WASHE
water · sanitation · health education
in Zambia

FIRST EDITION

Technology for Rural Water Supply

Jetted Well Standard Construction Details

Supplementary Module 2e

ONE ZAMBIA ONE NATION

DISS 2002

CONTENTS

Preface

In 1993 the Government of the Republic of Zambia (GRZ) initiated the water sector reform process that was aimed at the improvement of water supply and sanitation (WSS) services. Many changes have taken place in the sector since the initiation of the water sector reform process, the major ones being :

- the formulation and adoption of the National Water Policy in 1994
- the enactment of Water Supply and Sanitation Bill in 1997
- the development and adoption of the National Environmental Sanitation Strategy for Rural and Peri-Urban Areas in Zambia in 1997
- development of the Community WSS strategy 1999
- development of the Peri-urban WSS strategy 1999
- formation of National Water and Sanitation Council 1999

- National Water Policy 1994
- Water Supply and Sanitation Act No. 28 of 1997
- National Environmental Sanitation Strategy for rural & peri-urban areas
- draft CWSS Strategy 1999
- draft peri-urban WSS strategy 1999

The formulation and adoption of the National Water Policy in 1994 with the national goal of universal access to safe, adequate and reliable WSS services, has resulted into elaboration of community management strategies for integrated rural water supply, sanitation and hygiene education. Although a lot of progress has been made since the adoption of the National Water Policy, much still remains to be done beyond the year 2000. It is believed more progress could be achieved if the stated policy measures are persued and implemented. The National Water Policy measures are:-

National Goal: Universal access to safe, adequate and reliable WSS services

- to ensure that Rural Water Supply and Sanitation (RWSS) programmes are community based
- to develop a well defined investment programme for sustainable RWSS
- to develop cost recovery approaches as an integral part of RWSS
- to promote appropriate technology and research in RWSS
- to develop and implement a well articulated training programme

It is evident that adoption of the National Water Policy meant profound changes had to be made on how RWSS should be dealt with in future. Starting with the elaboration of community management strategies for integrated rural **Water** supply, **S**anitation and **H**ygiene **E**ducation which has subsequently developed into the WASHE strategy. WASHE strategy is a people oriented, inter-sectoral and integrated approach to planning, implementation and management of RWSS and hygiene initiatives.

WASHE is:

- people oriented.
- Inter-sectoral and integrated approach for RWSS

The adoption and implementation of WASHE with its emphasis of community management approach implies that agencies do not start with a detailed blue print but formulate guidelines that will facilitate community involvement and participation in planning, implementation, maintenance, management, monitoring and evaluation of programmes. The key concept that has emerged from WASHE is the partnership approach between communities and support agencies. Experience has shown that communities can take more responsibilities in the development of their projects when their capacities are enhanced.

Community Management means:

- Responsibility: the community assumes ownership of "the system" and "the process"
- Control: the community has the power to implement its own decisions
- Accountability: the community accepts the consequences of its decisions and understands that action rests with them
- Authority: the community has the right to make decisions about the action (intervention) taken to change their situation

The experiences gained in RWSS projects has also helped to understand that there is no sustainable development without human development (i.e. increasing the capabilities of people) and it should also be noted that no one can develop an individual or community except themselves. The role of a support agency is therefore to create an enabling environment in which individuals and communities can be creative, take initiative and assume responsibility by maximizing their potential for their development. This could be done through the use of participatory techniques.

Key concept in WASHE is the partnership between the community and support agencies

Working in close collaboration with thousands of communities means that support agencies need to be flexible and be able to adapt to changes that fit local organisations, indigenous knowledge, systems, skills and local needs. Realising that no two communities are alike, joint decision making with communities implies working in environments that can not be standardized and are relatively unpredictable and uncontrollable. It is obvious that no agency would want to be in such a position, hence the role of the agency is to reduce the unknown and the unpredictable to manageable proportion. This can be done by designing a learning environment through the development of the problem solving capacity within the agency and the communities.

In order to support the promulgation of the WASHE strategy to all levels of government and participating partners, GRZ proposed the establishment of National WASHE Co-ordinating and Training Team (N-WASHE). The team was established in April 1996 with the support from the Irish government. The main function of the team was to facilitate the establishment and development of intersectoral district committees (i.e. popularly known as D-WASHEs) in each district. The primary function of these district committees is to co-ordinate all water supply and sanitation programmes in their areas through joint development of integrated programming and planning. This entails district responsibility for co-ordinating planning, resource mobilisation, management and implementation of district specific rural water supply and sanitation initiatives.

The WASHE concept was formally launched by the two ministers of Energy and Water Development and Local Government and Housing at the first National Water Fair in Livingstone in May 1996. Since then the WASHE strategy has received considerable support from government, donors and NGOs working in the sector. All donors and NGOs active at district and field levels have adopted the WASHE strategy not only conceptually but through the provision of financial and human resources to support the training required for the establishment of D-WASHE and more recently village or V-WASHE committees. The major support agencies include Ireland Aid, UNICEF, JICA, DFID, GTZ, SNV, Africare and Water Aid. Since the launching of the National WASHE Team a total of 63 D-WASHE committees have been established and are functioning. It was the objective of the N-WASHE Team to establish D-WASHE Committees in all districts in the country with their development being a continous process.

ACKNOWLEDGMENTS

We acknowledge the valuable contributions made by many people and organisations involved in WASHE programmes, who have made it possible to develop this manual.

The DISS would like to especially acknowledge the tremendous contributions from the CEP Team Mongu, Western Province where the WASHE concept was 'conceived'. We would also like to thank all our partners who have shared their experiences in implementing WASHE in Zambia.

Management of the National WASHE Team, comprising Mr. Isaac Mbewe, the late Mr. Maurice Samani and all other team members did a lot to execute the WASHE concept throughout the rural provinces of Zambia, making the approach a success todate.

The research, development and production of this publication would not have been possible without considerable financial support from Irish Aid, for which we are most grateful.

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Section
1

Background

1.0 BACKGROUND

Work done by the Department of Water Affairs in Western Province of Zambia has shown that well jetting has a considerable potential for putting in place reliable water facilities both cheaply and quickly, where suitable groundwater conditions exist. Suitable conditions are typically alluvial, but excluding rock, thick beds of heavy clay where jetting is very slow and unstable sand which tends to collapse around the jetting pipe.

In Western Province of Zambia the water table is commonly encountered within the first 10 - 15m, the overlying soils being alluvial deposits often free of boulders or gravel deposits in most cases. Jetted wells have been sunk in these soil conditions. They have been sunk to support the groundwater development in areas where communities do not meet some of the selection criteria for borehole construction. They are also sunk in areas that are not accessible by large drilling equipment but have the potential for groundwater development and can be reached by light transport.

There are other parts of the country where conditions are suitable for well jetting down to the depth of 15 - 20m. It is therefore worth exploring such areas to construct jetted wells as an alternative in unconsolidated conditions to provide clean safe water supply facilities to the rural communities.

1.1. Module Objective

This module gives information on the construction of jetted wells in suitable soil conditions in Western Province of Zambia. This information will be helpful to planners and engineers in exploring other areas with conditions similar to those of Western Province, and to explore construction of jetted wells.

Section
2

Siting and location of well

Well construction

2.0 SITING AND LOCATION OF A WELL

Siting and location of the well point is a paramount issue. The well point should be sited or located where there is a possibility of having adequate water within the depth range stated above under section 1.0.

The community/users ought to be consulted in choosing the site. They must feel that the site is suitable in terms of distance from homesteads. Thus the site must be acceptable to the communities/users and issues of post-construction maintenance should be agreed upon by the community/users.

Other factors to take into consideration when siting a well point are as follows:

- site formation:- assistance should be sought from technically qualified personnel or institutions to ensure hydrogeological conditions are suitable for jetting (i.e. unconsolidated soil formations variation of water table should be within 3 or 4m)
- the site should be in an elevated ground so that during rainy season runoff will drain away from it rather than into the well.
- the site should be located at least 30m away from a latrine and uphill of a latrine where possible and feasible. Where the uphill location is not feasible it should be at least 30m from the pit latrine.
- the site should be at least 30m away from graves and animal kraals and should be uphill of the same.
- the site should be well away from a depression in the ground which will induce pollution in the aquifer.

THE JETTING PROCESS (WELL CONS TRUCTION)

Having selected the site, the same is then prepared for the construction to start.

With all the equipment in place the sinking of the well most often is started by hand auguring to provide a vertical and well aligned hole. In shallow water table conditions the hole is augured down to the water table. The jetting assembly is then lowered into the augured hole. (see illustration). The hole is then cut by a combined action of a water jet pumped through the jetting pipe at high pressure impinging on the soil surface and the rotary or percussion action of the cutting head (or jetting head). The assembly is lowered in the hole by the crane in the Western Province system, by two operators manually in the Vera Cruz system or by the pulley in the Tripod arrangement. The cut material is carried to the surface by the flow of water through the annular space between the jetting pipe and the wall of the well, thereby making way for the jetting pipe to penetrate deeper into the ground or aquifer. When the first drill pipe penetrates the formation the flow of water is stopped and the next section of the pipe added. The jetting process is started again until the hole is jetted to the required depth usually 10 - 15m or more provided rock or gravel bands are not encountered.

2.1 JETTING IN VARIOUS CONDITIONS

Alluvial deposits in which jetting can be successfully done as mentioned already consists generally of the following soil conditions:

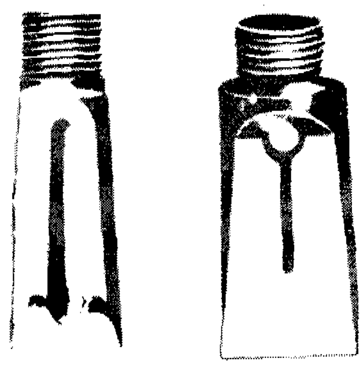
i) Dense clay soils

ii) medium textured soils

iii) light sand soil

2.1.1 Dense Clay Soils

In dense clay soils the rate of jetting is generally reduced and becomes slow. More force will be required to penetrate the formation to the required depth. The Vera Cruz experience reveals that it may take 7 hours to jet a 9m hole. In such soils rapid penetration can be enhanced by employing the spudding percussion which is imparted to the drive head by an increased number of workmen or by a hoist. A fluted or chisel head is recommended as jetting head to improve penetration in clay soils.



Bits for jetting in clay soil Diagram

2.1.2 Medium Textured Soil

In these soils the jetting system works well. Penetration is achieved by simply twisting the jetting pipe back and forth whilst applying some pressure. The rate of penetration can be as high as 1m per minute but the overall jetting time to a given depth is principally determined by the time required to add additional lengths of jetting pipes. Under normal circumstances a 10m well can be completed in three to four hours.

2.1.3. Light Sandy Soils

In light sandy soils the jetting system produces very good results, but a point is reached when the sand in the profile behaves like a fluid around the jetting pipe. Under these conditions the pipe sinks under its own weight. However when water flow is stopped the pipe becomes jammed as the sand flows in around it. The system can thus not be recommended where significant depths of pure sand are found in the profile. If it is desired that greater depths be achieved then drilling mud should be used. The drilling mud is pumped through the drill pipe down the hole. As it flows upwards through the annular space it carries along with its cuttings and the fluid sand situation on the wall of the hole is stabilised and allows the well to stand to completion time.

2.2 CASING INSTALLATION

When the well has been jetted to the desired depth and diameter the jetting systems is withdrawn from the well and well casing is installed in some instances the jetting pipe and Johnson screen used as the jetting nozzle are left in place as casing pipe and screen respectively. Where the jetting system is withdrawn and the well is cased in such a manner that the screen end is in the aquifer while the plain casing part is above the water table. The bottom end of the screen should be plugged off. This is to prevent uplifting of the fine particles or sand boiling up into the well.

2.3. GRAVEL PACK

When the casing pipe is installed a gravel filter is placed around the well screen. The filter material should be well washed, graded and have high porosity and permeability. The grading is similar to that done in deep wells with larger grain size close to the screen and in diminishing manner small grain particles to the wall of the well. The purpose of the gravel pack filter is to prevent fines moving from the wall of the well into the well.

2.4 GROUTING

This is the process whereby a mixture of concrete is used to fill the upper (0-1m) annular space between the casing and the wall of the well to seal off contaminated waters from the surface. After the well has been gravel packed to the desired column above the water table the remaining annular space should be grouted (see later).

2.5 WELL STRUCTURE

i) The jetting depth

The average drilling depth of jetted wells is determined by the prevailing hydrogeological conditions which has been described already in this report. It ranges between 10 - 15m both in the cases mentioned in this report (i.e. the Western Province of Zambia and Vera Cruz - Mexico)

ii) Diameter of the Well

The diameter of the well is 100 - 105mm. This diameter is sufficient to serve the population the well are designed for (200 people per water point).

iii) Casing pipes and well screens and bottom plug.

In some instances the jetting pipe and Johnson screen become the plain casing and screen respectively on completion of the well. The function of the bottom plug is already explained in this module.

iv) Grouting

The uppermost section of the well should be grouted as already stated above. The grout is to seal this section of the well against contamination or polluted water intrusion.

2.6 WELL DEVELOPMENT

Well development is the term used to describe the process which is undertaken after a well has been constructed to ensure good yield and quality (i.e. water which is clear and relatively free from suspended matter).

The objective of well development therefore is to remove the silt, fine sand and other materials from the well and the zone immediately around the screen. This process creates passages in the aquifer through which water can flow more freely towards the well.

In addition well development produces two other benefits as follows:-

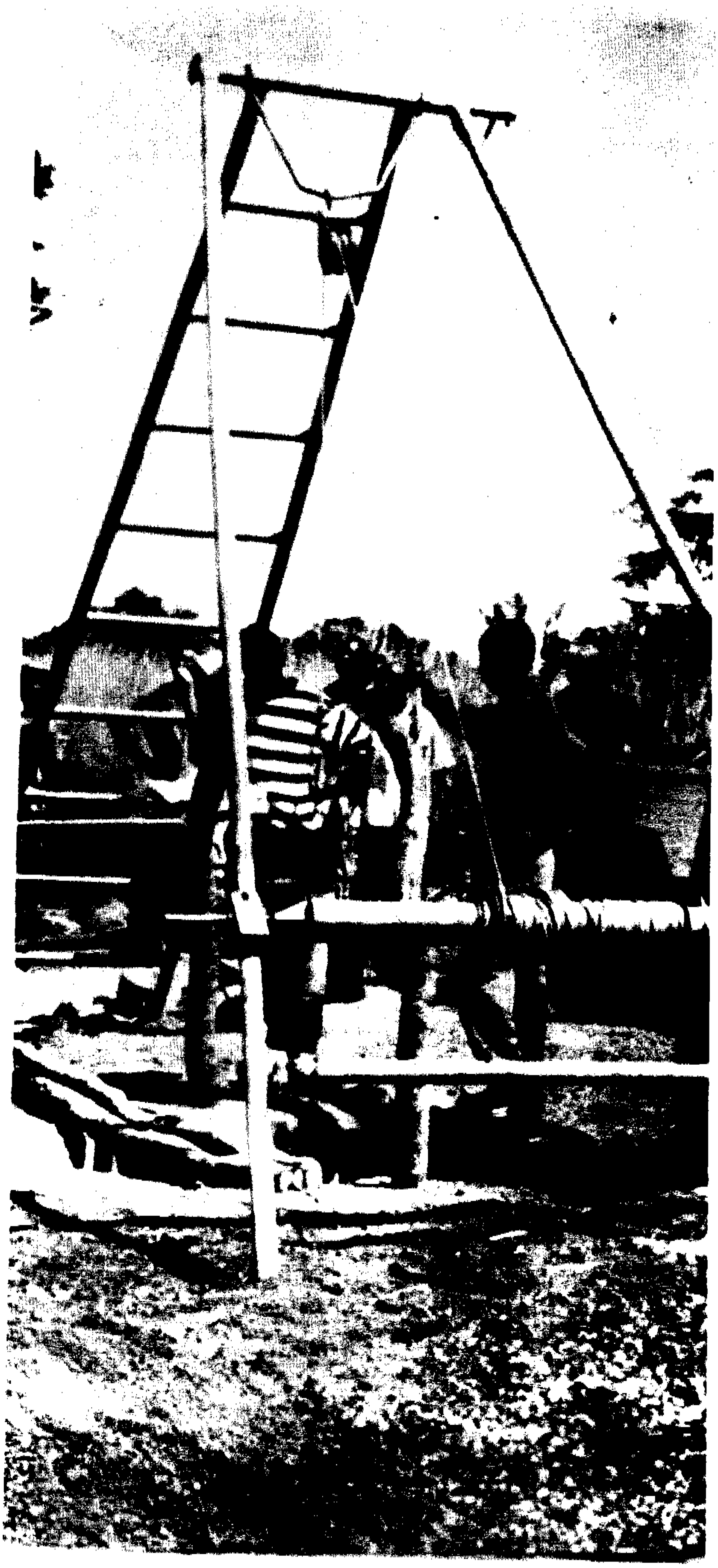
i) It corrects any clogging which might have occurred during construction especially where mud drilling is used.

ii) It grades the material in the water bearing formation immediately around the screen in such a way that a stable condition is achieved.

The jetted well is developed by over pumping using a portable motorised pump until clear water is obtained. This technique of development is used in Western Province of Zambia and in Vera Cruz - Mexico.

2.7 PUMP TESTING (PUMP PERFORMANCE)

The performance of jetted wells should be assessed. The yield of the wells when pumped either manually or by motorised driven suction lift pumps, is dependent on the permeability of the aquifer and the static water table depth. In the case of wells equipped with hand pumps the yield is usually restricted by the pump itself to about 0.36L/s. Wells in clay formation may sustain the rate of pumping for shorter periods than those in sandy formations which can sustain this rate indefinitely. For domestic wells which can supply 80 litres of water at one time is quite adequate. When pumping with 50mm centrifugal pump in a sandy aquifer a 105mm well can sustain a yield of approximately 1.5lts.



Section
3

Jetting Equipment

3.0. WELL JETTING EQUIPMENT

3.1.WESTERN PROVINCE EXPERIENCE

The major components of the well jetting system used in this country (Western Province) comprises the following:

i) A tractor equipped with a crane (for lifting the jetting assembly). The tractor also provides the means to transport crew members and materials

ii) Trailer onto which the materials are loaded

iii) Water tank (for jetting water storage)

iv) Pumping equipment for pumping water into the storage tank and for well construction.

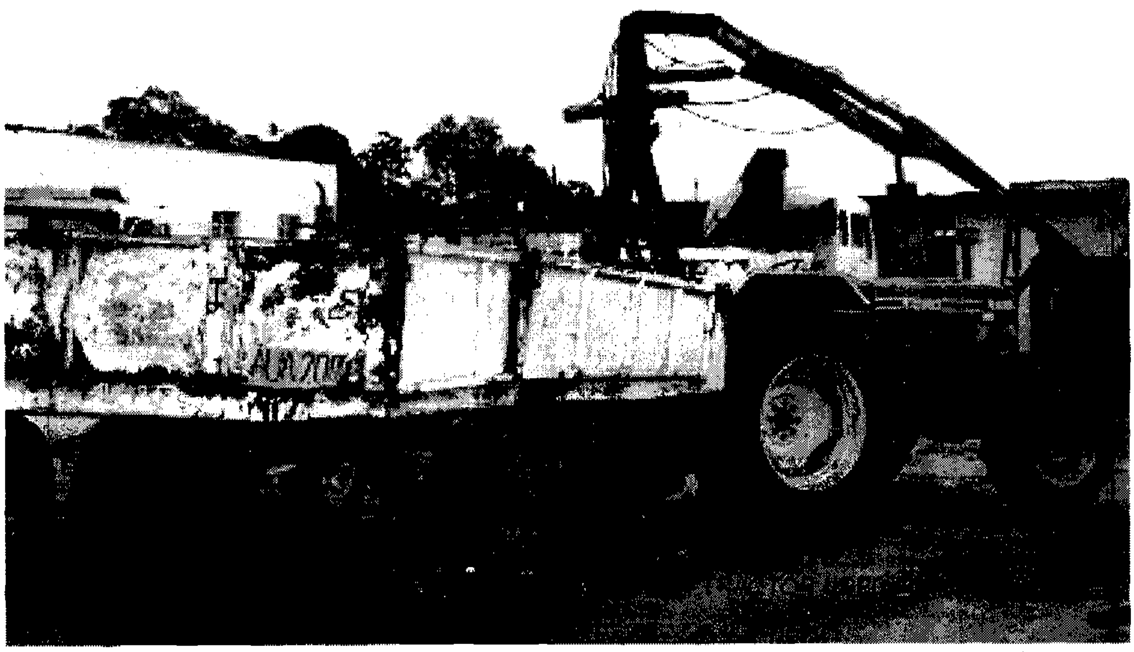
v) 75mm GI pipe (for casing and as part of the jetting assembly)

vi) 50mm Johnson Screen (used as a jetting head during construction and as screen during operation.

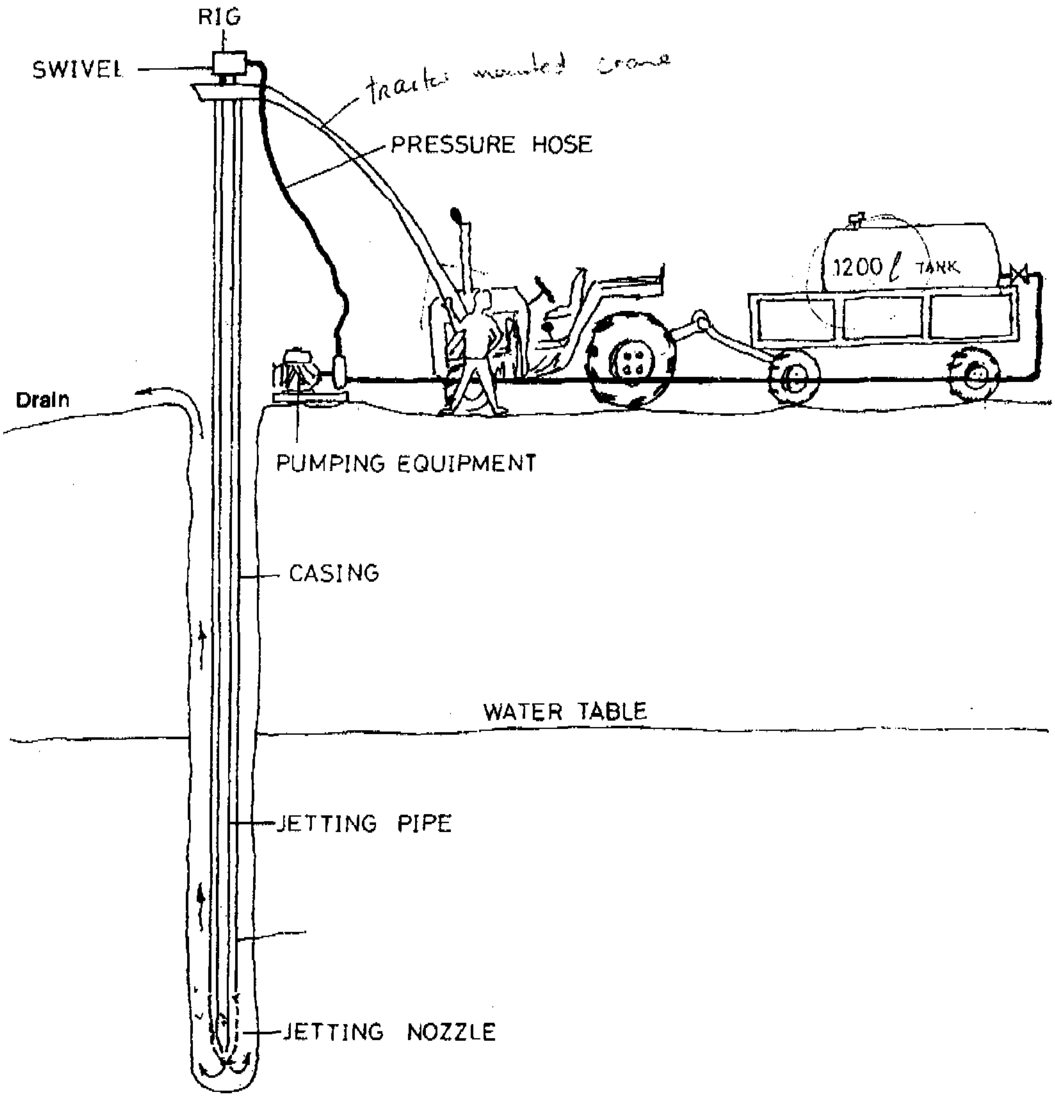
vii) 25mm GI pipe (used as a jetting pipe)

viii) Hand auger (to auger the hole down to water table when starting)

ix) 25mm and 50mm pressure hose for outlet and inlet connections



Tractor and crane for jetting: photo taken from Western Province



JETTED WELL CONSTRUCTION

3.2. Other Global Experiences

Other arrangements that can be replicated in this country are as follows:-

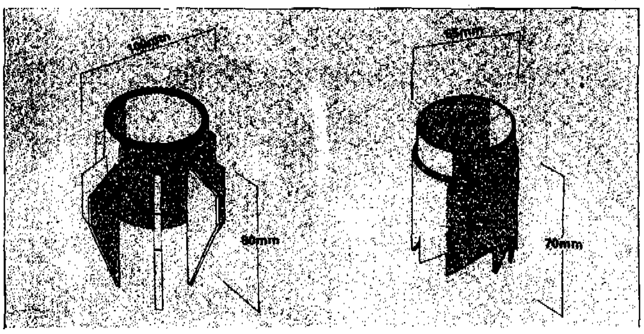
i) The Vera Cruz arrangements: This arrangement comprises the following components: -

- a lorry (should be a light truck) for transportation of crew equipment and material
- six galvanised steel jetting pipes of 32mm ID and 1.5m long
- one jetting pipe of the same diameter but 3.0m long. All the jetting pipes carry two sets of locating lugs enabling

the handling tools to be suitably located for the jetting pipe. (see illustration)

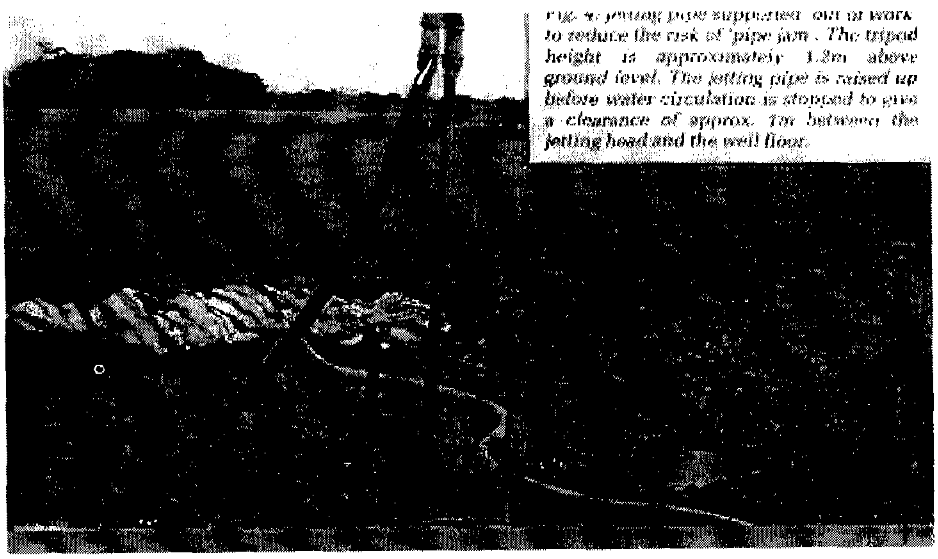
- jetting heads:- the size and format of the head used depends upon the diameter of the well the Vera Cruz arrangement uses two of the format illustrated below for light and medium textured soils.

Cutting heads for medium textured soils



- two handling tools shown in illustration
- two supports on which handling tool can be rested when the system is out of operation or when additional pipe sections are being connected.
- a 50mm centrifugal pump
- 10mm of 50mm suction horse to run between pump and water source.
- 15m of 50m delivery hose connecting the pumps to the jetting pipe by means of a 180" coupling
- a tarpaulin used to line the water reticulation pump

Mexico arrangement for well jetting

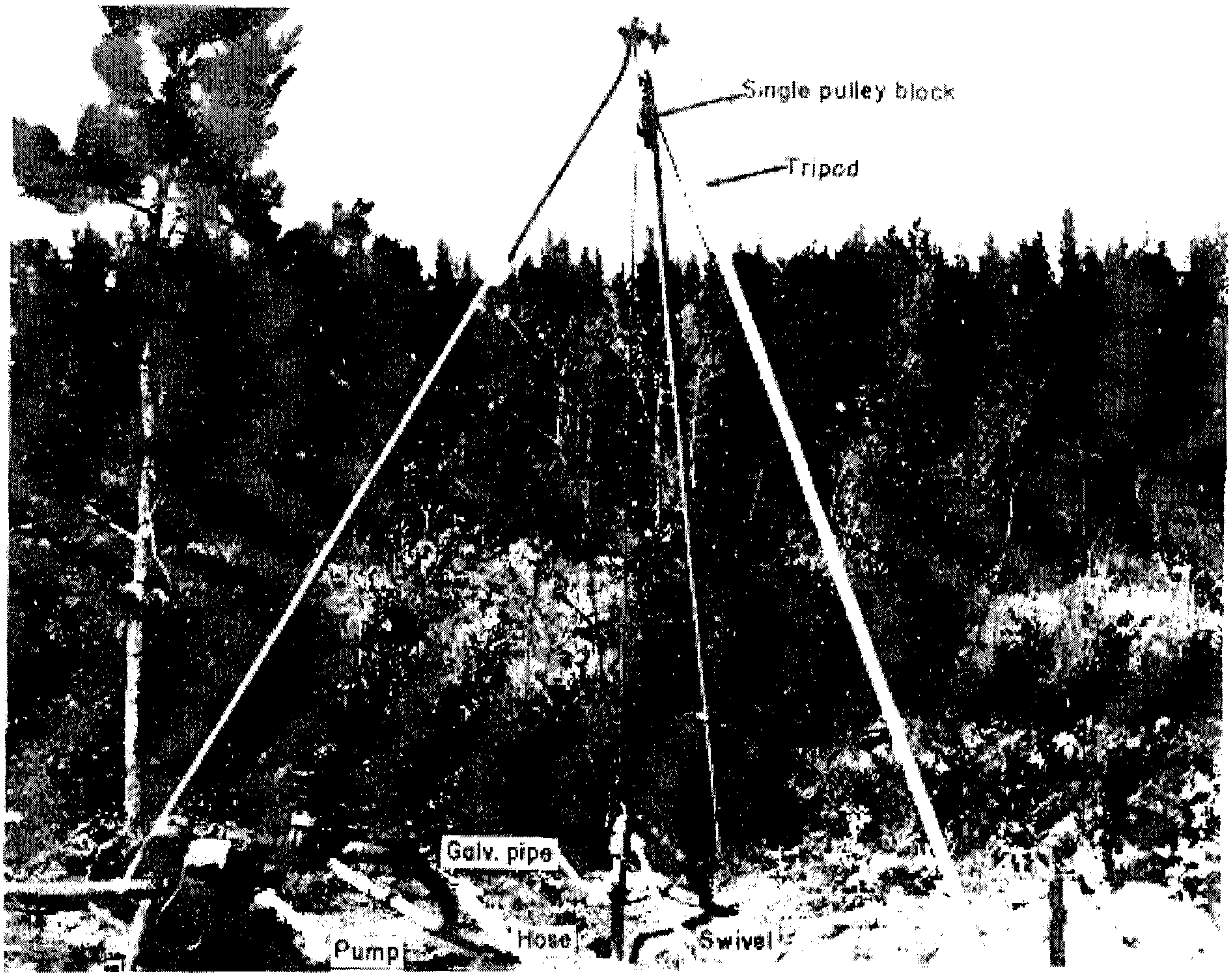


Manual jetting in Mexico

ii) The tripod arrangement

This consists of the following components:

- a tripod made of 50mm GI pipe used to suspend the GI drill pipe and bit from a U hook (at the appex of the tripod)
- a drill pipe and bit used for cutting the soil formation.
- a single pulley block and manila rope to which the drill pipe is hang and used to move the drill pipe up and down
- a pump used to pump the drilling fluid through a hose and small swivel.


Single pulley block
Tripod
Galv. pipe
Pump
Hose
Swivel

Section
4

Water Quality Assessment

4.0. WATER QUALITY ASSESSMENT

On completion of the well water samples need to be taken for physical, chemical and bacteriological analysis. Generally groundwater is clear, colourless and has little or no suspended matter. Colour is normally not a critical issue for groundwater.

The chemical quality of groundwater is influenced by the mineral content. It is important to assess the mineral content in order to determine the concentrations and establish whether these concentrations exceed the recommended limit for human consumption. If they do expert technical advise should be sought on the need and methods to remove the excessive amounts of the minerals concerned.

Groundwater is generally free from microbes, however it is important that analysis be undertaken to establish whether there is no bacteriological contamination of the water. If there is experts should be consulted on the means of removing the microbiological contamination and establish the source of this pollution. Generally flush chlorination may be undertaken to disinfect the well

It should be noted that samples taken for analysis should be assessed within the stipulated time before the external environment affects the conditions. Usually bacteriological analysis should be carried out within 24 hours of sampling. Chemical analysis should be done within 72 hours.

Section
5

Water lifting Devices

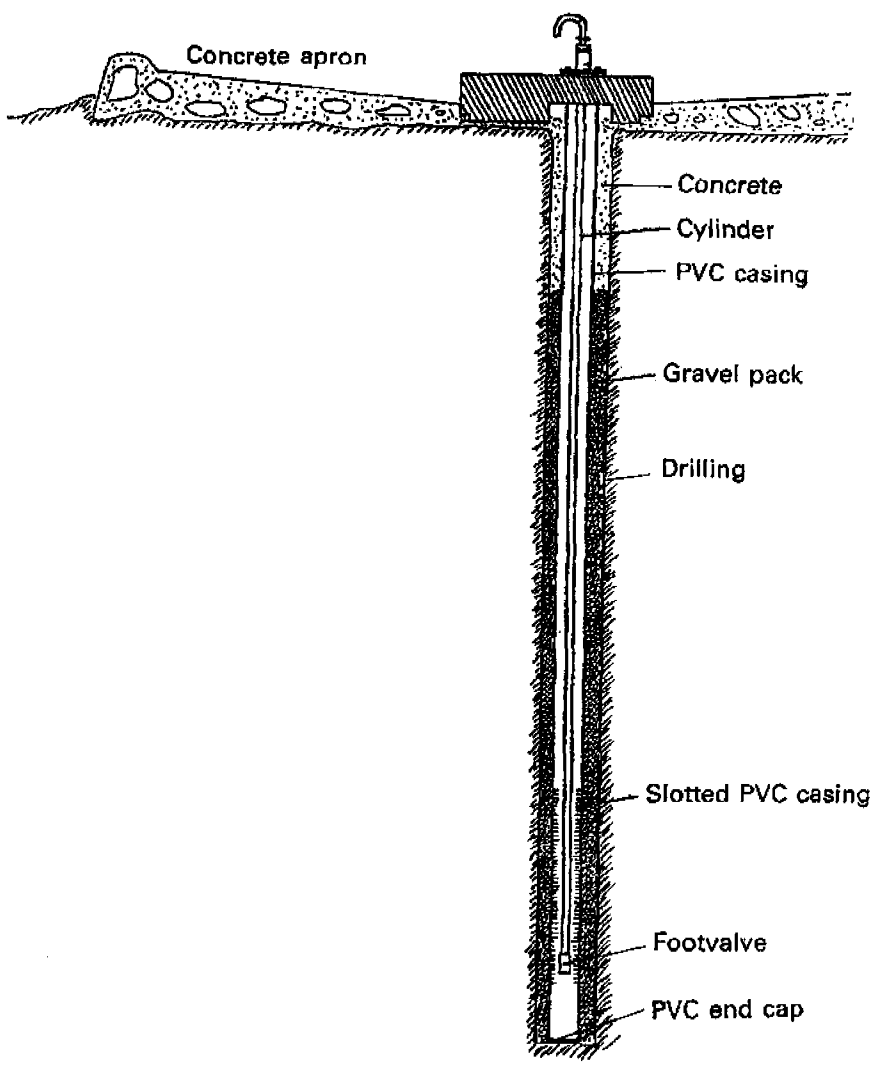
Above ground components

Facility Protection

5.0 WATERLIFTING DEVICE

Jetted wells are most often equipped with direct action pumps such as the Blair pump. Some unconventional pumps such as Vegnet pumps can also be installed on jetted wells. These pumps are limited in the lift of about 12m. In Zambia (i.e. Western Province) the Blair pump has been installed at 6m on average. This pump has proved to be reliable and easiest to maintain by the community. The Blair pump is one of those short listed by the Standardisation Committee to be in the Zambian standards for pumps.

Through the assessment by DWA in Western Province the Blair pump has recorded fewer breakdowns than deep well pumps. Therefore it is recommended that the Blair pump be adopted for jetted wells.



Blair pump installation adapted from Peter Morgan-Zimbabwe experience

ABOVE GROUND COMPONENTS

The above ground components are constructed to prevent contamination of the ground water in the well by that which accumulates immediately around the well. If spill water is allowed to pond around the well mosquito breeding will begin. Therefore other than preventing ground water contamination, above ground works prevent the ponding around the well.

The above ground components consist of 2 meter diameter apron and 10m long drain. It is advisable to construct these structures in reinforced concrete. This prevents cracking of the concrete works which if it happens could lead to polluting well water by run off water (spill water) and also increase strength which adds on the life span.

FACILITY PROTECTION

To restrict unwanted movement of animals, it is recommended that a fence be constructed around the facility. The fence should be constructed by the user community using locally available material especially hardwood poles where they are available. Other materials such as bamboos, brick and reeds could be used to put up the fence. In some instances communities prefer to plant trees for the fencing. However, expert advice should be sought on the type of trees to plant as other species consume a lot of water and could deplete the groundwater around the well through high evapotranspiration rates.

THE CORE TRAINING MANUALS AND
SUPPLEMENTARY MODULESPLEMENTARY MODULES

MANUALS AVAILABLE

TITLE AND DESCRIPTION

Manual 1 Understanding the WASHE Concept
Manual 2 WASHE in the Water Sector Reforms
Manual 3 Introducing WASHE at District Level
Manual 4 Establishing WASHE at District Level
Manual 5 Planning for WASHE at District Level

SUPPLEMENTARY MODULES AVAILABLE

1a Coverage Parameters for Rural Water Supply in Zambia.
1b The Status of Rural Water Supply in Zambia
1d Partners in WASHE
2a Making the right choice
2d Tube well standard construction
2e Jetted well standard construction
2f Borehole standard construction
5a Options for Excreta Disposal Facilities
6a Participatory Health and Hygiene Education (Theory)
6b Participatory Health and Hygiene Education (Practical)
7b Making Appointments
7c Community Mobilisation and Sensitisation
7d Conducting Community Assessment
7e Formation of a Village WASHE Committee
7f Site Selection
7g Planning for Construction and Rehabilitation
7h Community Participation During Construction
7i Village WASHE Committee Training
7j Community Problem Solving
7k Fund Raising and Management
7l Promoting Community Ownership
7m Community Participation in Monitoring
7n Well Completion Ceremony (Handover)
7o Community Management in Evaluation
7p Group Dynamics and Energiser Tool Kit
8 WASHE and Gender