Training Curriculum for Community-based Volunteers
Repair and Maintenance of Water Supply Systems

ECHO DRR Project
Kenya and Uganda

Humanitarian Aid and Civil Protection

Kenya Red Cross

Uganda Red Cross Society

International Federation of Red Cross and Red Crescent Societies

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Strategy 2020 voices the collective determination of the IFRC to move forward in tackling the major challenges that confront humanity in the next decade. Informed by the needs and vulnerabilities of the diverse communities with whom we work, as well as the basic rights and freedoms to which all are entitled, this strategy seeks to benefit all who look to Red Cross Red Crescent to help to build a more humane, dignified and peaceful world.

Over the next ten years, the collective focus of the IFRC will be on achieving the following strategic aims:

1. **Save lives, protect livelihoods and strengthen recovery from disasters and crises**
2. **Enable healthy and safe living**
3. **Promote social inclusion and a culture of non-violence and peace**

Table of contents

Foreword

Volunteers and communities are at the heart of the International Federation of Red Cross and Red Crescent Societies' mission to mobilize the power of humanity and improve the lives of vulnerable people. Red Cross volunteers play a vital role in helping to meet today's humanitarian challenges, not just during disasters and emergencies, but also in early recovery and on a day-to-day basis in their own communities.

Assisted by the European Community Humanitarian Office (ECHO), the International Federation of Red Cross and Red Crescent Societies (IFRC) has developed this curriculum to be used by National Societies to mobilize and train volunteers on community-based water supply and sanitation. Volunteers will be trained to carry out activities in the community, with a belief that local volunteers better understand how a particular community lives and works, as well as their water and sanitation needs.

Work done by Red Cross volunteers is integrated into existing water and sanitation services and mechanisms offered by governments, which usually become stretched during times of crises. Yet during these times, there are more people in need and they have a greater vulnerability.

This curriculum will be used to train Red Cross volunteers who will be called upon by government during times of crisis.

Creating a core group of easily available, readily deployable first responders is a way of strengthening water and sanitation services and public infrastructure systems by creating a surge of capacity when there is sudden need. The group of trained first responders will be given full identification that introduces them to support the government during times of crisis.

This new and innovative method of creating surge capacity is a Disaster Risk Reduction (DRR) activity that not only builds resilience in the community, but also creates a mechanism for good and timely early response to a crisis.

Abbreviations

AC	Alternating current
DC	Direct current
DRR	Disaster risk reduction
ECHO	European Commission Humanitarian Aid and Civil Protection
EWS	Early warning systems
FAO	Food and Agriculture Organisation of the United Nations
GI	Galvanised iron
HH	Household
IFRC	International Federation of Red Cross and Red Crescent Societies
M & E	Monitoring and evaluation
NGO	Non-governmental organisation
O and M	Operation and maintenance
OXFAM-GB	OXFAM Great Britain
PE	Polyethylene
PVC	Polyvinylchloride
Q & A	Questions and answers
RWH	Rainwater harvesting
SWOT	Strengths, weaknesses, opportunities, threats
TNA	Training needs assessment
TOT	Training of trainers
UNICEF	United Nations Children's Fund
WASH	Water Sanitation and Hygiene (UN notation)
WatSan	Water Sanitation and Hygiene (RC/RC notation)
WUA	Water users association

Note to the user

This curriculum is designed to facilitate the acquisition of knowledge, skills and attitudes for effective delivery of water supply and sanitation services by community-based volunteers.

The curriculum is presented in a simple format designed for easy understanding and practical implementation. It has been designed with close reference to other curricula developed by different partners in Kenya and Uganda, in particular the resource 'A Trainer's Manual for Community-managed Water Supplies in Kenya' (FAO & UNICEF, 2012). A list of references used in designing and developing the curriculum is provided at the end of this document.

Each module is split into separate topics, which cover:
- expected outputs
- timing
- appropriate methodology
- materials required
- all technical content (including repair and maintenance requirements, handouts, key templates and reference materials)
- safety rules
- evaluation.

Introduction

Community-based volunteers are individuals chosen by the community, who have been trained by Red Cross Red Crescent National Societies in various fields such as disaster preparedness, disaster response, health promotion or water and sanitation.

Community-based volunteers are at the front line of emergencies and are the most important resource for Red Cross Red Crescent National Societies. They assist their own communities and provide the critical link to National Societies' structures during disasters and other crises, such as drought, malnutrition, floods, earthquakes, conflicts and epidemics.

Community-based volunteers are best placed to provide this vital support because:

- Having local knowledge of local risks and vulnerabilities ensures that the actual needs of the community are addressed.
- Local actions prevent risks at their source, by avoiding exposure to local hazards - such as lack of access to water due to drought.
- A prepared, active and well-organized community can reduce their vulnerability and the impact of emergencies.
- Many lives can be saved in the first hours after an emergency before external help arrives.

Community-based volunteers benefit the people served, their communities and ultimately society because:

- Their services meet real needs and priorities for individuals and communities, as they bring new energy, capacity and creative ideas.
- Community residents have opportunities to build positive relationships with these volunteers which, in the long run, help the volunteers transform their communities.
- Where these volunteers are youth, communities see them in a different way - as resources, not problems. A new generation of caring and experienced citizens, activists and volunteers is cultivated.

Roles and functions of community-based volunteers

Community-based volunteers can cover a wide range of roles; but not every community-based volunteer will perform every job. Community-based volunteers will perform the following:

- provide assistance to government and to other actors during and in between times of drought, food insecurity and nutrition crisis by sensitizing communities
- repair and maintenance of water supply systems
- conduct regular sanitary surveys of water supply systems in their community
- report repair and maintenance actions undertaken, and areas where external support are required to relevant local government actors.

Target audience/group

This curriculum is specifically to train community-based volunteers or local artisans and technicians on the repair and maintenance of water systems.

These people could be independent or existing members of the following bodies, as long as they are permanent residents of the target communities:

- Water Management Committees
- Water Management Boards (Uganda) and Water Users Association (Kenya).

Selection criteria

Community-based volunteers should have the following qualities:

General qualifications

- Permanent residents in the target area
- Be willing to work within the community
- Ability to read and write
- Knowledge of local language
- Dependable
- Own or have a reference mobile phone

Specific qualifications

- Have basic technical knowledge/skills
- Hands-on and practical

Curriculum objectives

Overall goal: To develop a community-based surge capacity for water and sanitation-related emergencies in Kenya and Uganda.

Each topic has its own specific expected outputs and objectives, which are reflected in the curriculum and session guides below.

Training duration

The duration of the training will be five days. The training will be divided into five modules with a number of topics as listed below.

1. Training and facilitation

Selection criteria of facilitators

At all times, priority should be given to facilitators within the target community before outsourcing (liaise with Water Service Board, District Water Officers, Water Resources Management Authorities, or other implementing organizations in the target areas).

Facilitators should be experienced in community training, and have specialist skills in a water field e.g. engineering, water quality, surveying etc.

Introduction to the training process

Training is the process of imparting knowledge, skills and competence to an individual or group of people with the aim of improving their capacity to carry out a particular task or responsibility. Along with governance, community participation and customer relations, financial management and cross-cutting issues such as gender, poverty and environment, a key area that this curriculum focuses on in community-based water supply management is operation and maintenance (O and M):

- Water supply infrastructure is used on a daily basis and requires maintenance to prevent unexpected interruptions to supply, high repair costs and poor-quality services, and to increase its lifespan.

Effective and proper training which is carefully designed and implemented should lead to improved capacity and performance by the individual or group of people. Remember that the key point in training is to impart new knowledge, assist participants to develop their skills and encourage them to change their attitudes towards specific aspects of community-based water supply management.

A training programme is a set of activities and tasks that is put together in a way that aims to impart knowledge and/or instruction to improve the recipient's performance or to help them attain a required level of knowledge or skill. This curriculum gives guidance on training materials, approaches to training and on the methodologies used to achieve the key objectives and meet the needs of the participants.

Characteristics of a good trainer

Good trainers and facilitators have the following qualities and attributes:[1]

- **Be well organized:** Read the trainers guide before training so that you are well prepared and know how to handle your sessions.
- **Practise beforehand:** Know how to conduct the sessions in the local language. You will have to get used to translating phrases.
- **Be friendly:** Make everyone feel comfortable and part of the group.
- **Be observant:** As well as listening closely, learn information about the situation from non-verbal cues.
- **Use open questions:** These are questions that encourage people to give their own opinions, rather than a "yes/no" or single response. Example: "What problems do you have with your water sources?" or "How can you raise money for the new facility?" These questions facilitate open discussion. They allow people to express their own ideas and find their own solutions without fear of giving a wrong answer.
- **Wait for responses:** Give people time to think and come up with an answer. Do not bombard them with more questions.
- **Do not rush:** Find the pace that people feel comfortable with.
- **Do not do all the talking:** Remember, your job is to ask questions and get participants to do the talking.
- **Encourage everyone to contribute:** Make eye contact, use hand gestures, walk close to shy people and use people's names. Try to draw out the silent and control the talkative.
- **Use minimal encouragers:** "Yes … I see … And then? … Tell me more". They help to keep the person talking.
- **Listen actively:** Use eye contact and body language. Praise and encourage but do not over-praise.
- **Rephrase:** Briefly restate what people say in your own words, to make sure you have heard and understood correctly. When you rephrase make sure to do two things – 1) verify with the speaker if you have understood correctly, and 2) see if others want to add something.
- **Be gender aware:** Encourage women to be active in the discussions.
- **Probe:** Do not be satisfied with one answer. Ask follow-up questions to explore issues and make it clearer – "Why? What else? … Tell me more. Can you explain further?"
- **Redirecting** is a way of building on one person's answer in order to get others involved in the discussion. Example: "She said … What do others think?"

1 *Taken from UNICEF, FAO and OXFAM GB 2012. A Trainer's Manual for Community-managed Water Supplies in Kenya (Version 1). UNICEF-Kenya Country Office, FAO and OXFAM GB, Nairobi, Kenya.*

- **Check the level of participation:** Look around and see who is participating and who is not involved. Are people still interested?

- **Summarize:** Restate what people have said in a simple, brief form. This will make it easier for people to contribute.

- **Watch the energy levels:** Look for signs of tiredness or boredom. When people get tired, change the activity, introduce a song, or take a break.

- **Be a good time manager:** Estimate how much time each activity takes, watch the time and set an appropriate pace for the group.

- **Be flexible in planning:** Create an atmosphere of flexibility, creativity and experimentation and develop insight into the learning process of the participants while using time efficiently to organize learning situations in a good sequence.

- **Be open and self-reflective:** Be open to feedback from the participants about the way you work and take time to examine your own attitudes, values and ideas.

Encouraging participation

Various different techniques can be used to get information from a group, encourage participation and to keep the sessions as exciting and interesting as possible:[2]

- **Use warm-ups and energizers:** Warm-ups and energizers are not training techniques but they form an essential part of training. They are used to change the tempo of a session and encourage participants to move about and relax after spending time sitting in a discussion. Energizers should be active and humorous. Always be aware of the mood of the participants.

- **Use of questions during training:** The effective use of questions is one of the most important skills needed by trainers. By asking questions, you help the participants to think for themselves and it stimulates a process of discovery. If participants think about a problem and come up with an answer themselves, they are much more likely to remember the information than if you just told them that information as the trainer.

- **Use practical instruction:** Practical instruction is used to teach participants a skill, such as how to service a diesel engine or how to repair a handpump. Practical instruction is based on the principle that people learn by doing. Practice time for every participant forms a major part of the training session.

- **Use discussions, hum groups and buzz groups:** There are various types of discussion techniques used in participative training courses. The most common are the paired discussion (sometimes called a hum) and the group discussion (sometimes called a buzz group). A paired discussion involves dividing participants into pairs and asking them to discuss a problem or task, such as: "List the factors that limit the availability of borehole spare parts in your area of operation". During a discussion with all participants for both hum and buzz groups, you as the facilitator should ask probing questions to stimulate

2 *Taken from UNICEF, FAO and OXFAM GB 2012. A Trainer's Manual for Community-managed Water Supplies in Kenya (Version 1). UNICEF-Kenya Country Office, FAO and OXFAM GB, Nairobi, Kenya.*

debate, share experiences and encourage participants to come to a consensus on issues, or agree to differ in their opinion.

- **Encourage brainstorming:** One type of discussion method is brainstorming. This is a lively method used for gaining a rapid overview of participants' knowledge or ideas on a particular issue. A brainstorm should be run for 10 to 15 minutes. It is used to switch to a new subject; examine a subject very broadly; obtain 30 to 40 ideas quickly; and to create a lively atmosphere and wake people up and re-energize them.

- **Use debate:** Debate is useful for encouraging participants to think for themselves and identify key points for and against a particular issue. They also have to work as a team, decide which points to present during the debate and select a speaker to forward their views. An example of a debate can be technology choice between a solar-powered or diesel-powered water pump.

- **Come up with plays and drama for participants:** Plays and drama are extremely useful training techniques because they can be used to focus on real-life problems in an active way, especially where participants are encouraged to act out issues themselves. For example, problem plays are used specifically to pose a problem or issue. A short play depicting a problem and lasting only two to three minutes is enacted at the beginning of the session. Participants are then asked to draw out and analyse the causes of the problems, discuss how it related to their life situation and then to suggest solutions or strategies for tackling that problem.

- **Use pictures:** Pictures can be used to analyse issues that are difficult to depict in a play, such as overgrazing of animals around a borehole. The picture used should show only one problem and should not show possible solutions. It should be a simple line drawing, avoiding too much shading and colour, and with no abstract symbols that might confuse the picture.

- **Give participants exercises:** Exercises are used to give participants practice in certain skills and knowledge they have learnt. Examples include calculations of revenue to be expected at the end of the month, based on volume of water consumed and number of consumers, etc. You as a facilitator can prepare hypothetical problems and tasks and then ask participants to work through them. These exercises can be used to test the skills and knowledge of individual participants and so you can ask each person to work alone. When everyone has finished the exercise, these can be discussed in plenary (combined group).

- **Use training visits:** During training visits, participants are taken to a specific site outside the training venue e.g., a public water point for livestock. Training visits are very useful for putting theory into practice in a real situation. It is important that the visit is well-structured with specific learning objectives.

- **Use of stories, songs, fables and poetry:** Many rural or pastoral communities belong to societies that have a strong oral tradition in which stories, songs, fables and poetry form an important part of cultural life. Stories can be told by the facilitator or the participants, and can be an effective way of raising important issues during training.

- **Use games:** Games can be used to raise issues about behaviour and attitudes, such as how people behave in groups, conflict resolution, cooperation and teamwork. Games can also raise participants' awareness about how their behaviour as individuals and as a group affects others in both positive and negative way. The session should be structured with clear objectives and key learning points drawn out.

- **Use of training aids:** Training aids are used to help illustrate and reinforce key learning points during training. A wide range of training aids is available, such as flip charts and coloured markers, chalkboard and chalk, photographs, pictures, models, computer presentation systems e.g., video, slides and overhead projectors. The choice of training aids depends on many factors such as cost, electricity supply, literacy of the participants, the subject being covered in the training, etc.

Adult learning techniques

As a trainer or facilitator, you need to be conscious of the best approaches for conveying messages to adults. The method chosen for training adults influences the rate of learning and retention of new knowledge and skills. A combination of approaches is strongly recommended. See the example from Kenya below and the following tips for supporting adult learning.[3]

Example from the field, Kenya:
Five borehole attendants being trained to service diesel engines in Samburu District in Kenya were far more confident and competent in simple servicing of diesel engines and in identifying which parts were to be replaced because the trainer had demonstrated the process while they were all watching. After the demonstration, the most confident one was encouraged to demonstrate to the others how to service the engine and explain the process clearly. Each one of them got the opportunity to demonstrate and explain the process to others. The trainer assisted the trainees with any problems, and checked that each individual had acquired the relevant skills by the end of the training session. When trainees understood the role of each spare part and which tools to use in the process, they were more eager to service the engines properly. Their increased confidence also showed itself in reduced engine breakdowns.

Lesson:
Adults learn best when they do things practically (hands-on) and are able to teach others and immediately use the skills and knowledge they have acquired.

The following are various points related to adult learning:

a. Adults are often concerned that participating in a group will make them look weak, either professionally or personally

- Design training sessions that help people feel **safe** enough to ask questions and **confident** that they will be respected.
- Do not ask people to take **risks** too early in a workshop or course (e.g., engaging in a role-play exercise) unless they already know each other well.
- Provide opportunities and allow time for people to establish themselves in the group.

b. Adults bring a great deal of experience and knowledge to any learning situation

- Show **respect** for participants' experience by asking them to share ideas, opinions and knowledge.

3 *Taken from UNICEF, FAO and OXFAM GB 2012. A Trainer's Manual for Community-managed Water Supplies in Kenya (Version 1). UNICEF-Kenya Country Office, FAO and OXFAM GB, Nairobi, Kenya.*

- Verbally **recognize** that they may be a good resource for reaching your teaching goals. If you already know the participants, you may realize that particular individuals can provide helpful input before, during, or after your session(s).

c. Adults are decision-makers and self-directed learners
- Do not seek to make people obey you. Adults will do what they need to do.
- Be the **'guide on the side'** rather than the 'sage on the stage'.
- Listen to what they want and need and **be flexible** in your planning. **Seek feedback** from the group. Change your approach if your agenda or methods are not working.

d. Adults are motivated by information or tasks that they find meaningful
- Conduct some type of training **needs assessment** so that you are aware of what people want (and need) to learn, how much they already know, and the kinds of 'generative themes' that might affect their attention span.

e. Adults have many responsibilities and can be impatient when their time is wasted
- Be **thoughtful** and **kind**.
- Begin and end your session on time.
- Understand who is in the audience and why they are participating.
- Learn what questions they have about the subject.
- Don't cover material they already know unless there is a good reason for doing so.
- Recognize that your subject is only one of many that participants may be interested in learning more about.

Training evaluation

The training evaluation shall be done by means of the following:
- Question and answer sessions
- Demonstrations and simulation exercises (hands-on training)
- Field follow-up visits.

Certification

Skills will be evaluated four to six months after the training in a practical setting. If they are able to complete basic repair and maintenance tasks, they will be certified as a water technician according to the standards of the Governments of Kenya and Uganda.

2. Suggested training content and structure

Module title	Topic	Topic title	Time
1. Introduction	Topic 1	Introduction to the training: objectives and expectations	1 – 2 hours
2. Operation and maintenance for water supply systems	Topic 1	Introduction to operation and maintenance (O and M)	½ - 1 day
	Topic 2	Pipelines	2 hours
	Topic 3	Storage tanks	1 hour
	Topic 4	Consumer points	1 hour
	Topic 5	Dams and pans	1 hour
	Topic 6	Sand dams and subsurface dams	1 – 1½ hours
	Topic 7	Intakes	2 hours
	Topic 8	Shallow wells	2 hours
	Topic 9	Boreholes with submersible pumps	2 hours
	Topic 10	Roof catchment system for rainwater harvesting	1½ - 2 hours
	Topic 11	Handpumps	4 hours
	Topic 12	Wind pumps	4 hours
	Topic 13	Solar-powered pump systems	1 hour
	Topic 14	Diesel-powered generators	6 hours
3. Sanitary surveys	Topic 1	Sanitary surveys	2 hours
4. Preparing for a drought	Topic 1	Preparing for a drought and compiling an O and M schedule	2 hours
5. Certification	Topic 1	Technical certification of community-based volunteers	2 – 4 hours

Module 1: Introduction	
Topic 1: Introduction to the training	
Objectives	Participants have a clear understanding of: • Red Cross Red Crescent Movement and the role of community-based volunteers • key objectives of training • expectations after training (surge capacity for DRR)
Outputs	None
Timing	2 hours
Methodology	Presentation and discussion
Materials	Flip charts, markers, pens, notebooks
Session guide and content	
Red Cross Red Crescent Movement and role of community-based volunteers	Explain that National Red Cross Societies such as the Kenya Red Cross Society or the Uganda Red Cross Society are part of a wider humanitarian movement which assists vulnerable people without discrimination due to race, religion or status. Explain in more detail they key activities that Kenya or Uganda Red Cross Society is involved in (will depend on country and context). The National Red Cross Societies of Kenya and Uganda are mandated by their governments to carry out essential humanitarian and relief activities. Red Cross volunteers, living within the communities they serve, are among the first to witness the consequences of drought, food-insecurity and malnutrition. Volunteers are the most important component of the Red Cross movement, and are the foundation for all activities. Red Cross volunteers who have skills in the field of water supply and sanitation can provide assistance to the government and other actors, during and in-between drought and food-insecurity crises.
Objectives of training	Explain to participants that the overall goal of this training is to train and up-skill community-based volunteers or local artisans and technicians on the operation, repair and maintenance of water supply systems. By the end of the training, participants should be capable of carrying out basic operation, maintenance and repair tasks for various water supply systems. Participants should also be able to develop a basic operation and maintenance plan, and carry out a sanitary survey (including identify key recommended actions). Each topic below has its own specific expected outputs and objectives.
Expectations after training	Explain that as community-based volunteers, they will be able to perform the following: • provide assistance to government and to other actors during and in between times of drought, food insecurity and nutrition crisis by sensitizing communities • repair and maintenance of water supply systems • conduct regular sanitary surveys of water supply systems in their community • report repair and maintenance actions undertaken, and areas where external support are required to relevant local government actors.

Module 2: Operation and maintenance for water supply systems

Topic 1: Introduction to operation and maintenance

Objectives	Community members and committee members will have a better awareness of the proper O and M tasks and be able to link this to the cost of operating and maintaining their systems.
Outputs	• An O and M schedule • List of tools • List of suppliers with contact details • Contact numbers for individuals and organizations that can provide technical assistance or services for maintenance tasks or in case of unexpected breakdowns
Timing	Timing will vary according to each site. Allow ½ - 1 day.
Methodology	• Presentation, discussion and group exercises • Site walks around the system components
Materials	Flip charts, markers, pens, sample tools and equipment

Session guide and content

Mapping of the community water supply system

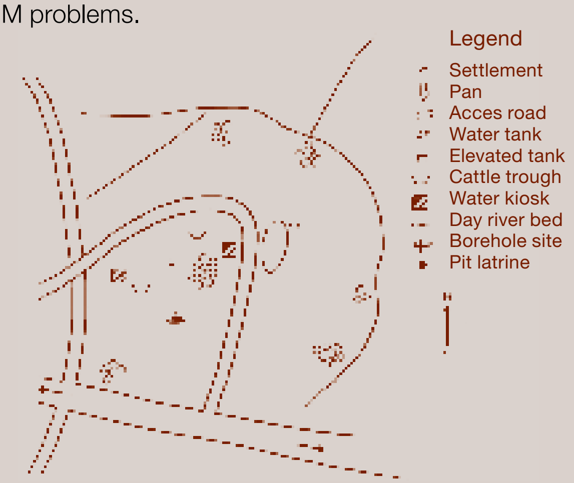
This is intended to be a practical session to gather information about the community and the specific components of their water supply system. It is important that the participants create their own map with minimal input or suggestions from the facilitator.

The facilitator should guide participants on a mapping exercise to identify water supply infrastructure within the community and follow that with a site walk to inspect the different components of the system, or different water points.

MAPPING EXERCISE

1. Start by selecting a suitable area to sketch a map on the ground.
2. Ask the group to use a flip chart and markers (or scrap materials) to make a map of their community and water system.
3. Ask some members of the group to take other participants on a tour of the map, including the main landmarks and water infrastructure components.
4. Based on the map and how people have described their community, initiate a discussion of issues on:
   a. What sort of problems make the systems non-operational
   b. Which part of the infrastructure is prone to problems
5. The facilitator should capture the features of the map onto a flip chart for future reference, with specific reference to the parts of the infrastructure that are prone to O and M problems.

Example map:



Site walk

With the training participants, undertake a site walk to inspect the different components of the system, making sure to visit the points that were identified in the mapping exercise as being prone to O and M problems.

At each component:
- review the purpose of the component
- the current status
- who is responsible for operating and/or maintaining it
- the O and M tasks that are undertaken at each site.

The purpose of the site walk is to confirm the problems already mentioned, to identify additional problems and to discuss possible solutions. This information will be used in developing the O and M schedule.

Identification of system components and common problems

Based on the mapping and site walk exercises, ask the participants to identify and name the different parts of the system, and explain the importance of each component.

For each component, get the group to state the purpose and the common problems. Draw a table on a flip chart similar to the one below and fill it in.

COMPONENT	PURPOSE	COMMON PROBLEMS

Identification of O and M problems

Start a discussion with the group about how the system performs as a whole with a few questions, such as:
- If the system stops working, is it usually because the water resource has run out or is it because the equipment or infrastructure has failed?
- When the system stops working, how long does it remain ‘not working’?

Ask the participants to name some problems that they associate with why the system does not work as well as it should. Note them down on a flip chart, and categorize the problems into four groups:
- organizational issues
- water resource issues
- design and expansion of the project
- O and M issues.

The intention is to focus on the O and M issues i.e., why the existing infrastructure is not working as well or as reliably as it should.

Developing an Operation and Maintenance Schedule

An O and M schedule is based on the understanding that performance is measured by the quality of service being provided.

Indicators of performance include:
- frequency of disruptions to supply
- length of disruptions to supply
- quality of water provided
- cost of water production versus payment charged and paid.

> Preventing a problem is much cheaper than fixing a problem. Preventing a problem keeps the system working. If the objective of the system is to provide a reliable service, then it is unacceptable for the system to break down or stop working.

It is better to stop the system briefly for routine maintenance than to wait until it breaks down.

The O and M schedule provides information on **what** has to be done, **by whom** and **when**.

A. Developing an O and M schedule
To develop an O and M schedule, go through each component of the system and discuss the tasks to be done, filling in the table below as required.

TASK	RESPONSIBLE	HOW OFTEN

B. Developing monitoring tools
It makes no sense to develop the O and M Schedule without ensuring that the tasks have been done. The easiest way to make sure that the tasks are carried out is to require the person responsible to sign off on a form when the task is completed. This means that a form or forms should be designed to suit the O and M schedule – this will be scheme and component specific.

The example below provides an indication of a monitoring tool for routine monthly maintenance tasks.

TASK	FREQUENCY	January	February	March	April
Change oil	Each month				
Patrol pipeline	Each month				

Inputs, spares, tools and technical assistance

Lead a discussion around the following topics:

A. INPUTS FOR ROUTINE OPERATIONS
Depending on the scheme or technology used, the project may require various supplies to operate properly.

These may include:
- fuel
- lubricants – oils and grease
- chemicals
- electricity
- meters for new connections
- fittings for new connections
- filters, etc.

Discuss the arrangements required to ensure that sufficient supplies are stockpiled and what measures need to be put in place to make sure that the availability of the supplies is not interrupted.

Issues include:
- stores – adequacy, access into, safety, security
- stores register
- requisition forms.

B. SPARE PARTS AND MATERIALS

Discuss which spare parts are required for routine maintenance and to handle emergencies. Draw up a list of the spare parts that the project should have available at all times.

These may include:
- filters for oil, fuel and air
- washers
- materials for pipeline repairs – glue, piping, fittings
- taps and tap washers
- spare locks
- replacement meters
- valves
- painting materials, solvents
- construction materials.

C. SUPPLY CHAIN

It is unwise to consider what spare parts are required without considering where these components are sourced. It is helpful to draw up a list of suppliers and to decide what minimum quantity of the spare parts and materials should be kept in the store.

When this minimum amount is reached, then a requisition form should be prepared to start the process of procuring additional spare parts and materials.

Spare	Minimum required in Store	Name and contact of Supplier 1	Name and contact of Supplier 2	Expected cost per unit on delivery

D. TOOLS

Discuss the tools required by every member of O and M staff. Draw up a list. Tools can be kept in the store room or officially issued to the appropriate Red Cross Red Crescent staff members.

SAMPLE TOOL LIST

Tools	Purpose(s)
1. Tool box	Storing tools
2. Wooden float 3. Steel float 4. Plastering trowel 5. Masonry trowel 6. Spirit level 7. Masonry hammer 8. Shovel	Masonry work
9. Steel brush 10. Die-stock 11. Joining compound 12. Pipe cutter 13. Chain spanner 14. Pipe wrenches 15. Pipe vice 16. Oil can	For GI (Galvanized Iron) pipework

17. Heating plate 18. Pocket-knife 19. File	For PVC pipework
20. Measuring tape 21. Hacksaw 22. Pliers 23. Sisal fibre	Multi-purpose tasks

See Handout 1: Essential tools for maintenance of water supply systems.

E. TECHNICAL ASSISTANCE AND SERVICES
Discuss with the participants how and from whom additional technical assistance should be obtained (e.g., local Red Cross Red Crescent branch, government, agency etc).

This information should be established before there is an emergency.

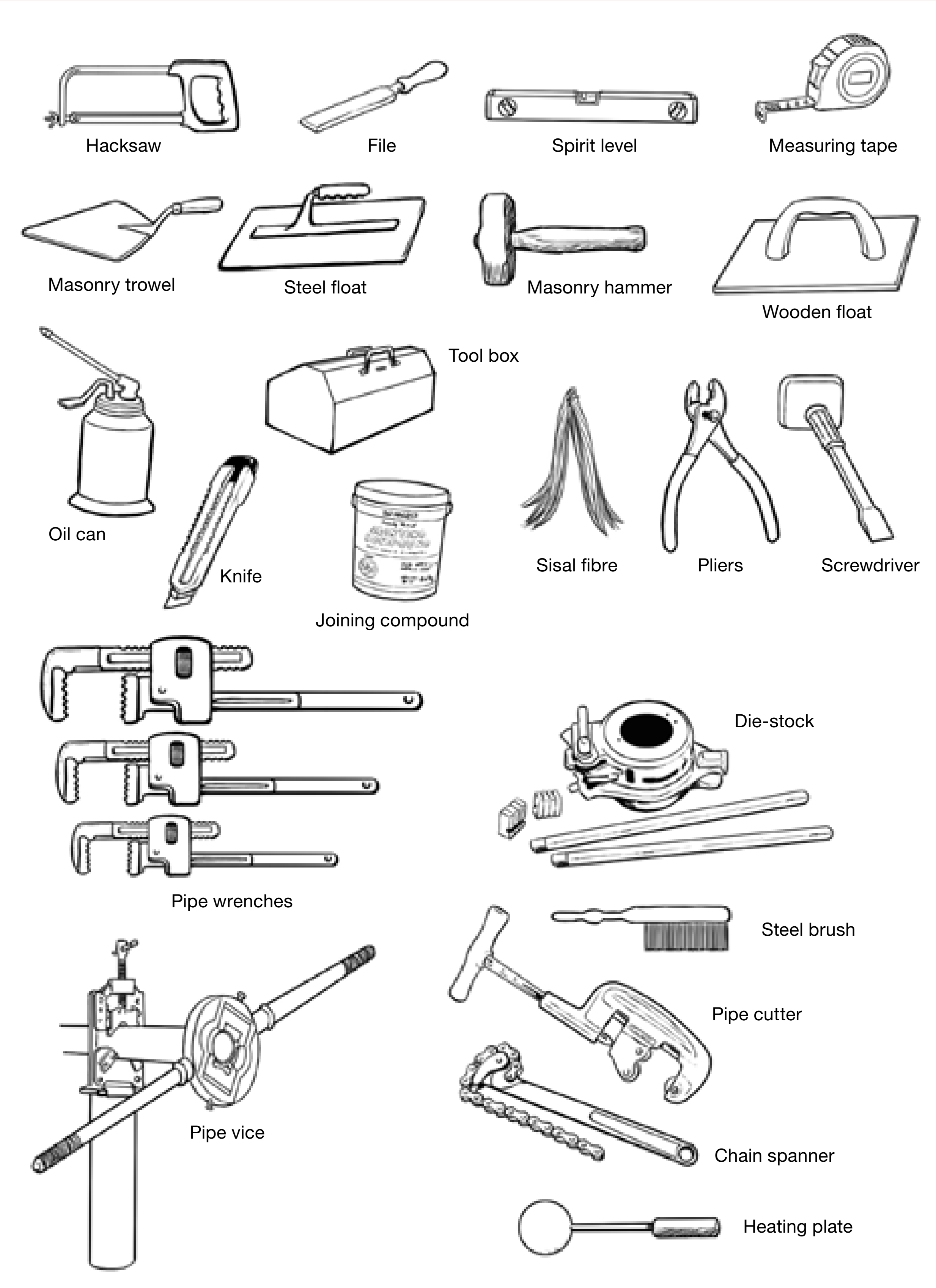
Technical assistance includes the services that are sourced from time to time or those individuals or offices to be contacted in case of a system breakdown. Draw up a list similar to the one shown below.

Component	Name of technical assistant	Contact details	Back-up contact	Contact details for back-up
Pump repair				
Generator repair				
Electrician				
Water quality				

Session handout

Handout 1: Essential tools for maintenance of water supply systems.

Handout 1: Essential tools for maintenance of water supply systems



Module 2: Operation and maintenance for water supply systems

Topic 2: Pipelines

Objectives	At the end of the session, the participants will be able to: • identify the main components of a pipeline • describe the functions of the key components • carry out pipeline maintenance
Outputs	An O and M schedule
Timing	2 hours
Methodology	This is intended to be a practical session. The components will be taught by demonstration of the system itself, not using drawings or descriptions. The flip chart can be used to illustrate details if necessary. Reinforce the learning by allowing participants to handle the parts and describe their functions to each other.
Materials	Valve key/wheel, pipe wrench, tools, tap, gate valve, non-return valve

Session guide and content

System identification

1. Gravity or pumped system

Using the diagrams in Handout 1 and 2, discuss the basic arrangement of the system:

- Is it a gravity or pumped system? (Note that many pumped systems also have a gravity component.)
- Which parts of the pipeline are under pressure?
- How much pressure? (Make an estimate if there are no pipeline profile drawings that show the pressure in different parts of the system.)
- How is the pressure controlled?
- What happens on a pumped scheme if there is a burst pipe? How about on a gravity system?
- Where are storage tanks positioned within a system?

2. Pipeline components

Identify and demonstrate the functions of the different components:

Component	Function
Source	Where the water originates
Intake	The structure to abstract the water from the source
Pumping main or gravity main line	The pipeline that conveys water to the storage tank(s)
Distribution lines	Pipeline branches from the main line or from the storage tank to the individual connections or water kiosks
Storage tanks	Installed to store water to supply peak demand
Break-pressure Tank	Decreases water pressure in the pipeline – brings pressure to atmospheric pressure
Pipe supports	Support the pipeline above ground; limit damage to pipeline during floods
Pipe markers	Mark the route of a buried pipeline
Control valves	Open or close the pipeline
Air valves	Release air from the high points in the pipeline

Washouts	Opened to clean out silt, sand and mud at low points in the pipeline
Meters	Master meter to measure abstraction; individual or kiosk meters to measure water consumed
Water points	Water kiosks, tap stands, cattle troughs and house connections

3. Valves
Note: Many valves do not work properly. This is frequently due to improper use or incorrect selection of the valve. Explain the differences between gate valves, non-return valves, washouts, air valves and stopcocks or taps, as outlined below:

Valves
1. Gate valves are designed to be fully open or fully closed.
2. Gate valves allow us to start or stop the flow of water in a pipe.
3. Gate valves should be opened or closed slowly to reduce the chance of hammer pressures.
4. Non-return valves control flow so that it goes in one direction only.
5. Air valves are placed at high points along a pipeline to release trapped air.
6. Washouts are placed at low points along a pipeline to drain the pipeline at a controlled point and to flush out any silt that has accumulated in the pipeline.
7. Stopcocks or taps can be used like a gate valve or to regulate flow.
8. Taps are most appropriate at consumer points because they are designed to be open and closed many times a day.

Specific pipeline O and M tasks

Ask participants what problems might occur if maintenance of the pipeline is not carried out properly. Identify components that require maintenance.

Typical maintenance tasks include:
- Repairing erosion around pipes and pipe supports.
- Repairing leaking or damaged pipes.
- Repairing damaged valve chambers.
- Checking for blocked or leaking air valves once a month.
- Opening washout valves once a month to clear silt (more often during periods of rain). Washouts should be opened and left open for a sufficient length of time to get water flowing fast to flush out all the silt. Check to see that all silt has been removed (look at colour of the water).
- Clearing any bush or shrubs along the pipeline route and keeping the pipe markers in a good condition.

Explain the importance of regular pipeline patrols. Ask how these patrols could be made easier.

A detailed session to demonstrate pipe repair may be necessary if the maintenance staff are not competent with the kind of repairs that are frequently needed. There are various ways of repairing pipe leakages, depending on the kind of pipe and materials available.

Allow the operator or plumber to demonstrate the repair technique (see Handout 3):
- repair of PVC pipes by heating pipe end to make a socket (OK for low pressure pipes).
- Repair of PVC pipes using a socket with rubber
- Repair of PVC pipes using a glued socket
- Repair of PE pipes using ready-made sockets
- Repair of GI pipes involving threading the pipe ends and inserting a union/joint fitting and replacement pipe length.

Discuss tasks to be considered during the preparation of an O and M schedule including:
- patrolling pipeline route identifying leaks, illegal connections, exposed pipe, damage to pipe cover, pipe markers or pipe supports
- opening washouts to clear out silt
- checking air valves to ensure all air has been released
- checking ballcocks and main valves
- reading the master meter
- reading individual or kiosk meters
- checking that consumption is in accordance with agreed uses.

Trouble shooting

Discuss the potential unexpected problems, what might be the causes and some possible solutions.

Problem	Probable Cause	Possible Solution
Numerous repeated breakages in pipeline	↘ Pipeline laid too shallow and pipe exposed to traffic loading Wrong type of pipe	↘ Consider relocating or replacing the pipeline. (Consult with a water engineer, qualified water technician or plumber.)
No water in pipe	↘ Breakage, burst ↘ Blockage – air lock ↘ Closed valve ↘ Source is dry ↘ Design problem	↘ Check pipeline carefully, starting at the intake level and check at various points whether water is reaching each point. (Consult with a water engineer or qualified water technician.)
Poor water quality	↘ Polluted raw water ↘ Burst that has Introduced Pollutants or sediments ↘ Faulty treatment	↘ Investigate the problem and identify a suitable solution. Carry out a water quality test if appropriate.
Low pressure	↘ High friction losses from movement of the pipework, restriction in pipes, bursts, low ↘ abstraction, excessive consumption	↘ Identify whether a maintenance solution will resolve low pressure; this may include water rationing, or the problem is related to a design issue. (Consult with a water engineer or qualified water technician.)

Spares, tools and technical assistance

Spare parts and materials for pipelines include:
- pipe lengths for the diameters common in the project
- fittings for appropriate diameters
- valves
- taps and tap washers
- threading tape
- glue.

Supply chain – most pipeline materials can be purchased at a well-provisioned hardware store.

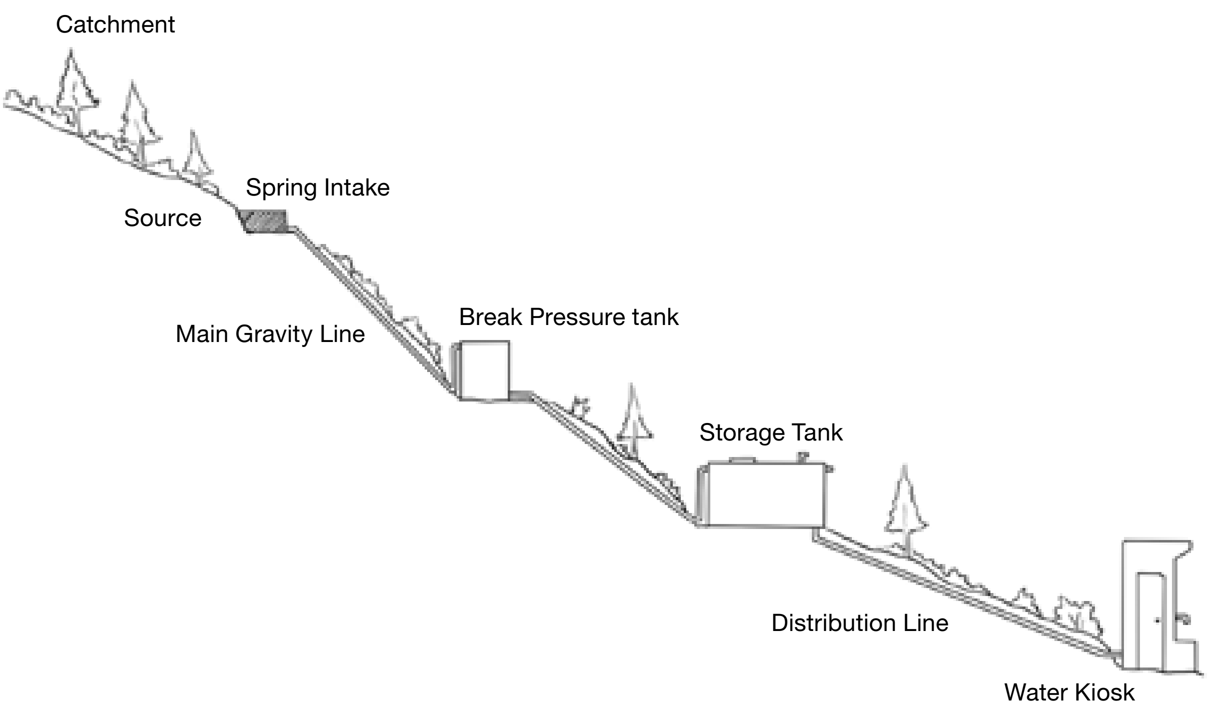
Technical assistance – this should be sought if a pipeline keeps bursting at a particular point.

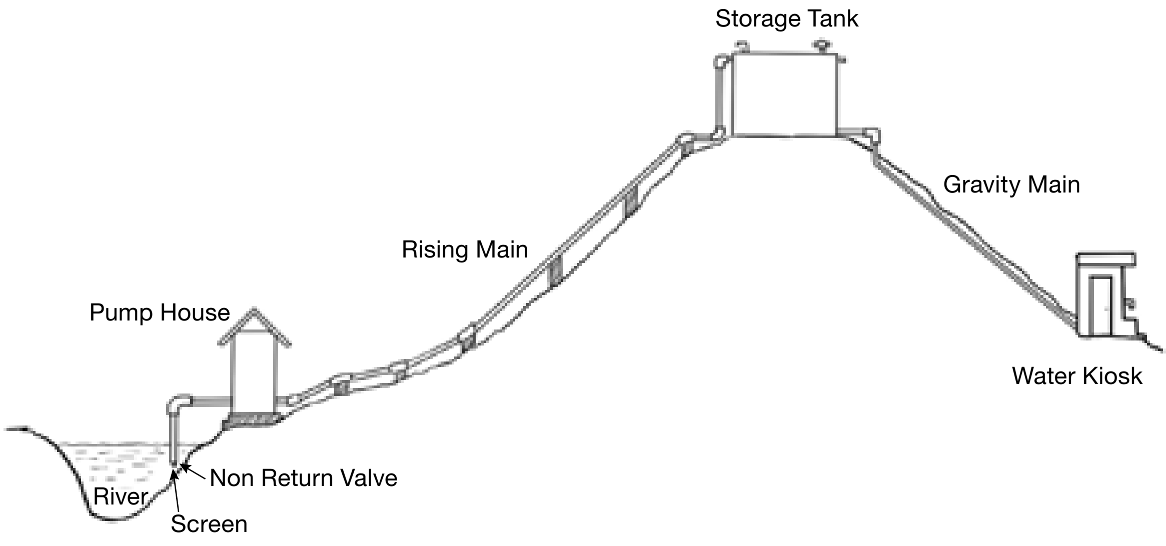
This may indicate:
- lack of anchor blocks or supports
- hammer pressures
- unusual stress on the pipe
- poor design.

Session handouts

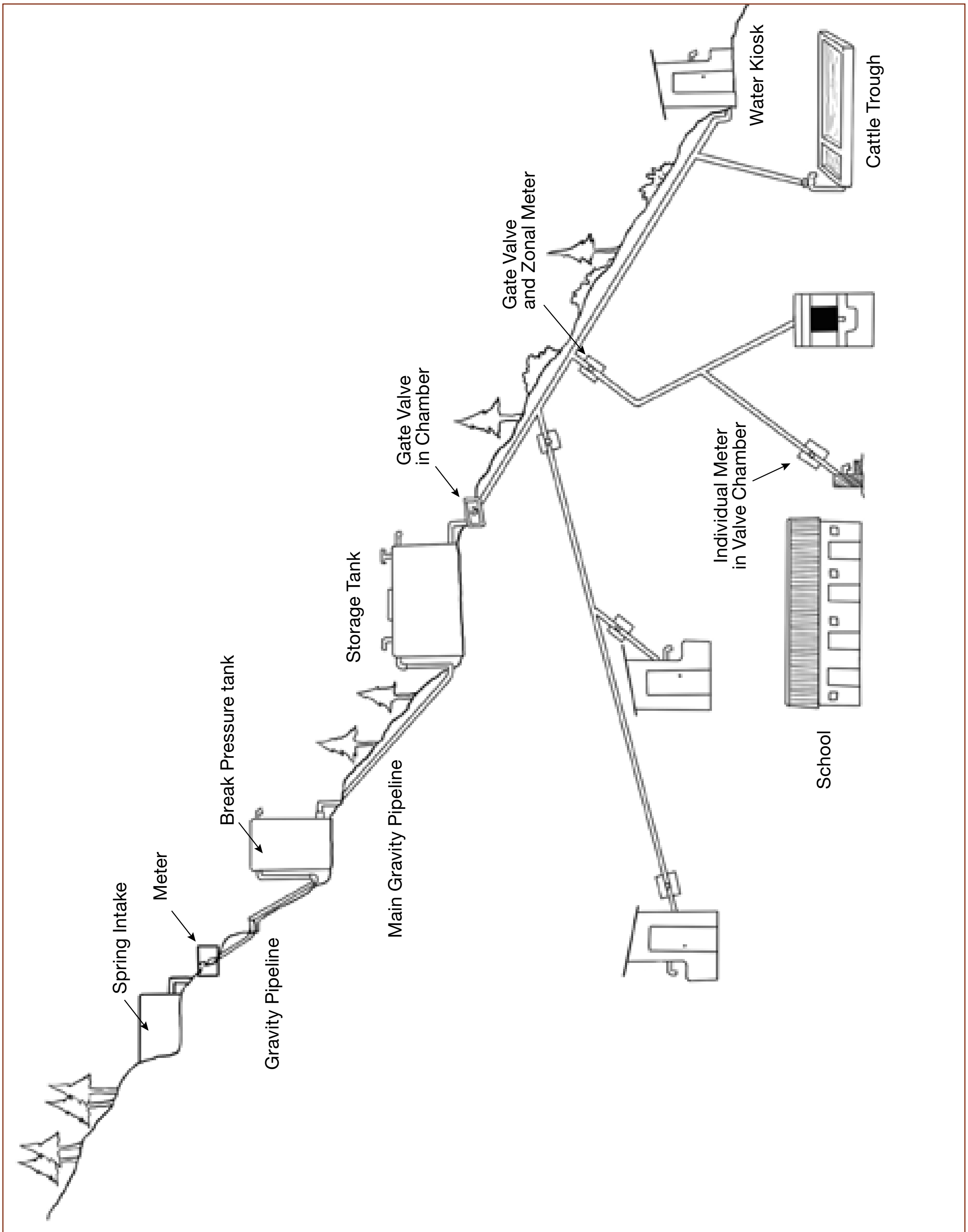
Handout 1: Gravity and pumped water supply systems
Handout 2: Typical pipe network
Handout 3: Repair of broken PVC pipe

Handout 1: Typical gravity and pumped water supply systems

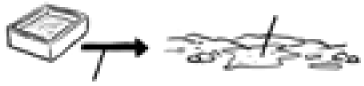




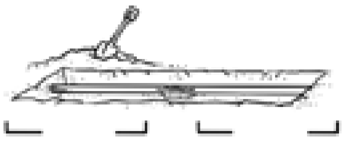
Handout 2: Typical pipe network



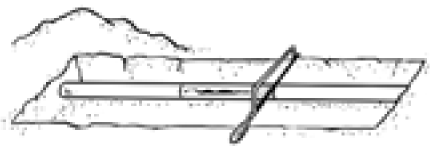
Handout 3: Repair of broken PVC pipe



1. Isolate the leaking section by closing the sluice or the gate valve.

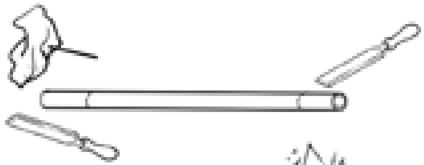


2. Dig the trench along the leaking pipe to find the leaking place that needs to be repaired. Dig the trench wide enough to give yourself working space. Dig the trench two meters on each side of the leaking point, to allow you to control the pipe.

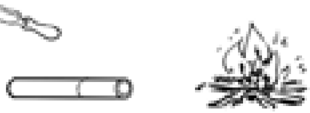


3. Cut out the leaking piece using a hack saw.

4. Cut out a new piece of pipe. The new piece must be longer than the old one. Measure the length of the old piece; add 75 millimetres on both ends. This will be your "socket pipe".

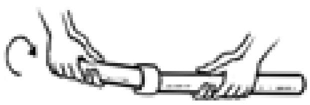


5. File the edges of the pipe where you cut. Clean the cut ends of the pipes with the mutton cloth. Also file and clean the ends of the pipes in the trench.



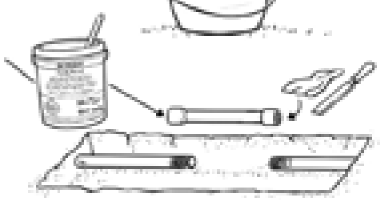
6. Cut a short piece of the same diameter pipe to use for forming the sockets. Make a small fire.

7. Heat the end of the socket pipe for a distance of 75 mm as your mark shows. Keep rotating the pipe so that it is equally heated all the way round.

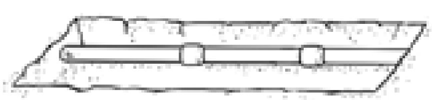


8. When the heated part is soft, insert the other short piece of pipe and rotate it until a socket is shaped. The socket should be 75 mm deep.

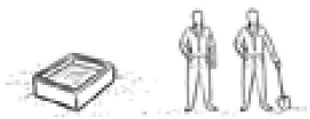
9. When the socket is correct, dip it unto a bucket of water to cool. Make another socket at the other end.



10. File the edges of the socket pipe. Clean the ends of the socket pipe with mutton cloth. Apply tangit inside the sockets and outside the pipe in the trench. Be sure to read the instructions on the tin of the tangit. Obey the instructions.



11. Connect the pipes. Do not move the connection for at least five minutes. Fill the trench except for the part that has been repaired. Do not let water go through for some hours. Turn on the water and check for leaks. If there are no leaks, cover the rest of the pipe.



This kind of repair needs two people, you and your relief operator.

Module 2: Operation and maintenance for water supply systems

Topic 3: Storage tanks

Objectives	At the end of the session, the participants will be able to: • identify the main components of a tank • describe the functions of the key components • carry out maintenance tasks.
Outputs	An O and M schedule
Timing	1 hour
Methodology	This is intended to be a practical session. The components will be taught by demonstration of the system itself, not using drawings or descriptions. The flip chart can be used to illustrate details if necessary. Reinforce the learning by allowing participants to handle the parts and describe their functions to each other.
Materials	• valve key/wheel • pipe wrench • brush or broom • materials to make tank repairs

Session guide and content

Introduction	Different kinds of tanks are available depending on the type of material they are made from, such as: • reinforced concrete (floor, walls, roof) • masonry walls on reinforced concrete floor and roof • rubble stone • brick • ferro cement • plastic • corrugated iron • steel. Tanks with different names occur in different kinds of projects relating to their function and placement, e.g.: • rainwater harvesting tank • rock catchment tank • Berkad (Somali name for an underground tank) • storage tank • break-pressure tank. The training session covers standard forms of tanks.
Identification of components	**Tank components** Using Handout 1, identify and demonstrate the functions of the key components:

COMPONENT	FUNCTION
Inlet valve	Valve to control flow into the tank; if closed, water does not enter tank
Inlet pipe	Lets water into tank above the tank's water level
Float valve	Valve on inlet pipe that automatically closes when the tank is full of water (not applicable on a rainwater harvesting (RWH) tank or a pumped rising main)
Washout	Pipe and valve that is opened to allow cleaning of the tank

Overflow	Disposes of excess water
Manhole/cover and ladder (external and internal)	Allows inspection and cleaning of tank
Ventilation pipe	Allows circulation of air to keep the water aerated; must have mesh or netting over ends of pipe to prevent insects or animals from entering tank

Specific tank O and M tasks

Ask participants what problems might occur if maintenance of the tank is not carried out properly. Identify components that require maintenance and demonstrate and discuss O and M procedures.

Discuss the O and M tasks, which may include:
- closing and opening the control valves once a month
- releasing a jammed float valve
- holding the float valve in the up position; there should be no flow
- holding the float valve in the down position; there should be normal water flow
- checking the float valve for leaks and seal leaks
- replacing the rubber washer if there is a leaking float valve (see Handout 1)
- replacing the pin on the float valve arm
- opening the washout and clearing silt from the tank once a month. (Note: The tank should be almost empty and the outlet valve must be closed before cleaning.)
- checking that the manhole is properly covered to prevent insects and animals from entering tank
- repairing any cracked or damaged tanks and covers
- repairing the mesh or netting over the ventilation pipes
- checking the support tower for elevated tank for structural defects
- checking the ladder in the tank to ensure it is safe to use.

Troubleshooting

Discuss the potential unexpected problems, what might be the causes and some possible solutions.

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Overflow from tank	↘ Failure of float valve ↘ Gate valve blocked (outlet side) ↘ Airlock in pipeline (outlet side)	↘ Replace the rubber washer (see Handout 2). ↘ Replace the pin. ↘ Remove and clear the valve (replace if necessary). Check/ open the nearest air valve.
Leaks from tank wall	↘ Crack in wall	↘ Repair on the inside – this will depend on the type of tank.
Cracks in roof	↘ Settlement of roof ↘ Too much loading on roof	↘ Seal all cracks; add additional support if necessary.

Spares, tools and technical assistance

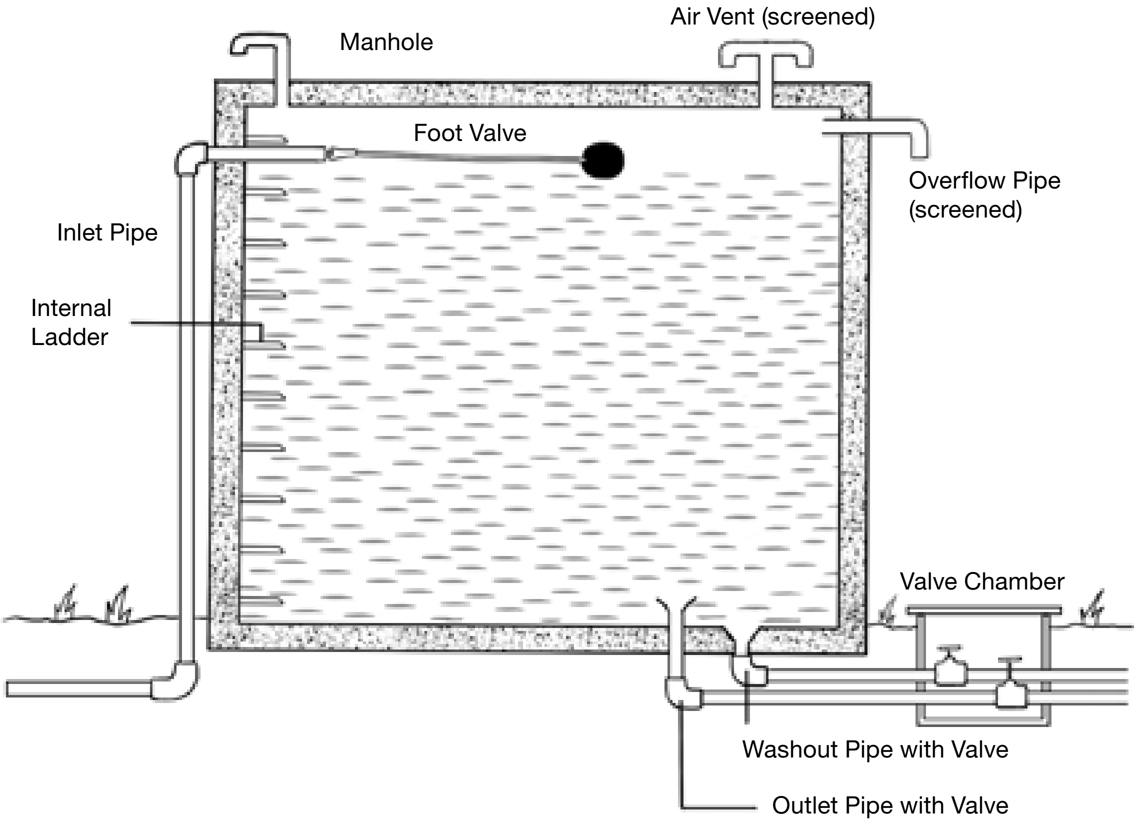
Tools:
- shovel and brush for removing silt
- masonry tools for cement plastered tanks
- pliers for repair of float valve

Spares – include:
- pin for float arm
- mesh, strainer
- check requirements of fittings for pipe inlets and control valves.

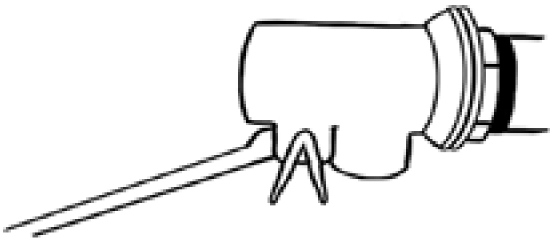
Supply chain – most tank materials can be purchased at a well-provisioned hardware store.

	Technical assistance – this should be sought if the tank wall has major leaks or if the roof shows significant cracks and the structural integrity of the roof is in doubt.
Session handouts	Handout 1: Sketch of a typical storage tank Handout 2: Diagram for replacement of the rubber washer on a float valve

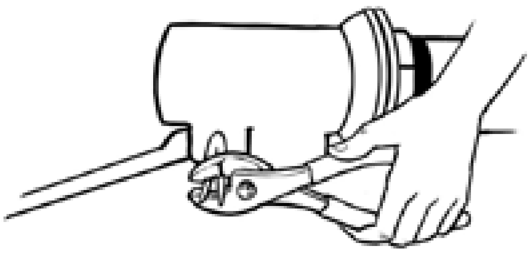
Handout 1: Sketch of a typical storage tank



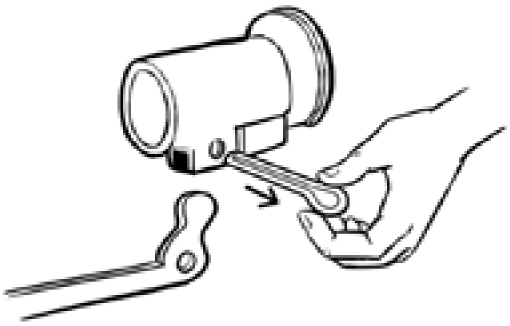
Handout 2: Replacement of the rubber washer on a float valve



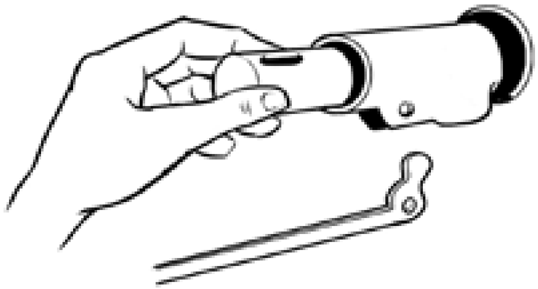
1. The faulty float valve.



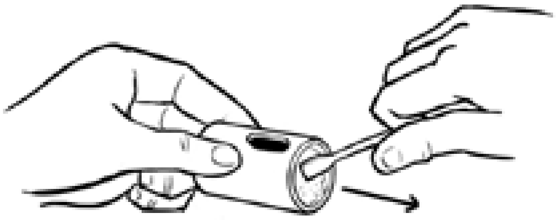
2. Press ends of the flexible metal lock together to ensure that it comes out of the assembly.



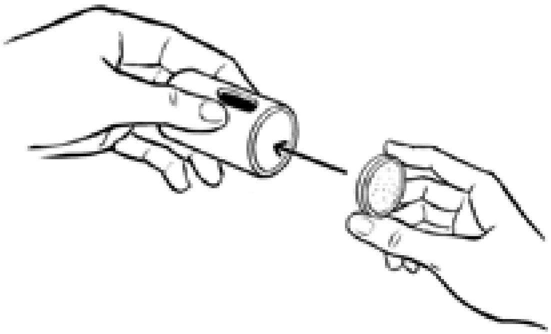
3. Remove the lock, thus releasing the connecting rod to the ball valve.



4. Remove the metal block containing the worn out rubber washer.



5. Remove the rubber washer using a flat metal plate.



6. Carefully insert a new rubber washer and reassemble the float valve.

Module 2: Operation and maintenance for water supply systems

Topic 4: Consumer points

Objectives	At the end of the session, the participants will be able to: • identify the main components of consumer water points • describe the functions of the key components of the water points • carry out water-point maintenance.
Outputs	An O and M schedule
Timing	1 hour
Methodology	This is intended to be a practical session. The components will be taught by demonstration of the system itself, not using drawings or descriptions. Reinforce the learning by allowing participants to handle components and describe their functions to each other.
Materials	• Valve key/wheel • Pipe wrench • Brush or broom • Bucket • Clock or timer

Session guide and content

Introduction	This is a general discussion of the O and M tasks for various consumer points which include: • tap stand • kiosk • cattle trough • individual connection.
Identification of components	**Water-point components** With reference to the drawings in Handout 1, identify and demonstrate the function of the key components:

ITEM	DESCRIPTION
Service or gate valve	Stopcock or gate valve that opens or closes the water supply
Pipe stand	Protects and supports the pipe at the water point
Tap or bibcock	Valve to control flow at water point
Float valve or ballcock	To control water in cattle trough
Meter	Measures flow though the pipe
Meter box	To protect meter
Apron	Concrete surround to water point
Drainage channel	Leads the water away from the water point to a soak pit or drain

1. Flow measurement
Measure the flow from the water point using a bucket and clock (how long does it take to fill the bucket?) or record readings on the flow meter. Measure the flow from another water point and compare the results. Discuss why the flows may be different.

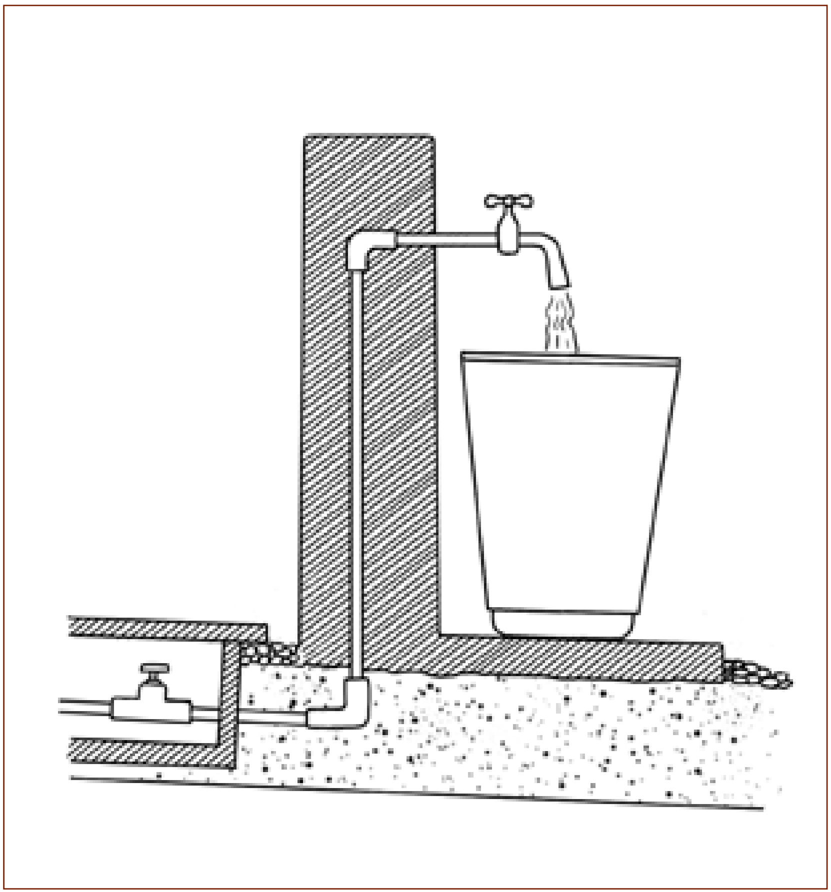
	Reasons may include: • location of water point; points close to tank may get more water • water pressure; height of tank above water point gives pressure • pipe leaks reduce pressure • blockages in pipes, valves or meter. **2. Water-point maintenance** A noticeable problem at many consumer points is associated with the care and management of the taps. Consideration should be given to: • using good-quality taps (brass – check against fake materials!) • consider the use of push-type (self-closing) taps where appropriate.
Specific water-point O and M tasks	Identify the O and M tasks associated with the water points. These may include: • checking the perimeter fence and repairing if necessary • checking the water kiosk structure and repairing if necessary • checking the tap • checking the tap by opening and closing it and checking for leakages or damage • replacing the washer if the tap leaks (see Handout 2) or replacing the tap • repairing any erosion around the pipes or the tap stand • repairing any leaking or damaged pipes • repairing any damaged valve chambers • closing and opening the service valves once a month • repairing any cracked or damaged concrete surround or drain • checking for stagnant water around the water point and clearing or opening the drain to soak away this water • clearing any bush or shrubs in the surrounding area and keeping the compound around the water point clean and free of rubbish and animal or human waste • checking that the meter is working properly • checking the ballcock on the cattle trough and repairing the pin and/or washer if needed • removing the meter, cleaning the filter and replacing the filter and/or meter if necessary. Ask participants what problems might occur if maintenance of the water points is not carried out properly. Identify any components that require maintenance and demonstrate and discuss O and M procedures.
Troubleshooting	Discuss the potential unexpected problems and what might be the cause.

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Leaking service or gate valve	↘ Worn-out valve	↘ Replace the valve. Check that the valve is not being used where a tap is more appropriate.
Little or no water flowing	↘ Storage tank empty ↘ Tank outlet pipe blocked ↘ Distribution pipe leaking or broken ↘ Airlock in distribution pipe ↘ Service or gate valve blocked or closed ↘ Meter blocked	↘ Check the flow in the transmission pipeline. ↘ Check the strainer and outlet valve. ↘ Repair the pipe. ↘ Check/open the nearest air valve. ↘ Remove and clear the valve (replace if necessary). ↘ Remove and clean the sieve/filter in meter.

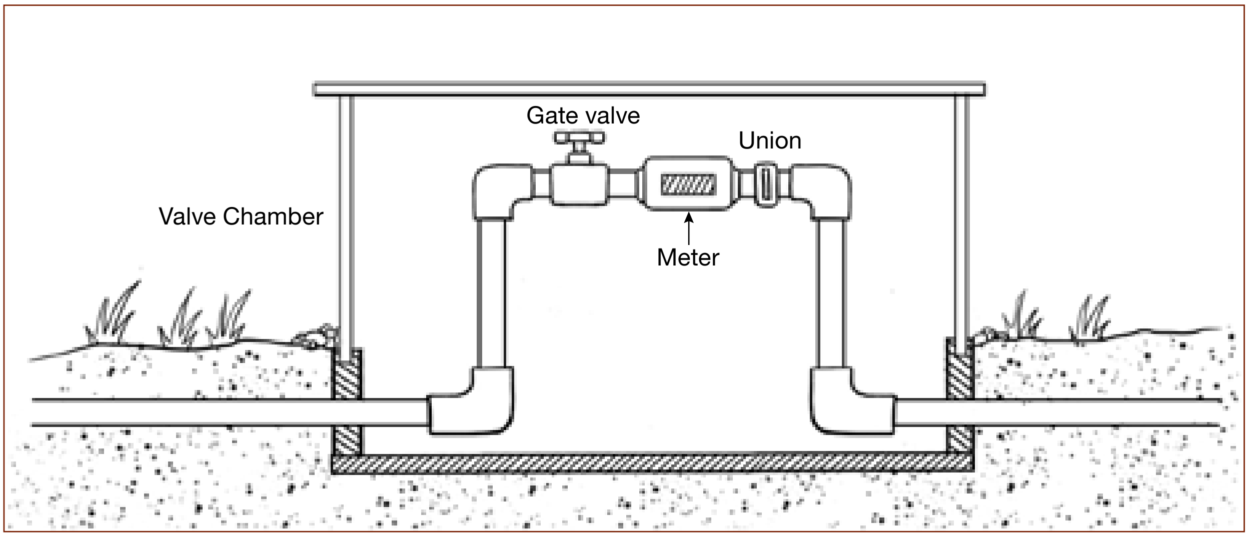
	Continuous leak from tap	↘ Worn-out screw thread in upper tap assembly ↘ Worn-out washer	↘ Replace the tap. ↘ Replace the washer (see Handout 2).
	Silty/Muddy water flow	↘ Silt/mud in tank ↘ Silt/mud in pipes	↘ De-silt the tank. ↘ Open all washouts.
	Air coming through meter and tap	↘ Air in pipe – indicates that tank goes empty	↘ Check the air valves; check operation of the tank.
	Hammer noise	↘ Rapid flow that is turned on/off too rapidly	↘ Slow opening/closing of the gate valves/taps.
	Poor water quality	↘ Contaminated raw water ↘ Poor storage ↘ Leaks in pipelines	↘ Review the water system from intake to consumer points to check for source of contamination. ↘ Take water-quality sample and analyse to establish the nature of the pollutants and a proper solution.
Tools, spare parts and technical assistance	Tools – see Handout for Module 1, Topic 1, for tools required. Spare parts – the following spare parts are usually required: • tap washers • tap • spare meter • meter sieve • gate valve • ball valve • spare pin for ballcock. Supply chain – most materials can be purchased at a well-provisioned hardware store. Note: Check for a supplier and the quality of taps and meters available. Technical assistance: • This should be sought if the meter frequently shows air coming through or if it becomes blocked. • Servicing of meters is a specialized skill and should be undertaken by a trained technician (KEWI offers short courses on meter servicing). • Persistent water-quality problems should be investigated by a water-quality specialist, based on laboratory analysis of water quality.		
Session handouts	Handout 1: Consumer water points Handout 2: Replacement of a worn-out washer on a tap stand		

Handout 1: Consumer water points

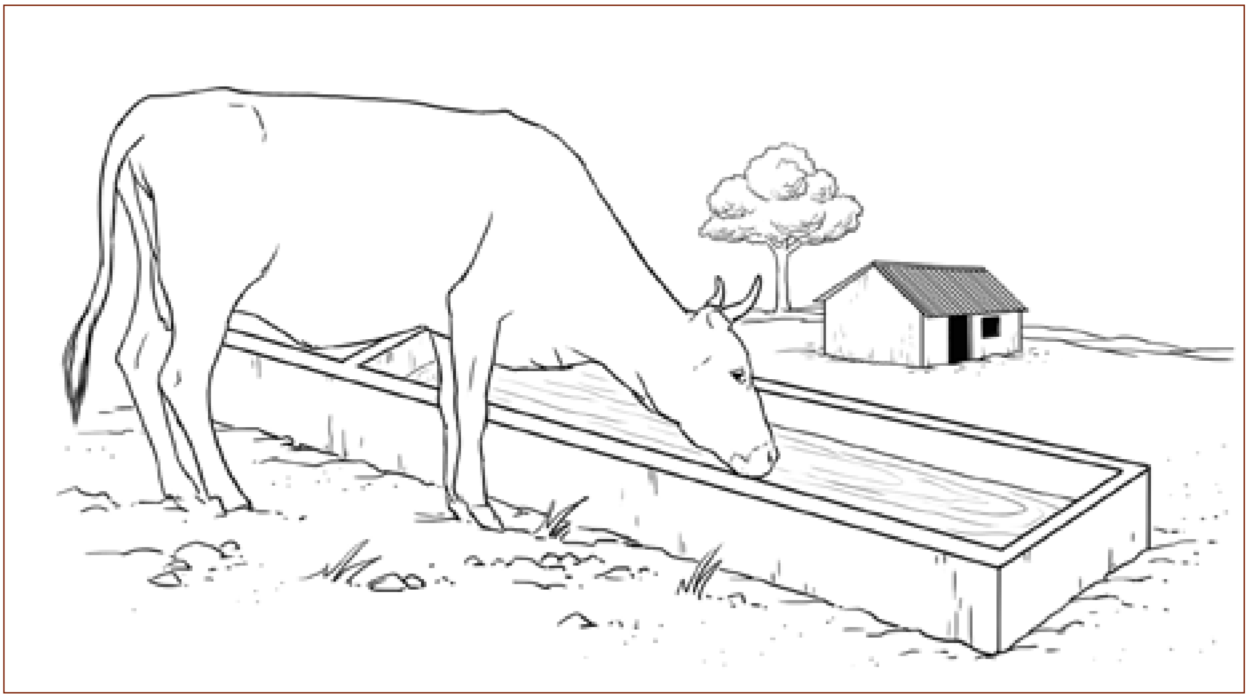
Tap Stand



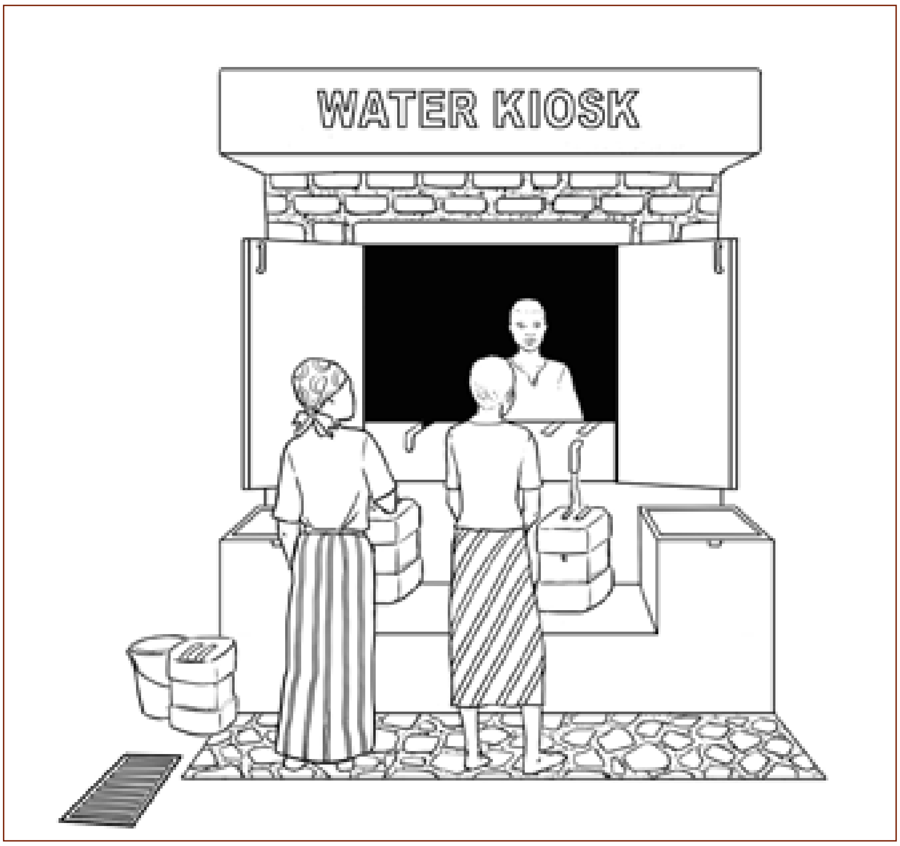
Individual Metered Connection



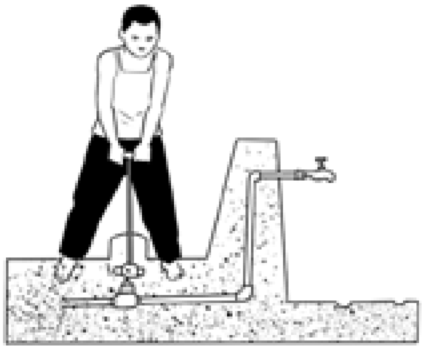
Cattle Trough

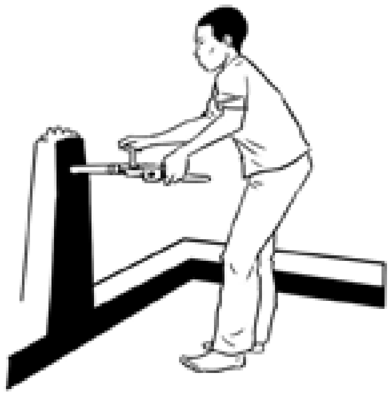


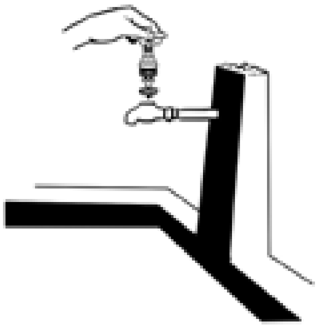
Water Kiosk

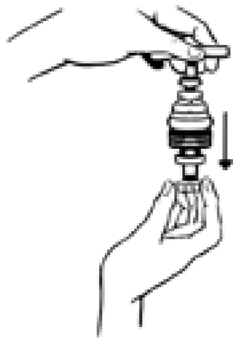


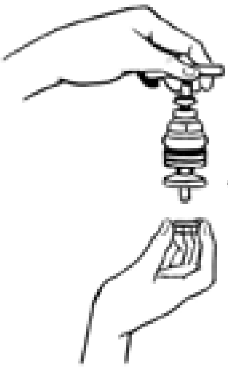
Handout 2: Replacement of a worn-out washer on a tap stand

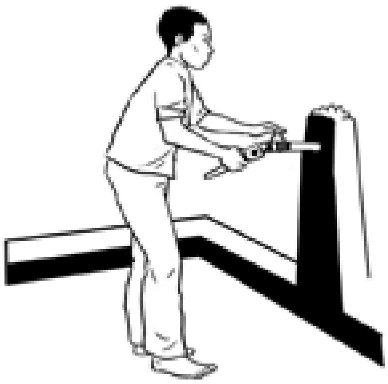

1. Close water supply to tap.


2. Open upper biptap assembly using a 14" pipe wrench.


3. Remove the assembly and identify the washer.


4. Remove the bottom nut and washer.


5. Replace with a new washer and return and secure nut.


6. Replace the assembly, open supply of water to tap, check to confirm no leaks.

Module 2: Operation and maintenance for water supply systems

Topic 5: Dams and pans

Objectives	At the end of the session, the participants will be able to: • identify the main components of a dam and a pan • describe the functions of the key components • carry out maintenance tasks.
Outputs	An O and M schedule
Timing	1 hour
Methodology	Site walk and practical demonstrations. The components will be taught by demonstrations on site. The flip chart can be used to illustrate details if necessary. Reinforce the learning by allowing participants to handle the parts and describe their functions to each other.
Materials	• Valve key/wheel • Pipe wrench • Tools – shovel, rake, etc.

Session guide and content

System identification

1. Purpose of the dam and pan

Discuss who uses the dam or pan and their purpose. This makes a big difference in regard to the type of water quality required from the source. If it is a livestock watering dam, then also discuss where domestic water is obtained.

2. Is it a dam or a pan?

Discuss the difference between a dam and a pan and decide whether the structure being viewed is a dam or pan (refer to drawings in Handout 1).

- Dams have a wall designed to hold back water.
- Dam walls must be structural and watertight.
- Pans hold water below original ground level.
- Pan embankments are not designed to hold water – they are created from the material that is excavated from the ground.

The issue in the distinction is that a dam wall should be able to hold water whereas the embankment on a pan serves no structural purpose. It is frequently and incorrectly stated that the embankments on pans are washed out because they were incorrectly built. However, an embankment being washed out can usually be explained by an inadequate spillway or outlet or incorrect spillway levels.

3. System components

Potential system components are listed below. The facilitator should identify those parts that are observed in the community structure.

Discuss the purpose of each component.

ITEM	PURPOSE
Catchment area	Area above the source where rain falls and the runoff comes from
Source	Where water is taken from, e.g., river or stream
Inlet channel	A channel that conveys water from the source and puts it into the dam or pan

Pan embankment	Wall of excavated material
Dam embankment	Wall that is built and compacted to hold the Water
Storage area	The volume that is filled with water
Spillway sill	Wall in the spillway to control top water level
Spillway channel	Channel to safely discharge excess water to watercourse or away from the dam or pan
Outlet/draw-off	Pipework to take water out of the dam
Perimeter fence	Constructed to prevent livestock, wild animals and children from entering the dam or pan area and contaminating the water

4. Catchment area maintenance
Where does the silt come from? Which part of the catchment contributes the most silt and why? Are soil erosion features (e.g., gullies), exposed roots of bushes and trees, etc. visible?

Discuss why vegetation is important to the catchment area:
- Vegetation holds the soil in place and so reduces the amount of silt created.
- Vegetation slows down runoff and helps water to soak into the soil.

Inspect the catchment area for signs of harmful activities (charcoal burning, over-grazing etc).

Discuss how the catchment area could be improved.

Specific dam and pan O and M tasks

Ask participants what problems might occur if maintenance of the dam or pan is not carried out properly. Identify components that require maintenance and demonstrate O and M procedures.

The most common problem with dams and pans is silting up, which reduces the stored volume and therefore the reliability or the period of time that there is water in the dam or pan after the end of a period of rain.

Discuss with the community how they can measure the amount of water available in their dam or pan at any time (e.g., place one or a series of permanent graduated gauges to enable staff to monitor water levels).

Discuss with the community how they can measure the amount of silt that has accumulated in their pan (e.g., place one or a series of permanent graduated gauges to enable staff to monitor the amount of silt).

Discuss de-silting options with the community:
- earthmoving equipment (bulldozers, tractors etc)
- draught animals and de-silting scoops (oxen, camels and handlers)
- by hand with shovels.

Discuss the cost and practicality of the different methods. The most common cause of dam or pan failure is over-topping of the embankment because the spillway is of insufficient size, is blocked by vegetation, or is at the wrong level.

Note: Spillways that do not get flow frequently may be neglected so cannot function as needed when there are high floods.

An additional problem is that the flood water through a spillway erodes the spillway, with the result that the capacity of the dam or pan is reduced.

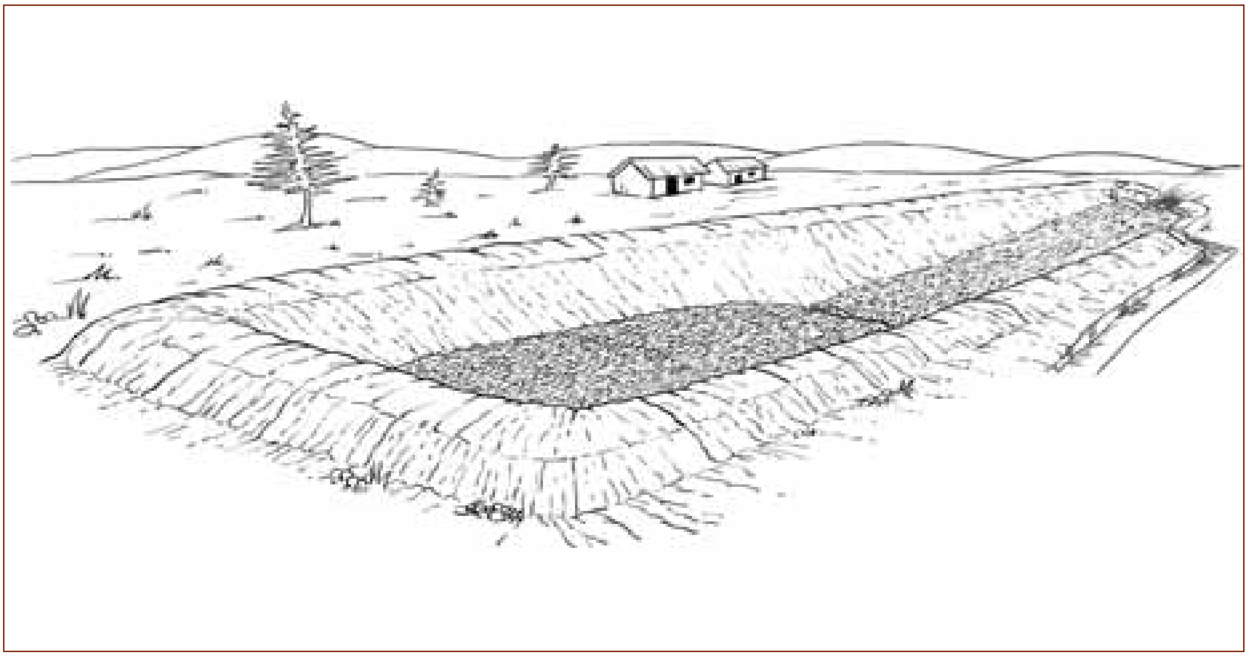
	Discuss the tasks relevant to the operations and maintenance of the system components. These may include: • patrolling the perimeter fence and repairing it. • clearing any bush or shrubs from around the inlet channel and repair it as necessary. (Note: An eroded inlet channel can become the main watercourse.) • inspecting and de-silting all silt traps and inlet channels. • de-silting the pan before the top water level reaches the embankment. (Note: The Inlet channel needs to be blocked during de-silting.) • clearing any bush or shrubs from the spillway • checking the sill of the spillway for damage and repairing as necessary • checking the spillway channel for signs of erosion and taking steps to prevent erosion by improving grass cover, stone pitching or spreading flow in the channel by building horizontal sill(s) • checking the dam embankment for cracks and erosion and repairing as necessary • check the dam embankment for tree or bush growth and removing;, improving the grass cover on the embankment area • checking the downstream side and toe of the dam wall for any leaks and repair as necessary • opening and closing all outlet valves once a month • monitoring leakage from the dam • checking for and removing any rodents nesting in the embankment area • reading the meter to monitor abstraction from the dam • reading the staff gauges to establish the water level.
Troubleshooting	Discuss the potential unexpected problems, what might be the causes and some possible solutions.

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Leakage along toe of dam wall	↘ Poor design and construction	↘ Monitor for leakages.
Water does not last long after end of rainy periods	↘ Reservoir area has accumulated a significant amount of silt ↘ Erosion of catchment area ↘ Excessive seepage due to pervious soil in reservoir area	↘ Remove silt from the reservoir area. ↘ Reduce erosion in the catchment area. ↘ Apply and mix in clay, preferably bentonite clay, to impoundment area.
No water from outlet	↘ Outlet pipe blocked	↘ Clear blockage at the mouth of the draw-off pipe. ↘ Protect the pipe by placing a ballast surround to the mouth of the draw-off pipe. (Note: a blocked pipe through a dam can be very difficult to unblock.) Do NOT remove the pipe.
Polluted water	↘ Livestock in dam or pan ↘ Contamination from catchment area	↘ Fence the dam or pan. ↘ Control access. ↘ Discourage open defecation in the catchment area.
Excessive weed growth	↘ High nutrient concentration in water	↘ Address source of nutrients, possibly by controlling access to the dam or pan or catchment area by livestock.

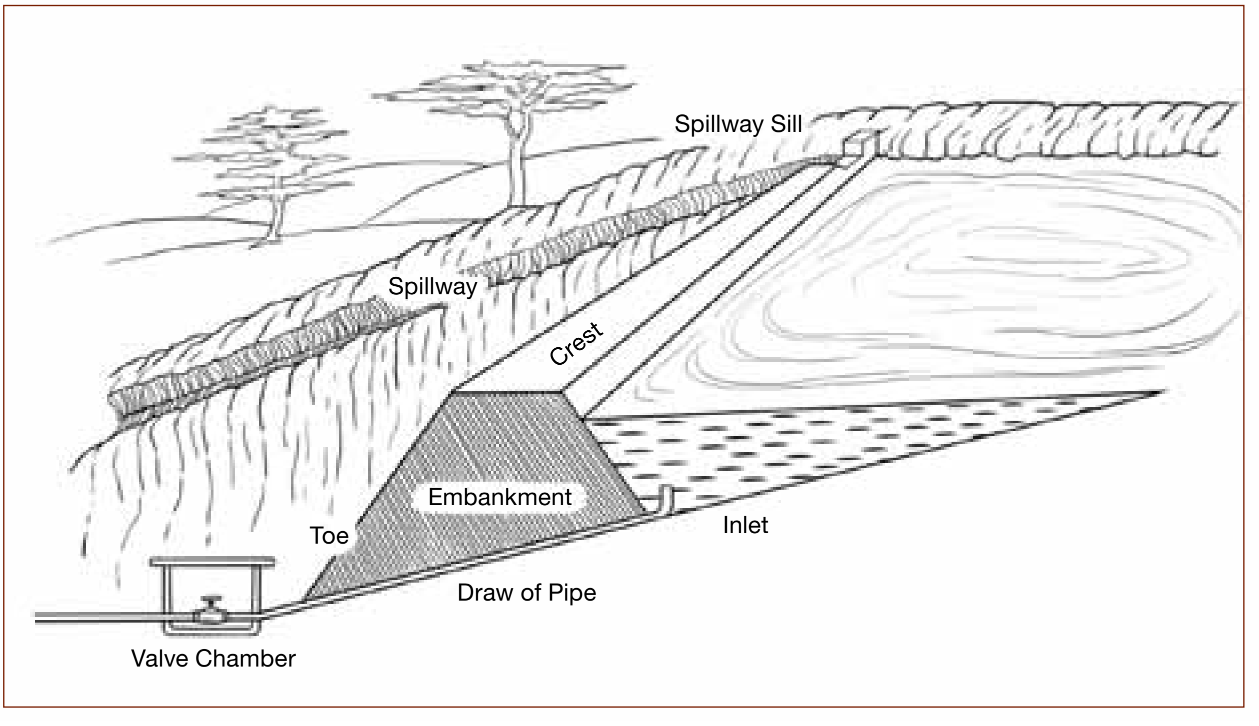
Tools, spares and technical assistance	Tools: • shovels, pickaxes, jembes (hoes), wheelbarrows for moving silt and undertaking embankment repairs • pangas (broad-bladed knives) for removing bush or shrubs. Spares – include: • valves for the outlet • taps and tap washers. Supply chain – O and M materials can be purchased at a well-provisioned hardware store. Technical assistance –this should be sought if the dam or pan shows signs of excessive leakage/seepage, erosion of inlet channel (pans) and erosion of spillways and where the reliability of the dam embankment is in doubt.
Session handouts	Handout 1: Diagrams of a pan and a dam

Handout 1: Diagrams of a pan and a dam

A Pan



A Dam



Module 2: Operation and maintenance for water supply systems

Topic 6: Sand dams and subsurface dams

Objectives	• To create awareness of the potential of sand dams and subsurface dams • To enable participants to understand the best way to manage and maintain the water supply • To create awareness of the problems that can arise with these types of dam and how they may be dealt with
Outputs	• Participants are aware of the potential for sand dams and subsurface dams. • Participants are aware of the importance of maintaining good water quality. • Participants are informed about ways to maintain the effectiveness of the structures. • Participants develop rules for the management and utilization of the resource.
Timing	One session of introduction taking 1 – 1½ hours followed by visits to dam sites. Diagrams can be used to illustrate any issues.
Methodology	Short presentations, informal and participatory question and answer session
Materials	Illustrations, flip charts, pens

Session guide and content

Introduction	Explain the difference between sand dams and subsurface dams. Explain the benefits that have arisen from the construction of these types of dam. Discuss the typical problems that arise in the management of the sand or subsurface dams and the utilization of the water. These dams have proved to be very important for water storage in dry or semi-arid areas. • Coarse sand can hold about 30 per cent of its volume as water. • In the dry season evaporation will take place but only to about 0.5 metres below the surface. • Water stored in these dams will reduce the need for people (usually women and girls) to travel long distances to get water in the dry season. • Water stored in these dams can improve the potential for tree nurseries, vegetable growing, brick making etc. in the bottom of valleys. • Protection of the water from pollution is very important. The construction of shallow wells can be used to improve the water quality. • Dam construction should ensure that wing walls provide protection from damage during high floods.
Field visit (if possible)	If possible, visit two or three dams showing good and bad management. If a field visit is not possible, use diagrams (see Handouts and Attachment). • Participants should pay attention to the effectiveness of the structure and the way the water is utilized. • Find out what guidelines or rules, if any, have been developed by the community for using the resource and how well they are implemented.
Specific sand dam and subsurface dam O and M tasks	Review the positives and negatives of the situations that have been studied. Develop guidelines or rules and schedules for community management of sand dams and subsurface dams. Discuss the tasks relevant to the O and M of the system components.

<table>
<tr><td></td><td>These may include:
• checking the condition of the sand dam to prevent avoidable contamination from livestock and laundry or bathing activities
• checking the wall of the sand dam for erosion on the sides or undercutting of dam wall. Establishing protective measures to prevent additional erosion.
• checking the dam wall for cracks and leaks. Undertaking plaster repairs as required
• opening and closing all outlet valves once a month
• for shallow wells with handpumps that are associated with a sand dam, refer to the session on handpumps.</td></tr>
<tr><td>Troubleshooting</td><td>Discuss the potential unexpected problems, what might be the causes, and some possible solutions.
<table>
<tr><th>PROBLEM</th><th>PROBABLE CAUSE</th><th>POSSIBLE SOLUTION</th></tr>
<tr><td>Water in sand dam but nothing in the well</td><td>↘ No connection between sand dam and shallow well
↘ Blockage of filter drain to shallow well</td><td>↘ Excavation and repair of filter drain.</td></tr>
<tr><td>No water in the sand dam</td><td>↘ Lack of inflow
↘ Seepage under or around the wall of the sand dam
↘ Faulty or leaking draw-off pipe</td><td>↘ Check for seepage path and take measures to prevent seepage by sealing the flow path with clay or waterproof plaster on upstream face of wall.
↘ Fix or replace the faulty or leaking draw-off pipe</td></tr>
<tr><td>No water in the sand dam</td><td>↘ Dam full of silt not sand
↘ Dam may be incorrectly sited in a watercourse with insufficient sandy material or the wall was raised too quickly during construction that can result in a top layer of silt which prevents water seeping into the lower sandy material</td><td>↘ Remove silt if the watercourse contains sufficient sandy material.</td></tr>
<tr><td>Wall at risk from erosion weakening the wall</td><td>↘ Turbulent and erosive water spilling over the wall
↘ Lack of sufficient protection for toe of wall</td><td>↘ Place grouted riprap (loose stone to form a structure that breaks up water flow) to create a protective apron on downstream toe of wall.</td></tr>
<tr><td>Polluted water</td><td>↘ Livestock or human activities polluting surface area of dam, resulting in contamination of the water</td><td>↘ Control access by establishing clear rules of access and behaviour and monitoring compliance to the rules.</td></tr>
<tr><td>No sand</td><td>↘ Sand harvested for construction purposes</td><td>↘ Control access through establishing clear rules of access and regulate quantity of sand harvested from the sand dam.</td></tr>
</table></td></tr>
<tr><td>Tools, spare parts and technical assistance</td><td>Tools:
• shovels, pickaxes, jembes (hoes), wheelbarrows for moving silt and undertaking repair of the wall.</td></tr>
</table>

	Spare parts include: • valves for outlet • taps and tap washers. Supply chain – O and M materials can be purchased at a well-provisioned hardware store. Technical assistance – this should be sought if the sand dam is showing signs of excessive erosion at the edge or downstream toe of the wall. If the sand dam is actually full of silt, technical assistance may be required to determine the best course of action. If there is no water in the shallow well, technical assistance to determine the best course of action may be required.
Session handouts and attachment	Handout 1: Maintenance and management of sand and subsurface dams Attachment 1: Exercise on sand dams

Handout 1: Maintenance and management of sand and subsurface dams System components

1. System components

Definition: The terms sand dams and subsurface dams are often used interchangeably for structures built across sand rivers. However, it is useful to make a distinction.

The term **sand dam** is used for a structure, usually of masonry or concrete, which is built across a sandy riverbed to a height of about one or two metres above the existing sand level. In this way sand is trapped behind the structure and the water level upstream is raised. During period of flooding, water passing over the dam creates a waterfall. Such dams are commonly built where there is a rock bar across the river so that the waterfall will not weaken the structure. Note: Before independence sand dams were referred to as subsurface dams. At that time the focus was on the water stored below the surface of the sand rather than on the structure itself.

The term **subsurface dam** is used for a structure that is built across a sand riverbed but only up to the existing level of the sand. Such structures can be made of masonry, concrete or well-compacted clay. As the sand levels above and below the dam are the same, there is no waterfall during flood periods.

The construction of sand dams and subsurface dams has been increasing particularly rapidly in eastern Kenya where there are many sandy rivers. But there has been serious competition between those who want to harvest sand for construction and those who want to conserve sand for water storage.

There are four components to consider: the river, the dam, the water reservoir and the method of abstraction.

a) River
Each river is different and therefore the design of a dam has to be appropriate to the situation. The best situation is where the riverbed slopes gently and any dam installed will cause the water to be held up for a considerable distance

upstream. Sand dams require high banks or wing walls to prevent flood water cutting round the side. The sand must be plentiful as a dam that fills with too much silt or clay will hold little water. Where a river is large, meandering, and has little slope to the riverbed, dams can be problematic as any obstruction to the flow of water may cause the river to change course, especially if the river banks are low.

b) Dams
Dams have to be constructed on a good foundation and sand dams require a strong apron of rock, masonry or concrete on the downstream side.

c) Water reservoir
The amount of water stored in the dam depends on the quality of sand. Where the sand is coarse, up to 30 per cent of the volume will be available for water storage. During the dry season some of the water will be lost to evaporation but once the water level falls to 50 centimetres below the surface, evaporation virtually ceases.

d) Water abstraction
There are three main ways for water abstraction:
Digging a hole in the sand and using a scoop made from a gourd to collect the water and pour it into jerrycans
Constructing a shallow well to the side of the reservoir
Installing a pipe in the dam wall and drawing off the water below the dam.

2. Maintenance

a) Dams
Subsurface dams should not require maintenance if they have been well constructed but sand dams may need repairs if there is any damage during periods of major flooding. The most likely damage is from flood waters cutting into the riverbank at the side of the dam wall. Repairs may involve installing wing walls or, if they already exist, strengthening and possibly extending them. Damage may also occur where the flood waters start weakening the dam on the lower side. Strengthening or extending the apron at the foot of the wall may be needed. When sand dams are under construction it is recommended to leave a gap in the centre of the wall and build it up in stages, adding about 30 centimetres after each flood that has deposited coarse sand. If the wall is built to its maximum height in one operation, there is a risk of silt and clay being deposited. But when the installation is in stages, the silt and clay should be carried over the wall and the coarse sand will be trapped where it is needed.

b) Water reservoir
The main problem is pollution. Livestock can contaminate the water if they are allowed to wander over the surface. People can contaminate the water if, for example, they bathe, wash laundry, clean motor bikes or cars and let the dirty water back into the reservoir. In one instance a farmer was seen spraying livestock against ticks close to the reservoir. The chemicals could be dangerous for people drawing water for drinking. Urinating or defecating close to the reservoir must be avoided because of the risk of spreading bilharzia (a human disease caused by parasitic worms) or gastroenteritis (infection of the bowel). While some increase in vegetation along the riverbank can be beneficial, it is a mistake to allow plants or bushes to intrude into the dam area as transpiration (loss of water vapour) will reduce the available water. Fencing of the reservoir area is useful in preventing contamination by livestock but this will apply only where a trough for watering animals has been installed.

c) Water abstraction

Water abstraction from a hole dug in the sand is the most common method but there can be problems. Dirty containers will add to the pollution of the water. A hole has to be dug deeper and deeper as the dry season progresses. The effort of hauling up 20-litre jerrycans from a deep hole can be difficult for children who are often the ones sent to fetch water and there is always a risk of the sand caving in. The hole is also prone to being silted each time there is flow in the riverbed.

Water abstraction from a shallow well installed on the riverbank is a better option as the water at the bottom of the well will have automatically been strained through the sand. However, there is the same need to ensure that the containers used for drawing the water are clean. Wells should preferably be installed above the highest point that floods are likely to reach but if this is not possible, some protection from flood damage will be needed (e.g. raising the well-head platform above high water levels).

Water abstraction through a pipe in the dam wall has certain advantages and disadvantages. Water can be taken from the pipe to a tap stand and a trough for livestock, thereby reducing the risk of pollution. In some situations there may be a legal requirement to keep a pipe open so that even in dry weather some water is allowed through the dam wall for the benefit of downstream users. In other situations it may be permitted to put a lockable gate valve or tap on the lower side to prevent wastage of water. But the risk of breakage or theft should be considered and a lockable manhole may have to be constructed. Any pipe installed through the dam wall must have a properly constructed filter on the upstream side or it will soon become blocked.

The maintenance of sand dams and subsurface dams should be the responsibility of a committee representing the local community. Issues on which decisions may be needed include:

- Who has rights to abstract water and what quantity of water is allowed?
- Who is responsible for maintaining a well and the windlass or pump if there is one? Who is responsible for the tap stand if there is one below the dam?
- Can people be allowed to abstract water upstream for vegetable growing?
- If the dam is to be fenced to exclude livestock, who is responsible for this?
- What should be done if sand harvesters come to take the sand for construction purposes?
- What should be done if people are found polluting the water?

One issue that will need more consideration in future is the rights of individuals versus the rights of the community. As individual rights become more firmly established on land that was previously owned by the community, the rights to access and abstract water need to be clearly established.

Attachment 1: Exercise on sand dams

Volunteers are invited to look at the drawing of a sand dam construction to try and identify any problems and suggested solutions.

Problems

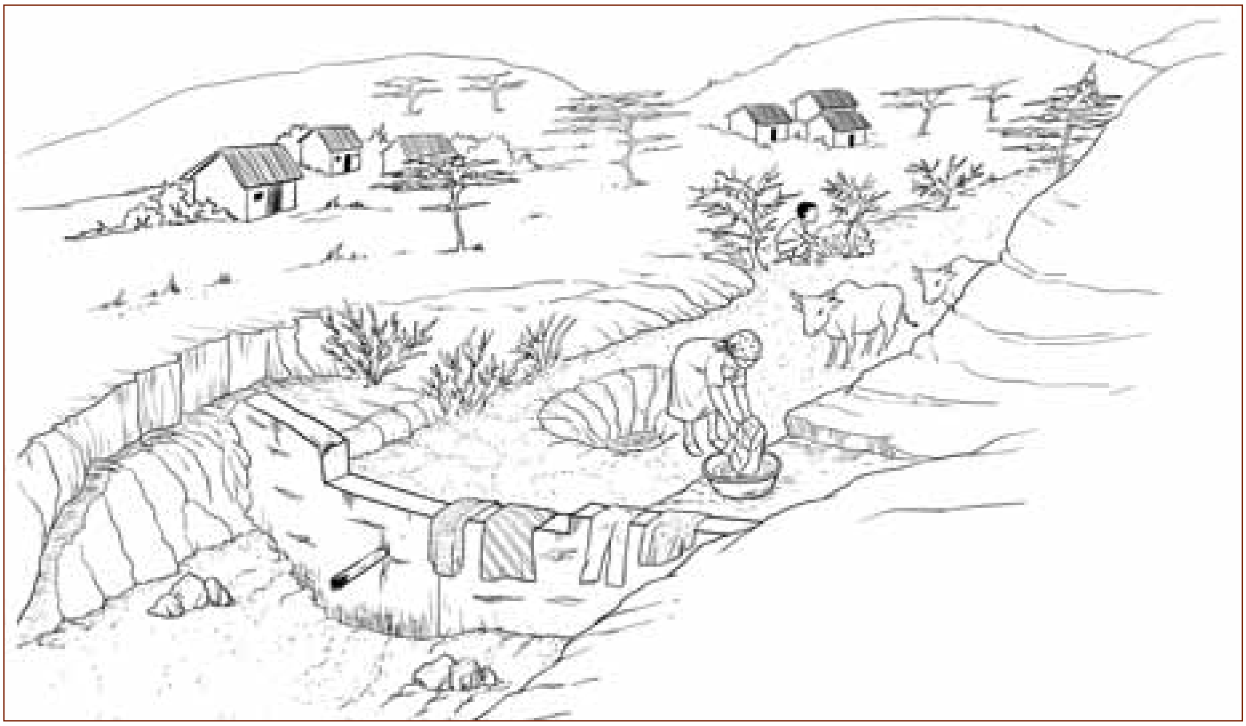
1. The wing wall is missing or broken and flood waters are bypassing the dam. Eventually all the sand will be swept downstream and the dam will cease to function.

2. The dam wall is being undercut by the waterfall during floods probably because the foundation was poorly constructed and there was no apron. If nothing is done it will collapse.
3. The dam is not fenced so livestock can wander in freely.
4. Weeds and bushes are growing on the dam and extracting water through transpiration.
5. Livestock are polluting the water.
6. A person is defecating on the riverbank.
7. A woman is washing clothes and tipping the dirty water back onto the sand.
8. The pipe has lost its tap and is spilling water that may be needed later.
9. The hole dug in the sand is deep and dangerous, especially for children trying to collect water.

Suggested solutions

1. Install a wing wall on proper foundations to ensure the flood waters go over the centre of the dam.
2. Repair the foundations and install an apron to take the impact of the water.
3. Provide a fence or hedge to the dam with a gate to enable people to access the dam.
4. Remove weeds and bushes growing within the dam.
5. Install a trough for watering livestock downstream and pipe the water from the dam to the trough.
6. Develop community awareness and education to prevent the spread of diseases and construct a pit latrine on the bank above the water level.
7. Install a shallow well to the side of the dam and educate the community to use water from this well for watering vegetables or tree seedlings (not drinking).
8. Check local regulations and find out if the pipe inlet must be kept open for the benefit of downstream users. If this is not necessary, pipe the water to a tap stand with a gate valve in a lockable manhole.

Sand Dam



Module 2: Operation and maintenance for water supply systems

Topic 7: Intakes

Objectives	• At the end of the session, the participants will be able to: • identify the main components of an intake • describe the functions of the key components • carry out intake maintenance.
Outputs	O and M schedule
Timing	Approximately 2 hours
Methodology	This is intended to be a practical session. The components will be taught by demonstration of the system itself. The flip chart can be used to illustrate details if necessary. Reinforce the learning by allowing participants to handle the parts and describe their functions to each other.
Materials	• Valve key/wheel • Pipe wrench • Tools – shovel, rake

Session guide and content

Introduction

This session covers intakes in general. There are many kinds of intakes and the facilitator should keep the discussion focused on the intake of the water supply system in the community's specific area.

Different kinds of intakes include:
- river intakes
- spring intakes
- lake intake
- infiltration gallery.

System identification

1. Catchment area maintenance

Discuss why vegetation is important to the catchment area:
- Vegetation holds soil in place and so reduces erosion and siltation.
- Vegetation slows down runoff and helps water to soak into the soil.

Inspect the catchment area for signs of harmful activities (charcoal burning, over-grazing, deforestation, etc).

Discuss how the catchment area could be improved.

Discuss which other institutions should be alerted in regard to catchment degradation and be lobbied for collective action.

2. Intake components

(See Handout 1 for diagrams of different kinds of intakes.)

COMPONENT	FUNCTION
Catchment area	Surface area where water flows towards the source
Source	Where the water originates – e.g., spring, river
Intake	The structure to abstract the water from the source
Intake chamber	Collects water from the source

	<table><tr><td>Valve chamber</td><td>Protects the control valve</td></tr><tr><td>Weir (river intake)</td><td>A wall that regulates the level of the river</td></tr><tr><td>Infiltration gallery</td><td>Perforated pipe and filter material that enables water to enter the pipe and be channelled to the sump</td></tr><tr><td>Sump</td><td>Collection chamber from which water is drawn</td></tr><tr><td>Screen or strainer</td><td>Sieves objects to prevent them from entering the pipeline</td></tr><tr><td>Washout</td><td>Pipe and valve that is opened to allow cleaning of the chamber</td></tr><tr><td>Perimeter fence</td><td>Boundary to stop livestock and children from entering The source area</td></tr><tr><td>Compensation pipe</td><td>Pipe at the bottom of the intake weir to allow for downstream flow regardless of level of the water above the weir</td></tr></table>
Specific intake O and M tasks	Discuss the tasks relevant to the O and M of the system components. These may include: • patrolling the catchment area for damage or harmful activities • reporting of any signs of catchment degradation to the Water Resource Management Authority (or similar body) • patrolling the perimeter fence and repairing as necessary • clearing the weir wall and screens of any debris • checking the walls or supports for any damage, undercutting or bypassing and repairing as necessary • opening the washout on the weir wall and removing any accumulated silt • opening the washouts to clear out any silt from the chambers • clearing the screen of any material and replacing the screen if damaged • disinfecting the spring box if someone has entered the area • reading the master meter and recording the results.
Troubleshooting	Discuss the potential unexpected problems, what might be the causes, and some possible solutions. **For spring intakes:** <table><tr><th>PROBLEM</th><th>PROBABLE CAUSE</th><th>POSSIBLE SOLUTION</th></tr><tr><td>Leaking gate valve</td><td>↘ Worn-out valve</td><td>↘ Replace the ‘stuffing’ box packing in gate valve or replace entire valve.</td></tr><tr><td>Little or no water flowing into intake chamber</td><td>↘ Inlet pipe blocked</td><td>↘ Inspect the source and unblock the pipe.</td></tr><tr><td>Overflow from intake chamber</td><td>↘ Gate valve blocked ↘ Blockage in pipeline (e.g., airlock) ↘ Damaged strainer ↘ Clogged strainer</td><td>↘ Remove and clear the valve (replace if necessary). ↘ Check/open the nearest air valve. ↘ Replace the strainer. ↘ Clean the strainer.</td></tr><tr><td>Dirty water</td><td>↘ Silt in chamber</td><td>↘ Clean out the chamber.</td></tr></table>

For river intakes with a weir wall or sump:

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Little or no water flowing into intake chamber or sump	↘ Screens on inlet chamber clogged	↘ Clean the screens.
Erosion around side of weir wall	↘ Insufficient height of wing and cut off walls to prevent flow around the weir	↘ Construct or raise the wing and cut-off walls to prevent flow around the weir.
Undercutting of weir wall on downstream toe or undercutting of sump	↘ Excessively turbulent flow over weir wall and insufficient width of downstream apron	↘ Provide a protected apron (constructed of concrete, grouted riprap, etc.) at toe of the weir wall or around the base of the sump.
Dirty water	↘ Excessive sediments upstream of weir wall ↘ Silt in intake chamber or sump	↘ Clean out any sediment from the area immediately upstream of weir. ↘ Clean out the chamber. ↘ Protect catchment from severe erosion.

For infiltration galleries:

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Little or no water flowing into intake chamber or sump	↘ No water within sandy material in riverbed ↘ Perforated pipe is blocked or damaged	↘ Excavate the shallow well to determine whether there is water in the sand in the riverbed. ↘ Remove the filter drain and draw-off pipe and reconstruct the infiltration gallery. Consider additional protection for the draw-off pipe.
Dirty water	↘ Filter material (gravel or sand) washed away and replaced with silt or silt-laden sand ↘ Silt in intake chamber or sump	↘ Check the condition of the filter drain. Replace the filter material if required. Consider additional protection of the filter material. ↘ Clean out the sump.

Tools, spare parts and technical assistance

Tools - see handout for Module 2, Topic 1.

Spare parts include:
- mesh for screens
- valves
- masonry materials.

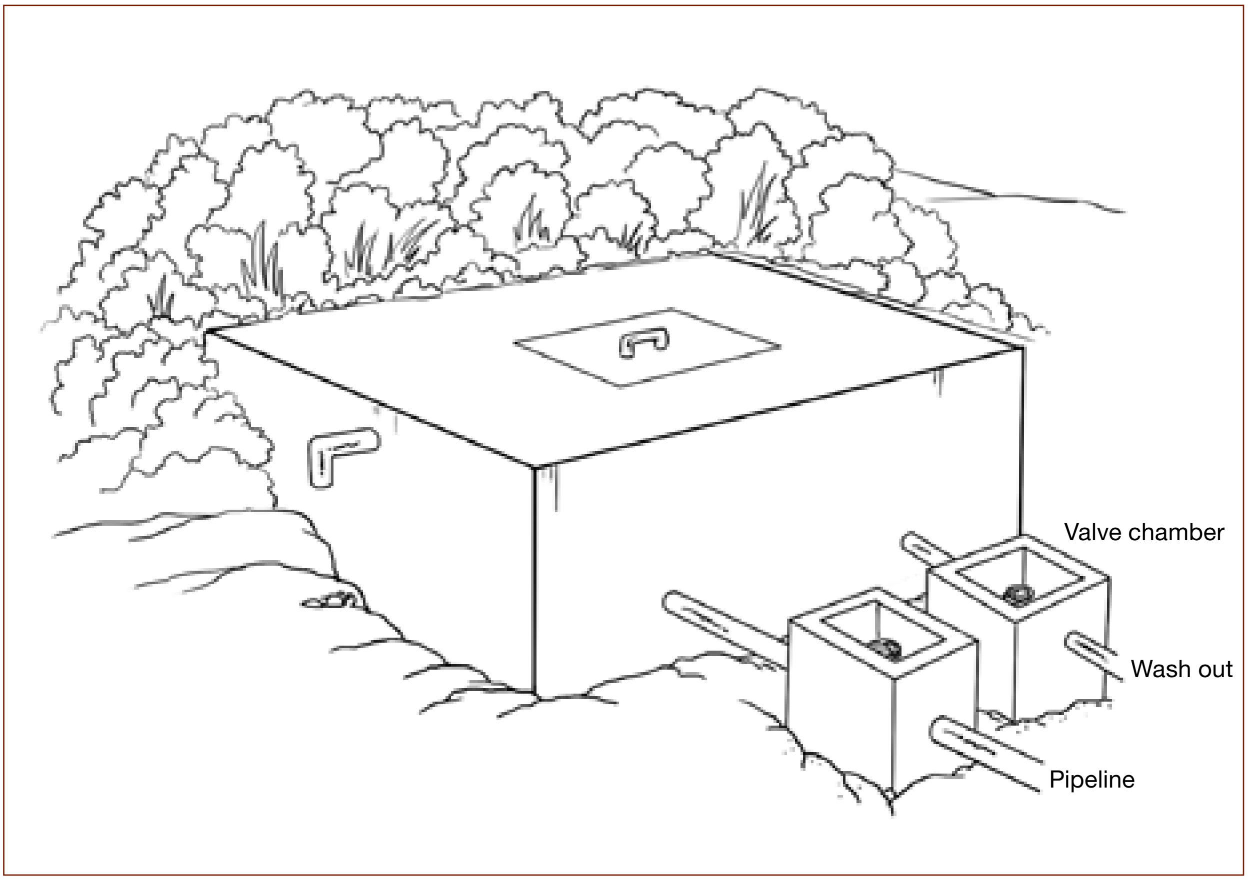
Supply chain – most intake materials can be purchased at a well-provisioned hardware store.

Technical assistance – this should be sought if the spring source diminishes without explanation. It is important that no back-pressure is placed on the source in a spring intake otherwise the eye of the spring may shift.

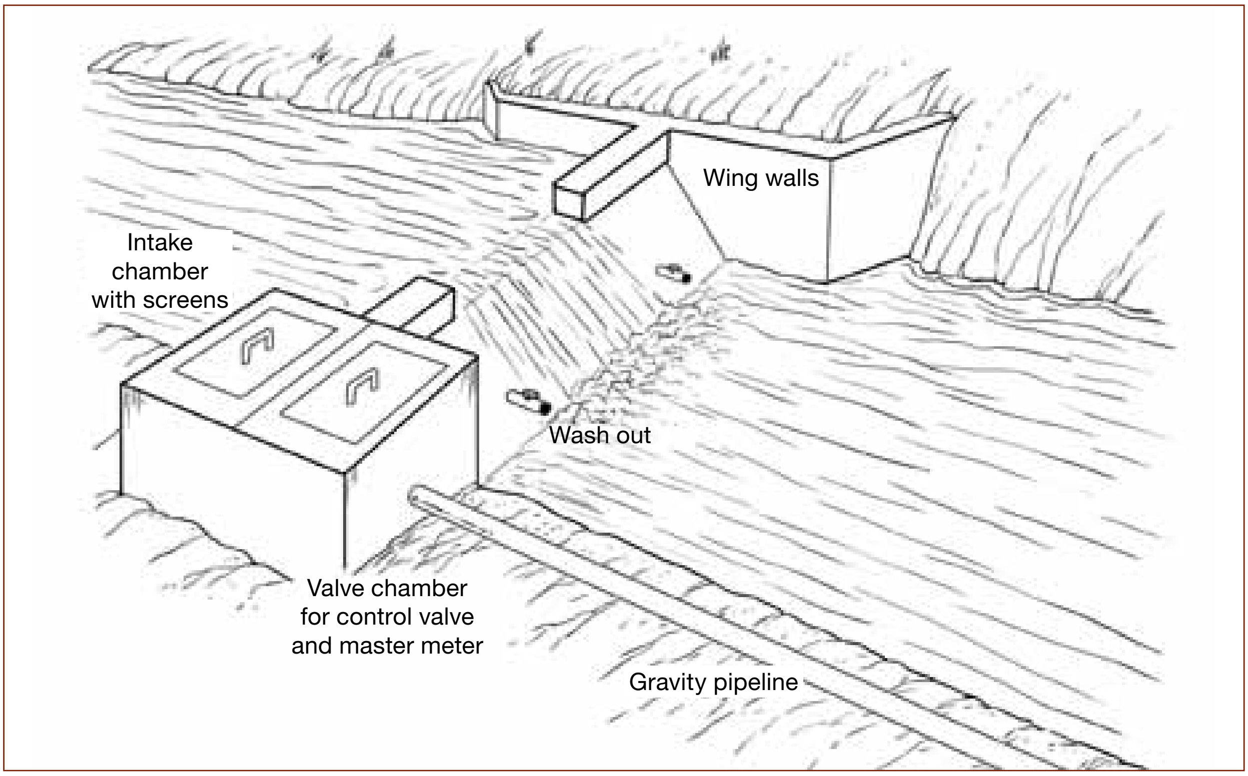
	Technical assistance may be required in a river intake if excessive or repeated erosion takes place around the weir or sump, to determine a more durable solution to the problem. Technical assistance should be obtained to determine a robust solution if the infiltration gallery frequently gets washed out or blocked.
Session handouts	Handout 1: Diagrams of different intakes

Handout 1: Diagrams of different intakes

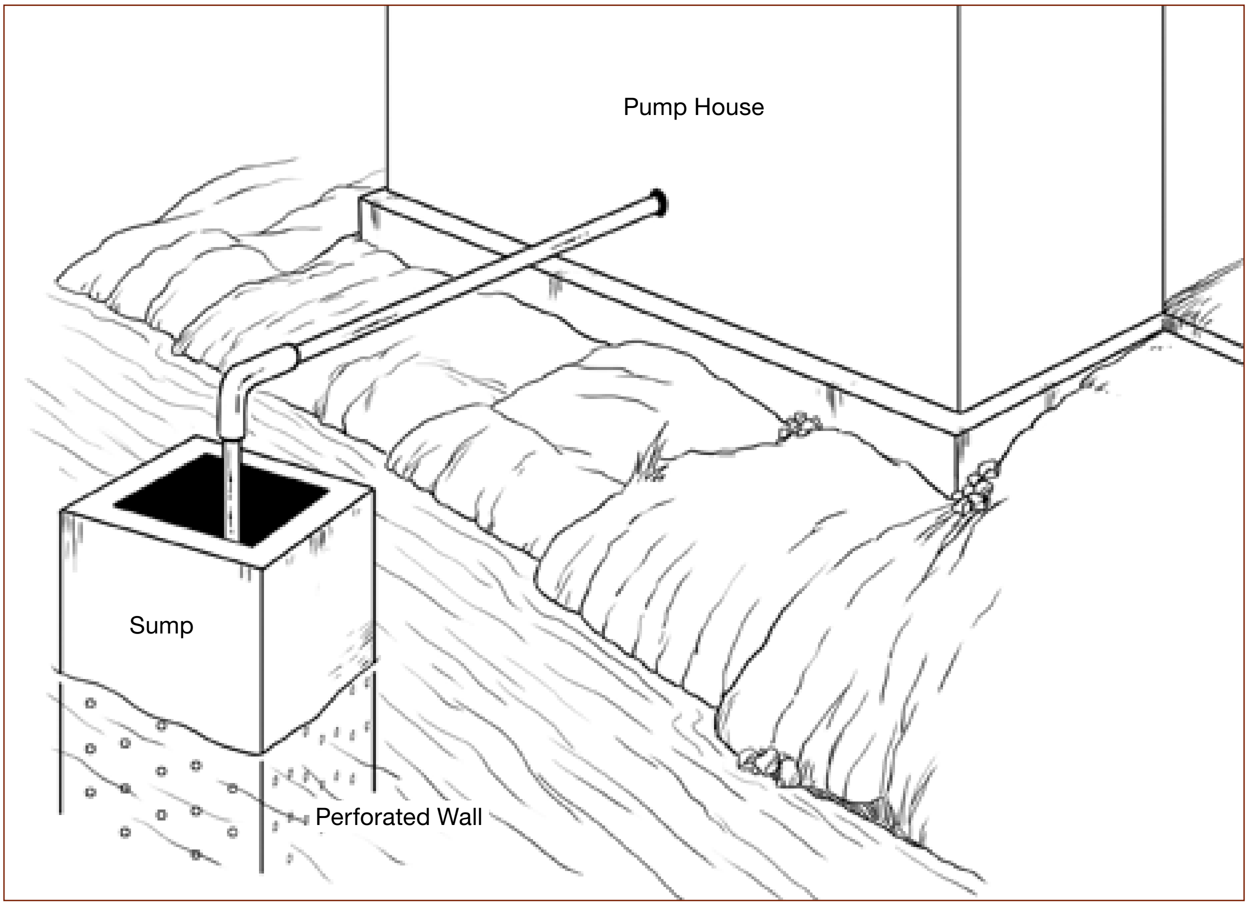
Spring intake



River intake with weir



River intake with sump and pump house



Module 2: Operation and maintenance for water supply systems

Topic 8: Shallow wells

Objectives	At the end of the session, the participants will be able to: • identify the main components of their shallow well • describe the functions of the key components • carry out well maintenance.
Outputs	An O and M schedule
Timing	2 hours
Methodology	This is intended to be a practical session. The components will be taught by demonstration of the system itself, not using drawings or description. The flip chart can be used to illustrate details if necessary. Reinforce the learning by allowing participants to identify the parts and describe their functions to each other.
Materials	Depends on extraction method

Session guide and content

System identification

System components

Potential system components are listed below (see Handout 1). The facilitator should identify those components that are observed in the community's shallow wells. Discuss issues related to each component.

ITEM	DESCRIPTION
Head wall	Wall built at the surface to prevent accidental entry into the well and to prevent runoff from entering the well
Extraction system	There is a variety of possible extraction systems for open wells: • human ladder • rope and bucket • rope and washer pump • windlass • handpumps (discussed in different session) • manual pump (e.g., Moneymaker or similar, within the limit of its suction head) • motorized or diesel-powered portable pump • solar-powered pump
Apron	Hard material (concrete slab) around well head to provide a clean and safe area for users to draw water and to prevent seepage of contaminated water into the well
Well lining	Hard material (e.g., concrete rings, brickwork, plastic culverts, etc.) that is used to prevent the walls of the well hole from collapsing
Drain	Constructed together with the apron to remove waste water away from apron and well head
Perimeter fence	Made from local material, to prevent unwanted access to well area

Specific shallow well O and M tasks

The facilitator should lead a discussion on how the well and extraction system is operated and maintained at present, drawing out any issues.

Relevant issues may include:

- Safety – how to prevent children from falling into well
- Inspection of the perimeter fence and system for controlling access to well area
- Is the well 'protected' or 'unprotected'? What does this mean?

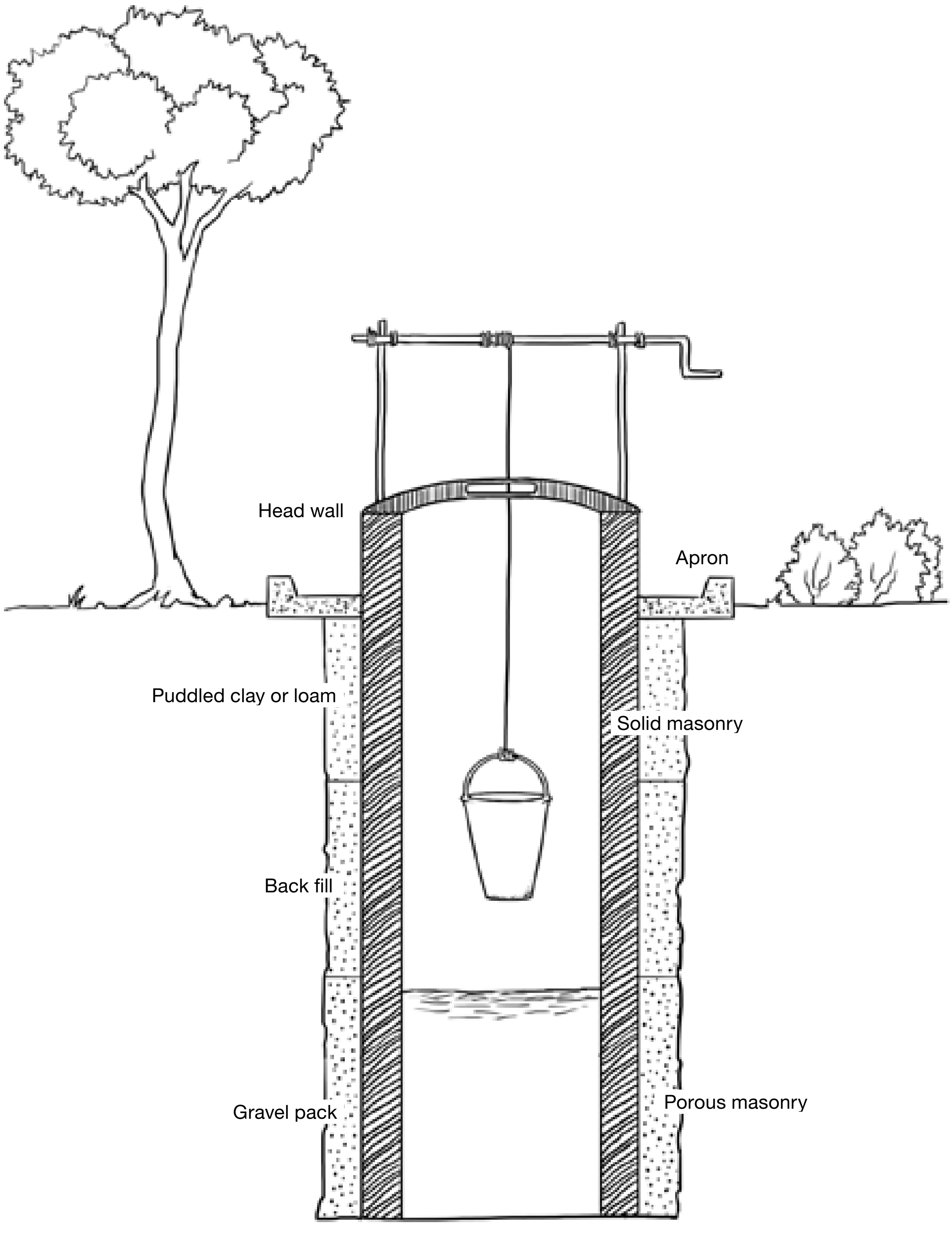
	• Contamination of the water – how to prevent contamination by runoff, dirty buckets or unwanted things being put into the well • Method of extraction – the need for a system that can be used safely and reliably by children, women and men • Inspection of the extraction system and checking for wear or damage, repairing or replacing as necessary • Inspection and repairs to the head wall and apron • Inspection and cleaning of the well (removing silt or any debris from inside the well) • Disinfection of the well through application of chlorine • Inspection of the well area and removal of rubbish and any faeces.
Troubleshooting	Discuss the potential unexpected problems, what might be the causes, and some possible solutions.

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Collapsing well	↘ Poor construction – usually insufficient well lining and well head	↘ Repair or improve the well lining, head wall and the apron.
Well goes dry	↘ Water level falls ↘ Water is extracted faster than the recharge rate	↘ Deepen the well – there is a limit as to how deep a well can be safely excavated. This depends on the surrounding material.
Well washed out by floods (in cases where well is placed in riverbed)	↘ Placing a well in a watercourse is risky and prone to damage due to the turbulence and force of the flood waters, and objects (e.g., logs, rocks) carried by the flood waters	↘ Seek a safer place in which to construct the well – usually at the edge of the watercourse. ↘ Alternatively, protect The well from flood water by building a hydrodynamic well head.
Well silted due to flooding	↘ Wrong placement of well in flood-prone area or insufficient height on the well head to prevent runoff inflow	↘ Raise the well head above flood level

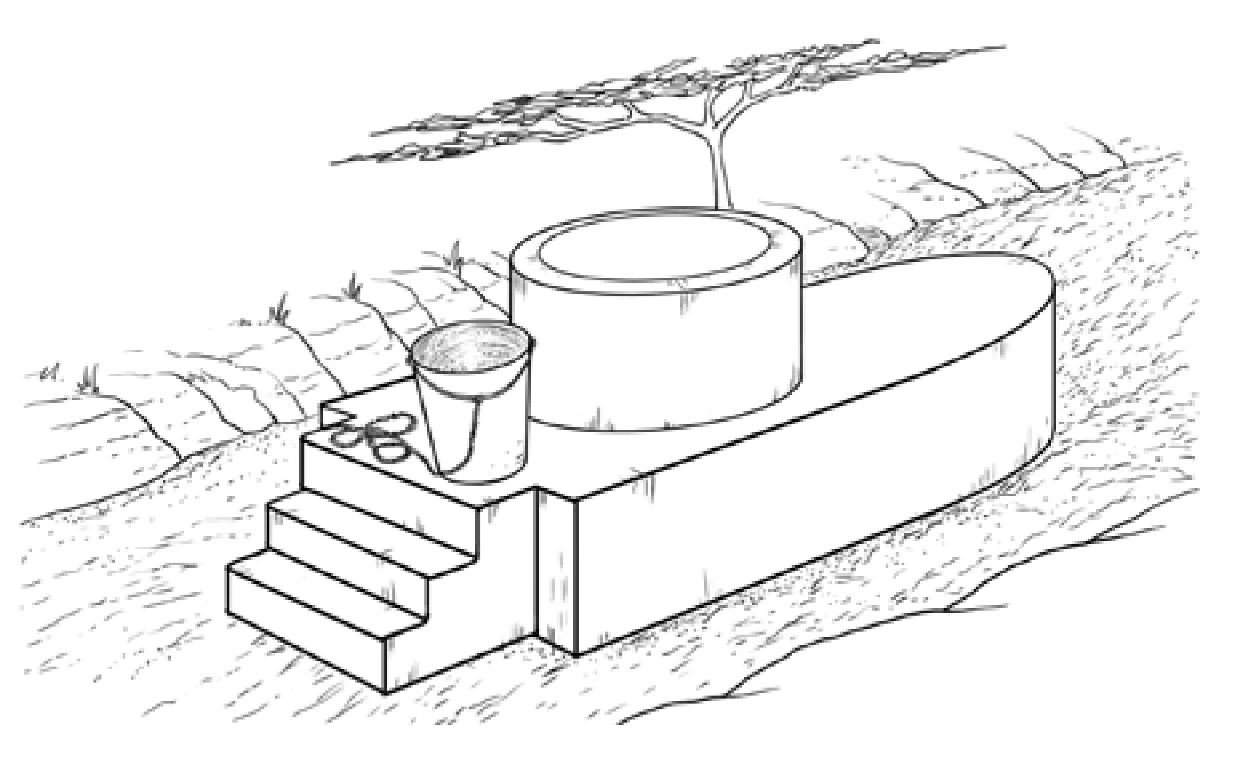
Tools, spares, and technical assistance	Tools: • shovels, buckets, ropes and ladder to enable de-silting of the well • masonry tools for repair to well head and apron. Spares: • chlorine compound for well disinfection • materials for the extraction system. Supply chain – O and M materials can be purchased at a well-provisioned hardware store. Technical assistance – de-silting a well is a task that requires expertise to enter and work in the confined space of a well. This experience is usually available within the village.
Session handouts	Handout 1: Diagrams of shallow wells

Handout 1: Diagrams of shallow wells

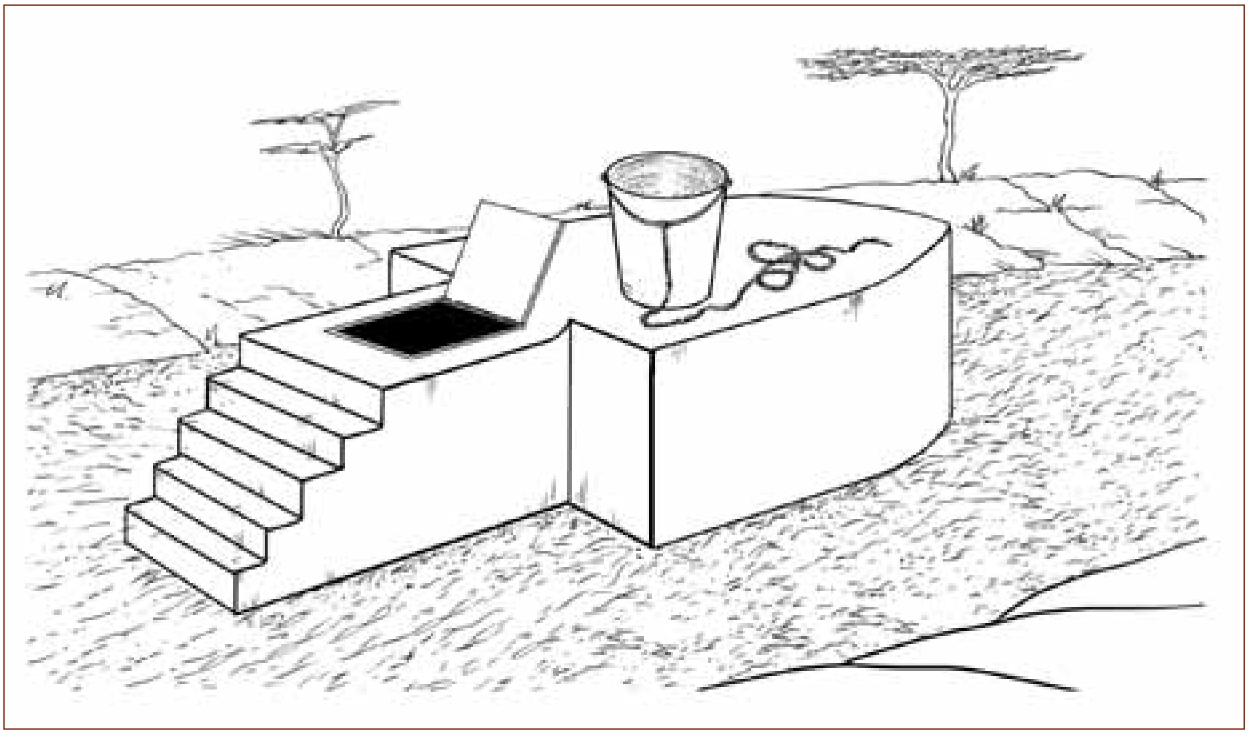
Typical Shallow Well



Shallow well with raised well head to prevent entry of river water



Shallow well with well head protection and lid to prevent damage and entry of river water



Module 2: Operation and maintenance for water supply systems

Topic 9: Boreholes with submersible pumps	
Objectives	Participants will be able to identify the different components of the borehole system.
Outputs	An O and M schedule
Timing	2 hours
Methodology	Site walk, question and answer session, demonstration
Materials	Flip charts, pens, flash cards
Session guide and content	
Introduction	Borehole systems typically include a number of different components. Most of these components are discussed individually under the sessions on generators, tanks, consumer water points and pipelines. This session is intended to be an introduction to boreholes.
System overview	In combination with a site walk, ask the participants to identify each component of their borehole system and discuss the purpose of each part (see Handouts 1 and 2).

ITEM	PURPOSE
Borehole	Protected hole which penetrates to the aquifer and which is filled by water from the aquifer
Wellhead	Prevents surface water from seeping down the edge of the casing and entering the aquifer or borehole
Borehole casing	Casing prevents the hole from collapsing
Screens	Perforated parts of the casing to allow water from the aquifer to enter the borehole
Seal	Prevents seepage water from moving from higher-positioned aquifers or near the surface to lower-placed aquifers
Submersible electrical pump	Raises water from the aquifer to the tank. The pump is located in the hole and is protected by the borehole casing
Rising main	Water is raised from the pump to the tank through the rising main
Dipper tube	Allows the water level in the borehole to be measured
Meter	Measures the volume of water extracted by the borehole from the aquifer
Pump house	Structure which usually contains the control panel. If the pump in use is an electrical submersible, then the pump house is likely to also contain the generator or the circuit board for the mains electricity power
Generator ('Genset')	Provides electricity to run the pump. The generator may also be a standby for when mains power is not available. It is driven by a motor/engine which may be diesel powered.
Control panel	A set of electrical circuits which has the of purpose controlling the power to the pump
Fuel store	A well-ventilated and secure store for fuel
Tank	Borehole water is typically raised to a ground-level or elevated tank from which water is distributed to the consumer points

Specific borehole O and M tasks

Discuss the tasks relevant to the operations and maintenance of the system components. Note: Specific sessions have been provided for generators, solar/voltaic-powered systems, wind pumps, tanks and consumer points.

Tasks may include:

- checking the pump house and fuel store structures for defects and repairing as required
- sweeping and cleaning out the pump house
- reading and recording of the current to the pump
- reading and recording of the voltage level to the pump
- reading and recording electricity meter readings (daily)
- reading and recording water meter readings (daily)
- if there is no meter, measuring discharge levels from the borehole using either a bucket and stopwatch or recording the time to fill the storage tank (remembering to close all outlets to the tank)
- calculating the power production ratio on a monthly basis (cubic metres per kilowatt-hour). (This is the water quantity produced by one kilowatt-hour. A reduction in the ratio indicates that the pump is not working efficiently or there is increasing resistance in the rising main.)
- once per year, taking a two-litre water sample (using a clean drinking water bottle) and sending in for chemical analysis. Changes to the water quality can provide early indication of borehole or aquifer problems
- checking the borehole permit and renewing if required
- paying water usage charges to the appropriate users association (or similar authority).

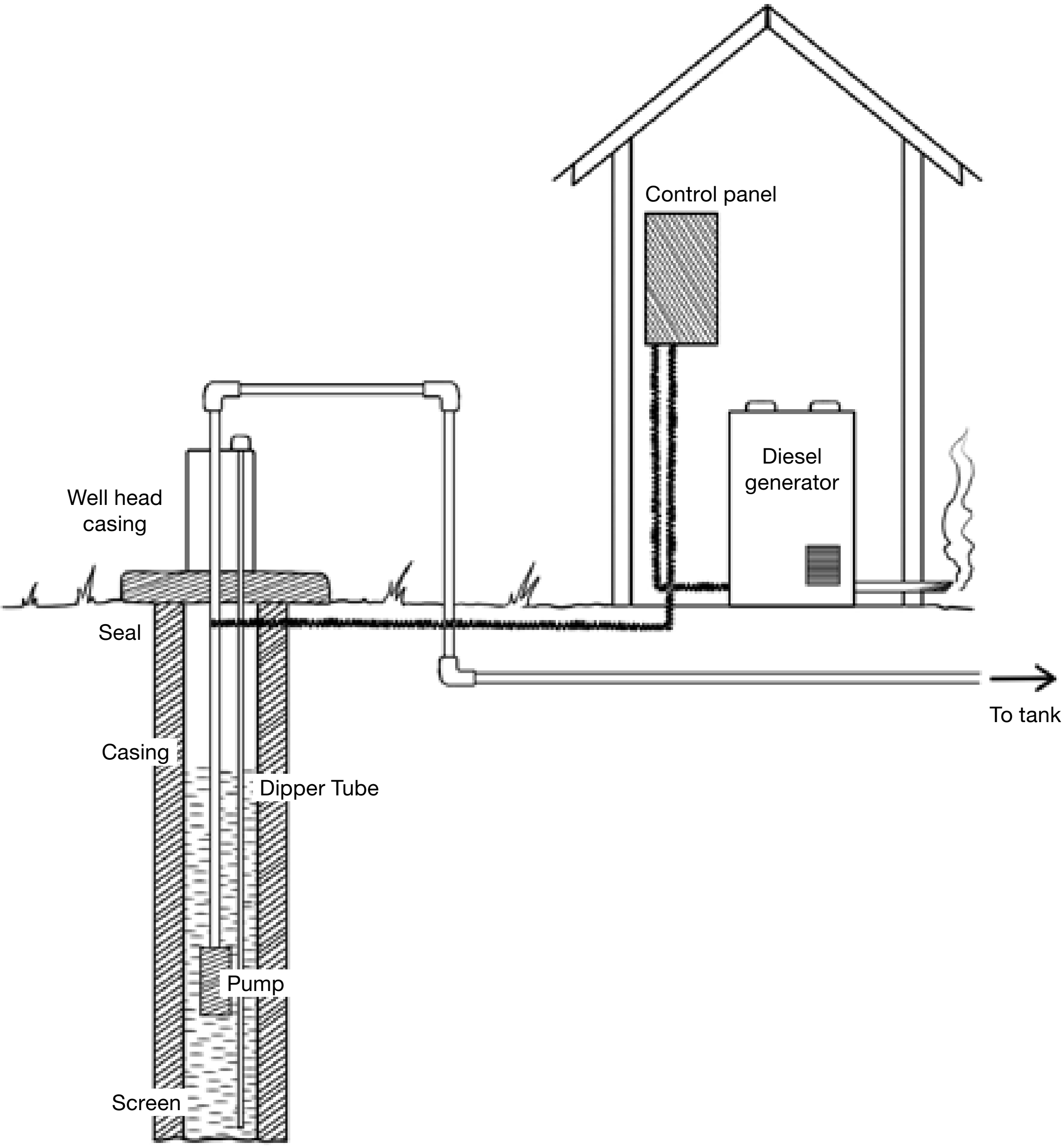
Troubleshooting

Discuss the potential unexpected problems, what might be the causes, and some possible solutions. In general, all remedial action should be carried out by skilled and qualified staff.

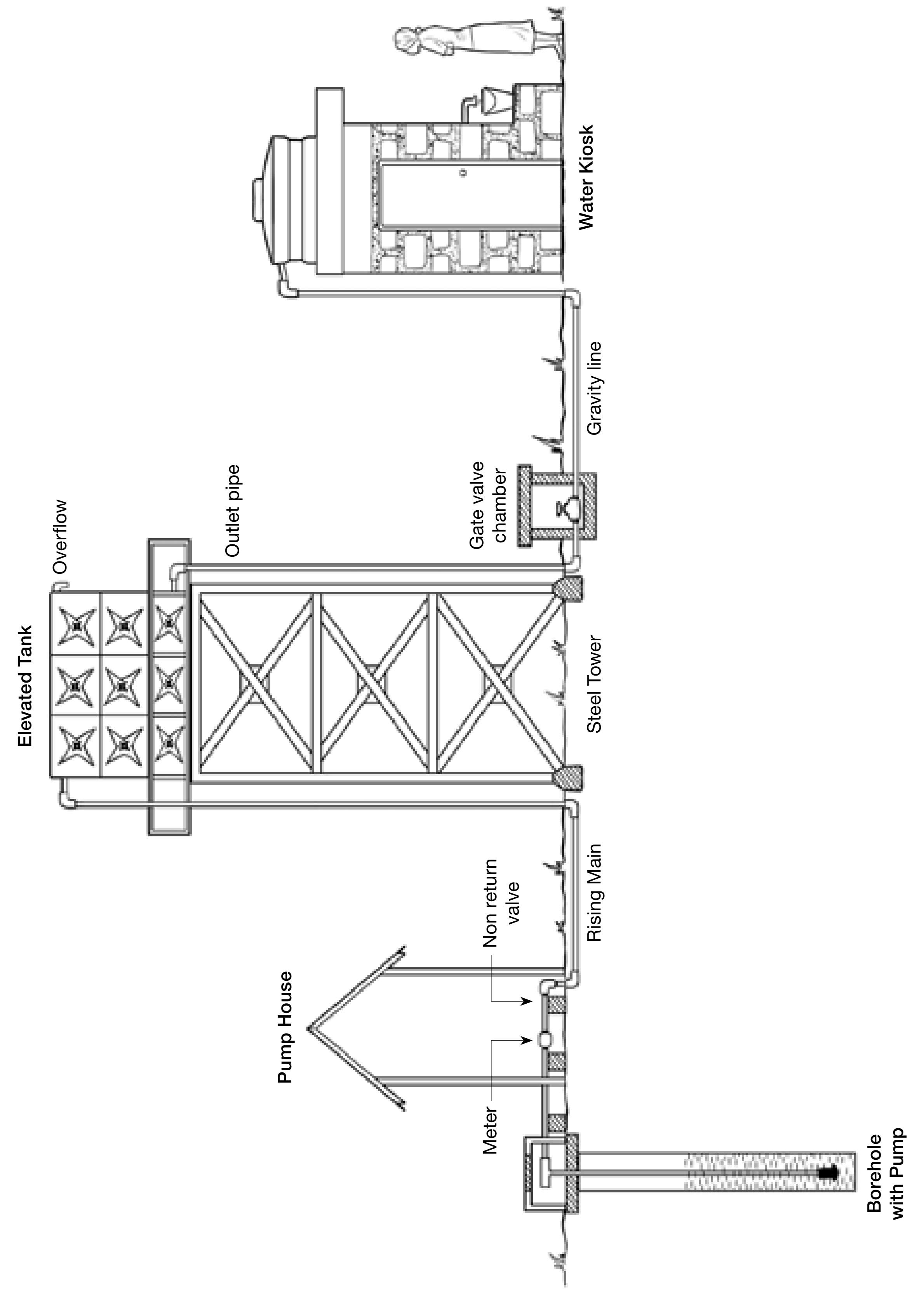
PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Pump fails to start	↘ Broken or loose electric connection ↘ Blown fuse - check the installation before replacing fuses ↘ Motor overload ↘ Low voltage ↘ Damaged supply cable insulation; check insulation resistance ↘ Cable - cable joint or motor windings may be wet or earthed ↘ Impeller plugged ↘ (Pump blocked with sand)	↘ Check power source. ↘ Check switches. ↘ Check fuses. ↘ Call for technical assistance.
No water from borehole	↘ No power to pump ↘ Pump is faulty and not working ↘ Pump not submerged (pump set too high or water level has fallen) ↘ Pump rotating in the wrong direction ↘ Leak(s) in riser pipe joints or corroded pipe ↘ Riser pipe joint threads corroded and disconnected ↘ Non-return valve in pump blocked or corroded ↘ Valves or discharge line blocked, damaged or not fully open ↘ Worn pump due to pumping sand or other particles	↘ Check power source. ↘ Check switches. ↘ Check fuses. ↘ Check depth of water in borehole. ↘ Call for technical assistance.

		↘ Blocked or damaged borehole screen ↘ Pumping head too high for pump ↘ Strainer or impellers blocked with sand or chemical deposits	
	Pump turns on and off frequently	↘ Excessive drawdown ↘ Capacity of pump exceeds borehole yield so water level drops below level of pump	↘ Call for technical assistance to investigate in detail. This may require test pumping, monitoring water level in borehole, changing pump, or lowering pump in borehole.
	Pump overload switch trips out	↘ Current overload or motor temperature sensor - possible causes: blockage, insufficient flow of water over motor, overload due to mechanical problems, low voltage ↘ Under-voltage - low voltage on supply system ↘ Incorrect oil level in dashpot operated overloads ↘ Low-level cut-out – excessive drawdown ↘ Incorrect overload settings	↘ Call for technical ↘ assistance. ↘ Check all settings.
	Borehole delivering less water than expected	↘ Screens are blocked ↘ Leaks in riser pipe	↘ Call for technical assistance to determine whether plunging of the borehole will result in improved yield. ↘ Remove riser pipe and repair or replace.
	Persistent case of sediments in borehole water (i.e., not immediately after borehole development)	↘ Sediments are passing through the screens	↘ Depending on the nature of the sediments, the sediments may be damaging to the pump. ↘ Check the water quality.
	Water quality is too saline	↘ Water in the aquifer is saline	↘ This is a feature of the aquifer and only surface treatment of the water (through reverse osmosis) can be used to make water potable.
Spares, tools and technical assistance	See topics related to pumps, tanks, pipelines and consumer points. Technical assistance – this should be sought from a registered hydro-geologist in the event of internal, 'down the borehole' problems. A specialist or qualified electrician is required for generator or electric problems and a specialized mechanic is required for problems with the motor/engine to the generator.		
Session handouts	Handout 1: Drawing of a borehole with submersible pump Handout 2: Typical borehole water supply		

Handout 1: Drawing of a borehole with submersible pump



Handout 2: Typical borehole water supply



Module 2: Operation and maintenance for water supply systems

Topic 10: Roof catchment systems for rainwater harvesting (RWH)	
Objectives	• To create awareness of the potential and procedures for RWH from roofs in different climatic regions • To enable participants to understand the problems associated with RWH from roofs and how they may be solved • To assist participants to expand RWH from roofs in cost-effective ways
Outputs	• Community support for the installation and maintenance of RWH systems • Expansion of effective RWH systems in the area • Participants have been informed about how to solve problems and where to get technical or financial assistance when needed • Participants have been informed about the health risks (usually negligible) associated with drinking untreated rainwater that has been harvested from roofs
Timing	1½ - 2 hours
Methodology	Short presentation, informal and participatory question and answer session
Materials	Photocopies of different installations, flip charts, pens
Session guide and content	
Introduction	• RWH is of increasing importance in view of the difficulties associated with the provision of clean piped water on a dependable basis to a growing population. • RWH can play an important role in promoting health as more water of better quality is available close to the homestead for washing hands, bathing, cooking and drinking. • RWH can reduce the labour of fetching water from streams and ponds. In dry seasons girls sometimes miss school on account of the need to fetch water. • RWH can provide supplementary irrigation for small gardens and support the production of vegetables, tree seedlings, etc. in dry periods.
Awareness creation for RWH	Find out from participants what experience they have had with RWH and what problems they have encountered. Find out from participants: a) How many live in houses where rainwater is harvested. If not, why not? b) How many use rainwater either from the house where they live or from a nearby building, e.g., school. c) How many use rainwater for drinking and cooking, for bathing, for washing clothes, for cleaning, for irrigation of plants. d) How many think that they could, or would like to, collect and use more rainwater. e) What do they believe to be the potential for RWH and what are the obstacles to collecting and storing it. Develop a list of the main issues to be addressed in the training.
How to deal with problems	Work through each issue to facilitate understanding, e.g.: • uncertainty of rainfall – how to plan for utilization of water • difficulty of knowing how to match the tank size with the roof size • problems of gutters and downpipes – how to prevent overflow and leakage • problems of tanks and draw-off – how to deal with any leakages • safety of rainwater – the causes and avoidance of contamination • finance – how to source finance and minimize costs without loss of efficiency.

Field visit (if possible)

Visit one or more buildings where RWH has been installed and carry out an evaluation of the installation, maintenance and utilization.

Participants could work in pairs and if possible each pair could visit different buildings and then report to a combined group discussion a summary of what they have observed.

Visit a site where a leaking tank is under repair to understand possibilities.

If no visit is possible, use Handout 1 and Attachment 1 (exercise).

Specific O and M tasks for RWH systems

Discuss the tasks relevant to the O and M of the system components.

These may include:
- inspecting gutters for cracked joints or loose brackets
- cleaning the gutters of silt and organic material
- cleaning or replacing the mesh or sieve/filter
- checking the tap and replacing the washer if the tap is leaking
- checking the drainage from the draw-off point and improving drainage if required
- cleaning out the tank
- disinfecting the tank
- where feasible, ensuring water is retained in the tank to avoid cracking.

Troubleshooting

Discuss the potential unexpected problems, what might be the causes, and some possible solutions.

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Water does not enter tank	↘ Blockage in downpipe ↘ Gutter is not installed at a gradient to allow water to flow to the tank; gutter sag	↘ Remove the blockage. ↘ Clean or replace the screens. ↘ Check the levels on the gutter and reset levels if required; put more brackets on the gutter.
No water in tank	↘ Leaky tap ↘ Leaky tank ↘ Overuse	↘ Check for and repair any leaks. ↘ Monitor usage.
Water does not last long after periods of rain	↘ Storage volume is low compared to consumption	↘ Regulate consumption. ↘ Provide additional storage if more water can be harvested. However, check whether the tank usually overflows. If not, then additional roof area and storage are required.
Smelly water	↘ Organic matter in tank decomposing	↘ Drain and clean the tank

Tools, spare parts and technical assistance

Tools – see tools listed in Module 2, Topic 1.

Spare parts include:
- tap washers
- mesh.

Supply chain – O and M materials can be purchased at a well-provisioned hardware store.

Technical assistance – RWH is a technology that generally does not require external technical assistance.

Session handouts and attachment

Handout 1: Handout on maintenance of RWH systems and safety precautions when using rainwater harvested from roofs
Attachment 1: Exercise on a RWH system

Handout 1: Maintenance of RWH systems and safety precautions when using rain from roofs

1. System components

The system of rainwater harvesting from roofs has four main components: the roof, the gutters, the downpipe and the tank. These are discussed briefly.

a) Roof
The most suitable roofs for RWH are made of tiles, galvanized metal sheets (mabati), concrete or roofing felt. Roofs that are thatched with grass or makuti (palm leaves) can also be used, though the water harvested is not as clean and may be contaminated. Roofs with asbestos cement sheeting are not recommended for rainwater harvesting because asbestos has carcinogenic (cancer-causing) properties.

A flat roof with a concrete or tiled surface can provide a good catchment surface. Roofing felt is less satisfactory.

Plastic sheets placed over thatch or used for greenhouses can be very useful for harvesting rainwater.

b) Gutters
Gutters are normally made from sheet metal or plastic. Metal gutters are made in sections that can be bolted or soldered together. Plastic gutters are made in sections that are either glued together or connected with plastic connector pieces. Certain types of bamboo with large stems can be used if they are split lengthwise and the joints are cleaned out. Some roofs on large buildings have concrete gutters as an integral part of the roof. The brackets supporting the gutters should be placed close enough so that the gutters cannot sag when full of water.

c) Downpipes
Downpipes are normally metal or plastic. Tall buildings sometimes have a chain to carry water to the ground.

d) Tanks
Tanks have traditionally been made of brick, stone, reinforced concrete, rubble stone or plastic. Tanks made of galvanized corrugated iron are common but prone to rusting and leakage after a few years. Tanks made of sheet metal are used in some parts of Kenya. Oil drums can be used and may be plastered inside with cement plaster to reduce contamination. Black plastic tanks have proved advantageous in many situations because they are light and easy to move. They are especially useful where building materials such as sand and stone are hard to get or are very expensive. Tanks are normally placed on a plinth (platform) about 50 centimetres from the ground to facilitate filling buckets and jerrycans at the outlet. Where the roof is low, this may not be possible and a pit may have to be dug with steps to access the outlet. Pipe inlet to tanks and tank overflow pipes should be at the top so that no storage space is wasted. Details on tanks are given in a separate section of this manual.

2. Maintenance

a) Roof
A well-made roof should not require maintenance except to prevent leaks. Flat roofs need to be swept periodically to remove leaves and other rubbish.

b) Gutters
The main problem with gutters is overflowing during heavy storms and leakage from their joints. Overflowing can be due to the accumulation of rubbish, so cleaning the gutters should be a routine measure before every rainy season. To minimize leaves falling into gutters it is advisable to cut back the branches of any trees overhanging the roof. Overflowing may also be due to a failure in design. Either the gutter is not large enough in relation to the size of the roof or it has insufficient slope to the outlet. Placing brackets too far apart can cause the gutter to sag and lead to overflowing too. Leakage at joints may be prevented using a bitumen sealant. As a rough guide, there should be one square centimetre of gutter cross-section for every square metre of roof area.

Gutters should normally have a one per cent slope to the outlet. Gutters are normally semi-circular or square shaped. It may sometimes be cheaper to make V-shaped metal gutters and to install splash guards to ensure that runoff from the roof does not flow over the gutter during heavy storms. These gutters can be installed where there is no fascia board attached to the end of the rafters.

c) Downpipes
Downpipes often have bends at the top where they connect to the gutter. If bends are at 90 degrees they are at risk of blocking with leaves and rubbish. Bends at 45 degrees should be used as they are less likely to block.

d) Tank
The main concern is to prevent rubbish, insects, rats etc. from entering the tank and polluting the water. The tank must have a tight lid on top that is large enough to allow cleaning periodically. Prevention of mosquitoes breeding is important and can be achieved using a screen around the lid and the inlet to the tank. There are two methods to remove rubbish. One is to have a first-flush device which, at the beginning of the rainy season, diverts rainwater into a container from which the rubbish can be removed periodically. Once the container is full, the rainwater goes straight to the tank. Another arrangement is to have a self-cleaning mesh screen over the entrance to the tank. If the screen is at 45 degrees, most of the rubbish will be washed off while most of the water goes into the tank.

Leaking or broken taps are a major problem with tanks. Where the tank is a communal water point, the tap should be lockable or enclosed in a lockable box. Leaks are often caused by worn-out washers, which are easily replaced if the necessary tools are available (usually a pipe wrench and/or adjustable spanner).

A tank should be cleaned from time to time depending on the amount of rubbish that comes in with the rainwater. This can be done when the tank is empty or almost empty. If the tank is a large one, a ladder will be needed for a person to climb in. Leaking tanks can often be repaired and made usable again. Methods of repairing different types of tanks can be found by searching the internet under www.infonet-biovision.org-water storage.

e) Water quality
Rainwater can be of very good quality if roofs, gutters and tanks are kept clean. However, droppings of birds, lizards etc. can cause some contamination. If rainwater is used for drinking, it will be safer if it is treated with a commercial water treatment product such as Waterguard or Jik that contains chlorine. Care is needed in following the instructions for using the liquid chemical.

Handout 2: Exercise on RWH

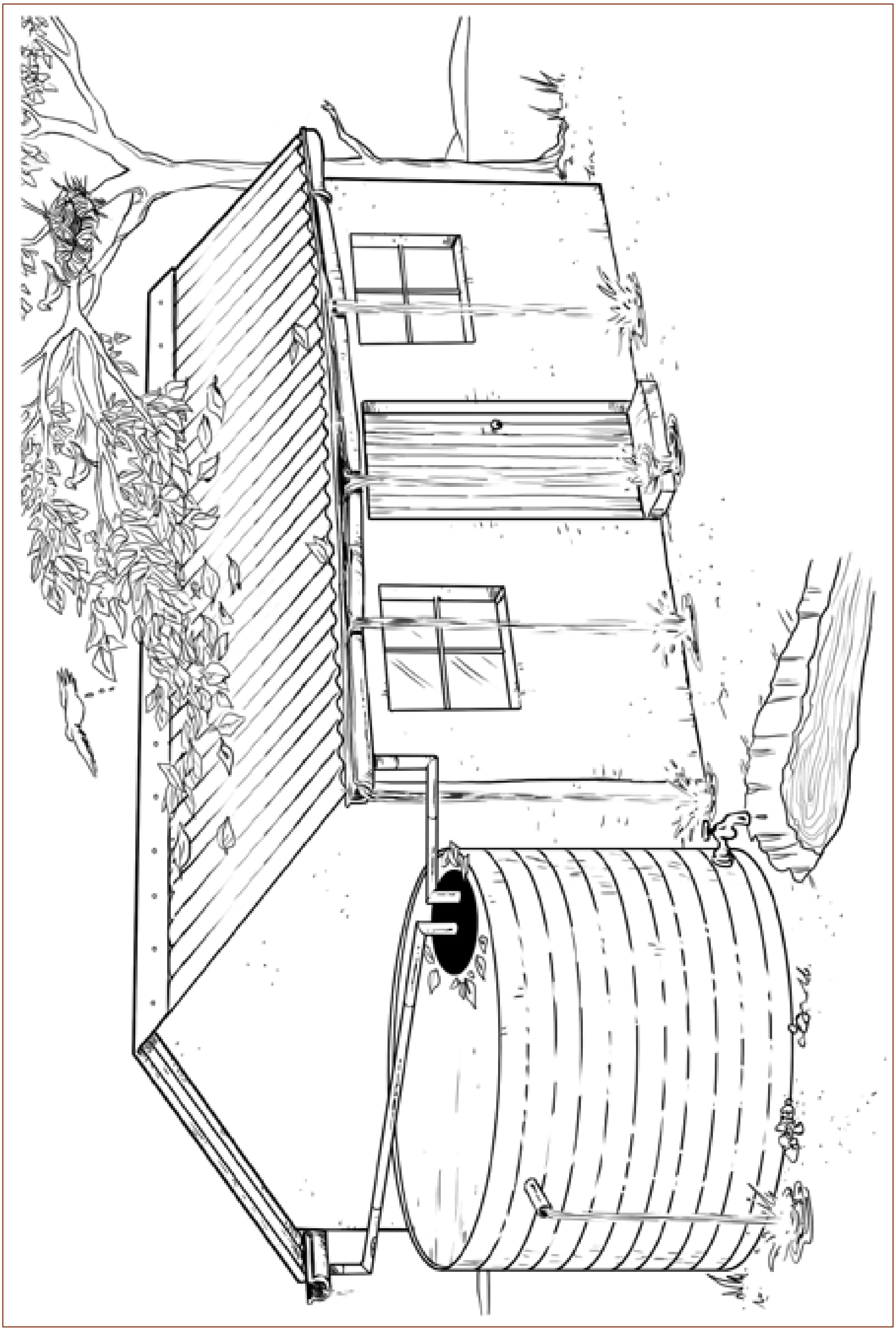
Trainees are invited to look at the drawing of a rainwater harvesting installation that is not working well (see diagram on following page) and to try and identify the problems and suggest solutions.

The Problems

1. The gutter brackets are too far apart and the gutter has sagged so that water is spilling out.
2. One of the gutter joints is leaking.
3. The rainwater tank is overflowing, which suggests that it may be not big enough to capture all the water from both sides of the roof.
4. The overflow from the rainwater tank is too low so the tank can never fill completely.
5. The outlet for drawing water from the tank is too high so all the water cannot be used.
6. The tank is sitting on the ground so to get a bucket under the outlet, a hole has been dug. This becomes wet and muddy because of spillage.
7. The top of the tank has no cover to prevent rats, lizards etc. from falling in.
8. There is no mesh or gauze to prevent mosquitoes from entering the tank.
9. The trees over the house encourage birds to pollute the roof with droppings.
10. Leaves from the trees will block the gutters and downpipes.
11. The downpipe has a 90-degree bend which is liable to block with the leaves.
12. There is no mechanism to prevent rubbish from passing straight into the tank.

Suggested solutions

1. Put brackets closer together or use a stronger material for the gutter.
2. Repair leaks by soldering if the gutter is metal or use bitumen sealant.
3. Look for a second tank to take water from the other side of the roof.
4. Close the existing overflow pipe and put a new one nearer the top of the tank.
5. Select or construct tanks with the outlet near the bottom.
6. Raise the tank on a plinth above ground level and make a drain to carry away any water that spills from the outlet.
7. Use a cover that rats, lizards and other animals cannot pass through.
8. Use mosquito mesh or gauze over the openings to the tank.
9. Cut back the branches of the trees so they don't overhang from the roof.
10. Clean the gutters before each rainy season.
11. If bends are needed in the downpipe, use ones at a 45-degree angle.
12. Check whether it is possible to install a 45-degree self-cleaning screen at the tank inlet.



Typical Rainwater Harvesting System

Module 2: Operation and maintenance for water supply systems

Topic 11: Handpumps

Objectives	At the end of the session, the participants will be able to: • describe the key components of the handpump and explain how it works • assemble and disassemble the handpump without assistance • identify maintenance requirements on the handpump • carry out routine maintenance of the key parts of the pump • recognize how poor maintenance of a handpump can reduce water yield
Outputs	An O and M schedule
Timing	Approximately 4 hours
Methodology	This session is intended to be made up of practical exercises. The components should be taught by demonstration of the system itself. Reinforce the learning by allowing participants to handle the parts and describe their functions to each other. A case study can be told as a story or acted as a role play. The purpose is to stimulate a discussion about how maintenance can keep the pump working. The story can be adapted to be more appropriate to a particular community.
Materials	Bucket, spanner, sample handpump for demonstration purposes, fishing tool

Session guide and content

Introduction	Many handpumps are designed to be operated and maintained at a village level. Despite this, evidence shows that 30 to 40 per cent of handpumps are not fully operational at any one time. This indicates that while village-level maintenance is possible, there are still significant issues in the implementation of this practice. There are many different kinds of handpumps commonly used in Kenya and Uganda, namely Afridev, India Mark 2 and Duba pumps. This session is non-specific in that it describes the importance of preventative maintenance of a standard handpump. However, the accompanying diagrams are specific to the Afridev handpump. Duba pumps are durable deep-well pumps. This material should be complemented by more detailed maintenance manuals for the specific type of handpump in the community.
Understanding the system	Start by explaining how the whole system works, from aquifer to delivery spout. Describe the following parts and explain their purpose:

ITEM	PURPOSE
Aquifer	↘ Source of water
Hand-dug well	↘ Hole that is excavated by hand to a depth sufficient to penetrate the water-bearing soil or rock
Drilled well or borehole	↘ Hole that is excavated by mechanical means to a depth sufficient to penetrate the water-bearing soil or rock
Handpump	↘ Equipment that allows someone at the surface to manually work the pump which is lower in the well
Apron	↘ Provides a firm base and foundation for the pump stand. It is a clean and convenient place from which users can draw water and prevents waste water from re-entering the well from the immediate vicinity of the well by providing a sanitary seal around the well

Drain or soak away	A drainage channel or pipe that takes excess water away and so prevents water from stagnating near the handpump
Fence	Prevents uncontrolled access to the well area. This is important to stop livestock polluting the well area and children from playing with the handpump.

Allow participants to discuss the system and to ask questions.

Understanding the pump mechanism

A. Remove the handpump from the well (including rods and plunger and foot valve) and explain the main parts (see Handout 1 for the Afridev handpump).

Above-ground components	1. Pump head assembly
	2. Pump stand assembly
Below-ground components (also called 'down-the-hole' components)	3. Rising main assembly
	4. Cylinder assembly
	5. Pump rod assembly
	6. Riser main support rope

B. Explain the basic components of the cylinder and how it works.
C. Explain how the pump rods and rising main work
D. Explain how the pump head works.

Reassemble the pump head, showing how the parts connect together.

Demonstrate how moving the handle causes the rods and the foot valve to move up and down.

Preventative maintenance

Explain the difference between:
- preventative maintenance
- breakdown maintenance.

Preventative maintenance
1. Undertaken while the system is in operation
2. Scheduled at an interval to pre-empt any failure of parts
3. Involves the replacement of parts before they have completely worn out and exceeded their lifespan
4. Intended to keep systems working without any unexpected breakdowns; it focuses on improving system reliability.

Breakdown maintenance
1. Undertaken only after the system has broken down.

Allow participants to discuss the advantages and disadvantages of each type of maintenance service.

The steps involved in preventative maintenance are:
a. Assessing whether or not a pump is functioning properly. If it is not, then understanding the nature of the problem and identifying the solution required.
b. Checking the discharge of the pump – this is done by observing whether the discharge rate of water from the pump is adequate and timely. This gives a very good picture of the condition of the Below-ground components of the pump are the cylinder, the riser pipe and the connecting rod assemblies.
c. Checking the physical condition of the pump – this is done by observing the movement of the handle, looking for external signs of wear and tear, rusting, condition of components such as nuts and bolts, flanges, handle and handle bracket, chain etc. These observations give the condition of the above-ground components of the pump.

	d. Dismantling the pump for maintenance, if necessary, and reassembling it after replacing the defective components or the components that have reached their serviceable lifespan e. Maintaining a record of the maintenance history and observations of pump condition for each pump in a given area (see Handout 2: Handpump maintenance record).
Testing performance of the handpump	**Demonstrate the Leakage Test and the Discharge Test** • Explain the purpose of the two tests, which is to determine whether there is a down-the-hole problem with the pump and the nature and extent of the problem. • Leakage in the rising main indicates that may be a worn bobbin or O-ring on the foot valve, disconnected rising main joints or cracked riser pipes. • Low discharge indicates that there may be a problem with the bobbins or the cup seal. **Leakage Test** • If the below-ground assembly of the handpump is leaking then the water level in the riser pipe will fall. When the handle of such a pump is operated it will not immediately yield water since the initial strokes of the handle will be required to fill the riser pipe to replace the water that has leaked out. • The method of assessing leakage is to count the number of idle (non-productive) strokes required before water begins to flow from the pump's spout. This test is performed after the pump not been used for 30 minutes. Count the number of strokes of the handle required before the pump begins to yield water. If the number of idle strokes exceeds five, then the leakage is unacceptable. • Leakage can be caused by a leak in a pipe joint, a small hole or tear in the riser pipe wall, worn-out bobbin valves or a leakage at the O-ring in the foot valve. • The cause of the leakage then needs to be diagnosed and corrected. • Proceed with the maintenance steps outlined in the Handout 3: Troubleshooting Chart for the Afridev handpump. **Discharge Test** • After completing the Leakage Test, the Discharge Test should start after the pump is producing water continuously when the pump handle is operated. • When water is flowing continuously, it should be collected in a container or bucket for 40 continuous and full strokes of the pump handle. • Measure the quantity of water collected. Ideally, the water collected should not be less than 16 litres. • If the discharge amounts to less than 10 litres, then it has dropped to lower than acceptable limits and the pump needs to be repaired. • Discharge can fall if the plunger U-seal or bobbin valve are worn out, the foot valve O-ring or bobbin valve are leaking or if there is a significant leak in the riser pipe. • A leak in the riser pipe can be further confirmed by conducting the Leakage Test. • Proceed with the maintenance steps outlined in the Troubleshooting Chart.
O and M schedule	In discussion with the community members, develop an O and M schedule for all the handpumps within the community. **1. Maintenance of pump surroundings** The handpump platform should offer good protection to the water source because it seals off the well from surface contamination. However, contamination can still occur, if: • the platform and drain are cracked or broken • the pump stand had become loose in its foundation

- waste water accumulates in the close vicinity of the well
- solid waste is disposed near the well in a rubbish dump
- animals (and humans) defecate close to the well
- the well is in the natural drainage path and the platform is prone to flooding during periods of rain.

All of the above should be prevented, corrected or repaired.

1.1 Weekly checks:
- Check that the base flange and head flange nuts and bolts are tight.
- Check that the fulcrum pin and hanger pin nuts are tight.
- Check that the handle moves smoothly, moves to its full arc and that water comes out when the handle is operated.

1.2 Three-monthly checks:
- Check if any nuts, bolts or parts in the pump head are missing. Replace any missing parts.
- Check if there is any unusual noise when the pump is operated. Refer to the Troubleshooting Chart and correct the problem.
- Check if the pump is loose in its foundation (even if the bolts are tight); this can allow contaminated waste water to enter the water source. Repair the platform, allowing time for the cement to set properly before reusing the pump.
- Check if the pump is yielding adequate water. This is done by conducting the Discharge Test.
- Check if there is any leakage in the pump. If more than five strokes are required before the pump begins to yield water, it means that the water level is dropping in the riser pipe due to a leakage.
- Reduction of discharge and leakage in the pump could be due to a number of reasons such a leak in a pipe joint, a small hole or tear in the riser pipe wall, worn-out bobbin valves or a leakage at the O-ring in the foot valve. The procedures for conducting the Discharge Test and the Leakage Test are described in detail above.
- Repairs to the rising main require a skilled mechanic with the proper equipment. It should not be attempted by the Caretaker alone.

1.3 Annual maintenance tasks:
- Replace the fulcrum or hanger bearings.
- Replace the plunger seal and plunger bobbin.
- Replace the foot valve bobbin and the foot valve O-ring.

To reiterate, it is important for the O and M tasks for the handpump caretaker to include:
- regularly checking that all nuts and bolts are tight and that the movement of the handle is smooth, complete and yields water
- performing the Leakage and Discharge Tests and recording the results
- checking the platform and draining for cracks and breaks; the pump stand should be firm
- eliminating collection and stagnation of waste water near the pump by keeping the drain free from blockage, or by filling with earth
- maintaining the fence, if any, around the pump to prevent animals from coming close to the pump
- keeping the pump's surroundings clean at all times
- instructing and motivating users to keep the pump's surroundings clean and dry and to use the pump properly
- checking the perimeter fence and repairing as required
- taking water-quality samples for analysis
- assisting in disinfecting the well
- assisting in de-silting the well.

Troubleshooting

Discuss the potential unexpected problems, what might be the causes and some possible solutions. (See Handout 3 for Troubleshooting Chart.)

Tools, spare parts, tools and technical assistance

Discussion questions:

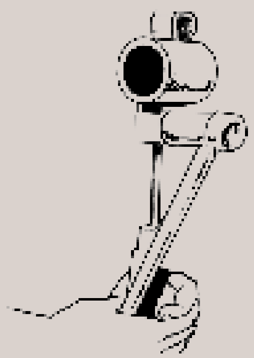
- What tools are needed for routine maintenance?
- What spare parts are needed for routine maintenance?
- Where are these tools and spare parts available from?
- If the system requires major repairs, where will they find a technician to repair the system?

The facilitators should discuss with the committee members about possible sources of spare parts and technical assistance if they are not familiar with all the possibilities.

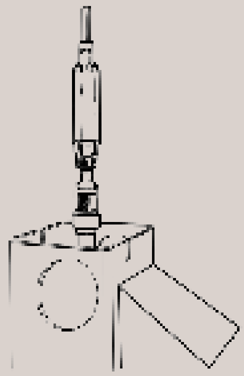
Tools

The tools for the Afridev and the India Mark 2 handpumps are slightly different, as illustrated below.

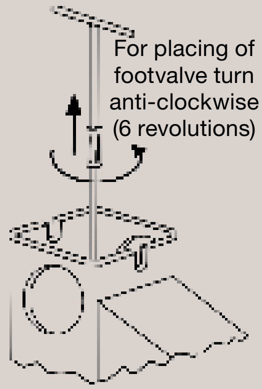
Afridev Tools



24 size spanner for M16 hexagonal nuts



Fishing tool for retrieving foot valve



Connecting tool

The rod resting tool is to be used when the cylinder installation depth is of the order 30 to 45 metres, as the total weight of pump rods is heavy.

India Mark 2

- 19mm spanner spares
- Fulcrum pin
- Bobbin
- O-ring
- Pump washer
- Cup seals
- Bearing bushes

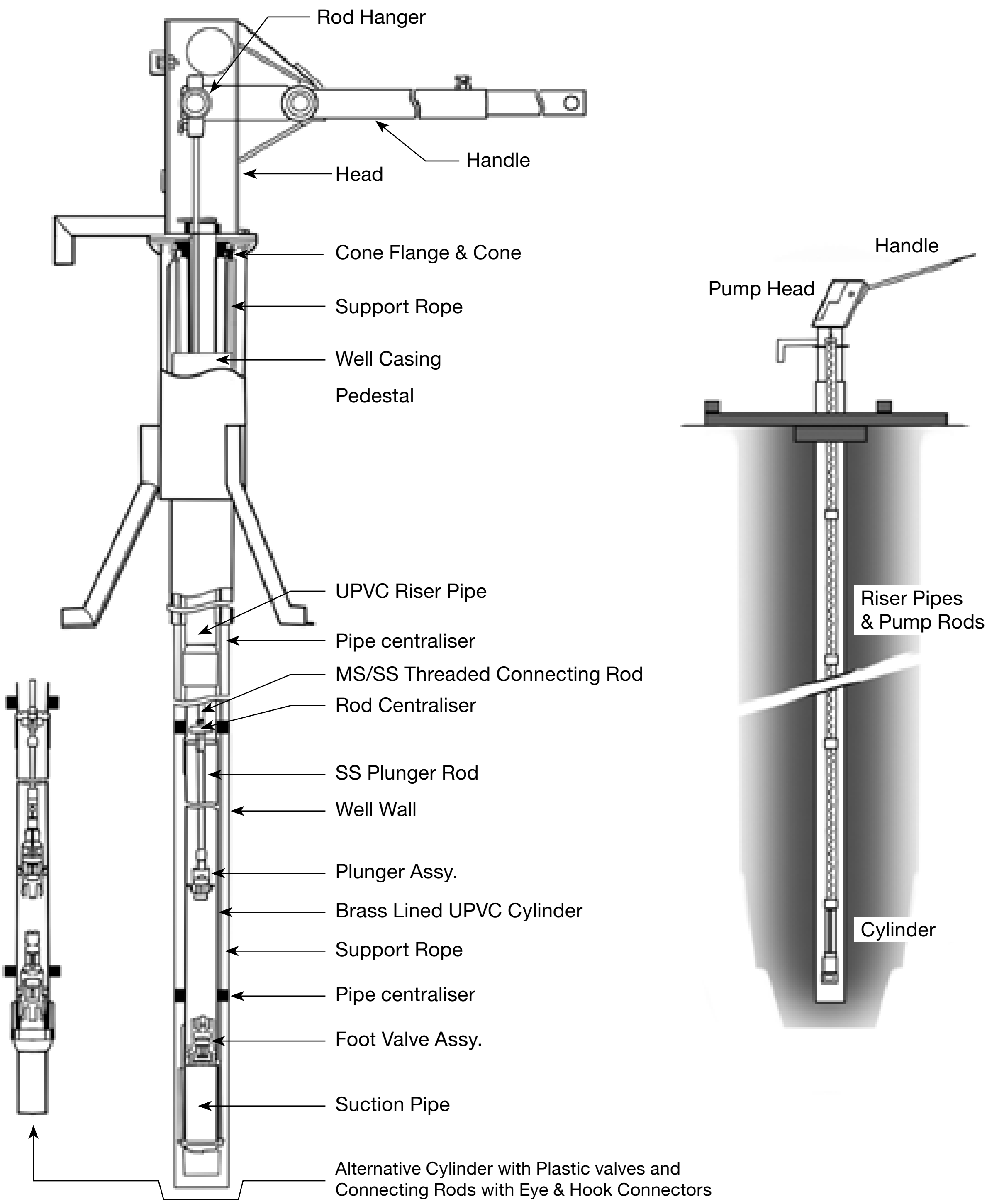
Supply chain – establish the location of the nearest store that stocks spare parts for the handpump. In addition, obtain the contact name and phone number for a suitable handpump maintenance provider.

	Name and contact of handpump technician (1)	Name and contact of handpump technician (2)
Name		
Telephone		

Technical assistance – this may be required if the well goes dry to ascertain whether the well should be made deeper.

Case study/group exercise	**Nzaui Case Study** The "Maji" NGO project constructed a handpump in Nzaui community. When this handpump was handed over to the community, it worked well in both the rainy season and the dry season. When people came to fill their jerrycans, a lot of water would come out after one or two strokes. After a year, though, it was very difficult to get water. A community worker, Monica, heard about the problem during a follow-up visit. She decided to gather information on the problem before she reported to the NGO that the pump was broken. Monica decided that she had better learn what the residents of Nzaui thought about the problem. She decided to just walk around and talk to people as she met them. In the discussion with elders (men) from Nzaui, the participants said, "Maji NGO put the well in a place where there is no water. The NGO should come back and make us a new well in a different place." In the discussion with women, they also thought that "Maji NGO" should come back and make a new well. However, Monica learned something else. The women who actually used the well said that water would come out if they pumped for a long time. However, it was not as much water as before. The women gave up using the well, because they spent too much time and effort to get such a little amount of water. Instead, they walked to other handpumps or used the traditional sources. Monica went to the handpump immediately and tested it. She found out that what the women said was true. Monica pumped for about 10 minutes and finally some water came out. She waited for a little while, and then pumped again. She had to pump for just as long before any water came out. **Discussion questions** Use the following questions to guide the discussion: **1.** What do you think is the probable problem with the well, and why? **2.** What would you do to determine the real problem? **3.** What would you advise Monica to do? Participants should be encouraged to discuss whether they feel that their operator or committee members would be able to identify and repair a problem like the one in the story.
Session handouts	Handout 1: Diagram of the Afridev handpump Handout 2: Handpump maintenance record Handout 3: Troubleshooting Chart for Afridev handpumps

Handout 1: Diagram of the Afridev handpump



Handout 2: Handpump maintenance record

Village/Community	
Location/sub-location	
Division/District	
GPS References	N/S E
Handpump Type	❑ Afridev ❑ India Mark II Other : . . . .
Hand Pump Code/Serial No:	

Preventive Maintenance – Results of Discharge & Leakage Tests			
Date	**1st Observation leakage - strokes**	**2nd Observation discharge - litres**	**Remarks**

Maintenance Interventions				
Date	**Complaints**	**Date repaired**	**Parts replaced**	**Costs & remarks***

* Remarks could include: Separate costs for parts and mechanics's fees and name

Handout 3: Troubleshooting Chart for the Afridev handpump

Problem	Indicator	Cause	Corrective steps
Reduced discharge, confirmed by the Discharge Test	Handle is difficult to operate	Cup seal is tight	Replace Cup seal
	Handle operation is normal	Complete stroke not available	The check for the correct length of pump rods has to be made every time the below-ground assembly is dismantled for repairs. Adjust the length of the top rod to get the full movement of the handle. Correct the stroke by adjusting the length of rod as described earlier
		Plunger seal defective/ worn out	Pull out rods, with plunger and foot valve. Examine the Plunger seal, Foot valve "O" ring and both the bobbins and sealing surfaces. Replace worn parts and reinstall rods.
		Bobbins worn out	
		Leakage in the foot valve "O" ring	
Delayed flow, confirmed by the Leakage Test	Handle operation is normal	Complete stroke not available	Correct the stroke by adjusting the length of rod as described earlier
		Leaky valves or leaking foot valve "O" ring	Pull out rods, with plunger and foot valve. Examine the foot valve "O" ring and both the bobbins and sealing surfaces. Replace worn parts and reinstall rods.
		Leakages in pipe joints	Take out the riser mains and look for a leakage. This could be due to external abrasion of pipes if the bore hole is not fully cased and/or if pipe centralizers have not been used. Perforation of PVC pipe from inside is also possible if rod centralizers have not been used and rod couplings have cut through the pipe from inside. Cut off the riser at the point of leakage, examine the inside of the pipe carefully for signs of wear, replace/repair the defective part/s of the riser main, following the pipe repair procedure.
Pump handle shaky	Handle is shaky when operated	Fulcrum Bushes are worn	Replace fulcrum bushes
		Fulcrum pin loose	Tighten nuts fully
		Hanger pin loose	Tighten nuts fully
	Pump head is shaking	Loose flange bolts	Tighten flange bolts and nuts
	Pump stand is shaking	Loose pump stand, cracked platform	Repair platform
Abnormal noise during operation	Handle operation is normal	Rods rubbing against pipes; centralizers worn out	Ensure that the rods are straight. Replace rod centralizers.
	Handle is rough/ uneven to operate	Rods bent and rubbing	Replace rods with good ones. Straighten bent rods if replacement rods are not available.
		Worn out fulcrum bushes, handle fork touches pump head	Replace fulcrum bushes

Problem	Indicator	Cause	Corrective steps
No Water	Handle is very easy to operate, virtually free	Pump rods have disconnected	The rods feel very free to lift. Pull out all rods till the broken/ disconnected rod joint comes out. Insert a small rod fishing tool into the riser pipes to extract the remaining rods, till the plunger assembly comes out. Replace the damaged rod/s (or rethread rod joint/s) and reinstall the plunger and rods as described in the Installation manual. **Alternative:** If no rod fishing tool is available, pull out the rod till the broken joint. Counting the number of rods that have come out, pull out the riser pipes for at least the length of rods pulled out earlier. Then pull out the riser pipe for least 3 m more (one pipe length) to be sure that remaining rods can be reached. Cut off the riser pipe to expose the remaining rods. Then pull out all the remaining rods till the plunger comes out. Use a repair socket with solvent cement to join the cut riser pipes. Allow the join to cure and lower the riser pipes. Now replace the damaged rod/s (or rethread rod joint/s), and proceed to reinstall plunger and the rods.
		Riser pipes have disconnected	Pull out the rods. The plunger should come up to indicate that the rod connections were intact. Remove the pump head and lift the cone flange. Carefully loosen the supporting ropes, keeping them taut. Lower the ropes a little to see if the tension on the ropes slacken – in which case the pipes have not disconnected. If the ropes go down and the tension remains on the ropes, then it indicates that the pipes have disconnected but is still hanging on the ropes. Anchor the ropes to bolts on the pump stand flange. Pull out the riser pipes that are attached to the cone. The length of riser pipes that come out would be shorter than the rods and the cylinder would be missing. A comparison of the lengths of the riser pipe and the rods will give an indication of the length of riser pipes that are now hanging by the support ropes. Pull out both end of the support rope evenly till the broken/ disconnected end of the riser pipes comes up. Then pull up all the remaining riser pipes. When the entire length of the rising main has been accounted for, examine the riser pipe thoroughly for any other damage. Cut off damaged parts and repair the rising main. Reinstall cylinder and riser pipes, taking care to repair the broken part carefully. A pipe fishing tool may have to be used in case the riser pipes do not come up with the support ropes. This may happen in case the upper end of the riser pipe fouls with the bore wall or the lower end of the casing pipe. Fishing will also be required if the support ropes have failed and the pipes have dropped to the bottom of the well.

Problem	Indicator	Cause	Corrective steps
			Alternative: If fishing is not possible or is unsuccessful, then consider installing new riser pipes and cylinder. This will be determined by the Static Water Level (SWL) in the bore well and the total depth of the bore. The bore should be deep enough and the SWL should be high enough to accommodate a new riser main and cylinder. Be sure to record these details on your repair work record.
	Handle operation is normal	Plunger seal defective Bobbins worn out	Pull out rods, with plunger and foot valve. Examine the Plunger seal, Foot valve "O" ring and both the bobbins and sealing surfaces. Replace worn parts and reinstall rods.
		Riser pipes have disengaged	Pulling out the rods does not reveal any problem. Remove the pump head and lift the cone flange. Untie the ropes very carefully and anchor them securely to the pump stand flange with anchor bolts. Lift the riser main out. As it comes out, the support ropes WILL NOT GO SLACK confirming that there is still weight suspended on the ropes. The final confirmation of a disengaged riser will be possible when only a short (in comparison to the rods) length of risers come out. After this, the support ropes have to be pulled out uniformly on both sides, to bring out the remaining length of rising main from the bore. When the entire length of the rising main has been accounted for, examine the riser pipe thoroughly for any other damage. Cut off damaged parts and repair the rising main. Reinstall cylinder riser pipes as per installation instructions, taking care to repair the broken part carefully. Fishing may have to be attempted as described earlier.
		Water level has dropped below the cylinder	Remove rods and plunger. Examination of plunger shows no defects. Remove riser pipes with cylinder. This assembly too shows no defect. Measure the SWL with plumb line. Also measure the total depth of the bore to judge if space is available for more riser pipes, i.e., a deeper cylinder setting. Compare the depth of SWL with the length of pipes pulled out. The pipes (including cylinder) should measure less that the SWL. This confirms that the water level has dropped below the cylinder level. Add at least one pipe to the riser mains and one rod or more, if the well depth can accommodate more riser pipes.

Module 2: Operation and maintenance for water supply systems	
Topic 12: Wind pumps	
Objectives	At the end of the session, the participants will be able to: • identify the main components of the wind pump system • describe the functions of the key components • explain how the water reaches the taps • tie and secure the rotor • carry out routine greasing of the moving parts • move around the wind pump safely.
Outputs	An O and M schedule
Timing	Approximately 4 hours
Methodology	This is intended to be a practical session. The components should be taught by demonstration of the system itself. Reinforce the learning by allowing participants to handle the parts and describe their functions to each other.
Materials	Wind pump, adjustable spanner, screw spanner, screwdriver, grease and grease gun
Session guide and content	
Introduction/note	This session supports a community to understand the basic operations and establish an O and M programme. It is based on the Kijito wind pump, although there are various other brands available (e.g., Southern Cross). Kijito is a local Kenyan company.
General layout	Start by explaining how the whole system works, from borehole to water points. (See Handout 1: Typical wind pump.) Describe the following parts: • borehole • pump cylinder ('down-the-hole' equipment) • windmill • pipe • tank or trough. Allow participants to discuss the system and to ask questions.
Identification of components	Explain the main parts of the windmill listed below. (See Handout 2: Detailed drawing of the Kijito wind pump.) • Rotor • Tower • Transmission assembly • Pump rods • Riser and stuffing box • Outlet • Base plate • Borehole casing It is not necessary for the participants to understand exactly how each component works. Explain how the parts operate together.

Routine maintenance

1. Safety procedures
Like many powerful mechanical devices, Kijito wind pumps can be dangerous if they are not used correctly and by someone with appropriate experience person. Carefully following the simple rules below will help prevent accidents.

Safety procedures for wind pump

1. Always work on the wind pump with at least two people; never work on a wind pump alone.
2. Keep your fingers well clear of any moving parts.
3. When climbing the wind pump keep your feet clear of the moving pump rods, and check you are not coming up directly under the rotor blades.
4. If possible, do not stand or work underneath the wind pump when someone is working on it, unless you are wearing a hard hat or helmet.
5. It is good practice to wear a hard hat or helmet at all times, even if you are just climbing the wind pump to check its operation. It is quite easy to get distracted and this could result in the crank striking your head as it rotates.
6. The towers have steps built into one of the tripod legs; please use them.
7. The tower is designed with sufficient clearance between it and the tower legs, to allow you a safe clearance, should the rotor change direction while you are up on the wind pump.
8. Even if you are experienced with working on the wind pump, it is a good idea to use a simple quick-release harness as well, to attach yourself to the tower. This also allows you to use both hands when necessary.
9. Never allow children to play on or near the wind pump.
10. Experienced people actually sit on top of the transmission while checking or servicing it. No matter how experienced you become, never do this without securing the rotor first.
11. While servicing your machine it is easy to leave grease on the tower. Please make sure it is wiped off before you leave, as it could cause someone to slip.

Where possible, demonstrate the dangers to participants.

2. How to furl and secure the wind-pump rotor (see diagram in Handout 2)

a) Choose an undamaged piece of rope at least two centimetres thick, and long enough to pass a double strand round both anchor points on the rotor.
b) Secure the middle of the piece of rope securely underneath one of the tower cross-beams just opposite the rotor ring.
c) Take one end and loop it round where the blade spar crosses the rotor ring, and choose one where the blade joins a rotor support spar. This will reduce the chance of damage to the rotor or blade spar during maintenance if the wind changes direction very strongly.
d) Having secured the rotor in this one place, get the assistant to turn the rotor until the rope is tight, and then take the other end of the rope and tie or lash it in the opposite direction to another blade and support bar.
e) Make sure the knots are tight.
f) Never leave the wind pump tied up after leaving the tower. A strong wind could result in the rotor being bent.
g) Never try to furl the wind pump while up the tower; this can be dangerous
h) Never leave the rope hanging from the furling chain, after the maintenance has been carried out, as it could get entangled, damaging the rotor, or enable unauthorized people to tamper with the machine. Make sure at least two people (the operator and assistant) can demonstrate how to do this satisfactorily.

3. Greasing
This is the main routine maintenance activity that should be carried out on wind pumps. Greasing prevents wear on the moving parts and helps to ensure that the wind pump runs for a long time without requiring major repairs.

<table>
<tr><td></td><td>Greasing must be done using a grease gun.
Greasing should be done every six months.

Each greasing session will use approximately 1 x ½-kilogram tin of grease.

Apply two to three strokes of the grease gun on each grease point.

The points that should be greased are shown on the diagram in Handout 2.
They are marked on the machine in red.

Make sure at least two people (the operator and assistant) can locate the grease points and can demonstrate how to do the greasing satisfactorily.</td></tr>
<tr><td>Establishing an O and M schedule</td><td>Review the points that have been demonstrated and ask the participants to draw up an O and M schedule.

O and M tasks include:
• patrolling the perimeter fence and repairing as necessary
• checking the tower frame for damage, loose bolts, or for areas of weakness
• checking the condition of the pumping rods and securing bolts where necessary
• greasing all grease nipples
• checking that the rotor blades are not bent or damaged
• measuring the volume of water delivered by each stroke to check the condition of the pump washers
• replacing the pump washers as necessary
• checking the pipeline from the wind pump to the tank
• testing all valves
• repainting the tower if required
• regularly taking water samples for analysis.</td></tr>
<tr><td>Troubleshooting</td><td>Discuss potential problems, what are the likely causes, and some possible solutions.

<table>
<tr><th>PROBLEM</th><th>PROBABLE CAUSE</th><th>POSSIBLE SOLUTION</th></tr>
<tr><td>Wind pump does not Self-furl</td><td>↘ Furling mechanism not working</td><td>↘ Repair the furling system.</td></tr>
<tr><td>Windmill working but no water being raised</td><td>↘ Borehole has run dry
↘ Pump washers leaking
↘ Leaky riser</td><td>↘ Remove the pump and Inspect or repair. Use The dipper to check the water level in the borehole.</td></tr>
</table></td></tr>
<tr><td>Tools, spare parts and technical assistance</td><td>See Module 1, Topic 1, for general tools.

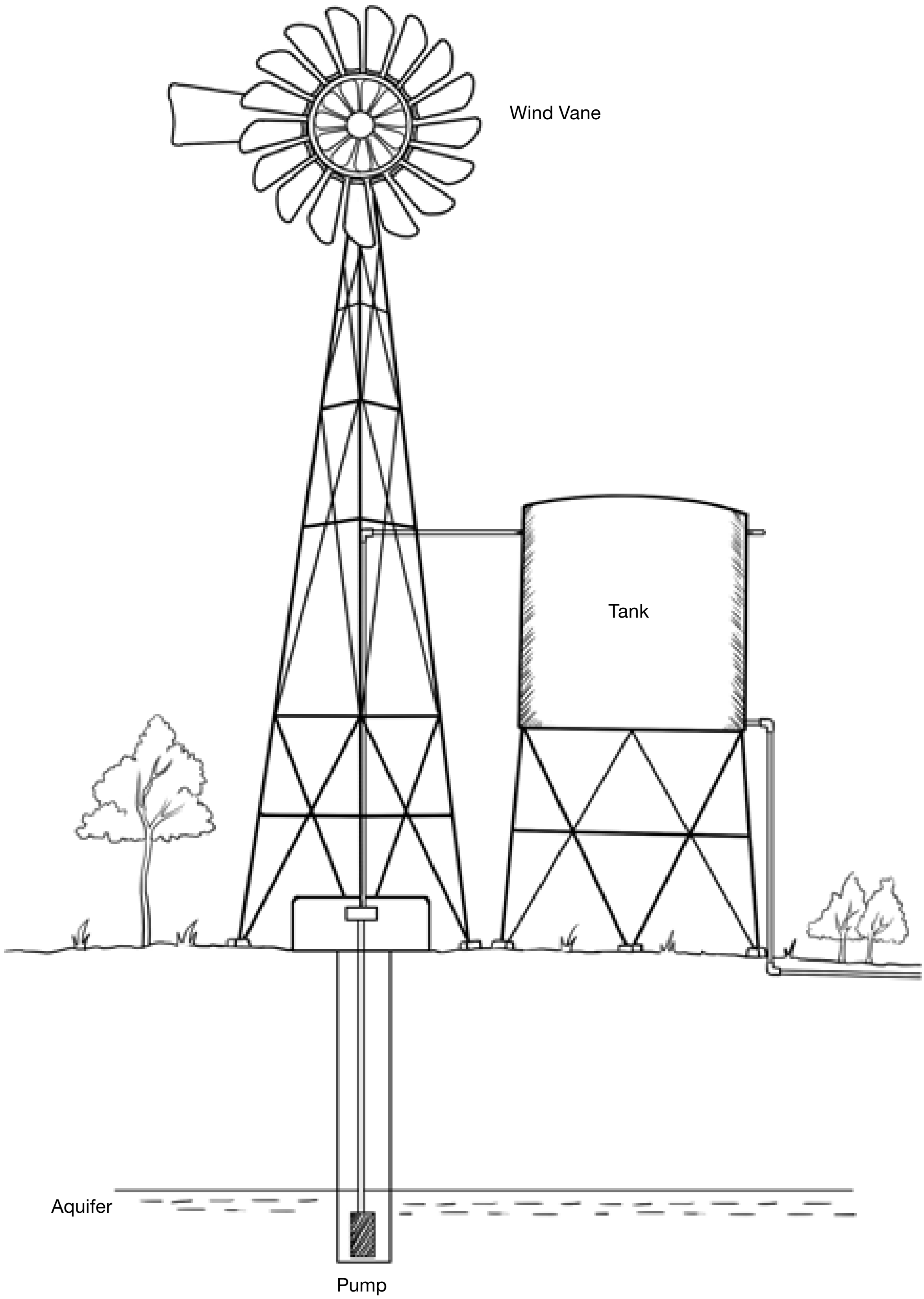
Tools:
• grease gun
• spares
• grease
• pump washers.

Supply chain – grease and other plumbing materials can be purchased at a well-provisioned hardware store.

Technical assistance – specialized technical assistance may be required to remove pump from borehole.

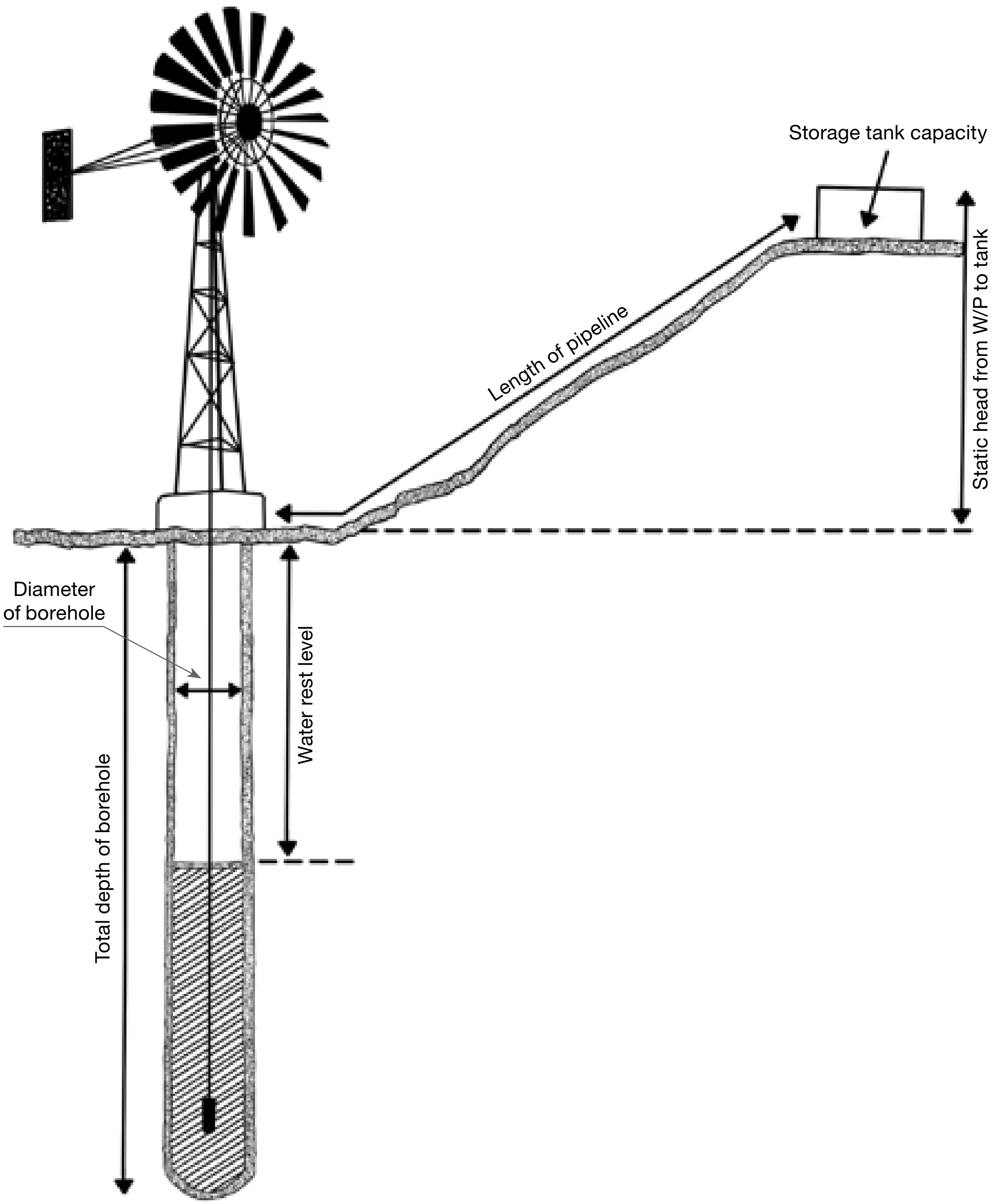
Specialized technical assistance is required to lower the tower. Specialized technical assistance should be sought if it is suspected that the borehole has run dry.</td></tr>
<tr><td>Session handouts</td><td>Handout 1: Typical wind pump
Handout 2: Detailed drawings for the Kijito wind pump</td></tr>
</table>

Handout 1: Typical wind pump

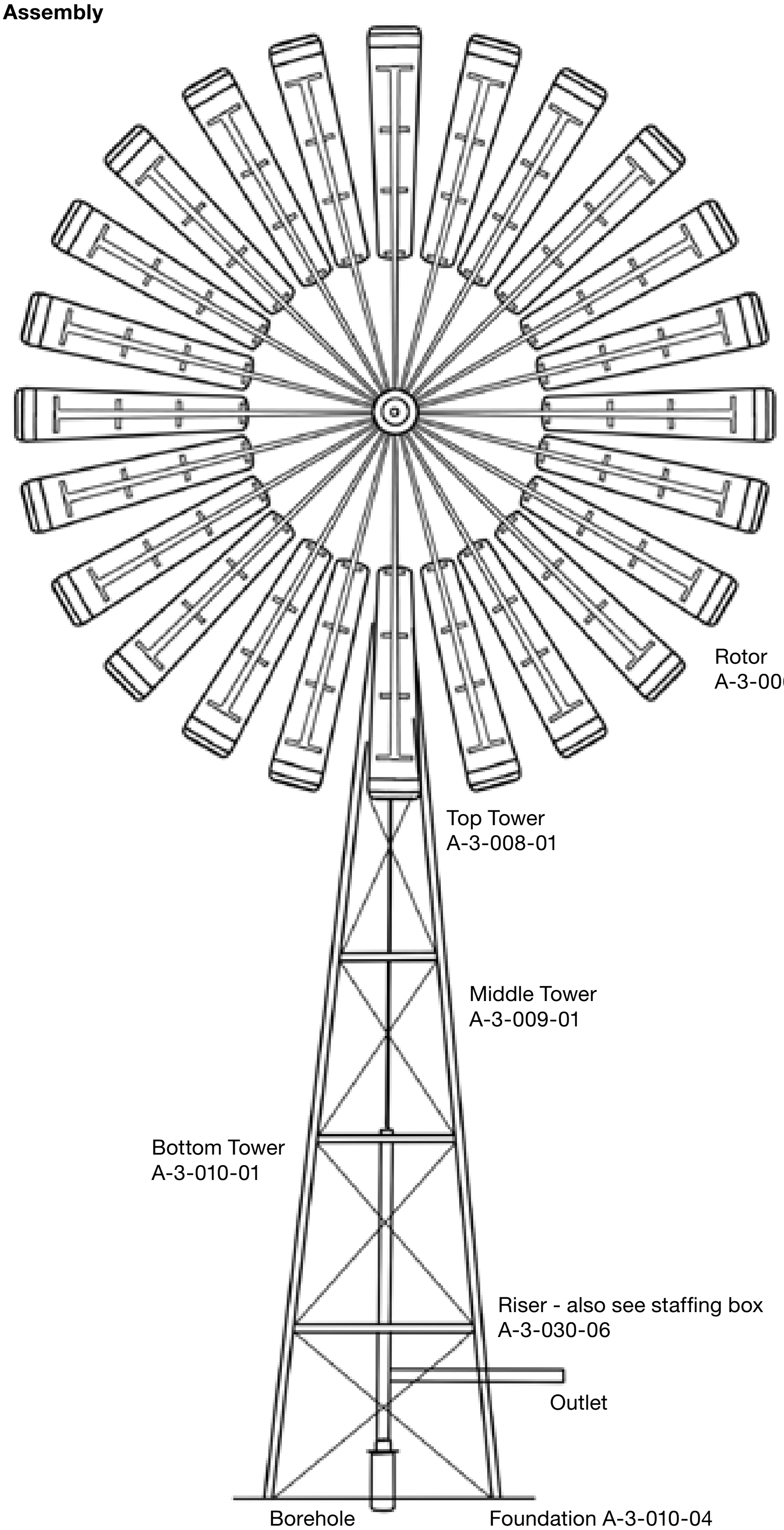


Handout 2: Detailed drawings of the Kijito wind pump

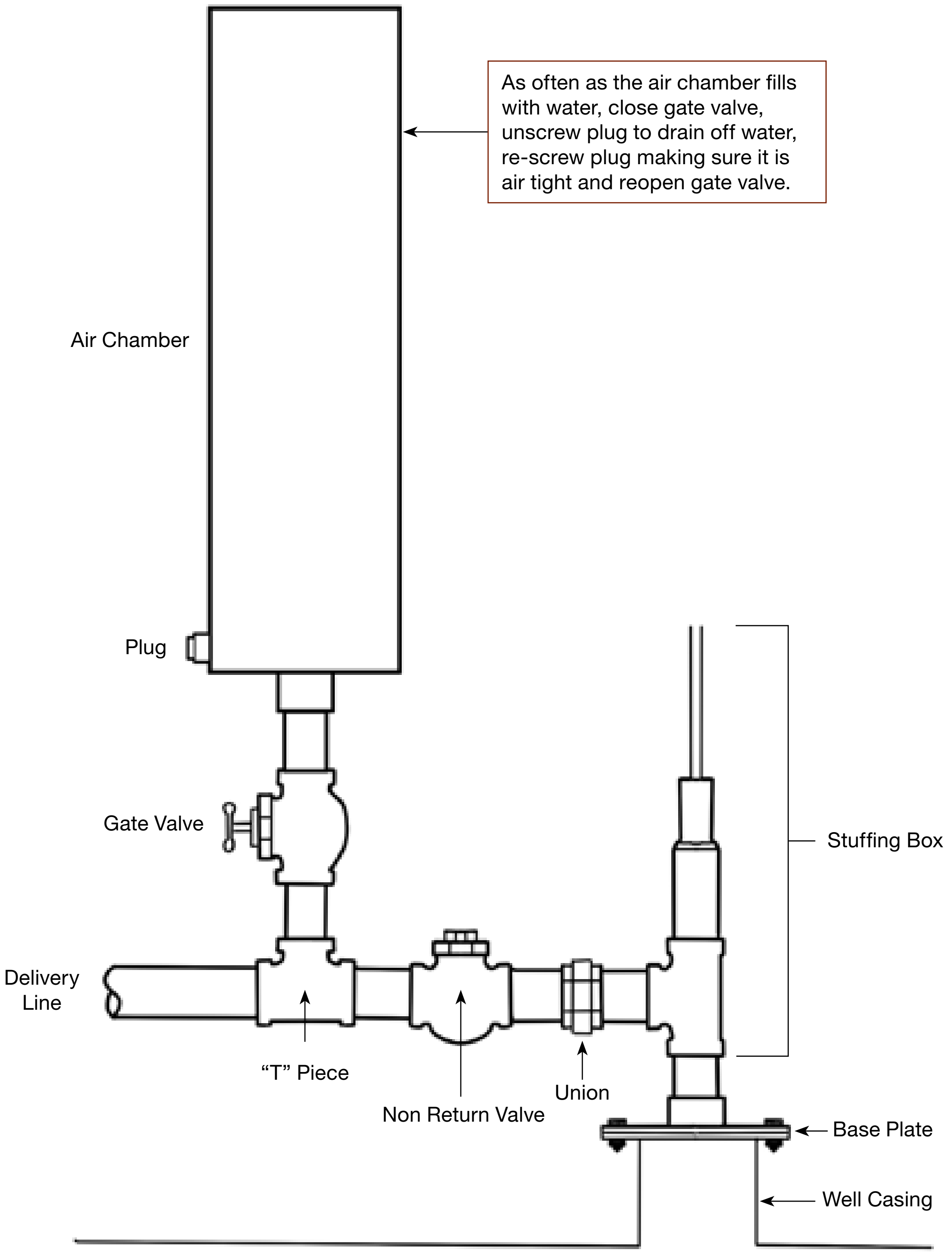
A "Kijito" wind pump



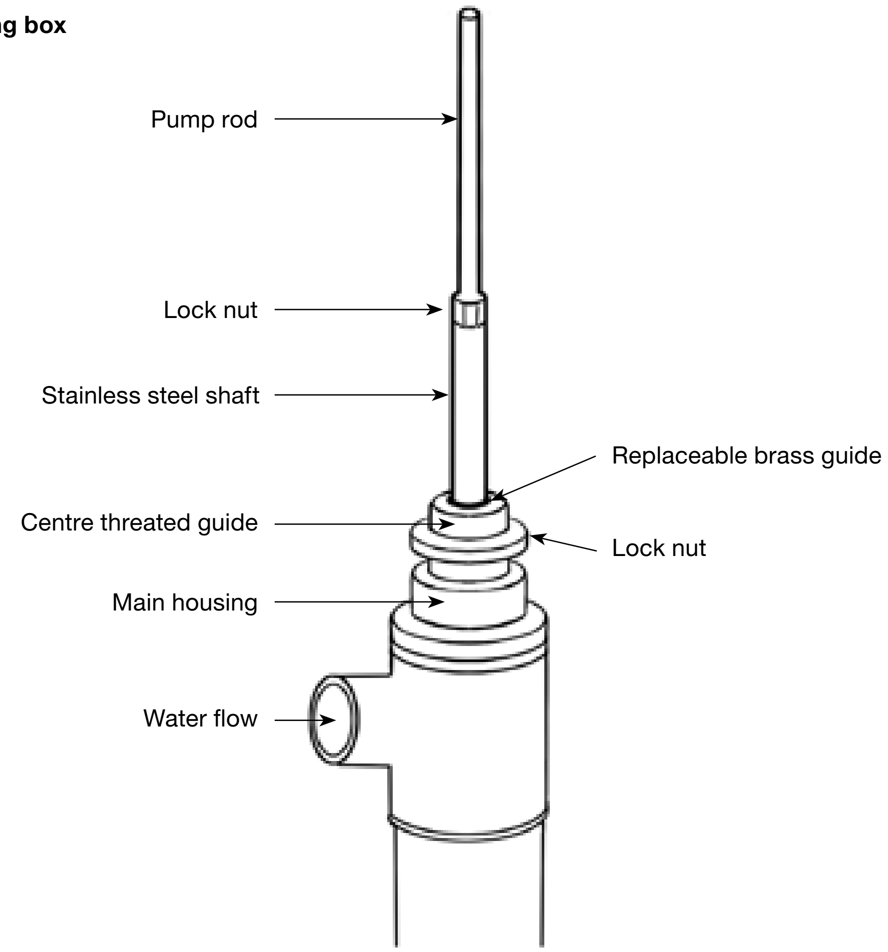
Wind Pump Assembly



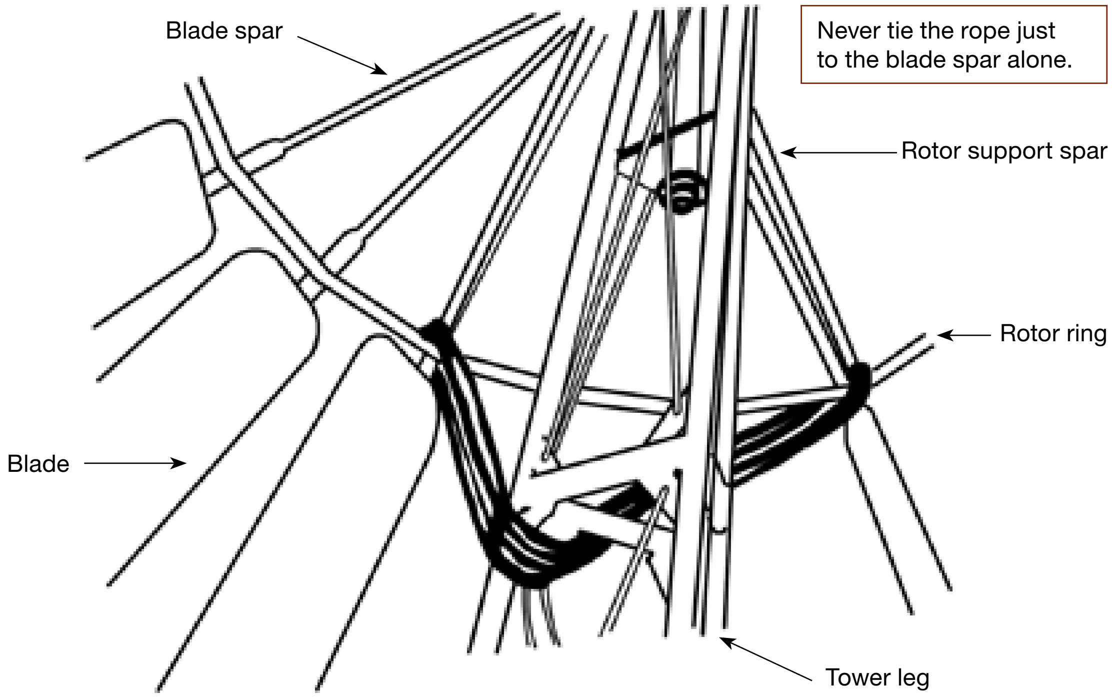
Layout of the stuffing box, non-return valve, gate valve and the air chamber



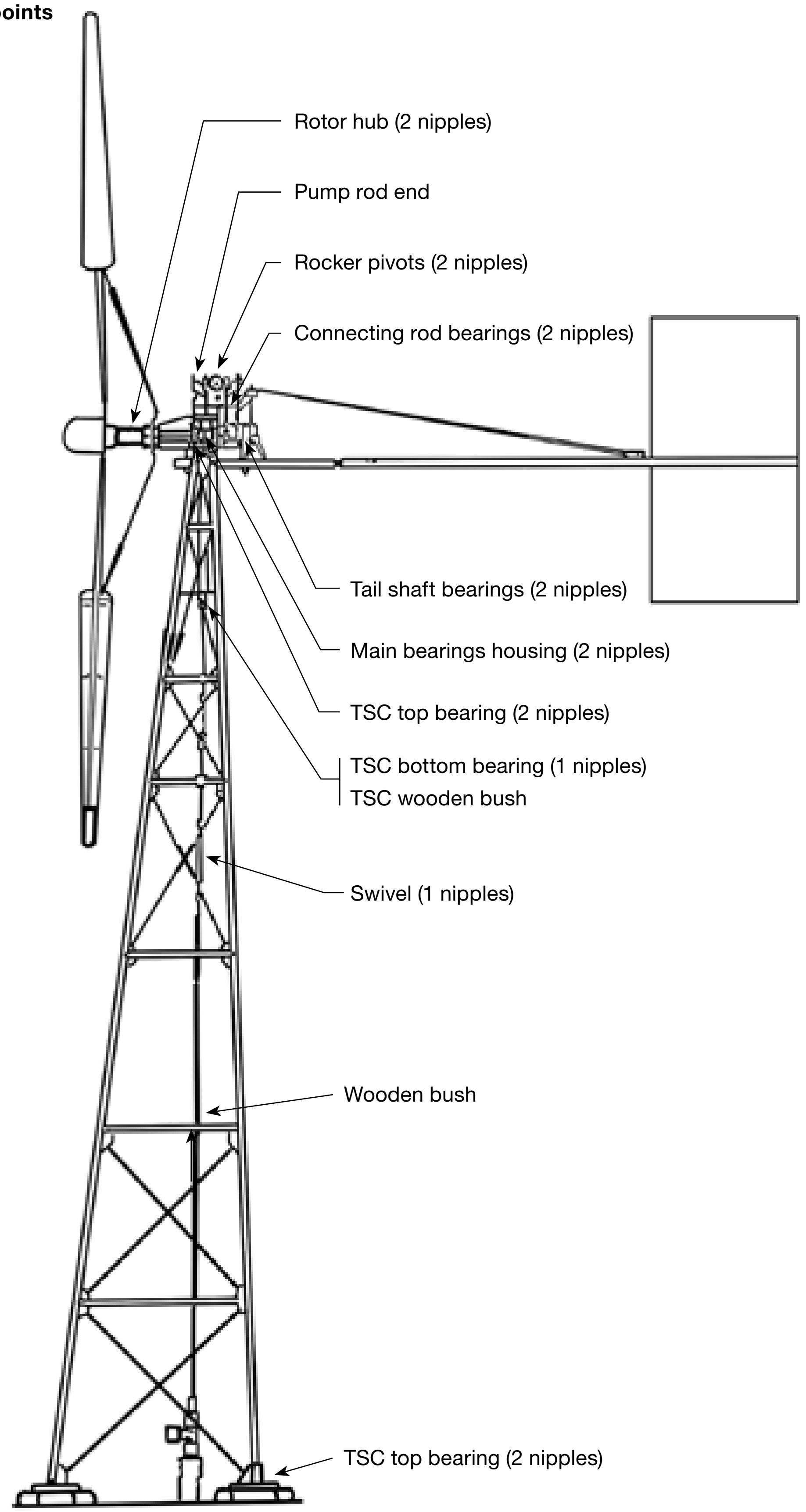
Kijito stuffing box



The correct way to tie up the rotor prior servicing



Lubrication points



Module 2: Operation and maintenance for water supply systems

Topic 13: Solar-powered pump systems

Objectives	At the end of the session, the participants will be able to: • identify the main components of a solar-powered pumping system • recognize problems that can arise from different components • understand the importance of paying for the water, even if the solar energy is free.
Outputs	An O and M schedule
Timing	Approximately 1 hour
Methodology	The session is focused on raising awareness of the community members so that they understand the system and the importance of paying for the water. Use the site walk, discussions, and question-and-answer sessions to raise awareness.
Materials	Flip chart, pens

Session guide and content

Introduction/note

Technically there is very little that can go wrong with a solar-powered system if it has been installed correctly. The submersible pump, in combination with the control unit, has a number of safety features that protect it in the event of problems occurring.

Whilst it is very 'hi-tech', the high level of reliability, minimal maintenance, need for spare parts and low operating costs make it suitable for rural locations. The main threat to the reliability of solar-powered systems is human interference, from vandalism and efforts at times of repair.

Overview of solar-powered system

Start by explaining the difference between a solar-powered system and a generating set system. Describe how the water is pumped from the borehole and flows to the water points. (Refer to the map developed in the first session.)

With reference to the site walk, community map and a schematic diagram of a solar-powered system (see Handout 1), describe the following components:

Solar panels or photovoltaic array - convert solar energy to DC electricity			
Either		**Or**	
Inverter: DC to AC	Used for power conditioning for high-power applications. Converts DC to AC	Regulator	Regulates voltage
Wires	For electrical power transmission	Belt and pulleys	Used for turning the shaft in the rising main
AC motor	Converts electrical output of the solar panels into mechanical energy	DC motor	Converts electrical output of the solar panels into mechanical energy
Submersible pump	Pump with an attached motor. Both the pump and the motor are below water level at the bottom of the borehole	Mono pump	A rotary pump mainly with discharge head, rising main and the pump element

	Allow participants to discuss the system and to ask questions. It is not necessary for the participants to understand exactly how each component works. Explain how the components operate together.
Maintenance of solar-powered system components	Explain and demonstrate maintenance procedures for the different components. **Caution: Solar-powered systems require qualified technicians for installation and repair.** Maintenance by unqualified technicians is a major cause of broken pumps. Only a trained electrician with prior experience of solar-powered pumps, as well as access to the manufacturer's catalogue containing the technical specification of the equipment, should be allowed to undertake repairs related to the wiring of the system or control panel. If there is a major overload or fault with the system, the control unit will fail as a protection measure to protect the pump. This is a warning that qualified expertise is required to investigate the nature of the problem. However, all too often, unqualified technicians try to bypass the control unit and wire the pump directly to the power source, bypassing the inbuilt protection features. This will inevitably lead to major failure and likely destruction of the whole system. a) Submersible pump – the submersible pump is manufactured to a very high specification and will operate on a daily basis without problem for at least five years, probably many more. The motor is contained within the pump and is cooled by the water passing over it. It has built-in protection features, which, together with the control panel, ensure that it is protected from risk of overheating, a drop in water level, or voltage irregularity. b) Control unit(s) – depending on the system in place, there may be a simple on/off control unit or a more complicated looking control panel with a digital display. In the event that there is a back-up power source, there may be two switches or control units. These are to protect the pump and should not be tampered with in any way and be installed and maintained only by a qualified electrician. The most common reason for solar-powered pumps being damaged is because an unqualified person has tried to fix it. Incorrect wiring can bypass the inbuilt protection features of the system and cause brand new equipment to be permanently damaged and unable to be repaired. Maintenance tasks include removing dust from the control panel on a weekly basis. c) Solar panels (photovoltaic modules) – these have no moving parts and there is very little that technically can go wrong with them. Consequently many of them therefore have a 20-year manufacturer's guarantee. The main risks to the panels is from theft, vandalism or by children throwing stones which causes damage. Theft in particular is a major problem in most areas, so community water committees need to ensure thorough security measures are in place to minimize these threats and to make sure that all control panels are well secured. Maintenance tasks include: • cleaning solar panels weekly if they are covered with dust (in very dusty areas clean twice a week using a wet cloth) • protecting the fragile solar panels (panels and solar pump are ideally to be within a fenced enclosure of a 40-metre radius for protection and therefore the fence requires to be kept in good condition and the gate should be safely secured) • when carrying out any servicing of this equipment ensuring the correctly qualified personnel do the work. d) Motors - some DC motors need replacement brushes; this is usually a simple operation (far simpler than, for example, servicing a small engine-powered pump). Brushes will probably need to be replaced after two years of operation.

e) Inverter (AC) automatic or regulator (DC) - as this equipment is usually affected by heat greater than 20 to 25 degrees Celsius, it is best to install it out of direct sunshine. If the temperature rises above this level, the system switches off and on. This switching on and off is not good for the equipment. This type of equipment should be kept away from water. It is an enclosed system and should not be tampered with.

f) Wires – these should be placed in conduits and buried underground and in case of replacement use the right wires (resistant to ultraviolet rays).

g) Pulleys and belts – check the tension of these and replace any damaged or worn-out ones.

h) Exposed terminals (on panels or inverter) – these should be checked regularly for corrosion or damage and repaired or replaced as necessary.

Troubleshooting

Discuss the potential unexpected problems, what might be the causes, and some possible solutions.

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Low or no power, or slow motor (less water is being pumped)	↘ Poor electrical connection due to dirt ↘ Wet or corroded terminals ↘ Insufficient sunlight ↘ Dusty solar panels	↘ Clean, dry or replace the terminals. ↘ Remove any dust.
System switching on and off	↘ Inverter or regulator poorly installed	↘ Install away from sunlight and water.
Motor stops	↘ Worn-out brushes	↘ Replace the brushes.
Water leaking from discharge head (mono pump)	↘ Leaking pump gland Seal	↘ Tighten the pump gland nuts slightly (do not over-tighten).

Tools, spare parts and technical assistance

Discuss the requirements, availability and procurement of tools, spare parts and technical assistance.

For solar-powered pumps, the majority of repairs require a specialized and qualified electrician. Many of the components have guarantees that would be invalid or stopped if the equipment is tampered with by unqualified personnel. In this regard, the most important information required is the name and contact numbers for the suppliers and qualified electricians who could be called on to diagnose problems and undertake repairs.

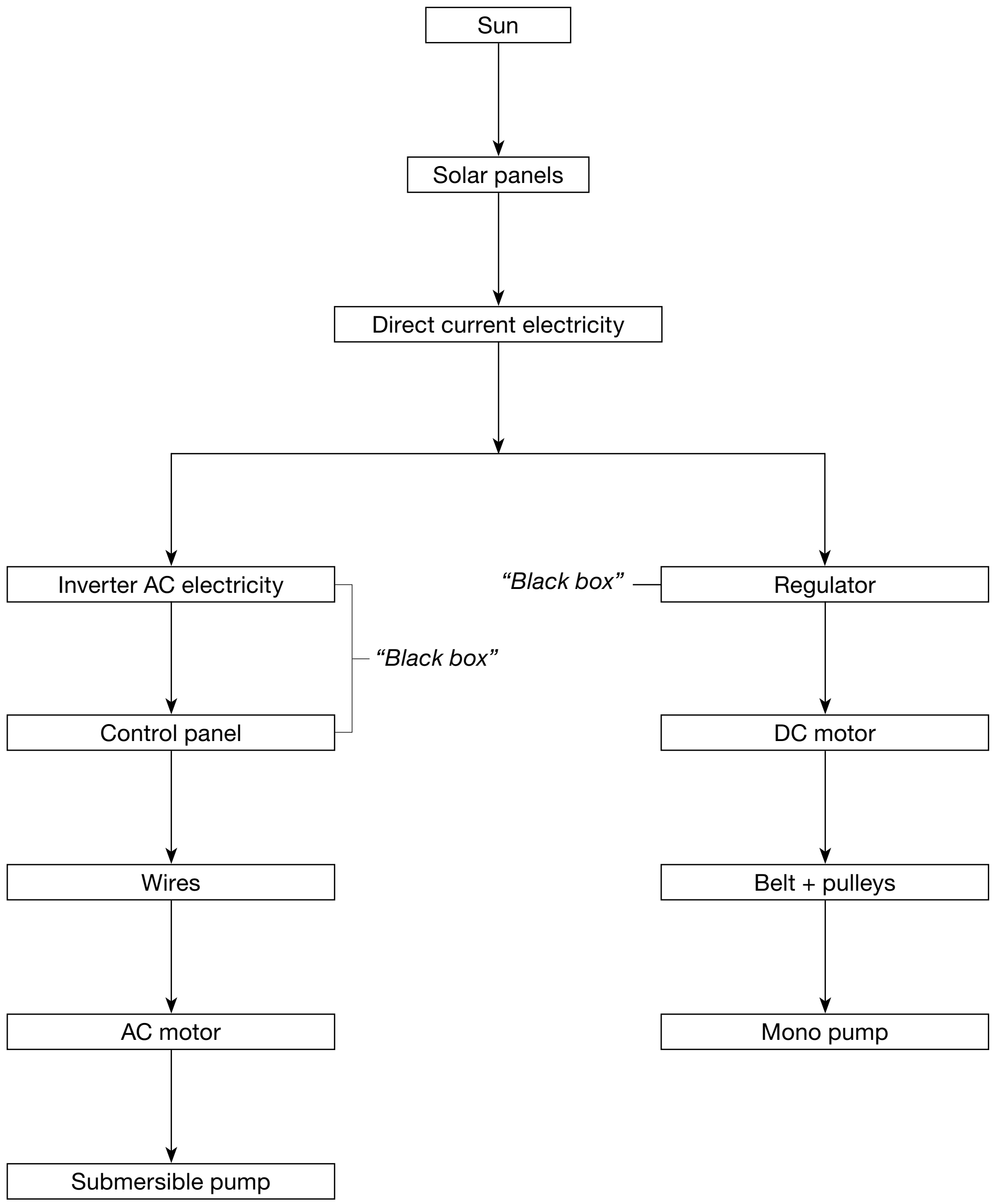
Technical assistance contact list

COMPONENT	Name of technical assistant	Contact details	Back-up contact	Contact details for back-up
Pump repair				
Generator repair				
Electrician				
Water quality				

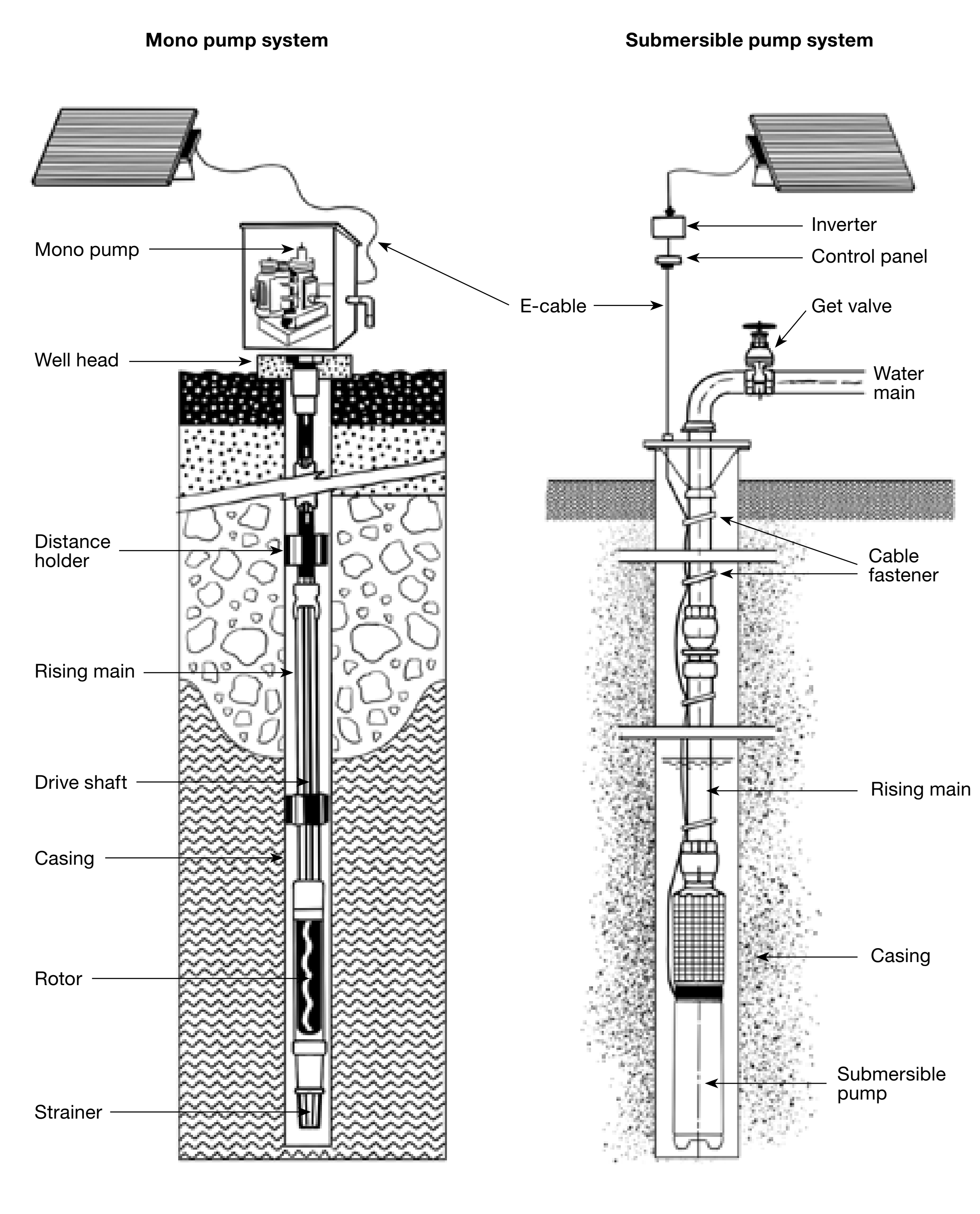
Session handouts

Handout 1: Schematic diagrams for solar-powered water supply
Handout 2: Components of a solar-powered water supply

Handout 1: Schematic diagrams for solar-powered water supply



Handout 2: Components of a solar-powered water supply



Module 2: Operation and maintenance for water supply systems

Topic 14: Diesel-powered generators

Objectives	At the end of the session, the participants will be able to: • identify the main components of air-cooled or water-cooled diesel engines • start and stop the engine • undertake a basic service the diesel engine • follow the safety measures and carry out routine maintenance.
Outputs	An O and M schedule
Timing	Approximately 6 hours
Methodology	This is intended to be a practical session. The components will be taught by demonstration of the system itself. The flip chart can be used to illustrate details if necessary. Reinforce the learning by allowing participants to handle the parts and describe their functions to each other.
Materials	Diesel engine; fuel; five litres of engine oil; fuel, oil and air filters (one of each); spanners, strapper

Session guide and content

Introduction/note	Diesel-powered generators are used in many boreholes and water intakes to drive electrical pumps. There is a wide variety of makes, although Lister-Peter and Perkins are common. The principles of the O and M tasks required are similar, regardless of the make or model. Specific requirements for each make and model should be obtained from the manufacturer's Operators Manual for each engine.
Identification of parts of a diesel-powered system	Identify the different parts of the pumping system and explain the purpose of each part.

COMPONENT	PURPOSE
Pump house	Keeps the engine and its control panel safe from unauthorized access
Fuel store	Keeps the fuel safe from uncontrolled access
Diesel engine	Turns on the alternator
Alternator	Generates electricity
Control panel	Controls the current to the pump and protects the pump from periods of high currents
Electrical pump (e.g., submersible pump in bottom of borehole)	Pumps water to the tank
Master meter	Measures water from the borehole

Now focus on a diesel-powered engine and explain the names and purpose of its different components.

Operating diesel-powered engines	Ask the operator to go through normal start-up procedures to see how the system currently operates. Observe and discuss improvements. (See Handout 1: Engine log.)

Start-up procedures

1. Check the oil level.
2. Check the fuel level and that fuel line is on.
3. Check the water level in the radiator reservoir.
4. Check for any loose wires or hoses.
5. Start the engine (using a crank or battery).
6. Record the start time on the Log Chart.

Switching-off Procedure

1. Turn the engine off.
2. Record the end time on the Log Chart.
3. Check for any oil leaks.

Safety Rules	Discuss the safety rules with the participants. **Safety rules: general** **1.** Keep a fire extinguisher or a bucket of sand close at hand to deal with fire. **2.** Smoking is not allowed in the pump house or fuel store. **3.** Wear protective clothing that fits well: no loose clothes that can get caught in the moving parts of the engine. **4.** Never put cleaning rags or other loose items in your pockets when you are in the pump house. They can get caught in the moving parts. **5.** Wear good protective shoes. **6.** Keep the floors of the pump house and store clean and dry, so that you will not slip or fall. **Safety rules: fuel and lubricants** **1.** Keep spare fuel and lubricants in a secure, ventilated store. **2.** Do not smoke in the fuel store or while refuelling is being carried out. Ensure the area is clear of any spectators or smokers. **3.** Use a pump or tap to take diesel out of a drum. Transferring diesel fuel by sucking it up with a hose is not good for your health. **4.** NEVER put fuel or oil into the engine while it is running. **5.** Do not use kerosene as a fuel. It reduces the life of the engine and the fuel pump. **Safety rules: during operations** **1.** Keep spectators out of the pump house while the engine is operating. **2.** Open the windows and ensure that the pump house is well ventilated. **3.** Do not open the radiator cap. **4.** Do not top up the radiator by pouring cold coolant into a hot engine as this may cause the cylinder head to crack. **5.** Keep your fingers away from moving parts of the engine. **6.** NEVER put fuel or oil into the engine while it is running. **7.** Never clean the engine when it is running. **8.** Do not operate the engine if the safety guard has been removed. **9.** Only one person should control the engine. **Safety rules: during maintenance work** **1.** Do not make any adjustments that you do not understand. **2.** Maintenance operations must be carried out on a cold engine. **3.** Maintenance operations must be carried out under sufficient lighting. **4.** Do not overfill the engine oil in the sump; this may cause the engine to give off smoke. **5.** Do not use salt water or any other coolant which can cause corrosion in the closed cooling unit. **6.** Disconnect the battery terminals before a repair is made to the electrical system. **7.** If you are working with chemicals, such as solvents, cleaners, chlorine etc., be careful. Read the instructions on the container and follow them closely. Some chemicals give out fumes that are poisonous if inhaled. Some of them will burn your skin.
Specific O and M tasks for diesel-powered engines	Discuss the tasks relevant to the O and M of the system components. Discuss Handout 2: Engine service log. See Handout 5 for a typical O and M schedule for diesel-powered engines. Draw up an O and M schedule with participants.

Troubleshooting

Discuss the potential unexpected problems, what might be the causes, and some possible solutions.

NO	PROBLEM	POSSIBLE CAUSE	REMEDY
1	WILL NOT START (i) Engine does not turn)	Battery is flat or has failed	(a) Check the liquid level; fill if necessary. Recharge the battery and check that all cells are working. (b) Replace the battery if it has failed.
		Starter circuit faulty	(a) Check, clean and refit the battery connections. (b) Check the circuit relay and starter solenoid.
		Starter faulty	(a) Replace the motor. Check that the starter is engaging; attempt to turn the engine by hand.
		Lubricating oil to thick	Replace with the correct grade of oil.
		Engine or alternator jammed	Inspect and remove any obstruction.
	(ii) Engine turns but does not fire	(a) No fuel atomizers (b) Air in fuel system (c) Dirty fuel or water in the fuel (d) Faulty lift pump (e) Faulty injection pump (f) Injection timing wrong	(a) Check there is fuel available in the tank. Check that all fuel valves are open. (b) Bleed the fuel system. (c) Clean or replace the fuel filter. (d) Check the fuel lift pump. (e) Check the fuel injection pump. (f) Reset the injection pump timing.
	(iii) Engine fires but fails to start	(a) Limited fuel supply (b) Faulty lift pump (c) Faulty injection pump (d) Fuel filter blocked (e) Air filter blocked (f) Worn or dirty injectors	(a) Bleed the fuel system and check it thoroughly for evidence of dirt or water. (b) Service the fuel lift pump. (c) Service the injection pump. (d) Clean or replace the fuel filter. (e) Clean or replace the air filter. (f) Service or change injectors.

2	Starts but misfires	(a) Limited fuel supply (b) Faulty lift pump (c) Faulty injection pump (d) Fuel filter blocked (e) Worn or dirty injectors (f) Loose or broken pipes (g) Incorrect valve clearances	(a) Bleed the fuel system and check it thoroughly for evidence of dirt or water. (b) Service the fuel lift pump. (c) Service the injection pump. (d) Clean or replace the fuel filter. (e) Service or change the injectors. (f) Tighten or replace the pipes. (g) Reset the valve clearances.
3	Starts but loses power	(a) All possible causes shown under 2 above (b) Air filter blocked (c) Faulty cylinder head or inlet manifold joints (d) Damaged or dirty turbocharger	Attention as shown in (a) to (g) above (under item 2 above). (i) Clean or replace the air filter. (j) Replace the gasket. (k) Clean or replace the filter.
4	Excessive fuel consumption	(a) Faulty injection pump (b) Worn or dirty injections (c) Incorrect valve clearance (d) Fuel pump timing incorrect (e) Incorrect fuel (f) Excessive engine wear	(a) Service the fuel injection pump. (b) Service or change the injectors. (c) Reset the valve clearance. (d) Reset the fuel pump timing. (e) Check the fuel specification. (f) Overhaul the engine.
5	Black exhaust smoke	(a) Faulty injection pump (b) Worn or dirty injectors (c) Air filter is blocked (d) Fuel pump timing incorrect (e) Incorrect fuel (f) Damaged or dirty turbocharger (g) Excessive load (h) Long running time on light load	(a) Service the fuel injection pump. (b) Service or change the injectors. (c) Clean or replace the air filter. (d) Reset the fuel pump timing. (e) Check the fuel specification. (f) Clean or replace the turbocharger. (g) Reduce the load as necessary. (h) Run on full load for a one-hour period.
6	Blue/white exhaust smoke	(a) Engine misfiring (b) Excessive engine wear	(a) See remedy under item 2 above. (b) Overhaul the engine.

7	Low lubricating oil pressure	(a) Low oil level in sump (b) Oil pressure gauge faulty (c) Oil filter blocked (d) Faulty relief valve (e) Oil pump worn (f) Excessive oil temp	(a) Add lubricating oil to normal level (b) Replace the oil-pressure gauge. (c) Clean or replace the oil filter. (d) Clean or replace the relief valve. (e) Replace the oil pump. (f) See the problem outlined in item 8 below.
8	High Engine temp	(a) Low level of coolant (b) Faulty thermostat (c) Fan belt slipping (d) Radiator matrix blocked (e) Blockage in cooling system (f) Low level of lubricating oil (g) Fuel injection pump's timing is incorrect (h) Cylinder head gasket failed	(a) Refill the radiator and check for any leaks. (b) Check and replace the thermostat if necessary. (c) Adjust the tension of the fan belt. (d) Clean out the radiator thoroughly. (e) Drain the system, flush it out and refill. (f) Refill the lubricating oil to the correct level. (g) Reset the timing of the fuel injection pump. (h) Remove the cylinder head and replace the gasket.

Tools, spare parts and technical assistance

Discuss the requirements, availability and procurement of tools, spare parts and technical assistance.

Tools – routine maintenance requires a funnel to assist in refuelling and topping up the oil.

Spare parts and materials:
- lubricant – oil
- filters – oil, fuel and air
- cotton waste (rags) for mopping up any spills.

Supply chain – establish where the nearest store is that stocks spare parts for the diesel engine.

Spare	Minimum required in store	Name and contact of Supplier 1	Name and contact of Supplier 2	Expected cost per unit on delivery

	Technical assistance – discuss where technical assistance can be sourced from when required.
Session handouts	Handout 1: Engine log Handout 2: Engine service form Handout 3: Diagram of the Lister TS3 diesel engine Handout 4: Preventative maintenance of a diesel-powered engines

COMPONENT	Name of technical assistant	Contact details	Back-up contact	Contact details for back-up
Engine repair				
Electrician				
Water quality				

Handout 1: Engine log

Name of Water Supply		Engine Type		
Sub-Location		GPS	Easting	Northing
Location				
Division				
District				

	At Start		During Operations		At End				
Date	Fuel Added (Litres)	Start Time	Voltage (Volts)	Current (Amps)	Time	Kw-Hrs (Meter reading)	Water pumped (Meter reading)	Comments Repairs Problems	Initials of Operator

Handout 2: Engine service form

Engine Make: .... Model: ....

Date of Service: .... Name of Mechanic: .... Tel: ....

Hours at Current Service: .... Hours at next Service: ....

CATEGORY	ITEM	CHECKED (Tick if checked)	WORK DONE	COMMENTS
LUBRICATION	Engine Oil			
	Oil Filter			
	Greasing			
FUEL SYSTEM	Fuel Filter			
	Injector/Fuel Pump (leakages)			
	Tank			
	Fuel Lines (cracks, leaks)			
ENGINE	Belts			
	Air Filter			
	Plugs/Injectors			
ELECTRICALS	Battery			

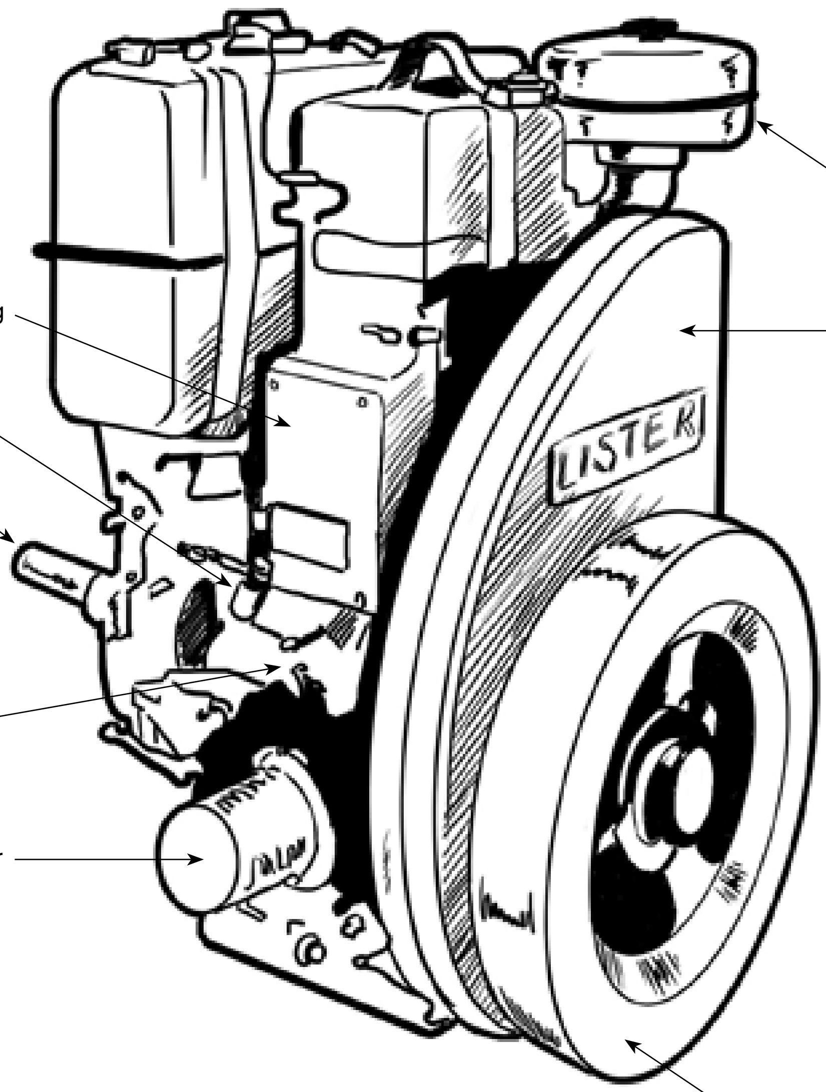
Comments ....

....

Signature: ....

Signed by (Name): ....

Handout 3: Diagram of the Lister TS3 diesel engine



Handout 4: Preventative maintenance of a diesel-powered engine

Daily operation or every 8 hours (to be undertaken by operator/caretaker)

- Check the fuel and engine oil levels; top up if necessary.
- Check the water level in the radiator and top up if necessary and secure the cap.
- Check the tension of the alternator drive belt; check condition of the battery and its water level.
- Check the lubricating oil pressure at the gauge.
- Check for loose nuts and bolts; check and correct any leaks or engine damage.
- In very dusty conditions clean the air cleaner element; drain and clean the dust bowl.
- Check the exhaust pipe.
- Check the foundation bolts.

Every 100 hours or 3 months (to be carried out by skilled mechanics)

- As for daily services – see above.
- Renew the engine's lubricating oil.
- Renew the engine's oil filter.
- Drain water from the fuel filter and pre-filter.
- Check the condition of the battery fitted.
- When moderately dusty, empty the dust bowl and clean or replace the air cleaner element.
- Clean the compressor's air filter.
- Check and adjust the idle speed.

Every 200 – 250 hours or 6 months (to be carried out by skilled mechanics)

- As for previous servicing above.
- Change the engine oil and oil filter element.
- Clean the fuel strainer and the fuel tank breather. Renew the fuel filter canister.
- Clean the battery terminals.

Every 400 hours or 12 months (to be carried out by skilled mechanics)

- As for previous servicing above.
- Replace the air cleaner element.
- Renew the fuel filter element.
- Check the concentration of the coolant.
- Check the battery charging system. Check the alternator drive belt for wear and tear. Check the wiring harness and connections, tightening them if required.
- Check the fuel injectors for performance.

After 600 hours or 18 months (to be carried by skilled mechanics)

- As for 200-hour servicing and maintenance above.
- Renew the coolant.
- Renew the alternator drive belt.
- Tighten the cylinder head.
- Check and adjust the valve clearances.
- Check the electrical system.
- Check all nuts and bolts for tightness and adjust as necessary.
- Check the engine mountings.

Module 3: Sanitary surveys	
Topic 1: Sanitary surveys	
Objectives	At the end of this session, participants will be able to: • explain what a sanitary survey is, and their purpose • fill in a simple sanitary survey for a covered dug well and handpump • describe actions required.
Outputs	Completed sanitary survey and list of actions to improve safety of water
Timing	1 – 2 hours
Methodology	Presentation, discussion and practical exercise
Materials	Paper, pens, flip charts, markers
Session guide and content	
Introduction to sanitary surveys	Initiate a discussion with the participants on what a sanitary survey is and what its purpose is. A sanitary inspection, or sanitary survey, is an on-site inspection and evaluation of the conditions, equipment and practices in a water supply system that pose an actual or potential danger to the health and well-being of the consumer (the person drinking or using the water). In communities, where qualified surveyors or engineers may not be able to conduct frequent visits, responsible community members can learn how to conduct sanitary surveys. There are sanitary surveys available for each type of water supply system. A sanitary survey is a simple form with questions about the water source and how well it is protected from potential sources of pollution. Sanitary surveys help communities to check that their water sources are safe and free from contaminants. To complete a sanitary survey you do not need a laboratory to be able to identify sources of water contamination and to take actions needed to address this contamination. It is important to fill in the relevant sanitary survey form every time there is water sampling (e.g., if done by local government). The sanitary survey contains information that is linked to the water source and the water storage container e.g., drums and tanks. Once they have completed the sanitary survey documentation, they should sign the report and either agree to act on the recommendations (where feasible) or be sure to notify the community-based user committee or local government (or whoever is responsible for the maintenance of the water supply system) to carry out the actions for improvement.
Example sanitary survey (field visit)	If possible, visit a dug well with a handpump mechanism with the participants. Guide the participants though an example of a sanitary survey (see Handout 1 for a sample form). Let them read each question and decide as a group the rating or score.

Actions from the sanitary survey	Discuss the key actions that can be undertaken from the sanitary survey observations and score. Brainstorm and note the key action items on a flip chart. Be sure to note who will do what, and by when. You could use the table below to record this information.

Action to be taken	Who will do it	By when	With what materials
Fence off from animals			
Make drainage apron and channel			
Fix cracked concrete			

Session Handouts	Handout 1: Example of a sanitary survey form for a covered dug well with a handpump

Handout 1: Sanitary survey form for covered dug well with a handpump

I. General Information

Village/Community: . . . .
District:. . . . .
Date:. . . . . Survey number: . . . .

II. Specific Information for Risk Assessment

1. Is there a toilet within 10 metres of the well and handpump?	**Y / N**
2. Is the nearest latrine on higher ground than the well and handpump?	**Y / N**
3. Is there any other source of pollution (e.g., animal excreta, rubbish) within 10m of the well?	**Y / N**
4. Is the drainage poor, causing non-moving water within two metres of the well?	**Y / N**
5. Is there a faulty drainage channel? Is it broken, allowing ponding?	**Y / N**
6. Is the wall or fencing around the well inadequate, allowing animals in?	**Y / N**
7. Is the concrete floor less than 1m wide all around the well?	**Y / N**
8. Is there any ponding on the concrete floor around the handpump?	**Y / N**
9. Are there any cracks in the concrete floor around the well which could permit water to enter the well?	**Y / N**
10. Is the handpump loose where it is attached to the base, allowing water to enter the casing or pipes?	**Y / N**
11. Is the cover of the well unsanitary?	**Y / N**
12. Are the walls of the well inadequately sealed at any point for three metres below ground level?	**Y / N**

Total score of risks: ..../12

Contamination risk score:
9 to 12 = very high
6 to 8 = high
3 to 5 = intermediate
0 to 2 = low.

III. Results and Recommendations

. . . .
. . . .
. . . .
. . . .

Name of Surveyor: . . . .

Signature of Surveyor: . . . .

Module 4: Preparing for a drought

Topic 1: Preparing for a drought and compiling an O and M schedule

Objectives	By the end of this session participants will have prepared a contingency plan for their water supply system, including a schedule of O and M tasks for the coming months
Outputs	A drought contingency plan and O and M schedule
Timing	Approximately 2 hours
Methodology	Discussions, brainstorming, practical exercise, storytelling
Materials	Flip charts, flash cards, pens
Session guide and content	
Supporting information	A drought is cyclic in nature and is described as a slow onset hazard. **A drought contingency plan must have the following features:** **1.** Be realistic and based on past experience **2.** Be developed in a participatory fashion that includes as many users of the water facility as possible and should be agreed upon by consensus **3.** Be specific to action i.e., it must define the what, why, where, how, when and by whom questions; **4.** An estimated budget and resources required **5.** Be linked to a source of resources (from revenue of water sales, community contributions and any 'concrete' external sources of funds the WUA members may be able to network with). These funds should be set aside to be used as a contingency fund and not as an O and M fund. The contingency plan is operationalized based on early-warning information, whether from the Government's EWS or traditional EWS indicators.
The need for drought preparations	Introduce drought preparedness by telling the following story: Two young families are both expecting babies. One family continuously puts aside resources for maternity hospital bills and buys small items e.g., towels, nappies, etc. in preparation for the delivery of the baby. The expectant mother went to the prenatal clinic every month to have herself checked. The other family went on with normal life with no visits to the prenatal clinic and no setting aside of funds for the costs of the delivery of the baby. Unfortunately for this second family, there were complications with the delivery because the child was not sitting well in the womb. The doctors blamed this family for not attending a prenatal clinic. The complication would have been avoided but now it was necessary for the mother to be operated on to save both her life and that of the baby. The cost of the operation was estimated at 60,000 Shillings. The husband had to run around begging his brothers to assist with the medical costs. **1.** Get the participants to brainstorm about the situation of these two families and make suggestions on what was the best thing to do. **2.** Get them to relate this situation to two WUAs, with one continuously preparing for drought and another not doing anything to prepare for it. **3.** In small groups ask the participants to think about the last drought that affected them and to do a SWOT analysis of their level of preparedness for that drought in relation to their water supply system and availability and access to water during that time of drought. Get the groups to each share their analysis.

What is a drought and why should we plan for it?

This session is a discussion to draw out the distinction between drought, aridity and water scarcity.

Ask participants to talk about these terms and come up with their understanding what they mean.

Aridity	This is a general feature of the climate. It indicates an area where the long-term average rainfall is much less than the water demand of plants. The net result is a habitat consisting of plants and animals adapted to very dry conditions. Aridity also implies that surface water sources are unreliable because rainfall is low and unpredictable. Aridity is a state of chronic water deficit.
Water scarcity	This is a general condition of lacking sufficient water for domestic or productive purposes. Features of water scarcity include long distances between water points.
Drought	Drought is a temporary situation in which water availability is less than normal.

Ask participants: "Why should we plan for a drought?" Document and discuss their responses. In addition, ask them to explain traditional systems for planning for and coping with a drought.

Answers may include:
- minimize disruptions of water supply
- minimize disruptions to social life (e.g., disruptions to children going to school)
- minimize economic losses
- prevent environmental degradation
- traditional coping system may include:
  - migration to areas with more reliable water and pasture
  - ensure that there is sufficient water storage to get through a drought
  - use reliable water sources (e.g., boreholes).

Drought is not just a feature that affects domestic water availability but also affects water for livestock, pasture availability and crops.

Stages of drought and contingency planning

It is helpful to consider what activities should be done at the different stages of the drought cycle. Ask participants to identify activities that should be done in each stage of the drought cycle: normal, alert, emergency and recovery.

DROUGHT STAGE	ACTIVITY
Mitigation/Normal	↘ Train volunteers and personnel in O and M. ↘ Ensure that the bank balance is healthy. ↘ Conduct any major repairs that are required.
Preparedness/Alert	↘ Stockpile spare parts and chemicals. ↘ Engage and train additional O and M staff to be able to handle the extra demand for water. ↘ Engage and train a management committee on financial, governance and drought contingency planning. ↘ Ensure that the bank balance is healthy. ↘ Ensure that the system is working properly and repair any leaks as necessary. ↘ Prepare and disinfect additional tanks within the community. ↘ Make contingency arrangements with water service providers and/or truckers for bringing water by bowser (check contract and logistic arrangements). ↘ Check the distance to and quality of alternative water sources.

	↘ Provide additional storage if necessary. ↘ Consider water demand management options (e.g., move livestock away from a water point, establish a drought ban on irrigation); notify the public of any impending water scarcity. ↘ Check and service standby equipment. ↘ Prepare alternative power arrangements for water supply systems that rely on mains power. ↘ Identify any vulnerable groups in the community and make specific provision for water to these groups.
Relief or emergency	↘ Notify the relevant authorities of an impending drought situation and coordinate responses which may include setting up a specific task force to handle issues quickly. ↘ Consider exemptions or deferred payments for water. ↘ Provide water services to distressed areas. ↘ Ensure water availability to public institutions. ↘ Keep the public informed of water availability. ↘ Engage alternative water sources and transport to make water available.
Reconstruction or recovery	↘ Monitor water services to vulnerable groups and ensure supplies are reaching them. ↘ Repair any damage to infrastructure and equipment. ↘ Relieve extra staff by arranging for them to have leave or to stand down. ↘ Recover any deferred payments.

Early-warning systems

One of the problems with a slow onset disaster like a drought is knowing when the situation is changing from normal to the alert stage and then to the relief stage. This requires monitoring.

Ask participants to brainstorm various indicators which signify that the situation is changing. Indicators may include:
- water availability in dams or pans and water points used by livestock
- water availability in rainwater harvesting storage tanks at public institutions (e.g., schools and health facilities)
- ability to pay for water
- demand for water at reliable water points.

How to prepare for drought

Explain to participants that under the normal and alert phases of the drought cycle, some of the key preparedness and contingency actions are being carried out as part of this project, e.g.:
- training them (as community-based volunteers) in operation, repair and maintenance of water supply systems
- stockpiling spare parts and tools
- identifying and carrying out any minor or major repairs that are required

Explain that to contribute to their community being better prepared for drought, as trained community volunteers in O and M of water supply systems, they are now expected to conduct routine maintenance and repairs on their local facilities and infrastructure. To do this they will need to use the skills and knowledge they have learnt or developed through these sessions.

Get participants to brainstorm and discuss the key O and M and repair tasks for their specific water supply system in their community. This is revision of Module 1: Topic 1 (see A and B below and ensure the group has compiled a complete O and M and monitoring schedule).

a) Developing an O and M schedule
To develop an O and M schedule, go through each component of the system and discuss the tasks to be done, filling in the table below as required.

TASK	RESPONSIBLE	HOW OFTEN

b) Developing monitoring tools
The easiest way to ensure that the tasks have been done is to require the person responsible to sign off on a form when the task has been carried out. This means that a form or forms should be designed to suit the O and M schedule – this will be scheme and component specific.

The example below provides an indication of a monitoring tool for routine monthly maintenance tasks.

TASK	FREQUENCY	January	February	March	April
Change oil	Each month				
Patrol pipeline	Each month				

Session handouts

None.

Module 5: Certification	
Topic 1: Technical certification of community-based volunteers	
Objectives	Technical skills and competency of trained community-based volunteers are observed and evaluated
Outputs	Technically certified community-based volunteers to repair and maintain water supply systems
Timing	Approximately 2 – 3 hours
Methodology	Practical
Materials	Tools, paper, pens
Session guide and content	
Notes for facilitator	Skills of trained community-based volunteers will be evaluated four to six (4 – 6) months after the training in a practical setting. If they are able to complete basic repair and maintenance tasks, they will be certified as a water technician according to the standards and curriculum. You can use the example checklist below as a guide to evaluating the skills of the community-based volunteers.

Example checklist for evaluating trained community-based volunteers

Date	
Village/Community	
Name of person being assessed	

Score the participant on their ability to answer the following questions or to complete the following tasks.

0 = no ability/knowledge, 3 = limited ability/knowledge, 5 = some ability/knowledge, 8 = good ability/knowledge, 10 = excellent ability/knowledge.

Question or task	**Score**
Name three routine maintenance tasks for pipelines.	**... / 10**
Can effectively repair a broken or leaking section of PVC pipe (if applicable in local community).	**... / 10**
Can effectively replace a washer on a tap-stand (or consumer water point).	**... / 10**
Describe two maintenance tasks for intakes.	**... / 10**
Can carry out basic maintenance of an intake (typical to local community).	**... / 10**
Can identify 3 different components of a borehole system and the purpose of each.	**... / 10**
Can explain the key component of RWH, and if possible carry out basic maintenance tasks for a simple RWH system.	**... / 10**
Can explain and carry out basic tasks for a 3 monthly maintenance check on a handpump.	**... / 10**
Can conduct a sanitary survey of a common water source in their local community (including recommendations for action).	**... / 10**
Explain what a drought is and identify two actions that can be done to prepare for a drought.	**... / 10**

Total score: .... / 100

Comments and Recommendations

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Name of Assessor:..

Signature of Assessor:...

Reference Materials

A Trainer's Manual for Community-managed Water Supplies in Kenya by Food and Agriculture Organization of the United Nations (FAO) and United Nations Children's Fund (UNICEF) Kenya Country Office, 2012

National Framework for Operation and Maintenance of Rural Water Supplies in Uganda, Ministry of Water and Environment, July 2011

International Federation of Red Cross and Red Crescent Societies' (IFRC) Water, Sanitation and Hygiene Curriculum, 2009

International Federation of Red Cross and Red Crescent Societies' (IFRC) Water, Sanitation and Hygiene Module 3: Sustainability in WASH, 2009

The Fundamental Principles of the International Red Cross and Red Crescent Movement

Humanity The International Red Cross and Red Crescent Movement, born of a desire to bring assistance without discrimination to the wounded on the battlefield, endeavours, in its international and national capacity, to prevent and alleviate human suffering wherever it may be found. Its purpose is to protect life and health and to ensure respect for the human being. It promotes mutual understanding, friendship, cooperation and lasting peace amongst all peoples.

Impartiality It makes no discrimination as to nationality, race, religious beliefs, class or political opinions. It endeavours to relieve the suffering of individuals, being guided solely by their needs, and to give priority to the most urgent cases of distress.

Neutrality In order to enjoy the confidence of all, the Movement may not take sides in hostilities or engage at any time in controversies of a political, racial, religious or ideological nature.

Independence The Movement is independent. The National Societies, while auxiliaries in the humanitarian services of their governments and subject to the laws of their respective countries, must always maintain their autonomy so that they may be able at all times to act in accordance with the principles of the Movement.

Voluntary service It is a voluntary relief movement not prompted in any manner by desire for gain.

Unity There can be only one Red Cross or Red Crescent Society in any one country. It must be open to all. It must carry on its humanitarian work throughout its territory.

Universality The International Red Cross and Red Crescent Movement, in which all societies have equal status and share equal responsibilities and duties in helping each other, is worldwide.

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