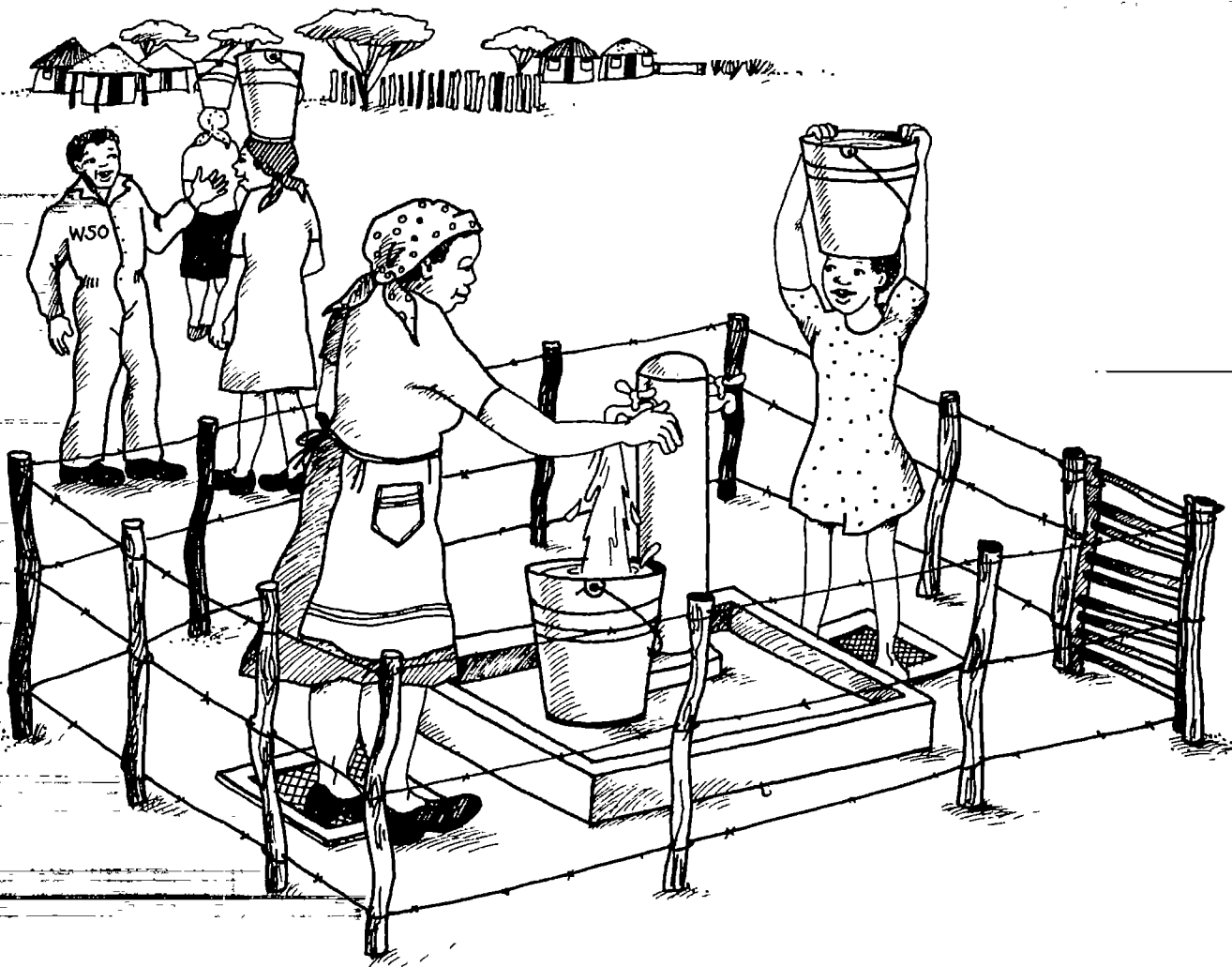


201 90HA

# Handbook

or

# Village Water Supply Operators



Unified Local Government Service  
Botswana

201-90HA-8767



**Handbook**  
**for**  
**Village Water Supply Operators**

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This handbook for Water Supply Operators is included in a project led by the training consultant at ULGS, Bengt Carlsson (SIPU). The handbook has been developed by a group of trainers from District Council Water Departments and Units:

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The handbook was edited by Bengt Carlsson and Ellen Drake (SIPU). Fred van der Geest (MLGL) has been technical editor and general advisor. Design and illustrations were done by Viera Larsson (SIPU).

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I would like to express ULGS gratitude to all persons involved in the production of this valuable handbook.

Gaborone in September 1990



P.L. Siele  
Establishment Secretary, UGLS

More information about the project can be obtained at ULGS, The Training Unit, Private Bag 0052, GABORONE, BOTSWANA. Telephone 354 100, 352 091, or SIPU, The International Division, S-171 96 SOLNA, SWEDEN.

Comments and suggestions concerning the handbook and its use should be made to the same recipients.

ULGS/SIPU, first edition September, 1990  
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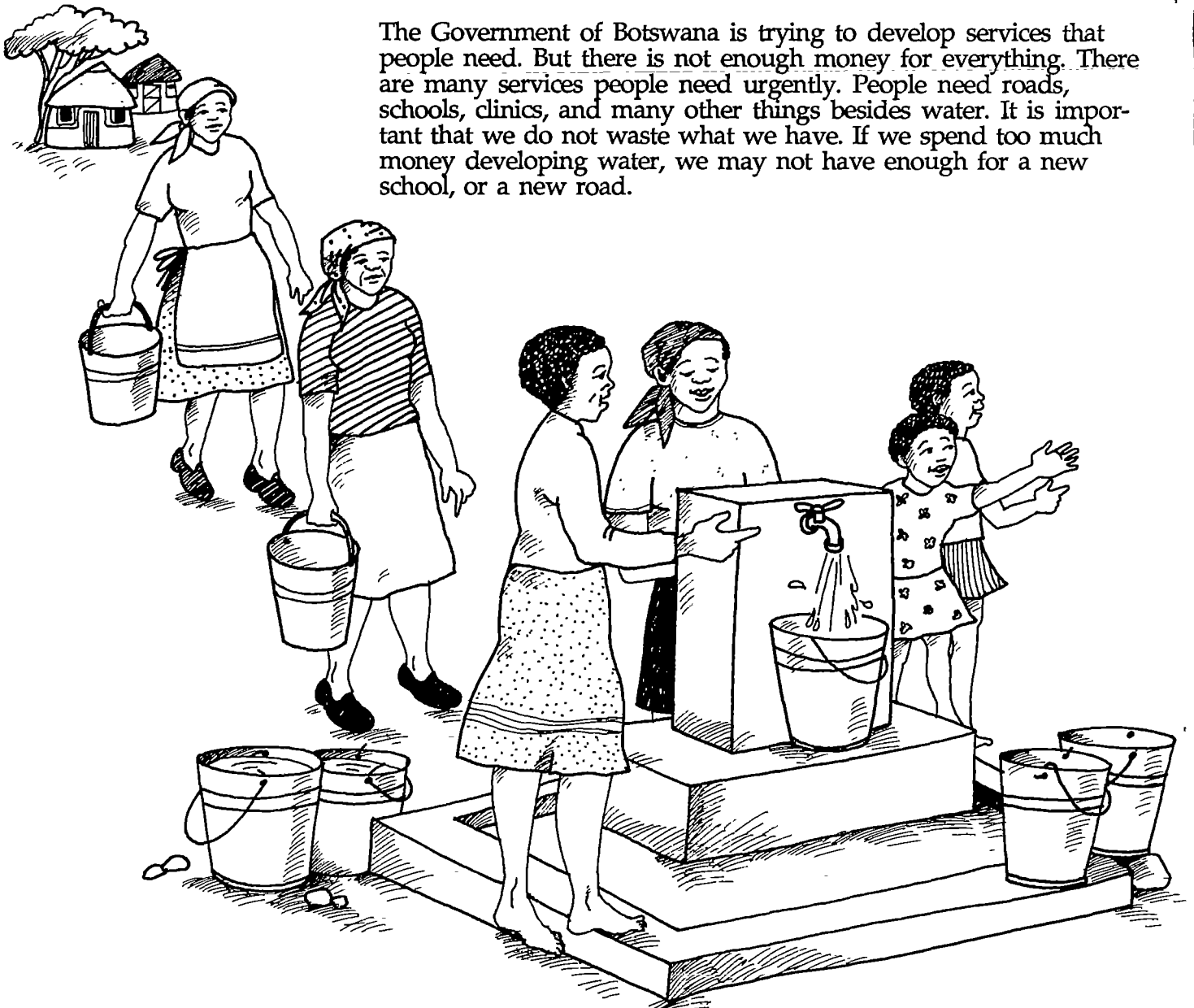
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SANITATION (IRC)

# 1. Introduction

Everyone who lives in Botswana knows the importance of water. The Village Water Supply Operator, who takes care of the water supply in each rural village in Botswana, has a very important job. This handbook has been written to help you, the Water Supply Operator (WSO) carry out your responsibilities.

The Government of Botswana is trying to develop services that people need. But there is not enough money for everything. There are many services people need urgently. People need roads, schools, clinics, and many other things besides water. It is important that we do not waste what we have. If we spend too much money developing water, we may not have enough for a new school, or a new road.



*Did you know?*

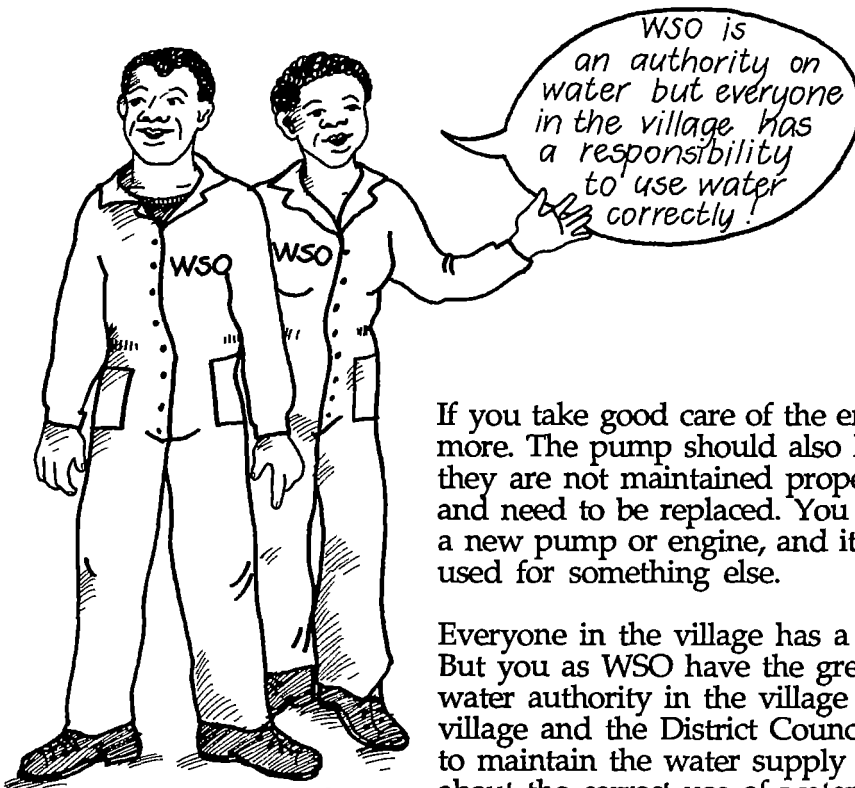
...that a water tap which is slowly leaking for one month wastes more than a thousand litres of water? This is almost the amount of water that one hundred people need for a day. The supply of water in any borehole is limited. So it is important to use the water carefully. You should be aware of this and should help explain it to people in the village.

*Did you know?*

...that many diseases are caused by mistakes in using water? If you do not use water to keep yourself and your environment clean, you can become ill. But water which is contaminated can also make you ill. Most of the children who die before the age of five years die because they get diarrhoea. This disease usually comes from drinking water which is not clean. Many other diseases are related to the misuse of water. The chapter about "Health" describes some of these diseases. It is important that you understand the need for clean water.

*Did you know?*

...that a village water supply system is worth a lot of money? The cost of installing it is about P500,000. It costs around P1,000 per month to operate. You as WSO have a very important responsibility, keeping the system working properly.



If you take good care of the engine, it should last ten years or more. The pump should also last ten years with proper care. But if they are not maintained properly, they will wear out very quickly and need to be replaced. You may have a long delay before getting a new pump or engine, and it will cost money which could be used for something else.

Everyone in the village has a responsibility to use water correctly. But you as WSO have the greatest responsibility. The WSO is the water authority in the village and the important link between the village and the District Council Water Department. It is your duty to maintain the water supply system, and to advise the people about the correct use of water. You should work with the Village Development Committee, the Village Health Committee and the Family Welfare Educator so that water is properly used for health and welfare.

Governments all over the world have decided that everyone should have good health care. They say there should be "health for all by the year 2000." Botswana is part of this world wide programme. But it can be achieved only if everyone helps. Clean water regularly supplied is one of the most important parts of this goal.

# 2.

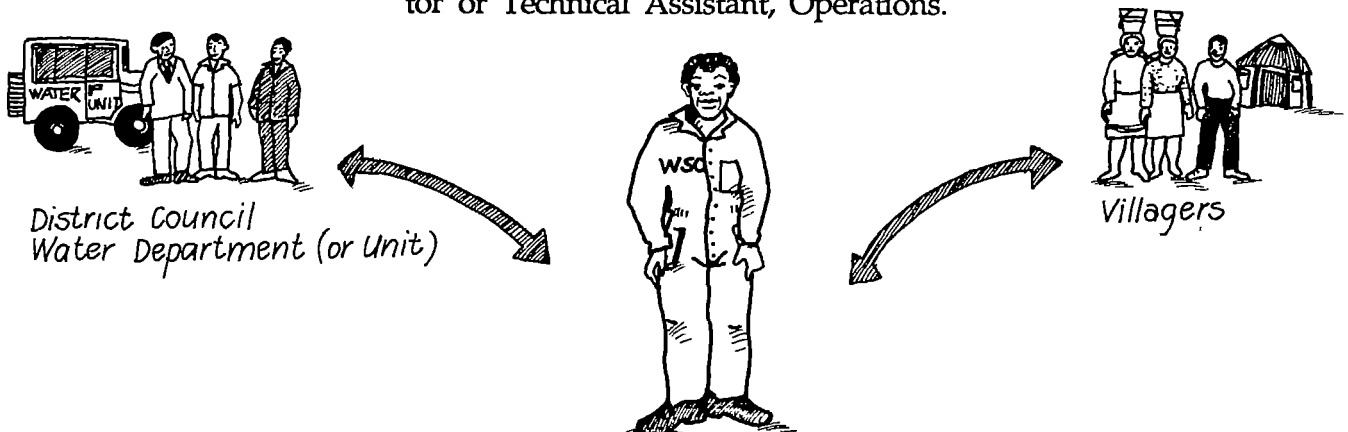
## The Job and the Organization

Every job must have a "job description." The purpose of the job description is to let the person doing the job know his or her duties in detail. It also helps make sure that one is properly supervised, and lets other people know what to ask from you. Every job also has a place in an organization. The WSO job is part of the Water Department and thus it also has a specific job description and a place within the organization.

### Job Description for Village Water Supply Operators

The Village Water Supply Operator (WSO) is the authority on water in the village and is responsible for supplying the villagers with clean water in sufficient quantities. The WSO operates and maintains the whole Village Water Supply System according to the standards set in this handbook. The WSO cooperates with the people of the village and gives them advice on all matters related to water and also makes sure that the water is not misused. The WSO is a member of the Village Extension Team and often is also a member of one or two of the village committees.

The WSO is a member of the District Council Water Staff and acts as the link between the villagers and the District Council Water Department or Unit. the WSO is responsible to the Senior Operator or Technical Assistant, Operations.



*WSO is a link between the District Council Water Unit and the villagers*



### Major tasks and operations

#### Task 1 :

The WSO cooperates with all village committees and gives villagers advice on all matters related to water.

##### Operations:

WSO monitors the water consumption in the village and gives advice on the use of water. He or she also prevents misuse of water.

WSO monitors the level of water in the bore hole.

WSO monitors the quality of the water.

WSO supervises the relief operator

#### Task 2 :

The WSO makes all water supply reports within his or her village.

##### Operations:

WSO records information in the log book every day, and writes total amounts in the book at the end of each month.

WSO reports break-downs to the Water Department and takes action according to emergency requirements.

WSO monitors and helps in all repairs and extension work being done by the Water Department.

WSO requests spares, tools and consumables, and keeps receipts and vouchers in good order.

WSO keeps tools, spares and consumables stored according to regulations.

#### Task 3 :

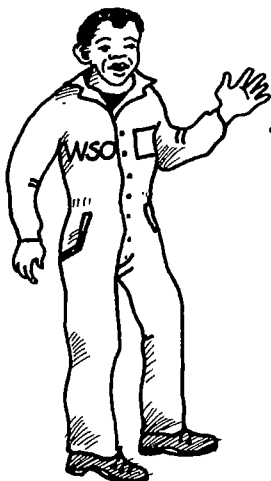
The WSO maintains the protected area around the bore hole and all its installations.

##### Operations:

WSO keeps the protected area clean and keeps grass and weeds from growing too tall.

WSO organizes the fencing of the protected area and keeps the fence and gates in good condition.

WSO cleans the pump house and store and keeps them in good condition.



**Task 4 :**

The WSO operates the engine and pump.

Operations:

WSO checks the gland packing every day, adjusts it and replaces it if necessary.

WSO checks the vee-belts every day, adjusts them and replaces them if necessary.

WSO checks all foundation bolts, nuts and screws on the engine and pump every day, and tightens them if necessary.

WSO services the fuel system.

WSO services the air system.

WSO services the exhaust system.

WSO keeps the engine and pump clean.

WSO starts and stops the engine

**Task 5 :**

The WSO maintains all pipe lines.

Operations:

WSO maintains water marker poles.

WSO detects and reports major leakages.

WSO detects and repairs minor leakages on distribution lines.

WSO detects and repairs minor leakages on service lines.

**Task 6 :**

The WSO maintains all public stand pipes.

Operations:

WSO keeps stand pipes and soakaways clean and in good repair.

WSO organizes fencing for the stand pipes, makes sure that animals do not go inside, and maintains the fence and gates.

WSO repairs and replaces stand pipe taps

**Task 7 :**

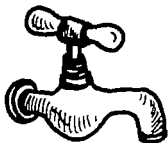
The WSO maintains all valves and other fittings of the reticulation system.

Operations:

WSO keeps all valve chambers clean and in good condition.

WSO checks all private connection water meters and the system water meter, and makes sure that they are operating properly.

WSO checks all valves and, if necessary, replaces worn out washers and gaskets.



Repair it!

**Task 8:**

The WSO maintains the reservoir of the village water supply system.

**Operations:**

WSO reports leakages.

WSO cleans the inside of the reservoir.

WSO keeps the gauge and all other fittings in good working order.

WSO organizes the fencing of the reservoir area and keeps the area clean and the fence and gate in good repair.

WSO keeps the reservoir soak away in good order.

WSO makes sure the reservoir is full at the end of the day.

**New entry qualifications**

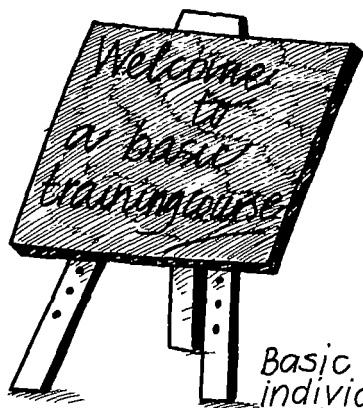
There has been a change in the requirements for entering service as a WSO. People already doing this job may continue, but new applicants must have a Standard Seven certificate. They should be able to read and write English, and do simple calculations correctly. The applicant should be between the ages of 21 and 45 years, and must be mentally and physically fit. The applicant should be a co-operative and careful person who is able to communicate easily with other people.

**Wages and benefits**

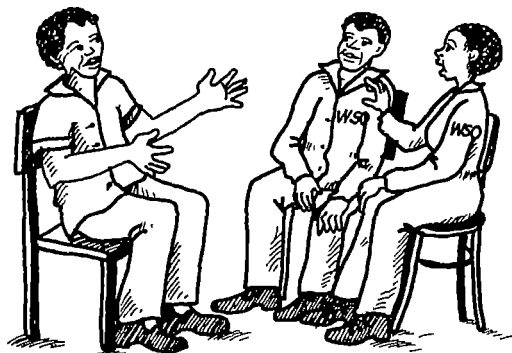
The WSO is a member of the Industrial Class. Regulations about Industrial Class workers apply to all WSOs.

**Training and follow-up**

Every WSO must have proper training to be able to perform well. The basic training comprises a 20-days' course and an individual follow-up in your own village. The course is organized and run by the Water Department. The course covers theory and practical exercises on all your duties. Every year there ought to be a short refresher course covering specific difficult parts of your job or follow-up of new routines.



Basic training, individual follow up and refresher courses are all parts of the training of the WSO



As part of your training and assessment, the trainer and your supervisor, will check to see whether you have understood the job properly. He or she will go over about 40 points and rate your performance. A copy of the check list is in Chapter 14 at the back of this hand book. The aim of this is to make sure you are doing your job correctly. If you are having any problems, you should tell the trainer what they are and ask him or her to help you.

When the trainer and the supervisor see that you are able to take full responsibility for your job, you ought to be given the complete set of tools and equipment shown on the list in Chapter 13.

The Head of the Water Department or Unit will also normally make an inspection of your performance at least twice a year as part of the over all inspection of the village water supply system.

**Regulations for industrial employees**

When you started working as a WSO, you should have been given a copy of the Industrial Handbook. It is a short version of the The Local Authorities Regulations for Industrial Employees, which you can find at the Water Department. These two books cover the rules about your job.

These books tell you, for instance, about appointment, probation period, promotion and appraisal. They also give rules about holidays, vacations, and disciplinary action that will be taken if you neglect your duties.

*When you study this Handbook you will probably find things that you would like to discuss. Write them down in the space next to a picture of a pencil and ask your trainer to help you to find the answers.*

*Write down your questions and your comments:*



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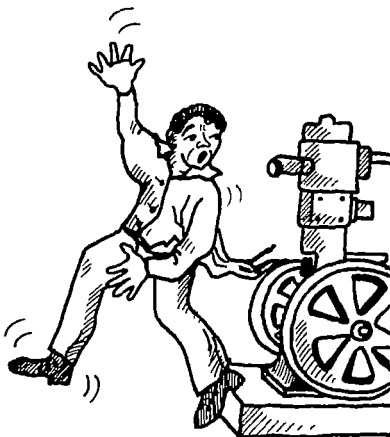
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## Safety Precautions

Some of the things you should do for your own safety are as follows:

*Remember!*

- Wear protective clothing which fits well. You should not have loose clothes which can get caught in the moving parts of the engine. You will be given a pair of overalls which you must wear whenever you are working. Both men and women should wear them.
- Never put cleaning rags or other loose items in your pockets when you are in the pump house. It can get caught in the moving parts.
- Wear shoes with steel caps.
- Always use a rope or safety belt when you are at risk of falling from the reservoir.
- Do not stand or jump over the vee belts in the pump house when the engine is running. Do not put the vee belts on the pulley when the engine is running.
- Inspect and oil the crank handle before you start the engine. Never leave the crank handle engaged with the engine when it is running.
- Keep your fingers away from moving parts of the engine.
- Use a pump or tap to take diesel out of the drum. Sucking diesel with a hose is not good for your health.
- Keep the floor of the pump house and store clean and dry, so that you will not slip and fall.
- Always keep the pump house windows open when the engine is running.
- Always work with someone else when you clean the water reservoir. Never work alone!
- Do not allow any fire in or near the pump house. Do not allow anyone to smoke inside the pump house.
- Never clean the engine when it is running. Never put fuel or oil into the engine when it is running.
- Never leave open trenches or dangerous situations after you have made repairs.
- If you are working with any chemicals, such as solvent, cleaners, chlorine etc., be careful. Read the instructions on the container and follow them. Some chemicals give out fumes which are harmful to your lungs if you breathe them. Some of them will burn your skin.



**NOT LIKE THIS!**

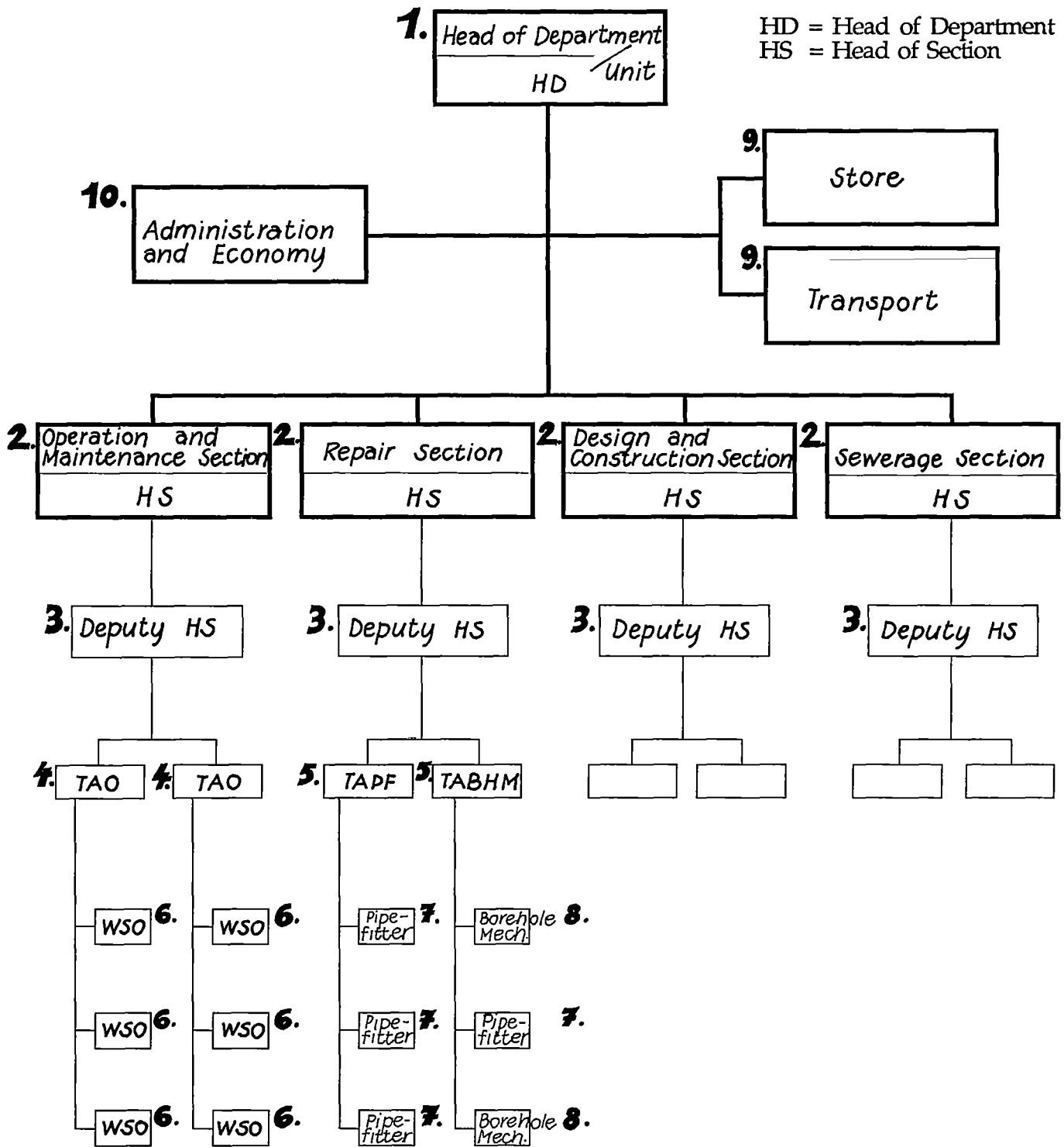
## **How the Water Department is Organized**

An organizational chart shows how different jobs are related to each other. In this chart you can find your own job and how it could fit in the Water Department organization. This chart shows how a water department could be organized. It has not yet been officially approved.

### **Parts of the Organizational Chart**

- 1.** Head of Department or Unit is the Senior Water Engineer or Chief Technical Officer.
- 2.** Head of Section is the Senior Technical Officer or Technical Officer. One of the Heads of Section is also Deputy Head of Department. Each Head of Section should be able to act as Head of Department or Unit. In small Departments the Repair Section, the Design/Construction Section and the Sewerage Section could be merged.
- 3.** Senior Technical Assistant is also the Deputy Section Head.
- 4.** Technical Assistant Operation, TAO, supervises the operation and maintenance of the Village Water Supply Systems performed by the WSO. There should be one TAO per 8 - 10 villages. Each team is responsible for the operation, maintenance and minor repairs of its own systems.
- 5.** Technical Assistant Pipefitter (TAPF) and Technical Assistant Borehole Mechanic (TABHM) are responsible for all major repairs of systems. In small Departments they are also responsible for extension work. A repair crew consists of a maximum of eight members, Pipefitters and Borehole Mechanics.
- 6.** Village Water Supply Operator, WSO
- 7.** Pipefitter
- 8.** Borehole Mechanic
- 9.** Store and Transport depending on other Departments in the Council.
- 10.** Administration and Economy headed by Senior Administrative Assistant, SAA.

## Organizational Chart District Council Water Department (Draft)



# 3.

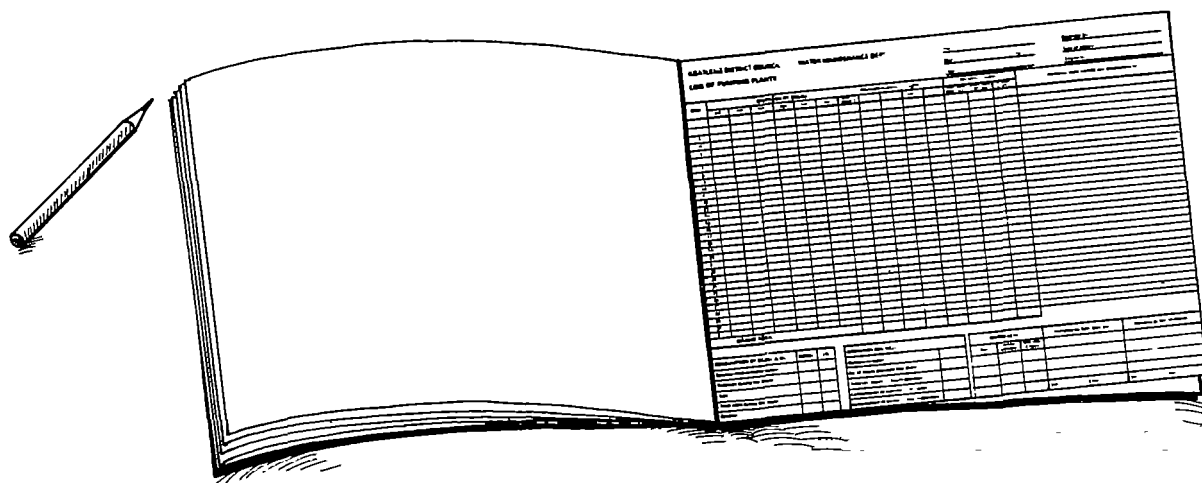
## Reporting and Administration

The Water Department's budgeting, planning and administration are based on reports from the villages. It is very important for you to keep records carefully and accurately.

There are three very important types of records you must keep regularly. You should know how to fill in the log book, how to make proper breakdown reports, and how to keep receipts and vouchers in good order.

### Keeping the Log Book

You must keep the log book up to date. This is the record of everything that happens in the system. It shows what has happened throughout all the months and years that the system has been working. From the log book the Head of the Water Department can get almost all the information he needs to plan ahead. He can find out how much water is produced and consumed, how much it costs to run the engine, how well it performs, and whether or not the bore hole and its installations cope with the level of service needed in the district. If you do not provide that information, neither you nor the Department will be able to do the job properly. Log book keeping is to be done daily! You should have a proper book, a pen, and a cover so that the log book does not get dirty.





**This you should do every day:**

You must write the following and sign your name:

- The times you started and stopped the engine.
- The total number of pumping hours.
- If you have received fuel or oil, from the Water Department, write down how much and include the voucher number.
- How much fuel and oil the engine has consumed.
- The water meter reading at the beginning of the day, before starting the engine; and after stopping at the end of the day. You should calculate and note the amount of water which has been pumped that day.
- Write down any other event of importance for the water supply system. For instance, you should record any repairs, servicing the engine, breakdowns, spare parts or other items received, and so on.

Date	OPERATION OF ENGINE							Received		Consumption		Delivery of water			Sign.	Remarks ..
	Start	Stop	start	Stop	start	Stop	Hours	Diesel	Oil	Diesel	Oil	Before start	After stop	Quant.		
1																
2																
3																
4																
5																
6																
7																

**This you should do once every week**

- Check the water level in the bore hole, in the morning just before pumping and in the evening just before you stop pumping. This will give you an early warning and protect the pump from running dry. It will also give you a warning if the bore hole is running dry.
- Put the readings in the log book in Table number 37 at the bottom of the sheet.

Date	Before Starting	Before Stopping



## Breakdown Reporting

You as WSO should be the first one to notice when the system is not working well and your duties are to report as soon as possible to your Water Department when there is something wrong. In most cases a breakdown means that the supply of water is in danger. Since the size of the tank is determined by the number of people living in the village on the basis that there should be a reserve supply enough to last two to three days, immediate action must be taken if there is a breakdown. This is also the main reason for you to make sure that the reservoir is full at the end of the day. If you do not report the breakdown immediately, people may be without water. The breakdown report should be as exact and detailed as possible. If it is not, much time will be wasted. It is expensive to transport the repair crew to a remote village, and if the crew does not know what tools or spare parts to bring, they may have to go back to the headquarters and return with the correct tools.

**Remember!** If you record everything in the log book, including the breakdown and the date that you made the report, you will be able to prove that you did your work correctly if anyone questions you.

To make a breakdown report, here are some key things to remember:

### **Where?**

- Write the name of the village and where in the system the breakdown occurred.

### **When?**

- When did this breakdown happen, and how much water is left? It is important to know when the breakdown occurred, so that the Water Department will know how much time is left before the water runs out.

### **What?**

- Describe in as much detail as possible what is wrong, and how serious is the problem.

### **Inform others**

- You should inform the chief, the VDC chairman, the clinic, the school and whoever else may be concerned if the water supply is interrupted. The Head of Department should have given you a letter authorizing you to ration water if necessary. The decision to ration water should be taken with the chief and the VDC.

### **Follow up**

- Make sure that the breakdown report has reached the Water Department and that something is being done about it.

**Note :** Make a note in the log book about the breakdown and the report. This protects you as well as making a record for the future.

SOUTHERN DISTRICT COUNCIL WATER DEPARTMENT

LOG OF PUMPING PLANTS (1)

AM = morning

PM = afternoon

RELIEF OPERATOR: Onkhetsetse

Date (10)	OPERATION OF ENGINE (11)							Received quantity (15)		Consumption (17)
	Start (12)	Stop (13)	Start (12)	Stop (13)	Start (12)	Stop (13)	Hours of operation (14)	Diesel l (17)	Oil l (18)	Diesel l (17)
1	7 00 AM	11 00 AM	2 00 PM	5 00 PM	-	-	7 h	-	-	5 6
2	7 30 AM	2 00 PM	-	-	-	-	6 h 30 min	-	-	5 2
3	7 00 AM	11 30 AM	2 30 PM	5 15 PM	-	-	7 h 15 min	-	-	5 8
4	7 15 AM	10 30 AM	11 00 AM	4 15 PM	-	-	8 h 30 min	200	20	6 8
5	6 45 AM	2 00 PM	-	-	-	-	7 h 15 min	-	-	5 7
6	7 30 AM	12 00	2 00 PM	4 45 PM	-	-	7 h 15 min	-	-	5 9
7	8 00 AM	2 00 PM	-	-	-	-	6 h	-	-	4 8
8	8 00 AM	1 20 PM	-	-	-	-	5 h 20 min	-	-	4 2
9	7 00 AM	4 00 PM	-	-	-	-	9 h	-	-	7 1
10	8 45 AM	5 00 PM	-	-	-	-	8 h 15 min	-	-	6 5
11	6 00 AM	10 00 AM	1 00 PM	6 00 PM	-	-	9 h	-	-	7 0
12	7 15 AM	9 30 AM	2 30 PM	5 10 PM	-	-	4 h 55 min	-	-	4 0
13	7 30 AM	4 15 PM	-	-	-	-	7 h 45 min	-	-	6 2
14	8 15 AM	9 45 AM	10 15 AM	1 00 PM	4 00 PM	6 00 PM	6 h 15 min	-	-	5 0
15	9 00 AM	2 30 PM	-	-	-	-	5 h 30 min	-	-	4 3
16	6 15 AM	9 30 AM	10 20 AM	3 45 PM	-	-	8 h 40 min	-	-	6 9
17	8 45 AM	4 00 PM	-	-	-	-	7 h 15 min	-	-	5 8
18	6 30 AM	9 00 AM	10 30 AM	4 30 PM	-	-	8 h 30 min	-	-	6 7
19	8 30 AM	2 45 PM	-	-	-	-	6 h 15 min	-	-	5 0
20	6 45 AM	8 30 AM	11 10 AM	2 15 PM	3 30 PM	6 00 PM	7 h 10 min	-	-	5 8
21	8 30 AM	3 15 PM	-	-	-	-	6 h 45 min	-	-	5 4
22	8 15 AM	2 30 PM	-	-	-	-	6 h 15 min	-	-	4 9
23	7 00 AM	8 30 AM	10 00 AM	11 10 AM	12 20 PM	4 30 PM	6 h 50 min	-	-	5 4
24	8 15 AM	9 00 AM	12 15 PM	5 00 PM	-	-	5 h 30 min	-	-	4 5
25	7 15 AM	3 45 PM	-	-	-	-	8 h 30 min	-	-	6 8
26	8 00 AM	10 10 AM	10 30 AM	4 15 PM	-	-	5 h 55 min	-	-	4 8
27	7 30 AM	4 00 PM	-	-	-	-	8 h 30 min	-	-	6 9
28	8 45 AM	1 30 PM	-	-	-	-	4 h 45 min	-	-	3 8
29	9 00 AM	2 20 PM	-	-	-	-	5 h 20 min	-	-	4 3
30	7 45 AM	9 10 AM	11 30 AM	4 30 PM	-	-	6 h 25 min	-	-	5 2
31	7 45 AM	4 15 PM	-	-	-	-	8 h 30 min	-	-	6 8
GRAND TOTAL							216 h 50 min	200 e	20 e	173 1 e

CONSUMPTION OF DIESEL & OIL (25)		OIL (18)
Balance from previous month (26)	40	4
Received during the month (27)	200	20
Total (28)	240	24
Total used during the month (29)	173	5
Balance (30)	67	19

OPERATION AND YIELD (31)	
Delivery of water m <sup>3</sup> (32)	64
No of hours operated this month (33)	216
Yield (m <sup>3</sup> water — hours operated) (34)	
Consumption of fuel (ml ÷ m <sup>3</sup> water) (35)	
Consumption of oil (ml ÷ hours operated) (36)	

Place (3) Mogojwegojwe

Borehole No. (7) 3246

Month (4) July 19 90 (5)

Type of engine (8) LISTER ST-1

Operator (6) Gloria Karrim (full time)

Engine No (9) R 298 ST-1 36

16)	Delivery of water (19)			Signature of Operator (23)	Remarks, work carried out, breakdowns, (24) Items received, invoice nos, etc
	Water meter (20) before start	Water meter after stop (21)	Pumped Quantity (22)		
3	016755	016777	22 m <sup>3</sup>	O.R.	Onkhethetse Rathedi, Relief Operator
	016777	016795	18 m <sup>3</sup>	G.K.	Replace of washers on standpipe 4
	016795	016815	20 m <sup>3</sup>	G.K.	
	016815	016838	23 m <sup>3</sup>	G.K.	Fuel delivery receipt nr 10789
	016838	016858	20 m <sup>3</sup>	G.K.	Meeting with FWE and schoolteachers
	016858	016878	20 m <sup>3</sup>	G.K.	
	016878	016895	17 m <sup>3</sup>	O.R.	
	016895	016910	15 m <sup>3</sup>	O.R.	Closed school extension, leaking pipe
	016910	016935	25 m <sup>3</sup>	G.K.	Repair of service line for school
	016935	016958	23 m <sup>3</sup>	G.K.	Request for airfilter and oilfilter for TAO
	016958	016985	27 m <sup>3</sup>	G.K.	
	016985	016998	13 m <sup>3</sup>	G.K.	
	016998	017022	24 m <sup>3</sup>	G.K.	
	017022	017042	20 m <sup>3</sup>	O.R.	Replaced two Vee-belts
	017042	017059	17 m <sup>3</sup>	O.R.	
	017059	017086	27 m <sup>3</sup>	G.K.	Request for new Vee-belts sent to Water Unit
	017086	017109	23 m <sup>3</sup>	G.K.	Replaced two water marker posts
	017109	017136	27 m <sup>3</sup>	G.K.	Checked all stand pipes with TAO
	017136	017156	20 m <sup>3</sup>	G.K.	Received new filters Receipt no 10947
4	017156	017178	22 m <sup>3</sup>	G.K.	Repair of bore hole fence
	017178	017199	21 m <sup>3</sup>	O.R.	
	017199	017218	19 m <sup>3</sup>	O.R.	(New Vee-belts, receipt 11009)
	017218	017239	21 m <sup>3</sup>	G.K.	Tappets setting with TAO.
3	017239	017256	17 m <sup>3</sup>	G.K.	Service of engine, oil filter, air filter change
	017256	017282	26 m <sup>3</sup>	G.K.	Kgotla meeting on stand pipe fencing
	017282	017300	18 m <sup>3</sup>	G.K.	
	017300	017326	26 m <sup>3</sup>	G.K.	Cleaned soak away on SP 2
	017326	017341	15 m <sup>3</sup>	O.R.	
	017341	017358	17 m <sup>3</sup>	O.R.	
5	017358	017378	20 m <sup>3</sup>	G.K.	checked all tools and spares with TAO. All is there
	017378	017404	26 m <sup>3</sup>	G.K.	Water meter readings, for water and SP
			649 m <sup>3</sup>		

WATER LEVEL (37)			Remarks by Technical Assistant by Operation (TAO) (40)	Remarks by Off in charge (41)	
Date (10)	Before start (38)	Before stop (39)			
2/7 1990	46,65m	90,56m	Oil consumption seems high	Monitor water table daily for	
9/7 1990	47,05m	90,90m	Needs overhaul Aug 90	two weeks. Report immediately	
16/7 1990	47,30m	91,20m	Good job on log book and Kgotla	if declining! Nice work	
23/7 1990	47,35m	91,30m	Water table drops steadily!	by all. Thank you!	
			Sign (42) <u>OMG</u>	Date (10) <u>5/8-90</u>	Sign (42) <u>KAO</u> Date (10) <u>10/8-90</u>

A sample of breakdown report:

Shoshong Village  
P.O. BOX 440

31 January 1990

To Head of Water Department,  
P/bag 002  
Mahalapye

Please be informed that my Lister B/1 does not function properly. There is black, thick smoke from the exhaust pipe when under full load.

It seems to be getting weaker every day since 27th of January 1990.

This needs your immediate response.

Thank you.

Yours faithfully

hekoko Molapisi  
(WSO)



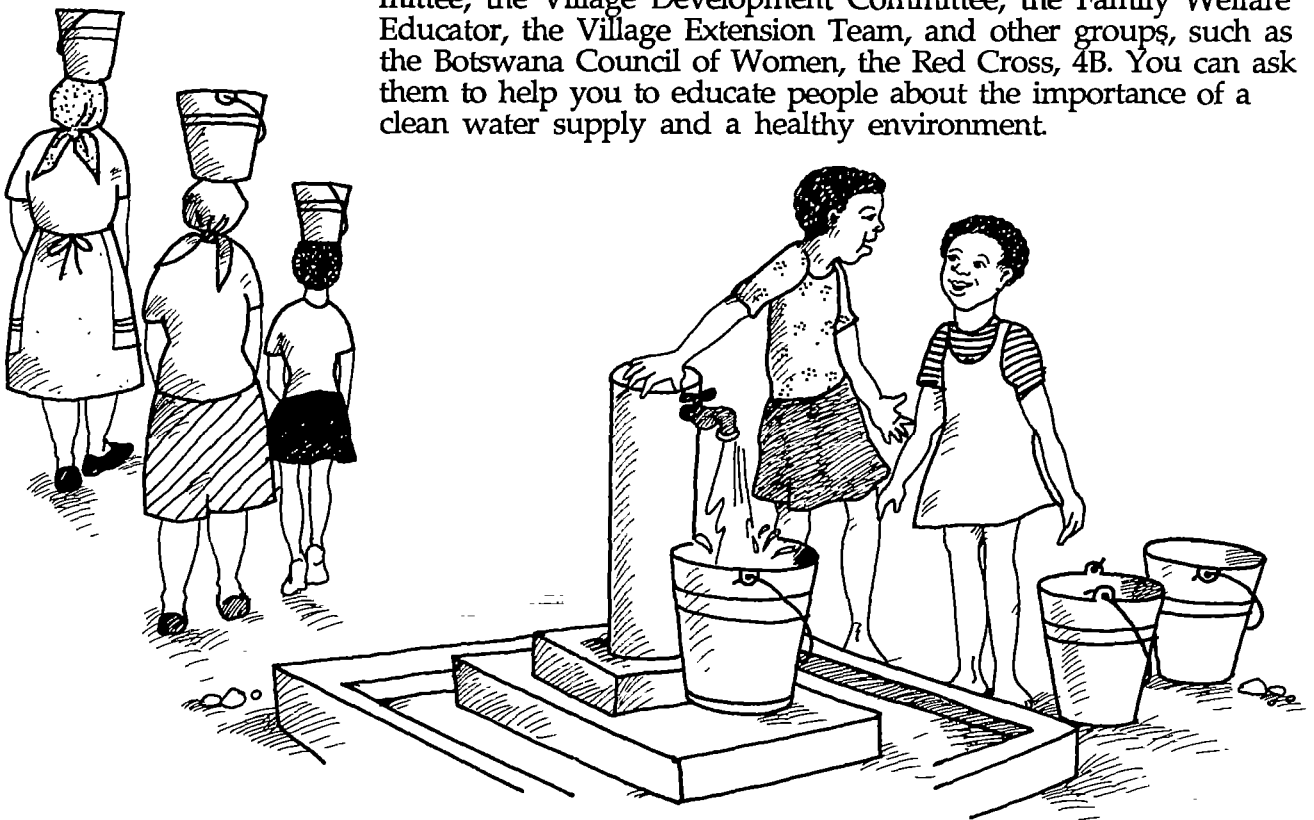
# 4.

## Co-operation

All of the ideas in this handbook are meant to help you do your job well. But the ideas in this section of the handbook are among the most important of all. It is important to maintain the water system properly, to keep the water from contamination, etc. But the purpose of doing those things is to help make a better life for the people of the village. This means everyone must co-operate.

A team of people once tested 500 samples of water in boreholes in Botswana and found that 425 of them were not harmfully contaminated. But almost all the samples taken from storage jars in people's homes were contaminated in such a way that they could make people sick.

It is useless to have clean water if people do not use it properly. That is why it is important to work with the Village Health Committee, the Village Development Committee, the Family Welfare Educator, the Village Extension Team, and other groups, such as the Botswana Council of Women, the Red Cross, 4B. You can ask them to help you to educate people about the importance of a clean water supply and a healthy environment.



Women and children are usually the ones who carry the water home. They are also the ones who wash the pots, handle the food, sweep the lolwapa and take care of the babies. So it is especially important that they know how to handle the water properly. If they do not know how to keep the water free from contamination, they should be educated about it.



Women work very hard. Sometimes they are too tired to do any extra work. If it makes more work for them to keep the water free of contamination, they may not be willing to do it. It is important to help the women by making their work easier.

It is also important to educate children about the proper way to handle water. They must be taught as soon as possible that they are not to put their hands into the water storage container at home, and that they should wash their hands after using the latrine. They should also wash their hands before handling food. They should also be taught not to play around the stand pipes.

Even a very young child can use a VIP latrine. It is important that everyone should use the latrine instead of using the bushes. It is not true that the faeces of small children are clean. Even the faeces of children can spread diseases.



There are some questions you should ask yourself about people's understanding of the use of water:

- Do people understand the need for water which is not contaminated? (if they do not, you should explain to them)
- Do people understand how to keep the water from becoming contaminated? (if not, show them)
- Is water for drinking put into clean buckets? Are lids kept on the buckets? (if not, you should explain the importance of doing so)
- Do people put their hands into the water which is for drinking? (if they do, you should explain why they should not)
- Do people or animals touch the mouth of the water tap? (if they do, you should stop them from doing so)
- Do people have latrines? Do they use them? (if not, find out why not and try to help them to get a latrine)
- Is the latrine kept clean? (if not, explain the importance of a clean latrine)
- Are there flies coming out of the latrine? (if so, find out why, and correct the problem)
- Do people wash their hands after using the latrine (or passing urine or faeces anywhere)? (if they do not, explain that it is important to do so)
- Do people always wash their hands before handling or eating food, (if they do not, explain its importance)
- Do they wash their hands before handling the plates and cups used for eating? (if they do not, explain its importance)

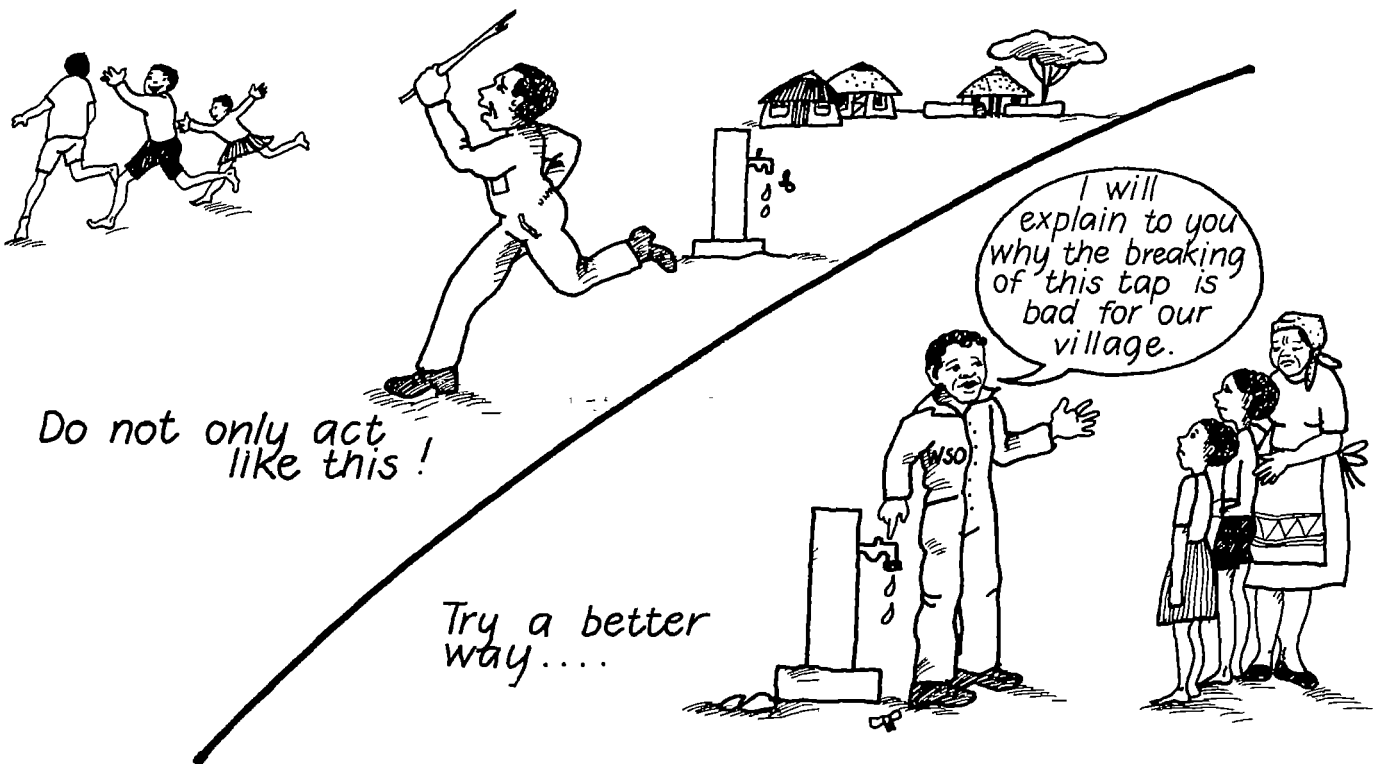
Sometimes people do not want to change their habits because they do not understand why it is important to change them. If that is the problem, you can ask the groups mentioned above to help you with an education programme. Perhaps you can form a "Water and Sanitation Subcommittee" under the VHC, and involve people in discussions about the topics covered in this handbook. You can also have a discussion at the kgotla.

If there is someone in the village who is respected by most people, that person may be asked to help by setting an example. The person may be encouraged to build a latrine, for instance. Sometimes education programmes are given by health workers. A person who is respected can help by introducing these programmes and supporting them.

The WSO is the important link between the Water Department and the people of the village. You should give advice on all matters concerning water. You should also help the people by making sure that they have the best service possible.

After you have completed your basic training as WSO you will know a lot about the water supply system and the proper use of water for health and sanitation. This knowledge is for you to share! Knowledge is one thing which increases when you share it.

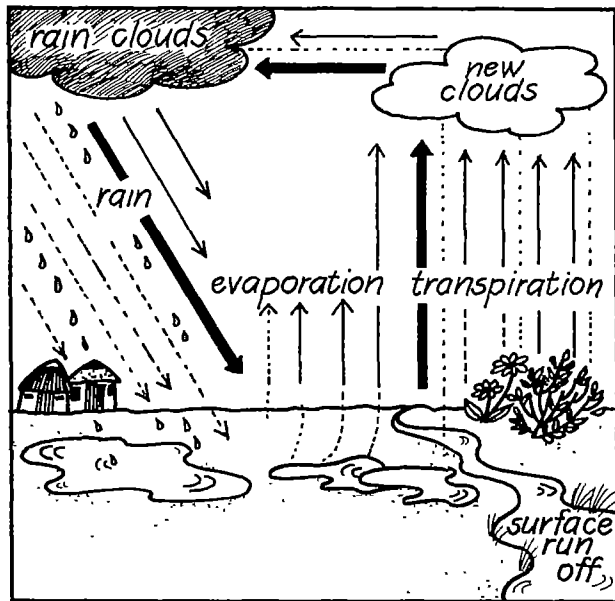
But you should also know how to share knowledge. People do not like to be told that they are wrong, that they are ignorant or stupid. You should also listen to people and learn about their problems. You should encourage them to do what is right, rather than criticising them for whatever they do that is wrong.





# 5. Water

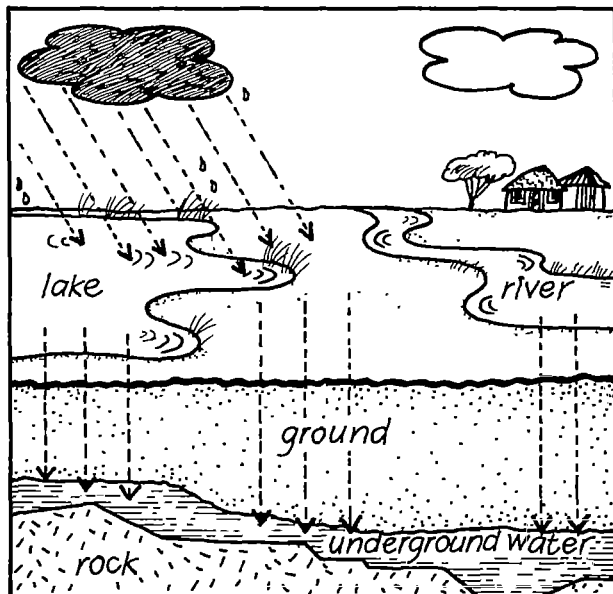
The water cycle is what happens to water in the environment.



When rain falls on land, some of the rain water evaporates - it rises into the sky, where it forms clouds. These clouds produce more rain. This process - rain falling, evaporating and rising up as water vapour, forming clouds and coming down again as rain, is a cycle. It is called a cycle because the water keeps going around.

Evaporation through plants is called **transpiration**. Transpiration occurs after the roots of plants have absorbed water. The plants use the water for growth, and then some of the water evaporates from the leaves and returns to the sky. It comes down again as rain. Transpiration is part of the water cycle.

Some of the rain water does not evaporate right away. It may remain on the surface of the ground for some time. Water may stay for a while in a pool, pan or lake; or it may run down a river bed. This process is called **surface run off**.



Some of the rain water may seep slowly down into the ground. If there is a lot of water, for example in a lake or dam, some of this water will also slowly go down under ground. Water which remains under ground is called **ground water**. Flow of ground water is usually very slow so it may appear to remain in the same place for a long time.

Not all rocks on or under ground are alike. Some of them are very dense and solid. Others are made of small pieces of sand or other material, with spaces between. These types of rock are said to be **porous**. A type of rock with spaces inside it, like the holes in a sponge, is said to have a high porosity. These spaces can store water under ground. Porous rocks are said to be **permeable** if the pore spaces are connected with each other. This means that water or other fluid can permeate, or go through them. Rocks which are very dense and solid are called **impermeable** rocks.

Porous rock under ground which produces enough water is called an **aquifer**. The water runs slowly through the porous rocks. Such water is called **ground water**. Its movement is called the **ground water flow**. The water of a spring is ground water which has flowed out of the ground by itself.

If the water does not come out of the ground by itself, people can dig wells or drill bore holes and pump the water out. This water is used for human beings, animals and plants. But it, too, eventually evaporates. The water passes out of the bodies of animals, humans, and through the leaves of plants. Then it evaporates. This evaporation again causes clouds to form - and thus the water cycle continues.

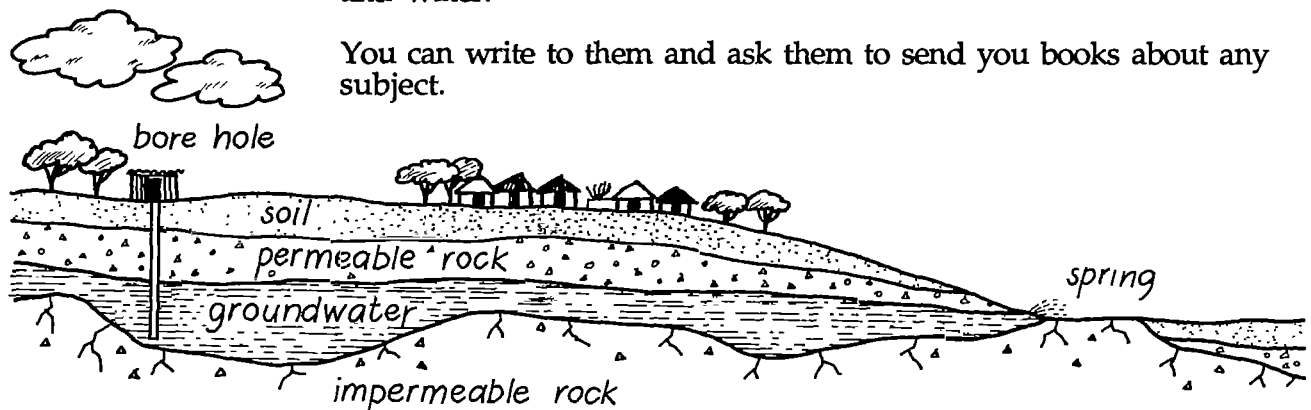
Ground water is not the same in different places. In some places, the ground water is plentiful. In other places, there may be little or no water. Sometimes the ground water is salty.

Sometimes the ground water can run easily through the porous aquifers and along cracks between the rocks under ground. Sometimes there are not many openings in the rocks, so that it is difficult for the water to go through. These are some of the reasons why some bore holes can produce a lot of good water, whereas others produce very little.

Ground water can be near the surface or also very deep under ground. If it is very deep, it is more difficult to pump out. But the water which is further under ground is less likely to become contaminated.

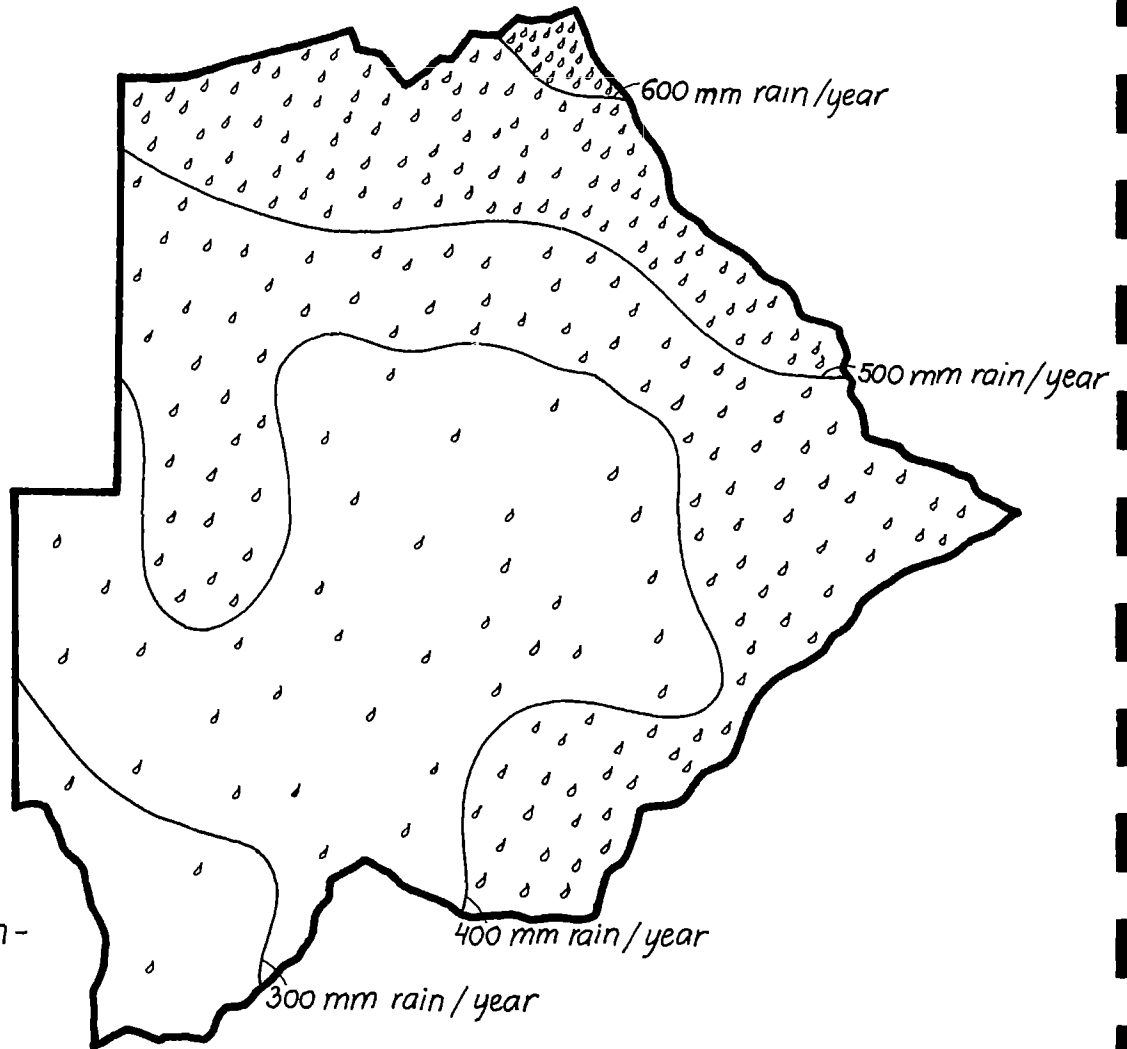
The Botswana National Library Service can lend (adima) you some books if you are interested in reading more about the land and water.

You can write to them and ask them to send you books about any subject.



## Water in Botswana

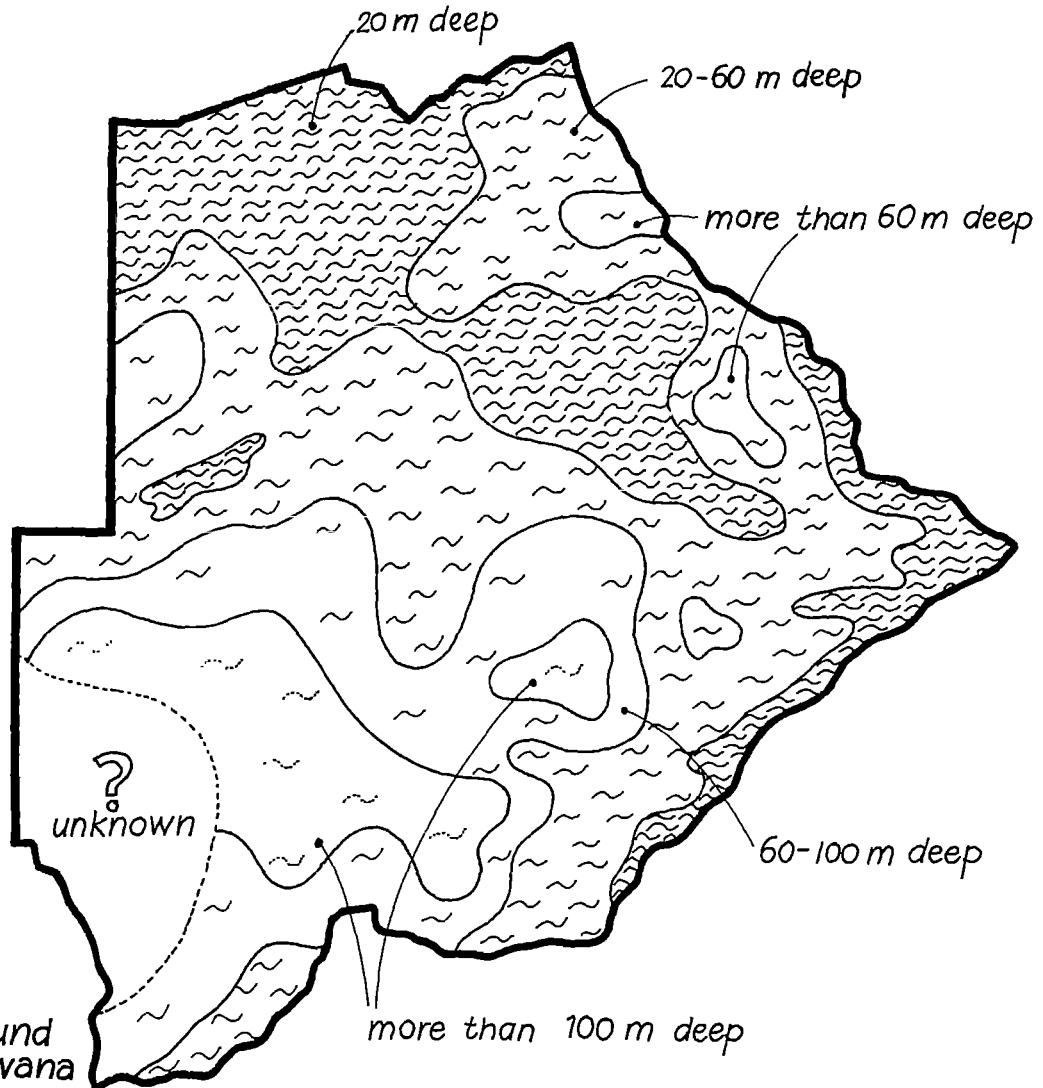
Botswana is located in a part of Africa which receives very little rain. The average yearly rainfall ranges from about 650 millimeters per year in the north east part of the country (Kasane and Kazungula) to less than 250 millimeters in the south-west (Bokspits). The map shows the average amounts of rainfall for the different parts of the country.



Some of the rain runs down streams and into rivers and lakes. Some of it seeps under ground and gradually fills the aquifers. But the amounts of water in the aquifers vary. The map on the next page shows the parts of Botswana where underground water is easy to find.

The northern and eastern parts of Botswana have more rainfall and more recharge to ground water than the rest of the country. In eastern Botswana, ground water is found at depths of between 30 and 100 meters, at the average.

In the central, southern and western regions there is much less rain and also less ground water. Over 80 per cent of Botswana is covered with Kgalagadi sand. The ground water is usually very deep beneath the sand; 100 meters is common. Most of the rain which falls on the sand evaporates. Very little of it seeps down to the aquifers. Much of the ground water in the Kgalagadi is salty or otherwise unfit to use. Even if there is fresh ground water, there may not be enough to supply a village with as much water as it needs.



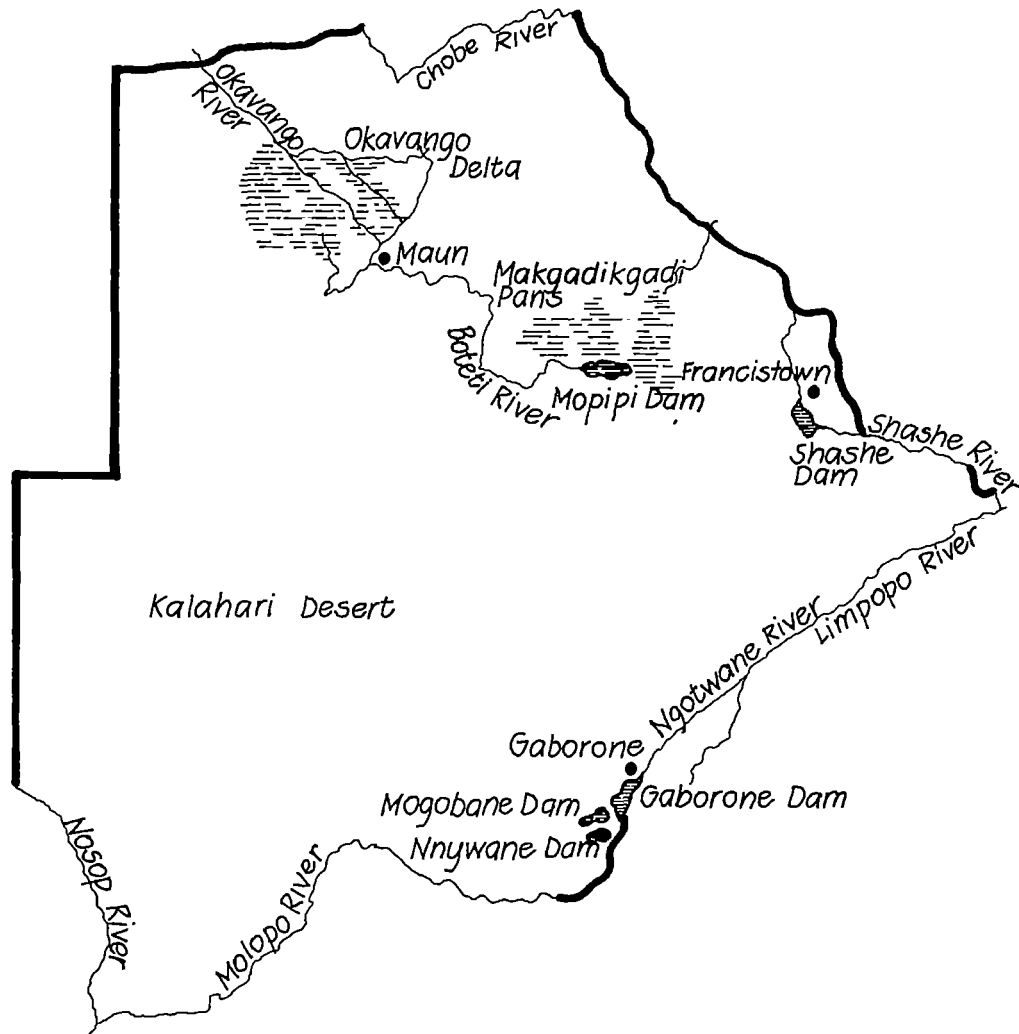
Most of the water which comes from stand pipes in Botswana comes from ground water supply. This water is pumped from bore holes.

Some of Botswana's water comes directly from surface water in rivers, lakes or dams.

Surface water in Botswana is rare except in the Okavango delta and along the northern border of the country. Because of Botswana's hot climate, water evaporates from the lakes, rivers and pans

very quickly. The map below shows the rivers, lakes and dams in Botswana.

A few people also collect rain water and store it in containers for use during the dry season. It is not difficult to collect water which runs off the roof of the house and store it in a drum. You can also make a storage tank under ground. This is one way to make sure that there is enough water for the household, even if the pump is not working. Water stored at home in a tank or drum should, of course, be kept clean and covered.



Rivers, lakes and dams in Botswana



## Monitoring the Quality and Amount of Water

It is important to know the quality of the ground water. If the water is salty, or contaminated, it is not good to use. There are some tests which can be made to find out the quality of the ground water. These tests are done twice a year by the District Health Team or by the Water Department.

The tests show if there are any disease organisms in the water. They also show whether or not there is any contamination by chemicals such as salt. If you suspect the water is contaminated, you should notify the Water Department and the health authorities immediately.

The amount of ground water in one area of the country may be very different from the amount in another place. It can also change from one time to another. If rain water is seeping into the ground water supply, obviously there will be more water during a rainy year than during a drought.

If there is a drought, or if a lot of water is being used, the bore hole may soon run dry.

In some parts of Botswana the aquifers may be very large. The amount of water that can be brought up out of a bore hole depends on the size and permeability of the aquifer. Its porosity is also important.

It is important to know how fast the water flows into the bore hole. If the hole refills very slowly after some water is pumped out, the bore hole may not produce water quickly enough if the pump is working very fast.

That is why you should check the water level once a week. You should check the level once in the morning, just before you start the engine, and then again in the evening, just before you turn it off.

You should enter the readings in the log book.

Write down  
your questions  
and your  
comments:




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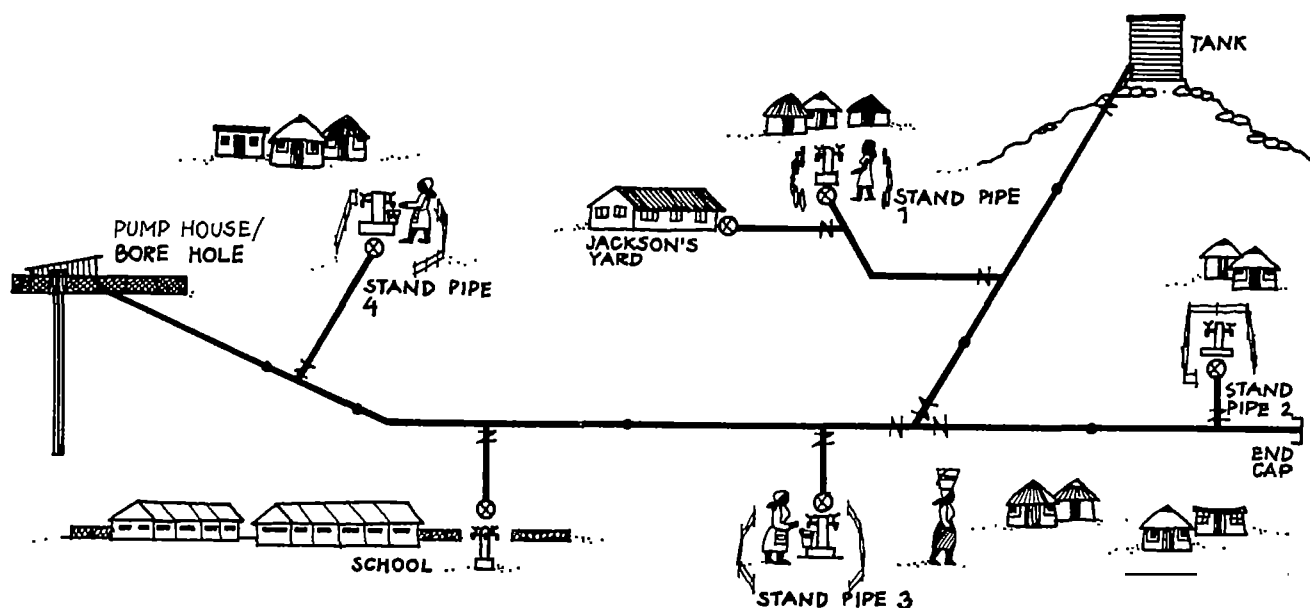


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## Design and Construction of a typical Water Supply System

A typical village water supply system is made of:

- A water source, usually a bore hole
- A pump house over the bore hole, which is equipped with a pump and an engine
- Pipe lines with valves for distributing the water through the village
- Some private connections
- Some stand pipes
- A reservoir or tank



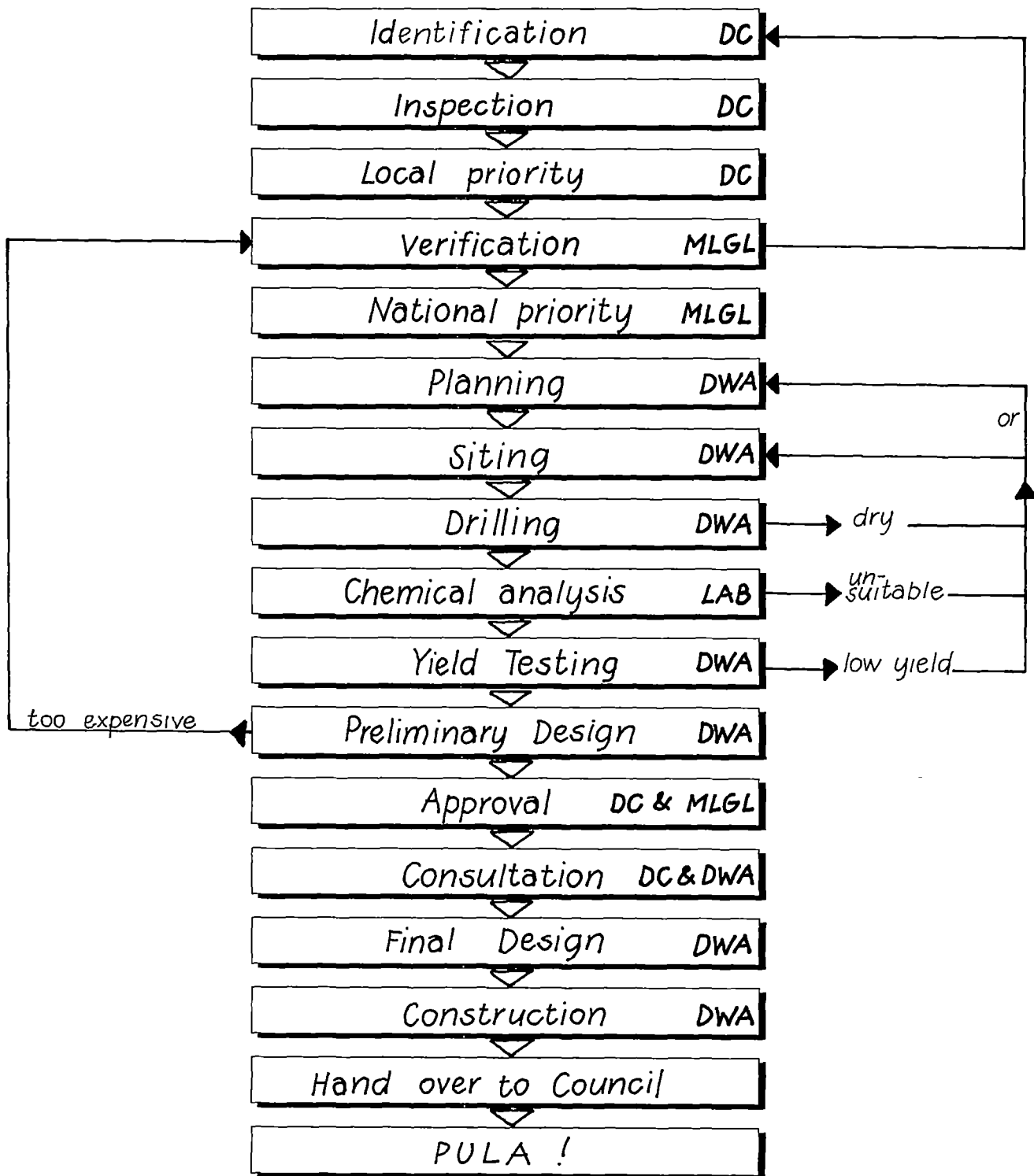
*The direct reticulation system*

Getting a water supply for a village takes a long time. It is very expensive. It also needs co-operation between the village, the District Council, Ministry of Local Government and Lands and the Department of Water Affairs of the Ministry of Mineral Resources and Water Affairs. Often, the Department of Water Affairs has to hire consultants to do part of the work.

The diagramme called Flow Chart, Rural Village Water Supply on page 34 shows the steps needed to get a water supply for a village. The steps are explained below:

- 1. Identification:** Identification is done by the District Council. A village is chosen if it is large enough to be given such an expensive thing as a water supply system.
- 2. Inspection:** The Council inspects the existing water supply to see what might be needed for the new system.
- 3. Local priority:** The District Council then decides which village of the ones in the district need to be supplied first. Sometimes there are many villages needing water, and the Council tries to decide which one has the most urgent need. Then the Council makes a proposal about the village to the Ministry of Local Government and Lands in Gaborone.
- 4. Verification:** The Ministry of Local Government and Lands must then decide whether the proposal fits into the plan for national development, and whether there is enough money.
- 5. National priority:** The Ministry of Local Government and Lands also has to compare proposals from different District Councils and decide which ones are most urgent. If there is enough money available, the Ministry of Local Government and Lands passes its recommendations to the Department of Water Affairs in the Ministry of Mineral Resources and Water Affairs.
- 6. Planning:** The Department of Water Affairs makes a plan for a bore hole and a water reticulation system.
- 7. Siting:** The Department of Water Affairs then finds four sites for the bore hole. Sometimes this needs an aerial survey; the Department has to hire an airplane to fly over the land to look for suitable places for water.
- 8. Drilling:** On the proposed sites the Department of Water Affairs moves in with a drilling rig to drill a bore hole. If the holes do not produce enough water, or if the water is salty, the department plans again and tries to find new sites.
- 9. Chemical analysis:** If the bore hole produces water, the laboratory must test it to see whether it is good for human use. If it is too salty or if it is contaminated in some other way, a new site must be found.
- 10. Yield testing:** If the water is good for human use, the Department of Water Affairs must test the bore hole to see if there is enough water to make it worth while to install a pump and connect the bore hole to the village water supply. If the yield is too low, the Department must drill again at some other place.

## Flow - Chart Rural Village Water Supply





# 6.

# Water Protection

Contamination or pollution of water can happen in many ways. No sensible person would drink water which looks unclean. But many times water can be unclean - that is, polluted or contaminated - even though it looks clean. For example, if someone puts colourless poison into the water, the poison may not be visible, but anyone who drinks the poisoned water can become ill. Likewise, if a disease organism gets into the water, you can not see it unless you look at it through a microscope in the clinic. But nevertheless it can make people ill.

Water can become contaminated, and should be protected

- at the bore hole
- along the pipes
- at the reservoir
- at the stand pipes
- in the household

### **At the bore hole:**

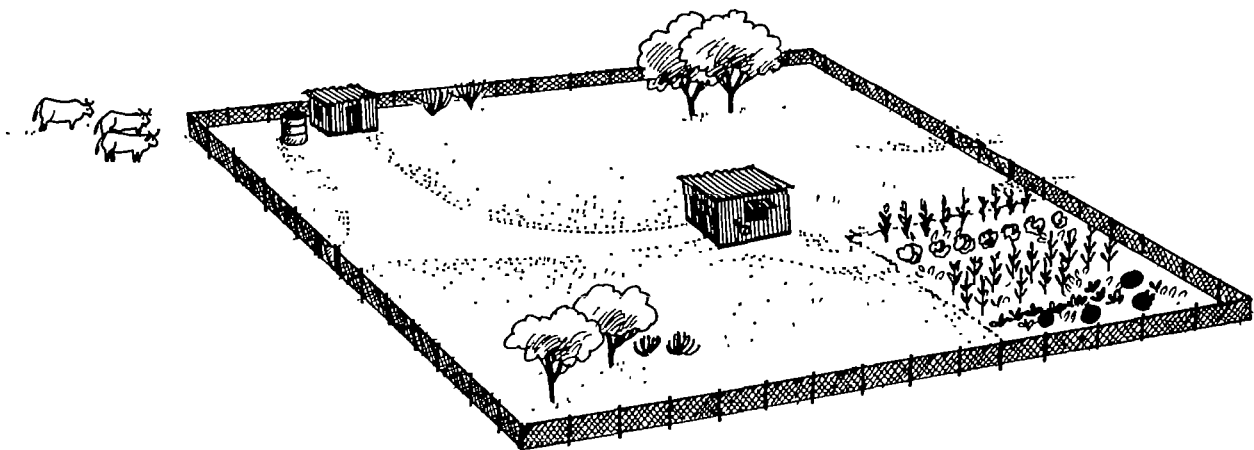
It is very important to keep the area around the bore hole free from contamination. The bore hole can be contaminated by the following:

- Cattle and other animals which are allowed to go near the bore hole. Animal faeces carry disease organisms which can remain in the soil for a long time, and which can seep down through the soil into the ground water. Animal faeces not only carry diseases, they can also affect the taste of the water. Please note: watering of private livestock from the village water supply system is not allowed!
- Spilling oil and fuel on the ground near the bore hole or anywhere inside the pump house. This can also seep down through the ground or drip directly into the bore hole and spoil the water.
- Rubbish left lying near the bore hole. Rubbish attracts insects and rats which carry diseases. If the rubbish is rotten, it may contaminate water that can seep into the soil.
- Latrines and septic tanks near the bore hole. Any material which seeps into the soil from the latrine or septic tank can get into the water supply and contaminate it.

- People defaecating or urinating on the ground near the bore hole can contaminate the soil and eventually the ground water.
- Industrial waste such as rubbish or chemicals may contaminate ground water.

**The WSO should do the following to protect the bore hole:**

- Make sure that there is a fence around the bore hole and that it is kept in good repair, to keep animals out. Do not forget to close and lock the gate! Do not allow animals to graze within the fenced area. The fenced area must be at least 50 by 50 metres. Tall grass and weeds should be cut, because insects such as mosquitoes hide there. (Do not cut down the trees, however, as they protect the environment.)
- Do not allow oil or fuel to spill around the bore hole. Be very careful when filling and draining the fuel tank, changing the fuel filter, or changing oil in the engine. Put a bucket under the engine to collect any fuel or oil which might spill. Keep the pump house clean and dry. If possible, keep fuel and oil in a store outside the pump house, within the fenced area. The store should have a concrete basin as a floor, so that if anything is spilled, it will not seep into the ground.
- Do not allow people to throw rubbish near the bore hole. If there is any rubbish there, remove it.
- Advise the Land Board not to allocate plots near the bore hole. The plots should be at least 100 meters away from the bore hole.
- Never allow people to defaecate or urinate near a bore hole. You and the health workers should teach people the importance of use of the latrine.
- Notify the head of the Water Department immediately if you suspect industrial pollution is leaking into the ground.



*Protected bore hole*

If the bore hole gets contaminated, it is almost impossible to make it clean again. A contaminated bore hole usually has to be closed forever. Then a new one must be made somewhere else. This causes inconvenience for everyone. There will be a long delay before there is a new water supply. It costs a lot of money to make a new bore hole. This money could have been spent for a new school, road or clinic. Sometimes it is not possible to find a new source of water. So you should be very careful to keep the bore hole free from contamination.

### **Along the pipes:**

Water can be contaminated in the pipes if there is a hole in the pipe. Leaking pipes not only cause water to be wasted, but they also allow dirt to get into the water supply system.

You should check the water supply system every day for leaks. If the water meter indicates that water is leaking somewhere, and if it is not leaking from the stand pipes, you should check the pipes for leaking pipes under ground. If the ground is wet, you should suspect a pipe is leaking near by.

After locating the leak, you should close the valves on each side of the leak and repair the leaking section as soon as possible. Make sure that no soil or filings have gone inside. In some cases the new section should also be disinfected before the valves are opened again. This is explained in detail in the section on "Leak Detection and Minor Repairs," page 90.

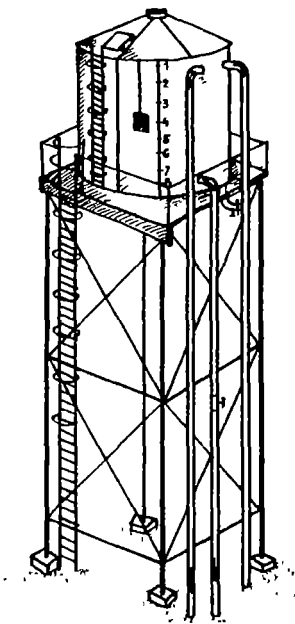
### **At the reservoir:**

Water can be contaminated at the reservoir by the faeces of birds or small animals. Dirt and dust can also contaminate the water.

Insects such as mosquitoes often spend the day in weeds and tall grass. They lay their eggs in the water and their larvae remain in the water until they become adult mosquitoes. Mosquitoes carry diseases such as malaria. There is more information about malaria in the chapter on HEALTH.

### **To prevent contamination at the reservoir:**

- Keep the reservoir covered. If dirt gets into the reservoir, you must clean it out. At least once a year the reservoir should be cleaned and flushed thoroughly.
- Remember to put on clean rubber boots and clean rubber gloves when washing the reservoir.
- The area around the reservoir should be fenced to keep animals out.
- Tall grass and weeds should be cut regularly. But poisonous insecticides should never be used near a reservoir or other water supply.



*The reservoir must have a cover and a closed lid*



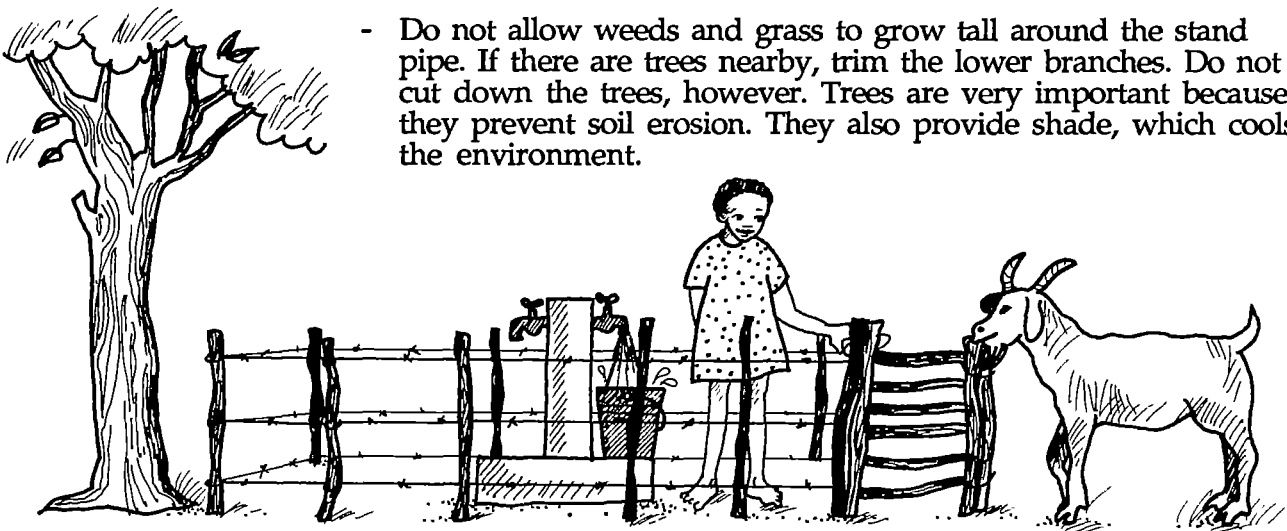
**At the stand pipes:**

There are many ways water can become contaminated at the stand pipes.

- Animals coming to drink at the stand pipe can lick the tap and contaminate it with disease organisms in their saliva. Animal faeces contain disease organisms which can get into the water supply and the soil near the stand pipe.
- Human beings can contaminate the tap if they put their mouths or hands directly on the mouth of the tap.
- Pools of water at the stand pipe can contain disease organisms such as hook worm. A person who walks without shoes on contaminated soil or in contaminated water can get hook worm. Pools of water also attract insects like mosquitoes and flies which carry disease organisms.
- Tall grass and weeds growing near the stand pipe attract insects such as mosquitoes. Mosquitoes do not contaminate the water directly but they carry diseases such as malaria. Snakes can also hide in tall grass.

**To prevent contamination at the stand pipes:**

- The area around the stand pipe should be fenced to keep animals out.
- People should be taught, in co-operation with the health workers and teachers, so that they do not put their mouths or hands on the mouth of the tap. Children should not be allowed to play at the stand pipes.
- Each stand pipe should have a proper soakaway. People should not be allowed to wash themselves, their pots or their clothes next to the stand pipe.
- Do not allow weeds and grass to grow tall around the stand pipe. If there are trees nearby, trim the lower branches. Do not cut down the trees, however. Trees are very important because they prevent soil erosion. They also provide shade, which cools the environment.



*Protected stand pipe*

**In the household:**

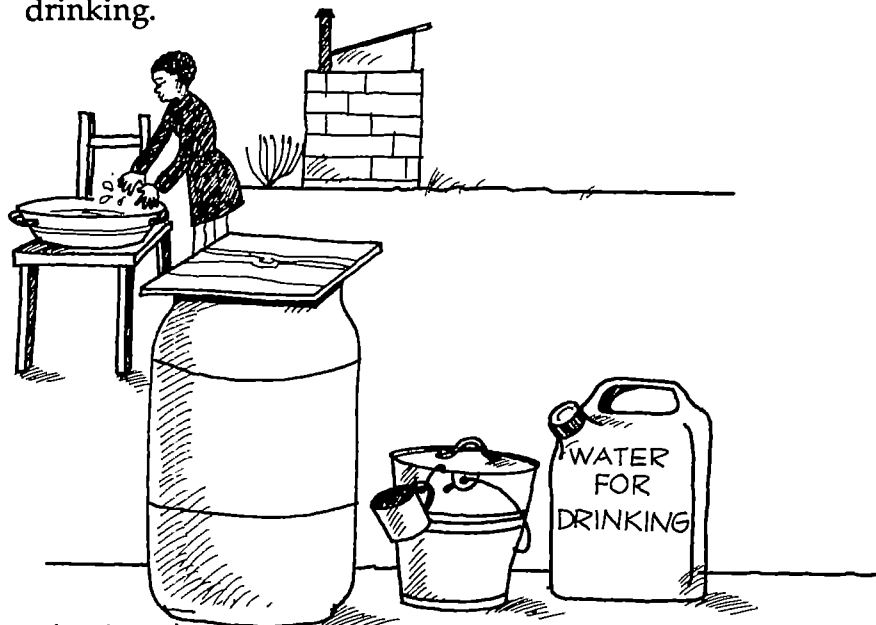
There is no use having clean water at the stand pipes if people allow it to become contaminated when it is carried to the home or inside their homes.

If water is stored in a contaminated container, the water will become contaminated.

Insects and small animals such as lizards and frogs can get into the storage container and contaminate it. Children putting their hands into the water can contaminate it with disease organisms, dirt and dust on their hands. Dust from the air can get into an uncovered container. People drinking from the cup used for dipping water contaminate the water. For example, if you have the flu and you drink from the cup used for dipping water, the organisms that cause the flu are on your mouth. They will get into the water and someone else who drinks that water can get flu.

**To prevent contamination in the household:**

- Water should be carried and stored in clean containers, and a lid should be kept on the container to keep dust and insects out.
- People should be advised always to wash their hands after using the latrine and before handling food or before handling the household water.
- It is better to have separate storage containers for the water which is used for drinking, and the water which is used for washing.
- People should never drink from the mug which is used for dipping water out of the storage container. Use a separate mug for drinking.



*Everybody in the household can help to protect water from contamination*



# 7. Health

This chapter is included so that you, as WSO, will become familiar with some of the diseases that can come from contaminated water, or that are caused by improper use of water. Misuse of water can mean using it wrongly, letting it get contaminated, or not using it when one should use it. For example, if you do not wash your hands after going to the latrine, you are not using water properly.

This chapter mentions only some of the main water-related diseases. There are many more which have not been included. You should always tell the health authorities if you suspect the water is contaminated.

Everyone knows that people must have water in order to live. A person can live for several weeks without food, but no one can live for more than a few days without water. Water, mixed with other substances, makes up more than half of the human body. An adult needs to drink two to three litres of water every day to replace the water that goes out from the body in sweat and urine. Water is one of the most important requirements for all life. Obviously, water is needed for health.

Water is also important for cleanliness. If your clothes, your house, or your body are dirty, you are likely to get sick. It is important to wash yourself daily, and to wash your hands after using the latrine and before you touch food.

But contaminated water can cause diseases. Some diseases are caused by organisms which are too small to see without a microscope. These organisms can live in water which looks clean, although it is not. Other diseases are caused by contamination from chemicals. Fuel and oil, cattle dip, insecticides, wastes from industry such as leather tanning are all chemicals which can contaminate the water.

Insects which live in the water sometimes carry disease organisms. For example, mosquitoes need water for part of their life cycle. Mosquitoes carry diseases such as malaria and yellow fever.



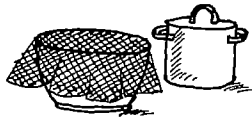
*A person is like a plant...  
No one can live without  
water.  
Water is life.*

## Some general Health Advice

It will help you to remain healthy if you do the following:



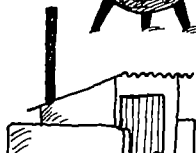
- Always wash your hands with soap and water:
  - before handling food
  - before eating
  - before feeding the baby
  - before handling water which is to be used for drinking
  - after using the latrine
  - after changing the baby's nappies



- Always keep food or water covered to prevent contamination by flies and other insects, dust etc.

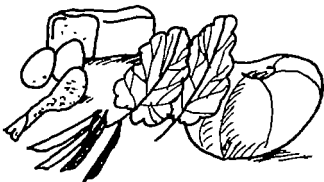


- Never drink contaminated water. If you think it may have been contaminated, boil it for at least ten minutes before you drink it. Water which comes from the river, the dam, or an open well may be contaminated even if it looks clean.



- Use the latrine instead of the bushes. Every household should have a latrine.

- If you have no latrine, cover all faeces with sand or soil. This will prevent flies from touching the faeces. Flies and other insects sometimes walk on faeces and then walk on human food. This contaminates the food. You should cover the faeces of babies and children as well as those of adults.

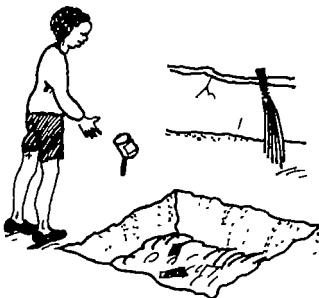


- Eat good food. Food should be clean (not contaminated), fresh and nutritious. The Family Welfare Educator, clinic or health post can supply you with a list of which foods are most nutritious.



- Babies should be breast-fed. Human breast milk is the best food for a young baby. If the mother can not breast-feed and must feed the baby with a bottle, the bottle and the teat should be free from contamination. The bottle and teat should be washed, and then boiled for at least 10 minutes or treated with a sterilizing agent such as Milton. If you give water to the baby, the water should have been boiled and kept in an uncontaminated container.

- If possible, wear shoes, especially where the soil is damp.



- Keep your environment clean. Do not throw rubbish on the ground. Burn it or bury it. Rubbish attracts insects such as cockroaches, flies and mosquitoes. It also attracts rats. These creatures all carry disease organisms. Keep weeds and bushes under control, because insects and rats can hide there. Snakes also like to hide in weeds, and they may be attracted by the rats and mice.

## Some Water-related Diseases

### Diarrhoea

If a person passes liquid faeces more than three times in a single day, that person has diarrhoea.

There are many causes of diarrhoea. It may be caused by a disease organism or a chemical in the water or food. It may be a symptom of another disease such as malaria. But it is a serious problem, especially in young children. Diarrhoea is one of the most common causes of death in children under the age of five in Botswana. Diarrhoea may also cause death of children who are already weak because of malnutrition.

It is important not to allow the water to be contaminated with disease organisms or chemicals. Prevention of disease is better than cure. However, if disease organisms such as bacteria have got into the water, you can purify the water by boiling it. This will prevent most of the diseases, but not all of them.

If a person develops diarrhoea, that person becomes tired, thirsty, and sometimes dizzy. Diarrhoea causes the body to lose water. Loss of water is called dehydration. If the person is vomiting as well as having diarrhoea, dehydration comes very quickly. This can be very serious, especially in young children and old people.

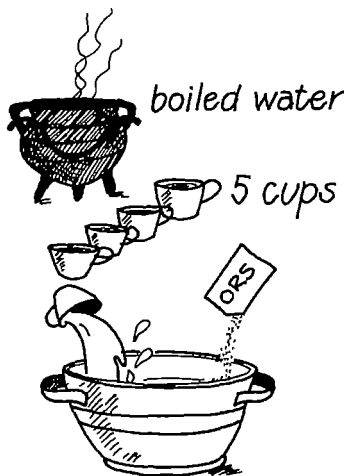
A person with diarrhoea should be given tea, soup, water which has been boiled, and other liquids. It is best to give the person liquids before the dehydration develops.

There is a drink which can be made to help treat dehydration. It is called Oral Rehydration Solution (ORS). You can get small packets of ORS from the clinic or health post.

The ORS drink is easy to prepare. Boil some water. Mix one packet of ORS with one litre (five cups) of boiled water. Let it cool, then give it to the sick person to drink.

If there are no ORS packets available, you can make a drink using salt, sugar and boiled water. Use eight level tea spoons (35 ml.) of sugar and one level tea spoon (5 ml.) of salt. Mix the salt and sugar with one litre (five cups) of boiled water. The drink should taste no more salty than tears.

#### MIX:



#### OR MIX:

5 cups of boiled water



Each time the sick person passes watery faeces, he or she should have at least one cup of the ORS drink. If the person is vomiting as well as passing liquid faeces, the drink should be given with a spoon until the vomiting stops. If the vomiting or diarrhoea does not stop, take the person to a doctor immediately.

## Bilharzia

Bilharzia, or schistosomiasis, is caused by a worm which lives part of the time in water. The worm is very small - too small to see without a microscope. It damages the liver, kidneys and other internal organs of the body. It can cause a person to die if it is not treated. It is a common disease among children of primary school age, because these children like to play in water.

There are two types of this disease. One type affects the intestines. If a person has this type of bilharzia, he or she may have pain in the stomach, diarrhoea, and sometimes blood in the faeces.

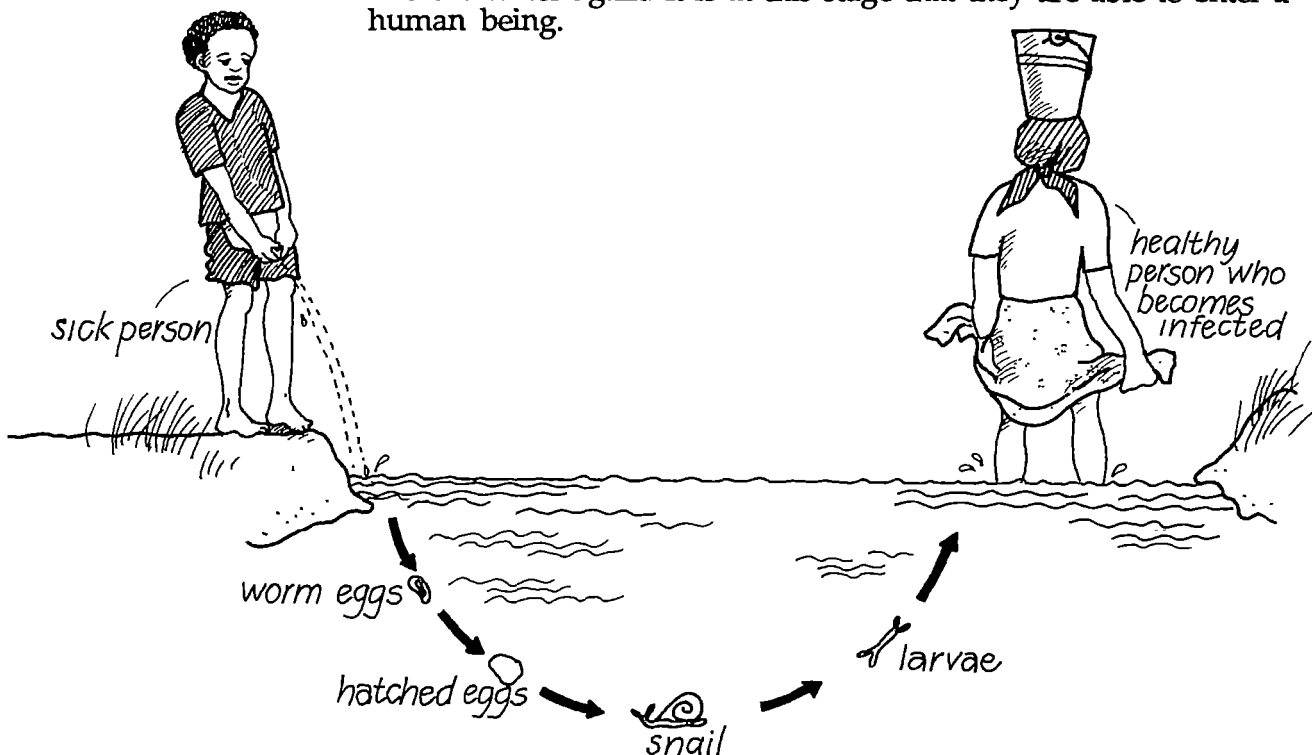
The other type of bilharzia affects the bladder. A person with this type of bilharzia may feel like urinating very often. Sometimes the person feels the urine is burning. There may be some blood in the urine. The urine will turn red because of the blood.

The worm which causes bilharzia needs water, a certain type of snail, and a human being in order to live. The worm gets into the human body through the skin, when the person comes into contact with infected water.

When a person has the bilharzia worms in his body, they pass out with the urine or faeces. If this happens near water, the worms get into the water. This happens during the egg stage of the worm's life cycle.

When the eggs are in the water, they hatch. They swim around until they find a certain type of snail. If they do not find that type of snail within 48 hours, they die. But if they find the snail, they enter the snail's body. They live there for a while and then come into the water again. It is at this stage that they are able to enter a human being.

How bilharzia is spread:



If people use a latrine instead of using the bush, this would help control the spread of bilharzia. This will help to keep the disease organism from getting into the water.

However, if the water is already contaminated, people need to use it carefully if they want to avoid becoming sick.

Do not swim, bathe, wash clothes or pots in a lake, dam, slow-moving river or pool of water where there might be snails. Take the water from the stand pipe. If you have to use water from a lake or river, store it for at least 48 hours (two days and two nights) before using it for washing. If you want to drink that water, you should also boil it before drinking it.

If you think you might have bilharzia, see a doctor as soon as possible. This is important for your own health and for the health of others.

### **Hepatitis**

Hepatitis is a serious disease which can cause permanent damage to the liver. A person with hepatitis usually has a headache, vomiting, and sometimes diarrhoea. The faeces are light in colour, but the urine is dark, the colour of tea. The person feels very tired. After some time, the white part of the person's eyes turns yellow.

There are several types of hepatitis. Some of them are spread by the use of contaminated injection needles or razor blades. Other types of hepatitis are caused by a disease organism that is found in contaminated water and food. Flies can carry the disease to food or directly to the person's body, for example by walking on a person's mouth.

To keep from getting hepatitis, you should do all the things mentioned under the section on general health advice. If you are getting an injection, you should be sure that the needle being used is a new, disposable one and is used only once. If you are using a razor blade, you should use a new, clean one.

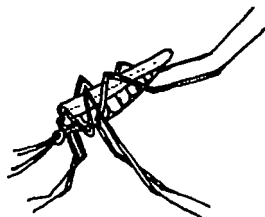
It is important to see the doctor if you think you may have hepatitis. You should stay in bed, should not drink alcohol, and should eat food which contains very little fat or oil.

### **Malaria**

Malaria usually starts with a fever, head ache and muscle pains. Sometimes the sick person has diarrhoea. It is a serious disease which can cause death.

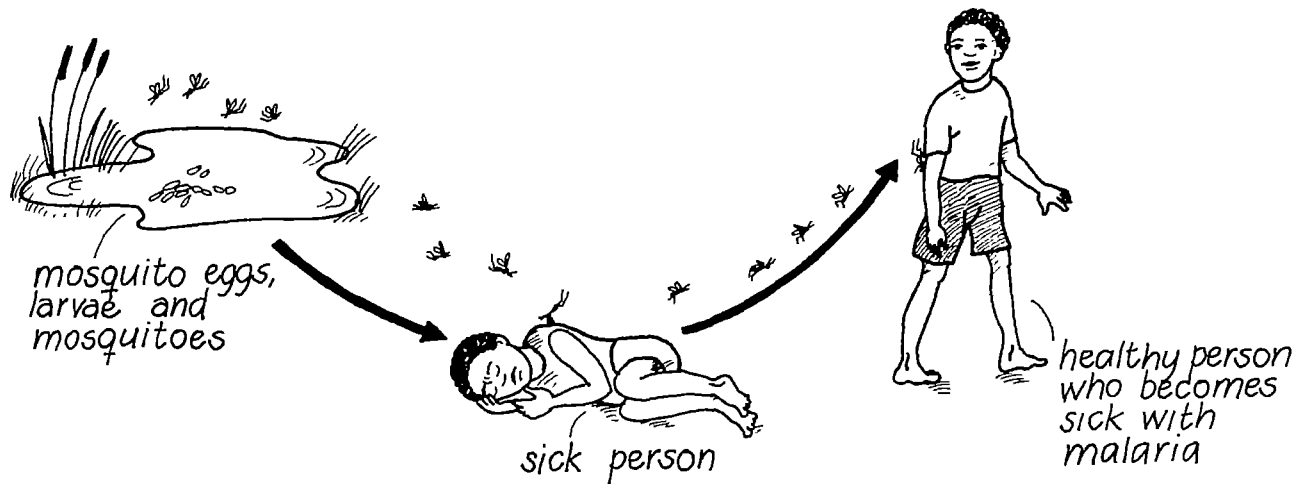
Malaria is carried by mosquitoes. If a person who has malaria in his or her blood is bitten by a mosquito, that mosquito can bite another person and pass the disease to the second person.

Mosquitoes lay their eggs in water. The young mosquitoes (larvae) live in the water until they are ready to change into adult mosquitoes. This can happen in pools of water near stand pipes, or uncovered containers of water anywhere.



*Malaria mosquito  
(enlarged picture)*





### How malaria is spread

To prevent malaria, you should try to limit the pools of water where the mosquitoes breed. You should also cut weeds where mosquitoes hide during the day. If there are a lot of mosquitoes, you should wear clothes which cover your body as much as possible.

If you think you may have malaria you should go to the clinic immediately. If you live in an area where there is very little malaria, such as the southern parts of Botswana, you should take some tablets for prevention of malaria if you are going to a region where there is a lot of malaria. The clinic or doctor can advise you which tablets are best.

### **Impetigo**

Impetigo is a skin disease common in children. It starts with a spot which becomes a blister, usually on the face, hands or knees. When the blister breaks, a yellowish crust forms. This spreads the disease to other parts of the body.

Impetigo can be passed easily from one person to another. Impetigo commonly starts when a person rubs his or her face with hands that are contaminated. Washing the hands and body with clean water and soap will help prevent the spread of this disease. Sheets, towels, blankets and clothes should also be washed regularly.

The disease can be treated with ointment or gentian violet. The doctor or clinic can give an injection if the person has a very bad case of impetigo.

### **Trachoma**

Trachoma is a disease of the eyes. The first signs of this disease are soreness of the eyes with tears. Later the eyes may produce a discharge like pus. Trachoma can cause blindness if it is not treated in time.

Trachoma is a common disease among children. It can be passed easily from one person to another. It can be passed by flies, which carry the disease organism from the eyes of a sick person to the eyes of a healthy person. It can be carried by contaminated towels and unwashed hands.

You should not rub your eyes with your hands. It is especially dangerous to rub them if you have not washed your hands. You should use a clean towel to dry your face. Do not share a towel with someone who has trachoma. If people use a latrine and if they cover rubbish or faeces, there will be few flies. This will help prevent the spread of trachoma. You should never let flies sit on your face, especially your eyes or mouth. If you suspect you have trachoma, you should see the doctor immediately.

### **Ringworm**

Ringworm is a skin disease which is passed very easily from one person to another. It is common in children. The disease organism that causes ringworm can live in the soil, on the floor, on the human body and on animals.

There are different types of ringworm. One is the type which grows on the scalp. It makes patches of scaly skin on the scalp, and causes the hair to fall out. Sometimes the scaly patches also become infected with impetigo.

Another type of ringworm affects the body. It usually starts as a pimple, which spreads at the edges. It spreads into a ring-like patch with a clear area in the middle. The patch itches and the skin becomes scaly.

Ringworm can also be found in the groin and buttocks. It starts with inflamed pimples inside the person's thighs. It is a common disease in men. This type of ringworm causes itching.

You can get ringworm from the soil, so it is important to keep your body and clothes clean. You can also get it by touching someone who has the disease, or from sitting in a chair or toilet seat that a diseased person has used. You can also get it by using a contaminated towel. Children who share the same bath water can get ringworm from each other or from the soil that is washed from their feet.

It is important to keep yourself clean. You should use only clean water for washing. For example, if you are bathing a child, put the child into the empty wash tub and use a dipper - not your hands, or a cloth - to pour clean water from the bucket onto the child's body. The water which has been used to wash the child should be thrown out. It should not be used for washing again.

If you dry yourself with a towel, be sure that the towel has not been used by someone who has ringworm. When you dry yourself, start with the upper part of your body and dry downwards. Dry your feet last. Do not touch animals such as cattle or other animals which have the disease.

The clinic can give you some ointment and tablets which will cure ringworm.

### Scabies

This is a skin disease which starts with very itchy pimples. If you scratch the pimples, they will turn into sores. Then some ridges about three to ten millimeters long develop on the skin.

The disease is carried by a mite (a very small spider-like creature) which lives only on human skin. If you share a bed or share clothing with someone who has this disease, you are likely to get it.

If you have the disease, you and all members of your household must go for treatment at the clinic. It is a disease which is passed easily from one person to another and everyone in the household must be treated at the same time. All the clothes, sheets, towels and blankets must be washed and disinfected, in order to kill all the mites. You can disinfect the clothes by boiling them.

### Hookworm

The hookworm is a very small worm, too small to see without a microscope. It lives in the human body and in the soil.

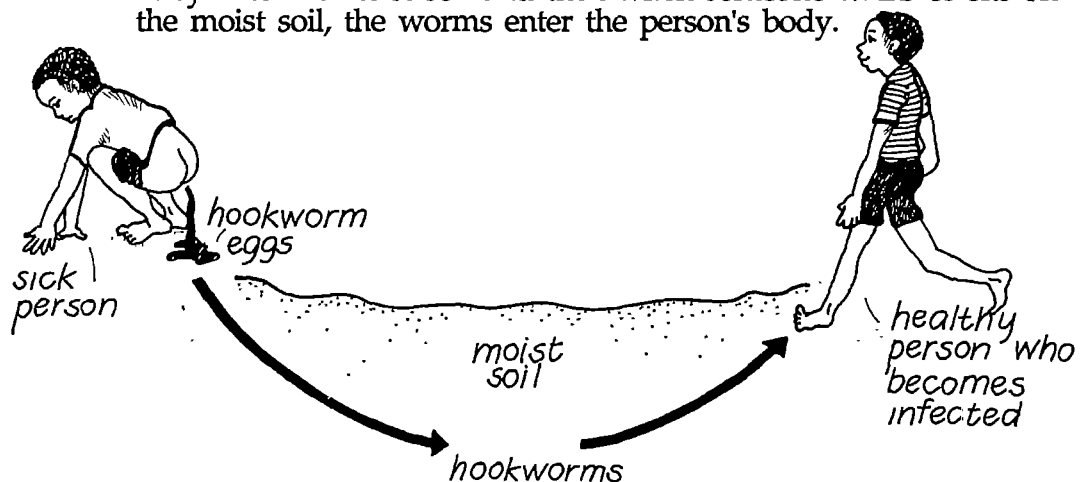
Hookworm causes the anus to itch. A child who often scratches his or her anus should be tested for hookworm. If there are many hookworms in the body, the person may feel weak and tired. Sometimes a person who has hookworm wants to eat soil.

You can get hookworms by walking without shoes on contaminated soil. The hookworms enter through the skin of the feet. This can cause itching of the feet.

After a few days the hookworms inside the body go into the lungs. This may make the person cough, and sometimes some blood comes up with the cough. The person coughs up the worms and swallows them.

A few days later the person may have diarrhoea or a stomach ache, because the hookworms are in the stomach and intestines. The worms suck the person's blood and cause the person to become weak. While they live in the person's intestines, the hookworms lay eggs. The eggs leave the body in the person's faeces. They hatch in moist soil and then when someone walks or sits on the moist soil, the worms enter the person's body.

How hookworm is spread :



To avoid getting hook worm, do not walk on damp ground unless you are wearing shoes. Wash your hands after using the latrine and before eating food or handling water used for drinking. You as WSO have a responsibility to prevent the spread of hookworm by keeping the area around the stand pipe dry. You should also make sure that no children leave faeces near the stand pipes. You should discourage children from playing near the stand pipe. You should go to the clinic for a test if you think you or your children have hookworm.

**Tapeworm**

Tapeworm is a type of worm which lives in the stomach and intestines. It can live in a human being or an animal. When it gets into cattle, it gives them "measles."

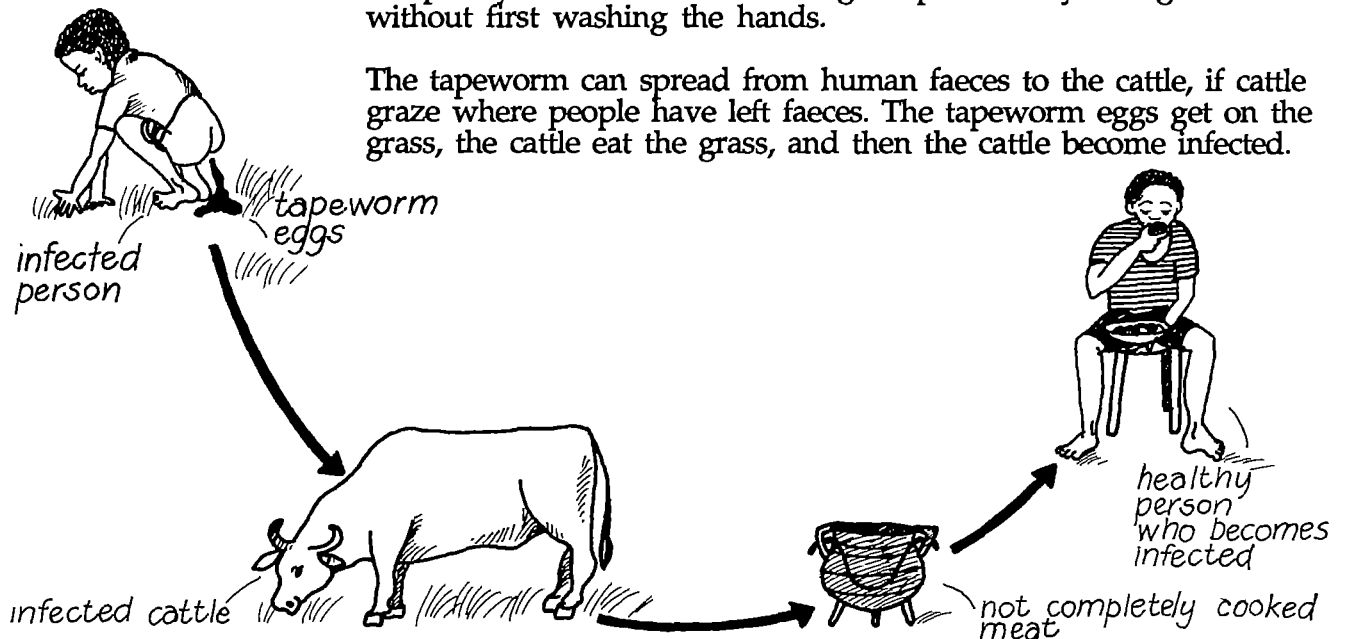
Tapeworm in the stomach or intestines may cause a mild stomach ache. Sometimes the tapeworm gets out of the intestines into other parts of the body. There it can cause cysts (lumps with worms inside). If the cysts form in the brain, they may cause headaches, fits, and sometimes death.

Sometimes a person who has tapeworm in his intestines will notice some short, white pieces of the worm in his faeces. Sometimes the pieces crawl out of the person's body and may be found in the person's underwear or in the bed.

How tapeworm is spread:

A person gets tape worm through eating meat which has not been completely cooked. One can also get tapeworm by eating food without first washing the hands.

The tapeworm can spread from human faeces to the cattle, if cattle graze where people have left faeces. The tapeworm eggs get on the grass, the cattle eat the grass, and then the cattle become infected.



To avoid getting tapeworm, be sure that all meat is well cooked, and always wash your hands before eating or handling food. It is important to use a latrine instead of using the bushes, because the faeces can give tapeworm to the cattle.

If you suspect you have tapeworm, you can get treatment for it at the clinic.



# 8.

# Sanitation

Sanitation means keeping yourself and your environment clean and free from contamination. Sanitation is very important for preventing the spread of disease.

## **The Use of a Latrine**

One of the most important ways to improve sanitation is to use a latrine instead of using the bush.

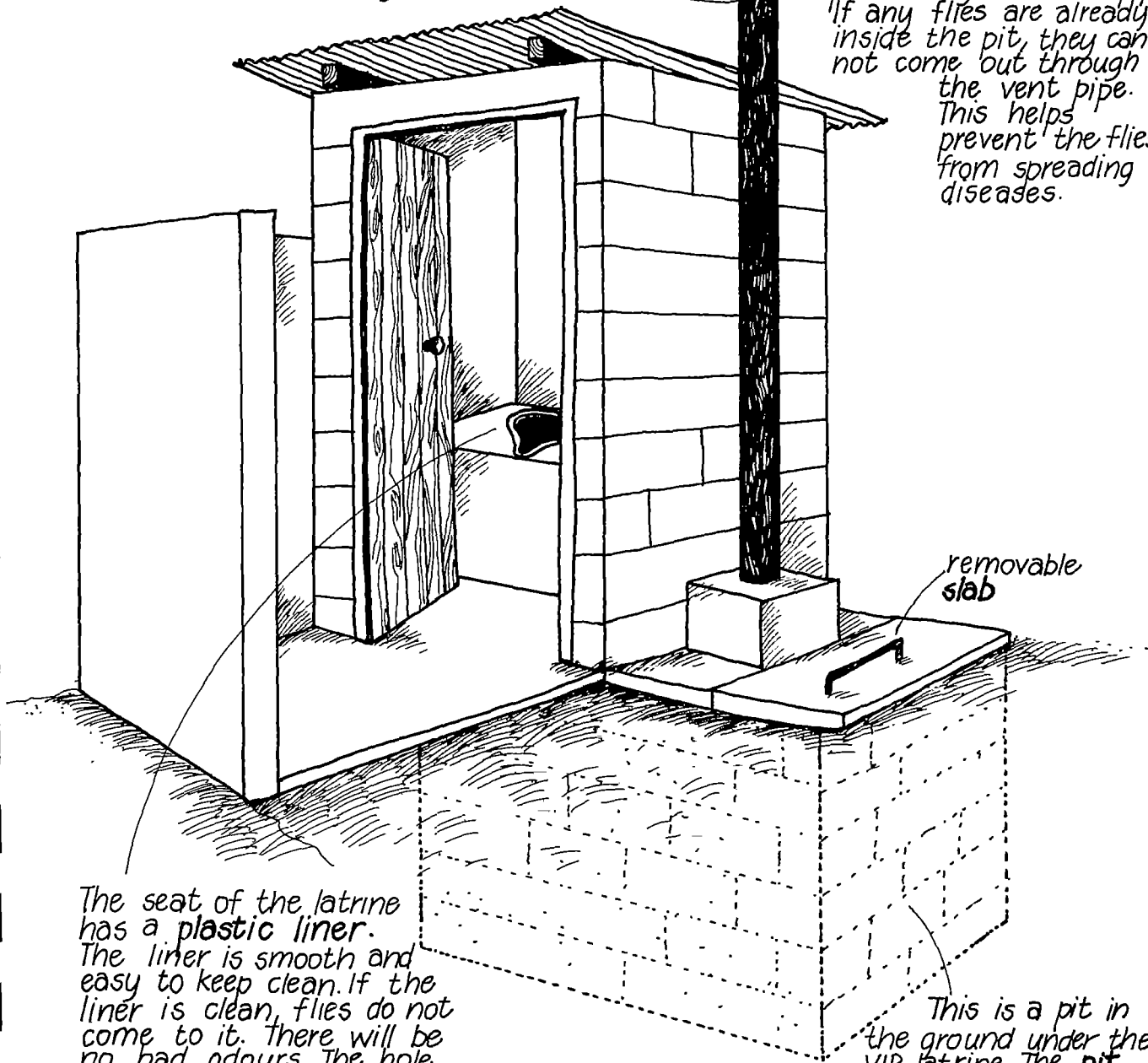
Water can be easily contaminated by faeces and urine. Some of the disease organisms which can get into the water and cause illness are listed in the chapter on health. It is important to use latrines so that faeces and urine are not exposed to flies, and so that the faeces and urine do not get into the water. Every household in the village should have a proper latrine.

The best latrine is the Ventilated Improved Pit Latrine, called the VIP latrine. This latrine differs from an ordinary latrine in several ways:

- The VIP latrine has a vent pipe
- The vent pipe of the VIP latrine has a fly screen covering the top
- The pit of the VIP latrine is lined
- The seat of the VIP latrine has plastic liner

The VIP latrine has a vent pipe. The vent pipe is at least 300 millimeters taller than the roof of the latrine. The vent pipe helps remove odours from the latrine. This makes the latrine more pleasant to use. It also keeps flies from coming to the latrine.

The vent pipe has a fly screen covering the top. This prevents flies from going into the pit through the vent pipe. If any flies are already inside the pit, they can not come out through the vent pipe. This helps prevent the flies from spreading diseases.



removable slab

The seat of the latrine has a plastic liner. The liner is smooth and easy to keep clean. If the liner is clean, flies do not come to it. There will be no bad odours. The hole in the liner is so small that no child can fall through it into the latrine. This makes it easy for small children to use the latrine.

This is a pit in the ground under the VIP latrine. The pit is lined with concrete blocks or other hard material. This prevents the pit from collapsing

during heavy rains. It also means that when the pit is full, it can be emptied. A slab is placed over part of the pit. When the slab is lifted, the pit can be emptied easily. Then it can be used again for many years.

**Where to get help to build a VIP latrine**

The national Rural Sanitation Programme is a government programme which helps people build VIP latrines in their villages. This programme operates in all districts. If a person in the village would like help in building a VIP latrine, that person should ask the Village Sanitation Co-ordinator and the District Sanitation Co-ordinator.

The project works in the following way:

- 1.** The person who wants the latrine should pay a registration fee.
- 2.** Then the person should dig the pit. The Sanitation Co-ordinator will help with advice on where to put the latrine and on the size of the pit. The latrine must be at least 10 metres away from any house. It should be at least 50 metres from the water supply or water drainage. The latrine should be built down hill from any water source. All of these points are important to avoid contamination of the ground water.
- 3.** When the pit is ready, the council will build the lining and put cover slabs on the pit.
- 4.** The owner of the latrine then builds the walls, roof and door of the latrine.
- 5.** When the building is complete, the council will fit the seat and the vent pipe.

*Remember!*

- !** Even if the VIP latrine project is not operating in your village, you can advise people about the VIP latrine and how to build it. You can get a plan for the latrine from the Council Public Health Department.

Write down your questions and your comments:



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## Rubbish

Many people do not understand that rubbish is a serious problem. Rubbish thrown around the lolwapa and the village can attract flies, rats, cockroaches, mosquitoes and other creatures which carry disease organisms. Broken bottles and tins are dangerous because people can step on them and cut their feet. For health and safety, it is important to encourage people to clean up rubbish properly.

Every household should have a rubbish pit. The pit should not be near the house. You can put it at least ten meters from the house, or at the corner of the yard. It should be at least one meter wide and one meter deep. It should be covered, to keep people from falling into it and to keep animals from going into the pit.

All rubbish such as tin cans, bottles, paper and plastic should be put into the pit. Every now and then you can burn the rubbish in the pit. This will help prevent disease organisms and flies from living there. Some of the bad odours will be controlled by burning. And if the rubbish is burned, it will take a long time to fill the pit completely.

If you have rubbish such as watermelon rinds and sweet reed fibers, you can make compost which can be used for fertilizing trees or a garden. Put that kind of rubbish into another pit. You can add some kraal manure and some of the weeds that you have cut. Mix them together and cover them with some soil. Turn the mixture every now and then - once a week is enough. After a few weeks it will turn into a rich compost good for the garden. You can add it to the soil where you have planted seeds, or put it at the base of a tree.

Where the District Council has put rubbish containers around the village, rubbish can be thrown into these.



Dig a rubbish pit  
in the corner of  
the yard. Cover it.

# 9.

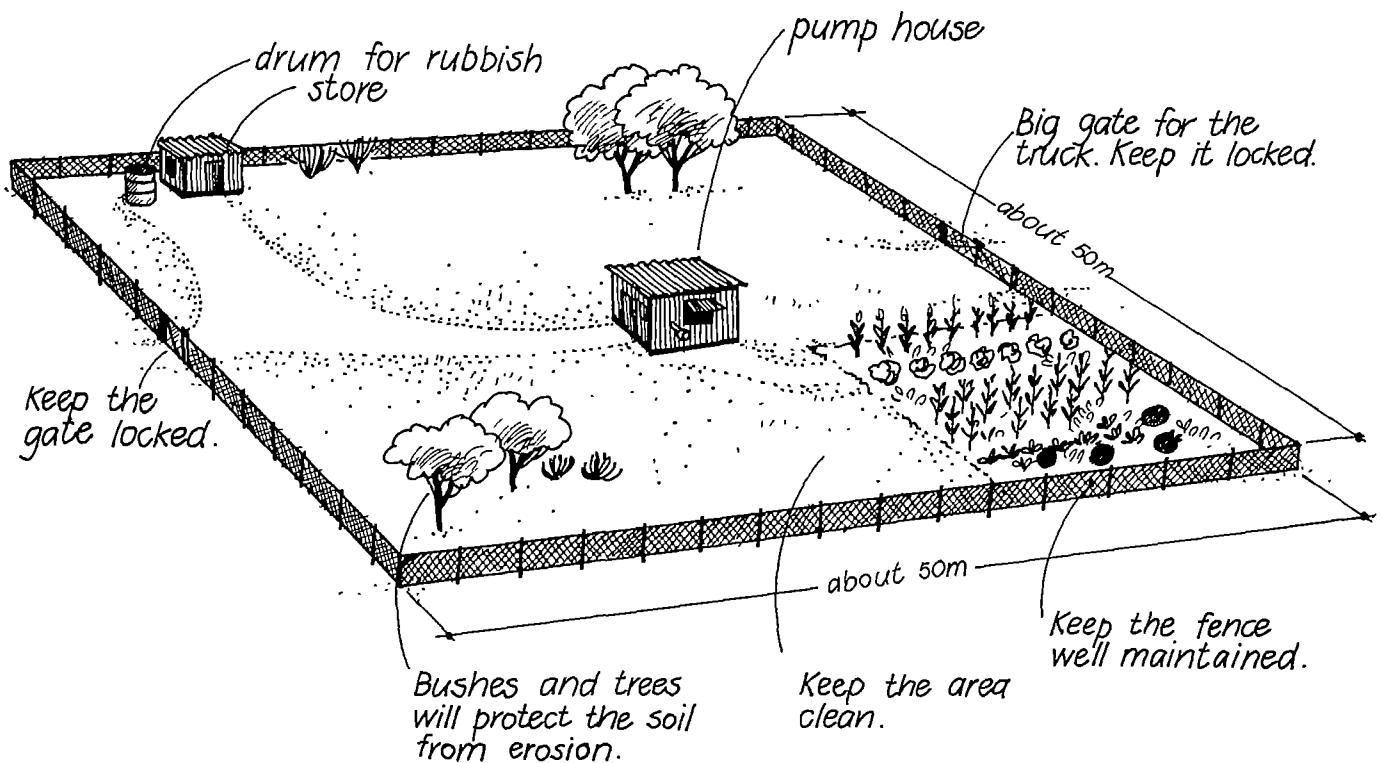
# The Pump House

## The Area around the Pump House

There should be a protected area of at least 50 by 50 meters around the pump house which has no contamination at all. This area should be fenced. It is your responsibility to make sure that the fence is there and that it is in good condition. You should make sure the gates are closed and locked and that no animals are inside. If you would like to plant some vegetables or fruit trees inside the protected area, you may do so.

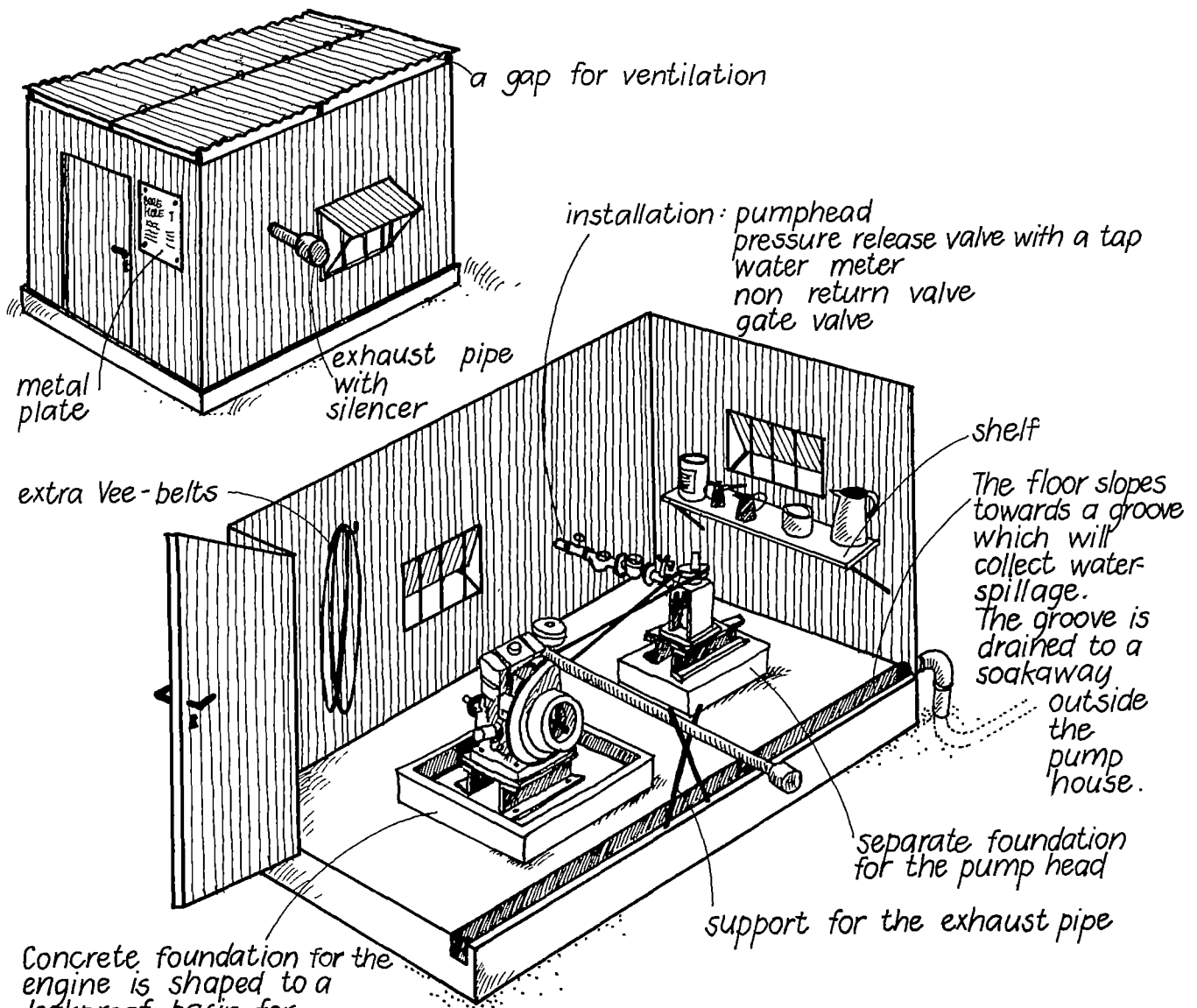
No waste fuel, oils, spare parts or rubbish should be left inside the protected area. All rubbish should be thrown into a drum or bin and carried away, or burned. Never pour oil or fuel on the ground!

Weeds and tall grass should be kept short but do not cut down trees or bushes. The trees and bushes will help protect the soil from erosion.



## The Pump House

Most of the pump houses used today are old. They will be replaced in the future, with pump houses which are up to today's standards. In this handbook the new pump houses are described. If you are working with an old pump house, you should try as much as possible to keep to the better standards.



Concrete foundation for the engine is shaped to a leakproof basin for collecting oil and fuel.

Fuel drum is at the store house.

The pump house foundation should be made separately from the foundations for the pump and engine. The pump head and the engine should have separate foundations, and the engine foundation should have a short wall around it, like a basin. The basin should hold at least 25 litres and should be leak-proof. This is to make sure that no fuel or oil which spills can go into the bore hole. If any oil or fuel spills, you should clean it up immediately.

If there is no separate store house, there must be a another leak-proof chamber with a volume of at least 320 litres in case the fuel drum spills.

Any water which leaks or spills inside the pump house must be drained into a soakaway. The soakaway should be at least two meters away from the pump house.

There should be a space between the inside of the pump house wall and the engine. This space should be at least 1.3 metres on the operating side and at least 0.6 metres on the back side of the engine.

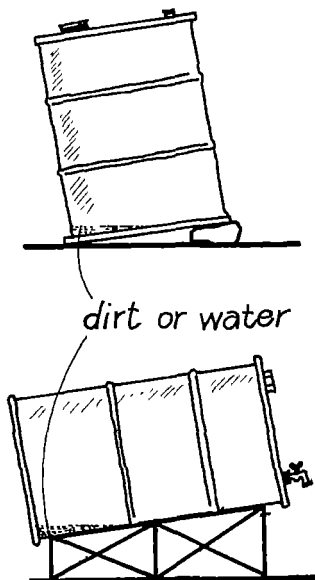
The inner height of the pump house should be at least 2.1 metres. The door should be in the middle on one of the end walls. It should be kept locked.

There should be three windows, with burglar proof bars, to allow air into the pump house. One opening should be in each side wall and one in the end opposite the door. The openings should be covered and lockable, but easy to keep open during the running of the engine.

There should be a metal plate near the door, fastened to the outside of the pump house. The bore hole number, the name of the village, the depth of the bore hole, the number of pipes and the pump type should be written on the metal plate.

The engine's exhaust pipe should be as straight as possible and must extend outside the pump house. There should be one or two shelves inside the pump house for storing funnels, oil cans etc.

The roof of the pump house should be fixed to the walls, but it should be possible to remove it for maintenance and removal of the pump and the engine. The roof should have a space of at least 50 millimeters between the bottom of the roof and the top of the walls. This, along with the windows, will help to let air in and out of the building. This is to keep the engine cool and to get fresh air into the engine.

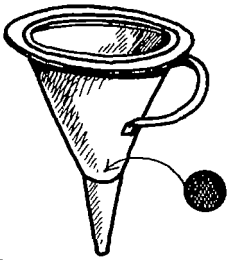


## **The Store and Tools**

The store is the place where fuel, oil, tools, and spare parts should be kept. In the new system, the store and the pump house will be in separate buildings. This will help to keep fuel and oil from getting into the bore hole. The store must not be close to the bore hole. It should have a leak-proof basin which holds at least 450 litres, to catch leaks.

The fuel drum should be kept in the store. It should be stored at an angle. Any dirt or water in the drum will sink to the bottom of the drum and will not be so likely to get mixed with the fuel which is to be used, if the drum is stored in this position.

It is not good for the engine if any dirt or water gets inside. So the fuel which is at the bottom of the drum should not be used. At least two centimeters at the bottom of the drum should be thrown into the waste drum and should be burnt.



The strainer of the funnel can easily get dirty. Keep the store room clean!

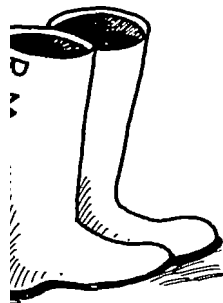
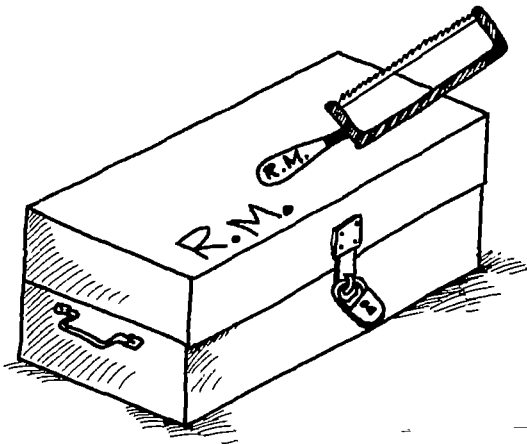
Always use clean containers for fuel. Fill the engine's fuel tank through a funnel which has a strainer to keep the dirt from going through. Funnels should always be kept clean. You should wash the funnel with fuel before you use it and keep it wrapped in a clean cloth when not in use.

Dirt and water from the bottom of the fuel container should be thrown into the waste drum. Collect all waste diesel, oil, used spare parts and cloths in a waste drum. Never, never throw it on the ground! The waste in the drum can be burnt. Or you can let the Water Department take it.

### Tools and equipment

To be able to do your work properly, you need some basic tools and spares. You should also wear protective clothing. You will find a list of tools at the back of this handbook. You should keep the smaller tools in a locked box. You will be responsible if the tools get lost or stolen.

You can paint or mark your tools and equipment so that you will know they belong to you. When you are not using your tools and equipment, keep them in the store or in the pump house and lock the door.



Mark your tools and your equipment.

Write down your questions and your comments :



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# 10.

# The Engine

In order for a pump to do its work, it must have something to make it move. Usually this is some kind of engine. There are pumps which are powered by diesel engines; electric engines; windmills; animals; and human beings. Electric engines can be supplied with electricity from the main power lines, by a generator or by solar panels. But the most common engine used these days in Botswana is the diesel engine.

## **The Diesel Engine and How It Works**

When a diesel engine is running, it gets hot. If it gets too hot, the parts will be damaged. So the engine has a cooling system which operates while the engine is running. Some engines are cooled by a flow of air; others are cooled by water.

The air cooled diesel engine is the most common engine for driving water pumps in Botswana.

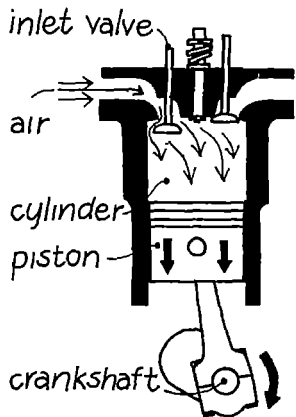
If the engine is properly maintained, it will be able to run for many thousands of hours before it needs a major overhaul. If you take good care of the engine, it will last a long time.

It is especially important to keep the engine and everything around it clean all the time. Make sure that the filters for air, fuel and oil are clean. The filters are there to protect the internal parts of the engine from dirt. If dirt gets inside the engine, it acts like sand paper. It rubs against the moving parts of the engine and makes them wear out quickly.

### **How the engine works**

The diesel engine is an internal combustion engine. This means that it works by means of fire (combustion) inside. Fire requires three things: air, heat and fuel. The fuel of the diesel internal combustion engine is diesel.

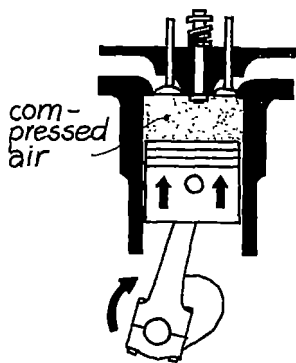
The engine produces power with four different up and down strokes of the piston. On each stroke, different things happen to the valves and injector. That is why we say the engine works according to a four stroke cycle. When the four strokes have been completed the engine repeats them, again and again, as long as the engine is running.



The four strokes are as follows:

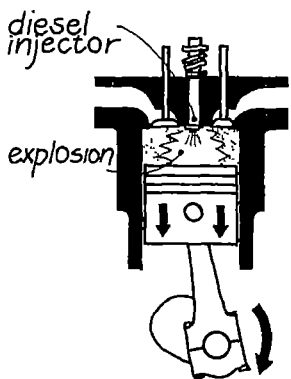
**1.**  
Inlet stroke

Starting at the top of the cylinder the piston moves down. The inlet valve opens and air is drawn into the cylinder by the downward movement of the piston. The engine now has the first of the three things needed for fire: air.



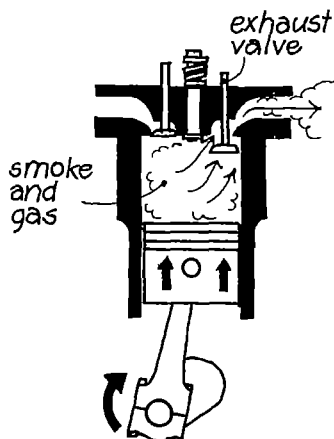
**2.**  
Compression stroke

On the second, or compression stroke, the piston moves up towards the top of the cylinder. Both valves are now closed so that the air can not escape. Because the air can not escape, it is compressed by the rising piston into a very small space. When the air is compressed it becomes very hot. The engine now has two things of the three: air and heat.



**3.**  
Power stroke

Just as the piston finishes the compression stroke, diesel is injected into the cylinder by the injector. The engine now has all three requirements for burning: air, heat and fuel. Because the air in the cylinder is hot, the injected diesel burns right away. When the diesel in the cylinder burns, it causes an explosion that forces the piston down and thus the power stroke is attained. The power from the power stroke makes the crank shaft move.

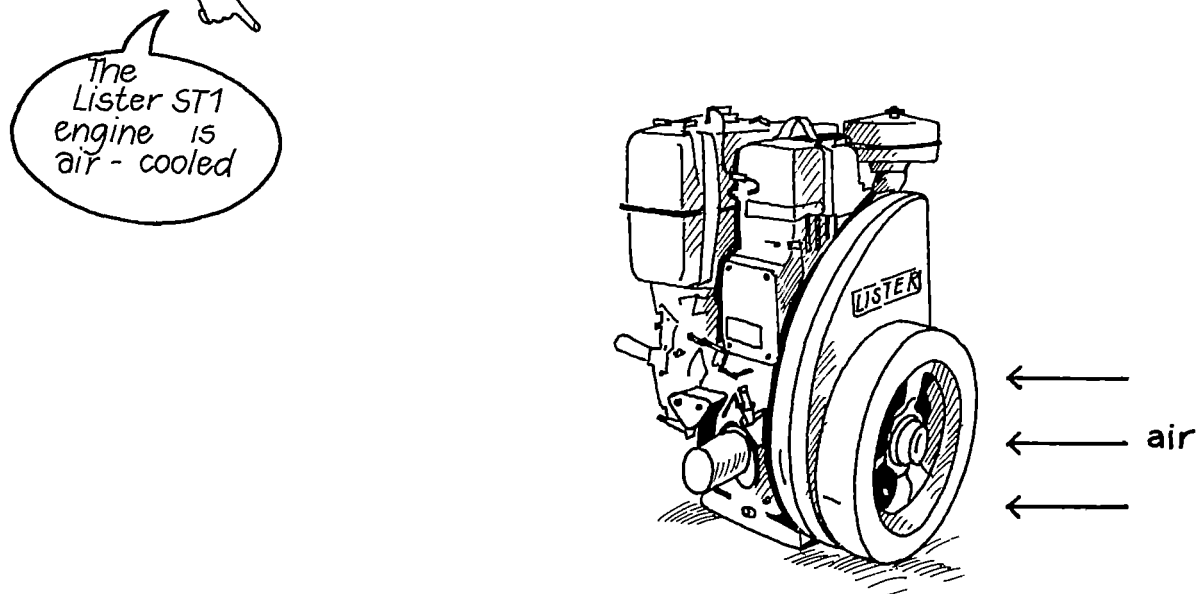
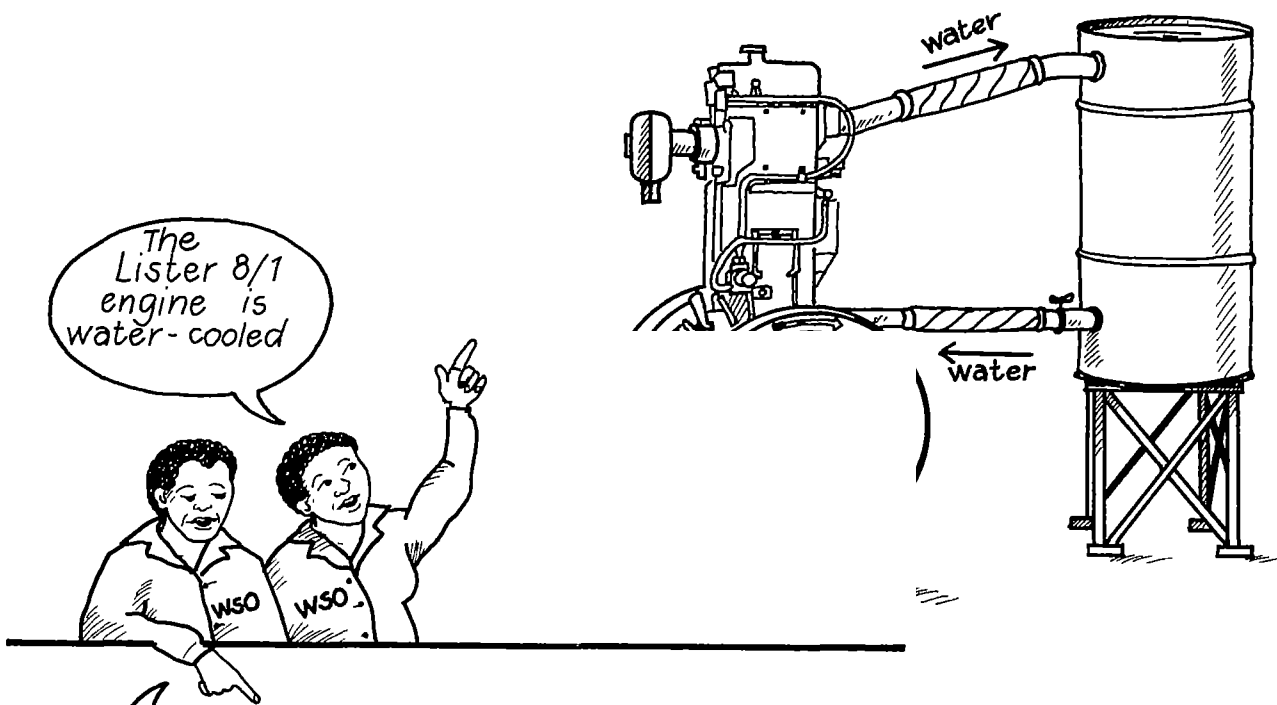


**4.**  
Exhaust stroke

Burning has taken place and the cylinder is now filled with smoke and gas. The engine must get rid of the smoke and gas before it can start a new series of strokes. In the fourth stroke the exhaust valve opens and the rising piston forces the gas out to the exhaust pipe. The piston is now ready for the first stroke again; the inlet valve opens and lets in new, clean air, and the process repeats itself.

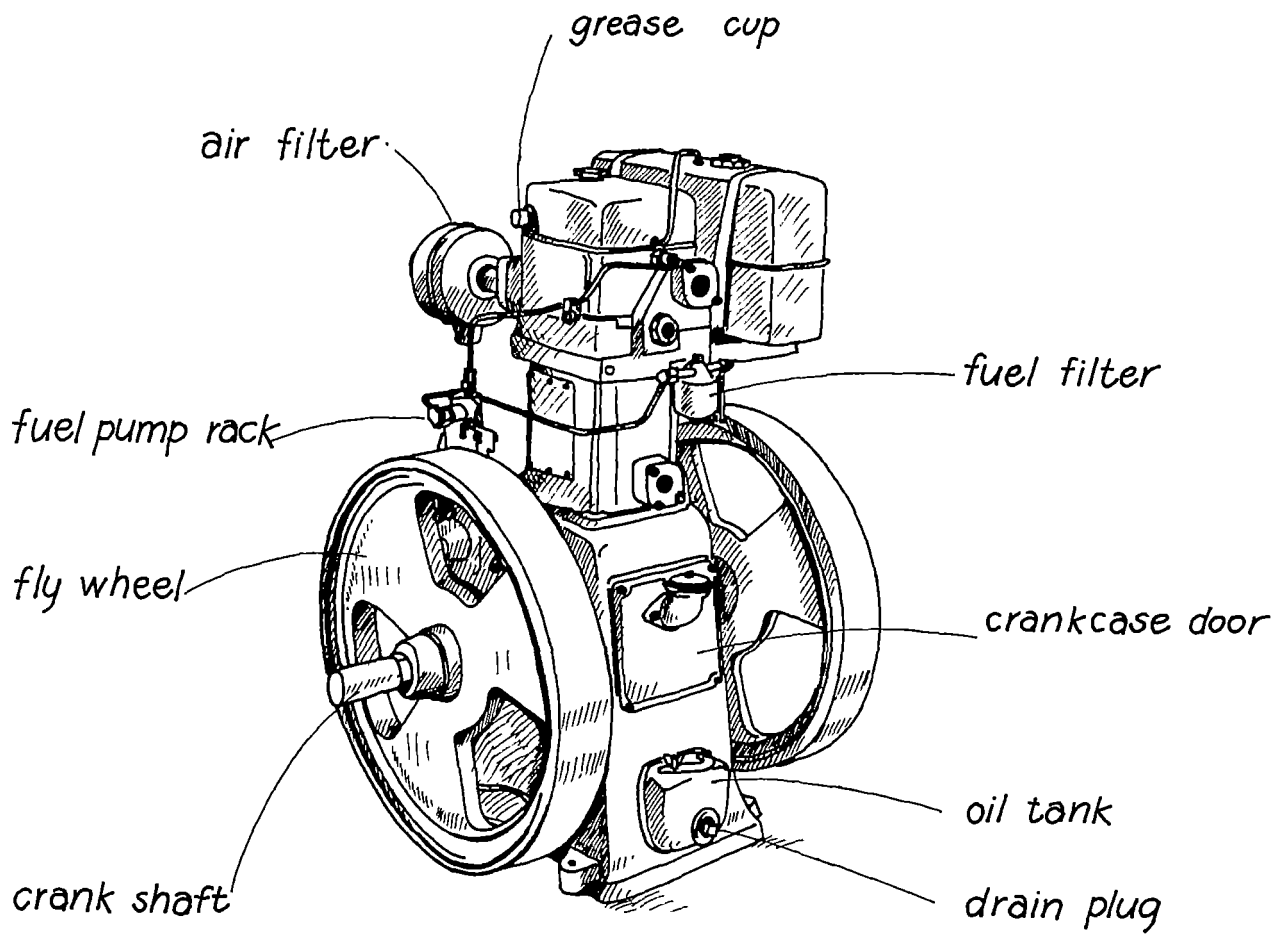
## Starting and Stopping the Diesel Engine

There is a correct procedure for starting and stopping an engine. The steps to be taken differ between different engines. Below you will find the procedures for the Lister 8/1 engine and the Lister ST1 engine. If you have another engine in your village water supply system, you must ask your supervisor for the right starting and stopping procedures.



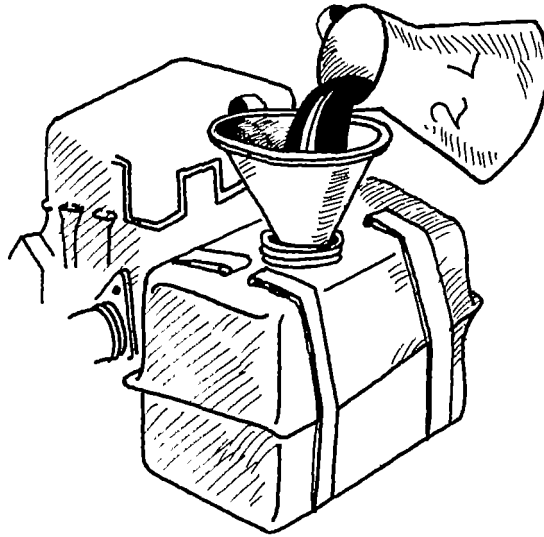
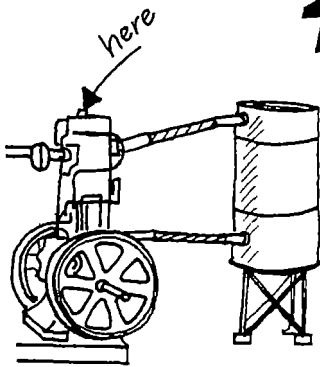


**The 8/1 water-cooled engine**



What to do before starting the engine:

1.

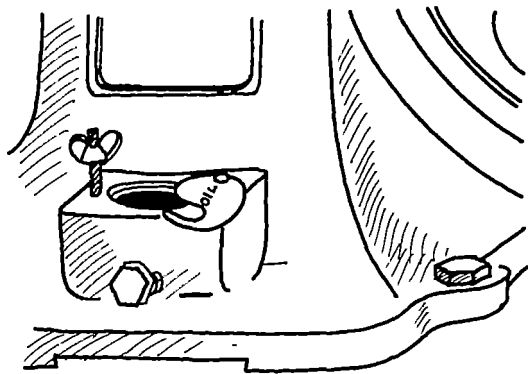
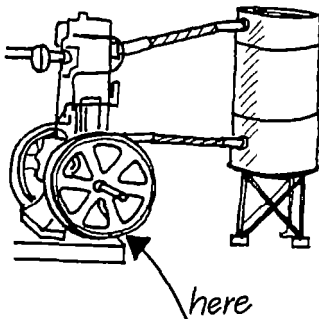


Check the level of fuel and refill if necessary  
Never let the engine run dry!

2.

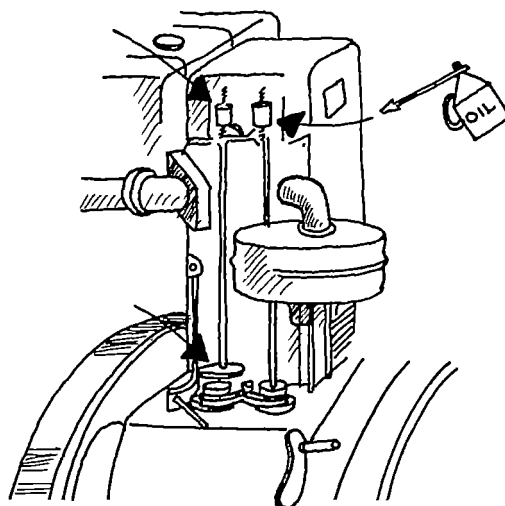
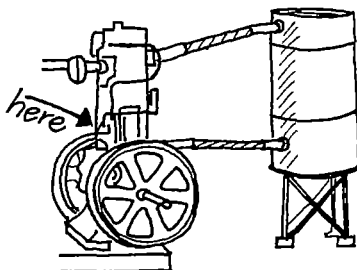
Check the reserve fuel.

3.



Check the oil level and add more if necessary.  
It is important to fill the oil to the correct level, because too much oil will make the engine run badly and too little oil will cause the engine to seize.

4.



Put oil on the valve stems, the governor linkage and the fuel pump rock, if they are dry.  
Oil the push rod cups if they are dry.

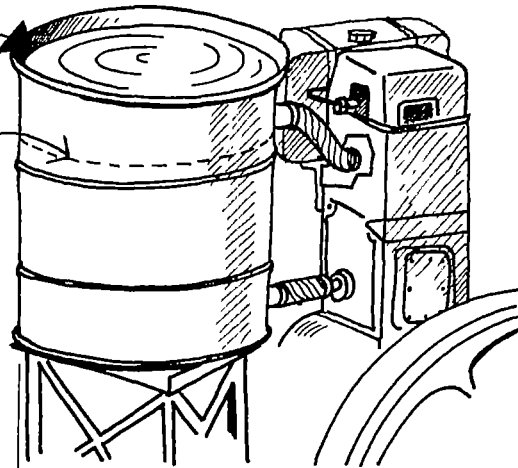




5.

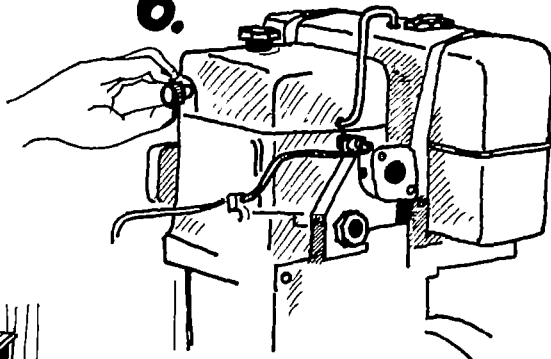
Right level

Never below the highest pipe

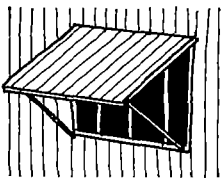


Check the water level and add more water if necessary. The water level must be 15 centimeters above the highest pipe. Never allow the water level to sink below the highest pipe.

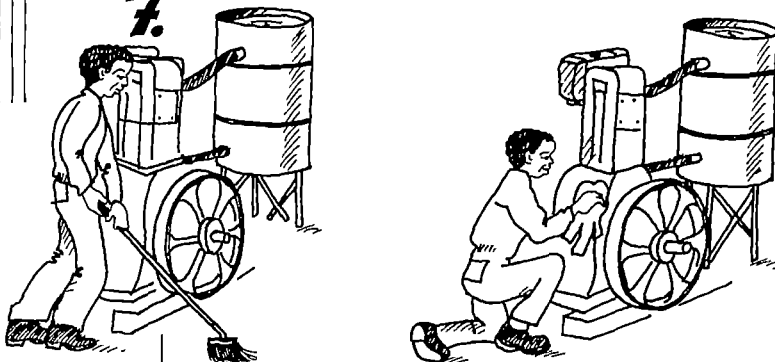
6.



Turn the grease cup half a turn



7.

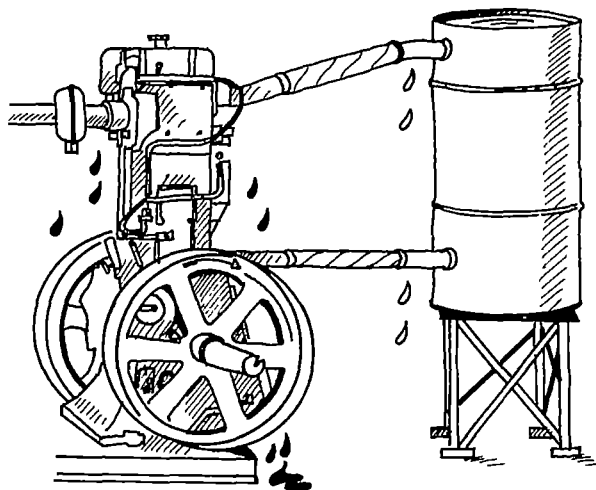


Open the windows of the pump house

Sweep the floor of the pump house.

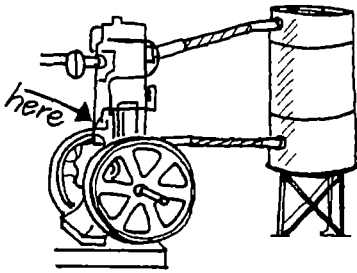
Clean the engine and the water hoses thoroughly.

8.

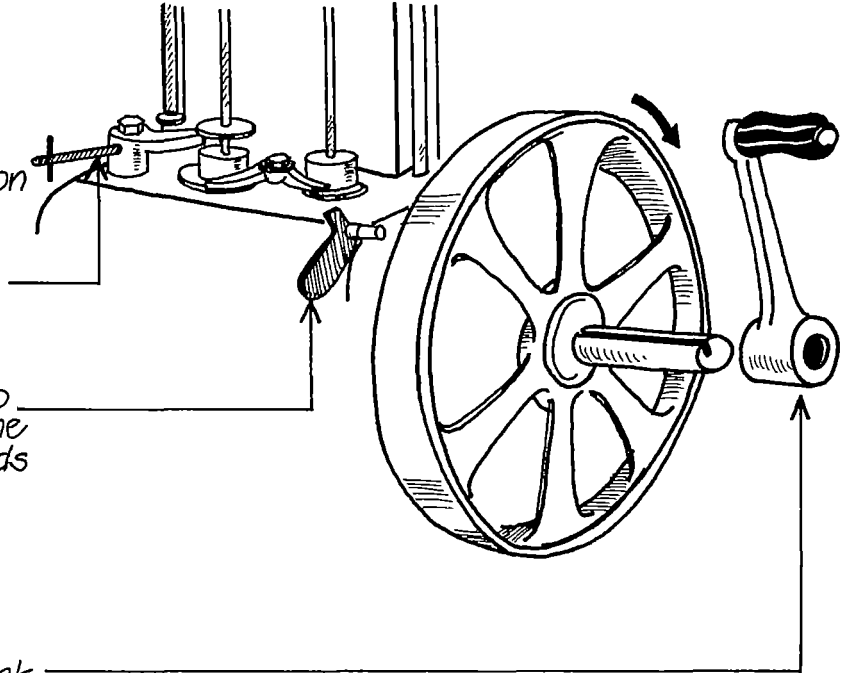


Check for oil, water or fuel leaks. Check the water tank for air bubbles or oil in the cooling water. If there is air or oil in the water, report it to your Water Department immediately.

Starting the engine:

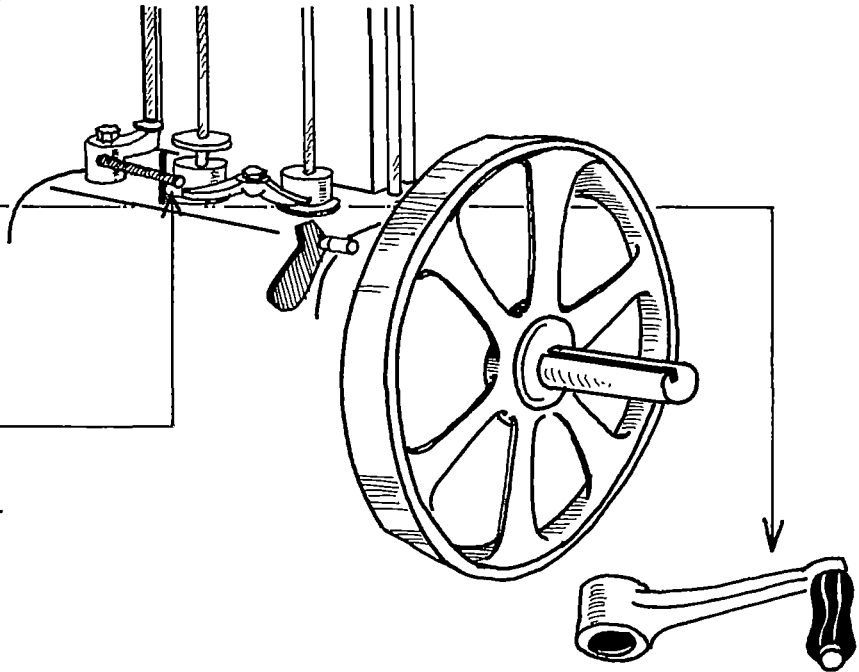


1. Decompress the engine. Turn the decompression lever so that the notch is under the valve stem tappet.



2. Open the fuel pump rack fully. Push the stop lever downwards and trip the overload pawl on the fuel pump.

3. Lightly oil the crank shaft and fit the crank handle. Crank the engine.



4. Remove the crank handle as soon as the engine has fired.

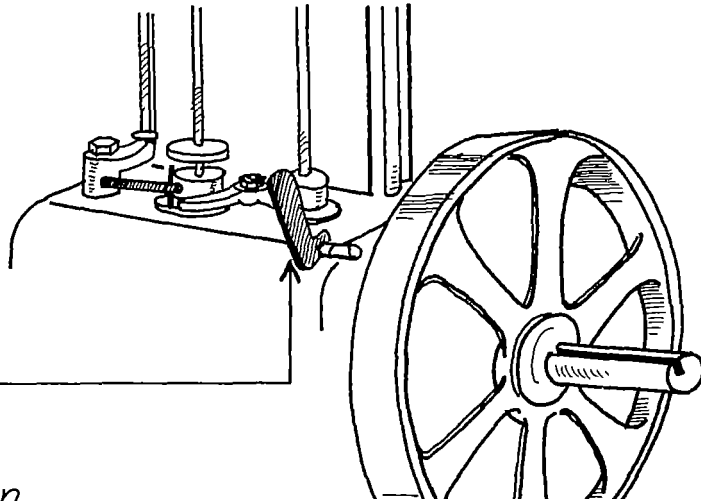
5. When starting speed has been reached, release the decompression lever and lock it.

## Stopping the engine:

**WARNING !**

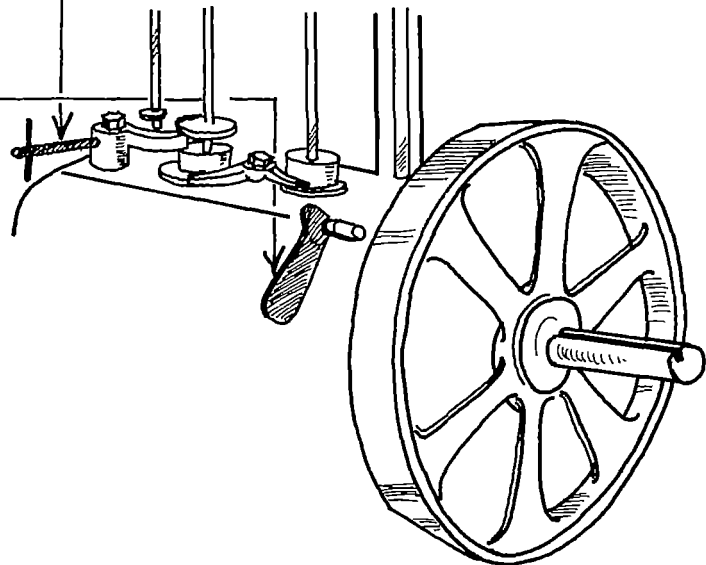
Never stop the engine by using the decompression lever.  
Do not stop the engine by shutting off the fuel supply to the fuel pump.

1. Lift the stop lever fully

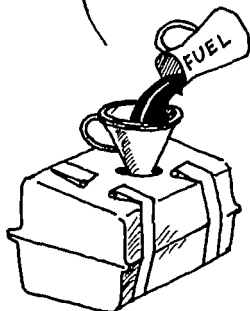


2. Turn the decompression lever so that the notch is under the valve stem tappet.

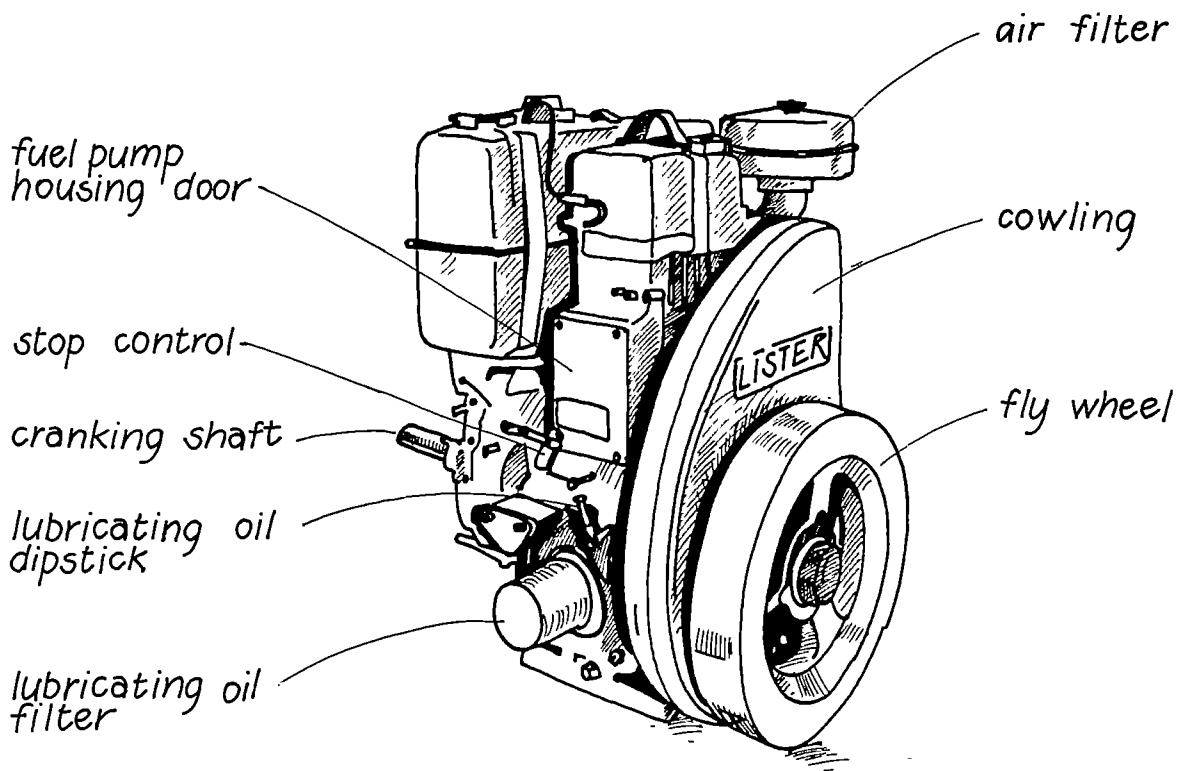
3. Just before the engine stops completely, lower the stop lever again. This will cause some diesel to enter the cylinder and will make starting easier.



4. Refill the fuel tank immediately after stopping the engine.



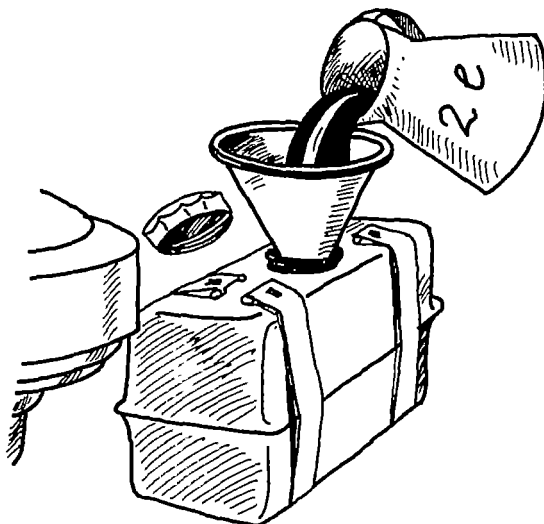
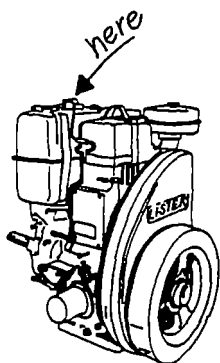
**The ST1 air-cooled engine**





What to do before starting the engine:

1.

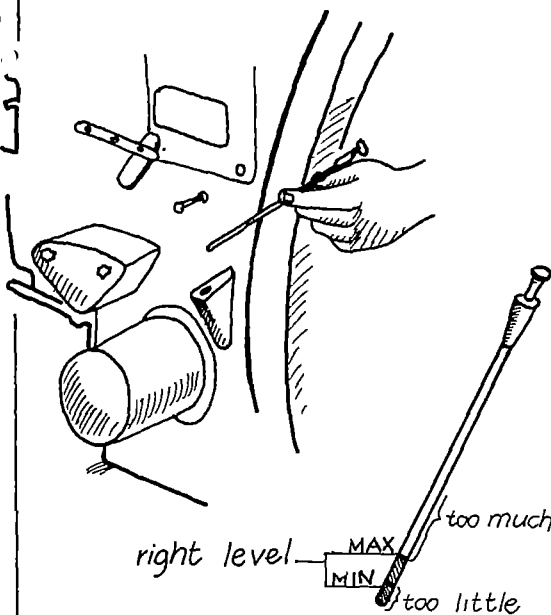
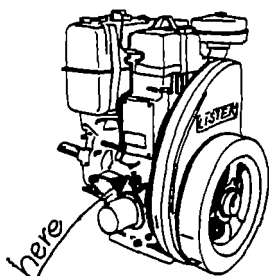


Check the level of fuel and refill if necessary.

2.

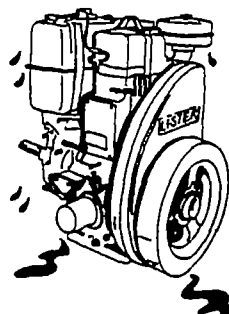
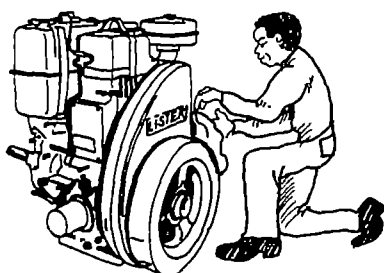
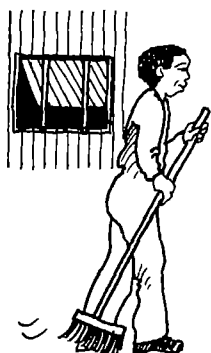
Check the reserve fuel.

3.



Check the oil level and add more if necessary. Read the oil level from the oil dip stick. It is important to fill the oil to the correct level, because too much oil will make the engine run badly and too little will cause it to seize.

4.



Open the windows of the pump house.

Clean the engine thoroughly

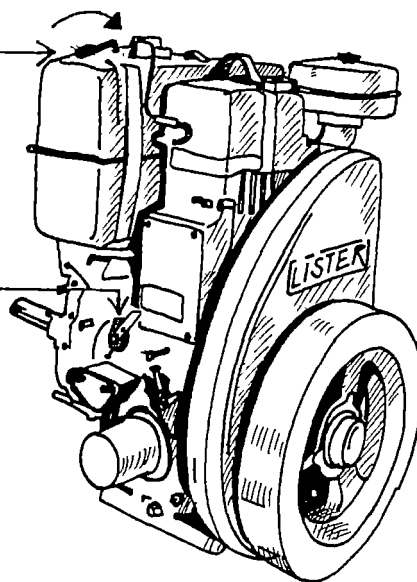
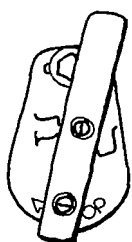
Check for oil or fuel leaks.

Put a drop of oil on the crank shaft.

Starting the engine:

1. Move the decompression lever over towards the fly wheel

2. Put the fuel control lever into the START position

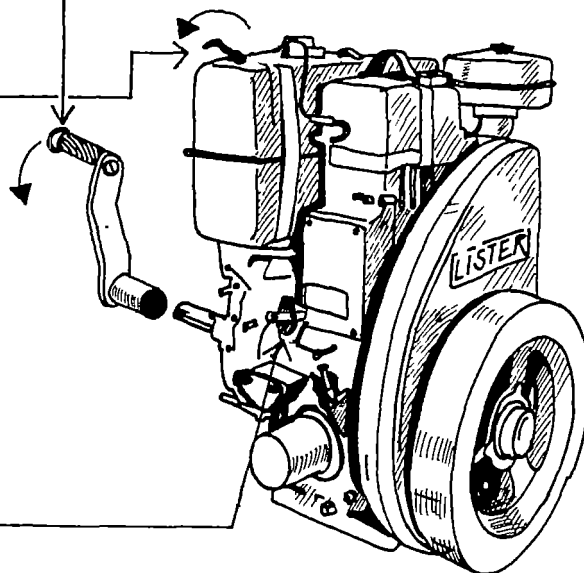
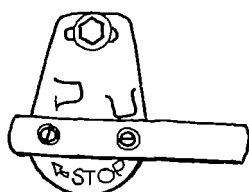


3. Turn the crank shaft three times

4. Turn the crank shaft to the starting speed and push the decompression lever away from the fly wheel.

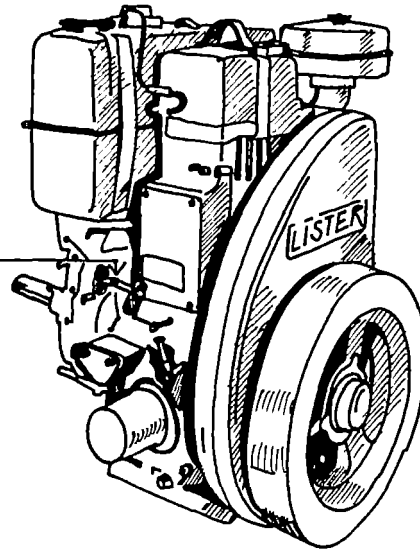
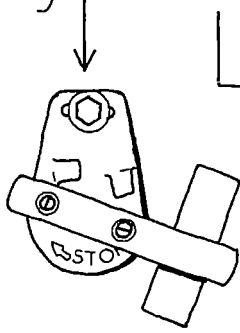
5. The engine should start and you remove the crank handle from the crank shaft.

6. When the engine is at the right speed, put the control lever into RUN position



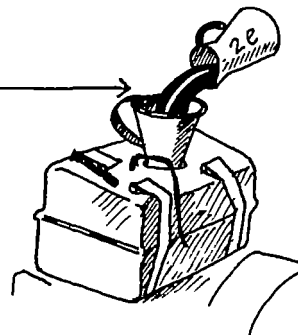
**Stopping the engine:**

- 1.** Push fuel control lever to STOP position and hold it there until the engine has stopped turning. Then let go.



- 2.** Pull out the fuel control lever and turn it back to START position. Push decompression lever back towards the fly wheel. (This will make it easier to start the engine next time)

- 3.** Refill the fuel tank immediately after stopping the engine.



Write down your questions and your comments:



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## Servicing the Diesel Engine

A diesel engine can run for many thousands of hours without need for major repairs, but only if it is serviced regularly. A water cooled engine should be able to run for about eight years before a major overhaul. An air-cooled engine needs the first major overhaul after about three years. If properly serviced, most engines should last for at least 15 years before they are replaced.

It is therefore very important that you service your engine according to this handbook.

### Servicing the air system

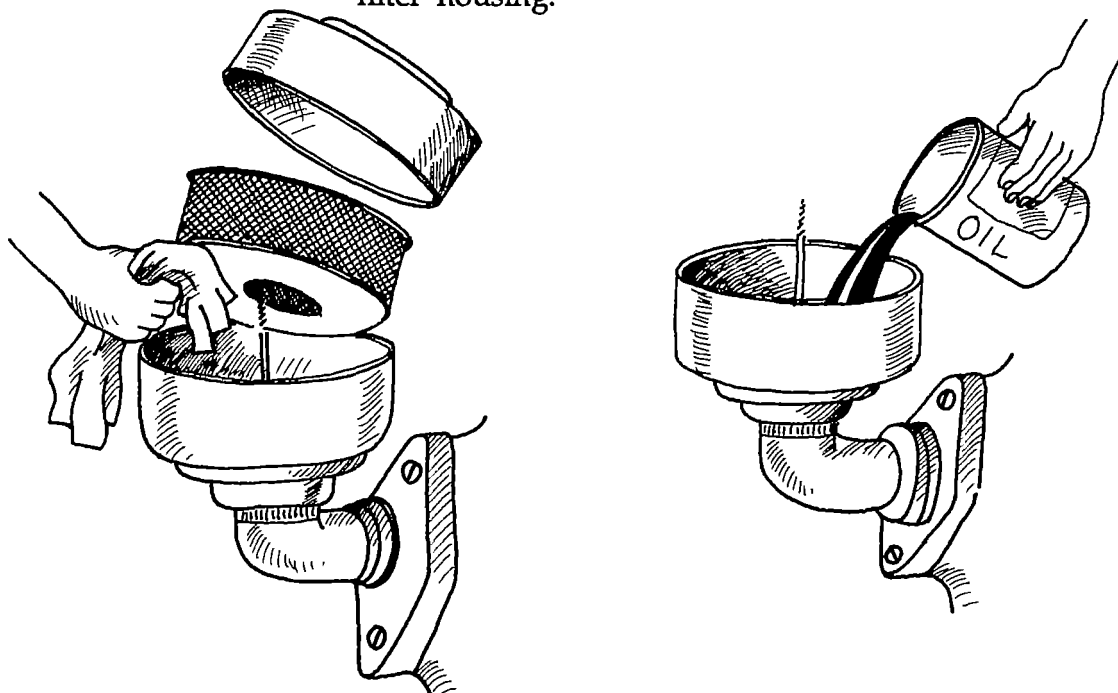
Air is needed by the air cooled engine for two reasons. It is needed for combustion, and it helps to cool the engine.

#### Air for combustion:

It is important to make sure that the air that goes into the engine is clean. Air with dust and sand will damage the moving parts and cause the engine to break down. This is why the engine must never be run without an air filter. There are two ways of cleaning the air: with a dry paper air filter, or with an oil bath filter.

When you remove the air filter from the intake, make sure that no dust, sand or other dirt can get into the engine.

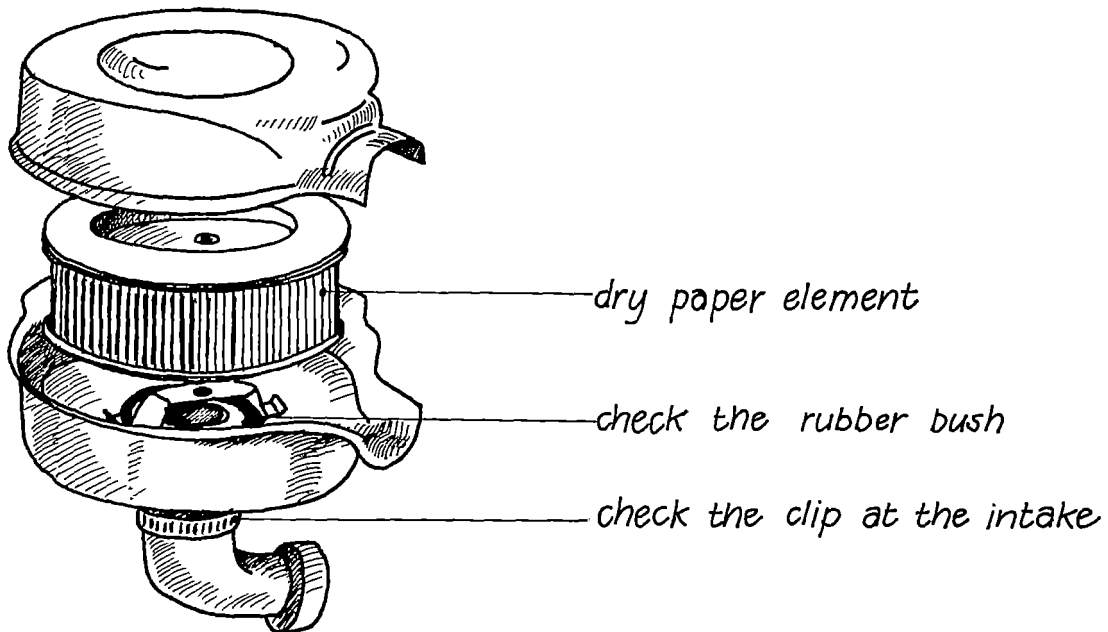
Take the air filter apart. If it is an oil bath type, wash the air filter with paraffin and refill the bath with oil to the proper level. Do not fill it too full! Fill it only to the level indicated on the inside of the filter housing.



*Oil bath filters should be cleaned once a week*

Air cleaners with paper elements should be taken out every now and then and shaken to get rid of loose sand and dust. If there is a lot of dust in the air, you will need to do this often. After every 250 hours of running you should change the paper element and put in a new one. (You can change it more often if there is a lot of dust.)

Before refitting the air filter onto the engine, make sure that the connection to the inlet manifold is in good condition. Many air filters use a rubber bush over the intake. Check this and replace it if necessary. The clip must also be in good condition. It should be able to make a tight joint.

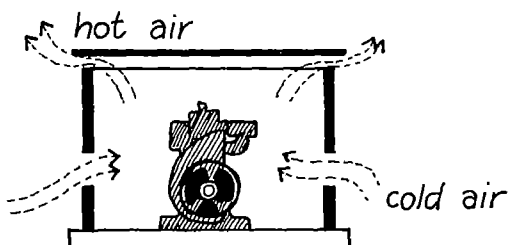


**Air for cooling:**

All diesel engines, both air and water cooled, need air for proper running. You must see that the pump house has enough air inside when the engine is running. That is why the pump house should have windows and a space between the roof and the walls.

Keep the engine as cool as possible. Cool air should be able to come in from outside; and hot air from inside the pump house should be allowed to get out.

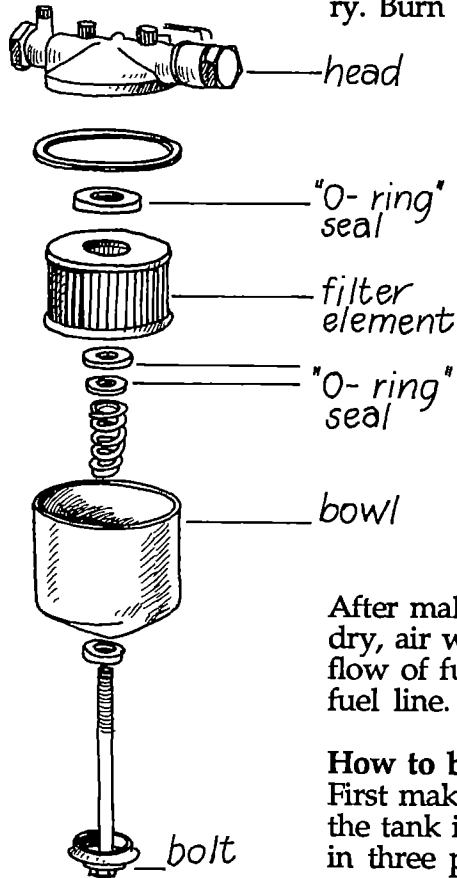
On air cooled engines the cooling air comes in through the fly wheel onto the fins on the hot cylinder. The fins should always be clean. If they get dirty the engine will get too hot and seize. You should clean the engine, including the fins, every day.



For proper cooling the pump house must have 3 windows and space between the roof and the walls.

### Servicing the fuel system

Drain the tank and change the fuel filter element every thousand hours of running. Check for fuel leaks, and tighten where necessary. Burn the fuel which you have drained out.



Unscrew the bolt at the bottom of the filter bowl and remove it. Clean the inside of the bowl and replace the fuel filter element. The "O-ring" seals should be renewed every time the filter element is replaced.

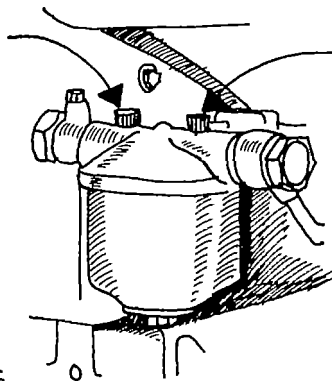
After making adjustments to the fuel system, or if the tank has run dry, air will enter the fuel line. These air locks will prevent the free flow of fuel and damage the engine. Therefore, you must bleed the fuel line.

#### How to bleed the fuel line:

First make sure that the tank is full. Allow the fuel to flow from the tank into the line by opening the fuel cock. Then bleed the line in three places.

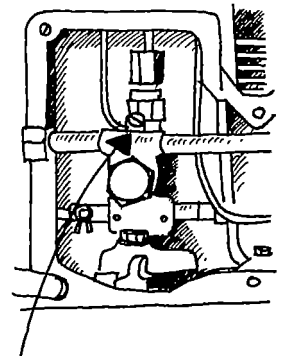
**1.**

Loosen the first thumb screw on the fuel filter head (the first thumb screw counted from the tank). Let the fuel come out. Do not allow the fuel to fall on the floor of the pump house! Catch it in a tin. When the fuel comes out with no bubbles, you can tighten the thumb screw again.



**2.**

loosen the second thumb screw on the fuel filter. Let the fuel come out, as before, until it has no bubbles. Then tighten the thumb screw again.



**3.**

Loosen the bleed screw on the fuel pump and let the fuel come out until it comes with no bubbles. Tighten the screw again.

Always make sure that the washers under the thumb screws are there.

On the air cooled engine the fuel pump is inside the engine. Remove the fuel pump cover and make sure that no fuel spills inside the engine. Use a very clean cloth to soak up the bleeding fuel.

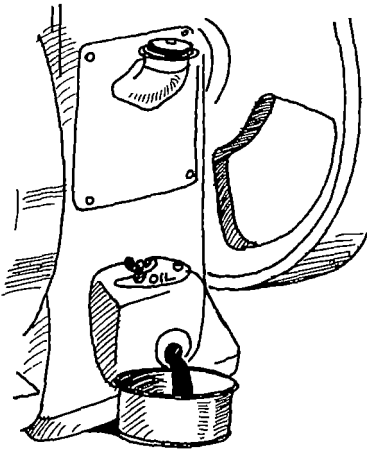
**Servicing the oil system**

The main purpose of lubricating oil is to keep the surfaces inside the engine from rubbing too tightly and getting scratched and worn out. The oil must be absolutely clean to keep the parts moving smoothly. If there is dust or sand in the oil, it grinds against the engine parts and makes them wear out faster.

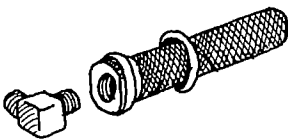
After the engine has run about 250 hours you should drain the oil from the engine into a container and burn it. This should be done shortly after the engine is stopped and while the oil is still hot and fluid. If it is a water cooled engine, the oil strainer should be cleaned with fuel.

With an air cooled engine, just change the oil filter. Remember to grease the seal ring with a drop of oil. The new filter should be fastened only hand tight.

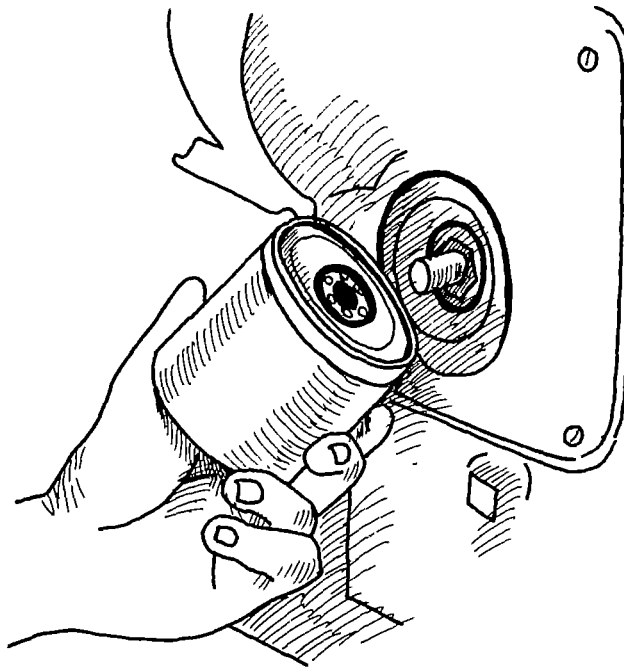
Refill the engine with new oil. Use only oil given to you by the Water Department. If you spill any oil, wipe it up immediately. Never allow any of it to drain into the bore hole!



Burn the old oil immediately



The mesh oil strainer



Change the old oil filter

### **Other service**

- Check the tightness of the bolts and nuts, and make sure there are no leaks.
- Check especially the foundation bolts that fit the engine to the foundation block. The bolts must be tightened to minimize shaking of the engine when it is running.
- Check the exhaust pipe. If it is dirty, tap it to shake out any dust or smoke particles. If it is very dirty, heat it in a fire to burn out the residue. The exhaust pipe should be kept as short and straight as possible. The pipe should slope slightly down, away from the engine so that water does not run back into the engine. The pipe must end outside the pump house. It should also have a silencer. If you have a very long pipe it must be fastened so that it will not shake. If it shakes, it will damage the manifold of the engine.
- Check the exhaust smoke. If it is dark or white, you should notify the Water Department as soon as possible.
- On the water cooled engine, refill the grease cup. Also check water hoses. If they have become hard and cracked, they need to be replaced. Be sure that the water is circulating freely through the hoses.
- If there is a clutch, that clutch requires grease every 50 hours.
- Clean the engine thoroughly.

### **The Vee Belts**

The engine is connected to the pump head with vee belts. The vee belts fit in the grooves of the pulleys. The engine speed and the size of the pulleys determine the speed of the pump.

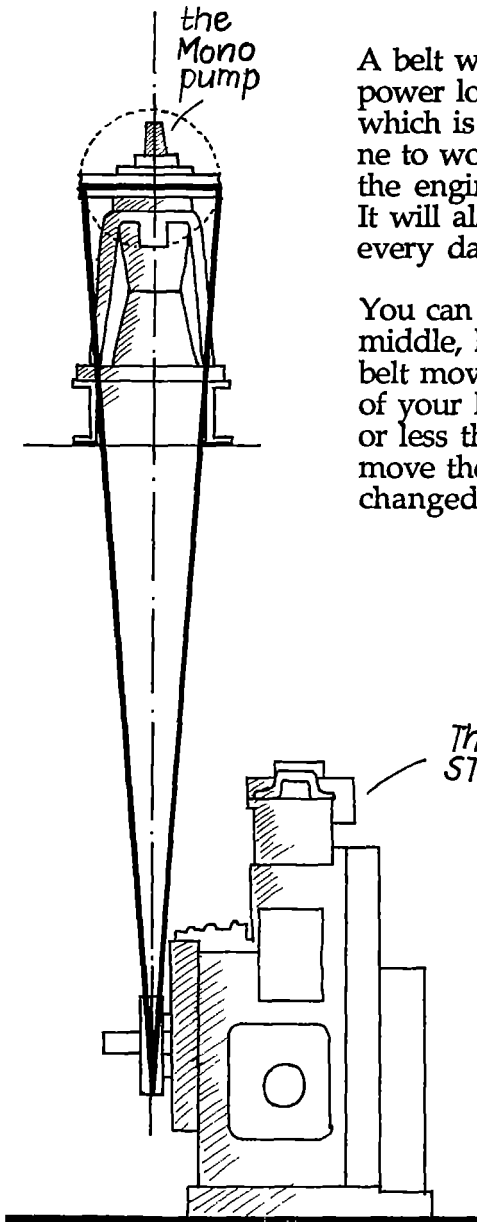
On the water cooled engine the drive belt pulley should be mounted close to the fly wheel. On the air cooled engine the pulley should not be mounted too close to the fly wheel, otherwise air can not pass to cool the engine.

If the engine pulley and pump head are not in line, the belts will not pull in a straight line. This will make them wear out quickly. Make sure that the engine and the pump head are aligned properly.

The vee belts should be kept dry and free of oil. If they are clean they will not become slippery and wear out too soon.

If a vee belt has frayed edges (pieces of string sticking out), this means the belt is wearing out. Replace it before it breaks. Always keep some new vee belts in store and make sure that they are the right size. All belts have size numbers painted on them.



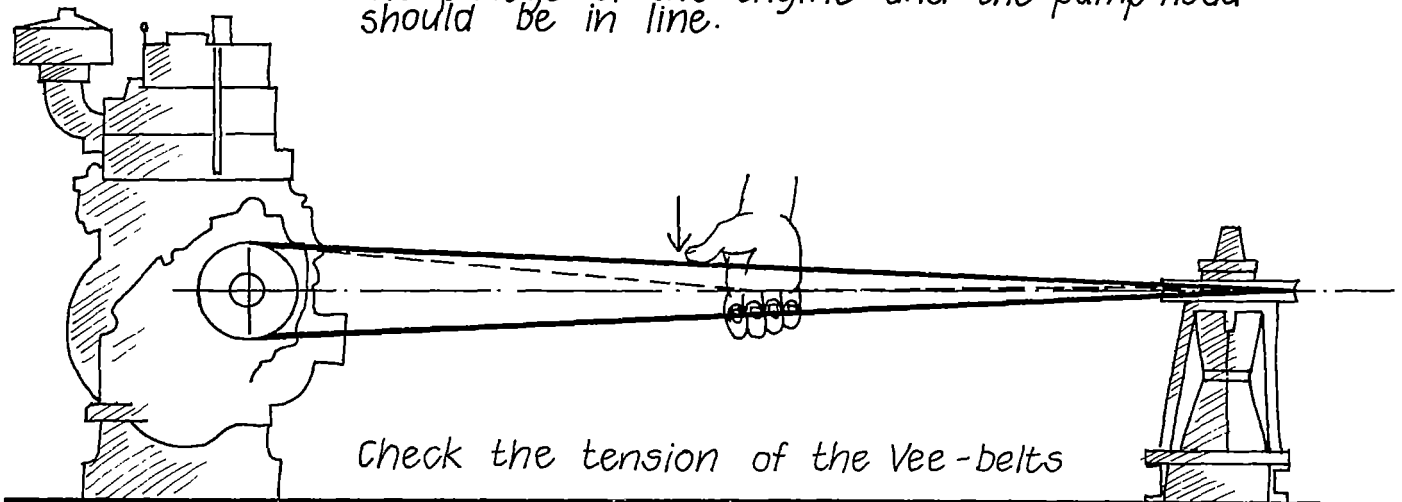


A belt which is too loose will slip over the pulleys. This will cause power loss and will also make the belt wear out quickly. A belt which is too tight will pull the pulley grooves and cause the engine to work too hard. This will damage the bearings in the pump or the engine.

It will also wear out the belt. Check the belts and their tension every day!

You can tell if the vee belt is tight enough if you press it in the middle, half way between the engine and the pump pulleys. If the belt moves about 50 to 80 millimeters (about as much as the width of your hand), the belt is correctly installed. If the belt moves more or less than this, the engine location should be changed. If you move the engine, make sure that the alignment of the belt is not changed.

The pulleys of the engine and the pump head should be in line.



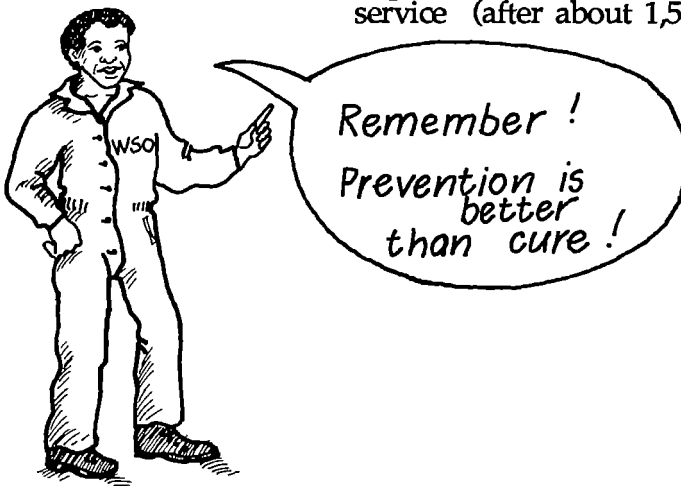
check the tension of the Vee-belts

## Preventive Maintenance

We have all heard that "prevention is better than cure." It is better to take care of the engine and prevent breakdowns, than to have to fix the engine when it breaks down. Preventive maintenance means giving the engine regular service and correcting any small problems before they become big ones.

Preventive maintenance means you should:

- Use only clean fuel and oil.
- Use only clean containers.
- Use only a funnel with a strainer.
- The filler cap and its gasket on the fuel tank must always be kept in good condition. The locking device on the cap should function perfectly and should fit tightly on the tank. The fuel tank should be filled with fuel after you stop the engine. The fuel tank should never be left empty over night! If it is left empty, water will condense inside the tank. The water will drip down into the fuel. This is very bad for the fuel system.
- Store the reserve fuel in a proper way.
- Replace oil, air and fuel filters in time.
- Make sure the holding-down bolts for the engine and the base frame are tight. However, do not tighten them too much, as you may pull the foundation bolts out of the concrete.
- Always keep the engine clean!
- Always keep the engine room clean and free from dust.
- Check the belt tension.
- Check the exhaust to see if it is smoking.
- Report any unusual noises, over-heating, engine vibrations and anything unusual to the Water Department.
- Report to the Water Department when the engine needs major service (after about 1,500 hours of running).



## **Using Electricity for Pumping**

Some pumps use electric power instead of a diesel engine. Electricity can come from three different types of supply: a generator set, Botswana Power Corporation, or solar power.

The electric power is used on two different types of pumps: the electro-motor driven mono pump, and the electric submersible pump. The electric submersible pump is under water, down inside the bore hole.

A generator set is made up of a small diesel engine and a generator which makes electricity. Generator sets are used mostly in river pumping systems and crooked bore holes. You should not try to maintain the generator.

You do not need to maintain an electric motor other than switching it on and off as needed. The only part of the electrically powered pump which may need maintenance is the submersible pump itself. This should be checked by someone from the Water Department every six months. If there are any problems with an electric engine, you should report it immediately to the Water Department.

**Safety:** Do not allow any water to get on the electric wires which supply electricity to the pump. It is dangerous to get water on the wires, or to touch them. You may get an electric shock if you do so.

### **Solar powered electric motors**

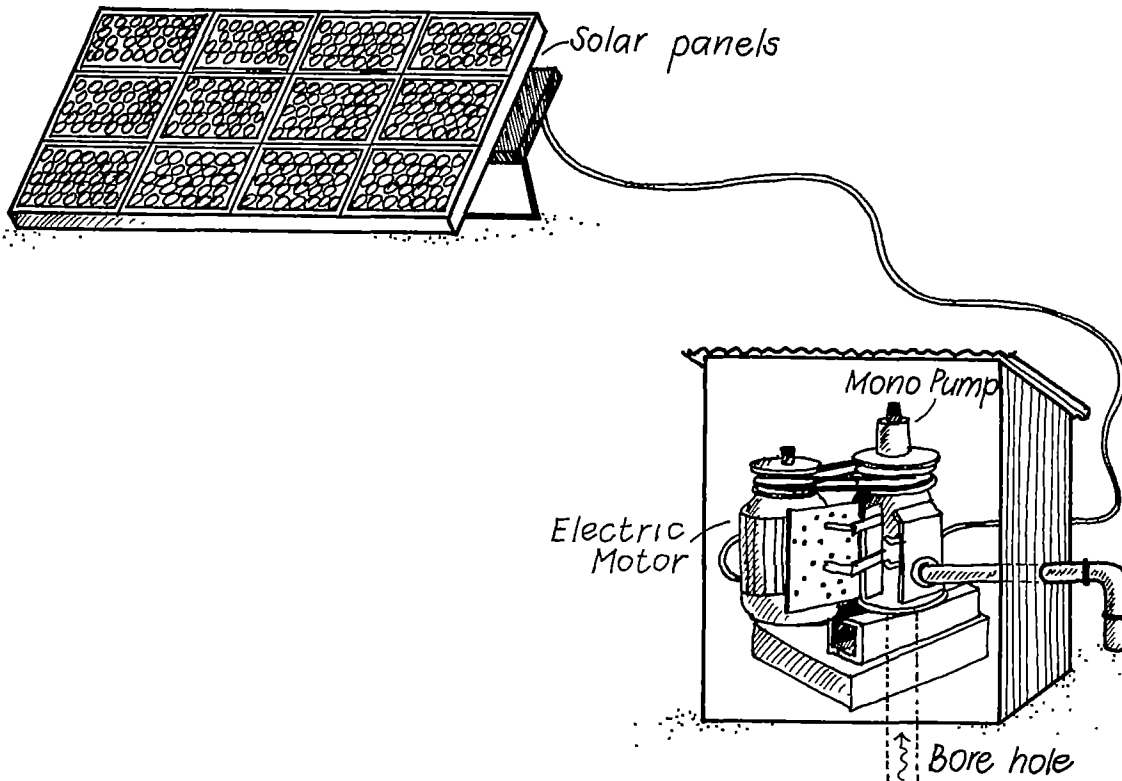
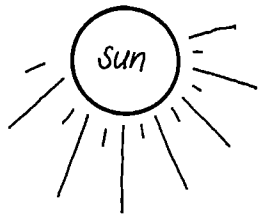
Some pump motors get electric power from the sun. These are called solar powered pumps, or PV (photovoltaic) pumps. The advantage of a solar powered pump is that it gets all the power it needs from the sun. This type of pump will be used more often in Botswana in the future.

When the sun shines on a solar panel (also called photovoltaic or PV panel) it generates a small amount of electricity. To get enough electricity to make a pump motor work, it is necessary to have several solar panels, connected by wires.

When the panels are producing electricity, the electricity passes through the controller to the motor which runs the pump. The controller regulates the amount of current to the pump. The controller should last for many years. If anything goes wrong with the controller, it must be replaced. This must be done by someone from the Water Department.

The solar powered motor does not have a battery for storing electricity, so the pump works only during the daylight hours. Except for this, the solar powered pump motor works just like any electrical motor.

The only part of the solar powered pump which may need maintenance is the pump itself. This should be tested and overhauled by someone from the Water Department every six months.



You will have to read the meter, make recordings in the log book, etc. just as you would for any other pump.

The solar panels do not have moving parts so they do not wear out. They should not be moved, however, because they are adjusted to get the most sun light when they are installed. They should also be protected from breakage, such as by stones thrown by children. Sometimes a hedge planted inside the fence will help protect the panels from stones. If the panels are dusty, they will not work as well as they should, so you may have to dust them occasionally. You should also make sure that no grass, bushes or trees shade the panels.

Write down  
your questions  
and your  
comments:



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# 11.

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# The Pump

There are different ways of getting water out of the ground. In most cases you would use a pump. In the previous chapter you could read about how a pump could be powered by a diesel engine or with an electric motor. In this chapter you can read about the pump itself.

## **The Rotary Mono Pump**

The most common pump in village water supply systems is the rotary Mono pump, driven by a diesel engine or an electric motor. This pump has three main parts: the discharge head, rising main and the pump element.

### **The discharge head**

The discharge head is in the pump house directly over the bore hole. If the head is not straight, the shafts will be forced to bend. That can damage the shafts, the rising main and discharge head.

The head is connected to the engine with vee belts. You can read about vee belts on page 76.

Make sure that the bolts which hold down the discharge head to the foundation are tight. Do not make them too tight, however.

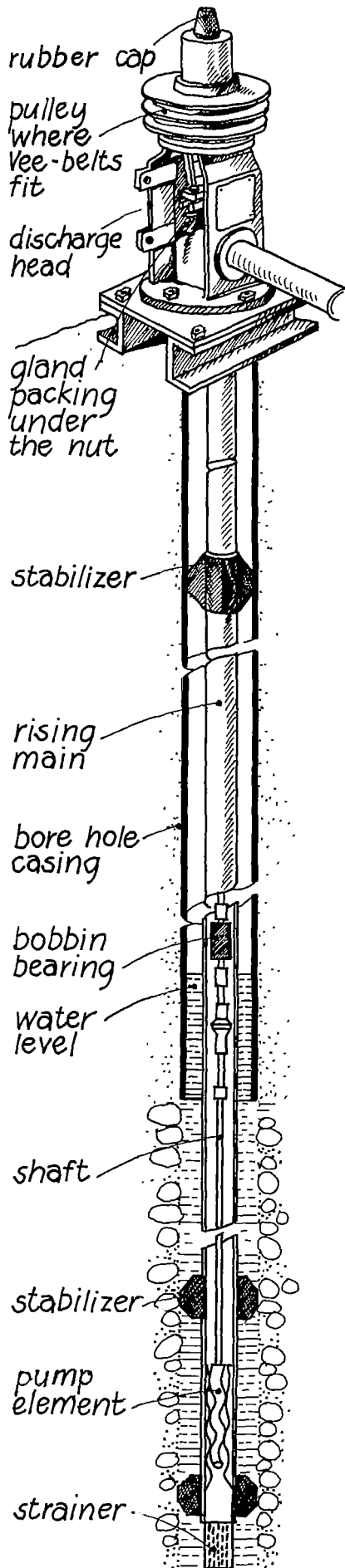
Never leave any wire in the top rod while the pump is turning.

Check the gland packings on the discharge head. Tighten them if necessary. However there should be a very small amount of leakage - just a drop of water all the time. Do not tighten them too much. If you can not adjust them any more, take them out and put in new gland packings.

Wipe the discharge head every day.

Check the ratchet pins. They are under the pulley. Make sure they are clean and free from grease. They should not allow the pulley to turn in the wrong direction.

If you hear any unfamiliar sound from the discharge head notify the Water Department immediately.



**The rising main**

The water is lifted inside a rising main that goes down under the water in the bore hole. The turning of the pulley makes the shaft inside the rising main turn around. The turning lifts the water.

Bobbin bearings made of rubber make sure that the shaft is in the center of the rising main. Rubber stabilizers hold the rising main firmly in the borehole casing. The stabilizers keep the rising main from moving too much. They also make it less noisy. If it becomes noisy, you know that something is wrong, and you should report to the Water Department.

Note that the turning of the pump element and shafts is anti-clockwise - that is, they go around the opposite direction from the way clock hands move.

**The pump element**

The pump element is at the bottom end of the rising main. It looks like a big screw. When it turns it lifts the water. At the very end of the rising main there is a strainer to keep sand from going into the pump element. Sand would damage the pump.

The yield of the bore hole determines the size of the pump element. A large one is needed if the bore hole has a lot of water.

Be sure that the pump is always pumping water, and not air. If air comes out instead of water, turn off the engine and notify the Water Department.

You should check the water level once a week. This is to protect the pump element from pumping air and seizing.

If you notice that the pump is pumping much less water than normal, tell the Water Department immediately. The reason for a sudden loss in amount of water could be a leak in the rising main, a damaged pump or a broken water meter.

## Hand Pumps

Most hand pumps are in lands areas, owned by syndicates or private individuals. Hand pumps owned by the Water Department are used only for back-up supplies when the normal water supply system breaks down. You should check the hand pump regularly to make sure that it is working properly. If it is not working, report to the Water Department immediately.

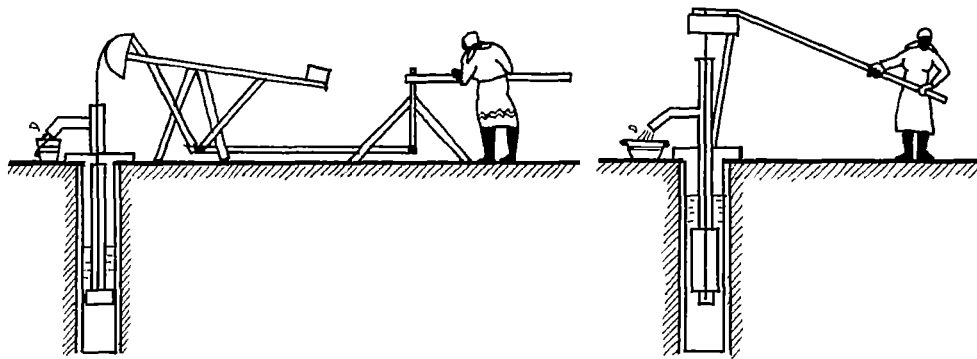
When the normal water supply system breaks down, people from the village can use the hand pumps.

Most hand pumps use the "lift pump" or the "reciprocating" method. Inside the rising main, down in the bore hole, under the water level, there is a cylinder. At the bottom of the cylinder, there is a valve that allows water from the bore hole to get in, but not out. Inside the cylinder there is a piston. The piston has a valve that allows the water to go up in the rising main but not down again. The piston is connected via a number of rods with the handle of the pump. When the handle is moved up and down, the piston goes up and down in the cylinder and thus lifts the water to the surface.

Of the many different types of hand pumps, four were chosen for future use in Botswana. These are:

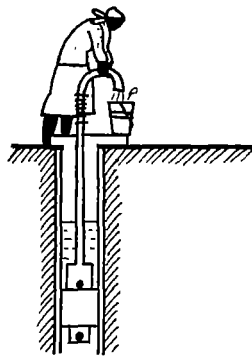
- **The Thebe pump,** which was developed at the Rural Industries Innovation Centre in Kanye. It is operated by a person pushing a handle as he or she walks around in a circle. It can pump water from a depth of around 100 meters.
- **The Bush pump,** which works by means of a handle about three meters long. It can lift water from a depth of around 60 meter, in some rare cases even up to as much as 100 meters. Most Bush pumps are installed to depths of between 30 and 40 meters. The pump is operated by moving the long handle up and down.
- **The Blair pump,** which has a hooked handle which you must pull up and push down to operate. The handle also acts as a spout. This pump comes originally from Zimbabwe. This pump can lift water only from shallow bore holes, down to 12 meters in depth. It is one of the most simple and cheap of hand pumps.
- **The India Mark II,** which works the same way the Bush pump operates. It can pump water from a depth of about 60-80 meters.



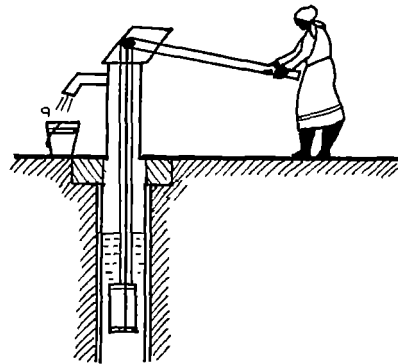


The Thebe pump

The Bush pump



The Blair pump



The India Mark II

Write down  
your questions  
and your  
comments:



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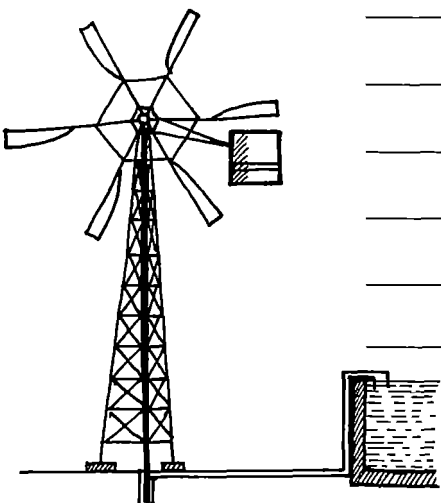
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Wind can be used for pumping water. In parts of Botswana where the wind is steady, people may use windmills.

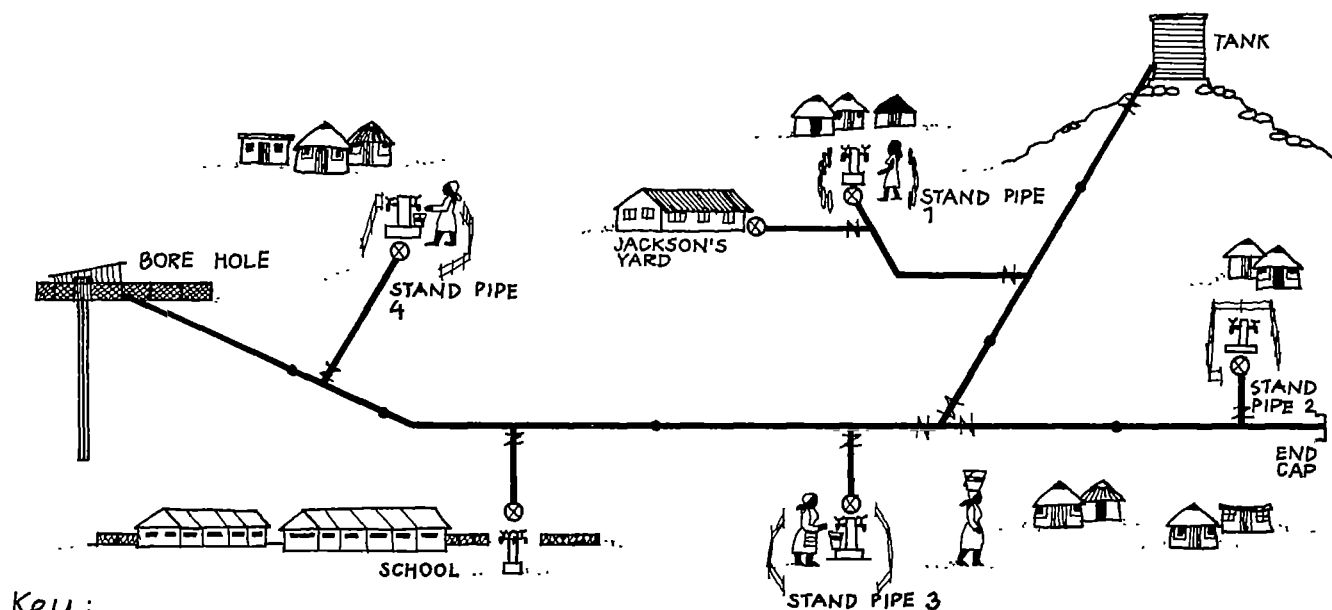
# 12.

# The Reticulation System

After the water has been pumped out of the bore hole, it is taken from the bore hole by a network of pipes. The pipes go under ground to the stand pipes, the storage tanks and to private connections. This is called the reticulation system.

There are two main types of reticulation systems. These are the direct system, and the indirect system.

*The direct reticulation system :*

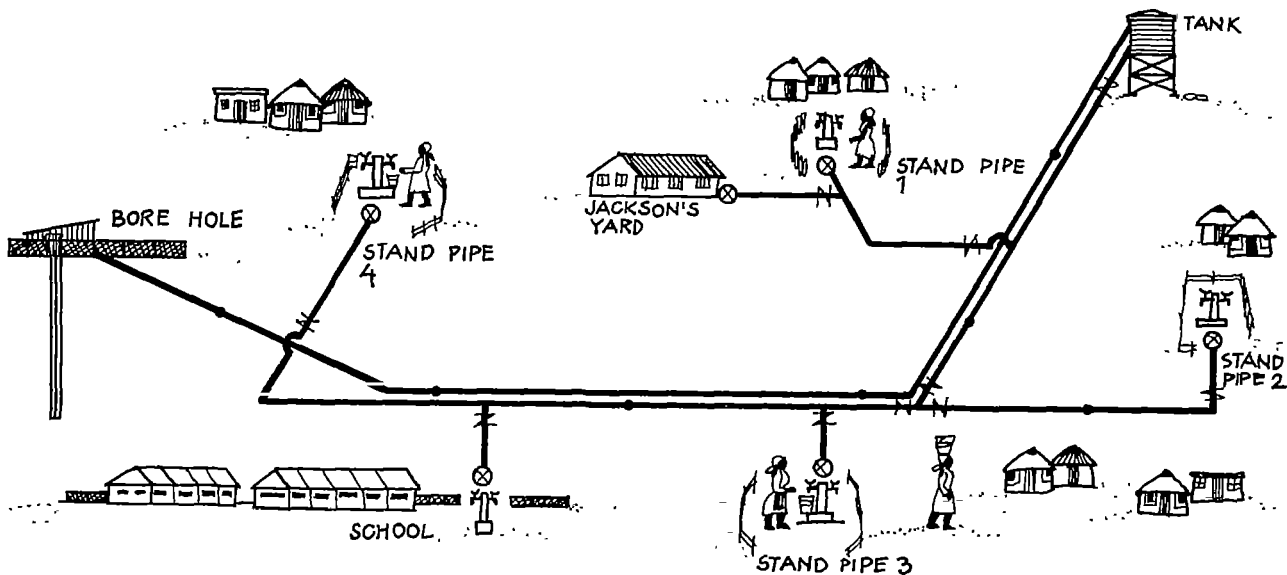


Key :

- pipe line
- N gate valve
- ⊗ stand pipe
- water marker post

When the water goes from the borehole directly to the stand pipes before going to the storage tank, this is called "the direct system". It is cheaper than the indirect system since fewer pipes are used and less fuel is needed for pumping the water.

### The indirect reticulation system :



If the water is taken from the bore hole straight to a storage tank before it goes to the stand pipes, this is "the indirect system." The main advantages of this system are that if the water in the bore hole becomes contaminated, it can be treated in the tank by chlorine or some other purifying chemicals before it is used. If the main pipe from the bore hole gets broken, the people can use water from the tank while the pipe is being repaired.

Each Village Water Supply System is shown on a map. A copy of that map should be kept in the pump house. Keep it in a protective cover.

See an example of a Village Water Supply System map on pages 88-89.

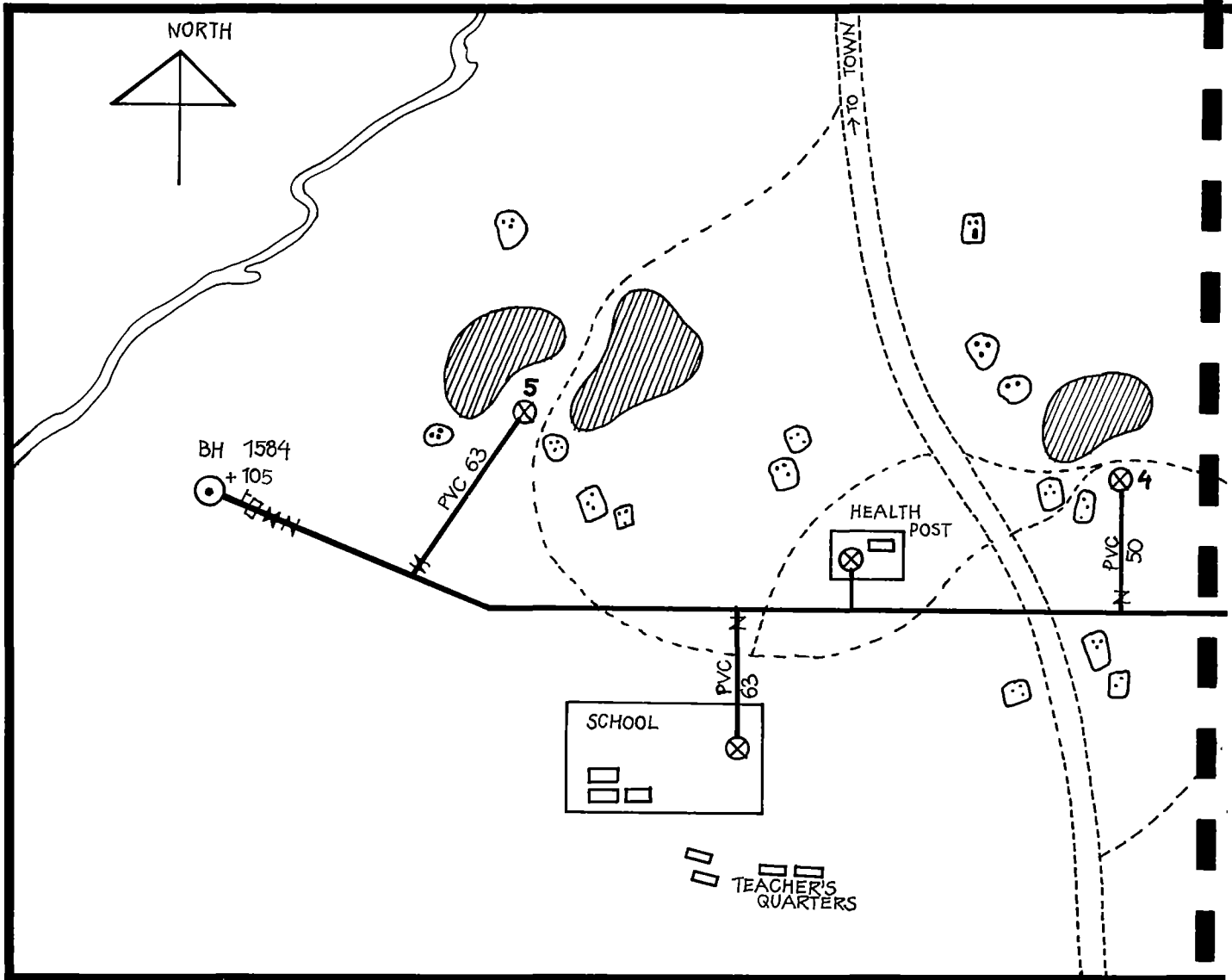
## Pipes

Water from the bore hole flows through the main lines to the distributing lines. The main lines are made of pipes which are 63 to 250 millimetres in diameter. The distributing lines are made of pipes from 50 to 63 millimetres. The distributing pipes end in servicing lines which go to stand pipes and private connections. Servicing lines are 20 to 25 millimeters in diameter.




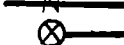
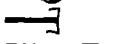
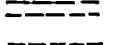


The system of pipes is called the reticulation system. You should have a map of the reticulation system. The pipe lines in the village should be marked with posts every 200 meters. Marker posts should also be placed at all bends, junctions, valves, rivers and road crossings.

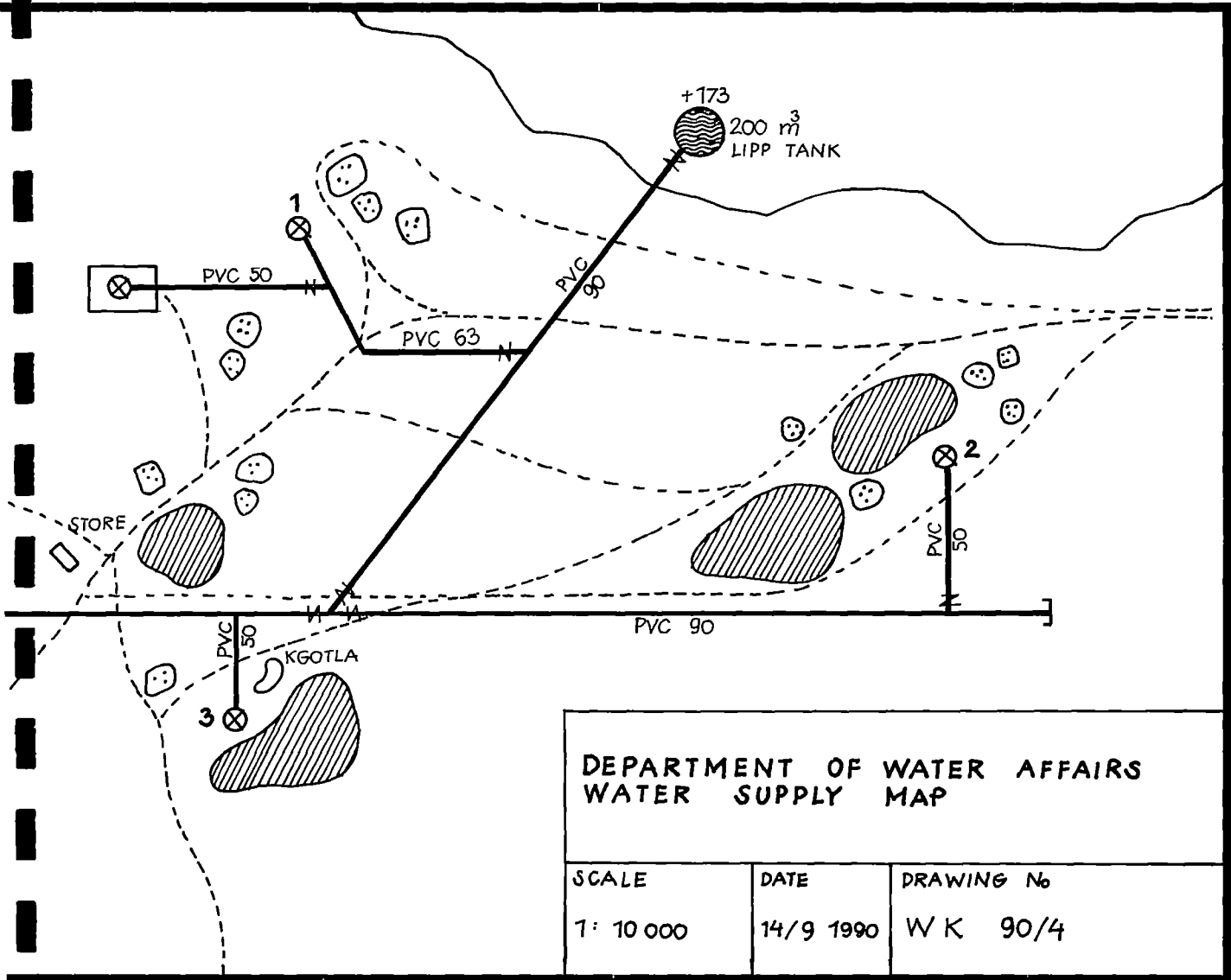
You should make new marker posts if the old ones are broken or missing. Use pieces of PVC pipe and fill them with cement.

Water Supply Map



LEGEND

-  GROUP OF COMPOUNDS
-  COMPOUND WITH HOUSES
- + 105 GROUND LEVEL
-  PIPE ROUTE, MATERIAL AND DIMENSION
-  GATE VALVE
-  STAND PIPE
-  END CAP
-  MAIN ROAD
-  TRACK



DEPARTMENT OF WATER AFFAIRS  
WATER SUPPLY MAP

SCALE	DATE	DRAWING No
1: 10 000	14/9 1990	W K 90/4

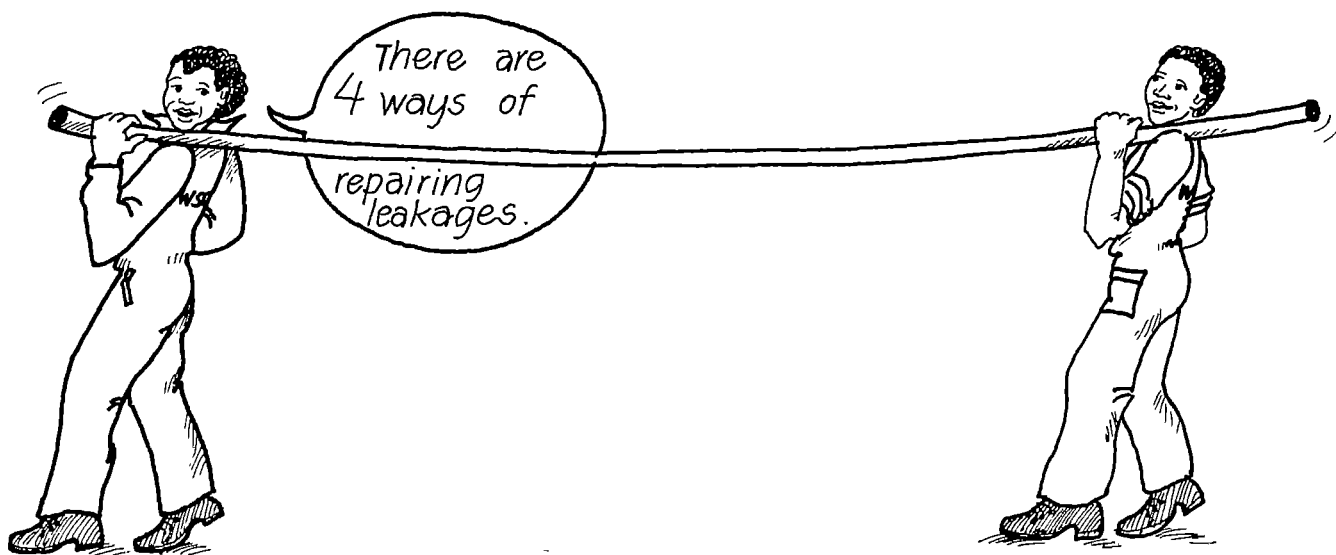
Three types of pipes are normally used:

- **P.V.C. pipes:**  
P.V.C. (poly vinyl chloride) is a type of plastic. It is sensitive to the sun's rays and so it should not be exposed to the sun for a long time. P.V.C. does not rust. It comes in lengths of six metres. The size of the pipe varies from 25 to 250 millimeters in diameter.
- **P.E.H. pipes:**  
P.E.H. (poly ethylene high density) is also a type of plastic. P.E.H. pipes come in rolls of 100 meters per roll. The size varies from 20 millimetres to 50 millimetres in diameter. This type of pipe is used in sizes of 20 to 25 millimetres for stand pipes and private connections.
- **G.S. pipes:**  
Galvanized steel pipes are often used in rocky ground. They vary in size between 20 and 250 millimeters in diameter. Probably you will not be dealing with galvanized pipes. Normally it is the job for the pipe fitter from the Water Department.

### **Leak detection and repairs**

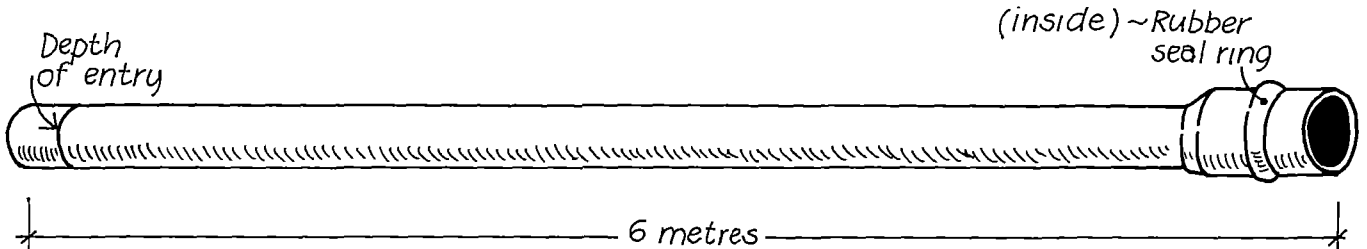
You should check the pipes daily for leakages. If you see a wet spot or a pool of water along the line you should dig down to see if the pipe is leaking. You can make a temporary repair with a piece of rubber from an inner tube and a piece of wire.

You should do repairs only on pipes from 20 millimeter P.E.H. pipes and 25 to 63 millimetre P.V.C. pipes. You should not repair main lines. When major repairs are needed, you should report to the Water Department. The leaking part of the system should be isolated immediately to avoid loss of water and contamination of the rest of the system.

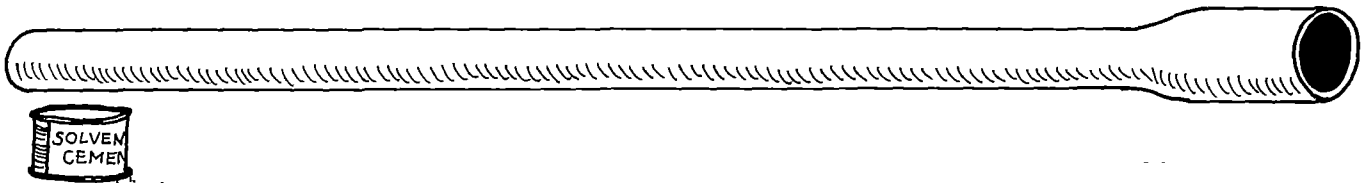


There are four ways of repairing leakages:

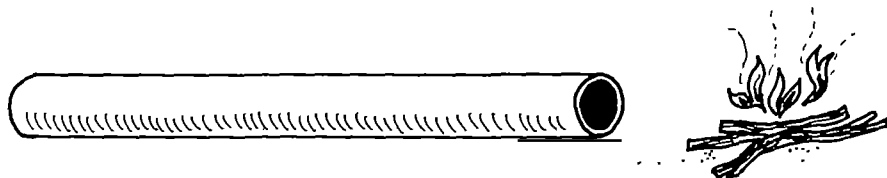
- 1. Repair of P.V.C. pipes using a socket with rubber:**  
You can use the whole pipe or a piece of pipe, but it must have a socket with a rubber seal ring inside. See how to do it on pages 92-93.



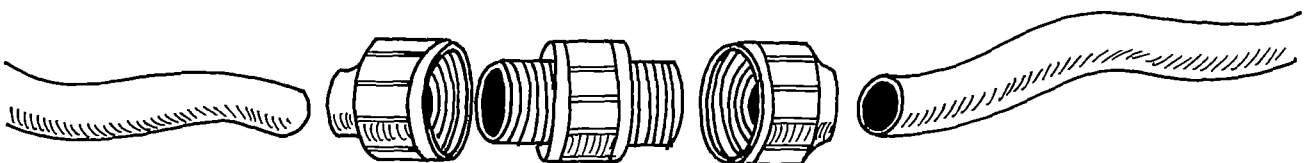
- 2. Repair of P.V.C. pipes using a socket without rubber:**  
You will need to use solvent cement as the seal. Apply the solvent cement according to the instructions. Apply the cement on the outside of the pipe and inside the socket.



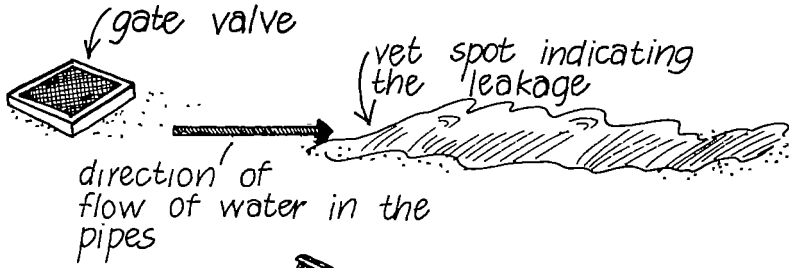
- 3. Repair using a piece of P.V.C. pipe and a fire:**  
See how to do it on pages 94-95.



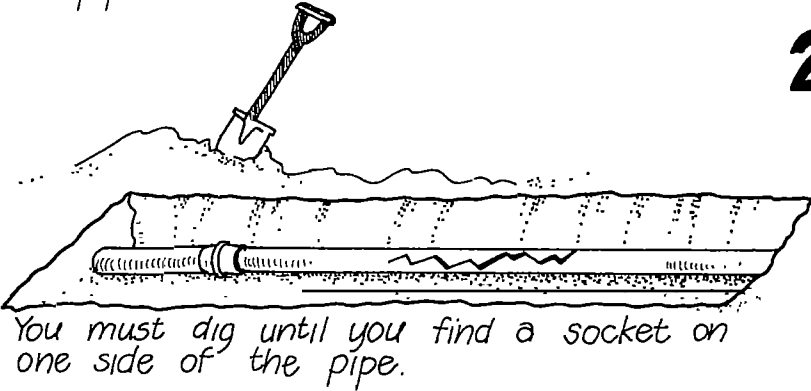
- 4. Repair of P.E.H. pipes using ready-made sockets:**  
Cut out the leaking part and replace it with a new one, using the sockets to join the pipes.



Repair of P.V.C. pipes using a socket with rubber



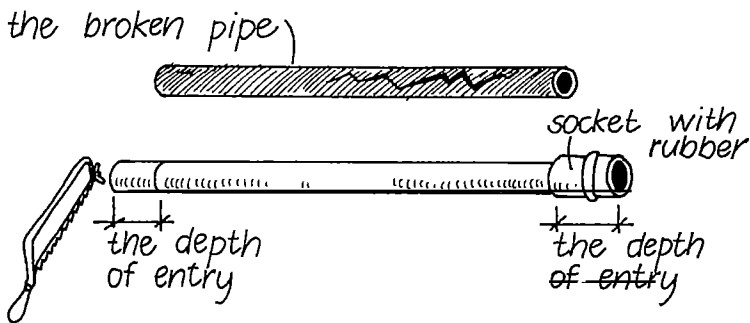
**1.** First isolate the leaking section by closing the sluice or the gate valve.



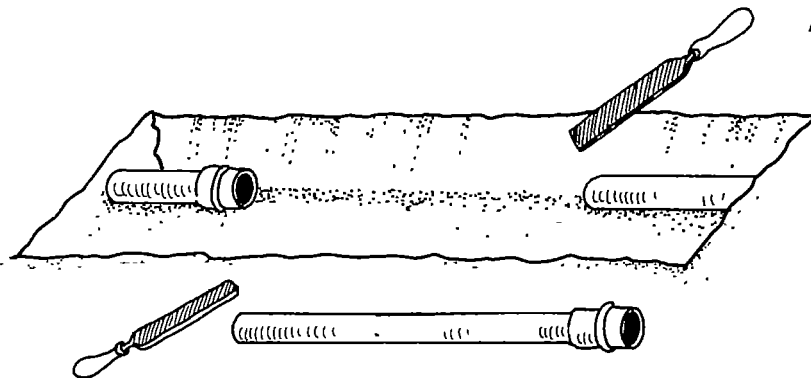
**2.** Dig a trench along the leaking pipe to find the place which needs to be repaired. Dig the trench wide enough to give yourself working space, and long enough to allow you to control the pipes to be fixed.



**3.** Cut out the leaking section with a hack saw.

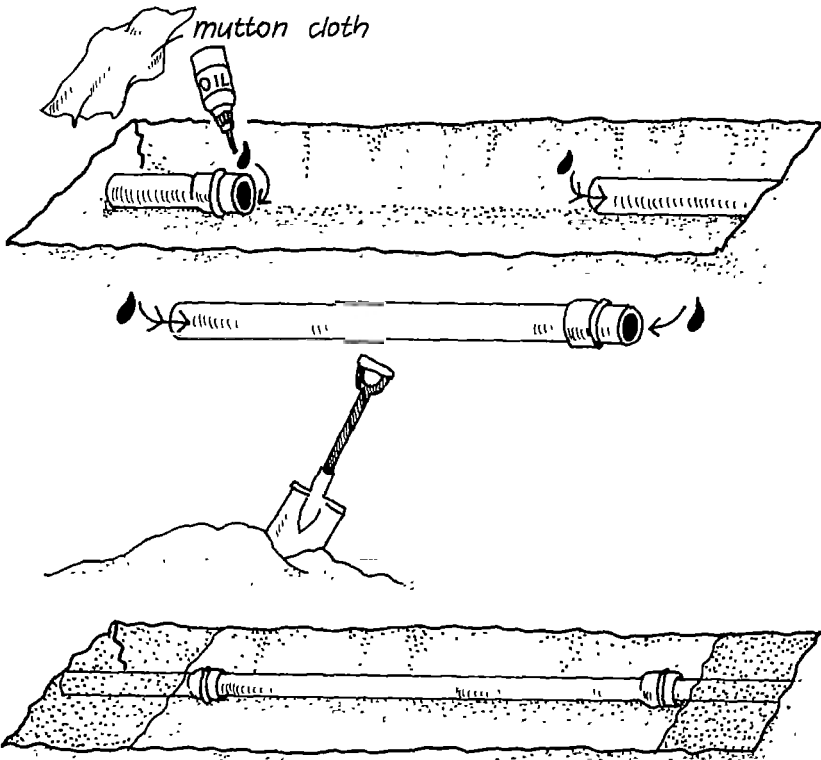


**4.** Cut a new piece. The piece must be slightly longer than the old one. Measure the length of the old piece and add the depth of entry on both sides.



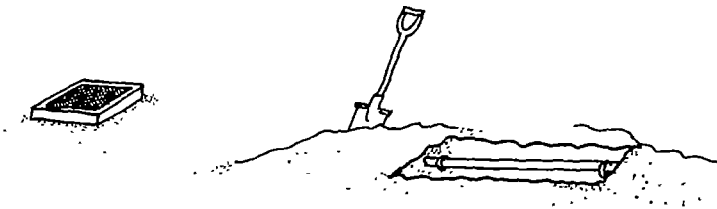
**5.** File the edges of the new piece of pipe and the edges of the pipe in the trench.



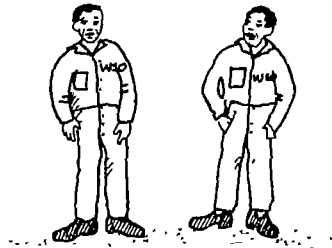


**6.** Clean the insides of the sockets and the outsides of the pipes, using mutton cloth. Apply lubricant oil inside the sockets and outside the pipes to make it easy to push the pipe ends inside the sockets. Connect the pipes.

**7.** After connecting the pipes put the soil back in the trench. But do not cover the newly connected part of the pipe.



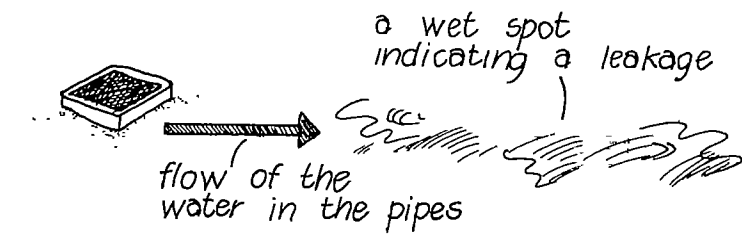
**8.** Open the valve and check to see if there is any leakage on the connections or the joints. If there is leakage, you must do the repair again. If there is no leakage, cover the rest of the trench with soft soil. Make sure that there is enough soil underneath the pipe line to support it firmly. But be sure there are no stones or other sharp objects under the pipe.



**9.** This kind of repair needs two people, yourself and your relief operator.

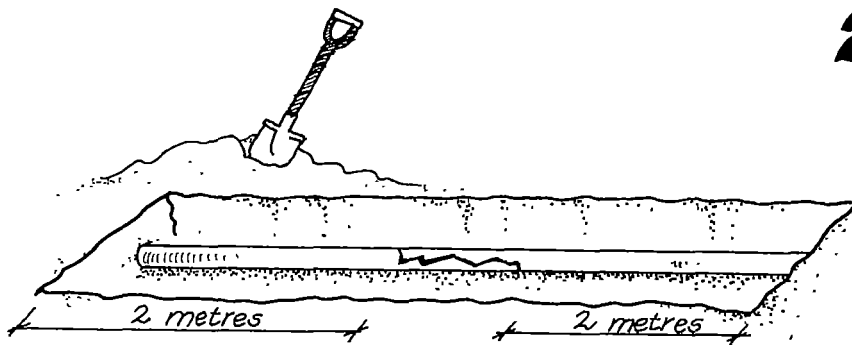
Sometimes the broken section is so big that it is better to replace the whole section of the pipe.

Repair of P.V.C. pipes using fire



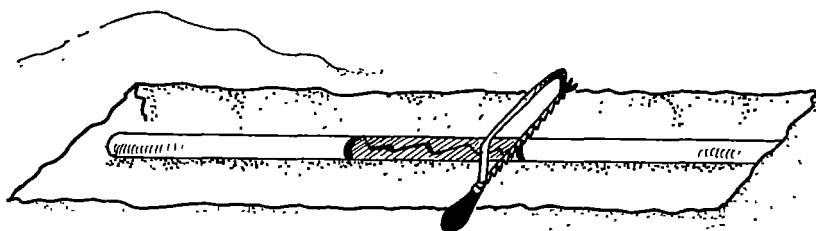
**1.**

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



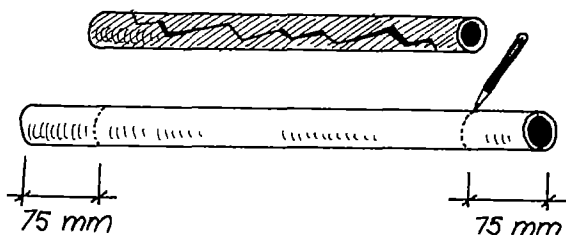
**2.**

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



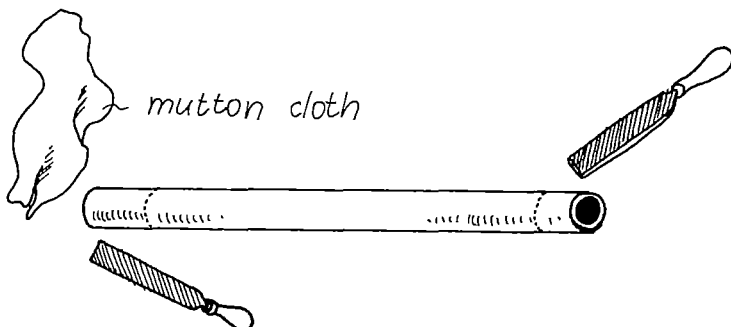
**3.**

Cut out the leaking piece. Use a hack saw.



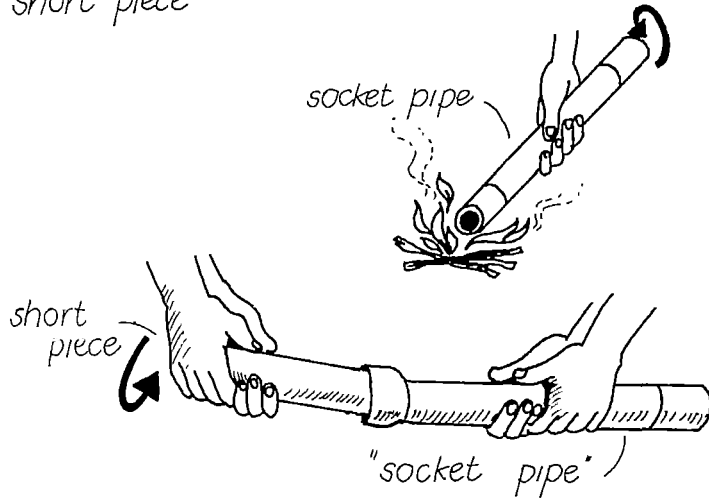
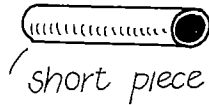
**4.**

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 pipes 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

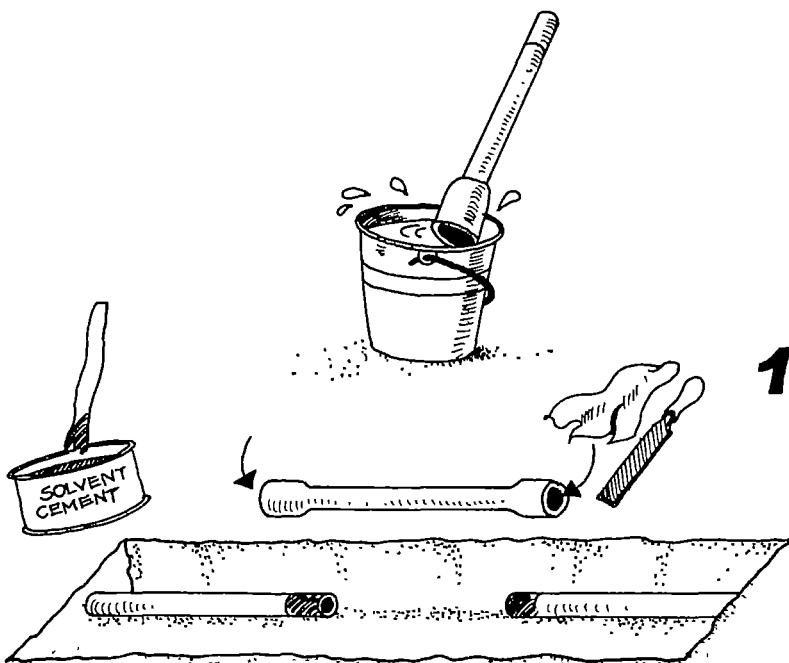


**6.** Cut a short piece of the same diameter pipe to use for forming the sockets. Make a small fire.

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

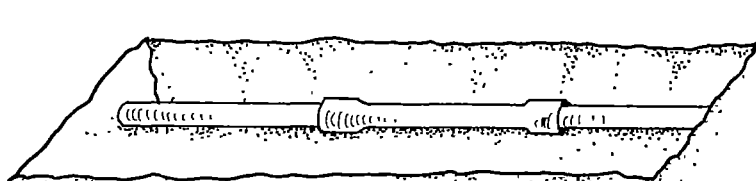
**8.** When the heated part is soft, insert the other short piece of pipe and rotate it. Keep turning it until a socket is shaped. The socket should be 75 millimetres deep.

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



**10.** File the edges of the socket pipe. Clean the ends of the socket pipe with mutton cloth.

Apply solvent cement inside the sockets and outside the pipe in the trench. Be sure to read the instructions on the tin of solvent cement. Obey the instructions.



**11.** Connect the pipes. Do not move the connection for at least five minutes.

Fill the trench except for the part which has been repaired. Do not let water go through for at least 24 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, yourself and your relief operator.

## Valves and Water Meters

There are many different types of valves, with different uses. Valves are placed in chambers. They must be inspected and kept in good condition, clean, covered and free from sand. You should look into the valve chamber to check if the valves are leaking. If so, report immediately to the Water Department.

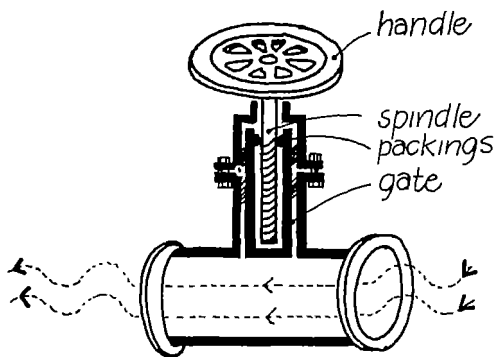
The most common valves are:

### Sluice valve

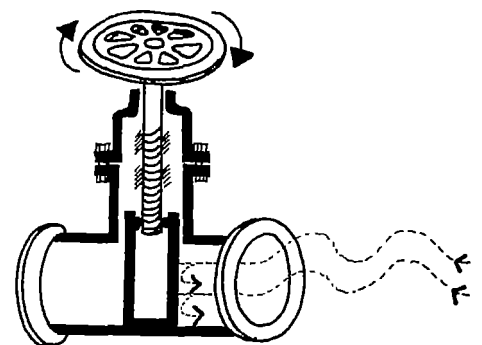
A sluice valve is used in big P.V.C. pipes from 63 millimetres up to 250 millimetres. The sluice valve has the same function as a gate valve. If the valve spindle is leaking, put in a new gland packing.

### Gate valve

Gate valves are used in every main line to close and open the supply during repair and cleaning.



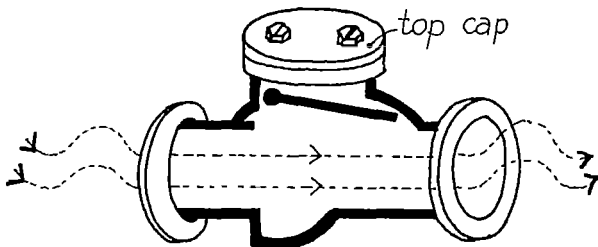
The water flows through the sluice/gate valve.



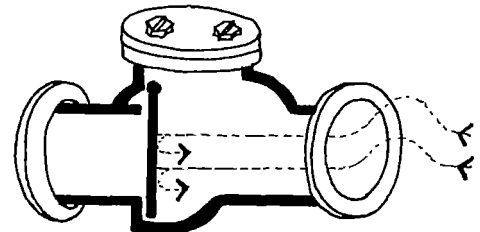
When the handle is turned the spindle moves the gate down. The valve is closed.

### Non-return valve or check valve

This valve allows the water to flow in one direction only. When the non-return valve is not working properly, you will hear water going back into the bore hole. This will cause the meter to reverse. The non-return valve is supposed to keep the water from going back and is normally fitted on the pipe inside the pump house.



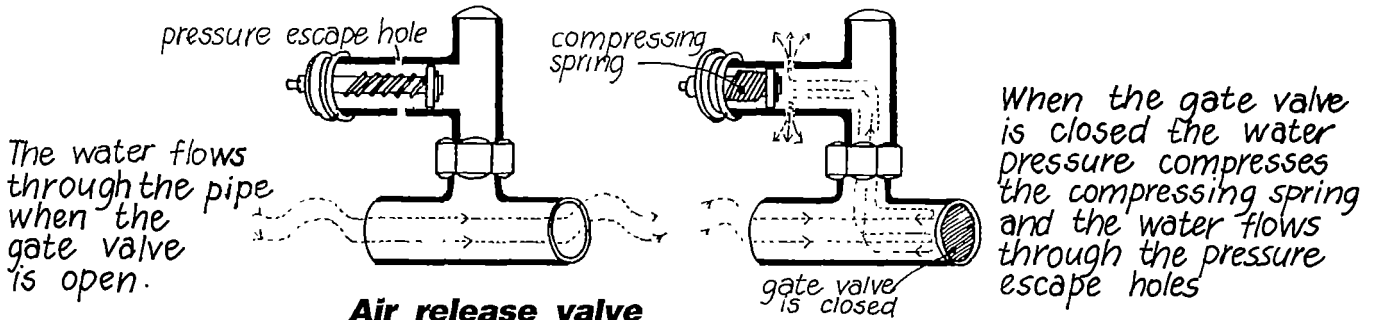
When the water flows from this direction the valve is open.



If the water would flow from opposite direction the valve would close.

**Pressure release valve**

This valve is installed on the pipe inside the pump house so that if by accident you start the engine while the gate valve is closed, it will warn you by automatically opening. This will prevent the damage to the engine, vee belts and rods in the raising mains.



**Air release valve**

This valve is installed in the main line. It is usually used for pipes that go long distances. The valve allows air that is trapped in the line to escape. This prevents damages to the system due to sudden changes in pressure.

**Wash out valve**

The wash out valves are installed at the lowest points of the pipe lines to make it easy to clean and repair the system. They are normally installed on big reticulation systems.

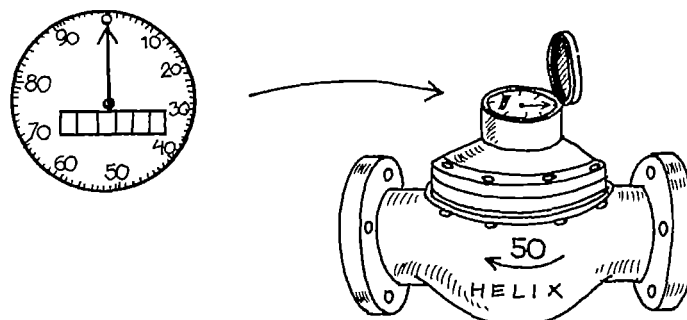
**Stop cock/valve**

On every service pipe and private connection, there should be a stop cock. This allows you to stop the flow of water, in case you want to change the water meter or prevent misuse of water, or waste of water, such as leaking toilets in the school.

**Water meter**

The water meter is not a valve; it shows how much water has passed a certain point in the system. The meter installed in private connections shows how much water the consumer has used.

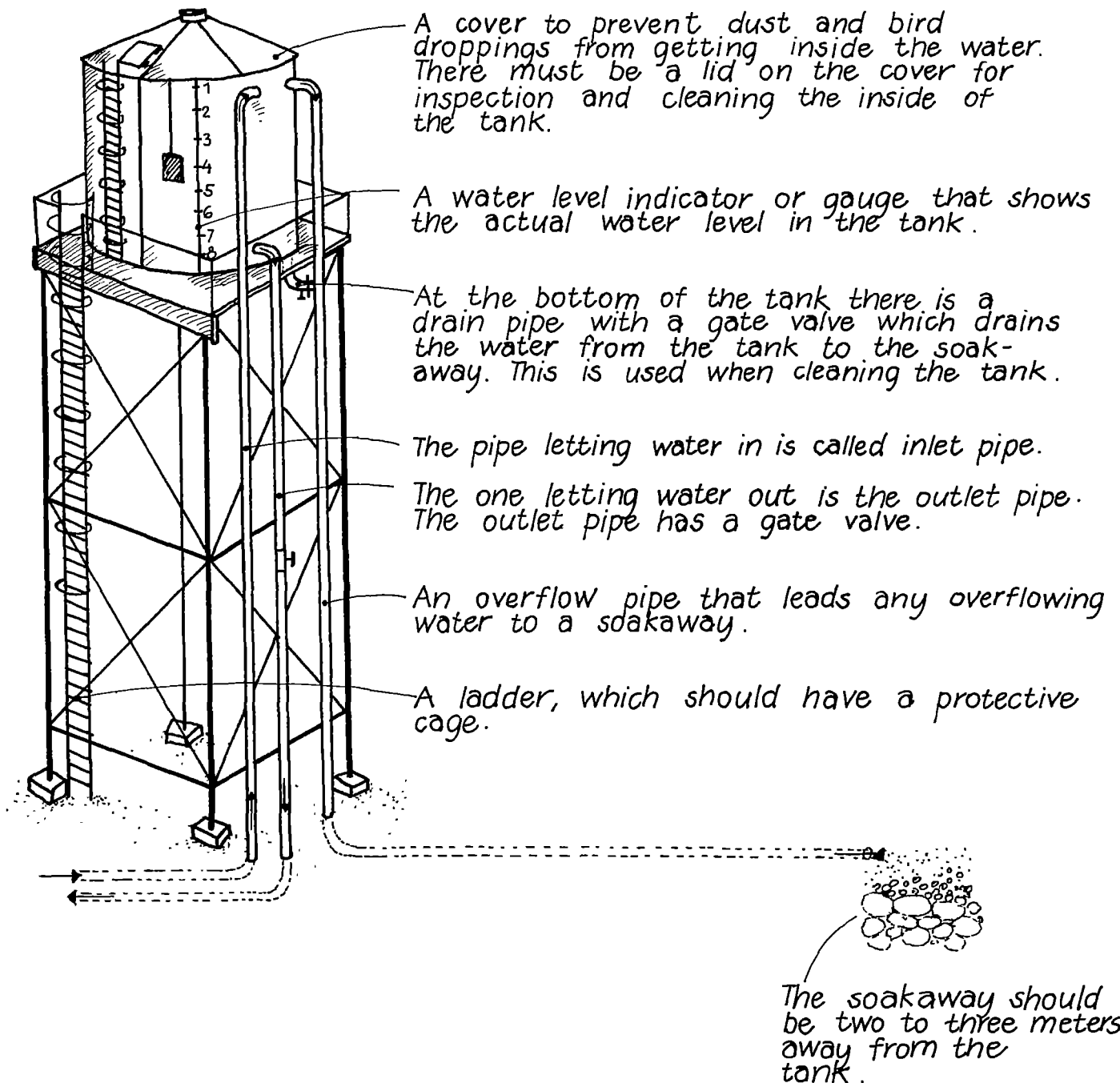
You must read the meter in the pump house every day, and enter the reading in the log book. You should also read the meter at every private connection once every month and hand over the information to the revenue collector or the Water Department. The Water Department should instruct you how to record readings from the Water meter at every public stand pipe.



## Tanks and Reservoirs

These days there are three types of tanks commonly used. These are the Lipp tank, the Hanoya tank and the Braithwaite tank. They are designed to store water and are placed at a higher position than the stand pipes so that the water will run into the pipes of the reticulation system. In this way the villagers will have water even when the pump is not running.

The water tank has the following parts:

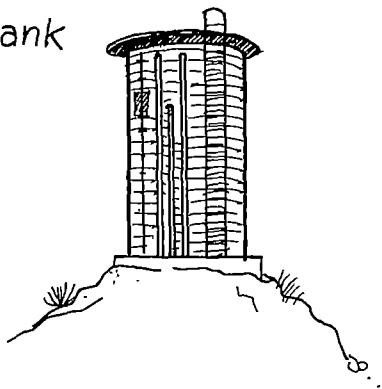


The area around the tank or reservoir should be fenced, if it is not on a hill. It should always be kept clean! No litter or rubbish should be thrown near by. Keep the weeds and grass around the tank from growing too tall. If birds make nests on the tank, take them away.

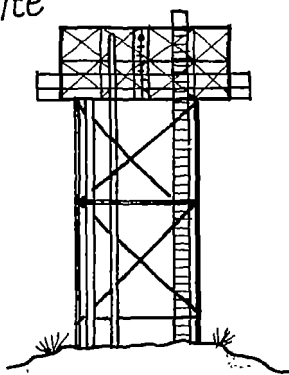
You must do a daily inspection of the tank. Check for leaks, check the roof and cover, the soakaway, and other parts. Do not allow any pools of water to form. You must clean the inside of the tank at least once a year, or more often if it gets dirty. The Water Department will provide you with the equipment you need. Never clean the tank alone! You should always have someone with you, for safety reasons.

It is very important that you make sure the tank is full every evening before you stop pumping. If you have any trouble in getting the engine started in the morning, and you need help from the Water Department, a full tank will serve the village while the repair is being done.

Lipp tank



Braithwaite tank



A tank can be situated on a hill or on a 6 meters high stand

## Stand Pipes and their Surroundings

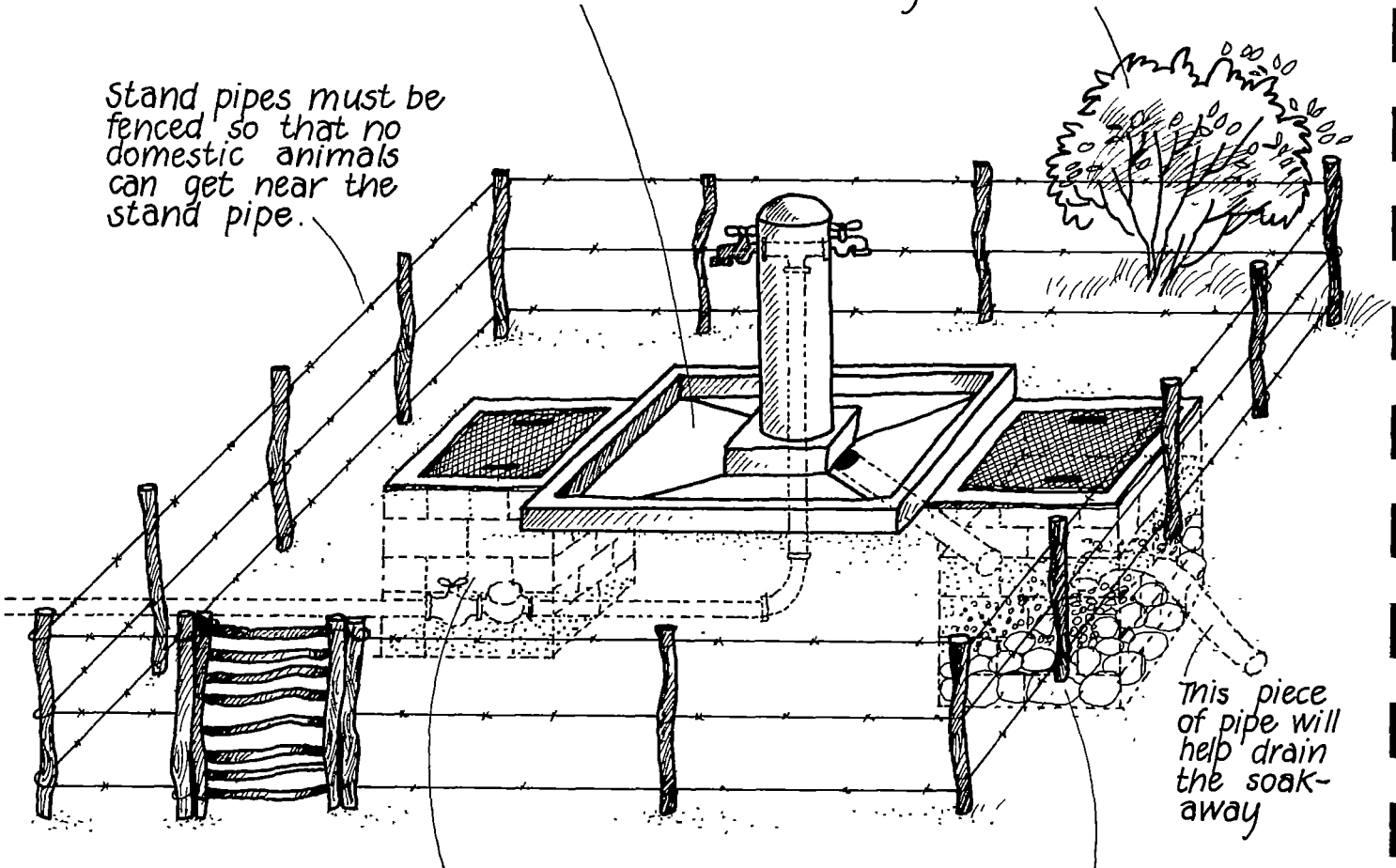
The location of public stand pipes should be discussed with the Village Development Committee and other representatives. People should not have to walk more than 400 meters (one way) to the stand pipe. It should take about one minute to fill an ordinary bucket. There should be one tap for every 100 people.

This stand pipe has two taps.

The stand pipe should have a concrete basin around the tap, with a drain pipe leading waste water to a soakaway.

Trees and bushes should be kept around the fenced area.

Stand pipes must be fenced so that no domestic animals can get near the stand pipe.



This piece of pipe will help drain the soakaway

Inside the valve chamber there are a water meter and a stop cock. The Water Department should tell you how to record readings from the stand pipe water meter.

The soakaway should be inside the fenced area. This soakaway has a lid which can be lifted to clean the soakaway. At the bottom there are stones, gravel and coarse sand. There is a lining made of cement blocks.

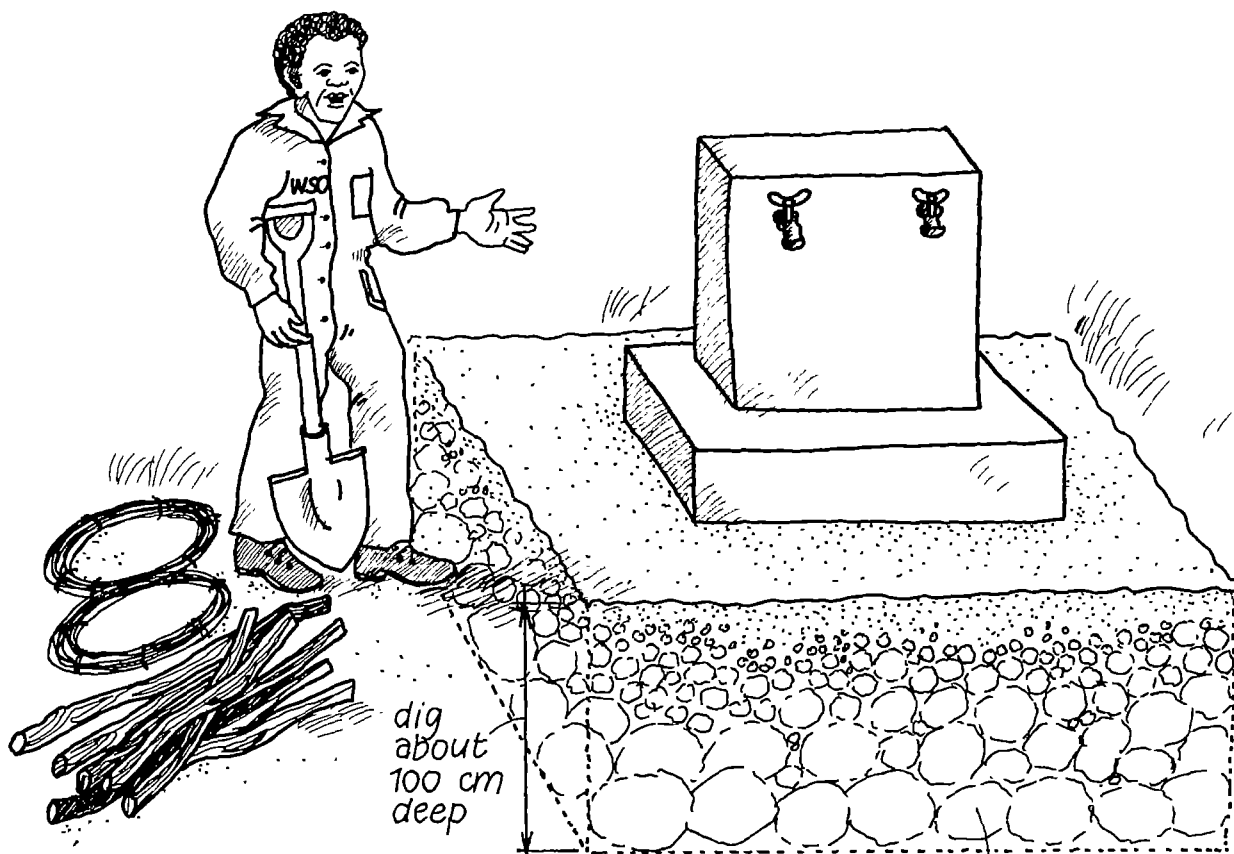


### Making a soakaway

If your stand pipes are not supplied with lined soakaways, you have to make them yourself. You can ask the people of the village to help you. Dig a pit around the stand pipe. Be careful not to damage the pipe line. Fill the pit with rocks. Put big rocks on the bottom and small ones on top. Finally, add a thin layer of sand. Check to make sure that the water soaks through the soakaway, and does not stay on top.

The pipe fitters from the Water Department can help you make an improved soakaway by building a lining for the pit.

Never allow pools of stagnant water near the stand pipe. No litter or other dirt should be allowed near the stand pipe. You should clean the soakaway when necessary by removing extra sand and dirt that has collected on the surface.



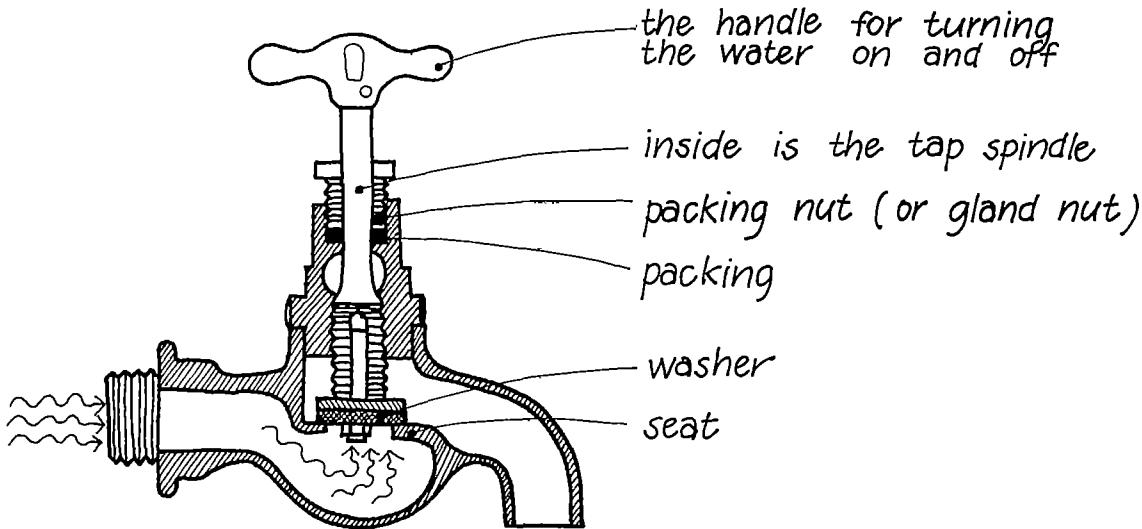
Do not forget that EVERY stand pipe should be fenced!

Soakaway pit will keep the stand pipe's surroundings dry.

### Maintaining the taps

On the tap there is a handle for turning the water on and off. Inside the tap you will find a spindle with a packing, a washer and a gasket.

This is a drawing which shows the inside of the tap.



A properly closed tap

You should check the stand pipes regularly to make sure there are no leakages. All private connections should also be checked. Pay particular attention to the council and government houses, the clinic, the post office, the school, and council officers' houses.

Some of the common problems you might find with taps are:

- **Water dripping from the tap when it is closed.**  
Cause: Worn washer or seat, or a piece of dirt on the washer.  
What to do: Change the washer. Remove the dirt, or if necessary replace the whole tap.
- **Water flowing from around the spindle or packing nut.**  
Cause: Packing nut not screwed down tightly.  
Defective packing box.  
What to do: Tighten the packing nut. Renew packings.
- **Spindle continually slipping when turned, and tap will not shut.**  
Cause: Handle loose on the spindle. Spindle thread worn out.  
What to do: Tighten the handle nut. Replace the tap.
- **Tap hard to turn on and off.**  
Cause: Packing nut too tight.  
What to do: Loosen the packing nut.
- **Loud noise in the tap when turned on.**  
Cause: Washer loose or valve loose on the spindle.  
What to do: Tighten the nut. Replace the tap.

Write down  
your questions  
and your  
comments :



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# 13.

# Tools, Spares and Consumables

This chapter covers the list of tools, spares and consumables which you should be given when you have completed your training satisfactorily.

## TOOLS AND EQUIPMENT

- 1 axe
- 1 drum stand and removable tap
- 1 step ladder
- 1 pipe wrench 14"
- 1 pipe wrench 18"
- 1 flat file
- 1 screw driver set
- 1 shifting spanner, 200 millimeters
- 1 shifting spanner, 450 millimeters
- 1 pair water pump pliers
- 2 Ring Open End Spanners, 19 millimeters
- 1 Ring Open End Spanner, 10 millimeters
- 1 Ring Open End Spanner, 11 millimeters
- 1 steel brush
- 1 soft brush
- 2 brooms with handle, one hard brush and one soft
- 1 oil can - one litre, calibrated
- 1 fuel can - two litres, calibrated
- 1 steel jerry can, 20 liters
- 1 oil filter removal tool
- 1 water hose, five meters
- 1 set Allen keys
- 4 locks, 35 millimeters (for pump house, tool box, gate and store)
- 2 overalls
- 1 pair of rubber gloves
- 1 pair of rubber boots
- 2 funnels with strainers
- 1 pair of leather boots
- 1 raincoat
- 1 pick
- 1 spade or shovel
- 1 galvanised bucket, 20 liters
- 1 pair of combination pliers
- 1 pair tin snips
- 1 safety helmet
- 1 safety belt
- 1 torch
- 1 tool box, lockable, with inventory list
- 1 rake
- 1 diesel tray

- 1 hack saw, frame and blades
- 1 roll fish line (for alignment)
- 1 five-meter measuring tape
- 1 hammer

**SPARES AND CONSUMABLES**

- 10 tap washers (different sizes, if needed)
- powder soap
- floor soap
- hand cleaner
- solvent cement
- 5 taps
- pipe lubricating oil
- gland packings for Mono head
- hemp
- PVC plain sockets (2 each size)
- 2 (T.E.H.) Plasson connectors
- mutton cloths for cleaning
- 1 oil filter, complete
- 1 fuel filter element
- 1 air filter element
- note books, pencils, pen, carbon paper, lever arch file, log book
- spare bolts and nuts
- threading tape
- batteries for torch

Some of the items on these lists will be given to you only after you have shown that you know how to take proper responsibility for them. You must sign that you have received these tools and equipment. You would normally have to pay for things which get lost or stolen.

Write down  
your questions  
and your  
comments:



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# 14.

## Check List

for the follow-up of training of the Village Water Supply Operator:

Name of Village: \_\_\_\_\_

District: \_\_\_\_\_

Name of operator(s): \_\_\_\_\_

Name of trainer/inspector: \_\_\_\_\_

Date of follow-up: \_\_\_\_\_

Tentative date for next follow-up: \_\_\_\_\_

Type of engine: \_\_\_\_\_ Type of pump: \_\_\_\_\_

Type of reticulation system: \_\_\_\_\_

Type of reservoir: \_\_\_\_\_ Number of stand pipes: \_\_\_\_\_

<b>A</b>	<b>The pump house and its surroundings</b>						Remarks
		Bad	Not satisfactory	Average	Good	Excellent	
1.	Fence around the protected area						
2.	Cleanliness of the protected area						
3.	Cleanliness of the pump house						
4.	The condition of the pump house						
	a. roof, walls, door, lock						
	b. ventilation						
	c. floor and foundation						
5.	Storage of						
	a. fuel, oil, lubricants						
	b. tools (make inventory)						
6.	Disposal of waste, oil, fuel, clothes, used spare parts, etc						
7.	Map of Village Supply System						

<b>B</b>	<b>Engine and pump</b>	Bad	Not satisfactory	Average	Good	Excellent	Remarks
1.	Cleanliness of the engine						
2.	Condition of air cleaner						
3.	Condition of oil filter						
4.	Condition of fuel filter						
5.	Foundation bolts for pump, engine, frame						
6.	Nuts, screws on engine						
7.	Cooling system						
8.	Leakages of oil, fuel						
9.	Lubrication and greasing of engine and clutch						
10.	Exhaust system						
11.	Starting and stopping of engine						
12.	Belt condition and tension						
13.	Condition of gland packings						
<b>C</b>	<b>Pipelines, stand pipes, reservoir</b>	Bad	Not satisfactory	Average	Good	Excellent	Remarks
1.	Condition of main water meter						
2.	Condition of tap in pump house						
3.	Condition of fittings in pump house						
4.	Pipeline and valve markers						
5.	Condition of valve chambers						
6.	Cleanliness of stand pipes and their surroundings						
7.	Condition of taps						
8.	Fencing of stand pipes						
9.	Condition of soakaways						
10.	Condition of private connections						
11.	Condition of reservoir						
12.	Cleanliness of reservoir and the surroundings						
13.	Fencing of reservoir						

<b>D</b>	<b>Reporting, safety relations</b>	Bad	Not satisfactory	Average	Good	Excellent	Remarks
1.	Log book keeping						
2.	Breakdown reporting						
3.	Safety precautions, protective clothing, appearance in the pump house						
4.	Cooperation and relation with village committees						
TOTAL NUMBER OF TICKS (A-D)							
X	Multiply the total number of ticks by:	- 2	- 1	1	2	5	
=	equals to NUMBER OF DEVELOPMENT POINTS						

**TOTAL NUMBER OF DEVELOPMENT POINTS:**

<b>E</b>	<b>Other remarks, decisions etc.</b>

\_\_\_\_\_  
Signed by operator

\_\_\_\_\_  
Signed by trainer





