WATER SUPPLY BY STRUCTURED SYSTEMS IN THE RURAL ENVIRONMENT.
THE GHANA CASE.

BY: ING. P.O. SACKEY

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THE GHANA CASE

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0. INTRODUCTION

Following the theme given, I wish to analyse and discuss the issues related to water supply by structured systems in the rural environment with particular reference to Ghana. The paper briefly gives a background of Ghana and poses the problems of water supply in the crowded housing communities in its rural environment. For attention to the framework of prospects for the 1990s, a close look is taken at the structured systems with particular reference to their institutional framework; especially the role of the differenct organisations; the type of equipment; equipment management, especially their financing, maintenance and renewal; and, cost recovery, with emphasis on billing, subscriptions and subsidies. The conclusion sums up the discussions and suggests directions for improvement.

1. BACKGROUND: GHANA AND ITS RURAL ENVIRONMENT

The latest population census in 1984 showed that 68 cent of Ghana's population of 12.2 million lived in rural areas operationally defined as settlements of less than 5000 people. As at now,, while 93 per cent of the urban populations enjoy safe drinking water, only 50 per cent of the citizens in rural ~~eares~~ areas do so. Though there is need for safe water for all, the problem is more recognised in the crowded housing zones of the rural environment than in the sparsely populated areas. To mitigate the problem, structured systems of water supply have been established.

2. STRUCTURED SYSTEMS OF WATER SUPPLY

Operationally, structured systems of water supply refer to the consciously adopted and organised framework of constructions or facilities for meeting water requirements on a massive scale. Governments have always expressed concern over the coverage of rural water supply and indeed ceremonies for the inauguration of rural water supplies have often provided fora for political rallies. The Government of Ghana has consistently pursued the policy of systematising the various structures of water supply. Currently, for economic and technological considerations, the following criteria have been adopted to guide planning for massive intervention especially where assistance is being sought from external support agencies:

(i) communities with population below 500 are provided with hand dug wells;

(ii) communities with population between 500 and 2000 are provided with boreholes fitted with hand pumps; and,

(iii) communities with population between 2000 and 5000 are considered for pipe borne water supply, mainly from mechanised boreholes or packaged treatment plants drawing water from nearby streams or rivers.

Two caveats must be stressed here. First, the categorisation is not a hard and fast line drawn between a water delivery system and size of community. It is possible, and is in practice, for relatively small communities near urban areas to enjoy urban water supply facilities.

The second caveat is that the categorisation does not, by any means, preclude other technologies such as rainwater harvesting, spring protection and gravity systems. These systems are developed when feasible. And, together with the wells, boreholes and piped systems are contributing immensely towards the provision of safe water as well as the elimination of infestations such as the guinea worm from our rural communities. In addition, one cannot ignore the important role which very simple technologies like improvised filters in the form of cloth, etc. are playing in making water pure.

For the development of structured systems of water supply for mass communities in rural environments in Ghana, the first issue for analysis and discussion is the institutional framework.

3. THE INSTITUTIONAL FRAMEWORK FOR STRUCTURED SYSTEMS OF WATER SUPPLY IN GHANA

The Ghana Water and Sewerage Corporation is responsible for all water supply problems in the country and operates under the umbrella of the Ministry of Works and Housing. The Ministry provides policy guidelines to the board of directors of the Corporation. At the same time, the Corporation is guided by the State Enterprises Commission in its commercial performance, corporate planning and target setting. The Corporation in fact signs a performance contract with the State Enterprises Commission. The Ministry of Finance and Economic Planning provides the funds for development through the Ministry of Works and Housing.

The Corporation has a Rural Water Supply Department which has been the subject of recent discussion. Concern has been expressed about the weakness of this department in promoting the development of rural water supply. Restructuring of the Rural Water Supply Department has been called for, among other things, to assume responsibility for supervising community management of rural water supply and sanitation. Henceforth, the scope of operation of the Department will be tailored to meet the needs of community management.

The activities of the department call for association with other agencies in order to achieve results. Government is pursuing a policy of decentralisation with one hundred and ten (110) district assemblies formed under the Ministry of Local Government. The Rural Water Supply Department of GWSC works through the Assemblies to get to the communities. The Assemblies have infra-structural committees on which the corporation is represented. Water and Sanitation sub-committees are formed from which district extension officers will promote activities of the sector. Thus the institutional framework of the rural water supply and sanitation body at the national level is where policy guidelines are provided and funds mobilised and channelled. At the regional level, some planning is done, funds distributed to districts, and district projects supervised. At the district level, the activities fuse into those of the district assembly. Project implementation in the district is by local contractors selected and managed by the district assemblies but supervised by the regional team of the Corporation. Hitherto, most district projects have been undertaken by direct labour. For instance, hand dug wells are being constructed by the communities themselves, assisted and supervised by GWSC engineers and well sinkers. Now, local contractors will be trained to do this. But in order not to lose the factor of community participation, it is proposed that the communities will sink the well up to a fixed depth, say five metres before the contractors continue it to completion.

The Department of Community Development of the Ministry of Local Government and the Environmental Health Division of the Ministry of Health have been providing inputs in the form of community animation and health education. Other organisations, like the National Council for Women and Development, the 31st December Women's Movement and the National Service Secretariat are all represented on planning committees, such as Central Coordinating Committees and Regional Coordinating Committees for programme implementation.

4. TECHNOLOGY AND EQUIPMENT

4.1. General

A government minister once lashed out at Water Supply Engineers: "Why do you people sit down, allow the rain to fall on the roofs and hills, run down the slopes to the valleys before you rise from your slumber to go and pump back the same water at great cost to the nation?" He was right in some way. Simple technologies such as rain catchment, and gravity systems are sometimes forgotten in favour of conventional technologies. In fact many young engineers think that there is little or no engineering practice in hand dug well construction. This makes rural water supply not attractive to such engineers because they think they have no room for training. But this is far from the truth. As Peter Banks, writing on Rural Water Supply and Sanitation argues, "the engineers, in dealing with projects for rural areas anywhere, will be reliant upon first principles, apparently outmoded technology in the main, and techniques that have in most instances long since ceased to be taught" (Dangerfield, B.J. 1983, p. 240). This is carried further by M.B. Pescod who, in an article on Low Cost Technology, produces an algorithm (Cf. Fig. 1) which may be a useful guide for young engineers in the selection of an appropriate source for utilisation in rural water supply (Dangerfield, op.cit., p. 266).

4.2 GRAVITY SYSTEMS

The preferred source will be one which requires no treatment and which can be delivered to the user by gravity, such as springs or surface source with an unpolluted and protected catchment. The case of Malawi is notable where such gravity systems of water supply have successfully been used to serve many villages at least cost. Two such systems exist in the hilly areas of the Volta Region in Ghana.

In rain water catchment, the problem to contend with is storage cisterns. Since there may be long months of dry season, sufficient water must be stored from the rains to last for the dry season and the cost of storage tanks may be high. Low cost technologies employ Ferro-cement tanks built of chicken wire and cement mortar and similar alternatives. A 5000 gallons (22 cubic meters) tank has been built at a cost of 550000 cedis (US $1375) in a typical rain catchment system in Ghana. This could serve a family or two of twelve persons through a three-month period of draught. The cost per head is about $115. It is however almost maintenance-free. This is to be compared with a borehole and hand pump which has an initial cost of around $42 per head. The other problem with harnessing rain water for community water supply is to be able to find sufficient roof area with good roofing material for common use by the community without legal problems.

4.3. Surface Water

The need for sophisticated technology in water treatment and O and M cost of pumping, makes surface water systems not the favourite choice for rural water supply. However, it cannot be avoided in some cases. In Northern Ghana, there are areas where dug-outs and small dams providing impoundments are the only feasible means of finding water both for human consumption and animal watering. In this case one may look at a system of infiltration gallery leading to a shallow well as a means of filtration for small communities. In other cases, treatment by the use of horizontal flow roughing filter and show sand filter may be considered.

In the Northern Region of Ghana, CIDA, in cooperation with the Ghana Water and Sewerage Corporation is conducting pilot studies towards extensive use of the horizontal flow roughing filter coupled with the slow sand filter. An interesting case was reported when the local stones used to fill the roughing filter were found to add colour to the water, thereby making the end product more coloured than the original raw water.

Another such plant has been built at Mafi Kumasi in the Volta Region of Ghana for a village of population around 5000. The Scheme was initiated and built purely by the community without Government support except some assistance from a charitable organisation in Switzerland. The plant is being run by the community. The initial cost was quoted at Us $ 530,000 or $106 per head.

4.4 Underground Water

Rural Water Supply from underground sources is quite popular and is well known to many. The use of boreholes or shallow wells to abstract the water is quite straightforward and hand pumps may be seen dotted about in many villages in Ghana. The problem is with the maintenance of these scattered point sources of water supply.

5. EQUIPMENT

The choice of technology must be guided by the type of equipment required and the cost of maintenance. The type of construction equipment normally required in rural water supply projects may be simple digging tools (pickaxes, shovels, head pans, ropes, buckets etc). But more sophisticated equipment such as air compressors, dewatering pumps, drilling rigs and vehicles are often required. To date, all these equipment have been owned and supplied by GWSC. The Corporation also has a drilling unit which owns seven rotary drilling rigs (three are defective now), accessories and supporting vehicles. They were acquired through support from ESAs. Under the restructuring, the drilling unit is to be privatised. The other construction equipment may be pooled into district plant pools from where local contractors may hire equipment.

Attempts at standardising on hand pumps are still going on but with some difficulty. Hand pump testing has been going on since 1974. Before the axe of standardisation could fall on the India Mark II pump which is in the widest use, the philosophy of VLOM (Village Level Operation and Management of Maintenance) came in and less robust but pumps simpler to maintain have increased the competition. Presently, the modified India Mark II hand pump with lightweight stainless steel riser pipes and rods and direct action Nira pump have been recommended for standardisation.

The Vergnet foot pump is also being used on a pilot project as well as the Afridev pump. Attempts at local manufacture of hand pumps are being pursued. The difficulties are that:

(a) Entrepreneurs need assurance of the market for pumps but funds for procurement come from ESAs. This is difficult to programme.

(b) For many pumps, the fast running spare parts can hardly be produced locally. Such items include ball bearings, chain, quality cup leather etc.

(c) The process of standardisation of pumps in still inconclusive.

6. FINANCING, MAINTENANCE AND RENEWAL

To touch on financing and maintenance of rural water supply systems, it may be pertinent to give the story of achievements in the sector so far.

From 1974 to 1978, a massive drilling programme financed by Canadian International Development Agency (CIDA), resulted in the provision of 2700 boreholes fitted with hand pumps in the Upper East and Upper West regions of the country. From 1979 to 1984, 3200 similar facilities were provided for seven of the eight remaining regions in Central and Southern Ghana. The funding agency was KFW of Germany. Both CIDA and KFW have since provided grant in the form of technical assistance to set up maintenance units for the pumps. Loans have also been given to the Government for the procurement of spare parts. GWSC assumes responsibility for all these hand pumps including more being provided by assistance from other ESAs (Japanese, French, UNICEF and others). 1400 boreholes fitted with hand pumps have also been provided by NGOs (Catholic and Presbyterian Churches, World Vision International and others). The NGOs bear responsibility for maintenance of their pumps but have indicated that they will hand them over to GWSC at a future date. The GWSC coordinates the activities of all NGOs through meetings and by the help of guidelines.

Presently, the organisation of maintenance consists of district maintenance centres from where GWSC's mechanics perform both routine maintenance and repairs of broken-down pumps. Beneficiary communities are expected to pay monthly tariff which started as 500 cedis per hand pump per month in 1985 but has gradually increased to 161 cedis per household per month. Collection of the tariff has been difficult and may be blamed on inadequate education and involvement of the communities at the start of the projects. Even in the CIDA-sponsored programme where a comprehensive "Water Utilisation Programme" has been going on since 1984, tariff collection still ranks about 70% of billing with old arrears outstanding. The situation in the 3000 wells KFW-financed programme was made worse by rapid deterioration of water quality due to extensive corrosion of galvanised iron rising mains. They have since been replaced with lightweight stainless steel pipes and rods.

Financing continues to depend heavily on ESA support with Government providing local funding.

7. COST RECOVERY

During the decade, a total of $ 255 million of external finding was mobilised for rural water supply, with Government providing 693 million cedis of local funding. In line with recommendation for restructuring of the sub-sector, the cost of planning and constructing rural water supplies would be shared by the communities (10%), Government (15%) and external financing agencies (75%), with community and ESAs paying the capital costs and the Government paying the operational costs of the RWS/S Units.

Two types of cost recovery may be identified:

(i) Recovery of capital cost, and
(ii) Recovery of recurrent cost.

Capital cost depends upon the type of pumps used.

Recurent cost depends to some extent on the type of maintenance system adopted. The idea of VLOM is aimed at achieving reduction of recurrent cost or at least to substitute some cash with voluntary labour. The annual cost of water production of a hand pumped community water supply has been computed as DM 1.13/m^3 based on a life of twenty years for the hand pump at a discount rate of 7.5% (GWSC Maintenance Unit, 1991 B, p. J-2). A revised estimate based on 5% discount rate is given in Table 2.

The median recurrent cost per thousand gallons of water produced to serve population range 1-1000 is estimated at US $0.843 (DM 0.34/$m^3$)(Saunders et al). The recurrent cost obtained from Table 2 is DM.11/m3. If capital cost is included the cost is DM.92/m3. Taken that there are 10 persons to a household and hence 30 households to a hand pump, the cost of water per household is DM 5.52 or DM .66 per month depending upon whether cost recovery includes capital cost or not. An average farmer producing five bags of millet could be earning about 20,000 cedis (DM 111) per annum (World Water, 1988). I would estimate the average annual earning of the farmer at 120000 cedis (DM 500).If he should be paying the full cost of water to the household, he could be spending 13.2% or 1.6% of his income, depending upon whether capital cost is included or not. In practice, there could be more than one income earner per household, thereby reducing the burden. The World Bank's recommendation is that tariff should not exceed 5% of income. Hence, full recovery of at least recurrent cost is possible in theory.

8. TARIFF AND WILLINGNESS TO PAY

Tariff collection has certainly been a problem. Many cost-saving steps have been taken to reduce cost of collection and to induce villagers to pay willingly. These include using maintenance mechanics as collectors and the offer of 2% rebate to villagers who willingly bring collection to the office. Table 1 shows the performance of tariff collection on the 3000 Wells Programme from 1985 to 1989. Table 5 is an income statement.

Although the tariff appears minimal from economic considerations, many complaints have come from the village communities concerning affordability. It is obvious that further increase of tariff would not be advisable in the near future, although costs are still rising (World Water, 1988). Worse still, the huge arrears standing in the consumer accounts are of much concern. Many of the villagers complain that they become scared by the magnitude of the arrears, but they could pay current bills if the arrears were written off. The causes of unwillingness on the part of villagers to pay their water tariff may therefore be attributed to the following:

(i) Insufficient and unconvincing animation at the start of the project;

(ii) Deterioration of water quality due to corrosion of galvanised iron pipes;

(iii) Inaccurate billing by the Organisation. At the start, some consumers were backdated in bills before they received notice of the introduction of tariff. Some brokendown hand pumps also continue to be included in bills;

(iv) Villagers, being farmers, receive their income mainly in the harvesting season but the organisation failed sometimes to take advantage of this period to collect tariff.

9. VLOM AND COST RECOVERY

The concept of village level operation and management of maintenance (VLOM) is considered to be a solution to the difficult task of collection of tariff. However, it does not absolve the village from raising funds towards the maintenance of the hand pump. The village needs to be organised to build up funds for the following:

(i) Purchase of spare parts
(ii) Replacement of the hand pump.
(iii) Incidental expenses.

In addition, government may have to take up the following responsibilities, otherwise the village will have to bear them:

(i) Recurrent cost of maintaining an institutional back up service; and,
(ii) Cost of maintenance of the boreholes.

The World Bank estimates that the cost of servicing VLOM hand pumps should be as low as US $0.05 -0.10 per user per year, or approximately one tenth of the cost range for conventional deep well hand pumps (IRC, 1987). However, it is not certain whether the estimates take into consideration well maintenance and any backup service. Evaluation reports on the operation of VLOM from some countries, including Niger, point to the need for a backup service. This view is echoed by Dangerfield (op. cit., p. 244). In a survey conducted in two regions of Ghana for the purpose of setting up pilot systems of maintenance by VLOM, one region opted rather reluctantly for VLOM whereas the other rejected the proposal, placing value on their time for farming and preferring to pay for the water organisation to do the maintenance (GWSC Maintenance Unit, 1991 A, P. L-5)). However, with more education, it may be possible to convince the villagers to accept to take care of their own pumps. The conviction must include concrete and positive examples of success of the VLOM system.

The crucial issue is the ability of the village to build up funds. As it may be difficult for some users to find the necessary funds as and when they are needed, which can lead to conflict, it is necessary to build up a reserve or revolving fund by asking each household to contribute a calculated amount regularly (monthly, quaterly, or each harvest time). This time, the determination of the contribution and the collection is in the hands of the villagers themselves. An essential precaution to be taken is proper accounting. This is necessary, for, it will:

(i) protect the treasurer against suspicion of mishandling of funds;

(ii) enhance credibility between users and the water committee;

(iii) give the correct picture whenever it becomes necessary to adjust contributions; and,

(iv) build up funds for additional development activities within the community.

10. CONCLUSION

The success and the sustainability of rural water supply systems as a whole are tied up with effective arrangements for management and cost recovery.

The system of hand pump maintenance by a central organisation is usually viewed as costly. Also cost recovery through collection of tariff is ineffective. Willingness of villagers to pay tariff is low. Therefore while intensifying community awareness through animation, the approach should lean towards the implementation of VLOM.

It is clear from the cost analysis that hand pumped water supply and other systems in general cannot be made affordable to the rural population unless Governments and ESAs bear some of the burden. Capital cost should be borne by Government and ESAs. Maintenance cost, including cost of spare parts can be borne by the village but Government must maintain a back-up institution whose functions should include the maintenance of boreholes.

Our rural communities need safe water just as their urban contemporaries enjoy. And, the earlier structured systems are developed to meet this need, the more we can expect higher quality life for such communities in the 1990s.

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TABLE 1 - PAYMENT OF REVENUE - 3000 WELL PROGRAMME

Regions	Pumps	85/II 2.Half	86/I 1.Half	86/II 2.Half	87/II 1.Half	87/II 2.Half	88/1 1.Half	88/II 2.Half	89/1 1.Half	Total
Ashansi 1)	1280	344,879	1,460.174	2,120,000	4,032,000	1,009,000	4,268,000	3,953,495	7,900,000	25,087,558
-per pump		269	1,141	1,656	3,150	788	3,334	3,089	6,172	19,599
Brong-Ahafo	180	349,700	315,500	338,273	1,318,752	824,400	413,273	1,456,633	1,928,530	6,945,061
- per pump 4)	100	3,497	3,155	3,383	13,188	8,244	4,133	8,092	10,714	54,406
Central 2)	280	17,018	78,240	175,692	939,128	486,610	486,396	189,465	294,400	2,666,949
-per pump		61	279	627	3,354	1,738	1,737	677	1,051	9,524
Eastern	560	17,319	17,319	767,836	1,314,606	581,557	883,493	728,454	2,625,620	6,936,204
-per pump		31	31	1,371	2,348	1,038	1,578	1,301	4,689	12,387
Volta	340	44,800	60,530	115,450	320,900	217,140	577,160	749,259	1,472,770	3,566,009
- per pump		132	178	340	967	639	1,698	2,204	4,332	10,490
Western 3)	560	5,000	120,914	608,013	1,122,149	763,117	561,010	435,060	1,949,370	5,564,633
-per pump		9	216	1,086	2,004	1,363	1,002	777	3,481	9,938
Total	3200	778,716	2,052,677	4,125,264	9,055,535	3,881,824	7,189,332	7,512,366	16,170,690	50,766,404
Cedis/pump		251	662	1,331	2,921	1,252	2,319	2,348	5,053	16,138
Working Pumps		90%	75%	60%	50%	45%	40%	40%	50%	

1) With Sefwi Wiawso and Dunkwa Districts
2) Without Dunkwa District
3) Without Sefwi Wiawso District
4) For the 100 wells, from 88/II for 180 wells

* By courtesy of 3000 wells mce unit. CWSC.

Table 2

COST OF WATER PRODUCTION

ITEM	DESCRIPTION	FIRST COST DM	LIFE YRS	ANNUAL COST @ 5% DISCOUNT
1.	Cost of 4" borehole 40m depth	16,000	20	1283.20
2.	Add 20% for dry/low yield wells	3,200	20	256.64
3.	Annual cost of hand pump and spares (see table 3)	-	-	185.9
4.	Installation of hand pump	200	20	16.04
5.	Unforeseen expenses (5%)	1060	20	85.01
6.	Annual recurrent cost of hand pump maintenance	-	1	100.00
7.	Annual cost of well maintenance	-	1	80.00
8.	Total			2006.79
	Assuming 300 persons to a hand pump and a consumption of 20 l/cl/d, Cost of water production in DM/m³		=	0.92

If capital cost is disregarded, the cost is as follows:

1.	Annual cost of hand pump Spares (See table 3)	53.1
2.	Annual cost of hand pump maintenance	100.00
3.	Annual cost of well maintenance	80.00
	Total	233.1
	Assuming 300 per persons to a hand pump and a consumption of 20 ll/c/d, Cost of water production in Dm/m³	0.11

Table 3

COSTS IN DM FOR INDIA MKII HAND PUMPS PER ANNUM BASIS MAY, 1989, AT 5.0% INTEREST RATE
Pump design for very aggressive well water (stainless steel pipes + rods)
Conversion Head modified with Flange Bearings

Description / Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Upper pump part	450.0)										360.0	(without pedestal)								
Clay. Mark cylinder	180.0)	First Cost DM 1720									180.0									
7 Atlas Copco pipes	760.0)																			
7 Atlas Copco rods	315.0)																			
6 Fixed rod guides	15.0)					15.0					15.0					15.0				
1 Stainl. Steel rod											45.0									
1 Stainl. steel pipe											100.0									
1 Set bearings						60.0										60.0				
1 Set cup washers						5.0										5.0				
1 chain + bolt						12.0										12.0				
Cylinder 1.0%	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Pump head 1.0%	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Consumables, others	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Initial spares with a value of 10% of the first cost and a salvage value of 20% of the first cost

Annual costs	DM 1728.8	8.8	8.8	8.8	8.8	57.8	8.8	8.8	8.8	8.8	622.8	8.8	8.8	8.8	8.8	57.8	8.8	8.8	8.8	8.8
Initial spares	DM 172.0																			
Salvage value	DM 344.0																			
Present day	DM 1900.8	8.4	8.0	7.6	7.2	45.3	6.6	6.3	6.0	5.7	382.3	5.1	4.9	4.7	4.4	27.8	4.0	3.8	3.7	- 126.2
Sum present day	DM 2316.4																			
Total annual	DM 185.9																			

Table 4

RECURRENT COSTS IN DM FOR INDIA MKII HAND PUMPS PER ANNUM BASIS MAY, 1989, AT 5.0% INTEREST RATE Pump design for very agressive well water (stainless steel pipes + rods)
Conversion Head modified with Flange Bearings

Description / Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Upper pump part	450.0)										360.0	(without pedestal)								
Clay. Mark cylinder	180.0)	First Cost DM 1720									180.0									
7 Atlas Copco pipes	760.0)																			
7 Atlas Copco rods	315.0)																			
6 Fixed rod guides	15.0)					15.0					15.0					15.0				
1 Stainl. Steel rod											45.0									
1 Stainl. steel pipe											100.0									
1 Set bearings						60.0										60.0				
1 Set cup washers						5.0										5.0				
1 chain + bolt						12.0										12.0				
Cylinder 1.0%	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Pump head 1.0%	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	1.5
Consumables, others	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Initial spares with a value of 10% of the first cost and a salvage value of 20% of the first cost

Description / Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Annual costs DM	8.8	8.8	8.8	8.8	8.8	100.8	8.8	8.8	8.8	8.8	708.8	8.8	8.8	8.8	8.8	100.8	8.8	8.8	8.8	8.8
Initial spares DM	.0																			
Salvage value DM	.0																			
Present day DM	8.8	8.4	8.0	7.6	7.2	79.0	6.6	6.3	6.0	5.7	435.1	5.1	4.9	4.7	4.4	48.5	4.0	3.8	3.7	3.5
Sum present day DM	661.2																			
Total annual DM	53.1																			

* By courtesy of 3000 wells mce unit GWSC.

Table 5

INCOME STATEMENT

Year	185/II 2.Half	186/I 1.Half	186/II 2.Half	187/II 1.Half	187/II 2.Half	188/1 1.Half	188/II 2.Half	189/I 1.Half
Exch. rate cedis/DM	92	92	170	170	170	180	180	180
Tariff cedis/P/m/.	500	500	1200	1200	1440	1800	1800	2160
No. of pumps working	2880	2400	1920	1600	1440	1280	1280	1600
Billing/receivable x 1000 cedis	8640	7200	13824	11520	12442	13824	13824	20736
Collection Cost x 1000 cedis	30881	25774	38042	31702	28531	26853	26853	33566
Collection as % of billing	9	28.5	29.8	78.6	31.2	52	54.3	78
Cross subsidy x 1000 cedis	30103	23721	38917	22646	24649	19663	19341	17395