PLAN INTERNATIONAL

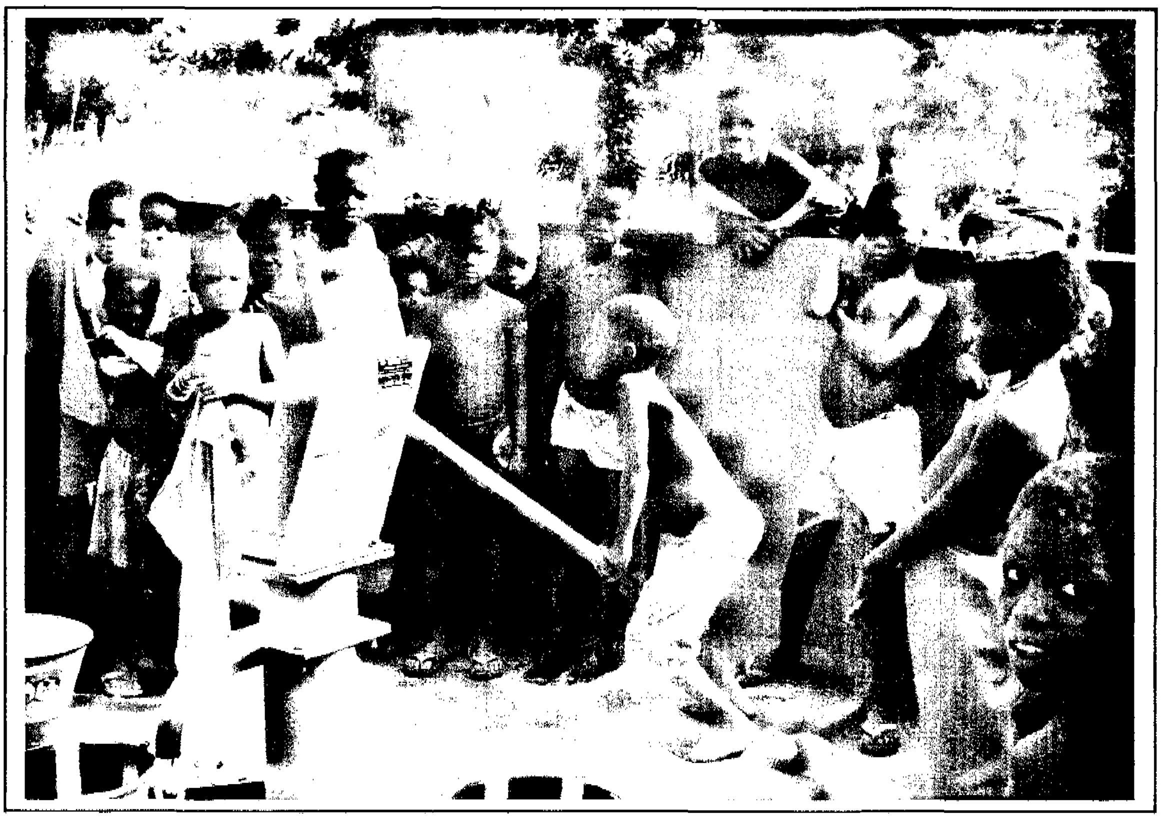
IRC

WEST AFRICA WATER PROGRAM

Evaluation and advisory mission

Final report

Part 3: Background information



CFP Ingénierie

CELLULE DE FORMATION PROFESSIONNELLE A L'INGENIERIE

PLAN INTERNATIONAL

CFPI
Cellule de Formation
Professionnnelle à l'Ingénierie

IRC
International
Water and
Sanitation Centre

WEST AFRICA WATER PROGRAM
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Part 3: Background information

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Introduction

This document represents the third part of the final evaluation report of the PLAN INTERNATIONAL Water Programme in West Africa. It is meant to be used as a reference manual for programme and field staff.

Upon request of the West African Regional Office of PLAN INTERNATIONAL, an evaluation of PLAN INTERNATIONAL's Water Programme in West Africa was made by a team of external consultants composed of professionals from IRC, International Water and Sanitation Centre (Delft, the Netherlands), and professionals from CFPI, Cellule de Formation Professionnelle à l'Ingénierie (Ouagadougou, Burkina Faso).

This evaluation was carried out from the month of October 2000 until January 2001, and focused on four countries out of the eleven that PLAN INTERNATIONAL covers in the Region, namely Burkina Faso, Mali, Senegal and Togo. In each country, were selected six sample communities where in depth studies were made in terms of impact and sustainability. PLAN's approach in each country and region was also evaluated in terms of efficiency and effectiveness. The findings of the six sample communities in each country were validated through triangulation and discussions with local and national major stakeholders.

The evaluation team used a participatory approach and tried to gather the point of views of all major stakeholders involved: a) various social groups of selected communities; b) local / regional / national government counterparts; c) private contractors; d) PLAN staff at all levels. PLAN's staff has been extensively involved in this exercise, from its conception until its final stage. This evaluation has become in a way a learning exercise, where everyone had the opportunity to review and comment on the findings and recommendations of the evaluation, as well as get familiar with the use of participatory methodologies.

Findings

The main lessons learnt from this evaluation exercise are the following:

In general

1. Since the late nineties, PLAN INTERNATIONAL has gradually positioned itself as a development organization and has contributed in raising water accessibility in the Region, and in initiating community and institutional development. However, its profile and sector knowledge could be enhanced with more exposure in the development of national or regional strategies and more experience sharing with other sector organizations.

2. The water supply and sanitation sector is presently going through important new developments worldwide, and the evaluation team has noted a certain isolation of PLAN concerning these new developments. Not enough information circulates from outside and but also within PLAN regional / country offices. PLAN could benefit from more experience exchange and therefore enhance some "cross-pollination".

3. The evaluation team has noted the importance given by PLAN to transparent and administrative procedures which makes it a rather efficient organization, however more attention needs to be given to the effectiveness of its approach, especially in the areas of sustainability, behaviour change, the use of participatory approaches, community development, gender equity, poverty assessment, cost recovery and genuine demand.

At community level

4. Communities participate in the start through their initial request for improved water supply and contribute either financially or in-kind during the construction, however there is not enough community participation in project design, technology choice and basic monitoring. They should be able to make an informed choice out of a range of technical options with full awareness of their technical, maintenance and financial implications, in order to reach a feeling of ownership and awareness on future tasks and responsibilities.

5. Community needs are expressed mainly through the channels of village authorities. It is not sure that the needs of all social groups, young, old, men, women, children, ethnic minority are taken care of in an equitable way, and in that sense not enough participatory diagnosis is carried out. Field staff need to be more exposed to both the knowledge of participatory methodologies and community development, and its application.

6. Although PLAN's interventions have greatly improved water supply coverage in the regions visited, accessibility to improved water supply points does not benefit all members of a same community. As a result some of the community members have to travel distances which can exceed one 1 km, and in some communities the evaluation team has come across whole neighborhoods which were unserved.

7. Water quantity remains a concern especially during dry seasons, not only because of source scarcity but also because of higher frequency of breakdowns due to heavy usage of pumps. Water needs other than for domestic purposes are in most cases only partially met.

8. Water quality could not be measured as such by the evaluation team, but it was noted that water quality monitoring and disinfection is very seldomly practiced. Furthermore, hygiene behavior in terms of water transport and storage is rarely satisfactory.

9. Community management is one the backbone of sustainability of small community water supply. The evaluation team has noted with interest that communities are systematically organized, but the problem of management capacity is not automatically resolved. The more complex the technology, the more management capacity is required. The management set-up for piped systems does not appear to be strong enough.

10. Almost all new committees include women, but rarely with management positions. The team did not come across with an organized strategy concerning gender awareness raising and situation analysis.

11. Long term cost recovery mechanisms are very insufficiently dealt with communities and PLAN's approach in that regard needs to be sharpened. PLAN needs to guide communities more thoroughly in tariff design, and decision-making on type of rates to apply (fixed rates, metered rates, selling of water at consumption). Fees do not cover all costs. Capacity to pay of communities does not seem the main issue, but willingness to pay can, especially if water supply is not satisfactory.

12. There are no major problems concerning construction of water supply systems. However, improvements to be made on technical design.

PLAN's support

13. PLAN has an efficient administrative and financial management system, although sometimes generating some bureaucratic delays.

14. Planning for country programme activities is participatory and the fact that PLAN has PU offices in areas of intervention increases its closeness to field realities. Budget for water and sanitation reaches from 20 to 30% of total budget, which shows the importance given to it. However, budget allocations for sanitation is still quite low, and more synergies could be sought with other programmes (such as health and education).

15. The new "faire faire" philosophy and partnership approach which PLAN has adopted has helped to move from a role of implementor to the one of a facilitator, thus using more local and national capacities in the design and implementation of projects. PLAN is considered by local and national partners as a reliable and serious partner. However, what will happen once PLAN leaves the area? Local and national institutions, who are mainly involved in construction activities with PLAN, do not have, in most cases, the capacity to follow-up in order to support communities in a sustainable way.

16. PLAN enjoys a quite unique situation of closeness to field realities because of the proximity of Programme Units to the areas of intervention, and especially because of the long term (15 years or more) direct relationships that Community development agents (ADCs) have with villages. However, PLAN is not taking enough benefit from this situation, as ADCs are more engaged in "sponsorship" activities than development work. Furthermore, this situation could have given the opportunity to organize an effective monitoring system and follow-up support.

17. IEC activities, although numerous and varied in terms of communication means, have not always systematically generated the expected changes of hygiene behaviour at community level. A revision of some of the messages, approaches and tools used could be necessary.

18. Not enough synergies are used between the development of water, hygiene and sanitation in schools and dispensaries and community development.

19. Training of committee members is done in most of the country visited, but not all. When this is done, there is a lack of follow-up on additional training needs a community might have. The training is often done after the construction or the rehabilitation of the services that could be a constraint for its impact. No follow up is done from the part of PLAN as part of an on the job training exercise.

20. Children benefit from the improvement of water supply services but the opinions and specific needs of children are insufficiently considered.

21. Country strategy plans need to spell out more systematically the ways and means of achieving sustainability, and include indicators that can monitor it. Despite the fact that new development concepts have been integrated in PLAN's documents, changes are required in the way sector professionals think, work and interact with communities, and this is maybe one of the greatest challenge PLAN has to face today.

Recommendations

The evaluation team wishes therefore to formulate as a global recommendation to improve the effectiveness of PLAN's approach and to optimize its operational efficiency.

Imprc 'ement of PLAN's effectiveness

The evaluation team recommends that PLAN INTERNATIONAL reviews and consolidates, at regional level and in each of the country visited during this evaluation exercise, seven main issues, that are key to sustainable water supply development, in order to improve the effectiveness of its approach. The evaluation team would also like to stress the point that community participation is a key principle of rural sustainable water supply. This means that communities should be involved in all phases of the project cycle, as experience shows that this can generate an ownership feeling. The seven key issues are the following (specific recommendations regarding these issues are spelt out in the document):

1. Equity, gender and demand
2. Technology choice
3. Water quality
4. Community management and cost recovery
5. Participatory monitoring
6. Behavioural change
7. Integration of water supply and water resource management

The evaluation team has observed during its mission that sanitation and hygiene related activities were taking place, but a specific impact and appropriateness study needs to be done on these issues, as they were not part of the terms of references of this exercise. The team therefore recommends to proceed with an assessment of the existing situation regarding the appropriateness of the approach used for the improvement of sanitation services and behavioural change (at domestic and school levels), as well as the effectiveness of the means, budget and tools used.

Optimizing PLAN's operational efficiency

The evaluation team recommends to consolidate seven main aspects of PLAN's support, that are key to sustainable water supply development, in order to optimize its operational efficiency. The seven aspects are the following (each of these aspects are detailed in the main report):

1. Upgrade skills and knowledge of staff on sustainability and participatory approach
2. Clarify and define ADCs roles
3. Specify roles of water and sanitation advisors
4. Consolidate monitoring and follow-up aspects
5. Develop institutional capacity building activities
6. Review IEC and training activities
7. Improve integration of water, hygiene and sanitation

Finally, the evaluation team proposes a plan of action regarding capacity building of PLAN's staff in the whole region of West Africa, mainly on sustainability issues, technology choice, participatory techniques, monitoring, working and planning with communities and general project management.

1. Field guide used for the evaluation

1.1 Introduction

The methodology which has been used for the participatory evaluation of the "Water" programmes of PLAN West Africa has been especially developed for this evaluation and is building on earlier experiences evaluating the demand responsiveness, gender and poverty approach of programmes and the sustainability of the constructed water supply services. The evaluation is set up in such a way that it will assess the impact at community level, the approach and the effectiveness of the approach used by PLAN for the implementation of its "water" programmes and the operational aspects.

The basic principle of a participatory approach is that not only the evaluators will be able to assess the situation, but also all involved actors will be enabled to do so. A participatory evaluation is thus, not merely the collection of data and information, but also a tool to provide all actors means to express themselves and generate information as well as to give them insight into their respective situation, which is a first condition for action, if action is needed. Furthermore the use of participatory tools such as pocket voting and community mapping enables the evaluation team to collect relevant and credible information in a short time.

To be able to provide a concrete overview of the impact of PLAN's interventions at community level, this evaluation has combined the use of participatory assessment at community level with more conventional research methods, by scoring the outcomes of the participatory tools sessions on ordinal scales. The scoring will make it possible to carry out both qualitative and quantitative analysis of the data and will enable the team to compare the outcomes of the evaluation in the various countries.

In this guide the tools which have been used by the evaluation teams in the community will be described. The first chapter contains the schedule of the work as will be undertaken in each of the communities visited. In the second chapter the various tools which are used during the evaluation will be described in detail. Attention will be given to the objectives, the process, the information which will emerge during the exercise and the necessary materials. The third chapter will focus on the synthesis of the information. It includes the list of indicators used for this study, on which is indicated which tool is used to collect the information and how each of the indicator is rated. At the end of the chapter the tables will be presented which can be used for registering the information which has been collected in the community.

A ***« community file »*** for each visited community will contain:

- Community data sheet
- School and Health center observation and scoring sheets
- A copy on A4 of the community map as drawn by the community
- Indicators data sheet

1. 2 Programme of a community visit

This programme describes the way how a visit to the community can be organised. When organising such a visit it is important to take into account the time that is necessary for the transport from one community to another.

Day 1 – Morning

Arrival.
Greeting of the local leader and explanation of the programme
Community inventory
Community mapping with a representative group of the community
Making of appointments for the next day
Planning of the transect walks and the visit of the households
Focus group discussion with the Water Point Committee

Day 1 – Afternoon

Transect walk:
- Observations in the community
- Discussion during visit of water points
- Discussions during household visits

Visits of the schools and health centres
Arrangements of the meetings for the next day

Day 2 – Morning

Focus group discussions with the users of the water point using:
- Rope voting
- Card voting
- Ladder
- Pocket voting

Day 2 – Afternoon

Presentation of the findings to the community
Start of the synthesis of the community data
Elaboration of "Community file"

1.3 Tools for the collection of the data

1.3.1 Community Inventory

☛ Objectives
- Introduction of the team and explanation of reasons of visit
- Collection of community data
- Organisation of the meetings with the community groups

☛ **Process**

A first meeting is organised with the local leaders (men and women), the water point committee members and some other important members of the community. At the beginning of the meeting the approach of the evaluation and the programme of the visit are explained and discussed. This is followed by the collection of the basic information on the community for which the list of issues that need to be discussed can be found below.

☛ **Information to emerge**

- Ethnic groups in the community
- Number of inhabitants of the community
- Number of neighbourhoods and their names
- The predominant economic activities of the community
- The level of education in the community
- The period of the dry and the wet season
- The first year of intervention of PLAN in the community
- Information on other projects which have programs in the community
- The number of water points (private/public) and the type of technology / neighbourhoods
- Information on the water points constructed / rehabilitated by PLAN
- Quantity of water in general in the community (very little water; poor; medium; good)
- Water treatment
- The availability of assistance from PLAN, and the kind of assistance which is available

☛ **Material**

- Guide with the questions. Note book

1.3.2 Community map

☛ **Objective**

- To learn about the community's situation with regards to all water supply and sanitation facilities

☛ **Process**

The facilitator explains the purpose of the exercise and starts a discussion with the community group with the purpose of developing a basic list of features that should be indicated on the map. These could include roads, lanes, paths and homes; major land marks such as forests, hills, crop fields, schools and mosques, churches, all water sources, both natural and constructed, all public sanitation facilities and households with private latrines, homes of men and women whose work includes the provision or maintenance of water supply and sanitation services or women who have received training of any kind. To make the exercise easier the facilitator can ask the group to make a legend. Depending on the size of the group this exercise can be done in-groups of men and women, jointly or separately.

If the drawing was done in the soil, transfer and copy the map onto paper. Leave one copy in the community, and keep a second copy with the other assessment data for later aggregation of data.

The team will use the map for further reference, particularly in planning the route for the transect walks, the water points and the neighbourhoods that need be visited, in order to include neighbourhoods, which are served by water points, as well as neighbourhoods, which are not served.

☛ **Information to emerge**

- General lay out of the community (roads, neighbourhoods, infrastructures)
- Number, type and location of all water sources
- Households and areas, which do not have easy access to any type of improved water sources
- Location of the PLAN and non-PLAN households

- □ The number of households which have no access to latrines
- □ Homes of community members with roles in providing and maintaining water supply and sanitation services and of members which have received training for the construction or maintenance of services

☛ Material

- A4 papers. Big sheets – such as brown packing paper, if the map is not made on the ground. Markers, pencils. Note book. Guide with the list of information that needs to emerge. Local available materials such as twigs, leaves, dust, sand, chalk or match sticks.

1.3.3 Transect walks in the community

☛ Objectives

- To determine the general condition in the community with regard to the conditions of the private and public water supply and sanitation services as well as the hygiene conditions in the community and the households
- To cross check some of the information on the community map

☛ Process

This activity is carried out with a group of men and women representing the water point committee and one each from the various neighbourhoods. The transect walks are planned using the community map. They are planned in such a way that areas with disadvantageous and advantages households as well households which are in areas which are served and which are not served by an improved water supply are visited. During the transect walk different households and water points are visited. During the household visits the hygiene conditions, the water storage and the presence, use and conditions of the latrines are assessed. During the visits to the water points, the team observes the quality of the design and the construction, and the protection of the water point. People who are met are asked to give their opinion about various aspects related to the water supply in their neighbourhood.

☛ Information to emerge

<u>Visiting the water points:</u>

- □ Risk of contamination of the water trough human, animal or chemical waste
- □ The protection of the source
- □ The functioning of the system
- □ The quality of the construction
- □ The quality of the design (from an engineering point of view)
- □ The presence of a drainage system for waste water
- □ The extension capacity of the system
- □ The water treatment

<u>Visiting the households :</u>

- □ The general state of the latrines
- □ The water storage
- □ The water drawing
- □ The water transport

☛ Material

- Guide. Notebook.

1.3.4 Visits of the schools and health centres

☛ Objectives

- To assess the conditions of the water and sanitation services at the schools and the health centres
- To assess the opinions of the children with regard to the interventions of PLAN in the community

Process
During the visits to the schools and the health centres, the team will visit the latrines and the water points, which serve the schools and the health centres. When possible a discussion can be held with the children on the interventions of PLAN. The teachers and the head master will be asked whether hygiene education is part of the curriculum and if this is the case, the team members can ask to view the available hygiene educational materials. With the personnel of the health centres, the general hygiene situation will discuss as well as the prevalent diseases.

Information to emerge
- State, hygiene and functioning of the water points
- Number, state, hygiene and use of latrines at schools and health centres
- Indicate whether hygiene education is thought at school level or not, and whether materials are available or not.

Materials
- Guide. Notebook.

1.3.5 Focussed discussion with management/water point committee

Objectives
- To collect information on the management of the water point(s)
- To revise the account books of the committee and all other documents which are available

Process
At the start of the meeting the team explains the reason of the visit and the approach and method which will be used during the evaluation. After this introduction the team leader asks various questions and starts a discussion with the committee about the management of the water point, their problems and successes. During this discussion the team can make use of the list, which can be found below and which indicates information which should emerge from the discussion. At the end of the discussion the team-leader will ask if the team can see the account books of the committee and if available all other documents which are kept by the committee.

Information to emerge
- Composition of the committee (women – men), and the roles of each of the committee members
- The contribution in kind and in cash which have been made at the start of the programme
- The control and monitoring of contributions which have been made at the start
- The control of the users and the committee on the design and the construction
- The training and who has been trained
- The payment system
- The monitoring and the control of the payment system
- The number of users paying
- The frequency and the length of break downs and who is responsible to organise repairs
- The procedures which will be followed in case of a break down
- The calculation of the budget and the cost which are included
- The legal status of the committee
- The maintenance
- The treatment of water
- The selling of water
- The control and monitoring of the water quality

Materials
- Guide. Notebook

1.3.6 Focussed group discussions with community groups

For the focus group discussion with community groups, various participatory tools are used such as rope voting, pocket voting, card voting and the ladder exercise. After the exercise the team members start a focus discussion by asking questions which have the purpose to better understand the results which have been gathered with the tools. So the questions to be asked should provoke answers that explain the why of the results of the exercises and the specific problems. All these exercises are preferably done in separate groups for men and women.

Rope voting

Objectives
- To assess the satisfaction with various aspects of the water supply services

Process
One team member explains the objective of the exercise using a rope. The purpose of the exercise is to assess the satisfaction of the users with regard to the water quantity, which is delivered by the system in the different seasons, the water quality, the control of the water quality, and their satisfaction of the management of the system.
During the explanation of the exercise the team member will explain that the ends are marked with two symbols, a smiling face indicating "all satisfied" and a sad face indicating "not satisfied at all". The mid point and the quarter points are also marked to indicate it is a continuum.
After this, the team member introduces the concept which is being assessed and asks all the participants to take a position somewhere on the rope, which reflects his or her satisfaction. The team members record the position of all the participants. This is followed by a short focus discussion during which the participants will be asked questions, which will help the team to better understand the results, which have been gathered with the tool.

Information to emerge
- The degree of satisfaction on the quantity of the water in the different seasons and in general
- The degree of satisfaction on the quantity of the water point
- The degree of satisfaction on the on the functioning of the system
- The degree of satisfaction with the design of the water point
- The degree of satisfaction with the quality of the water in different seasons
- The degree of satisfaction on the management of the system

Materials
- Rope. Tape. Note book and guide. Papers. Markers.

Card voting

Objective
- To identify who have been involved in the important decisions, which have been taken with regard to the water supply services

Process
A member of the team explains that with this tool the team would like to identify how many people have been involved in the decision taking with regard to the design and the management of the water supply service. Every participants receives two cards of different colours, one which is representing that the person felt he or she was consulted and involved in making a decision and the other represents that the persons was not involved or consulted. With this tool information will be gathered on how many people have been involved in the process of initiating the project, the choice of location, the choice of technology, the system of cost recovery and the organisation of the management. This is followed by a short focus discussion during which the participants will be asked questions, which will help the team to better understand the results, which have been gathered with the tool.

Information to emerge
- Who has initiated the project?
- Who has been consulted involved in:
- The choice of the location
- The choice of technology
- The choice of the cost recovery system
- The choice of the organisation of the management

Materials
- A5 and A4 papers of different colours. Markers. Notebook

Scale of perceived benefits

Objective
- To assess the perceived benefits and to rate them according to its importance

Process
Asking the group to identify the various benefits from the water supply service starts the discussion. The answers are noted on cards in form of drawings or symbols, which illustrate the benefit in such a way that every one understands all the cards. Once the group feels they have listed all the benefits, they are invited to prioritize the benefits in order of importance. After the prioritization the group receives 100 small stones or seeds which will have to be divided by the group over the various benefits in such a way that the number of beans which are next to a picture represents the importance of that benefit compared to the others. This is followed by a short focus discussion during which the participants will be asked questions, which will help the team to better understand the results, which have been gathered with the tool.

Information to emerge

- The perceived benefits
- The weight of the various benefits

Materials
- A4 papers of various colors
- Makers
- 100 beans or small stones
- Notebook

Pocket voting

Objective
- To identify the behavior of the community members with regard to the use of water sources

Process
On the back of a cloth or on a car the team members affirm small drawings in a matrix form. The drawings characterize the range of local water sources in the community and a picture on which

water is used for drinking purposes. The water sources are listed in a horizontal row and picture depicting drinking in a vertical row. Each cell in the matrix gets an envelope. Each participant gets one slip for voting. The team member explains what the drawings represent and how the activity will be done. For the voting each participant goes behind the voting screen and selects the source he or she is using for drinking purposes. When all the participants have been able to vote one of the team members counts the votes and registers them. This is followed by a short focus discussion during which the participants will be asked questions, which will help the team to better understand the results, which have been gathered with the tool.

☛ **Information to emerge**
- The effective use of the water point for drinking purposes

☛ **Materials**
- Envelopes. Tape. 5 papers. Markers. Small bits of coloured paper

1.4 Restitution with the community

☛ **Objectives**
- Presentation of the collected data
- Verification of the data with the community members

☛ **Process**
At the end of the visit to the community a general meeting with the community is organized during which the collected information is presented. During this meeting the team leader will present the results of the research. When a participatory approach has been used, and all the members of the community have been consulted and involved in the process of data collection, it very important to present the results of the research at the end of the visit. After the presentation the community will give the opportunity to react on the results. At the end of the meeting a final discussion can take place ion the sustainability of the services in the community.

1.5 Synthesis of the information

It is proposed to synthesise the information of each community in two formats:

- A table with the indicators for which uses a system of rating.
- With a table containing the general information for each community.

These two synthesis reports, together with a copy of the community map will form the ***« COMMUNITY FILE »***.

Community data sheet

Country: **Community and region :**

Date of visit :

Authorities met :

Ethnic groups in the community

Number of inhabitants

Number of neighbourhoods and their names

The economical activities in the community

The level of education in the community

Dry period in the area

The first year of intervention of PLAN in the community

Information on the other projects which have interventions in the community

The quantity of water in general in the community

(very little ; poor; medium ; good)

treatment of the water?

Availability of support (PLAN or others)

(none ; sporadic; occasional (specify) ; regular)

Neighbourhood	Water point / year – PLAN – others	Functioning	Observations - construction/ sanitation /rehabilitation/hygiene

- General hygiene in the community (sanitary risk; poor; medium, good)
  (latrines, usage of latrines, waste disposal in the community, prevalent diseases….)

Village data						
Region						
Population						
Predominant economic activity						
Social cohesion within village						
N. of neighborhoods						
N. of improved wells (general/**PLAN**)						
N. of well equipped with pump (general / **PLAN**)						
N. of boreholes (general / **PLAN**)						
Family latrines						
First contact with PLAN						
Total PLAN waterpoints						
Water quantity dry season (in general)						
Water quantity wet season (in general)						
Water treatment						
General community environmental hygiene						
Mention of possible water-related diseases						
School						
N. of teachers / N.students / N.classrooms						
Accessibility of water						
N. facility for washing hands						
N. of latrines (teachers / girls / boys)						
Type of latrines						
General state of latrines						
Hygiene education done						
Availability of hygiene education material						
Training of teachers by PLAN on hygiene educ.						
Health dispensary						

Type of center Availability of water N. of latrines Type of latrines					
General state of latrines					
Indicators					
Type of technology evaluated					
A. Sustainability					
A.1 Technical quality					
A.1.1 Quality of design					
A.1.2 Quality of construction					
A.1.3 Extension capacity					
A.1.4 Water testing (source)					
A.2 Effective functioning					
A.2.1 Protection of source					
A.2.2 Functioning					
A.2.3 Water quality monitoring					
A.2.4 Water quantity dry season (men / women)					
A.2.5 Water quantity wet season (men / women)					
A.2.6 Continuity of service					
A.2.7 Absence of leakages					
A.3 Sustainable financing					
A.3.1 Users paying					
A.3.2 Payments covering all costs					
A.3.3 Payment system					
A.4 Effective management and O&M					
A.4.1 Account books					
A.4.2 Control of funds					
A.4.3 Legal status?					

A.4.4 Breakdowns					
A.4.5 Timeliness of repair					
A.5 Effective and hygienic use					
A.5.1 Usage for drinking in % (men/women/children)					
A.5.2 Cleanliness of surroundings					
A.5.3 Hygiene water transport					
A.5.4 Hygiene water storage					
A.6 User satisfaction					
A.6.1 Satisfaction on management (men/women)					
A.6.2 Satisfaction on functioning (men/women)					
A.6.3 Satisfaction water quality (men/women)					
B. Demand					
B.1 Effective demand					
B.1.1 Initial financial contribution					
B.1.2 Contribution in kind					
B.1.3 Community initiated project?					
B.2 Community decision on					
B.2.1 Organization of management					
B.2.2 Site location					
B.2.3 Cost recovery system					
C. Equity					
C.1 Gender approach at start					
C.1.2 Initial women needs assessed					
C.1.2 Initial men needs assessed					
C.1.3 Initial children needs assessed					
C.2 Gender approach in management					
C.2.1 % of females in committee					
C.2.2 Management roles of women					
C.3 Poverty assessment					
D. Community participation					
D.1 In project design					

D.2 In small repairs					
D.3 In preventive maintenance					
D.4 In monitoring					
D.5 Committee empowered (training)					
E. Support and external factors					
E.1 Availability of spare parts					
E.2 Availability of expertise					
E.2.1 Availability technical assistance					
E.2.2 Training of local artisans by PLAN					
E.2.3 IEC by PLAN					

Information sheet with explanation on the rating of indicators and the tools used

Village data	**Rates - weights**					**Tools used in communities**
Region						
Population						Discussion with local leaders
Predominant economic activity						Discussion with local leaders
Social cohesion within village						Discussion with local leaders
N. of neighborhoods						Community map+discussion
N. of improved wells (general / **PLAN**)						Community map+discussion
N. of well equipped with pump (general / **PLAN**)						Community map+discussion
N. of boreholes (general / **PLAN**)						Community map+discussion
Family latrines	no use of latrines	use of latrines				Transect walks
First contact with PLAN						Discussion with local leaders
Total PLAN waterpoints						Community map+discussion
Water quantity dry season (in general)	0% no water	35% poor	65% medium	100% good		Community map+rope exercise
Water quantity wet season (in general)	0% no water	35% poor	65% medium	100% good		Community map+rope exercise
Water treatment	at start	yes	no			Discussion with local leaders+WPC
General community environmental hygiene	0% sanitary risk	35% poor	65% medium	100% good		Transect walks
Mention of possible water-related diseases						Health centers and discussions
School						
N. of teachers / N.students / N.classrooms						Visit school and latrines and
Accessibility of water	0% no water	50% a bit far	100% accessible			discussion with the teachers
N. facility for washing hands	0% no facilities	100% facil. available				and with some of the students
N. of latrines (teachers / girls / boys)						
Type of latrines						
General state of latrines	0% sanitary risk	35% poor	65% medium	100% good		
Hygiene education done	no	yes				
Availability of hygiene education material	no	yes				
Training of teachers by PLAN on hygiene educ.	no	yes				
Health dispensary						
Type of center						Visit the health centers and latrines
Availability of water	0% no water	50% a bit far	100% accessible			and discussions with personnel
N. of latrines						

Type of latrines						
General state of latrines	0% sanitary risk	35% poor	65% medium	100% good		
Indicators						
Type of technology evaluated						
A. Sustainability						
A.1 Technical quality						
A.1.1 Quality of design	0% > 6 faults	25% 4-5 faults	50% 3-4 faults	75% 1-2 faults	100% 0 faults	Transect walk+discussion with users
A.1.2 Quality of construction	0% > 6 faults	25% 4-5 faults	50% 3-4 faults	75% 1-2 faults	100% 0 faults	Transect walk+discussion with users
A.1.3 Extension capacity	0% not possible	35% poor	65% medium	100% good		Transect walk
A.1.4 Water testing (source)	0% never done	35% start only	65% irregular	100% regular		Discussion with the WPC
A.2 Effective functioning						
A.2.1 Protection of source	0% no protection	35% poor	65% medium	100% good		Transect walk
A.2.2 Functioning	0% not operational	35% poor	65% medium	100% good		Transect walk
A.2.3 Water quality monitoring	0% never	50% irregular	100% regular			Discussion with the WPC
A.2.4 Water quantity dry season (men / women)	0% no water	35% poor	65% medium	100% good		Rope voting + discussion
A.2.5 Water quantity wet season (men / women)	0% no water	35% poor	65% medium	100% good		Rope voting + discussion
A.2.6 Continuity of service	0% very irregular	35% irregular	65% medium	100% continuous		Rope voting + discussion
A.2.7 Absence of leakages	0% important leakages	35% medium	65% poor leakages	100% no leakages		Transect walk
A.3 Sustainable financing						
A.3.1 Users paying	0% no paying users	35% few paying	65% large number	100% all paying		Discussion with the WPC
A.3.2 Payments covering all costs	0% no cost recovered	35% maintenance	65%	100% full cost recovery		Discussion with the WPC
A.3.3 Payment system	0% no system	50% unique tariff	100% differentiated			Discussion with the WPC
A.4 Effective management and O&M						
A.4.1 Account books	0% non existent	35% poor	65% medium	100% good		Discussion with the WPC+cheking
A.4.2 Control of funds	0% never	50% irregular	100% regular			Discussion with the WPC+cheking
A.4.3 Legal status?	0% no legal status	100% legal status				Discussion with the WPC
A.4.4 Breakdowns	0% very frequently	35% frequently	65% sometimes	100% never		Discussion with users + rope voting
A.4.5 Timeliness of repair	0% after 1 month	35% after a week	65% in a few days	100% within a day		Discussion with users + rope voting
A.5 Effective and hygienic use						
A.5.1 Usage for drinking in % (men/women/children)						Pocket voting+discussion

A.5.2 Cleanliness of surroundings	0% sanitary risk	35% poor	65% medium	100% good		Transect walk
A.5.3 Hygiene water transport	0% sanitary risk	35% poor	65% medium	100% good		Transect walk
A.5.4 Hygiene water storage	0% sanitary risk	35% poor	65% medium	100% good		Transect walk
A.6 User satisfaction						
A.6.1 Satisfaction on management (men/women)	0% not satisfied	35% partly satisfied	65% satisfied	100% very satisfied		Rope voting + discussion
A.6.2 Satisfaction on functioning (men/women)	0% not satisfied	35% partly satisfied	65% satisfied	100% very satisfied		Rope voting + discussion
A.6.3 Satisfaction water quality (men/women)	0% not satisfied	35% partly satisfied	65% satisfied	100% very satisfied		Rope voting + discussion
B. Demand						
B.1 Effective demand						
B.1.1 Initial financial contribution	0% no contribution	100% contributed				Card voting and discussion
B.1.2 Contribution in kind	0% no contribution	100% contributed				Card voting and discussion
B.1.3 Community initiated project?	0% PLAN	35% PLAN+leaders	65% PLAN+men	100% Comm.+PLAN		Card voting and discussion
B.2 Community decision on						
B.2.1 Organization of management	0% PLAN	35% PLAN+leaders	65% PLAN+men	100% Comm.+PLAN		Card voting and discussion
B.2.2 Site location	0% PLAN	35% PLAN+leaders	65% PLAN+men	100% Comm.+PLAN		Card voting and discussion
B.2.3 Cost recovery system	0% PLAN	35% PLAN+leaders	65% PLAN+men	100% Comm.+PLAN		Card voting and discussion
C. Equity						
C.1 Gender approach at start						
C.1.2 Initial women needs assessed	0% not assessed	50% partially	100% assessed			Card voting and discussion
C.1.2 Initial men needs assessed	0% not assessed	50% partially	100% assessed			Card voting and discussion
C.1.3 Initial children needs assessed	0% not assessed	50% partially	100% assessed			Card voting and discussion
C.2 Gender approach in management						
C.2.1 % of females in committee	proportion in %					Discussion with the WPC
C.2.2 Management roles of women	management roles:	(vice) president	(vice) secretary	(vice) treasurer		Discussion with the WPC
C.3 Poverty assessment	***0% not done***	***100% done***				
D. Community participation						
D.1 In project design	0% no participation	50% partial	100% full participation			Card voting and discussion
D.2 In small repairs	0% not by community	50% partially by com.	100% by community			Card voting and discussion
D.3 In preventive maintenance	0% not by community	50% partially by com.	100% by community			Card voting and discussion

D.4 In monitoring	0% not by community	50% partially by com.	100% by community			Card voting and discussion
D.5 Committee empowered (training)	0% no	50% certain members	100% all members			Discussion with the WP
E. Support and external factors						
E.1 Availability of spare parts	0% not accessible	35% difficult	65% accessible	100% easily accessible		Discussion with the WP
E.2 Availability of expertise	0% not accessible	35% difficult	65% accessible	100% easily accessible		Discussion with the WP
E.2.1 Availability technical assistance	0% not accessible	35% difficult	65% accessible	100% easily accessible		Discussion with the WP
E.2.2 Training of local artisans by PLAN	no	yes				Discussion with the WP
E.2.3 IEC by PLAN	no	yes				Discussion with the WP

2. Behavioural change

"Testing matrix" for behavioural change[1]

Criteria for evaluating likelihood of behavioural change

Health impact of behaviour change	Complexity of behaviour change	Consequences on health of behaviour change
0. No impact on health 1. Minor impact 2. Some impact 3. Significant impact 4. Very significant impact 5. Eliminates the problem	0. Unrealistic 1. Involves too many actions 2. Involve many actions 3. Involves few actions 4. Involves two actions 5. Involves one action	0. No consequences 1. Little consequences 2. Some consequences 3. Significant consequences 4. Major consequences 5. Consequences guaranteed
Frequency of behaviour	**Cost and effort of engaging behaviour change**	**Persistence needed to induce behavioural change**
0. Too cumbersome 1. Must be done hourly 2. Must be done once a day 3. May be done every few days 4. May be done once a week 5. May be done occasionally	0. Unrealistic 1. Requires important resources and effort 2. Requires significant resources and effort 3. Requires some resources and effort 4. Few resources or effort 5. Requires only existing resources	0. Unrealistic 1. Requires compliance for several weeks 2. Compliance for a week 3. Compliance for several days 4. Compliance for a day 5. Very brief compliance
Compatibility with existing activities	**Observability**	**Similar practices**
0. Totally incompatible 1. Significantly incompatible 2. Some incompatibility 3. Little incompatibility 4. Easy to incorporate in existing activities 5. Type of activity already widely practiced	0. Cannot be observed by an outsider 1. Very difficult to obverse 2. Difficult to observe 3. Is observable with attention 4. Observable 5. Cannot be missed	0. Nothing like this is done 1. Slightly similar 2. Existing practice similar 3. Several similar practices 4. Many similar practices 5. Similar practices widely existing

For each proposed behavioural change, score 0 to 5 for each of the nine boxes. Aggregate the total score for each behavioural change. If the score is less than 20, it is highly unlikely that the audience will make the change. Different goals must be set. If the score is over 36, it is highly likely that the goal will be achieved.

[1] From Motivating behaviour change (UNICEF – IRC)

3. Key aspects of gender analysis[2]

3.1 Elements for a gender analysis

When dealing with gender the main issues are how work, control and benefits are divided between women and men of different classes and age groups. For the formulation, assessment and review of policies, projects and programmes, the following six questions may form the basis for the analysis of gender in water resources development and management:

1. *How are men and women using the resource and for what purpose(s)?*
2. *How are contributions (labour, time, payments, and contributions in kind) to the development and management of water resources divided between men and women?*
3. *Who makes the decisions and controls their implementation, at the various levels?*
4. *Who gets the project or programme resources, such as jobs and training?*
5. *To whom go the benefits and the control over these benefits, such as status, water, products produced with this water, income resulting from products and functions and decisions on how this income is used?*
6. *How is the division of these attributes among women and among men of different wealth, age, and religious and ethic divisions? In other words: do some women and men benefit more than others?*

Indicators for developing and assessing such a gender approach are the division, between men and women, rich and poor, of the access to information; the contributions to implementation and management; the decision-making power; the share in project resources and benefits; and the control over these benefits. A gender approach analyses current gender divisions and strives for a more balanced division between men and women of different ages, marital and socio-economic status in terms of: a) *the access to information; b) the amount of physical work; c) the division of contributions in time and cash; d) the degree of decision making; e) the access to resources and benefits: water, training, jobs, income; f) the control over these resources and benefits.*

Men and women in community-managed services

In the past it has been quite uncommon to see both women and men on organizations that manage improved domestic water supply services. This is now rapidly changing. Female members of local management organizations are the result of appointments by local leaders or interventions by the programme agencies. Alternatively they are chosen by the men and women in the communities themselves. Reported experience suggest that the latter is more effective than the former. When the Gujarat Water Supply and Sewerage Board sent a government order to the formal village leaders that they should select women on the water committees, many of the women were only members on paper. The leader had passed their house and taken their name and thumbprint on an official paper, but they did not know what exactly they were supposed to do and had never taken part in any management activities.

Where water committee members are chosen by their fellow men and women, formal barriers may impede the election of women. Because board members are usually chosen from association members, excellent women candidates who are not heads of household have been excluded. Both water supply and irrigation user associations in the Philippines had almost no women in decision making and managing functions, because only heads of household were

[2] Extracts taken from « Gender revisited », by Christine van Wijk. 1999. TP 33-E. IRC, Delft, The Netherlands.

permitted to be members of user associations. Individual membership of user associations for male and female heads of households gives women a better guarantee of a voice in collective decisions and ensures that both men and women contribute to the service. As one woman in a Mexican user association stated: 'Sometimes I think one way and my husband thinks differently. But both votes count'.

The effects of female participation in management on the women and men in communities are manifold. Recognition of women's management tasks and training for new tasks and skills have increased their status and self-confidence. Women in Visayayas in the Philippines reported that their views are increasingly met with respect and their needs met with regard to time of meetings, design of water supply and design of latrines. They now believe that they can really contribute something for the good of the community and be 'partners in progress' and not be 'for decorative purposes only'. Some believe they are no longer subordinate to the men. Male and female leaders welcome their participation because women have a role in development and they need the women's capacities, though sometimes limited to traditional female roles.

In a project in Indonesia women grew in knowledge, self-confidence and leadership and autonomous management of water systems increased. Special training gave female committee members in Malawi the confidence to take management decisions themselves. The committees with more women also managed a higher latrine coverage (896 latrines or 95 percent coverage), of which 68 percent were 'in satisfactory condition'. Under male leadership the result was 632 latrines or 67 percent coverage and 43 percent 'in satisfactory condition'. Other effects of the gender strategy were: more connections, better payment and management of payments and less water wastage and poor drainage at the communal waterpoints. There were, however, also negative effects: more tension between men and women and withdrawal of the men from their shared responsibility for a community water supply. In New Delhi, 'many of the men eventually became reconciled to the participation of women inside or outside the project areas, and the women developed feelings of self-reliance.... Attitudes of older women changed to some extent, particularly in allowing their daughters and daughters-in-law to leave their houses to participate...'.

On the other hand, women still tend to take part in management only at the very lowest level, for example in tap and village committees. At the higher level, representatives are generally men. It is at this level that the more important management decisions are made, for example in a Sri Lanka programme. Similarly, in Bhutan and Zimbabwe the district and ward committees in which the main decisions are made are exclusively male. Relegation of women to the lowest levels was not the case in an urban project in New Delhi which used layered representation. Women chose their own representative at the quarter and neighbourhood level. The levels consisted of 15 to 100 families and 250-400 families. Representatives from these levels were for the first time invited to civic functions and became members of neighbourhood councils which managed projects for 1,500 to 4,000 families. Two-third of these women attended higher level meetings occasionally and one-fifth regular.

Sometimes, agencies promote the management of water supplies exclusively by women and do not address male responsibilities and tasks. It also occurs that project agencies pay so much attention to women's, as compared to men's involvement, that the service comes to be seen as a women's project, for which only the women are responsible. Women's groups that build rainwater collection reservoirs at their members' houses also tend to finance these facilities single-handedly, for example in Kenya, Tonga and the Philippines. In such cases projects cause women to carry the burden of a community water supply from which also male household members profit, irrespective of women's higher workload and lower resources. The decision to do it alone may, however, also stem from necessity or choice. In her analysis of 24 women's groups that build rainwater tanks in Kenya, Wacher found that half of the members were single parents and that the women feared to lose control when they were no longer solely in charge of all tasks. Reporting on her experiences, Kavita, reports how women were only prepared to bring in the men when they felt they had enough skills and confidence. 'After about ten years of separate training and activities, the women felt that men should be equally involved. "What about our husbands?" they asked. "If we had been getting the training together with our men, we could have been sharing ideas, plans and development activities in our villages".

There are other cases where only women manage a water supply service. Women's organizations in low-income neighbourhoods in the capitals of Honduras and Kenya buy water in bulk from the town water supply and sell it through vending points to the households. Although here, too, the women do not get support from the men, the difference is that the services bring them financial profit which they control themselves. In Nairobi, Kenya, the women use the water for beer brewing and tea stalls and depend no longer on private kioskholders who charge high prices. Women at the Kenyan coast use water and time gains for economic projects and use an unknown share of the profit to maintain the pump. In Honduras, the costs of ten litres of water became fixed at 10 cents while in the past private vendors had charged as much as 35 to 50 cents during the dry season.

3.2 Ways to overcome constraints to women's participation

Activity	*Mechanism*
Project initiation	Programmes establish contacts with male leadership to understand and support also participation of women
Information and dialogue	Programmes use information channels and materials that reach also women
Meetings	Programmes facilitate women to participate and speak out in project meetings: • suitable time and place • awareness of meeting and invitation to attend • appropriate seating arrangements (not at the back) • facilitation of speaking out (vernacular language, discussion breaks, choosing spokeswoman, etc.) • separate meeting with women where necessary
Planning	Water and sanitation projects are linked to economic and educational development programmes, so that women can make developmental use of water and timegains and get new meeting and learning opportunities when traditional meeting and learning opportunities are reduced
Decision making	Programmes enable also women to participate in informed choices on: • caretakers and mechanics • committee members • design and location of facilities • local management arrangements • local financing system
Representation	Women choose their own representatives for trust, ease of contact, leadership capacity, feasibility (time and family support)
Management	Programmes build on traditional tasks, skills and knowledge of women for new roles in water supply, sanitation and water management (without excluding men): • management of water, waste and soil use • maintenance and repair of water points • hygiene education with fellow women • construction of latrines and monitoring their maintenance and use • management of funds
Training	Also women are trained for technical and managerial tasks Programme staff and management are aware of reasons and trained on practicalities of equivalent participation of women and men

4. Working and planning with communities[3]

4.1 Key elements

One of the first tasks that a manager or a group of persons is faced with, while working with communities, is to understand and assess what is the present situation. There are many different ways to go about this. One can read reports and studies which have been written on a particular project; one can hold a series of professional staff meetings, and ask staff about their perception of a situation; or one can make field visits in order to visualize a situation.

However, experience shows that good plans are based on a participatory assessment or evaluation of a situation; they reflect better field realities and are a way to involve communities right from the start in future responsibilities.

People do not always have the same perception and vision of a problem, since they belong to different cultures and have different priorities in their working or living environments. Participatory planning is based on reaching a common understanding of problems. It is simple, democratic and motivating. It allows a group of professionals at different levels, from different departments, or sectors, together with community members and users in reaching a common consensus about a situation.

Key characteristics of the demand responsive approach

(a) community members can make informed choices about: whether to participate in the project; technological and service level options based on their willingness to pay and on the principle that more expensive systems cost more; when and how their services are delivered; how funds are managed and accounted for; and how their services are operated and maintained;

(b) the government plays a facilitating role, sets clear national policies and strategies, encourages broad stakeholder consultations, and facilitates capacity building and learning; and

(c) an enabling environment is created for the participation of a wide range of providers of goods, services and technical assistance to communities, including the private sector and NGOs;

(d) an adequate flow of information is provided to the community, and procedures are adopted that will facilitate collective decisions within the community and between the community and other actors (social intermediation).

Source: Community Water Supply and Sanitation Conference, World Bank/UNDP/World Bank Water and Sanitation Group, May 1998

The process of community diagnosis

The question of whether a community diagnosis is to be carried out in a participatory way can be looked at from two perspectives: pragmatic and ethical.Pragmatic considerations include how much time is available for the diagnosis, the skills of the staff, how many communities are to be 'covered', as well as the type of information that is needed and how detailed and

[3] Extracts taken from « Management of Operation and Maintenance of rural water supply and sanitation – A TrainingGuide for Planners and Managers » prepared by François Brikké, IRC, WHO, Geneva. 2000.

reliable that information needs to be. Ethical considerations include whether the community members want a diagnosis to be done, and if so, who will decide which areas should be explored, who will make the observations, who will conduct interviews and with whom, and who will determine how the information will be used.

A community diagnosis seeks to gather information that will be used as the basis for planning and implementing development activities, and to prepare people for action. The assessment will include issues such as the roles of men and women in local management, the effects of gender on the efficiency and use of water supplies, environmental concerns such as water source protection and watershed management, and issues of cost recovery and community-based financial management. The outcomes of a community diagnosis provide insights into problems that have negative effects on the management of the water supply system, the local knowledge and resources available to improve the existing situation, and strategies to resolve these problems. Community diagnosis has a number of distinguishable elements:

- building and maintaining rapport;
- establishing a local investigating team;
- collecting general and factual information;
- determining the range of topics of interest for further exploration;
- screening indigenous knowledge and existing management practices for possible application in water supply management;
- collecting detailed information on identified topics: problems, potentials and available resources;
- prioritizing problems, identifying the root causes of problems and establishing selection criteria;
- identifying and selecting potential solutions and possible problem-solving strategies; and
- providing feedback to the community.

Although community diagnosis is often seen as a step in development that has a clear beginning and an end, experience has shown that it is a continuous process, and that it is also iterative: newly revealed facts trigger new questions that require further exploration. Once action to improve a problem situation has begun, the community will probably run into unexplored areas that require renewed or further investigation.

4.2 Professional behaviour of staff working with communities

He or she should preferably be a professional **acquainted with participatory methodologies**. This is because a participatory research is based on using facilitation techniques rather than "conventional" research techniques, although not excluded. Facilitation works best when certain values are accepted and practiced not only by the facilitator, but also by the entire group — values such as **democracy** (each person has the opportunity to participate without prejudice), **responsibility** (each person is responsible for his/her experiences and behaviour), and **cooperation** (the facilitator and participants work together to achieve the same collective goal).

As a facilitator, you can influence the group dynamics and discussions by how you present your information, what kind of atmosphere you set within the group, and your attitudes towards the people you are working with. Many participants will be unfamiliar with facilitation as a leadership style. You should make sure everyone in the group understands what your role is. Your own attitude towards your skills and resources should be a humble one. Demonstrate to the participants that their opinions count, by respecting their ideas as if they were your own.

Communication is the essential ingredient of any group. Your effectiveness as a facilitator depends on your ability to communicate well with the group and to help the group members to communicate effectively with each other. Some factors will enable you to communicate better, such as:

- **Your language** (making sure that the terms you use are easily understood by the group)
- **Your style** (the way you dress and interact with others)
- **The way you listen** (when someone is talking to us, we are often not really listening but thinking about what we are going to say in answer; therefore, when you listen to someone, try not to immediately evaluate what is being said in terms of how it affects you; instead, try to understand what it means from the other person's perspective)
- **Being aware of what is happening in the group** (restlessness, silence, attention, postures)
- **Giving feedback** (after an exercise, a discussion, or a session, it helps the group to be made aware of the progress made).

Your role as a facilitator in a discussion is also important. Here are some hints which could enhance your work in facilitating discussions:

1. Everyone should know exactly **what the discussion is about**, and what is the reason for having it.
2. **Use questions** to stimulate discussion. The following provocative "open" questions enable the facilitator to encourage a group to find ideas in a creative way: "What is similar? What can be changed? Why? How? Who? When? By which means?". Avoid "closed" questions requiring "yes" or "no" answers, which are unsuitable for group discussions.
3. **Prepare questions in advance.**
4. Relate the discussion to the **participant's experience** (it is difficult for people to feel involved in a discussion which is highly abstract or beyond their own experience; give examples from field experiences).
5. **List ideas on a board** as they are proposed, and regroup or summarize them.
6. **Clarify and interpret** (you may sometimes rephrase what has been said to make it clearer).
7. **Keep the discussion focused on the subject** (your role may include reminding the group when the discussion strays off the subject or goes into matters not in the agenda that was agreed on at the beginning).
8. **Keep pace, with awareness of time** (it may be your role to make the group aware of how the discussion is proceeding and when it may be time to move on).
9. **Use humour** to break tension and boredom.

4.3 Overview of tools for planning and working with the community

Tools	Brief description	Advantages / disadvantages
PRA *Participatory Rural Appraisal*	Process used in development programs to help rural communities organize their knowledge, identify and prioritize local development needs an develop long-term action plans; consists in preliminary visits, participatory data collection exercises, participatory analysis and planning.	**Advantages** : full participation of communities right from the start; plans reflect a field reality; establishment of good working relationships and communication lines between authorities and the community. **Disadvantages** : needs to be familiar with participatory techniques; takes time.
Mind mapping	Thought processes are brought together in a spontaneous - associative way. A "map" of landmarks appears, which are classified and organized into a branching arrangement	**Advantages** : Open, expandable; good for vision development, very versatile. **Disadvantages** : global overview, emphasizes linear relationships.
SWOP *(Successes Weaknesses Obstacles Potentials)*	Simple, flexible, versatile working tool for situation analysis in groups. It records positive and negative experiences of participants, as well their assessment of obstacles and potentials in a given situation.	**Advantages** : Easy, can be understood in an intercultural setting. No special material needed. **Disadvantages** : Does not offer concrete solutions, just possibilities.
Brainstorming	Group puts forward as many suggestions as possible about a set theme. The ideas are sorted out, analyzed, evaluated. Classification can be done with "Immediately feasible", or "needs further development"	**Advantages** : Easy, quick; stimulates intuitive and spontaneous thinking. **Disadvantages** : Few suggestions are actually used; effort is often under estimated.
Scenario-writing	Design of alternative views for the future, with labels of "probable", "optimistic" and "pessimistic" options. Can start with a situation analysis, then prognosis analysis and programme phase.	**Advantages** : Suitable for complex, long term problems. Widens the planning horizons; **Disadvantages** : Time intensive; needs good information base.
OOPP *Objective Oriented Project Planning*	Systematic planning method based on teamwork and visualization, and logical analysis. Includes an analysis of participation, problems analysis, objective analysis, choice of alternatives; and project planning matrix.	**Advantages** : promotes mutual understanding of problems; clarifies cause and effect relationships; enables participation of professionals together with beneficiaries; only parts of it can be used, such as the problem analysis **Disadvantages** : Reality only accessible through rational thinking; requires a good facilitator.
Morphological box	Systematic search for alternative solutions. Possible solutions are broken up into elements and the most important characteristic of each element is identified. All these are arranged into a "morphological" box. Combination are drawn between various elements with lines.	**Advantages** : Suitable for clearly defined problems where combinations and variations are important. **Disadvantages** : Less suitable for problems which require high degree of analysis.
Utility value analysis	The situation is presented with various alternatives. Criteria are developed for the acceptation of the project. Each criteria is weighted (W), and each alternative is assessed for each criteria (A) (Ex: 1 to 10). Utility value will be W x A. A final comparative evaluation is done for decision-making.	**Advantages** : qualitative and quantitative assessment of a situation; versatile in its application. **Disadvantages** : Assessment and weighing figures should be documented. Can be difficult to understand for communities
Task chart	Used to organize work procedures, with functions of staff.	**Advantages** : organizational chart, good basis for job description **Disadvantages** : only operational plan, depends on previous analysis.
Bar chart ***(Gantt-chart)***	Used for the chronological planning of tasks, with the individual working steps listed on an activity axis	**Advantages** : graphic and simple. **Disadvantages** : relies on previous analysis. Interconnections difficult.

Flow chart	Describing the sequence of activities and a structured process in the form of an algorithm	**Advantages :** Simple and easy, suitable for routine planning. **Disadvantages :** relies on previous analysis; suitable for s single- ,rocess.
Action research	Above tools can be used, but is included a review of experiences in the field, in a participatory way and over time.	**Advantages :** close to reality, integrates social change dimension, learning on experience; **Disadvantages** : time consuming; need acceptance of participatory results.
Mapping of community	Drawing of a simple map of the community, developed by both women's and men's groups, showing boundaries, water sources, housing infrastructure, roads, etc..	**Advantages :** provides a vision of the community by the community, and updates information; **Disadvantages** : more an information collection tool than planning tool
Village History	Shows on a time line local, national and international events which were important for the community, resulting from discussions with the communities.	**Advantages :** provides information about the community's past experience and problems. **Disadvantages :** needs several sources of information for validity
Transect walk	Description of the natural environment, areas of use and with particular problems or possible opportunities, resulting from a walk with community members	**Advantages :** direct information on surroundings observed and shared with community members. **Disadvantages** : requires afterwards a further analysis.
Trendlines	Provides a brief summary on trends on specific issues (health, water availability, etc...), as a result of small group discussions.	**Advantages :** graphic, visual **Disadvantages** : provides only very general, global information
Problem ranking	Shows key problem identified by the community, and the priority which they attach to having these problems solved	**Advantages :** participatory analysis on values and priorities **Disadvantages :** does not analyze the causes
Venn diagram	Represents groups or institutions in the form of circles (the bigger the circle, the bigger the role). The position of circles to one anoter shows the type of relationship that co-exist between the groups and institutions	**Advantages :** good visualisation and understading of how groups relate to one another **Disadvantages :** subjective and provided only limted information.
Pocket chart voting	Voting on drawings representing specific situations or alternatives	**Advantages** : democratic; expresses desires. **Disadvantages** : requires material & experience

5. Towards sustainable cost recovery[4]

In the light of major present sector trends and past trials, sustainable cost recovery of community water supply is based on seven key factors mutually dependent from one another:

1. **Clear financial arrangements**
2. **Willingness to pay**
3. **Minimizing costs**
4. **Adequate tariff structure**
5. **Access to other sources of financing**
6. **Sound financial management practices**
7. **Enabling and supporting environment**

5.1 Clear Financial arrangements

Cost-sharing arrangements can be organized between the community and local/ national government agency in order to reach a full cost coverage. This will have to be materialized in a formal agreement or contract in which all parties have obligations. Financial responsibilities are very often linked with operational responsibilities, and can be organized as follows [5]:

O&M of handpumps : who is responsible ? (adapted from Wash Report N.93)

O&M tasks	**Operational responsibility**	**Financial responsibility**
Monitoring hand pump use and encourage proper use	Community	Community
Check all nuts and bolts, and tighten if necessary	Community	Community
Check and adjust pump handle and stuffing box	Community	Community
Grease or oil all hinge pins, bearings, or sliding parts	Community	Community
Clean the pump, well head, concrete apron, and drainage area	Community	Community
Check well head, concrete apron, drainage area, repair cracks	Community	Community
Measure output per stroke and compare with expected output	Community	Community
Disassemble pump, check drop pipe, cylinder, leathers, and foot valve. Check corrosion and wear. Repair or replace if necessary.	Community & local mechanic	Community
Conduct other well, handpump or apron repairs if necessary	Community & local mechanic	Community
Repaint handpump periodically, as necessary	Community	Community
Conduct water test for micro-biological contamination	Government	Government
In case of contamination, locate and correct source of contamination, and disinfect	Mechanic or government agency	Community & government
Conduct water level check and well yield test. Adjust cylinder setting if necessary	Government agency	Government
Record all operations and maintenance activities in notebook	Community	Community
Manage a stock of spare parts, tools and supplies on site	Community, local mechanic, private sector and government	
Replace entire handpump when fully worn	Local mechanic, private sector or government agency	Community & government

[4] Extracts taken from « Seven key factors for sustainable cost recovery – in the context of community water supply », by François Brikké and co. IRC Occasional Paper (Draft Version 2000), IRC, Delft, The Netherlands.

[5] Adapted from "Helping communities manage their finance", (1993), WASH Technical Report N.93.

5.2 Willingness to pay

Willingness to pay (WTP) being an explicit dimension of the demand of communities, is also a strong pre-requisite for the financial sustainability of a water supply system. It depends on a series of factors which are exposed below. Furthermore, WTP is a useful yardstick for assessing project feasibility.

Factors influencing willingness to pay (WTP)
Demand and participation of communities A project which is initiated upon a community's request and demand, and in which the community has been involved right from the start, can contribute to a greater WTP.
Service level Evidence suggests that there is a higher WTP for house or yard water supplies; however, this is a broad trend, and there is also evidence to suggest that low income groups are prepared to pay significant amounts for basic service levels
Service standard If a system does not perform consistently and provide an acceptable level of service, WTP is likely to diminish
Perceived benefits WTP is dependent on the benefits to be gained; the extent to which these are perceived by consumers is important. Agencies and communities may not share the same perception of benefits; within communities variations also exist, often linked to who stands to gain more than others. An awareness of these subtle differences in consumer preferences is central to developing a sustainable programme.
Relationship to production Where water use can be linked to productive activities or income-generating activities in particular e.g., garden irrigation, livestock watering, WTP will likely be elevated. Again, the improved supply must be able to deliver this advantage to a greater extent than an existing source.
Level of income Income directly relates to WTP. Where the cost of a water supply exceeds the means of consumers, WTP is a mute issue.
Price The chosen price level is likely to affect consumers' WTP for an improved service or continue with existing supplies. A balance is required between establishing a price that both covers costs and relates to what people are prepared to pay.
Relative costs Consumers may compare the cost of a service to other services, e.g., schooling or power supplies as benchmarks for measuring the relative costs of water supply. If the relative costs are too high for water supply, WTP may be affected.
Opportunity cost of time Is the value attached to time, comparing out to its next best use, e.g., productive activities. The value attached to this time may influence WTP and the extent the improved source of supply may save time. The value attached to time may be perceived differently within communities, and within households (i.e., between men and women). Daily time and physical effort in collecting water can influence WTP.
Characteristics of existing sources Where users consider their existing sources as acceptable, they are unlikely to be willing to pay for an improved service. Variables including perceived quality, reliability of supply, and distance from home will influence the WTP for an improved supply
Reputation of service agency The credibility of a service agency will affect WTP. The service agency (public, private, or community institution) must be able to deliver the expected service
Community cohesion In rural areas in particular, cost recovery may be managed through voluntary contributions to a common fund. Cohesion within the community is essential, but cannot be assumed. Lack of trust or conflict between members may reduce cooperation, irrespective of felt need. Associated factors may extend to collection systems, and tariffs.
Policy environment Policies of providing water in rural areas free of charge or well below cost, may influence WTP since

consumers may equate water services with public assistance. Although these policies are being revised, new policies may not be clearly communicated and applied consistently.
Socio-cultural factors Socio-cultural practices and traditions may vary WTP and will often have location-specific outcomes. Where water is considered a sacred 'gift from God' for instance, there may resistance to payment.
Perception of ownership and responsibility The degree of community autonomy over water supply services may affect WTP, as a sense of ownership often encourages responsibility and pride in the supply system and may result in increased WTP for the service where it is guided by the community. System handover to the community does not necessarily imply the above, and may be affected by, among other things, a history of government support in water service provision, or ineffective consultation or implementation regarding the service; WTP is likely to be adversely affected in these situations.
Transparency of financial management Transparency may be closely linked to the reputation of the service agency or local management organization and is often a matter of trust. Where user contributions are clearly accounted for, consumers will be motivated to continue these payments and WTP will be retained accordingly
Institutional framework The organization of a water supply system, for instance, the way water committees operate and interface with other institutions and consumers themselves, determines the effectiveness of the system and subsequent user support. A democratic, transparent management framework is likely to maximize user WTP in the long term.

Adapted from Evans, 1992

As it can be seen in the above table, WTP may have a strong affinity with a range of cultural, social and institutional factors that complicate efforts to measure it. Decision-making by consumers may not follow rational economic norms and consumers may instead reveal their own, location-specific criteria in source selection.

5.3 Optimizing costs

Costs need to be identified, estimated and analyzed, and communities need to be informed about them in order to be fully aware the implications of choosing a particular technology.

What are the costs ?

Investment costs
• Pre-feasibility study, project design, social work • Equipment, materials, parts and tools • Construction costs • Human Resource Development, training • Institutional capacity building
Recurrent costs *
• Material (consumable, chemicals, energy, tools spare parts and equipment) • Works personnel (operation, maintenance, routine preventive maintenance, routine repairs, unanticipated repairs; construction for minor rehabilitation) • Management personnel (planning, supervision, financial management, administration, monitoring) • Follow-up (training support, technical assistance, institutional strengthening, monitoring and evaluation) • Financial costs (interest, amortization, depreciation, exchange rate variations; inflation) • Environmental costs (water source protection and conservation; waste water treatment) • Other costs (Transport; services paid to a private contractor) (Unaccounted for water, both due to leakage in system and bad administration, and vandalism; they become a cost the community if not prevented)
Future investment costs
• Construction for major rehabilitation, replacement, extension

* Recurrent expenditures comprise *fixed* costs such as annualized financing costs or water source protection fees, and *variable* recurrent costs according to output and other factors such as physical conditions.

How to estimate O&M costs ?

There are usually no difficulties in estimating investment costs. However, the case is different for recurrent costs. Using experiences in other similar projects although useful can be misleading, as recurrent costs vary widely from one project to another, in terms of what has been included in their calculation. Basic recurrent costs can be measured in the following way:

Basic recurrent costs estimation

1. List all O&M activities needed, and their frequency.
2. According to each activity, list all human resources, material, spare parts, energy, tools and equipment required.
3. Estimate quantity and volume needed for each requirement.
4. Define activity cost
5. Sum up all costs of all activities

This basic recurrent costs estimation does not include such elements as depreciation, replacement costs, initial capital reimbursement, training costs, environmental protection costs, etc. Depending on the strategy and policy of projects, these additional costs might have to be added.

Minimizing costs

An important aspect of costs analysis is how to optimize or reduce O&M costs. Costs can be significantly reduced in the following way :

- choosing a technology with non expensive spare parts or expensive operation costs
- reducing the transport costs to go and buy spare parts and chemicals (making spare parts more accessible and available)
- reducing dependence on chemical use (alternative water treatment technology for instance, such as multi-stage filtration system)
- reducing dependence on fuel or electric consumption (Solar; gravity)
- by installing firmly a maintenance culture within the community and professional staff
- by organizing preventive maintenance activities where users are also involved
- by a systematic leakage control
- by applying economies of scale for larger systems (reduces costs for the consumer)
- by applying a control for unaccounted for water (both because of leakage and of bad management)
- by installing proper administrative and financial control mechanisms

5.4 Appropriate tariff design

Designing a tariff requires that one keeps in mind equity, affordability and willingness to pay. Eq''ty, in the sense that all members of the community, rich / poor, men / women, have an equal access to the benefits of improved water supply and sanitation services. O&M costs can only be recovered from users if they are both able and willing to pay for a water supply. It is generally admitted that people should not have to pay more than 3 to 5 percent of their income for water and sanitation services. A higher percentage of income expended on water will mean other important needs may not be fully met. Great care is therefore required when setting user's tariffs and contributions.

While starting with setting up a tariff structure, one should specify what costs need to be covered, since some costs might be covered by other financial mechanisms, see next section, or determine which other organizations and institutions are responsible. Should waste water treatment and sanitation be included in the tariff ? Should the tariff only cover short term O&M costs ? Should the tariff cover the estimated unaccounted for water?

It is also important to specify to whom the tariff will paid to, as it can be paid to a water committee, an operator, or to the local authority. Or is water vending the most appropriate option to be considered. Water re-vending might double or triple the original price, (as it is done in some low-income urban areas, where there are no other alternatives to safe drinking water supply than water sold by re-vendors).

Setting up a tariff should be done with and by the community, as it will allow the community to bear the full responsibility of applying decisions made and as it will be better accepted since the community knows why this tariff is determined as it is. However, project and support staff should assist the community in the calculations and financial feasibility of a tariff design and user charges. There are different options for regular charges : non metered flat rates; non metered graded rates, block rates, metered rates and mixed system rates.[6]

Non-metered flat rates

In a flat rate system, each user household pays a fixed a mount of money, regardless of the volume of water used. In its simplest form, the total amount of money needed for the upkeep of the improved water supply system, is divided equally over the number of households using the system. Payment may be per month, per season, or per year, depending on what is most convenient for the users of the service. Flat rates are easy to organize with private taps or group connections. IN these cases it is clear who is the user and who is not, and should be limited to the situations where social and economic start are almost equal. Families, who live at a further distance or who have their own water source may particularly object to pay the same amount of money as those who live close to the tap. Adjustments should be made accordingly. A major disadvantage of non metered flat rates is that they are not equitable in the sense that low-income households pay then same amount as the better-off, what ever the consumption. They are however easy to administer.

Non metered graded rates

Users and households are classified into several categories, based on estimated differences of water use and income. The advantage of non metered graded rates is that they take into account the consumption level and payment capacity of users, and therefore could reach a more equitable tariff structure. It is also a way to account for rough estimations of consumption volume, without investing in a metering system. The introduction of graded rates is easiest when clear and valid indicators of water use and income level can be found (land, herd, size of house). An alternative system to graded rates is to raise a levy on cash

[6] Adapted from "What price water ?", Occasional paper N.10, IRC

crops on top of already existing rates, which will be used for the maintenance of the water supply system. However disputes may arise over the basis for grading, as some people may feel they have been favoured and others not..

Block rates
Apart from a basis rate which is fixed with references to affordability by the poor, the rest of the consumers may be charged a price equal to the volume consumed by the consumers, with ranges or blocks (from 0 to 10 m^3; from 10 to 20 m^3, etc.).

It is sometimes argued that the block rates should be declining because of possible economies of scale. It is doubtful, however, that there are such significant economies of scale per consumer basis. Considering the growth in services needed in developing countries, the most appropriate policy is an increasing block structure, with progressively increasing tariffs.

Metered rates
While graded rates based on social judgments or indicators have the advantage that they avoid the introduction of more complex metered connections, water meters enables to charge according to the actual volume consumed. If properly reinforced, metering induced users to avoid water wastage, which will reduce long-term costs or unaccounted for water losses. Individual household meters are not only expensive to install, they also need to be read regularly and make the administration more complex. Special staff has to read meters, write bills and accept payments. Metering therefore requires administrative and management capacities. The added cost of installing and operating meters, as well as billing and collection may outweigh the benefits of the system, notably in rural areas. In practice often a proxy is used, such as pipe diameter, number of connections or indeed container size where purchased from vendors. A major constraint to user participation in piped systems with metered connections, is the high connection fee which water agencies charge to individual households wishing to install a private tap. One way to alleviate this problem is to spread the connection fee in time, and include in the monthly water rate.

For or against water metering ?

For water metering	Against water metering
Regular income	High installation costs
Equity	Meters need maintenance and repairs
Reduction of water waste	Vandalism
Only one parameter : cost per m^3	Long delays in payment
Technical control of the system	Heavy administrative procedures for billing
Accounting made easier	Needs personnel for meter reading

Mixed system
Another option to cover the recurrent costs of a community water scheme is to combine paid private connections with free public standposts. When there are enough private connections it becomes possible to finance the cost of public taps for the lowest income groups from a surplus of the rates paid by the private users. However, households which can afford to take a house connection do not always do so, when there are enough free standposts. This system should be accompanied by sensibilisation and information activities promoting private tap connections, as well.

5.5 Access to other financing options and mechanisms

It is indeed important to plan and determine financial mechanisms which will allow to cover for all costs, if those are not covered by user's fees, and especially for big repairs, rehabilitation, extension and replacement. In this context, the access of alternative sources of financing makes sense, which could range from access to credit facilities, installation of a Fund, subsidies, cost-sharing arrangements with authorities. The following table provides an overview of different financing mechanisms which could be available other than tariffs and rates.

Summary of financing options and mechanisms other than tariffs and rates
Voluntary funds Done in communities with a tradition of fund raising and seasonal income, at the occasion of financial contribution for construction and big repairs. People can contribute according to their ability to pay, however contributions may not be linked to water use and is difficult to control.
General community revenue Done in communities which have their own sources of income, for construction, extension. Disputes may arise on the priorities to give to the use of these resources
Cooperative funds Water supply initiated and financed through production cooperative or village revolving fund, for construction and expansion works.
Revolving funds Starting capital may come from a Government donation or the issue of shares to individual households. On the basis of this capital, loans are given to individual households or groups. Upon repayment, new loans are given to other members or groups
Water vending Through water kiosks, concession sales, coin-operated taps, water carrying systems or community-based distribution systems. Users buy water from these distribution points. The distributors pay a fee to the main water supplier.
Taxation (municipal resources) Municipalities can collect the necessary funds through local taxes; Payment can be linked to income level, but charges may not reflect the level of water consumption. This option represents a limited scope for community involvement in decision-making and financial system management.
Cross - subsidy One way to make the service equitable and affordable for all is to subsidize the poor and surcharge the high income consumers. Another cross-subsidization could be done between sectors, within the same community or municipality.
Government subsidies Central government and local authorities allocate part of their budget to operation and maintenance activities. Subsidization can also come through the reduction of spare part and chemical prices, free technical personnel available to communities if requested.
Loan through a bank A bank allocates a loan to a water committee. However most banks have a poor small credit policy for rural communities. Communities cannot always produce the necessary guarantee. The Grameen Bank, in Bangladesh, is proposing a new bank approach to respond to the needs of the rural areas.
Micro-credit schemes Communities organize through local associations, micro-credit schemes, where individuals and groups can borrow money with a pre-determined and agreed with interest. These schemes are adapted to Community needs and realities, but have a limit to their lending capacity in volume.
Social and Development Funds Many developing countries have put in place, special funds which give access to money for social and development purposes, with an interest rate which can be much lower than on the financial market. However, access to these funds are often for local authorities and municipalities, and not necessarily for communities. It is therefore important that communities and municipalities work in partnership. Access to these Funds can be eased through the payment of a regular fee which will give the possibility to have loan ii case of necessity.
Donations (twining, other members) Donations can come through individuals (former inhabitants of a village who live in a city or abroad). In some cases, villages are twinned with other villages and cities in other countries, and grants have been allocated through this mechanisms in the past
Private sector involvement The private sector can invest some of its own capital in a water scheme. However, it will look for something in return which can justify its investment, such as future contracts or ownership.

5.6 Sound financial management

Many communities and, in certain remote areas, municipalities as well, lack skills in financial management which will allow to organize, implement and control a cost recovery system in an efficient way.

The table below is summarizing the basic aspects of financial management which need to be implemented by a Water Committee, and what are possible options :

Financial management issues	Possible options
What cost to budget for ?	Remuneration; tools and spare parts; small repairs only; all repairs; extension, rehabilitation
What sources of income to use ?	Regular user payments (monthly, sale per unit); village funds; voluntary contributions; credit schemes; government subsidy
How to collect money ?	Billing; collection at water point; fund raising when breakdown; taking money from a fund
When to collect money ?	Per service provided; monthly; after harvest; beginning of financial year
Who collects the money ?	Care taker; operator; user group; village Water Committee Community leaders
Where to keep the money ?	In a safe; in the village account; in a bank account; in a development fund
How to register movements of expenditures and incomes ?	Log book; daily journal; bookkeeping; bank statements
How to pay the mechanic or caretaker ?	Per job; per month (fix + % of sales); per year after harvest In cash / kind
Who administers the funds ?	The Committee Treasurer (man or woman); a village accountant; bank accountant
What are funds used for ?	Payment of expenditures related to O&M of water point; generating bank interest; use for other development projects
Who orders payments ?	Operator; treasurer; water Committee; village leaders; assembly of users
What type of financial control ?	Receipts from book-keeping; regular meetings of water committee; feed back to users; social control; checking with meter reading; checking with bank statements
How to monitor ?	Use of log book; make a quarterly review and overview of the situation on expenditures, and incomes, % of people who do not pay.
What to do with bad payers ?	Analysis of reasons fro bad payment; improvement of service; improvement of relationship with the users; campaign on benefits of good payments; rescheduling of debt Sanctions

5.7 An enabling and supporting environment

An enabling and supporting environment encompasses the legal, economical and institutional framework, as well as national or local policies which are clearly spelt out regarding sector cost recovery. It encompasses also the availability of support services and equipment (including availability and accessibility of spare parts) within an acceptable geographical area and affordable financial range. Finally, the enabling environment includes the capacity to train and assist communities on financial issues.

6. Water quality[7]

6.1 Key aspects of water quality

Water can be contaminated by the following elements: a) pathogens which include bacteria, amoebas, viruses as well as eggs and larva of parasitic worms; b) harmful chemicals from human activities (industrial wastes, pesticides, fertilizers); c) or certain chemicals and minerals coming from the natural environment. Some non harmful contaminants can have an influence on the taste, smell, colour and temperature of water, and could be unacceptable by the community.

Water from surface water is often contaminated, whereas water coming from groundwater is normally purer, although can also be contaminated by harmful chemicals generated either from human activity, inappropriate sanitation practices or coming from the natural environment. Rainwater captured with rooftop harvesting system or with small catchment dams are relatively pure especially when the first waters are allowed to flow initially, when the rainy season starts.
The following water treatment technologies could be explored (certain household treatment aspects straining through fine cloth, aeration, coagulation and flocculation, ceramic filters, desalination, iron removal, manganese removal, fluoride removal and arsenic removal are also delt with in annex 12):

Household water treatment systems

- Boiling
- Household slow sand filter
- Solar Disinfection
- Domestic chlorination

Community water treatment systems

- Pot chlorination in well
- Storage and sedimentation
- Up-flow roughing filter
- Slow sand filtration
- Chlorination in piped water supply systems

Should water be chlorinated or not ?[8]

Water treatment processes as described above (storage, sedimentation, filtration, etc ..) can reduce the pathogen contents in water, however not always completely. Chemical disinfection is an effective mean of removing such organisms. Boiling and solar disinfection are effective however cannot be done for large quantities of water. Chlorine compounds will destroy pathogens usually after 30 minutes. It has the advantage that a measurable residual of chlorine can be maintained in water supply, which provides further potential for disinfinction (residual should be generally be in the range 0.3 to 0.5 mg of chlorine per liter of treated water).

[7] Extracts taken from « Linking Technology Choice with Operation and Maintenance , in the context of community water supply and sanitation », by François Brikké. 1997. IRC / WHO. Geneva. Switzerland
[8] Extracts from Technical Brief N.46 : Chlorination of community water supplies, in Waterlines Vol.14 N.2, 1995

Chlorine should be added **after** other treatment processes have been applied, and **before** storage and use. There are several sources of chlorine (sodium hypochlorite) for domestic use which have different degrees of active chlorine concentration (in brackets), such as javel water (1%), household bleach (5%), bleaching powder (up to 35%), or purpose made tablets (up to 70%). Deciding on the right amount can be difficult because it will depend on substances present in the water, air tightness, temperature and light

The use of chlorine is however not recommended in the following cases : a) when a regular supply of chlorine is not available or when the community cannot afford it; b) when chlorine reacts with other chemicals in a harmful way; c) when monitoring cannot be organized; d) users do not accept the resulting taste.

Reducing concentration of chemicals in water

Iron and manganese removal

Water collected from boreholes can be found to have a high concentration of iron (above 0.3mg/litre), which can be the result of natural high iron content in the soil, or the result of steel corrosion (pipes, borehole casings and screens). This can cause an unpleasant metallic taste and odour, and stains on laundry and food, but is not known to be harmful to human health. However, this can cause communities to accept water bacteriologically infected with no taste, instead of safe water with a metallic taste. Simple treatment are based on aeration followed by filtration, but it needs the periodic cleaning of the stones and sand used for filtration.

Similar problems appear with excessive manganese concentration in water (0.1mg/litre), and can be removed by aeration followed by filtration and settlement.

Fluoride removal

High concentration of fluoride (above 1.5 mg/ litre) can damage bones and teeth. Low-cost treatment methods include lime softening or the use of pre treated bone. The Nalgonda system uses lime to soften water and alum as a coagulant followed by settlement, simultaneously with chlorination.

Arsenic removal

Arsenic is widely distributed throughout the earth's crust and is introduced into water from the dissolution of minerals and ores, from industrial effluents, and from atmospheric deposition. Excessive amounts of arsenic are toxic. Simple treatment methods include the addition of lime to soften water followed by settlement.

6.2 Overview of effectiveness of various treatment systems

An overview of major household water treatment systems is proposed in the following table.

Household water treatment systems and their effectiveness (- : not significant or unknown; ☺ : little; ☺☺ : medium; ☺☺☺ : major)

Description of treatment system (1)	Treatment effectiveness over various elements affecting water quality									
	Bacteria, amoebas	Guinea-worm	Cercaria	Iron Man-ganese	Fluoride	Arsenic	Salts	Odour Taste	Organic material	Turbidity
Straining through fine cloth Consists in pouring raw water through a piece of fine, clean cotton cloth removing a certain amount of suspended solids.	-	☺☺☺	-	-	-	-	-	-	☺	☺
Aeration Oxidizes iron and manganese. Also important for effectiveness of slow sand filtration, especially if not enough oxygen in surface water. Can be done easily by shaking a vessel. Otherwise allowing water to trickle through perforated trays containing small stones.	-	-	-	☺☺☺	-	-	-	☺☺	☺	-
Storage / pre-settlement Storing water just for a day can result in the elimination of some bacteria (Cercaria: 48 hours). Longer period of storage will lead to further reduction. Suspended solids and pathogens will begin to setle at the bottom of a container, and the top of the container will be used after sedimentation.	☺	-	☺☺☺	☺	-	-	-	☺	☺☺	☺☺
Coagulation, flocculation & settlement In coagulation, a liquid substance (ex: aluminium phosphate, depending on water and solids) is added to change the behaviour of suspended particles, which become attracted to the coagulant. The flocculation process follows the coagulation consisting usually of slow gentle stirring. Particles come together and form larger particles which are then removed by sedimentation / settlement or filtration.	☺	-	☺	☺	☺☺☺	☺☺☺	-	☺	☺	☺☺

Description of treatment system (2)	Treatment effectiveness over various elements affecting water quality									
	Bacteria, amoebas	Guinea -worm	Cercaria	Iron Man-ganese	Fluoride	Arsenic	Salts	Odour Taste	Organic material	Turbidity
Slow sand filtration Water passes slowly downwards through a bed of fine sand at a steady rate. Water should not be too turbid otherwise filter will get clogged. Pathogens are naturally removed at the top layer where a biological film builds up. The ability of certain households to remove effectively pathogens can however be low.	☺☺☺	☺☺☺	☺☺☺	☺☺	-	☺☺☺	-	☺☺	☺☺	☺
Rapid sand filtration Sand used is coarser than above and flow rate is faster. Used for removing suspended solids and effective for coagulation / flocculation. There is no build up of biological film. hence disinfection is needed. In upflow filters, trapped debris become easier to clean. A mixed option (UNICEF filter) consists of various layers (fine sand; gravel; charcoal).	☺	☺☺	☺	☺☺	-	☺☺☺	-	☺☺	☺☺	☺☺
Charcoal filter Granular charcoal can be used during filtration and is effective in removing tastes, odour and colour. However, it should be replaces regularly because can become ground for bacteria breeding.	-	-	-	-	-	-	-	☺☺☺	-	-
Ceramic filter The purifying element is a porous, unglazed ceramic cylinder. Open porous jars can also be used. Appropriate only for fairly clear water. Impurities are deposited on surface and filters with very small pore size can remove most pathogens.	☺☺☺	☺☺☺	☺☺☺	-	-	-	-	☺☺	☺☺	☺☺☺

Description of treatment system (3)	Treatment effectiveness over various elements affecting water quality									
	Bacteria, amoebas	Guinea -worm	Cercaria	Iron Man-ganese	Fluoride	Arsenic	Salts	Odour Taste	Organic material	Turbidity
Solar disinfection Ultra-violet radiation will destroy most pathogens. Effectiveness is enhanced by increasing temperature. A safe exposure in tropical areas is about five hours centered around midday. An easy way is to expose half blackened bottles to the sun. Shaking the bottle before radiation increases effectiveness.	☺☺☺	☺☺	☺☺	-	-	-	-	-	-	-
Chemical disinfection Chlorination is the most widely used method for disinfecting drinking water. Liquids such as bleach, powders such as bleaching powder and purpose-made tablets can be used. Iodine is another chemical disinfectant. Deciding on the right amount can be difficult because it depends on substances in water and on season (see fact sheet)	☺☺☺	-	☺☺☺	-	-	-	-	☺	☺☺☺	-
Boiling Reaching 100°C for a few minutes will kill most pathogens and a lot are already killed at lower teperatures such as 70°C. Can be expensive because of use of fuel / charcoal.	☺☺☺	☺☺☺	☺☺☺	-	-	-	-	-	-	-
Desalination / evaporation Desalination by distillation produces water without chemical salts and can be applied at household level.	☺☺☺	☺☺☺	☺☺☺	☺☺☺	☺☺☺	☺☺☺	☺☺☺	☺☺☺	☺☺☺	☺☺☺

Adapted from Brian Skinner and Rod Shaw "Household water treatment 1" Technical Brief N.58 in Waterlines Vol.17 N.2 1998

7. Monitoring indicators [9]

Example from the MEP (Minimum Evaluation Procedure) of WHO

1. measuring functioning of systems

Indicators for water supply
- Water quantity (liters/person/day)
- Water quality (E.Coli ; fluorides concentration and other chemicals)
- Reliability (frequency and duration of breakdowns)
- Commodity (distance)

Indicators for sanitation
- Proportion of households having an improved latrine
- Hygienic state of latrines (% of clean latrines/ number visited)
- Reliability of installations (qualitative... % in good state/ number visited)

Indicators for Hygiene
- Understanding of the language of the messages (% of people speaking the language)
- Understanding of the content of the messages (sampling; with good; medium, low understanding, and proportion)
- Access to the messages (N. of people reached by TV or radio, etc..)

2. Measuring use of systems

Indicators for water supply
Proportion of households using the system
Volume of water used by destination

Indicators for sanitation
Proportion of users using the improved latrines

Indicators for hygiene
Behaviour in terms of water storage
Cleaning of hands after defecation
Knowledge of Oral rehydration

Example from "Tools for managing change", World Bank Technical paper N.207

1. Sustainability

Reliability of systems
- Quality of water at source
- Number of facilities in working order
- Adequate maintenance (low frequency of breakdowns, quick repairs, low downtime of facilities)

[9] Extracts taken from « Management of Operation and Maintenance for Rural Water Supply and Sanitation – A Training Guide for Planners and Managers », prepared by François Brikké. 2000. IRC/WHO, Geneva, Switzerland.

Human capacity development
- Management abilities (who decides, men/women)
- Knowledge and skills (understanding of men/women on improvement of system; proportion of technical skills availability)
- Confidence/self-concept (rating scales on self perception; leadership; initiative and sense of efficacy

Local institutional capacity
- Autonomy (who defines rules? who controls finances?)
- Supportive leadership (style of management; working methodology)
- Systems for learning and problem-solving (systems in place to resolve conflict, and corrective actions)

Cost sharing and unit costs
- Community contribution
- Agency contribution
- Unit costs

Collaboration among organizations
- Planning (collaboration; participatory planning)
- Activities (collaboration)

2. Effective use

Optimal use
- Number and characteristics of users
- Quantity of water used (all purposes)
- Time taken to use facilities
- Management of water resources (protection)

Hygienic use
- Water quality at home
- Water transport and storage practices
- Home practices to improve water quality
- Site and home cleanliness
- Personal hygiene practices

Consistent use
- Pattern of daily use
- Pattern of seasonal use

3. Replicability

Community ability to expand services

Additional water/ latrine facilities built
Number of upgraded facilities
New development activities initiated

Transferability of agency strategies

Proportion and role specialized personnel
Established institutional framework
Budget size and sheltering
Documented administrative / implementation procedures
Other special / unique conditions

Example from "Tools for the assessment of operation and maintenance status of water supplies" WHO and the O&M Working Group of the Water Supply and Sanitation Collaborative Council

• Management system:	System in existence and being followed
• Functioning supply points:	$\frac{\text{Number in working order}}{\text{Total number}} \times 100$
• Reliability:	$\frac{\text{Functioning time}}{\text{Total elapsed time}} \times 100$
• Spare parts accessibility:	Mean time for arrival of identified spares/materials
• Cost:	Average O&M cost per user
• Operating revenue	$\frac{\text{Operating revenue}}{\text{Population served}} \times 100$
• Cost recovery	$\frac{\text{receipts + subsidies}}{\text{Average O\&M costs}} \times 100$
• VLOM Personnel	$\frac{\text{N. of systems with functioning committees}}{\text{Total number of systems}}$
• Supply continuity	$\frac{\text{Average number of hours of daily supply}}{24}$
• Flow rating	$\frac{\text{Present discharge}}{\text{Discharge at handing over of scheme}}$
• Pressure rating	$\frac{\text{Present pressure}}{\text{Discharge at handing over of scheme}}$
• Water quality	% samples > target number E. Coli per 100ml
• Training (VLOM)	N. of VLOM personnel trained per community (men and women)
• Materials and spare parts	N. of outstanding repairs due to lack of spare parts N . of outstanding materials orders N. of items out of stock N. of spare part requisitions per water supply/year

Example from "Technology transfer in water supply and sanitation" – A learning experience from Colombia – Technical paper 32-E, IRC, CINARA

Indicators for the evaluation of water supply systems

	Theme	*Indicator*	*Desired level*
1.	Coverage	No. of connected households / Total no. of households	100%
2.	Available quantity	Max. flow in the system / Min. flow in the source	Less than 50%
2.1	Production	Actual flow in the system / Design flow	Less than 100%
2.2	Quantity of use	Supply quantity per user / Design capacity per user	Less than 100%
3.	Continuity	Number of supply hours per day	24 hours
3.1	Continuity in the source	Reduction over time	No reduction
4.	Quality	Turbidity Residual Chlorine in distribution net	Less than 5 NTU 0.3 - 0.6 mg/l
5.	Use of other water sources	No. of persons using other sources / No. of persons interviewed	0%
5.1	Efficient water use	No. of houses with leaking taps / No. of houses visited	0%
6.	Management capacity	No. of indebted users / Total no. of users	Less than 5%
		Supervision of the operator	Yes
6.1	O&M capacity	Trained operator with work tools	Yes
6.2	Representation of women	No. of trained women in the committee / No. of trained committee members	50%
7.	Cost	Monthly revenue / Monthly expenditures	More than one
7.1	Tariffs	Monthly tariff / Monthly family income	Less than 3%

8. Low-cost water supply technologies[10]

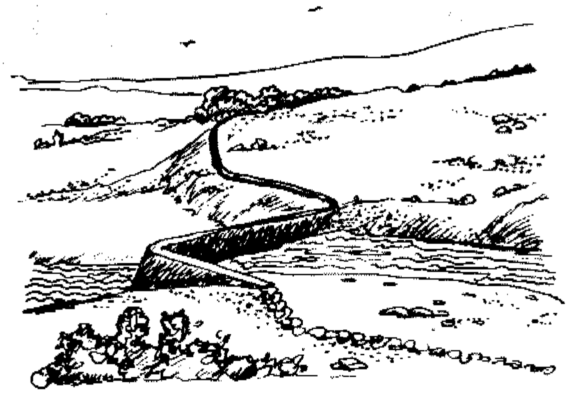
- *8.1 Catchment and storage dams*
- *8.2 Roof top water harvesting*
- *8.3 Dug well*
- *8.4 Spring water captation*
- *8.5 Direct action pump*
- *8.6 Deep well diaphragm pump*
- *8.7 Deep well piston pump*
- *8.8 Rope and bucket*
- *8.9 Rope pump*
- *8.10 Suction plunger handpump*
- *8.11 Dommestic connection*
- *8.12 Public standpost*

[10] Extracts taken from « Linking Technology Choice with Operation and Maintenance, in the context of community water supply and sanitation », prepared by Framçois Brikké and co. 1997. IRC / WHO, Geneva, Switzerland.

8.1 Catchment and Storage Dams

☐ Brief description of technology

With the help of a dam, the rainwater or snow catchment of a natural surface like a bedrock area or a valley can be made available for human use. Water is caught and stored behind the dam or diverted to a separate reservoir. Important parameters in the planning of dams are annual rainfall and evaporation pattern, present use and runoff coefficient of catchment area, water demand, geology and geography of catchment area and building site. Dams may consist of raised banks of compacted earth (usually with an impermeable clay core, stone aprons and a spillway to discharge excess runoff), masonry or concrete (reinforced or not). In this publication we only refer to dams of less than a few metres high. Users can take the water directly from the dam or it can be treated and distributed in a larger system.



initial cost: Depending very much on local circumstances. To get an impression, the cost per m^3 storage volume for a 13,000 m^3 rock catchment in Kenya was US$1.60. For an earth dam of 30,000 m^3 in Tanzania this figure was US$1.90 but for an 80,000 m^3 earth dam in Mali only US$0.20 (1989 data, Lee and Visscher 1990).

Dimensions: From one metre high and a few metres wide to hundreds of metres wide and high.

area of use: Mostly in hilly or mountainous regions where other water sources are scarce.

design: For dams higher than a few metres, design by specialized engineers is recommended.

☐ Description of O&M activities

operation

Operation by a caretaker may include activities such as opening or closing of valves or sluices in the dam or conduits to a reservoir. Abstraction of the water from the water points is usually done by the users, often women and children.

maintenance

All year round, cattle and people have to be kept away from the catchment area and reservoir. This can be enhanced by: regular patrolling by a watchman in the area, fencing the area and construction of tap points downstream of the reservoir. The dam, valves, sluices and conduits have to be checked for leaks and structural failures. If repairs cannot be carried out immediately, the spots of failure should be marked. The catchment area must be checked for contamination and erosion. To control erosion, just before the rainy season grass or trees may be planted. For this purpose, a nursery may have to be started.

Once or a few times per year, the reservoir may be left to fall dry for a short period to reduce the danger of bilharzia. The reservoir, silt traps, gutters etc. must be desilted at least once per year.

To avoid mosquito breeding and the possible spread of malaria, Tilapia fish can be introduced to the reservoir (each year if it runs dry). Fish excrement pollutes a reservoir less than if the reservoir has no fish and organisms are allowed to breed unchecked.

All O&M activities on the reservoirs and catchment areas can normally be executed by the users of the system. Major repairs may be performed by local craftsmen, using locally available tools and materials.

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
check for leaks, damage, erosion etc.	daily	local		
repair leaks in dam	occasionally	local	clay, cement, sand, gravel	hoes, spades, buckets, trowels etc.
repair or replace valves	occasionally	local	washer, spare valve	
desilt dam, conduits, silt traps etc.	annually	local		hoes, spades, buckets, wheelbarrows etc.

☐ Actors implied and skills required in O&M

actor	role	skills
user	use water, keep catchment area clean, assist in maintenance activities	no special skills
caretaker	perform small repairs	basic skills
water committee	organize repairs and cleaning, collect fees	organizing skills
local technician	repair concrete, masonry and piping	masonry, basic plumbing
external support	check water quality of system, stimulate and guide local organization	extension

Organizational aspects

For proper and sustainable functioning of a surface harvesting system, users will need to establish an organization that can effectively deal with issues such as the allowed water consumption by each user, prevention of use by unauthorized passers-by, of water contamination and of unequitable abstraction, solving upstream-downstream conflicts where the system has altered the natural hydrology, execution of O&M activities, and financing of O&M. Agreements will have to be made on contributions in cash, kind or labour by each household to O&M of the system.

For O&M tasks at the reservoir and the catchment area a person who lives or farms near the site could be appointed. This person could also be made responsible for water allocation if water is obtained by the users near or at the reservoir, and be involved in monitoring activities. His authority should be clear and accepted by the people.

☐ Recurrent costs

Recurrent material costs may vary greatly although they are usually small. The recurrent personnel costs, in cash or kind (for caretakers, watchmen, labourers, committee members and craftsmen), will need to be added and may in certain cases far exceed the recurrent material costs, for instance where erosion control measures in the catchment need to be maintained, which may require high labour inputs on a regular basis.

☐ Problems, limitations and remarks

frequent problems

Contamination of the water, siltation of the reservoirs, endangering activities in the catchment area like chemical spraying, overgrazing, agro-industry, industry, land clearing, settlements, etc.. Earth dams can be damaged by animals or people walking over them. Undermining of dams and reservoirs by seepage, rodents or other causes.

Dam failure, collapse or injury due to wrong designs or unforeseen large runoffs. Waterborne and water-related diseases like bilharzia and malaria.

limitations

When demand is high and rainfall is low or very irregular, large catchment areas and dams are needed. Even if water law does provide some protection, catchment areas are vulnerable to damage by other people. If local soil and geographic conditions are unfavourable, transport of materials (clay, sand, gravel) and construction of the dam may become very expensive.

Catchment areas are unsuitable if there is no suitable site for the dam or reservoir, for instance if the ground beneath does not provide a strong and sound enough foundation to support the structures and prevent seepage, if the dam or reservoir would have to be too large (or expensive) because the depth-to-surface ratio is too small, or if percolation or evaporation losses would be too large.

The investment in labour, cash and/or kind needed for the implementation and/or maintenance of surface harvesting systems may be beyond the capacity of communities.

If populated centres or important infrastructure are located downstream it may for security reasons be decided not to construct the system at that site.

remarks

Users normally highly value the taste and flavour of their drinking water. These can differ with different catchment areas. In certain cases this may affect the users' acceptability of the system.

Recommended literature

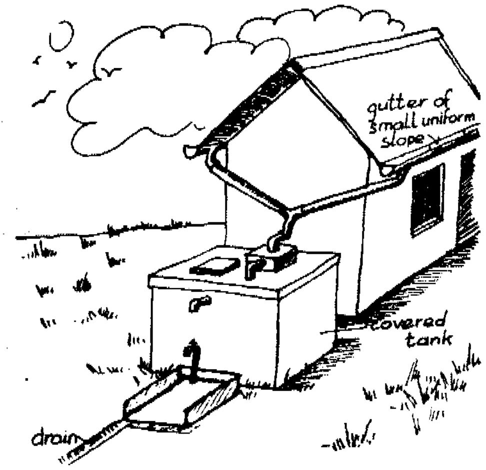
Lee, Michael D. and Visscher, Jan Teun (1992). (design; construction; organizational; socio-economic)

Lee, M.D. and Visscher, J.T. (1990). (case studies; technical; organizational; socio-economic)

8.2 Rooftop Water Harvesting

☐ Brief description of technology

Rooftop catchment systems gather rainwater caught on the roof of a house, school etc. using gutters and downpipes (made of local wood, bamboo, galvanized iron or PVC) and lead it to one or more storage containers ranging from simple pots to large ferrocement tanks. If properly designed, a foul flush device or detachable downpipe is fitted for exclusion of the first 20 litres of runoff during a rainstorm, which is generally most contaminated with dust, leaves, insects and bird droppings. Sometimes runoff water is led through a small filter consisting of gravel, sand and charcoal before entering the storage tank. Water may be abstracted from the tank by a tap, handpump or bucket and rope system.



initial cost: In Southern Africa US$ 320 for a system with 11 m galvanized iron gutter, 1.3 m^3 galvanized iron tank, downpiping, tap and filters, not including transport (Erskine, 1991). Where roofs are not suitable for water harvesting, cost of roof improvement and gutters will have to be added to the cost of a tank. Such costs were found to vary between about US$4 (Kenya, subsidized) and US$12 (Togo) per m^2 (Lee and Visscher, 1992). Total capital costs for rooftop rainwater catchment systems are usually higher than for other water supply systems.

yield: Potentially almost 1 litre per horizontal square meter per mm rainfall. The quantities usually are only sufficient for drinking purposes.

area of use: Most developing countries with one or two rainy seasons (especially in arid and semi-arid zones with average annual rainfall figures ranging from 250-750 mm) and where other improved water supply systems are difficult to realize.

construction: Systems are usually produced locally

☐ Description of O&M activities

operation

In case there is no foul flush device, the user or caretaker has to divert away the first 20 litres or so of every rainstorm. Fully automatic foul flush devices often are not very reliable. Water is taken from the storage tank by tapping, pumping or using a bucket and rope. For reasons of hygiene, the first two methods are preferred.

maintenance

Just before the start of the rainy season, the complete system has to be checked for holes and broken or affected parts and repaired if necessary. Taps or handpumps have to be serviced (see fact sheets on handpumps).

During the rainy season the system is checked regularly, cleaned when dirty and after ever dry period of more than a month. Filters should be cleaned every few months, filter sand washed at least every six months and painting of the outside of metal tanks may be needed about once a year. Leaks have to be repaired throughout the year, especially leaking tanks and taps, as they present health risks. Chlorination of the water may be necessary (see fact sheet on chlorination).

All operation and maintenance activities can normally be executed by the users of the system. Major repairs such as that of a broken roof or tank, can usually be executed by a local craftsman, using locally available tools and materials. Maintenance is simple but should be given ample attention.

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean system	1 - 3 times per year	local	chlorine	broom, brush, bucket
divert foul flush	every storm	local		
clean filters	twice a year	local	sand, charcoal, plastic mesh	
disinfect reservoir	occasionally	local	chlorine	bucket
repair roof, gutters and piping	occasionally	local	tiles, metal sheet, asbestos cement sheet etc., bamboo or PVC pipes, nails, wire	hammer, saw, pliers, tin cutter
repair tap or pump	occasionally	local or area	washers, cupseals etc.	spanner, screwdriver
paint outside of metal reservoir	annually	local	anticorrosive paint	steelbrush, paintbrush
repair ferrocement reservoir	occasionally	local	cement, sand, gravel, metal mesh, wire	trowel, bucket, pliers

☐ *Actors implied and skills required in O&M*

actor	role	skills
user	close taps after taking water, keep system clean	no special skills
caretaker	check functioning, divert first flush, clean filters and rest of system, perform small repairs	basic skills
water committee	supervise caretaker, collect fees	organizational skills
local craftsman	repair roof, piping and tank	basic plumbing and masonry
external support	check water quality, stimulate and guide local organization, train users	microbial analysis, extension work

Organizational aspects

The organization of O&M of communally shared roof or ground tank supplies is considerably more difficult than for privately owned systems. Rooftop harvesting systems at schools, for instance, may suffer water losses from a tap left dripping, and padlocks are often needed to ensure careful control over the supply. Ideally, one person should be responsible for overseeing the regular cleaning and occasional repair of the system, control of water use etc.. Selling the water is an option to ensure income for O&M and restrict water use. Where several households have installed a communal system, for instance several roofs connected to one tank, the users may want to establish a water committee to manage O&M activities, which may include collection of fees, control of the caretaker's work and of the water use by each family.

External agents can play an important role in monitoring the condition of the systems and the water quality, providing access to credit facilities in order to buy or replace a system, training of users/caretakers for management and execution of O&M, and training of local craftsmen for larger repairs.

☐ Recurrent costs

Recurrent costs for materials and spare parts are very low. In most literature these costs are even considered negligible. The recurrent personnel costs, in cash or kind (for caretakers, committee members and craftsmen), will need to be added.

☐ Problems, limitations and remarks

frequent problems

Corrosion of metal roofs, gutters etc.. Failure of functioning of the foul flush diverter due to neglect of maintenance. Leaking taps at the reservoir and problems with handpumps.

Contamination of uncovered tanks especially where water is abstracted with a rope and bucket.

Tanks may provide a breeding place for mosquitoes which may increase the danger of diseases such as malaria.

limitations

The water may be insufficient to fulfill drinking water needs during certain periods in the year, making it necessary to also develop other sources or go back to traditional sources to overcome these periods.

The investment needed for the construction of a tank and suitable roofing is often beyond the financial capacity of households or communities.

remarks

Thatched roofs produce less and more contaminated water. Tiled or metal roofs give the cleanest water.

The acceptation of rooftop water harvesting as a suitable system may depend on the users' perception regarding the taste of the water.

☐ Recommended literature

Lee, Michael D. and Visscher, Jan Teun (1992). (design; construction; organizational; socio-economic)

Lee, M.D. and Visscher, J.T. (1990). (case studies; technical; organizational; socio-economic)

Pacey, Arnold and Cullis, Adrian (1986). (design; construction; organizational; socio-economic)

8.3 Dug Well

☐ Brief description of technology

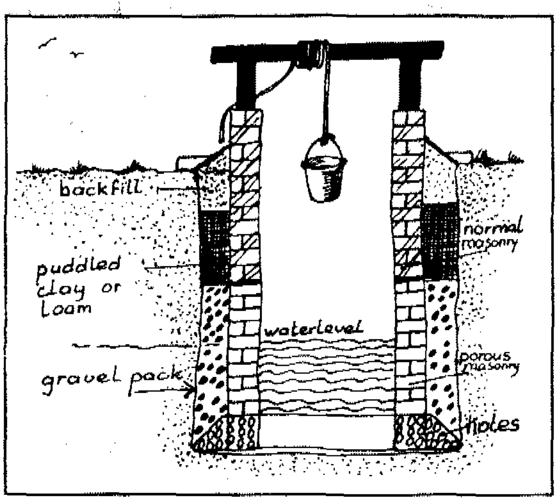
A dug well gives access to groundwater from an aquifer and facilitates its abstraction. The term 'dug' refers to those wells which can be entered by a person to clean or deepen and which will therefore rarely be less than 0.8 m in diameter. Two main types are distinguished:

Traditional wells. These are hand-dug holes to reach the groundwater, usually without a lining and without any above ground protection. They are very susceptible to contamination and will not be further discussed in this fact sheet.

Improved wells. These are wells dug by hand or by machinery, consisting of three main parts:

- A stone, brick or concrete apron with the above-ground part of the well lining (the headwall) raised to a height which is convenient for the method used to collect water from the well. The apron prevents polluted water from seeping back down the sides of the well, provides a hard standing for users and directs water away from the well to a drainage channel. The covered headwall prevents spilt water, rainfall, runoff, debris, people and animals from entering or falling inside and keeps sunlight out.
- The lining between ground- and water level, made of armed concrete rings, masonry with bricks or concrete blocks etc., preventing the well from collapsing. In consolidated formations lining may not be necessary. In such cases at least the top metre of the well should be lined to prevent any contaminated surface water from draining into the well.
- The lining under the water level which prevents the well from collapsing and facilitates groundwater entering the well. Therefore the lining material in this part is usually perforated with small holes or given a slightly different composition (e.g. permeable concrete) as compared to the lining above groundwater level.

Other components often found are: a drain to guide water further away from the well, usually towards a soakaway, filled with large stones where the water can infiltrate back



into the ground or evaporate from the stone surfaces at a safe distance from the well, and a fence with a gate, surrounding the well. The expected life of a modern dug well is at least 50 years.

initial cost:	Capital costs vary considerably and depend on a large number of factors. In the Sahel region, the average cost for a 1.8 m diameter dug well, 20 m deep of which 5 m under water is about US$8,200 (1993 data, Debris and Collignon, 1994). In Ghana an 8m deep well with apron recently cost US$820 (1992 data, Baumann 1993b).
range of depth:	From a few to over 50 metres.
yield:	About 5 m^3 per day can be considered as a good yield.
area of use:	In areas where a sufficient quality and quantity of groundwater can be abstracted throughout the year from an aquifer within about 50 m from the surface (sometimes even deeper) and where other water systems are less suitable

☐ Description of O&M activities

operation

In the case of water abstraction with a rope and bucket, operation may exist of taking off and replacing the cover of the well. For other water abstraction methods, see the respective fact sheets.

maintenance

Usually little maintenance is required. Maintenance activities may consist of:

Check daily for any debris visible in the well and remove if possible. Clean the concrete apron. Check the fence and drainage and repair or clean.

At the end of the dry season drain the well by taking as much water out as possible, clean debris and algae from it with a brush and clean water, repair where necessary and then disinfect. If the well has fallen dry or does not yield enough water, it has to be extended and lined further downwards.

Check concrete apron and the part of the well lining above groundwater level for cracks or other ruptures and repair if necessary.

Check for undermining of the apron by erosion or settlement of filled in material. Ensure that no latrines or other contamination sources are constructed within 30 m from the well.

Maintenance can normally be executed by the users of the system or by a caretaker or watchman, whereas larger repairs may require higher skilled labour which can usually be provided by local craftsmen.

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean well site	daily	local		bucket, broom
disinfect well	occasionally	local	chlorine	bucket
clean well	annually	local		brush, bucket, ropes
repair apron, headwall and drain	annually	local	cement, sand, gravel, bricks	trowel, bucket, wheel barrow, spade
repair lining	occasionally	local	cement, sand, gravel, bricks etc.	trowel, bucket, wheel barrow, ropes
deepen well and extend lining further downwards	occasionally	local or area	cement, sand, gravel, bricks, concrete rings etc.	pump, bucket, ropes
repair fence	occasionally	local	wood, nails, wire, mesh	axe, saw, machete, hammer, pliers etc.
clean drain	occasionally	local		hoe, spade, bucket, wheel barrow

☐ Actors implied and skills required in O&M

actor	role	skills
water user	use water, keep site clean, assist with major maintenance tasks	no special skills
caretaker	monitor water use, keep site clean	basic skills for cleaning and disinfection
water committee	supervise caretaker, organize major maintenance, collect fees	organizational skills
mason	repair lining, headwall and apron	masonry
specialized well builder	deepen well	pumping, underwater excavation, masonry
external support	check water quality, stimulate and guide users' organization	microbial analysis, extension work

Organizational aspects

When wells are not only for family use, the people may need to establish an organization that can effectively deal with issues such as the control or supervision of water use, prevention of water contamination, execution of O&M activities, financing of O&M and monitoring of water quality. Although (or maybe because) the number of O&M activities required is limited and usually costs very little, they should be given ample attention, as many wells have been abandoned because they were contaminated or had collapsed as a result of lack of maintenance. Maintenance is normally executed by the person who also takes care of the maintenance of the communal water abstraction system. If no communal abstraction system is used (e.g. where everybody uses his or her own rope and bucket), well maintenance will have to be organized separately. Proper management may also contribute to preventing social conflict over these and other issues.

It may be difficult for a community, even if they have the financial means, to make available the skilled labour, tools, equipment and materials needed for construction and for several maintenance activities, such as draining the well.

Recurrent costs

Recurrent material costs are usually small. The recurrent personnel costs, in cash or kind (for caretakers, watchmen, labourers, committee members and craftsmen), will need to be added but usually will be low as well. Reported recurrent costs: from zero to US$2 per capita per year in Africa and Asia (1984 figures, Burnett 1984) and US$30 per well per year in Ghana (Baumann 1993b).

Problems, limitations and remarks

frequent problems

Collapse of the well where a lining is not properly maintained, old, or nonexistent. Wells running dry or yielding less than before because: dry season water levels were not taken into account; water abstraction is higher than natural recharge rates; inflow of groundwater is reduced due to clogging of lining. The groundwater may get contaminated through the well or by pollutants seeping to the aquifer through the soil.

limitations

Well construction depends on geohydrological conditions like presence, depth and yield of aquifers and presence of rock formations above them. Wells constructed at locations which are too far from the users' households or which are too difficult to reach, will not or insufficiently be used or maintained.

Wells should not be sunk near places with latrines or where cattle gather and vice versa; usually the distance should be 30 m, although this is no guarantee that contamination will not occur. The investment, in labour, cash or kind, needed for the construction of an improved dug well may be beyond the capacity of communities.

remarks

In many situations wells are not exclusively used for drinking water supply. Irrigation may be another use. When assessing the development potential of wells with the community, it is important to place this in a wider context, including all water uses and their effect on water availability.

Use of well and pump could be enhanced by proper apron design, adding clothes washing and bathing facilities, diverting wastewater to irrigate vegetable plots etc.

Some advantages of dug wells over most drilled wells are:

- they can often be constructed with only locally available tools, materials and skills;
- in case the water lifting system breaks down and cannot be repaired, they can continue to be used with rope and bucket;
- they can be further deepened if the groundwater table drops;
- they have a greater storage capacity;
- they can be repaired and desilted by the community;
- they can be constructed in formations where hand or even mechanical drilling is difficult or impossible.

Recommended literature

Debris, T. and Collignon, B. (1994). (organization, socio-economic, case studies)

WEDC (1991). (design; construction)

Morgan, Peter (1990). (design; construction; upgrading)

Nyangeri, Ezekiel E.N. (1986). (design; rehabilitation; O&M; case studies)

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8.4 Spring Water Captation

☐ Brief description of technology

Spring water captation systems abduct and protect ground water flows at the points where these arrive at the surface to facilitate their abstraction. Spring water is usually fed from a sand or gravel water-bearing ground formation (aquifer), or a water flow through fissured rock. Where solid or clay layers block the underground flow of water, it is forced upward and can come to the surface. The water may emerge either in the open as a spring, or invisibly as an outflow into a river, stream, lake or the sea. The main parts of a spring water captation are a drain under the lowest natural water level, a protective structure providing stability and a seal to prevent surface water from leaking in. The drain usually is placed in a gravel pack covered with sand and may lead to a conduit or a reservoir. The protective structure may be made of concrete or masonry and the seal is usually made of puddled clay and sometimes plastic. A screened overflow pipe guarantees that the water can flow freely out of the spring at all times. To prevent contamination from infiltrating from the surface, a ditch, known as the interceptor drain, diverts surface water away from the spring box and a fence keeps animals out of the spring area.

There are many types of spring captations, ranging from a simple headwall with backfill to more complicated structures like tunnel systems for collecting water from a larger area.

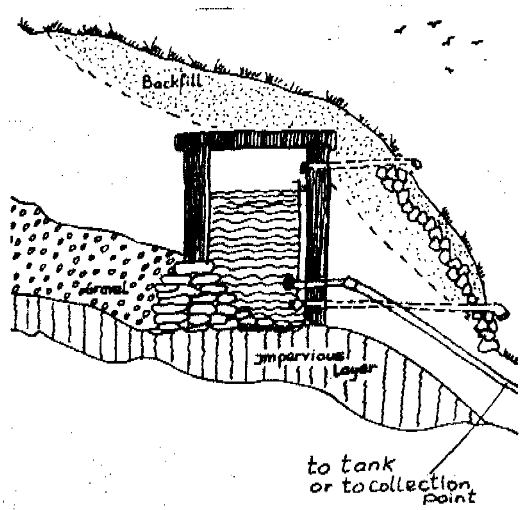
initial cost: Capital costs vary considerably and depend on a large number of factors. In Nepal a relatively large spring box serving 150 households including facilities for clothes washing was constructed for about US$1,000 (1989 data, Rienstra 1990), including costs for unskilled labour. In Kenya minor structures for an average of 110 persons were constructed costing US$200, including a headwall, backfill, fencing and labour and transportation costs. Major spring structures for an average of 350 persons cost about US$400 also including a spring box (1986 data, Nyangeri 1986).

dimensions: From 0.5 m^2 to many square metres.

yield: From less than 0.1 l/s to many l/s.

area of use: In areas where groundwater arrives at the surface, usually at hill or mountain sides.

construction: Spring water captation systems are constructed on-site, often by local craftsmen.



☐ Description of O&M activities

operation

Water should be permitted to flow out freely all the time to prevent it finding another way out of the aquifer. Operation may include activities such as opening or closing valves to divert the water to a reservoir, a conduit or a drain. Spring and surroundings must be kept clean.

maintenance

Prevent contamination (e.g. open defecation, latrines, cattle gathering places, use of pesticides/chemicals etc.) both in the area where the spring water infiltrates into the ground (if possible) and in the immediate surroundings of the spring.

Check the surface drains, animal-proof fence and gate and repair if necessary. Protect the vegetative cover both in the area where the spring water infiltrates into the ground (if possible) and in the immediate surroundings of the spring (prevent clogging of the aquifer by vegetative growth (roots) in the immediate surroundings of the spring). Check the water flow from the spring box. If there is an increase in turbidity or flow after a rainstorm, surface run-off has to be identified and the protection of the spring im;·oved. If water flow decreases, it has to be suspected that the collection system is clogged. It may then be necessary to take out the gravel and replace with new gravel, or, in case a seep collection system is used, to clean the collection pipes. Regular water samples must be taken and analyzed to check for evidence of faecal contamination.

Annually open the washout, remove all accumulated silt. Check all screens; replace (with non-rusting materials, e.g. copper or plastic screening) if damaged or blocked, clean if dirty. After cleaning, make sure to close the washout valve thoroughly and replace and seal the manhole cover. Disinfect the springbox every time a person has entered to clean or repair it or when bacteriological contamination is. Leaks in the protective seal or undermining of the headwall and damage caused by erosion or settlement of soil have to be repaired.

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean well surroundings	weekly	local		broom, bucket, hoe, machete
check turbidity	after each flood	local		
check water quantity	occasionally	local		bucket, watch
repair fence and clean surface drains	occasionally	local	wood, rope, wire	machete, axe, knife, hoe, spade, pick axe
check water quality	regularly	area	laboratory reagents	laboratory equipment
wash and disinfect spring	annually	local	chlorine	bucket, wrench, brush
repair piping and valves	occasionally	local or area	spare pipes and valves, cement, sand, gravel	bucket, trowel, wrench, flat spanners
repair cracks	annually	local	cement, sand, gravel, clay	bucket, trowel, hoe, spade, wheel barrow

☐ Actors implied and skills required in O&M

actor	role	skills
user	use water, report malfunctioning, keep site clean, assist in major repairs	no special skills
caretaker	keep site clean, check for damage, perform small repairs	basic skills
water committee	organize bigger repairs, control caretaker's work	organizational skills
mason	repair masonry or concrete	masonry
external support	check water quality, guide and stimulate local organization	microbial analysis, extension work

Organizational aspects

In many cases, springs are communally owned. Users may need to establish an organization that can effectively deal with issues such as the control or supervision of the water use, prevention of water contamination, execution of O&M activities, financing of O&M and monitoring of water quality, systems performance etc. Proper management may also contribute to preventing social conflict over these and other issues.

For the execution of O&M tasks at the spring site, a person who lives or farms near this site could be appointed. This person could also be made responsible for water allocation if water is obtained by the users near or at the site, and be involved in monitoring activities. His or her authority should be clear and accepted by all users □

Recurrent costs

Recurrent material costs are usually very low. The recurrent personnel costs, in cash or kind (for caretakers, watchmen, labourers, committee members and craftsmen), will need to be added but will usually be low as well. Total recurrent costs are usually less than US$1 per year per capita, which often even includes O&M costs for the water transport system. Several sources report that "O&M costs are minimal and, for this reason, spring water technology is the technology of choice wherever sites permit." Problems may arise though when a sudden large investment is needed for a large repair or replacement of the system.

□ Problems, limitations and remarks

frequent problems

Erosion or collapse of the spring box due to wrong design, construction errors, large surface run-off flows or damage caused by people or animals. Leaks in the box or leaking taps and valves. Contamination of the spring water due to cracks in the seal or to behaviour of people. Damaged piping because of faulty construction, abuse or corrosion. Improper drainage of surface runoff, outflow and wastewater. Clogged pipes because of siltation or plant roots. Poor accessibility for water users.

limitations

Springs may not deliver enough water or fall dry during certain parts of the year. Not all springs produce clean water of acceptable taste. Springs may be sited too far from the households or on privately owned land. In some cases, cost of construction, large repairs or replacement may be beyond the capacity of communities. Some spring water is very corrosive.

remarks

Usually spring water is of good quality but this should be checked; examples exist where the water was fed from a polluted stream that had gone underground or where the catchment area was contaminated. Unprotected springs are almost always contaminated at the outlet.

□ Recommended literature

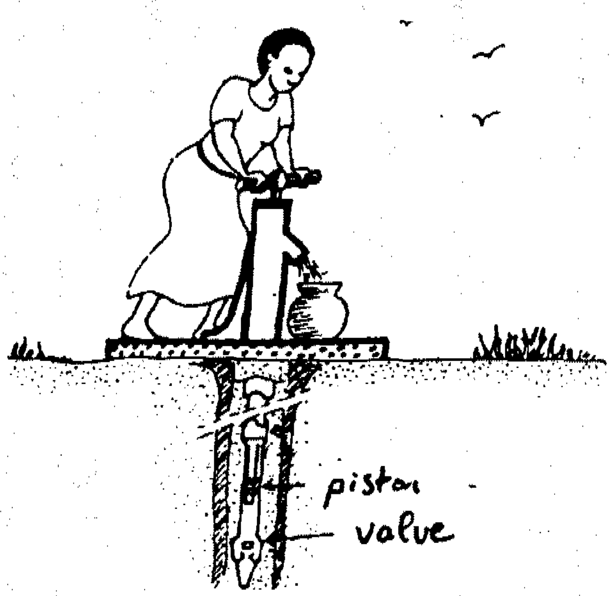
Nyangeri, Ezekiel E.N. (1986). (design; construction; O&M; socio-economic; case studies)

WEDC (1991). (design; construction)

Jordan, Thomas D. (1984). (design; construction; O&M; organization)

8.5 Direct Action Handpump

☐ Brief description of technology



Direct action handpumps are usually mainly made of PVC and other plastics and installed on boreholes of limited depth. The user at the pump stand directly moves the pump rod in an up-and-down motion, holding a T-bar handle. The plunger at the lower end of the pump rod is located under the groundwater level. On the up-stroke, the plunger lifts water into the rising main and replacement water is drawn into the cylinder through the foot valve. On the down-stroke, the foot valve closes, and water passes the plunger to be lifted on the next up-stroke. The elimination of the mechanical advantage (such as deepwell handpumps have through a lever or flywheel) restricts the application of direct action pumps to the depth from which an individual can physically lift the column of water (about 12 m). The mechanical simplicity and the potential for low-cost, lightweight construction makes these pumps well equipped to meet VLOM objectives.

initial cost: Varying from about US$100 to over 900 *(1985 prices, Arlosoroff et al.,* 1987). Models that are particularly suitable for village level O&M cost less than US$150.

range of depth: 0-12 m.

yield: 0.25-0.42 l/s at 12 m.

area of use: Rural and low-income peri-urban areas where groundwater tables are within 12 m from the surface.

construction: Blair; Ethiopia BP50; Malawi Mark V; Nira AF85; Tara; Wavin.

☐ Description of O&M activities

operation

Operation of the pump is done by moving a handle up and down. As the plunger is located under water, no priming is needed. Adults and even children can pump, although if the water table is below 5 m it may be difficult for children. Pump stand and site must be kept clean.

maintenance

Maintenance of direct action pumps is relatively simple and can be taught to users or caretakers, sometimes within a few hours.

For preventive maintenance usually only one or two persons are needed. Activities consist of checking pump performance and appearance of water daily (if the water is cloudy with silt, the borehole must be cleaned). The pump should be taken apart and checked annually.

Small repairs are the replacement of worn cupseals and washers straightening of bent pump rods and replacement of corroded lock nuts. For major repairs (e.g. broken pump rod or rising main, cracks in welding of metal parts), more highly skilled persons may be needed.

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean pump and site	daily	local		broom
check performance	daily	local		
check whole pump	annually	local		spanners, screwdriver
replace cupseals and washers	occasionally	local	cupseals washers	spanners, screwdriver
replace pump rod and/or pump handle	occasionally	local	pump rod pump handle	spanners, wrench
replace cylinder and/or plunger and/or foot valve	occasionally	local or area	cylinder plunger foot valve	spanners, wrench, screwdriver
repair rising mains	occasionally	local or area	PVC tubing, PVC solvent and sandpaper or GI tubing, teflon or hemp	saw and file or two pipe wrenches
repair pump platform	annually	local	cement, sand, gravel	bucket, trowel

☐ Actors implied and skills required in O&M

actor	role	skills
user	pump water keep site clean warn in case of malfunctioning	no special skills required
caretaker	keep site clean do small repairs check pump annually	basic maintenance skills
water committee	organize maintenance collect fees	basic organizational skills
local merchant	sell spare parts	no special skills
local or area mechanic	perform more major repairs	welding
external support	check water quality stimulate and guide local organization	microbial analysis, extension work

Organizational aspects

O&M can very well be organized at community level. As maintenance is relatively simple, a good organization will result in a reliable service.

☐ Recurrent costs

Apart from personnel costs, recurrent costs mainly consist of expenses for spare parts. In Ghana annual costs recently were found to be US$3.35 per capita per year or US$.61 per m^3, based on 15 l/capita/day, including capital amortization and other costs at an interest rate of 10 percent (Baumann 1993a). According to Reynolds (1992), a Tara handpump can be sustained for about US$.10 per user per year.

☐ Problems, limitations and remarks

frequent problems

Worn washers, plungers and foot valve parts.
Abrasion of the seal on the PVC cylinder and between the pump rod and rising main (nitrile rubber seals have proven substantially better). Broken or damaged handles.

limitations

The maximum lift is limited to about 12 m.
The forces required at the handle to pump the water may be too high for children, especially when the water table is below 5 m.

remarks

At least a moderate industrial base is recommended for manufacturing these pumps, because good quality PVC is needed. Some designs have a relatively low discharge.

☐ Recommended literature

Arlosoroff, Saul et al. (1987). (technical; planning; O&M; costs)

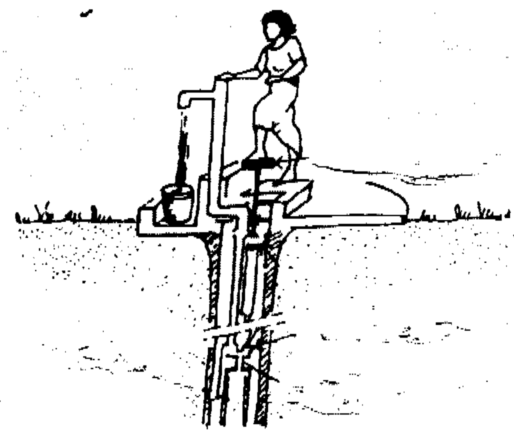
Reynolds, John (1992). (technical; performance; costs)

Morgan, Peter (1990). (Blair pump: design, installation and maintenance)

8.6 Deep well Diaphragm Pump

☐ Brief description of technology

Inside a cylindrical pump body at the bottom of the well, a flexible diaphragm shrinks and expands like a tube-shaped balloon, taking the water in through an inlet valve and forcing it out through an outlet valve connected to a flexible hose which leads it to the surface. The movement of the diaphragm is caused by a separate hydraulic circuit consisting of a cylinder and piston in the pump stand, and the water-filled pilot pipe which is also a flexible hose. The piston is moved, usually by pushing down a foot pedal, although conventional lever handles may also be used to apply such force. When foot pressure is removed, the elasticity of the diaphragm forces water out of it and back up the pilot pipe to lift the pedal. The pump models are still being improved and most imperfections have been corrected.



The principle of the pump is attractive because it allows the use of thin flexible hoses, making it easy to install or remove without the need for special tools or equipment. Replacing spare parts is usually easy; only replacement of the diaphragm may need the assistance of a skilled mechanic. It is possible to install several pumps in a single well or borehole.

initial cost: The whole pump, for a depth of 30 m: US$860 (1986 figures, Ministère de la Cooperation et du Développement/CIEH, 1990). Burkina Faso and Benin, 1993: Vergnet costs US$1460 - 1820 depending on installation depth, including 10% VAT. (Baumann, 1993a)

range of depth: 10 to 70 cm.
yield: 0.50 l/s at 10 m depth, 0.32 l/s at 30 m and 0.24 l/s at 45 m. Some publications state lower yields.
useful life: 8 years.
area of use: Burkina Faso, Mali, Cameroon, Ghana, Mauritania, Liberia, Niger.
construction: Vergnet; ABI-ASM (no longer in production).

☐ Description of O&M activities

operation

Operation is done by pushing down a pedal by foot (or, in certain types, by a handle). Considerable effort is needed to push the pedal, which is acceptable since full body weight can be applied. Some reports state difficulty for operation by children and pregnant women.

maintenance

Every day, the pump head, platform and surroundings are cleaned; nuts and bolts must be tight. Every month the drive piston, rings and guide bushing are checked and replaced if necessary. Depending on borehole conditions and at least once a year, the downhole parts have to be checked and the whole pump is washed with clean water. A major repair is the replacement of the diaphragm. This has to be done every 2 to 5 years. Some diaphragms are supplied with a 3 year guarantee.

The pump can be extracted from a well and re-installed within half an hour by a village pump caretaker. Only one spanner is needed to service the pump. The plunger seals in the cylinder at the pump stand can easily be replaced by a village pump caretaker and cost very little. Replacement of the diaphragm will require a skilled mechanic (some mechanics have even been able to repair ruptured diaphragms).

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean pump and site	daily	local		broom, bucket
grease pump stand parts	weekly	local	grease	lubricator
check whole pump	monthly	local		spanner
replace piston parts	occasionally	local	piston seal, pedal rod guide etc.	spanner
replace in- and outlet washers	occasionally	local	washers	spanner
replace diaphragm	every 3 to 5 years	area	diaphragm	spanner
repair platform	annually	local	sand, cement, gravel	trowel, bucket

☐ Actors implied and skills required in O&M

actor	role	skills
user	pump water keep site clean warn in case of malfunctioning	no special skills
caretaker	keep site clean perform small repairs	basic maintenance
area mechanic	replace diaphragm	specific skill
water committee	supervise caretaker collect fees	organizing skills
external support	check water quality, stimulate and guide local organization	microbial analysis, extension work

Organizational aspects

Deep well diaphragm pumps are typically communal pumps. The water committee should appoint a caretaker who lives close to the pump site. This person will need some training for maintenance and hygiene. The committee should be able to get in contact with the area mechanic fast and it must have the financial means to pay directly and in cash for repairs. Area mechanics need special training for replacement of the diaphragm. Often the supplier of the pump provides maintenance facilities.

☐ Recurrent costs

Recurrent costs per pump were found to be US$360 in the first 35 months of a pump's lifetime, This did not include replacement of the diaphragm because these were still functioning during the time of the investigation (Burkina Faso, Mohamed, 1989). Vergnet reports the cost of a diaphragm to be US$150 (1995, personal communication). Diaphragms are reported to need replacement once every two to five years. The recurrent costs in cash or kind for caretakers and committee members, and a mechanic in case the diaphragm needs to be replaced, will need to be added.

☐ *Problems, limitations and remarks*

frequent problems

Pedal rod guides and plunger seals are the parts that need to be replaced most regularly; also plunger guides have been reported to wear out relatively quickly. Drive hoses often get unprimed due to leakage past the plunger seals, leading to the need to raise the foot pedals by hand. When solid particles enter the down hole pumping element this may cause the diaphragm to become inoperative and finally be ruptured if it is not cleaned.

limitations

Some sources mention that the pump is unsuitable for use by children or pregnant women due to the high force required at the pedal at greater depths. When the community is unable to suddenly pay the high costs for replacement of the diaphragm or when no skilled mechanic is available when such replacement is needed, users may temporarily be forced to return to their traditional sources.

remarks

Production of the pump stand requires moderate skills in steel fabrication and fitting, while the pumping element demands advanced manufacturing techniques and tight quality control. In many countries it will thus remain necessary to import these parts.

☐ Recommended literature

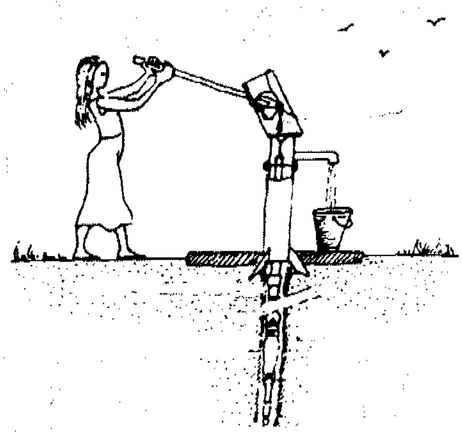
Arlosoroff, Saul et al. (1987). (technical; planning; O&M; costs)

Fonseka, Joe and Baumann, Erich (1994). (maintenance; costs)

8.7 Deep well Piston Handpump

☐ Brief description of technology

In a deep well piston handpump, the piston is placed in a cylinder below the water level which is usually in the range of 15 to 45 m below the ground. The pumping motion by the user at the pump stand is transferred to the piston by means of a series of connected pumping rods inside the rising main. On the up-stroke, the plunger lifts water into the rising main and replacement water is drawn into the cylinder through the footvalve. On the down-stroke, the footvalve closes, and water passes the plunger to be lifted on the next up-stroke. The pumping height is limited only by the effort needed to lift water to the surface. Nowadays most cylinders have an open top which allows the piston and footvalve to be removed through the rising main for servicing and repairs while the rising main and cylinder can stay in place. The pump rods have special connectors allowing for assembly and dismantling with no or only very simple tools. The joints incorporate pump rod centralizers that prevent wear of the rising main. To a large extent improved models can be maintained at village level.



initial cost: For well depths between 25 - 35 m, prices vary from about US$40 for a cylinder, plunger and footvalve set to be installed under a locally made pump head, to over US$2300 for a complete pump with many stainless steel parts. (1985 prices, Arlosoroff et al.) Most good pumps cost between US$300 and 500

range of depth: 15 - 45 m, depths up to about 100 m are possible

yield: 0.25 - 0.36 l/s at 25 m and 0.18 - 0.28 l/s at 45 m depth

useful life: 6 to 12 years

area of use: Rural and low-income peri-urban areas where groundwater tables are within 100 m but preferably within 45 m from the surface

construction: Afridev/Aquadev; Bestobell Micro; Bush pump; Blair pump; India Mark II and III; Kardia; Tropic (Duba); UPM; Volanta; etc.

☐ Description of O&M activities

operation

Operation of the pump is done by moving a handle up and down or by rotating the handle of a flywheel. This can be done by adults and even children. Handle forces are usually kept within acceptable limits (depending on brand and lifting heights). Pump and site must be kept clean.

maintenance

Preventive maintenance usually consists of checking pump functioning and cleaning pump and site daily, greasing weakly, checking all parts of the pump stand monthly and taking the whole pump apart for a check, cleaning the parts with clean water and painting the pump stand annually.

Pump rods that show bad corrosion must be replaced. Under normal conditions, a galvanized steel pump rod needs replacement every five to six years. Rising mains consisting of galvanized iron have to be removed and checked and pipes with badly corroded threads must be replaced. Small repairs are the replacement of bearings, cupseals and washers, straightening bent pumping rods etc. Major repairs may involve the replacement of the plunger, footvalve, cylinder, pump rods, rising main, pump handle, fulcrum etc. With open top cylinder pumps, all preventive maintenance activities can normally be executed by a village pump caretaker. For major repairs and problems external support may be needed. Closed top cylinder pumps often need special lifting equipment to pull up the rising main and cylinder for maintenance of parts down in the hole.

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean pump and site	daily	local		broom, brush
grease bearings	weekly	local	grease or oil	lubricator
check pump stand parts	monthly	local		spanner
replace pump stand parts	occasionally	local	nuts and bolts, bearings, pump handle	spanners, screwdriver
replace cupseals	annually or less	local or area	cupseals	spanners, wrench, knife, screwdriver etc.
redo threads in pump rod or main	occasionally	local or area	oil	pipe threader, tackle
replace footvalve, plunger or cylinder	occasionally	area	footvalve, plunger or cylinder	spanners, wrench
replace pump rod or main	occasionally	area	pump rods or main tubing	spanners, wrench, pipe threader
repair platform	annually	local	gravel sand, cement	bucket, trowel

☐ Actors implied and skills required in O&M

actor	role	skills
user	pump water keep site clean warn in case of malfunctioning	no special skills
caretaker	keep site clean regularly check pump do small repairs	basic maintenance
water committee	supervise caretaker collect fees	organizing skills
area mechanic	perform more major repairs	some special skills, depending on brand
external support	check water quality, stimulate and guide local organization	microbial analysis, extension work

Organizational aspects

Most deep well pumps are too expensive for family use and will have to be used at communal level. The price of these pumps also means extra importance of fundraising. Communities have to organize themselves in order to maintain the pump in good working condition. Often a caretaker is appointed and a pump committee coordinates activities. External support is often provided by state or non-governmental organizations but becomes costly. In some cases small private enterprises, paid directly by the communities, are now doing this job very satisfactorily.

☐ Recurrent costs

The costs for preventive maintenance may range between US$12 and 60 per pump per year for spare parts and materials (based on price indications from several brands). The recurrent personnel costs, in cash or kind (for caretakers, committee members, and, in case larger repairs are needed, mechanics or other skilled people) will need to be added.

☐ Problems, limitations and remarks

frequent problems

Replacement of plunger seals is the most common repair needed. Problems with local manufacture, centering mostly around quality control, are often reported, especially in African countries.

Hook and eye connections of pump rods tend to break more often than conventional connections. Rods also reportly get disconnected or bend spontaneously sometimes.

Especially where groundwater is corrosive, corrosion has been reported to affect the pump rods (if not made of stainless steel), the rising main (if GI), the cylinder, and the pump head bearing housing and other pump stand parts. Broken or shaky handles, mainly due to worn out or otherwise affected bearings. The number of problems usually increases with increasing groundwater depth.

limitations

The maximum lift differs per brand, varying between about 45 and 100 m. The forces required to turn the handle of the pump may be high in certain cases, depending on the brand and on the depth of the well.

remarks

The quality of the material used for the rising main should be as high as possible to reduce the number of repairs needed on this part. Many of these pumps can be produced in developing countries. Rigorous quality control is needed. Piston pumps may be driven by a windmill but often rotary pumps are preferred because of their lower starting torque.

☐ Recommended literature

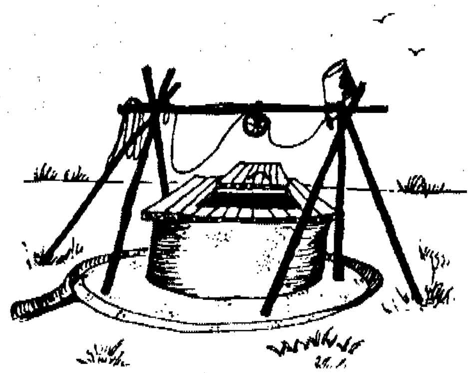
Arlosoroff, Saul et al. (1987). (technical; planning; O&M; costs)

Reynolds, John (1992). (technical; performance; costs)

8.8 Rope and Bucket

☐ Brief description of technology

Mostly used with handdug wells. A bucket on a rope is lowered into the water. When hitting the water, the bucket dips and fills itself and is pulled up with the rope. The rope might be held only with the hands, run through a pulley or be wound on a windlass. Sometimes animal traction is used in combination with a pulley. Improved systems use a rope through a pulley and two buckets, one on each end of the rope. For water depths of less than 10 m, one can use a windlass with a hose running from the bottom of the bucket to a spout at the side of the well. Even with this system and a protected well, hygiene is poorer than with a bucket pump.



rope to US$150 with a windlass, hose and closed superstructure in Liberia. (Milkov 1987).

range of depth: 0-15 m (greater depths are possible).
yield: 0.25 l/s at 10 m.
area of use: All over the world, mainly in rural areas.
construction: Buckets, ropes, pulleys and windlasses are manufactured locally; buckets and ropes also by larger industries.

☐ Description of O&M activities

operation

Lower and raise the bucket by paying out and pulling in the rope or rotating the windlass. One must be careful not to dirty the rope or bucket.

maintenance

Preventive maintenance consists of greasing the bearings of the windlass or pulley.
Small repairs are limited to patching of holes in bucket and hose, reconnecting hinge of bucket and fixing windlass bearings or handle. All repairs can be done by local people and with tools and materials available in the community or area.

More major repairs and replacement mainly consist of replacing a bucket, hose, rope or part or all of the windlass. Woven nylon ropes may last two years, twined nylon or sisal ropes only last a couple of months. A good quality hose may last over two years and buckets, depending on material and quality, may last a year.

For well maintenance: see fact sheet on dug wells. For well disinfection: see fact sheet on chlorination.

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
grease axles of windlass or pulley	every two weeks	local	grease or oil	lubricator
replace bucket	each year	local	bucket, wire	knife
replace rope	every two years	local	rope, wire	knife
replace hose	every two years	local	hose, wire, rubber straps from tyres	knife, tongs

☐ Actors implied and skills required in O&M

actor	role	skills
user	lower and lift the bucket keep site clean warn in case of malfunctioning	no special skills
caretaker	keep site clean, do small repairs	basic maintenance
water committee	organize well cleaning, collect fees	organizing skills
local artisan	repair of bucket, windlass, well cover, etc.	tinnery, carpentry
shopkeeper/trader	sale of rope, bucket, etc.	no special skills
external support	check water quality, stimulate and guide local organization	microbial analysis, extension work

Organizational aspects

When people use their own rope and bucket, no extra organization is required. For community wells, usually a community committee organizes the maintenance and cleaning of the well, maintenance of the windlass, etc. Most repairs can be paid with ad hoc fund raising.

☐ Recurrent costs

Consist of occasional purchase of rope, bucket, hose, wire, etc.; occasional repair costs of windlass are low. Annual per capita costs for rope and bucket in Upper Volta were reported to range from US$.56 to 1.36 (Hofkes, 1983). These costs varied with well depth and family size. For costs of well disinfection see fact sheet on pot chlorination.

☐ Problems, limitations and remarks

frequent problems

Fast deterioration of bad quality rope. Sisal rope only lasts for a few months. Bucket falls into well. To prevent this, communities can keep a spare bucket available and fit the bucket in a protective cage, for instance like the design described in Carty, D. (1990). In windlass with hose systems the hose breaks frequently.

limitations

Very poor hygiene, especially when rope and bucket touch hands or ground. Communal wells often tend to get more contaminated than family-owned wells. Therefore the latter should be aimed for where possible. Only suitable for limited depths, although examples are known of rope and bucket systems exceeding 50 m

remarks

See also Fact Sheet 4.4 on dug wells.

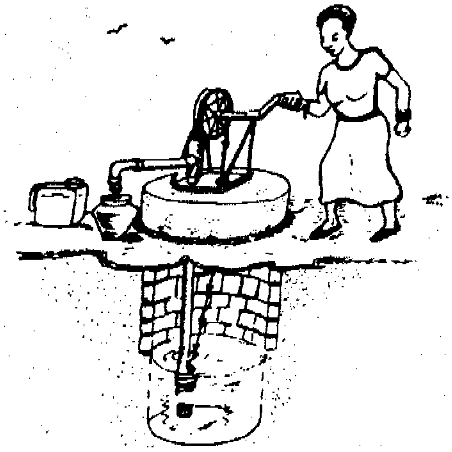
☐ Recommended literature

Morgan, Peter (1990). (design, construction, O&M, hygiene)

8.9 Rope Pump

☐ Brief description of technology

The basic parts of a rope pump are a pulley wheel above the well, a riser pipe from under the water level to an outlet just under the wheel, and a rope with rubber or plastic washers that goes through the pipe, over the wheel, back down into the well and into the pipe again. When the wheel is being turned, the upward moving washers lift water into the pipe towards the outflow. Other important parts are an underwater rope guide that guides the re-entrance of the rope and washers into the pipe, and the frame structure that holds the wheel. The rope pump can be made completely at village level using wood, an old car tyre, rope and PVC or bored out bamboo tubing.



In Nicaragua, local industries produce an improved type with a metal wheel and frame, industry-made washers and a guide block of concrete with a piece of ceramic and PVC tubes.

Over 5,000 of these pumps are working. Water can be lifted from up to 50 m below ground level and delivered 5 m above it. Special models for 3-inch boreholes exist and combinations with windmills and small gasoline engines are giving good results.

initial cost: US$15 - 35 for a traditional model and US$90 for a commercial handmoved model with piping (1995 data, Nicaragua).
range of depth: 0 - 50 m.

yield: 0.6 l/a at 10 m, 0.15 l/s at 50 m.
area of use: Rural and peri-urban areas of Nicaragua, Bolivia, Indonesia, Ghana, Burkina Faso and other countries.
construction: Many local manufacturers.

☐ Description of O&M activities

operation

This can be done by men, women and children. Turning the handle of the pulley wheel makes the water come up. After pumping, the wheel has to be held for a moment in order to drain the water in the riser pipe and to prevent the washers from being pulled back in the pipe, which would cause extra wear. Site and pump must be kept clean.

maintenance

Depending on use and type of bearings, at intervals not to exceed one week, the axle bearings must be greased. Fixation of the pulley wheel and other parts have to be checked regularly and the rope must be checked for excessive wear. Users have to observe performance of the pump. Most problems occur with the rope or washers getting stuck or slipping over the pulley wheel. About every six months till every three years, the rope has to be replaced, which takes about half an hour, and every few years the washers have to be renewed. Tubes last for at least six years and, depending on construction, maintenance and use, the frame and pulley wheel of the pump can last from six to twelve years. The rope guide should last for several years. To change it the rising main should be taken out, which can be done by hand by a few people. All repairs can be done by the users themselves, sometimes with the assistance of a craftsman for welding.

☐

O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
grease bearings	weekly	local	grease or oil	lubricator
check rope and frame structure	weekly	local		
replace rope	annually	local	nylon rope	knife
paint frame	annually	local	anticorrosive paint	steelbrush, paintbrush
replace washers	every two years	local	washers or old car tyre	knife
replace tubes	every six years	local	PVC tubing, solvent cement	saw, file
repair platform	every year	local	cement, sand, gravel	trowel, bucket
replace guideblock	occasionally	local	wire, strips of car inner tube, guideblock or wood and drinking glass	pliers, knife, hammer and chisel
repair frame structure	occasionally	local or area	wood and nails or scraps of metal and welding electrodes or acetylene and oxygene	welding equipment or hammer, chisel and saw

☐ Actors implied and skills required in O&M

actor	role	skills
user	pump water, observe functioning of pump	no special skills
caretaker	lubricate, check rope, clean site	basic skills
water committee	supervise caretaker, collect fees	organizational skills
local or area craftsman	repair pulley and frame structure	carpentry for wooden structure, welding for metal structure
external support	control water quality, guide and stimulate organization.	microbial analysis, extension work

Organizational aspects

Rope pumps are used by communities and individual households. Maintenance needs are simple but frequent. Users should take good care of their pump. Hygiene is more important than with many other types of pump. In case of communal use, these factors require very good users organization.

☐ Recurrent costs

Recurrent costs are for new rope and pistons, paint, bearings, guide block, rising main, outlet spout, etc. and may rise to a low average cost per year.

☐ Problems, limitations and remarks

frequent problems

Excessive wear of the rope because of exposure to sun. Poor installation of inferior quality, pulley or guide block. Problems with the pulley wheel. Poor quality of pistons, frame structure, pulley and guide block. Rope exposed to open environment, needs to be protected.

limitations

Traditional rope pumps have a lift of only about 10 m. The pump requires more care by users than many other pumps and is more susceptible to contamination.

remarks

Although quality of design and construction may differ significantly , the rope pump has the potential to be low in cost and operated and maintained at the village level.

☐ Recommended literature

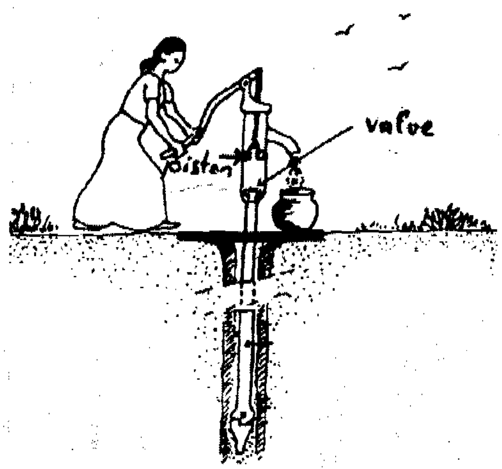
Hemert, Bernard van et al. (1992). (design; construction; O&M; organization)

Lammerink, M. et al. (1995). (performance; socio-economic)

8.10 Suction Plunger Handpump

☐ Brief description of technology

A suction plunger handpump has its cylinder and plunger (or piston) located above the water level, usually within the pump stand itself. These pumps must be primed by pouring water on the plunger. On the up-stroke of the plunger, the pressure in the suction pipe is reduced and the atmospheric pressure on the water outside pushes the water up into this pipe. On the down-stroke, a check valve at the inlet of the suction pipe closes and water passes the plunger through the opened plunger valve. With the next upstroke this water is pushed up by the plunger and flows out at the top while new water flows up in the suction pipe. The barometric pressure and the effectiveness of the seals limit the maximum suction height to about 7 m at sea level and less at higher altitude.



initial cost: US$35 (Thailand 1985 including 10 m galvanized iron drop pipe and footvalve) to US$185 (Wasp pump, India 1983 price without suction pipe) (Arlosoroff et al, 1987).
range of depth: 0 - 7 m.
yield: 0.4 to 0.6 l/s at 7m.
area of use: In rural and low-income peri-urban areas where groundwater tables are within 7 m from the surface.

trademarks: AID Suction; Bandung, Inalsa Suction; Jetmatic Suction; Lucky, New No. 6; Rower, SYB-100; Wasp.

☐ Description of O&M activities

operation

Operation begins with priming the pump by pouring clean water on the plunger through the top of the pump stand. Pumping is done by moving a handle up and down, usually while standing beside the pump. With the rower pump, the user sits. Most suction handpumps can be easily operated by men, women and children.

maintenance

With most or all moving parts above ground level, suction pumps are relatively easy to maintain. This can normally be done by a village pump caretaker or by the users themselves, using simple tools, basic spare parts and materials (it must be noted that several brands cannot be completely maintained at local level). The basic skills needed for preventive maintenance (e.g. greasing, being able to take pump-stand apart, replace spare parts etc.) can be taught to pump caretakers within a time span varying from a few hours to a few days, depending on the complexity of the system, materials used etc.

Preventive maintenance consists of greasing bearings every week, inspection of the interior of the pump stand once a month and inspection of the whole pump stand once a year. Most things can be done by one or two persons but depending on the total weight of these parts more people may be needed when pump parts have to be lifted out of the well or borehole.

During these inspections, smaller repairs like replacement of washers etc. may prove to be necessary.
For major repairs (e.g. broken rising main, cracks in welding of metal parts), higher skilled persons as well as more specialized tools and materials may be needed.

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
prime	daily	local	clean water	bucket or can
check functioning	daily	local		
clean site	daily	local		broom
grease pump stand parts	weekly	local	oil or grease	lubricator
check pump stand parts	monthly	local		spanners
adjust loose bolts	occasionally	local		spanners
replace pump stand parts	occasionally	local or area	washers, cupseals, bearings etc.	
check whole pump	annually	local or area		spanners, pipe wrench etc. depending on model
replace worn parts	annually	local or area	washers, cupseals, bearings etc.	spanners, pipe wrench etc. depending on model
repair broken parts	occasionally	area	welding electrodes	spanners, pipe wrench, welder, file, etc, depending on model
paint pump stand	annually	local	anticorrosive paint	brush
repair platform	annually	local	sand, cement	bucket, trowel

☐ Actors implied and skills required in O&M

actor	role	skills
user	pump water warn in case of malfunctioning	no special skills required
local caretaker	ensure after proper use of pump give regular maintenance perform simple repairs keep pump and site clean	basic skills
water committee	check work of caretaker collect contributions for maintenance and repairs	organizational skills
area technician	perform major repairs	metalworking skills, treading, welding
local or area merchant	sell spare parts	no special skills
external support	check water quality, stimulate and guide local organization	microbial analysis, extension work

Organizational aspects

Many suction handpumps are family pumps and are cared for by one family. For communal pumps the user group or community will need an organization with several skilled persons. The more complex types of pumps may need some special organization for more major repairs. Private enterprises sometimes play an important role in performing repairs and selling spare parts.

☐ Recurrent costs

Apart from the fees for the caretaker and the water committee, recurrent costs consist of new washers, cup-seals and bearings about every year, depending on brand and use of the pump and quality of the water. Plunger, valves and plunger rod may need to be replaced too. Some pumps may function without major problems for over seven years, but weaker designs may fail within a year when conditions are harsh.

☐ Problems, limitations and remarks

frequent problems

Worn washers, cupseals and bearings. Excessive corrosion causing broken pump rods and leaks in rising mains. Low quality of many pumps.

limitations

The maximum pumping lift of about 7 m is the biggest drawback of suction pumps. If the water table falls below that level, the pump becomes inoperable and must be replaced with a deep well pump. Suction pumps must be primed, for which contaminated water is often used. Most pumps are designed for family use and are not sturdy enough for more intensive communal use.

remarks

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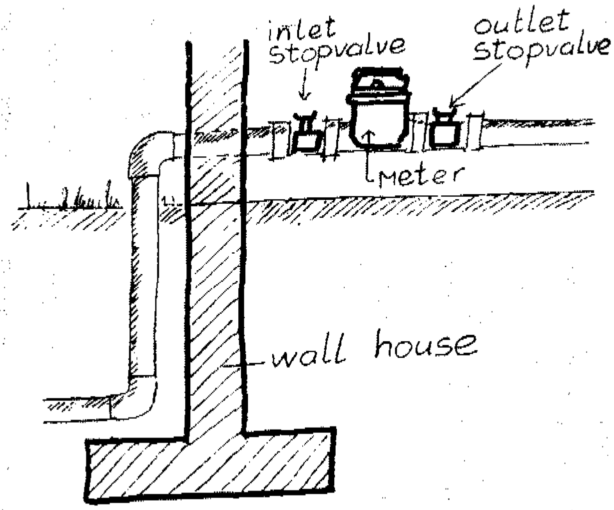
☐ Recommended literature

Arlosoroff, Saul et al. (1987). (technical; planning; O&M; costs)

8.11 Domestic Connection

☐ Brief description of technology



When enough water and funds are available, it can be an option to connect every house or yard to a piped water system. This is more convenient for water users, generally increases water use and improves hygiene. A service pipe, usually made of polyethylene or PVC leads from the distribution network to the house or the yard. It leads to a single tap on a post or to a system of pipes and taps in the house. At the entry point to the premises, a gate valve and a water meter can be installed. Drainage facilities must also be provided.

The residual pressure head of the water at household connections preferably should be between 10 and 30 metres and should never be under 7 or over 60 metres. A combination of charged household and free public water outlets in one community is not recommended.

initial cost: Costs depend very much on what is included. A very simple connection with a wooden standpost could cost as little as US$10, not including manpower and extra distribution tubing.

user per connection: Usually one (extended) family.

yield: 0.225 l/s per tap

area of use: Piped water systems all over the world.

☐ Description of O&M activities

operation

Taps are used throughout the day. They should not be left open or leak. Formation of mud and pools by wastewater must be avoided. The tap and site have to be cleaned daily and the drain inspected.

maintenance

Once in a while a rubber washer or other part of the tap may have to be replaced. Any structure on the tap site and the drainage system may need repairing too. Occasionally the tubing may leak or need replacement. For maintenance of a water meter, see Fact Sheet 8.7 on small flow water meters.

☐ O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
tap water	daily	local		jar, bucket, can etc.
clean site	daily	local		broom or brush
inspect and clean drain	daily	local		hoe, spade
repair or replace valve	occasionally	local	rubber or leather washer, gland seal, Teflon, flax, spare valve	spanners, screwdriver, pipe wrench
repair valvestand, apron or drain	occasionally	local	wood, nails, cement, sand, water, etc.	hammer, saw, trowel, bucket, etc.
repair piping	occasionally	local	pipe nipples, connectors, elbows etc., oil, Teflon, flax or plumbing putty	pipe wrench, pipe cutter, saw, file, pipe threader

☐ Actors implied and skills required in O&M

actor	role	skills
user	tap water, keep site clean	no special skills
mason	*repair tapstand and apron*	masonry
plumber	repair piping and taps	basic plumbing
water committee	monitor hygiene habits, train household members	training skills, understanding of hygiene
external support	check water quality, train water committee	microbial analysis, training skills

Organizational aspects

Operation and maintenance of the connection are organized by the household itself. Occasionally, the community water committee may check hygiene habits and inform people on how to improve these. When water is scarce or pressure is too low in part of the network, the water committee has to motivate or force users to limit their water use. A network with household connections is more complicated than one with public tapstands but some management aspects may be simpler because no tapstand committees are needed.

☐ Recurrent costs

Recurrent cost for a domestic connection comprise one or two minor repairs of the tap per year and occasionally some repair of the pipes, site and drainage system.

☐ Problems, limitations and remarks

frequent problems

Uncontrolled leakage. Unfair distribution of water between the households.

limitations

Initial costs for household connections are higher. Also the network gets more complicated to maintain. If water is scarce, it may be difficult to guarantee water for all.

remarks

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☐ Recommended literature

Jordan, Thomas D. (1984). (design; construction)

8.12 Public Standpost

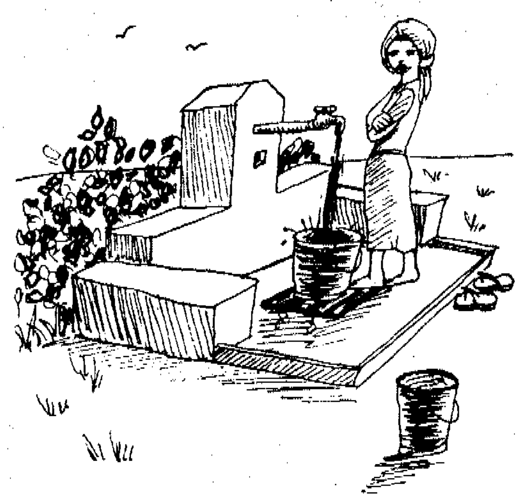
☐ Brief description of technology

At a public standpost or tapstand people from various households can get water from one or more taps. Because they are used by many people and often not so well taken care of, the design and construction have to be more sturdy than with domestic connections. The standpost includes a service connection to the supplying water conduit, a supporting column or wall and one or more 0.5 inch protruding far enough from this column or wall to enable easy filling of the water containers. The taps can be a globe or a self-closing type. The column or wall may be of wood, brickwork, dry stone masonry, concrete, etc. Some standposts have a regulating valve in the connection to the mains that can be set and locked to limit maximum flow. Also a water meter may be included (see Fact Sheet 8.7 on small flow water meters). A solid stone or concrete slab or apron under the tap and a drainage system must lead spilled water away and prevent the formation of muddy pools. A fence may be needed to keep cattle away.

The residual pressure head of the water at the tapstand should preferably be between 10 and 30 metres and should never be under 7 or over 56 metres. Location and design for a public standpost have to be determined in close cooperation with future users.

initial cost: In 1995 a self-closing tap for 0.5 to 1-inch pipes costs US$12 (UNDP/APSO, 1995). Cheaper taps can be found. Other costs depend largely on standpost design.

number of taps: 1 to 3 and more.



☐ Description of O&M activities

operation

Water users clean and fill their containers at the tap. Bathing and washing of clothes is usually not permitted at the standpost itself. The tap site has to be cleaned daily and the drain inspected.

maintenance

The drain must be cleaned at least once a month. Formation of pools must be prevented at all times. Once in a while a rubber washer or other part of a tap may have to be replaced. The fence may need repair too. If the structure gets serious cracks it must be repaired, and when wood rots it must be treated or replaced. Occasionally the tubing may leak or need replacement. For maintenance of a water meter, see Fact Sheet 8.7 on small flow water meters.