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Global Workshop on appropriate water and waste water treatment technology for developing countries

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WHO INTERNATIONAL REFERENCE CENTRE
FOR
COMMUNITY WATER SUPPLY

GLOBAL WORKSHOP ON APPROPRIATE WATER AND WASTE WATER TREATMENT TECHNOLOGY FOR DEVELOPING COUNTRIES

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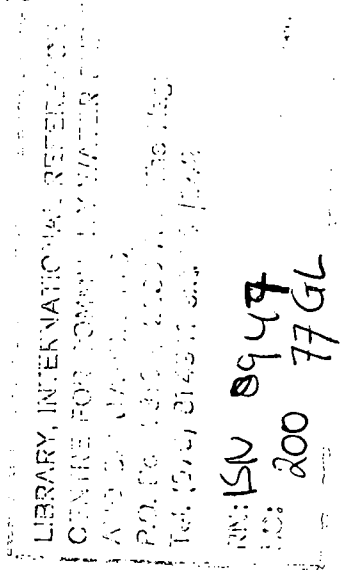

REPORT

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C O N T E N T S

1. INTRODUCTION

Results of a global survey carried out by the World Health Organization in 1971/1972 of community water supply and excreta disposal conditions and needs in developing countries, stress the alarming situation in which over 1000 million, or nearly one third, of the world's population have no adequate water supply; and the excreta disposal situation is even worse.

To improve the 1970 situation the United Nations Second Development Decade goals for community water supply were set at supplying all urban population either by house connections or by public standposts and at providing reasonable access to safe water for one quarter in the rural areas by 1980 *; but despite strong efforts to achieve these goals the number of extra people being served by 1980 will not match the resultant increase in population.

The water supply situation calls for a drastic change in current methods. Major problems in planning supplies for small communities or rural areas in developing countries are related to the lower priority given to such projects in national planning, the shortage of funds, the difficulty in finding skilled personnel, inadequate institutional arrangements and lack of involvement of the local community. In the technical field, it is widely recognized that proposals for a more appropriate technology are necessary.

In a meeting of directors of institutions collaborating with the WHO International Reference Centre for Community Water Supply, held in Bilthoven, the Netherlands, 1973, several proposals for the development of suitable technologies were made and a study on appropriate methods and techniques for developing countries has been taken up by the Centre in its programmes.

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*Based on mid-decade achievements (1975), targets for 1980 were revised, e.g. for rural water supply, they were increased from 25 to 36 per cent. Also, for the first time excreta disposal targets were set. Reference: Community Water Supply and Waste Water Disposal (Mid-Decade Progress Report), Director General's report to the 29th World Health Assembly, WHO, A29/12 Rev.1.

At the same time the University of Oklahoma, with the U.S. Agency for International Development as sponsor, initiated a study on a systematic approach for the choice of appropriate methods for water and waste water treatment in developing countries.

In a collaborative effort between the University of Oklahoma and the International Reference Centre this workshop on Appropriate Water and Waste Water Treatment Technology was organized, in which results of studies undertaken were presented and discussed.

Though the studies of the University of Oklahoma were limited to treatment, it was found necessary to expand the range of topics discussed at the meeting to deal with Appropriate Technology in Water Supply and Sanitation in Developing Countries.

The objectives of this workshop were:

- to assess the state of the art and to identify the role that appropriate technology can play in the development of water supply and sanitation in developing countries;
- to formulate technical and organizational recommendations and to agree upon priorities for studies, projects or other activities; and
- to discuss the development of internationally co-ordinated programmes and the operation mechanisms for implementing the activities planned as a result of the meeting.

2. ADDRESSES AND STATE-OF-THE-ART REVIEWS

The several speakers highlighted in their presentations the various aspects of the main theme of this meeting. The following is a brief report on these presentations.

In the opening address, Mr. F. Deeleman, Secretary-General of the Netherlands Royal Tropical Institute, described man's efforts to secure for himself the indispensable water he needs and to use no tools and techniques which have been developed and modernized with the transition to an industrial society. Certain urban areas which have intensive contact with the industrialized world had no trouble to absorb western technology in many rural areas, however, such direct transfer of western technology and systems inappropriate to local conditions was bound to fail. Appropriate technology should be developed which is locally reproducible and a review should be made of current transfer methods. Many barriers had to be overcome, including the psychological one which regarded such techniques as inferior. A modern approach to the matter was necessary and efforts to promote their acceptance and use in international programmes were referred to.

Describing the USAID-sponsored project on Low Cost Water and Waste Water Treatment in Developing Countries, Prof. George W. Reid referred to its two main activities:

1. The development of a predictive model meant as a tool for selecting the optimum treatment process for water or waste water in a specific country, given the existing resources and aimed at avoiding wastage. (This subject was treated more fully under item 8.1. of the agenda, see page II.1)
2. Providing a network of global study sites aimed at obtaining data on adaptive techniques of several treatment processes studied under different socio-economic conditions. The results were intended to be used primarily for demonstrating the value of adaptive technology transfer, and as a feedback for validating and upgrading the predictive model which was being developed. In addition to these financially supported studies, collaboration was being sought for obtaining data from ongoing projects.

Other studies which supported the above activities were the state-of-the-art reviews on water and waste treatment in developing countries; historic treatment techniques; the collection of unpublished information; and a simplified field kit which was being developed to provide control and to support the studies. As the project had progressed, it was thought useful to present the basic idea and results obtained thus far to this workshop for review and evaluation. In due course, validation would be made and the results disseminated. For this, cooperation would be sought through

international channels.

In his address entitled "Internationally Co-ordinated Programmes on Community Water Supply in Developing Countries": Mr. J.M.G. van Damme reviewed the unsatisfactory situation in water supply and sanitation in rural areas of developing countries. Through a WHO questionnaire and via other agencies major constraints had been identified such as institutional weakness, the need for increased government support. In an attempt to improve the situation, a number of international organizations had associated themselves to develop an integrated plan for accelerating the provision of water supply and sanitation in rural areas. The idea was gaining ground that co-ordinated, multi-sectoral approach was required to get maximum results contributing to a total overall development. In addition to the construction of water supply and sanitation facilities, systematic training programmes, the transfer of appropriate information, the stimulation of community awareness and involvement and demonstration of suitable techniques consonant to local resources were needed. It was, he concluded, the purpose of the workshop to discuss and identify the areas which needed improvement and the appropriate techniques and methods which should be developed and promoted.

Mr. J. Haijkens gave a historic review of water and waste water treatment processes. The development of a number of water treatment, distribution and storage techniques was discussed and it was shown that many of these sometimes forgotten methods might, nowadays, have practical value under certain conditions. This did not imply that these techniques should be transferred as they were. Important information could, however, be gained by studying their underlaying principles and by paying attention to inventive designs. Certain adaptations might be needed to make them appropriate to the new environment. A study of history was therefore useful and a compilation of suitable techniques was recommended.

In his state-of-the-art review on treatment methods for water supplies in rural areas of developing countries, Prof. L. Huisman surveyed processes and techniques which could be used in these areas. Basic to all activities was a general understanding and appreciation by the population of value and need of safe water. Other quality standards would probably be relaxed, and solutions should be used which were within the resources of the rural population e.g., they should be simple and cost little. A first choice would be to recover ground water which was bacteriologically safe. Usually little or no treatment was necessary. When yields were insufficient, artificial recharge could be applied. In treating surface water, the use of chemicals would complicate the matter considerably and this should, therefore, be avoided as much as possible. Several processes were discussed which were relevant

for application where skills were limited, covering the whole area of drinking water supply from roof catchment of rainwater to a complete single treatment in slow sand filters, disinfection and transport. Many illustrations were included to promote the ideas and to assist in construction.

Dr. J.F. Malina in a state-of-the-art paper on "Sewage Treatment in Developing Countries" (co-authored by Dr. L.W. Canter) reviewed the literature available in English. The paper centred on treatment of sewered waste waters. Only a small percentage of the population in developing countries had some kind of treatment. The main reason for this was the high cost of sewerage and that of conventional sewage treatment. A list of relevant disposal techniques was included in the paper along with waste water treatment and treatment goals in developed and developing countries. Current goals associated with developing countries were oriented towards:
- protection of public health through the elimination of pathogens; and
- removal of suspended solids and oxygen demanding materials.
To meet these goals in developing countries, mainly located in tropical areas, the stabilization pond was identified as a good treatment process. Ponds are being used in many countries. Dr. Malina presented an overview of the history, design and performance characteristics of ponds including cost data. Consideration was also thought necessary for the application of anaerobic digestion systems for energy recovery from the sludge produced, especially in more populated areas and where people could be trained. Long term goals might require more sophisticated processes.

In a presentation on "The Significance of Developing Countries Techniques for National Programmes", Mr. T.K. Tjiook referred to well-identified elements in successful programmes in rural water supply such as institutional arrangements for management; operation and maintenance; financing means by, for example, a revolving fund; mass approach by the use of standard designs; and direct involvement of the community in the programme. Many failures resulting from the use of imported techniques indicated the need for an appropriate technology which was consonant to local socio-economic conditions. Different solutions might be needed for the widely varying conditions and a compilation of available techniques would be useful: from this could be selected the one most likely to succeed. Collection of practical solutions was reported which had been obtained from an IRC mail survey, asking for experience from the field and unpublished information. To enable governments to begin major programmes aimed at speadily improving progress in water supply and sanitation, techniques and methods should be proposed which would be developed and run by the local people. International assistance in transfer of knowledge, adaptation and demonstration for local acceptance was also deemed necessary.

In his introductory speech on "Rural Water Supply and Sanitation in Developing Countries", Dr. B.H. Dieterich pointed out the great need for water supply and sanitation facilities for the rural and urban fringe areas. Also, in view of the greater number of people living in these areas, governments should be urged to give priority and allocate more funds to this sector. In this respect, it might be necessary to review current service standards in order to get more population coverage. Another major pre-condition for rural improvement was the participation of the community involved. Based on the underprivileged population, involvement of the people was necessary for continuous service. There is a great need for training and upgrading of local professionals and non-professionals. Much knowledge was already available on the technical aspects a technology involved and efforts should now be made to establish communication channels for transference of the relevant know-how. Technological research was, in some instances, needed but should only play a complimentary role. Dr. Dieterich concluded by stating that the formulation of good programmes was important together with obtaining motivated people who could implement these for the benefit of low-income groups.

3. GENERAL DISCUSSIONS AND IDENTIFICATION OF THE PROBLEM

In discussing appropriate water and waste water treatment technology for the developing countries and identifying the problems involved, there was a common understanding of the meaning of 'appropriate technology' and its relation to the prevailing conditions in developing countries. Generally speaking, these conditions involve a shortage of resources (including finance and trained personnel) and inadequate institutional structures (insufficient organization and administration to back up the programmes).

Direct transfer of techniques originating in industrialized countries in many cases caused problems and led to non-maintenance and disrepair, or break-down of supplies. Obviously, these techniques were less appropriate and less responsive to the existing conditions. It was agreed that maximizing the use of available resources such as locally obtainable materials and the application of solutions which could be easily managed by the local people was necessary.

Generalizations cannot be made about conditions in the developing countries themselves. There is a great difference between rural communities which still use traditional methods and urban areas which are more exposed to western influence. The latter are more susceptible to adoption of standard western techniques. Recognizing that each situation would need a specific solution, the meeting considered that technology alone would not solve the problem and that institutional weaknesses should be overcome and the general infrastructures improved.

It was agreed that more consideration should also be given to the use of international funds to assist governments in giving increased attention to the rural sector and low income groups which constituted the most needy part of the population in developing countries. Though recognizing that dispersed populations were in great need, it was also observed that measures could be made more effective by application to organized groups (nucleated units, villages, etc.).

In the target sector, administration, organization and motivation of the people play an important role. Whether people want the system and whether they will maintain it, is in many cases a decisive factor in deciding whether the technology being considered will be appropriate. The involvement of people concerned from the beginning of a project might increase the acceptability of the supply by the users.

In discussing the role that appropriate technology played in the field of water

supply and sanitation, in general much emphasis was given to the human factor, including motivation and consumer acceptance. But also the organizational, managerial and administrative aspects were stressed frequently, as well as the required exchange of information and the difficulties concerning the implementation of appropriate techniques.

Dedicated individuals and organizations are required to introduce appropriate technology and to urge people to try the unconventional; also a mechanism for communication, interaction and motivation is necessary. Motivation of people is a very important aspect of the application process, especially at village level. Also, the people who would have to implement the programme have to be convinced. Local professionals are frequently concerned with a possible failure; and they often prefer to rely on a foreign consultant rather than taking risks themselves to introduce techniques which might be more appropriate, but for which no established experience is available.

In different cultures, different values might be given to the standards of safety of drinking water; in certain instances, much persuasion might be necessary to get people to use the safe water.

For good operation and maintenance of water supply systems, private ownership is often a more successful base than public ownership.

It was thought the implementation of a programme in appropriate technology should include an appropriate organization with well trained staff, who understand the limitations of the systems; failures are often due to inappropriate management, e.g., in supplying spare parts. Governmental agencies should recognize better the locally available resources and capabilities so that an optimal use can be made of these resources. The need to involve all levels, including users at village level, introduces the basic problem of appropriate information as well as appropriate administration.

There is a distinct need to prepare engineers to understand better and to orientate themselves to the rural areas, where the needs are greatest. The training of local engineers, who in turn will train other local people in the country seems to be an effective approach. At village level, normally no engineer will be available; analogous to the 'barefoot doctor' concept that was used for health care delivery programmes, a suggestion was made for training a 'barefoot engineer' who comes from and works in the village.

In the water supply and sanitation field, a wealth of information is available. What is needed is an effective information exchange system to transfer the knowledge, rather than searching for new techniques or the 'miracle pump'. A new approach is needed to handle the wealth of information available in several languages. Collection of unpublished practices and technical solutions, as initiated by the International Reference Centre for Community Water Supply by means of a mail survey, should be continued and the results disseminated. The transfer of appropriate technology depends very much on the communication process, based on an understanding of the socio-economic and political situation; the latter is necessary for a correct analysis of the problem. The importance of feedback and evaluation in the process of information transfer should be stressed; experience from the field can be usefully exchanged in workshops.

There is a need to intensify training, so that local people can understand the basic principles of the various processes and support the new ideas introduced; for the laymen , handbooks in simple language should be written. Pilot demonstration plants are very useful to instruct local professionals and convince them of the feasibility of simpler solutions. Pilot demonstration plants associated with universities constitute a training mechanism, of a possibility to training consultants via short courses. An experimental plant connected with a plant in operation would be even more convincing.

Appropriate technology implies the use of solutions which varies according to the different conditions. An array of alternatives should be made available, from which the most relevant could be selected for a particular situation. The technology is appropriate, if it is accepted by the users and if it promises a better performance due to good operation and maintenance by the community; it also allows a wider coverage due to the use of local resources and its low cost. For selecting the most appropriate solution for the particular conditions full knowledge of and experience in high level technology is required. In Latin America, India and other countries, advanced technology is being applied and adapted in developing simplified techniques using local materials; it is suggested that similar resources be tapped in other countries as well.

4. ASSESSMENT AND APPROACH

To enable more detailed assessment of the problems in water supply and sanitation, discussions were held in three working groups: water supply, waste disposal and related socio-economic aspects.

After considering the general features of the problems in the respective sections, the important topics and most promising techniques were reviewed and relevant aspects for developing countries were stressed. Research needs were identified and recommendations for further action were made. These are summarized below under the following headings:

4.1. Drinking Water
4.2. Sewage and Excreta Disposal
4.3. Socio-Economic Aspects

At the end of each subsection the titles of the respective studies which were recommended by the group are listed with a reference to the page number on which the full description is to be found.

4.1. Findings and Recommendations for the Drinking Water Sector

4.1.1. General

To date, the provision of a water supply to the urban poor and rural populations has had a low priority in many countries. This might have been caused by:

- inadequate institutional structures;
- financial constraints (high unit cost, no coverage of running costs);
- technical problems; and/or
- unavailability of manpower (at various levels, but especially for operation and maintenance).

With respect to water supply, the following general observations and recommendations were stressed. Efforts should be made to motivate governments to implement water supply schemes through their planning agencies and not to consider these as isolated activities. Furthermore, an overall regional approach should be used for planning rather than a case-by-case approach. In the design, construction and operation of water supply systems, maximum use should be made of local manpower and resources. In each region, there should be a strong institution involved in water supply. Existing institutions should be strengthened or new ones established, and strong

ties should be made between these institutions and existing universities.

Education, motivation and participation of the water consumers is extremely important. Training is an equally important area which requires attention. Considerable effort should be put into the dissemination of information to all levels, including engineers, technicians and plant operators. Testing of water quality in water supplies is in every case a desirable aim. This includes undertaking pre-tests before schemes are designed, and monitoring the systems after installation. It was recognized that the ability to test supplies on a regular basis depended on local conditions and resources. It is important, however, to have feedback of data on existing schemes in order to make recommendations for future supplies. In adapting technology to local conditions, it is necessary to take geographical, cultural, sociological and economic differences in the different regions of the world which may require different solutions into account. Generalizations can lead to misapplication of the techniques.

4.1.2. Water consumption

In medium and small water supply schemes there has been a tendency to overestimate per capita needs; furthermore uncontrolled wastage can lead to high demands.

There is, therefore, a necessity to revise design parameters, especially with respect to the type of community to be served, the methods of distribution (e.g. public standposts or house connection), the existence of sewer systems and other methods of excreta disposal, etc.

4.1.3. Water sources

4.1.3.1. Groundwater

Not enough use has been made of this important resource in the past, due to:
- ignorance of its existence;
- lack of drilling equipment and/or expertise;
- non-acceptance; and
- problems with pumps (availability, maintenance and repair).

Groundwater must in future receive primary attention as a source for water supply, where it is available in sufficient quantity and has acceptable quality, and where its use is economically feasible. One of the principal advantages to be noted is that, usually, no treatment is necessary (except perhaps disinfection).

More studies are needed on the availability and methods of exploitation, including drilling equipment.

In order to increase the availability of groundwater, more attention should be given to the use of artificial recharge with the help of qualified experts on this subject. Further research is necessary on the most suitable method for developing countries.

Further recommendations for technological work in this field are:

- An inventory should be made on means of reaching groundwater by excavation or drilling.
- Continued encouragement of the development of man-powered pumps (manual and pedal operated): Co-ordination and improved exchange of information is needed between inventors and development agencies and operators in the field.
- A co-ordinated effort of collection, digestion and dissemination of information on "the use of wind and solar energy for lifting water" should be made.

It is also highly desirable that each country develops its own water resources agency, which would collect all pertinent data on water resources, exploitation and hydrogeology.

4.1.3.2. Rain water

Rain water was considered to be a very important source of supply and encouragement of increased usage was thought necessary. A survey should be made of existing techniques and of the regions where this approach would be feasible. Important points to be considered in such a studywere the materials of construction to be used, the danger arising from contamination, the provision of storage capacity and the treatment which might be necessary. The economics of their use as compared to other systems should also be examined.

A monograph should be prepared outlining the methods for rain water collection and guidelines on the system.

Study recommended: WS 1 - Simple techniques for collecting rain water (see page 22)

4.1.3.3. Surface water

Unlike groundwater, surface water is always prone to contamination. It was thought that sanitary protection and control and in most cases disinfection at the very least, should be provided.

4.1.3.4. Choice of source

The order of preference in obtaining supplies should be as follows:

1. Groundwater, requiring no treatment, recovered at various places at short distances from the consumers.
2. Spring water, requiring no treatment, recovered at some distance and carried to the consumption area by a gravity system.
3. Groundwater, requiring simple treatment, recovered locally.
4. Individual and collective rain water supplies.
5. Spring water, requiring simple treatment and gravity supply.
6. Lake water, requiring simple treatment, recovered at some distance and carried to the distribution area by a pump-driven, piped supply.
7. Water from rivers, requiring extensive treatment and pumping to the supply area.

4.1.4. Catchment

Control of catchment areas to minimize erosion can result in better quality water that may not need treatment. Any treatment required can be of a more simple nature, such as slow sand filtration. For a limited catchment area, the surface can be treated to make it more impervious and to increase run-off.

4.1.5. Water treatment

4.1.5.1. General

The treatment plant should be of the simplest design possible. Collection of water-quality data before the plant is designed is essential. Where possible, the use of chemicals should be avoided or minimized. The use of mechanical equipment should also be kept to a minimum since its operation is found to be unreliable in developing countries. Design in stages should be used, wherever possible.

4.1.5.2. Rural supplies

In the case of rural supplies, it is paramount to avoid treatment; and consideration should be given to utilizing methods of withdrawing water from ground and surface sources that avoid treatment.

Some of the methods which could yield significant results include:

- artificial and induced recharge;
- surface water intakes which act as roughing filters; and
- simple systems for purification of rain water.

All the treatment systems indicated in the following sections can be suitably modified for utilization in rural systems.

Study recommended: WS 2 - Methods to eliminate treatment (e.g. by artificial recharge) (see page 22)

4.1.5.3. Pre-treatment

With high turbidity rivers, the use of bank-side or river bed induced infiltration should be encouraged. This can reduce the turbidity going forward to the treatment plant and, in some cases, allows simpler processes to be used.

Plain sedimentation is another device for reducing turbidity before treatment and the use of extended plain sedimentation should be examined in more detail. Storage systems with up to seven days capacity should be examined and cheap construction methods for such reservoirs should be investigated.

Again the preparation of a monograph on this subject was thought to be extremely useful.

Studies recommended: WS 3 - Extended plain sedimentation (see page 22)
WS 4 - Special types of intake systems for improving the quality of raw water (see page 22)

4.1.5.4. Slow sand filtration

The use of slow sand filtration was strongly recommended for those areas where the quality of the raw water was suitable. It was recognized to be an ineffective process for colour removal but this was considered unimportant where the product was accepted by the consumers. The process is in widespread use in developing and developed countries and has been accepted as a very reliable technique. It was recognized that there could be a problem with algal growth both in the reservoir system and on the filters, which could lead to operational difficulties. Ways of overcoming this problem included the design of off-takes in the source and reservoir, circulation in the reservoir, covering of slow sand filters and intermittent operation. Another method of dealing with algae in raw water is to use roughing filters ahead of the slow sand beds. The process could be used for all sizes of schemes including very small supplies. Its more widespread adoption might be advanced by seeking locally available materials as an alternative to graded sand.

The use of low rate up-flow sand filters should be further examined since they have been used effectively in some parts of the world.

Studies recommended: WS 5 - Use of slow sand filtration (see page 22)
WS 6 - Use of low rate up-flow sand filters (see page 22)

4.1.5.5. Chemical treatment

4.1.5.5.1. Preparation and dosing of chemicals

The use of dry feeders should be avoided; and in mostly all cases solution feeders are preferred. Dry feeders are more expensive, less reliable and less efficient than solution feeders. The latter do not have to be imported. Simple systems of solution dosing as used in various parts of the world should be investigated and a monograph should be prepared on this subject. For pH correction, the use of lime saturators should be encouraged.

4.1.5.5.2. Mixing

The use of mechanical mixing systems should be avoided, hydraulic devices being preferred. There is considerable evidence available that mechanical mixers produce hydraulic conditions which lead to low efficiencies in coagulant use.

4.1.5.5.3. Flocculation

Two types of flocculators exist combined flocculation-sedimentation units and separate flocculators. For separate flocculation, the use of mechanical devices should be avoided since they have been shown to be unreliable in developing countries. Efficient forms of hydraulic flocculators using baffles are known and can be promoted for increased use. Alternative forms of hydraulic flocculators such as granular bed flocculators and spiral flow devices should be further examined.

Study recommended: WS 7 - Hydraulic flocculators (see page 22)

4.1.5.5.4. Sedimentation

Several systems of sedimentation can be identified. These include floc-blanket sedimentation, horizontal and vertical flow settling tanks and inclined plate or tube systems. Whatever the system, the use of mechanical agitation should be avoided. Although it was recognized that the floc-blanket system sometimes offered economic advantages it was thought that its use should be carefully considered

since it is inherently a more sensitive system, normally requiring considerable supervision. Raw water quality is a critical factor in the use of these tanks.

In horizontal flow tanks, the use of mechanical systems for sludge removal should be discouraged. It has been found that, in developing countries, poor maintenance and lack of spares leads to a high failure rate.

The use of inclined tube or plate clarifiers constructed from local materials should be encouraged since they are known to be cheap and effective systems.

4.1.5.5.5. Rapid sand filtration

Dual-medio filters offer considerable advantages in terms of reduced cost. However, the question of backwashing conditions and loss of medio needs attention. Locally available materials should be examined as an alternative to anthracite for dual-media systems.

Filtration rates should be based on the filter influent quality and on local conditions. Mechanical rate controllers should be eliminated and these should be replaced by weirs and orifices. Such systems could be applied to contact filters and declining-rate filters.

Effective backwashing without pumps could be achieved by a simple design in which one filter is washed with the effluent from the remaining filters. In this way, practically all pipes and fittings can be eliminated. Such plants are now in operation.

A system using up-flow filtration followed by a down-flow bed should be examined as an alternative to conventional flocculation, sedimentation and filtration systems.

Studies recommended: WS 8 - Use of up-flow, down-flow filtration (see page 22)
WS 9 - Designs of small plants (see page 22)

4.1.5.6. Disinfection

In the dosing of gaseous chlorine, it was recognized that there was a need to examine simpler systems, perhaps constructed from local materials. The safety of these systems, however, must receive attention. The use of dosing systems involving various chlorine compounds such as bleaching powder should be examined. A world-wide survey should be made of existing chlorine dosing systems and a monograph should be prepared on this subject. Special attention should be given to dispensers for tube wells and dug wells.

Studies recommended: WS 10 - Simple chlorine dosing methods (see page 22)
WS 11 - Alternative disinfection chemicals (see page 22)

4.1.6. Distribution systems

The distribution system, where required, is the most expensive part of the water supply. Considerable opportunity exist for cost reduction in the various elements of the piped system. For example:

- the use of small diameter pipes, from 25 mm upwards;
- design for lower pressures (10 m);
- the reduction of the number of valves, crosses and specials;
- except in special cases, design criteria need not include fire protection. Fires could be handled by tank trucks, portable pumps and nozzles.

Study recommended: WS 12 - Low-cost faucet for public standposts (see page 22)

4.1.7. Service reservoirs

Certain recent construction techniques, such as the use of precast elements and impermeable films, should be considered to reduce cost.

For ground-level reservoirs, a capacity of 25 per cent of the daily demand is sufficient in most cases. With adequate pumps, the elevated storage tank could have a capacity as low as 2 per cent of the daily demand, provided that power cuts are minimal. The use of reservoir piping, valves and specials should be minimized.

4.1.8. House connections

In rural areas, waste and cost could be reduced by using small size service connection pipes (down to 10 mm). With larger pipes, flow-limiting devices or meters could be used (in supplies to large scale consumers only).

4.1.9. Individual water supplies

With technical guidance and assistance to obtain and finance the materials required, a family should be able to develop and maintain its own water supply. Pamphlets should be prepared and widely distributed to stimulate and guide the family.

Other studies recommended: WS 13 - Types of lifting devices (see page 23)
WS 14 - Test kits (see page 23)
WS 15 - Cost analysis of water treatment plants (see page 23)

AREAS OF STUDY IDENTIFIED IN THE WATER SUPPLY SECTOR

No.	Title	Objectives
WS 1	Simple techniques for collecting rain water	To assess the suitability of catchment systems of rain water for rural supplies and to disseminate the information.
WS 2	Methods to eliminate treatment (e.g. by artificial recharge)	To obtain systems that can utilize surface waters for rural supplies without treatment by using infiltration galleries or wells.
WS 3	Extended plain sedimentation	To study process and low cost construction methods
WS 4	Special types of intake systems for improving the quality of raw water	To study methods of surface water intake that act as roughing filters, such as riverbed or bank filtration.
WS 5	Use of slow sand filtration	To promote the use of slow sand filtration for rural water supply.
WS 6	Use of low rate up-flow sand filters	To evaluate the process as an alternative to slow sand filtration.
WS 7	Hydraulic flocculators	To study and improve the coagulation of surface water by hydraulic means, such as spiral flow, granular flocculation, etc.
WS 8	Use of up-flow, down-flow filtration	To study the conditions under which the combination contact up-flow and down-flow polishing filter can be used as an alternative to conventional flocculation, sedimentation and filtration systems
WS 9	Designs of small plants	Study, development and information transfer of designs of small plants for rural areas that can be constructed with local materials with a minimum of pipes, specials and equipment.
WS 10	Simple chlorine dosing methods	To review and evaluate simple dosing methods of chlorine and chlorine compounds in the practice of disinfection.
WS 11	Alternative disinfection chemicals	To study the use of alternative disinfection chemicals which can be produced or obtained locally.
WS 12	Low-cost faucet for public standposts	To develop a low-cost faucet for public standposts that is less likely to be stolen than brass faucets.

AREAS OF STUDY IDENTIFIED IN THE WATER SUPPLY SECTOR

No.	Title	Objectives
WS 13	Types of lifting devices	To survey and evaluate all types of equipment used to elevate water in developing countries (e.g. pumping devices)
WS 14	Test kits	To survey and evaluate different test kits for use in developing countries.
WS 15	Cost analysis of water treatment plants	To develop a methodology to enable cost comparisons to be made between various countries.

4.2. Findings and Recommendations for the Sewage and Excreta Disposal Sector

4.2.1. General

Of the total 1,720 million people (in 1970) in developing countries 1,361 million are without excreta or sewage disposal facilities. Eighty-two million rural people have disposal facilities such as pit privies; 169 million urban people have household disposal systems such as septic tanks, while 108 million urbanites have facilities connected to sewers. Unfortunately, only 13 million are serviced by sewage treatment facilities; this represents only 0.8 per cent of the total population. * The rate of sewerage construction is falling behind population growth, consequently the rate of providing treatment for those households connected to sewers will not rise above the 0.8 per cent figure for many years to come.

Against the above background, it was decided that the discussions should cover sewage treatment technology and also excreta disposal and utilization.

Industrial wastes were also thought to need consideration though, they were beyond the terms of reference of this meeting. Often industrial waste treatment facilities established within an area, served as demonstration units for the community.

There is a general lack of awareness of the need for proper sewage treatment and excreta disposal. This results in low priority being given to the solution of this problem, and the absence of any official mechanism to assess the problem and to define the policies and objectives to be pursued. It is thus essential to promote conditions leading to the establishment of the necessary organization or mechanism to perform such tasks. Further, there was a tendency to postpone the provision of pollution control facilities to the point at which the problem became too great for solution with community resources.

Besides sewage and excreta treatment, it was thought that there exist considerable scope for reduction in costs of collection systems. Unfortunately, there was no opportunity for in-depth consideration of this aspect at the meeting.

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*Pineo, C.S. & Subrahmanyam, D.V. (1975), Community Water Supply and Excreta Disposal Situation in the Developing Countries, a Commentary (Geneva: World Health Organization) Offset Publication no. 15.

4.2.2. Sewage treatment

4.2.2.1. Construction and equipment

The general situation in developing countries is that to solve sewage treatment problems resort to imported technology is necessary. To improve this, adaptation of sewage treatment technology utilizing local materials, concepts and skills should be promoted. Government and private resources should be channeled to encourage local manufacture of equipment for sewage treatment facilities.

Studies recommended: WD 1 - Task force evaluation (see page 30)
WD 2 - Local manufacture of equipment and products (see page 30)
WD 3 - Systematic costing of collection and treatment of sewage (see page 30)

4.2.2.2. Operation and maintenance

Many existing sewage treatment facilities are in bad condition due to bad selection of technology, poor design, inadequate repair, lack of spare parts, lack of preventive maintenance, lack of trained personnel and lack of appreciation of the need for proper maintenance of sewage treatment facilities. Although there were many facets to solving this problem, primary considerations related to education and training, as well as to the selection of technology and design in accordance with local conditions.

Study recommended: WD 4 - Demonstration sewage plants (see page 30)

4.2.2.3. Specific concepts and promising technologies

The group recommended that the following criteria be considered in the selection of treatment processes for developing countries:

- simplicity in design and operation;
- minimum use of equipment, which should if possible be available locally;
- the availability of land and its appreciation in value;
- financially feasible alternatives;
- treatment process(es) should give an effluent which satisfied effluent quality objectives.

It was emphasized that before appropriate technologies could be selected the degree of treatment required needed to be clearly established through data collection and evaluation. The group felt that the following treatment processes were more

applicable in developing countries:

- waste stabilization ponds;
- aerated lagoons; and
- extended aeration.

The following sewage disposal alternatives also merited consideration:

- marine disposal;
- sewage irrigation; and
- subsurface disposal of septic tank effluent (for individual households).

4.2.2.3.1. Waste stabilization ponds

Under tropical conditions, the algal content of the effluent of waste stabilization ponds is often beneficial to the receiving waters and irrigated lands. The potential for fish culture in waste stabilization ponds was often not realized. Research is required into (5 meter) deep facultative ponds under high loading rates. Further study into the economics of ponds was required, highlighting the appreciation in value of pond-land, if the ponds were to be relocated elsewhere in the future. More research into the use of multiple serial ponds to reduce land requirements and foster improved destruction of pathogens and stabilization of organics was needed. Research on combinations of sewage treatment processes with facultative ponds was required, such as in (1) aerated ponds, (2) effluent recirculation and (3) deep ponds.

Studies recommended: WD 5 - Pond performance (see page 30)
WD 6 - Algae recovery (see page 30)
WD 7 - Combination of sewage treatment processes (see page 30)

4.2.2.3.2. Aerated lagoons

In many countries sufficient capabilities exist for constructing and operating aerated lagoons using locally manufactured aerators. The working group felt that with regard to aerated lagoons the current emphasis should be focussed on information dissemination, development of design criteria and demonstrations in the field where no such lagoons existed.

Study recommended: WD 8 - Aerated lagoons (see page 30)

4.2.2.3.3. Extended aeration

Among the methods capable of giving a better quality effluent than the above stated methods, extended aeration was the most suitable for developing countries owing to its relative simple operation and the equipment required. The group noted the fact that the method in question required a high input of energy which tended to make it uneconomical for large cities or where an effluent of lower quality was acceptable. Examples of this method included the Oxidation Ditch, though other ways of achieving extended aeration also existed and could be developed further.

4.2.2.3.4. Stepwise and modular development

Consideration should be given to the step-wise development of sewage treatment processes as sewage loads increased with population growth. For example, a deep facultative pond could be converted to an aerated lagoon by adding aerators, and then to an extended aeration lagoon by incorporating added sludge settlement and recirculating facilities.

4.2.2.3.5. Marine disposal

Coastal communities are becoming more and more interested in sea disposal, both on and off-shore, without damaging health and aesthetic or recreational facilities, especially where tourism is important. Relatively simple oceanographic survey facilities need to be developed which can be utilized at the local level for small outfalls; for this, import of expertise is not required.

Study recommended: WD 9 - Oceanographic surveys (see page 30)

4.2.2.3.6. Sewage irrigation

Sewage irrigation with or without pretreatment often constitutes a welcome alternative to waste disposal to a water course, provided the facility is designed carefully with due regard to possible effects on soil and crops and is operated with care particularly with respect to health.

4.2.3. Excreta disposal and re-use in developing countries

In the developing countries, the present rate of institutional, manpower and budgetary allocation for excreta disposal improvement is entirely insufficient to meet current demand or even to keep up with population solution. Fundamental shifts in orientation and approaches, including rural community development, have to be made if the very limited available resources are to be used efficiently.

Field studies on sanitary excreta disposal in developing countries should be made. Numerous technologies are being tried out in various countries and had been developed during the past fifteen years. Such experimentation and research remains largely unpublished, unrecognized and without inter-research group communication. This situation should be rectified and technologies compared directly, in situ.

Methods of excreta disposal and utilization which have been tested and/or are being used include *:

Slotted pit privy
PRAI latrine **
Pit latrine
Bore-hole latrine
Overhung latrine
South African channel privy
Bio or Gobar gas plant
Open, indiscriminate defecation
Beach defecation
Aquaprivy
Kumasi toilet
Partition toilet
Comfort toilet (many types)
Bucket latrine
Aquaprivy/sewerage system
Vacuum truck and vault
Excreta composting at the community level
Chinese field storage pot and agricultural use
Water seal toilet (seat and squat)
Village pond aquaculture

*Wagner, E.G. & Lanoix, J.N. (1958), Excreta disposal for rural areas and small communities; (Geneva: World Health Organization) Monograph Series, No. 39. McGarry, M.G. (1975), Developing Country Sanitation, Report prepared for the International Development Research Centre, Canada.

**Planning Research and Action Institute, Lucknow.

Excreta management systems are of crucial importance to dissemination and use in developing countries and to the way in which the technologies were propagated. The purely technical appraoch currently taken by responsible agencies might be applicable to rural towns and cities but has not been effective in reaching the village level.

Field trials of disseminating technology at the community level need to be undertaken which directly involves the villager in the whole process of development, including sanitation.

Studies recommended: WD 10 - Study of current indigenous practices of village and household excreta disposal using aquaculture (see page 30)

WD 11 - Evaluation of Biogas plants (see page 30)

WD 12 - Excreta disposal facilities in rural areas (see page 30)

WD 13 - Agricultural use of excreta (see page 31)

WD 14 - Working group on sewerless waste disposal technology and schemes (see page 31)

Also recommended for further development were:

WD 15 - Rural health care development (see page 31)

WD 16 - Optimization of water resource uses (see page 31)

WD 17 - Establishment of sewage organizations (see page 31)

WD 18 - Study of new design parameters for sewers (see page 31)

AREAS OF STUDY IDENTIFIED IN THE WASTE DISPOSAL SECTOR

No.	Title	Objectives
WD 1	Task force evaluation	A task force evaluation of technologies being used in developing countries as well as those having potential for such use through in-field visits, literature reviews, cost effectiveness analyses, etc.
WD 2	Local manufacture of equipment and products	The development of local industries to manufacture products applicable to water supply and water pollution control through such agencies as United Nations Industrial Development Organization.
WD 3	Systematic costing of collection and treatment of sewage	The development of a method for systematic costing of sewage collection and treatment.
WD 4	Demonstration sewage plants	To encourage governments to install demonstration units for the purpose of propagating appropriate technologies for sewage treatment.
WD 5	Pond performance	To study deep and shallow pond performance with a view to reducing land requirements and improving pathogen die-off.
WD 6	Algae recovery	To study the recovery of algae as a source of protein.
WD 7	Combination of sewage treatment processes	To study combinations of sewage treatment processes in facultative waste stabilization ponds
WD 8	Aerated lagoons	To develop design criteria, encourage field demonstration and disseminate the information on aerated lagoons.
WD 9	Oceanographic surveys	To develop oceanographic survey facilties for small outfalls.
WD 10	Study of current indigenous practices of village and household excreta disposal using aquaculture	To utilize sewage and maximize fresh or marine fish production.
WD 11	Evaluation of Biogas plants	To evaluate and analyse the cost-benefit of Biogas plants utilizing excreta, agricultural and agro-industrial waste. The study of existing plants in operation should be emphasized.
WD 12	Excreta disposal facilities in rural areas	Community development studies for the provision and proper utilization of excreta disposal facilities in rural areas (study of processes).

AREAS OF STUDY IDENTIFIED IN THE WASTE DISPOSAL SECTOR

No.	Title	Objectives
WD 13	Agricultural use of excreta	To study the use of excreta in agriculture and the health implications of such practices.
WD 14	Working group on sewerless waste disposal technology and schemes	To discuss and evaluate the state of the art of sewerless waste disposal techniques.
WD 15	Rural health care development	To study the introduction of water supply and sanitation through the rural health care delivery system i.e., through the village level worker or the 'barefoot' engineer.
WD 16	Optimization of water resource uses	To develop methodologies for optimizing water resources used in river basins including aspects of pollution control.
WD 17	Establishment of sewage organizations	To encourage the establishment of sewage organizations.
WD 18	Study of new design parameters for sewers	To obtain cost reductions by easing design criteria and the use of alternative materials.

4.3. Findings and Recommendations for the Socio-Economic Sector

4.3.1. General

In view of the need to assist developing countries to improve their strategies for increasing the rate of rural water and sanitation coverage, the meeting felt that unless substantial changes were made in current approaches, the countries would not be able to provide even the most basic water and sanitation services to all those who need them, within any reasonable time frame.

To meet this challenge it was felt that greater use should be made of those schemes that involved community participation, self-help and/or self-reliance and technologies which were truly responsive to the countries' human, technical and financial resources.

It was observed that too often there was a lack of communication between designers, administrators and users. This has frequently resulted in the inappropriate application of technical and administrative solutions to problems which were basically sociological in nature. The result has often been that an overly expensive, socially unacceptable solution has been imposed from the top down without adequate consultation with the user in outlying regions. This misapplication of resources has usually been caused by the lack of an adequate socio-economic training and/or awareness on the part of those involved.

In seeking ways to assist the countries to develop and apply solutions which would be appropriate to their needs and priorities, it was felt that the international community (i.e., agencies, foundations, bilateral programmes, etc.) should develop a co-ordinating mechanism to serve as a central body for the exchange of information, the motivation of adaptive research and promotion of 'in-country' solutions.

To achieve the above goals, it was felt that the countries should develop a strategy that included the following elements:

- National Plans
- A Feedback Mechanism
- Case Study Reporting
- Motivation and Communication
- Technical Co-operation
- Continuous Mechanism
- Design and Construction
- Adaptive Research and Implementation

These various aspects are detailed in the following sections. To meet some of the more general needs of the socio-economic sector the meeting proposed that the following studies be made:

Studies recommended: SE 1 - Promotion of programmes of community water supply and sanitation (see page 39)
SE 2 - Programme acceleration (see page 39)
SE 3 - Development of socio-economic training schemes (see page 39)
SE 4 - Study of self-help/self-reliance schemes (see page 39)

4.3.2. National plans

It was the consensus of the group that water supply and sanitation must be considered as an integral part of the development process. The first stage in the provision of these basic services to the communities of the developing world would be to assist each country to develop a national plan within the overall concept of a rural/community development programme. To do this, it was felt that a set of programme goals must be developed and that a plan of action (incorporating a strategy for financing schemes and recruitment of resources) should be drawn up.

Motivation of the local people involved will only be possible if they are given the opportunity to influence the national plan and by stating their priorities. To reach the people of the villages will only be possible if the communication between the planning department and the villagers is improved. A national plan should consider the use of better indicators than the GNP in measuring development, for instance literacy and the morbidity rate.

The integrated approach of rural/community development would mean a co-operative effort of the different disciplines, e.g. agricultural education, health care, nutrition, sanitation and housing, and the participation of women. In order to improve access to data necessary for developing national plans, the planning organization should establish a data bank and/or an information system. Experience has shown that the basic financing can be found with the local people, who should be assisted by government and aid funds in reaching their objectives.

Studies recommended: SE 5 - Integrated approach (see page 39)
SE 6 - Regional seminar on the place of water supply and sanitation within the socio-economic context of rural development and the need for a national plan. (see page 39)

SE 7 - Assisting countries in developing a national plan for community water supply and sanitation in combination with a plan for rural/community development (see page 40)

SE 8 - Assisting countries in setting up a data bank for relevant information (see page 40)

4.3.3. A feedback mechanism

The situation of applying science to development is considered a dynamic situation in which technology is applied to existing systems for their improvement. To realize an effective exchange of ideas, a mechanism should be established for exchange of experience in implementing appropriate technologies. The transfer of information should make knowledge available in order to promote decisions. This mechanism would be of an interdisciplinary and dynamic nature which would continually review its needs and life.

At the international level, the International Reference Centre for Community Water Supply may act as an international co-ordinating body. At the national level, a government or official mechanism which involves a local authority might be identified, and if necessary, should be strengthened. If such an organization does not exist one might be especially created for this purpose. Such a national organization should liaise closely with the local institutions in its territory. It should collect the information from the various local institutions and, after compilation, should send the material to the International Reference Centre.

Study recommended: SE 9 - National feedback mechanism with international co-ordination (see page 40)

4.3.4. Case study reporting

Besides exchange of information on all subjects relevant to community water supply and sanitation the exchange of information should be especially dedicated to results of a problem-oriented approach (in case study form) with special emphasis on social acceptance, aspects of finance and management and technical solutions. This information should be adapted and distributed at a national level.

The task of the national body is to transform the information for national and international dissemination. The information is to be used as a guideline in order to enable everyone to work along the concept of appropriate technology, recognizing the countries' responsibility to declare their own education and information programme, training of engineers and the promotion of concepts to policy makers.

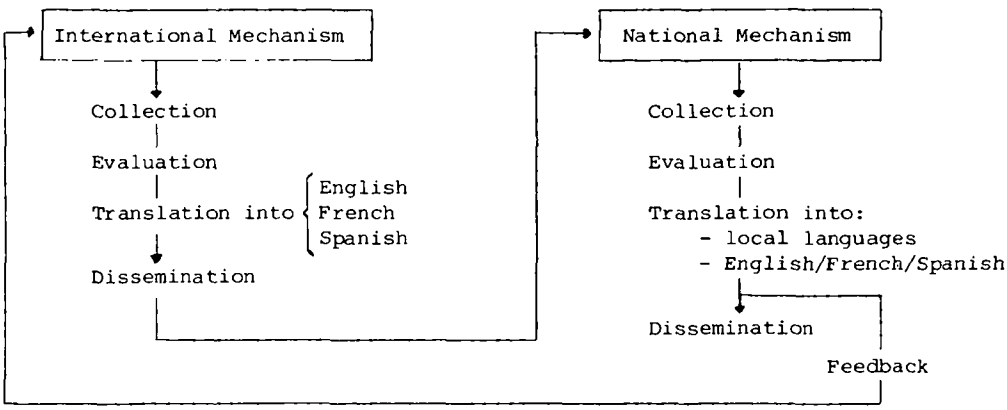
In summary, there is a great deficiency in the exchange of information on adapted solutions implemented successfully in various regions of the world. This is particularly true for information in the form of a problem-oriented approach (case study form).

Study recommended: SE 10 - Case study reporting (see page 40)

4.3.5. Motivation and communication

The working group was aware of the use of various languages which complicated the exchange of information on a national and international basis, thus it was the consensus of the group that at least three languages should be used. To ensure the technology transfer as well as the information exchange, translation is needed of material collected in several different languages into English, French and Spanish; furthermore, it is felt that translation into local languages should be the responsibility of the national organization.

Diagram showing information, dissemination (including translation) and feedback



As in the developing countries, information transfer and dissemination from international, as well as from local sources, frequently need much improvement. Mass communication techniques should be incorporated in efforts to motivate governments and the people.

The working group felt that the development programmes should 'pull' the appropriate technology from the developed as well as the developing countries. This should be done in response to the needs as identified at the national level in the developing

countries and which are often very culturally oriented. The existence of an international as well as a national mechanism would ensure the transference of the information available so that most developing countries could benefit from the availability of such relevant information to promote the improvement of their water supply and sanitation situation.

Studies recommended: SE 11 - Establishing an international information exchange system (see page 40)
SE 12 - Identification of information transfer techniques (languages) (see page 40)
SE 13 - Cultural adaptation (see page 41)
SE 14 - Non-published materials (see page 41)

4.3.6. Technical co-operation

There is a need to determine the form of assistance to be provided to developing nations so that they will receive and use the socio-economic and technical information available in both developed and other developing nations. This information has to be gathered from lessons learnt in the tried and tested local situation and then transferred to the local area where the information may be used.

It was agreed that awareness of the importance of proper sanitation is necessary before communities would improve their sanitary conditions. Those experiences in creating community awareness would be extremely valuable if gathered and written up for use in developing nations.

To the same end, the experiences gained in the socio-economic and technical areas would be valuable to developing nations.

Studies recommended: SE 15 - Series of guidelines (see page 41)
SE 16 - International, national and local seminars and workshops (see page 41)
SE 17 - Local studies by international and national experts (see page 41)

4.3.7. Continuous mechanism

It was felt that there was an urgent need for a continuous mechanism for information exchange to improve the field of sanitation. It was expected that this mechanism could continuously develop ideas, design criteria or guidelines and assist in

improving and upgrading facilities.

Studies recommended: SE 18 - In-country information exchange mechanism (see page 41)
SE 19 - National training centres for rural workers (see page 41)

4.3.8. Design and construction

Generally, international consultants and contractors are not specialized and are less interested in rural water and waste disposal projects utilizing appropriate technology.

Organization of regional training conferences on appropriate technology should therefore be conducted for country national engineers and contractos, the purpose of which would be the transfer of knowledge and the promotion of interest in appropriate technology for rural water supply and waste disposal. National training centres should be established to train local engineers and contractors in the methodology of appropriate technology in rural water supply and waste disposal.

Studies recommended: SE 20 - National and regional training of country national engineers and contractors (see page 41)
SE 21 - Seminars for international consultants (see page 42)

4.3.9. Adaptive research and implementation

Much of the previous work in this field had been directed to the larger urban areas that in many cases had had the necessary resources. The meeting felt that greater emphasis should now be directed towards dispersed populations and how to serve them with improved water and waste water treatment. It also felt that future research should be directed towards overall economic development of rural and lesser developed areas. The group stressed that there was a real need for the evaluation of existing operations. Evaluation of the performance of existing schemes should deal with the following elements:

- financial structure requirements;
- the management of water and waste water systems, their operation and maintenance;
- benefits of the project or project systems;
- cost effectiveness (where appropriate); and
- the effect on the user.

To date, little had been done in this field, however, and the funds allocated for research and development appeared to be small. The group also felt that research

should be directed towards an examination of local construction practices and how they could be adapted to local conditions. This should also include examination of local manufacturers. These enterprises should be assisted and promoted wherever there appeared to be an opportunity for improving developmental progress in an area. In many rural areas, there was often a lack of skilled manpower capable of constructing the types of facilities needed for improved sanitary services.

Study recommended: SE 22 - Evaluation of local production practices (see page 42)

Also recommended for (further) study:

SE 23 - Prediction model development (see page 42)

SE 24 - Impact studies (see page 42)

AREAS OF STUDY IDENTIFIED IN THE SOCIO-ECONOMIC SECTOR

No.	Title	Objectives
SE 1	Promotion of programmes of community water supply and sanitation	To assist those working in the field: to develop materials, ideas and documents that can be used to explain and/or promote these programmes to the users and the general public. To assist those working in programme administration: to develop materials, ideas and documents that can be used to obtain the additional human and financial resources that will be needed for the proposed accelerated programmes.
SE 2	Programme acceleration	To investigate the various technical, financial and social reasons why current programmes have not met their goals. To develop guidelines for areas of additional, needed research. To promote national workshops for developing techniques and strategies which are more responsive to the realities of the countries' resources and goals.
SE 3	Development of socio-economic training schemes	To investigate current training practices for professionals, technicians and promotors involved in these programmes. To investigate how these match current needs. To identify and promote sources at all levels which will be responsive to the goals set by the countries for their expanded programmes.
SE 4	Study of self-help/self-reliance schemes	To investigate current practices of such schemes by a multi-disciplinary team (engineer/economist/sociologist). To evaluate the cost-effectiveness of these practices. To develop a guideline based on these practices and the findings of the evaluation team. To promote national workshops to integrate national capabilities and such modern technology as are appropriate.
SE 5	Integrated approach	To investigate the various disciplines necessary for an integrated approach to promote rural/community development.
SE 6	Regional seminars on the place of water supply and sanitation within the socio-economic context of rural development and the need for a national plan	Calling up information and promoting of co-operation between disciplines involved.

AREAS OF STUDY IDENTIFIED IN THE SOCIO-ECONOMIC SECTOR

No.	Title	Objectives
SE 7	Assisting countries in developing a national plan for community water supply and sanitation in combination with a plan for rural/community development	Setting goals, creating a plan of action for each region and country.
SE 8	Assisting countries in setting up a data bank for relevant information	The collection of data and provision of access to data collected.
SE 9	National feedback mechanism with international co-ordination	To collect data on the performance of improved systems, and pass on the information to the international co-ordinating body for further study.
SE 10	Case study reporting	To encourage the reporting of case studies, which should emphasize the following: technical solutions and method of implementation adopted; social acceptance by the community served; financial and managerial aspects; problems encountered during and after implementation and how they were resolved; and final results achieved. To make those concerned aware of the existence of solutions to specific problems that have been implemented successfully in a particular locality. To motivate and encourage others to apply the same solutions with some modifications, if necessary, to problems which are of a similar nature.
SE 11	Establishing an international information exchange system	To establish a mechanism for international information exchange. To make other countries aware of the existence of such a mechanism which should: collect data/information; evaluate data/information and list relevant priorities; and disseminate the information.
SE 12	Identification of information transfer techniques (languages)	To improve existing the mechanism and/or establish the mechanism which: collects data/information available locally and or internationally; evaluates data/information and lists relevant priorities; and translates into local language (for local use), into English, French or Spanish (for feedback). To disseminate in the form of a publication, demonstration or training and upgrading as needed. To give a feedback.

AREAS OF STUDY IDENTIFIED IN THE SOCIO-ECONOMIC SECTOR

No.	Title	Objectives
SE 13	Cultural adaptation	To study the problems of transfering the practices of one culture to another and from one language to another at local, national and international level. To develop training workshops in the proposed techniques.
SE 14	Non-published materials	To develop methods for finding, translating and publishing information concerning non-published material currently in use. To develop techniques for dissemination via appropriate social communication routes.
SE 15	Series of guidelines	To publish case studies by an international agency on the creation of sanitation awareness at the community level. To publish case studies on local community sanitation regarding the actual improvement of community sanitation once the awareness has been generated. Such case studies should include experiences gained in the promoting, organizing and operating of community sanitation systems.
SE 16	International, national and local seminars and workshops	To further communicate the case studies gathered.
SE 17	Local studies by international and national experts	To further communicate the case studies gathered.
SE 18	In-country information exchange mechanism	To investigate the possibilities for the setting up of a continuous mechanism for collecting, evaluating and distributing the information.
SE 19	National training centres for rural workers	To set up centres for training technicians and sanitarians (possibly combined with nutricians, etc.) in order to make them aware of the significance and the possibilities of appropriate solutions.
SE 20	National and regional training of country national engineers and contractors	To train local engineers and contractors in the methodology of appropriate technology for rural water supply and waste disposal and to encourage local engineers and contractors to take responsibility for design and construction of rural water supply and waste disposal projects using appropriate technology.

AREAS OF STUDY IDENTIFIED IN THE SOCIO-ECONOMIC SECTOR

No.	Title	Objectives
SE 21	Seminars for international consultants	To provide international consultants with knowledge on appropriate technology in design and construction of rural water supply and waste disposal systems. To encourage adoption of same. To encourage international consultants to train country local engineers and contractors and assist these engineers and contractors in initiating projects in same.
SE 22	Evaluation of local construction practices	To verify the performance of existing schemes and systems that have been built in developing countries in the area of water and waste water improvement. Consideration should also be given to projects in related areas. The studies should consider the five elements as listed on page 37, (4.3.9.) The results of these systems should be made available to those organizations considering similar projects.
SE 23	Prediction model development	To further develop a methodology for predicting suitable water and waste water processes such as initiated at the University of Oklahoma and to test and validate the model in many countries.
SE 24	Impact studies	To study the relationship between water supply and sanitation and community health and development.

5. SYSTEMS APPROACH

In the framework of a project on "Low Cost Water and Waste Treatment in Developing Countries" being carried out at the University of Oklahoma, a review of a study on "Prediction Methodology for Suitable Water and Waste Water Processes" * was presented by Prof. G.W. Reid.

The model developed was a first attempt to bring together a number of critical inputs relating to the effective installation and use of various water and waste water treatment methods, processes and combination of processes. Using in-country resources, socio-economic and demographic data, water quality and cost parameters, the model would serve to forecast the most suitable treatment process under the given local/regional conditions. The primary objective of such a model was to provide a tool to assist the responsible engineer to have an overview of all plausible processes and their related costs, plus the operation, maintenance and manpower requirements. This tool in turn would assist the engineer to work with planners and administrators in a more effective manner.

The meeting agreed that the model should primarily be used by the design engineer. In discussing the concept of the model, its potential role in the planning process was recognized. Since it was a first attempt, the model was limited in its scope and its raw data inputs. Field validation and further development are needed. Testing and validation of the model should be done in as many situations as possible (countries or regions proposed included Brazil, Colombia and Africa). Many participants offered their cooperation to furnish system and cost data as well as information on cases of success and failure. The group also emphasized the potential need and use of the model to be extended to a total systems approach as a relevant tool for decision-makers. In addition to the need for having a special seminar on the model, specific recommendation and support was given by Latin American representatives to conduct 'expert' workshops, one on water only and the other on sewage.

* The paper on "Prediction Methodology" is published as the IRC Technical Paper no. 8.

6. CONCLUSIONS AND PRIORITY RECOMMENDATIONS

With the background provided by the presentations, state-of-the-art reviews succeeded in clarifying the role that appropriate technology can play in the water supply and sanitation field in developing countries. The main outcome of the workshop was the assignment of priorities to the projects considered to contribute to an improved coverage of water supply and sanitation in developing countries. These priorities are listed at the end of this section, together with institutes which were identified as possibly interested in participating in priority projects.

The subjects which were identified by the working groups on Water Supply, Waste Disposal and Socio-Economics to merit further study were once again evaluated from the regional point of view on their relevance to Asia, Africa and Latin America. In a plenary meeting those projects were selected that merit highest priority for execution. For these priority projects, names of institutions were indicated which might well be interested in participating actively in the execution phase. These projects and institutions are listed on page 46-48.

In discussing the list of projects on the socio-economic aspects, it was understood that they should be related to the projects on the water supply as well as on the sewage disposal list. For the project "The Development of a Prediction Model" (SE23), which should also incorporate "Cost Analysis of Water Treatment Plants" (WS15), "Optimization of Water Resources Uses" (WD16) and "Systematic Costing of Collection and Treatment of Sewage" (WD3), the following general statement was endorsed:

> "It is recommended that further improvement and testing of the prediction methodology as presented by Prof. G.W. Reid be continued and particularly that participants should attempt to give support by gathering more basic data needed to optimize the model."

Furthermore, the plenary session unanimously recommended that the state-of-the-art paper of Prof. L. Huisman on Drinking Water Supply be extended, including the results of the mail survey on Practical Solutions in Drinking Water Supply and Waste Treatment for Developing Countries and using additional contributions from the participants; and that this paper be published and disseminated by the IRC.

The holding of a similar workshop on "Utilization of Groundwater for Simple Village Systems" was recommended. This should be organized by the International Reference Centre. It was further recommended that conferences dealing with third world problems should preferably be held in developing countries. It was suggested that a suitable

meeting place on the topic would be Hyderabad in India.

There was a general consensus that the International Reference Centre should co-ordinate the decisions that had been arrived at during the meeting and should take a first step in initiating follow-up at the regional and national levels. Furthermore, it was agreed that the Centre would publish the proceedings of the workshop.

PRIORITIES GIVEN TO THE STUDIES, DEVELOPMENT AND OTHER ACTIVITIES RECOMMENDED BY THE WORKSHOP AND INSTITUTIONS IDENTIFIED AS POSSIBLY INTERESTED IN PARTICIPATING IN THESE PRIORITY PROJECTS

No.	Title	Institution(s) identified
	Water Supply (WS)	
WS 2	Methods to eliminate treatment (e.g. by artificial recharge)	- Dutch Water Works Association (the Netherlands) - National Water Supply and Drainage Board (Sri Lanka) - University of Sri Lanka (Sri Lanka) - Water Research Centre (WRC, United Kingdom)
WS 10/11	Simple chlorine dosing methods/Alternative disinfection chemicals	- National Water Pollution Control Commission (NWPCC, Manilla)
WS 9	Designs of small plants	- Servicio Nacional de Agua Potable (SNAP, Argentina) - National Environmental Engineering Research Institute (NEERI, India) - Centro Panamericano de Ingenieria Sanitaria y Ciencias del Ambiente (CEPIS, Peru) - National Water Supply and Drainage Board (Sri Lanka)
WS 13	Types of lifting devices	- University of Sao Paulo (Brazil) - Department of Public Health Engineering (DPHE, Bangladesh) - Directorate of Water Resources (Tanzania) - Commité Inter-Africain d'Etudes Hydrauliques (CIEH, Upper Volta) - The All India Institute for Public Health and Hygiene (India) - University of Science and Technology (Ghana) - University of Waterloo (Canada) - Intermediate Technology Development Group (ITDG, United Kingdom) - OXFAM (United Kingdom) - American Well Drillers Association (U.S.A.)
WS 5	Use of slow sand filtration	- Department of Public Works (Indonesia) - University of Sao Paulo (Brazil) - National Water Supply and Drainage Board (Sri Lanka) - Jamaica

PRIORITIES GIVEN TO THE STUDIES, DEVELOPMENT AND OTHER ACTIVITIES RECOMMENDED BY THE WORKSHOP AND INSTITUTIONS IDENTIFIED AS POSSIBLY INTERESTED IN PARTICIPATING IN THESE PRIORITY PROJECTS

No.	Title	Institution(s) identified
	Waste Disposal (WD)	
WD 16	Optimization of water resource uses	- Centro Panamericano de Ingenieria Sanitaria y Ciencias del Ambiente (CEPIS, Peru) and - University of Oklahoma (U.S.A.)
WD 5	*Pond performance*	- *Companhia Estadual de Tecnologia de Saneamento* Básico de Controle de Poluiçao das Aguas (CETESB, Brazil) - Centro Panamericano de Ingenieria Sanitaria y Ciencias del Ambiente (CEPIS, Peru and University of Oklahoma (U.S.A.) - University of Sao Paulo (Brazil) - National Environmental Engineering Research Institute (NEERI, India) - National Water Supply and Drainage Board (Sri Lanka) - Asian Institute of Technology (AIT, Thailand) - City Council Nairobi (Kenya) - Technion (Israel)
WD 15	Rural health care development	- International Institute for Rural Reconstruction (Philippines) - Department of Health (Indonesia) - World Health Organization - U.S. Agency for International Development Research is at present being carried out in: *Cameroon, Colombia, Guatemala, Iran, Malawi,* Nepal, Venezuela
WD 12	Excreta disposal facilities in rural areas	- University of Science and Technology (Ghana) - University of Dar-es-Salaam (Tanzania) - U.S. Agency for International Development (Indonesia-project) - CIMDER (Colombia) - Directorate of Public Health Engineering (Bangladesh)
WD 14	Working group on sewerless waste disposal technology and schemes	- University of Oklahoma (U.S.A.) - Ministry of Local Government and Land (Botswana) - U.N. Conference on Human Settlements, (HABITAT), Vancouver, 31 May - 11 June 1976.

PRIORITIES GIVEN TO THE STUDIES, DEVELOPMENT AND OTHER ACTIVITIES RECOMMENDED BY THE WORKSHOP AND INSTITUTIONS IDENTIFIED AS POSSIBLY INTERESTED IN PARTICIPATING IN THESE PRIORITY PROJECTS

No.	Title	Institution(s) identified
	Socio-economics (SE)	
SE 1	Promotion of programmes of community water supply and sanitation	
SE 2	Programme acceleration	
SE 3	Development of socio-economic training schemes	
SE 4	Study of self-help/self-reliance schemes	
SE 19/ 20	National training centres for rural workers/National and regional training of country national engineers and contractors	- International Institute for Rural Reconstruction (Philippines) - U.S. Agency for International Development
SE 21	Seminars for international consultants	- Centro Panamericano de Ingenieria Sanitaria y Ciencias del Ambiente (CEPIS, Peru)
SE 9	National feedback mechanism with international co-ordination	- Companhia Estadual de Tecnologia de Saneamento Básico de Controle de Poluiçao das Aguas (CETESB, Brazil)
SE 24	Impact studies	- Research is at present being carried out in: Cameroon, Colombia, Guatemala, Iran, Malawi, Nepal, Venezuela (see also Project WD 15)

ANNEX I

GLOBAL WORKSHOP ON

APPROPRIATE WATER AND WASTE WATER TREATMENT TECHNOLOGY

FOR DEVELOPING COUNTRIES

Voorburg, The Hague, 17-22 November 1975

Agenda

1. Opening

   1.1. Opening speech - Mr. F. Deeleman, Sec. General, Royal Tropical Institute

2. Adoption of Agenda

3. Keynote Addresses

   3.1 Low Cost Water and Waste Treatment in Developing Countries - Prof. G.W. Reid
   3.2 Internationally Co-ordinated Programmes on Community Water Supply in Developing Countries - Mr. J.M.G. van Damme
   3.3 Rural Water Supply and Sanitation in Developing Countries - Dr. B.H. Dieterich

4. Historic Review

   4.1 Techniques in Water and Sewage Treatment throughout the Centuries - Mr. J. Haijkens

5. State of the Art

   5.1 Treatment Methods for Water Supplies in Rural Areas of Developing Countries - Prof. L. Huisman
   5.2 Sewage Treatment in Developing Countries - Dr. J. Malina and Dr. L. Canter
   5.3 The Significance of Developing Countries' Techniques for National Programmes - Mr. T.K. Tjiook

6. Working Group Sessions

   6.1 Water Technology
   6.2 Sewage Technology
   6.3 Socio-economic aspects of implementation

7. Workshop Summary

8. Systems Approach

   8.1 Prediction Methodology for Suitable Water and Waste Water Processes - Prof. G.W. Reid

9. Regional Transfer and Implementation

   Panels: - Latin America
   - Middle East/Africa
   - Far East

10. Adoption of final recommendations

11. Concluding Session

ANNEX II

GLOBAL WORKSHOP ON
APPROPRIATE WATER AND WASTE WATER TREATMENT TECHNOLOGY
FOR DEVELOPING COUNTRIES

Voorburg, The Hague, 17-22 November 1975

List of Participants

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ANNEX III

GLOBAL WORKSHOP ON
APPROPRIATE WATER AND WASTE WATER TREATMENT TECHNOLOGY
FOR DEVELOPING COUNTRIES

Voorburg, The Hague, 17-22 November 1975

List of Background Papers

- Azevedo Netto, Dr. J.M. de, Water and Sewage Treatment Techniques in Brasil (Case Study)
- Beyer, M.G., Ground Water Occurrence and Extraction, Some Approximate Basic Data
- Beyer, M.G., Water Supply from Rain Catchment, Springs and Ground Water Resources, Some Suggestions for Technological Work
- Canter, L.W. & Malina, J.F., Sewage Treatment in Developing Countries
- Damme, J.M.G. van, Internationally Co-ordinated Programmes on Community Water Supply in Developing Countries
- Doeleman, F., Opening Speech
- Huisman, Prof. L., Treatment Methods for Water Supplies in Rural Areas of Developing Countries
- Mahmoud, Dr. I.A., Case Study of Addis Ababa Sewerage Project
- Reid, Prof. G.W., Low Cost Water and Waste Water Treatment in Developing Countries, Project Presentation
- Reid, Prof. G.W., Water Test Kit I: User's Manual
- Reid, Prof. G.W. & Discenza, R., Manual Computation Method, Supplement I
- Reid, Prof. G.W. & Discenza, R., Prediction Methodology for Suitable Water and Waste Water Processes
- Reid, Prof. G.W. & Muiga, M.I., A Mathematical Model for Predicting Water Demand, Waste Water Disposal and Cost of Water and Waste Water Treatment Systems in Developing Countries
- Reid, Prof. G.W. & Muiga, M.I., Demand and Cost Models for Developing Countries
- Schumacher, E.F., Intermediate Technology - Its Meaning and Purpose
- Spangler, C.D., Developing Low Cost Water Supplies for Small Village
- Tjiook, T.K., The Significance of Developing Countries' Techniques for National Programmes
- University of Oklahoma, Data Requirement