[National workshop on operation and maintenance of rural and urban water supply and sanitation systems : Kadoma, Zimbabwe 26 - 29 November 1996 : various papers]

National Workshop
on Operation & Maintenance
of Rural and Urban
Water Supply and Sanitation Systems

Kadoma, Zimbabwe 26 - 29 November 1996

PROGRAMME

Tuesday 26 / 11/ 96

08.30	Welcome remarks	NAC Chairman
	Introductions	W Rukasha
	Housekeeping	S Makanga
	Programme review	**Chairperson**
09.30	Presentation of recommendations and plan of operation from previous workshop	**G Nhunhama**
10.00	*Tea / Coffee break*	
10.30	Official Opening	**T. Bare**
11.00	Rural Sanitation Presentation of the state of O&M in Rural Zimbabwe supported by a case study	**MOH & CW**
12.00	Urban Sanitation Presentation of the state of O&M in Urban Zimbabwe supported by a case study	**Engineers' Forum**
13.00	*Lunch*	
14.00	Rural Water Supply Presentation of the state of O&M in Rural Zimbabwe supported by a case study	**DDF**
15.00	Urban Water Supply Presentation of the state of O&M in Urban Zimbabwe supported by a case study	**Engineers' Forum**
16.00	*Tea/Coffee Break*	
16.30	Analysis of O&M in urban and rural water and sanitation Presentation and discussions	**P. Taylor**

17.30	End of first day_	

Wednesday 27 / 11 / 96

08.00	Report on progress of Africa 2000	
	General aspects	**F. Brikké**
	Achievements in Zimbabwe	**M, Musingarabwi**
08.45	O&M in the international scene	
	O&M Working Group	
	Tools prepared	
	Trends in O&M	**F, Brikké**
10.00	*Tea/Coffee Break*	
10.30	Introduction to group work	**S Makanga**
	Working Groups (start)	
13.00	*Lunch*	
14.00	Working Groups (continued)	
16.00	*Tea/Coffee Break*	
16.30	Working Groups (continued & end)	
17.30	End of second day	

Thursday 28 / 11 / 96

08.00	Field Visit
	Kadoma sewage works
	Kadoma water works
13.00	*Packed Lunch*
14.00	Sanyati (IRWSSP)
17.30	Return to Ranch
19.00	*Social evening*

Friday 29 / 11/ 96

08.00	Presentations of reports of Working Groups and field visit observations in plenary & discussions	**Working Groups**
10.00	*Tea/Coffee Break*	
10.30	Presentations of reports (continued)	**Working Groups**
11.30	Presentation of main Workshop recommendations, propositions on follow-up & discussions	**Facilitator**
12.15	Evaluation of Workshop	**Facilitator**
12.45	Closure	
13.00	*Lunch and departure*	

OPERATION AND MAINTENANCE OF RURAL SANITATION FACILITIES IN ZIMBABWE

A CASE STUDY

BY:

Maxwell Jonga
Provincial Environmental Health Officer
MASHONALAND EAST PROVINCE

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OPERATION AND MAINTENANCE OF RURAL SANITATION FACILITIES IN ZIMBABWE: A CASE STUDY

1. PREAMBLE

Commendable progress has been made in the rural water supply and sanitation programme in Zimbabwe since independence in 1980. The adoption of the International Decade for Water Supply and Sanitation by the Government of Zimbabwe in 1982 marked the turning point in the improvement of water supply and sanitation coverage in Zimbabwe.

Unfortunately, the achievements realised during the decade are not commensurate with the operation and maintenance systems available. Operation and maintenance does not seem to be given due priority in ensuring the sustainability of rural water supply and sanitation systems.

Consequently, there is an apparent dearth of information on operation and maintenance, especially of the rural sanitation systems. Whenever operation and maintenance of rural water supply and sanitation is planned, the sanitation component is often relegated to a very low profile.

Probably this is partly because the need for operation and maintenance in rural sanitation is rather abstract and, is often considered to be long term. However, the fact that the impact of poor operation and maintenance in sanitation is long term and therefore difficult to mitigate is often overlooked.

It would appear sanitation is better placed for operation and maintenance than water supplies. This is due to the fact that rural sanitation facilities take long to require major maintenance. In addition, they are individually owned and enjoy a sense of responsibility and ownership from the individual households. Apart from collapsing and filling, all maintenance requirements are generally cheaper and easier for the individual household. Yet, not much has been put in place to ensure sustainability of the rural sanitation systems.

It is therefore fundamental that an aggressive approach to the operation and maintenance of rural sanitation facilities be adopted as a matter of priority. This will ensure the much needed sustainability of the Public Health and Social investment that has been realised during the past 14 years.

1.1 THE EVOLUTION OF SANITATION IN ZIMBABWE

The evolution of sanitation development in rural Zimbabwe dates back to the mid - 1950s in pre - independent Zimbabwe.

It started with the enrolment of the first group of the then Native Hygiene Demonstrators (NHDs) at the Domboshava National Training Centre in 1947. This cadre (NHD) was to spearhead the hygiene development in the neglected poor rural areas.
During that time there was no material subsidy for sanitation from either the Government or Donors. Infrustructural development was virtually non - existent and institutional arrangements were almost zero. The NHD had the single - handed arduous task of health and hygiene education, motivation and mobilisation of the community on sanitation development, and other preventive and promotive health services. With this scenario, sanitation development got to a very slow start as it was both time consuming and laborious to convince one single family to construct a pit latrine.

The technology of choice at that time was the conventional pit latrine. The benefits of this technology at that time outweighed its disadvantages of offensive odours and fly breeding. This marked what was to become one of the most successful rural water supply and sanitation programmes in Africa in the 20th century.

Overally, there was very little progress for the next 20 years, which was compounded by poor and inappropriate technology choices. This period also witnessed trials with various technologies such as the chieng - mai squat pan, the watergate, the aqua privy and others.

It was not until the late 1970s that the famous Blair Ventilated Improved Pit (BVIP) latrine was developed in Zimbabwe by the Blair Research Laboratory. This was to become the most appropriate, affordable and sustainable sanitation technology in Zimbabwe for the following more than 20 years.

The ventilated improved pit latrine (VIP) offers a safe and reliable method of human excreta disposal particularly suitable for rural areas, where water is scarce. When built to specifications, the VIP is odourless and reduces flybreeding to the bearest minimum. These advantages have inherent implications on the use, operation, maintenance and ultimately the sustainability of the sanitation programme.

1.2 RURAL SANITATION SERVICE LEVELS IN ZIMBABWE

Since Zimbabwe's independence in 1980 the rural sanitation programme has made some substantial strides. The following table illustrates the service coverage levels in Zimbabwe by Province as at December 1995. In 1980 the national service level coverage was approximately 5%.

PROVINCE	NO. OF HOUSEHOLDS	NO. OF VIPS	% COVERAGE
Matebeleland North	117 363	30 563	26.4
Matebeleland North	109 671	14 043	12,8
Midlands	177 095	30 650	17.3
Masvingo	258 020	76 657	30.0
Mashonaland West	213 401	34 820	16.3
Mashonaland Central	162 417	31 307	19.3
Mashonaland East	206 623	43 024	20.8
Manicaland	284 997	47 179	16.6
TOTALS	1529 587	308 243	20.15

2.0 STATEMENT OF THE PROBLEM

There has been some remarkable improvement in the national sanitation service coverage levels in rural Zimbabwe since 1980. The coverage rose from about 5% in 1980 to approximately 20.1% in 1995.

The emphasis on operation and maintenance has been essentially biased towards the water supply component. Consequently, there is a dearth of information on the state of affairs regarding the operation and maintenance of sanitation facilities. It is , therefore, not clear how sustainable the current rural sanitation programme is in Zimbabwe.

3.0 OBJECTIVES OF THE STUDY

3.1 GENERAL OBJECTIVE

To make a critical assessment of the operation and maintenance systems of the rural sanitation programme in Zimbabwe.

3.2 SPECIFIC OBJECTIVES

i) To examine the sanitation technologies and institutional arrangements available and in use in the rural sanitation programme in Zimbabwe.

ii) To assess the sustainability of the sanitation programme in Rural Zimbabwe.

iii) To assess the extent to which the rural sanitation facilities are being used.

iv) To assess the structural standard of sanitation facilities in rural areas.

v) To assess the extent to which the rural sanitation facilities are being maintained.

vi) To make recommendations on the way forward in ensuring sustainable sanitation development in Zimbabwe.

4. STUDY AREA

The rural areas of Zimbabwe.

5. STUDY DESIGN

A cross - sectional study.

6. METHODOLOGY

6.1 SAMPLING

Four out of eight provinces in Zimbabwe were sampled using the simple random sampling method. Within the sampled provinces toilets were conveniently sampled as follows:

- toilets constructed up to 1984
- toilets constructed between 1985 and 1989
- toilets constructed between 1990 and 1994
- toilets constructed in 1995
- It was found necessary to include 30 low cost 3 bag version toilets in Murehwa district of Mashonaland East.

6.2 DATA COLLECTION

A structural questionnaire was drafted and pretested in Hwedza district of Mashonaland East Province. A few necessary adjustments were made. The questionnaire was administered in the sampled areas by the researcher between July and August 1996.

- Households with toilets constructed during the selected periods were visited. Physical inspections of the existing toilet and the immediate surroundings were carried out.
- This included assessments of the level of pit contents using a hunter's torch.

- Interviews of householders and community leaders were conducted.

- Key informants involved in sanitation at Provincial, district and ward levels were interviewed.

- Other information was obtained from environmental observations at homesteads.

- It was also found necessary to collect data from an area where the low cost 3 bag version had been implemented since 1991. This was mainly to try and assess the longevity of this type of structure for purposes of assessing sustainability of the technology.

7. DATA PROCESSING AND ANALYSIS

Data was processed and analyzed using EPI - INFO 6 software.

8. LIMITATIONS OF THE STUDY

a) The sample size was rather small considering the total number of existing latrines in rural Zimbabwe at the time of the study.

b) Due to limited time it was not possible to carry out wide ranging interviews with representatives of all sectors and agencies who are stakeholders in rural sanitation.

c) In some areas it was not possible to get the targeted latrines mostly because there were very few or no toilets built during the required period, or there was no time to search for them.

e) Most households whose toilets had collapsed and were not usable were left out of the study. However some of them were included in discussions but without using the questionnaire.

9. FINDINGS

9.1 A very large proportion of toilets (97.6%) were being used. Information from the respondents, was confirmed by the presence of fresh human excreta in the pits. Those not being used (2.4%) were either near collapse or collapsed.

9.2(a) Of the toilets built before and up to 1984 12 (30%) were found full whilst 12 (30%) were more than half full, and 15 (37.5%) were less than half full, and I (2.5%) were half full.

(b) Out of the toilets built between 1985 and 1989, 11(21.2%) were found full.

Out of those constructed between 1990 and 1994, 5(9.6%) were full and 9(17.3%) were more than half full. 14 (26.9%) were more than half full or full. None (0%) were full amongst those constructed in 1995.

9.3 LATRINE MAINTENANCE

- 86% of the toilets receive some form of maintenance and 14% receive no maintenance at all.

- The main form of maintenance done on the toilets is cleaning inside and clearing of surroundings (85.4%)

- 6% of the toilets receive structural maintenance while only 0.6% have their vent pipes checked and cleared.

9.4 ANAL CLEANSING MATERIAL

a) Of all the households sampled 134 (81.7%) use newsprint only for anal cleansing, whilst 2(1.2%) use mealie cobs and newsprint, and 5 (9.6%) use other materials like sticks plus newsprint.

9.5 STRUCTURAL STATUS OF TOILETS

40(36.0%) of the toilets were in a good structural status whilst 26 (15.9%) were in a very good status and 40 (24.4%) were in a fair status.

A total of 18 (10.98%) were in a poor status, 16 (9.8%) in a very poor status and (4) 2.4% were collapsed.

- 60% of toilets constructed up to 1984 ranged between fair and very good as compared to 79% constructed during 1985 to 1989, 86.3% during 1990 - 1994 and 77.8% in 1995.

9.6 AVAILABILITY OF FLYSCREENS

- 69.5% of the toilets were fitted with flyscreens of which 74.6% were intact

- 25.4% of the flyscreens were worn

- The majority of those who did not receive any subsidy did not provide flyscreens on their latrines.

9.7 SUBSIDY

Of the households sampled, 66.5% received subsidies in the form of cement and flyscreen from the Government or Donors, whilst 32.3% did not get any subsidy. 1.2% did not know.

9.8 On what they will do in the event of their toilet filling up or collapsing, the following was found:

- 68.3% indicated that they will build on their own.

- 25.6% would contact Ministry of Health and Child Welfare for assistance, while 1.8% would either build on their own failing which they would contact Ministry of Health and Child Welfare.

- 1.25% had no idea what to do whilst 1.25% indicated they would disludge the filled toilet.

- Of those who did not receive any subsidy, 100% indicated that they would replace the toilets, if need arises, without asking for external assistance.

- Of those who received material subsidy 54.0% indicated that they would replace their toilets without seeking any material assistance.

9.9 **USE OF LATRINES FOR BATHING**

- 78.7% of the latrines are used for bathing. Those not using them for bathing either have a structure, usually made of wooden pole and grass, or use metal baths inside houses, or bath in rivers or streams.

9.10 **WASH HAND FACILITIES**

- Of the sampled toilets (20) 12.2% had wash facilities and (144) 87.8% had no wash hand facilities.

- Only 25% of the wash hand tanks were being used.

- All toilets with wash hand tanks were built between 1991 and 1994.

- Wash hand tanks were found in only one province. This was in the area of low - cost 3 bag version.

9.11 **NUMBER OF USERS IN RELATION TO AMOUNT OF FAECAL MATTER IN THE PIT**

- 20.6% of toilets used by 1 - 5 people were more than half full or full

- 46% of toilets used by 6 - 10 people were more than half full or full

- 57% of toilets used by more than 10 people were more than half full or full

9.12 The existing institutional structures at Provincial and district levels were very active in the planning and implementation of the water and sanitation programme.

However, the enthusiasm seemed to be either non - existent where the programme was not donor funded, or die down when the donor support was withdrawn.

None of those structures had anything to do with operation and maintenance in the sanitation component.

9.13 There was no indication of regular inspections of blair latrines by health staff after completion of construction, to check on the hygienic and structural maintenance.

10. DISCUSSION AND CONCLUSIONS

10.1 USE OF LATRINES

A large majority of the people who have toilets in Zimbabwe use them (97.6%). This is an indication that the rural community appreciates the importance of latrines. This high rate of use has a bearing on operation and maintenance and hence sustainability of sanitation facilities. Once people get used to using the toilet, it can be assumed that they are more likely to maintain them and to replace them if they happen to fill up or collapse. However, if a closer look is taken, it is found that only 64.6% of the toilets had a structural status ranging from fair to very good. 35.4% are in a poor structural state. A very small percentage of those ranging from poor to very poor could have their structural status attributable to poor workmanship. The large remainder of poor structural status may therefore be due to poor maintenance.

The use of blair latrines as bathrooms is pleasing as it contributes to the hygienic maintenance of the latrine. The waste water also enhances the biodegradation of faecal matter in the pit thereby prolonging the pit life span.

Although not much can be deduced as far as the effect of anal cleansing material on the life of the pit is concerned, there is no doubt that newsprint, which is mostly used, is easily biodegradable. Coupled with the waste water from bathing, this should help to prolong the life of the pit.

The number of users of a latrine has some bearing on the life of the latrine. The more the users the faster the toilet fills, with toilets used by more than 10 people getting full much faster. Given the problem of replacement alluded to elsewhere in this document, it has some important implications on the sustainability of the rural sanitation programme.

It was also noted that latrines that are full continue to be used. This renders the latrine as hazardous as a situation where there is no toilet, as there is increased fly breeding, offensive odours and easy access to human excreta by flies. People seem to continue using the full latrine until it is completely unusable without making any contingent measures to avoid a lag period. This means there is a period when there is no toilet

between the filling up of the existing latrine and its replacement. A substantial percentage of households whose toilets had collapsed were sharing with neighbours, where toilets were available. Although this is good in a way, it results in the toilet filling up faster than usual.

10.2 MAINTENANCE AND STRUCTURAL STATUS OF THE LATRINES

An important observation is that the hygienic standards of latrines is generally very high. Some of the floors were even polished. This indicates commitment to and appreciation of the importance of hygiene by the community. The toilets are hygienically cared for and surroundings cleared as a matter of routine.

However, the fact that only 6% of the toilets receive some form of structural maintenance throws, the sustainability of the sanitation programme into doubt. A very small proportion of cracked walls and floors, and peeling plaster are repaired as the need arises.

The reduction of fly breeding is one of the major advantages of the blair latrine. Therefore the proportion of defective toilets in this regard is unacceptably high. This trend is likely to get worse especially so, given the fact that only 0.6% of the households ever inspect the condition of the flyscreen. The flyscreen is a vital integral component of the blair latrine, and yet it is often neglected. This paints a gloomy picture in terms of sustainability.

The 69.5% only availability of flyscreens is cause for concern. This means that a large proportion of latrines are not functioning fully as blair latrines. This problem is compounded by the fact that 25.4% of the existing flyscreens are worn.

10.3 LIFE SPAN OF A BLAIR LATRINE

Judging from the percentage of toilets ranging from more than half full to full, for the period up to 1995, the life span of a blair latrine can be generally said to be 10 to 15 years for a family of 6 to 10 people.

Therefore, the technology of choice in rural sanitation in Zimbabwe contributes substantially to the sustainability of the rural sanitation programme.

In addition the technology facilitates easy maintenance.

Like any other structure the blair latrine is liable to natural deterioration in structural status as it gets older, and therefore needs constant maintenance in order to keep it in a satisfactory structural condition.

10.4 MATERIAL SUBSIDY

There has been some tremendous support received by rural communities from the Government and non - governmental organisations during the implementation of the sanitation programme in Zimbabwe. This support has mainly been in the form of cement and the flyscreen. The subsidy amounts to approximately 35% of the unit cost of a single blair latrine.

The community contributes about 65% towards the construction of the toilet. This is in the form of locally available materials like bricks, sand and stones. They also dig the pit and pay the builder of the latrine.

With this amount of contribution, the community is expected to have a sense of ownership towards the latrine and therefore use and maintain it properly. It is encouraging to note that 68.3% of the respondents would replace the toilet when the need arises without any external, assistance. Where they have not been subsidised, there is total commitment to replace on their own.

It is however disappointing to note that where people have been subsidised the replacement rate on a self - help basis is very low. This kind of scenario does not auger very well for the sustainability of the rural sanitation programme which depends so heavily on material subsidy.

10.5 INSTITUTIONAL STRUCTURES

There are viable institutional structures dealing with water and sanitation at both Provincial and District levels in all the provinces sampled. These are in the form of Water and Sanitation Sub Committees. These structures mainly deal with the planning, coordination and implementation of the rural water supply and sanitation programme. These structures have done tremendously well in this aspect. They also deal with operation and maintenance of water supplies.

However, there was virtually no indication of these structures having anything to practically do with operation and maintenance of sanitation facilities. This shows a serious weakness in the sustainability of the rural sanitation programme in Zimbabwe.

The explanation for this state of affairs is that water is essentially a community immediate felt need. Therefore, the provision, operation and maintenance of water supplies is inevitably demand driven.

The District Water and Sanitation Sub-committees appeared to be more active in those districts where there is a current donor-funded water and sanitation programme. The activity appeared to go down when the programme is wound up.

There was no indication of the existence of any viable structures dealing with water and sanitation at ward level.

The situation at village level is slightly different. Here there are water point committees at some water points mainly at boreholes and deep wells, but none at communal shallow wells.

Therefore the situation is such that there is no structure in place at any level, to deal with operation and maintenance of sanitation facilities. Under these circumstances, it is difficult to assume that the rural sanitation programme can be sustainable.

10.6 HYGIENE ENABLING FACILITIES

An interesting development in the rural sanitation programme is the inclusion of a wash hand tank as an important integral component of a blair latrine. This should be viewed as a milestone in encouraging positive behaviour change in personal hygiene. For a long time health workers have been educating the public to wash their hands after using the toilet. This message had almost become a rhetoric because there was no enabling facility. Therefore, the latrine wash hand tank will probably provide a lasting solution as a hygiene enabling facility.

This important development was conspicuous in Mashonaland East province where it has been a common feature since 1991. However it is disappointing to note that only 25% of the sampled wash hand tanks showed signs of being used.

10.7 CONCLUSION

Some tremendous achievements have been made in the rural sanitation programme in Zimbabwe. There has been some impressive amount of political, professional, and community commitment towards the programme. However, all this commitment is being frustrated by the lack of an operation and maintenance system, specifically for sanitation, in order to ensure the sustainability of the programme sustainable sanitation development will go a long way in contributing to the overall national socio - economic development of the rural communities of Zimbabwe.

11. RECOMMENDATIONS

11.1 A national operation and maintenance system for the rural sanitation programme should be established in Zimbabwe. This will guarantee sustainable sanitation development in the country and enhance and safeguard the investment that has already been committed to this important programme. Sanitation should be viewed as an important and integral part of health and social development.

11.2 When subsidies are given, the fact that there shall not be any repeat supply in cases of collapse or filling up of latrines must be inculcated into the community. This will ensure that there are no false expectations of repeat subsidies, and the community will start making arrangements for replacement immediately the need arises.

11.3 There is need for vigorous and continuous health education and community motivation towards the structural maintenance of latrines. This should be carried out by Environmental Health Technicians (EHTs) during their domiciliary visits, when they should inspect and advise accordingly on a regular basis. During these visits EHTs should identify those latrines that have collapsed or are about to fill up and to start making contingency measures for replacement.

The community should be advised against the use of filled up latrines, as they pose a serious health hazard. Toilets that are full should have their squat holes and entrances sealed and left intact. These can be used years later when the contents have undergone adequate biodegradation.

11.4 The issue of operation and maintenance of sanitation facilities must be given equal priority to that accorded the water supply component. The Provincial and District Water and Sanitation Sub Committees should include operation and maintenance of sanitation facilities at the planning stage. This should include the setting up of community structures at ward and village level to specifically spearhead this aspect during and after the implementation of projects. Project committees must be established at village level. Their responsibility should primarily include the operation and maintenance of latrines.

11.5 There is need to carry out an inventory of all blair latrines in the country, with a view to identifying all those without or with broken flyscreens. Those without or with broken ones should be provided with flyscreens. Efforts should be made to ensure that those members of the community who construct blair toilets without any material subsidy be provided with flyscreens. Durable flyscreens do not seem to be available in the country and are therefore being sourced from outside. This makes it difficult for individuals to procure them.

The community should be advised on how to inspect flyscreens in order to ensure they are in good condition at all times.

11.6 The Ministry of Health & Child Welfare should as matter of priority, create more posts for EHTs in all provinces, if the sanitation programme is to be sustainable. This is a cadre who plays a pivotal role in the operation and maintenance of sanitary facilities through regular domiciliary visits and physical inspections as well as face to face information, education and communication.

11.7 The National Action Committee on Water Supply and Sanitation should make serious efforts to facilitate the mobility of EHTs. In this regard, the issue of the motor cycle revolving fund should be revisited and reasons for its collapse thoroughly investigated.

11.8 The Rural District Councils should play a more active role in the operation and maintenance of sanitary facilities. This is regarded as the most important link in ensuring the sustainability of the rural sanitation programme.

1. HOUSEHOLDS SURVEYED: SUMMARY.

DISTRICT:	No. OF HOUSEHOLDS DONE:	PERCENTAGE:
MUREHWA	30	18.3%
MZINGWANE	22	13.4%
BUBI	20	12.2%
SHURUGWI	52	31.7%
GUTU	40	24.4%
TOTAL SURVEYED:	164	100%

2. NUMMBER OF USERS PER LATRINE:

NUMBER OF USERS:	NUMBER OF LATRINES BY USERS:	PERCENTAGE BY USERS:
1 - 5 PEOPLE	63	38.4%
6 - 10 PEOPLE	88	53.7%
>10 PEOPLE	13	7.9%
TOTAL:	164	100%

COMMENTS: Average number of users per household was 6-10 people.

3. PERIOD/DURATION OF TOILET CONSTRUCTION:

YEAR IN WHICH LATRINE WAS BUILT:					TOTAL:
1984 & BEFORE:	1985 - 1989:	1990 - 1994:	1995 & AFTER:	NO RESPONSE:	
41	53	51	18	1	164
25%	32.3%	31.1%	11%	0.6%	100%

COMMENTS: For the households surveyed, the median year was 1988.
The surveyed latrines were built between 1978 and 1995.

5. NUMBER OF HOUSEHOLDS THAT GOT MATERIAL SUBSIDYT:

	GOT SUBSIDY:	DID NOT GET SUBSIDY:	NOT SURE/NO RESPONSE:	TOTAL:
NUMBER:	109	53	2	164
PERCENTAGE:	66.5%	32.3%	1.2%	100%

6. NUMBER WITH HAND WASH FACILITIES:

	WITH WASH HAND FACILITIES:	WITHOUT WASH HAND FACILITIES:	TOTAL:
NUMBER:	20	144	164
PERCENTAGE:	12.2%	87.8%	100%

COMMENTS: - Number of Wash Hand Facilities with water/being uesd = 6 out of 20, = 25%.
- Only one district/ province's toilets had wash hand facilities.
- 55% of latrines with wash hand facilities were built in 1993.
- All latrines with wash hand facilities in the survey were built between 1991 and 1993.
- 83.3% of wash hand facilities which had wqater were found to used i.e. 5 out of 6.

7. NUMBER OF TOILETS BEING USED:

	NUMBER OF LATRINES:	PERCENTAGE:
LATRINES BEING USED:	160	97.6%
LATRINES NOT BEING USED:	4	2.4%
TOTAL:	164	100%

COMMENTS: - All the tlatrines not being used were due to the fact that they had colapsed.
- The latrines that were colapse were built in the years 1981, 1984, 1995 and one year of construction not indicated. This showed that duration is not linked to colapse.

8.1 NUMBER OF USERS AND YEAR LATRINE WAS BUILT:

	YEAR LATRINE WAS BUILT:				
	1984 & BEFORE:	1985 - 1989:	1990 - 1994:	1995 & AFTER:	NO RESPOND:
1 - 5 PEOPLE	16	19	21	8	0
6 - 10 PEOPLE	23	27	27	9	1
>10 PEOPLE	2	7	3	1	0
TOTAL:	41	53	51	18	1

8.2 COMPARISON OF NUMBER OF AMOUNT OF FAECAL MATTER AGAINST NUBER OF USERS AND DURATION:

No.OF USERS	YEAR LATRINE WAS BUILT:																TOTAL
	1984 & BEFORE:				1985 - 1989:				1990 - 1994:				1995 & AFTER:				
	<1/2	1/2	>1/2	FULL	<1/2	1/2	>1/2	FULL	<1/2	1/2	>1/2	FULL	<1/2	1/2	>1/2	FULL	
1-5	7	1	4	3	11	4	2	1	19	2	3	0	6	0	0	0	63
6-10	7	0	6	8	2	11	4	5	11	4	6	3	9	0	0	0	76
>10	1	0	2	1	3	2	2	5	1	1	0	2	1	0	0	0	21
TOTAL	15	1	12	12	16	17	8	11	31	7	9	5	16	0	0	0	160
%	37.5	2.5	30	30	19.2	37.7	9.6	21.2	59.6	13.5	17.3	9.6	100	0	0	0	100%

COMMENTS: - 4 Latrines data on level of faecal matter not collected due to colapse.

9. COMPARISON OF ANAL CLEANSING MATERIAL AGAINST LEVEL FAECAL MATTER

LEVEL	TYPE OF ANAL CLEANSING MATERIAL:									TOTAL
	TOILET PAPER:		NEWS PRINT:			MEALIE COBS:		OTHERS:	NOT APPLI-CABLE	
	ONLY	& NEWS PRINT	ONLY	& MEALIE COBS	& OTHERS	ONLY	& OTHERS	ONLY		
<1/2	2	0	70	0	1	0	1	3	0	78
1/2	0	1	21	1	0	0	0	3	0	25
>1/2	1	1	23	0	0	1	0	2	0	28
FULL	0	1	20	1	4	0	1	2	0	29
N/A	0	0	0	0	0	0	0	0	4	4
TOTAL	3	3	134	2	5	1	2	10	4	164
%	1.85	1.85	81.7	1.25	3	0.6	1.25	6.1	2.4	100

10. COMPARISON OF PEOPLE STAYING AT HOUSEHOLD AGAINST THOSE WHO USE:

NUMBER OF PEOPLE STAYING:	NUMBER OF PEOPLE WHO USE:				TOTAL:
	1 - 5	6 - 10	>10	N/A	
1 - 5	58	2	3	1	64
6 - 10	4	72	8	3	87
>10	0	3	10	0	13
TOTAL	62	77	21	4	164
PERCENTAGE:	37.8%	47%	12.8%	2.4%	100

COMMENTS: - Not applicable = not used due to colapse.

- Standard deviation = 10out of 164, i.e. at least about 6.1% of the households were sharing latrines with other households and the same percentage were had some of their household members not using the latrine.

11.1 STRUCTURAL STATUS OF LATRINES:

LATRINE STATUS:	NUMBER:	PERCENTAGE:
VERY GOOD	26	15.9%
GOOD	59	36%
FAIR	40	24.4%
POOR	18	10.9%
VERY POOR	16	9.8%
COLAPSED	4	2.4%
NOT APPLICABLE/NOT RECORDED	1	0.6%
TOTAL	164	100%

11.2 PERIOD WITH BEST STRUCTURES:

STATE OF LATRINES:	PERIOD BUILT:					TOTAL:
	1984 & BEFORE:	1985 - 1989:	1990 - 1994:	1995 & AFTER:	NO RESPONSE:	
VERY GOOD	2	10	8	6	0	26
GOOD	16	18	17	8	0	59
FAIR	7	14	19	0	0	40
POOR	9	4	5	0	0	18
VERY POOR	6	5	2	3	0	16
COLAPSED	1	2	0	1	0	4
N/A	0	0	0	0	1	1
TOTAL	41	53	51	18	1	164

11.3 COMPARISON OF PERIOD AND STRUCTURAL STATUS:

PERIOD	VERY GOOD		GOOD		FAIR		POOR		VERY POOR		COLAPSED		NOT RECORD		TOTAL	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1984 & -	2	4.9	16	39	7	17	9	22	6	14.65	1	2.4	0	0	41	100
1985-89	10	18.9	18	34	14	26.4	4	7.5	5	9.4	2	3.8	0	0	53	100
1990 - 94	8	15.7	17	33.3	19	37.3	5	9.8	2	3.9	0	0	0	0	51	100
1995 & +	6	33.3	8	44.4	0	0	0	0	3	16.7	1	5.6	0	0	18	100
N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	100	1	100
TOTAL	26	--	59	--	40	--	18	--	16	--	4	--	1	--	164	100

12. WHAT COMMUNITY DOES WHEN LATRINE FILL-UP OR COLAPSE:

ACTION:	NUMBER	PERCENTAGE:
BUILT ON MY OWN	112	68.3%
BUILT ON MY OWN AND CONTACT MIN.OF HEALTH	3	1.8%
CONTACT MIN. OF HEALTH	42	25.6%
NO IDEA WHAT TO DO	2	1.25%
DO NOTHING	3	1.8%
OTHER eg DISLUDGE PIT.	2	1.25%
TOTAL RESPONSES:	164	100%

13. FLY-SCREENS MAINTAINANCE:

	NUMBER:	PERCENTAGE:	No.NOT INTACT:	PERCENTAGE:	No.INTACT:	PERCENTAGE:
WITH FLY-SCREENS	114	69.5%	29	25.4%	85	74.6%
WITHOUT FLY-SCREENS	44	26.8%	N/A	N/A	N/A	N/A
NO RESPONSE	6	3.7%	N/A	N/A	N/A	N/A
TOTAL:	164	100%	---	---	---	---

14. COMPARISON OF LATRINE MAINTAINANCE:

TYPE OF MAINTAINANCE:	NUMBER:	PERCENTAGE:
CLEANING INSIDE (ONLY)	66	40.2%
CLEANING INSIDE & CLEARING SURROUNDINGS	51	31%
CLEANING INSIDE & CLEANING VENTPIPE	1	0.6%
CLEANING INSIDE & STRUCTURAL REPAIRS	10	6.0%
.STRUCTURAL REPAIRS (ONLY)	0	0%
CLEANING INSIDE, CLEARING SURROUNDINGS & STRUCTURAL REPAIRS	2	1.2%
CLEANING INSIDE, STRUCTURAL REPAIRS & OTHERS	5	3%
CLEANING INSIDE, CLEARING SURROUNDINGS & OTHERS	1	0.6%
CLEANING INSIDE, CLEANING VENTPIPE & OTHERS	1	0.6%
CLEARING SURROUNDING (ONLY)	1	0.6%
OTHERS	1	0.6%
CLEANING INSIDE & VENTPIPE & CLEARING SURROUNDINGS	3	1.8%
NO MAINTAINANCE DINE	23	14%
TOTAL:	164	100%

COMMENTS: - 86% do at least some form of maintainance to their latrine.
- The major forms of maintainance done are cleaning inside and clearing surroundings of the

latrines.

15. USE OF LATRINE AS A BATHROOM:

CATEGORY:	NUMBER:	PERCENTAGE:
WHO USE AS BATHROOM	129	78.65%
WHO DO NOT USE AS BATHROOM	35	21.35%
TOTAL:	164	100%

15.1 COMPARISON OF LATRINES NOT USED AS A BATHROOM:

LEVEL OF FAECAL MATTER	NUMBER WHO DO NOT USE LATRINE AS BATHROOM:				TOTAL NUMBER	PERCENTAGE
	1 - 5 USERS	6 - 10 USERS	>10 USERS	N/A		
<1/2	10	6	1	0	17	48.6%
1/2	2	2	0	0	4	11.4%
g>1/2	2	3	0	0	5	14.3%
FULL	0	3	2	0	5	14.3%
N/A	0	0	0	4	4	11.4%
TOTAL	14	14	3	4	35	100%

15.2 LATRINES USED AS BATHROOM:

LEVEL OF FAECAL MATTER	NUMBER WHO USE LATRINE AS BATHROOM:				TOTAL NUMBER	PERCENTAGE
	1 - 5 USERS	6 - 10 USERS	>10 USERS	N/A		
<1/2	32	24	5	0	61	47.3%
1/2	5	13	3	0	21	16.3%
>1/2	7	13	3	0	23	17.8%
FULL	4	13	7	0	24	18.6%
N/A	0	0	0	0	0	0.0%
TOTAL	48	63	18	0	129	100%

WORKSHOP ON OPERATION AND MAINTENANCE OF URBAN & RURAL WATER & SANITATION SYSTEMS

KADOMA, ZIMBABWE

25TH - 29TH NOVEMBER 1996

PRESENTED BY ENG E. MUDZURI
DEPUTY CHIEF ENGINEER (W & S) BRANCH

CITY OF HARARE
DEPARTMENT OF WORKS

THE OPERATION AND MAINTENANCE FOR URBAN SANITATION SYSTEMS

1.0 INTRODUCTION

1.1 GENERAL

Water is a limited natural resource - Purifying contaminated water and renovating it is nature's role. The global ecosystem is stressed due to increasing environmental pollution. Our challenge is to preserve our precious environment for the next generations. Our commitment to this challenge is answered through technological innovation in design, construction and operation and maintenance of water and waste water treatment systems.

1.2 SANITATION AND WATER POLLUTION PREVENTION

Sewerage is the nucleus of urban facilities to improve living environment. To prevent and protect the public water bodies, an appropriate operation and maintenance system of sewerage facilities is essential.

municipal sewage and industrial waste water result from the use of water in dwellings i.e. kitchens, bathrooms, laundries, etc. and from widespread industrial activities. Such water borne wastes arise from the general use of water made available by the public water supply and industrial water supply. In Zimbabwe urban water supply and waste water collection is done by Local Authorities or Municipalities.

The disposal of water borne wastes in urban communities requires substantial engineering works, from sewer pipe connection at consumer point, sewer pipe reticulation, pumping stations to the treatment works including the final disposal of sludge and screenings.

The disposal approach should be looked at not only from the viewpoint of sanitation but also from those of water pollution prevention and water conservation.

To achieve the objectives of water borne wastes, the facilities disposing the wastes must

be properly maintained and administrative and technical staff commensurating with their nature and extent are necessary. The means of disposal must therefore be technically and financially be related to the whole economy of the community, its water economy, its urban planning and administration and its technical and financial resources.

The costs of waste disposal should not be confined to the costs of engineering design and construction but must be provided for good operation and maintenance of the overall disposal facilities.

1.3 NECESSITY OF OPERATION AND MAINTENANCE

What is fundamentally required to prevent sewer spillages and effective treatment of wastewaters is the establishment of competent organizations, capable personnel and well organised and appropriate operation and maintenance of sewers, pumping stations and waste water treatment plants. The personnel in charge of operation and maintenance must have sufficient knowledge in every field concerned and must strive towards better management of the system by exchanging information among themselves locally and internationally. All personnel are required to understand the problems to be addressed and to continually strive towards upgrading operation and maintenance technology by being aware of the objectives to be achieved at all times.

1.4 POINTS TO BE CONSIDERED FOR APPROPRIATE OPERATION AND MAINTENANCE

In developing countries there are many sanitation facilities and treatment plant which do not achieve expected performance because of improper operation and maintenance. What is essential is to examine the operations and maintenance of such facilities in advance in as much detail as possible beginning with planning and design with respect to the following.

(a) Staff required for the operation and maintenance of facilities and required number number of engineers.
(b) Methods of maintaining all plant and equipment and relevant action to be taken against failures.
(c) Method and frequency of water analysis
(d) Provision of a proper budget and the actual financing of the operating costs.
(e) Provision of spares and finance to enhance the maintenance works.

2.0 OPERATION AND MAINTENANCE SYSTEMS

2.1 To organise an operation and maintenance system the following classification detail is essential as a general guide.

i) Acquisition of proper operations and maintenance technology taking cognisance of the following:-

(a) appoint personnel in charge of operation and maintenance.
(b) listen to opinion expressed by staff in charge of operations and maintenance through design and construction phases of facilities.

(c) To perform a through trial runs of all plants and equipment prior to the commissioning of facilities (during this trial run). All personnel in charge of operations and maintenance must be present.
(d) All personnel in charge of operations and maintenance must study and

understand the following:-

- as built drawings in a completed form.
- operation manuals and reports on plant maintenance.
- instruction manuals for all plant and equipment.

(e) Personnel in charge of operation and maintenance must be allowed to inspect and study similar facilities whenever possible prior to plant commissioning.

ii) Operation and maintenance of sewer and sewage channel facilities.

iii) Knowledge with respect to house connections and industrial and commercial connections.

iv) Matters pertinent to environmental protection.

v) Operation and maintenance of pump stations and waste water treatment facilities.

vi) execution of budget and management of assets.

The maintenance and management operations with respect to waste water treatment facilities are as shown in Table 1 Figure 1 and Annexure 1 for pumpstations and treatment works and Table 2, Figure 2 and Annexure 2 for sewer mains.

The tables show the general works performed while the figures show the operation of management for operations maintenance. The annexures are examples of inspection sheets for the facilities.

TABLE 1 MAINTENANCE AND MANAGEMENT OPERATION WITH REAPECT TO WASTEWATER

Function		Principal Duties
Administration		General affairs, personnel allowance, budget, closing account, accounting and others
Excution of budget		1. Purchase and management of of materials(fuels, consumables etc) 2. Contracting of construction wor, commissioning etc.
Asset management		Management and maintenance of fixed assets
Operation and maintenance of pumping stations and wastewater treatment plants	Work concerning operation	1. Planning of wastewater and sludge treatment programs 2. Planning of operation programs of equipments for pumping stations and wastewater treatment plants 3. Preparation design, supervision, and execution of operation and management programs for pumping stations and wastewater treatment plants. 4. Disposal planning for grit, screenings, sludge cake and incineration ash and transport, supervision and excution 5. Design, supervision and excution of building/vegetation cleaning and management. 6. Recording and sorting of pumping station and wastewater treatment plant operation and maintenance (daybooks, monthly reports, annual reports) 7. Realization of instructions and operations with respect to unusual circumstances and emergencies
	Work concerning maintenance and inspection	With respect to maintenance and inspection of the machines and electrical equipment of pumping station and wastewater treatment plants: 1. Preparationof guidelines 2. Planning of work program 3. Excution of design and superavision
	Repair and improvement	1. Preparation, design, wupervision, excution of repair work
Work concerning water quality control		1. Planning and excution of water quality test, surveys and studies 2. Excution of industrial wastewater tests 3. Preparation of operation guidline 4. Response to unusual circumstances

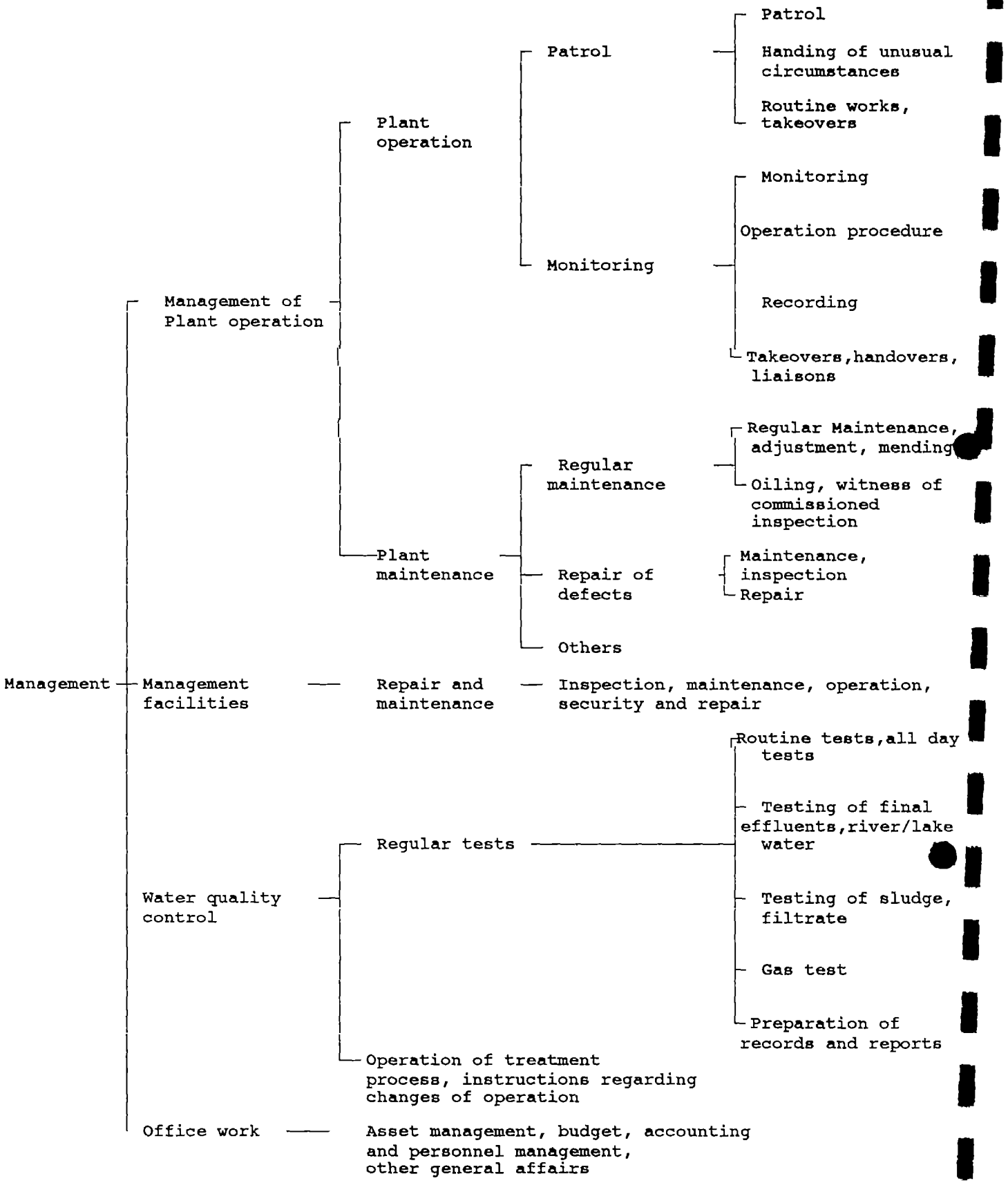

Figure 1 Management of Treatment Plants

MONTHLY INSPECTION OF EQUIPMENTS DATE

CHECK SHEET ⊃ — 7 MANAGER CHIEF ENGINEER INSPECTOR

Replenished Oil And Grease

Item			Replenishment Quantity
6	ø350	○○ Grease No2	Upper—100g Lower—150g
	ø600		Upper—300g Lower—500g
7	ø350	○○ Grease No2	Upper—100g Lower—100g
	ø600		Upper—500g Lower—500g

Equipment (LFL Sewage)

No4 LFL Sewage Pump (ø600)

No3 LFL Sewage Pump (ø600)

No2 LFL Sewage Pump (ø350)

No1 LFL Sewage Pump (ø350)

No	CHECK LIST	RESULT OF CHECK			
1	Abnormal vibration in running(pump part,motor part)	✓			
2	Confirm normality of shaft seal water (low-rel.ev, flow-right)				
3	Confirm quantity of leaking seal water from gland				
4	Confirm normality of temperature of pump bearing,upper and lower motor bearing. (Standard value is room temperature+ 40 °C or less than 65°C)				
5	Exchange of gland packing of pump bearing				
6	Replenishment or exchange of grease of pump bearing (Frequency, replenishment ;4times a year, Exchange,annual)				
7	Replenishment or exchange of grease of motor bearing (Frequency, replenishment ;4times a year, Exchange;annual)				

NOTE

✓— Good(Complete)
×— Not Good(Necessity To Service)
— replenishment of Oil And Rate
○— exchange of Oil And Rate

MONTHLY INSPECTION OF EQUIPMENTS

CHECK SHEET ⊃ — 8 MANAGER CHIEF ENGINEER INSPECTOR

Replenished Oil And Grease

Item	Replenishment Quantity

Equipment (LFL Sewage)

No2 Seal Water Pump For Main Pump

No1 Seal Water Pump For Main Pump

No	CHECK LIST	RESULT OF CHECK			
1	Abnormal noise,heat, vibration of pump body or motor				
2	Confirm opening degree of valves				
3	Confirm pressure gage and damage				
4	Cleaning of equipments				
5					
6					
7					
8					
9					
10					
11					

NOTE

✓— Good(Complete)
×— Not Good(Necessity To Service)
— replenishment of Oil And rate
○— Exchange of Oil And rate

ANNEXURE 1

TABLE 2

FACILITIES SUBJECT TO INSPECTION ON SEWER PIPES

FACILITY NAME	INSPECTION POINTS	FREQUENCY OF INSPECTION
SEWER PIPE	. Condition of connecting point to manhole . Volume of silt accumulation . Subsidence, clogging, meandering, breakage . Abrasion, corrosion, cracking of pipes . Discontinuous or dislocated joints . Protrusion of buried structure in pipe . Infiltration of underground water . Condition of ground surface above sewers	At least once a year
MANHOLE	. Abrasion, breakage, distortion of lid & metal frame . Abrasion, breakage, slip of manhole ring . Crack in structure of floor plate & exposure of reinforcement bars . Difference in level with road surface . Corrosion or absence of ladder or step irons . Scouring or breakage of condition of invert . Clogging, breakage and condition of connecting pipes . Infiltration of underground water . Differential settlement (tilting of invert levels) . Presence of obstructing matter such as sticks and roots	At least once a year
SEWER OUTLET TO TREATMENT PLANT	. Influent of unknown origin . Presence of foreign matter such as soils, sticks, etc. . Confirmation of gate operations . Evidence of overload	At least once a month

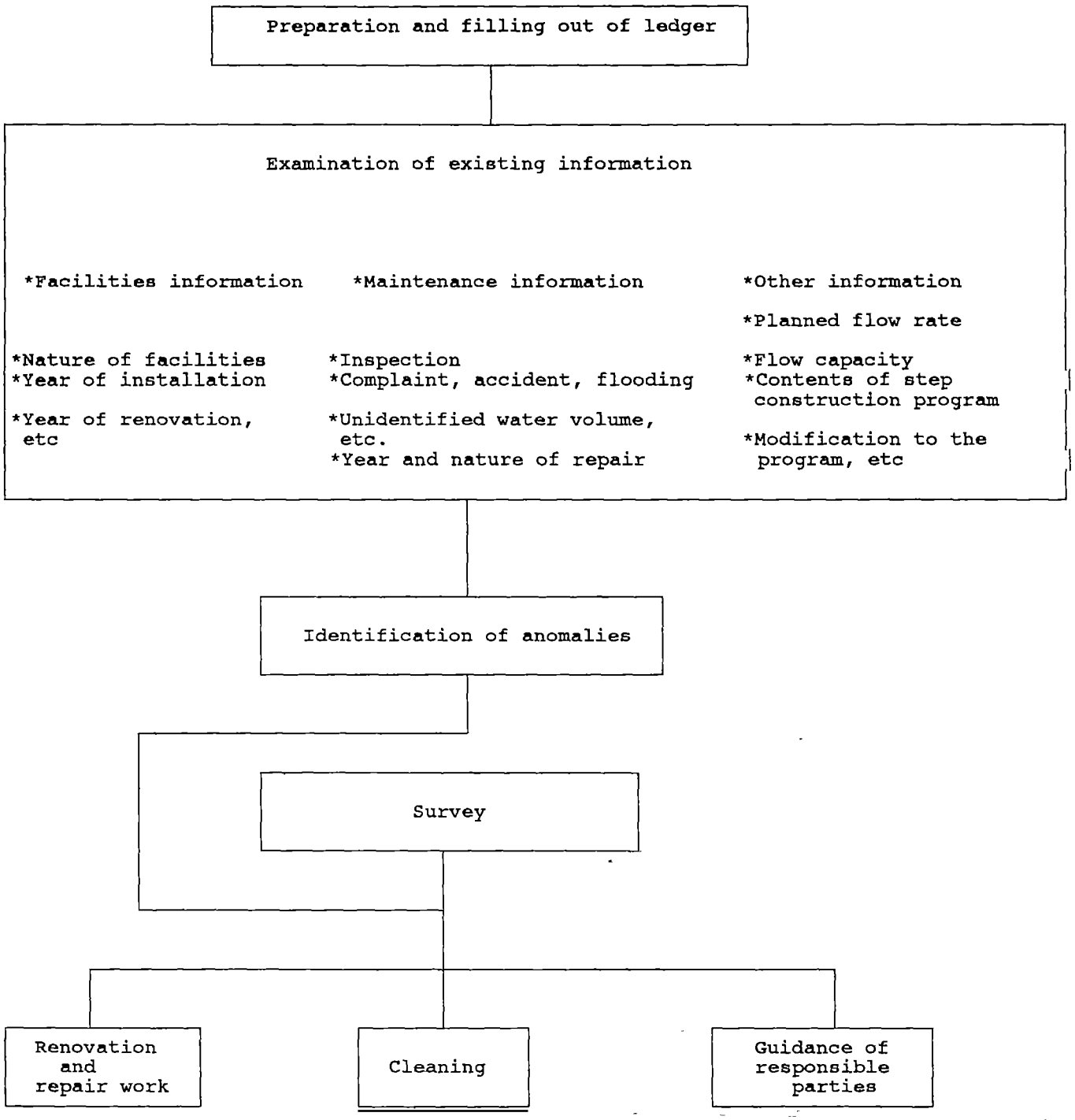

Figure 2 Flow of inspection and survey

ANNEXURE 2 : SURVEY EXAMPLE

Method of survey / Objective of survey	① Survey of groundwater level. ② Survey of connections ③ Survey of changes in gradient ④ Survey of flow rate. ⑤ Survey of wastewater quality ⑥ Survey of watertightness ⑦ Survey of sewer invert elevation.						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Breakage		○	○			○	
(2) Infiltrating water	○	○		○	○	○	
(3) Flow capacity			○	○		○	○
(4) Progress of aging			○			○	
(5) Influent wastewater		○		○	○		

3.0 OPERATION & MAINTENANCE OF MECHANICAL AND ELECTRICAL FACILITIES

3.1 DETAILS OF OPERATION AND MAINTENANCE

Pumpimg stations and treatment facilities' operations cannot usually be suspended for a long period of time, so to avoid this, action to be taken in case of accidents involving plant facilities and equipment must be determined in advance. A treatment plant comprises intake works, wastewater treatment, sludge treatment, electrical/mechanica facilities and pumps with by-products of various hazardous materials such as combustible gas from digesters and hydrogen sulphide. Accordingly, various hazards such as accidents resulting in human injury and death, oxygen deficiency, fire explosion, etc. are present at all times. Therefore, care must be taken to ensure acquisition of necessary knowledge for the handling and operation of equipment so tha accidents can be effectively prevented.

Principal operations and maintenance works in pumpstations and treatment facilities are usually executed during day time while work during night time should be restricted to the operation and monitoring of facilities. Failed equipment is usually replaced by spare equipment or repaired as much as possible during the day shift time work.

In the annual, monthly and daily regular operation of facilities depending on planned schedules the main work entails operation and monitoring of facilities as well as repai and adjustment of failed equipment which may not be repaired during night shift.

Principal operation and maintenance work in pumpstation and waste water treatmer plants are summarized in Table 3 while Table 4 is an inspection and adjustment ledge sheet.

Table 4 Inspection and adjustment

Equipment		Inspection item	Details of work (Repair)	Point of work (Repair)	Note *	Note **
Gate	Motor driven Confirm operation of limit switch contact.	Outlook	Visual inspection of rusting, deformation	To be repaired as soon as possible if abnormality has been identified	day	
		Operation	Confirmation of On-off operation Manual-automatic changeover	Operate moving portion as much as possible Confirm whether changeover is precise	month	
		Spindle, gear	Exposed portion must be cleaned and grease must be applied, because foreign matter may get caught and cause rusting	If spindle is long and provided with a steady brace, dust is likely to accumulate to make operation difficult Clean at all times.	month	month
		Torque, limit switch	Confirm operation of torque switch	Change of setting must be in accordance with operation manual and test report It is not preferable to raise the scale setting as long as operating conditions remain unchanged	month	
			Confirm operation of limit switch contact	Confirm whether operation of limit switch is normal. Open and close gate near maximum capacity by motor drive. Changeover to manual drive and open and close manually near maximum capacity but not so much as to set off the limit switch Operating point of limit switch is then set It is not preferable to change limit switch setting position as long as operating conditions have not changed.	month	
Screen	Continuous type	Outlook Reducing gear bearings	Corrosion, abrasion Abnormal noise, oil leak	Visual inspection Confirm by operation	day day	 month
		Torque limiter, shear pin	Replenishment of lubricating oils, hydraulic fluid(Number of spare shear pins should be a little larger)	Equipment may continue to revolve even when shear pin has broken down. This is due to insufficiency of grease. Care must be taken.	month	month
		Sprocket chain	Chain tension adjustment	Adjust by means of take-up, being careful that the rake is horizontal	month	
		Rake lever	Confirm wiper operation and interlocking between rake and	Confirm whether appropriate.	day	

Equipment		Inspection item	Details of work (Repair)	Point of work (Repair)	Note *	Note **
Internal combustion engine, diesel engine	Starter	Starting air tank	Inspect pressure.	Is pressure within specified value?	day	
			Drain	Drain water	week	
		Starting air distribution valve	Confirm operation	Is movent smooth?	year	
		Various relays	Inspect operating characteristics, contavts		6 months	
		Storage battery	Measure voltage, specific gravity, fluid level	Confirm electrical change by means of specific gravity meter.	month	
		Valves of staeter	Inspect interior	Apply oil to make operation smooth	6 months	
			Inspect aor leak	By noise	week	
		Piping	Inspect air leak.	By noise	week	
		Compressor	Air charge test	Is charging time too long?	3 months	
	Oil fuel system	Oil fuel filter	Dischage of sludge	Open drain valve	6 months	
			Overhaul	Cleaning by means of light oil	6 months	
		Tank Service tank	Inspect oil volume		day	
			Discharge of sludge	Open discharge valc and check for presence of moisture, sludge.	6 months	
		Fuel transfer pump	Operation test		month	
	Lubricating system	Lubricating oil filter	Discharge of sludge	Open drain valve	6 months	
			Overhaul	Clean by means of light oil	6 months	
		Lubricating oil	Exchange	Exchange as appropriate by analyzing oil		year
			Inspecting volume of oil and replenishing	Pay attention to the increase in volume of lubricating oil because it may be due to the ingress of cooling water and oil fuel.	month	As appro-priate
	Cooling water system	Cooling water tank	Inspect water level		week	
		Cooling water pump	Abnormal noise, vibration		month	

Equipment		Inspection item	Details of work (Repair)	Point of work (Repair)	Note *	Note **
Pump	Main pump	Outlook	Cleaning, rusting Visual inspection	Confirm whether contaminated by dust,oil and so on	day	
			Tightening of bolt	Pay special attention to coupling bolt	year	
		Vibration, abnormal noise	Presence of abnormality		day	
		Bearing temperature	Confirm whether room temperature is below + 40℃		day	
		Bearing lubricating oil	Volume Dirtiness	Replenish as appropriate	day month	Replace year
		Gland portion	Temperature rise	Is sealing water normal?	day	
			Water leak volume from gland packing (Visual inspection)	Is water continuing to leak in small volume?	day	
			Abrasion of gland packing (Visual inspection)	Judge by means of volume of water leaking from seal portion	month	
			Exchange of gland packing	Exchange regularly	year	
		Electric current, pressure	Is value normal?	Record and check trend	day	
Pump	Main pump	Protective device	Protective device including flow relay, pressure switch, temperature switch and the like	Confirm operation	year	
Internal combustion engine, diesel engine	Outlook of engine	Outlook	Cleaning, rusting Visual inspection	Is engine dirtied by oil, dust and so on?	day	
			Oil leak Visual inspection		day	
			Inspect whether bolt and nut are loose	Touch	3 months	
		Piping	Inspect leak		week	
		Rubber vibration insulator	Visual inspection	Whether ther is wearing or cracking?	6 month	

Equipment		Inspection item	Details of work (Repair)	Point of work (Repair)	Note *	Note **
Power transmission	Reducing gear	Outlook	Cleaning, rusting Visual inspection	Is reducing gear dirtied by dust, oil and so on?	day	
			Oil leak Visual inspection		day	
			Inspect whether bolt and nut are loose?	Touch	3 months	
		Vibration, abnormal noise	Presence of abnomality		day	
		Hydraulic fluid, lubricating oil	Inspect oil volume	Replenishment (Including grease)	month	As appro-priate
			Exchange	Exchange as appropriate by analyzing oil.		year
	Coupling	Vibration, abnormal noise	Presence of abnormality		day	
		Shaft center	Confirm shaft center	Measure by means of dial gauge	year	

Note * Inspection frequency
** Oiling frequency

3.2 PERSONNEL IN CHARGE OF OPERATION & MAINTENANCE

Personnel must accomplish incubent duties with reference to the following:-

(i) Personnel must understand well all fundamental items concerning facilities under one's charge such as planning and design as well as all matters pertinent to the maintenance thereof

(ii) Personnel must understand well the handling and characteristics of principal equipment

(iii) Personnel must have general knowledge with respect to machinery, electricity and instrumentation

(iv) Personnel must acquire requisite qualifications

(v) Personnel must understand details of duties which are not only directly under one's current charge but also related to those under one's charge

(vi) Personnel must understand fundamental matters concerning water quality

(vii) Personnel must have cognizance of liaison systems in the case of accident or emergency.

4.0 MAINTENANCE SYSTEMS

4.1 All the above can be achieved in two approaches in maintenance namely:

(i) Preventive maintenance

(ii) Reactive maintenance

4.1.2 Preventive Maintenance

The best approach to have effective maintenance is to have a well planned preventive maintenance. In this approach all equipment, plant and pipes are regularly checked and maintained depending on the state of equipment.

In this type of maintenance all ledger sheets and annexures as in items 2 and 3 above are utilised to assess and effect repair/replacement of spares before breakdowns.

In this type of maintenance the operating authority needs adequate funding to maintain a good stock of spares.

If spares are available in stock and a well trained maintenance crew is in place the maintenance work can be speedily done reducing down time on plant and equipment and reducing costs caused by serious breakdowns hence providing a vital service and minimising pollution of the water bodies.

4.1.3. Reactive Maintenance.

Just like preventive maintenance needs to be done urgently and down time should be reduced to a minimum.

This is maintenance of plant done when unforseen breakdowns O.K. or accidents. In this case there is need to keep a good register of companies that supply the services in case of breakdowns/accidents so that they can approached and supply service/maintenance work at short notice.

5.0. Financing

It is prudent that to have an effective O & M system a fairly good financial budget has to be put in place. In developing Countries a lot of money is put into capital projects with very little finances being allocated to O & M. This results in rapid deterioration of sanitation facilities and subsequent failure which will either force the operating Authority to invest more capital for new works or even abandon some of the works due to lack of finance.

It must be stressed that a sound financial and manpower base is essential for effective maintenance of Urban Sanitation facilities.

5.2. Revenue Sources for Operation and Maintenance

5.2.1. Expenses for operation and maintenance include direct O & M costs and principal, interest and redemption costs. The majority of test expenses should be covered by sewerage charges and general accounts for the operating Authority. The Central Government has to be involved at Capital and principal borrowing by assisting in providing cheap financing to the operating authority.

5.2.2. Sewage Charges

Sewage charges should be collected on the basis of the following considerations.

a) Must be appropriate to the volume and quality of the sewage discharged by the user.

b) Must not exceed the cost required to conduct efficient Management.

c) Must be clearly specified rate and fixed amount considering domestic and industrial Waste water separately.

d) Sewage charges must take into account economic realities of the Community and Government. They must comply with the general thinking on the way of bearing O&M costs and the basic principles of Sewage charges. They must be in a cost range allowing efficient Management of the system. A well calculated balance in revenue and expenditure must be achieved over the years on a long term basis.

6.0. OPERATION AND MAITENANCE OF SANITATION FACILITIES IN HARARE

6.1 PRESENT STATUS OF SEWAGE WORKS

City of Harare caters for the treatment almost 60 - 80% of the sewage produced in Harare at five sewerage treatment works namely:
Firle, Crowborough, Donnybrook, Marlborough and Hatcliffe (see table below).

TREATMENT PLANT	PRESENT CAPACITY	PROPOSED/FUTURE CAPACITY 1997-2000	METHOD OF TREATMENT
FIRLE SEWAGE WORKS	72Ml/d	144Ml/d (1997) 186Ml/d (2000)	BIO FILTERS (36Ml/d) M.A.S.P.(Remainder)
CROWBOROUGH SEWAGE WORKS	54Ml/d	114Ml/d (1999/2000)	36Ml/d BIO FILTERS M.A.S.P (Remainder
DONNYBROOK PONDS	4Ml/d	4Ml/d	Biological Ponds
MARLBOROUGH PONDS	2.5Ml/d	2.5Ml/d	Biological Ponds
HATCLIFFE PONDS	0.58Ml/d	2.5Ml/d (1999)	Oxidation ditch 0.58Ml MASP (Remainder)

The remainder of the sewage treatment from the low density suburbs is catered for by on-site disposal using mainly septic tanks.

The various locations of the sewage plants is dictated by the topography of the city where catchments are pronounced by small streams to minimise use of pumps for raw sewage transmission.

6.2. CITY OF HARARE SEWERAGE SYSTEMS

The City of Harare is located upstream of its water source impoundments and hence a poorly monitored sewage treatment process would result in pollution of the drinking water sources resulting in high costs in treatment of eutrophicated waters.

The country, Zimbabwe has suffered frequent severe droughts in the past 10 - 15 years such that lack of raw water has forced the city to move from conventional Biological Filters and Pond Treatment methods to a more costly maintenance demanding Modified Activated Sludge System (BADENPHO) so as to enhance improved treatment process at high removal levels of mirrates and phosphates (10mg/l and 1mg/l respectively). The treated effluent from the Modified Activated Sludge (MAS) Plants is discharged into the stream to augument raw water sources.

6.3. SEWERAGE RETICULATION

The Sewerage Reticulation System in Harare is mainly a network of a variety of pipes (Earthenware, Asbestos Cement, Steel and Reinforced Concrete) with varying diameters ranging from 100mm diameter for domestic connection to 1350mm diameter trunk mains. A total length of sewer reticulation pipe lengths aggregate to about 3000km.

The sewer collected is mainly composed of domestic waste, industrial and commercial waste. The stormwater has a different collecting system which collects and discharges directly to the river.

6.4. SEWERAGE MAINTENANCE

The City has Sewage Workshops which do day-to-day maintenance of sewage reticulation lines, construction of new mains and cleaning of choked sewers using both manpower and high velocity machines.

The Sewage Treatment Plants especially the Modified Activated Sludge (MAS) Plants, being highly mechanized need a lot of Electrical and Mechanical input.

A service Department is available within the City's Department of Works for such maintenance work. Pump stations are also maintained by the same Department (see Annexure B on Organization Chart).

6.5. PROBLEMS ENCOUNTERED IN SEWERAGE MAINTENANCE

The major problems encountered in Sewage Maintenance are financially biased, Zimbabwe being a developing country. The major problems are:-

(i) Lack of Capital financing from own resources to purchase:
   (a) Vehicles, plant and equipment
   (b) Spares to reduce downtime during maintenance
   (c) Remuneration to maintain Senior Technical Personnel

(ii) Other problems are related to high chokes of sewers due to the poor sewer users who use sand to wash pots, etc. This causes frequent chokes in sewer reticulations and high wear-tear on the pumps.

DDF WATER DIVISION

OVERVIEW OF THE OPERATIONS AND MAINTENANCE SYSTEMS FOR RURAL WATER SUPPLIES IN ZIMBABWE

PREPARED BY

E.T TORIRO

OCTOBER

1996

THE MAINTENANCE OF RURAL WATER SUPPLY

The maintenance of rural water supply infrastructure in Zimbabwe is the most difficult task. This is so because our country is a developing country where inevitably maintenance compete heavily with capital infrastructural development. Zimbabwe finds itself in this predicament because of a lot capital works being wholly / co funded by ESAs and GOZ coupled with partly O and M provisions as shown below.

DDF WATER DIVISION

O & M PROVISIONS 1988 -1997

YEAR	AMOUNT $Z
1988-89	3 100 001
1989-90	4 261 130
1990-91	5 299 999
1991-92	5 739 480
1992-93	6 639 480
1993-94	5 890 630
1994-95	9 195 000
1995-96	9 000 000
1996-97	10 177 012

Water points in Zimbabwe have various forms of lifting devices ranging from motorised engines to simple lift pumps. The capacity of rural population in terms of maintenance of these primary water supplies is varied in accordance with the social, economic and technical conditions of the beneficiary community. The attached schedule on National Rural Water Supply situation shows the types of technology in the Zimbabwe Water Supply Sector excluding shallow wells

The maintenance of handpumps is complicated by spatial distribution of the infrastructure +/- 30 000 water points dotted all over the countryside - each water point being in an environment which is unique to itself both geographically and socially. Due to this variance, only general conditions can be provided based in sociological and technical factors.

There are about 514 piped schemes which in most cases are beyond the capacity of

the rural people in terms of running costs. Since independence efforts have been concentrated towards cultivating community involvement in infrastructural development as exemplified by formation of water point committees. DDF has the responsibility of maintaining infrastructure, and over the years the fund has devised strategies to ensure maximum support for maintenance programmes. Such strategies have been derived from continuous assessment of sociological and technical issues.

Community Based Management strategy for example , revolves around the partnership between Government and the beneficiary communities as a way of transferring responsibilities to communities and users. The question is how? When one changes instance, in this case government, the provider, one turns around the receiver and says now you are your own, one will need the political will. Above all the change in peoples attitudes is not one sided but must involve all the stake holders i.e providers and beneficiaries . Quite often as technologists, we do not talk about the need to change our attitudes. We believe in convincing them not ourselves.

It has been our experience in DDF that quite a number of pump minders do not believe that preventive maintenance of pump is the responsibility of communities therefore go around greasing pumps resulting in apathy in communities. It is important to note that participation can only be on equal terms and this requires the devolution of power and responsibility so that communities believe in their ability to select their own leadership and to determine their own destiny with guidelines and support from technocrats .

In view of the above and as part of trying to contain costs, DDF with assistance from NAC/External support agencies has been working on the CBM of primary water supplies in Chivi, Zaka, Kwekwe, Beitbridge etc.

Community Based Management

Community Based Management of programmes is revealed through the planning controlling and organizing of programmes at a local level. The major objective is to address the actual priorities of the beneficiaries, to allow for the full participation of the local communities, to allow the decision making processes to be locally made and not foreign imposed, to provide a framework for alternative methods of addressing problems, to reduce the dependency syndrome toward central government.

The Rural Water Sector has identified some pathways of introducing the concepts of Community Based Management. These are through the maintenance of handpumps and hygiene education. The pathways seek to address the use of local potentials in planning, controlling and actual implementation. This is being achieved through participatory training methods which results, in retrospective mapping, village plans and consultative inventories. There has been a great realisation that while the National Water master plan recommended community mobilisation, a more appropriate approach is that of community education. This concept ensures a long lasting effect than the former. In other works it ensures sustainability.

A more pronounced shift from the former methods of programme implementation have been the concentration on the software i.e more education rather that technical training. This has proved to have enhanced sustainable effects on the programme and the user communities

CONTAINING AND REDUCING MAINTENANCE COSTS BY CBM

CONSIDERATION/LIMITATIONS

Community Based Management biased in favour of recurrent running costs rather than investment costs.

- For primary water supply maintenance CBM

  Ensures a policy of gradual handover of recurrent costs

- The current economic water supply water programmes carry the full burden of recurrent cost from start onwards.

RECOMMENDATION

To make CBM work it is advisable to:-

Distribute costs within the community to be decided by water committees and Government continues to facilitate the process in order to avoid risk of abandonment of pumps which is really certain in alternative water access areas. Health targets may not be achieved as a result of local economic conditions and preferences. Rates or levies set by communities are to be in accordance with economic, technical and social conditions of the beneficiary communities

CBM CALLS FOR

a) The strengthening of health and hygiene education using the participatory approach. Health education takes top priority and becomes part and parcel of the mobilization slogan.

b) The maximum utilization of the RDCs and local leadership in fostering towards community management as there has to be political will whose assurance can be cultivated by councillors.

c) A thorough assessment of needs to avoid an oversupply / undersupply of facilities. Communities must be given the option of deciding on the service level. The consequence of such decisions have to be communicated to them.

d) The maximum utilization of all water especially for income generating projects i.e water points must be seen as a source of income not only from a health point of view. Our population is no longer nomadic but has joined the economic environment.

e) Communities must make financial contibutions towards maintenance in one form or another, buying spares parts and of feeding communities etc.

f) It is my honest opinion that pump mechanics be adopted by RDCs and be paid from part of levy collected by councils.

g) The NAC must continue to support the handpump rehabilitation programmes which can be done once in 10-15 years. Civil works construction is also important as a convenient activity.

h) A rehabilitated water point requires preventive maintenance and minor repairs such as replacement of leather cups. Rehabilitation will be Governments biggest contribution to the maintenance programme and I feel that the local populations has capacity which can be nurtured to maintain water points for the sustenance of upkeep of water supply infrastructure.

i) The CBM programme must maximise the technologies such as the extractable piston which are more user friendly.

ZIMBABWE Province	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Mashonaland West	[illegible]	[illegible]	[illegible]	207	12	2	73	3	11	62	[illegible]	[illegible]
Matabeleland North	[illegible]	[illegible]	[illegible]	288	212	10	82	0	[illegible]	[illegible]	[illegible]	[illegible]
Matabeleland South	[illegible]	[illegible]	[illegible]	827	46	2	101	16	80	620	[illegible]	[illegible]
Midlands	3,466	242	7	1,088	79	7	78	1	[illegible]	468	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70	[illegible]	30	0	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	22,490	1,354	6	10,388	762	7	530	32	6	2,080	217	9

Missing data: [illegible]

MANICALAND Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Buhera	734	42	6	325	28	9	19	0		38	2	5
Chimanimani	258	32	12	104	10	10	18	0		53	51	96
Chipinge	884	43	5	95	8	8	8	0		2	0	
Makoni	814	3	0	740	60	8	9	1	11	43	15	35
Mutare	803	11	1	286	14	5	8	0		52	8	15
Mutasa	326	0		215	15	7	6	1	17	0	0	
Nyanga	399	6	2	248	10	4	7	1	14	12	1	8
TOTAL	4,116	137	3	1,993	145	7	75	3	4	200	77	39

MASHONALAND CENTRAL Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Bindura	124	5	4	39	0		4	0		3	0	
Centenary	280	33	12	25	9	36	3	1	33	9	3	33
Guruve	585	82	18	175	28	16	8	0		31	0	
Mazowe	145	4	3	25	5	20	4	1	25	8	2	25
Mt Darwin	441	7	2	215	4	2	13	0		66	0	
Rushinga	313	36	12	80	5	6	9	0		39	10	26
Shamva	202	0		411	0		14	0		38	0	
TOTAL	2,050	167	8	600	52	9	55	2	4	192	15	8

MASHONALAND EAST Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Chivhu	310	7	2	319	0		7	0		17	6	35
Goromonzi	187	0		81	0		3	0		23	0	
Marondera	187	3	2	49	2	4	9	1	11	18	0	
Mudzi	464	7	2	181	7	4	10	0		83	0	
Murehwa	342	0		47	0		12	3	25	9	1	11
Mutoko	561	8	1	178	5	3	5	1	7	11	4	36
Seke	180	8	9	28	7	25	8	0		14	0	
UMP	300	2	1	120	14	12	11	2	18	41	0	
Wedza	[illegible]	[illegible]	[illegible]	[illegible]	2	[illegible]	12	0	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	2,957	42	1	1,051	47	4	87	7	8	242	12	5

MASHONALAND WEST Districts:	Boreholes	Dry	Dry	Deep Wells	Dry	Dry	Schemes	Dry	Dry	Dams	Dry	Dry
Chegutu		3		20	2					48	3	
[illegible]												
Makonde		7		0	0					27	3	
Zvimba	156	0		111	0		8	0		27	0	
TOTAL	2,242	39	2	507	12	2	23	3	13	182	12	7

MATABELELAND NORTH Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Binga	254	15	6	426	83	19	1	0		23	0	
Bubi	131	44	34	20	19	95	8	0		24	7	29
Hwange	323	46	14	84	10	12	22	0		12	1	8
[illegible]	434	19	4	223	33	15	1	0		13	31	
Nkayi	348	5	1	348	7	2	5	0		86		
[illegible]	520	74	14	151	60	40	40	0		14		
Umguza	130	15	12	49	0		7	0		14		14
[illegible]	131	15	11	46						14		
TOTAL	2,240	213	10	1,298	212	16	82	0		186	23	12

MATABELELAND SOUTH Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Beitbridge	344	2	1	809	4	1	31	15	48	25	7	28
Esigodini	180	8	3	132	6	5	2	1	50	76	1	1
Gwanda	224	0		757	0		18	0		141	1	1
Filabusi	448	21	5	73	19	26	5	0		172	0	
Kezi	255	0		370	0		33	0		68	2	3
Plumtree	678	5	1	386	16	4	14	0		143	0	
[illegible]	678			386			14			143		
TOTAL	2,027	34	2	2,327	45	2	101	16	16	625	11	2

MIDLANDS Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Gokwe North	402	22	5	11	3	27	15	1	7	18	0	
Gokwe South	894	15	2	16	4	25	4	0		20	0	
Gweru	217	18	8	135	38	28	15	0		60	4	7
Kwekwe	594	26	4	81	8	10	8	0		52	4	8
Mberengwa	818	87	11	542	0		8	0		137	0	
Mvuma	311	16	5	58	1	2	17	0		49	0	
Shurugwi	348	26	8	62	12	19	8	0		78	1	1
Zvishavane	303	32	11	175	13	7	9	0		57	0	
TOTAL	3,496	242	7	1,088	79	7	79	1	1	469	9	2

MASVINGO Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Bikita	324	57	18	134	36	27	4	0		37	3	8
Chiredzi	664	134	20	212	34	16	10	0		13	7	54
Chivi	438	60	14	253	20	8	4	0		87	0	
[illegible]	462	12		245	0		4	0		251	251	
Masvingo	418	104	25	204	60	29	4	0		46	30	65
Mwenezi	381	73	20	92	18	20	2	0		42	5	12
Zaka	405	35	9	394	2	1	2			24	8	
[illegible]												
TOTAL	3,072	475	15	1,524	170	11	30	0		294	53	20

MASHONALAND WEST Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Chegutu	228	13	6	20	2	10	2	0		48	3	7
Kadoma	949	5	1	81	4	5	2	0		24	2	9
Kariba	111	0		167	1	1	8	1	13	8	1	13
Karoi	852	14	2	138	5	4	0	0		50	3	6
Makonde	246	7	3	0	0		5	2	40	27	3	11
Zvimba	158	0		111	0		6	0		27	0	

MATABELELAND NORTH Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Binga	254	15	6	426	83	19	1	0		23	0	
Bubi	131	44	34	20	19	95	6	0		24	7	29
Hwange	320	46	14	84	10	12	22	0		12	1	8
Lupane	434	19	4	222	33	15	1	0		13	3	23
Nkayi	348	5	1	346	7	2	5	0		88	10	11
Tsholotsho	620	74	12	151	60	40	40	0		14	0	
Umguza	130	15	12	49	0		7	0		141	2	14

MATABELELAND SOUTH Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Beitbridge	344	2	1	609	4	1	31	15	48	25	7	28
Esigodini	186	6	3	132	8	5	2	1	50	78	1	1
Gwanda	224	0		757	0		18	0		141	1	1
Filabusi	448	21	5	73	19	26	5	0		172	0	
Kezi	255	0		370	0		33	0		88	2	3
Plumtree	576	5	1	398	18	4	14	0		143	0	

MIDLANDS Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Gokwe North	402	22	5	11	3	27	15	1	7	19	0	
Gokwe South	394	15	2	18	4	25	4	0		30	0	
Gweru	217	18	8	135	38	28	15	0		60	4	7
Kwekwe	594	26	4	91	8	9	9	0		52	4	8
Mberengwa	818	97	14	542	0		9	0		137	0	
Mkumbi	311	16	5	58	1	2	17	0		49	0	
Shurugwi	346	26	8	62	12	19	8	0		78	1	1
Zvishavane	303	32	11	175	13	7	9	0		57	0	

MASVINGO Districts:	Boreholes	Dry	% Dry	Deep Wells	Dry	% Dry	Piped Water Schemes	Dry	% Dry	Dams	Dry	% Dry
Bikita	324	57	18	104	36	35	4	0		37	3	8
Chiredzi	664	134	20	212	34	16	10	0		13	7	54
Chivi	436	30	7	253	20	8	4	0		97	0	
Gutu	462	12	3	345	0		4	0		35	25	71
Masvingo	418	104	25	204	60	29	4	0		48	10	21
Mwenezi	381	73	20	92	18	20	3	0		42	5	12
Zaka	405	35	9	384	2	1	3	0		24	8	33

PAPER ON OPERATIONS AND MAINTENANCE OF URBAN WATER SUPPLIES

PAPER PRESENTED AT THE NATIONAL WORKSHOP ON OPERATIONS AND MAINTENANCE OF URBAN AND RURAL WATER AND SANITATION SYSTEMS AT KADOMA RANCH MOTEL.

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(Civil) MZweIE - City Engineer
KWEKWE CITY COUNCIL

CASE STUDY - KWEKWE

1.0 INTRODUCTION

This paper looks on the general operations and maintenance of Urban Water supplies and then zeros in Kwekwe in particular for specific study.

2.0 ORGANISATIONAL AND INSTITUTIONAL FRAME WORK ISSUES

2.1 INSTITUTIONAL FRAME WORK

Urban Local Authorities are mandated by the Urban Council's Act to supply water to its community.

To that regard the same Act subject to the provisions of the Water Act of 1976 allows Councils to construct works (treatment plants, pumping mains and reservoirs) within or outside the Council boundaries for purposes of providing and maintaining a supply of water. The Act also allows the Council to enter into Agreements for purchase and sale of water.

The Urban Council's Act also empowers the Council to enforce the connection into its mains of premises within Council areas, which are not supplied with Municipal Water.

Also the Act empowers the Council to protect its water supply services in terms of buildings proximity to pipes excavations and unlawful connections into the municipal system.

The supply standards are not enshrined in the Act. Local authorities seem to be guided by W.H.O standards, guidelines for international drinking water but there is no enforcement of the standards as such except by the Local Authority itself in the interest and safety of its end users.

2.1.1 GENERAL OVERVIEW OF KWEKWE SYSTEM

Kwekwe holds a ministerial water agreement to abstract water from Sebakwe Dam an amount of 15 million cubic meters per annum. Zisco Steel which is the water authority for Redcliff Municipality also holds a ministerial abstraction agreement from Sebakwe Dam of 15 million cubic meters per annum.

Sebakwe Dam is a major dam according to Ministry of Water Development with a capacity of 262 000 000 cubic meters and a safe yield at 4% risk level of 90 000 000 cubic meters.

Water is released down stream and travels approximately 40km to Dutchman's pool a pick-up weir with a capacity of 5 000 000 cubic meters.

The combined allocation to Zisco Steel and Kwekwe City Council is treated at Dutchman's pool Water works by Kwekwe City Council.

TREATMENT WORKS

The present works is rated at 90 000 cubic meters a day. It is divided into three phases constructed between 1956 and 1980.

Currently a dual coagulant dosing system exists for both Ferri-Floc 1820 and aluminium sulphate.

At the present moment ferri-floc 1820 is used as a coagulant and a flocutant. Preliming is done for PH correction. The water is clarified, filtered and then dosed with chlorine before passing into treated water reservoirs for pumping into Kwekwe and Chicago reservoirs.

Clarifier sludge is thickened in lagoons and the supernatant from the clarifier sludge, together with filter back wash water are recycled to the inlet works.

DIAGRAMMATIC PRESENTATION OF WATER SUPPLY ABSTRACTION WORKS TO CHICAGO RESERVOIRS

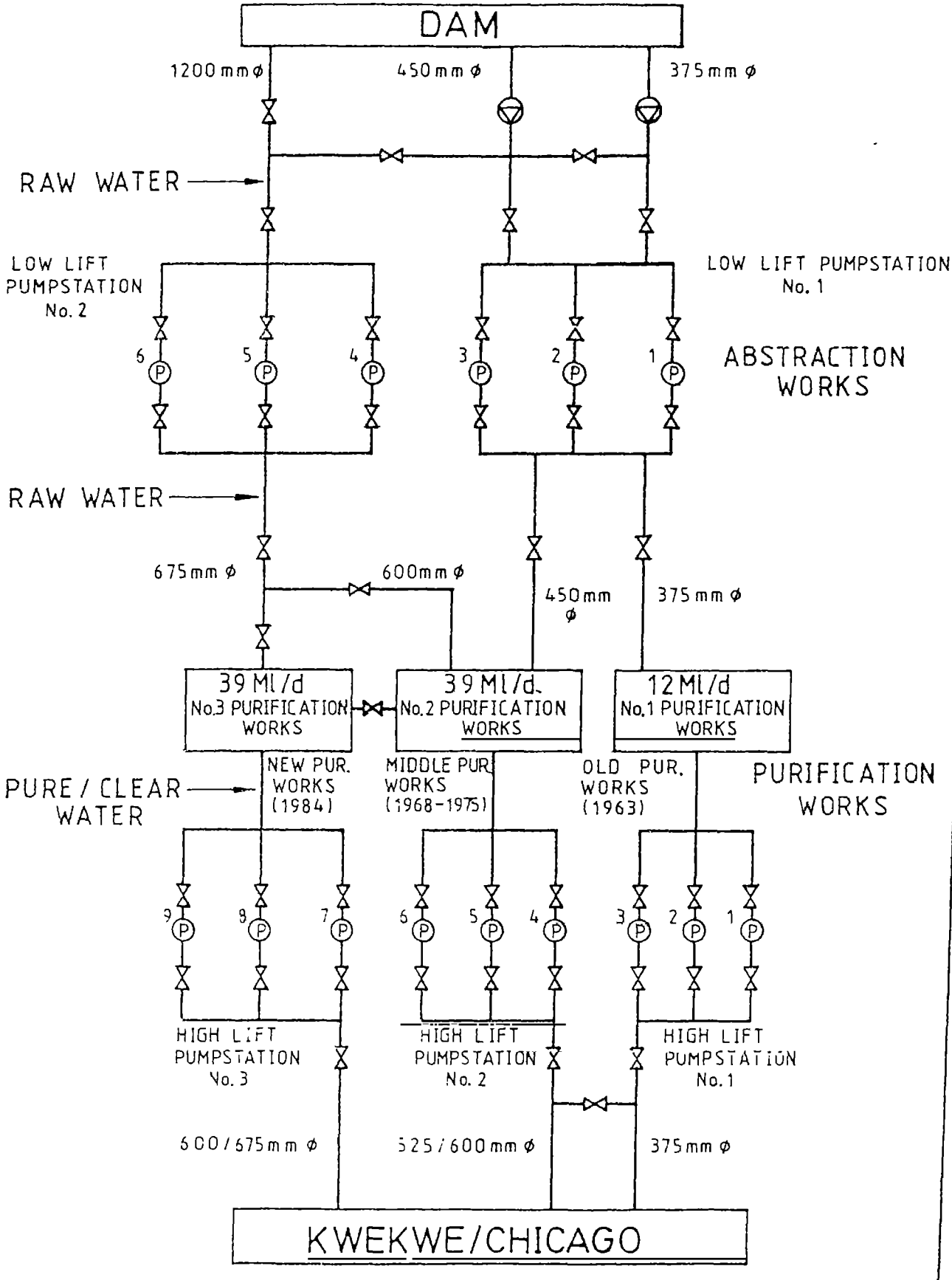


FIGURE 5 2

In general the works produces water in accordance with the recommendations of the W.H.O guidelines.

Phase I works whilst 34 years old still produces good quality effluent. The operations and maintenance of the above three phases are all the same.

PUMPING MAINS

The water is pumped to Chicago reservoir through the pumping mains. One 675mm nb, 600mm nb and 375mm nb A.C pipes. Pumping mains double up as distribution mains.

STORAGE RESERVOIRS

The combined storage capacity for Chicago reservoirs which also supply Zisco Steel is 75ML. The water works highlift pumps are designed to meet peak week demand that is 1.4 times the average daily demand therefore the reservoirs are basically balancing storage reservoirs.

2.2 ORGANISATIONAL AND MANAGEMENT OF OPERATIONS AND MAINTENANCE

The Management of operations and maintenance of water supply is the responsibility of the Engineer's department (Department of Works) as referred to by other towns). The Engineer or the Director of Works is overally responsible.

In most Local Authorities they are two sections which directly deal with the operations and maintenance of the water supply.

The abstraction and treatment is normally headed by a Water works Superintended and his staff. The staff may consists of the laboratory technicians (or chemists) operators and general labourers. The laboratory staff do jar tests to determine the level of coagulant and other chemicals dosages. They also do analysis of the finished product to determine the quality. Operators normally do the physical operations of sorting pumps, adjusting dosages, backwash operations and problem shooting when the plant is operational. The general labourers normally attend to the water works gardens. In other Local Authorities they are no chemists, the operators themselves who are trained do all the tests and also operations. The second section involved in the operations and maintenance of the supply are the plumbers section also headed by s Superintended or Chief Plumber or Fitter and Turner. Their main job is to attend to and rectify burst pipes for both the pumping mains and reticulation network. They are arranged into reaction teams. In the case of Kwekwe find Appendix B for manpower under the two sections.

3.0 **PLANNING**

Planning for operations and maintenance is done by the Engineer's department. The department normally engages consultants to estimate growth rates, uprating periods initial budgets for the treatment plants.

The day to day running operations planning is normally based on the operational manuals designed at construction stages. The pumping mains and distribution operations and maintenance are mainly a crises management issue. The Management of the reticulation systems is also crises management. The initial designs and constructions are normally done professionally. Management and planning for reticulation systems during operations becomes another crises issue. Leak detection programmes is not planned for and there is no accounting for water losses. In some cases reticulation and distribution masterplans in the form of drawings are non-existent.

3.2 PLANNING (KWEKWE CASE)

(a) PLANNING FOR FUTURE GROWTH OF TOWN - TREATMENT CAPACITY

Pumping capacity, storage capacity and reticulation needs Consultant Engineers were engaged to come up with a five year development plan in terms of:-

(1) Growth of demand

(2) Capacity of treatment enhancement

(3) Storage capacity enhancement

(4) Distribution network uprating.

(i) GROWTH OF DEMAND

The consultants used figures from 1969 to 1977 and figures from 1983 to 1991, there was a break in the available figures from 1977 to 1982.

The figures were from monthly figures pumped from Dutchman's pool, Water works and a cumulative total based on water readings from domestic, commercial, industrial consumers, public buildings and bulk meters.

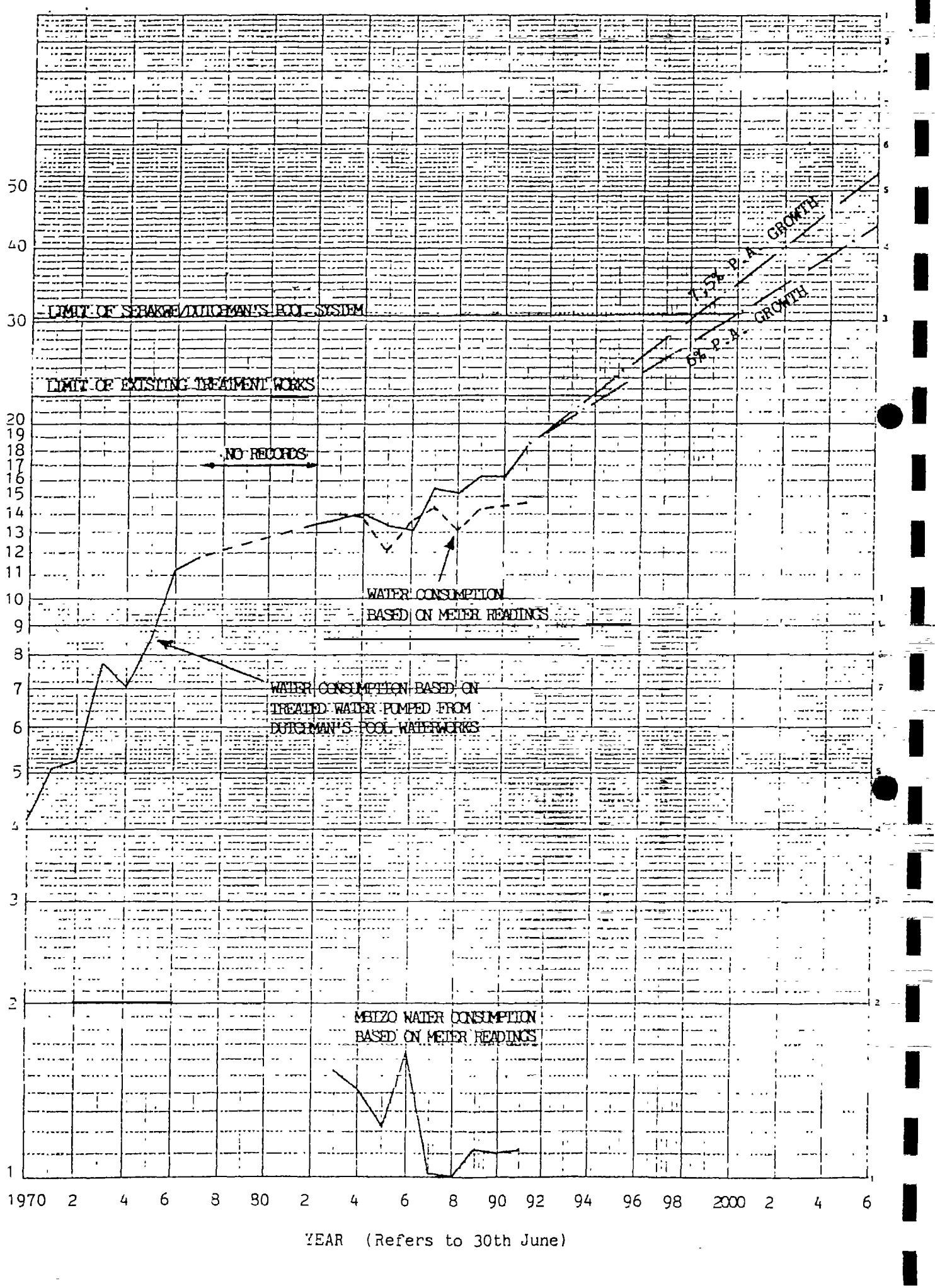
From the above it was calculated that pipeline losses peaked 23.1% in 1990/91 season. Treatment losses at the same time are 4.9% therefore pipeline losses are in the order of 18.2%.

Because of defective consumer meters, figures for growth rate were based on water pumped from Dutchman's pool water works. The graph next page depicts the picture. Linear regression analysis gave a growth rate of 6% per annum compounded.

page 8

FIGURE 5.1

...RVE HISTORICAL WATER CONSUMPTION AND FUTURE DEMAND

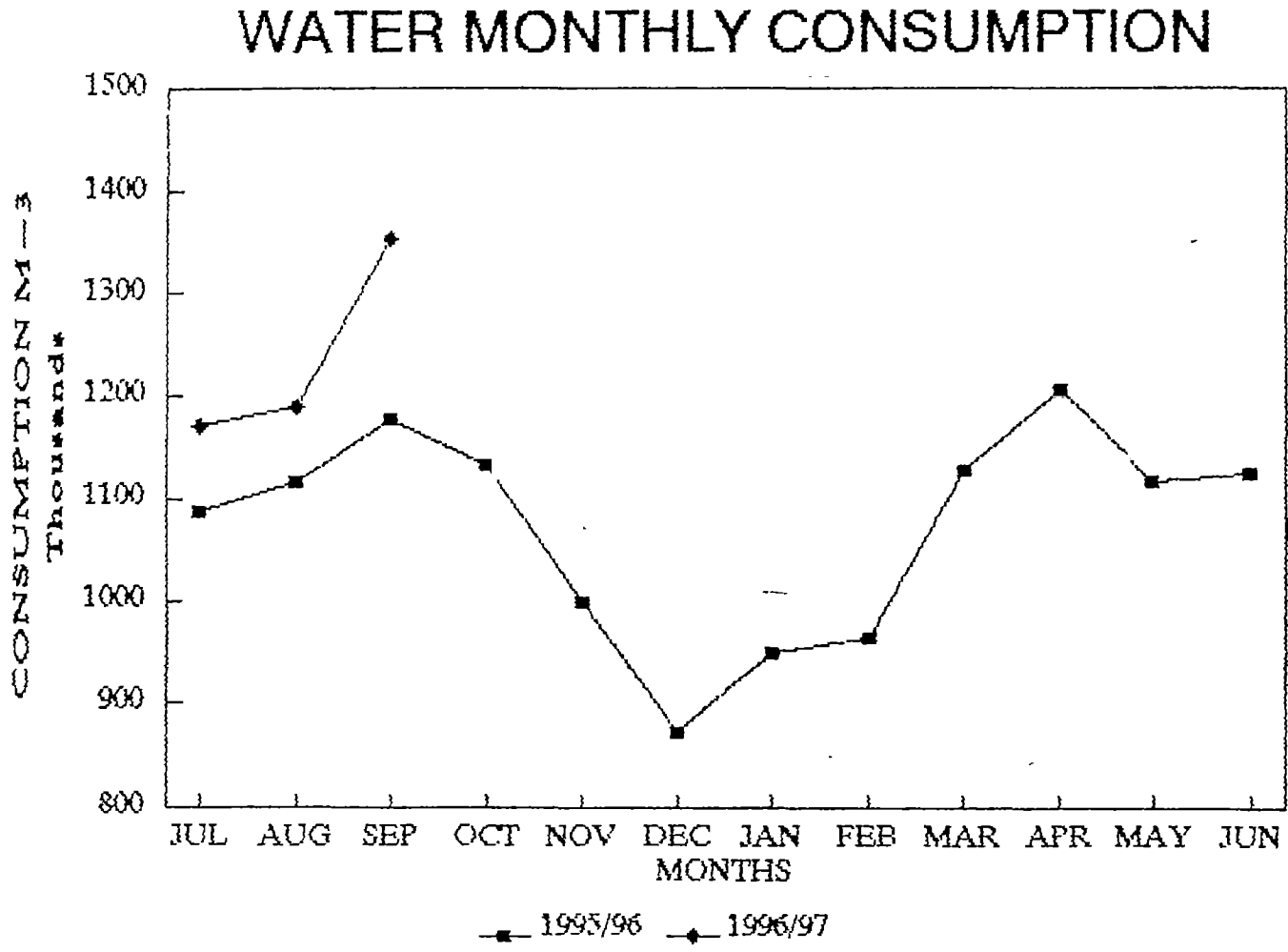


To substantiate these growth rates physical developments were considered. It was forecasted that high density areas would grow by 44% in 5 years a compound figure of 7.6% per annum linking it to the 6% per annum water demand growth.

Industrial area was expected to increase by 498 hectares an increase in water consumption per annum of 7.2%. Thus the figure of 6% per annum was supported by physical anticipated growth.

PRESENT REALITY

For 1995/96 the estimated demand would be 24 x 10^6m5 per annum from the graph on page 10 but the demand for that year was actually 12 895 983m^3 that is 12.9 x 10^6m3 half of the forecasted figures. (see graph)



MONTH	1995/96	1996/97
JUL	1089067	1171384
AUG	1117906	1191000
SEP	1177791	1352253
OCT	1133745	
NOV	1000245	
DEC	873631	
JAN	951041	
FEB	967226	
MAR	1129008	
APR	1208271	
MAY	1120000	
JUN	1128052	

Graph 2

There are two major factors contributing to the above scenario.

(i) 1992/93 drought introduced severe water rationing cutting most domestic consumption by almost 50%. Industrial and Institutional establishments introduced other sources for industrial source reducing the dependency on Municipal water. The demand never picked up after lifting of rationing.

(ii) The 498 hectares of anticipated industrial growth, Mashonaland Holding though possessing serviced land never pitched up to set the cotton ginnery as proposed. The Sencoal Mine investment in Kwekwe remains unrealised.

The growth of high density areas is only about 19.5% rather than 44% a growth rate of about 3.6% per annum compounded.

(ii) **CAPACITY OF TREATMENT**

It was planned to enhance treatment capacity by 44ML per day on the bases of the already said growth demand that is Phase IV was supposed to be built by 1994 at a cost of $30 000 000.00. There has been no augmentation of treatment plant though the project has been on our P.S.I.P submissions for several years (later on it was deferred to a later date in favour of increasing storage capacity only and increase pumping hours.

(iii) **STORAGE CAPACITY ENHANCEMENT**

It was supposed to be increased by 32ML at a cost of about $20 million. This reservoir has not been built.

(iv) **PUMPING MAINS AND DISTRIBUTION NETWORK**

A 600mm nb A.C pumping main at a cost of about $18 000 000.00 was supposed to have been constructed in conjunction with the uprating of treatment plant. This has also been deferred. A distribution network, ringing main a 350 nb in Mbizo is being constructed at present value of $7 million as per planning.

SUMMARY OF ABOVE OBSERVATIONS

Planning for the future of water supplies is not a case of mathematical formulation and ingenuity done, it is interwoven with socio-economic factors and natural disasters.

DID THE DROUGHT POST-PONE AN EMINENT HEAVY FINANCIAL BURDENS UPON KWEKWE?.

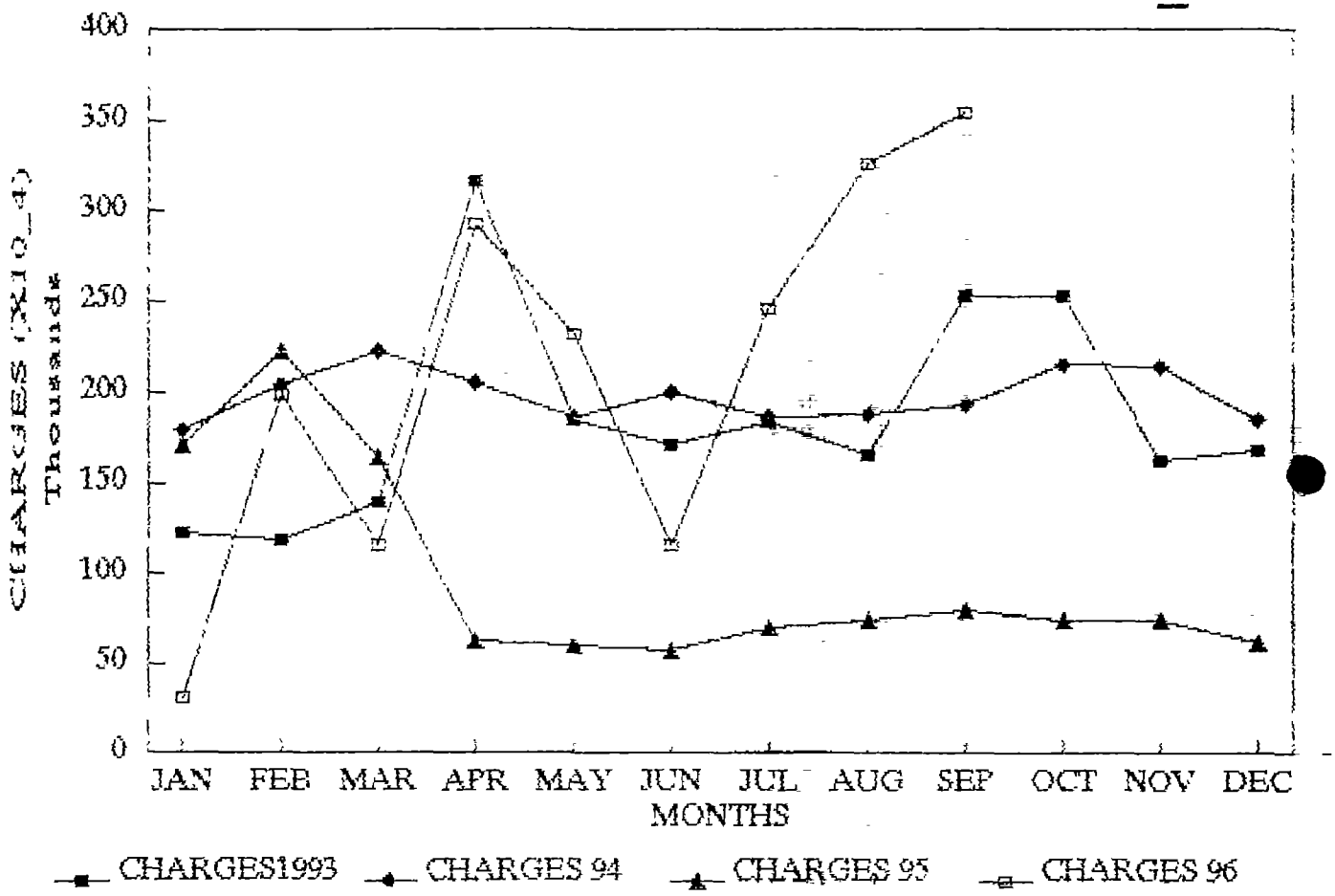
3.2 **PLANNING FOR ECONOMICAL WAYS OF OPERATIONS AND QUALITY WATER SUPPLY AT TREATMENT WORKS**

To get the best value for money in terms of water treatment chemicals. Tenders were invited for supply of chemicals mainly coagulants. A company from South Africa N.C.P in conjunction with A I Davis won the tender to supply the coagulant ferri floc 1820.

The package included a $1 million dollar dosing plant. Making the treatment plant capable of switching from alum coagulant to ferri flock coagulant - see Appendix A attached for schedule of alum and ferri floc dosages compared on a monthly bases and value for money cost. Electricity costs have been reduced by introducing power factor correction at the treatment works. Forward planning in terms of replacement of absolute plant remains absent. Phase 2 has a residual life of zero yet there has been no replacement of pumps and motors. The pumps have been repaired over and over again.

In terms of energy consumption of treatment works Kwekwe City Council introduced power factor correction. On the graph on the next page the average 1995 monthly are below the 1994 average though you would expect them to be higher because of inflation and the rise in Zimbabwe Electricity Supply Authority charges on a yearly basis.

WATERWORKS ZESA CHARGES 1993_1996



MONTHS	1993	1994	1995	1996
JAN	122074.8	177945.6	169906.8	29724.11
FEB	117853.1	203460.6	220936.8	198323.1
MAR	137828.1	222102.3	163859.4	115072
APR	316127.7	204550.5	61997.88	292866.9
MAY	183857.2	184844.1	58866.15	231858.1
JUN	170384.6	200000	56572.95	115072
JUL	182597.6	184852.1	69160.94	244591.2
AUG	164372.8	187584.6	73361.6	325445.2
SEP	252158	192643.5	78066.8	353703.4
OCT	251678	215197.5	73555.82	
NOV	161384	212652.3	73181.25	
DEC	168050	183464.4	61044.59	

3.2 (C) PLANNING FOR MAINTENANCE OF EXISTING DISTRIBUTION SYSTEMS (PLANNING)

There exists no planned programme. Planning for replacement of plant and equipment that has reached economic design life is not in exitance which could be a reason why the maintenance budget is very high. The budget is not proportional to the present value of investment. Phase I of the treatment works has zero residual value and yet no pumps and motors have been entirely replaced. No distribution mains and reticulation network replacement planning is in place. Pipes are replaced only when they burst and in the case of G.I piping when they are heavily corroded which results in other areas being cut off. In the high density of Mbizo about 100 houses reticulated with G.I pipes clogged reducing pressure to unacceptable levels. Adequate pressures were restored after 3 months with replacement of the existing G.I pipes. The above scenario could have been avoided with forward planning.

3.2 (D) PLANNINGS FOR FUTURE DISTRIBUTION SYSTEMS

When the loped network is designed for a new housing infrastructure programme extensive pressure testing is done for the connection point into the new network. The designs however do not consider leaving some nodal pressure points for future connections.

As the network grows larger the outer areas in the system experience a continuous decreasing pressure and the problem is solved by a ring main. An analysis of the above problem is very difficult in Kwekwe now. The design programme used in the department for water reticulation design is loop and it is limited to only 500 pipes and 400 nodes. It can not be used to analyze the whole network globally.

For future plans the City of Kwekwe has engaged consultants to produce a feasibility and cost determining report on Water Distribution Network Inventory and Master Plan. This is computerised master plan. As the water supply network system ages, it becomes imperative that the technology and services for maintenance techniques and management are improved to sustain operational efficiency.

The master plan study develops and introduces the technology, service and facilities that the City's Engineer's who are charged with water supply management can use to analyze and monitor these systems to come up with factual results that can be used to assist on the decision making process for the proper performance expansion and maintenance of the system. The project is likely to be funded next financial year.

4.0 FUNDING

Funds for capital developments that is upgrading and offsite services development are loans from central government loaned at government interest rates. For operations and maintenance revenue account funds are used. Normally there is no differentiation between revenue fund, all revenue income being used for re-current expenditure.

In other words income from water sales does not necessarily fund operations, maintenance and overhead costs for water supply but for other Council expenditures even subsidizing non profitable ventures.

4.1 LEVEL OF FUNDING

LOANS

In terms of loans the following schedule indicates loans from Central Government

FINANCIAL YEAR	AMOUNT $	WORKS
1974/75	874 000.00	Phase II of treatment works
1976/77	8 000.00	Phase II of treatment works
1977/78	108 006.00	Phase II of treatment works
1979/80	40 000.00	Phase III of treatment works
1980/81	2 934 000.00	Phase III of treatment works
1981/82	3 200 000.00	Phase III of treatment works
1982/83	1 700 000.00	Phase III of treatment works

1983/84	450 000.00	Phase III of treatment works
1992/93	450 000.00	350mm nb main stages
1993/94	720 000.00	350mm nb main stages
1994/95	533 549.00	Mbizo Offsite water mains
1995/96	1 000 000.00	Spine Mains
1996/97	6 000 000.00	Spine Mains

Currently Kwekwe City Council repays water loans alone at a cost of $1,55 million per annum. This a very heavy burden which sometimes is not always met. The capital costs of putting up water supply system in place is crippling and I assume its almost the same for every Local Authority. The City Council intends to borrow money from the open market for a reservoir construction thus increasing the burden further.

OPERATIONS AND MAINTENANCE FUNDING

The funding is for salaries of staff involved in the operations and maintenance of the whole water supply system, the maintenance of the treatment plant, pumping mains and distribution network. The funds have to come from the water sales.

LEVEL OF FUNDING OVER THE PAST SIX YEARS AND EXPENDITURE

WATER SUPPLY AND RETICULATION

YEAR	BUDGET $	PROFIT	ACTUAL EXP. $
1989/90	4 056 000.00	1 099 134.11	4 393 940.89
1990/91	6 919 990.00	Not available	Not available
1991/92	9 124 200.00	Not available	Not available
1992/93	7 803 000.00	342 715.00	6 502 540.00
1993/94	10 858 100.00	830 392.00	11 057 802.00
1994/95	14 384 529.00	5 556 871.00	11 827 893.00
1995/96	13 149 593.00	Not yet available	Not available

The above scenario indicates that in general the actual expenditure is more than budgeted for. The level of funding internally is inadequate for the operations and maintenance. The trend has remained like that and continues to be so. The ramifications for such a scenario is discussed under strategy for sustainability.

5. **USER INVOLVEMENT**

The user involvement in the operations and maintenance is mainly limited to reporting burst pipes and leaks. The user also maintains the line, after his domestic water meter or the Council maintains it for him on cost recovery basis.

5.1 **USER INVOLVEMENT**

Institutions and big companies run their own internal water reticulation. We have an agreement with Zisco Steel whereby Zisco Steel pays part of the capital development at water works, they pay 64.4% on capital development. This is mainly due to the fact that about 64.4% of the water treated is for Zisco Steel.

6. **STRATEGY FOR EMERGENCIES**

Emergencies in operations and maintenance of water supplies:-

(1) Burst pipes and valves failure

(2) Pump breakdowns

(3) Shortage of resource itself (droughts).

In general the first two are solved by having stand-by mobile crews to react to faults immediately when they are reported.

SHORTAGE OF RESOURCE

The next popular strategy is water rationing. Hosepipe bans are effected and surcharges introduced for any excess usage of water. A Local Authority can also influence the Ministry of Water to declare the area a water shortage area thus suspending all agricultural usage of water and also harnessing any existing water resource for the use of U.I.M (Urban, Industrial and mining).

6.1.0 **STRATEGY FOR EMERGENCIES (KWEKWE)**

6.1.1 **Burst pipes and valve failures.**

The reports are attended to by a crew of plumber and general hands. This crew is not entirely on standby. It will be doing other plumbing duties which it has to leave and attend to the burst pipe. During the night when a burst pipe occurs, the standby driver picks up plumbers from home and their general hands. This system causes delay in reaction time to burst pipes as the guys have to be followed up sometimes to different places they go to after work. The following is routine maintenance schedule for the month of September 1996.

WATER RETICULATION

Routine maintenance was carried out on all leaking valves and hydrants. During the course of the month:

6 Water Connections were made.

2 Hydrants were repaired.

3 Valves was also repaired.

Below are burst pipes attended to during the month.

Location	Size & Mater.	Time Reported	Time Reconnected
Mbizo 16	1x20mmGMSpipe	01.00 p.m.	04.00 p.m.
Takawira Ave	1x100mmACpipe	07.00 a.m.	08.00 p.m
Takawira Ave	1x100mmACpipe	08.00 p.m.	09.00 p.m.
Takawira Ave	1x75mmACpipe	09.00 a.m.	10.00 a.m.
Chitepo Ave	2x20mmGMSpipe	02.00 p.m.	07.30 p.m.
Takawira Ave	1x100mmACpipe	01.00 a.m.	05.00 p.m.
Amaveni L23	1x50mmACpipe	04.00 p.m.	08.00 p.m.
Amaveni L33	1x75mmACpipe	08.00 p.m.	11.00 p.m.
Python Way	2x100mmACpipe	07.00 a.m.	04.00 p.m.
Edison Street	1x150mmACPipe	10.00 a.m.	01.00 p.m.
Takawira Ave	1x100mmACPipe	07.00 a.m.	11.00 a.m.
Mbizo 12	1x75mmACpipe	07.00 a.m.	01.00 p.m.
Beaulea Drive	1x75mmACpipe	07.00 p.m.	10.00 p.m.
Mbizo 6	1x75mmACpipe	12.00 a.m.	07.00 a.m.
Mbizo 12	1x75mmACpipe	08.00 a.m.	01.00 p.m.
Mbizo 1	1x27"Main	08.00 a.m.	06.00 p.m.
Mbizo 16	2x150mmACpipe	05.00 p.m.	10.00 p.m.
Clyed Road	1x100mmACpipe	05.00 p.m.	10.00 p.m.
Burma Road	1x100mmACpipe	05.00 p.m.	11.00 p.m.
Mandela Way	1x150mmACpipe	03.00 a.m.	07.00 a.m.
Takawira Ave	1x100mmACpipe	12.00 p.m.	01.00 p.m.
M Ndhlovu	1x75mmACpipe	01.00 p.m.	01.30 p.m.
Mbizo 1	1x150mmACpipe	10.00 a.m.	01.00 p.m.

It is anticipated that by the end of this financial year a mobile crew would be in place for 24 hour service. A new car has already been allocated for this new system and labour increased to put plumbers on shift so that there is 24 hour coverage. The reaction team would be based in the works yard on a 24 hour service and receiving their complaints through the fire brigade phones. Currently some complaints come through the fire brigade and some through the maintenance units yards and the Civic Centre.

6.1.2 **PUMP BREAKDOWNS AND ELECTRICAL BREAKDOWNS**

The mechanical breakdowns are attended to by our mechanical crew of fitters and turners.

The electrical breakdowns are attended to by our electrical crew of electricians.

6.1.3 **SHORTAGE OF THE RESOURCE (KWEKWE)**

During the 1992/93 drought a water conservation action committee was formed where all the stake holders in the Sebakwe catchment area were represented. The brief was to spear head methods of conservation and diseminate information on the general need for conservation of water. Strong rationing was put in place and fines for exceeding the maximum allocation was introduced.

During 1995 September it became necessary to introduce rationing. The following schedule is a complete picture of the system put in place.

To: All Consumers

Due to our worsening water situation which now stands as follows:

Capacity	27.75×10^6 m^3
% Capacity	10.5%

This water will last until the beginning of July if no serious rationing is carried out and there is no significant inflow this rain season. Therefore water rationing has now been reviewed and stands as follows:-

WATER RATIONING SCHEME

1. **Consumption Allocation**

User Category	QUANTITY
1. Individual metered house/ High Density flats	15m^3 per month of or 500 litres/house/day
2. Individual metered house/ Low density	20m^3/month or 667 litres/day
3. Multipurpose Buildings with water meters	70% of last six months' average

4.	Churches - Sport Clubs	70% of last six months' average
5.	Restaurants, Beerhalls	70% of last six months' average
6.	Industrial, Manufacturing and Commercial facilities	70% of last six months' average
7.	Hospital and Clinics	70% of last six months' average
8.	Hotels	70% of last six months' average
9.	Building Operations	70% of last six months' average
10.	Swimming pools	No residential or private pools are to have Municipal water.

2. **PENALTY CHARGE FOR DOMESTIC CONSUMERS**

Monthly Consumption in Kilo litres or m^3	Surcharge above allocation
0 - 20	1C/1 Litre
21 - 40	1C/0.5 Litre
41 - 60	1C/0.25 Litre
60 and over	2C/Litre

NOTES

1. Last six months is defined as May, June, July, August, September and October.

2. For use of hosepipes on any private lawns and gardens and cars the following will be levied:

1st time offender	$ 50.00 and disc inserted
2nd time offender	$100.00
3rd time offender	$150.00

3. For residential households topping their swimming pools the following fines will be levied:

1st time offender	$100.00 fine and disc inserted
2nd time offender	$200.00 fine
3rd time offender	$300.00 fine

4. Municipal Police will be responsible for monitoring use of hosepipes.

5. It is recommended that a water conservation task force be set up. We target to reduce overal consumption by 40%.

Average monthly consumption - 1222445m^3

Target monthly consumption - 733467m^3

Rationing introduces on Council involuntary demand management. The negative effects are that it reduces revenue on the part of income.

In general the operating rule for urban water supply is that they should be 21 months of water supply at any given time. For Sebakwe dam it means at 56 million cubic metres it means all agricultural activity is suspended and water is reserved for U.I.M users.

7. **STRATEGY FOR SUBSTAINABILITY**

The current situation is bleak, they are very few Local Authorities that would be able without central government loans to sustain upgradings of treatments plants to meet demand, new reservoirs to increase storage capacities and pumping mains to increase capacity. Cities tend to borrow from the open market increasing their financial burden.

(1) The correct sustainable strategy is that the user should pay to recover costs for operations and maintenance of systems. Overheads and a margin of profit for future funding of upgradings of systems must also be included in the cost to be borne by the user.

(ii) A separate account ought to be opened to bank profits from water sales. In other words profits of water supplies need to be capitalised for future upgradings and replacement of capital equipment.

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Kwekwe Generally makes a profit in the water account. The following schedule shows the profits from water account:

YEAR	INCOME	EXPENDITURE	PROFIT
1989/90	5 493 075.00	4 393 980.89	1 099 134.11
1990/91	Not available	Not available	Not available
1991/92	Not available	Not available	Not available
1992/93	6 845 255.00	6 502 540.00	342 715.00
1993/94	11 588 194	11 057 802.00	830 392.00
1994/95	15 419 452.00	11 827 893.00	3 556 871.00
1995/96	Not available	Not available	Not available

An earlier schedule on level of funding shows that funding is inadequate whilst the water account makes a profit. The inadequacy in funding of maintenance programmes put a great stress on the whole system. Capital funds are dwindling from central government. In general some feelings are that central government collects income tax from the citizens of Kwekwe as such must continue to fund the capital developments in water supplies of Local Government. This school of thought however does not take into account that with equitable distribution of financial resources available to Central Government it is not possible to fund the level required to sustain the water supply system. Therefore in future capitalization of profits into a separate account must be carried out.

The present situation where profits from the water supply are used to subsidize non-profit making Council operations tatamounts to "milking a cow everyday without feeding it". The water supply system will crumble and the capital to revitalize them will be astronomical and out of reach of most urban Local Authorities.

The other worrying factor for Kwekwe is whether the profit is real or an abstract figure. There is virtually no system in place to calculate the real unit cost of water. The present selling rates are as follows:-

Domestic	\$1.15 for first 10m³ thereafter \$1.44 per m³
Zisco Steel	\$1.56 per m³
Commercial	\$52.50 up to 20 cubic metres thereafter \$2.30m³
Industrial	\$90.63 up to 20 cubic metres thereafter \$2.25m³

These figures are arrived at by putting an incremental factor on last year's figures and once ratified by Full Council become the new rates.

There is no consideration of replacements value, capital redemption the residual value of operating plants. There is no forecast into the future by estimating design lives of the systems and coming up with the whole life cycle cost of system to determine actual costs.

33/

It is therefore imperative that the correct strategy for future sustainability is to determine actual costs, charge a cost and a profit margin for the unit rate. The differential tariffs are alright because they introduce an element of demand management and user pays principle but there is no doubt that the base must be a true cost. The water account system can go further and forecast future times where there is need of capital injection and profits margin introduced on the bases of those forecasts.

This paper could have looked at a crude discounting method of calculating the unit cost of water had the time been permitting and also if it was easy to dig up information of equipment capital costs of the existing Kwekwe water supply system.

PERFORMANCE OF NEW CHEMICALS

All three phases went on Ferric Floc 1820 as a coagulant on the 29th April 1996.

JAR TESTS RESULTS

DOSAGE

DATE	FERRIC FLOC	ALUM EQUIVALENT
01/09/96 TO 30/09/96	Average Dosage 32ppm -36ppm	50 - 55ppm

The plant is running at the indicated doses of Ferric Floc and the effluent has never been any better. The average turbidity is zero. (Turbidity is the absence of colour).

On alum the plant would normally be run at least 15ppm above Jar Tests because of solid nature of alum Kibbles (Limited surface area).

Alum average =55ppm.

Raw Water treated from 1 September 1996 to 30 September 1996
=1 329 740m3

Total amount of Ferric Floc 1820
$= \frac{34 \times 1\ 329\ 740 kgs}{1\ 000}$

$= 45\ 211.00 kgs$

Alum Equivalent

$= \frac{55 \times 1\ 329\ 740}{1\ 000}$

=73 135.7kgs

Alum equivalent optimised for quality
=73 135,7kgs x 1.3
=95 076,40kgs

Ferric Floc Costs ZAs Zim$	Alum Costs Z$ Zim$	Amount of Water Treated in ml
$250 346.37	$285 227.20	1 329.74ml
$192.78/ml	Cost Per Ml $214.50/ml	

This is comparing only Ferric Floc without additives and Alum without additives, that is, lime and chlorine. Chlorine is constant fo r both coagulants.

Lime used for Alum is more than that used for Ferric Floc. The reason being that Alum is sulphuric and based and Ferric Floc is Hydrochloric acid based. Sulphuric acid is a stronger and therefore takes more lime to correct PH.

Therefore, it would only push the costs per Ml for Alum up.

The costs will vary from month to month depending upon the quality of Raw Water.

We have also received a Million dollar dosing system for ferric floc free of charge. We therefore can switch from one chemical to the other quickly in response to market changes without being held to a ransom by any chemical company as long as our contract is over. See Appendix A.

APPENDIX A

F/FLOC AND ALUM DOSAGES

SEPTEMBER 1996

DATE	DOSAGE AS PER FLOC TES G/M-3 OR PPM		ACTUAL PLANT DOSAGE G/M-3 OR PPM		RAW WATER CONSUMPTION	F/FLOC USED	TURBIDITY	
DATE	ALUM	F/FLOC	ALUM	F/FLOC 182	M-3DAY	KGS/DAY	RAW	PURE
1-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	46700 M-3	1400-KG	84 NTU	2.6 NTU
2-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	40140 M-3	2520-KG	84 NTU	0.52 NTU
3-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	50720 M-3	-	84 NTU	0.71 NTU
4-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	48840 M-3	3360-KG	84 NTU	0.90 NTU
5-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	46480 M-3	2240-KG	84 NTU	0.60 NTU
6-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	47060 M-3	3220-KG	84 NTU	0. NTU
7-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	47460 M-3	2800-KG	84 NTU	0 NTU
8-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	41090 M-3	1400-KG	84 NTU	0.91 NTU
9-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	34130 M-3	1400-KG	84 NTU	0.91 NTU
10-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	47700 M-3	1400-KG	84 NTU	1 0 NTU
11-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	42420 M-3	1400-KG	84 NTU	1.5 NTU
12-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	50830 M-3	2800-KG	84 NTU	1.0 NTU
13-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	44570 M-3	1400-KG	84 NTU	1.0 NTU
14-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	43500 M-3	1960-KG	84 NTU	0 NTU
15-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	50800 M-3	1400-KG	84 NTU	1 0 NTU
16-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	44090 M-3	4200-KG	86 NTU	0 81 NTU
17-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	52920 M-3	2800-KG	86 NTU	0.54 NTU
18-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	49000 M-3	-	86 NTU	0.65 NTU
19-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	43400 M-3	4200-KG	86 NTU	0.44 NTU
20-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	47520 M-3	1400-KG	86 NTU	0 NTU
21-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	41020 M-3	1400-KG	86 NTU	0. NTU
22-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	40460 M-3	2800-KG	86 NTU	0.44 NTU
23-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	43680 M-3	2800-KG	86 NTU	0.52 NTU
24-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	44210 M-3	1400-KG	86 NTU	0.71 NTU
25-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	56520 M-3	2800-KG	93 NTU	0 54 NTU
26-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	46170 M-3	1400-KG	93 NTU	0.71 NTU
27-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	41250 M-3	-	93 NTU	0 NTU
28-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	46940 M-3	4200-KG	93 NTU	0. NTU
29-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM	49920 M-3	1400-KG	93 NTU	0.90 NTU
30-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM		-	93 NTU	0.90 NTU
31-9-96	50PPM-55PP	32PPM-34PP	55PPM	34PPM				
					1,329.740-M-3	53.956-KG		

WATER WORKS MANPOWER - APPENDIX B

NUMBER	DESIGNATION	GRADE
1	Waterworks Superintendent	D1
2	Deputy Waterworks Superintendent	C5
3	Waterworks Operator	B3 P.A
4	Waterworks Operator	B3 P.A
5	Assistant Waterworks Operator	B2
6	Assistant Waterworks Operator	B2
7	Trainee Waterworks Operator	A3
8	Lab. Overseer	B1
9	Waterworks Attendant	B1
10	Waterworks Attendant	B1
11	Waterworks Attendant	B1
12	Waterworks Attendant	B1
13	Waterworks Attendant	B1
14	Waterworks Attendant	B1
15	Waterworks Attendant	B1
16	Waterworks Attendant	B1
17	Waterworks Attendant	B1
18	Waterworks Attendant	B1
19	Waterworks Attendant	B1
20	Waterworks Attendant	B1
21	Waterworks Attendant	B1
22	Waterworks Attendant	B1
23	Waterworks Attendant	B1
24	Waterworks Attendant	B1
25	Waterworks Attendant	B1

26	Waterworks Attendant	B1
27	Waterworks Attendant	B1
28	Waterworks Attendant	B1
29	Waterworks Attendant	B1
30	General Labourer	A3
31	General Labourer	A3
32	General Labourer	A3
33	General Labourer	A3
34	General Labourer	A3
35	General Labourer	A3

WATER RETICULATION (APPENDIX B)

NUMBER	DESIGNATION	GRADE
1	Waterworks Superintended	C4
2	Plumber	C3
3	Plumber	B2
4	Plumber	B2
5	General Labourer	A3
6	General Labourer	A3
7	General Labourer	A3
8	General Labourer	A3
9	Plumber	C3
10	Lab. Overseer	B1
11	General Labourer	A3
12	General Labourer	A3
13	General Labourer	A3
14	General Labourer	A3
15	General Labourer	A3
16	General Labourer	A3
17	General Labourer	A3
18	General Labourer	A3
19	General Labourer	A3
20	General Labourer	A3
21	General Labourer	A3
22	General Labourer	A3

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OPERATION AND MAINTENANCE OF URBAN SANITATION SYSTEMS

Kadoma, 25 - 29 Nov, 1996.

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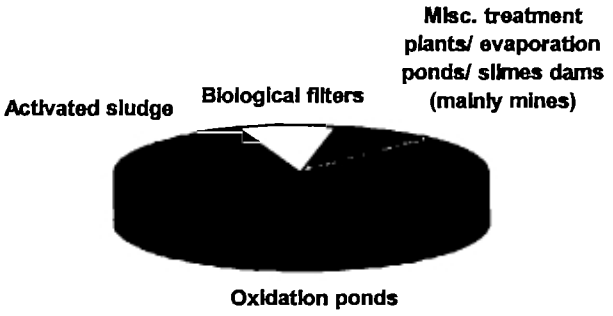
Based on a paper by the same authors entitled " Urban Sanitation in Zimbabwe" currently being prepared for publication.

Acknowledgments. We would like to thank the Department of Water Resources Pollution Control Branch for assistance with information and Dr Zaranyika for permission to quote his data on water quality in Lake Chivero. This report was made possible through support from the World Bank Water and Sanitation Program.

WASTEWATER DISPOSAL SYSTEMS

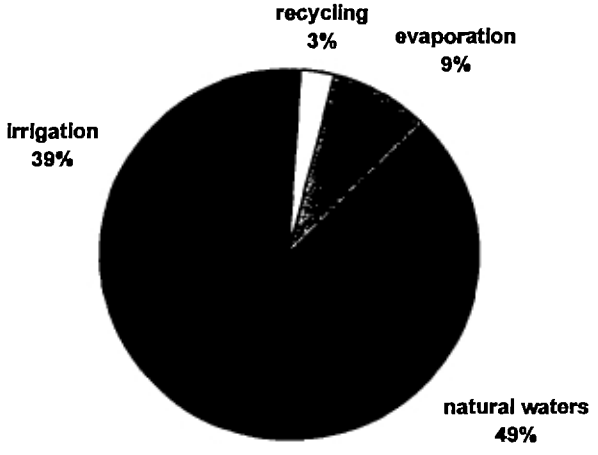
Off-site treatment systems



Treatment systems for wastewater from urban areas are mainly oxidation ponds. From an examination of over 100 wastewater treatment systems by the Pollution Control Branch of the Department of Water Resources, effluent is disposed of primarily to natural water courses.

Methods used for the disposal of treated wastewater

Effluent disposal



Effluent reuse for irrigation is viewed as a convenient way of disposing of inadequately treated waste water which would otherwise pollute a natural water body. Beneficially, it may also result in some revenue generation if the waste is irrigated onto local authority land but often it is supplied almost free to the recipient farmer. There are few examples of true recycling of treated wastewater but Marondera has been actively examining the cost benefits of recycling water from the wastewater treatment plant rather than constructing an expensive new water storage and reticulation system.

Disposal of treated effluent has posed problems in that technology available for most urban centres, even when working satisfactorily, produces water of high phosphate and nitrate levels causing pollution and eutrophication of receiving water. Techniques for the full recycling of wastewater have not been widely adopted in Zimbabwe and the most significant method of avoiding pollution has been the use of effluent for irrigation. This use is controlled by the guidelines laid down in the Public health (Effluent) Regulations, 1970, which regulate the use of sewage effluent for irrigation purposes. The disposal of effluent into natural water bodies is controlled by the Water (Effluent and Waste Water) Regulations, 1977.
The result of inadequate control over the effluent quality is the release of poor quality effluent and the data for Lake Chivero have been well documented.

Levels of phosphate, nitrate and chloride ions (mg/l) at Lake Chivero in Oct 1995. (Zaranyika, 1996) (* exceeds WHO drinking water standards).

	Range	**Mean**
Phosphate	5.14-11.86	8.0*
Nitrate	1.70-45.70	12.0*
Chloride	137-221	177

Heavy metal concentrations in water samples from Lake Chivero spillway, April 1996. (Zaranyika, 1996). (* exceeds WHO drinking water standards).

Element	**ppm**
Cadmium	0.018*
Copper	0.261
Nickel	0.147*
Lead	0.362*
Zinc	0.061

OPERATIONAL STATUS OF TECHNOLOGY

The PCB inspect water in rivers and trace problems back to their source. A number of local authorities are polluting natural waters in terms of the Water Act and the smaller growth points and service centres are also considered to be major offenders. The condition of the plants when last visited by the PCB shows that only 20% could be

regarded as good with almost 45% in the poor category. There is no fixed schedule of examination of sites with some not visited since the 1970's but the indications from the table are that there has been an improvement in the condition of the plants over the last 20 years.

Condition of treatment plants visited by the PCB at the last visit, which varies from 1971 to 1996, and those visited within the last three years. (poor = maintenance lacking, plant just run down; average = some maintenance being done; good = well maintained plant with good housekeeping).

Condition of plant	All Data	Plant visited between 1994-96
Poor	44	13
Average	37	19
Good	22	11

The quality of effluent from these plants is also poor in the majority of cases.

Quality of effluent examined from treatment plants from 1971 - 1996 and those from 1994-96. (Poor = most parameters do not meet required standards; average = more than half the parameters meet the standards; good = all parameters meet the standards).

Condition of plant	All Data	Plant visited between 1994-96
Poor	51	23
Average	34	15
Good	11	8

The majority of sewerage reticulation systems are facing problems due to overloading and especially in the high density areas. Where additional treatment works have been built or extensions made to existing ones, often the reticulation system has not been upgraded as the increased flows are coming from infilling or densification, subletting and increased occupancy rates. Common problems, and in cases such as Marondera they are serious, are leakage and blockages.

HUMAN RESOURCES

Whilst the City of Harare has been offering training of water and wastewater treatment plant operators on an informal basis for many years there are no regulations requiring that treatment plants have to be operated by qualified staff. Given the importance of these tasks, both in preventing epidemics by ensuring potable water is supplied, and in protecting the water resources and general environment from harmful pollution, as well as the large amount of money invested in the infrastructure, it is important to ensure the correct operation and maintenance of the facilities. The larger urban centres have at least a town engineer in charge of works and therefore there is access to qualified advice and supervision for the treatment works. The small urban centres may not have any staff with

technical qualifications and may rely solely on an untrained labour to manage the wastewater treatment works.

The PCB of the DWR have only 4 staff and are clearly unable to visit all potential sites of water pollution on a regular basis. The pollution control regulations are difficult to enforce for this and a variety of other reasons ands thus urban authorities are not investing adequate finance and attention into the maintenance of sanitation services. Sanitation is an emerging problem of serious proportions and requires a review of both legislation and monitoring systems if we are to begin to address it before the situation becomes too difficult to manage.

COMMUNITY BASED MANAGEMENT OF WATER POINTS IN CHIVI DISTRICT

BY: REMEMBER MBETU
KADOMA WORKSHOP :NOVEMBER 25 TO 29 1996

ABBRIVIATIONS

CBM	-	Community Based Maintenance
UNICEF	-	United Nations Children Fund
DDF	-	District Development Fund
O&M	-	Operations and Maintenance
NORAD	-	Norwegian Agency Development
DWSSC	-	District Water and Sanitation Sub-committee
VIDCCO	-	Village Development Committee
MLGRUD	-	Ministry of Local Government, Rural and Urban Development
MNAEC	-	Ministry of National Affairs and Employment Creation
MOH&CW	-	Ministry of Health and Child Welfare
AGRITEX	-	Agriculture Extension
RDS	-	Rural District Counci

METHOD OF APPROACH

The topic will be split into three stages. Firstly, an analysis of the maintenance situation i.e. of hand pumps in Chivi District before the introduction of Community Based Management in 1992 will be made.

Secondly, an attempt will be made to critically look at the situation 5 years later (1992 to 1996). This will involve:-

- The planning techniques used.
- The resources mobilisation.
- The management of the programme with special emphasise on monitoring and evaluation and then user involvement and other agencies.

Thirdly, I will put forward some suggestions and strategies for sustainability in the maintenance of handpumps.

Although this document is somewhat critical in its tone and focusing more on the problems than on solutions, the intention, however is not to criticise for its own sake, but to contribute to the ongoing debates on ways to develop and improve a sustainable maintenance system.

SITUATION ANALYSIS INDEPENDENCE UP TO 1992

UNICEF, in Situation Analysis Update 1994 noted with concern that, as the number of pumps continue to rise through Donor and Government Programme in Zimbabwe;

- The average age of the pumps rises as well.
- As the pumps get older, the breakdown rates seemed to increase.
- Also the Donors have shown less interest in developing supporting systems to ensure the smooth operation and use of these Primary Water Points especially in the maintenance.

While the maintenance costs per water point continue to escalate, the real maintenance budget per water point continue to fall as witnessed by the D3B vote handpump maintenance by DDF on yearly basis.

Although the 3 tier maintenance system which was adopted and adapted in 1979 by DDF aimed at reducing the downtime and operational costs to a certain extent, the system has been found wanting as it had its own problems.

Unfortunately, since independence the number of water points in Chivi District almost doubled from 540 in 1980 to 776 in 1996 while the recurrent budget allocations per water point have in real terms been falling considerably from about $150.00 in 1990 to $40.00 in 1996.

The accelerated development of water points in Chivi District has been a result of massive financial injection into the water sector by Donors, NORAD in particularly, NGOs, Lutheran and Care International to name but a few and the Government itself through the Public Sector Investment Programme.

However, the maintenance phase of the water points was left to the Government and under the 5 year Economic Structural Adjustment Programme (ESAP) that was introduced in 1991, the DDF became static because of a number of reasons as outlined below.

- The effectiveness of the pumpminders was compromised by guaranting them on a DDF's monthly wage bill, water point users therefore became less willing to assist pumpminders in carrying out the repair work.

- The continued rise in the O&M costs combined with the drop in recurrent budget allocations made the Government recurrent budget inadequate to meet the maintenance requirements.

- Accelerated increases in new water point development and the need to rehabilitate the ageing handpumps worsened the handpump maintenance burden, with preventive maintenance being the major casualty.

- Pumpminder support systems (provision of spares, appropriate tools and supervision) from the DMT was inadequate. Longer downtime periods became common in areas where alternative water sources were present - even from unprotected sources i.e. from 6 months to even 1 year.

Against this background the DDF and UNICEF representatives in the Province realised that Chivi District was heading for a crisis in the maintenance and repair of its rural water points. They sold the idea of Community Based Management of water points to the District.

The District, through its DWSSC accepted the whole concept and agreed to give it a trial in one ward in the District i.e. Ward 18 and later move on to Ward 20.

The DWSSC with the assistance of the Provincial staff approached the Councillor for the ward and leadership to sell the idea.

In this context, leadership refers to the Local Chief, Headman, VIDCO Heads, Kraal Heads and Councillor. The leadership agreed to discuss the concept with the users (Community) through meetings.

At the meetings the following was agreed:-

- That the respective communities would identify and choose the village mechanics.

5) Hygiene Education
6) Documentation.

VILLAGE MECHANIC

1) Advising on better use of handpumps
2) Undertaking preventive maintenance
3) All repairs and rehabilitation
4) Hygiene Education.

The roles of the agencies were as follows:-

MLGRUD
a) Documentation of the processes and experiences
b) Liaison between District and Province
c) Monitoring implementors progress
d) Compilation of half year and annual reports.

MOH&CW
a) Collection of water samples from repaired boreholes
b) Hygiene Education before, during and after CBM implementation.
c) Sanitary inspection of water points e.g. headworks.
d) Promotion of linkage between hygiene behaviour and needs for CBM.

DDF
a) Spares distribution and issuing of tools.
b) Monitoring of technical performance of village mechanics.
c) Phased transfer of responsibilities from Government to Communities.
d) Technical training of village mechanics covering problem identification, analysis, dismantling, repair and pump rehabilitation.
e) Provision of relevant technical information for the community to make informed decisions e.g. rate of breakdowns, cost of repairs.

MNAEC
a) Facilitation of village mechanics training sessions on community participation.
b) Imparting community mobilisation techniques.
c) Monitoring and reviewing of community contributions in the O&M of pumps.
d) Training on community development and recommendation of village mechanics.

RDC
a) It is unfortunate that the role of the RDC was not so pronounced that time.

EXPERIENCES DURING IMPLEMENTATION

1) First and foremost, the programme brought a lot of excitement to the District just like all new programmes when they are newly introduced. The negative effect being that other activities suffered as everyone rushed to CBM.

2) The programme was centred on individuals i.e. (DWSSC). Experience has shown that one can replicate a programme and not people and CBM was once perceived as a DDF baby.

3) The involvement of Chivi RDC was minimal although the Councillors were involved at Ward level.

4) The supply of tools from UNICEF/DDF was erratic.

5) Falling in of pipes and rods by trained mechanics has been on the increase suggesting that the training had not been effective, most of the village mechanics attribute it on the little time allocated for training - 2 weeks.

6) Two evaluations were carried out in 1993 and 1994 respectively.

7) To date 15 wards have been covered and 826 village mechanics trained.

8) The monitoring of the programme through follow ups has not been adequate if not non existent.

   This has resulted in the pumpminders maintaining their original role of repairing, instead of supervising and giving back up support to the trained village mechanics.

9) Monthly meetings with pumpminders have revealed that they continue to view CBM as a threat to their own continued existence in DDF. Against such a scenario, one begins to question their commitment in supporting CBM.

10) On a positive note there has been some improvement in the downtime in areas where CBM has been introduced at least from 4 days to 1 week and in non CBM areas from 1 to 2 weeks.

11) The programme is heavily depended on external financial support as witnessed by a temporary stoppage of activities when funds were not released by UNICEF.