HTN Case Study

Karl Erpf

The Bush Pump

The National Standard Handpump of Zimbabwe

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February 1998

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Contents

Acknowledgements

Dr. Peter Morgan has been involved in the water and sanitation sector of Zimbabwe since 1972 and designed the "B -Type Bush Pump" in 1987. Until today he has been involved in R&D work on this pump, especially in the development of a series of new "down hole components" and in developments for easier maintenance. As the designer and developer of many other well-known products like "Blair Latrine", "Blair Pump", "Bucket Pump", "Upgraded Family Well" etc., he is most experienced in this field. Thanks to his contributions and "back ground information" it was possible to write this case study.

Strong support was obtained from Mr. George Nhunhama, Chairman National Coordination Unit of the Ministry of Local Government.

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Mr. Edwin Toriro of DDF, Mr. Bijaya Rajbhandari, Ms. Therese Dooly, and Mr. Sam Maunganidze of UNICEF, for their valuable contributions.

Introduction

Despite amazing reports of success and excellent records in the water policy of Zimbabwe, the Bush Pump never had such a reputation when installed outside of Zimbabwe.

This phenomena was the reason of the SKAT-HTN mission in June 1997, to have a close look at this pump and to find out what had made this pump so popular in this country for more than sixty years.

It was planned to write a case study after that trip and to make it accessible to anyone interested, either by mail or via Internet.

As a reference:

On 26 June 1996, an external assessment report was made by the Consumer's Association, Research & Testing Centre, Knowlhill, Milton Keynes, MK58NL,UK.

The pump tested was an "open top" version with a cylinder diameter of 50mm.

History of the Bush Pump

The Bush Pump was described many times before as a remarkable handpump although it is almost unknown internationally.

Like no other handpump globally in use, the Bush Pump has a long history. It was originally designed by Tommy Murgatroyd in the year 1933, a Government Water Supply Officer in Matabeleland, the western part of Zimbabwe.

Due to the fact that welding was not known at that time, the pump was made of standard pipes and plates, which were bolted together. According to „modern“ handpump designs, the Murgatroyd pump was well overdesigned in respect of material strength. That is the reason why it seems to be a clumsy pump when one sees it for the first time. This clumsiness is a major factor why quite a number of early models of these handpumps have survived until today. The initial models remained almost unchanged for about 40 years.

Cecil Andersen, an Engineer of the Ministry of Water, made the first major changes in the mid-60s. He replaced some of the bolted parts with components that were welded together.

The remarkable idea to bolt the pumphead directly to the well casing dates back to that time. The improved pump was given the name of Bush Pump, it became the National Standard and was spread all over the country.

After Independence in 1980, the government of Zimbabwe insisted on retaining its own national handpump, but many variations of the pump were built by NGOs and also some government departments. These were used alongside the standard Anderson model.

Old Lutheran Bush Pump (A-Type)

As a result, the government of Zimbabwe decided to modernise and standardise a new National Standard Handpump, the B-Type Bush Pump, which was designed by their staff and retained the most successful features of earlier models. The B-Type pump head went through two years of heavy duty endurance testing before it was accepted as a new national standard pump. Since then the number of B-Type Bush Pumps installed in Zimbabwe has increased to about 18'000.

Presently (February 1998) about 33'200 Bush Pumps are installed and include the following models:

- 18'000 pumps Standard B-Type, manufactured since 1987. Included in this figure are approx. 1000 nos of 50 + 63.5mm extractable models.
- 9'000 pumps Standard A-Type, manufactured between 1970 and 1980.
- 6'500 pumps of various brands like:
  - Murgatroyd Pump (less then 100 numbers).
  - DDF Long Type Pump.
  - Low Well Lutheran Pump.
  - Chain Pump and others.

Old DDF long model (A-Type) on dug well

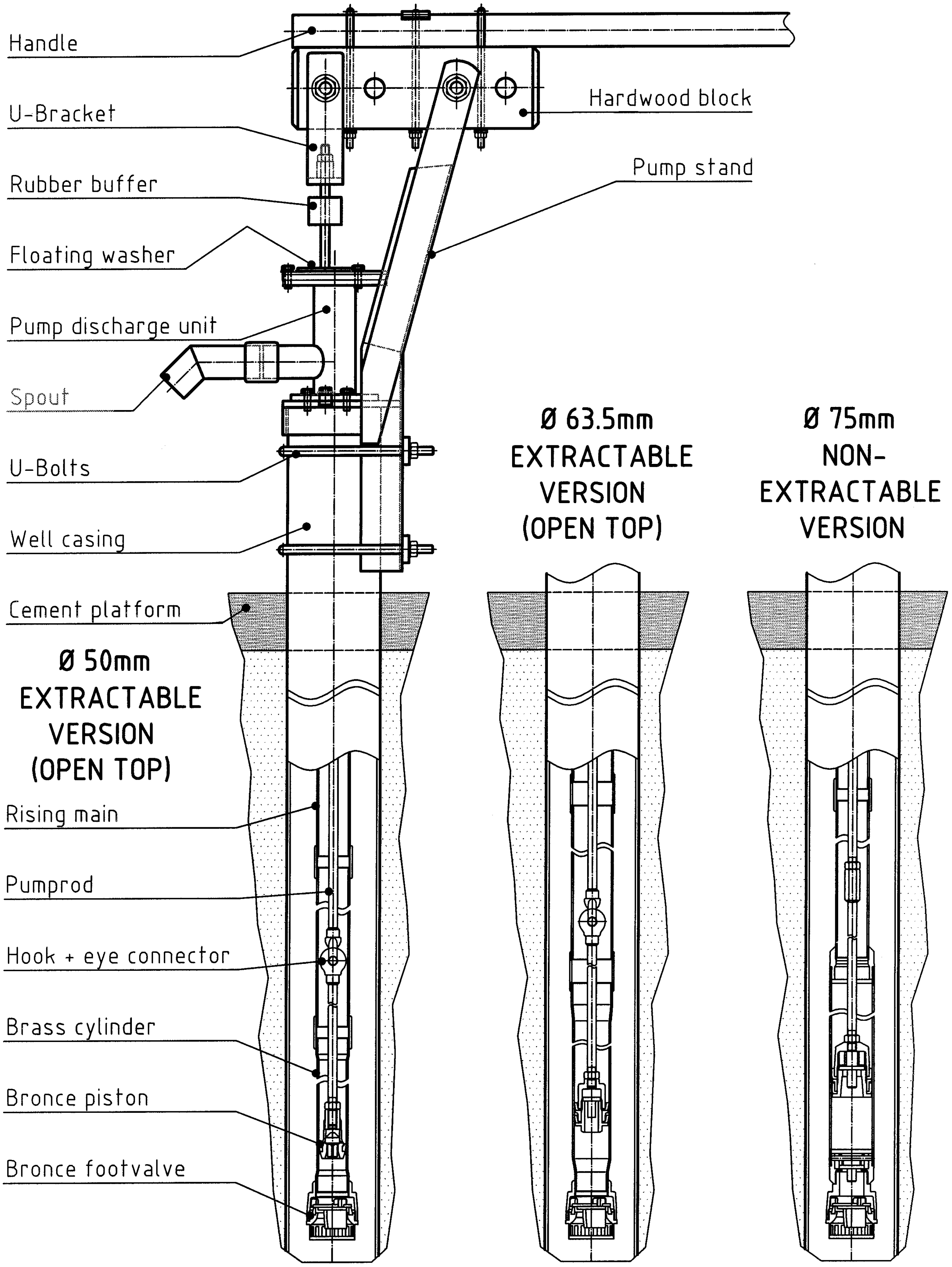
Work on the Ø 50mm open top cylinder models of the Bush Pump began in 1985 and the Ø 63.5mm open top cylinder was first placed on trial in 1987. Until mid 1996 most work was undertaken with the Ø 50 m m system, after that time the Ø 63.5mm system was mass produced and reintroduced into the programme. The Ø 75mm open top cylinder system went on the market in late 1996. However over 95% of all Bush Pumps in Zimbabwe do not use open top cylinders, although in 1998 it is being introduced on a wider scale.

Most Bush Pumps use Ø 75mm brass cylinders with Ø 50mm NB GI pipes. They are not user-friendly although many attempts were made to encourage the users to participate more fully in the maintenance. This did not succeed because of difficult repairs and heavy tools.

There is a clear preference for the user-friendly open top models, especially for the Ø 63.5mm model, as the output is greater than the Ø 50mm model.

Several districts are experimenting with user-friendly pumps so that the villagers and school children can get more involved with maintenance.

Diagram of Pump Types



Comparison of discharge between the different models

The following discharge figures are theoretical. They are influenced by many factors like the operator's physical strength, duration of pumping etc.

In the schedule below it is assumed that the input of pump force is 75 Watt.

The figures in the schedule show the approximate amount of water drawn, in m^3/h.

Head	Ø50mm cylinder	Ø63.5mm cylinder	Ø75mm cylinder
10m	1.3	1.8	2.3
20m	0.9	1.3	1.7
30m	0.7	0.9	1.25
40m	0.55	0.75	0.95
50m	0.45	0.6	0.8
60m	0.4	0.55	0.7

Note:
There are several Bush Pumps which work in the range of depth down to 100m.

Technical description

The B-Type Bush Pump is a conventional lever action handpump and has like most of its earlier „relatives“, the same successful details in common:

- Hardwood block that acts as both a bearing and lever mechanism.
- Sturdy, heavy-duty pumphead.
- Pumpstand directly bolted on the borehole casing.
- Brass cylinder, mostly Ø75mm.
- Brass piston and footvalve.
- GI pipes as rising main, mostly Ø50mm.
- Pumprod of mild steel, mostly Ø16mm.
- GI pipe for the handle.

Cylinder variety for extractable B-Type Pumps

Local manufacturing

The Bush Pump has an excellent potential for local manufacturing and is presently produced by 12 different companies in Zimbabwe.

The main manufacturers are:

- V&W Engineering Harare, approximately 60% of the total numbers of B-Type pumps.
- DDF-Workshop Harare, approximately 10%.
- S+M Engineering Harare, approximately 8%.
- AB Mining in Bulawayo, approximately 8%.
- Stewarts & Lloyds Harare, approximately 5% (Workshop in Bulawayo).
- Others 14%

The total number of Bush Pumps installed in the country is around 3000 per annum.

Finished pump components

Quality control of products

Peter Morgan is working on quality control in collaboration with UNICEF in Harare. Besides a brief description how to inspect the pumps, there is a new recommendation for inspection, the Examination Chart for Inspection of Pump Head" (see Appendix II).

Installation

The installation of the Bush Pump has to be done by experienced mechanics. The different steps of installation are well described and illustrated in the „Installation and Maintenance Manual". Lifting tackle and special tools are used for the installation of the „down hole components" of the standard B-Type pump and for the riser pipes of the different „open top" versions.

The installation of new pumps is mostly done by DDF, but the Department of Water Development, NGOs and contractors working for the government also install pumps. Most user friendly pumps have been installed by DDF and Mvuramanzi Trust.

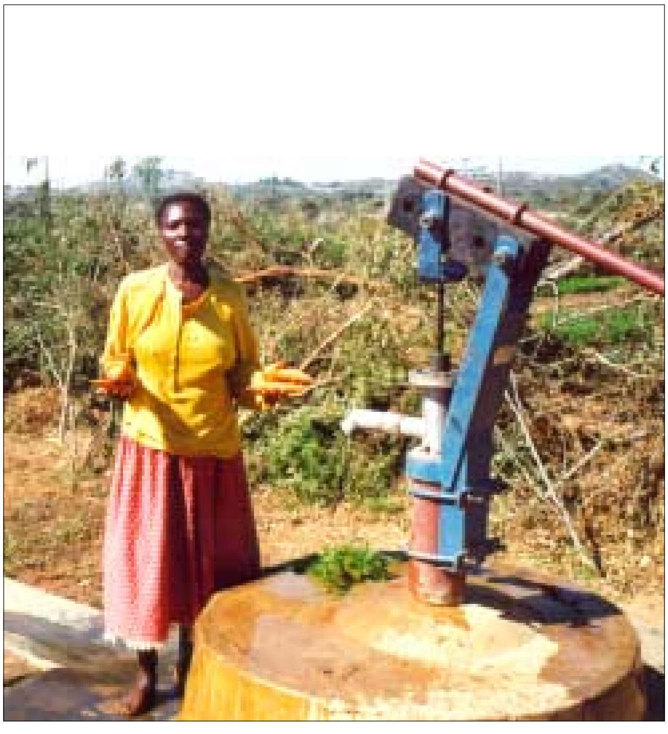
Maintenance

After the one tier system of the early 80s („field gangs“ or „barefoot mechanics“), **District Development Fund** (DDF) started with the

Three tier system:

- **At the water point level**, a water point committee is selected by the pump users. One of its members is the caretaker. The main function of the committee is to organise preventive maintenance like tightening of bolts and greasing of the moving parts of the pump head, cleaning of pump surroundings and reporting of breakdowns.
- **At the ward level** is the pump minder, who is a DDF trained pump mechanic and considered as casual staff. His function is to repair broken pumps, keep records of all repairs done and to report monthly to the field officer. The pump minders are paid a monthly allowance and obtain all tools and spare-parts needed from DDF.
- **At the district level** there is a water supply operative who attends the repairs that cannot be done by the pump minders. The water supply operatives are equipped with heavy vehicles for transportation of materials and spare parts to the pump sites. The water supply operatives are supervised by a water supply supervisor who in turn reports to a field officer (water). The function of these two positions in the area of maintenance is to provide logistical support and to ensure quality of service. The entire district level personnel are full-time employees of DDF.

The maintenance is done by DDF with a yearly budget of Z$ 20 million which is approx. US$ 1.1 million (exchange rate 1 : 0.0538 at the end of 1997) This amount is used to service 33’200 pumps including transport, labour and spares. This budget allocation is quite inadequate.



B-Type Bush Pump on dug well

The allocated amount per pump dropped considerably from Z$ 120. 00 in the year 1989 to Z$ 45.00 in the year 1996 and is expected to come down to about Z$ 39.00 in 1997. As a comparison; the cost for a plunger seal is approximately Z$ 40.00.

As a result of this drastic reduction of the allocation provided by the government in the last few years, DDF started to urge pump users to participate in the maintenance of their pumps. This system has evolved further in some experimental areas, where the communities have been encouraged to look after their pumps with less assistance from DDF. This system is known as „Community Based Maintenance" (CBM) and is operated through DDF, with the support of UNICEF.

31'500 of the total 32'200 Bush Pumps installed so far, are non extractable pumps (Ø 75mm cylinder and Ø 50mm GI rising main), whose „down hole components" are difficult to repair by the pump users themselves.

Even for the routine replacement of a piston seal, which is the most commonly undertaken maintenance procedure, special lifting equipment is required to remove the pipes with the cylinder assembly.

The open top versions which have been tested successfully enables the community to withdraw the piston without lifting the riser pipe and the cylinder, when replacing the seal. Piston seal replacement is the most common reason for attending the down hole components.

Given these circumstances, it might take many years to establish CBM throughout the country which would bring a relief to the tight financial situation of DDF.

During the transition phase it is essential that the excellent maintenance under the DDF 3 tier system that made the Bush Pump so reliable, can be carried on. Additional funds would need to be allocated to prevent a collapse of the present successful drinking water supply in the rural areas.

B-Type Bush Pump on borehole

Design improvements

Since the pump head is a robust unit, easily accessible for preventive maintenance like tightening and greasing of bolts, the maintenance records shows that no design change was required.

The following new „down hole components" were developed:

- The extractable system with cylinder Ø50mm
- The extractable system with cylinder Ø63.5mm
- The extractable system with cylinder Ø75mm

Together with the development of the extractable systems, some remarkable improvements were designed and successfully tested:

- Pumprods with casehardened „hook and eye" connectors
- Pumprod holder, for easy removal of pumprods and plunger
- Pumprod extractor, for fishing lost or broken pumprods inside the rising main
- Different sizes of seals (cup seal) of Nitrile rubber

Pressure Type Bush Pump

- One piece brass plunger (monoblock) with Nitrile rubber bobbin

At present the following tests are under way or planned:

- Nitrile rubber seals being tested:

  1) New India MK III, Ø 50mm type which replaces the earlier Afridev type.

  2) New configuration of Ø 63.5mm seal, single seal on monoblock brass piston.

- HDPE rising main pipes.

- V&W Engineering is testing a newly developed “Pressure Type Bush Pump” that is able to pump water direct into overhead stored water tanks.

- On special request a “gantry” is available that can be installed together with the pump. This setup is permanently fixed and it is very useful for lowering or lifting the “down hole components” during installation or maintenance.

Technical documentation

The following documentation is available:

- Technical drawings and partlist of
  "The 75mm Non Extractable System"
- Technical drawings and partlist of
  "The 50mm Extractable System"
  "The 63.5mm Extractable System"
  "The 75mm Extractable System"
- "Installation and Maintenance Manual" for the all Bush Pump types.
- "Examination Chart for Inspection of Pump Head", including a brief description of how to inspect.

Information about these documentations is available from "National Action Committee for Rural Water Supplies and Sanitation Programme", Government of Zimbabwe.

It is planned to incorporate the Bush Pump into the "International Handpump Specifications" by SKAT-HTN, hopefully at the end of 1998.

Complete toolkit for Bush Pumps

Prices of Pumps and Spareparts

In 1997 the costs of components with Ø 50mm / Ø 63.5mm extractable piston were as follows:

1) Pumphead	US$	73.20	+	15% tax
2) 50mm NB steel pipe	US$	5.20 /m	+	15% tax
3) 65mm NB steel pipe	US$	7.10 /m	+	15% tax
4) 50mm open top cylinder + plunger/footvalve	US$	50.20	+	15% tax
5) 63.5mm open top cylinder + plunger/footvalve	US$	56.30	+	15% tax
6) 16mm hook and eye rod	US$	5.70 /3m length	+	15% tax

Total cost of a 30m x Ø50mm open top pump:

	US$	84.20	(head)
+	US$	179.90	(pipes)
+	US$	57.95	(cylinder + plunger/footvalve)
+	US$	65.45	(hook + eye rods)
=	**US$**	**387.50**	

All 1997 prices in Z$ were changed into US$ at the end of 1997 (exchange rate = 1 : 0.0538).

Total cost of a 30m x Ø63.5mm open top pump:

	US$	84.20	(head)
+	US$	245.30	(pipes)
+	US$	64.75	(cylinder + plunger/footvalve)
+	US$	65.45	(hook + eye rods)
=	**US$**	**459.70**	

The cost for maintening the user-friendly pump (open top) will be very low as long as the working parts are in good order. Whilst precise data can only be provided after several years of widescale use, the following theoretical schedule can be used as a guide in terms of replacement of items and costs (at 1997 prices). A 30m pump has been used as a basis. These costs do not include transport and DDF staff costs, but concern just spare-parts.

It should be noted that labour and transport cost (not considered), can be considerably higher than the cost of materials.

The 50mm open top B-Type Bush Pump

	total cost		cost per year	
Years 1 - 5	total cost		cost per year	
- 10 seals for 5 years (US$ 1.08)*	US$	10.80	US$	2.16
Total	US$	10.80	US$	2.16

* assuming 6 months life (1 seal per piston)

Years 5 – 10	total cost		cost per year	
- 10 seals for further 5 years	US$	10.80	US$	2.16
- Replacement of half of the rods	US$	32.68	US$	6.54
- Replacement of one fifth of the pipes	US$	35.98	US$	7.18
- Replacement of piston bobbin	US$	1.08	US$	0.22
- Replacement of 2x floating washer	US$	2.16	US$	0.44
Total	US$	82.70	US$	16.55

Years 10 – 15	total cost		cost per year	
- 10 seals for further 5 years	US$	10.80	US$	2.16
- Replacement of all rods	US$	65.45	US$	13.04
- Replacement of 2/3 of the pipes	US$	120.10	US$	24.00
- New cylinder + piston + footvalve	US$	57.90	US$	11.60
- Pump head refurbishment (estimate)	US$	26.95	US$	5.40
Total	US$	281.20	US$	56.20

Note: The complete replacement of the pump system in 10 – 15 years would cost **US$ 387.50**
Refurbishment of the whole pump system would represent 72% of the total replacement costs.
Many pumps will operate far beyond the 10 - 15 years period. Many pump heads may require only minor refurbishment, many pipes and rods may be serviceable. The cylinder, piston and footvalve may also be in good order. Many Bush Pumps are known to last for many decades.

Years 15 – 20
It is assumed for this exercise that the pump suffered serious wear and all parts will require replacement during the 15 - 20 years period. Thus the cost would be **US$ 387.50** as stated before.

The 63.5mm open top B-Type Bush Pump

Years 1 - 5	total cost		cost per year	
- 10 seals for 5 years (US$ 1.08)*	US$	10.80	US$	2.16
Total	US$	10.80	US$	2.16

* assuming 6 months life (2 seals per piston)

Years 5 – 10	total cost		cost per year	
- 10 seals for further 5 years	US$	10.80	US$	2.16
- Replacement of half the rods	US$	32.68	US$	6.54
- Replacement of one fifth of the pipes	US$	49.06	US$	9.83
- Replacement of 2x floating washer	US$	2.16	US$	0.44
Total	US$	94.70	US$	18.95

Years 10 – 15	total cost		cost per year	
- 10 seals for further 5 years	US$	10.80	US$	2.16
- Replacement of all rods	US$	65.45	US$	13.10
- Replacement of 2/3 of the pipes	US$	163.55	US$	32.68
- New cylinder + piston + footvalve	US$	64.75	US$	12.96
- Pump head refurbishment (estimate)	US$	26.95	US$	5.40
Total	US$	331.50	US$	66.30

Note: The complete replacement of the pump system after 10 – 15 years would cost **US$ 459.70**
Refurbishment of the whole pump system would represent 72% of the total replacement costs.
Many pumps will operate far beyond the 10 - 15 years period. Many pump heads may require only minor refurbishment, many pipes and rods may be serviceable. The cylinder, piston and footvalve may also be in good order. Many Bush Pumps are known to last for many decades.

Years 15 – 20
It is assumed for this exercise that the pump suffered serious wear and all parts will require replacement during the 15 - 20 years period. Thus the cost would be **US$ 459.70** as stated before.

Note:
All prices given above have been changed from the local price list (Zimbabwe $) into US$. The value of the Z$ dropped drastically towards the end of 1997. The exchange rate in December 97 was Z$ 18.58 for US$1.00 (the price list above was calculated with this rate). The present exchange rate in February 1998 is Z$ 19.43 for US$ 1.00. This devaluation will affect the costs of pumps.

Findings

No doubt, this pump has an excellent potential. It is easy to manufacture it in many developing countries. Presently a small number of pumps is manufactured in Namibia and most probably also in South Africa.

Especially the "user-friendly" version with its "open top" cylinder diameter of 50 mm and 63.5mm will have the advantage to be favoured by the communities. The easy handling for preventive maintenance is ideal for "Community Based Management" (CBM) and reduced involvement of expensive DDF staff will lower the maintenance cost.

Regarding future export possibilities of the Bush Pump or the prospect that it could be manufactured elsewhere in the world, it is important to consider the need of:

- international specifications of all pump types, to receive international recognition.
- a Quality Control Manual for manufacturing and end control, in order to keep the high quality standard.

B-Type Bush Pump near school

The success of the Bush Pump clearly highlights the factors which are important for achieving sustainability in water supply:

- Strong support of the "Water Supply Policy" by the Government
- Standardisation of a small number of different types of handpumps
- Pump production with a constant quality level
- Well trained installation and maintenance mechanics
- A strict maintenance concept
- Well organised spare-part supply
- Training and involvement of the pump users.

This ideal situation in Zimbabwe with the government backing the above points, combined with the development of an extremely strong and sturdy pump, was the reason that made the Bush Pump so famous and reliable. This institutional setup has weakened in the last few years, due to a lack of funding for maintenance. The allocated amount per pump per year has dropped dramatically (see the figures on page 9). It will be a top priority to find money for maintaining the present infrastructure; otherwise a large number of pumps will go out of order.

Appendix I:
List of pumps visited during the field trip.

In order to visit many pump sites in a rather short time a two day roundtrip was made, starting from Harare, passing through Chivhu, Gutu, The Great Zimbabwe Monument, Masvingo, Mvuma, Chivhu and returning back to Harare. 17 pumps of many different types were inspected:

1. B-Type (V+W) on borehole, in good working order, used for donkeys watering.
2. B-Type (V+W) on borehole, with gantry of Ø 50mm pipe, in good working order, support for long spout needed.
3. B-Type (V+W) on borehole, with gantry, less well maintained but in working order, also used for watering a vegetable garden.
4. Old DDF long model, A-Type, on dugwell, acceptable working order.
5. DDF B-Type on borehole, heavy to use, some parts not matching, faulty U-bracket plates, no spring washers, no lock nut on U-bracket, short side plates on pump stand, Ø 40mm pipe handle (should be 50mm), approximately 50 to 60m borehole, however the pump was working with a good discharge.
6. Old A-Type on borehole, large pump which was built between the 1960s and late 1980s, in remarkable good order, a few bolts were missing, good discharge.
7. Lutheran Bush Pump (A-Type), on dugwell, long spout which is typical for this brand, short stroke, working.
8. Old A-Type on borehole, pump not tightly bolted to borehole, pump at angle, faulty bolts leading to creaking sound during pumping, however in acceptable working condition.
9. B-Type (V+W) on borehole, well used pump, with both main head bolts missing and replaced with iron bars (concrete reinforcement bars), pump was working well with a good discharge.
10. Old DDF long model (A Type), on dugwell, all downhole components were removed, pump head in good order. (This was the only pump of the whole trip that was not working.)
11. B-Type (V+W) on borehole, head bolts did not match because they were taken from an older model of B-Type head, no spring washers but the pump worked well and the discharge was good.
12. B-Type Bush Pump (uncertain manufacturer), fitted on borehole, heavily used, near a school, pump loose on a Ø 125mm borehole casing, rough handling, pumping air, borehole inadequate water intake, however pump was in working order and delivering water.
13. B-Type (V+W) on borehole, heavily used pump, many people still pumping after dark, pump in good order and delivery was excellent (40 l/min).

14. Old A-Type on dugwell, pump was worn but working well, good delivery.
15. B-Type (V+W) on dugwell, open top model with Ø 75mm cylinder, working well, used also for watering a large vegetable garden.
16. "New" A-Type made by DDF (about 1987/89), on borehole, guide pipe broken and pumprod bent, much pumping before water delivery (footvalve leaking), however water delivery was acceptable when fully pumped.
17. Lutheran Bush Pump on private dugwell, rear head bolt loose and thread worn, water delivery was good.

Several pumps had missing bolts and other parts were worn, but still continued to deliver water. A typical feature of the Bush Pump is that it is able to deliver water even when badly worn or when parts are missing. The open arrangement of the head gear allows local adaptations of the pump head, so that pumping can continue.

All downhole components of the pumps inspected might use the Ø 75mm cylinder. Most used Ø 16mm pumprods connected with standard threaded rod sockets. The Lutheran Bush Pumps might be fitted with a Ø 40mm rising main and Ø 12mm pumprods.

All pumps visited had "non extractable components" apart from the pump No.15.

The standard Ø 75mm cylinder (non extractable type), is a strong and reliable unit, well used and tested over several decades. It is still the most common unit used throughout the country despite the tendency in future, to change to the "user-friendly" open top models of Ø 50mm and Ø 63.5mm.

Footvalves on several pumps inspected might be faulty. Many types of footvalves are available in Zimbabwe, but only one type (which is standardised) is known to give a prolonged reliable service. The National Action Committee has recommended the standardised unit for many years, but pumps ordered at district level continue to include footvalves of poor quality.

Missing head bolts replaced by reinforcement bars, pump still working

Appendix II:
Examination Chart for Inspection of "B" Type Bush Pump head.

The following points are critical to the design of the "B" type Bush Pump head.

MANUFACTURER .... DATE ....

1. Angle of pump head.

This is very critical. It can be tested by standing the pump upright and placing the wooden block in a horizontal position and the rod in the vertical position. Also check that the **centres of the bolt holes in the wooden block are exactly 240mm apart**. When the pump head angle is correct the front surface of the descending rod should be **75mm** (+/- 3mm) behind the front edge of the floating washer housing. This is shown on the Bush Pump technical drawings.

Distance between working block hole centres **(240mm**) front ....

Distance between pump rod and front of floating washer housing (**75mm**) ....

COMMENTS ....

2. Alignment of pump head

The head should not be twisted and the pump stand should sit exactly vertically on the borehole casing. Inspect the pump from front and side to see that the rod enters the floating washer housing centrally and not to one side.

COMMENTS ....

3. Thickness of pump stand uprights

COMMENTS: Thickness (**12mm**) = ...

4. Head bolt holes in pump stand

These should be 36mm (range 35.5 - 36mm) and 25mm (range 24.5 - 25mm) respectively. The 25mm hole should have a double thickness of 12mm plate increased by a 12mm thick washer welded to the pump stand to make a total thickness of 24mm. Note: head bolt securing plate should be below bolt head and horizontal (see drawings).

Large hole (**36mm**) = ... Small hole (**25mm**) = ...

12mm thickness washer added (**Y/N**) ....

Head bolt securing plate horizontal (**Y/N**) ....

5. Free movement of 100mm diameter floating washers (2)

Ensure that these move freely within the floating washer housing.

COMMENTS ....

6. Floating washer housing

The overall outer diameter of the housing should be 190mm. The lower plate is 10mm thick and the central spacer ring is 10mm thick. The upper plate is 6mm thick. The central hole diameter should be 60mm.

Thickness of upper plate (**6mm**)..

Thickness of lower plate (**10mm**) ....

Thickness of central spacer ring (**10mm**) ....

Diameter of upper plate (**190mm**) ....

Diameter of central hole (**60mm**) ....

7. Size of Floating washers (2)

These should have a diameter of 100mm of 6mm plate with a central hole 17mm in diameter.

Thickness of plate (**6mm**) ....

Diameter of washer (**100mm**).................................. Diameter of central hole (**17mm**) ....

8. Height of vertical member of water discharge pipe

The height should be 200mm (65mm nominal bore GI pipe - outside diameter 77mm+- 1mm). Diameter of dip plug hole should be 24mm to suit M24 plug.

Height (**200mm**) = ...

Size (**65mm NB**) = ...

Diameter dip plug hole (**24mm** to suit M24 plug) ....

9. Diameter of base plate

Diameter (**160mm**) .... Thickness (**12mm**) ....

10. Head bolt quality

Ensure that the bolt is fitted securely and is fastened by a **M24** nut and **4.5m** thick spring washer. There should be no play in the unit. The bolt should be made from a **35mm** diameter bright mild steel shaft and the overall bolt length is **231mm**. The main working surface of the bolt is **165mm** long and should be **35mm** in diameter. One end of the bolt is reduced in thickness to **24mm** over a length of **50mm**. Half of this (**25mm**) is threaded for a **M24** nut. The remaining **25mm** length of **24mm** diameter shaft is unthreaded and is held within the U bracket or upper pump stand. The other end of the bolt is reduced to **20mm** diameter over a **16mm** length for attachment by welding to the bolt head. The bolt head measures **50mm X 50mm** and is **16mm** thick. The **16mm** reduced diameter section of the bolt is welded within a **20mm** hole made in the centre of the bolt head. The head bolt securing plate is welded below the bolt on the pump stand and above the head bolt on the U bracket. The securing plates should make contact with the head bo1t and not be distant from it. They are designed to hold the bolt in place and stop it rotating. The securing plates are also **16mm** thick. On the pump stand the securing plate is horizontal (see pump drawings).

Head bolt diameter (**35mm**) .... and material (**BMS**) ....

Length of main shaft (**165mm**) actual = ...

Length of reduced diameter shaft (**50mm**) actual = ...

Length of threaded section (**25mm**) ....

Size of bolt head (**50mm X 50mm X 16mm**) ....

Other Comments ....

11. Spring washer

Check these are in place and **4.5mm - 5mm** thickness

COMMENTS ....

12. Wooden head block

Check size with drawings (450 X 150 X 150mm) and ensure the bolt holes (two sets) are correct distance apart at the centres - 240mm. This is important as it determines the correct entry of the rod into the floating washer housing. The block should be boiled in oil and cooled overnight in the oil to penetrate. The head bolts should rotate easily within the block. Test for this. The bolt hole diameter should lie between 36mm and 37mm but may require drilling to 38mm if the wood is inclined to swell. The holes for the handle U bolts should also be correctly placed they should be 75mm apart. The U bolt nuts are tightened against a plate (125mmX 25mm) held tight by spring washers.

COMMENTS ON WOODEN BLOCK

Holes drilled square? ....

Distance between forward working holes (**240mm**) = ...

Distance between rear working holes (**240mm**) = ...

Hole diameter (**36mm - 37mm**) = ...

Distance between U bolt holes (**75mm**) = ...

Handle U bolt securing plate (spring washer?) ....

13. Handle U bolts

These should follow the specs on the drawing (210mm beyond bend) and not be too long otherwise they foul other moving parts of the pump. They should be fitted with spring washers mounted against the securing plate (see above).

COMMENTS ....

14. Quality of 50mm socket for attachment to steel pipe

This should be heavy duty steam pipe: COMMENTS ....

15. The main U bolts

These should follow the specs on the drawings - i.e. **200mm** beyond bend. They should not be too long and should fit properly in the holes located in the mounting plates welded to the pump stand. These have hole centres **180mm** apart. Threads should be long enough to ensure complete tightening of head to borehole casing.

COMMENTS ....

16. U Bracket

This should be 12mm thick and follow all the measurements on the drawings. The uprights and the base section should be square (uprights 154mm apart). The threaded socket, which secures the rod, should be the right length (30mm) and welded square to the U bracket. The rod should descend squarely from the U bracket. The rod should descend in a central line through the floating washer housing. The securing plate holding the head bolt should be welded above the bolt head. The head bolt holes in the U bracket should be 36mm and 25mm in diameter for insertion of the forward head bolt. The 25mm hole should have a double thickness of 12mm plate increased by a 12mm thick washer welded to the U bracket to make a total thickness of 24mm. Forward and rear head bolts are identical. Distance between hole centres and upper surface of U bracket base should be 165mm (177mm to lower surface).

COMMENTS ON U BRACKET

Thickness plate (**12mm**) = ...

Height 16mm socket (**30mm**) = ...

Position of bolt securing plate (**above**) ....

Head bolt hole (large **36mm**) = ...

Head bolt hole (small **25mm**) ....

12mm thickness washer added (**Y/N**) ....

Distance between hole centre and upper surface U base (**165mm**) ....

Distance between uprights (**154mm**) ....

COMMENTS ....

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....

17. Rubber buffer

This should be about 50mm high and 60mm in diameter with a central 16mm hole.

Height (**50mm**) .... Width (**60mm**) ....

Central hole ....

18. Handle size

This should be 50mm GI pipe, 2.5m long unless otherwise specified.

COMMENTS on handle:

Diameter = ... Length = ...

Note: For pumps used down to about 20 -30m a 40mm handle is preferred. Deeper pumps require a 50mm X 2.5m handle filled with concrete. Very deep pumps (80 - 100m) require a 50mm X 3m handle filled with concrete - see installation manual.

19. Water outlet pipe

This should follow drawings. Horizontal component about 264mm. A 50mm socket should be fitted to allow for cattle trough takeoff.

COMMENT ....

20. Quality of welding

COMMENTS ....

21. General appearance (Painting etc).

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22. Metal pump makers plate added?(Y/N) ....

23. General comments

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24. Recommendations

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Signed ....

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