

Private Sector Participation in Low Cost Water Well Drilling

Knowledge and Research (KAR) Project R7126

**Water Quality Data for Five Pounder Well and Five Hand-
Augured Wells in Katabi Sub County, Mpigi District, Uganda.
[Including June 2001 Data for Two Wells in Mukono and Jinja Districts]**

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- the Directorate of Water Development
- Mpigi district,
- Mukono district,
- the many small business with whom we have worked,
- the numerous individuals who have acted as consultants or assistants to the project,
- the four Cranfield MSc students whose findings informed the project at various stages,
- and last but not least those who provided funding for the work: DFID, DANIDA, UNICEF, SIDA, DWD, Mpigi, Mukono and Jinja districts, Water Aid, the PAF, and an anonymous donor in the USA.

It is our hope that the work which we have started in this short project can continue and build on the foundation provided by the many partners and stakeholders involved.

2 BACKGROUND

This report contributes to the findings, implications, and future plans of a project, initiated by Cranfield University (Silsoe, UK) entitled “Private Sector Participation in Low Cost Water Well Drilling”. The project was funded by DFID from July 1998 to June 2001, with additional funding partners (Government of Uganda, DANIDA, SIDA, UNICEF, Water Aid, and an anonymous donor) joining at various stages throughout this three-year period.

The three-year Project had two overall aims:

- to develop, and transfer to the private sector, technology suitable for affordable shallow well construction
- to research the process of technology transfer and the conditions necessary for its success, in the context of rural water source construction

The first aim of the project was addressed through three main objectives or outputs:

- ◆ the design, field testing, and evaluation of a new human-powered drilling rig (the “Pounder rig”)
- ◆ the uptake of the technology by a small number of contractors, and their use of the rig in commercial contracts
- ◆ the establishment of a sustainable means by which the rig and subsequent spare parts will be made available in country

The research aspect of the project used the technology transfer and uptake process as a gateway to action research. The process of developing the technology and introducing it into the private sector, and the concurrent investigation and learning process, were intertwined in such a way that the project informed the research, and the research informed the project. Both benefited.

The overall research question was:

“what enabling conditions and external actions are necessary to stimulate and strengthen effective rural water supply service delivery by the private sector?”

3 Introduction

On a number of occasions project partners in central or local Government expressed concerns about the quality of water which would emerge from Pounder wells. Although this was not considered by the project to represent a significant risk¹, it was important to take these anxieties seriously, and produce evidence one way or the other to settle the issue. Consequently, once DANIDA co-funding was approved in December 1999, equipment was purchased and a period of water quality monitoring was undertaken, comparing five Pounder wells completed in 1999 in Katabi sub-county of Mpigi district, with five hand augered wells drilled in 1998, nearby. Monitoring of the Pounder wells commenced in March 2000, and continued to the end of the project. Monitoring of the non-Pounder wells commenced in June 2000. Both sets were monitored approximately monthly. The Pounder wells were monitored on 14 dates, and the non-Pounder wells on 10 dates.

4 Results

Table 4.1 lists source locations and dates of monitoring.

Table 4.1 Locations and dates of Pounder and non-Pounder wells monitored

Pounder Wells			
Reference	Name	GPS location ²	Monitoring dates
PW2/6	Kajubi (Fence)	N 00 08.104 E 032.31.956	2000 : 14 th March, 6 th April, 29 th April, 27 th May, 1 st July, 29 th July, 2 nd Sept, 30 th Sept, 30 th Oct, 20 th Dec 2001 : 1 st Apr, 22 nd Apr, 20 th May, 25 th June
PW2/7	Valley (Captain)	N 00 08.495 E 032.32.140	
PW2/8	Ndula (Pond)	N 00 07.950 E 032.31.871	
PW2/9	Zzika (Steep Slope)	N 00 07.166 E 032.31.632	
PW2/11	Bukandekade	N 00 07.212 E 032 31.410	
Non-Pounder Wells			
TW2/109	Big Tree	N 00 06.052 E 032 29.730	2000 : 2 nd July, 30 th July, 3 rd Sept, 1 st Oct, 31 st Oct, 21 st Dec 2001 : 31 st Mar, 21 st Apr, 19 th May, 24 th June
Tw2/108	Sand Pit	N 00 05.823 E 032 29.748	
TW2/110	Two Pumps	N 00 05.737 E 032 29.804	
TW2/116	Mugezi	N 00 07.614 E 032 31.642	
TW2/16	Night	N 00 08.248 E 032 31.948	

¹ Because percolation of water through a very few metres only of unsaturated ground is effective in removing pathogens. As long as the well has a good sanitary seal, water quality of shallow wells is generally not problematic.

² All GPS references are in latitude and longitude, expressed as degrees, minutes, decimal fractions of minutes.

The parameters measured, with reasons, were:

- thermo-tolerant coliforms (**faecal coliforms**): as an indicator of faecal contamination and hence risk of presence of faecal pathogens
- **iron**: because high levels of iron may cause consumers to reject disease-free source water in favour of faecally contaminated waters. High iron levels may be natural, or resulting from pump or well casing/screen corrosion
- **turbidity**: because (a) high levels may indicate poor well development (although not in the case of naturally occurring fines which refuse to be developed out), and (b) high levels may cause consumer rejection in favour of inferior water
- **pH**: as a crude indicator of groundwater corrosivity.

Faecal coliforms were measured with a Del Agua kit (portable membrane filtration equipment with incubator set at 44.5C). Three replicate samples were taken at each source on each date, and results arithmetically averaged. On each date a control sample of distilled water was included for quality control purposes. Resources did not allow for any household testing of faecal coliforms.

Iron was measured colorimetrically with a Hanna Instruments kit, type HI93721.

Turbidity was measured using the turbidity tubes supplied with the Del Agua kit.

pH was initially measured using indicator tablets, but in June 2000 this was changed to a digital display stick-type pH meter.

The results of the faecal coliform testing are shown in Figure 4.1 below. In the case of the Pounder wells, all measured values are below 50FC/100ml (the Ugandan standard for untreated supplies). All but one of the values are below 20FC/100ml, and only 5 values (out of 64) exceed 10FC/100ml. These are very encouraging.

The faecal coliform counts of the non-Pounder wells are not as good as those for the Pounder wells. Nine values (out of 43) exceed the 50 FC/100ml standard. However, 30 values lie below 20 FC/100ml, and 22 values lie below 10 FC/100ml. Two of the 5 non-Pounder wells (TW2/109 and TW2/110) show high counts, especially the former.

The dissolved iron content of the Pounder wells (Figure 4.2) shows a very interesting pattern. Values are generally low (less than 0.5 mg/l) up to about December 2000, but from January through April 2001 iron levels rise to 1-2mg/l. After April, levels drop again. This pattern is consistent with the fact that heavy corrosion was observed in below ground pump components (galvanised pump rods) in April 2001, when the GI rods were replaced with stainless steel. The April water samples were taken immediately after replacement of the rods, when the borehole still probably contained a lot of iron which had originated from corrosion of the old rods.

The iron contents of the non-Pounder wells are generally higher than those of the Pounder wells. Twenty two out of 43 values exceed 1 mg/l, rising to nearly 3 mg/l. This

is probably accounted for by the somewhat greater age of the installations there, which almost certainly have galvanised rods.

Turbidity values of Pounder wells are all 5NTU or less, except for one well (PW2/9) which had values of 10NTU or more on four dates. Since September 2000 though, all values for this well have been 5NTU.

Turbidity values for non-Pounder wells are all 5NTU, except well TW2/108 which has consistent values of 10NTU.

pH values for the Pounder well waters mostly lie between 5.0 and 5.9, but there are 8 occasions when pH dropped below 5.0, and to as low as 3.9. These values are very low, and instrument (calibration) error cannot be ruled out.

pH values for non-Pounder wells all lie between 5.5 and 6.5, except for one value which dropped to 5.0. Again instrument calibration error cannot be ruled out.

To summarise, the water quality data over 12-15 months from the small sample of Pounder and non-Pounder wells included in this study give rise to the following conclusions:

- All Pounder well data gives faecal coliform counts well within the GoU standard.
- Faecal contamination of Pounder wells is no worse than that experienced by other shallow wells. The data in fact show Pounder wells to be better in this regard than their comparison group of hand-augered wells.
- Groundwaters can have quite low pH values, which can cause severe corrosion of galvanised below-ground pump components. This corrosion can lead to rapidly increasing dissolved iron contents. Replacement of GI rods with SS causes iron levels to drop.
- Turbidity values in both groups of wells are generally low, and in this sample give no cause for concern.

The full water quality data, together with observations of handpump yield and source condition/care, can be seen below in section 3.

Figure 4.1 Faecal coliform counts of Pounder (upper) and hand augered (lower) wells [Note same time scales, but different y-scales]

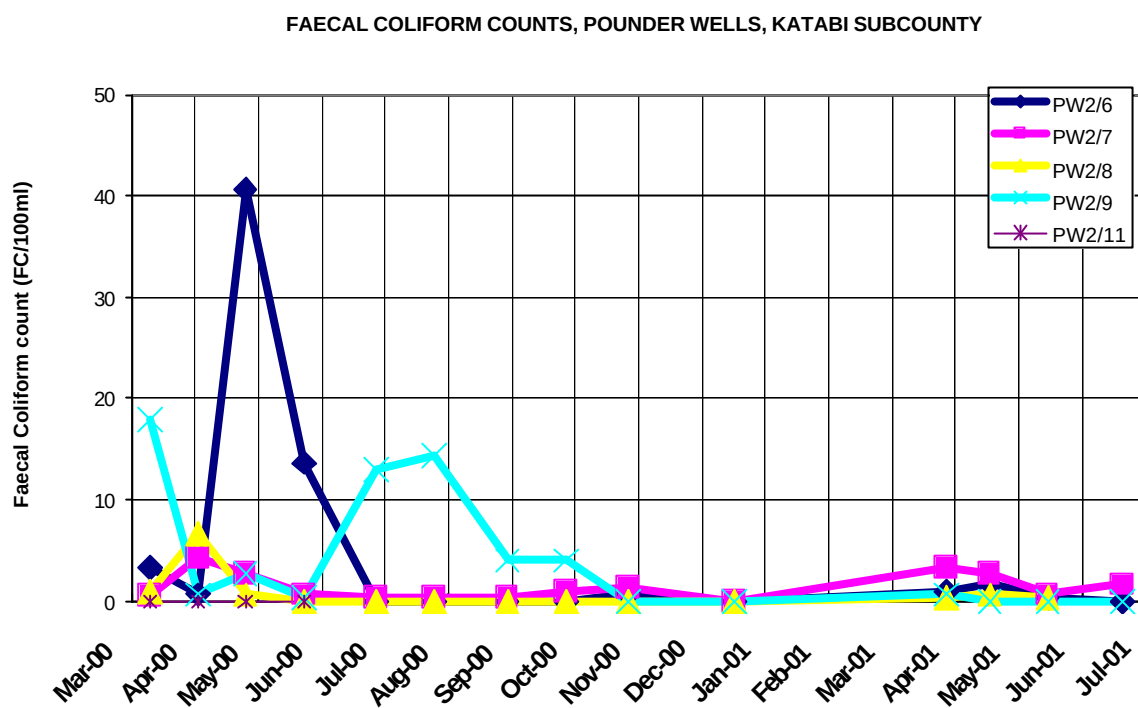
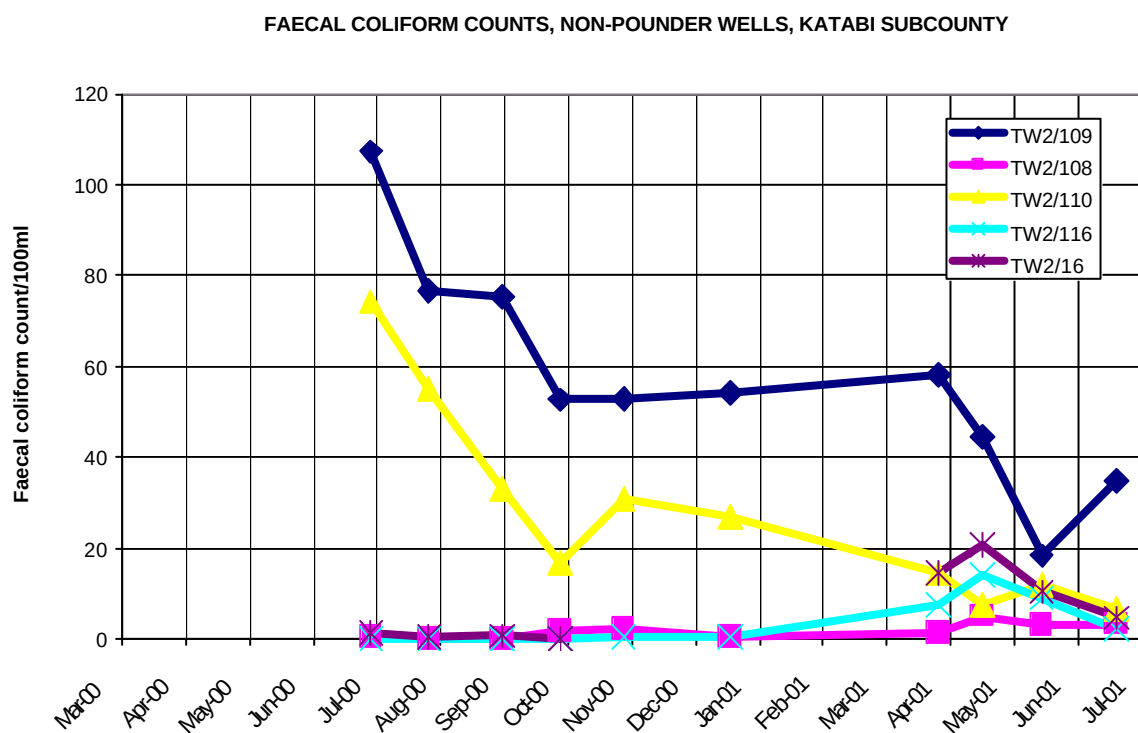
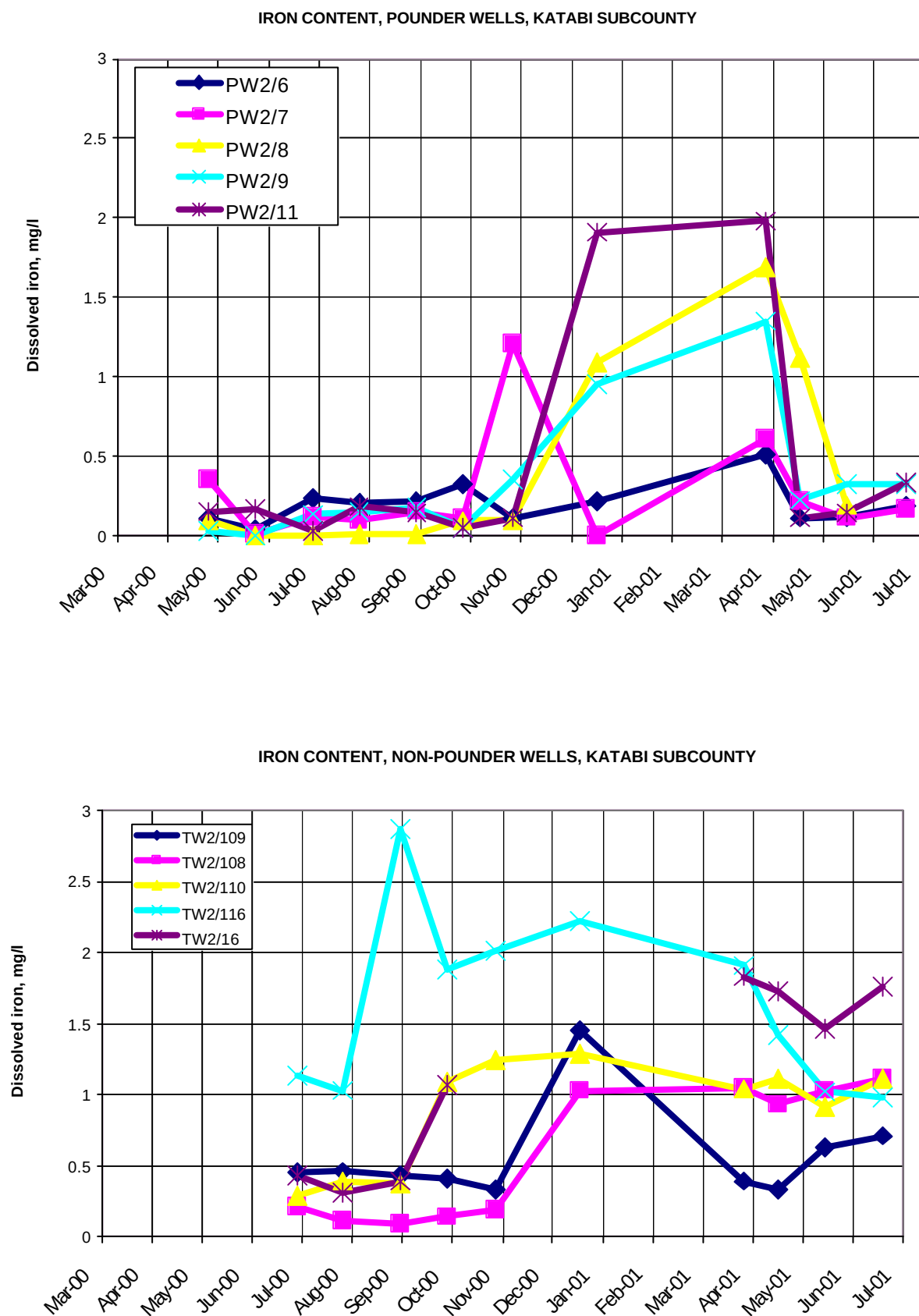


Figure 4.2 Iron contents of Pounder wells (upper) and hand-augered wells (lower)



5 Tables Of Results

Full water quality data for the Pounder and Non-Pounder wells.

5.1 Katabi Wells - Pounder Sources Water Quality and Pump Data, March 2000 – June 2001

Date: 14 March 2000

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	< 5	< 6.8	-	1	HP	100	5 ³	5	-	Short, broken handle
							2	HP	100	3	3		
							3	HP	100	2	2		
Valley Zone (Captain)	PW 2/7	clear	none	< 5	< 6.8	-	1	HP	100	-	-	-	Short broken handle (contaminated, do not use)
							2	HP	100	1	1		
							3	HP	100	0	0		
Ndaula (big pond)	PW 2/8	clear	none	< 5	< 6.8	-	1	HP	100	1	1	-	Short broken handle,
							2	HP	100	1	1		
							3	HP	100	1	1		
Zzika (Steep slope)	PW 2/9	clear	none	5	< 6.8	-	1	HP	100	21	21	-	
							2	HP	100	10	10		
							3	HP	100	23	23		
Bukandek ande (Huts)	PW 2/11	clear	none	< 5	< 6.8	-	1	HP	100	0	0	-	
							2	HP	100	0	0		
							3	HP	100	0	0		
							Control	distilled water	100	0	0		

³ Fingers touched dish lid

Date: 6 April 2000

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	< 5	< 6.8	-	1	HP	100	2	2	-	Very slight cracking at base of pump stand
							2	HP	100	0	0		
							3	HP	100	0	0		
Valley Zone (Captain)	PW 2/7	clear	none	< 5	< 6.8	-	1	HP	100	6	6	-	cracking at base of pump stand
							2	HP	100	1	1		
							3	HP	100	6	6		
Ndaula (big pond)	PW 2/8	clear	none	< 5	< 6.8	-	1	HP	100	9	9	-	Water not draining away
							2	HP	100	10	10		
							3	HP	100	1	1		
Zzika (Steep slope)	PW 2/9	clear	none	10	< 6.8	-	1	HP	100	1	1	-	
				30			2	HP	100	0	0		
				< 5			3	HP	100	1	1		
Bukandekande (Huts)	PW 2/11	clear	none	< 10	< 6.8	-	1	HP	100	0	0	-	
							2	HP	100	0	0		
							3 Control	HP boiled water	100	0	0		

The well discharge was not measured for the first two months.

Date: 29 April 2000

Season: Rainy

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	< 5	< 6.8	0.11	1	HP	100	35	35	0.44	Broken handle, water escaping at tank joint, cracked cement works to channel, protruding pedestal at base of pump.
							2	HP	100	42	42		
							3	HP	100	45	45		
Valley Zone (Captain)	PW 2/7	clear	none	< 5	< 6.8	0.35	1	HP	100	2	2	0.33	Broken handle broken apron floor at pump base, Nut and washer missing. Water start flowing at 15 strokes
							2	HP	100	1	1		
							3	HP	100	5	5		
Ndaula (big pond) Zzika (Steep slope)	PW 2/8	clear	none	< 5	< 6.8	0.09	1	HP	100	1	1	0.50	Broken handle, water not draining from the apron, missing bolt and nut
							2	HP	100	0	0		
							3	HP	100	1	1		
	PW 2/9	clear	none	20	< 6.8	0.03	1	HP	100	5	5	0.40	good
							2	HP	100	2	2		
							3	HP	100	1	1		
Bukandekande (Huts)	PW 2/11	clear	none	< 5	< 6.8	0.15	1	HP	100	0	0	0.36	good
							2	HP	100	0	0		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

None of the wells reflected any element of community ownership/participation

Date: 27 May, 2000

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	<5	<6.8	0.04	1	HP	100	10	10	0.44	Broken handle; more water escaping at tank joint; cracked cement works to channel; protruding pedestal at base of pump.
							2	HP	100	17	17		
							3	HP	100	14	14		
Valley Zone (Captain)	PW 2/7	clear	none	<5	<6.8	0.01	1	HP	100	1	1	0.32	Broken handle, broken apron floor at pump base; nut and washer missing.
							2	HP	100	1	1		
							3	HP	100	0	0		
Ndaula (big pond)	PW 2/8	clear	none	<5	<6.8	0.00	1	HP	100	0	0	0.50	Broken handle; water not draining from the apron; missing bolt and nut
							2	HP	100	0	0		
							3	HP	100	0	0		
Zzika* (Steep slope)	PW 2/9	clear	none	10	<6.8	0.00	1	HP	100	1	1	0.40	Good condition
							2	HP	100	0	0		
							3	HP	100	0	0		
Bukandekande (Huts)	PW 2/11	clear	none	<5	<6.8	0.16	1	HP	100	0	0	0.35	Good condition
							2	HP	100	0	0		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

Committees for each water source selected but not yet trained.

* Access path improved by Watsource Committee with participation of water user group.

Date: 1 July, 2000

Season: Wet

Source of Supply		Colour	Odour	pH		Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair						
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml								
Kajubi (Fence)	PW 2/6	clear	none	5	5.68	0.23	1	HP	100	0	0	0.45	Broken handle; no more water escaping at tank joint (nuts tightened); cracked cement works to channel; protruding pedestal at base of pump. Broken handle, broken apron floor at pump base repaired by community. Missing nut and washer replaced.						
							2	HP	100	0	0								
							3	HP	100	0	0								
Valley Zone (Captain)	PW 2/7	clear	none	5	5.61	0.12	1	HP	100	1	1	0.31							
							2	HP	100	0	0								
							3	HP	100	0	0								
Ndaula (big pond)	PW 2/8	clear	none	5	5.86	0.00	1	HP	100	0	0	0.59	Broken handle; water not draining from the apron; missing bolt and nut						
							2	HP	100	0	0								
Zzika* (Steep slope)	PW 2/9	clear	none	5	5.80	0.13	3	HP	100	0	0	0.40		Good condition					
																2	HP	100	11
Bukandek ande (Huts)	PW 2/11	clear	none	5	5.57	0.03	3	HP	100	0	0	0.35	Missing bolt and nut to tank.						
															1	HP	100	0	0
															2	HP	100	0	0
							Control	HP Boiled water	100	0	0								

Date: 29 July, 2000

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi * (Fence)	PW 2/6	clear	none	5	5.66	0.20	1	HP	100	0	0	0.43	Broken handle; Pump found to have broken down (1 day). Repair made before sampling (pump rod had broken).
							2	HP	100	0	0		
							3	HP	100	0	0		
Valley Zone (Captain)	PW 2/7	clear	none	5	5.68	0.09	1	HP	100	1	1	0.30	Broken handle, broken apron floor at pump base repaired by community. Missing nut and washer replaced.
							2	HP	100	0	0		
							3	HP	100	0	0		
Ndaula (big pond)	PW 2/8	clear	none	5	5.80	0.01	1	HP	100	0	0	0.52	Broken handle; water not draining from the apron; missing bolt and nut
							2	HP	100	0	0		
							3	HP	100	0	0		
Zzika* (Steep slope)	PW 2/9	clear	none	10	5.84	0.15	1	HP	100	15	15	0.35	Good condition
							2	HP	100	17	17		
							3	HP	100	11	11		
Bukandek ande (Huts)	PW 2/11	clear	none	5	5.60	0.18	1	HP	100	0	0	0.31	Missing bolt and nut to tank. Bearings worn out (handle not firmly fitted).
							2	HP	100	0	0		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

* Samples were taken after the turbidity had been brought down to 5 NTU after pumping for about 15 minutes following repairs. (Repairs made by Dan (Health Assistant), who is a member of the monitoring team member).

Date: 2 September, 2000

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	5	5.69	0.21	1	HP	100	0	0	0.41	Broken handle;
							2	HP	100	0	0		
							3	HP	100	0	0		
Valley Zone (Captain)	PW 2/7	clear	none	5	5.65	0.15	1	HP	100	0	0	0.32	Broken handle. Water tank joint not tight. Water escaping on pumping
							2	HP	100	1	1		
							3	HP	100	0	0		
Ndaula (big pond)	PW 2/8	clear	none	5	5.89	0.01	1	HP	100	0	0	0.55	Broken handle; water not draining from the apron; missing bolt and nut
							2	HP	100	0	0		
							3	HP	100	0	0		
Zzika* (Steep slope)	PW 2/9	clear	none	5	5.88	0.17	1	HP	100	3	3	0.35	Handle feels very light on pumping
							2	HP	100	7	7		
							3	HP	100	2	2		
Bukandek ande (Huts)	PW 2/11	clear	none	5	5.59	0.14	1	HP	100	0	0	0.31	Missing bolt and nut to tank. Bearings worn out. Broken cement works at base of pump. Dirty environment
							2	HP	100	0	0		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

Date: 30 September, 2000

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	5	<6.8	0.32	1	HP	100	0	0	0.38	Broken handle;
							2	HP	100	0	0		
							3	HP	100	0	0		
Valley Zone (Captain)	PW 2/7	clear	none	5	<6.8	0.11	1	HP	100	1	1	0.30	Broken handle; Water escaping at tank joint on pumping
							2	HP	100	1	1		
							3	HP	100	1	1		
Ndaula (big pond)	PW 2/8	clear	none	5	<6.8	0.09	1	HP	100	0	0	0.49	Broken handle. Missing bolt and nut
							2	HP	100	0	0		
							3	HP	100	0	0		
Zzika* (Steep slope)	PW 2/9	clear	none	5	<6.8	0.05	1	HP	100	3	3	0.38	Light handle on pumping
							2	HP	100	7	7		
							3	HP	100	2	2		
Bukandek ande (Huts)	PW 2/11	clear	none	5	<6.8	0.05	1	HP	100	0	0	0.37*	Missing bolt and nut to tank. Bearings to handle worn out. Broken cement works at base of pump.
							2	HP	100	0	0		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

* Difficult to maintain steady pumping rhythm due to unsteady handle.

Date: 30 October, 2000

Season: Wet

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	5	5.41	0.11	1	HP	100	2	2	0.41	Broken handle;
							2	HP	100	0	0		
							3	HP	100	0	0		
Valley Zone (Captain)	PW 2/7	clear	none	5	5.15	1.21	1	HP	100	1	1	0.33	Broken handle.
							2	HP	100	0	0		
							3	HP	100	3	3		
Ndaula (big pond)	PW 2/8	clear	none	5	4.16	0.09	1	HP	100	0	0	0.37	Broken handle; bolt and nut still missing
							2	HP	100	0	0		
							3	HP	100	0	0		
Zzika* (Steep slope)	PW 2/9	clear	none	5	3.90	0.35	1	HP	100	0	0	0.37	Light handle
							2	HP	100	0	0		
							3	HP	100	0	0		
Bukandekande (Huts)	PW 2/11	clear	none	5	5.51	0.11	1	HP	100	0	0	0.30*	Missing bolt and nut. Handle loose. Broken cement works at base of pump.
							2	HP	100	1	1		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

* Difficult to pump steadily due to loose handle

Date: 20 December, 2000

Season: Wet

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	5	5.40	0.21	1	HP	100	0	0	0.39	Broken handle;
							2	HP	100	0	0		
							3	HP	100	0	0		
*Valley Zone (Captain)	PW 2/7												Handpump broken down
Ndaula (big pond)	PW 2/8	clear	none	5	5.11	1.09	1	HP	100	0	0	0.43	Broken handle; bolt and nut still missing
							2	HP	100	0	0		
							3	HP	100	0	0		
Zzika* (Steep slope)	PW 2/9	clear	none	5	4.02	0.95	1	HP	100	0	0	0.45	Light handle
							2	HP	100	0	0		
							3	HP	100	0	0		
Bukandek ande (Huts)	PW 2/11	clear	none	5	5.01	1.91	1	HP	100	1	1	0.29**	Missing bolt and nut. Broken cement works at base of pump not repaired. Very loose handle
							2	HP	100	1	1		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

* No samples taken

** Very loose handle makes it difficult

Date: 1 April, 2001

Season: Wet

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	5	5.30	0.51	1	HP	100	0	0	0.39	Broken handle Dirty surrounding
							2	HP	100	1	1		
							3	HP	100	2	2		
Valley Zone (Captain)	PW 2/7	clear	none	5	5.21	0.61	1	HP	100	6	6	0.43	Broken handle
							2	HP	100	1	1		
							3	HP	100	3	3		
Ndaula (big pond)	PW 2/8	clear	none	5	5.61	1.69	1	HP	100	0	0	0.31*	Broken handle Difficult to pump. Water flows after prolonged pumping
							2	HP	100	0	0		
							3	HP	100	1	1		
Zzika (Steep slope)	PW 2/9	clear	none	5	4.93	1.35	1	HP	100	0	0	0.44	Light handle
							2	HP	100	0	0		
							3	HP	100	2	2		
Bukandek ande (Huts)	PW 2/11	clear	none	5	4.98	1.98	1	HP	100	1	1	0.39*	Missing bolt and nut. Broken cement works at base of pump not repaired. Loose handle not repaired
							2	HP	100	1	1		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

* Difficult to measure flow due to difficulty in pumping

Date: 22 April, 2001

Season: Wet

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	5	5.20	0.11	1	HP	100	1	1	0.33**	Broken handle Dirty surrounding
							2	HP	100	1	1		
							3	HP	100	3	3		
Valley Zone (Captain)	PW 2/7	clear	none	5	5.10	0.21	1	HP	100	4	4	0.37**	Broken handle
							2	HP	100	3	3		
							3	HP	100	1	1		
Ndaula (big pond)	PW 2/8	clear	none	5	5.31	1.12	1	HP	100	1	1	0.38**	Broken handle Difficult to pump. Water flows after prolonged pumping
							2	HP	100	0	0		
							3	HP	100	1	1		
Zzika (Steep slope)	PW 2/9	clear	none	5	4.73	0.22	1	HP	100	0	0	0.39	Light handle
							2	HP	100	0	0		
							3	HP	100	0	0		
Bukandek ande (Huts)	PW 2/11	clear	none	5	4.78	0.11	1	HP	100	1	1	0.36**	Missing bolt and nut. Broken cement works at base of pump not repaired. Loose handle not repaired
							2	HP	100	3	3		
							3	HP	100	9	9		
							Control	Boiled water	100	0	0		

* Samples taken after replacement of galvanized iron rods with steel rods.

** Difficult to measure well discharge due to difficulty in pumping

Date: 20 May, 2001

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	5	5.23	0.12	1	HP	100	0	0	0.31*	Broken handle
							2	HP	100	0	0		
							3	HP	100	1	1		
Valley Zone (Captain)	PW 2/7	clear	none	5	5.55	0.11	1	HP	100	0	0	0.39*	Broken handle
							2	HP	100	1	1		
							3	HP	100	1	1		
Ndaula (big pond)	PW 2/8	clear	none	5	5.21	0.19	1	HP	100	1	1	0.30*	Broken handle Difficult to pump. Water flows after prolonged pumping
							2	HP	100	0	0		
							3	HP	100	0	0		
Zzika (Steep slope)	PW 2/9	clear	none	5	5.01	0.32	1	HP	100	0	0	0.41	Light handle
							2	HP	100	0	0		
							3	HP	100	0	0		
Bukandek ande (Huts)	PW 2/11	clear	none	5	4.32	0.14	1	HP	100	1	1	0.32*	Missing bolt and nut. Broken cement works at base of pump not repaired. Loose handle not repaired
							2	HP	100	0	0		
							3	HP	100	4	4		
							Control	Boiled water	100	0	0		

* Difficult to measure well discharge due to difficulty in pumping

Date: 25 June, 2001

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kajubi (Fence)	PW 2/6	clear	none	5	< 6.8	0.19	1	HP	100	0	0	0.30*	Broken handle
							2	HP	100	0	0		
							3	HP	100	0	0		
Valley Zone (Captain)	PW 2/7	clear	none	5	< 6.8	0.16	1	HP	100	3	3	0.33*	Broken handle
							2	HP	100	1	1		
							3	HP	100	1	1		
Ndaula (big pond)**	PW 2/8												Pump not working
Zzika (Steep slope)	PW 2/9	clear	none	5	< 6.8	0.32	1	HP	100	0	0	0.41	Light handle
							2	HP	100	0	0		
							3	HP	100	0	0		
Bukandek ande (Huts)	PW 2/11	clear	none	5	< 6.8	0.33	1	HP	100	1	1	0.31*	Missing bolt and nut. Broken cement works at base of pump not repaired. Loose handle not repaired
							2	HP	100	1	1		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

* Difficult to measure well discharge due to difficulty in pumping

** Community has purchased the spare parts, to be fixed soon by Health Assistant (Dan)

5.2 Katabi Wells – Non-Pounder Sources Water Quality and Pump Data, July 2000 – June 2001

Date: 2 July, 2000

Season: Wet

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kanisa Zone (Big tree)*	TW 2/10 9	clear	none	5	6.08	0.45	1	HP	100	112	112	0.35	Chipped floor to apron otherwise good.
							2	HP	100	101	101		
							3	HP	100	109	109		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	6.27	0.21	1	HP	100	1	1	0.33	Missing bolt and nut
							2	HP	100	0	0		
							3	HP	100	0	0		
Tadeo (Double)**	TW 2/11 0	clear	none	5	5.96	0.29	1	HP	100	73	73	0.45	Good condition
							2	HP	100	81	81		
							3	HP	100	69	69		
Kauku (Bananas)	TW 2/11 6	clear	none	5	5.80	1.13	1	HP	100	0	0	0.43	Broken handle (had been welded)
							2	HP	100	0	0		
							3	HP	100	0	0		
Kauku (Night)	TW 2/16	clear	none	5	5.92	0.43	1	HP	100	3	3	0.40	Broken handle
							2	HP	100	0	0		
							3	HP	100	1	1		
							Control	Boiled water	100	0	0		

* Handles welded

** Evidence of community care

Date: 30 July, 2000

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kanisa Zone (Big tree)	TW 2/10 9	clear	none	5	6.09	0.46	1	HP	100	34	34	0.33	Chipped floor to apron otherwise good.
							2	HP	100	97	97		
							3	HP	100	99	99		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	6.55	0.11	1	HP	100	0	0	0.32	Good condition
							2	HP	100	0	0		
							3	HP	100	0	0		
Tadeo (Double)	TW 2/11 0	clear	none	5	5.99	0.39	1	HP	100	56	56	0.42	Missing bolt and nut
							2	HP	100	53	53		
							3	HP	100	56	56		
Kauku (Bananas)	TW 2/11 6	clear	none	5	5.93	1.03	1	HP	100	0	0	0.40	Broken handle (had been welded)
							2	HP	100	0	0		
							3	HP	100	0	0		
Kauku (Night)	TW 2/16	clear	none	5	5.55	0.31	1	HP	100	0	0	0.40	Broken handle
							2	HP	100	0	0		
							3	HP	100	1	1		
							Control	Boiled water	100	0	0		

* Missing bolt and nut replaced by monitoring team.

Date: 3 September, 2000

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kanisa Zone (Big tree)	TW 2/10 9	clear	none	5	6.07	0.43	1	HP	100	80	80	0.31	Chipped floor to apron. Light handle on pumping (O-ring worn out?).
							2	HP	100	67	67		
							3	HP	100	79	79		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	6.57	0.09	1	HP	100	0	0	0.36	Good condition Clean environment
							2	HP	100	0	0		
							3	HP	100	0	0		
Tadeo (Double)	TW 2/11 0	clear	none	5	5.96	0.37	1	HP	100	31	31	0.39	Missing bolt and nut Clean environment
							2	HP	100	23	23		
							3	HP	100	45	45		
Kauku (Bananas)	TW 2/11 6	clear	none	5	5.99	2.87	1	HP	100	0	0	0.40	Broken handle (had been welded)
							2	HP	100	0	0		
							3	HP	100	0	0		
Kauku (Night)	TW 2/16	clear	none	5	5.51	0.39	1	HP	100	1	1	0.39	Broken handle
							2	HP	100	0	0		
							3	HP	100	1	1		
							Control	Boiled water	100	0	0		

Date: 1 October, 2000

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kanisa Zone (Big tree)	TW 2/10 9	clear	none	5	<6.8	0.41	1	HP	100	22	22	0.30	O-ring to handle worn out.
							2	HP	100	59	59		
							3	HP	100	77	77		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	<6.8	0.14	1	HP	100	1	1	0.33	Good condition
							2	HP	100	0	0		
							3	HP	100	4	4		
Tadeo (Double)	TW 2/11 0	clear	none	5	<6.8	1.09	1	HP	100	22	22	0.39	Missing bolt and nut Clean environment
							2	HP	100	12	12		
							3	HP	100	16	16		
Kauku (Bananas)	TW 2/11 6	clear	none	5	<6.8	1.88	1	HP	100	0	0	0.41	Broken handle
							2	HP	100	0	0		
							3	HP	100	0	0		
Kauku (Night)	TW 2/16	clear	none	5	<6.8	1.07	1	HP	100	0	0	0.37	Broken handle
							2	HP	100	0	0		
							3	HP	100	0	0		
							Control	Boiled water	100	0	0		

Date: 31 October, 2000

Season: Wet

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kanisa Zone (Big tree)	TW 2/10 9	clear	none	5	6.01	0.33	1	HP	100	12	12	0.33*	Loose handle.
							2	HP	100	55	55		
							3	HP	100	92	92		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	6.13	0.19	1	HP	100	4	4	0.31	Good condition
							2	HP	100	1	1		
							3	HP	100	1	1		
Tadeo (Double)	TW 2/11 0	clear	none	5	6.01	1.24	1	HP	100	22	22	0.30	Missing bolt and nut Clean environment
							2	HP	100	16	16		
							3	HP	100	55	55		
Kauku (Bananas)	TW 2/11 6	clear	none	5	5.77	2.01	1	HP	100	0	0	0.47	Broken handle Dirty environment
							2	HP	100	1	1		
							3	HP	100	0	0		
Kauku (Night)**	TW 2/16												Handpump not working since mid-October. Community making contributions to get it repaired
							Control	Boiled water	100	0	0		

* Loose handle makes difficult to pump full stroke

** Samples not taken. Handpump not working

Date: 21 December, 2000

Season: Wet

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kanisa Zone (Big tree)	TW 2/10 9	clear	none	5	5.99	1.45	1	HP	100	61	61	0.30*	Loose handle.
							2	HP	100	57	57		
							3	HP	100	44	44		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	6.11	1.03	1	HP	100	0	0	0.37	Good condition.
							2	HP	100	1	1		
							3	HP	100	0	0		
Tadeo (Double)	TW 2/11 0	clear	none	5	5.79	1.29	1	HP	100	19	19	0.36	Missing bolt and nut
							2	HP	100	31	31		
							3	HP	100	31	35		
Kauku (Bananas)	TW 2/11 6	clear	none	5	6.01	2.22	1	HP	100	0	0	0.35	Broken handle
							2	HP	100	1	1		
							3	HP	100	0	0		
Kauku (Night)*													Handpump not yet repaired. Community hopes to get it working by January 2001.
							Control	Boiled water	100	0	0		

* Difficult to make full strokes

** No samples taken. Handpump not working

Date: 31 March, 2001

Season: Wet

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kanisa Zone (Big tree)	TW 2/10 9	clear	none	5	6.00	0.39	1	HP	100	25	25	0.34	Loose handle. No repairs effected
							2	HP	100	62	62		
							3	HP	100	87	87		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	6.79	1.05	1	HP	100	3	3	0.38	Good condition
							2	HP	100	0	0		
							3	HP	100	1	1		
Tadeo (Double)	TW 2/11 0	clear	none	5	6.41	1.04	1	HP	100	13	13	0.31	Missing bolt and nut
							2	HP	100	11	11		
							3	HP	100	19	19		
Kauku (Bananas)	TW 2/11 6	clear	none	5	5.00	1.91	1	HP	100	9	9	0.41	Broken handle
							2	HP	100	12	12		
							3	HP	100	2	2		
Kauku (Night)	TW 2/16	clear	none	5	6.02	1.83	1	HP	100	12	12	0.39	Broken handle Clean environment
							2	HP	100	22	22		
							3	HP	100	10	10		
							Control	Boiled water	100	0	0		

Date: 21 April, 2001

Season: Wet

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C. / 100 ml		
Kanisa Zone (Big tree)	TW 2/10 9	clear	none	5	6.12	0.33	1	HP	100	42	42	0.31	Loose handle Dirty environment
							2	HP	100	15	15		
							3	HP	100	77	77		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	5.91	0.93	1	HP	100	10	10	0.37	Good condition
							2	HP	100	3	3		
							3	HP	100	5	5		
Tadeo (Double)	TW 2/11 0	clear	none	5	6.23	1.11	1	HP	100	12	12	0.38	Missing bolt and nut
							2	HP	100	2	2		
							3	HP	100	9	9		
Kauku (Bananas)	TW 2/11 6	clear	none	5	5.90	1.42	1	HP	100	15	15	0.39	Broken handle Clean environment
							2	HP	100	12	12		
							3	HP	100	15	15		
Kauku (Night)	TW 2/16	clear	none	5	6.15	1.73	1	HP	100	33	33	0.36	Broken handle Clean environment
							2	HP	100	12	12		
							3	HP	100	17	17		
							Control	Boiled water	100	0	0		

Date: 19 May , 2001

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Kanisa Zone (Big tree)	TW 2/10 9	clear	none	5	6.52	0.63	1	HP	100	22	22	0.31	Loose handle No repairs
							2	HP	100	10	10		
							3	HP	100	33	33		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	6.12	1.03	1	HP	100	1	1	0.35	Clean environment Good condition
							2	HP	100	5	5		
							3	HP	100	3	3		
Tadeo (Double)	TW 2/11 0	clear	none	5	6.03	0.91	1	HP	100	11	11	0.39	Missing bolt and nut
							2	HP	100	15	15		
							3	HP	100	10	10		
Kauku (Bananas)	TW 2/11 6	clear	none	5	5.99	1.02	1	HP	100	11	11	0.33	Broken handle
							2	HP	100	9	9		
							3	HP	100	7	7		
Kauku (Night)	TW 2/16	clear	none	5	5.52	1.46	1	HP	100	12	12	0.36	Broken handle
							2	HP	100	12	12		
							3	HP	100	7	7		
							Control	Boiled water	100	0	0		

Date: 24 June , 2001

Season: Dry

Source of Supply		Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village	Well No.						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C/ 100 ml		
Kanisa Zone (Big tree)	TW 2/10 9	clear	none	5	<6.8	0.71	1	HP	100	25	25	0.30	Loose handle No repairs effected Clean environment
							2	HP	100	36	36		
							3	HP	100	44	44		
Kanisa Zone (Sandpit)*	TW 2/10 8	clear	none	10	<6.8	1.11	1	HP	100	0	0	0.35	Good condition
							2	HP	100	3	3		
							3	HP	100	7	7		
Tadeo (Double)	TW 2/11 0	clear	none	5	<6.8	1.11	1	HP	100	4	4	0.35	Clean environment Missing bolt and nut
							2	HP	100	4	4		
							3	HP	100	12	12		
Kauku (Bananas)	TW 2/11 6	clear	none	5	<6.8	0.98	1	HP	100	3	3	0.32	Broken handle
							2	HP	100	2	2		
							3	HP	100	2	2		
Kauku (Night)	TW 2/16	clear	none	5	<6.8	1.76	1	HP	100	1	1	0.37	Broken handle
							2	HP	100	6	6		
							3	HP	100	7	7		
							Control	Boiled water	100	0	0		

5.3 Jinja and Mukono Wells – Pounder Sources Water Quality and Pump Data

Pounder Wells Mukono District**Date:** 19th / 20th June 2001**Season:** Dry

Source of Supply	Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village						Sample No.	Source	Vol. Filt. (ml)	No. of F.C.	F.C / 100 ml		
Ntunda	Milky	none	30*	< 6.8	0.12	1	HP	100	0	0	0.34	Good condition
						2	HP	100	0	0		
						3	HP	100	1	1		
Kasubi**												Water not drain easily from apron
						Control	Boiled water	100	0	0		

- Turbidity improves on continued pumping.

** Mud comes out on continued pumping

Pounder Wells Jinja district**Date: 19th June 2001****Season: Dry**

Source of Supply	Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village						Sample No.	Source	Vol. Filt. (ml)	No. of F.C .	F.C / 100 ml		
Makenke	Brown	none	100	< 6.8	0.15	1	HP	100	0	0	0.33	Good condition
						2	HP	100	0	0		
						3	HP	100	0	0		
Bukwang a	clear	none	< 5	< 6.8	0.18	1	HP	100	0	0	0.35	Fence has been erected to protect the well
						2	HP	100	0	0		
						3	HP	100	0	0		
						Control	Boiled water	100	0	0		

- Turbidity improves on continued pumping.

5.4 Jinja and Mukono Wells – Non-Pounder Sources Water Quality and Pump Data

Non- Pounder Wells Mukono District

Date: 20th June 2001 **Season:** Dry

Source of Supply	Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Village						Sample No.	Source	Vol. Filt. (ml)	No. of F.C .	F.C/ 100 ml		
Katazi	Clear	None	< 5	< 6.8	1.91	1	HP	100	10	10	0.35	Good condition
						2	HP	100	5	5		
						3	HP	100	7	7		
Kyabazala	Clear	None	< 5	< 6.8	1.88	1	HP	100	3	3	0.33	Clogged drainage channel
						2	HP	100	1	1		
						3	HP	100	7	7		
						Control	Boiled water	100	0	0		

Salty taste

Non-Pounder Wells Jinja District

Date:	20 th June 2001			Season		Dry					Well discharge (l/s) at about 1 full stroke per second	State of Repair
Source of Supply	Colour	Odour	Turbidity (NTU)	pH	Iron	Faecal Coliforms						
Village						Sample No.	Source	Vol. Filt. (ml)	No. of F.C .	F.C / 100 ml		
Namulesa*	Clear	none	5	< 6.8	1.99	1	HP	100	0	0	0.32	Good condition
						2	HP	100	0	0		
						3	HP	100	0	0		
Lubiri	Clear	none	< 5	< 6.8	1.75	1	HP	100	22	22	0.35	Chipped cement finishing to apron
						2	HP	100	12	12		
						3	HP	100	20	20		
						Control	Boiled water	100	0	0		

- Salty taste



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<https://dspace.org/>

Private Sector Participation in Low Cost Water Well Drilling.

Rwamwanja, R.; Danert, Kerstin; Carter, Richard C.

2001

Cranfield University

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