length of pipeline and any other system that includes pumping and thus next to the necessary funds for pumps gives rise to higher recurrent cost due to energy requirements and additional maintenance. In the comparison, some allowance should also be made for the ease of operation which is inherent to a gravity system. As far as possible, therefore, the siting and the lay-out of the plant should be such that the local topography is made best use of in respect to the application of gravity flow.

ref. 1.3.5. 1.3.6.

European experience shows that the biological purification process in slow sand filter is usually completed at a depth of about 0.6 m. For tropical and sub-tropical climates, the rate of biological purification in the filter bed will be greater and so it will have been completed at a dept less than 0.6 m. A minimum filterbed thickness of 0.6 m seems therefore appropriate for graded sand with an Effective Size (E.S.) around 0.2 mm and a Uniformity Coefficient (U.C.) less than 3.

When graded sand is not available, ungraded sand (builder grade sand) with an E.S. ranging from 0.15-0.35 mm and U.C. between 2 and 5 has also proved to give satisfactory results when used as the filter medium. However, the minimum filter bed thickness should then be increased to 0.7 m. To allow for necessary scraping, 0.3 m is usually added to the minimum filterbed thickness, bringing the initial thickness to 0.90 for graded and 1.0 m for ungraded sand. When after a series of scrapings, the minimum filterbed thickness has been reached, the bed has to be resanded.

2.4. Operation and maintenance

ref. 1.4.1.

The International Reference Centre for Community Water Supply and Sanitation is currently in the process of preparing a training manual on the Operation and Maintenance of Slow Sand Filters. This Manual is expected to be available in the second half of 1981. The training manual is meant for instructors at a sub-professional level who will use it to acquaint themselves with the operational process and also with the teaching methods advised. On the basis of the guidelines provided in the manual a national or local version should be prepared in the local language which should take into account the locally prevailing water supply practices.

ref. 1.4.2. The most effective way to operate a slow sand filter is to run it for 24 hours a day. Applying that mode of operation ensures an effluent quality of excellent hygienic standards. However, if that is not possible, the only alternative which is then acceptable is declining rate filtration. This specific mode of operation can be applied to bridge the gap between shifts of full-scale operation of the filter.

At the end of a shift the operator closes the inlet valve but the filtration regulating valve is kept in the normal position. The supernatant water will drain through the filter at a continuously declining rate, in that way still producing filtered water even though the operator is absent. Operating the filters at declining rate requires a larger filterbed area than continuous operation but is sometimes necessary in case of intermittent power supplies, or to reduce the cost of fuel and operator's wages. The effluent quality of filters which between shifts are operated at declining rate, is quite acceptable and only a slight deterioration of the overall bacteriological performance of the filters can be noted.

However, intermittent operation should not be allowed since it has been shown conclusively that an unacceptable breakthrough of faecal pollution occurs 4-5 hours after restarting the filters.

ref. 1.4.3. Two main features of the slow sand filtration are the relatively easy operation and the considerable improvement of physical and bacteriological characteristics of the raw water treated. Ease of operation very much depends on proper design and construction, while the efficiency of the purification process fully depends on the time allowed for the development of the filterskin and the bacteriological flora. Temperature and raw water quality determine to a great extent, the period required for so-called ripening. This period may range from several weeks to a few months. Since ripening may take quite some time, it is evident that proper chlorination has to be applied in those cases when public demand forces the waterworks authorities to supply water from the plant, before ripening is completed.

Under normal operating conditions, the filtration rate will be kept as constant as possible. However, due to clogging, the resistance of the filterbed gradually increases and therefore, the operator has to compensate for that by opening the filter regulating valve a little bit every day. When the regulating valve has been fully opened and the rate of flow starts to decrease the filter has to be taken out of service for cleaning.

ref. 1.4.4. Depending on the seasonal variation of the raw water quality, especially with reference to turbidity, the interval between consecutive cleaning operations may vary between 60 and 90 days.

Cleaning of the filterbed is accomplished by draining the supernatant water and scraping the top 1-2 cms of the bed.

ref. 1.4.5. After cleaning, the filter has to be refilled with water. This process, called backfilling, has to be done from the bottom up in order to drive out the air bubbles which have been introduced during the cleaning exercise. In the absence of a overhead storage tank, backfilling may well be realized by using filtered water from the adjacent filter. If this method of operation leads to a temporarily reduced output of the plant, the population should be informed in advance about the reduced supply.

ref. 1.4.6. When the filter is put back into service, a period of at least 24 hours is required to allow for re-ripening of the bed. After that period, the bacteriological flora has sufficiently re-established itself to be able to produce safe effluent which can then be put back into the supply. It should be noted here that in the cooler areas in the tropics (e.g. mountains), this ripening period might have to be extended to a few days.

ref. 1.4.7. Records are to be maintained so as to provide information on the performance of the filters, a check on the work of the operating staff and also to provide data for planning future improvements. In village SSF plants which will have limited staff, the records to be maintained should be kept to the minimum. They may consist of data on daily hours of operation of raw water and clear water pumps, periodical loss of head and rate of filtration, quantities of chemicals used and daily output from the plant. In order to be able to record the daily production of water, a water meter should be included in the supply main of the waterworks.

In the rural situation, there are several constraints to the adoption of a proper water quality monitoring programme, such as lack of adequate laboratory facilities and trained personnel and the long distances which may involve unacceptable delays between sample collection and testing. The cost of testing may also be high.

ref. 1.4.8. Therefore, daily testing of important water quality parameters will not be within the possibilities of many of the rural water supply schemes. All the same, simple routine tests for turbidity and residual chlorine can be performed by the operator himself after some training. Regular supervision is necessary to check and ensure the reliability of the results of these tests.

ref. 1.4.9. Complete physico-chemical and bacteriological tests of the raw and treated water should be carried out periodically by a higher level agency. However, noting the lack of laboratory facilities available especially in the rural areas, it is of utmost importance that national and local governments should assist the agencies responsible for water quality testing with the establishment of regional district laboratories to monitor the waterworks.

2.5. Operator

ref. 1.5.1. The agency responsible for the construction of the waterworks should, in consultation with the community try to choose a local man or woman to be trained as an operator.

ref. 1.5.2. The employment of a community member enhances the cooperation of the community, while at the same time, the community member is less likely to quit his job, even if poorly paid.

The salary of an operator is quite often very low and not commensurate with the responsibility entrusted to him. This is particularly the case in those communities where a local council, e.g. village water committee is in charge of the overall management of the waterworks. Poor payment will adversely affect the continued operation of the community water supply scheme. The operator, for want of additional income, may have to take up other jobs somewhere else, sometimes at some distance from the waterworks. This obviously will be at the expense of the time he could have spent on proper operation and maintenance. All the same slow sand filter plant at village level, in the absence of the operator, generally work far better than other treatment systems. The operator, now a recognized professional, may also apply to another agency for a similar or any other technical job usually for better wages.

If the local water committee is not able to pay fair wages to the operator, they may offer additional incentives like free housing, free house connection or possibly the use of a plot of land near the waterworks for farming. In small communities, the additional income required by the operator may possibly come from a combined job as village health worker and operator of the water supply.

ref. 1.5.3.

The curriculum for training of an operator of a water supply scheme in a rural area can be divided into two main sections The technical knowledge and skills of the operator should comprise background knowledge on the water cycle and water-sources, pollution and the need for treatment etc. More importantly the specific features of the scheme he is going to operate should be explained and the skills required for proper operation and maintenance, taught.

A basic knowledge of sanitation is also required. The ways in which a number of common water-related and faecal-oral diseases can be transmitted, as well as the methods and practices required to break the transmission cycles, should be known to the operator.

This knowledge will enable him to correctly advise and explain to the user's the hygienic practices involved in water collection and storage, and also the regulations. The set of regulations may be related to the technical and social management of the water supply system. This may include guidelines on prevention of pollution and wastage of water and also information to the community about occasional reduced water supply due to maintenance of treatment plant or distribution system.

2.6. Health education and water-related behaviour change

ref. 1.6.1. The health improvements to be expected from purified water, as distinct from those resulting from increased access to water of any quality, concern only the category of diseases transmitted by faecal-oral routes*. Increased <u>access</u> to water should lead automatically to greater <u>use</u> of water, thus improved cleanliness and a reduction in the incidence of both faecal-oral disease and also those others, like scabies, which are "water-washed". But here we are concerned with realizing the additional benefits of <u>treated</u> water. Though some of these diseases are classically "water-borne", they can also in fact all be transmitted in an unhygienic environment by other means which do not involve the water supply; in particular the load of gastro-intestinal infections, which interact with poor nutrition to produce high mortality among young children, may be little affected by water treatment (purification) alone unless there is also an improvement in hygiene and sanitation in the household. Efforts should be made to improve hygiene and sanitation <u>alongside</u> the introduction of a treated water supply. This is not just a matter of the <u>general</u> desirability of improved hygiene and sanitation. The need is for a health education component carried out as part of the programme. Advantage can be taken of the fact that a service is being provided, in order to secure the cooperation of the community for health education activities and for the changes in health-related practices.

ref. 1.6.2. 1.6.3. 1.6.6. The health education programme should be planned together with the com-

---

* Together with urinary schistosomiasis and - locally - guinea worm.

ref. 1.6.7. 1.6.9. 1.6.10. munity, since the community will have the best knowledge of its own circumstances. The required changes in practices can then be discussed, together with the ways in which health education will be carried out, in a water of health committee or, in the smaller settlements, in open assembly.

ref. 1.6.4. It is important that an atmosphere of dialogue is created in which the difficulties and constraints facing community members (especially the poor) in changing their practices are openly discussed, and ways found in which the changes can be facilitated.

ref. 1.6.5. Direct health education of community members can best be provided by those who know the circumstances and can communicate with them most easily. This generally means fellow community members. However, they should also have an adequate background of knowledge in hygiene and sanitation. The ideal health educator is, therefore, a community health worker, a community member given a short-training in health work. Many countries have already planned primary health care programmes in which community health workers will be the main channel for health education to the rural population. Where such persons have already been trained, they should be at the centre of the health education process in the present context also. In any case, other community members who are interested should be given an orientation in the relevant areas of hygiene and sanitation, so that they can help in spreading the ideas to others.

ref. 1.6.6. In planning the health education programme with the community, it will be helpful for the health staff to bring a schedule or list of the type of information about the community and its existing health-related practices which it found useful to gather, when planning and implementing health education programmes in similar communities elsewhere in the country. Whatever data can not be given by the community representatives involved in planning the programme should be obtained by observation (e.g. of the
ref. 1.6.7. condition of sanitary facilities) and by asking those who can give the relevant information on specific topics ("key persons"), whether these are community members or not. The personnel of primary health care facilities serving the community may be able to provide a useful insight

into its water-related health problems, through their knowledge of the morbidity pattern as reflected in the cases which reach them. However, there will almost always be alternative sources of health care of various types, traditional and modern, so these cases are unlikely to be fully representative of the overall pattern of diseases.

ref. 1.6.11. Involvement in the planning and implementation of the health education programme will help the primary health staff to increase their familiarity with the community and its health problems. Thus they will be in a position to improve the promotive and preventive aspects of their service to the community.

Many of the water and health-related practices which will be under discussion relate to the activities of women. Women are usually most directly concerned with hygiene in the home as well as with water-carrying, storage, use and disposal.
They are also most often in direct control of children. It is clearly essential that the women of the community should be effectively reached by the health education process, and for this, it is equally appropriate that they should be effectively involved in the planning and implementation of the health education programme. In some socio-cultural circumstances, this will have to be through separate women's groups. Women are often most effective in communicating with other women, and female staff should also be involved in planning and implementation of the health education component.

2.7. Impact study

An ongoing programme will not require an impact evaluation to be made in every community served - an undue diversion of resources would be required to do so. However, it will be desirable to ascertain the impact, even if only approximately of the programme* in general namely the introduction of

* "The 'programme' may ofcourse be a formally separate one, or simply a type of water supply project. In the latter case, these remarks refer to the evaluation of the impact of projects of this type. The agency may well wish to make a comparative evaluation of the health impact of projects of this type and of others".

slow sand filtres through community participation and health education. For this, a small sample of the communities served may be taken. Since slow sand filtration is a water purification technique, evaluation of the health impact will be the only concern.
Economic impact need not necessarily be considered because it will be the same for projects with or without water purification, except for the economic impact resulting through health improvements.

It is difficult to evaluate health impact, since many variables affect health in general and the incidence of the specific water-related diseases.
Definition and measurement of diseases also present a problem as does the collection of comparable data. An attempt should be made however, to measure changes in the practices of water use, hygiene and sanitation as reported by the population before and after the programme has been carried out.

ref. 1.7.1.

For this purpose, a household questionnaire survey will be appropriate. Questions should be chosen and worded in such a way as to minimize the tendency for people to report practices they know the interviewer will regard as correct. It may also be possible to confirm improvements in health, with respect to water-related diseases are concerned, by comparative analysis of morbidity records covering the community; however, these data have their limitations. It is necessary to compare changes in the incidence of water-related diseases with changes in the incidence of other diseases. Nutritional status measurements of young children (weight for age of children aged 1 to 4 years) probably provide the best measure of overall health levels. The average weight-for-age figures in a community should theoretically reflect improvements due to a water purification/hygiene and sanitation programme, since the reduction of episodes of diarrhoeal disease should enable children to gain weight better.

It must be stressed that to obtain any worthwhile findings in the measurement of health impact is difficult. There is no point in trying to do it for every community.

2.8. Further research and development

A number of topics are suggested as areas for further research and development.

Although declining rate filtration was considered the mode of operation which in many cases for practical reasons would have to be resorted to, it was at the same time recognized that additional research was required.

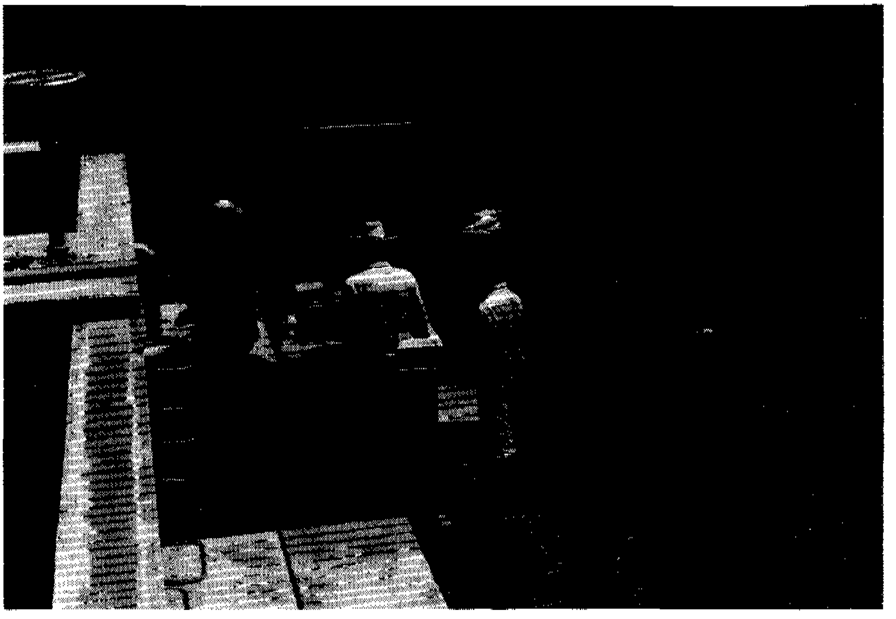
ref. 1.8.1. More specifically these studies should concentrate on the economic and management implications of declining rate filtration.

ref. 1.8.2. A practical point was raised in this respect with regard to the adaptation or development of chlorination equipment which would be suited for operation under declining rate conditions.

ref. 1.8.3. The non-availability of suitable and fool-proof inlet control arrangements is causing operational problems, especially in the case of gravity flow. The design and development therefore of a relialbe inlet control device such as a ball-valve would be highly desirable.

It was recommended to initiate a study on the minimum filterbed thickness required to produce a bacteriologically safe water in relation to the filtration rate and the prevailing range of temperatures.

ref. 1.8.4. In tropical and sub-tropical climates it could well be that the higher bacteriological performance of the filter could lead to a reduction of the minimum required thickness of the filter medium, thus directly reducing the cost of construction.



Testing water quality in Alto de los Idolos, Colombia

INAS Photograph

The proposed water supply project is being discussed in a community meeting, Colombia.

3. summary of country reports

3.1. Colombia

Village demonstration plants

Alto de los Idolos in Huila is an archeological centre of the culture of the San Agustîn Indians.

The population is scattered throughout the area, each house possessing a small plot for farming.

The distribution system of 21 km was built in 1978, while the slow sand filters were added towards the end of 1979.

Puerto Asis is a small town in Putumayo district in the Amazonas region. Putumayo district is one of the poorest in Colombia.

The water supply system is expected to come into operation in the first quarter of 1981.

Baseline health survey

In Alto de los Idolos a research programme was executed on the prevalence and magnitude of water related diseases together with an opinion survey on the need and value of the water supply.

In 98% of the stool samples examined, the presence of protozoa or helminths was shown, with a number of persons being affected by more parasites. Nearly everybody agreed that "the construction of the water supply is useful", but while 80% said so because of economic reasons only 20% mentioned the improvement in health and hygiene.

This result can be explained from the two-phase approach which is adopted by the Institute Nacional de Salud. In order to supply as many communities with water as possible the available funds are initially used for the construction of a supply-system only. In a second phase this system is upgraded to include water treatment.

During that second phase the INAS informs the population extensively about the health aspects of a safe water supply.

Community Education and Participation in Colombia can be divided in five stages.

Stage 1: study of the community to draw up an inventory of the sanitary, economic, social and cultural aspects involved.

Stage 2: project preparation by a Programme Engineer, includes a topographic survey, plans and specifications.

Stage 3: motivation, promotion and organization of the community by a development worker (or promotor), contacting of influential local groups and authorities, meeting with residents and the community action board. This culminates in the formal signing of the contract between the Instituto Nacional de Salud and the community for the construction and financing of the slow sand filtration plant and the arrangement for local, government and donor contributions as well as the administrative responsibilities once the system would be completed.

Stage 4: construction. Throughout the construction period extensive support is provided to the community by a promotor. An engineer takes care of the technical supervision.

Stage 5: (construction completed) administration by a community management board, and supervision by a development worker (or promotor).

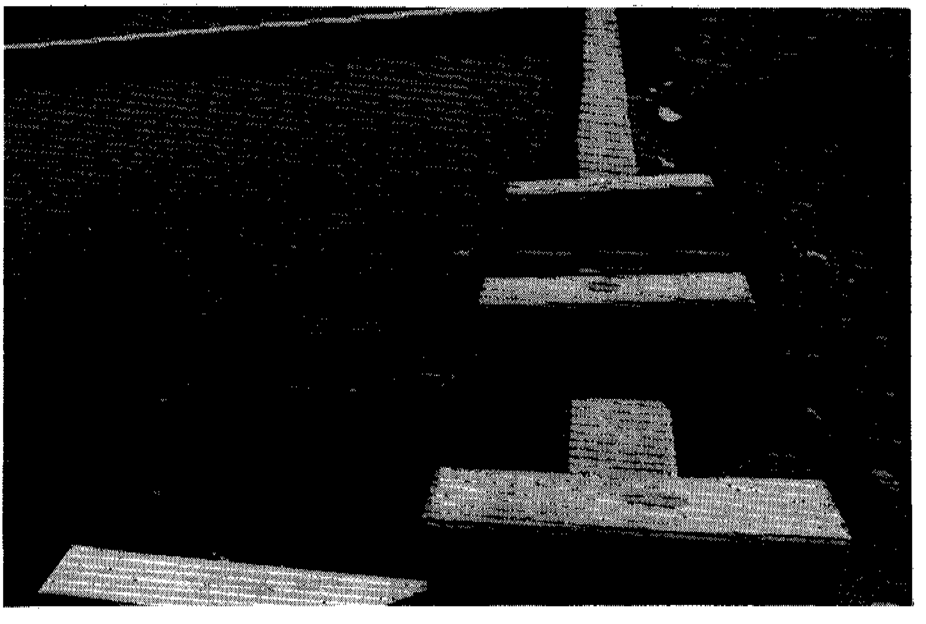
Special features

The filters in Alto de los Idolos are of the upflow-type. The performance of the filters is fair: 80% reduction of bacteriological pollution.

One of the two filters will shortly be converted in a down-flow filter so as to compare the performance of both types and to see which one is working best under the prevailing circumstances.

	Plant I	Plant II
Department	Huila	Putumayo
Village	Alto de Los Idolos	Puerto Asis
Date completed	December 1979	(under construction)
Population	1978 : 1150 1998 : 1700	1978 : 14,000 1988 : 18,000
Design Water Supply	150 lcd	70 lcd
Plant Capacity	16 m^3/hr	80 m^3/hr
Raw Water Source	Guadualito Creek	Negra Creek
Pre-treatment	plain sedimentation	aeration, plain sedimentation
Slow Sand Filters	6.3 x 6.3 m^2 (x 2)	6 x 23 m^2 x (3)
Over Head Storage	80 m^3	190 m^3 (+ 500 m^3)
Distribution	houseconnections	houseconnections
Estimated Cost (Col $) 48 Col $ = 1 US $	3,778,000	13,290,000

Demonstration slow sand filter plants in Colombia



Inlet construction of a slow sand filter at El Fau.
Rahad Irrigation Scheme, Sudan.

3.2. Sudan

Village demonstration plants

Two villages in the Rahad Irrigation Scheme have been selected to serve as demonstration villages for the Slow Sand Filtration Project in the Sudan.

The Rahad Irrigation Scheme is located on the East bank of the river Rahad, roughly 260 km South-East of Khartoum. In the first stage of the project 250,000 ha. of semi desert land originally utilized for rain grown sorghum, will be transformed in a fertile farming area in which 100,000 people will be resettled. In the next two stages another 250,000 ha. will be developed. In order to structure the resettling of original inhabitants of the area as well as of incoming labourers a number of planned settlements is constructed consisting of a government block and a water treatment plant.

According to the development plan, all the villages in the Rahad irrigated scheme, will be provided with piped water supply. Ground water will be used as a source of supply where suitably available within a narrow strip along the Rahad river, while surface water, after treatment by plain sedimentation and slow sand filtration, will be used for domestic supplies in the remaining villages of Rahad. The surface water is taken from the irrigation canals.

Health education

The social service department is currently being set-up in this irrigation project. It is planned to follow the same methodology as was used in the Gezira area.

This comprised inter alia activities such as:

- training of health workers for the various health education activities.
- meetings with different groups: women's associations, youth organizations.

- radio and television broadcasts on important local health problems.
- stimulating participation in health centre activities, especially where it concerns nutrition and child care.

Province	Kassala/Gezira
Village	
Population	2000-2500
Design Water Supply	40 lcd
Plant Capacity	3 m^3/hr
Raw Water Source	Irrigation Canal
Pre-treatment	Sedimentation
Slow Sand Filters	6 m Ø (x 2)
Over Head Storage	80 m^3
Distribution	standpost and houseconnections
Estimated Cost	

Demonstration slow sand filters in Rahad irrigation scheme, Sudan

3.3. India

Village demonstration plants

Extensive research was carried out in the first phase of the SSF project on important parameters of Slow Sand Filtration. This research was supported by a review of relevant Indian literature and field observations at an existing plant.
As a result of the research phase a number of guidelines were compiled for design, construction, operation and maintenance of slow sand filters. To test these recommendations under field conditions, four village-demonstration plants have been constructed and commissioned in the states of Andhra Pradesh, Haryana, Maharastra and Tamil Nadu.
While selecting villages for the location of demonstration plants, careful attention has been given to the population size, water supply needs of the village, source and quality of raw water, socio-economic and cultural background of the community and its willingness to effectively participate in the programme.

NEERI Photograph

Health education session at the orientation course for village health workers, Borujwada, India.

The detailed structural designs and the construction of the demonstration plants were carried out by the respective state engineering departments incharge of rural water supplies with technical assistance from the National Environmental Engineering Research Institute (NEERI), as and when required. The lay-out of the plants and the choice of construction materials were decided, keeping in mind the local conditions and the availability and cost of materials.

Health education and community extension

An integrated health education and community extension programme forms an essential activity of the demonstration project. The general objective of the programme is to develop and implement a methodology to prepare the community to effectively utilize the improved water supply and to assess the impact of health education on sanitation. A health education strategy developed by the Central Health Education Bureau (CHEB), New Delhi, with

NEERI Photograph

Festive display on the occasion of the inauguration of the Kamayagoundanpatti Demonstration Plant, India.

modifications to suit the local needs and requirements is being implemented in the project villages by the state and local agencies with overall co-ordination by NEERI.

Special features

The underdrains of the plant at Kamayagoundanpatti (Tamil Nadu) consist of a system of PVC pipe manifold and laterals with locally developed permeable capsules which are placed at 1.0 m c/c and topped with a thin layer of pea gravel. This type of underdrain has been found to be effective and cheaper than the conventional ones.
In general hard broken stone, which is more readily available and cheaper than rounded pebbles, has been used as supporting gravel layers.

The cost of operation and maintenance for the water supply scheme in Borujwada (Maharasthra) is met in a special way. The IRC-contribution to the project has been deposited in a bank-account as a long-term fixed deposit. The monthly interest received from this account enables the village committee to pay for the recurring costs of operation and maintenance such as the salary of the operator and expenditure on energy and repairs.

	Plant I	Plant II	Plant III	Plant IV
State	Andhra Pradesh	Haryana	Maharastra	Tamil Nadu
Village	Pothunuru	Abubshahar (group of villages)	Borujwada	Kamayya-goundanpatti
Date completed	April 1979	March 1979	November 1979	March 1979
Population	1971 : 3250 2001 : 6250	1971 : 8700 1991 : 12700	1976 : 700 2006 : 1300	1976 : 8,500 1986 : 10,000
Design water supply	45 lcd	45 lcd	70 lcd	45 lcd
Plant Capacity	17.5 m^3/hr	31.4 m^3/hr	5.7 m^3/hr	22.6 m^3/hr
Raw Water Source	Eluru Canal	Bhakra Irrigation Canal	River Kolar	River Suruliar
Pre-treatment	Storage $3^1/_2$ months	Storage 1 month	Infiltration Gallery	Plain Sedimentation + horizontal prefiltration
Slow Sand Filters	11 x 7.9 m^2 (x2)	10 m ∅ (x 4)	5 x 3.8 m^2 (x 2)	12 m ∅ (x 2)
Over Head Storage	91 m^3	225 m^3	35 m^3	90 m^3
Distribution	Standposts	standposts	standposts	standposts and house-connections
Estimated Cost (Indian Rs) 7.7 Rs = 1 US $	368,000	1,668,000	270,000	410,000

Demonstration slow sand filter plants in India

3.4. Jamaica

Village demonstration plants

The Endeavour water supply project is situated about 10 miles south of Montego Bay in a mountainous area. The local population is fairly poor and mainly dependent on agriculture. Great distances have to be covered to collect water and this results in the rather low hygienic standards in the area.

The Peace river water supply project is intended to supply water to four agricultural communities in the Mocho Mountain range. Thompson town, the main community of the area is fairly well developed. The general standard of living in the area could be described as being average for rural farming communities in Jamaica. Most of the area is served by public and private rainwater catchment tanks, which are inadequate during the dry season.

Community education and participation

An extensive baseline health survey was executed in both project villages. Already during this period of baseline studies a representative on involvement of the community was attempted through the adoption of the following measures:

- The fullest possible representation of the formal health and health-related agencies and the formal and informal leadership of the community, aimed at and achieved in the composition of the Local Coordinating Committee.
- Participation of the representatives on the Committee in the decision-making process has been a prime feature in the development, planning and implementation of the Village's Baseline Surveys. Furthermore, approximately 30% of the interviewers involved in the Baseline Survey were drawn from among Community Secondary School leavers. The remainder were from Community Health Aides and Maternity

District Midwives, all of whom received special training in interviewing techniques.

- Information to the Community and its organizations in relation to the project and the Baseline Surveys were transmitted with the assistance of the Public Health Nurses and Inspectors, Community Health Aides and District Midwives.

Evaluation of the results of the baseline health surveys has resulted in a health education programme which is tailored to the requirements of the community. Next to health education the community education aims to:

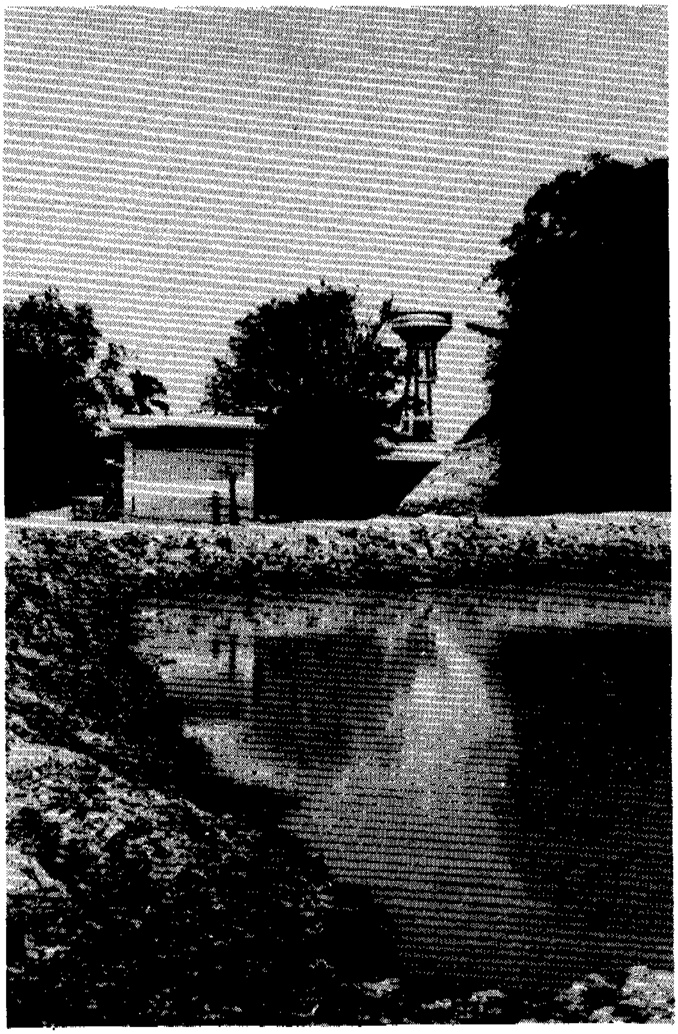
- inform the community about the project and associated activities
- stimulate and heighten community awareness and interest in the SSF Project
- facilitate community acceptance and support for the SSF Project.

Specific features

Adverse weather conditions have caused quite some delay in the implementation of the project. In June 1979 severe flooding occurred on the island, while in August 1980 Jamaica was hit by Hurricane Alan. These calamities forced the National Water Authority to shift its priorities to the restoration of the damaged water supplies. In addition there has been a noticeable downturn in the economic situation, which has given rise to shortages of certain vital building materials such as steel and cement. However, a rescheduled construction programme envisages completion of both plants in the first quarter of 1981.

	Plant I	Plant II
Province (Parish)	Clarendon	St. James
Village	Victoria, etc.	Endeavour, etc.
Population	1980 : 4,900 1990 : 5,500 2000 : 6,000	2,400 2,600 2,900
Design Water Supply	90 lcd	1980 : 90 lcd
Plant Capacity	50 m^3/hr	25 m^3/hr
Raw Water Source	Peace River	Blue Hole
Pre-treatment	not required	protection of source
Slow Sand Filters	85 m^2 (x 4)	9.2 x 9.2 m^2 (x 2)
Over Head Storage	800 m^3	450 m^3
Distribution	standposts	standposts
Estimated Cost (J $) 2 J $ = 1 US $	600,000	——

Demonstration slow sand filter plants in Jamaica



Storage pond, pump house and overhead storage tank at Ban Bangloa, Thailand.

3.5. Thailand

Village demonstration plants

Three villages were selected:
Ban Bangloa in Singburi Province is situated along the banks of the Chao Praya River. Parallel to the river, at a distance of about 300 m runs an irrigation canal from which the water for the watersupply is taken. Before the installation of the slow sand filter, the villagers used to take water from the river and from privately owned shallow wells. In the dry season, these wells run dry as the water level in the river falls. The villagers then have to descend the rather steep slope of the river bank and walk some distance on the dry bed of the river in order to collect water. The river was not chosen as raw water source because of its great seasonal fluctuation.

Ban Thadindam (Lopburi Province) is a fairly recent development built on a piece of land which is cleared from the surrounding forest. The village houses are built fairly close together.

With an average monthly family income 20% above the national average this agricultural community is fairly well off. However due to the fact that a perennial stream was passing through the village the willingness to pay for water was initially low.

Ban Thaluong in Lopburi Province has only recently been added to the project villages. Although named after the existing village, the watersupply will mainly provide water to the new district capital which is under construction nearby. Since most of the old village is being resettled to the site of the district capital no substantial CEP-programme could as yet be executed.

Community education and participation

Before the construction started a community education programme was implemented through the local health workers and sanitarians of the Provincial Health Bureau. The programme focused on health, hygiene and water-related diseases with the aim to enhance cooperation and participation by the community. Simultaneously a door-to-door interview was made to collect data on the individual and socio-economic conditions of the community. At the end of the health-education programme a KAP*-test was executed. However both health education and monitoring of user's practices has continued to take place at regular intervals.

Special features

The pretreatment system adopted to reduce the high turbidities during the rainy season is a so-called "horizontal flow-coarse pre-filter" that has been developed by the Asian Institute of Technology during Phase I of the SSF-project. AIT is now assisting the executing agency with monitoring the performance of this filter under village-scale conditions.
A cost-comparison between slow and rapid sand filters (when designed for and operated under the same conditions) shows that the cost of construction of a SSF-plant is about 10% higher but the cost of operation may well be lower by 25-50% of that of a rapid sand filtration plant. In the Thai circumstances the summarized expenditures for construction and operation and maintenance show that slow sand filtration is cheaper than rapid sand filtration for a design period beyond 8 years. It should be noted however that the cost of land has not been included in the comparison since the land is usually donated by the community.

As can be noticed from the following table the revenue collection in Ban Bangloa has decreased to about half during the rainy season. This is due to the fact that during the rainy season part of the water requirements can be met by the still existing shallow wells and rainwater collection devices.

---

* KAP: Knowledge, Attitude, Practice.

Month 1980	Revenue	Salary	Fuel	Operation and Maintenance costs Oil	Chlorine	Cleaning	Maintenance	Total Expenses
Dry season								
April	5.965	600	1.900	158	185	—	—	2.843
May	4.799	600	1.747	160	165	200	255	3.127
Rainy season								
June	3.050	600	1.468	132	150	—	275	2.625
July	2.550	600	1.554	125	140	200	315	2.932

Operation and Maintenance Costs of Ban Bangloa Water Supply Treatment Plant. (US$ 1 = 20) (charge per m^3 = 3)

	Plant I	Plant II	Plant III
Province	Singhburi	Lopburi	Lopburi
Village	Ban Bangloa	Ban Tha Dindam	Ban Thaluong
Date Completed	March 1980	December 1979	(under construction)
Population 1979 1989	1900 2500	850 1150	2000 2650
Design Water Supply	80 lcd	80 lcd	80 lcd
Plant Capacity	10 m^3/hr	5 m^3/hr	15 m^3/hr
Raw Water Source	Irrigation Canal	Impounded Spring	Impounded Spring
Pre-treatment	Storage (6 weeks) Horizontal Pre-filtration	Storage (6 weeks) Horizontal Pre-filtration	Storage (4 weeks) Horizontal Pre-filtration not required
Slow Sand Filters	5 x 6 m^2 [1])	5 x 6 m^2 [1])	6 x 8 m^2 (x 2)
Over Head Storage	45 m^3	60 m^3	45 m^3
Distribution	houseconnections	houseconnections	houseconnections
Estimated Cost (Thai Baht) 20 B = 1 US $	1,689,000	863,000	1,462,500

[1]) Initially two Slow Sand Filters were planned but in the allocated budget only the construction of one filter could be accomodated.

Demonstration slow sand filter plants in Thailand

3.6. Kenya

Village demonstration plants

Kisekini in Machakos and Giathieko in Kiambu have been selected as demonstration villages. Through the spirit of 'Harambee'* both communities already constructed a small piped water supply system some years ago.
The Slow Sand Filters which will now be included in the water supply systems of the two villages are expected to be completed in the second half of 1981.

In the context of this project the Ministry of Water Development has decided to investigate the unsatisfactory working of the existing Slow Sand Filter in West Karachuonyo.
Main causes of the poor performance of the treatment plant were poor design and inadequate operation and maintenance. Action has been taken to rehabilitate the plant and to correct the operation and maintenance procedures.

Community education and participation

To prepare a health education programme which would be relevant to the health and socio-economic problems of the community a community survey was executed by the Health Education Department. This exercise resulted in a programme that in order to create the awareness within the community of the importance of clean water, gave due attention to hygiene and environmental health. Also an explanation of the Slow Sand Filtration process and the required maintenance was included.

In the two project villages committees were established to ensure full popular participation in the process of preparation, construction and

---

* 'Harambee' means "pulling together" in Swahili and is the national kenyan motto for self-help.

eventually maintenance of the slow sand filters. Through these village committees the extension workers influence the community to create understanding, involvement and participation. In community gatherings government officials, village committee members and other community leaders communicated and discussed the various aspects of the project. Further understanding of and commitment to the project was enhanced through the discussions the extension workers had with opinion leaders and women groups and in the schools.

These discussions are important because similar projects that have been implemented without the involvement of the community have been neglected after completion. The community abandons these projects because it does not consider them their own. In their opinion such a project belongs to those who constructed it. This danger does not arise in this project because the community views the extension workers as people assisting them to improve their water supply and not as outsiders deciding for them.

Imponded spring, and excavation for the construction of the slow sand filtration plant at Kisekini, Kenya.

	Plant I	Plant II	Plant III
Province	Eastern	Central	Nyanza
Village	Kisekini (Machakos)	Giathieko	West Karachuonyo
Completed	SSF only still under construction	SSF only still under construction	C. 1955
Population	1200 1500	5000 6000	
Design per capita water supply	100 lcd	25 lcd	
Plant Capacity	9 m^3/hr	16 m^3/hr	50 m^3/hr
Raw Water Source	Kitatuni River	Kamatare River	Lake Victoria
Pre-treatment	none	none	none
Slow Sand Filters	7.5 x 6 m^3 (x 3)	12 x 5 m^3 (x 2)	3 x 15 m^2 (x 3)
Over Head Storage	200 m^3	90 m^3	
Distribution	standposts, few houseconnections	standposts houseconnections	standposts

Demonstration slow sand filter plants in Kenya

annexes

list of participants

Humberto Peralta, C.	Chief Engineer Basic Rural Sanitation Division Instituto Nacional de Salud Apartado Aereo 80080 Bogota Colombia
Santacruz, M.	Supervising Engineer Instituto Nacional de Salud Apartado Aereo 599 Pasto Colombia
Saipetch, A.	Director of Regional Office, Khonkaen c/o Mr. Lert Chainarong Provincial Waterworks Authority 72 Jang Wattana Road Bangkhen Bangkok 21 Thailand
Buaseemuang, Ms. M.	Provincial Waterworks Authority 72 Jang Wattana Road Bangkhen Bangkok 21 Thailand
Waweru, N.N.	Ministry of Health Department of Public Health P.O. Box 30016 Nairobi Kenya
Munoru, P.G.	Head Self-Help Section Ministry of Water Development P.O. Box 30521 Nairobi Kenya
Muir, B.L.	Bureau of Health Education Ministry of Health and Environmental Control 21 Slipe Pen Road Kingston Jamaica
O'Connor, J.A.	National Water Commission 18 Oxford Road P.O. Box 65 Kingston Jamaica

Van Damme, Drs. J.M.G.	Manager IRC P.O. Box 5500 2280 HM RIJSWIJK The Netherlands
Sumathi Rao, Mrs. Dr.	Health Educator & Training Officer Directorate of Public Health & Preventive Medicine Madras 625 006 India
Krishnamurthy, Dr. P.	District Health Officer c/o District Health Officer Madurai 625 020 India
John Philip, Dr. T.	Assistant Director of Medical and Health Services (Health Education) State Health Educational Bureau Sultan Bazar Hyderabad-500 001 India
Subba Rao, V.	Executive Engineer Panchayati Raj P.O. Eluru West Godavari Dist. (AP) India
Raman, A.	Scientist-in-charge NEERI Delhi Zonal Laboratory Chandrawal Water Works Alipore Road New Delhi 110 024 India
Bhasale, M.D.	Superintending Engineer Environmental Engineering Circle U D & P H Department Nagpur India
Patwardhan, S.S.	Executive Engineer Environmental Engineering Division Maharashtra Water Supply & Sewerage Board Telenkhedi, Civil Lines Nagpur India
Ghosal, Dr. B.L.	Director Directorate General of Health Services Central Health Education Bureau Kotla Road, Temple Lane New Delhi 110 002 India

Murthy, U.R.K.	Chief Engineer (RWS & Adm) Panchayati Raj Department Government of Andhra Pradesh Hyderabad India
Kondala Rao, R.	Superintending Engineer Panchayati Raj Kakinada (AP) India
Bawa, P.S.	Research Officer Directorate General of Health Services Central Health Education Bureau Kotla Road, Temple Lane New Delhi 110 002 India
Patil, S.K.	Executive Engineer Maharashtra Water Supply & Sewerage Board Environmental Engineering Division Nagpur India
Sapkal, Dr. P.N.	District Health Officer Zilla Parishad Nagpur India
Saxena, G.C.	Officer-in-charge Directorate of Health Services, Haryana Chandigarh India
Gurdeep Singh	Superintending Engineer Public Health Circle Hissar (Haryana) India
De Wilde, K.	Observer to the meeting Government of the Netherlands c/o E.T.C. Kastanjelaan 5 3833 AN Leusden The Netherlands

secretariate

Sundaresan, Dr. B.B.	Chairman Director NEERI
Paramasivam, R.	Head Water Engineering Division NEERI

White, Dr. A.T.	Rapporteur to the meeting c/o IRC
Heijnen, Ir. H.A.	Project manager Slow Sand Filtration Project IRC

annex 2

papers presented during the meeting

1. "Design and Construction of Slow Sand Filters"
   Paramasivam R. and Mhaisalkar V.A.

2. "Operation and Maintenance of Slow Sand Filters Plants"
   Raman A. and Haraprasad V.

3. "Training of Operators of Slow Sand Filter Plants"
   Heijnen Ir. H.A.

4. "Baseline Health Surveys"
   Muir B.L.

5. "Community Participation"
   White Dr. A.T.

annex 3

list of background papers

1. "Status report on Slow Sand Filtration Project in Colombia"
   Humberto Peralta C. and Santacruz M.

2. "Status report on Slow Sand Filtration Project in Sudan"
   Heijnen Ir. H.A.

3. "Status report on Slow Sand Filtration Project in Jamaica"
   Muir B.L. and O'Connor J.A.

4. "Status report on Slow Sand Filtration Project in India"
   National Environmental Engineering Research Institute, Nagpur

5. "Status report on Slow Sand Filtration Project in Kenya"
   Waweru N.N., Mbai D. and Munoru P.G.

6. "Status report on Slow Sand Filtration Project in Thailand"
   Saipetch A. and Buaseemuang Ms. S.

7. "Health Education Activities Slow Sand Filtration Project, Pothunuru"
   Directorate of Medical and Health Services Andhra Pradesh, Hyderabad - 500001

8. "Health Education Service Programme in village Borujwada, Maharashtra, an action research study"
   Ghosal Dr. B.C. and Bawa P.S.

9. "Health Education Project Kamayyagoundenpatty, Madurai district, Nadu"
   Sumathy S. Rao Mrs. Dr.

10. "Health Education Programma on Slow Sand Filtration in Abub Shahar"
Saxena G.G.

11. "Health Education and Community Participation in Slow Sand Filtration Programme in India - Phase II. An Action research Study"
Ghosal Dr. B.C., Hiramani A.B. and Bawa P.S.

12. "Involvement of Community Health Programmes, on operational guide for health workers"
Sinha K.S. and Bawa P.S.

13. "Observations on design and construction aspects of Slow Sand Filtration Demonstration Plant at Abub Shahar, Haryana"
Raman A., Gurdeep Singh and Nagpal J.L.

14. "Observations on operation and maintenance of village demonstration plant on Slow Sand Filtration at Abub Shahar, Haryana"
Raman A., Gurdeep Singh and Nagpal J.L.

15. "Experiences in the design, construction and operation of Slow Sand Filters at Pothunuru"
Murthy U.R.K., Kondala Rao R. and Subba Rao V.